Table of contents

Author speaker is underlined.

Tuesday 24 april 2012 - Friday 27 april 2012

EN - Environmental noise (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

HS - Hearing and speech (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

MA - Musical acoustics (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

MI - Measurement and instrumentation (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

NV - Noise and vibration engineering (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

PU - Physical acoustics and underwater acoustics (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

PU-S01: Non linear acoustic phenomena (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

PU-S03: Phononic crystal and metamaterials (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

PU-S04: Non destructive testing and evaluation (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

PU-S08: Bones and ultrasound (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

PU-S09: Biomedical and biological ultrasounds (Poster session)

Room: Grande Halle

Tuesday 24 april 2012 - Friday 27 april 2012

SP - Sound perception (Poster session)

Room: Grande Halle

Tuesday 24 april 2012

Keynote lecture: Pr. Daniel Juvé

Room: Lord RAYLEIGH
Chair Person (s): P. Lafon

Tuesday 24 april 2012

Keynote lecture: Pr. Yiu Wai Lam

Room: Paul LANGEVIN
Chair Person (s): W. Davies

Tuesday 24 april 2012

EN-S05: Wind turbine noise

Room: Ray STEPHENS
Chair Person (s): D. Ecotiere

Tuesday 24 april 2012

MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Room: Pierre CHAVASSE
Chair Person (s): S. Dos Santos, B. Drinkwater

Tuesday 24 april 2012

NV-S11: Numerical methods in vibroacoustics

Room: Paul LANGEVIN
Chair Person (s): C. Pezerat

Tuesday 24 april 2012

PU-S11: Geophysics and seismics

Room: François CANAC
Chair Person (s): P. Roux, S. Catheline

Tuesday 24 april 2012

SP-S02: Sound spatialisation: from the transducer to the listener

Room: Peter BARNETT
Chair Person (s): R. Nicol, A. Tew

Tuesday 24 april 2012

NV-S08: Passive control in vibroacoustics

Room: Yves ROCARD
Chair Person (s): N. Dauchez, K. Horoshenkov

Tuesday 24 april 2012

EN-S06: Manufactured noise reducing devices (noise barriers)

Room: Ray STEPHENS
Chair Person (s): J. Defrance, R. Kirby

Tuesday 24 april 2012

AA-S06: Computational room acoustics

Room: Philip DOAK
Chair Person (s): I. Schmich, M. Hodgson

Tuesday 24 april 2012

AH-S05: Numerical methods in aeroacoustics

Room: Ray STEPHENS
Chair Person (s): X. Gloerfelt, G. Gabard

Tuesday 24 april 2012

MA-S06: Nonlinear aspects of musical instruments

Room: John TYNDALL
Chair Person (s): T. Hélie, S. Bilbao

Tuesday 24 april 2012

MI-S05: Inversion methods for acoustic imaging

Room: Pierre CHAVASSE
Chair Person (s): J. Idier, F. Fazi

Tuesday 24 april 2012

PU-S01: Non linear acoustic phenomena

Room: Paul LANGEVIN

Chair Person (s): O. Bou Matar, R. Cleveland

Tuesday 24 april 2012

PU-S12: Ultrasound and lasers

Room: François CANAC
Chair Person (s): B. Audoin

Tuesday 24 april 2012

MI-S04: Wave propagation in heterogeneous media: modeling and simulation
Room: Yves ROCARD
Chair Person (s): S. Naili, V.-H. Nguyen, W. Parnell

Tuesday 24 april 2012

EN-S08: Engineering models for noise mapping

Room: Philip DOAK
Chair Person (s): G. Dutilleux

Tuesday 24 april 2012

MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

Room: Pierre CHAVASSE
Chair Person (s): S. Dos Santos, V. Gibiat

Tuesday 24 april 2012

AA-G01: Room acoustics

Room: Philip DOAK
Chair Person (s): I. Schmich, M. Hodgson

Tuesday 24 april 2012

MA-G01: Musical acoustics

Room: John TYNDALL
Chair Person (s): C. Vergez, D. Sharp

Tuesday 24 april 2012

PU-G01: Physical acoustics

Room: Lord RAYLEIGH
Chair Person (s): C. Potel, O. Poncelet, N. Wilkie-Chancellier

Tuesday 24 april 2012

SP-G01: Sound perception

Room: Peter BARNETT
Chair Person (s): R. Nicol, S. Meunier, P. Susini

Wednesday 25 april 2012

Keynote lecture: Dr. Carl Hopkins

Room: Paul LANGEVIN
Chair Person (s): Y.W. Lam

Wednesday 25 april 2012

Keynote: Pr. Daniel Pressnitzer

Room: Lord RAYLEIGH
Chair Person (s): R. Nicol

Wednesday 25 april 2012

AH-S01: Wall pressure fluctuations

Room: Philip DOAK
Chair Person (s): D. Ricot

Wednesday 25 april 2012

EN-S02: Transportation and industrial noise

Room: Ray STEPHENS
Chair Person (s): J. Lelong, R. Mackenzie

Wednesday 25 april 2012

MA-S03: Interaction between a musician and his/her instrument

Room: John TYNDALL
Chair Person (s): J.-L. Le Carrou, B. Richardson

Wednesday 25 april 2012

MA-S09: Measurement techniques for studying musical instruments and speech (co-organised with 'Hearing and Speech')

Room: Peter BARNETT
Chair Person (s): C. Vergez, D. Sharp

Wednesday 25 april 2012

MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Room: Pierre CHAVASSE
Chair Person (s): S. Naili, V.-H. Nguyen, W. Parnell

Wednesday 25 april 2012

NV-S09: Acoustic holography

Room: Yves ROCARD
Chair Person (s): J.-H. Thomas

Wednesday 25 april 2012

PU-S06: Ultrasonic imaging

Room: Paul LANGEVIN
Chair Person (s): M. Tanter

Wednesday 25 april 2012

PU-S10: Health assessment of natural media and food

Room: Lord RAYLEIGH
Chair Person (s): E. Leclezio

Wednesday 25 april 2012

PU-S12: Ultrasound and lasers

Room: François CANAC
Chair Person (s): B. Audoin

Wednesday 25 april 2012

MA-S02: Transients in self-sustained musical instruments

Room: John TYNDALL
Chair Person (s): A. Almeida

Wednesday 25 april 2012

PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Room: Lord RAYLEIGH
Chair Person (s): J.-P. Groby, C. Glorieux, K. Horoshenkov, O. Umnova

14:20 **Phase velocity and attenuation of leaky interface waves at the fluid/porous-medium interface** 197
K. Van Dalen, G. Drijkoningen and D. Smeulders

14:40 **Wave propagation in Porous Piezoelectric Layer immersed in fluid** 197
P. Khurana and C. Glorieux

15:00 **Ultrasonic investigation on water-saturated porous scatterers under different boundary conditions** 197
S. Derible and H. Franklin

15:20 **Biot-JKD model: simulation of 1D transient poroelastic waves** 198
E. Blanc, G. Chiavassa and B. Lombard

15:40 **Parametric study of a metaporous made of solid inclusions embedded in a rigid frame porous material** 198
C. Lagarrigue, O. Dazel, J.-P. Groby and V. Tournat

16:40 **On the use of periodic inclusions embedded in porous lining to enhanced attenuation in waveguides** 198
B. Nennig, Y. Renou and Y. Aurégan

17:00 **Enhancement of the absorption of a backed rigid frame porous layer using a 2-dimensional periodic multi-irregularities rigid backing** 199
B. Brouard, J.-P. Groby, O. Dazel, B. Nennig and L. Kelders

17:20 **Acoustical properties of macroscopically inhomogeneous porous medium** 199
K. V. Horoshenkov, S. Masaharanon, K. Khan, A. Geslain, J.-P. Groby and O. Dazel

17:40 **A semi-empirical model to predict the acoustic behaviour of fully and partially reticulated polyurethane foams based on microstructure properties** 199
O. Doutres and N. Atalla

18:00 **Inverse method for porous material characterization using the constraint satisfaction problem approach** 200
N. Dauchez and P.-A. Yvars

18:20 **Estimation of acoustic and elastic properties of plastic foam using acoustic-to-frame coupling** 200
H.-C. Shin, S. Taherzadeh and K. Attenborough

18:40 **A direct link between microstructure and acoustical macro-behaviour of real double porosity foams** 200
F. Chevillotte, C. Perrot, L. Jaouen, F.-X. Bécot, E. Guillon and G. Houvenaghel

Wednesday 25 april 2012

NV-S02: Acoustic black hole and applications

Room: Yves ROCARD
Chair Person (s): F. Gautier, V. Krylov

13:20 **Potentialities of the acoustic black hole effect for damping plate vibrations** 201
A. Pelat, J. Cuenca, F. Gautier and L. Barguet

13:40 **Analytical solution of parabolically tapered rod flexural vibration equation** 201
M. Mironov

14:00 **Improving the acoustic black hole effect for vibration damping in one-dimensional structures** 202
J. Cuenca, A. Pelat, F. Gautier and N. S. Ferguson

14:20 **Damping of flexural vibrations in rectangular plates by slots of power-law profile** 202
E. P. Bowyer, V. V. Krylov and D. J. O'Boy

Wednesday 25 april 2012

SP-S01: Soundscape

Room: Peter BARNETT
Chair Person (s): C. Lavandier, W. Davies

Wednesday 25 april 2012

MA-S07: Physical modelling of brass/reed instruments and human voice (co-organised with 'Hearing and Speech')

Room: John TYNDALL
Chair Person (s): X. Pelorson

Wednesday 25 april 2012

AA-S07: Variable room acoustics - Diffusion

Room: François CANAC
Chair Person (s): I. Schmich, M. Hodgson

14:40	**Scattering sound field prediction over periodic facing walls containing rectangular cavities** A. Khanfir, A. Faiz, J. Ducourneau and J. Chatillon	213
15:00	**Ray-tracing modelling of the diffraction by half-planes and slits based on the energy flow lines concept** A. Billon and J.-J. Embrechts	214
15:20	**Measurement of sound diffusion coefficients of scattering furnishing volumes present in workplaces** A. Faiz, J. Ducourneau, A. Khanfir and J. Chatillon	214
15:40	**Searching for a theoretical relation between reverberation and the scattering coefficients of surfaces in a room** J.-J. Embrechts	214

Wednesday 25 april 2012

PU-S05: Structural health monitoring

Room: Paul LANGEVIN
Chair Person (s): R. El Guerjouma

16:40	**Structural health monitoring using acoustic pressure response** V. Arora, Y.H. Wijnant and A.D. Boer	215
17:00	**Damping analysis in flexural vibration of sandwich beams with debonding** I.M. Moustapha, A. El Mahi, R. El Guerjouma and O. Dazel	215
17:20	**Hilbert-Huang Transform versus Fourier based analysis for diffused ultrasonic waves structural health monitoring in polymer based composite materials** S.E. Hamdi, A. Le Duff, G. Plantier, L. Simon, R. El Guerjouma and M.H. Ben Ghozlen	216
17:40	**Interaction of fundamental Lamb modes with a point impact damaged zone in composite plates** D. Singh, R. El Guerjouma and M. Bentahar	216
18:00	**Carbon nanotubes and graphene-based microsonar for embedded monitoring of microporosity** B. Lebental, N. Sridi, F. Bouanis, C.-S. Cojocaru, F. Bourquin and A. Ghis	216
18:20	**Creep-rupture prediction by naive bayes classifiers** M. Darwiche, G. Bousaleh, M. Feuilloy, D. Schang and R. El Guerjouma	217
18:40	**Non Destructive Evaluation and Structural Health Monitoring of structural materials by means of nonlinear acoustics and acoustic emission** R. El Guerjouma, M. Bentahar, J.-H. Thomas and A. El Mahi	217

Wednesday 25 april 2012

AA-S01: Acoustics of offices

Room: François CANAC
Chair Person (s): Y. Le Muet

17:00	**Acoustic of open spaces - Overview of standardization work** Y. Le Muet	217
17:20	**Efficiency of an acoustic table screen between two work stations in open plan offices** I. Schmich, C. Rougier, P. Jean and P. Chevret	218
17:40	**Objective and subjective assessment of disturbance by office noise - Relevance of the use of the speech transmission index** A. Ebissou, P. Chevret and E. Parizet	218

Wednesday 25 april 2012

NV-S07: Mid-Frequency

Room: Yves ROCARD
Chair Person (s): J.-L. Guyader, R.S. Langley

Wednesday 25 april 2012

MI-G01: Measurement and instrumentation

Room: Pierre CHAVASSE
Chair Person (s): A. Le Duff, J. Shelton

Wednesday 25 april 2012

AB-G01: Animal bioacoustics

Room: Ray STEPHENS
Chair Person (s): T. Aubin, P. Lepper

Wednesday 25 april 2012

AH-G01: Aeroacoutics

Room: Philip DOAK
Chair Person (s): C. Bailly

Wednesday 25 april 2012

AB-G01: Animal bioacoustics

Room: Ray STEPHENS
Chair Person (s): G. Alcuri, G. Dutilleux

Thursday 26 april 2012

Keynote lecture: Dr. Marc Deschamps

Room: Lord RAYLEIGH
Chair Person (s): P. Lasaygues

Thursday 26 april 2012

Keynote lecture: Pr. Stuart Bolton

Room: Paul LANGEVIN
Chair Person (s): M. Smith

Thursday 26 april 2012

Invited Conference and Concert: Pr. Barry Truax

Room: Lord RAYLEIGH
Chair Person (s): C. Lavandier

Thursday 26 april 2012

AH-S06: Thermoacoustic refrigerators

Room: Peter BARNETT
Chair Person (s): D. Marx, A. Morgans

Thursday 26 april 2012

EA-S05: Electroacoustics for room acoustics

Room: Ray STEPHENS
Chair Person (s): X. Meynial, E. Start, V. Adam

Thursday 26 april 2012

MA-S05: Instrument making and acoustics

Room: John TYNDALL
Chair Person (s): J. Gilbert, A. Mamou-Mani

Thursday 26 april 2012

MI-S03: Signal processing

Room: Pierre CHAVASSE
Chair Person (s): J.-M. Girault

Thursday 26 april 2012

NV-S01: Smart vibroacoustics

Room: Yves ROCARD
Chair Person (s): M. Ouisse, F. Scarpa

Thursday 26 april 2012

PU-S04: Non destructive testing and evaluation

Room: Paul LANGEVIN
Chair Person (s): C. Potel, S. Dixon

Thursday 26 april 2012

PU-S07: Therapeutic ultrasound

Room: Lord RAYLEIGH
Chair Person (s): C. Lafon, R. Cleveland

Thursday 26 april 2012

EA-S06: Miniature transducers (MEMS loudspeakers, digital loudspeakers, hearing aids technologies...)

Room: Ray STEPHENS
Chair Person (s): S. Durand, R. Barham

Thursday 26 april 2012

AA-S02: Practical aspects of room or building acoustics (feedback, regulatory aspects...)

Room: François CANAC
Chair Person (s): M. Asselineau

Thursday 26 april 2012

EN-S01: Outdoor sound propagation: meteorological and ground effects, uncertainties, numerical or experimental aspects

Room: Philip DOAK
Chair Person (s): P. Blanc-Benon, K. Attenborough

Thursday 26 april 2012

PU-S13: Sensors, transducers and acoustics microsystems

Room: Ray STEPHENS
Chair Person (s): G. Feuillard

Thursday 26 april 2012

PU-S08: Bones and ultrasound

Room: Lord RAYLEIGH
Chair Person (s): P. Lasaygues, K. Raum, M. Muller

Thursday 26 april 2012

AH-S04: Impedance conditions with flow

Room: Peter BARNETT
Chair Person (s): P. Lafon

Thursday 26 april 2012

NV-S04: Structure-borne noise source identification

Room: Yves ROCARD
Chair Person (s): C. Pezerat, F. Fazi

Thursday 26 april 2012

PU-S03: Phononic crystal and metamaterials

Room: François CANAC
Chair Person (s): B. Morvan, O. Poncelet, D. Elford

Thursday 26 april 2012

AA-G02: Building acoustics

Room: Philip DOAK
Chair Person (s): M. Asselineau

Thursday 26 april 2012

PU-G02: Underwater acoustics

Room: François CANAC
Chair Person (s): J.-P. Sessarego, N. Chotiros

Thursday 26 april 2012

NV-G01: Noise and vibration engineering

Room: Yves ROCARD
Chair Person (s): C. Pezerat, M. Smith

Friday 27 april 2012

Keynote lecture: Pr. Robin Cleveland

Room: Paul LANGEVIN
Chair Person (s): V. Humphrey

Friday 27 april 2012

Keynote: Pr. Murray Campbell

Room: Lord RAYLEIGH
Chair Person (s): C. Vergez

Friday 27 april 2012

AA-S04: Global approaches of building acoustics (including thermal, accessibility and sustainability performance)

Room: Yves ROCARD
Chair Person (s): J.-B. Chene, A. Krasnic

Friday 27 april 2012

AH-S02: Fan and turbomachinery noise

Room: Peter BARNETT
Chair Person (s): M. Lebrun, P. Joseph

Friday 27 april 2012

EA-S01: Advanced techniques for transducer characterization

Room: Lord RAYLEIGH
Chair Person (s): M. Melon, P. Lotton

Friday 27 april 2012

EN-S03: Urban acoustics

Room: Paul LANGEVIN
Chair Person (s): S. Félix, J. Kang

Friday 27 april 2012

MA-S01: Violin-like instruments: from acoustics to perception

Room: John TYNDALL
Chair Person (s): C. Fritz

Friday 27 april 2012

MA-S04: Sound synthesis and control

Room: Philip DOAK
Chair Person (s): F. Blanc, I. Drumm

Friday 27 april 2012

NV-S05: Railway noise

Room: Pierre CHAVASSE
Chair Person (s): F. Poisson, D. Thomson

Friday 27 april 2012

PU-S03: Phononic crystal and metamaterials

Room: François CANAC
Chair Person (s): B. Morvan, O. Poncelet, D. Elford

Friday 27 april 2012

AA-S03: Acoustics of light frame buildings (wooden building...)

Room: Yves ROCARD
Chair Person (s): C. Guigou-Carter, C. Hopkins

Friday 27 april 2012

PU-S09: Biomedical and biological ultrasounds

Room: Pierre CHAVASSE
Chair Person (s): E. Franceschini

Friday 27 april 2012

AH-S03: Infrasound: generation, propagation and applications to remote sensing

Room: Peter BARNETT
Chair Person (s): P. Blanc-Benon

Friday 27 april 2012

EA-S07: Active noise: transducers and metamaterials

Room: Ray STEPHENS
Chair Person (s): R. Boulandet, M. Collet, P. Darlington, S. Daley

Friday 27 april 2012

EN-S07: Acoustical properties of natural materials and greening for noise control

Room: Yves ROCARD
Chair Person (s): J. Defrance, K. Horoshenkov

Friday 27 april 2012

MA-S08: Acoustics of historical and archaeological musical instruments

Room: John TYNDALL
Chair Person (s): X. Boutillon, M. Campbell

Friday 27 april 2012

NV-S06: Rolling and tyre-road noise

Room: Philip DOAK
Chair Person (s): L. Gagliardini

Friday 27 april 2012

ED-G01: Education in acoustics

Room: Ray STEPHENS
Chair Person (s): C. Potel, S. Dance

Friday 27 april 2012

HS-G01: Hearing and speech

Room: Lord RAYLEIGH

Chair Person (s): X. Pelorson, G. Hunter

Abstracts

Mon 16:40 Marin MERSENNE Plenary lecture: Pr. Kirill Horoshenkov

Acoustical monitoring of water infrastructure – (000606)

K. V. Horoshenkov
University of Bradford, Great Horton Road, BD7 1DP Bradford, UK
Corresponding author E-mail: k.horoshenkov@brad.ac.uk

Accurate data on the boundary conditions and hydraulic flows in urban water infrastructure are required to predict accurately the probability of flooding, structural damage, ground subsidence incidents and to optimise the rehabilitation work. Airborne acoustic waves can provide reliable means to measure remotely the hydraulic, operational and structural characteristics of this infrastructure. This talk focuses on a new acoustical technology developed at the University of Bradford which can be used to detect and locate damage, blockages, sediment deposition, water level variations and hydraulic energy losses in underground networks of pipes. It explains how various pattern recognition methods can be applied to discriminate between the acoustic signatures recorded for a range of conditions in a realistic pipe and to detect a change. The talk also presents some field work results proving that the proposed acoustical technology allows for a very rapid, remote inspection of urban underground water infrastructure. It is argued that in the future this technology will partly replace more conventional and slower CCTV inspection methods.

Mon 17:10 Marin MERSENNE Plenary lecture: Pr. Noureddine Atalla

Practical modeling of the vibroacoustics response of structures with attached noise control materials – (000863)

N. Atalla
Groupe d'Acoustique de l'Université de Sherbrooke, 2500 Boulevard de l'Université, Faculté de Génie, Sherbrooke, Canada J1K2R1 QC
Corresponding author E-mail: Noureddine.Atalla@Usherbrooke.ca

This paper presents a review of vibroacoustics models of porous elastic materials. In particular the practical modeling of the vibration and acoustic responses of panels with attached sound packages is discussed using both analytical and numerical methods. Special attention will be devoted to the modeling, using simple methods, of various types of porous materials (rigid, limp, porous elastic...) in various mounting conditions (single wall and double wall) together with the calculation of various vibroacoustics indicators (vibration response, radiated power, transmission loss, added damping, air-borne insertion loss, Structure-borne insertion loss...) under various excitations (acoustical, mechanical, TBL...). In particular, examples illustrating the practicality and usefulness of these methods will be discussed.

Tue-Frid Grande Halle AA - Architectural and building acoustics (Poster session)

An efficient time domain solver for the acoustic wave equation – (Contributed, 000120)

R. Mehra[a], N. Raghuvanshi[b], L. Savioja[c], M. Lin[a] and D. Manocha[a]
[a]Department of Computer Science [Chapel Hill], Campus Box 3175, Brooks Computer Science Building 201 South Columbia Street UNC-Chapel Hill Chapel Hill, NC 27599-3175 USA; [b]Microsoft Research, One Microsoft Way, Redmond, WA 98052, USA; [c]Aalto University School of Science, PO Box 15400, FI-00076 Aalto, Finland
Corresponding author E-mail: Lauri.Savioja@aalto.fi

An efficient numerical solver for time domain solution of the wave equation for the purpose of propagation in small and large acoustic spaces is presented. It is based on the adaptive rectangular decomposition technique that subdivides a space into rectangular partitions and within each partition utilizes the analytical solution of the wave equation. This technique allows numerical computations in kilohertz range for auralization and visualization purposes. This can help engineers to quickly locate geometric features responsible for acoustical defects in practical engineering applications like noise control. It is demonstrated that by carefully mapping all the components of the technique on the GPU architecture, significant improvement in performance can be achieved while maintaining accuracy comparable to a high-order finite difference time domain (FDTD) solver. It is an order of magnitude faster than corresponding CPU-based solver and three orders of magnitude faster than the CPU-based FDTD solver. This

technique can perform a 1 s long simulation on complex-shaped 3D scenes of air volume 7500 m^3 till 1650 Hz within 18 min on a desktop machine.

Tue-Frid Grande Halle AA - Architectural and building acoustics (Poster session)

Correction of computational artifacts in numerical solving of diffusion equation for room acoustics – (Contributed, 000223)

J. Kraszewski and A. Dobrucki
Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland
Corresponding author E-mail: jaroslaw.kraszewski@pwr.wroc.pl

In the paper a numerical algorithm for solving of diffusion equation in application for room acoustics is presented. The 1D, 2D and 3D models are considered. It has been observed that using simple FTCS algorithm for solving the diffusion equation, an additional energy is generated when the acoustic wave is reflected from the walls. The energy is doubled when the wave reflects from the surface, it is multiplied by 4 when the wave achieves an edge, and it is multiplied by 8 for reflection from the corner. This numerical phenomenon influences the calculated reverberation time. In 3D model the reverberation time is inconsistent with Sabine and Eyring formulae. The difference is about 50%. A heuristic modification of algorithm is proposed. Using this modified algorithm the additional energy is not generated and computed reverberation time differs from Sabine and Eyring formulas 6 - 10%.

Tue-Frid Grande Halle AA - Architectural and building acoustics (Poster session)

I-Simpa, a graphical user interface devoted to host 3D sound propagation numerical codes – (Contributed, 000367)

J. Picaut and N. Fortin
Département Infrastructures et Mobilité (IFSTTAR/IM), Route de Bouaye, CS4, 44344 Bouguenais Cedex
Corresponding author E-mail: judicael.picaut@ifsttar.fr

Whatever for indoor noise applications (room acoustics, noise in vehicles...) or sound propagation in the environment (open field, urban areas...), many numerical codes have been developed by researchers. Most of them have many common aspects, like the definition of the domain geometry and the materials (boundary conditions, impedance...), the definition of sound sources and of receivers (position, spectrum, directivity...). Moreover, they all have the same objective that is to predict the sound field within the domain, with several acoustics indicators, like acoustic pressure or sound levels, and through several representations (impulse response, spectrum...). In order to make easier the use of such codes (pre and post-processing of data), as well as for facilitating comparisons between models, a specific graphical user interface (I-Simpa) was developed specifically. In addition to previously cited facilities, this tool allows users to implement their own numerical models, as well as to manipulate the interface and to develop specific treatments by creating built-in Python(TM) scripts. As example, the paper will present the implementation of an energetic model for room acoustics predictions. The final objective is to create a community around this tool in order to exchange numerical codes, scripts... and information.

Tue-Frid Grande Halle AA - Architectural and building acoustics (Poster session)

Investigation on the effects of source directivity on Chinese speech intelligibility based on auralization – (Contributed, 000613)

J. Peng[a], T. Wang[b] and S. Wu[b]
[a]Department of Physics, School of Science, South China University of Technology,381 Wushan Road, 510640 Guangzhou, China; [b]State Key Laboratory of Subtropical Building Science, South China University of Technology, 381 Wushan Road, 510640 Guangzhou, China
Corresponding author E-mail: arshxwu@scut.edu.cn

Subjective Chinese speech intelligibility was evaluated by using an omnidirectional source,i.e., a source with the approximate directivity of human speaker and a human speaker source in both real and simulated rectangular rooms with different reverberation time. The result shows that subjective Chinese speech intelligibility scores have statistical differences under different source conditions . Speech intelligibility scores obtained by using omnidirectional source are lower than those obtained by using the other two sources. Therefore, it will underestimate the

speech intelligibility in rooms. Subject Chinese speech intelligibility obtained from auralization is basically the same as that which obtained in actual rooms under different source directivity conditions. By using auralization technique one can properly evaluate the subjective Chinese speech intelligibility even with different directional sources.

Tue-Frid Grande Halle AB - Animal bioacoustics (Poster session)

Time and frequency cues used by bottlenose dolphins for target discrimination – (Contributed, 000070)

G. Zaslavski
RAMOT Tel-Aviv University, Gordon, app 7, 42442 Netanya, Israel
Corresponding author E-mail: gennadi.zaslavski@gmail.com

Dolphins echolocate by emitting very short clicks and processing the echoes returned by underwater objects. Although the ability of dolphins to detect and discriminate among underwater objects is well documented, the controversy over acoustic features of object echoes processed by the dolphins remains heated, as ever. Most of the target discrimination models in dolphins are based on frequency analysis of the target echoes. Furthermore, a long ago rejected notion about dolphins' ability to modify spectral content of outgoing click to fit specific echolocation task and target characteristics is becoming popular again. The biggest obstacle for the frequency domain models is dolphins' ability to discriminate between brief time-reversed signals having identical frequency spectra. To overcome this problem a short time-frequency analysis of target echoes in dolphins was suggested. However in order to fit existing behavioral experimental results with dolphins into the time-frequency model, an extremely high auditory time resolution has to be assumed in the first place. Some behavioral results indicating the bottlenose dolphin's auditory time resolution as high as about twenty microseconds will be discussed.

Tue-Frid Grande Halle AB - Animal bioacoustics (Poster session)

Stability and change in short songs of yellow-rumped and red-rumped caciques (Cacicus cela and Cacicus haemorrhous) – (Contributed, 000218)

H. Thieltges, L. Henry and P. Deleporte
UMR 6552 Ethos Université de Rennes 1, Bt 25, campus de Beaulieu, 263 Avenue du General Leclerc CS 74205, 35042 Rennes, France
Corresponding author E-mail: helene.thieltges@univ-rennes1.fr

Functional analysis of bird song dialects have been the object of extensive researches. Several hypotheses emerged from these investigations, among which the ësocial adaptation hypothesis': using the same dialectal variant as social partners would facilitate the integration of newcomers into a social group. The social dialect could also constitute a local population or group marker. The social adaptation model predicts changes in bird vocalizations in response to social changes. In a previous study, we found local dialectical variants in French Guyanian populations of yellow-rumped and red-rumped caciques, two congeneric species of Icterid birds, both living in large multi-males / multi-females groups. We found dialects characterized by time and frequency parameters in male ëshort songs' involved in social communication. The social adaptation hypothesis predicts a progressive change in local dialectal vocalization types. In the present study, we analyze the temporal evolution of timing and frequency parameters of male short songs in these two species, over five years at the same localities.

Tue-Frid Grande Halle EA - Electroacoustics (Poster session)

Electrodynamic loudspeakers suspensions nonlinearities, study and measurements – (Contributed, 000343)

B. Maillou, A. Novak, J. Blondeau, B. Brouard, J.-M. Génevaux, P. Lotton and L. Simon
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: balbine.maillou.etu@univ-lemans.fr

Nonlinearities characterization and identification of acoustical systems is an active research field, notably in the area of electroacoustics. An innovative characterization and identification method, based on the nonlinear convolution and the use of a synchronized swept-sine excitation signal, has recently been developped. In this paper, this method is applied to the study of the nonlinearities exhibited by the mechanical suspensions of an electrodynamic

loudspeaker. Nonlinear behaviours are specially studied as function of the amplitude of the displacement of the membrane of the loudspeaker. In this context, we develop an experimental setup from the signal generator to the mobile part of the tested component, specially designed in order to obtain a great harmonic distortion measurement dynamic range and, thus, to allow the measurement of weak nonlinearities. Nonlinearities are estimated for both the external and internal suspensions independently, and for several kinds of loudspeakers. Results are compared with those obtained by other methods available in the literature.

Tue-Frid Grande Halle EA - Electroacoustics (Poster session)

Optimization of electric shunt resonant circuits for electroacoustic absorbers – (Invited, 000494)

H. Lissek, R. Boulandet and E. Rivet
Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: herve.lissek@epfl.ch

Sound absorption can be achieved in a relatively simple manner with passive or active electroacoustic absorbers. Electroacoustic absorbers are basically loudspeakers, the membrane of which is used as an absorber/reflector of sound, and the electric terminals of which are connected to a dedicated electric load. This electric "shuntï can be a simple electric resistor, or an active device employing feedback control on acoustic and/or electric quantities (aka. direct impedance control). Whilst the latter allows significant broadening of acoustic absorption performances that could not be obtained with simple passive resistors, it is also possible to find passive shunt alternatives that allows interesting acoustic performances without the use of expensive and energy consuming electric disposals. A simple configuration of shunt electric resonator is proposed as an alternative to active shunt for broadening the performances of passive electroacoustic absorbers.

Tue-Frid Grande Halle EA - Electroacoustics (Poster session)

UWB SAW sensors and tags – (Contributed, 000527)

M. Lamothe, V. Plessky, J.-M. Friedt and S. Ballandras
femto-st, 26 chemin de l'epitaphe, Equipe CoSyMa, 25000 Besançon, France
Corresponding author E-mail: ballandr@femto-st.fr

The radio Ultra Wide Band (UWB) technology brings many benefits, such as extremely low power of emitted especially attractive for sensors for the medical world. For the RFID tags wide frequency band allows to get large number of codes on the chip with radically reduced size. We have developed a prototype of a wide frequency band SAW sensor operating in a frequency range from 200MHz to 400MHz. The compressed pulse is about 5ns long which corresponds to theoretical expectations. Using LFM signals allows to get record low losses in the sensor. Correlation between compressed peaks will be used to extract the temperature with precision better than 0.1°C, and using the UWB signals simplifies the post processing algorithms. The sensor can have ID function due to different positions of reflectors and/or different dispersion of the LFM transducer.

Tue-Frid Grande Halle EN - Environmental noise (Poster session)

Problématique de bouchons d'oreilles en aeronautique militaire – (Contributed, 000112)

D. Sarafian and G. Andeol
Institut de Recherche Biomédicale des Armées, BP 73, 91223 Brétigny Sur Orge, France
Corresponding author E-mail: dsarafian@imassa.fr

Dans le milieu aéronautique militaire, l'exposition de l'opérateur au bruit est particulièrement élevée. Cette exposition impose de proposer aux opérateurs une double protection (casque plus bouchons d'oreilles). Dans cette étude, nous avons évalué les aspects ergonomiques et les atténuations acoustiques de bouchons d'oreilles utilisés en double protection parmi une population d'utilisateurs habituels. Les atténuations acoustiques sont mesurées selon la norme REAT et les aspects ergonomiques sont évalués au travers de questionnaires. Les bouchons d'oreilles sont de type personnalisés en silicone (n=15), personnalisés en acrylique (n=10), génériques en mousse équipés de mini haut-parleurs (n=11), et personnalisés en silicone avec un contrôle qualité in situ (n=19). Les résultats obtenus montrent que l'atténuation mesurée est différente des spécifications indiquées par le fabricant. Selon le type de bouchon, environ un tiers des personnes ne supporte pas le port. Pour le reste de la population,

la tolérance au port des bouchons ne permet pas un port pendant la durée totale de l'exposition au bruit. Cette étude a également permis de mettre en évidence des relations entre les atténuations acoustiques et les aspects ergonomiques. Enfin, des recommandations sont émises pour le choix de bouchons d'oreilles.

Tue-Frid Grande Halle EN - Environmental noise (Poster session)

Use of textile nanofibers to improve the sound absorption coefficient of drilled panels for acoustic applications – (Contributed, 000146)

J. Alba, R. Del Rey, L. Berto and C. Hervás
Universidad Politécnica de Valencia, C/ Paraninf n°1, 46730 Grao De Gandia, Spain
Corresponding author E-mail: lauberca@upv.es

Nowadays combinations of textile materials are common solutions in acoustics aplications as absorbent acoustic materials. Researches developed previously make possible to assert that the nanofibers textile veils combined with the textile wools, will improve the acoustic proprieties of the latter. These kind of nanofibers textile veils are made with a process known as "electrospinning processï Furthermore, these kinds of combinations present an airflow resistivity value within the range established by the Technical Edification Code in Spain, so that, we can use these kinds of materials in sound insulation applications to reduce sound waves confined between two walls in a multi partition or in many other applications such as noise reduction in air conditioning systems or in the design of the electroacoustic systems In this work we have studied the application of nanofibers as a cover of the polyester wools which are placed under drilled panels. We can assert that an increase of just 1% of the absorbent material thickness with a nanofibers veils, is enough to improve the acoustic absorption at low frequencies, in the cases submitted.

Tue-Frid Grande Halle EN - Environmental noise (Poster session)

Wind turbine environmental noise certification: a comparison of one local regulatory/planning process in California and the European Union – (Contributed, 000562)

J. C. Bennett
County of San Diego, DPLU, 5201 Ruffin Road, Suite B, San Diego, 92123, USA
Corresponding author E-mail: jc.bennett@cox.net

The development of wind turbine noise standards in the County of San Diego represents a convergence of existing local regulations with the current imperative to develop alternative energy resources. A similar, but different process has been going on in Europe where national standards are being developed and implemented. A comparison of this California example with the evolving regulations in Europe is used to point out the strengths and weaknesses of each approach. One difference is how the state of California had encouraged the development of general noise regulations at the county level yielding unique results in each locality compared to Europe where a consistent set of regulations and development goals were considered a priority. Part of this comparison will include a short review of community planning in California during the 1970's as well as the more current developments in noise planning in California and the European Union. The key underlying theme of this comparison will be to examine how governments rely on planning and technical expertise to achieve both economic success and sustainable quality of life for their communities.

Tue-Frid Grande Halle EN - Environmental noise (Poster session)

Le bruit dans les jardins familiaux d'ˆle de France – (Contributed, 000663)

L.-A. Gille[a] and G. Autret[b]
[a]CETE Ile de France, 319 avenue Georges Clémenceau, BP 505, 77015 Melun Cedex, France; [b]Laboratoire Régional des Ponts et Chaussées de l'Est Parisien Melun, 319, avenue Georges Clémenceau BP 505 77015 Melun Cedex
Corresponding author E-mail: laure-anne.gille@developpement-durable.gouv.fr

Les jardins familiaux se situent fréquemment en bordure d'infrastructures de transport et en subissent les nuisances, avérées et potentielles. Cette étude sur les jardins familiaux d'ˆle-de-France a ainsi comme objectif de proposer des solutions pour améliorer l'ambiance sonore de ceux existants et d'établir les caractéristiques environnementales nécessaires à la création de nouveaux jardins. Les cartes de bruit des grandes infrastructures de transports terrestres réalisées en 2007 et celles de 2012 sont utilisées pour établir un état des lieux des niveaux sonores, exprimés en L_{den} ou L_n, au sein de ces jardins. Plusieurs bases de données pourront être utilisées : infrastructures routières et ferrée, autres indicateurs, ICPE, sites EDF... afin de déterminer si ces jardins existants sont exposés à des nuisances provenant de plus d'une source. Cet état des lieux permet de sélectionner des sites exposés à différents niveaux sonores. Des mesures acoustiques pourront y être réalisées afin de conforter le choix et de préciser l'influence des aménagements réalisés (merlons, cabanons, claustras...). Des entretiens avec les usagers permettront d'évaluer si la présence des sources de bruit a conditionné leur utilisation du jardin. Enfin, l'impact de plusieurs aménagements de protections sur le niveau sonore pourra être simulé numériquement.

Tue-Frid Grande Halle EN - Environmental noise (Poster session)

The efficiency of environmental impact assessments relating to noise issues – (Contributed, 000694)

Z. Krukle
University of Latvia, Raina Boulevard 19, LV-1586 Riga, Latvia
Corresponding author E-mail: zanda.krukle@inbox.lv

The environmental impact assessment (EIA) is a management tool which is used to provide acceptable and sustainable living space through the preemptive appraisal of proposed schemes which have potential negative impacts on the environment quality. This appraisal includes consideration of environment and holistic health factors and contains methods to prevent or reduce possible harmful effects. One of the factors which are considered in EIA's is noise emissions. The appropriate and effective assessment of environmental noise issues via this process is especially important in countries where noise control systems are underdeveloped and environmental matters are often viewed as restrictive of business activities.
In order to determine whether the aim of the EIA relating to environmental noise issues is achieved, the process and results of an EIA for transport sector projects in Latvia are investigated. The research includes analysis of EIA reports, conditions and decisions of the managing institution as well as an analysis of the projects which were the subject of EIA's and are now in operation. The results of this study are a critical examination of the requirements and efficiency of the EIA process, identification of the shortcomings and suggestions for improvements.

Tue-Frid Grande Halle EN - Environmental noise (Poster session)

Analysis of in situ acoustical performance of concrete noise barriers – (Contributed, 000830)

F. Leccese, F. Fantozzi and G. Salvadori
University of Pisa, Dept of Energy and System Engineer (DESE), Largo L. Lazzarino, 56122 Pisa, Italy
Corresponding author E-mail: f.leccese@ing.unipi.it

The need to enhance the people's mobility has produced a significant increase in the environmental pollution, including transportation noise. In order to reduce transportation noise it is possible to act directly on transport media or on the urban environment, by protecting sensitive receptors with techniques for noise reduction. The noise barriers are one of the most common examples of noise reduction devices.
In this paper the authors show and discuss the results of an in situ analysis of the acoustical performance of concrete noise barriers, installed in an important highway infrastructure of the Central Italy. The structure of examined barriers is composed of 8 overlapping panels made by autoclaved aerated concrete. The faces of the panels, facing the noise source, can be smooth or machined with high pressure water jets. In order to increase the sound absorption of the barriers, till to the higher quality class (A4) indicated in EN 1793-5, semi-cylindrical acoustical absorbers have been designed. They are made by metallic micro-holed envelope with the cavity partially filled by suitably shaped polyester fiber and they can be installed at variable distances from the face of the panel.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Behavior of speech acoustics parameters and compensatory strategies adopted in noised environment – (Contributed, 000026)

L. Falek, H. Teffahi and A. Djeradi
USTHB electronics en computer Faculty, BP 32 Bab Ezzouar El Alia, 16111 Algiers, Algeria
Corresponding author E-mail: lfalek@hotmail.fr

We acoustically analyzed behavior of speech signal produced in noisy constraint by four speakers, when noise is sent by a helmet to speaker and when noise is sent by high speaker. The goal is to find speech signal acoustic parameters which are most sensitive to noise and the compensatory strategies adopted by the speakers to counter this constraint. Results obtained in both cases show a great constraint influence over timing, energy, fundamental frequency F0, formants (F1, F2) of the analyzed units. They can be summarized such as: (1) In temporal field: We noted an increase in analyzed units duration. We can conclude that speaker tends to slow down his elocution rhythm with constraint in order to better render comprehensible itself; (2) In energy field: there is an increase in intensity. Thus the speaker speaks extremely in noise constraint; (3) In frequential field: (a) We noted an increase in formants F0 and F1 but F2 stay stable in spite of noise constraint. It's meaning that the speakers, while speaking extremely, increase their aperture but the vowels anteriority does not change. (b) Vocalic spaces are reduced with centralization. It's meaning that the speakers modify their formants to avoid constraint while remaining understandable.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Labial constraint effects on the speech signal acoustic parameters – (Contributed, 000027)

L. Falek, H. Teffahi and A. Djeradi
USTHB electronics en computer Faculty, BP 32 Bab Ezzouar El Alia, 16111 Algiers, Algeria
Corresponding author E-mail: lfalek@hotmail.fr

We studied in this work the influence of labial constraint in speech production. We acoustically analyzed vowels behavior in constraint, then the constraint influence on the coarticulation on 4 speakers. Results obtained show a great influence of the constraint on the acoustic parameters in particular on the frequential parameters which are key parameters in synthesis, recognition and coding systems of the speech and in orthophonics reeducation programmes for handicapped persons. These results can be summarized such as: In the temporal field: A temporal reduction in the analyzed units, therefore the speaker tends to accelerate his rate/rhythm of elocution with the constraint. In the frequential field: (1) Spaces vocalic F2 (F1) are reduced but without centralization of the vowels. Thus the speakers reach with difficulty their acoustic targets with the constraint to see not at all; (2) there is variation of fundamental frequency according to the formants F0 (F1), F0 (F2) and F0 (F3). However direction of variation depends on speaker. Thus constraint varies the intonation; (3) locus equation slope obtained increase all with constraint. Thus labial constraint increases coarticulation degree.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Amplitude modulation of vowel glottal pulses: application to sleep inertia – (Contributed, 000061)

R. Ruiz[a], P. Plantin De Hugues[b] and C. Legros[c]
[a]LA.boratoire de Recherche en Audiovisuel (LA.R.A), Université Toulouse-le Mirail, 5 allées Antonio Machado, 31058 Toulouse Cedex 9, France; [b]Bureau d'Enquêtes et d'Analyses (B.E.A), Aéroport du Bourget, 93352 Le Bourget Cedex, France; [c]Laboratoire d'Acoustique de l'Université Toulouse-le Mirail, Université Toulouse-le Mirail, 5 allées Antonio Machado, 31058 Toulouse Cedex 9, France
Corresponding author E-mail: robert.ruiz@univ-tlse2.fr

Human voice carries non-linguistic information about emotion, fatigue, stress, truth, psychological illnesses etc. The proofs of this are well-established nowadays. In real-life situations, in laboratory conditions and from a cross-cultural point of view, the speaker's psycho-physiological disorders induce vocal modifications. Many acoustic parameters are measured. They belong to the dynamic and spectral planes. Phase space is also involved. Amplitude modulation is one of them. Unlike prosody and vocal quality features, this has not been widely studied. In this paper, a method for estimation vowel glottal pulses amplitude modulations is proposed. After pulse detection, a sinusoidal fit is applied leading to an estimate of the amplitude modulation frequency. This method has already been used in experiments on sleep inertia effects on the voice. A pilot is suddenly awakened to undertake aeronautical psychomotor tasks. Results show the existence of an amplitude modulation. Their validity is based on determination coefficient measurements taking into account the number of pitch periods. Additionally, shimmer measurements show an increase after awakening. It can thus be concluded that sleep inertia has an effect on vowels uttered by the pilot.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Mechanisms of vowel epenthesis in consonant clusters: an EMA study – (Contributed, 000075)

S. Funatsu[a] and M. Fujimoto[b]
[a]Prefectural University of Hiroshima, 1-1-71 Ujinahigashi Minami-ku, 734-8558 Hiroshima, Japan; [b]National Institute for Japanese Language and Linguistics, 10-2 Midori-machi, 190-8561 Tachikawa, Japan
Corresponding author E-mail: funatsu@pu-hiroshima.ac.jp

The mechanisms of vowel epenthesis in consonant clusters were investigated using an electromagnetic articulograph (EMA). The target languages were Japanese and German. Japanese does not allow consonant clusters, while German does. Two Japanese speakers and two German speakers participated in this experiment. For Japanese speakers, normalized tongue tip displacements from the first consonant to the second consonant in clusters (/bn/, /pn/) were significantly larger than those of German speakers ($p<0.001$). Also, the normalized moving times of tongue tip for Japanese speakers were significantly longer than those for German speakers ($p<0.001$). These results suggested that the coarticulation between first and second consonant for Japanese speakers would be weaker than that for German speakers. Moreover, from the measurement of tongue back movement, the timing between articulatory movement and vocal fold vibration would affect the vowel epenthesis.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Discrimination of Chinese pronunciations of aspirated dental and retroflex syllables according to breathing power and its frequency dependency during VOT – (Contributed, 000110)

H. Akemi and A. Yasuda
Toyama National College of Technology, 1-2 Ebie-neriya, Imizu city, Toyama, 933-0293, JAP, 933-0293 Toyama, Japan
Corresponding author E-mail: hoshino@nc-toyama.ac.jp

Retroflexing of aspirates in Chinese is generally considered to be difficult for Japanese students learning pronunciation, because the Japanese language has no such sounds. In particular, discriminating utterances with aspirated dental and retroflex syllables is the most difficult. As we observed in our study, a classroom of Japanese students of Chinese uttered aspirated retroflex sounds modeled after examples uttered by a native Chinese instructor, however, the utterances sounded like dental syllables to the instructor, and many students could not produce the correct sounds. Warping the tongue was not enough to produce the correct articulation, because there is no retroflex sounds amongst the Japanese syllables. In the present paper, the authors extracted the features of the correct pronunciation of the aspirated dental syllables ca[tsëa],ci[tsëi] and ce[tsëγ], and the aspirated retroflex ones cha[#Dëa],chi[#Dëi],and che[#Dëγ], by analyzing breathing power and its frequency dependency during VOT (Voice Onset Time) of sounds uttered by nine Chinese native speakers and ten Japanese students. We will develop an automatic discrimination system by using the deduced evaluation standards.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Child DiaPix: development of a child friendly speech elicitation task – (Contributed, 000221)

L. K. Kuhn
Brunel University, Kingston Lane, UB8 3PH Uxbridge, UK
Corresponding author E-mail: lisa.kuhn@brunel.ac.uk

Increasing need for a child friendly method to elicit spontaneous speech in children has led the researcher to create two simplified versions of the original DiaPix UK task (Hazan & Baker, 2010) in order to enhance linguistic and developmental research. A child and an adult sample took part in this spot-the-difference task which created natural conversations as a basis for voice recordings. The study also assessed altruistic tendencies of the speakers in order to facilitate future personality research before evaluating task efficiency across all participants. Results suggested that the simplified street as well as the simplified beach DiaPix picture scenes were equally suitable for eliciting spontaneous speech in children, although adults outperformed children on most task efficiency measures. Especially children aged 7 and below faltered in their ability to solve the task independently. In conclusion, a simplified DiaPix task seems a promising new linguistic as well as interactive research method for children aged 8 and above for spontaneous speech elicitation and a wider range of applications.
Current data collection from German primary school children aims to enrich findings and to provide cross cultural aspects of using this new child friendly speech elicitation method across England as well as Germany.

Tue-Frid Grande Halle HS - Hearing and speech (Poster session)

Multiple description coding in MELP coder for voice over IP – (Contributed, 000455)

M. Saidi
USTHB, Ait El Hadj 9 Rue Boumezrag 16008 Bab El oued Alge, 16008 Alger, Algeria
Corresponding author E-mail: mohammed.saidi@yahoo.fr

In VoIP systems, CELP coders, such as G.729, are commonly used as they offer good speech quality in the absence of packet loss. However, the quality degrades in presence of losses. This is due to the existence of long-term predictor in this coder. Otherwise, harmonic coders such as MELP may be a good alternative for VoIP due to their higher resilience to packet loss. In this work, we deal the problem of packetization scheme based on Multiple Description Coding (MDC) applied to the MELP coder. A packet will contain information on two MELP coders operating at 2.4 and 1.2 Kbps respectively. The packetization is achieved using 135 bits in 22.5 ms corresponding to a total rate of 6 kbps. The results show that under typical VoIP operating conditions, the method performs well and outperforms CELP coders when operating at 8 kbps without MDC.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

The acoustical effect of the pad resonator in the saxophone – (Contributed, 000379)

P. Eveno[a], M. Curtit[b], J.-P. Dalmont[c] and R. Caussé[a]
[a]IRCAM, 1 place Igor Stravinsky, 75004 Paris, France; [b]ITEMM, 71 Avenue Olivier Messiaen, 72000 Le Mans, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: pauline.eveno@ircam.fr

The saxophone is one of the wind instruments with the largest side holes. The pads, inserted inside the key play an important role on the acoustics of the instruments. The first role of a pad is to seal the side hole when it is closed. However, a lot of musicians and instrument makers consider that they have an important role on the timbre of the instrument. Indeed, early in the history of the saxophone, "resonatorsï (as they are called by both musicians and craftsmen) appear. These are flat disks made of metal or plastic fixed in the middle of the pad. In order to understand the role of these "resonatorsï, measurements of the input impedance of a cylinder topped by a key with interchangeable pads (with and without resonators) are performed. Significant differences between pads with and without "resonatorsï are highlighted for small key heights. A study of the vibrations of the pads shows that these differences can be explained by the high mobility of the pads without "resonatorï which appear to be in practice "stiffenersï. Measurements on a whole saxophone show that the consequence of such differences on a saxophone is limited.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

Nonlinearities in recorder tone holes: effect of undercutting – (Contributed, 000441)

M. Curtit[a], J.-P. Dalmont[b] and P. Bolton[c]
[a]ITEMM, 71 Avenue Olivier Messiaen, 72000 Le Mans, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Facteur de flute à bec, 22, Le Grand Portail, 84570 Villes-Sur-Auzon, France
Corresponding author E-mail: philippe.bolton@flute-a-bec.com

Early woodwind instruments have small tone holes that are usually undercut. Undercutting consists in rounding off or chamfering the holes' edges where they meet the main bore.
The consequences on the acoustics can be classified in two categories, which are the linear and the non linear acoustical effects. Linear effects are induced by the modification of the hole geometry, which can be modelled in the linear theory by a cylindrical hole with a larger section and a slight change in position along the bore. It is shown that makers use those modifications as a way of tuning instruments during the last stages of the manufacturing process.
The other effect of undercutting is to reduce the kinetic energy loss caused by discontinuities in the vicinity of the hole. Experimental results show the consequences on the recorder, especially modifications of the pressure thresholds of oscillating regimes. Other characteristics of played notes are also studied, such as the spectral centroid or the radiated power.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

Measurement of attack transients in a clarinet driven by a ramp-like varying pressure – (Contributed, 000467)

B. Bergeot[a], A. Almeida[a], C. Vergez[b] and B. Gazengel[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]LMA - CNRS (UPR 7051), 31 chemin Joseph-Aiguier, 13402 Marseille, Cedex 20, France
Corresponding author E-mail: baptiste.bergeot.etu@univ-lemans.fr

We investigate the influence of a time-varying blowing pressure on the oscillation threshold and attack transient of a clarinet. In this experimental study, a clarinet is blown through an artificial mouth, which allows the time profile of the blowing pressure to be controlled during the experiment. The chosen profile is a slowly increasing linear ramp, until a given steady value is reached. Different experiments have been carried out and analyzed. Depending on the slope of the ramp and on the steady value, but also on the opening of the reed channel at rest, the steady state (oscillating or not), the oscillation threshold and the attack transient are determined. Does the fact that the blowing pressure varies in time have a similar influence on a real clarinet as on a simplified model ? To answer this question, the experimental results are compared to the conclusions presented in a companion paper where a mixed numerical/analytical approach has been developed on a simplified clarinet model. Characteristics such as bifurcation delay and dynamic bifurcation are addressed.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

Active control applied to string instruments – (Contributed, 000525)

S. Benacchio[a], A. Mamou-Mani[a], B. Chomette[b] and R. Caussé[a]
[a]IRCAM, 1 Place Igor Stravinsky, 75004 Paris, France; [b]Institut d'Alembert, 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: benacchio@ircam.fr

This study aims to control the soundboard's vibrational eigenmodes in order to modify the timbre of string instruments.
These structures are wooden plates of complex shapes, excited by strings through a bridge. In order to apply an efficient control on such systems, modal parameters are given by identification using classic algorithms on experimental measurements. Then it is possible to design a digital controller using these parameters and classic control methods. This controller is applied in a feedback loop. Quantity, dimensions and positions of sensors and actuators needed for the control are obtained from an intermediate optimisation step.

At first, a simplified system is studied. The experiment is conducted on a rectangular spruce plate, boundary embedded and excited by an only string. The method described above is applied on this system. This simplified case and its results in term of changes in eigenmodes are presented here.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

An aid to innovation in instrument-making: a collaborative approach between workshops and research laboratories – (Contributed, 000536)

V. Doutaut
ITEMM, 71, avenue Olivier Messiaen, 72000 Le Mans, France
Corresponding author E-mail: vincent.doutaut@itemm.fr

The economics of French instrument-making is mostly made up of very small handicraft enterprises. But craftsmen do not always have the means to embark, by themselves, on an innovation strategy. The idea is to try to respond to current challenges in instrument making; for example, the reduction in costs of design times or the adaptation to customer needs. All of this necessitates the development of low cost tools for characterising and prototyping of instruments dedicated to their use in workshops. Examples of collaborative approach between instrument makers and research laboratories are presented. Mainly,the Pafi project, for "Instrument-making aid platformï, is ambitious. It aims to develop characterisation tools more widely for all the instrument families. The project's originality lies in the fact that ten "pilot craftsmenï are associated with every stage of development. The Pafi project involves a research programme and the support of the craftsmen for developing the hardware and software. Bearing in mind the international economic context, these experiences may act as a basis for broadening and pursuing this initiative on an international scale. The open and progressive nature of the work means that we can consider such a prospect with a view to maintaining the small-scale production of high-quality instruments.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

Experimental analysis of the vibroacoustics of a trombone bell – (Contributed, 000537)

M. Secail-Geraud, F. Gautier and J. Gilbert
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: mathieu.secail-geraud@univ-lemans.fr

The influence of wall vibrations on the sound produced by a wind instrument has engendered a long-lasting debate among scientists, musicians, and instrument makers. The vibrations of a sounding wind instrument can clearly be felt and measured but the influence of these vibrations on the radiated sound is more difficult to bring to light, because the fluid-structure couplings involved are particularly weak excepted when coincidence effects occur. The case of the trombone bell is particular because this part of the instrument is large and thin, which favours vibrations of large amplitudes. An experimental study has been performed using a tank of water in which the studied trombone is placed. The tank can be filled with water in order to modify the mechanical modes of the system in a continuous manner. Such an experiment is designed from the historical experiment made by D. C. Miller one century ago for studying the acoustics of vibrating organ pipes (Science 29 (735), 161-171, 1909). The acoustic impedance and mechanical responses of a trombone bell excited by a loudspeaker or an impact hammer are measured for different levels of water permitting a fine analysis of the vibroacoustics couplings.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

A Laboratory TOOL for the strings instrument makers – (Contributed, 000551)

S. F. Pakzad[a] and T. Jeandroz[b]
[a]ALSF, 9 Avenue Marcel Perrin, 95540 Mery Sur Oise, France; [b]LTRT, 3 rue du Marolet, 95430 Auvers Sur Oise, France
Corresponding author E-mail: acoustic@alsf-lab.com

The discussion that we suggest here relates directly with multiple sessions from Instrument making to measurement techniques. To discuss about the Acoustics of musical instruments, we explain the mathematical form of the acoustic function of the instruments. If we consider the acoustics of the musical instruments as a mathematical formula, we can study it as a 4-port module with an input multiplied in the module function and the output. The mathematical function of this acoustical body of the instrument is a nonlinear Multi order complex function. The produced sound is the application of the function to the input or the mechanical vibrations of the strings. De-correlating and de-modulating the Complex sound of the musical instruments and studying the decomposed sound is the first milestone of understanding the behavior of Acoustical Instruments. The strings instrument makers who have the golden ears too, use their very sharp sensitive hearing capabilities to feel the de-correlation, which is why this domain of acoustics remains as an art reserved to some very few genius artisans. To open scientifically the gates of musical acoustic, our S7B module treats the complex results of the acoustical instruments.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

A non optimization-based method for reconstructing wind instruments bore shape – (Contributed, 000590)

G. Le Vey
IRCCyN/Ecole des Mines de Nantes, 4, rue A. Kastler, BP 20722, 44307 Nantes, France
Corresponding author E-mail: levey@emn.fr

The presented work is concerned with a prospective method towards the reconstruction of the bore shape of wind instruments. One contemplated application is to the study of ancient wind instruments.
The so-called 'horn equation' is well-known for modelling propagation in variable section bores of wind instruments. Apart from strict modelling purposes, it has been used together with several optimization methods for the reconstruction of bore shapes of wind instruments. This work investigates properties of a quadratic invariant of second order linear differential equations of the Sturm-Liouville type. The question of reconstructing the potential appearing in such an equation thanks to this invariant is then applied to the horn wave equation, amounting to the bore shape reconstruction from external measurements that at this stage, are supposed to be feasible. Contrary to most of the approaches known to the author, the method presented here does not rely on optimization. On another side, one pending question, thus critical to the method, is that of the measurements that should be made in order to make this approach effective in practice. This should motivate discussions within the conference audience. As this research is prospective, no case study will be presented.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

DROPIC: A tool for the study of string instruments in playing conditions – (Contributed, 000640)

J.-L. Le Carrou[a], D. Chadefaux[a], M.-A. Vitrani[b], S. Billout[a] and L. Quartier[a]
[a]Equipe LAM - d'Alembert, 11, rue de Lourmel, 75015 Paris, France; [b]Institut des Systèmes Intelligents et Robotique, Université Pierre et Marie Curie - Paris VI Boite courrier 173 4 Place Jussieu 75252 Paris cedex 05
Corresponding author E-mail: jean-loic.le_carrou@upmc.fr

The study of musical instruments in playing conditions requires a highly controllable and repeatable excitatory mechanism. This mechanism has to be able to reproduce as closely as possible the human gesture in order to be representative of a playing technique. In the paper, we describe the development of a new string plucking device for the concert harp. This system, called DROPIC (Doigt RObotisé PInceur de Cordes), is a position-controlled two-degrees of freedom robot with a configurable silicone fingertip. In order to compare the plucking performed by DROPIC and by a harpist, trajectories are captured by a high-speed camera and the soundboard's vibrations are measured with an accelerometer. A set of features extracted from these data shows that the DROPIC plucking is comparable to the harpist one with a better repeatability. In addition to classical vibration and acoustic sensors, DROPIC can now be used to pluck a string and allows us to measure temporal features as well as spectro-temporal features in a repeatable and controllable playing context, thus creating an alternative to classical frequency-domain measurements of string instruments.

Tue-Frid Grande Halle MA - Musical acoustics (Poster session)

Independent features for content-based music genre classifiaction – (Contributed, 000833)

L. Fergani
University of Sciences and Technology, BP14, El-Alia, Bab Ezzouar, Algiers,Algeria, 16111 Algiers, Algeria
Corresponding author E-mail: lamifer@msn.com

In this paper, we propose a new feature approach for genre classification of musical signals based on Independent Component Analysis. This approach take account of the fact that the redundancy of information between features may decrease the music genre classification rates. We thus introduce Independent Component Analysis to achieve independency of the features components. The new independent features are then used for genre classification through Support Vector Machine (SVM) or artificial neural network (ANN) classifiers. We will show through different experiments that this approach gives better accuracy rates than classical feature sets such as wavelet based, spectral, temporal or MFCC feature sets associated with different classifiers such as Multiclass SVM, Multilabel SVM and also ANN. These results are obtained with a database of 800 songs issued from the database of the Algerian radio. We thus obtain scores of 83% to 92% for eight genres. Interesting comparative results are reported and commented.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Concentrated Spectrogram of audio acoustic signals - a comparative study – (Contributed, 000067)

K. Czarnecki, M. Moszyński and M. Rojewski
Gdansk University of Technology, 11/12 Gabriela Narutowicza Street, 80-233 Gdańsk, Poland
Corresponding author E-mail: krzycz@eti.pg.gda.pl

The paper presents new results of time-frequency (TF) analysis of audio acoustic discrete-time signals. As a method of the analysis the authors propose to use the energy concentrating spectrograph also known as "Reassignment method" or "Cross- spectral method". This approach involves signal's local group delay (LGD) and channelized instantaneous frequency (CIF) to purposely redistribute in TF plain all Short-time Fourier transform (STFT) lines. Some comparisons of classical and concentrated spectrograms of various musical instruments including violin, flute, piano and guitar are presented. Various features of signals especially instantaneous frequency (IF) and amplitude modulation (vibrato) of their components and sound onsets are illustrated and discused.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Micro-embolic signatures detection through GARCH parameters – (Contributed, 000272)

J.-M. Girault[a], S. Ménigot[a], K. Addakiri[a] and B. Guibert[b]
[a]Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours; [b]Atys Medical, 17, Parc d'Arbora, 69510 Soucieu En Jarrest, France
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

Detection of micro-emboli is of great clinical importance to prevent cerebro-vascular events. Standard detection techniques implemented in the most commonly used systems are generally based on the comparison between a decision information (energy) and a threshold. The value of this threshold can be set just above the statistically highest detected energy of a blood Doppler signal. This choice of threshold consequently prevents all detection of micro-emboli events whose energy might be lower than the systolic energy. In this study three detectors were tested and compared: i) a standard energy detector, ii) a detector based on AR parameters and iii) a detector based on GARCH parameters. From *in vivo* signals and for a detection rate set to 100%, the false alarm rates were of 33%, 5% and 3% for the standard energy detector, for the detector based on a AR(2) model and for the proposed detector based on the GARCH(1,1) model, respectively. This study demonstrates that GARCH technique detects micro-emboli which did not identified by classical methods. Large micro-emboli are all detected, but small micro-emboli are only detected with parametric techniques. The new detector opens up new prospects to detect small emboli, despite the need for further studies to incorporate technique "on line".

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Rotary inertia effects on the propagation of elastic waves in thin FGM plates – (Contributed, 000277)

M. Mehrkash, M. Azhari and H.R. Mirdamadi
Department of Civil Engineering-Isfahan University of Technology, Imam Khomeini Street-University Square-University Street, 8415683111 Isfahan, Iran
Corresponding author E-mail: m.mehrkash@cv.iut.ac.ir

For the study of mechanical behaviour of thin functionally graded material plates, the classical plates theory (CPT) might be used. In this simple and approximate theory, the rotary inertia term is often neglected. When the problem regards the dynamical analysis of plates, such as acoustic wave propagation, especially at high frequencies, there would be some concerns whether this term may be ignored or not. The present paper discusses how the rotary inertia can affect the transient wave motion due to impulsive loading in thin inhomogeneous FGM plates. It is assumed that the plate material properties variations follow a simple power law distribution function in terms of the volume fractions of the constituents in the thickness direction. Based on the classical theory of plates and employing Fourier transform technique and modal analysis, elastic wave responses of the FGM plate are obtained. The analysis is carried out for several volume fraction indices and the models of which the inertia term would be considered or not, then, the results are compared with the homogeneous ones. Moreover, influences of the mentioned term on dispersion curves of thin FGM plates are shown.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Elastic wave propagation in FGM plates with in-plane forces – (Contributed, 000278)

M. Mehrkash, M. Azhari and H.R. Mirdamadi
Department of Civil Engineering-Isfahan University of Technology, Imam Khomeini Street-University Square-University Street, 8415683111 Isfahan, Iran
Corresponding author E-mail: m.mehrkash@cv.iut.ac.ir

The major function of plates refers to their bending behaviour. This flexural performance, normally regards the out of plane loadings and displacements. Nevertheless, especially in non-homogeneous plates because of bending and stretching coupling, due to their heterogeneity, in-plane forces may interfere in the plate flexural behaviour. In this study, the effects of in-plane forces on the propagation of elastic waves in thin and thick functionally graded material plates are investigated. Material properties of the plate are assumed to be graded in the thickness direction according to a power law distribution in terms of the volume fractions of the constituents. The source of the transient acoustic waves could be an impulsive line or point load. Based on the classical, Mindlin's as well as Reddy's third order shear deformation plate theories, the displacement responses of FGM plates, in the presence of in-plane forces, are obtained. For this purpose, Fourier transform and modal analysis are used. The results are

illustrated for FGM plates with different volume fraction indices. The sensitivity of FGM plates' dispersion curves to the in-plane forces will also be discussed.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Intonation des phrases interrogatives et affirmatives en langue Berbère – (Contributed, 000294)

H. Teffahi and R. Halimouche
USTHB electronics en computer Faculty, BP 32 Bab Ezzouar El Alia, 16111 Algiers, Algeria
Corresponding author E-mail: hteffahi@gmail.com

This work is at the frontier between multimedia information retrieval and automatic speech processing. During the last years, a new task emerged in speech processing: the rich transcription of an audio document. An important meta-data for rich transcription is the information on sentence type (i.e. sentence of interrogative or affirmative type). The study on the prosodic differences between these two types of sentences, the detection and classification of sentence type in Berber language is the main subject of this research work. Our departure is a study on French language. We've realized a system for segmentation and automatic detection of sentence type based on both prosodic. After this first study on French, we've extended our research in Berber language, a language where all studies until now on prosodic system are still preliminary. We've carried a study on the prosodic differences between interrogative and affirmative sentences. A classification motor has been built.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Cramer-Rao bounds for acoustic emission events localization in a flat plate – (Contributed, 000315)

A. Le Duff, S.E. Hamdi, G. Plantier, A. Sourice and R. Feron
Groupe ESEO, rue Merlet de la Boulaye, 49009 Angers, France
Corresponding author E-mail: alain.le_duff@eseo.fr

This article addresses the problem of 2D localization of acoustics source in a plate. This localization is based on Time Difference of Arrival (TDOA) measurements thanks to an array of three sensors arbitrary distributed on the 2D plane. Some previous works proposed approximated solutions or maximum likelihood methods.
In order to obtain a fast, but robust and accuracy, algorithm, allowing an online estimation of the location of hits or Acoustic Emission (AE) events in a composite plate for example, the authors propose an exact solution of the TDOA problem by solving a nonlinear system of coupled equations. The exact analytical Cramer-Rao Bounds (CRBs) on the variance of the estimations is then presented. Moreover, the statistical performances of the method are illustrated by means of Monte-Carlo simulations and are compared to the CRBs. These last expressions can be very useful in order to justify the accuracy of TDOA measurements and for guiding the choice of the sensors position.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Seismic imaging of transmission overhead line structure foundations – (Contributed, 000354)

D. Vautrin[a], M. Voorons[b], J. Idier[a], Y. Goussard[b] and N. Paul[c]
[a]IRCCyN, 1 rue de la Noë, 44321 Nantes, France; [b]Ecole Polytechnique de Montreal, Campus de l'Université de Montréal 2500, chemin de Polytechnique Montréal (Québec) H3T 1J4; [c]EDF R&D, département STEP, 6 quai Watier, 78401 Chatou, France
Corresponding author E-mail: denis.vautrin@irccyn.ec-nantes.fr

This work deals with the nondestructive testing of foundations by means of a seismic imaging procedure. Our goal is to propose an inversion scheme that determines the shape of the foundations from the measured data with an acceptable computational effort. The inversion procedure was defined from a model based on the linear elastic wave equations in two dimensions. The inverse problem is particularly difficult to solve for several reasons: the distribution of numerous physical characteristics must be estimated, the relation between the underground characteristics and the measured data is highly nonlinear, and this is a large scale and ill conditioned problem. Three inversion techniques are proposed. They minimize a regularized least-square criterion iteratively. The first circumvent the difficulties of the problem by means of algorithmical and mathematical techniques. It favours the reconstruc-

tion of smooth areas separated by sharp boundaries. Two additional methods were developed. They take into account more specific characteristics of the problem. Tests were performed on synthetic data. The results show that the first method leads to satisfying results. The addition of more specific priors leads to more precise and faster reconstructions.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Source localization using a sparse representation of sensor measurements – (Contributed, 000388)

J. Lardies, H. Ma and M. Berthillier
FEMTO-ST, Département de Mécanique Appliquée, 24 rue de l'Épitaphe, 25000 Besancon, France
Corresponding author E-mail: joseph.lardies@univ-fcomte.fr

We propose a non-parametric technique for source localization with passive sensor arrays, using the concept of a sparse representation of sensor measurements. We give an interpretation of sensor data by sparsely representing these data in an overcomplete basis, stressing the fact that the source position is usually sparse relative to entire spatial domain. In this way, the estimation problem is put in a model-fitting framework in which source position is achieved by finding the sparsest representation of the data. The approach presented in the communication is based on the singular value decomposition (SVD) of multiple samples of the array output and the use of a second-order cone programming for optimization of a resulting objective function. We formulate the problem in a variational framework, where we minimize a regularized objective function for finding an estimate of the signal energy as a function of acoustical source position. The key is to use an appropriate non-quadratic regularizing functional which leads to sparsity constraints and superresolution. The acoustical sources can be correlated or uncorrelated, wideband or narrowband, in nearfield or farfield. Numerical and experimental results in an anechoic room are presented. Our algorithm is compared to traditional algorithms such as beamforming, Capon and MUSIC.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Quantitative ultrasonic tomography of high acoustic impedance contrast targets – (Contributed, 000646)

R. Guillermin, P. Lasaygues and G. Rabau
Laboratoire de Mécanique et d'Acoustique, 31 chemin Joseph Aiguier, 13402 Marseille Cedex 20, France
Corresponding author E-mail: guillermin@lma.cnrs-mrs.fr

This study is concerned whith the ultrasonic imagery of elastic materials like cylinders or tubes by a diffraction tomography technic. Green's representaton is used to obtain an integral representation of the scattered field, and a discrete formulation of the inverse problem is obtained using a moment method. An iterative non-linear algorithm minimizing the discrepancy between the measured and computed scattered fields is used to reconstruct the sound speed profile in the target area. The minimization process is performed using a conjugated-gradient method. An experimental study with elastic targets immersed in water was performed. Cylindrical targets of various cross-sections have been selected. Inversions of both numerical and experimental data are presented and compared.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Adipose tissue imaging using ultrasound pulse subtraction cancellation ratio – (Contributed, 000802)

R.A. Fowler[a], J.-M. Mari[a], E. Canet-Soulas[b] and C. Lafon[a]
[a]Application des ultrasons à la thérapie, Pôle santé Lyon est, 151 cours Albert Thomas 69424 Lyon cedex 03; [b]Laboratoire de recherche en cardiovasculaire, métabolisme, diabétologie et nutrition, Faculté de Médecine Lyon Sud - BP 12 - 165 Chemin du Grand Revoyet - 69921 Oullins cedex INSA, Bât. IMBL, La Doua - 11 Avenue Jean Capelle - 69621 Villeurbanne Cedex
Corresponding author E-mail: andrew.fowler@inserm.fr

Non-linear Ultrasound imaging has been used extensively for enhancing the visualization of the accumulation of micro-bubble contrast agents. The goal of this study is to apply this approach to adipose tissue, a tissue type with a high non-linear coefficient, in order to enhance the visibility of visceral adipose tissue depots using ultrasound. The technique used in this study was pulse subtraction. This technique, implemented on an Ultrasonix RP 500 scanner with a 5 MHz centre frequency probe, is based on taking a single pulse Bb-mode image, then constructing a virtual image for a two pulse b-mode image, then subtracting this virtual image from an actual two-pulse b-mode im-

age. The imaging parameters were first optimized using both oil-based, and aqueous gel phantoms. The parameters were tested ex vivo using a section of pork belly, then the protocol was used in vivo to image the retroperitoneal fat depot on a healthy wistar rat. The ratio of cancellation for each pixel was then calculated and mapped. It was found that tissues with higher non-linear coefficients had a lower cancellation ratio.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Acoustic sources joint localization and characterization using compressive sampling – (Contributed, 000823)

A. Peillot[a], F. Ollivier[a], G. Chardon[b] and L. Daudet[b]
[a]UPMC - Institut Jean Le Rond d'Alembert, 2 place de la gare de ceinture, 78210 Saint Cyr L'Ecole, France; [b]Institut Langevin, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: francois.ollivier@upmc.fr

In this work, a Compressive Sampling (CS) strategy is developed in order to jointly achieve two complementary tasks regarding sound sources: localization and identification. Here, the sources are assumed sparse in the spatial domain, and greedy techniques are used for their localization. The case of coherent sources located in a plane is studied both numerically and experimentally at different frequencies. Results show that, in this framework, CS source localization is reliable using a significantly smaller number of microphones than classical techniques (standard or high resolution beamforming techniques), while overcoming some of their pitfalls. We then use a similar technique for the identification of the source nature, i.e. its radiation pattern, and here the sparsity domain is extended to a basis of elementary radiating functions. We present simulation and experimental results using calibrated sources and measurements performed with a 3D array of 80 randomly distributed microphones. This study investigates the limitations of Compressive Sampling in terms of resolution and reliability of the identification, with respect to the number of sensors, the signal to noise ratio and the density of the reconstruction region.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Ultrasonic characterization of yogurt fermentation process – (Contributed, 000827)

D. Izbaim[a], B. Faiz[a], A. Moudden[b], M. Malainine[a] and I. Aboudaoud[a]
[a]Faculté des sciences d'Agadir - Université Ibn Zohr, Département de physique,Faculté des sciences d'Agadir, B.P 8106 Agadir, Maroc, 80000 Agadir, Morocco; [b]Ecole Supérieure de Technologie d'Agadir, B.P 33/S Agadir, Maroc, 80000 Agadir, Morocco
Corresponding author E-mail: dizbaim@gmail.com

The objective of this work is to characterize the fermentation of yogurt based on an ultrasonic technique. Conventionally, the acidity of the yogurt is measured by a pH meter to determine the progress of fermentation. However, the pH meter should be cleaned and calibrated for each measurement and, therefore, this method is not practical. In this regard, ultrasonic techniques are fast, non-invasive and inexpensive. The measurement of ultrasonic parameters such as amplitude and time-of-flight of the echoes backscattered by samples of yogurt were able to provid information on the phases of the fermentation and so on the state of yogurt over time. The major contribution of this work is the detection with high precision the moment when the fermentation process should end to stop the growth of bacteria.

Tue-Frid Grande Halle MI - Measurement and instrumentation (Poster session)

Begining of fish defrosting by using non-destructive ultrasonic technique – (Contributed, 000844)

M. Malainine[a], B. Faiz[a], A. Moudden[b], D. Izbaim[a], G. Maze[c] and I. Aboudaoud[a]
[a]Faculté des sciences d'Agadir - Université Ibn Zohr, B.P 8106 Agadir, Maroc, 80000 Agadir, Morocco; [b]Ecole Supérieure de Technologie d'Agadir, B.P 33/S Agadir, Maroc, 80000 Agadir, Morocco; [c]LOMC, IUT, Université du Havre, Place Robert Schuman, Place Robert Schuman, 76610 Le Havre, France
Corresponding author E-mail: malaininemohamed@gmail.com

During the experiments carried out in the laboratory on the monitoring and study of fish thawing by ultrasonic technique. We had difficulties in detecting the begining of the thawing which is the main criterion of fish quality control. To correct the problem we use the singular value decomposition (s.v.d.) method which is a mathematical tool.This allowed us to show by the ultrasonic technique the thawing start for cod which is a fish that had an aver-

age fat content. The results were good with a central frequency transducer equal to 500 kHz. However for salmon which is a fish that had a high content of fat; and for centrals frequencies transducers above 500 kHz the observed results were not very good.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Effect of pavement temperature on the macrotexture of a semidense asphalt surface – (Contributed, 000213)

J. Luong, M. Bueno, V.F. Vázquez, U. Viñuela and S.E. Paje
UCLM-LA2IC, Av Camilo Jose Cela, s/n, 13071 Ciudad Real, Spain
Corresponding author E-mail: jeanne.luong@uclm.es

The temperature of the softening point of most bitumen is above 35°C. Increasing the pavement temperature could change the texture surface of the pavement. The aim of this work is to analyze the influence of the surface temperature on the macrotexture of a semidense asphalt pavement located in an urban area and a semidense asphalt sample in laboratory. The superficial macrotexture profiles at different surface temperatures were measured with the LaserStaticPG-LA^{2}IC and a texture scanner. The mean profile depth (MPD) and the texture spectra have been used for the macrotexture analysis. The analysis of the results shows that increasing pavement temperature does not necessary leads to a variation in the MPD index but a change of texture level has been observed for temperature superior to 40°C. Moreover this study has allowed observing the repeatability of the measurements realized with the new LaserStaticPG-LA^{2}IC and ensure another technique of road texture auscultation associating MPD and texture spectrum analysis to be used.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Using a genetic algorithm on the concept of an active anechoic multicellular layer – (Contributed, 000231)

T. Nicolas
Université Saint-Joseph, Campus des Sciences et Technologies, Faculté D'Ingénierie - ESIB, 11072050 Beyrouth, Lebanon
Corresponding author E-mail: tony.nicolas@usj.edu.lb

In previous paper we propose the concept of an active anechoic multicellular layer. This layer wraps the body of a submarine and the animation of this layer with an adequate algorithm makes the submarine anechoic to incidental sonar plane waves. The electronic architecture of this multicellular layer is based on a systolic model, more precisely on the architecture of a SIMD parallel computer (Single Instruction Multiple Data). Each cell of the layer acts independently and communicates by direct electronic links with its neighbors. All the cells do the same control algorithm on local data. The key of the anechoïcity of the layer is based on a parallel linear real time algorithm for the detection of the incident plane waves. In this article, we propose a new approach for detection of incident plane waves based on the evolutionary (genetic) algorithms. We also present a set of results that illustrate the improvement of the anechoicity of the layer.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Influence of texture spectra on CPX noise of SMA pavements – (Contributed, 000234)

J. Luong, V.F. Vázquez, M. Bueno, F. Terán and S.E. Paje
UCLM-LA2IC, Av Camilo Jose Cela, s/n, 13071 Ciudad Real, Spain
Corresponding author E-mail: victoriano.fernandez@uclm.es

This work presents an experimental study of the influence of road texture profiles on the close proximity (CPX) noise of road surface courses type Stone Mastic Asphalt (SMA), which were used for rehabilitation of a road section. Acoustical field characterization has been performed through the measurement of CPX noise spectra with TiresonicMk4-LA2IC. Road profiles along the test sections have been measured with a static profiling laser device. These profiles have enabled us to obtain, by numerical calculations, results of the Mean Profile Depth (MPD) calculated over a certain profile distance (baseline), and the Texture Profile Level (Lt) as a function of wavelength. One of the aims of this study was to analyse the relationship between texture spectra and the noise emitted by the tyre/pavement interaction. In addition, normal incidence sound absorption spectra of compacted SMA sample cores also have been measured using the two-microphone impedance tube.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Mechanical impedance and CPX noise of SMA pavements – (Contributed, 000235)

V.F. Vázquez and S.E. Paje
UCLM-LA2IC, Av Camilo Jose Cela, s/n, 13071 Ciudad Real, Spain
Corresponding author E-mail: victoriano.fernandez@uclm.es

CPX noise is the sound measured in close proximity to the tyre/pavement contact patch when a vehicle is rolling. The mechanical impedance or dynamic stiffness of the pavement is one of the factors involved in the generation of this type of noise. The reduction of the impact noise generation mechanism can be achieved with the construction of mixtures with lower dynamic stiffness. On the other hand, SMA mixtures, widely used in Europe, have come into use recently in Spain as a surface layer. The aim of this work, carried out by the Laboratory of Acoustic Applied to Civil Engineering (LA2IC), is to establish a stiffness indicator of the bituminous mixtures according to European Standards. Thus, the dynamic stiffness has been studied in different samples, and the results have been compared with test made on different SMA core samples, which have been taken from an experimental road section. Dynamic stiffness was measured with an impact hammer, an accelerometer and a data acquisition system. Laboratory results have been analyzed in order to establish the accuracy of the method and the relationship with the CPX noise.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Railway equivalent noise sources definition: ESM implementation and optimization – (Contributed, 000254)

E. Bongini[a] and H. Marcus[b]
[a]Innovation & Recherche SNCF, 40 Avenue des terroirs de France, 75012 Paris, France; [b]Institut d'Alembert - Université Pierre et Marie Curie, 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: hugomarcus@hotmail.com

Within the scope of a better integration of railway system in environment, prediction of trains pass-by noise is a growing concern for railway operators. SNCF has therefore developed the software VAMPPASS dedicated to pass-by noise simulation. The synthesis method implemented in VAMPPASS requires the definition of equivalent noise sources representative to real noise sources on the train. Equivalent sources definition is mainly based on experimental characterization. Measurement methods based on 1D-array devices have been optimized on a real train and post-processing methods have been developed for identifying mono-multipole equivalent sources, defined with the spherical harmonics formalism. This kind of method needs a heavy optimization process, applied on several parameters. It can imply large error coefficients on the radiated pressure field.

The present study aims to investigate the potential of Equivalent Source Method (ESM, a transfer matrix based method) to fulfil the requirements of VAMPPASS. In the first chapter, the ESM basis is presented. The second chapter is dedicated to the ESM implementation on a train scale model, with multi-monopoles or multi-dipoles equivalent sources. In the third chapter, improvements of the ESM for VAMPPASS requirements are discussed: genetic algorithm method has been used to optimize the equivalent noise sources locations.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

In Car rattle noise management – (Contributed, 000333)

F. Amadu and A. Fenieres
arkamys, 31 rue pouchett, 75017 Paris, France
Corresponding author E-mail: afenieres@arkamys.com

Rattling is an audible and unwanted noise radiated by structures and objects mechanically or acoustically linked to the loudspeakers.

The study presents a system of digital processes to prevent rattling that suppresses or reduces rattling whilst retaining the original perception of low frequency energy.

The principle is to generate low frequency harmonics which are subsequently added to the original signal. The loudspeakers are able to reproduce the harmonics correctly, before the ërattling frequencies' are removed. Thanks to the psychoacoustic effect known as the ëmissing fundamental' theory, the listener perceives a good low frequency rendering without being disturbed by the rattles.

The tasks are carried out in the following order: (1) Identify the frequency bands at which rattling occurs, (2) Use a low-frequency band to generate harmonics (including the rattling frequencies), (3) Add the harmonics to the origi-

nal signal, (4) Remove the energy at the frequencies which are causing the rattling.
By using this method, the bass rendering can be improved by avoiding rattle noise and pushing the loudspeaker into the low frequencies that the speaker or the doors cannot handle.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Inverse parametric optimization method for the characterization of the acoustic field radiated by a rail with a microphone array - Experimental validation with a modal shaker – (Contributed, 000438)

B. Faure[a], O. Chiello[b], M.-A. Pallas[b] and C. Servière[c]
[a]SNCF, Direction de l'Innovation et de la Recherche, 40, avenue des Terroirs de France, 75611 Paris Cedex 12, France; [b]IFSTTAR, 25 avenue F. Mitterrand, case 24, 69675 Bron Cedex, France; [c]Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex
Corresponding author E-mail: baldrik.faure@sncf.fr

For speeds up to 300 km/h, rolling noise is the main railway noise source. It arises from the acoustic radiation of various elements such as wheels, rails or sleepers. The rail, which mainly contributes to rolling noise at mid-frequencies and dominates from 500 Hz to 1000 Hz approximately, is an extended coherent source for which classical array processing methods are inappropriate to noise source identification. The properties of the acoustic field radiated by the rail are heterogeneous with regard to space and frequency, and depend on the vibration waves that propagate along the rail through the structural wavenumbers. In this paper, an inverse parametric optimization method is proposed to characterize the acoustic field radiated by a rail from microphone array measurements. The unknown parameters of a vibro-acoustical model (amplitudes and complex wavenumbers) are estimated through the minimization of a least squares criterion applied to the measured and modelled spectral matrices of the array. First, simulations are performed in order to appraise the performance of the method, in the case of vertical point excitations on the rail. This simple case is then validated experimentally for a single vertical point excitation using a modal shaker and a horizontal linear array.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Porous air inlet ducts: acoustic power radiated along the duct compared to nozzle noise – (Contributed, 000476)

M. Baudry
Tristone Flowtech Solutions, 1 rue du Tertre, ZI Nantes-Carquefou, 44300 Nantes, France, Metropolitan
Corresponding author E-mail: matthieu.baudry@tristone.com

The air intake systems of internal combustion engines are comprised of ducts and air boxes (e.g. air cleaner). The lengths of the ducts induce resonances that may be excited by the air pulsations generated by the air intake valves of the engine.
In cases of loud air intake noise, when acoustic devices cannot be used to counteract resonances, a common solution is to use porous ducts: non woven ducts, or ducts with slits (considered as local porosities). Such a solution has an important drawbacks: (1) Dust can fill the pores, leading to loss of effectiveness; (2) The acoustic power radiated along the duct increases.
The last issue is addressed here with measurements: the acoustic power radiated along the duct is compared to the acoustic power radiated by the nozzle, in different conditions (with or without porosity, homogeneous or discrete porosity, various airflow velocities).
The aim is to validate that porosities give a good balance between the decrease of nozzle noise resonances and the increase of radiated noise along the duct.

Tue-Frid Grande Halle NV - Noise and vibration engineering (Poster session)

Modeling of cylindrical baffle mufflers for low frequency sound propagation – (Contributed, 000660)

R. Binois[a], N. Dauchez[b], J.-M. Ville[c], E. Perrey-Debain[c] and G. Beillard[a]
[a]ALHYANGE Acoustique, 60 rue du Faubourg Poissonnière, 75010 Paris, France; [b]SUPMECA, 3, rue Fernand Hainaut, 93407 Saint Ouen Cedex, France; [c]Laboratoire Roberval, Rue Personne de Roberval, BP 20529 F-60205 Compiègne Cedex
Corresponding author E-mail: remy.binois@supmeca.fr

Baffle mufflers are widely used in building airflow systems. These mufflers are made up of diaphragms and porous materials inserted in constant section ducts. This work is focus on the low frequency range [63-500] Hz and considers a cylindrical geometry. The aim of this study is to predict the acoustic transmission loss of such silencer in order to improve its efficiency. The first step presented in this paper deals with the muffler insertion into an air-free flow networks using the transfer matrix method. Indeed an analytical low frequency approach computes the global transfer matrix of one cylindrical muffler, analogous to two diaphragms in series with porous material in-between. The first transverse mode is taking into account in the two discontinuities as well as a pseudo plane wave in the porous-air section [Journal of Sound and Vibration (2001) 243(3), 461-473]. Results are then compared with experiments and simulation by finite element method. The effect of the porous material thickness, the baffle length and geometry are finally highlighted.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Shock wave emission from ultrasound-induced cavitation bubbles – (Contributed, 000006)

E.-A. Brujan
University Politehnica Bucharest, Spl. Independentei 313, 060042 Bucharest, Romania
Corresponding author E-mail: eabrujan@yahoo.com

The final stage of the collapse of individual bubbles and hemispherical cloud of bubbles attached to a rigid boundary was investigated by ultra high-speed photography with up to 200 million frames/s. In the case of individual bubbles the shock pressure is as large as 8 GPa. In the case of an hemispherical cloud of bubbles two types of secondary shock wave emission were observed during cloud rebound. In the first case, the secondary shock wave emission is a consequence of the free collapse of a bubble within the cloud by the ambient pressure in the fluid. In the second case, it is a consequence of the interaction of the cloud-collapse-induced shock wave with microbubbles situated close to the collapse site of the cloud. The latter can be very powerful, resulting in a secondary shock wave emission with a maximum amplitude of about 0.5 GPa.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Développement de capteurs interdigités sur substrat piézoélectrique de type PZT pour la génération des ondes de surface en haute fréquence – (Contributed, 000033)

M. Duquennoy[a], O. Rigo[b], S. Hocquet[c], C. Courtois[d], J. Deboucq[a], M. Rguiti[d], L. Seronveaux[b], M. Ouaftouh[a], D. Vandormael[b], F. Jenot[a] and V. Lardot[c]
[a]IEMN-DOAE, Université de Valenciennes, Le Mont Houy, 59313 Valenciennes, France; [b]SIRRIS, Liège Science Park, Rue du Bois Saint-Jean 12, BE-4102 Seraing, Belgium; [c]CRIBC (membre d'EMRA), 4, Avenue Gouverneur Cornez, 7000 Mons, Belgium; [d]LMCPA, Université de Valenciennes, PECMA, Z.I. Champ de l'Abbesse, 59600 Maubeuge, France
Corresponding author E-mail: marc.duquennoy@univ-valenciennes.fr

Cet article porte sur la réalisation de capteurs interdigités (IDT pour Interdigital Transducer) sur des supports piézoélectriques PZT. L'enjeu est de disposer de capteurs dont la fréquence propre est la plus élevée possible afin de générer des ondes de surface ou de plaque haute fréquence. Dans la littérature scientifique, les fréquences maximales proposées sont de l'ordre de quelques mégahertz. Or pour analyser des matériaux revêtus avec des couches minces, il est nécessaire de disposer de capteurs travaillant à plus hautes fréquences pour obtenir une meilleure sensibilité des ondes ultrasonores vis-à-vis des paramètres physiques des couches permettant ainsi leur caractérisation. Une partie importante cet article est consacrée aux techniques permettant de réaliser des électrodes interdigitées à la surface des substrats PZT ayant des résolutions importantes. Les techniques testées sont des techniques basées premièrement sur l'ablation et la gravure laser et d'autre part sur l'impression d'encre. Les impératifs de réalisation de ces capteurs interdigités imposent premièrement des largeurs d'électrodes extrêmement faibles et deuxièmement de s'adapter aux caractéristiques intrinsèques des PZT avec en particulier une porosité et une rugosité relativement importantes. Les études ont permis d'obtenir des capteurs IDT adaptés à une gamme de fréquences comprises entre 2 et 25 MHz sur PZT.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Picosecond acoustics in diamond anvils cells: the combination of extrems – (Contributed, 000099)

S. Ayrinhac[a], F. Decremps[a], L. Belliard[b], M. Gauthier[a] and B. Perrin[c]
[a]Institut de minéralogie et de physique des milieux condensés, Campus Boucicaut 140, rue de Lourmel 75015 - Paris; [b]Institut des

Nanosciences de Paris, Campus Boucicaut 140 rue de Lourmel 75015 Paris; [c]INSP, 4 place Jussieu, 75252 Paris, France, Metropolitan
Corresponding author E-mail: frederic.decremps@impmc.upmc.fr

The main objective of this communication is to demonstrate the relevancy of recent technological break-through in hypersonic measurements under extreme conditions through the circumscribed studies of metallic compounds. Sound velocity measurements under high pressure and high temperatures in many different samples (single-crystalline metal and semiconductor, pure iron or liquid mercury) will illustrate the capabilities of major progress on ultrafast acoustics instrumentation and diamond anvils design during the last three years [Phys. Rev. Lett. 100, 3550 (2008); Rev. Sci. Instrum. 80, 73902 (2009); Phys. Rev. B 82, 104119 (2010)].

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Recovering the weak and lost sources in the Sea Acoustic – (Contributed, 000164)

S. F. Pakzad[a] and T. Jeandroz[b]
[a]ALSF, 9 Avenue Marcel Perrin, 95540 Mery Sur Oise, France; [b]LTRT, 3 rue du Marolet, 95430 Auvers Sur Oise, France
Corresponding author E-mail: acoustic@alsf-lab.com

Sea Acoustic is a nonlinear Function for the sound and Ultrasound Perception. All types of unwanted signals are considered as noise. Contrary to the common believes, the noise is never added to the information. The information is "correlatedï with noise. And the information is never lost, regardless of how weak or small, even when the signal level is below noise level it is never lost and can be recovered by "de-correlationï. Two kind of Noise are predominant in the sea acoustic domain: Multi path received signals; Multi source received signals; These two groups of signals are correlated or modulated with the desired signals and will generate a reshaped signal that can be very different from the original signal. As described above, even in the case of the two known acoustical sources, their correlation is too complex to be analyzed theoretically by known mathematical formulas. Now if one of the known sources is replaced by noise (RANDOM and UKNOWN), the complexity of the equations is even higher. Our solution is the recognition and extraction and distinction of all the sources included the lost or buried sources under noise inside this concert.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Lamb waves propagation in functionally graded piezoelectric materials with exponential variation – (Contributed, 000189)

M. Ben Amor[a] and M.H. Ben Ghozlen[b]
[a]Institut Préparatoire aux Etudes d'Ingénieurs de Sfax, Rte Menzel Chaker km 0.5, 3018 Sfax, Tunisia; [b]Faculté des Sciences de Sfax, Rte Soukra km 3.B.P. 1171, 3000 Sfax, Tunisia
Corresponding author E-mail: morched_benamor@yahoo.fr

Aluminum nitride (AlN) Lamb wave devices utilizing the lowest order symmetric (S0) mode have attracted interests for wireless communication systems. The (S0) mode has a high phase velocity, thus being suitable for high frequency applications. In this work, the propagation of the fundamental symmetric (S0) Lamb wave mode in a functionally graded piezoelectric material is investigated by Peano-series method. We here assume that all material properties of the piezoelectric layer have the same exponential function distribution along the depth direction. The effects of the gradient variation of material constants on the phase velocity and the coupled electromechanical factor are obtained. It can be seen that the gradient coefficient has a strong influence on the electromechanical coupling factor. The highest value of the electromechanical coupling factor shifts to the high frequency zone with an increase in the magnitude of the gradient coefficient, which can be used to design different SAW sensors with high performance working at different frequencies by adjusting the extent of the gradient property.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Characterisation of vanadia doped titania nano thin film using acoustical and other techniques – (Contributed, 000232)

J. Irudayaraj
St. Joseph's College, Trichy, GRACE House, 39, 4th CROSS WEST, GOKULAM NAGAR, KATTUR, 620 019 Trichy, India
Corresponding author E-mail: jnaadarsh@hotmail.com

The functional characteristics of a nano thin film/coating depends critically upon its interface characteristics and adhesion to the substrate. The acoustical and mechanical properties of nano thin films and multilayer assemblies are important both for technological applications of these materials and for basic scientific studies of their physical behavior. This report presents the characterisation on the synthesised vanadia (4 mol.%) doped titania (TiO2) nano films by acoustical and other techniques. The acoustical, optical and structural characteristics of TiO2 films on Si (100) and quartz-glass substrates have been investigated. The surface acoustic wave properties of Vanadia doped TiO2 films were presented. Acoustical characterisation has been done with High frequency ultrasound sensors. They have been well correlated with the X-Ray diffraction, SEM, and UV- visible spectroscopy studies.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

A portative celerimeter for measurement and analysis of compressional speed and attenuation in marine sediments: description and first results – (Contributed, 000281)

X. J. Demoulin[a], L. Guillon[b], R. Bourdon[c], L. Dufrechou[c], P. Guyomard[d] and T. Garlan[d]
[a]MAREE, Parc technologique de Soye, Espace Crea - 15 rue Galilée, 56270 ¨ ploemeur, France; [b]Institut de recherche de l'Ecole Navale, Ecole Navale, 29240 Brest Cedex 9, France; [c]RTSYS, 34 ZA de Kervidanou, 29300 Mellac, France; [d]SHOM, CS92803, 29228 Brest Cedex 2, France
Corresponding author E-mail: xdemoulin@maree.fr

Geoacoustic parameters of the seafloor are required for accurate sonar prediction and analysis of seismic reflection profiles, especially in shallow water. They are generally established by means of empirical relations. The presented work is part of CARASEDIM, an experimental project devoted to refine these geoacoustical relations in marine sediments, including coarse sands. We focus on the results of the celerimeter prototype that has been developed for that purpose. This portative device is equipped with two emitting probes and two receiving probes allowing to transmit signals between 40kHz and 400kHz. It is designed to both laboratory and in-situ measurements. We discuss about the processing techniques, the protocole of measurement and about the first results. Some laboratory results are presented in both real coarse sands and artificial glass beads. They are compared with theoretical models of sound propagation in sediments based on various assumptions (fluid, visco-elastic, porous...).

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

In vivo assessment of corneal shear anisotropy using supersonic shear wave imaging – (Contributed, 000285)

T.-M. Nguyen[a], J.-F. Aubry[a], D. Touboul[b], J. Bercoff[c] and M. Tanter[a]
[a]Institut Langevin Ondes et Images, 10 rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France; [b]Centre Hospitalo-Universitaire de Bordeaux, Place Amélie Raba-Léon, 33000 Bordeaux, France; [c]SuperSonic Imagine, 510 Rue René Descartes, Les Jardins de la Duranne - Bât E & F, 13857 Aix-En-Provence, France
Corresponding author E-mail: thu-mai.nguyen@espci.fr

The cornea is mainly composed of fibrillar collagen. The fibers organization ensures the cornea transparency and determines its biomechanics. Understanding these properties is a crucial issue in ophthalmology to improve the management of refractive surgery. Here, we propose Supersonic Shear Wave Imaging (SSI) for the *in vivo* assessment of the corneal elastic anisotropy. The tissue shear modulus can be retrieved from the speed of a shear wave propagating through the tissue. In the SSI technique, the shear wave is induced and tracked using an ultrafast (30000 frames/sec) ultrasonic scanner (Aixplorer, SuperSonic Imagine). We performed *in vivo* 3D scans on porcine eyes. Elasticity maps exhibited significantly higher shear wave speed along the horizontal meridian of the cornea (8.7 ± 0.3 m/s) than along the diagonal and vertical directions (6.6 ± 0.2 m/s). *Ex vivo* X-ray diffraction measurements [The Anat. Rec. 290, 1542-1550 (2007)] have shown that the collagen fibers have one preferential orientation in porcine corneas. The elasticity maps obtained *in vivo* using SSI are consistent with *ex vivo* results reported in literature, demonstrating the sensitivity of SSI to collagen fibers orientation.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Structural Health Monitoring of Smart Composite Material by Acoustic Emission – (Contributed, 000352)

S. Masmoudi[a], A. El Mahi[a], S. Turki[b] and R. El Guerjouma[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9;

[b]Faculté des Science de Sfax, Département physique, B.P. 1171, 3000 Sfax, Tunisia
Corresponding author E-mail: masmoudi.sahir@yahoo.fr

This paper presents a health monitoring study of composites incorporating integrated piezoelectric sensors. Firstly, experimental research is focused on examining the effects of the embedded sensors on the structural integrity of composites subjected to flexural loads. A series of specimens of composite with and without embedded piezoelectric sensors were fabricated in E-glass fibre/epoxy with a unidirectional play laminate. The composite specimens with sensors embedded in the mid-plane and without sensors were tested in three-point bending tests in static and creep loading while continuously monitoring the response by the acoustic emission (AE) technique. The AE signals were analysed using the classification k-means method in order to identify the different damages and to follow the evolution of these various mechanisms for both types of materials (with and without sensors). The static flexural tests indicate that the ultimate strength of the embedded composites is reduced, while the elastic modulus is not significantly affected. The acoustic emission analysis shows that the integration of the sensor presents advantages of the detection of the acoustic events.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Direct and inverse scattering of transient acoustic waves by a double-layered porous materials having an elastic frame – (Contributed, 000360)

M. Sadouki[a], M. Fellah[a], Z.E.A. Fellah[b], E. Ogam[b] and C. Depollier[c]
[a]Laboratoire de Physique Théorique, Faculté de Physique, USTHB, BP 32 El Alia, Bab Ezzouar, 16111 Bab Ezzouar, Algeria; [b]LMA – CNRS (UPR 7051) / Aix-Marseille University, 31 chemin Joseph Aiguier, 13402 Marseille, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: sad.mus17@yahoo.fr

The direct and inverse scattering problems of ultrasonic wave propagation in double-layered porous materials is studied. The inverse problem is solved using experimental transmitted waves at normal incidence. The double-layered porous media consist of two slabs of homogeneous isotropic porous materials with an elastic frame. The ultrasonic propagation in multilayered porous material is modelled using Biot's theory. The sensitivity of the Biot parameters with respect to the transmitted wave is studied showing the e-ect on each parameter on transmitted waveforms. The direct and inverse scattering problems are discussed for double-layered porous samples using experimental transmitted waves

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Acoustic properties of perforated plates and screens – (Contributed, 000370)

H.L. Ruiz Villamil[a], P. Cobo[a], T. Dupont[b] and P. Leclaire[b]
[a]Centro de Acústica Aplicada y Evaluación no Destructiva, Calle Serrano 144, 28006 Madrid, Spain; [b]LRMA-DRIVE, ISAT, 49 rue Mademoiselle Bourgeois - BP 31, 58027 Nevers, France
Corresponding author E-mail: Philippe.Leclaire@u-bourgogne.fr

In previous works, an acoustic model for Microperforated Insertion Unit (MIU), was developed to determine the input impedance of a system composed of a thin mesh (or screen) glued onto a perforated plate. An alternative approach is proposed by means of the equivalent fluid model of Johnson-Champoux-Allard involving five physical parameters: the tortuosity, the thermal and viscous characteristic lengths, the porosity and the flow resistivity. The input impedance of a multiple layer system can then be found by use of the transfer matrix method. Since the meshes have fairly simple structures, it was possible to model an elementary representative cell and to use calculated values for the five parameters. The resistivity was also evaluated from absorption measurement for the screen alone in an impedance tube. For the thermal and viscous characteristic lengths, the calculated values were also compared to measurements obtained from a microscope image of the elementary cells of the screen. A hybrid model using the theory by Maa for the perforated plate and the theory by Johnson-Champoux-Allard for the micrometric mesh was developed. This model is in very good agreement with experimental results.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Ultrasonic transducers based on curved lead-free piezoelectric thick films for high resolution medical imaging – (Contributed, 000405)

F. Levassort[a], K. Astafiev[b], R. Lou-Moeller[b], J.-M. Grégoire[a], L. Nielsen[b], W.W. Wolny[b] and M. Lethiecq[c]
[a]Université François Rabelais de Tours, UMRS Imagerie et Cerveau, 10, boulevard Tonnellé, BP 3223, 37032 Tours Cedex 01, France; [b]Meggitt A/S, Hejreskovvej 18A, DK-3490 Kvistgaard, Denmark; [c]Université François Rabelais de Tours, GREMAN, ENIVL, Rue de la Chocolaterie BP 3410, 41034 Blois, France
Corresponding author E-mail: franck.levassort@univ-tours.fr

KNN-based lead free ferroelectric materials are receiving much attention due to their high electromechanical properties that make them promising candidates to replace the lead-based piezoceramics that will eventually be banned by environmental regulations in many countries over the world. Studies include the development of KNN thick films that are particularly well adapted for high frequency applications due to higher wave velocities and a dielectric constant in an acceptable range for single element transducers. Here, a KNN based thick film is deposited on a curved substrate by pad-printing in order to be used in a focused high frequency transducer. This substrate is a porous lead-free KNN cylinder specifically developed to exhibit the required acoustical properties of a backing (acoustical impedance, high attenuationoe) and is compatible with the high sintering temperature of the KNN thick film. Electromechanical properties of the piezoelectric thick film in thickness mode were deduced (kt over 35%). This structure was used to fabricate a transducer which was characterized (relative bandwidth over 90%). Finally this transducer was integrated in a high frequency imaging system and its performance allowed skin images to be produced. To conclude, the replacement of lead-based high frequency transducers by "greenï devices is a viable option.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Fast simulation of nonlinear radio frequency ultrasound images in inhomogeneous nonlinear media: CREANUIS – (Contributed, 000499)

F. Varray[a], M. Toulemonde[a,b], O. Basset[a] and C. Cachard[a]
[a]Centre de recherche en applications et traitement de l'image pour la santé, 7 avenue Jean Capelle, Bat Blaise Pascal, 69621 Villeurbanne Cedex; [b]Department of Electronics and Telecommunications [Florence], Via S. Marta, 3 50139 Firenze
Corresponding author E-mail: francois.varray@creatis.univ-lyon1.fr

The simulation of ultrasound image is usually based on two main strategies: either a linear convolution or the use of an acoustics model. However, only the linear propagation of the pressure wave is considered. CREANUIS is a recent simulation tool (freely available on the Internet: http://www.creatis.insa-lyon.fr/site/en/CREANUIS) which implements the nonlinear propagation of the wave to create realistic ultrasound images [Varray et al., IEEE International Ultrasonics Symposium 201] and opens new simulations perspectives based on nonlinear propagation: amplitude modulation, pulse inversion, second harmonic inversion...
The nonlinear propagation in CREANUIS is simulated using a generalization of the angular spectrum method (GASM). This approach is implemented on a graphic processing unit (GPU) for a fast computation. Moreover, in GASM simulation, the possible inhomogeneity of the nonlinear parameter can be considered. It directly impacts the increase of the harmonics during propagation and consequently the resulting RF image. These resulting images perfectly translate the nonlinear parameter change in the medium. Finally, the total computation time for CREANUIS (fundamental and second-harmonic image) compared to FieldII (fundamental image only) is reduced by a factor comprised between 2 and 4 according to the geometric considerations.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Theoretical study and numerical simulation of pulsed ultrasonic field emitted by a phased-array transducer and reflected by a fluid-fluid interface – (Contributed, 000509)

A. Oudina, H. Djelouah and N. Maghlaoui
Houari Boumediene University of Sciences and Technology, USTHB, BP 32, El Alia, DZ-16111 Algiers, Algeria, 16111 Algiers, Algeria
Corresponding author E-mail: hkourgli@yahoo.fr

This study is devoted to the calculation in transient mode, of the acoustic field transmitted and received by an ultrasonic linear array after a reflection at a fluid-fluid interface. This calculation is based on the theoretical model of a spherical wave pulse emitted by a point source reflected from a plane interface separating two fluid media, and detected by a point receiver. This model uses a Fourier transform in the time space followed by a Hankel transform on space variables. By using this method, the reflected field is expressed under the form of integrals numerically evaluated by Gauss integration methods. The superposition principle is then applied to calculate the resulting field received by a set of receiving elements of the array and radiated by the same or by another set of the array elements. The results obtained for different configurations of the linear array and different delay laws, both on transmission and reception, are interpreted by using the ray model and by studying the particularities of the phenomena appearing at the critical angles. Keywords: Interface, linear array, fluid, spherical wave.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Peculiarities of photon-phonon interaction in femtosecond delay lines using phenomenon of strong elastic anisotropy in crystals – (Contributed, 000538)

V. Molchanov, S. Chizhikov, O. Makarov and K. Yushkov
MISIS, Leninsky prospect 4, 119049 Moscow, Russian Federation
Corresponding author E-mail: v.ya.molchanov@gmail.com

Acousto-optical dispersive delay lines seem to be almost the ideal instrument for adaptive shaping of femtosecond laser pulses. We present the main consideration to the specific schemes of quasicollinear interaction of light and ultrasound in crystals by using strong acoustic anisotropy of the media as well as acoustic wave reflection from the facets of the crystal. The phenomena of strong acoustic anisotropy offer novel areas in development of light dispersive delay lines. Different experimental delay lines were designed and fabricated on base of paratellurite, lithium niobate and KDP single crystals. Experimental research was performed on high-power ultrafast laser systems. The obtained results were in a good agreement with theoretical predictions.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Characterization by laser-ultrasonics of thin film/substrate structure: application to the detection of microcracks – (Contributed, 000543)

S. Fourez, F. Jenot, M. Ouaftouh, M. Duquennoy and M. Ourak
IEMN-DOAE, Université de Valenciennes, Le Mont Houy, 59313 Valenciennes, France
Corresponding author E-mail: Sabrina.fourez@univ-valenciennes.fr

Surface coatings are often used in electronic, microelectronic or optic and their characterization is usually a major issue. For example, thickness control of coated materials and microcracks detection are very important. In this work, the sample consists of a micrometric gold thin film deposited by evaporation on a silicon substrate. Surface acoustic waves generated and detected by laser are used for non destructive testing. This method has the advantage to be a contactless technique with a large bandwidth. In a first part, the film thickness influence on the first Rayleigh mode has been theoretically studied. Then, the effect of a film thickness variation has been highlighted. In order to predict the propagation of the first Rayleigh mode, a finite element method is also presented. Finally, the interaction of this mode with microcracks is theoretically and experimentally investigated.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Temperature dependence of elasticity of poro-elastic layer – (Contributed, 000557)

C. Glorieux[a], J. Descheemaeker[a], J.-P. Groby[b], L. Boeckx[c] and P. Khurana[d]
[a]K.U. Leuven, Celestijnenlaan 200D, 3001 Heverlee, Belgium; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]VK Engineering, Axxes Business Park, Guldensporenpark Building A n° 4, 9820 Merelbeke, Belgium; [d]Katholieke Universtiteit Leuven, Laboratorium voor Akoestiek en Thermische Fysica, Celestijnenlaan 200D, B-3001 Leuven, Belgium
Corresponding author E-mail: christ.glorieux@fys.kuleuven.be

Besides their structural complexity, the acoustic behaviour of polymer-based poro-elastic layers is also complicated due to their frequency dependent elasticity. In this work, we address the frequency and temperature dependence of the elastic behaviour in general, and the shear modulus in particular, of poro-visco-elastic materials. The analysis is based on the monitoring of mechanically excited guided acoustic wave propagation by means of a laser Doppler vibrometer scanning technique. The concept and practical implementation of the experimental method are presented, as well as the signal processing procedure and data analysis. Conclusions are drawn concerning the specific visco-elastic behavior of mechanically relaxing materials in a porous morphology.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Ultrasonic monitoring of the in-situ polymerization of carbon fiber based thermoplastic composite materials – (Contributed, 000594)

C. Mechri, R. El Guerjouma and M. Bentahar
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: mourad.bentahar@univ-lemans.fr

Composite materials have grown an increasing interest in the last decade. They present the advantage of reducing weight keeping an excellent weight to strength ratio. These materials found application in various fields such as aerospace, automobile etc. In the aeronautic field, replacing aluminum by carbon fiber based composite (CFC) allows a weight gain of 50 %. On the other hand, CFC has some inconvenience; the relatively high production cost and the process time that reaches few hours. Therefore, the in-situ monitoring of the physical properties, namely mechanical of such structure is of extreme importance. In this communication, we report the results of the monitoring of epoxy resin polymerization during the curing process. An experimental set-up was developed in order to measure in real time the evolution of elastic modulus. Depending on temperature, we could monitor the different phases of the polymerization process from the mechanical point of view. In fact we could observe a three-phase-polymerization process; softening of the material, hardening and finally stabilization of the mechanical properties. On the other hand, acoustic absorption was studied. This parameter exhibit an important change during the phase transition.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

The measurement of complex intensity near the open end of a flanged cylindrical pipe – (Contributed, 000596)

J. Prisutova and K. V. Horoshenkov
University of Bradford, Great Horton Road, BD7 1DP Bradford, UK
Corresponding author E-mail: J.Prisutova@student.bradford.ac.uk

The measurement of acoustic intensity assumes taking the time average of the energy flow and treating the intensity as a real quantity. However, one may extract additional information if the intensity is viewed as a complex quantity which contains information about the local mean energy flow and local energy oscillations. In this paper experiments are reported using a tri-axial Microflown intensity probe to measure the complex instantaneous intensity near the open end of a flanged pipe. The measurements are then used to quantify the energy travelling out of the pipe and the energy oscillating back and forth inside the pipe. This has a potential significance for acoustic detection of structural and operational conditions inside the pipe as one would expect oscillating energy to be increased and travelling energy to be decreased in the presence of a cross-sectional change. These experiments are carried out in the high frequency range to show the interaction between a plane wave and the first circumferential mode. Here, the amplitude of the circumferential mode is found to be strongly related to the relative position of the source in the pipe, and the complex intensity is seen to change in transverse as well as the axial direction.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Bubbly liquid with multi-size bubble population – (Contributed, 000628)

S. Kovinskaya
Mechmath LLC, 14530 Bluebird Trail, Prior Lake, 55372, USA
Corresponding author E-mail: mechmath@mechmath.com

Linear pressure waves in compressible fluids with multi-size bubble population are considered. The dispersive equation is investigated to determine the essential frequency band for the each sub-population. Separation of the resonance frequency bands of the neighboring sub-populations as an equilibrium criterion allows for determination of the bubble size distribution that matches experimental data. The energy radiated by the bubbles belonging to each sub-population is found. A dependency of the radiated energy on wavenumber is found. The developed model lets to understand the fundamental physical processes leading to the -5/3 power law scaling of oceanic ambient noise level with frequency known as the Knudsen spectrum.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Ultrafast plane wave imaging: application to spectral Doppler – (Contributed, 000631)

B.-F. Osmanski, G. Montaldo and M. Tanter
Institut Langevin ESPCI ParisTech - CNRS UMR 7587 - INSERM U979, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: bruno-felix.osmanski@espci.fr

Conventional ultrasound Doppler techniques are based on focused beam to insonify the medium which leads to a tradeoff between the field of view and the resolution: a limited amount of 15 temporal points for 2D imaging mode or only one line for pulse wave mode. Recently, the introduction of ultrafast plane wave imaging has enabling acquisitions of hundreds of temporal samples over a large field of view. This huge amount of data can be used in different ways than in conventional Doppler modes to extract information about the flow. First, using properties of Doppler spectrum and calibrated data, we retrieve the out of plane speed vector component in transverse flow acquisitions, improving a previous technique called spectral broadening. An experimental demonstration is performed in vivo on a carotid artery. Secondly, we study how ultrafast plane wave acquisitions allows to withdraw the geometric broadening on Doppler spectrums to visualize only the speed and its gradient. This new technique becomes highly sensitive to the type of the flow profile and turbulences. A comparison between this technique and conventional pulse wave Doppler is performed in vivo on the carotid artery.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Semi-analytical characterisation of a homogeneous rigid frame porous material using P-P probes – (Contributed, 000650)

B. Brouard[a], J.-P. Groby[a], D. Parmentier[b], O. Dazel[a], L. Kelders[c] and M. Henry[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Centre de Transfert de Technologie du Mans, 20 rue Thalès de Milet, 72000 Le Mans, France; [c]Laboratory of Acoustics and Thermal Physics, KULeuven, B-3001 Heverlee, Belgium
Corresponding author E-mail: bruno.brouard@univ-lemans.fr

A new experimental set-up is presented for the characterisation of a homogeneous rigid frame porous material.
Acoustical pressures are measured in front of and behind a porous plate using a P-P probe in an anechoic room. The equivalent density $\rho_{eq}(\omega)$ and bulk modulus $K_{eq}(\omega)$ of the porous medium are then analytically recovered from measurements. A numerical inversion procedure using the least square method allows us to obtain a good estimation of the five following acoustical parameters: the porosity ϕ, the tortuosity α_∞, the flow resistivity σ, the viscous characteristic length Λ and the thermal characteristic length Λ'.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Determination of the Boltzmann constant with an acoustic quasi-spherical resonator filled with argon – (Contributed, 000704)

A. Guillou, L. Pitre, F. Sparasci, D. Truong, L. Risegari and M. E. Himbert
Laboratoire Commun de Métrologie, 61 rue du Landy, 93210 La Plaine Saint Denis, France
Corresponding author E-mail: arnaud.guillou@cnam.fr

There is an important interest in the international metrology community for new accurate determinations of the Boltzmann constant k_{B}, in order to redefine the unit of thermodynamic temperature, the kelvin. The value of the Boltzmann constant is linked to the speed of sound c in a noble gas. The method described here consists in measur-

ing c inside a quasi-spherical acoustic resonator of inner volume of 0.5 l filled with argon, during an isotherm process at the temperature of the triple point of water (273.16 K) from 0.05 MPa to 0.7 MPa. The determination of k_B at LNE-LCM CNAM with this technique allowed us to obtain the value k_B = 1.380 647 74 (171)$\cdot 10^{-23}$ J$\cdot$K^{-1}, i.e. with a relative uncertainty of $1.24\cdot 10^{-6}$. In this paper, we particularly focus on the parameters of the experiment which have an effect on the measurement of c with this method (like gas purity, static pressure, etc) and how they were carefully controlled to get the lowest uncertainty on k_B up to now.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Modelling tools for the simulation of microgenerators based on piezo-semiconducting nanowires – (Contributed, 000732)

O. Graton[a], G. Poulin-Vittrant[a], L.-P. Tran Huu Hue[a] and M. Lethiecq[b]
[a]Université François Rabelais, ENIVL, Rue de la Chocolaterie, 41034 Blois, France; [b]Université François Rabelais de Tours, GREMAN, ENIVL, Rue de la Chocolaterie BP 3410, 41034 Blois, France
Corresponding author E-mail: olivier.graton@univ-tours.fr

Novel mechanical energy micro-harvesters using ZnO nanowire (NW) arrays as active elements have recently appeared. The electrical power generation process is based on the coupling between piezoelectric and semiconducting properties of ZnO NWs. We have developed two specific models to simulate the electromechanical conversion that occurs in mechanically activated NWs and to predict the performance of NW-based microgenerators. These models, based on two distinct approaches, take into account both the piezoelectric effect and semiconducting properties of NWs. An original analytical numerical model is dedicated to the simulation of the intrinsic electromechanical conversion that occurs in a bent NW in the presence of free charge carriers. In addition, a modelling strategy was specifically developed in order to establish a dynamic model of NW-based microgenerators without falling into the different pitfalls relative to the simulation of ZnO nanowires. These two approaches are complementary and are helpful for the physical understanding of the device operation. Moreover, it indicates tendencies to optimise the generator performance. The energy conversion efficiency is maximised for high aspect ratio NWs and an optimal concentration of impurities, both in the case of a single deformed NW and for a NW array microgenerator.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Using a boundary element method to validate the concept of an active anechoic multicellular layer – (Contributed, 000738)

T. Nicolas
Université Saint-Joseph, Campus des Sciences et Technologies, Faculté D'Ingénierie - ESIB, 11072050 Beyrouth, Lebanon
Corresponding author E-mail: tony.nicolas@usj.edu.lb

In previous paper we propose the concept of an active anechoic multicellular layer. This layer wraps the body of a submarine and the animation of this layer with an adequate algorithm makes the submarine anechoic to incidental sonar plane waves. To validate this concept we sent a plane wave to a flat square layer, then we animated this latter with the adequate algorithm described above, and deduce the conditions that made the layer anechoic. At this level, and based on the deduced conditions, we calculated the field radiated in space using the boundary finite element method. In this article, we describe the process of the calculation, the formal calculation of the singular integrals and we present the results that validate the concept of the active anechoic multicellular layer we propose.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Now casting Anthropogenic Ocean Noise in High Pressure Areas – (Contributed, 000782)

T. Folegot[a], C. Gervaise[b], Y. Stephan[c], D. Clorennec[a] and B. Kinda[d]
[a]Quiet-Oceans, 135, rue Claude Chappe, 29280 Plouzane, France; [b]Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex; [c]Service Hydrographique et Océanographique de la Marine, 13 rue du Chatellier 29200 Brest; [d]Extraction et Exploitation de l'Information en Environnements Incertains, 2 rue François Verny, 29806 Brest cedex 9, France
Corresponding author E-mail: thomas.folegot@quiet-oceans.com

In order to address the issue of ambient noise monitoring under the Marine Strategy Framework Directive, a global anthropogenic noise prediction system called Quonops© has been designed similarly to meteorological forecasting systems. Quonops© combines real-time environmental data and real-time human information and assimilates real-time acoustic measurements to produce the resulting 3D ocean noise fields as a function of time. The system has been thought to cover most basins and activities. The French Hydrographic Office and ENSTA Bretagne have conducted a monitoring experiment in the West-end of the British Channel in the vicinity of the Ushant traffic separation scheme. Two hydrophones were deployed at about mid-depth, one at the border of the south-going route, another 10NM off the same route. It has been observed that even with high noise levels, the measure is likely to be affected by local events, inducing up to 30dB dynamics at the scale of hours. Quonops© has been implemented to now-cast the low frequency noise in the same area. The comparison at the hydrophone locations of the prediction and measurement has shown good agreement, predicting in particular the statistical and stochastic content of the ambient noise in such a high pressure area.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Interaction of elastic waves with a cylindrical nano-inclusion – (Contributed, 000790)

S. Sodagar
Petroleum University of Technology, Abadan Institute of Technology, North Bovardeh, Postal code 63165, 0 Abadan, Iran
Corresponding author E-mail: sodagar@mie.utoronto.ca

At nanoscale, surface and interface have significant effects on the physical and mechanical properties of solids, due to the increasing ratio of surface/interface area to volume. The diffraction of plane compressional and shear waves by a cylindrical nano-inclusion are investigated in this paper. To account for the effect of surface/interface energy at nanoscale, the surface/interface elasticity is adopted in analysis. The mathematical modeling shows that surface/interface parameter has significant effect on the diffraction of elastic waves when the radius of the inclusion decreases to nanometers. However, the numerical results show that beyond a critical interfacial parameter, the surface/interface effect does not affect on the diffracted wave from the nano-inclusion and the form function becomes independent of variation of the surface/interface energy.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Scattering of complex geometries by Finite Element Method – (Contributed, 000798)

N. González-Salido[a], A. Islas-Cital[b], F. Camarena[a], R. Pico[a] and P.R. Atkins[b]
[a]Universidad Politecnica de Valencia, Paranimf 1, 46730 Gandia, Valencia, Spain, 46730 Gandia, Spain; [b]University of Birmingham, School of Electronic, Electrical & Computer Engineering, Gisbert Kapp Building, University of Birmingham, Edgbaston, B15 2TT Birmingham, UK
Corresponding author E-mail: rpico@fis.upv.es

The back-scattering of complex finite geometries targets to plane incoming waves is investigated. The information obtained from the echoes (amplitude and phase) is used to characterize certain properties of the scatterers as the shape, size or orientation. Simple geometries as spheres, cylinders and spheroids are often used in underwateracoustic and medical imaging to model the different the scattering of structures, such as fish swim bladders, blood cells, or the fibbers of heart.
Theoretical models include the effects of diffraction, reflection and transmission adapted to the shape, composition and size relative to the wavelength of the different objects. In particular, there are analytical solutions derived by Faran forsimple geometries such as sphere and cylinder, but for the other cases, numerical methods like T-matrix, or approximate simple solutions must be used.

In this work, the finite element method was used to model the scattering from submerged targets with these simple geometries and elastic and rigid boundary conditions. A vibroacoustic model is used to couple the structure with the surrounding fluid medium. Numerical results show good agreement when compared with theoretical predictions and experimental data.

Tue-Frid Grande Halle PU - Physical acoustics and underwater acoustics (Poster session)

Attenuation of acoustic waves in Lithium Niobate crystals with impurities – (Contributed, 000801)

F. R. Akhmedzhanov[a] and F. N. Juraev[b]
[a]Samarkand state university, 8 passage 1, Firdavsi street, 140105 Samarkand, Uzbekistan; [b]Navoi state mining institute, 27a, Yuzhnaya street, 210100 Navoi, Uzbekistan
Corresponding author E-mail: farkhad2@yahoo.com

The attenuation of longitudinal and transverse acoustic waves in pure and doped by Mg, Zn, Cu and Cr impurities Lithium Niobate crystals has been investigated. The examined samples LiNbO3 crystals were oriented along the crystallographic axes. Piezoelectric transducers of Lithium Niobate of appropriate cuts are used to excite the longitudinal and the transverse acoustic waves with the frequencies of 0.4-1.8 GHz. The attenuation of acoustic waves was determined by Bragg light diffraction method at the temperatures of 295 and 480 K with accuracy about 5%. The results of these measurements have been shown that the influence of impurities on the attenuation of longitudinal or transversal waves is different. The impurities of Cu, Zn, Mg reduce the decrease of attenuation the longitudinal waves in 1.5-2 times and insignificantly increase of the attenuation of the transversal waves. The obtained results are interpreted in the framework of various mechanisms of attenuation including the electron-phonon and Akhiezer mechanisms. The attenuation of the transversal waves depends also from effective Grunaizen parameter which describes the anisotropy of the phonon-phonon interaction. Moreover the influence of dielectric losses on the attenuation of piezo-active acoustic waves in LiNbO3 crystals is discussed.

Tue-Frid Grande Halle PU-S01: Non linear acoustic phenomena (Poster session)

Speckle reduction with multitaper approach to improve B/A imaging – (Contributed, 000283)

M. Toulemonde[a,b], F. Varray[a], P. Tortoli[c], C. Cachard[a] and O. Basset[a]

[a]Centre de recherche en applications et traitement de l'image pour la santé, 7 avenue Jean Capelle, Bat Blaise Pascal, 69621 Villeurbanne Cedex; [b]Department of Electronics and Telecommunications [Florence], Via S. Marta, 3 50139 Firenze; [c]Università degli studi di Firenze, Via S. Marta, 3, 50139 Firenze, Italy

Corresponding author E-mail: matthieu.toulemonde@creatis.univ-lyon1.fr

During the propagation of an ultrasound wave, harmonic frequencies appear due to the nonlinear property of the tissue. When tissue characterization is concerned, the nonlinear parameter B/A can be interesting to differentiate normal and pathological tissues.
A recent paper proposes an extended comparative method (ECM) to image the B/A parameter in inhomogeneous media. However, the accuracy of this approach is limited by the presence of speckle in the image. We propose to improve the B/A parameter estimation in radio frequency image thanks to a speckle reduction approach based on a multitaper compounding method [Jensen et al., IEEE International Ultrasonics Symposium 2011].
Different orthogonal apodization functions (Slepian sequences) in reception are used to provide orthogonal tapers. In spite of a reduction of the lateral and axial resolution, about two to four times for the lateral resolution, the combination of the different images results in a significant increase of the SNR, 1,6 to 2,3 for the second harmonic, which allow a better estimation of the B/A parameter. The efficiency of the technique is validated on simulated data provided by CREANUIS [Varray et al., IEEE International Ultrasonics Symposium 2010] simulator and experimental results will be presented.

Tue-Frid Grande Halle PU-S01: Non linear acoustic phenomena (Poster session)

Evolution of intensive acoustical noise pulses (the numerical simulation with Fast Legendre Transform Algorithm) – (Contributed, 000421)

I. Demin, S. Gurbatov and N. Pronchatov-Rubtsov

Nizhny Novgorod State University, 23 Gagarin Ave., 603950 Nizhny Novgorod, Russian Federation

Corresponding author E-mail: phdem56@gmail.com

The propagation of finite amplitude sound waves is of fundamental interest in nonlinear acoustics. In the simplest model of propagation in fluids these waves are described by the well-known Burgers' equation (plane waves). In studies of nonlinear wave propagation an important problem is to find the waveform of the asymptotic wave at long time after the preparation of the initial wave or at long distance from the source emitting the wave. In case of noise-type initial disturbance, the analytical calculation the velocity field is very complicated mathematical problem. The Fast Legendre Transform Algorithm should be applied to solve the problem. In the present paper we consider the numerical simulation of evolution of complex pulses which are characterized by two scales. For such signals the generation of a low-frequency component or a non-zero mean field takes place. It has also been shown that, for a pulse with random carrier, the parameters of the asymptotic waveform depend weakly on the fine structure of the initial pulse, but that the old-age behaviour is very sensitive to the properties of the carrier.

Tue-Frid Grande Halle PU-S01: Non linear acoustic phenomena (Poster session)

Selective acoustic destruction of lipid shell microbubbles – (Contributed, 000548)

A. Karampatzakis, C. Sennoga, R. Eckersley and M.-X. Tang
Imperial College London, Imperial College London, South Kensington Campus, London SW7 2AZ
Corresponding author E-mail: andrewskg@gmail.com

Microbubbles (MB) combined with ultrasound are widely used for imaging and therapeutic applications. MB size affects their behaviour, and the inherit size polydispersity of MB solutions limits their performance.
We propose a method of modifying bubble size distribution within a population by transmitting an acoustic pulse of tailored properties, aimed to destroy MBs of certain sizes.
Transmission measurements were made in bulk suspensions of lipid MBs. The effects of the destruction pulse were evaluated by comparing the FFT spectra of a pre-destruction pulse to those of an identical post-destruction one, which were found to be significantly different. For destruction pulses of 2, 2.5 and 3 MHz, the peak change occurred at 1.73MHz (2.79dB), 1.79MHz (2.61dB) and 2.04MHz (1.73dB), respectively, indicating the destruction and/or alteration of a sub-population of MBs.
Additionally, for a constant driving frequency, gradually increasing the peak negative pressure from 50 to 290 kPa caused the frequency of maximum change to be shifted downwards by 650kHz. Similarly, increasing the pulse length from 5 to 160 cycles caused a downward shift of 470kHz.
Our results indicate that, by adjusting the acoustic parameters of the driving pulse, it is possible to selectively destruct MBs within a certain size range.

Tue-Frid Grande Halle PU-S01: Non linear acoustic phenomena (Poster session)

The parametric propagation in underwater acoustics: experimental results – (Contributed, 000735)

E. Bouttard[a], V. Labat[a], O. Bou Matar[b] and T. Chonavel[c]
[a]Institut de Recherche de l'Ecole Navale (EA 3634), BCRM Brest CC 600 29240 Brest Cedex 9; [b]Institut d'électronique, de microélectronique et de nanotechnologie, avenue Poincaré, Cité scientifique, BP 69, 59652 Villeneuve d'Ascq cedex; [c]Département Signal et Communications, Technopôle Brest-Iroise CS 83818 29238 Brest Cedex 3
Corresponding author E-mail: etienne.bouttard@ecole-navale.fr

In underwater acoustics, detection of buried objects in sediments (cables, mines...) is a complex problem. Indeed, in order to ensure sufficient penetration depth in marine sediments, low frequencies have to be used, implying a low resolution. A solution proposed to solve this problem is the parametric emission based on the nonlinear properties of seawater. This method can generate a low frequency wave from two directional high frequencies beams. The aim of this work is to present experimental results of a parametric propagation. Experiments have been carried out in a water tank in various configurations. These experimental measurements are then compared with simulation results obtained with a numerical model based on a fractional-step method presented at the Underwater Acoustic Measurements conference in 2011.

Tue-Frid Grande Halle PU-S01: Non linear acoustic phenomena (Poster session)

Nonlinear elastodynamic simulations using a Discontinuous Galerkin method on graphics processors – (Contributed, 000808)

O. Bou Matar and P.-Y. Guerder
Institut d'électronique, de microélectronique et de nanotechnologie, avenue Poincaré, Cité scientifique, BP 69, 59652 Villeneuve d'Ascq cedex
Corresponding author E-mail: olivier.boumatar@iemn.univ-lille1.fr

A nodal Discontinuous Galerkin Finite Element Method (DG-FEM) to solve the linear and nonlinear elastic wave equation, written in a conservative form, in heterogeneous media with arbitrary high order accuracy in space on unstructured meshes has been implemented based on the free software Hedge. This enables nodal DG to run on a single CPU, multi CPU (MPI) or GPUs. The speedup obtained with this DG-FEM software between CPUs and GPUs varies from 14 to 65. The adopted formalism allows the introduction of different kinds of elastic nonlinearities, such as the classical quadratic and cubic nonlinearities, or the quadratic hysteretic nonlinearities. Absorbing layers perfectly matched to the calculation domain of the Nearly Perfectly Matched Layers type have been introduced to simulate, when needed, semi-infinite or infinite media. Examples of application in the fields of nonlinear phononic crystals and nonlinear imaging of defects in MEMS will be presented.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Matryoshka locally resonant sonic crystal – (Contributed, 000044)

D. P. Elford, L. Chalmers, G. M. Swallowe and F. Kusmartsev
Loughborough University, Department of Physics, Loughborough University, LE11 3TU Loughborough, Leicestershire, UK
Corresponding author E-mail: phde@lboro.ac.uk

The results of numerical modelling of sonic crystals with resonant array elements are reported. The investigated resonant elements include plain slotted cylinders as well as various their combinations, in particular, Russian doll or Matryoshka configurations. The acoustic band structure and transmission characteristics of such systems have been computed with the use of finite element methods. The general concept of a locally resonant sonic crystal is proposed, which utilises acoustic resonances to form additional band gaps that are decoupled from Bragg gaps. An existence of a separate attenuation mechanism associated with the resonant elements, which increases performance in the lower frequency regime has been identified. The results show a formation of broad band gaps positioned significantly below the first Bragg frequency. For low frequency broadband attenuation a most optimal configuration is the Matryoshka sonic crystal, where each scattering unit is composed of multiple concentric slotted cylinders. This system forms numerous gaps in the lower frequency regime, below Bragg bands, whilst maintaining a reduced crystal size viable for noise barrier technology. The finding opens new perspectives for construction of sound barriers in the low frequency range usually inaccessible by traditional means including conventional sonic crystals.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Elastic waves in phononic granular membranes – (Contributed, 000060)

H. Pichard[a], A. Duclos[a], J.-P. Groby[a], V. Tournat[a] and V. Gusev[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: helene.pichard.etu@univ-lemans.fr

Elastic membranes composed of a few number of interacting articles/nanoparticles or grains layers can be encountered in different applications including sensors and filters for the individual molecules. Membranes, which are constructed through spatially periodic assembling of particles, exhibit phononic properties, interesting in view of the possible nondestructive testing of these membranes or in view of their applications to control elastic waves propagation. Some results on the elastic properties of multilayered phononic granular membranes, where each particle possesses up to 3 translational and 3 rotational degrees of freedom, are reported. The specific feature of granular metamaterials is known to be an efficient interaction between the shear and the rotational elastic motions of the grains, which leads to the existence of the mixed shear/rotational elastic modes [Phys. Rev. E 82, 031305 (2010)]. The influence of number of granular layers, of bending and spin rigidity of the inter-grain contacts on the phononic properties of granular membranes is analyzed.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Experimental study of water wave carpet cloak – (Contributed, 000177)

A. A. Maurel[a], C. Palacios[b], V. Pagneux[c] and P. Petitjeans[d]
[a]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France; [b]ESPCI, 10 rue Vauquelin, 75005 Paris, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [d]PMMH/ESPCI, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: agnes.maurel@espci.fr

It has been proposed by Li and Pendry (Phys. Rev. Lett. 101, 203901 2008) a so-called "carpet cloakï able to conceal an object under a curved reflecting surface, imitating the reflection of the flat surface. Since, such cloaking has been tested experimentally in the context of electromagnetic and acoustic waves. The ability of cloaking floating structures in the context of water waves has many applications, notably for coastline protection. We present an experimental study of carpet cloaking for wave in shallow water. The use of a space time resolved method to characterize the field of surface elevation allows to characterize quantitatively the efficiency of the cloaking.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Propagation of elastic waves in 1D periodic waveguides with symmetric stubs – (Contributed, 000186)

A.-C. Hladky-Hennion[a], C. Granger[a], J. Vasseur[a] and M. De Billy[b]
[a]IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France; [b]IJLRD, UMR CNRS 7190, Université Pierre et Marie Curie-Paris 6, 78210 Saint Cyr L'ecole, France
Corresponding author E-mail: anne-christine.hladky@isen.fr

The wave propagation in periodic systems has received a great deal of attention during the last years. By analogy with the studies driven on photonic crystals, many works were conducted on phononic crystals. In this presentation, the propagation of elastic waves through a one dimensional chain of beads with symmetrically grafted stubs is experimentally as well as numerically investigated. One dimensional chains of beads with periodically grafted stubs are considered. Results on the transmission of elastic wave through a finite number of cells are presented and show that one can obtain different band structures by varying the properties of the side beads (or stubs). The existence and the properties of gaps, pass-bands and dispersion-less modes in the power spectrum of the transmitted acoustical signal through the specimen, are strongly dependent on the material of the stubs with comparison to the one of the waveguide. By a proper choice of the material of the periodic waveguide and stubs, it is possible to optimize the acoustic-phonon band structure. The presence of the stub in the chain introduces dips and peaks in the displacement plots that can have potential applications for rejective and selective filtering.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Acoustic process of second harmonic generation in a one-dimensional diatomic granular chain – (Contributed, 000241)

J. Cabaret, V. Tournat and P. Béquin
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jeremy.cabaret.etu@univ-lemans.fr

The acoustic process of second harmonic generation in a diatomic granular chain is studied in the weakly nonlinear regime. The diatomic granular chain is a phononic crystal which exhibits band gaps and two modes of propagation for the longitudinal elastic waves. In the limit of a much higher applied static stress on the chain than the dynamic perturbation of the wave, the quadratic approximation for the elastic non-linearity of each constant is taken. Analytic results accounting for this quadratic nonlinearity of contacts and keeping a discrete description of the medium (which allows to consider strong dispersive regimes) are presented. They are compared to experimental results obtained in a 1D chain made with millimeter scale grains of two different masses arranged alternatively. Different cases are analyzed depending on the propagative or evanescent character of the fundamental on harmonic waves and on the acoustical or optical-type propagation modes. Finally, we observe and provide interpretations on the nonlinear resonances of the finite diatomic chain.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Effects of a default on the reflectivity of plane periodic media – (Contributed, 000341)

O. Lenoir[a], A. Khaled[b], P. Marechal[a] and D. Chenouni[b]
[a]Laboratoire Ondes et Milieux Complexes, Université du Havre, Place R. Schuman, 76610 Le Havre, France; [b]Laboratoire d'Electronique Si gnaux Systèmes et d'Informatique, Faculté des sciences Dar El Mahraz, 30000 Fès, Morocco
Corresponding author E-mail: olivier.lenoir@univ-lehavre.fr

The influence of defect layers in a fluid-loaded plane multilayer composed of N periods is highlighted by analyzing the stop bands and pass bands of the reflection coefficient. The period is composed of two plates exhibiting a high impedance contrast, in aluminum and polyethylene for instance. No attenuation is taken into account Two types of defect layers are considered: either the thickness of a plate in one period is varied, or a layer made up of another material is inserted between two adjacent periods. The transmission coefficient is obtained with a numerically stable transfer matrix method. The study consists in comparing the plots of the transmission coefficient of a structure with no defect to the ones of structures with defects inserted at different locations. The variations of the resonance frequencies in the pass bands according to the defect position, as well as the width of the stop bands, are studied. A particular attention has been paid to the resonances at low frequency, linked with the so-called vertical modes. In the case of a defect included between two periods, it may appear very narrow pass bands in the stop bands.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Numerical and experimental characterization of pre-fractal anisotropic stacks – (Contributed, 000400)

M.-F. Ponge, X. Jacob and V. Gibiat
Laboratoire PHASE, 118 Route de Narbonne, 31062 Toulouse, France
Corresponding author E-mail: marie-fraise.ponge@univ-tlse3.fr,

In this work, propagation in multi-layered anisotropic media is numerically and experimentally investigated. Acoustic properties of pre-fractal samples constituted by a succession of orthotropic layers are studied. Complex media (periodic, disordered or fractal) are known for their remarkable properties as regards to acoustic wave propagation. Fractals appear to be between periodicity and disorder and their intrinsic proportional transformation impacts directly on waves propagation. Indeed, they represent very well natural irregularities, but they are also built from a repetitive pattern at different scales: they are self-similar. The layers orientations in the stack follow a self-similar sequence. It can be demonstrated that such pre-fractal media are similar to periodic structures with defects. The fractal type affects the introduced disorder. Bulk waves propagation in multi-layered anisotropic media is theoretically described by the stiffness matrix method (published by Rokhlin and Wang in 2002). From the resolution of Christoffel equation, stresses and displacements in each layer are connected by a matrix formalism. Pre-fractal stacks are numerically and experimentally characterized. They are also compared with classical fractal, periodic and disordered structures.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Design of wideband attenuation devices based on Sonic Crystals made of multi-phenomena scatterers – (Contributed, 000452)

V. Romero-Garcia[a], S. Castiñeira-Ibañez[a], J.V. Sanchez-Perez[b] and L.M. Garcia-Raffi[a]
[a]Universidad Politecnica de Valencia, Paranimf 1, 46730 Gandia, Valencia, Spain, 46730 Gandia, Spain; [b]Centro de Tecnologias Fisicas: A. M. A., U.P.V., Camino de Vera s/n, 46022 Valencia, Spain, 46022 Valencia, Spain
Corresponding author E-mail: virogar1@gmail.com

Sonic Crystals (SCs) are periodic structures of solid scatterers embedded in a fluid. Perhaps, the most celebrated property of SCs is the presence of ranges of frequencies, known as band gaps, where only evanescent modes are excited. As a consequence, in finite SCs the propagation of waves at these frequencies is attenuated. However the mere existence of these attenuation bands is not enough to design effective attenuation devices. In this work we report the theoretical and experimental design of multi-phenomena scatterers presenting resonances, absorption and scattering in the audible range. The design of the scatterers has been improved for its use outdoors. We use these scatterers to construct a periodic structure making use of the Bragg reflections, together with resonances and the absorption, in order to combine the three phenomena working independently in different ranges of frequencies. Thus the overall effect is a wideband of attenuated frequencies. The resultant device has been acoustically standardized obtaining the expected results, following the norms UNE-EN 1793-1:1998, 1793-2:1998 and 1793-3:1998. The structural efforts of these devices have been measured in an wind tunnel. The improvements with respect to the classical noise screens are discussed in the work.

Tue-Frid Grande Halle PU-S03: Phononic crystal and metamaterials (Poster session)

Non-radiative complete SAW bandgap of 2D phononic crystals on semi-infinite LiNbO3 substrate – (Contributed, 000453)

D. Yudistira[a], Y. Pennec[a], B. Djafari-Rouhani[a], S. Dupont[a] and V. Laude[b]
[a]Institut d'électronique, de microélectronique et de nanotechnologie, avenue Poincaré, Cité scientifique, BP 69, 59652 Villeneuve d'Ascq cedex; [b]Franche-Comté Électronique Mécanique, Thermique et Optique - Sciences et Technologies, 32 avenue de l'Observatoire 25044 Besancon Cedex
Corresponding author E-mail: d.yudistira@gmail.com

We theoretically demonstrate the existence of complete surface acoustic wave (SAW) bandgap on 2D piezoelectric phononic crystals (PC) consisting of finite air hole arrays with honeycomb arrangement embedded on a semi-infinite lithium niobate substrate. Up to now, with a single material structure, complete SAW bandgaps were only demonstrated in the case of a periodic array of pillars on a substrate. We have also investigated other lattices, such as square and triangular, but they exhibit partial SAW bandgaps only. The SAW bandgap is determined from PC band structure calculated by means of 3D finite element method (FEM) for which the slowness curve of lithium

niobate crystal is incorporated in order to determine the corresponding irreducible Brillouin zone. The effect of the arrays structures and subsequent possible imperfection in the shape of the air hole on the SAW bandgap have been investigated. We found that, for a given parameter of the air hole, the SAW bandgap is fully situated inside non-radiative region below the sound cone of lithium niobate substrate. The polarization and symmetry of the SAW branches are studied and discussed in relation with the transmission of a SAW through a finite size photonic crystal.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

New approach for the damage mechanisms identification in the glass-epoxy composites – (Contributed, 000169)

A. Satour[a], S. Montresor[b], M. Bentahar[b], F. Boubenider[c] and R. Elguerjouma[b]
[a]Technical and Scientific Research Center for Welding and Control, BP 64, Road of Dely Ibrahim, Cheraga, 16100 Algiers, Algeria; [b]Uiversité du Maine, LAUM, CNRS, Université du Maine, Avenue Olivier Messiaen, 72085, 72000 Le Mans, France; [c]University of sciences and technology Houari Boumedienne, Laboratory of physics of materials B.P. 32 El Allia- Bab Ezzouar, 16111 Algiers, Algeria
Corresponding author E-mail: satourabida@yahoo.fr

The aim of this work is to introduce a new approach for clustering the acoustic emission data occurring during the fracture process of glass fibre reinforced polymer (GFRP) plates. In particular, we have developed signal processing techniques based on continues wavelet transform in order to isolate the acoustic signature corresponding to each damage mechanism (fibre breakage, matrix cracking, etc.). Models are then established in the form of dictionaries, whose elements are the waveforms collected during specific experiments in which the creates damage mechanisms are well known. The conducted experiments allowed isolating not only strongly excited mechanisms but also those whose amplitude is below the detection threshold (which are usually considered as noise and hence systematically eliminated by using automatic threshold). This valuable decrease in the threshold (from 30dB to 25dB) will be used in the study of precursor mechanisms as well as slow dynamic experiments.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Characterization of a parametric loudspeaker and its application in NDT – (Contributed, 000383)

S. De Simone[a], L. Di Marcoberardino[b], P. Calicchia[a] and J. Marchal[b]
[a]Institute of Acoustics and Sensors, Via del Fosso del Cavalliere,100, 00133 Rome, Italy; [b]Institute Jean Le Rond d'Alembert, 2 place de la gare de Ceinture, 78210 Saint Cyr L'Ecole, France
Corresponding author E-mail: sara.desimone@idasc.cnr.it

The parametric loudspeaker combines the high directivity at the audio frequencies with the small size of the transducer, thanks to the nonlinear interaction of finite-amplitude ultrasonic waves. These properties make this class of sources an attractive investigation tool especially for non destructive testing (NDT). Till now the research has been mainly focused on the optimization of the transducer and the signal pre-processing, while only recently actual applications mainly in the field of material's acoustical characterization are emerging. The authors present the analysis of the pressure field generated by a commercial parametric loudspeaker integrated in a system purposely developed for acoustic diagnostics on objects of heritage interest. It was used in an investigation on the renaissance panel painting Annunciazione by the Italian artist Benozzo Gozzoli (XV century) revealing pictorial film detachments. Preliminary results are here presented, disclosing the potential of the parametric loudspeaker for the enhancement of the spatial resolution in the acoustic measurement, of the non invasiveness of the investigation tool, and also of the operator comfort.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Inspection problem of composite materials using an ultrasonic signal processing – (Contributed, 000385)

A. Benammar[a], R. Drai[a] and A. Guessoum[b]
[a]Centre de recherche en CND, Route de Dély-brahim BP 64, 16000 Cheraga, Algeria; [b]Département d'Electronique, Faculté des sciences de l'ingénieur, Université Sâad Dahlab de Blida, BP 120, Route de Soumaa, 09000 Blida, Algeria
Corresponding author E-mail: Abs_benammar@yahoo.fr

In this paper, signal processing techniques associated to ultrasonic instrumentation are tested for their ability to resolve echoes reflected by delaminations in carbon fiber reinforced polymer multi-layered composite materials (CFRP). These techniques include the L2 norm deconvolution and the expectation-maximization (EM) algorithm. A simulation study on defect detection was performed, and results were validated experimentally on CFRP with and without delamination defects taken from aircraft. Comparative study of the methods for their ability to resolve echoes is made. Theoretical and experimental results indicate resolution enhancement in detecting and locating delamination defects.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Ultrasonic characterization of mechanical properties of metal powders – (Contributed, 000524)

L. Barguet, M. Bentahar, C. Pezerat and R. El Guerjouma
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: laurianne.barguet.etu@univ-lemans.fr

In modern industrial applications involving metals, many research studies are conducted in order to substitute conventional materials by reinforced metal matrix composites. These materials are developed using powder metallurgy processes with mechanical alloying. Therefore, reinforced micro/nanoscale dispersions are obtained by co-grinding metallic powders with oxide using several types of mill such as balls milling. The mill is a cylindrical tank whose rotation around its main axis generates the milling process, which is operated by the existing steel beads within the powder. The grinding results from different combinations of collisions between beads and powders on the tank walls. During this process, the characteristics of the powder such as the grain size or shape evolve and get stabilized after a given number of rotating cycles. It becomes then important to find a non-invasive way in order to quantify the grinding quality while processing. In this contribution we present experimental results corresponding to pulsed ultrasonic through-transmission characterization of metallic powders of different characteristics (FeAlZrCB and Fe3Cr1Mo0.5Mn0.2V). In particular, the ultrasonic bench has been calibrated using metal powders with different grain sizes (50-500 micrometers). Ultrasonic characterization is based on the coherent ballistic pulse and the speckle-like multiply scattered signal, which compose the transmitted signal.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Modelling tools for ultrasonic inspection of bimetallic welds – (Contributed, 000530)

A. Gardahaut[a], K. Jezzine[a] and D. Cassereau[b]
[a]CEA-LIST, Bâtiment 611 - Point Courrier 120, 91191 Gif-Sur-Yvette Cedex, France; [b]Equipe de Statistique Appliquée, 10 rue Vauquelin, 75231 Paris cedex 05
Corresponding author E-mail: audrey.gardahaut@cea.fr

Modelling tools for the ultrasonic inspection of bimetallic welds, which link ferritic and stainless steel parts, are presented. Those structures are difficult to control as anisotropy, heterogeneity and grain orientation distribution can impede the detection of defects. Dynamic ray tracing is an efficient method to simulate the ultrasonic propagation in welds. The weld can be described as a set of several anisotropic homogeneous domains with a given crystallographic orientation. In this case, the rays travel in straight lines inside each homogeneous domain. Nevertheless, if the domains are small compared to the wavelength and exhibit strong variations in grain orientation, a chaotic behaviour of rays may be observed, leading to inaccurate results. To overcome this problem, a smooth description of the grain orientation has to be used. To achieve such a description, the grain orientations are computed on a grid thanks to image processing techniques performed on a macrography of the weld. In this paper, we first present the image processing techniques that have been implemented. Then, we expose our first modelling results using dynamic ray tracing on a smooth description of the grain orientation and compare it to results obtained using a set of homogeneous domains to describe the weld and experimental results.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

On the comparison of absorbing regions methods – (Contributed, 000575)

W. Ke[a], S. Yaacoubi[b] and P. McKeon[c]
[a]Institut de Soudure, 4 boulevard henri becquerel, 57970 Yutz, France; [b]Institut de Soudure, 4 boulevard Henri Becquerel, 57970 Yutz, France; [c]UMI Georgia Tech - CNRS 2958, Metz Technopole, 2 rue Marconi, 57070 Metz, France
Corresponding author E-mail: peter.mckeon@gatech.edu

Numerical simulation methods are very useful in Non Destructive Testing because they save time, lower cost and allow for the investigation of diverse experimental configurations. However, these methods consume relatively long CPU time and system memory. Different solutions exist to minimize these limitations. Absorbing region methods are among them when it's possible. These kinds of regions are also made to minimize or eliminate the spurious reflections at the boundaries of the simulated structure for more efficient signal processing. These methods are employed in many other fields such as geophysics, telecommunication, etc. There are different ways to design appropriate absorbing regions. Different approaches will be investigated and compared to show the advantage and limits of each one. Some examples will be presented.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Validation of a thermal compensation technique for Coda Wave Interferometry (CWI) analysis of acousto-elastic effect – (Contributed, 000580)

Y. Zhang[a], O. Abraham[a], V. Tournat[b], A. Le Duff[c], B. Lascoup[d], A. Loukili[e], F. Grondin[e] and O. Durand[a]
[a]IFSTTAR, MACS, CS4, Rout de Bouaye, 44341 Bouguenais, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Groupe ESEO, rue Merlet de la Boulaye, 49009 Angers, France; [d]ESTACA, Parc Universitaire Laval-Changé, Rue Georges Charpak, 53061 Laval, France; [e]GeM, CNRS 6183, Ecole Centrale de Nantes, 1 rue de la Noë, 44321 Nantes, France
Corresponding author E-mail: yuxiang.zhang@ifsttar.fr

Acousto-elastic effect is an observation of material's nonlinear elastic properties, which are sensitive to early stage damages. In a study of acousto- elasticity, stress-induced velocity variation is a key parameter for the understanding of material's mechanical behaviors and a reliable estimation of acousto-elastic coefficient. In heterogeneous material as concrete, Coda Wave Interferometry (CWI) analysis can monitor the variation of the propagation velocity with a high precision (relative resolution of $10^{-3}\%$), which makes it adequate for studying the acousto-elastic effect in concrete. On the other hand, as propagation velocity is also affected by temperature, the thermal-induced velocity variation causes a non-negligible bias to the CWI result of stress-induced velocity variation. In this paper we present a bias control technique for CWI analysis designed for the compensation of: 1) the thermal-induced velocity change due to environmental temperature fluctuation and 2) experimental bias resulting from entire procedures of measurement and signal processing. Its effectiveness is tested under laboratory condition by applying direct uniaxial tensile force on a concrete specimen.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Coda Wave Interferometry (CWI) for monitoring early-age cementitious mortar – (Contributed, 000588)

Y. Zhang[a], O. Abraham[a], P. Mounanga[b], A.-N. Leklou[b], V. Tournat[c], A. Le Duff[d], B. Lascoup[e] and O. Durand[a]
[a]IFSTTAR, MACS, CS4, Rout de Bouaye, 44341 Bouguenais, France; [b]GeM, UMR CNRS 6183 IUT Saint-Nazaire, 58 rue Michel Ange, 44606 Saint-Nazaire, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [d]Groupe ESEO, rue Merlet de la Boulaye, 49009 Angers, France; [e]ESTACA, Parc Universitaire Laval-Changé, Rue Georges Charpak, 53061 Laval, France
Corresponding author E-mail: yuxiang.zhang@ifsttar.fr

The hardening procedure of a cement-based mortar (mixed by cement past and uni- dimension glass beams) is studied with Coda Wave Interferometry (CWI) for a hydration time between 8 and 70 hours. Due to the continuous hydration of the cement paste, the hardening procedure involves not only a fast evolution of elastic properties, but also a autogenous shrinkage which can cause local stress and risks of micro-cracking. Traditional ultrasonic method (pulse velocity measurement) can estimate the variation of elastic properties by measuring compressive-wave's propagation velocity. Coda Wave Interferometry (CWI) of multiple scattered waves gives access to a velocity variation dominated by shear- waves. On the other hand, with the confirmed observation of micro-cracks occurring around cement/glass interfaces by Scanning Electronic Microscopy (SEM), we discuss the possibility of using CWI analysis for micro-cracking detection.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Acoustic emission analysis of a laminate under a different loading rate – (Contributed, 000804)

I. Ben Ammar[a], A. El Mahi[a], C. Karra[b], R. El Guerjouma[a] and M. El Haddar[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]U2MP Unité de Mécanique, Modélisation et Production (U2MP), Ecole Nationale d'Ingénieurs de Sfax, Route Soukra Km 3.5, 3038 Sfax, Tunisia
Corresponding author E-mail: benammarimene@gmail.com

The aim of this work is the identification with acoustic emission and the analysis of the damage mechanisms of a cross-laminated. A different laminate composed of epoxy resin and reinforced with glass fibers (GFRP), carbon fibers (CFRP) and hybrid fibers (HFRP) are considered. Static tests were performed, to study the influence of stacking sequence of laminates, the effect of thickness of 90° layers of fibers on behavior and the evolution of damage mechanisms. The specimens are solicited in buckling and traction tests. The acoustic signatures corresponding to the various damage mechanisms from material (matrix cracking, interfacial debonding...) are identified and their chronologies of appearances during the buckling and traction tests of the specimens are followed.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Non linear acoustic applied to the concrete study – (Contributed, 000853)

A. Quiviger[a], J.-P. Zardan[a], V. Garnier[a], C. Payan[a], J.-F. Chaix[a] and J. Salin[b]
[a]AMU - LMA équipe LCND, Boulevard Gaston Berger, 13122 Aix En Provence, France; [b]EDF R&D, 6, Quai Watier, 78401 Chatou Cedex, France
Corresponding author E-mail: vincent.garnier@univ-amu.fr

To characterize concrete, ultrasonic sound is a tool that has been developed to access damage and cracking. Its heterogeneity and the scales of sizes of micro-structural elements are necessary to consider a wide range of tools for characterization. We define the parameters that can be extracted from the wave propagation and vibration conditions into a beam in the laboratory. The scale measures are specified and the importance of each test condition is explained. We focus on nonlinear acoustics which is particularly appropriate for monitoring the developments on the mesoscopic scale. We study the conditions for harmonic generation and modulation, and specify the possibilities of working with energy. The beams in some cases are cracked over a determined length. The findings present the advantages of this technique and the difficulties inherent to their on site implementation.

Tue-Frid Grande Halle PU-S04: Non destructive testing and evaluation (Poster session)

Studying the ultrasonic characterization of industrial plasters – (Contributed, 000854)

J.-F. Chaix[a], V. Garnier[a], A. Sadikaly[b], I. Berline[c] and G. Counil[b]
[a]AMU - LMA équipe LCND, Boulevard Gaston Berger, 13122 Aix En Provence, France; [b]AMU - LCND, Boulevard Gaston Berger, 13122 Aix En Provence, France; [c]Saint Gobain Recherche, 39 Quai Lucien Lefranc, BP 135, 93303 Aubervilliers Cedex, France
Corresponding author E-mail: vincent.garnier@univ-amu.fr

Saint-Gobain produces building materials made from plaster. These are materials containing gypsum and air scatterers. The latter strongly influence the mechanical strength and the volume density. Solutions for ultrasonic non-destructive characterization are designed to enable a better understanding of the influence of process parameters and to optimize this process. The model of homogenisation of Waterman-Truell is chosen to simulate the propagation of compression waves in the plaster medium. Validation tests of the model using ultrasound by immersion were set up for samples in vacuum sealed bag. The test results are close to those obtained from the model. The first results of characterization by ultrasonic air are also presented. The potential for non-destructive characterization of plaster using non-contact ultrasound is demonstrated.

Tue-Frid Grande Halle PU-S08: Bones and ultrasound (Poster session)

Children cortical bone characterisation: the ultrasonic issue – (Contributed, 000082)

J.-P. Berteau[a], C. Baron[a], M. Pithioux[a], P. Chabrand[a] and P. Lasaygues[b]
[a]CNRS - Aix Marseille Univ, 163 avenue de Luminy, 13288 Marseille, France; [b]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: jean-philippe.BERTEAU@univmed.fr

Nowadays there is a strong interest in the characterization of the growing process of children bone. Recent works considered osteoporosis as a pediatric disease with geriatric consequences and children are concerned by specific infantile osteo-pathologies. However, few mechanical properties of cortical growing bone are available in literature and do not yield to gold standards. The goal of this study is to evaluate the validity of ultrasonic characterization of elastic properties for growing bone. Nine surgery wastes from fibula auto-transplants (5 to 16 years old children with accordance of French ethical committee) are included in a two-step method process. A non-destructive ultrasonic evaluation (7 and 10 MHz) yields to acoustic Young's modulus (E_a) and a micro-three point bending test yields to Young's modulus (E). Ultrasonic testing provides an average E_a of 15.2 GPa (+/- 2.9) at 7 MHz and 15.49 GPa (+/- 3.95) at 10 MHz, and micro-flexion an average E of 10.13 GPa (+/- 5.29). A linear correlation between E_a and E is found (R^2 value is 0.78 at 7 MHz and 0.79 at 10 MHz). To our knowledge, this is the highest R^2 between destructive and non-destructive method found in literature for human cortical bone.

Tue-Frid Grande Halle PU-S08: Bones and ultrasound (Poster session)

Comparative study of nonlinear ultrasonic methods applied to experimental models of prostheses osseointegration – (Contributed, 000257)

J. Riviere[a], S. Haupert[a], P. A. Johnson[b] and P. Laugier[a]
[a]Laboratoire d'Imagerie Paramétrique, 15 Rue de l'école de Médecine 75006 Paris; [b]EES17, Los Alamos National Laboratory, Los Alamos, New Mexico, 87545, USA
Corresponding author E-mail: riviere_jacques@yahoo.fr

This study is part of the long-term perspective to implement in vivo some new noninvasive methods to monitor the bone prostheses sealing or osseointegration (dental implants, hip prostheses). Although the most widely used clinically, X-ray radiography suffers from low sensitivity, limiting for instance its ability to detect early loosening of a prosthesis. The potential of methods developed over the past twenty years and based on elasticity measurements has been shown in vitro, but their in vivo effectiveness is still questionable. Our objective was to evaluate the potential of new methods based on nonlinear elasticity measurements that have emerged in the fields of geophysics and nondestructive testing, and which showed greater sensitivity than the linear elastic response to the presence of weak contacts within a rigid structure, such as cracks. For this, several osseointegration and sealing models (with manifold damping and boundary conditions) have been studied experimentally using different nonlinear elasticity techniques. Finally, this experimental study allowed the extraction of the most promising nonlinear parameters and the evaluation of their respective advantages and limitations for an in vivo application.

Tue-Frid Grande Halle PU-S08: Bones and ultrasound (Poster session)

Finite Element modelling of the measurement of guided wave propagation in a transverse isotropic material with an ultrasonic array – (Contributed, 000347)

L. Moreau, J.-G. Minonzio, J. Foiret, M. Talmant and P. Laugier
UPMC CNRS LIP, 15 rue de l'école de médecine, 75006 Paris, France
Corresponding author E-mail: ludovic.moreau@upmc.fr

Cortical bone porosity has proved to be an important indicator of bone fragility. Since cortical bone was reported to behave like a waveguide, the potential for ultrasonic guided waves to detect porosity has naturally become a research axis. Indeed, measuring the velocity of guided wave modes in cortical bone is an important step towards bone characterization, because the velocities can be used in turn to evaluate both the stiffness coefficients and the thickness of cortical bone. However, the heterogeneous, dissipative and irregular nature of bone requires special care on the experimental protocol to obtain robust data and on the reference waveguide model used to interpret the data. In this context, finite element (FE) modelling is useful to interpret experimental results. Signals are obtained with a multi-emitter multi-receiver axial transmission probe. A specific guided mode wavenumber measurement method, adapted to clinical requirements, has been proposed. This paper investigates FE modelling of the experimental setup. In particular, the impact of the silicon layer at the front of the probe on wavenumber evaluation is studied. 2D FE results obtained from a bone-mimicking plate and on realistic bone geometry are presented and compared to experimental results.

Tue-Frid Grande Halle PU-S08: Bones and ultrasound (Poster session)

Characterization of a bone mimicking phantom by means of circumferential guided waves dispersion curves – (Contributed, 000479)

P. Nauleau[a], E. Cochard[b], J.-G. Minonzio[a], Q. Grimal[a], C. Prada[b] and P. Laugier[a]
[a]Laboratoire d'Imagerie Paramétrique, 15 rue de l'école de médecine, 75006 Paris, France; [b]Institut Langevin, ESPCI ParisTech, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: pierre.nauleau@upmc.fr

Previous studies have evidenced the circumferential propagation of waves guided by the roughly cylindrical cortical shell of the femoral neck. We hypothesize that measuring the phase velocities of such waves could yield estimates of the cortical thickness and material properties, which could improve fracture risk prediction. The objective of this study is to test the ability of the DORT method, processing based on time reversal principle, to measure circumferential guided waves in a bone-mimicking tube.
The tube has the typical dimensions of the mid-femoral neck. A focused array specifically designed for this study was used for emission and reception. To serve as a noise-free reference, the experiment was also simulated based on an analytical formulation. The DORT method was applied to experimentally recorded and simulated data to retrieve the guided waves dispersion curves.
Five branches of modes were obtained. They were identified by comparison with the theoretical dispersion curves of a semi-immersed plate. Experimental branches can be used in an inverse scheme to obtain estimations of the shell properties. This study shows that measuring circumferential guided waves is feasible in a structure with dimensions and material properties (elasticity, attenuation) close to those of the cortical compartment of the femoral neck.

Tue-Frid Grande Halle PU-S08: Bones and ultrasound (Poster session)

Bone properties determination from guided wave velocities: an in vitro test case study – (Contributed, 000620)

J. Foiret, J.-G. Minonzio, M. Talmant and P. Laugier
UPMC CNRS LIP, 15 rue de l'école de médecine, 75006 Paris, France
Corresponding author E-mail: josquin.foiret@upmc.fr

Ultrasonic guided mode propagation has been suggested as a mean for assessment of cortical bone properties such as porosity and thickness, through inverse procedure based on the identification of experimental guided wave spectrum (wavenumber as function of frequency) to a reference model. However, while a high number of unknowns (stiffnesses, density, thickness) must be determined, several factors inherent to measurement on bone such as absorption reduce the quantity of experimental data. Moreover, spatial variability of geometry and elasticity implies to develop dedicated measurement sequence to improve the robustness of stable experimental data. A feasibility study on an *in vitro* radius (forearm) is presented. Experimental signals were obtained using a probe dedicated to clinical use (broadband 1 MHz signals) associated with a dedicated signal processing efficient for dissipative materials. The reference model was a 2D transverse isotropic plate model with the bone material considered as a homogenized biphasic model (bone matrix/porosity) with elastic properties of the bone matrix a priori known. Estimated parameters were a thickness of 2.3 mm and stiffness coefficients (in GPa) of $c_{11} = 29.4$, $c_{13} = 8.8$, $c_{33} = 18.3$ and $c_{55} = 5.4$. Current works focus on the robustness and the accuracy of the technique.

Tue-Frid Grande Halle PU-S08: Bones and ultrasound (Poster session)

Investigation on influencing factors of ultrasonic long bone image quality and reconstruction error – (Contributed, 000765)

R. Zheng
University of Alberta, Department of Physics, Edmonton, Canada T6G2E1
Corresponding author E-mail: ruiz@ualberta.ca

Ultrasonic imaging techniques based on the acoustic inversion theories and methodologies can be applied to reconstruct the internal structures of long bones. To verify the imaging algorithms and investigate the reconstruction discrepancy from the original images, the reflectivity models were firstly converted from the CT image and then used to generate three separate sets of simulated data using forward operator, convolution, and finite-difference methods respectively. A group of real data were also collected on the prototype bone sample. The reconstruction errors between the synthetic and predicted data were calculated, the reconstructed images were compared with the original model, and the influence factors such as aperture, noise, inversion regularization were discussed. The results

demonstrate that the discrepancy is mainly located in the end and deep structures. The major reasons for the reconstruction error and information loss can be attributed to three aspects: 1) numerical truncation errors, 2) diffraction during the wave propagation, and 3) attenuation due to scattering and absorption. The compensation methods such as smaller aperture, signal processing and proper regularization constraints can be employed to improve the image quality and reduce the reconstruction errors.

Tue-Frid Grande Halle PU-S09: Biomedical and biological ultrasounds (Poster session)

Tracking biopsy needle using Kalman filter and RANSAC algorithm with 3D ultrasound – (Contributed, 000256)

Y. Zhao, H. Liebgott and C. Cachard
Centre de recherche en applications et traitement de l'image pour la santé, 7 avenue Jean Capelle, Bat Blaise Pascal, 69621 Villeurbanne Cedex
Corresponding author E-mail: yue.zhao@creatis.insa-lyon.fr

RANSAC algorithm has been implemented for the detection of micro-tools (biopsy metallic needles) inserted in human tissue, and this method has the capacity to detect the position of the needle in real time. However, RANSAC algorithm depends on randomly selected models so that the robustness is poor. Therefore, a Kalman filter has been added in order to increase the stability, and realize an application in a dynamic situation. A constant velocity model was chosen for the Kalman filter. The result from RANSAC algorithm (estimate tip position of needle) was set as one part of the measurement vector. Because the speed of insertion is unknown, the speckle tracking method was added to measure the inserting speed, which is another measurement for Kalman filter. The predicted tip position of Kalman filter was compared with that of RANSAC result. The simulation has been done with the simulated volume in both static situation and dynamic situation. The result shows that in static situation, the root mean square error (RMSE) of Kalman was reduced 44.79% compared with RANSAC; in dynamic situation, the RMSE of Kalman filter was reduce by 26.5%.

Tue-Frid Grande Halle PU-S09: Biomedical and biological ultrasounds (Poster session)

Frequency and concentration dependence of the ultrasonic backscatter coefficient in a soft tissue mimicking material – (Contributed, 000393)

N. Houhat and T. Boutkedjirt
Faculty of physics USTHB, BP 32, El Alia, BabEzzouar, 16111 Algiers, Algeria
Corresponding author E-mail: houhat.nesrine@yahoo.fr

In medical ultrasound, the backscatter coefficient is used to quantify the scattering properties of biological tissues. It is defined as the differential scattering cross section per unit volume for a scattering angle of 180°. In this study, measurements of the backscatter coefficient are made on Tissues Mimicking Materials (TMM). These are materials the acoustic properties of which (velocity propagation, attenuation, scattering) are close to those of biological tissues.
Measurements of this coefficient have been achieved on a mixture of gelatin and distilled water containing graphite particles of mean radius 18 μm, which were randomly distributed. TMM samples with graphite concentrations ranging from 50 to 200 g per liter of gelatin have been investigated. The backscatter coefficient was evaluated using both Sigelman and Reid [JASA 53, 1351 (1973)] and Chen [IEEE Trans. UFFC 44, 515 (1997)] methods in a frequency range around 5 MHz. The evolution of this coefficient as a function of frequency for different scatterers concentration will be presented. Comparison of experimental values with those predicted by the Faran theory [JASA 23, 405 (1951)] permits the estimation of the number density of graphite particles in the TMM.

Tue-Frid Grande Halle PU-S09: Biomedical and biological ultrasounds (Poster session)

Acoustical method and device for determination of lipid and protein spectra of blood serum – (Contributed, 000422)

I. Demin[a], A. Klemina[a], S. Gurbatov[a] and V. Klemin[b]
[a]Nizhny Novgorod State University, 23 Gagarin Ave., 603950 Nizhny Novgorod, Russian Federation; [b]Nizhny Novgorod 'Firma 'BIOM', 32 Veterinary Str., 603098 Nizhny Novgorod, Russian Federation
Corresponding author E-mail: phdem56@gmail.com

Investigation of acoustical characteristics of biological fluids for the purposes of medical diagnostics is the important problem, because of the analysis of interaction of ultrasonic waves with biomacromolecules allows to receive the unique information on their structure and properties. One of few methods, allowing to measure velocity and absorption of ultrasound in biological fluids with sufficient precision is a method of a ultrasonic interferometer of constant length or resonator method. Acoustical resonator method for determination of lipid and protein spectra of blood serum is described. This device have two ultrasonic resonator cells with volume of 80 mkl each. The cells are placed in a specially designed ultrathermostat and are operated at about 8 MHz by means of compact electronic unit. The method allows to determinate without reagents lipid components (cholesterol total, cholesterol of high and low density and triglycerides), and total protein and protein fractions in blood serum during two minutes. Traditional methods determine these components during fifteen minutes and with reagents. Comparative investigations acoustics and traditional methods shows very high correlation agreements.

Tue-Frid Grande Halle PU-S09: Biomedical and biological ultrasounds (Poster session)

Nonlinear tissue mimicking phantoms characterization using the Nakagami statistical model: simulations and measurements – (Contributed, 000515)

N. Bahbah[a], H. Djelouah[a] and A. Bouakaz[b]
[a]Houari Boumediene University of Sciences and Technology, USTHB, BP 32, El Alia, DZ-16111 Algiers, Algeria, 16111 Aliers, Algeria; [b]INSERM U930 CNRS ERL3106, Université François Rabelais, CHU Bretonneau, 2 Blvd. Tonnellé, 37044 Tours, France
Corresponding author E-mail: djelouah_hakim@yahoo.fr

In order to improve the tissue characterization, the probability density function of ultrasonic backscattered echoes which may be treated as random signals, is modeled by using Nakagami statistical distribution. Recently, it has been found that Nakagami statistical model constitutes a quite good model in tissue characterization due to its simplicity and general character.
In the present study, computer simulations and experiments on phantoms have been carried out to test the validity of Nakagami distribution in order to model the backscattered envelope of ultrasonic signals in the nonlinear regime. Experiments were performed using a 5MHz linear array connected to an open research platform. A commercially available phantom was used to mimick tissue backscatter. For different sizes and positions of the sampling window, the RF signals have been acquired at different frequencies and bandwidths, then filtered around the center frequency and around twice the center frequency. The signals obtained have been analyzed in order to evaluate the Nakagami parameter (m), the scaling parameter (Ω) and the probability density function. These results have been compared to those obtained by using Field II software.

Tue-Frid Grande Halle PU-S09: Biomedical and biological ultrasounds (Poster session)

Novel ultrasound contrast agents with a liquid core – (Contributed, 000770)

K. Astafyeva[a], W. Urbach[a], N. Tsapis[b], E. Fattal[b], C. Contino-Pepin[c] and N. Taulier[a]
[a]Université Pierre et Marie Curie, Laboratoire d'Imagerie Paramétrique, UMR CNRS 7623, 15 rue de l'école de médecine, 75006 Paris, France; [b]Université Paris-Sud, ; [c]Université d'Avignon et des Pays de Vaucluse, 33 rue Louis Pasteur, 84000 Avignon, France
Corresponding author E-mail: ksenia.astafyeva@gmail.com

We have developed novel nano-Ultrasound Contrast Agents (nUCA) which are highly stable and last several weeks in solution. They consist of a liquid core filled with perfluorocarbons and the shell which is made either with polymers or fluorinated surfactants. The chemical structure of this shell can be modified to alter its physical features. The various physical properties have been experimentally characterized, including UCA radius, shell thickness, densities and adiabatic compressibilities of the agents. The relationship between these physical characteristics of our nUCA and their ultrasonic properties have been investigated. In this research ultrasound backscattering was performed in vitro measurements and simulations using ultrasound waves at 5 and 50 MHz. Also ultrasound attenuation measurements were carried out in a wide range of frequencies (from 3 to 100 MHz). Using a commercial echograph, we checked in mice that our agents induce a significant enhancement in the backscattered signal. Model drugs have been successfully encapsulated into our agents, which can also be functionalised with a RGD peptide to target angiogenesis. The destruction of some of our agents has been achieved using a high ultrasonic field, thus they can be used not only for ultrasound imaging, but also as drug carriers for therapeutic applications.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Subjective assessments of spherical microphone arrays - Paired comparisons of two arrays designed using different microphone models – (Contributed, 000101)

V. Koehl[a], M. Paquier[a] and S. Delikaris-Manias[b]
[a]Université de Bretagne Occidentale, 6, avenue Victor Le Gorgeu, CS 93837, 29238 Brest Cedex 3, France; [b]Ecole Nationale d'Ingénieurs de Brest - CERV, 25, rue Claude Chappe, BP 38, 29280 Plouzané, France
Corresponding author E-mail: vincent.koehl@univ-brest.fr

Microphone arrays are commonly used to capture sound fields. As the number of sensors forming the array increases, the spatial sampling accuracy at high frequencies improves. Numerous prototypes of spherical arrays were developed over the last years. However, much less attention has been paid to the intrinsic performances of the sensors than to their number and arrangement. This study aims at evaluating the relative performances of two rigid spherical microphone arrays of the exact same size differing only in their capsules (pressure sensors). The two recording systems are based on higher order ambisonics and were used to acquire the exact same sound scene. Four short music excerpts were decoded as various types of audio content (mono, stereo and multichannel) and displayed through dedicated loudspeaker setups. The recordings issued by the two arrays were then to be compared by pairs, on a similarity basis and on a preference one, by twelve expert listeners (sound engineering students). The results showed that the perceived differences and preferences depended on the way stimuli were rendered. These assessments were consistent with those obtained from naïve listeners in a previous study, although experts perceived significantly better the differences and reported more pronounced preferences.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Spatial localization of sounds with hearing protection devices allowing speech communication – (Contributed, 000130)

V. Zimpfer[a], D. Sarafian[b], K. Buck[a] and P. Hamery[a]
[a]Institut franco-allemand de recherches de Saint-Louis, 5 rue du Général Cassagnou, BP 70034, 68300 SAINT-LOUIS - France; [b]Institut de Recherche Biomédicale des Armées, BP 73, 91223 Brétigny Sur Orge, France
Corresponding author E-mail: dsarafian@imassa.fr

Level-dependent hearing protection devices protect the ear against harmful noise exposure, like impulse noise with high peak pressure levels, but allow unaltered perception of the quiet acoustic environment. Using this type of protection, speech communication is possible. For these hearing protection devices (HPDs) two principles exist: 1) passive systems (like nonlinear earplugs) and 2) active systems (talk-through systems) using electronics for the reproduction of the acoustic environment. The goal of this study is to quantify the degradation of spatial perception when these protections are worn. To which level is the localization still possible? Tests are realized in order to estimate the localization errors of sound in space with and without wearing level-dependent HPDs. Different kinds of protectors have been used. These tests show that the use of one of these HPDs impedes on the spatial perception: confusions between top-down as well as between in front-back perception.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Efficiency of loudness models for the evaluation of airplane cockpit noise comfort – (Contributed, 000214)

E. Parizet[a], Y. Padayashi[a] and O. Collery[b]
[a]Laboratoire Vibrations Acoustique INSA Lyon, 25 bis avenue Jean Capelle, Villeurbanne, F-69621 Lyon, France; [b]Airbus Opération SAS, 316 route de Bayonne, 31060 Toulouse, France
Corresponding author E-mail: etienne.parizet@lva.insa-lyon.fr

Aircraft interior noise is a major design stake with respect to airline requirements for passenger and crew comfort. The focus was put here on cockpit noise. The goal of this study was to evaluate unpleasantness of such sounds and to propose metrics for its prediction. Six sounds recorded in various airplanes were used; one of them was modified in order to reduce the level of an emerging low-frequency component, leading to a number of seven stimuli. These stimuli were used in a pair-comparison experiment in a sound-proof booth. 31 listeners participated to the experiment. Results could be analysed using a BTL model, which provided an unpleasantness scaling of the stimuli. Unpleasantness was clearly related to loudness; due to the high level in the very low frequency bands, A-weighted level failed to represent loudness. Two loudness models were also used: the ISO-532 one and the ANSI S3.4 one.

It appeared that the former gave better results. It is argued that this is due to the evolution of loudness values in the low frequency range, which is different between these two models.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

COST short term scientific mission: training course on soundscape analysis: soundwalk, recordings, analysis and listening tests – (Contributed, 000313)

P. N. Dökmeci[a], F. Aletta[b], M. Frost[c], I. Garcia[d], M. Galuszka[e], J. Kocinski[e], H. Lin[f], A. Mundt[c], M. Tomás[g], K. Genuit[h] and B. Schulte-Fortkamp[c]

[a]University of Sheffield, School of Architecture, S10 2TN Sheffield, UK; [b]Ri.A.S. Built Environment Control Laboratory, Second University of Naples, 81031 Aversa, Italy; [c]Technical University of Berlin, Einsteinufer st., 10587 Berlin, Germany; [d]Tecnalia, Parque Tecnológico de Bizkaia, 48160 Derio, Spain; [e]Institute of Acoustics, Adam Mickiewicz University, 85 Umultowska Str., 61 614 Poznan, Poland; [f]Foreign Economic Cooperation Office, Ministry of Env Protection of the People's Republic of China, 115 Xizhimennei Nanxiaojie, Xicheng District, 100035 Beijing, China; [g]AAC Acústica + Lumínica, Parque Tecnológico de Álava, Miñano, E-01510 Vitoria-Gasteiz, Spain; [h]HEAD Acoustics GmbH, Ebertstr. 30a, 52134 Herzogenrath, Germany

Corresponding author E-mail: p.dokmeci@sheffield.ac.uk

The collaborative and comprehensive work of group-1, who have attended the short term scientific mission (STSM) initiated through COST: Action TD0804, for the training on soundscape recording and analysis techniques is presented. Group-1, was composed of 9 young researchers who were trained by experienced researchers. The theoretical part of the training school included firstly, introduction to measurement technology, its theory and practical use and secondly, the basic analysis of sound by the conventional indicators and psychoacoustic parameters. Practice on field study was accomplished through semi-structured interview techniques, and evaluation of the recorded dialogue by grounded theory. All these theoretical and practical exercises were followed by a case study. The case study was designed as a sound walk on a pre-defined route, which was accompanied with binaural recordings and soundscape evaluation survey. The STSM for training on the soundscape recording and analysis was accomplished through the presentations and discussions of the results for the case studies of the groups. The results of the recordings and surveys as well as the results of the comparative lab-listening tests of the recorded sound samples of group-1 are presented and discussed as the major parts of this study.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

On the variations of inter-aural time differences (ITDs) with frequency – (Contributed, 000327)

V. Benichoux, M. Rébillat and R. Brette

Dpt. d'études cognitives, ENS Paris, Ecole Normale Supérieure, 29 Rue d'Ulm, 75230 Paris, France

Corresponding author E-mail: marc.rebillat@ens.fr

Inter-aural time differences (ITDs) constitute an important localization cue for azimuth estimation, particularly below 1.5 kHz. As a first approximation, it is commonly assumed that ITDs do not depend on frequency. Nevertheless, Kuhn (JASA, 1977) shows theoretically and experimentally that due to diffraction effects around the head, ITDs depend on frequency. Low frequency ITDs should thus be 1.5 times greater than high frequency ones. In this paper, different classical tools that can be adapted to compute the ITD variations with frequency are described: onset time differences, maximum of the cross correlation, and phase slope differences. The reliability of each tool regarding ITD computation is assessed on the basis of head-related transfer functions (HRTFs) coming from a spherical head model. The effective frequency dependence of ITDs is finally shown by analyzing real human and animal HRTFs.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Noise/Signal: two different listening experiences for deterministic and non deterministic sound stimulus – (Contributed, 000371)

R. C. Borges

Universidade Federal de Minas Gerais, Av. Antônio Carlos, 6627 - Pampulha, 31270-901 Belo Horizonte, Brazil

Corresponding author E-mail: rborges@cpdee.ufmg.br

The duality between signal and noise is widely observed in the scientific context of the 20th century. Noise is retrospectively associated to nuisance, annoyance, and was even subjectively defined as a non-signal. Definition, anyway, takes noise away from its original meaning, turns it into signal and keeps this duality existing through time. This work treats the subject as a matter of perception, more specifically, as a matter of two different listening experiences for deterministic and non deterministic sound stimulus. People with trained ears were asked to freely choose adjectives for pairs of sounds took from a group of: three different probability distributed white noises, a pink noise, a Brownian noise, a square, a square with aliasing effect, a sawtooth, and a pure sine wave. Twenty seven acoustic descriptors were extracted from the samples, from spectral kurtosis to dissonance level. The results were submitted to factorial analysis for finding the best descriptors when separating both groups of sounds, and which physical parameters are correlated to semantic ones. The results points 'granularity/continuity' as the most successful adjectives for separating signal from noise, the presence of a fundamental frequency as a determinant for the distinction, and some correlation between subjective and objective data.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

A laboratory study on the evaluation of soundscape – (Contributed, 000374)

A. Ozcevik and Z. Yuksel Can
Yildiz Technical University, Faculty of Architecture, Yildiz Technical, University, Besiktas, +90 34349 Istanbul, Turkey
Corresponding author E-mail: karabi@yildiz.edu.tr

This study is the second part of a research on a new approach for the evaluation of soundscape. In a previous paper, a field study of subjective evaluation through a survey form consisting of two parts (a questionnaire and a semantic differential test) was introduced. This part of the study aims to assess if the subjective evaluation of soundscapes in laboratory environment is consistent with the data obtained from the field study. The research has three steps; preparing the recordings, calculating the sound quality metrics, and realizing the laboratory study. The sound recordings are obtained by the soundwalk method at the previous areas. The original recordings, which lasted approximately 15 minutes, are edited to reduce the duration to 5 minutes to suit the laboratory tests. Sound quality metrics; loudness, sharpness, fluctuation strength and roughness, are chosen accordingly to both the pilot study and the soundscape literature. The laboratory study consisted of jury tests and listening tests. Data held from the laboratory study is statistically analyzed to attain the subjective evaluation of soundscapes. The information obtained from this study will be used in the next stage which is the comparative analysis between the field and the laboratory studies.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Spatial audio quality in regard to 3D video – (Contributed, 000502)

S. Moulin, R. Nicol and L. Gros
France Télécom - Orange Labs, FT/OLNC/RD/TECH/OPERA/TPS, 2 Av. Pierre Marzin, 22300 Lannion, France
Corresponding author E-mail: rozenn.nicol@orange.com

3D movies provide an improved immersion in terms of visual perception. As for the associate audio channels, most of them are mixed for the conventional format of "multichannel 5.1ï. It should be considered that today there are various ways of listening to 5.1 audio content, either over loudspeaker arrays (for instance ITU standard 5.1 set-up), or over headphones. Recently sound projectors were introduced, in order to render surround sound with compact equipments. The choice of the solution to render multichannel audio has obviously an impact on the perceived quality of the sound. In addition, this latter will also depend on whether a visual content is presented in combination with the audio content. This paper will reexamine these issues in the new context of 3D video. The perceived quality of the spatial sound will be assessed by a listening test for a set of audiovisual excerpts of a 3D movie.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Motor noise influence on acceleration perception in a dynamic driving simulator – (Contributed, 000598)

J.-F. Sciabica[a], V. Roussarie[b], S. Ystad[a] and R. Kronland-Martinet[a]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]PSA Peugeot Citroën, route de Gizy, DRIA/DSTF VV1402, 78943 Velizy Villacoublay Cedex, France
Corresponding author E-mail: jeanfrancois.sciabica@mpsa.com

Automotive acoustic is living a revolution due to new power train introduction. Interior car noise is now designed, offering fresh perspective in terms of sound ambiance. For 4-cylinders car, interior car noise can sound more expressive in order to increase sensation by motor organic modification. Our goal is indeed to conceive interior car sound which is well fitted with car dynamic. This experience studies the relation between acoustic perception and motion perception in a dynamic driving simulator. We test motor noise influence on the car perceived power during an acceleration by modifying motor noise loudness and brigthness. Subjects sit in passenger side three different accelerations are reproduced in the driving simulator. We show that car perceived power increased with loudness whereas brightness doesn't have an impact.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Discrimination thresholds of the reverberation in large volumes by naïve listeners – (Contributed, 000642)

A. Billon[a] and J.-J. Embrechts[b]
[a]Laboratoire d'Étude des Phénomènes de Transfert et de l'Instantanéité : Agro-industrie et Bâtiment, Bâtiment Fourier Avenue Michel Crépeau F-17042 La Rochelle Cedex 1; [b]University of Liege - Acoustics Labo, Campus du Sart-Tilman, B28, B-4000 Liege 1, Belgium
Corresponding author E-mail: abillon@ulg.ac.be

Reverberation is one of the main perceptual dimensions allowing to rate and to discriminate the acoustics of rooms. Several studies concerning its perceptive threshold have been carried out previously. The resulting threshold values are somewhat scattered, varying between 4% and more than 20%. These studies differ in terms of sound stimuli, length of the reverberation, experiment design and experience of the subjects. In this study, a comparison and an adjustment experiments were carried out using three sound stimuli: white noise, male spoken words and an orchestral extract. The room impulse responses used in these comparisons are characterized by frequency-dependent decays. The reverberation time at 1000Hz of the mean impulse response was 1,89s which is representative of a medium size concert hall. The subjects were students with half of them playing a musical instrument regularly. They had no prior experience in terms of perceptual audio testing. A differentiation threshold around 10% is obtained, varying slightly with the experimental conditions and the sound stimuli. The thresholds obtained for speech signals were lower of about 2% than those obtained for white noise and the orchestral piece of music.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Distance perception of recorded instruments in virtual monitoring environments – (Contributed, 000659)

F. Georgiou[a] and B. Fazenda[b]
[a]University of Salford, Newton Building G11, University of Salford, M5 4WT Manchester, UK; [b]University of Salford, Newton Building N118, University of Salford, M5 4WT Manchester, UK
Corresponding author E-mail: f.georgiou1@edu.salford.ac.uk

Accurate distance perception in virtual audio systems is very important and during the last decade there has been an increased interest in this research area. In this research paper we investigate the effects of the different types of music stimulus on the perception of distance and how well modelled BRIRs simulate distance perception compared to measured ones. The BRIR were measured on a small and medium sized room. BRIR were generated for identical conditions modelled through a hybrid image source model with exponentially decaying noise for the simulation of late reverberation. Two subjective tests were conducted. In the first five musical instrument samples were convolved with the measured and modelled BRIR in order to observe their effect on distance perception. On the second test, the efficiency of the modelled BRIR was investigated by doing a direct comparison with the measured BRIR.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Timbre description of the sound of air-treatment systems for predicting acoustic comfort – (Contributed, 000742)

A. Minard[a], A. Billon[b], B. Goujard[b], B. Robin[a], F. Fournier[a], J.-J. Embrechts[c] and A. Sakout[b]
[a]CIAT, avenue Jean Falconnier, 01350 Culoz, France; [b]Laboratoire d'Étude des Phénomènes de Transfert et de l'Instantanéité : Agro-industrie et Bâtiment, Bâtiment Fourier Avenue Michel Crépeau F-17042 La Rochelle Cedex 1; [c]University of Liege - Acoustics Labo, Campus du Sart-Tilman, B28, B-4000 Liege 1, Belgium
Corresponding author E-mail: antoine.minard@univ-lr.fr

This study aims at defining reliable acoustic cues for the measure, characterization and prediction of the acoustic comfort of air-treatment systems (ATS). To meet customers' expectations, industrial products tend increasingly to follow a process of "sound design". In this process, the perceptual evaluation of sound quality is a necessary step to define acoustic specifications. In this context, this study aims at defining the main perceptual attributes of the sound of air-treatment systems in order to predict users' preferences. The timbre space of a sound dataset extracted from a large recording database was thus identified through a similarity experiment where participants were asked to rate the resemblance between each pair of sounds. The results of this experiment were analyzed with a Multidimensional Scaling (MDS) method in order to extract the main perceptual attributes. Finally, these attributes were linked to relevant audio features through a regression method in order to define a reliable computable metric of acoustic comfort. This study was conducted through the Vaicteur Air^2 project supported by OSEO.

Tue-Frid Grande Halle SP - Sound perception (Poster session)

Perceptual differences between sounds produced by different continuous interactions – (Contributed, 000773)

S. Conan, M. Aramaki, R. Kronland-Martinet, E. Thoret and S. Ystad
Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: aramaki@lma.cnrs-mrs.fr

The presented study is part of a general framework consisting in designing an intuitive control strategy of a generic synthesis model simulating continuous interaction sounds such as scraping, sliding, rolling or rubbing. For that purpose, we need to identify perceptually relevant signal properties mediating the recognition of such sound categories. Some studies tend to suggest the existence of acoustic features related to velocity or periodic modulations but, to our knowledge, the auditory distinction between these interactions is still not well-known and no formal investigations have been conducted so far. This study aimed at presenting a perceptual evaluation method, with brings to the light the differences between these interaction sounds. Such sounds were synthesized based on existing models and a morphing procedure between these sound categories was used to create intermediate sounds. Then, sounds were evaluated by subjects in a categorization task. Analyses of data revealed characteristic signal morphologies associated to each interaction sound category, thereby useful for the design of intuitive control of the generic synthesis model.

Tue 8:00 Lord RAYLEIGH Keynote lecture: Pr. Daniel Juvé

Aeroacoustics: convergence between direct computations and experiments – (000859)

D. Juvé
LMFA Ecole Centrale de Lyon, 36, avenue Guy de Collongue, 69134 Ecully, France
Corresponding author E-mail: daniel.juve@ec-lyon.fr

Recent evolutions of numerical methods and of experimental techniques used for the characterization of sound generated by flows will be reviewed. In the flow region it is now possible to obtain a rather complete view of the time-evolution of turbulent structures using Time Resolved Particle Image Velocimetry; this type of information is very similar to what can be computed by Large Eddy Simulations. In that sense there is a convergence between experimental and numerical approaches and common post-processing tools can be used to obtain some information on the physics of flow noise. However each approach has its own strengths and deficiencies; for example numerical simulations are limited to relatively low Reynolds numbers and conclusions drawn in these conditions are sometimes dangerous to extrapolate to real -high Reynolds number-configurations. On the other hand experimental data in the acoustic field are relatively sparse due to the small number of sensors available whereas complete information is easily obtained from numerical simulations. The combined used of time-resolved experimental and numerical data on the same configurations is therefore an avenue for progressing toward the understanding of noise generation process and the development of noise reduction strategies.

Tue 8:00 Paul LANGEVIN Keynote lecture: Pr. Yiu Wai Lam

Time domain modelling of room acoustics – (000864)

Y.W. Lam and J. Hargreaves
University of Salford, School of Computing, Science and Engineering, M5 4WT Salford, UK
Corresponding author E-mail: y.w.lam@salford.ac.uk

Time domain modelling offers many advantages for room acoustics investigations. It directly generates the room's impulse response which is an important piece of information for acoustic quality assessment. It is efficient for broadband calculations over a short time duration. The most common room acoustics modelling method is currently based on geometrical room acoustics in the time domain. It is efficient and provides practical approximations. However, its accuracy is ultimately limited by its approximation of wave behaviours. Wave based models, which are more accurate but expensive, have been gaining interests due to more efficient numerical schemes. One example is the finite difference time domain method. This paper gives some examples of developments in this method for room acoustics. Another example is the time domain boundary element method. Although it is harder to implement, it has an advantage that a change in source or room does not require complete recalculation of the interaction matrix. This is useful for time variant simulation or auralisation. Here we also introduces the concept of ëwave matching', and see if it has the potential to be developed into a new, efficient time domain wave based modelling method.

Tue 9:00 Ray STEPHENS EN-S05: Wind turbine noise

Wind turbine amplitude modulation: research to improve understanding as to its cause & effect – (Contributed, 000699)

M. M. Cand[a], A. J. Bullmore[a], M. Smith[b], S. Von-Hunerbein[c] and R. Davis[d]
[a]Hoare Lea Acoustics, 140 Aztec West Business Park, Almondsbury, BS32 4TX Bristol, UK; [b]Institute of Sound and Vibration Research, University of Southampton, University Road, S017 1B Southampton, UK; [c]Acoustics Research Centre, University of Salford, Salford, M5 4WT Greater Manchester, UK; [d]Robert Davis Associates, The Holt, Upper Timsbury, SO51 0NU Romsey, UK
Corresponding author E-mail: matthewcand@hoarelea.com

The issue of amplitude modulated noise (often referred to as ëblade swish' or ëAM') arising from the operation of wind turbines is presently receiving a high focus of attention. Whilst the acceptability of audible noise from wind turbines continues to be the subject of considerable debate, the specific issue of AM has come to the fore in recent years.
The issue of AM is not a new one, having been the subject of a previous study undertaken on behalf of the UK Government by the University of Salford in 2007. That study was initiated following complaints of what was believed to be problematic levels of low frequency noise arising from a limited number of operational wind farms.

A research project has been underway to improve understanding of the phenomenon, and develop an objective method for quantifying levels of AM and provide a well-defined dose-response relationship. This paper will discuss the results of this research. The project is 100% funded by RenewableUK.

Tue 9:20 Ray STEPHENS EN-S05: Wind turbine noise

Estimation of uncertainties due to the wind-induced noise in a screened microphone – (Contributed, 000607)

D. Ecotiere
Laboratoire Régional des Ponts et Chaussées de Strasbourg, 11 rue Jean Mentelin, 67035 Strasbourg, France
Corresponding author E-mail: david.ecotiere@developpement-durable.gouv.fr

An outdoor sound measurement can be influenced by the noise induced by the wind at a screened microphone. This noise originates from turbulences that come from the direct interaction between the wind and the wind screen, as well as those generated by the interaction between the wind and the surrounding surfaces, specially the ground. The wind noise contribution introduces a bias in the measurement results which depends on the noise source, the wind speed, and other parameters such as the ground roughness length or the atmospheric stability for example. We present here an estimation of this bias, as well as the uncertainties associated to this bias coming from some input parameters. These estimations were obtained using some Monte Carlo simulations and a wind-induced noise model (van den Berg, 2006). Some practical applications are also presented.

Tue 9:40 Ray STEPHENS EN-S05: Wind turbine noise

Mechanisms of amplitude modulation in wind turbine noise – (Contributed, 000731)

M. Smith[a], A. J. Bullmore[b], M. M. Cand[b] and R. Davis[c]
[a]Institute of Sound and Vibration Research, University of Southampton, University Road, S017 1B Southampton, UK; [b]Hoare Lea Acoustics, 140 Aztec West Business Park, Almondsbury, BS32 4TX Bristol, UK; [c]Robert Davis Associates, The Holt, Upper Timsbury,

SO51 0NU Romsey, UK
Corresponding author E-mail: mgs@isvr.soton.ac.uk

The noise produced by wind turbines is inherently time varying. This amplitude modulation is normally due to the directivity of the dominant trailing edge noise sources combined with the changing position and orientation of the rotating blades. In some circumstances the level and character of the amplitude modulation is altered and this paper outlines results from a Renewable UK funded research programme into the possible causes. Besides the variability of the normal trailing edge noise mechanism, other factors investigated include the possibility of blade stall or increased levels of inflow turbulence under some wind conditions combined with various propagation factors such as the effect of wind gradients and atmospheric absorption.

Tue 9:00 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Nonlinear ultrasound parameter measurement for clay suspended particles characterization – (Contributed, 000824)

H. Jakjoud, A. Chitnalah, N. Aouzale and H. Soucrati
Laboratory of Electrical Sciences and Technology, Faculty of Sciences and Technology, 40000 Marrakech, Morocco
Corresponding author E-mail: chitnala@yahoo.com

Finite amplitude insert substitution method is used to measure the nonlinear ultrasound parameter in clay particles suspended in water. The analytical expressions of the fundamental and the second harmonic are obtained by integrating the KZK equation in multilayer structure using the quasi-linear assumption and a set of Gaussian beams. In order to validate the technique, measurements are performed in methanol and Glycerol. The results fit well with literature ones. Then we used this technique to investigat a sample of water with clay particles. The sample is filled out into a slice layer and inserted into a well known medium orthogonally to the propagation direction. The concentration of particles ranges from 10g/l to 50g/l. The celerity, the absorption and the nonlinear coefficient are measured. We noted that the nonlinear ultrasound parameter shows a linear variation within the clay's particles concentration and it shows a good sensibility.

Tue 9:20 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

The application of the factor analysis to the studies of the nonlinear dynamic elasticity – (Contributed, 000011)

V. Tsaplev and P. Grushevsky
North-West State Technical University, 5, Millionnaya Street, Department of Physics, 191186 Saint-Petersburg, Russian Federation
Corresponding author E-mail: valery@convergences-fr.ru

The application of the factor analysis to the studies of the nonlinear elasticity of the piezoceramic materials is presented. All physical properties of these materials are strongly nonlinear dielectric, elastic and unelastic. Moreover, all these properties manifest creep. Simultaneous measurements of all these characteristics are very labor and time consuming and often even impossible, especially concerning the second or third-order elastic moduli. The usage of the factor analysis methods helps to optimize the process. The results of the application of these methods to the study of the titanate-barium and PZT piezoceramics elastic moduli, internal friction and non-stationary creep are presented.

Tue 9:40 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Signal processing for the detection and quantification of the noncollinear nonlinear interaction – (Contributed, 000868)

A. J. Croxford, J. N. Potter and B. Drinkwater
University of Bristol, Department of Mechanical Engineering, University Walk, BS8 1TR Bristol, UK
Corresponding author E-mail: b.drinkwater@bristol.ac.uk

Nonlinear techniques offer great potential for the detection and quantification of early stage damage. One such approach is the noncollinear technique. This relies on the interaction of two shear waves in a nonlinear medium leading to the generation of a third wave. The size, mode, frequency and wave vector of this wave is dependent on

the input parameters and the nature of the nonlinearity present in the material. This paper looks at how signal processing and careful selection of operating conditions can be used to ensure the maximum resolution of this nonlinear signal. Specifically how different input frequencies can be used to aid the measurement of the nonlinear signal, and how changing the input signal can be used to steer the beam to obtain spatial information. These factors combine to make the final post capture signal processing more straightforward and result in a relatively simple nonlinear measurement that can be readily resolved from the background noise. The paper describes both an analytical study of how the noncollinear measurement is made and an experimental validation of the conclusions and the relevant signal processing techniques.

Tue 10:40 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Application of coded transmission technique to Ultrasonic Computed Tomography of soft tissues – (Contributed, 000108)

P. Lasaygues, J. Rouyer and S. Mensah
Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: lasaygues@lma.cnrs-mrs.fr

Ultrasonic Computed Tomography (UCT) is an ultrasonic imaging modality of soft tissues. The main performance of the UCT is to improve the image resolution by eliminating unwanted noise, and/or wave interference such as speckle. When an acoustical properties contrast exists between the material and the mean medium, such as microcalcification under soft tissues for example, the presence of some physical phenomena generates complex signals consisting of several packets with different signatures, which it is often difficult to interpret in terms of wave path, in terms of depth-dependencies, or in terms of reflectivity, velocity or attenuation. To improve the quality of the tomogram, several approaches have been used so far; such as filtering or deconvolution, which may be sophisticated and unstable. An alternative methods is to consider the waveform generated by the array, and propagating in the reference medium before the scatterer, and in particular methods based on a coded waveforms, which make it possible to process the local, and much more global information available in terms of frequency and time parameters. In this work, the Golay coded excitations are performed as processing tools, before tomographic image reconstruction to increase the signal-to-noise ratio and the depth inspection of soft tissues.

Tue 11:00 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Non contact acoustic exploration method for concrete using SLDV and LRAD – (Contributed, 000069)

T. Sugimoto[a], R. Akamatsu[a], N. Utagawa[b] and S. Tsujino[b]
[a]Toin Univ. of Yokohama, 1614, Kurogane-cho, Aoba-ku, 225-8503 Yokohama, Japan; [b]Sato Kogyo Co., Ltd., 4-12-19, Nihonbashi-honcho, Chuo-ku, 103-8639 Tokyo, Japan
Corresponding author E-mail: tsugimot@cc.toin.ac.jp

The hammering test is a representative method in inspection for cavities and delaminations at shallow area of concrete surface. Although this method is used widely because it is not expensive, efficiency of the defect-judging largely depends on the tester's experience and long measurement time is necessary for wide area inspection. Other methods have been developed, however, it is necessary to contact or approach to the inspection object during a measurement. Therefore, we propose a new non-contact acoustic imaging method for nondestructive inspection using scanning laser Doppler vibrometer (SLDV) and long range acoustic device (LRAD). In this method, Surface vibration, which is generated by air borne sound, is measured using SLDV. This time, the styrofoam board was buried at shallow depth in the concrete are used as a substitute of a cavity in the concrete. As an experimental result, a styrofoam board is clearly imaged by the vibration velocity of the concrete surface. Furthermore, we confirmed that our proposed method can apply even 10 m away distance, and the measurement distance is about within 20 m under the present conditions. It means that the non destructive inspection for concrete from a long distance is possible.

Tue 11:20 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Small calcification depiction in ultrasonography using correlation technique for breast cancer screening – (Contributed, 000417)

H. Taki, T. Sakamoto, M. Yamakawa, T. Shiina and T. Sato
Kyoto University, Yoshida-honmachi, Sakyo-ku, Kyoto 606-8501, Japan, 606-8501 Osaka, Japan
Corresponding author E-mail: hirofumi.taki@mb6.seikyou.ne.jp

In breast cancer screening mammography plays the primary role to depict small calcifications that accompany cancers; however, it involves exposure to ionizing radiation, and it is not effective in younger women for detecting cancers in the pre-menopausal breast. In order to realize the breast cancer screening without radiation exposure for all people including young women, we have proposed an ultrasound calcification depiction method employing correlation technique. Since a calcification has a large acoustic impedance mismatch to soft tissue, it is supposed that the waveform of an ultrasound pulse changes at the position of the calcification. The method utilizes the deterioration in the cross-correlation between adjacent scan lines caused by the waveform change. In this study, we investigate the performance of the method in the condition close to a clinical environment. The result shows that the method has the potential to depict small calcifications without acoustic shadowing, indicating the capability of the method to improve the sensitivity of ultrasonography in small calcification detection.

Tue 11:40 Pierre CHAVASSE MI-S01: Signal processing for nonlinear NDT and biomedical imaging

Research & Medical Doppler platform – (Contributed, 000444)

M. Lewandowski[a], M. Walczak[a], P. Karwat[a], B. Witek[a], A. Nowicki[a] and P. Karłowicz[b]
[a]Institute of Fundamental Technological Research PAS, Pawinskiego 5B, 02-106 Warsaw, Poland; [b]Sonomed, Pruszkowska 4d, 02-118 Warsaw, Poland
Corresponding author E-mail: mlew@ippt.gov.pl

A new ultrasound digital transcranial Doppler system (digiTDS) is introduced. The digiTDS enables the diagnosis of intracranial vessels and the assessment of the blood flow. The device can display a color map of flow velocities in time-depth domain and a spectrogram of Doppler signal obtained at a selected depth. The system offers the multigate processing which allows to display simultaneously a number of spectrograms and to reconstruct a flow velocity profile. The digital signal processing in the digiTDS is divided between hardware and software. The hardware part, based on the FPGA, executes a signal demodulation and reduces the data stream. The software part, executed on the PC, performs the Doppler processing and the visualization. The hardware-software partitioning enables building of a flexible Doppler platform at a relatively low cost. The detailed description of the system internals and the algorithm optimization are presented. The digiTDS is a new useful tool for transcranial applications as well as in general Doppler research. Its design fulfills all required medical standards, so it can be used both in laboratory and clinical practice.

Tue 9:00 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Numerical simulation of noise generated by multi asperity contact between rough surfaces – (Contributed, 000489)

V.H. Dang, A. Le Bot and J. Perret Liaudet
Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: viet-hung.dang2@ec-lyon.fr

The friction between heterogeneous, rough and complex surfaces induces vibration in the solids and radiates noise in the surrounding media. In this study, we propose a numerical approach based on a modal development to estimate the statistical properties of local dynamics which cannot be obtained by experiments. The approach consists in three algorithms: the contact detection, the calculation of contact forces and the time integration of the governing equations. The validation of the method is then discussed by comparison with the finite element software Abaqus and some experimental results. The calculation results show that noise is an increasing function of the surface roughness and sliding speed. The basic mechanism responsible of noise is asperity shocks occurring at the interface that convert a part of the kinetic energy of the sliding solid into acoustical energy.

Tue 9:20 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Static correction of acoustic models with application to vibro-acoustic coupling – (Contributed, 000679)

J.-M. Lagache[a] and S. Assaf[b]
[a]PSA Peugeot - Citroën, Centre Technique de la Garenne Colombes Case courrier LG098 18, rue des Fauvelles 92256 La Garenne Colombes cedex; [b]ESTACA, 34 rue Victor Hugo, 92532 Levallois Perret Cedex, France
Corresponding author E-mail: samir.assaf@estaca.fr

A direct determination of modal remainders in truncated modal series, in structural or acoustic analyses, has been recently proposed by the authors, leading to explicit expressions of the response of a free-floating mechanical system or of an acoustic cavity, by "acceleratedï modal formulae including static terms and accelerated modal series. The general method,- termed "Method of Orthocomplementï,- will be recalled in the paper, especially the pseudo-inversion techniques required by the singular static terms. Since the coupling of an acoustic cavity results from the reduction of the acoustic dynamic stiffness, inv(H - Qw^2), to generalized degrees of freedom defined by the coupling matrix, it will be shown that applying the preceding formulae leads to two possible vibro-acoustic methods: (1) a low frequency method based on the algebraic computation of static terms, which delivers the added stiffness and mass matrices to be used from the Helmholtz 0Hz frequency to the first non-zero acoustic frequency; (2) a general method where the static terms are complemented by a reasonable number of cavity modes.

Tue 9:40 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Prediction of acoustic pressure in an enclosed space by numerical means – (Contributed, 000655)

Ö. Demirkan and M. Çalışkan
Middle East Technical University, Department of Mechanical Engineering, 06800 Ankara, Turkey
Corresponding author E-mail: demirkan@metu.edu.tr

In this study, acoustic pressure inside an enclosed domain is investigated at low frequency region. The acoustic response due to a monopole inside a rigid walled rectangular cavity is predicted. The acoustic domain is analysed by using the finite element method (FEM) and boundary element method (BEM). The results are then compared with an analytical model. These widely used methods in acoustic analysis are evaluated on the basis of inherint drawbacks and advantages. The mesh sizes and computational time are also discussed. Moreover, the acoustic pressure response of rigid walled cavity backed by an elastic plate is studied using FEM and BEM. Computational results are comparatively evaluated.

Tue 10:40 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Transmission Loss trim FEM simulation of lightweight automotive dashboard insulators with consideration of the instrument panel – (Contributed, 000201)

L. Dejaeger[a], J.-F. Rondeau[a], P. Chanudet[b] and B. Auffray[b]
[a]Faurecia Interior Systems, Centre R&D, BP 13, Route de Villemontry, 08210 Mouzon, France; [b]PSA, Route de Gisy, 78943 Vélizy Villacoublay Cedex, France
Corresponding author E-mail: ludovic.dejaeger@faurecia.com

In previous studies, good correlation results between Transmission Loss measurements and Transmission Loss FEM simulations on dashboard or floor insulators were obtained. Regarding dashboard insulators, those works were done without considering the Instrument Panel. The weight reduction strong trend in vehicles design impacts obviously the noise treatments. In order to ensure an equivalent noise reduction performance, a way to proceed is, for example, to reduce the heavy layer (septum) weight and to compensate the loss of insulation by adding an absorption layer.
Without taking into account the absorption and masking effects linked to the presence of the Instrument Panel the overall insulation performances of the front vehicle unit are not properly estimated. In this paper, a numerical study dealing with Transmission Loss simulation of a dashboard insulator with consideration of the Instrument Panel including absorbing felts was carried out in order to predict the insulation performances of a complete front vehicle unit.
In this numerical study, weight localization on dashboard insulators was optimized in order to improve noise reduction performances for airborne and structureborne noise excitation in the middle frequency range. Finally a ranking, between all studied solutions, from pure absorbing systems to highly insulating noise treatments is presented.

Tue 11:00 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Recent developments in Code_Aster to compute FRF and modes of VEM with frequency dependent properties – (Contributed, 000356)

N. Merlette[a], E. Pagnacco[b] and A. Ladier[b]
[a]TANGENT'DELTA, 1 rue Adolphe Robert, 58200 Cosne Sur Loire, France; [b]Laboratoire de Mécanique de Rouen, INSA de Rouen, Avenue de l'Université, 76800 Saint Etienne Du Rouvray, France
Corresponding author E-mail: nicolas.merlette@tgdelta.com

ViscoElastic Materials (VEM) are intensively used to solve NVH issues. Damping pads and anti flutter products reduce the structure borne noise. Sealants and absorbing materials prevent the air borne transmission. Adhesives are common solutions to assemble parts. Whereas VEM are well known, the finite element analysis of their dynamic behavior is not straightforward. Most of the time, the use of a computer aided engineering software requires to simplify VEM as standard elastic materials. This simplification is not always the obvious thing to do and may lead to inaccurate results. The paper tackles the way how advanced capabilities are introduced in Code_Aster to take into account frequency dependent properties of VEM. The computing of frequency response functions and modes of vibration (real or complex) is addressed. Having frequency dependent modes is a step forward for the modal projection method and for the model updating with an experimental modal basis as a reference. The new capabilities are then compared with the standard approaches in the case of an automotive windshield. Two VEM are considered: the windshield bonding and the polyvinylbutyral of the laminated glass.

Tue 11:20 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Reduced order model for noise and vibration attenuation of water immersed viscoelastic sandwich structures – (Contributed, 000243)

L. Rouleau[a], J.-F. Deu[a], A. Legay[a], J.-F. Sigrist[b] and P. Marin-Curtoud[c]
[a]Laboratoire de Mécanique des Structures et des Systèmes Couplés, 292, rue Saint Martin 75141 Paris Cedex 03; [b]Département Dynamique des Structures, CESMAN, DCNS research, Indret, 44620 La Montagne, France; [c]DGA Techniques Navales, BP 40915, 83050 Toulon Cedex, France
Corresponding author E-mail: lucie.rouleau@cnam.fr

The structural optimisation of structures with constrained viscoelastic layers is a major issue in the conception of submarines, to assure stealthiness performances. This work proposes reduction methods to solve the system composed of a sandwich structure with a viscoelastic core coupled to fluids in the frequency domain. The first one consists in developping added mass operators to take into account the fluid. The second one is the combination of modal projection and iterative methods to evaluate the reduced problem and estimate the dissipative energy in view of optimization. This numerical strategy is applied to the response of a bidimensional sandwich ring coupled to internal and external fluids and extended to a tridimensional structure.

Tue 11:40 Paul LANGEVIN NV-S11: Numerical methods in vibroacoustics

Numerical transmission loss calculations for perforated dissipative mufflers containing heterogeneous material and mean flow – (Contributed, 000096)

A. G. Antebas[a], F. D. Denia[b], E. M. Sánchez-Orgaz[b] and F. J. Fuenmayor[b]
[a]CTAG (Centro Tecnológico de Automoción de Galicia), Polígono Industrial A Granxa, Calle A, parcelas 249-250, 36400 Porriño (pontevedra), Spain; [b]Centro de Investigación de Tecnología de Vehículos, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain
Corresponding author E-mail: anan1@upvnet.upv.es

In this work, a finite element approach has been developed to study the acoustic behaviour of perforated dissipative mufflers with heterogeneous absorbent material and the presence of mean flow. The heterogeneous properties can appear, for example, during the manufacturing processes of the dissipative muffler or due to the flow of soot particles within the absorbent material. A uniform mean flow is considered within the central passage and a perforated duct separates this flow from the outer dissipative chamber. First, the finite element method is applied to the wave equation for a stationary non-homogeneous medium (outer chamber) and a moving homogeneous medium (central passage). The absorbent material is characterized as an equivalent fluid, by means of its complex density and speed of sound. To introduce the variations of these properties within the material, a coordinate-dependent function is proposed for the filling density. This yields a heterogeneous resistivity, which produces spatial modifications of the equivalent properties. The acoustic impedance of the perforated duct has been also modified to include the heterogeneous properties of the dissipative medium. Finally, the effect of the mean flow Mach number, filling density and porosity of the perforated duct on the acoustic attenuation of the muffler is studied.

Tue 9:00 François CANAC PU-S11: Geophysics and seismics

Laboratory benchmarks vs. Synthetic modeling of seismic wave propagation in complex environments (BENCHIE Project) – (Contributed, 000194)

N. Favretto-Cristini[a], P. Cristini[a], D. Komatitsch[a], B. Ursin[b], A. Tantsereva[b] and A. M. Aizenberg[c]
[a]CNRS-LMA, 31 chemin Joseph-Aiguier, 13402 Marseille, France; [b]NTNU Department of Petroleum Engineering and Applied Geophysics, S.P.Andersens v. 15A, 7491 Trondheim, Norway; [c]Institute of Petroleum Geology and Geophysics SB RAS, Pr.Ac.Koptyug 3, 630090 Novosibirsk, Russian Federation
Corresponding author E-mail: favretto@lma.cnrs-mrs.fr

Accurate simulations of seismic wave propagation in complex geological structures with great and rapid variations of topography are of primary interest for environmental & industrial applications. Unfortunately, difficulties arise for such complex environments, due essentially to the existence of shadow zones, head waves, diffractions & edge effects. Usually, methods and codes are tested against " validated "" ones, but one might wonder which method/code ultimately approaches the " real "" solution. An original approach for seismics is to compare synthetic seismic data to controlled laboratory data for a well-described configuration, in order to analyze the respective limitations of each method/code. This is one of the objectives of the BENCHIE project. In this presentation we will present some preliminary results provided by both laboratory experiments conducted in a tank and numerical simulations of wave propagation. The laboratory data have been obtained by zero-offset acquisitions at different ultrasonic frequencies on the Marseille model which is made up of anticlines, fault and truncated pyramid. The numerical results have been obtained by two methods: the Spectral-Element Method and the Tip-Wave Superposition Method.

Tue 9:20 François CANAC PU-S11: Geophysics and seismics

Surface-wave retrieval from ambient-noise observations using crosscorrelation and multidimensional deconvolution – (Invited, 000212)

K. Van Dalen, E. Ruigrok and K. Wapenaar
Delft University of Technology, Stevinweg 1, 2628CN Delft, Netherlands
Corresponding author E-mail: k.n.vandalen@tudelft.nl

The crosscorrelation of ambient-noise observations of two different seismic receivers is known to yield an approximation of the Green's function as if one of the receivers were a source. We apply this principle to field observations collected at two seismic arrays in southwestern USA: the RISTRA array and the CDROM array. We use especially responses from noise sources lying at the North Pacific Ocean. We will show results containing clear evidence that surface waves can successfully be retrieved from these observations in both the single-frequency and double-frequency microseism bands. We will also show the result of multidimensional deconvolution of the retrieved Green's function by the so-called point-spread function. We compute this function from the ambient-noise field to quantify the smearing of the virtual source in space and time due to the lack of equipartitioning of the noise sources. The deconvolution process is known to partially correct for this lack of equipartitioning and might thus increase the accuracy of the retrieved Green's function.

Tue 9:40 François CANAC PU-S11: Geophysics and seismics

Passive spatio-temporal inverse filter – (Invited, 000054)

T. Gallot[a], S. Catheline[b], P. Roux[b] and M. Campillo[b]
[a]Massachussetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Ma, 02139-430, USA; [b]Institut des Sciences de la Terre, ISTerre BP 53, 38041 Grenoble Cedex 9, France
Corresponding author E-mail: gallott@mit.edu

Green's functions recovering from ambient noise require strong hypothesis, including isotropic distribution of the noise sources. This ideal distribution is not achieved in most of the experimental applications, yielding to bias in the Green's function reconstruction. To minimize this bias, a spatio-temporal inverse filter is proposed. In this study, an experimental active seismic dataset is used to compute a directive noise field. The method is then implemented on this controlled dataset. The results indicate that the passive inverse filter can efficiently compensate for the noise wavefield directivity by manipulating the spatio-temporal degrees of freedom of a complex wave field.

Tue 10:00 François CANAC PU-S11: Geophysics and seismics

Feasibility modeling of time-lapse seismic noise interferometry for CO2-monitoring – (Invited, 000338)

A. R. Verdel[a], J. W. Thorbecke[b] and D. S. Draganov[b]
[a]TNO Geo Energy, Princetonlaan 6, 3584 CB Utrecht, Netherlands; [b]Delft University of Technology, Stevinweg 1, 2628 CN Delft, Netherlands
Corresponding author E-mail: arie.verdel@tno.nl

In ambient noise seismic interferometry for body wave retrieval, data traces are measured over a long period of time and correlated with each other to attempt to retrieve P-wave reflection data that can be interpreted in terms of contrasts in elastic subsurface layer properties. It is the intention at TNO Geo Energy to use this technique in a time-lapse application: the monitoring of CO2-migration paths in the subsurface at the demonstration site for CO2-sequestration in Ketzin, Germany. The quality of the retrieved reflection data is, among others, dependent on the number of noise sources measured during the recording time, the source strength distribution, and the source location distribution. In this paper, we present modeling results representing a feasibility study of the utilization of ambient noise seismic interferometry for monitoring the Ketzin subsurface. We investigate the dependence of the results on the variation, with time, of subsurface elastic layer properties due to injection-induced insitu CO2-saturation changes. For this purpose, dedicated finite-difference modeling software was used that was developed recently at Delft University of Technology. The outcome of this study will determine whether the Ketzin field data could actually be used for application of the ambient noise interferometry technique for CO2-monitoring.

Tue 10:40 François CANAC PU-S11: Geophysics and seismics

Friction experiments with elastography: the slow slip and the super-shear regimes – (Contributed, 000840)

S. Catheline[a], S. Latour[a], T. Gallot[b], C. Voisin[a], F. Renard[a], E. Larose[c] and M. Campillo[a]
[a]Institut des Sciences de la Terre, ISTerre BP 53, 38041 Grenoble Cedex 9, France; [b]Massachussetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Ma, 02139-430, USA; [c]ISTerre - CNRS, 1381, rue de la piscine, 38400 Saint Martin D'Hères, France
Corresponding author E-mail: stefan.catheline@obs.ujf-grenoble.fr

To get an insight into the processes underlying dynamic friction that plays an important role in seismic sources for example, we developed a sliding dynamic experiment coupled to elastography imaging. This experimental setup permits to observe simultaneously the frictional interface and the waves emitted in the bulk during slipping. We use soft solids made of hydro-organic gel of PVA, in contact with either glass or sandpaper. The huge interest of such soft solids is that ultrasonic waves allows to observe in real time the rupture nucleation and propagation, as well as shear waves themselves inside the medium. We investigate the friction in two different cases. In the case of friction on sand paper, links are formed between the gel and the sand paper by local pinning. The breaking of these links emits a characteristic wave pattern, and their occurrence is related to the local sliding velocity. In a very different way, when the gel slide on a glass surface, with an interlayer of sand grains, the slip occurs as successive rupture events, with a rupture front crossing the whole surface. We can study then the rupture velocity, and in the cases of ruptures faster than the shear wave velocity, we observe a Mach cone of shear waves.

Tue 11:00 François CANAC PU-S11: Geophysics and seismics

Wandering of the modal parameters in existing building: application to structural health monitoring – (Contributed, 000847)

P. Gueguen
IFSTTAR/ISTerre, BP 53, 38041 Grenoble Cedex 9, France
Corresponding author E-mail: pgueg@obs.ujf-grenoble.fr

Ambient vibrations in building is of increasing interest for applications in mechanical engineering, civil engineering and earthquake engineering. With advances in data acquisition systems (number of measurement points, continuous recording, low-noise instrument) and advances in signal processing algorithms, further and better studies can be conducted on civil engineering structures for evaluating their modal parameters and their physical properties. This study is focused on long- and short-term variations of frequency and damping in buildings. After a brief overview of the physical meanings and the practical interest for earthquake engineering, some examples are shown. They concerns the transient variations of modal parameters related with non-linear behaviour of the sys-

tem, the permanent decrease of frequency and damping after extrem event and the natural wandering of modal parameters, often related to atmospheric conditions. These changes, however, confirms the great stability and confidence measurements in buildings using modal analysis. This information helps to consider the relevancy of analysis of existing monitoring (damage, ageing, and so on) and can better calibrate the mechanical models used for the analysis of seismic vulnerability of existing structures, and thereby help reduce variability of their estimates.

Tue 11:20 François CANAC PU-S11: Geophysics and seismics

Benefits of the horizontal component in quantitative imaging of near-surface interfaces with lateral variations: synthetic model inversion and reduced scale modeling – (Contributed, 000737)

R. Valensi[a], D. Leparoux[a], O. Durand[a], F. Bretaudeau[b], R. Brossier[c] and P. Côte[a]
[a]IFSTTAR, Route de Bouaye, CS4, 44344 Bouguenais Cedex, France; [b]Institut de radioprotection et de sûreté nucléaire, BP17 92262 Fontenay-aux-Roses Cedex; [c]Institut des sciences de la Terre, BP 53 38041 Grenoble cedex 9
Corresponding author E-mail: raphael.valensi@ifsttar.fr

In near-surface quantitative seismic imaging, the mechanical properties of an heterogeneous medium are usually inferred from the measure of the normal velocity component at different locations. In this study, it is proposed to investigate the benefits of measuring also the tangential velocity component. For that purpose, a realistic synthetic model is defined and the benefits of each component are analyzed in the framework of seismic imaging by Full Waveform inversion. The model is a two-layer medium including lateral variations close to the surface and the synthetic data are generated using a visco-elastic finite elements code. An analysis of the information contained for the different components is carried out and the behavior of the inversion algorithm is studied for each component. To conclude this part, inversion results from inversion strategies integrating the two components are presented. The last part concerns the experimental modeling facility developed in order to experimentally validate the imaging methods. This measurement bench reproduces seismic measurement configurations at a reduced scale using an ultrasonic source and a laser interferometer. This facility has already been validated for the case of the measurement of the vertical component, and first experimental results of the horizontal component are presented.

Tue 11:40 François CANAC PU-S11: Geophysics and seismics

Ground motion prediction in los angeles of large M7+ earthquakes on the San Andreas fault using the virtual source approach – (Invited, 000046)

M. Denolle[a], G. C. Beroza[a], E. M. Dunham[a] and G. A. Prieto[b]
[a]Stanford University, 397 Panama Mall, Stanford, 94305, USA; [b]Departamento de Física, Universidad de los Andes, Calle 18A # 1-10 Bloque Ip, Of. 301, Universidad de los Andes, AA 4976 Bogotá, Columbia
Corresponding author E-mail: mdenolle@stanford.edu

Predicting ground motion for potential large earthquakes is a key factor in seismic hazard analysis for densely populated areas. Seismologists turn to physics-based simulations that attempt to accurately take into account complexity of the source, propagation effects and site response. Our incomplete knowledge of the crustal structure directly affects the uncertainties in those simulations.
To validate the physics-based approach, we compute the Earth impulse responses combining both ambient seismic field and coda-wave cross-correlations in a way that preserves the amplitude information (elastic and inelastic). To account for more realistic source parameters, we have to consider the source-depth dependence in the excitation of surface waves and the radiation pattern of a double-couple source. We estimate those using a Chebyshev spectral collocation method and compute the surface-wave eigenfunctions for a complex 1D crustal structure. We validated that the impulse response reproduced well the long-period (4-10s) ground motion for moderate earthquakes in California.
Based on the results, we use a virtual source approach to estimate ground shaking in Los Angeles area for M7+ scenario earthquakes on the southern San Andreas Fault. We compare the resulting sensitivity of the sedimentary basin to surface waves with that calculated from the physics-based simulations.

Tue 12:00 François CANAC PU-S11: Geophysics and seismics

Extracting dispersion curve and filtering of acoustic data with wavelet transform – (Contributed, 000481)

H.-P. Valero[a], B. Bose[b] and S. Aeron[c]
[a]Schlumberger, 2-2-1, Fuchinobe, 229-0006 Sagamihara-Shi, Japan; [b]Schlumberger, 1 Hampshire Street, Cambridge, 02139-1578,

USA; [c]Schlumberger, 1 Hampshire Street, Cambridge, AK 02139-1578, USA
Corresponding author E-mail: hvalero@slb.com

Dispersion curves of acoustic data carry important information about the acoustic state of the rock. By dispersion curves, we refer to the group and phase slowness (reciprocal of velocity) as a function of frequency. Because such information is critical to quantitatively understand the formation properties of rocks there is a need for robust and automatic method for extracting dispersion curves from acoustic waves received by an array of receivers to characterize the properties of the rocks surrounding a borehole. In this paper we propose an approach to automatically extract the slowness dispersion of acoustic waves received by an array of receivers. The method has been developed in order to achieve the dispersion extraction without the use of any physical model, but rather exploiting the time frequency localization of the propagating mode and the continuity of the dispersion curve as a function of frequency. After the dispersion curve extraction is performed, properties of the continuous wavelet transform allow the reconstruction of the mode corresponding to the extracted dispersion curve. This approach can then be done iteratively to extract various modes propagating across a receiver array. Examples on synthetic and real data will be presented to illustrate this methodology.

Tue 9:00 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

Representation of sound fields for audio recording and reproduction – (Invited, 000787)

F. M. Fazi[a], M. Noisternig[b] and O. Warusfel[b]
[a]University of Southampton, Highfield, SO171BJ Southampton, UK; [b]Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris
Corresponding author E-mail: ff1@isvr.soton.ac.uk

Spherical and circular microphone arrays and loudspeaker arrays are often used for the recording and reproduction of a given sound field. A number of approaches and formats are available for the representation of the recorded field, some of which are more popular among the audio engineering community (B-format, virtual microphones, etc.) whilst other representations are widely used in the literature on mathematics (generalized Fourier series, single layer potential, Herglotz wave function, etc.). In this paper, some of the properties of the various approaches and some of their differences are discussed. The analysis includes the representation of near-field sources and the choice of basis functions used for the representation.

Tue 9:20 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

Morphoacoustic perturbation analysis: principles and validation – (Contributed, 000616)

A. I. Tew, C. T. Hetherington and J. B. Thorpe
University of York, Department of Electronics, Heslington, YO10 5DD York, UK
Corresponding author E-mail: tony.tew@york.ac.uk

This paper presents a frequency domain technique for investigating the relationship between acoustic properties of the human hearing system and the morphology responsible for creating them. Exploiting reciprocity, the boundary element method is applied to determine head-related transfer functions (HRTFs) for various directions and distances from a surface mesh model of a head and pinnae. Small orthogonal surface harmonic deformations are applied to the mesh one at a time and stored in a database together with the resulting, approximately linear, changes to the HRTFs (delta HRTFs). Once the computationally intensive process of constructing the database has been completed, identifying the morphological origins of arbitrary acoustic spectral features is very rapid. A weight for each database harmonic is determined according to how strongly its delta HRTF influences the acoustic feature of interest. The same weights are then used to sum the corresponding orthogonal deformations. Regions of high deformation are chiefly responsible for creating that acoustic feature. The method, which we term morphoacoustic perturbation analysis, will be described in greater detail and preliminary results which have been validated by direct acoustic measurement will be presented.

Tue 9:40 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

Assessment of spatial audio quality based on sound attributes – (Contributed, 000696)

S. Le Bagousse[a], M. Paquier[b] and C. Colomes[a]
[a]Orange Labs, 4 rue du clos courtel, 35510 Cesson Sevigné, France; [b]Université de Bretagne Occidentale, 6, avenue Victor Le Gorgeu,

CS 93837, 29238 Brest Cedex 3, France
Corresponding author E-mail: sarah.lebagousse@orange.com

Spatial audio technologies become very important in audio broadcast services. But, there is a lack of methods for evaluating spatial audio quality. Standards do not take into account spatial dimension of sound and assessments are limited to the overall quality particularly in the context of audio coding. Through different elicitation methods, a long list of attributes has been established to characterize sound but it is difficult to include them in a listening test. A previous study aimed at clustering attributes in families. Thus 3 families of attributes were highlighted, "timbre", "space" and "defaults". The overall quality and these three families were evaluated in the listening test presented in this article. The test protocol was based on the Mushra recommendation. However it included three anchors specific to each attribute and no reference in order to evaluate quality instead of fidelity. The aim of the experiment described in this paper was to verify the influence of those 3 attributes on the overall quality in a 5.1 reproduction system. It results that the defaults attribute has more influence on the overall quality than the timbre and the timbre. Moreover the presentation of the three attributes on the same interface adds no bias.

Tue 10:00 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

Auditory localization and reaching movements in the peripersonal space – (Contributed, 000145)

G. Parseihian and B. F. Katz
LIMSI-CNRS, BP 133 Bât 508, 91403 Orsay, France
Corresponding author E-mail: gaetan.parseihian@limsi.fr

While numerous studies have examined auditory localization processes for relatively distant sound sources very few were interested in sources within 1m of a listener's head. This study examines the precision of hand reaching movement towards an auditory object. An experimental platform (semicircle, radius 1m) was constructed with 35 small loudspeakers placed under an acoustically transparent grid. This setup was also established in a virtual auditory environment using binaural synthesis. Blindfolded subjects were seated within the platform at table height. Stimulus positions consists of seven different azimuth angles (-30, 0, 30, 60, 90, 120 and 150 degrees) with five distances conditions (35, 48 61, 74 and 87 cm). Test protocol consisted of a brief audio stimulus followed by the subject placing their index finger at the location of the sound object. The current experiment explores the effect of the used hand on the reaching error and comparing the performance of real sound localization with virtual sound localization.

Tue 10:40 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

On loudspeaker rendering of auditory distance in higher order Ambisonics – (Invited, 000828)

G. Kearney[a], M. Gorzel[b] and F. Boland[b]
[a]University of York, Department of Theatre, Film and Television, University of York, Baird Lane Heslington (East), YO10 5GB York, UK; [b]Department of Electronic and Electrical Engineering [Dublin], Trinity College Dublin Dept. of Electronic and Electrical Engineering Printing House Dublin 2
Corresponding author E-mail: gavin.kearney@york.ac.uk

In this paper we investigate the perceived distance of sound sources rendered over loudspeaker arrays. We consider the perception of sound source distance with sources rendered within an array of loudspeakers as well as beyond the loudspeaker array radius. In particular, we explore this perception with Ambisonic soundfields up to 3rd Order. Sources are rendered for distances ranging from 0.2m to 8m and soundfields are presented over a 16 channel spherical loudspeaker array. 10 subjects are asked to gauge the source distance of female speech and pink noise bursts for each Ambisonic order. Test stimuli are created from measurements of 1st order spatial impulse responses in a reverberant room and their encoding to higher order spherical harmonic representations using the Directional Audio Coding methodology.
Analysis of variance of the results demonstrates that the perception of source distance is largely independent of the Ambisonic order and more-so dependent on the monoaural cues of level difference and direct-to-reverberant ratio. Sound source distance without reverberation for each spatialisation method is also presented for comparison. It is shown for the rendered spatialisation methods, that the perception of distance is more dependent on relative loudness and source association than on wavefront curvature.

Tue 11:00 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

Perceptual assessment of binaural decoding of first-order ambisonics – (Contributed, 000394)

J. Palacino, R. Nicol, M. Emerit and L. Gros
France Télécom - Orange Labs, FT/OLNC/RD/TECH/OPERA/TPS, 2 Av. Pierre Marzin, 22300 Lannion, France
Corresponding author E-mail: julian.palacino@orange.com

The first-order Ambisonics microphone (e.g. Soundfield®) is a both compact and efficient set-up for spatial audio recording with the benefit of a full 3D spatialization. Another advantage is that the signals delivered by this microphone (i.e. B-Format) can be rendered over headphones by applying appropriate processing, while ensuring that the 3D spatial information is preserved. With the growing use of personal devices, it should be considered that most audio content is listened to over headphones. Thus first-order Ambisonics recording provides an attractive solution to pick-up 3D audio content compatible with headphone reproduction. "Binaural decodingï refers to the processing to adapt B-Format for headphone rendering (i.e. "binaural formatï). One solution is based on binaural synthesis of virtual loudspeakers. One promising way to improve the decoding is active processing which takes information from a pre-analysis of the sound scene, particularly in terms of spatial information. This paper will compare various binaural decoders. The perceived quality is assessed by a listening test for a set of audio excerpts taken from the sound recording of classical music and which includes solo, trio, chorus, applauses and public ambience.

Tue 11:20 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

From vibration to perception: using Large Multi-Actuator Panels (LaMAPs) to create coherent audio-visual environments – (Invited, 000325)

M. Rébillat[a], E. Corteel[b], B. F. Katz[c] and X. Boutillon[d]
[a]Département d'études cognitives, Ecole Normale Supérieure Paris, 29 Rue d'Ulm, 75230 Paris, France; [b]sonic emotion labs, 42 bis rue de Lourmel, 75015 Paris, France; [c]LIMSI-CNRS, BP 133 Bât 508, 91403 Orsay, France; [d]Laboratoire de Mécanique des Solides, Ecole Polytechnique, 91128 Palaiseau, France
Corresponding author E-mail: marc.rebillat@ens.fr

Virtual reality aims at providing users with consistent audio-visual worlds where they would behave and learn as if they were in the real world. In this context, specific acoustic transducers are thus needed in order to fulfill spatial requirements simultaneously on visual and audio rendering and to make them coherent. Large multi-actuator panels (LaMAPs) allow for the combined creation of a screen and of a loudspeaker array, and thus for the coherent creation of an audio and a visual virtual worlds. They thus constitute an attractive alternative to electro-dynamical loudspeakers and multi-actuator panels (MAPs), used so far. In this paper, the vibroacoustic behavior of LaMAPs is studied and it is shown that LaMAPs can be used as secondary sources for wave field synthesis (WFS). The auditory virtual environment created by LaMAPs driven by WFS is then perceptually tested. A previous experiment showed that the azimuth of a virtual source is correctly perceived by users. In the present experiment, users have to estimate the egocentric distance of an audio virtual object by means of triangulated blind walking. Obtained results indicate that LaMAPs can be confidently used for the creation of auditory virtual worlds by means of WFS.

Tue 11:40 Peter BARNETT SP-S02: Sound spatialisation: from the transducer to the listener

Practical 3 dimensional sound reproduction using Wave Field Synthesis, theory and perceptual validation – (Invited, 000330)

E. Corteel[a], L. Rohr[b], X. Falourd[b], K.-V. Nguyen[a] and H. Lissek[b]
[a]sonic emotion labs, 42 bis rue de Lourmel, 75015 Paris, France; [b]Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: etienne.corteel@sonicemotion.com

Sound field reproduction using Wave Field Synthesis has been so far limited to the positioning of virtual sources and listeners in the horizontal plane only. These simplifications were originally proposed to reduce the number of required loudspeakers although the underlying formulation (Kirchhoff-Helmholtz) describes the reproduction of 3 dimensional sound fields in a 3 dimensional subspace.

The authors propose here a revised formulation of Wave Field Synthesis in 3 dimensions that limits the number of required loudspeakers, allowing for irregular and incomplete loudspeaker layouts. A "source width controlï

parameter is further proposed to reduce localization blur using a virtual source dependent loudspeaker selection criterion.
The proposed approach is finally evaluated in an extended listening area. The experiment relies on an elevation localization comparison using individual loudspeakers as targets and 3D WFS (with or without source width control) as pointer on a 24 channels loudspeaker array that covers the frontal quarter of the upper half of a rectangular room.

Tue 10:20 Yves ROCARD NV-S08: Passive control in vibroacoustics

A wave-based approach to estimate porous material properties – (Invited, 000852)

M. Ichchou, O. Bareille and A. Chettah
Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: mohamed.ichchou@ec-lyon.fr

The focus of this paper is the estimation of the acoustic properties of porous material by reconstructing the acoustic field. The proposed technique first estimates the wavenumber of the acoustic field. The incident and reflected wave components are then identified through cost function optimization, and the accuracy of the for- mulation is assessed. The surface impedance and acoustic absorption are evaluated for a number of porous materials. The non-acoustic parameters are thus derived using an inverse approach. The results show good correlation when compared to experiments. Within the framework of this study, foams and compound granulates were specifically tested.

Tue 10:40 Yves ROCARD NV-S08: Passive control in vibroacoustics

On the modelling of the acoustical properties of hemp concrete – (Contributed, 000745)

P. Glé[a], K. V. Horoshenkov[b], E. Gourdon[a] and L. Arnaud[a]
[a]Département Génie Civil et Bâtiment, Rue Maurice Audin 69518 Vaulx-en-Velin cedex; [b]University of Bradford, Great Horton Road, BD7 1DP Bradford, UK
Corresponding author E-mail: philippe.gle@entpe.fr

Hemp concrete is an attractive alternative to traditional materials used in building construction. It has a very low environmental impact and it is characterized by high thermal insulation and sound absorption properties. The shape of hemp aggregates is parallelepiped and individual particles in a hemp mix can be organized in a plurality of ways. As a result, modeling of such material is quite complicated. This paper is focused on the fundamental understanding of the relations between the particle shape and size distribution and the acoustical properties of the resultant material mix. The sound absorption and the transmission loss of various hemp aggregates is characterized using laboratory experiments and three theoretical models. These models are used to relate the particle size distribution to the pore size distribution. It is shown that the pore size distribution is a main characteristic which controls the observed acoustical behavior.

Tue 11:00 Yves ROCARD NV-S08: Passive control in vibroacoustics

Vibroacoustics of thin micro-perforated sound absorbers – (Contributed, 000029)

C. Maury[a], T. Bravo[b] and C. Pinhede[a]
[a]Ecole Centrale Marseille - LMA, CNRS - LMA, 31 chemin Joseph Aiguier, 13402 Marseille Cedex 20, France; [b]Centro de Acustica Aplicada y Evaluacion No Destructiva (CAEND), CSIC - UPM, Serrano 144, 28006 Madrid, Spain
Corresponding author E-mail: cedric.maury@centrale-marseille.fr

Lightweight Micro-Perforated Panels (MPP) backed by an air cavity constitute compact sound absorbing resonators, mostly efficient in the mid-frequency range, and that may be constructed using transparent, fibreless and recyclable materials. These soundproof devices have been intensively studied due to their important applications in building acoustics and the aeronautic, astronautic and automotive industries. However, MPPs have been often considered as rigid structures. The work presented here is a theoretical and experimental study on the influence of panel vibrations on the sound absorption and transmission properties of thin MPPs. Measurements show that the absorption performance generates extra absorption peaks or dips that cannot be understood assuming a rigid MPP. A theoretical framework is presented that exactly accounts for structural-acoustic interaction between the MPP and the cavity for general cross-sectional shapes and panel boundary conditions. This model is validated against experimen-

tal data acquired from impedance tube, laser vibrometric scans of the panels surface and transmission loss measurements. Coupled-mode analysis explains the nature of the observed spectral peaks for a wide range of perforation ratio and cavity depth.

Tue 11:20 Yves ROCARD NV-S08: Passive control in vibroacoustics

Assessment of the validity of statistical energy analysis and transfer matrix method for the prediction of sound transmission loss through aircraft double-walls – (Contributed, 000309)

B. Campolina[a], N. Atalla[b] and N. Dauchez[c]
[a]Airbus Operations SAS, 316 route de Bayonne, Cedex 09, 31060 Toulouse, France; [b]Groupe d'Acoustique de l'Université de Sherbrooke, 2500 Boulevard de l'Université, Faculté de Génie, Sherbrooke, Canada J1K2R1 QC; [c]SUPMECA, 3, rue Fernand Hainaut, 93407 Saint Ouen Cedex, France
Corresponding author E-mail: bruno.campolina@airbus.com

The accuracy of sound transmission loss (TL) predictions of aircraft double-walls using transfer matrix method (TMM) and statistical energy analysis (SEA) is examined in this paper. The studied system is composed of: (1) a laminate composite skin panel whose critical frequency is around 4000 Hz, (2) an air gap partially filled with a fibrous layer and (3) a sandwich trim panel with critical frequency around 2500 Hz. The structure is submitted to a diffuse acoustic field in the frequency range from 100 Hz to 10 kHz. A transfer path analysis shows that for this structure, including a highly-radiating trim with a low critical frequency, the resonant transmission through the cavity between panels is dominant over a large frequency range. This transmission path is not accounted for in the TMM formulation, resulting in an overestimation of the transmission loss compared to measurements and SEA computation. On the other hand, for practical purposes, both approaches are able to predict the impact in the TL of modifying the parameters of the skin panel for frequencies below its critical frequency.

Tue 11:40 Yves ROCARD NV-S08: Passive control in vibroacoustics

The use of ray-tracing method for the prediction of the insertion loss of enclosures – (Contributed, 000247)

N. Trompette and J. Chatillon
INRS, Rue du Morvan, CS 60027, 54519 Vandoeuvre Les Nancy, France
Corresponding author E-mail: jacques.chatillon@inrs.fr

Among noise control techniques, enclosures are widely used. The prediction of their insertion loss is therefore an important matter. A numerical model was implemented. It uses a ray-tracing method that consists in determining the paths of acoustic rays and in evaluating the energy loss along those paths. In our model, the diffraction is neglected and sources in the enclosure are supposed to be omnidirectional. The model allows calculating both the insertion loss and the acoustic pressure outside the enclosure. For the purposes of validation, a campaign of tests was conducted in a semi-anechoic chamber for different enclosures. Predictions of the global insertion loss and of the outside pressures over the whole frequency range [250 Hz-4 kHz] were of good accuracy. But the model tends to over-estimate the pressure levels for the lower frequency band and to under-estimate them for the upper frequency bands. Energetic ray tracing reveals to be a good tool for predicting global acoustic behavior of enclosure. But it is of poor accuracy at low frequency because it does not account for the modal behavior of waves into cavities and leaves. Discrepancies at high frequencies can be explained by leaks and the fact that diffraction was neglected.

Tue 10:40 Ray STEPHENS EN-S06: Manufactured noise reducing devices (noise barriers)

Holistic optimisation of noise reducing devices – (Invited, 000153)

T. Leissing[a], F. Grannec[a], J. Defrance[a], P. Jean[a], D. Lutgendorf[b], C. Heinkele[c] and J.-P. Clairbois[d]
[a]CSTB, 24 rue Joseph Fourier, 38400 Saint Martin D'Hères, France, Metropolitan; [b]TNO, Oude Waalsdorperweg 63, 2597 Den Haag, Netherlands; [c]Laboratoire Régional de Strasbourg, 11, rue Jean Mentelin, 67035 Strasbourg Cedex 2, France; [d]Acoustic Technologies, Brugmann avenue 215, 1050 Brussels, Belgium
Corresponding author E-mail: thomas.leissing@cstb.fr

The work presented in this paper is part of the QUIESST European project, in which one of the objective is to perform multi-objective holistic optimisations of noise reducing devices. We present here optimisation results concerning the extrinsic performances of noise barriers. The performances under interest are acoustical, economical and environmental. The variety of noise barriers considered is very wide, ranging from straight and flat barriers, to rough or capped barriers. A total number of nine noise reducing device families are optimised. Acoustical performances are obtained from numerical calculations: the Boundary Element Method (in 2D) is used to obtain relative sound pressure levels at a set of receivers in different situations. Theses situations include road and rail sources; rural and urban cases; flat, embanked and depressed topographies. The economical performance is calculated according to the maintenance cost of the different materials in use in the barrier. Four environmental performances indicators are considered; their calculation is based on a life-cycle assessment analysis. All performances are expressed as a gain (or loss) relative to a reference screen. It is shown that the optimisation procedure allows one to obtain a wide variety of optimised noise reducing devices, and hence provides a helpful design tool by allowing one to focus on specific parameters.

Tue 11:00 Ray STEPHENS EN-S06: Manufactured noise reducing devices (noise barriers)

Influence of ground reflections and loudspeaker directivity on measurements of in-situ sound absorption – (Invited, 000326)

M. Conter, R. Wehr, M. Haider and S. Gasparoni
AIT - Austrian Institute of Technology, Giefinggasse 2, A1210 Vienna, Austria
Corresponding author E-mail: marco.conter@ait.ac.at

Sound absorption is a relevant property for the acoustic quality of noise barriers. The Adrienne method is the most used in-situ measurement method in Europe for testing the acoustic performance of noise reducing devices in real life conditions. This method was introduced in 2003 with the technical specification CEN/TS 1793-5 and the development of this method is now one of the main objectives of the European project QUIESST. In the frame of this project AIT Mobility has performed a first measurement campaign in order to investigate the influence of ground reflections and the role of the sound source for measurements of sound absorption in the near field. Two different sound sources and different microphone heights have been used for analyzing the influence of the source directivity and the role of ground reflections. The study shows that particular attention should be paid to the source directivity and to the microphone position, while the ground reflection does not seems to represent a problem for the method at all.

Tue 11:20 Ray STEPHENS EN-S06: Manufactured noise reducing devices (noise barriers)

Prediction of scattering effects by sonic crystal noise barriers in 2d and 3d finite difference simulations – (Contributed, 000457)

S. H. Hoare and D. T. Murphy
Department of Electronics [York], Department of Electronics, The University of York, Heslington Lane, YO105DD York, UK
Corresponding author E-mail: dtm3@ohm.york.ac.uk

Sonic crystals have been investigated in recent years both as a potential form of noise barrier, and as a form of sonic art aimed at enhancing perception of the surrounding acoustic environment. The broader aim of this research is concerned with the auralization of these structures, which has, as yet, rarely been attempted. In a previous publication, prediction of the acoustic wave propagation through 2-D arrays of solid, cylindrical scatterers embedded in air was performed in 2-D Finite Difference Time Domain (FDTD) simulations. In this paper, the model has been extended into the third dimension and the results are compared with those obtained in the previous experiment. In both the 2-D and 3-D simulations the location of the fundamental band gap corresponds with the predicted location - predictions being based on simple theoretical considerations relating the frequency of the transmission gaps to the array configuration.

Tue 11:40 Ray STEPHENS EN-S06: Manufactured noise reducing devices (noise barriers)

Transport noise reduction by low height sonic crystal noise barriers – (Invited, 000004)

F. Koussa[a], J. Defrance[a], P. Jean[a] and P. Blanc-Benon[b]
[a]CSTB, 24, rue Joseph Fourier, 38400 Saint Martin D'Hères, France; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: faouzi.koussa@cstb.fr

Noise barriers along roads and railways are one of the existing solutions to protect inhabitants from noise. In this research we attempt to create quiet areas in cities using sonic crystal noise barriers. For aesthetic and security aspects, such protections do not exceed a size of 1m×1m in a vertical section. Cylindrical scatterers with added acoustical properties of resonance and absorption are used in this work to improve the acoustic performance of low height sonic crystal barriers. Numerical simulations, using a 2D Boundary Element Method (BEM), are carried out to evaluate their acoustic properties in terms of insertion loss. Our results show that the effectiveness of low height sonic crystal noises barriers is significant for road and tramway noise over the entire frequency range of study.

Tue 12:00 Ray STEPHENS EN-S06: Manufactured noise reducing devices (noise barriers)

Influence of partial disorder on the insertion loss of sonic crystals with low filling fractions – (Contributed, 000242)

S. Taherzadeh, K. Attenborough and I. Bashir
The Open University, DDEM, Maths, Computing and Technology, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: s.taherzadeh@open.ac.uk

Sonic crystal structures consisting of periodically-arranged solid vertical cylinders can act as sound barriers at certain frequencies. Their performance depends on the filling fraction which is determined by the spacing and cylinder radius. To be effective the filling fraction must be high i.e. the diameter of the scattering elements must be comparable to the centre-to-centre spacing. This means that periodic arrays with relatively low filling fractions such as in trees belts are not effective as traffic noise barriers. The effects of partially perturbing the positions of sonic crystal elements have been investigated by modelling and laboratory measurements and have been shown to improve the insertion loss of the periodic structure. It is argued that partial perturbation of regular tree planting near highways will improve their noise attenuation.

Tue 13:40 Philip DOAK AA-S06: Computational room acoustics

Wave based modelling of enclosed spaces by a sequence of matrix multiplications – (Contributed, 000684)

R. C. Opdam, D. De Vries and M. Vorländer
RWTH Aachen University, Institute of Technical Acoustics, Neustrasse 50, 52066 Aachen, Germany
Corresponding author E-mail: rob.opdam@akustik.rwth-aachen.de

In room acoustical planning it is important to obtain realistic impulse responses from simulations to calculate the well-known room acoustical parameters as reverberation time, clarity etc. In most cases this is done by using a hybrid implementation of ray-tracing and mirror image sources. This paper presents a method adopted from the field of seismic imaging, which is based on the concept of wave field extrapolation. The advantage of modelling with the full wave character of sound propagation is that all physical phenomena can be simulated correctly (i.e. diffraction). The proposed algorithm uses a sequence of matrix multiplications that represent generalized spatial convolutions. The matrices give ample insight in the physical processes, like: propagation, non-locally reacting (complex) reflection properties, absorption and directivity of source(s) and receiver(s). The algorithm is theoretically able to solve for an infinite number of reflections. A comparison is made with conventional methods. Therefore, a simple rectangular room with uniform walls and a three-dimensional configuration of an L-shaped wall, placed in an anechoic environment, are simulated. The plate is firstly covered with a hard surface and secondly with a non-locally reacting absorber.

Tue 14:00 Philip DOAK AA-S06: Computational room acoustics

Comparison of radiosity and ray-tracing methods for coupled rooms – (Contributed, 000591)

J. Dondaine[a], A. Le Bot[b], J. Rech[c] and S. Mussa Peretto[a]
[a]Française de Mécanique, ZI Artois Flandres, 62090 Haisnes, France; [b]Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex; [c]ENISE, 58 Rue Jean Parot, 42100 Saint-Étienne, France
Corresponding author E-mail: jimmy.dondaine@mpsa.com

In the field of geometrical acoustics, the radiosity method is based on an analogy with the so-called view factor method in thermics. The method has been successfully applied to the prediction of reverberation time as well as the calculation of sound pressure level maps in single room. It has been shown to be equivalent to the ray-tracing technique with diffuse reflection on walls. In this study, the radiosity method is applied to coupled rooms. Transmission and reflection of sound on the separating wall are taken into account by means of Snell's law. Numerical results with the software CeRes are presented and compared with standard ray-tracing. The method is found to be useful for designing enclosures of noise sources.

Tue 14:20 Philip DOAK AA-S06: Computational room acoustics

Modeling and simulation of the sound propagation by the FDTD method – (Invited, 000635)

A. Gramez[a], J.-L. Guyader[b] and F. Boubenider[c]
[a]EPSTA, Lycée El Emir, Bab El oued, Alger, 16000 Alger, Algeria; [b]Laboratoire Vibrations Acoustique, Bâtiment St. Exupéry, INSA Lyon, 25 bis, avenue Jean Capelle 69621 Villeurbanne Cedex; [c]University of sciences and technology Houari Boumedienne, Laboratory of physics of materials B.P. 32 El Allia- Bab Ezzouar, 16111 Algiers, Algeria
Corresponding author E-mail: a.gramez@gmail.com

The FDTD (finite difference time domain) method has emerged as a promising technique for the study of the field sound propagation phenomena in room acoustics. Unlike the frequency modeling methods, this technique, based on the time and spatial discretization, can yield a temporal description of the acoustics wave's propagation problem, which is useful in real-time simulation and auralization of room acoustics. In this paper, we discuss the implementation of a computer code based on the finite difference time domain method. We study and visualize the sound field propagation of an acoustic pulse in two-dimensional geometries rooms. The different results of the simulation will be compared to the an analytical solutions of the propagation wave equation in the same geometries.

Tue 14:40 Philip DOAK AA-S06: Computational room acoustics

An hybrid beam and particle tracing with time dependant radiosity for accurate impulse response of rooms prediction – (Invited, 000750)

N. Noe[a], C. Rougier[b], J. Rouch[b] and I. Schmich[b]
[a]Centre Scientifique et Technique du Bâtiment (CSTB Nantes), 11 rue Henri Picherit, 44000 Nantes, France; [b]Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères
Corresponding author E-mail: nicolas.noe@cstb.fr

Ray-tracing is widely used for echograms prediction in room acoustics. Several ray-based technics exist, each of them with pros and cons. In this paper we propose a method that merges beam tracing, particle tracing and time dependant radiosity in order to compute accurate impulse responses. This method mixes advantages of each technique: precise direct and early specular reflections (and even diffraction) with phase information for beam tracing, mixed diffuse and specular contributions and late reverberation for particle tracing, smooth purely diffuse exchanges with radiosity. Our method builds the impulse response from pressure FRF (narrow band) computed with beam-tracing and pseudo-echograms (wide band) computed with particle tracing and radiosity, using signal-processing. It carefully avoids contribution overlapping between the three techniques.

Tue 15:00 Philip DOAK AA-S06: Computational room acoustics

SPPS, a particle-tracing numerical code for indoor and outdoor sound propagation prediction – (Invited, 000368)

J. Picaut and N. Fortin
Département Infrastructures et Mobilité (IFSTTAR/IM), Route de Bouaye, CS4, 44344 Bouguenais Cedex
Corresponding author E-mail: judicael.picaut@ifsttar.fr

Geometrical and energetically models are widely used in outdoor and indoor noise predictions. Several approaches have been considered, amongst them, one can cited the ray and beam-tracing methods, the image-source method, the radiosity method... Another approach is based on the use of sound particles to model the sound propagation in complex environments. Similarly to the ray-tracing methods, the sound particles concept allows to model many acoustics phenomena like absorption, transmission, reflection and diffusion on surfaces, scattering by fitting objects,

meteorological effects... Two approaches can be followed: a probabilistic one, considering that the energy that is carried by the particle is constant and using Monte-Carlo methods for the modelling of acoustics phenomena; a deterministic one, considering that the energy of sound particles is modified according to the acoustics phenomena. In this paper, a numerical code (SPPS), using both approaches is presented and many applications are shown. In addition, several comparisons with experimental data and other methods are also proposed.

Tue 15:20 Philip DOAK AA-S06: Computational room acoustics

Energy- and wave-based beam-tracing prediction of room-acoustical parameters using different boundary conditions – (Invited, 000807)

M. Hodgson and B. Yousefzadeh
University of British Columbia, SPPH - 3rd Floor, 2206 East Mall, Vancouver, Bc, Canada V6T1Z3
Corresponding author E-mail: murray.hodgson@ubc.ca

A beam-tracing model was used to predict the transient responses of rooms. The model is wave-based and can be applied to rooms with extended-reaction surfaces. Room surfaces can be modeled as multiple layers of solid, fluid or poro-elastic materials with acoustical properties that are calculated using Biot theory. Both wave-based and energy-based versions of the beam-tracing model have been applied to various room configurations to study the effects of using different boundary conditions (local vs. extended reaction and phase changes on reflection) on room-acoustical parameters. Very significant differences occurred in all parameters when interference effects were taken into account, whether partly (ignoring phase change on reflection) or entirely (wave-based modeling). Modeling surfaces as of local or of extended reaction was found to be significant for surfaces that consist of multiple layers, specifically when one of the layers is air. For multi-layers of solid materials with an air-cavity, significant differences occurred around their mass-air-mass resonance. While these changes affected reverberation times and sound strengths in most room configurations, their effect on Rapid Speech Transmission Index remained mostly insignificant. The results have been explained in part by considering the absorption and reflection characteristics of the test surfaces used in each configuration.

Tue 15:40 Philip DOAK AA-S06: Computational room acoustics

A method for predicting the reverberation time and decay curves of rectangular rooms with non-uniform absorption distribution using Statistical Energy Analysis – (Contributed, 000151)

L. I. Wilmshurst and D. J. Thompson
Dynamics Group-ISVR - University of Southampton, University Road, SO17 1BJ Southampton, UK
Corresponding author E-mail: djt@soton.ac.uk

The subject of reverberation time in non-diffuse environments has been of considerable interest to acoustic engineers since the inception of room acoustics in the early twentieth century. Numerous prediction methods have been developed with the aim of accurately predicting the reverberation time of an enclosure under these circumstances, although a completely universal method has yet to be devised. This paper examines the decay processes in rooms where absorption is unevenly distributed throughout the enclosure, which is a common occurrence in practice and often leads to a non-diffuse sound field. In order to establish the nature of these decay processes, a seven-subsystem Statistical Energy Analysis model was developed, based initially on the axial, tangential and oblique mode groups and then extended to encompass the dimensions of formation. The damping loss factors were obtained analytically through the use of three independent methods as a means of verification and comparison. In addition to this, a method for deriving the coupling loss factors analytically from the scattering coefficients of the walls is also established. The validity of the predictions obtained using this method is then tested using various computer simulations and experimental data.

Tue 16:00 Philip DOAK AA-S06: Computational room acoustics

Precomputed acoustic radiance transfer for interactive higher-order reflections in dynamic scenes – (Contributed, 000288)

L. Antani[a], A. Chandak[a], L. Savioja[b] and D. Manocha[a]
[a]Department of Computer Science [Chapel Hill], Campus Box 3175, Brooks Computer Science Building 201 South Columbia Street UNC-Chapel Hill Chapel Hill, NC 27599-3175 USA; [b]Aalto University School of Science, PO Box 15400, FI-00076 Aalto, Finland
Corresponding author E-mail: Lauri.Savioja@aalto.fi

Realistic sound propagation significantly enhances immersion in interactive applications such as games and virtual reality. However, prior sound propagation algorithms cannot model higher-order reflections and long impulse responses at interactive rates in scenes with moving sources and listeners. We present an interactive sound propagation algorithm that can compute high orders of specular and diffuse reflections as well as edge diffractions in dynamic environments with moving sources. Our formulation is based on a precomputed acoustic transfer operator, which models sound propagation between static portions of the scene, and captures reflections, diffraction and scattering. The transfer operator is compactly represented using the Karhunen-Loeve transform. At run-time, we use a two-pass approach that combines interactive ray tracing (for early reflections) and acoustic radiance transfer (for higher-order reflections and late reverberation). The approach allows accuracy to be traded off for efficiency on-the-fly, and has a low memory overhead (typically few tens of MB for each scene). The approach generates plausible, dynamic sound propagation effects in complex game scenes with moving sources and listeners at interactive rates on a desktop PC. We demonstrate the performance of our algorithm in different scenes, including an integration of the technique with Valve's Source game engine.

Tue 13:40 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Investigation of a turbulent channel flow using large eddy simulation – (Contributed, 000147)

F. Kremer[a], C. Bogey[a] and C. Bailly[b]
[a]Ecole Centrale de Lyon, Centre Acoustique, 36 Avenue Guy de Collongue, 69134 Ecully, France; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: francois.kremer@ec-lyon.fr

The LES of a compressible turbulent channel flow is performed at a Mach number of 0.5 and a friction Reynolds number $Re_\tau = u_\tau h/\nu$ around 300, where u_τ is the friction velocity and h is the half-width of the channel. Explicit low-dissipation numerical schemes are employed for spatial derivatives and time integration. Nine simulations are carried out on grids with different mesh spacings in order to study the mesh convergence of turbulence statistics, regarding the mean and fluctuating streamwise velocity profiles. These quantities are found to not vary significantly for mesh spacings smaller than 7.5 and 30 wall units in the spanwise and streamwise directions, respectively. An additional simulation is performed using a semi-implicit Runge-Kutta algorithm, which has been developed for wall-bounded flows. With this algorithm, terms involving wall-normal derivatives are integrated implicitly, while the other terms are integrated explicitly. Thus, the CFL constraint in the wall-normal direction is relaxed. The simulations finaly provide a numerical database, from which wall pressure, wall shear stress and velocity spectra are computed to give insights into the structures developing in the flow.

Tue 14:00 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

3D FEM-BEM coupled resolution for acoustic waves propagation in potential flow – (Contributed, 000170)

N. Balin[a], G. Sylvand[a] and F. Casenave[b]
[a]EADS France, Batiment Campus Engineering / Service IW/SE/MA, BP 90112, 31703 Blagnac Cedex, France; [b]Centre d'Enseignement et de Recherche en Mathématiques et Calcul Scientifique, 6 et 8 avenue Blaise Pascal Cité Descartes - Champs sur Marne 77455 Marne la Vallée Cedex 2
Corresponding author E-mail: nolwenn.balin@eads.net

In order to reduce the environmental impact of aircrafts, it is necessary to accurately simulate the acoustics waves propagation in complex environment. A classical method used to compute the noise propagation on large distances is the Boundary Element Method. However this method restricts the flow to a uniform one.
To improve the level of modeling, we present here a coupling between Finite Element (FEM) and Boundary Element Methods (BEM) to solve the acoustic propagation problem that consists in a potential flow near the aircraft and a uniform flow far-away from the aircraft. The Lorentz transformation is introduced in the exterior domain to easily use the Boundary Element Method for the uniform flow. This transformation is also applied in the interior domain to obtain a natural coupling between the two domains.

3-D numerical results representative of industrial configurations, and in particular results with modal acoustic sources in the potential flow, will be shown.

Tue 14:20 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

The perturbed low Mach number approximation for the aeroacoustic computation of anisothermal flows – (Contributed, 000449)

C. Nana, D. Marx, C. Prax and V. Fortuné
Institut Pprime, CNRS - Université de Poitiers - ENSMA, ENSIP, 6 rue Marcel Doré, Batiment B17, BP 633, 86022 Poitiers, France
Corresponding author E-mail: cyril.nana@univ-poitiers.fr

We present here a new hybrid method for the computation of the sound emitted by subsonic flows with temperature and density inhomogeneities. This method consists in splitting the flow field into a hydrodynamic part and an acoustic one thanks to a low Mach number approximation of the Navier-Stokes equations. We therefore consider the hydrodynamic part to be quasi incompressible. The acoustic quantities are obtained by a perturbation of the compressible Navier-Stokes equations from which hydrodynamic quantities are subtracted. These become a source term based on the convective derivative of the hydrodynamic pressure. The method has been successfully applied to isothermal and anisothermal excited mixing layers. The validity of the proposed method is assessed by comparison to a compressible direct numerical simulation on the one hand and to LEE computations with different source terms on the other hand.

Tue 14:40 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Numerical analysis of an aeroacoustic field using Complex Variable Method – (Contributed, 000523)

E. Gaudard[a], R. Marchiano[a], P. Druault[a] and F. A. Van Herpe[b]
[a]UPMC-IJLRDA(UMR 7190), 4, Place Jussieu, Cedex 05, 75252 Paris, France; [b]PSA PEUGEOT CITROËN, Case Courrier VV1405, Centre Technique de Vélizy A - Route de Gisy, 78140 Velizy Villacoublay, France
Corresponding author E-mail: gaudard@dalembert.upmc.fr

This study deals with identification and characterization of aeroacoustic sources in turbulent flows. Analysis of aeroacoustic noise generation and propagation often requires huge amount of data. Here, a versatile method called Complex Variables Method (CVM) is proposed. It is a powerful tool dedicated to analyze numerical simulations by adding a small imaginary part to variables and parameters, without post- processing. Depending on the initialization of these imaginary parts, CVM provides different informations. The method is illustrated with numerical simulations showing that it can be efficiently used to get the sensibility to various parameters or to distinguish and follow the acoustic part in the total fields.

Tue 15:00 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Lattice Boltzmann aero-acoustics modelling of flow around obstacles – (Contributed, 000584)

H. Machrouki[a], D. Ricot[b] and O. Coste[a]
[a]GANTHA, 12 boulevard Chasseigne, 86000 Poitiers, France; [b]RENAULT, Research Advanced Engineering and Materials Department, TCR AVA 1 63, 1 av. du Golf, 78288 Guyancourt, France
Corresponding author E-mail: h.machrouki@signal-developpement.com

In this paper, we suggest to present and discuss the aeroacoustics modelling of flow around different obstacles using LaBS software which is based on Lattice Boltzmann method. Within the framework of a consortium including industrial companies and academics institutes, LaBS was created around Lattice Boltzmann method (LBM). One of the advantages of LBM compared to classical CFD methods is its ability to determine aeroacoustic field by a direct computation of acoustic phenomena. To discuss LaBS performances, a jet flow is studied around a model composed of a cube which is mounted behind a fence. Various reports of scales and velocities are studied. This flow is characterized by the existence of different types of noise (detachment, impact, wake...). Computational results are compared with a complete list of experimental measurements (hot wire, PIV, acoustic source localization...). From an aerodynamic point of view, the flow's global structure is found by computation and unsteady quantities are correctly simulated. From an acoustic point of view, computation and measurements converge on location of the main source and on dipole behavior of radiation.

Tue 15:20 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

CABARET scheme with conservation-flux asynchronous time-stepping for computational aero-acoustics – (Contributed, 000638)

V. A. Semiletov and S. A. Karabasov
Whittle Laboratory Cambridge University Engineering Department, 1 JJ Thompson Avenue, CB3 0DY Cambridge, UK
Corresponding author E-mail: vs346@cam.ac.uk

Large disparity of flow scales is a typical feature of aeroacoustic calculations. Because of the low-dispersion and low-dissipation requirement, most of the numerical schemes are based on explicit time stepping. According to the Courant-Friedrichs-Lewy (CFL) stability criterion, the numerical efficiency, in case of synchronous time stepping, drops down because all but the smallest cells are effectively forced to march in time with a very small time step. Asynchronous time stepping, i.e., when the solution in different cell sizes is updated at different rates and adjusted to the cell-local CFL number rather than to a global one, is one popular way of improving the efficiency of explicit methods on highly non-uniform grids. In this paper, a new asynchronous time-stepping technique is implemented for the Compact Accurately Boundary-Adjusting high-REsolution Technique (CABARET) scheme. CABARET is a conservative, low-dissipative and low-dispersive explicit advection scheme that has a very compact stencil. With synchronous time stepping, CABARET has been successfully used for computational aeroacoustics and hydrodynamics problems before. Suggested asynchronous time stepping method has the following important properties: (i) simplicity and flexibility of the original computational grid stencil, (ii) strict flux conservation property and (iii) a built-in recipe for the treatment of inactive flow regions.

Tue 15:40 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Time-harmonic acoustic scattering in a complex flow – (Invited, 000307)

J.F. Mercier[a], A.-S. Bonnet-Bendhia[a], F. Millot[b], S. Pernet[b] and E. Peynaud[b]
[a]POEMS-CNRS/ENSTA/INRIA, 32 Boulevard Victor, 75015 Paris, France; [b]CERFACS, 42 Avenue Gaspard Coriolis 31057 Toulouse Cedex 1
Corresponding author E-mail: jean-francois.mercier@ensta-paristech.fr

We are interested in the numerical simulation of time harmonic acoustic scattering in presence of a complex flow on a unstructured mesh. Galbrun's equation, whose unknown is the perturbation of displacement, is attractive, compared to the linearized Euler's equations, because it is close to a wave equation which allows the use of classical Lagrange Finite Element, and it is well adapted to take into account boundary conditions, like impedance or interface with an elastic structure. However, a direct discretization of Galbrun's equation with Lagrange Finite Element leads to numerical troubles. We propose a method that allows both to obtain a stable numerical scheme and non-reflecting artificial boundary conditions. This method requires to introduce a new quantity related to hydrodynamic vortices which satisfies a convection equation. A hybrid numerical method is proposed, coupling finite elements for Galbrun's equation and a Discontinuous Galerkin scheme for the convection equation. Several 2D numerical results are presented to show the efficiency of the method. In the 3D case, an attractive alternative to Galbrun's equation is Goldstein's equations: here the vorticity vanishes where the flow is potential which reduces the cost of the Discontinuous Galerkin scheme.

Tue 16:40 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Overview of CAA techniques applied to various propulsion and cooling systems – (Invited, 000881)

S. Moreau
Université de Sherbrooke, 2500 boulevard de l'université, Sherbrooke, Canada J1K2R1
Corresponding author E-mail: stephane.smoreau@gmail.com

Noise reduction driven by more stringent specifications requires the introduction of acoustic predictions in the design process of many flow-moving machines. However, reproducing their noise spectrum especially for highspeed turbo-engines that contains both tonal and broadband components over a large range of frequencies may seem a daunting task. Two main Computational Aero-Acoustics approaches can be used to estimate noise. First, a hybrid method where the noise sources are computed accurately in a limited zone, the surface in wall-bounded cases, the shear region in free shear-layer flows and the far-field acoustic pressure is then obtained by an acoustical analogy. Secondly, direct noise computation can be performed using compressible turbulent simulations. The latter is still limited to basic flows at low Reynolds numbers, except maybe at low Mach numbers where the Lattice Boltzmann

Method provides an effcient way to compute noise radiation of complex installed systems. Both paths are first illustrated on two canonical problems, airfoil self-noise and single-stream cold jet noise, and then on more complex systems such as low-speed fan noise and high-speed nozzle jet noise.

Tue 17:00 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Jet noise prediction using a sweeping based turbulence generation process – (Contributed, 000248)

A. Lafitte[a], E. Laurendeau[b], T. Le Garrec[c] and C. Bailly[d]

[a]Liebherr Aerospace, 29 avenue de la division Leclerc, 92320 Chatillon, France; [b]Liebherr Aerospace, 408 avenue des Etats-Unis, 31016 Toulouse, France; [c]Onera, Département de Simulation Numérique des Ecoulements et Aéroacoustique, BP 72 - 29, avenue de la Division Leclerc, 92322 Chatillon Cedex; [d]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex

Corresponding author E-mail: anthony.lafitte@onera.fr

A predictive tool of the noise generated by jet pumps, developed by Liebherr Aerospace for aircraft air conditioning systems application, is introduced in this paper. The model is simplified to the geometry of a confined subsonic jet. Starting from a steady RANS computation, a turbulent velocity field is built from a stochastic method to compute acoustic sources to be injected in Euler equations to model the near-field acoustic propagation. For CPU cost reductions, the far-field radiation is recovered using an acoustic analogy.

In one hand, a new combined approach based on the sweeping hypothesis to generate isotropic turbulent fields is introduced. This model noticeably allows a satisfying modeling of the velocity correlation functions and more generally of the decorrelation process of the turbulent field. It also takes correctly into account the convection effects of the turbulent structures in the shear layer and has the advantage of being energy preserving [Lafitte et al., AIAA 2011-2088].

On the other hand, the coupling between this model and Onera's Euler solver sAbrinA.v0 is tested on a subsonic free jet with a nozzle diameter D=80 mm at Mach number 0.72. Numerical spectra in the far-field are compared to experimental data available at the Onera.

Tue 17:20 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Finite element simulation of noise radiation through shear layers – (Contributed, 000001)

A. Prinn[a], G. Gabard[a] and H. Beriot[b]

[a]ISVR, University of Southampton, University Road, SO17 1BJ Southampton, UK; [b]LMS International - Leuven, LMS International Researchpark Haasrode ZI Interleuvenlaan 68 3001 Leuven

Corresponding author E-mail: gabard@soton.ac.uk

Predicting sound propagation through the jet exhaust of an aero-engine presents the specific difficulty of representing the refraction effect of the mean flow shear. This is described in full in the linearised Euler equations but this model remains rather expensive to solve numerically. The other model commonly used in industry, the linearised potential theory, is faster to solve but needs to be modified to represent a shear layer. This paper presents a way to describe a vortex sheet in a finite element model based on the linearised potential theory. The key issues to address are the continuity of pressure and displacement that has to be enforced across the vortex sheet, as well as the implementation of the Kutta condition at the nozzle lip. Validation results are presented by comparison with analytical results. It is shown that the discretization of the continuity conditions is crucial to obtain a robust and accurate numerical model.

Tue 17:40 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Transparent boundary condition for acoustic propagation in duct with bulk-reacting liner – (Contributed, 000826)

E. E. Redon[a], B. Ouedraogo[b] and P. Leclaire[c]

[a]Laboratoire Vibrations Acoustique, Bâtiment St. Exupéry, INSA Lyon, 25 bis, avenue Jean Capelle 69621 Villeurbanne Cedex; [b]Département de Recherche en Ingénierie des Véhicules pour l'Environnement, 9, avenue Alain Savary, 21000 Dijon; [c]LRMA-DRIVE, ISAT, 49 rue Mademoiselle Bourgeois - BP 31, 58027 Nevers, France

Corresponding author E-mail: emmanuel.redon@insa-lyon.fr

The proposed study focuses on the modeling of acoustic wave propagation in infinite guides lined with bulk-reacting sound absorbing material which allows acoustic propagation through the lining. The finite element method is used, it is then necessary to limit the numerical domain by an artificial boundary on which a transparent boundary condition is introduced. The method described in this work consist to write the transparent condition as a Dirichlet to Neumann operator (DTN) based on a modal decomposition of the pressure in the guide. This study is a generalization of recent works with absorbent materials modeled with impedances boundary condition. The presented method can be useful for the acoustic design of silencers, air-conditioning ducts, industrial fans, and other similar applications.

Tue 18:00 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Numerical prediction of absorbing materials via Computational AeroAcoustics – (Contributed, 000220)

M. Escouflaire and S. Redonnet
Onera, Département de Simulation Numérique des Ecoulements et Aéroacoustique, BP 72 - 29, avenue de la Division Leclerc, 92322 Chatillon Cedex
Corresponding author E-mail: marie.escouflaire@onera.fr

In the context of reduction of the propulsive noise of airplanes, manufacturers are led to generalize the employment of "sound absorbing materialsï (or "linersï), and to optimize their use. The aim of the present study is to improve the numerical prediction of noise attenuation by accurately modelling such absorbing materials either for time domain approaches (such as Computational AeroAcoustics) or for frequency domain methods (such as Boundary Element Method). Such a modelling raises several key questions, which are related to various aspects such as the type of flow involved (heterogeneities, turbulent boundary layers, etc.), the sound levels considered (non-linear phenomena), the diffraction effects induced by ruptures of impedance, etc. Besides specific theoretical developments dedicated to the accurate modelling of acoustic liners, the present work relies on specific calculations, to be compared against other results (analytical, numerical, and/or experimental). Therefore, a numerical campaign has been recently initiated, which aim is to numerically duplicate several canonical tests of noise absorption by acoustic liners. These cases will be used as means of validation to improve the consideration of an accurate acoustic impedance boundary condition for Onera's time and frequency domains solvers.

Tue 18:20 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Numerical study of the aeroacoustic behavior of a subsonic confined cavity – (Contributed, 000183)

P. Lafon[a], J. Berland[a], F. Crouzet[a], F. Daude[a] and C. Bailly[b]
[a]EDF R&D, 1 avenue du Général de Gaulle, 92141 Clamart, France; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: philippe.lafon@edf.fr

Ducted cavities are well-known configurations in pipe systems. Their aeroacoustic behavior is typical of the one observed in industrial situations for flow control devices like valves for example. It is found that, for some flow conditions, strong noise tones are radiated. In this paper, we study with the help of a 3D compressible turbulent computation a plane 3D geometry for which we have experimental data. The first objective of this work is to have a better understanding of the physical phenomena in order to try to find solutions when such problems occur in practical situations. The second objective is to test numerical approaches in order to be able to take into account more complex geometries like rounded corners that is a crucial point on a physical point of view.

Tue 18:40 Ray STEPHENS AH-S05: Numerical methods in aeroacoustics

Numerical study of low Reynolds number airfoil flows – (Contributed, 000733)

O. Marsden and T. Charrel
Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: olivier.marsden@ec-lyon.fr

A numerical study of the flow and acoustic field around low Reynolds number NACA0012 airfoils is presented in this work. Unsteady flow fields are computed by solving the 2D compressible Navier Stokes equations using low-dispersion and low-dissipation optimized finite-difference schemes. The chord based Reynolds number of the airfoil

is varied between 5,000 and 50,000, for angles of attack in the range 0 to 7 degrees and for Mach numbers between 0.2 and 0.5. Numerical velocity, wall pressure and far field acoustic results are compared to those of various DNS in the literature. Strouhal number scaling of the vortex shedding in the wake is illustrated, and acoustic scaling of the trailing edge noise as a function of Mach number is examined. Effects of airfoil incidence on far field noise levels and directivity are also presented.

Tue 13:40 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Numerical tools for musical instruments acoustics: analysing nonlinear physical models using continuation of periodic solutions – (Invited, 000319)

S. Karkar, C. Vergez and B. Cochelin
LMA – CNRS (UPR 7051) / Aix-Marseille University, 31, chemin J. Aiguier, 13402 Marseille Cedex 20, France
Corresponding author E-mail: karkar@lma.cnrs-mrs.fr

We propose a new approach based on numerical continuation and bifurcation analysis for the study of physical models of instruments that produce self- sustained oscillation.
Numerical continuation consists in following how a given solution of a set of equations is modified when one (or several) parameter of these equations are allowed to vary. Several physical models (clarinet, saxophone, and violin) are formulated as nonlinear dynamical systems, whose periodic solutions are directly obtained using the harmonic balance method. This method yields a set of nonlinear algebraic equations. The solution of this system, which represent a periodic solution of the instrument, is then followed using a numerical continuation tool when a control parameter (e.g. the blowing pressure) varies.
This approach enables us to compute the whole periodic regime of the instruments, without any additional simplification of the models, thus giving access to characteristics such as playing frequency, sound level, as well as sound spectrum as a functions of the blowing pressure.

Tue 14:20 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Choice of algorithms for reed instruments oscillations: how to solve the equation for the nonlinear characteristics? – (Invited, 000161)

J. Kergomard, P. Guillemain and F. Silva
Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: kergomard@lma.cnrs-mrs.fr

For the simplest model of clarinet-like instruments, leading to the iterated map scheme, the solving of the nonlinear characteristic equation involves the inversion of the modified characteristic function linking the incoming wave to the outcoming one. The inversion can be problematic when the reed opening is large, i.e. when the associated dimensionless parameter is larger than unity, the inverse function being multi-valued. The problem was already noticed by Gokhstein (1981) concerning oboes or bassoons. To overcome this difficulty, several discretization schemes can be found, e.g. by modelling a reed as a one degree of freedom oscillator, or by modelling the air in the mouthpiece as a simple spring. The use of these schemes at their limits allows studying how the choice between the solutions can be done when using the classical scheme with the multi-valued function for the incoming/outcoming waves. The case of conical reed instruments is particularly investigated.

Tue 14:40 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Influence of the reed flow on the intonation of the clarinet – (Contributed, 000461)

J.-P. Dalmont[a], P. Guillemain[b] and P.-A. Taillard[c]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [c]Schola cantorum basiliensis, Cerisier 16a, 2300 La Chaux-De-Fonds, Switzerland
Corresponding author E-mail: jean-pierre.dalmont@univ-lemans.fr

The playing frequency of a reed instrument is generally mainly imposed by the resonator. That said, numerous other factors have an influence on the playing frequency. Among those, the volume velocity pulsated by the reed must be taken into account in the models as it lowers significantly the playing frequency. At first order, this volume velocity can be taken into account by adding an equivalent volume of about 1.cm^3 at the entrance of the

pipe. However, the concept of equivalent volume is theoretically only valid for linear vibrations i.e., for the clarinet, for the non beating reed regime. In the beating regime, this volume is likely to vary quite a lot with the mouth pressure which can lead to intonation problems. In addition, this volume depends much on the reed opening, but experiments performed with an artificial mouth show that for usual openings (0.3-0.7 mm) the intonation remains surprisingly stable. This suggests that the reed and mouthpiece makers know how to control this problem by a well chosen design of the lay. A counter-example is obtained by using a Claripatch^{TM} especially designed so that intonation is particularly difficult to control.

Tue 15:00 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Numerical resolution of a physical model of flute-like instruments: comparison between different approaches – (Invited, 000528)

S. Terrien[a], R. Auvray[b], B. Fabre[b], P.-Y. Lagrée[c] and C. Vergez[a]
[a]LMA - CNRS (UPR 7051), 31 chemin Joseph-Aiguier, 13402 Marseille, Cedex 20, France; [b]Équipe LAM - d'Alembert, 11 rue de Lourmel, 75015 Paris, France; [c]CNRS / équipe FCIH - d'Alembert, 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: terrien@lma.cnrs-mrs.fr

The study of flute-like instruments involves several subfields of investigation such as acoustics of the waves in the pipe, hydrodynamics of a jet perturbed by an acoustic field and aeroacoustics of a jet/labium interaction. Historically, several models of flute-like instruments have been proposed, including the results from separated studies of the parts mentioned above.
In this paper, such a model is written, taking into account the following elements: (1) hydrodynamics of a jet perturbed by an acoustic field, through a delay equation, corresponding to the convection of a perturbation of the jet from the flue exit to the labium, (2) aeroacoustics of a jet/labium interaction, through a nonlinear equation, which highlights the presence of a dipolar pressure source, (3)acoustics of the waves in the pipe, through a modal formulation, (4) nonlinear losses at the labium, through an additional nonlinear term.

This description includes two non-linear terms, which require numerical solving. This paper aims at comparing different approaches in terms of the resolution of the non linear equations. The following aspects of the model behaviour are addressed: amplitude/frequency evolution along periodic branches, regime changes, hysteresis...

Tue 15:20 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Proposition of a Green-Volterra formalism to solve dynamics of a nonlinear string – (Contributed, 000772)

D. Roze and T. Hélie
IRCAM, 1 place Igor Stravinsky, 75004 Paris, France
Corresponding author E-mail: david.roze@ircam.fr

The convolution kernels of a Volterra series give a generalization of impulse responses to the case of weakly nonlinear input-to-output systems.
In acoustics, this formalism has yet been used to solve, e.g. the problem of a nonlinear string excited by a force $f(t)$ (considered as the input), spatially distributed by a time invariant function.
In this paper, we propose a similar generalization for the case of Green functions in order to tackle inputs that depend on both the space and the time variables.
The method to derive the "Green-Volterra" kernels is described and its application to the string is presented.

Tue 15:40 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Measures and models of real triodes, for the simulation of guitar amplifiers – (Contributed, 000680)

I. Cohen and T. Hélie
IRCAM, 1 place Igor Stravinsky, 75004 Paris, France
Corresponding author E-mail: ivan.cohen@orosys.fr

This paper deals with measurements of vacuum tubes to improve models and guitar amplifier simulations. A measurement device has been created. A first set up is dedicated to study the static regimes of real dual triodes 12AX7s. A second one is used to study the dynamic regimes mainly involved by parasitic capacitances. Char-

acterizations of 12AX7s are obtained, including general triode parameters displayed in datasheets and measured parasitic capacitances values. They give quantitative elements to compare the behaviour of real tubes in guitar amplifiers, as tube sellers do. By using these measures, existing mathematic triode models have been compared with new models, developed to match real tube behaviours. These comparisons lead to define a new model which is more accurate than the usual Norman Koren's one. This model includes grid current modeling, dependent on plate-to-cathode and grid-to-cathode voltages around triodes. Parameters have been estimated from measures on both new and warn real tubes in our disposal. These results have been successfully used in real-time multi-stage guitar amplifier simulations.

Tue 16:40 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

What can we learn about the wolf phenomenon from a linearized analysis? – (Invited, 000176)

V. Debut[a], J. Antunes[a] and O. Inacio[b]
[a]Instituto Tecnologico e Nuclear, Estrada Nacional 10, 2686 Sacavem, Portugal; [b]Instituto Politecnico do Porto, Escola Superior de Musica e Artes do Espectaculo, IPP/ESMAE Rua da Alegria 503, 4000 Porto, Portugal
Corresponding author E-mail: vincentdebut@itn.pt

String players are well aware of a perverse phenomenon known as wolf notes. Physically, such undesirable effect results from severe interaction between string and body vibrations, which are coupled at the bridge, when the sounding note approaches the frequency of a low-damped body mode.
The phenomenon invested considerable efforts to deal with string/body coupled system. Different approaches have been adopted to achieve nonlinear time-domain simulations, including methods based on wave propagation with reflections, as well as time-domain modal methods used by the present authors.
Recently, our modelling approach for bowed bars was used to address the linearized modal dynamics of the bowed string/body coupled system. The stability analysis provides a range of instability for a pair of coupled modes as the playing frequency approaches that of the instrument body, suggesting that the basic mechanism of wolf phenomenon can be explained by a linearized approach.

In this paper, we examine the features of the linearized modal dynamics of the bowed string/body coupled model and explore the influence of bowing parameters on the modal frequency and damping. The results from our linearized analysis show a dependence of the wolf beating frequency on the playing control parameters (bow normal force and tangential velocity), as observed in the nonlinear time-domain computations.

Tue 17:20 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Differential geometry applied to acoustics: non linear propagation in Reissner beams – (Invited, 000497)

J. Bensoam
ircam, 6, place I. Stravinsky, 75004 Paris, France
Corresponding author E-mail: bensoam@ircam.fr

Although acoustics is one of the disciplines of mechanics, its "geometrization" is still limited to a few areas. As shown in the work on nonlinear propagation in Reissner beams, it seems that an interpretation of the theories of acoustics through the concepts of differential geometry can help to address the non-linear phenomena in their intrinsic qualities. This results in a field of research aimed at establishing and solving dynamic models purged of any artificial nonlinearity by taking advantage of symmetry properties underlying the use of Lie groups. As an illustration, numerical and analytical trajectories of Reisner beams in the configuration space of transformation matrix will be presented.

Tue 17:40 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Nonlinear plate vibrations: A modal approach with application to cymbals and gongs – (Contributed, 000047)

M. Ducceschi[a], C. Touzé[a] and S. Bilbao[b]
[a]UME (Unité de Mécanique), ENSTA - ParisTech, Chemin de la Hunière, 91761 Palaiseau, France; [b]University of Edinburgh, Room 7306B, James Clerk Maxwell Building, King's Buildings, EH9 3JZ Edinburgh, UK
Corresponding author E-mail: ducceschi@ensta.fr

Geometrically nonlinear vibrations of plates are investigated with the purpose of sound synthesis and application to cymbals, gongs and thunder plates. Von-Kármán equations are used to describe the motion of the plate when the amplitude is comparable to the plate thickness. In this contribution, the case of a rectangular plate is considered, and a modal approach is selected. A general procedure, adapted from a paper by Li [JSV, 2004], is proposed in order to deal with various case of boundary conditions, for which no analytical solutions are available. After discretisation, one is left with a system of ordinary differential equations for the temporal modal coordinates, with cubic coupling terms. The results are validated by comparing frequency-response curves with other either found in literature, or computed with a finite difference approach, showing good agreement. The nonlinear dynamics of a simply supported plate is investigated by computing its frequency-energy plot (FEP), displaying variations of eigenfrequencies with amplitude and highlighting their interactions via internal resonance. The proposed method provides a possible strategy for modelling the shimmering sounds of musical instruments such as gongs and cymbals, as it allows for an accurate description of modal viscous damping. Finally, impulsive sounds will be shown and compared to those obtained with a finite difference approach.

Tue 18:00 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Estimations of non-linearities in structural vibrations of string musical instruments – (Contributed, 000470)

K. Ege[a], M. Rébillat[b] and X. Boutillon[c]
[a]Laboratoire Vibrations Acoustique, INSA de Lyon, 25 bis Avenue Jean Capelle, 69621 Villeurbanne, France; [b]Département d'études cognitives, Ecole Normale Supérieure Paris, 29 Rue d'Ulm, 75230 Paris, France; [c]Laboratoire de Mécanique des Solides, Ecole Polytechnique, 91128 Palaiseau, France
Corresponding author E-mail: kerem.ege@insa-lyon.fr

Under the (possibly non-linear) excitation of strings, the wooden structure of string instruments is generally assumed to undergo linear vibrations. As an alternative to the direct measurement of the distortion rate at several vibration levels and frequencies, we characterise weak non-linearities by a signal-model approach based on cascade of Hammerstein models. In this approach, one measurement is sufficient to predict the distortion rate of a system at any vibration level, as a function of the exciting frequency. The experiment consists in exciting the instrument acoustically. The linear and non-linear contributions to the response of (a) the loudspeaker coupled to the room, (b) the instrument can be separated. Some methodological issues will be discussed. Findings pertaining to several instruments - pianos, guitars, violins - will be presented.

Tue 18:20 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Analysis of the nonlinear effect of the capo bar-string interaction in grand piano – (Contributed, 000205)

A. Stulov
Institute of Cybernetics at TUT, Akadeemia 21, 12618 Tallinn, Estonia
Corresponding author E-mail: stulov@ioc.ee

The treble strings of grand pianos usually terminate at a capo bar, which is situated above the strings. The apex of a V-shaped section of the capo bar defines the end of the speaking length of the strings. Accurate modeling of the piano string - capo bar interaction requires that the curvature of V-shaped section be recognized and included. The model that realizes this with numerical calculation is described, and results relating the effect of the capo bar are presented. The finite curvature of the capo bar at the point of the piano string termination causes the nonlinear vibrations of the string. As result, the spectrum of the string vibrations depends not only on the amplitude of the hammer impact, but the spectral structure changes continuously as time passes, even when the hammer left the string and it vibrates freely after that.

Tue 18:40 John TYNDALL MA-S06: Nonlinear aspects of musical instruments

Modeling of the part-pedaling effect in the piano – (Contributed, 000329)

A. Stulov[a], V. Välimäki[b] and H.-M. Lehtonen[b]
[a]Institute of Cybernetics at TUT, Akadeemia 21, 12618 Tallinn, Estonia; [b]Aalto University, Department of Signal Processing and Acoustics, P.O. Box 13000, FI-00076 AALTO Espoo, Finland
Corresponding author E-mail: stulov@ioc.ee

This study presents the theoretical modeling of the part - pedaling effect in the piano. Part - pedaling means a common use of the sustain pedal where the pedal is not fully depressed, but pressed somewhere between the two extremes. The model implies to consider the distributions of the string deflection and the string velocity along the string as functions created by the traveling nondispersive waves generated by the hammer impact and moving in both directions. The damper restricts the amplitude of the string deflection in the region of its position, and also suppresses the "up" velocity of the string. Such nonlinear model gives possibility to calculate the spectrograms of the string vibration tone, and to compare the numerical calculations with the measured example tones of the string. To obtain the appropriate decay rates of the string vibrations, the damping factor at one termination of the string is induced. The modeling confirms that in the bass range the nonlinear amplitude limitation causes energy transfer from the lower partials to higher partials, which can excite missing modes during the damper-string interaction.

Tue 13:40 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

Comparison of inverse methods and particle velocity based techniques for transfer path analysis – (Invited, 000191)

D. Fernandez Comesaña[a], K. Holland[b], J. Wind[a] and H.-E. De Bree[a]
[a]Microflown Technologies B.V, Tivolilaan 205, Arnhem, 6824BV Arnhem, Netherlands; [b]Institute of Sound and Vibration (ISVR) , University Road, Highfield, S017 1BJ Southampton, UK
Corresponding author E-mail: fernandez@microflown.com

Direct sound field visualization is not always the best way to assess complex noise problems. Maps of sound pressure, particle velocity or intensity in the vicinity of a source might not be directly related to the pressure contribution for a given position. Transfer path analysis has been implemented for many years to evaluate this case scenario, which requires using information of the environment and the sound source. Inverse methods commonly require a detailed geometric description of the problem along with sound pressure measurements. On the other hand, particle velocity methods rely on measuring the reciprocal transfer path and the velocity close to the sources. This paper presents the theoretical bases of the two principles and compares the advantages and disadvantages of the two methods applied to real industrial applications.

Tue 14:00 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

Nearfield acoustic holography in wind tunnel by means of velocity LDV measurements – (Contributed, 000215)

H. Parisot-Dupuis, F. Simon and E. Piot
ONERA - The French Aerospace Lab, 2 av Edouard Belin, F-31055 Toulouse, France
Corresponding author E-mail: Helene.Parisot_Dupuis@onera.fr

With the efforts made on environmental noise reduction, aeroacoustic studies in wind tunnel are required to characterize the main sources during airplanes conception. For a long time, beamforming, based on farfield microphone measurements, has been the only method used. Recently, a new method based on Nearfield Acoustic Holography using a convected spectral pressure-to-pressure propagator was tested too (Kwon & al. JASA 2010). This method avoids some errors linked to farfield measurements and allows the integration of convection effects in the propagator without any assumption on sources. However, nearfield microphone measurements are required, which creates flow and measurements disturbances. That is why it is interesting to develop another method allowing wind tunnel aeroacoustic sources characterization by means of non-intrusive nearfield measurements. This paper presents a numerical and experimental validation of a new method coupling Nearfield Acoustic Holography based on a convected real velocity-to-pressure propagator with LDV velocity measurements. Simulations in the case of combinations of monopoles radiating in uniform subsonic flow show a good characterization of sources and demonstrates the interest of using the real form of the convected velocity-to-pressure propagator. A wind tunnel campaign with a flush-mounted loudspeaker seems to confirm the feasibility of this method.

Tue 14:20 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

CAA-based acoustic beamforming for noise identification in complex media – (Contributed, 000611)

Y. Pene[a], V. Fleury[a], D. C. Mincu[a] and C. Polacsek[b]
[a]ONERA, 29 avenue de la Division Leclerc, 92322 Chatillon, France; [b]Onera, Département de Simulation Numérique des Ecoulements et Aéroacoustique, BP 72 - 29, avenue de la Division Leclerc, 92322 Chatillon Cedex
Corresponding author E-mail: vincent.fleury@onera.fr

Beamforming methods use analytical Green functions to describe the acoustic propagation between noise sources and microphones. For example, due to flow heterogeneity and complex boundary conditions, the Green functions become analytically difficult to determine in the case of a realistic turbofan engine. The aim of this work is to overcome the analytical Green functions determination difficulties by employing CAA tools. In order to numerically evaluate these functions, we propose a method based on non linear euler equations implemented in the Onera's sAbrinA-v0 code. The noise source area is sampled as a finite distribution of monopoles which emit simultaneously. The sound field is then computed from the source points to the microphones. An ARMA based algorithm is applied to evaluate Green functions betweenn each monopole and each microphone. First of all, the approach is validated from analytical simple test cases, such as the propagation of a monopole in uniform flow. Once achieved, more delicate problems will be processed, such as the presence of multiple sources, flow gradients and complex geometries.

Tue 14:40 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

Acoustical inverse problems regularization: direct definition of filter factors using Signal-to-Noise Ratio – (Contributed, 000335)

P. A. Gauthier, A. Gerard, C. Camier and A. Berry
GAUS, Université de Sherbrooke, 2500 Boul. de l'Université, Sherbrooke, Canada J1K2R1
Corresponding author E-mail: anthony.gerard@usherbrooke.ca

Acoustic imaging aims at localization and characterization of sound sources using microphone arrays. In this paper a new regularization method for acoustic imaging by inverse approach is proposed. The method first relies on the singular value decomposition of the plant matrix and on the projection of the measured data on the corresponding singular vectors. In place of regularization using classical methods such as truncated singular value decomposition and Tikhonov regularization, the proposed method involves the direct definition of the filter factors on the basis of a thresholding operation, defined from the estimated measurement noise. The thresholding operation is achieved using modified filter functions. This has the advantage of symplifying the selection of the best regularization amount. Theoretical results show that this method is promising, in terms of ease of implementation and accuracy of results, in comparison with Tikhonov regularization and truncated singular value decomposition.

Tue 15:00 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

Identification of vibration excitation using a regularized Finite Element operator and a deconvolution post-process – (Contributed, 000406)

C. Renzi[a], C. Pezerat[b] and J.-L. Guyader[a]
[a]LVA, INSA-Lyon, Bâtiment St. Exupéry, INSA Lyon, 25 bis, avenue Jean Capelle, 69621 Villeurbanne Cedex, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: charles.pezerat@univ-lemans.fr

The Force Analysis Technique FAT is an experimental inverse approach that aims to identify vibration sources from the measurement of displacement field of a structure. Based on the verification of the local dynamic behaviour of the structure, the FAT constitutes an interesting inverse problem since boundary conditions and sources outside the studied domain may not be known. In its first developments, the FAT was written for analytically known structures like beams, plates and shells but more recently, its adaptation to more complex structures was possible thanks to the use of Finite Element Method and model reductions. In this mathematical adaptation, the regularization of the problem is done by a double inversion of the numerical operator where the well known Tikhonov regularization is applied in the second inversion. In order to correct the smoothing effect on regularized results, it is then proposed to apply a deconvolution post-process made by the Richardson-Lucy algorithm. After the description of all steps constituting the method, several experimental results on structures excited by a point force are shown. In addition to the location of the force, it is also shown how the quantification of the force is improved by the deconvolution in comparison with direct measurements.

Tue 15:20 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

Full-field reconstruction from scanned measurements without references: the latent variable approach – (Contributed, 000073)

J. Antoni
LVA, INSA, University of Lyon, Bâtiment St. Exupéry, 25 bis avenue Jean Capelle, F-69621 Villeurbanne, France
Corresponding author E-mail: jerome.antoni@insa-lyon.fr

In inverse acoustics, the spatial resolution of the source field that can be reconstructed from microphone array measurements is fundamentally limited by the size of the array and the microphone density. One approach to mimic large arrays with high microphone density is to scan the object of interest by moving a small array around it. This typically requires that a number of fixed references are available in order to preserve the phase relationships between consecutive snapshots, or that measurements are made in the near-field in order to allow the successive reconstruction of "patchesï of the source in front of the array by deliberately neglecting radiation of the source field not covered by the array. In the present work, a solution is introduced that can reconstruct the full source field of the radiating object from consecutive snapshots, but without the need for fixed references and without the edge effects of the patch approach. Under the stationary assumption, the problem is shown to boil down to the factorisation of a structured covariance matrix. This is undertaken within a Bayesian probabilistic approach, where the source field is encoded by latent variables which are iteratively reconstructed by using an Expected-Maximisation (EM) algorithm.

Tue 15:40 Pierre CHAVASSE MI-S05: Inversion methods for acoustic imaging

Bayesian sparse regularization in near-field wideband aeroacoustic imaging for wind tunnel test – (Contributed, 000064)

N. Chu[a], J. Picheral[b] and A. Djafari[a]

[a]Laboratoire des signaux et systèmes, 3 rue Joliot-Curie, 91192 Gif Sur Yvette, France, Metropolitan; [b]Supelec, Département Signaux & Systèmes, 91192 Gif-sur-Yvette, France

Corresponding author E-mail: Ning.CHU@lss.supelec.fr

Near-field wideband aerocoustic imaging has arosed great interests on source localizations and strength estimations. But most of the classical methods are neither robust nor capable to obtain wide dynamic range in the low Signal to Noise Ratio situation, espetially in correlated noise. In this paper, we at first propose the Bayesian Approach with Sparse Regularization for Acoustic Imaging (BASRAI) to suppress the correlated noise and simultaneously to locate near-field wideband uncorrelated sources and estimate source powers in poor SNR case. Regularization parameter selection is investigated by Baysian inference. We also build up the Universal Correction Model of Propagation to correct the acoustic propagation affected by wind effect. By simulations and wind tunnel data offered by Renault S2A, our approach is then compared with some of the state of the art methods: the Beamforming, the DAMAS, the Diagonal Removal DAMAS, the DAMAS with sparsity constraint, the Covariance Matrix Fitting and the CLEAN. Moreover, the proposed approach is applied for imaging extended acoustic sources on simulations and hybrid data. We finally show the advantage to be of robustness to noise, wide dynamic range, super resolution and feasibility in 2D and 3D acoustic imaging for wind tunnel test based on the non-uniform 2D microphone array.

Tue 13:40 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Cavitation bubble structure generated by an ultrasonic horn: experimental evidence of energy pumping – (Contributed, 000051)

B. Dubus and C. Granger

IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France

Corresponding author E-mail: bertrand.dubus@isen.fr

The cavitation field generated by an ultrasonic horn transducer at low frequency and high power is known to self-organize into a conical bubble structure. Recently published results suggest that this bubble structure behaves as a non linear resonator. As such device couples linear (transducer) and non linear resonators (bubble structure), the mechanism of irreversible energy transfer from linear to non linear resonator called "energy pumping" could take place when the adequate excitation amplitude is reached. Experiments are performed on a horn transducer radiating in a water tank driven by a pulsed sinusoidal excitation (20 kHz). Horn surface velocity is monitored by laser vibrometry and acoustic pressure is measured in the cavitation field using an hydrophone. Images of the cavitation bubble structure are obtained with a high speed camera at 7000 frames per second. When the electrical excitation is stopped, horn vibration amplitude decreases whereas the pressure amplitude remains constant and bubble structure unchanged. When horn vibration vanishes, pressure amplitude starts decreasing and bubble structure disappears. This result, which shows that the cavitation cloud pumps irreversibly energy from the transducer, opens the field up to new strategies in high power sonoreactors optimization and scale-up.

Tue 14:00 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

First insight into mechanisms involved in cavitation enhancement by the use of bifrequency excitation – (Contributed, 000150)

B. Gilles, C. Inserra, I. Saletes, H. Shambsborhan and J.-C. Béra
Application des ultrasons à la thérapie, Pôle santé Lyon est, 151 cours Albert Thomas 69424 Lyon cedex 03
Corresponding author E-mail: bruno.gilles@inserm.fr

Focused ultrasound experiments were carried out on cavitation targets of controlled roughness in degassed water in order to study the cavitation threshold and the development of cavitation beyond this threshold. A monofrequency pulsed excitation was compared to a bifrequency pulsed excitation involving two neighbouring frequency components. According to experimental results, a bifrequency excitation modifies cavitation threshold and stimulates cavitation activity beyond threshold in comparison to a monofrequency waveform. For high (respectively low) monofrequency thresholds, the bifrequency excitation reduces (respectively increases) the threshold value. This shows that nonlinear effects are involved in the process. Numerical simulations of the dynamics of a single bubble in a bifrequency oscillating pressure field have been done. It appears that the cavitation threshold is modified for specific initial bubble radius, which is not sufficient to explain experimental observations. To simulate first-order nonlinear propagation effect, the difference frequency component was superimposed to the excitation field, reducing the cavitation threshold on a wider range of initial bubble radius. Considering this larger effect, the experimental observations could be related to the spectral broadening of the excitation due to higher order nonlinear combinations of primary frequencies.

Tue 14:20 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

PIV measurements of 3-dimensional acoustic Rayleigh streaming in a square cross-section standing wave resonator – (Contributed, 000411)

I. Reyt[a], Y. Rafat[b], L. Mongeau[b], R. Taher[b] and H. Bailliet[a]
[a]CNRS - Université de Poitiers - ENSMA, ENSIP, 6 rue Marcel Doré, Batiment B17, BP 633, 86022 Poitiers, France; [b]McGill university, 845 Sherbrooke St. W., Montreal, Canada H3A 2T5
Corresponding author E-mail: ida.reyt@etu.univ-poitiers.fr

Rayleigh streaming may hamper the efficiency of thermoacoustic devices through the creation of convective heat transfer between the stack and heat exchangers. A better understanding and characterization of Rayleigh streaming flows is useful to assess their impact on the efficiency of thermoacoustic engines. Streaming flows in idealized configurations such as between infinite parallel plates or in cylindrical waveguides has been investigated in earlier studies. As a first step towards the investigation of streaming in more realistic configurations, streaming flows in a resonator with a square cross-section was investigated. Non-symmetric streaming structures were anticipated. For a horizontal waveguide, velocity fields within the horizontal plane were measured using Particle Image Velocimetry (PIV). These measurements were performed at several vertical positions so that three-dimensional streaming cell structures could be reconstructed from the different planar streaming velocity fields. The acoustic streaming within the boundary layer was also studied by zooming near the wall of the channel. The three dimensional streaming cells reconstructed by combining the data in the different planes reveals the nature of the streaming flow structures in the square cross-section standing wave tube. Streaming amplitudes were quantified and were compared with predictions from theoretical models.

Tue 14:40 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Different regimes for water wave turbulence – (Contributed, 000565)

A. Przadka[a], M. Sobkowiak[a], P. Petitjeans[a], A. A. Maurel[b] and V. Pagneux[c]
[a]PMMH/ESPCI, 10 rue Vauquelin, 75005 Paris, France; [b]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: adam.przadka@espci.fr

The experimental investigations on gravity-capillary water wave turbulence (WT) were studied. The behavior of the wave energy density in the wavenumber-frequency space was inspected for various forcing frequency bandwidths and forcing amplitudes. Depending on the bandwidth, the gravity spectral slope is found to be either forcing dependent, as classically observed in laboratory experiments, or forcing independent. In the latter case, the

wave spectrum is consistent with the Zakharov-Filonenko cascade predicted within WT theory. The studies of the inertial ranges for capillary waves show also the spectral slope close to that predicted by the theory. The scaling laws in the function of the injected power have also been investigated. The wave elevation was measured with good accuracy in time and in space using an optical method (Fourier Transform Profilometry) based on the analysis of the deformation of projected fringes, recently adapted by our group for water waves characterization.

Tue 15:00 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Interaction of weak shocks leading to Mach stem formation in focused beams and reflections from a rigid surface: numerical modeling and experiment – (Contributed, 000760)

M. Karzova[a], E. Salze[b], S. Ollivier[b], T. Castelain[b,c], B. André[b], P. V. Yuldashev[b], V. Khokhlova[a], O. Sapozhnikov[a] and P. Blanc-Benon[b]

[a]M.V.Lomonosov Moscow State University, Faculty of Physics, Leninskie Gory, 119991 Moscow, Russian Federation; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex; [c]Université de Lyon, 43 Boulevard du 11 Novembre 1918, 69622 Villeurbanne Cedex, France

Corresponding author E-mail: masha@acs366.phys.msu.ru

Mach stem is a well-known structure observed in the process of interaction of two strong shock waves (Mach number $M_a > 0.1$), typically in the case of reflections from a rigid boundary. However this phenomenon has not been studied in detail for weak shocks in nonlinear acoustic fields, i.e. for acoustic Mach number in the range from 10^{-3} to 10^{-2}. In acoustics, interaction of shocks occurs in the case of reflections or in the focusing of high power nonlinear beams. The goal of this paper is to investigate this phenomenon in a field of weak shocks both numerically and experimentally. The KZK nonlinear evolution equation was used to show the formation of the Mach stem in the focal region of the periodic and pulsed beams for the Mach number of about 10^{-3}. Experiments were performed in air using spark-generated N-waves reflecting from a rigid boundary. Shock fronts were visualized using Schlieren method. Regular and irregular reflections were observed experimentally and corresponding values of critical parameters for either type of reflection to occur were determined. This work is supported by the French/Russian International Program for Scientific Cooperation PICS (RFBR 10-02-91062/CNRS 5063).

Tue 15:20 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Development and analysis of non-linearity in the pressure waves resulting from thermoacoustic heat engines – (Contributed, 000072)

A. H. Ibrahim[a], A. A. Elbeltagy[a], M. M. Emam[a] and E. Abdel-Rahman[a,b]

[a]The American University in Cairo, School of Sciences & Engineering, (On leave from Cairo University), 11835 New Cairo, Egypt; [b]Mechanical Power Engineering Department, Cairo University, 12613 Cairo, Egypt

Corresponding author E-mail: ehab_ab@aucegypt.edu

Thermoacoustic heat engines are intrinsically simple, reliable, environmentally friendly and reasonably efficient. The second law of thermodynamics dictates that higher conversion efficiencies necessitates high temperatures at the hot side of the stack for higher efficiencies. In this work, a thermoacoustic prototype was built and tested. Operating the engine at a temperature just above the onset temperature generates an acoustic wave at the fundamental mode (with no nonlinearity observed) as defined by the engine's geometry with heat to acoustic conversion efficiency relatively low. As the temperature difference across the stack increases, the resulting acoustic wave distorts with observed nonlinearities. Yet, the heat to acoustic conversion efficiency improves. Further increase in the temperature difference across the stack increases the distortion in the wave with development of more nonlinearity. Moreover, the heat to acoustic conversion efficiency decreases. Numerical analysis of the resulting waves shows that the AC-coupled distorted waves can be numerically re-constructed by considering only the harmonics of the fundamental frequency of the wave, indicating that at the operation range considered harmonics were the only source of non-linearity.

Tue 15:40 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Nonlinear tube waves – (Contributed, 000671)

C. Klieber and D. L. Johnson

Schlumberger-Doll Research, One Hampshire Street, Cambridge, 02139, USA

Corresponding author E-mail: cklieber@slb.com

A tube wave is an acoustic normal mode in which the energy is confined to the vicinity of a fluid-filled cylinder within an elastic solid. In the current study, we report on nonlinear tube wave propagation in a water-filled steel pipe, in particular the evolution of various frequency components of a narrow-band (multiple-cycle) pulse train. The dispersive behavior of the tube wave requires a careful selection of the frequency combinations under study (phase matching). In a first series of experiments, a transducer launches a pulse train of a single initial frequency, ω, and we examine the evolution of the pressure amplitude at its harmonic frequency, 2ω (second harmonic generation). In a second series, we study a pulse train consisting of two different initial frequencies, ω_1 and ω_2. In addition to the second harmonics of each initial frequency, nonlinear effects lead to the generation of signals centered around the difference and sum frequencies, $\omega_2 - \omega_1$ and $\omega_2 + \omega_1$, respectively (three-wave mixing). We find that the evolution of all examined pressure amplitudes shows excellent agreement with our theoretical model, which, in addition, allows the determination of an effective nonlinearity parameter, β, of the system.

Tue 16:40 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Acoustic characterization of slow compaction dynamics in noncohesive disordered granular media – (Contributed, 000121)

J.-B. Legland[a], V. Tournat[a] and V. Gusev[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jean_baptiste.legland@univ-lemans.fr

Noncohesive disordered granular media are well known to exhibit very complex behaviour when being excited by mechanical solicitations. This work presents our studies of the slow dynamics in granular media undergoing a compaction process. The characterization of slow dynamics is performed by an acoustic probing of the packing after mechanical solicitation. With this aim we have built a special setup to increase the density of the granular medium and to probe its elastic properties by the acoustic resonance method. Elastic modulus and acoustic dissipation are extracted from the frequency and the quality factor of resonances. To clarify how the contact properties between grains modify the acoustic parameters during the compaction we have also studied the influence of the temperature and the humidity on the acoustic measurements. Interpretations of the experimental observations are proposed.

This work is supported by project "STABINGRAM" ANR-2010-BLAN-0927-03.

Tue 17:00 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Experimental study of nonlinear acoustic waves in a granular chain – (Contributed, 000246)

J. Cabaret[a], V. Tournat[a], P. Béquin[a], V. Andreev[b] and V. Gusev[c]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Lomonosov Moscow State University, Leninskie Gory, 119991 Moscow, Russian Federation; [c]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jeremy.cabaret.etu@univ-lemans.fr

The nonlinear acoustic propagation is experimentally studied in a monoatomic and straight granular chain made with identical spherical beads. The interaction law between the beads is well described by the intrinsically nonlinear Hertz-Mindlin theory, leading to a nonlinear propagation of the acoustic waves. We focus here on the study of the nonlinear resonance phenomenon in a finite length granular chain. We observe dispersion in linear wave propagation associated to the periodicity of the medium, but also a dispersion of nonlinearity. Interpretations on the basis of the hysteretic contact behavior are provided for the latter phenomenon, and lead to the conclusion that under some conditions this type of medium exhibits a dominant nonlinearity of the hysteretic type.

Tue 17:20 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Revealing highly complex elastic nonlinear behavior of Earth materials applying dynamic acousto-elastic testing (DAET) – (Contributed, 000493)

G. Renaud[a], P.-Y. Le Bas[b] and P. A. Johnson[b]
[a]Erasmus Medical Center, Dr. Molewaterplein 50, 3015 GE Rotterdam, Netherlands; [b]Earth and Environmental Sciences, Los Alamos National Laboratory, MS D443, Los Alamos, NM 87545, USA
Corresponding author E-mail: g.renaud@erasmusmc.nl

A reliable physics-based theory that directly relates material elastic nonlinearity to damage and other features that may be responsible for the elastic nonlinear response (inter-grain soft bonds, dislocations) does not yet exist. Dynamic acousto-elasticity has significant implication to development of a physics based theory. The method provides the means to dynamically study the wavespeed - strain and attenuation-strain behaviors through the full wave cycle in contrast to most methods that measure average response. The method relies on exciting a sample with a low frequency vibration (several kHz) of strain amplitude ranging from 10^{-7} to 10^{-5} in order to cycle it through stress-strain multiple times. Simultaneously, a high frequency ultrasonic source (2 MHz) applies pulses with high repetition rate to read variations in elasticity and dissipation. By integrating the velocity-stress data, we extract the dynamic stress-strain behavior. Thus the low frequency amplitude-dependent anelastic energy dissipation can be assessed. We report preliminary results in 11 different room-dry rock samples, including a crystalline rock (granite), sandstones and limestones. The behaviors of the 6 investigated sandstones show a striking similarity, although they have different microstructures. We also show how acoustical conditioning can modify nonlinear elastodynamics, bringing temporarily the material in a metastable state.

Tue 17:40 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Nonlinear contactless optoacoustic technique for crack detection and evaluation – (Contributed, 000166)

S. Mezil[a], N. Chigarev[a], V. Tournat[a] and V. Gusev[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9;
[b]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: sylvain.mezil@univ-lemans.fr

Nonlinear techniques for non destructive testing provide cracks detection with high sensitivity. The frequency-mixing technique [J. Appl. Phys. 106, 036101 (2009)] is based on the absorption of two laser beams independently modulated at frequencies f_L and f_H (with $f_L \ll f_H$) and focused at the same spot, generating thermoelastic and acoustic waves, respectively. When the focusing is on a crack, the thermoelastic wave causes crack breathing, resulting in the generation of the frequency sidelobes $f_H \pm n f_L$ ($n = 1, 2, ...$), absent otherwise. The technique can be implemented all-optically through detection by deflectometry or interferometry [Opt. Lett. 36, 3449 (2011)]. Here we report two-dimensional crack imaging with a 50 μm resolution and a 40 dB range contrast.
The theoretical model [J. Appl. Phys. 107, 124905 (2010)] explains frequency-mixing phenomena. Here we report an extension of the theory, including possible hysteresis in the crack breathing motion. The fit of the extended theory to the measured amplitudes and phases of the sidelobes provides opportunity to determine crack parameters.
This research is supported by ANR project "ANL-MEMSï ANR-10-BLAN-092302.

Tue 18:00 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Nonlinear guided waves to characterize damage in glass fiber reinforced plastics (FRPC) – (Contributed, 000716)

Y. Baccouche[a], M. Bentahar[a], R. El Guerjouma[a] and M.H. Ben Ghozlen[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9;
[b]Faculté des Sciences de Sfax, Rte Soukra km 3.B.P. 1171, 3000 Sfax, Tunisia
Corresponding author E-mail: Yosra.el_Baccouche.Etu@univ-lemans.fr

Sensitivity of nonlinear acoustic methods to the presence and the evolution of micro-damage has been proven in various studies on a wide range of materials (composites, concrete, rocks, etc.). This sensitivity is due to the relationship existing between the elastic properties of the above-mentioned materials and the created strain during the passage of the acoustic disturbances. In nonlinear resonance experiments, where a single mode is considered, this observation has been proposed to explain the decrease in resonance frequency as a function of the dynamic strain. Thereby, the hysteretic parameters corresponding to the elastic modulus as well as damping are determined for a single frequency. In this work, we propose a guided wave approach to determine and corresponding to a GFRP taken at intact as well as damaged states. By changing the bending modes, and are determined as function of frequency. In addition, the dispersion of the generated guided wave's velocity has also been determined as a function of strain. Experimental results reveal interesting correlations between velocity variations and excitation amplitude.

Tue 18:20 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Comparaison of temporal and frequency methods applied to ultrasonic nonlinear signals – (Contributed, 000404)

S. Idjimarene[a], M. Bentahar[a], M. Scalerandi[b] and R. El Guerjouma[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]DAST, Politecnico di torino, Corso Duca Degli Abruzzi 42, 10129 Torino, Italy
Corresponding author E-mail: laum@univ-lemans.fr

Since microcracks are considerably shorter than the acoustic wavelength, linear acoustic measurements are often not sensitive to such microscopic imperfections. Thereby, alternative methods can be applied to detect the nonlinearities present in a temporal signal as evidence of microdamage. Most methods rely on the analysis of the signal in the frequency domain. However, despite the diversity of the existing methods, the amplitudes of the higher order harmonics, generated by microcracks, are often small and consequently submerged within the noise. As an alternative, the scaling subtraction method (SSM) can be used, working in the time domain. The use of SSM increases the signal to noise ratio compared to Fourier based analysis methods. Simulation data corresponding to nonlinear ultrasonic waves propagating in hysteretic elastic media are used. Data are analyzed in both time (SSM) and frequency (FFT) domains. Results of the analysis are compared and the efficiency of the two approaches is estimated when equipment and environmental noises contaminate the signal. Furthermore, the kind of nonlinearity present in the sample is studied when the intensity of nonlinearity increases. The sensitivity of the above-mentioned approaches is discussed as a function of the excitation frequency, as well as the strength and the position of the nonlinear scatterer.

Tue 18:40 Paul LANGEVIN PU-S01: Non linear acoustic phenomena

Molecular simulation of sound for development of nanoacoustics – (Contributed, 000846)

T. Yano
Osaka University, Yamada-oka 2-1, 565-0871 Suita, Japan
Corresponding author E-mail: yano@mech.eng.osaka-u.ac.jp

Large scale molecular dynamics simulations have been performed to clarify the nonlinear and non-equilibrium processes of high-frequency sound waves in a gas. Since the number density of molecules in a gas is considerably small compared with those in liquids and the wavelengths of sound are very large compared with molecular scales even for high-frequency (gigahertz) sound, we put more than 0.3 million molecules in a simulation box with the length of several micrometers in the direction of wave propagation. The one-dimensional sound wave is generated by a harmonic oscillation of sound source with the Lennard-Jones intermolecular potential, which is the same as that of gas molecules. As a result, we find that the large amplitude and high-frequency sound propagates with strong attenuation, in some cases, exhibiting a stream-like profile accompanied with mass, momentum, and energy transports. This leads to a completely different picture and a different dispersion relation from a classical theory of high-frequency sound based on the linear standing wave analysis.

Tue 13:40 François CANAC PU-S12: Ultrasound and lasers

Zero Group Velocity and backward Lamb modes – (Invited, 000719)

C. Prada[a], F. D. Philippe[a], D. Clorennec[b], M. Cès[a] and D. Royer[a]
[a]Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, Univ Paris Diderot, 75005 Paris, France; [b]Quiet-Oceans, 135, rue Claude Chappe, 29280 Plouzane, France
Corresponding author E-mail: claire.prada-julia@espci.fr

Laser ultrasonics techniques are very useful to investigate Lamb modes in plates. In this talk, the remarkable properties of zero group velocity (ZGV) and backward Lamb modes will be discussed and illustrated through measurements done with nanoseconds laser ultrasonics. These modes originate from the repulsion between two dispersion branches having close cut off frequencies, corresponding to a longitudinal and a transverse thickness mode of the same symmetry. The lowest branch exhibits a minimum corresponding to the ZGV mode and a negative slope associated to backward propagation. The frequency spectrum of the plate elastic response to a local impact is entirely dominated by ZGV resonances and for isotropic plates the set of resonance frequencies provides an accurate measurement of the local Poisson's ratio. When either the transverse or the longitudinal acoustic velocity is known, plate thickness can be precisely determined. Backward modes, having negative phase velocities, exist in the vicinity of a

ZGV mode. It will be shown that mode conversion from the S2 forward mode to the S2b backward mode can be achieved at a plate thickness change. Then, negative refraction and focusing can be obtained with a simple flat lens.

Tue 14:00 François CANAC PU-S12: Ultrasound and lasers

Non contact measurement of thin layer thickness by zero group velocity Lamb modes – (Contributed, 000570)

M. Cès[a], D. Clorennec[b], D. Royer[a] and C. Prada[a]
[a]Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, Univ Paris Diderot, 75005 Paris, France; [b]Quiet-Oceans, 135, rue Claude Chappe, 29280 Plouzane, France
Corresponding author E-mail: maximin.ces@espci.fr

A homogeneous elastic plate can support non-propagating Lamb modes having a zero group velocity (ZGV) for nonzero values of their wave number, giving rise to sharp resonances. For plates covered with a thin layer, it was shown that the frequency of the S_1S_2 ZGV resonance was shifted proportionally to the mass loading through a factor which depends on the mechanical properties of the layer and of the substrate.
As they are non-contact and broadband, Laser Based Ultrasonics techniques are very efficient to investigate mechanical vibrations. In our experiments, Lamb modes were generated by a Nd:YAG pulsed laser. An optical interferometer was used to measure the displacement normal to the plate surface at the same point on the non-coated face. Gold layers of a few hundred nanometers were detected through a 1.5-mm thick Duralumin plate. The shift of the 1.9-MHz resonance frequency of the fundamental ZGV mode is proportional to the layer thickness: typically 10 kHz per μm for a gold layer deposited on a Duralumin plate. Taking into account the influence of the temperature, a 240-nm gold layer was measured with a $\pm$4% uncertainty. This thickness has been verified by scanning the coated face with an optical profiling system.

Tue 14:20 François CANAC PU-S12: Ultrasound and lasers

Evaluation of sub-micrometer thick multilayered colloidal films by the method of resonant hypersound spectroscopy – (Contributed, 000412)

A. Ayouch[a], P. Ruello[a], V. Gusev[a], G. Vaudel[a], X. Dieudonnée[b], H. Piombini[b], P. Belleville[b] and K. Valle[b]
[a]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]CEA Le Ripault, BP 16 37260 Monts
Corresponding author E-mail: pascal.ruello@univ-lemans.fr

Resonant ultrasound spectroscopy, which consists in measuring the resonance frequencies of oscillations in ultrasonic frequency range, is a well-established technique for the evaluation of elastic properties of structures. The use of picosecond laser ultrasonics experimental technique for the generation and detection of acoustic vibrations, allows experimental evaluation of the resonance oscillations of sub-micrometer size structures, typically in the GHz, i.e. in hypersonic frequency domain. This communication exposes the results of an experimental evaluation of the elastic properties of sub-micrometer thick multilayered colloidal films. The individual layers of the films deposited on opaque substrate are disordered silica assemblies with well controlled nanoparticles surface chemistry. The nanoparticles diameter is 10nm. The colloidal films, composed of different number of layers, have all the same thickness of about H=400nm. Our experiments revealed the dependence of the resonance frequencies of the films on the number of identical individual layers composing the films. The experimental data are used to characterize the dependence of the elastic properties of the individual layers on their thickness and to estimate the quality of adhesion between the individual layers composing the films. These original results demonstrate the ability of picosecond acoustics methods to probe elasticity of soft colloidal films.

Tue 14:40 François CANAC PU-S12: Ultrasound and lasers

Flaws detection using laser-ultrasound and mode conversion – (Contributed, 000466)

F. Faese, F. Jenot, M. Ouaftouh and M. Duquennoy
IEMN-DOAE, Université de Valenciennes, Le Mont Houy, 59313 Valenciennes, France
Corresponding author E-mail: frederic.faese@univ-valenciennes.fr

Industries such as the aeronautic industry or iron and steel industry are increasingly interested in laser ultrasonics, which is a cutting-edge technique used in non-destructive testing and evaluation. Compared to conventional methods such as piezoelectric transducers or EMATs, the main advantages of laser ultrasonics are a large bandwidth, its non-contact aspects and the ability to control high temperature and/or geometrically complex materials. Ultrasonic waves generation in an aluminium sample by a pulsed Nd:YAG laser, their detection by interferometry and their interaction with a slot are presented. Considering experimental results and finite element method simulation, the advantages of using a thermoelastic line generation as well as temporal and frequency effects of the slot on the surface acoustic waves will be explained. Associated with wave-conversion phenomena, these results lead to an original flaw detection and characterization method.

The authors are grateful to the ANR for its contribution in ECO CND project through its support in the "production durable et technologies de l'environnement ECOTECHï program.

Tue 15:00 François CANAC PU-S12: Ultrasound and lasers

Evaluation of transverse elastic properties of fibers used in composite materials by laser resonant ultrasound spectroscopy – (Contributed, 000774)

D. Mounier[a], C. Poilâne[b], C. Bûcher[a] and P. Picart[a]
[a]Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans, France; [b]IUT d'Alençon - Université de Caen Basse-Normandie, Site Universitaire de Montfoulon, 61250 Damigny, France
Corresponding author E-mail: denis.mounier@univ-lemans.fr

We evaluate the elastic properties of glass, carbon, and flax fibers that are used to manufacture composite materials. The transverse elastic properties of fibers are more difficult to measure than the longitudinal properties. But the knowledge of the transverse properties is mandatory to predict correctly the mechanical behavior of a composite material. We apply the laser resonant ultrasound spectroscopy (RUS) technique to evaluate the transverse Young modulus and Poisson ratio of fibers. The mechanical vibrations of a cross section are generated by a pulsed subnanosecond laser beam focused and shaped on the fiber as a line parallel to the fiber. The vibrations are detected optically by the probe beam of an interferometer, focused at the zone of excitation. The measured eigenfrequencies range from 5 MHz for flax fibers to 500 MHz for carbon and glass fibers. Using finite element modeling, the eigenmodes of fibers are identified and the mechanical properties of the fiber materials are evaluated. The transverse elastic properties of carbon fibers are significantly different from the longitudinal properties. For flax fibers, the strong damping of modes which is observed could explain the strong damping of flax fiber reinforced polymers.

Tue 15:20 François CANAC PU-S12: Ultrasound and lasers

Experimental observation of acoustic streaming in cavitation bubble fields – (Contributed, 000392)

T. Nowak and R. Mettin
Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany
Corresponding author E-mail: r.mettin@physik3.gwdg.de

We use a special fluorescence microscope setup with simultaneously high speed recordings and particle tracking velocimetry to observe streaming in acoustic bubble fields. One point of interest is to correlate the streaming and bubble motion. It is well known that bubble motion can cause streaming and bubble translation and nucleation are impacted by streaming. By applying a static over pressure it is possible to prevent cavitation and observe the pure acoustic streaming. We show observations of different sound fields with different frequencies thus also different bubble structures. Partially the camera observations are compared with electrochemical measurements to see the streaming inside the boundary layer.

Tue 15:40 François CANAC PU-S12: Ultrasound and lasers

Peculiarities of acoustooptic interaction in media with strong acoustic anisotropy – (Contributed, 000085)

S. N. Mantsevich[a] and V. I. Balakshy[b]
[a]Space Research Institute, Profsoyuznaya str. 84/32, 117997 Moscow, Russian Federation; [b]M.V. Lomonosov Moscow State University, Vorobevy Gory 1, Physics Dept., 119991 Moscow, Russian Federation
Corresponding author E-mail: snmantsevich@yahoo.com

Actually optoelectronic devices based on the acoustooptic (AO) interaction are widely used to control the optical radiation. Usually treating the AO interaction acoustic beam is considered to be ideal, this means that magnitude of acoustic wave is equal in all points and wave fronts are plane. But it is impossible to realize such beams in practice. Fundamental reasons for appearance of inhomogeneous acoustic beam are diffraction effects produced by finite size of transducer. Acoustic anisotropy also influences on the structure of acoustic beam. Nowadays crystals with extra large anisotropy of elastic properties such as tellurium dioxide, calomel and others are used in acoustooptics and it is obvious that in the process of AO devices characteristics evaluation it is not possible to neglect media anisotropy in which acoustic waves are being aroused. In the presented work general solution of acoustic beam diffraction in the anisotropic media was obtained. Structure of acoustic field was caclulated for several directions in the paratellurite crystal. Influence of acoustic field structure on the efficiency of AO interaction and AO filter transfer functions was examined.

Tue 16:40 François CANAC PU-S12: Ultrasound and lasers

Photoacoustics to guide and monitor ultrasound therapy – (Contributed, 000720)

A. Prost, M. Pernot, J.-M. Chassot and E. Bossy
Institut Langevin - Ondes et Images, 10 rue Vauquelin, ESPCI ParisTech, 75231 Paris, France
Corresponding author E-mail: amaury.prost@espci.fr

Photoacoustic imaging has recently been proposed as a promising method to guide and/or monitor therapy based on high intensity focused ultrasound (HIFU). In this work, different steps of a photoacoustic-guided HIFU scenario will be presented. The initial step involves detecting selectively the photoacoustic signals from a targeted area, such as a tumor. To do so, functionalized gold nanoparticules are interesting contrast agents as their absorption spectrum presents a strong resonance, providing a way to discriminate GNR-generated photoacoustic signals from background signals. Once selectively detected, photoacoustic signals may be used to refocus HIFU towards the targeted area, based for instance on time-reversal approaches. As the optical properties of the targeted area change during therapy, photoacoustic imaging may also be used to monitor the therapy process. This work will present results obtained with a special dual-mode 128-element array, designed for both photoacoustic detection and HIFU emission with the same elements. Results on the detection of GNR-loaded cells in vitro and real-time photoacoustic-assisted HIFU will be presented.

Tue 17:00 François CANAC PU-S12: Ultrasound and lasers

Development of an acoustic-resolution photoacoustic microscope – (Contributed, 000658)

O. Simandoux, J.-M. Chassot, E. Fort and E. Bossy
Institut Langevin, ESPCI ParisTech, 10 rue Vauquelin, 75231 Paris, France
Corresponding author E-mail: olivier.simandoux@espci.fr

Photoacoustic imaging is a recent, rapidly growing imaging technique. It has the unique ability to provide images in soft tissues in the optically diffusive regime with both optical absorption contrast and ultrasound resolution. One of the photoacoustic imaging modalities is called acoustic-resolution photoacoustic microscopy. It is aiming at resolution from a few microns to 100 microns over depths up to a centimeter. In this work, a photoacoustic microscope using a mechanically scanned single element focused transducer is described. The following characteristics of our microscope are studied: image contrast, signal-to-noise ratio, resolution and acquisition time, and imaging depth. Images are made at different optical wavelength ranging from 532nm to the near-infrared of the therapeutic window. This set-up is intended to image tumor model on small animals.

Tue 17:20 François CANAC PU-S12: Ultrasound and lasers

Semi-analytical time-reversal imaging of a volume source in solids – (Contributed, 000178)

S. Raetz, T. Dehoux and B. Audoin
I2M-Bordeaux, Acoustic Physical Dep., 351 cours de la Libération, 33405 Talence, France
Corresponding author E-mail: bertrand.audoin@u-bordeaux1.fr

Based on the ability of acoustic waves to relive their past life, the time-reversal principle is of great interest for acoustic imaging. Many applications deal with focusing in soft materials. However, few applications concern solids because compressional- and shear-wave velocities are of the same order of magnitude, leading to mode conversion at interfaces. Moreover, only surface sources have been considered in solids. The purpose of this work is therefore twofold: imaging a *volume* acoustic source in a *solid*.
The volume source is obtained by focusing a laser beam to a line with finite lateral dimension on the surface of a plate. The laser beam penetrates over a depth depending on the optical properties of the material. The normal displacements caused by acoustic waves generated by this volume source are measured at a surface of the plate. To analyze the optimal experimental configuration, normal displacements representing accurately the typical laser-ultrasonics data are computed. The time-reversal process, i.e., the playback of these normal displacements that leads to the reconstruction of the volume source, is experimentally complicated in laser-ultrasonics. A semi-analytical modeling is thus developed. Simultaneous imaging of the lateral dimension and penetration of the source is obtained and limitations are discussed.

Tue 17:40 François CANAC PU-S12: Ultrasound and lasers

Generation and detection of sinusoidal ultrasonic waves in the GHz-THz frequency range – (Contributed, 000777)

D. Mounier[a], T. Nowak[a], J.-M. Breteau[a], G. Vaudel[b], T. Pezeril[b], P. Picart[a], P. Ruello[b] and V. Gusev[b]
[a]Université du Maine, Avenue Olivier Messiaen, 72085 Le Mans, France; [b]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: denis.mounier@univ-lemans.fr

Through a sinusoidal thermo-modulation of a thin metallic film deposited on a substrate, monochromatic acoustic waves can be generated in the substrate (Damen, PRL 1995). Two interfering tunable lasers are used to induce a thermo-modulation at a frequency equal to the lasers beating frequency. Thus, the generated ultrasonic waves can be continuously tuned from 0 Hz up to the THz range by tuning the optical frequency of each pump laser. For the detection of the sinusoidal acoustic waves, an additional CW laser is used as a probe, which interacts with the laser-generated acoustic beam. The detection of the weak perturbation of the probe beam intensity induced by the acoustic beam requires a particular modulation of the pump lasers. We describe the experiments, which demonstrate that the detection of sinusoidal acoustic waves at frequencies in the GHz-THz range is possible. With a precise control of the optical frequency of both pump lasers, it becomes feasible to generate monochromatic acoustic waves with a very narrow line-width, typically less than one MHz. Ultrasound spectroscopy with high resolution is achievable using such monochromatic acoustic waves. This technique would be beneficial for the study of nano-resonators with very high-quality factors, such as nano-membranes and nano-rods.

Tue 18:00 François CANAC PU-S12: Ultrasound and lasers

Heterodyne ultrafast pump-probe experiments, towards acoustic imaging with 1 GHz to 100 GHz spectral range – (Contributed, 000714)

A. Abbas[a], Y. Guillet[b], B. Audoin[b], J.-M. Rampnoux[c], S. Dilhaire[c], J. Carlier[d], P. Rigail[d] and E. Mottay[d]
[a]I2M/LOMA/Amplitude systèmes, 351 cours de la Libération, 33405 Talence, France; [b]I2M-Bordeaux, Acoustic Physical Dep., 351 cours de la Libération, 33405 Talence, France; [c]LOMA, Photonic Dep., 351 cours de la libération, 33405 Talence, France; [d]Amplitude systèmes, 11, avenue de Canteranne, Cité de la Photonique, 33600 Pessac, France
Corresponding author E-mail: allaoua.abbas@etu.u-bordeaux1.fr

Usual femtosecond pump-probe experiments allow the generation and the detection of acoustic waves in the GHz-THz frequency range for investigation of matter properties at sub-micron scales. The main drawback of these experiments is their acquisition speed limitation due to the use of mechanical delay line. We present a pump-probe heterodyne setup which uses two mode-locked lasers (400 fs FHMW pulses at nearly 50 MHz repetition rate). A controlled frequency shift (100 Hz to 1 KHz) of their repetition rates synthesized by a Phase Locked Loop permits to generate the pump-probe delay and to discard the setup of any mechanical translation stage. An accurate control of the beating frequency is needed to achieve the temporal resolution required to detect high acoustic frequencies. Any fluctuation of this beating frequency induces an uncertainty on the pump-probe delay (jitter) and reduces the system bandwidth. We will expose the metrological method allowing the measurement of this jitter, which turns out to be smaller than 500 fs. This jitter value should permit the detection of waves over a large band spectrum, from few GHz to several hundreds of GHz with a 50 MHz spectral resolution. Experimental pump-probe measurements on different physical systems will highlight this feature.

Tue 18:20 François CANAC PU-S12: Ultrasound and lasers

Versatile ultrafast pump-probe imaging with high sensitivity CCD camera – (Contributed, 000771)

T. Pezeril[a], C. Klieber[a], V. Temnov[a], J.-R. Huntzinger[b] and A. Anane[c]
[a]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Groupe d'étude des semiconducteurs, RPE - N.21 - CC074 Place Eugène Bataillon 34095 Montpellier Cedex 5; [c]Unité mixte de physique CNRS/Thalès, Domaine de Corbeville 91404 Orsay Cedex
Corresponding author E-mail: thomas.pezeril@univ-lemans.fr

A powerful imaging technique based on femtosecond time-resolved measurements with a high dynamic range, commercial CCD camera is presented. Ultrafast phenomena induced by a femtosecond laser pump are visualized through the lock-in type acquisition of images recorded by a femtosecond laser probe. This technique allows time-resolved measurements of laser excited phenomena at multiple probe wavelengths (spectrometer mode) or conventional imaging of the sample surface (imaging mode). Two examples based on time-resolved imaging of the sample surface are presented. First, we follow the non-linear reshaping of an acoustic strain pulse in a hybrid gold/cobalt layer at ambient temperature in a sequence of images. Second, we examine time-resolved images of transient thermal heating in graphene samples where we observe heat dissipation as fast as one picosecond which neither depends on the number of layers nor the shape of the graphene sample. A wealth of adaptations of the presented technique can be considered such as imaging of ultrasonic echoes in biological samples (ultrasonic microscopy with resolution down to tens of nanometer).

Tue 18:40 François CANAC PU-S12: Ultrasound and lasers

Ultrasonic signal synthesis for acousto-optical white light filtering with arbitrary spectral transmission function – (Contributed, 000534)

K. Yushkov, V. Molchanov and S. Chizhikov
MISIS, Leninsky prospect 4, 119049 Moscow, Russian Federation
Corresponding author E-mail: v.ya.molchanov@gmail.com

Acousto-optical filtering of broadband light is based on Bragg phase matching between light and single-frequency ultrasound in crystals with strong anisotropy of acoustic and optical properties. Conventionally, acousto-optical method provides easy tuning of transmitted optical wavelength, but the shape of transmission function can not be adaptively adjusted. We developed a novel algorithm for feeding acousto-optic tunable filters that provides possibility for arbitrary transformation of transmission function. The method is based on linear frequency modulation of permittivity tensor of the crystal by ultrasound. Precise shaping of transmission function was obtained with the help of amplitude modulation and nonlinear phase modulation.

Quasicollinear filter on the base of paratellurite crystal was designed and fabricated for experimental verification of the algorithm. The device was operating with 80 % diffraction efficiency for radiation with the bandwidth of 150 nm centered at 800 nm, and spectral resolution was higher than 10 cm^{-1}. Experiments with broadband femtosecond laser oscillator demonstrated variable band-pass and notch filtering as well as multi-window transmission function.

Tue 14:00 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

How to use disorder for guiding a broadband acoustic wave ? – (Contributed, 000508)

A. Bretagne and A. Tourin
Institut Langevin ESPCI ParisTech - CNRS UMR 7587 - INSERM U979, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: alice.bretagne@espci.fr

In 1989, the concept of transverse localization was introduced as a new form of localization of light in the sense of Anderson [H. De Raedt et al. Phys. Rev. Lett., vol. 62, no. 1, pp. 47-50, 1989.]. Recently T. Schwartz et al. [Nature, vol. 446, p. 52, 2007] reported the first experimental demonstration of this prediction. To do so, they studied the propagation of light in 2 dimensional disordered photonic lattices, and proved that light was indeed exponentially localized in the transverse plane. Here, we present an equivalent scheme to guide MHz-ultrasonic broadband waves. We explore propagation of MHz-ultrasound in a medium which is either ordered or disordered in the two transverse dimensions (x,y) but invariant in the propagation direction (z). Our samples are made of parallel arrangements of cylindrical scatterers (0.8mm in diameter) embedded in a soft elastic matrix. In the disordered case, the probe beam is laterally confined with an exponential transverse intensity profile, which gives the first demon-

stration of the transverse localization of acoustic waves. Moreover we prove that the typical dispersion experienced by the pulsed waves in the ordered sample is almost cancelled in the Anderson localized one, hence resulting in a spatio- temporally guided wave.

Tue 14:20 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Propagation of guided waves in a non-uniform acoustic waveguide – (Invited, 000308)

J.F. Mercier[a] and A. A. Maurel[b]
[a]POEMS-CNRS/ENSTA/INRIA, 32 Boulevard Victor, 75015 Paris, France; [b]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France
Corresponding author E-mail: jean-francois.mercier@ensta-paristech.fr

We study the time harmonic propagation of acoustic waves in a waveguide with varying cross section. This is done using a multimodal approach. The modal components are expressed thanks to an integral representation (Lipmann Schwinger representation) that is used to iterate the Born approximation. We compare the classical approach in which the infinite sum of modes is truncated in the practice to a new formalism in which the sum of modes is finite and an extra mode is artificially added. This method has been shown to ensure a better convergence because the additional mode allows a better approximation of the boundary condition at the walls. Numerical calculations are proposed and compared to direct finite element simulations to validate the iterated Born approximation. Analytical solutions are proposed in the first Born approximation and compared to classical results for the low frequency regime.

Tue 14:40 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Propagation of guided waves through weak penetrable scatterers – (Invited, 000039)

A. A. Maurel[a] and J.F. Mercier[b]
[a]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France; [b]POEMS-CNRS/ENSTA/INRIA, 32 Boulevard Victor, 75015 Paris, France
Corresponding author E-mail: agnes.maurel@espci.fr

The scattering of a scalar wave propagating in a waveguide containing weak penetrable scatterers is inspected in the Born approximation. The scatterers are of arbitrary shape and present a contrast both in density and in celerity (or bulk modulus), a situation that can be translated in the context of SH waves, water waves or TE/TM polarized electromagnetic waves. For small size of inclusions compared to the waveguide height, analytical expressions of the transmission and reflexion coefficients are derived, and compared to result of direct numerical simulations. The cases of periodically and randomly distributed inclusions are considered in more details, and compared with unbounded propagation through inclusions. Comparisons with previous results valid in the low frequency regime are proposed.

Tue 15:00 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Hyperelastic cloaking theory: Transformation elasticity with prestressed solids – (Invited, 000418)

W. J. Parnell[a] and A. N. Norris[b]
[a]University of Manchester, Oxford Road, M13 9PL Manchester, UK; [b]Rutgers University, Mechanical and Aerospace Engineering, Piscataway, NJ 08854, USA
Corresponding author E-mail: william.parnell@manchester.ac.uk

Interest in cloaking theory (rendering objects near-invisible to incident waves) and its practical realization has grown significantly since the early theoretical work in 2006 of Leonhardt and the Pendry group in optics and electromagnetism respectively. Methods have largely been based on the idea of coordinate transformations, which motivate the design of cloaking metamaterials. These materials are able to guide waves around a specific region of space. Research has subsequently focused on the possibility of cloaking in the contexts of acoustics, surface waves in fluids, heat transfer, fluid flow and linear elastodynamics.

It was shown by Milton and co-workers that elastodynamic cloaking is made difficult due to the lack of invariance of Navier's equations under general coordinate transformations. Restricted mappings do preserve the form of equations but the transformed elastic modulus tensor does not possess the minor symmetries.

We shall show that it is theoretically possible to construct elastodynamic cloaks by pre-stressing hyperelastic

solids. We discuss an initial simple case (antiplane waves) [Parnell, W.J. "Nonlinear pre-stress for cloaking from antiplane elastic waves", Proc Roy Soc A, online version: doi: 10.1098/rspa.2011.0477] and describe various generalizations including finite antiplane cloaks and more general elastodynamic problems.

Tue 15:20 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Efficient acoustic filtering for oilfield technology – (Contributed, 000419)

T. Kinoshita and N. Sakiyama
Schlumberger K.K., 2-2-1 Fuchinobe, Chuo, 252-0206 Sagamihara, Japan
Corresponding author E-mail: tkinoshita@slb.com

Logging while drilling (LWD) acoustic measurement provides timely analysis for borehole stability and drilling optimization in the oilfield. An LWD acoustic tool is composed of a drill collar (thick steel pipe) equipped with an acoustic source and receivers to probe rocks surrounding the borehole. The drill collar area is favorable for tool wave propagation from the transmitter to the receiver section of the tool. Minimizing such arrival is critical to avoid unwanted interference with formation signal. In order to decrease such interferences, multiple grooves of different sizes are machined inside the drill collar. Nonhomogeneity of the structure constructs a solid filter similar to a solid rod loaded with heavy masses. The stop-band and attenuation of the tool propagation largely depend on the distribution and size of the grooves machined into the collar. Their characteristics as an acoustic filter are also subject to properties of borehole fluid, where the drill collar is immersed. Therefore, the groove pattern has to be designed by modeling with consideration to many factors within given constraints. A method to optimize the groove pattern for given acoustic characteristics is discussed in this paper. The application to real data will illustrate the effectiveness of this methodology.

Tue 15:40 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Modelling the emergence of the coherent field for cavities in a solid matrix – (Invited, 000190)

V. J. Pinfield and R. E. Challis
University of Nottingham, Electrical Systems and Optics Division, Faculty of Engineering, Tower Building, University Park, Nottingham, NG7 2RD Nottingham, UK
Corresponding author E-mail: valerie.pinfield@nottingham.ac.uk

What is the acoustic field reflected from a region of spherical cavities distributed in a solid medium? The question has application in the field of non-destructive testing of composite materials, in which porosity is present. Whilst the most common solution would be to model the coherent field, is this necessarily a valid description for a finite region with a particular fixed set of cavity locations? The coherent field emerges only after taking an ensemble average over all possible scatterer locations. A semi-analytical model of the scattered field from a region of spherical scatterers was used to determine the conditions under which the coherent field is representative of that reflected by a single realisation of scatterer locations. A set of simulations was carried out for single realisations of randomly-generated cavity positions, using a far-field scattering amplitude in the long-wavelength limit to define the scattered field arriving at a receiving device. Comparison with the corresponding coherent field, representing the ensemble-average result, shows the conditions in which the coherent field can be applied to the field reflected from such materials.

Tue 16:40 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Ultrasonic wave propagation in heterogeneous media – (Invited, 000403)

L. Cunningham[a], A. J. Mulholland[a], G. Harvey[b] and C. Bird[c]
[a]University of Strathclyde, Department of Mathematics and Statistics, 26 Richmond Street, G1 1XH Glasgow, UK; [b]PZFlex Europe, 50 Richmond Street, G1 1XP Glasgow, UK; [c]Doosan Babcock, T&E Building, Porterfield Rd, PA4 8DJ Renfrew, UK
Corresponding author E-mail: anthony.mulholland@strath.ac.uk

The non-destructive testing of austenitic steel welds using ultrasound is of vital importance for assessing safety critical structures such as those found in the nuclear industry. The internal geometry of these welds is heterogeneous and highly scattering and this makes it difficult to detect and characterise any defects within them. To help reduce these scattering effects and improve defect imaging Full Matrix Capture is being applied to ultrasonic transducer arrays. There is a need therefore to develop post-processing algorithms that best utilise the data from such devices. This paper considers the use of a time-frequency domain method known as the Decomposition of the Time Reversal Operator (DORT) method. To develop this method and to demonstrate its efficacy in tackling this problem a series of simulated data sets are used. The simulated data is generated using a finite element method (PZFLEX) with the heterogeneous internal microstructure of the weld being given by previous Electron Backscatter Diffraction measurements. A range of artificial flaws are then inserted into this geometry. By varying the flaw size and type, a comparison is conducted between the DORT method and the Total Focusing Method (TFM) and their relative ability to perform flaw detection assessed.

Tue 17:00 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Discussion on various model of multiple scattering in acoustics and elastic heterogeneous media – (Invited, 000163)

L. Le Marrec and G. Futhazar
IRMAR - Université Rennes 1, Campus Beaulieu, 35042 Rennes, France
Corresponding author E-mail: loic.lemarrec@univ-rennes1.fr

The propagation of acoustic or elastic wave through an heterogeneous domain is investigated in 2D. For heterogeneous medium composed of discrete scattered embedded in a homogeneous matrix, effective medium theories consists in modeling the coherent part of the wave obtained form equivalent propagation along various distribution of scatterer. The main objective is to determine attenuation and dispersion of the wave. In the case of half-space or slab, transmission and reflection coefficient can be obtained. Here various model are presented and compared in the classical case: half-space heterogeneous domain probed by incident plane wave. A synthetic formalism is the occasion to generalized this problem to any bounded domain. It is the occasion to highlight some particular features of this full 2D-problem (where translational invariance along one direction is broken). In particular a new synthetic formulation of the QCA is proposed. Asymptotic calculation will be presented for low-frequency regime or dilute media.

Tue 17:20 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Studies of acoustic wave propagation in water-filled piping: wall thickness effect – (Contributed, 000103)

A. Mokhtari and V. Chatoorgoon
University of Manitoba, Room E2-327 Engineering Information and Technology Complex, 75A Chancellors Circle, University of Manitoba, Winnipeg, Canada R3T 5V6
Corresponding author E-mail: chatoorg@cc.umanitoba.ca

The effect of acoustic wave propagation in primary heat transport systems is the subject of study in this paper.Thus, the behavior of acoustic wave propagation in piping systems filled with water is examined here through fundamental experiments and analysis. A simple experimental acoustic wave propagation facility has been built at the University of Manitoba and initial experiments show conclusively that analytical methods do not predict well the acoustic amplitude and frequency above 100 Hz. The reasons, unknown at this time, must be sought through fundamental simple experiments on the various parameters that affect acoustic wave propagation. Thus, fundamental experiments on parametric effects have commenced at the University of Manitoba with the built facility. This paper presents the findings and discusses the effect of pipe wall thickness in an attempt to determine if thicker walls improve the agreement between experiment and theory above 100 Hz.

Tue 17:40 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Using the MFS for the analysis of the sound absorption by a porous plate containing a periodic array of inclusions – (Contributed, 000756)

E. Perrey-Debain[a] and B. Nennig[b]
[a]Laboratoire Roberval, Rue Personne de Roberval, BP 20529 F-60205 Compiègne Cedex; [b]Laboratoire d'Ingénierie des Systèmes Mécaniques et des MAtériaux, Supméca - 3, rue Fernand Hainaut - 93407 St Ouen Cedex
Corresponding author E-mail: emmanuel.perrey-debain@utc.fr

The Method of Fundamental Solutions (MFS) is now a well-established technique that has proved to be reliable for a specific range of wave problems such as the scattering of acoustic and elastic waves by scatterers of regular shapes or by gratings. The aim of this work is to show that the technique can be used to model absorption problems whereby an incident acoustic wave impinges on a porous plate of finite thickness in which periodic inclusions are embedded. The inclusions may be of different type such as rigid scatterers of various shape or cavities filled with air or with another porous material. The extension of the MFS to periodic problems is obtained by using appropriate periodic Green's functions for which highly convergent series exist. The influence of the inclusions is illustrated on various examples in order to enhance the absorption properties in the low frequency range or around specific frequency ranges.

Tue 18:00 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Coherent phonons scattering by interstitial impurities in a quantum wire – (Contributed, 000022)

M.-S. Rabia
Université Mouloud Mammeri, Laboratoire de Mécanique des Structures et, Energétique, 15000 Tizi-Ouzou, Algeria
Corresponding author E-mail: m2msr@yahoo.fr

We investigate, in the harmonic approximation framework, the influence of interstitial defect on the scattering properties of elastic waves in quantum wire. The model is composed of two infinite atomic chains, assimilated to a perfect crystallographic waveguide, containing interstitial impurities. The problem is treated numerically using the matching method based on the Landauer-Büttiker principle. Considering the scattering boundary conditions as well as the conditions of symmetry, we study first the reticular dynamics of the perfect lattice witch consists, essentially, to determine the vibrating eigenmodes (propagating and evanescent modes) and their corresponding polarizations. The defect region, incorporated later in the waveguide, allows one to establish the mathematical formalism necessary to the diffusion. Numerical results show that the presence of defect in a quantum wire modifies particularly its mechanical and vibrational properties by the creation of new localized states and by bulk and surface phonons scattering. Its influence results in a general decrease of the transmission probability amplitude accentuated by Fabry-Pérot oscillations (interferences between reflected waves in the perturbed region) and/or Fano-like resonances (coherent coupling between propagating modes and localized-defect states). The transmission spectra, obtained by scattering experiments, can thus be regarded as fingerprints of the specific defect structure.

Tue 18:20 Yves ROCARD MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Finite size effect for the effective propagation in a periodic structure with disorder – (Invited, 000587)

V. Pagneux[a], A. A. Maurel[b] and P. P. Martin[c]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France; [c]Dpt App. Maths & Stat., Colorado School of Mines, Golden, CO 80401-1887, USA
Corresponding author E-mail: vincent.pagneux@univ-lemans.fr

Propagation in periodic media are known to display specific properties such as forbidden bad gap for instance. When disorder is introduced in the periodic medium, these properties are modified and it is instructive to obtain the effective medium that characterize how is the medium response in average. In this work, we are interested by finite size effects and we consider the effective medium theory of a finite slab of periodic medium perturbed by weak disorder. By applying the Dyson formalism for the Green function, it is shown that the effective potential is inhomogeneous in space and depends on the size of the slab. It is an instance of the importance of size effect for finite slab concerning the averaged response or the averaged scattering. A comparison of the results obtained with this inhomogeneous effective potential and the results obtained by CPA method will be presented.

Tue 16:40 Philip DOAK EN-S08: Engineering models for noise mapping

Comparison of engineering models of outdoor sound propagation: NMPB2008 and Harmonoise-Imagine – (Contributed, 000604)

D. Ecotiere, C. Foy and G. Dutilleux
Laboratoire Régional des Ponts et Chaussées de Strasbourg, 11 rue Jean Mentelin, 67035 Strasbourg, France
Corresponding author E-mail: david.ecotiere@developpement-durable.gouv.fr

Different models of outdoor sound propagation can be used to predict transportation and industry noise for noise mapping or environmental impact assessment. We present here a comparison of noise attenuations predicted by a) the French engineering model NMPB 2008, designed for railway, road or industrial noise, b) the engineering model elaborated in the European Harmonoise/Imagine projects. The comparison has first been done by comparing the deviations between models for calculated sound attenuation for both homogeneous and downward propagation situations and for 7 experimental site configurations. Some significant deviations can be observed mainly for high frequencies and also for homogeneous propagation conditions. A comparison between calculated and experimental sound attenuations is also presented for each method, on the basis of 5 road noise experimental campaigns, where each site is representative of different common topographies. Some statistically significant deviations between both mean and standard deviation are observed between the two models. In light of these road traffic noise cases, the NMPB 2008 model appears to have a better accuracy and a better precision than the Harmonoise/Imagine model have.

Tue 17:00 Philip DOAK EN-S08: Engineering models for noise mapping

A simple approach for making noise maps within a GIS software – (Contributed, 000366)

N. Fortin[a], J. Picaut[a], E. Bocher[b], G. Petit[b], A. Guéganno[b] and G. Dutilleux[c]
[a]Département Infrastructures et Mobilité (IFSTTAR/IM), Route de Bouaye, CS4, 44344 Bouguenais Cedex; [b]Institut de recherche en sciences et en technologies de la ville, IRSTV - FR CNRS 2488 Rue Massenet - 81931 44319 Nantes Cedex 3; [c]Laboratoire Régional de Strasbourg, 11, rue Jean Mentelin, 67035 Strasbourg Cedex 2, France
Corresponding author E-mail: erwan.bocher@ec-nantes.fr

This study is a part of a pluridisciplinary project on the assessment of the environmental impacts of an urban mobility plan and their socio-economic consequences. One of the main objectives is to be able to build and to compare noise maps of large cities, related to various mobility plan parameters. Considering the computational time that is required for making classical noise maps a simplified approach of the French standard NMPB2008 method of sound propagation in urban areas has been proposed. A striking feature of the proposed approach is that the model is implemented within a two-dimensional geographic information system software (OrbisGIS). Incidentally a specific attention has been paid to the optimization of algorithms in order to reduce computational times and memory footprint. The method is then able to produce noise maps in few hours on a personal computer, for very large domains, around several millions of squared meters. A validation is presented by comparing noise maps produced by the proposed approach with ”regularï noise maps of Nantes Métropole using the French standard method. Lastly, several mobility plans have been compared by considering their impacts on the spreading of noise in the urban environment.

Tue 17:20 Philip DOAK EN-S08: Engineering models for noise mapping

Sound speed profiles linearisation for engineering methods – (Contributed, 000539)

F. Junker
EDF R&D, 1 Avenue du Général de Gaulle, 92141 Clamart Cedex, France
Corresponding author E-mail: fabrice.junker@edf.fr

Due to the large distances and the numerous sources to be considered, environmental noise impact is calculated using engineering methods. These methods are based on path finding approaches. Many studies have shown that the influence of meteorological effects has to be taken into account to get realistic results. This can be achieved by curving the ray paths or by using the curved ground analogy considering a linear variation of the sound speed along the height. As the real sound speed profiles are well defined by a combination of linear and logarithmic functions of the height, a suitable linearisation approach has to be done. This is the scope of this paper. It is based on the comparison of two sets of results from Parabolic Equation calculations. A first set of calculations is done using realistic linear/logarithmic profiles. A second set is done using linear profiles. A comparison between the two sets shows that the linearisation approach must consider not only the geometric parameters (source and receiver heights, propagation distance) but also the absorption of the ground.

Tue 17:40 Philip DOAK EN-S08: Engineering models for noise mapping

Optimized 3D ray tracing algorithm for environmental acoustic studies – (Contributed, 000533)

M. Dreher[a], G. Dutilleux[b] and F. Junker[c]
[a]INRIA Rhône-Alpes, ZIRST 655 Avenue de l'Europe Montbonnot 38334 Saint Ismier cedex; [b]Laboratoire Régional de Strasbourg,

11, rue Jean Mentelin, 67035 Strasbourg Cedex 2, France; [c]EDF R&D, 1 Avenue du Général de Gaulle, 92141 Clamart Cedex, France
Corresponding author E-mail: dreher.matthieu@gmail.com

Ray tracing is a well known algorithm for the generation of realistic synthesis images. It is also applied in the acoustic domain. The computational cost of the full 3D algorithm was previously an obstacle leading to approximations like the 2D 1/2 ray tracing. Despite the fact that this method significantly reduces the needed computations, it also limits the realism of the approach. This article proposes a study of the 3D ray tracing algorithm in the acoustic context. It presents several methods which can be used to reduce the computation time using different acceleration structures. Design decisions and optimisations made on the general ray tracing engine are explained. Then the choice of the acceleration structure and the propagation methods to use is clarified. The implantation was tested in the TYMPAN environment provided by EDF R&D using the NMPB08 method. To conclude, different results and takeaways are discussed.

Tue 18:00 Philip DOAK EN-S08: Engineering models for noise mapping

A general approach for extending the range of application of standard noise mapping methods – (Contributed, 000566)

D. Van Maercke, T. Leissing and P. Jean
CSTB, 24, rue Joseph Fourier, 38400 Saint Martin D'Hères, France
Corresponding author E-mail: dirk.van-maercke@cstb.fr

Standard noise mapping software implements standard prediction methods. Such methods are often unable to predict the effects of complex or innovative noise reduction measures, and therefore unsuitable for local planning and impact studies. On the other hand, advanced prediction schemes are considered too slow for practical use in noise mapping. In this paper we will present a new approach combining standard engineering noise prediction schemes with user-defined extensions. Extensions are used to predict level differences and/or additional insertion losses for the complex devices as compared to standard devices supported by the standards. The insertion losses can be estimated from experimental data, from analytical considerations or by means of numerical simulations. This approach can be used to implement such features as: barriers with cantilever, trenches with partial covering, interaction between train body and nearby barriers, reflections from complex walls, diffraction by screen tops, low barriers near traffic lanes, belts of trees with specific planting schemes, ground roughness elementsoe Extensions are implemented as independent software modules and therefore do not interfere with the standard methods. Disabling extensions allows calculation of noise maps according to legal requirements, enabling extensions allows assessment of noise levels at the local level, including the effects of innovative mitigations.

Tue 18:20 Philip DOAK EN-S08: Engineering models for noise mapping

Exploring the use of mobile sensors for noise and black carbon measurements in an urban environment – (Contributed, 000560)

A. Can, T. Van Renterghem and D. Botteldooren
Ghent University / IFSTTAR, Acoustics Group, Department of Information Technology, St. Pietersnieuwstraat 41, 9000 Gent, Belgium
Corresponding author E-mail: arnaud.can@ifsttar.fr

Mobile sensors can be interesting in the context of monitoring of noise levels and airborne pollutant concentrations, to obtain measurements over a large zone with one single sensor, and to increase the spatial accuracy of predictions, while avoiding some expensive modelling. Mobile sensors can be combined to classical fixed station, to improve the accuracy and the reliability of predictions. The purpose of this paper is to explore how mobile measurements should be processed to obtain reliable estimations in spite of the strong variability of the data collected. Mobile measurements have been collected on a bicycle equipped with a global positioning system (GPS), in an area of Gent (Belgium). The 1s-sound pressure levels and 1s-black carbon concentrations evolutions were measured. In addition, 5 continuous monitoring fixed stations were placed at building facades. Different processing methods are compared, based on different temporal and spatial weighting aggregations. The possibility to take profit of the fixed stations to refine estimations is tested, according to the noise levels collected at fixed stations and the distance between mobile and fixed sensors. Finally, the operational conditions required to obtain reliable estimations based on mobile measures are discussed.

Tue 16:40 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

Experimental time reversal of water waves – (Contributed, 000569)

A. Przadka[a], S. Feat[a], P. Petitjeans[a], V. Pagneux[b], A. A. Maurel[c] and M. Fink[c]
[a]PMMH/ESPCI, 10 rue Vauquelin, 75005 Paris, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France
Corresponding author E-mail: adam.przadka@espci.fr

The phenomenon of the time reversal refocusing of gravity-capillary waves in water tank cavity has been studied experimentally. The injection of a short pulse imposed by the wave generator leads (after several reflections from the boundaries of the tank/obstacles) to the appearance of the complex pattern. By re-injection of the time-reversed signals in the corresponding measurement positions, the temporal and spatial refocalisation can be observed in the initial source point. Owing to the reverberating effect of the cavity, only few channels are sufficient to reconstruct the surface wave at the point source, even if the absorption is not negligible. Space-time resolved measurements of the waves during the refocusing allow to quantitatively demonstrate that the quality of the refocusing increases linearly with the number of re-emitting channels. Numerical simulations corresponding to water waves at larger scales, with negligible damping, indicate the possibility of very high quality refocusing.

The wave elevation was measured with good accuracy in time and in space using an optical method (Fourier Transform Profilometry) based on the analysis of the deformation of projected fringes, recently adapted by our group for water waves characterization.

Tue 17:00 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

Sonic Time Reversal Imaging optimization in reverberating, confined or noisy environments – (Contributed, 000609)

E. Bavu, M. Melon, C. Auzou, S. Lobreau, C. Langrenne and A. Garcia
Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03
Corresponding author E-mail: eric.bavu@cnam.fr

Time reversal (TR) is a powerful method for the imaging and localization of sound sources. Classical TR is based on the recording of the pressure field on a time reversal mirror (TRM), followed by a numerical backpropagation of the time-reversed signals in a simulated propagation environment. To achieve accurate imaging, Green functions (GF) describing the environment must be well-known. When dealing with reverberating environments, precise numerical backpropagation is a rather complicated problem to solve.
In order to avoid this situation, we propose a field separation method (FSM) in order to recover data that would be measured on the TRM in free-space, corresponding to the well-known free-field GF. This method consists in measuring the acoustic pressure on a double-layer hemispherical TRM. Outgoing waves are separated from ingoing waves by using spherical-harmonic expansions. The outgoing contribution is then time-reversed and numerically backpropagated using the free-field GF, allowing to achieve accurate imaging. This FSM also allows to separate contributions from sources outside the region of interest. This new method is illustrated by simulations and measurements in a car-trunk mockup and in a reverberating room. Imaging resolution will be discussed using several TR schemes, taking advantage of the double layer p-p measurements.

Tue 17:20 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

Optimal Spatiotemporal Focusing Through Multiple Scattering Media – (Contributed, 000513)

J. Aulbach[a], A. Bretagne[b], M. Tanter[b], M. Fink[b] and A. Tourin[b]
[a]FOM Institute AMOLF, Science Park 104, 1098 XG Amsterdam, Netherlands; [b]Institut Langevin ESPCI ParisTech - CNRS UMR 7587 - INSERM U979, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: arnaud.tourin@espci.fr

In the context of echographic imaging, focusing of ultrasound in the human body can be achieved with a transducer array and electronic delay lines. However, that principle is not practicable any more as soon as the thickness of the medium of interest exceeds the mean free path. In such multiple scattering media, it was shown that spatiotemporal focusing can be achieved using time-reversal: a training pulse is sent from a source located at the intended focal point, travels through the scattering medium and is captured at a transducer array, the time reversal mirror (TRM). The waveforms received on the TRM are flipped in time and sent back, resulting in a wave converging at the desired focus location. Time reversal focusing is optimal in the sense that it achieves a spatiotemporal matched filter. Here we propose an approach for optimal focusing that does not require a direct measurement of the impulse response between the transducer array and the intended focal point. The key idea is to use a nonlinear feedback intensity signal to shape the incident pulsed wave front. We show that the limit of a true spatiotemporal matched filter can be achieved contrary to analogous methods recently proposed in optics.

Tue 17:40 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

One channel spatio-temporal inversion of acoustic wave in reverberant cavities – (Contributed, 000841)

S. Catheline, M. Rupin and P. Roux
Institut des Sciences de la Terre, ISTerre BP 53, 38041 Grenoble Cedex 9, France
Corresponding author E-mail: stefan.catheline@obs.ujf-grenoble.fr

It has been recently shown that it was possible to optimally recover the Green functions from a complex wave field despite of a non-isotropic distribution of noise sources. The method used is based on a particular use of the inverse filter (IF) formalism which is called the passive IF. Based on this formalism, we have investigated the possibility to control the spatio-temporal degrees of freedom in a reverberant cavity for the focusing of waves (active processes). The understanding of this phenomenon can be very useful in a lot of different applications like in acoustical imaging, seismology, or telecommunications. In the present work, the spatio-temporal focalization of ultrasounds in reverberant cavities is studied using medical arrays and water tanks. Through experiments, a complete spatio-temporal inversion is realized to synthesize optimized emitting signals. The result generalizes the focalization control over a spatial vector and during an arbitrary time window.

Tue 18:00 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

MIMO feedback and application to detection – (Contributed, 000492)

J. De Rosny and M. Carron
Institut Langevin "ondes et images", 10 Rue Vauquelin 75231 Paris Cedex 05
Corresponding author E-mail: julien.derosny@espci.fr

The feedback effect is well known but unwanted, by sound engineers. It results from a feedback loop between a microphone and a loudspeaker. Recently, it has been shown that we can take benefit of this effect to estimate with a very good accuracy some parameters such as sound speed. More recently, some experimental results has shown the effect of a local perturbation on the top of an ultrasonic wavewguide. Here we generalize the concept to MIMO (Multiple Input Multiple Output) system where the feedback effect occurs between an array of emitters and an array of receivers. We propose to model the MIMO feedback effect by introducing a feedback matrix. Thanks to the singular decomposition of this matrix times the transfert matrix, we are able to predict the spatial dependence of the feedback effect either on the emitting array and on the receiving array. In a second part, we present experimental results that are obtained with an array of about 10 microphones and an array of about 10 loudspeakers. Several feedback matrices have been tested. One of them is inspired from time reversal. We have applied this technique to detect a person who goes across this acoustic barrier.

Tue 18:20 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

Spatial resolution of time-reversal mirrors in two-dimensional and three-dimensional free space environments – (Contributed, 000544)

I. Rakotoarisoa, D. Marx, C. Prax and V. Valeau
Institut Pprime - D2 - Branche FTC, Université de Poitiers-ENSMA-CNRS, 6, rue Marcel Doré, 86022 Poitiers, France
Corresponding author E-mail: christian.prax@univ-poitiers.fr

Time-reversal can be used to locate unknown acoustics sources in a medium at rest or in a flow. This method is based on the time-reversal invariance of the wave propagation equation. A series of time-reversal simulations has been performed with a "mirror" in two-dimensional and three-dimensional free space environments. The waves propagation is simulated by solving the linearized Euler's equations. The results permit to characterize the time-reversal method in terms of spatial resolution and localisation error by analyzing the focal spot width for each simulation. In this paper, mathematical expressions of the time-reversed pressure and approached formulas for

the resolution are derived following the diffraction theory and the phase conjugation in two and three-dimensional cases. Numerical and theoretical results are then compared. The focal spot width is then fully determined by two ratios involving three parameters: the array-source distance, the array length and the wavelength.

Tue 18:40 Pierre CHAVASSE MI-S02: Time reversal and optimization for sonic and ultrasonic imaging

Ultrasonic imaging based on frequency-domain optimization form – (Contributed, 000785)

S. Rodriguez, P. Sahuguet, X. Jacob and V. Gibiat
Laboratoire PHASE, 118 Route de Narbonne, 31062 Toulouse, France
Corresponding author E-mail: rodriguez.samuel@yahoo.fr

The Time-Domain Topological Energy (TDTE) imaging method is based on the time domain simulation of the acoustic propagation of both the experimental excitation signal and the time-reversed experimental measured signals. The image is obtained by integrating the product of the two fields numerically obtained on the time domain. It enhances the quality of the image by refocusing the energy in the virtual domain at the locations of the diffusive objects of the inspected medium. The purpose of our work is to apply the same method in the frequency domain for the propagation of wave in solids and fluids in order to reduce the computation cost. The finite element method is used and the experimental results presented are obtained with a composite sample and with a media imitating biological tissues.

Tue 9:00 Philip DOAK AA-G01: Room acoustics

Acoustical design for rehearsal halls of Guangdong Xing Hai Orchestra – (Contributed, 000619)

Y. Zhao and S. Wu
State Key Laboratory of Subtropical Building Science, South China University of Technology, 381 Wushan Road, 510640 Guangzhou, China
Corresponding author E-mail: arzhyzh@scut.edu.cn

The rehearsal halls of Guangdong Xinghai Orchestra are exclusive for the orchestra. The rehearsal halls include a main room for western symphony rehearsal and an adjutant room for Chinese national music rehearsal. The acoustical design includes sound insulation, noise control and room acoustics design. Different room acoustics parameters are designed for the two rehearsal halls. After its completion, an acoustical measurement was also taken. Rehearsal performances were held inside both rooms regularly. The musicians of Guangdong Xinghai Orchestra highly appreciate the acoustics of these two rooms. This paper introduces the acoustical design of the rehearsal halls and the acoustical measurement in detail.

Tue 9:20 Philip DOAK AA-G01: Room acoustics

Statistical analysis of a set of Parisian Concert Halls and Theatres – (Invited, 000834)

J.-D. Polack, F. Leão Figueiredo and S. Liu
LAM/IJLRA - Université Pierre et Marie, 11 rue de Lourmel, 75015 Paris, France
Corresponding author E-mail: jean-dominique.polack@upmc.fr

During the year of 2009, the room acoustics group of the LAM (Équipe Lutheries, Acoustique, Musique de l'Institut Jean Le Rond d'Alembert - Université Pierre et Marie Curie, Paris) performed a series of acoustical measurements in music halls in Paris. The halls were chosen in regarding their importance to the historic, architectural or acoustic domains. The measured ensemble of fourteen rooms includes quite different architectural designs. The measurements were made both in empty and in occupied rooms, and a comprehensive series of statistical analysis was carried out to fully characterize the database thus obtained. The presentation briefly describes the protocol, then moves on to the statistical analysis. The results obtained draw new insight into the structure of room acoustical measurements, and will be compared with results from the literature.

Tue 9:40 Philip DOAK AA-G01: Room acoustics

Room acoustic auralization with Ambisonics – (Invited, 000835)

J.-D. Polack and F. Leão Figueiredo
LAM/IJLRA - Université Pierre et Marie, 11 rue de Lourmel, 75015 Paris, France
Corresponding author E-mail: jean-dominique.polack@upmc.fr

During the year of 2009, the room acoustics group of the LAM (Équipe Lutheries, Acoustique, Musique de l'Institut Jean Le Rond d'Alembert - Université Pierre et Marie Curie, Paris) performed a series of acoustical measurements in music halls in Paris. The halls were chosen in regarding their importance to the historic, architectural or acoustic domains. The measured ensemble of fourteen rooms includes quite different architectural designs. The measurements were carried out with a Soundfield microphone, in order to afterward recreate the sampled sound field in the listening room at LAM. The presentation describes the tools used to realise the auralization, then moves on to the subjective tests realised with the system. Statistical analysis was carried out on the results of the subjective tests. The results draw insight into the qualities of auralization for reproducing sound field, but also on its limitations.

Tue 10:00 Philip DOAK AA-G01: Room acoustics

Recent acoustic upgrades in Verizon Hall at the Kimmel Performing Arts Center – (Contributed, 000572)

D. Schuette
Threshold Acoustics LLC, 53 West Jackson Boulevard, Suite 815, Chicago, 60604, USA
Corresponding author E-mail: dschuette@thresholdacoustics.com

The Kimmel Performing arts Center in Philadelphia, Pennsylvania, USA opened in late 2001. In 2011, the year of its tenth anniversary, acoustic upgrades occurred within Verizon Hall, the 2500-seat concert hall at the heart of the Kimmel Center, resulting in noted positive changes in the room's sound. These improvements include: increased projection and presence for the Fred J Cooper Memorial Organ; enhanced on-stage ensemble hearing conditions; increased full-frequency response for the organ, orchestra, and chorus; improved tonal quality for the sound-reinforcement system; and notable improvement in sound level and presence from the stage. The cumulative result is a perception of enhanced reverberation and presence for non-amplified events and a better sense of balance and clarity for amplified presentations. Final analysis of test data will indicate whether the changes have resulted in an increase in reverberation level or longer reverberation time. This paper will present an overview of the architectural changes and the results of the detailed analysis of the testing performed before and after the changes were implemented.

Tue 10:40 Philip DOAK AA-G01: Room acoustics

Acoustic solid angle criteria in practice: transforming the Chapelle Corneille in Rouen into a concert hall – (Invited, 000339)

Y. Jurkiewicz, E. Kahle and T. Wulfrank
Kahle Acoustics, 188 avenue Molière, 1050 Bruxelles, Belgium
Corresponding author E-mail: yjurkiewicz@kahle.be

A new concert hall for early music, chamber music and small ensembles is to be outfitted in a 17th century church in the city Rouen. The Chapelle Corneille is a large and beautifully renovated landmarked monument, with highly reverberant acoustics. The addition of a large amount of early energy is a major requirement for the acoustic transformation of the church into an Auditorium. But the imperatives of historical preservation are strong, and a previous project was cancelled due to an addition of acoustic reflectors that was judged visually offensive. During the architectural competition that followed the first project cancellation, the use of a new criteria based on solid angles made it possible for our design team to consider many options and quickly estimate their acoustic efficiency. This approach led to innovative solutions, both acoustically effective and architecturally integrated.

Tue 11:00 Philip DOAK AA-G01: Room acoustics

Influence of audience on propagation of sound at low frequencies – (Contributed, 000645)

E. Shabalina[a] and M. Vorländer[b]
[a]ITA RWTH Aachen University, Neustrasse 50, 52066 Aachen, Germany; [b]RWTH Aachen University, Institute of Technical Acoustics, Templergraben 55, 52056 Aachen, Germany
Corresponding author E-mail: elena.shabalina@akustik.rwth-aachen.de

At open-air festivals and large scale concerts subwoofers are often placed in a row in front of the stage. This arrangement provides even sound pressure level distribution over the audience area, but the audience itself often stands tightly packed in front of the stage. The sound waves from the subwoofers propagate therefore partly through the crowd and the propagation is strongly influenced by its density. An interesting effect that occurs is the reinforcement of lower frequencies at certain positions within the audience. This effect might be generated by interference of sound waves travelling partly through the audience and partly over the audience. The effect was shown by measurements, conducted at several rock concerts, and BEM-modeling. The paper presents measurement and simulation results; possible theoretical approaches to the problem are discussed.

Tue 11:20 Philip DOAK AA-G01: Room acoustics

Analysis of acoustic requirements of a small hall of a theatre according to the coupling factor with the stage tower – (Contributed, 000831)

F. Leccese, G. Salvadori and M. Francesconi
University of Pisa, Dept of Energy and System Engineer (DESE), Largo L. Lazzarino, 56122 Pisa, Italy
Corresponding author E-mail: f.leccese@ing.unipi.it

In recent years in Italy, the renovation or construction of public buildings, especially auditoriums (for music) and theaters (for prose and the lyric) has become a widespread practice in urban restoration of small and medium-sized towns. The most pervasive tendency in contemporary architectural design of auditoriums and theaters is to realize one-space hall without galleries or balconies, with an accurate furniture design.
In the case of theaters, the size of the stage tower is comparable to the one of the audience hall and it has an equivalent absorption area similar to the hall one, depending on the scenes equipments in the stage tower.

In this paper the results of the analysis of acoustic requirements of a small theatre hall built in San Miniato (Tuscany, Italy) are shown and discussed. The analysis has been conducted using the acoustic simulation software RAMSETE. In particular the influence of the stage tower on the room acoustic has been examined, focusing on the coupling factor between the two spaces.

Tue 11:40 Philip DOAK AA-G01: Room acoustics

The acoustics of performance spaces (theatres and stadiums): a case study – (Contributed, 000866)

M. Boeck[a], M. Navvab[b], G. Heilmann[a] and F. Bisegna[c]
[a]gfai tech GmbH, Volmerstraße 3, 12489 Berlin-Adlershof, Germany; [b]Taubman College of Architecture and Urban Planning, The University of Michigan, 2000 Bonisteel Boulevard, Ann Arbor, MI 48109-2069, USA; [c]Dept. DIAEE, Faculty of Engineering, SAPIENZA University of Rome, Via Eudossiana, 18, 00184 Rome, Italy
Corresponding author E-mail: gilles.rhone@pm-instrumentation.com

Beamforming is an excellent approach to acquire the acoustic signature of rooms and buildings, superimposing acoustic images on 3D models to create informative 3D acoustic maps. These measurements give information on various factors such as sound propagation, reflective and absorptive surfaces, leakages, sound bridges, reverberation time and many more. While simulations serve to merely predict the acoustic behavior of performance spaces, measurements at the real site allow for verification of these simulations by acquiring the true acoustic signature of these spaces. Such on-site measurements have been carried out at the Michigan Stadium, US as well as the Coliseum and the Ancient Ostia in Rome, Italy. This practical paper aims to present measurements carried out on theatres and stadiums and the results thereof showing the applicability of beamforming systems to this end.

Tue 12:00 Philip DOAK AA-G01: Room acoustics

The acoustical performance of mosques' main prayer hall geometry in the eastern province, Saudi arabia – (Contributed, 000118)

H. Hossam Eldien and H. Al Qahtani
Dammam Univ., P O Box 2397, 31451 Dammam, Saudi Arabia
Corresponding author E-mail: hany.hossam@gmail.com

The study of mosque acoustics, with regard to acoustical characteristics, sound quality for speech intelligibility, and other applicable acoustic criteria, has been largely neglected. In this study we discuss how mosque design is influenced by worship considerations. In this study the acoustical characteristics of typically constructed contemporary mosques without domes in Saudi Arabia had been investigated. Simulation and extensive field measurements had been taken in varies representative mosques of different sizes and architectural features in order to characterize their acoustical quality and to identify the impact of its prayer hall form on their acoustics performance. Objective room-acoustic indicators such as reverberation time (RT), the early decay time (EDT), The D50 parameter (D-50) and clarity (C-50), were measured and calculated. The speech transmission index (STI) had been evaluated without the operation of existing sound reinforcement systems. The results will show the acoustical quality in the investigated mosques, unoccupied case.

Tue 9:00 John TYNDALL MA-G01: Musical acoustics

Touring a singing sculpture to promote acoustics – (Contributed, 000129)

I. Drumm and A. Belantara
The University of Salford, The Crescent, M5 4WT Salford, UK
Corresponding author E-mail: i.drumm@salford.ac.uk

During 2010/2011 acousticians at the University of Salford and the University of Southampton collaborated with artist Luke Jerram to design and tour his remarkable singing sculpture, Aeolus. Aeolus is a giant Aeolian Harp, designed to automatically create beautiful musical compositions in changing winds. Associated with Aeolus was an ambitious outreach programme designed to promote the science of Acoustics. This paper will discuss the principle workings of Aeolian harps and their optimal application to Aeolus. The paper will also present an evaluation of this project's science public engagement impact and discuss the merits of scientists collaborating with artists to raise the profile of scientific research.

Tue 9:20 John TYNDALL MA-G01: Musical acoustics

Creating new musical rules for listeners with a cochlear implant – (Contributed, 000554)

J. Marozeau and H. Innes-Brown
The Bionics Institute, 384 Albert st, 3002 East-Melbourne, Australia
Corresponding author E-mail: jmarozeau@bionicsinstitute.org

The rules of western music were developed across centuries and driven by two main constraints: the physics of the instruments and the mechanics of the auditory system. For example, the importance of intervals such as the octave and the fifth can be linked to the physics of instruments that impose energy at multiples of the fundamental frequency. Likewise, the semitone (the smallest common interval in music), can be linked to the frequency selectivity of the auditory system. Created by musicians with normal hearing, these rules collapse for listeners with hearing loss. Hearing impairment can result in changes such as elevated sensitivity, widening of critical bands, and recruitment. Furthermore, hearing devices such as the cochlear implant generally discard parts of the signal that carry pitch information. To address this problem a new framework was developed based on audience response data and psychoacoustics experiments. The enjoyment of six new works, developed in collaboration with electroacoustic composers specifically to address the impaired auditory system, was assessed. A psychoacoustics study involved enhancing auditory streaming cues in existing music: enhancing the perceptual difference between different instruments or lines of melody in order to make their separation easier for hearing impaired listeners.

Tue 9:40 John TYNDALL MA-G01: Musical acoustics

Edge tone in an organ pipe foot model – (Contributed, 000729)

I. Vaik and G. Paál
BUTE, Dept. Hydrodynamic Systems, Muegyetem rkp 1-3, H-1111 Budapest, Hungary
Corresponding author E-mail: vaik@hds.bme.hu

Organ pipes feet are typical examples of the edge tone flow configuration when a free jet interacts with a sharp object and oscillates around it in a more or less periodic manner. In the steady state the resonator of the organ pipe stabilizes the oscillation and forces a certain frequency on the oscillation. However, in the initial phase of the organ pipe sound, the so-called attack transient, the resonator does not play a major role, rather the foot, corresponding to an edge tone configuration. As a first step towards modeling the sound the goal of this paper is to model the flow in a realistic organ pipe foot model using computational fluid dynamics (CFD). The numerical results were verified by the measurements of Außerlechner et al. [Journal of Acoustic Society of America 126 (2), pp. 878-886 (2009)] and were found to be in good agreement.

Tue 10:40 John TYNDALL MA-G01: Musical acoustics

A comparative study of the maximum vocal levels of classical singers for the two main laryngeal mechanisms – (Contributed, 000736)

S. Lamesch, B. Doval and M. Castellengo
LAM - IJLRDA, 11, rue de Lourmel, 75015 Paris, France
Corresponding author E-mail: lamesch@lam.jussieu.fr

During vocal performance, two main laryngeal vibratory mechanisms (namely M1 and M2) come into play allowing the singer to reach a complete vocal range. A previous study showed that the maximum SPL is on the average 10 dB stronger for the vowel /a/ than for /i/ in M1, but remains the same for the two vowels in M2. To explain this observation, we have studied the energy repartition among the strongest harmonics and their rank. 21 singers (13 males and 8 females) produced crescendi on /a/ and on /i/, from C3 to C5, in M1 and in M2, since this tessitura includes the overlapping area of both mechanisms. We recorded the sounds and the electroglottographic signals. Our results showed that the strongest harmonic is the first one for /i/ within the tessitura under examination, for females as well as for males (except a few tenors). For /a/, the whole spectrum is weaker in M2 than in M1. The number of the strongest harmonic depends on the fundamental frequency, and is lower or equal in M2 compared to M1. We will discuss the contribution of different glottal flow waveforms and resonantial adjustments for M1 and M2, and for /i/ and /a/.

Tue 11:00 John TYNDALL MA-G01: Musical acoustics

Measurements of musical instruments with surrounding spherical arrays – (Invited, 000678)

G. K. Behler, M. Pollow and M. Vorländer
RWTH Aachen University, Institute of Technical Acoustics, Templergraben 55, 52056 Aachen, Germany
Corresponding author E-mail: gkb@akustik.rwth-aachen.de

The directivities of natural sound sources such as musical instruments are often neglected in auralization, both when working with measured or simulated acoustical environments. This is due to the complex nature of both the radiation of musical instruments and the post-processing involved in this task. However, as the directivity patterns constitute an audible part of the tonal characteristic of a musical instrument in a room, it is advisable to take their directivities into account. To conduct the measurements, a large surrounding spherical microphone array was constructed that allows to fully encompass the musician in an anechoic chamber. Hereby great care has to be taken in the design process of the recording device in order to obtain a broad-band omnidirectional sensitivity of the used microphones. The acquired multi-channel audio data can be then used to analyze the directivities of the recorded instrument

Tue 11:20 John TYNDALL MA-G01: Musical acoustics

Post-processing and center adjustment of measured directivity data of musical instruments – (Contributed, 000677)

M. Pollow, G. K. Behler and M. Vorländer
RWTH Aachen University, Institute of Technical Acoustics, Templergraben 55, 52056 Aachen, Germany
Corresponding author E-mail: mpo@akustik.rwth-aachen.de

Surrounding spherical microphone arrays can capture the radiation pattern of sound sources placed inside the array. Depending on the exact positioning of the sound source, the obtained measurement results vary, as amplitude and phase differences arise due to the different traveling time of the radiated sound. Using the spherical harmonic decomposition of the sound field, it is noticeable that displaced sound sources need a much higher number of modal components for an accurate description. As surrounding spherical microphone arrays are severely limited in their spatial resolution correct centering is crucial for higher frequencies. In practice, however, a precise alignment to the physical center of the array is impossible. With the help of realignment algorithms it is possible to virtually shift the sound source to the center of the array to allow a more accurate description in the spherical harmonic domain. Alternatively, a magnitude only approach can be employed, resulting in a more robust representation regarding incorrect centering in the array.
In this contribution different post-processing strategies are presented with the goal to provide directivity patterns of musical instruments for application in both measurement and simulation.

Tue 11:40 John TYNDALL MA-G01: Musical acoustics

Modeling the radiation characteristics of woodwind instruments – (Invited, 000697)

R. Caussé, M. Noisternig, V. Le Piouffle and N. Misdariis
Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris
Corresponding author E-mail: rene.causse@ircam.fr

In reverberant acoustic environments the perception of timbre at a listener's position depends on the radiation characteristics of the sound source. Numerous studies have shown that radiation patterns of acoustic instruments vary with frequency and time. Thus, one area of large concern that is a topic of ongoing research is the measurement, reproduction, and compact description of sound source radiation patterns. A simple and efficient physical model for calculating the directional pattern of woodwind instruments with curved tubes is presented in this study. It calculates the far-field sound pressure on a sphere surrounding the instrument, also taking into account the directivity of the openings (holes and the bell). Simulation results are compared to the radiation patterns of a saxophone measured in an anechoic chamber with a surrounding spherical microphone array.

Tue 9:00 Lord RAYLEIGH PU-G01: Physical acoustics

Measured and predicted of the longitudinal and transverse velocities of tube material using the Wigner-Ville and fuzzy logic techniques – (Contributed, 000005)

R. Latif[a], Y. Nahraoui[a], E.H. Aassif[b] and G. Maze[c]
[a]ESSI ENSA Ibn Zohr University, ENSA BP 1136, 80000 Agadir, Morocco; [b]Faculté des sciences d'Agadir, Université Ibn Zohr, Département de physique, Faculté des sciences d'Agadir, B.P 8106, 80000 Agadir, Morocco; [c]LOMC, IUT, Université du Havre, Place Robert Schuman, Place Robert Schuman, 76610 Le Havre, France
Corresponding author E-mail: latif_rachid@yahoo.fr

Intelligent modelling tools as artificial neural network (ANN) and fuzzy logic approach are demonstrated to be competent when applied individuality to a variety of problems such as modelling and prediction. Recently there has been a growing interest in combining both these approaches, and as a result, neuro-fuzzy computing techniques have evolved. The advantage of using neuro-fuzzy (ANFIS) in this study for field modelling is given by the flexibility to adapt and relies on observed data rather than on analytical model of the system that some once it is difficult to establish it. In this work, we applied the fuzzy logic for modelling, measuring and predicting of the longitudinal and transverse velocities of material constituting the tube. The useful data to train and to test the performances of the model are determined from the values calculated trajectories of the proper modes theory of resonances and those extracted from time-frequency representations of Wigner-Ville. This representation is applied of the acoustic signal backscattered by an aluminium cylindrical shell immersed in water. The obtained values of

the longitudinal and transverse velocities of material tube are in good agreement with those given in the scientific literature.

Tue 9:20 Lord RAYLEIGH PU-G01: Physical acoustics

How upgoing and downgoing energy fluxes contribute to the establishment of lamb waves in an immersed elastic plate – (Contributed, 000331)

E. Ducasse and M. Deschamps
Institut de Mécanique et d'Ingénierie de Bordeaux (I2M), UMR CNRS 5295, Arts et Métiers ParisTech, Université de Bordeaux, 351 cours de la Libération, 33405 Talence, France
Corresponding author E-mail: e.ducasse@i2m.u-bordeaux1.fr

Ultrasonic guided waves in an anisotropic elastic plate immersed in a fluid can be considered as the result of successive reflections from the two interfaces.
Inhomogeneous waves are involved in the problem if the incidence angle θ is greater than the first critical angle θ_c. In this case, the energy is transmitted from one side to the other by the coupling of two inhomogeneous waves with conjugate wavenumbers and the same kind of polarization, whereas each of these latter inhomogeneous waves does not transfer energy through the plate.
Thus, *nonstandard upgoing and downgoing waves* are defined such that, firstly, their power fluxes are upgoing and downgoing, respectively, and, lastly, their interaction energy is zero. In this light, any Lamb wave can be considered as the result of interferences of upgoing and downgoing waves, as well-known for $\theta < \theta_c$.

In addition, an interesting physical phenomenon is described for one specific pair "*angle of incidence/frequency*": the quasi-energy brought by the incident harmonic plane wave crosses the plate without any conversion to reflected waves either at the first interface or at the second interface. In this zone, there is a perfect impedance matching between the fluid and the plate.

Tue 9:40 Lord RAYLEIGH PU-G01: Physical acoustics

Three-dimensional Acoustic Radiation Force on an Arbitrary Located Elastic Sphere – (Contributed, 000364)

D. Baresch[a], J.-L. Thomas[a] and R. Marchiano[b]
[a]UPMC-INSP (UMR 7588)/IJLRDA(UMR 7190), 4, Place Jussieu, Cedex 05 - boite courrier 840, 75252 Paris, France; [b]UPMC/CNRS, Institut Jean Le Rond D'Alembert - UMR CNRS 7190, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: regis.marchiano@upmc.fr

This work aims to model the forces acting on an elastic sphere placed in the field of an acoustic vortex. From this theoretical investigation we derive an expression of the axial and transverse forces exerted on the sphere. Acoustic vortex refers to a type of beam having an helicoidal wave front. Such a wavefront is due to a screw type phase singularity and hence the beam has a central dark core of zero amplitude surrounded by a high intensity ring. The spheres are allowed to be arbitrarily located in the acoustic field, thus, one can study the axial and transverse stability of the spheres. We find that an azimuthal force component appears and is capable to rotate the sphere around the propagation axis. This confirms the transfer of orbital angular momentum from the beam to the sphere. Furthermore, axial forces may turn negative when appropriate parameters are selected and yields a dragging force towards the source of the beam acting as a Tractor Beam. In addition to extending the understanding of the nature of forces arising in an acoustic vortex, numerical results provide an impetus for further designing acoustic tweezers for potential applications in particle entrapment and remote controlled manipulation.

Tue 10:40 Lord RAYLEIGH PU-G01: Physical acoustics

Acoustic properties of emulsions with locally resonant scatterers – (Contributed, 000429)

T. Brunet[a], B. Mascaro[a], S. Raffy[b], O. Mondain-Monval[b], J. Leng[c], O. Poncelet[a] and C. Aristégui[a]
[a]University of Bordeaux, CNRS, UMR 5295, I2M - Bâtiment A4, 351, cours de la Libération, 33405 Talence, France; [b]Centre de recherches Paul Pascal, 115, Av Albert Schweitzer 33600 Pessac; [c]Laboratoire du Futur, 178 avenue du Docteur Schweitzer 33608 Pessac Cedex
Corresponding author E-mail: thomas.brunet@u-bordeaux1.fr

We present the results of ultrasonic pulse propagation experiments on dilute emulsions of resonant scatterers. Thanks to microfluidics, we achieved highly monodisperse oil-droplet dispersions embedded in a Bingham fluid. Underwater measurements allowed us to evidence up to about ten sharp Mie resonances, on both the acoustic attenuation and the phase velocity in the MHz range. These ultrasonic experiments are compared to theoretical predictions derived within the framework of the independent scattering approximation with an excellent quantitative agreement. The influence of the emulsion polydispersity is also investigated as well as the dependence of the acoustic properties on both size droplet and volume fraction in dilute regimes, for which the coupling between scatterers is negligible.

Tue 11:00 Lord RAYLEIGH PU-G01: Physical acoustics

Acoustic field in cavities filled with thermo-viscous binary gas mixtures, determination of gas mixtures thermophysical properties – (Contributed, 000446)

C. Guianvarc'h[a] and M. Bruneau[b]
[a]INRiM, strada delle Cacce 91, 10135 Torino, Italy; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: c.guianvarch@inrim.it

The acoustic behaviour in thermo-viscous gas mixtures involves deviations from the adiabatic and laminar movement in pure gases, which results from the influence of several diffusive fields, namely shear, entropic, and concentration variation fields, taking their energy to the acoustic field itself. Actually, a strong coupling between these fields occurs inside boundary layers while their effects appear to be additive processes in the bulk of the medium.
Although recent literature on this subject leads to results of interest, these results still have limitations because they do not provide complete solutions for the propagative and diffusive fields in and out of the boundary layers.
The aim of this work is to provide such complete solutions in the whole domains considered, in order to get a better analytical understanding of the fields abovementioned in closed cavities and ducts. More particularly here, we consider the possible use of acoustic methods in spherical cavities for the accurate determination of binary gas mixtures thermophysical properties (speed of sound, first acoustic virial coefficient, thermal conductivity, mutual diffusion coefficient), that have been greatly improved during the past two decades.

Tue 11:20 Lord RAYLEIGH PU-G01: Physical acoustics

Experimental investigation of the acoustic properties of liquids foams – (Contributed, 000510)

J. Pierre, F. Elias, C. Gay, C. Derec and V. Leroy
MSC - Université Paris Diderot, 10 rue Alice Domont et Léonie Duquet, 75013 Paris, France
Corresponding author E-mail: juliet.pierre@gmail.com

Liquid foams are mixtures of gas and liquid, with a liquid volume fraction $\phi_l \leq 0.3$, stabilized with surfactants. Because of their composition and structure, liquid foams are very complex and unstable media with particular acoustical properties. Experimental studies are not very numerous; they have shown a strong dependence of the velocity and attenuation of sound on parameters such as ϕ_l and the average bubble size [1]. The existent theories explain a part of the acoustic behaviour of liquid foams, but are not exactly in accordance with the experimental data found in the literature. For example, the experimental phase velocities [Phys. Rev. E 66 (2002) 021404] are larger than the velocities predicted by the Wood approximation [A. B. Wood, A Textbook of sound (Bell, London, 1932)].
We present an experimental investigation of liquid foams by an ultrasonic setup based on two broadband **air** transducers (40-200kHz). The acoustic properties are deduced from the reflected signal. We discuss experimental results with commercial (shaving foams) and custom-made controlled foams and compare them with available models. The evolution of the acoustic properties with the aging of the foams is also discussed.

Tue 11:40 Lord RAYLEIGH PU-G01: Physical acoustics

Recovery of the effective wavenumber and dynamical mass density for materials with inclusions – (Contributed, 000599)

G. Lepert[a], C. Aristégui[a], O. Poncelet[a], T. Brunet[a], C. Audoly[b] and P. Parneix[c]
[a]University of Bordeaux, CNRS, UMR 5295, I2M - Bâtiment A4, 351, cours de la Libération, 33405 Talence, France; [b]DCNS Research, CEMIS, 83076 Toulon, France; [c]DCNS Research, CESMAN, 44620 La Montagne, France
Corresponding author E-mail: christophe.aristegui@u-bordeaux1.fr

For many years, the study of material with locally resonant inclusions has known a great interest. Due to their attractive macroscopic acoustic properties, which do not exist in natural materials, many applications governed by the contrast between the constituent properties can be achieved/expected: cloaking, enhanced absorption, flat plate lens, wave trappingoe Such structures containing inclusions are usually modeled as effective homogeneous materials with complex-valued and frequency-dependent effective wavenumber and mass density. In this context, we derived a method for the simultaneous determination of both parameters using an immersed sample. First, its reliability is demonstrated using theoretical input data with simulated measurement noise. Finally, the characterization method is applied to experimental waveforms measured on test panels made with materials designed in order to exhibit cavity resonances over the frequency range of study.

Tue 14:00 Lord RAYLEIGH PU-G01: Physical acoustics

Wave-quasi-particle dualism for surface acoustic waves: theory and applications – (Contributed, 000017)

G. A. Maugin and M. Rousseau
CNRS, Institut Jean le Rond d'Alembert, CNRS UMR 7190, Université Pierre et Marie Curie (Paris 6), 75252 Paris, France
Corresponding author E-mail: gerard.maugin@upmc.fr

Following along the line of the theory proposed initially at CFA-2010, the present contribution presents the recent progress achieved in this trend of research. In particular, for some exemplary modes of propagation, it is shown that quasi-particles of definite "massï can be associated with these modes via an application of the celebrated Noether's theorem of variational field theory (or its generalization in presence of dissipation). New results include accounting for (i) the elastic nonlinearity of the substrate, (ii) its viscosity, (iii) the presence of a thin glued active film on top of the surface. The motion of the exhibited quasi-particles may be inertial, or not (in the presence of friction related to viscosity). It is reminded that the main tool here is the exploitation of the canonical conservation laws of wave momentum and energy integrated over a volume element representative of the wave mode. The problem of transmission-reflection at an interface between two elastic media is considered as an example showing the alternate wavelike and particle-like pictures of the solution. References: Proc. Roy. Soc. London, A467, 495-507, 2011; Int. J. Eng. Sci., 48, 1462-1469, 2010; ibid, 50, 10-21, 2012; Int. J. Non-linear Mech., 47, 67-71, 2012.

Tue 14:20 Lord RAYLEIGH PU-G01: Physical acoustics

Experimental determination of the diffusion constant for ultrasonic waves in 2-D multiple scattering media with focused beamforming – (Contributed, 000175)

N. Viard and A. Derode
Institut Langevin, 10, rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: nicolas.viard@espci.fr

Experimental measurements of the diffusion constant for ultrasonic waves (around 3 MHz) propagating in water through a scattering slab (parallel metallic rods) are presented. Sample thickness is around ten times the transport mean free path. Several hundreds of transmitting/receiving positions, 40 mm off the sample surfaces, are used. Focused beamforming is achieved in emission and reception in order to mimic a set of virtual sources and receivers located at the sample surface. The ensemble average of the transmitted intensity $\langle I(x,t)\rangle$ is estimated by averaging over all possible couples of sources/receivers apart by the same off-axis distance x. Under the diffusion approximation, $\langle I(x,t)\rangle$ shows a gaussian dependence on x, which makes it possible to measure a diffusion constant D and thereby characterize the scattering medium. We discuss the experimental results and pinpoint the difficulties of measuring a reliable value for D on a real sample. As it was observed in previous works on the mean free path, the diffusion constant D strongly depends on frequency, due to the resonant nature of the scatterers.

Tue 14:40 Lord RAYLEIGH PU-G01: Physical acoustics

Electrodes geometry and surface waves generation on a quartz disk: experimental study – (Contributed, 000424)

Y. Wang, N. Wilkie-Chancellier, L. Martinez and S. Serfaty
Laboratoire SATIE (UMR CNRS 8029), Université de Cergy-Pontoise, 5 mail Gay Lussac, 95031 Neuville Sur Oise, France
Corresponding author E-mail: yu_wang@hotmail.fr

The elaboration of new soft hybrid materials requires adapted smart sensors. Among the ultrasonic techniques, the use of an AT cut quartz is a solution that allows the complete tracking of the mechanical properties of the material in contact. In order to get a RF wireless excitation of such a sensor in a wide frequency bandwidth, the tuning of the electrodes geometry is determinant as it must be based on closed loops. The aim of the present experimental study is to analyse the role played by the electrodes shape upon the generation of the surface waves. Several electrodes excitation geometries are presented in order to optimize the surface wave focusing at the center of the sensor. The quartz disk is excited by a voltage pulse and the quartz surface is scanned by a laser vibrometer (JOPCS, 195, 1-8 (2009)). The surface waves and the transient aspects linked to the electrodes shape borders are analysed by using the 3D Gabor transform (Ultrasonics, 43, 1173-1177 (2006)). The observed waves and their generation sources are presented, revealing new insight about the modelisation of the sensor electrodes. A comparison with classical electrodes shapes is carried out.

Tue 15:00 Lord RAYLEIGH PU-G01: Physical acoustics

Pure shear-waves attenuation evaluation in anisotropic materials from plane wave's angular spectrum decomposition of the transmitted beam in an immersion tank – (Contributed, 000563)

P. Guy[a], T. Monnier[a] and B. Chassignole[b]
[a]Matériaux, ingénierie et sciences, Bâtiment Blaise Pascal 7, avenue Jean Capelle 69621 Villeurbanne Cedex; [b]EDF R&D, Site des Renardières, Avenue des Renardières - Ecuelle, 77818 Moret Sur Loing, France
Corresponding author E-mail: philippe.guy@insa-lyon.fr

In the past decades many papers dealt with attenuation evaluation in anisotropic polycristals. Usually, authors address this problem through the analysis of a transmitted ultrasonic beam in normal incidence. Some of them proposed diffraction correction to account for the beam spreading. Nevertheless, in practice paraxial longitudinal and shear waves propagate and the measured quantity represents the overall attenuation experienced by the two kinds of waves that are comprised in the beam which propagates into the solid. In this paper, an original experimental device will be described, which allows to isolate shear waves and to evaluate their attenuation by the plane wave's angular spectrum decomposition of the transmitted beam. Experimental results obtained on isotropic as well as on orthotropic stainless steel samples will be presented, compared and discussed.

Tue 15:20 Lord RAYLEIGH PU-G01: Physical acoustics

Ultrasonic wave transport in weakly confined granular media in the intermediate frequency regime – (Contributed, 000739)

S. Job[a], A. Strybulevych[b] and J.H. Page[b]
[a]Laboratoire d'Ingénierie des Systèmes Mécaniques et des MAtériaux, Supméca - 3, rue Fernand Hainaut - 93407 St Ouen Cedex; [b]Department of Physics and Astronomy, University of Manitoba, Winnipeg, Canada R3T 2N2
Corresponding author E-mail: stephane.job@supmeca.fr

We present preliminary experimental observations of ultrasonic wave transport in non-cohesive randomly close packed granular media under low confinement pressures, near the unjamming transition. Our samples are 10-mm-thick and 165-mm-diameter slabs made of 1.25-mm-diameter aluminium spheres (monodisperse sample), eventually mixed with 0.9-mm-diameter borosilicate spheres (bidisperse sample). The slabs are covered by thin plastic sheets, which allow maintaining a partial vacuum (0.1 to 0.9 atm) in the samples. Wave transport is investigated over a wide frequency range (25 kHz to 1 MHz) by analyzing the coherent ballistic transmitted field (phase and group velocities, attenuation and scattering mean free path) and the incoherent multiply scattered coda [JH Page et al., Phys. Rev. E, 52, 3106 (1995)]. We find that the time-of-flight intensity profile of the coda is independent of frequency over a wide range of frequencies for which the wavelength is comparable with the sizes of the scatterers. This suggests a plateau in the diffusion coefficient, as predicted by Vitelli and co-workers [Phys. Rev. E 81, 021301 (2010)]. At higher frequencies, the intensity profile becomes progressively confined spatially, providing evidence for the approach to Anderson localization of ultrasonic waves in the medium [Hu et al., Nature Phys. 4, 945, (2008)].

Tue 15:40 Lord RAYLEIGH PU-G01: Physical acoustics

On the use of a SAFE-PML technique for modeling two-dimensional open elastic waveguides – (Contributed, 000439)

F. Treyssede[a], K.-L. Nguyen[a], A.-S. Bonnet-Bendhia[b] and C. Hazard[b]
[a]IFSTTAR-MACS, Route de Bouaye, CS4, 44344 Bouguenais Cedex, France; [b]ENSTA-UMA, POEMS (UMR7231), 32, Boulevard Victor, 75739 Paris Cedex 15, France
Corresponding author E-mail: fabien.treyssede@ifsttar.fr

Elastic guided waves are of interest for inspecting structures due to their ability to propagate over long distances. However, when the guiding structure is embedded into a solid matrix, usually considered as unbounded, waveguides are open and waves can be trapped or leaky. In the latter case, the leakage of energy into the surrounding medium yields attenuation along the axis of the waveguide, which can strongly limit the application of guided wave techniques. Analytical tools have been developed for studying open waveguides but they are limited to simple geometry (plates, cylinders). With numerical methods, one of the difficulty is that leaky modes attenuate along the axis (complex wavenumber) and exponentially grow along the transverse direction. A simple procedure used with existing codes consists in using absorbing layers of artificially growing viscoelasticity, but large layers are often required. The goal of this work is to propose a numerical approach for computing modes in open elastic waveguides combining the so-called semi-analytical finite element method and a perfectly matched layer technique. Two-dimensional problems are considered. Numerical solutions are compared to analytical results. The efficiency of both perfectly matched and absorbing layer techniques is evaluated.

Tue 16:40 Lord RAYLEIGH PU-G01: Physical acoustics

Beat phenomenon at the arrival of a guided mode in a semi-infinite acoustic duct – (Contributed, 000511)

P. Gatignol[a], M. Bruneau[b], P. Lanceleur[a] and C. Potel[b]
[a]Université de Technologie de Compiègne, Laboratoire Roberval, BP 20529, 60205 Compiegne, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: philippe.gatignol@utc.fr

A guided mode, generated at an initial time in the terminal section of a semi-infinite acoustic duct, will undergo dispersion effects during its propagation. It is well known (see [L. Brillouin, Wave Propagation and Group Velocity, Academic Press, 1960]) that at an observation point in the duct, after the arrival of a small precursor that moves with the speed of sound, the main part of the signal does arrive with the group velocity relative to the leading frequency. The axial propagation of the mode is governed by a Klein-Gordon equation and the problem may be solved by a Laplace transform. A careful numerical evaluation of the inverse Laplace integral in the complex plane shows that the amplitude of the mode yields oscillations at the first stage of its arrival. A steepest descent evaluation of the Laplace integral (see [M. Roseau, Asymptotic Wave Theory, North-Holland, 1976]) allows to explain that phenomenon in terms of beats between the main wave and the modes with neighboring frequencies.

Tue 17:00 Lord RAYLEIGH PU-G01: Physical acoustics

Statistical model of the impulse response of a reverberant plate: application to parameter estimation and correlation analysis – (Contributed, 000531)

E. Moulin[a], H. Achdjian[a], J. Assaad[a], F. Benmeddour[a], K. Hourany[b] and Y. Zaatar[b]
[a]IEMN, Le Mont Houy, F-59313 Valenciennes, France; [b]Université Libanaise,
Corresponding author E-mail: emmanuel.moulin@univ-valenciennes.fr

The acoustic reverberation in a solid plate can be conveniently modeled through a nonstationary random process based on the image-sources method. The interest of such a statistical model is to allow the prediction of a general behaviour (in the form of mathematical expectations) from a limited set of experimentally accessible parameters. Contrary to previous works, the model presented here takes into account the dispersive nature of plate waves (Lamb waves). Then, the relations between the average signal envelopes or correlation functions and the reverberation properties of the medium and the relative positions of the noise source, the sensor(s) and, possibly, the defect are derived. Two kinds of possible applications of these theoretical results will be illustrated: (1) parameter extraction such as source-receiver distance, structural dimensions or propagation velocities through curve-fitting; (2) imaging potentialities from ambient acoustic noise correlation.

Tue 17:20 Lord RAYLEIGH PU-G01: Physical acoustics

The sound power output of a monopole source in a cylindrical pipe containing area discontinuities – (Contributed, 000581)

W. Duan and R. Kirby
Brunel University, Kingston Lane, Uxbridge, UB8 1PH Middlesex, UK
Corresponding author E-mail: wenbo.duan@brunel.ac.uk

The sound power of a monopole source in free space is well known, and it is also known that the radiating sound power is not only determined by the source itself, but also the immediate environment surrounding the source. In this paper, a hybrid finite element method is used to study the sound power radiating from a monopole source placed close to a pipe discontinuity. It is found that while the sound power of a monopole source in free space increases as frequency squared, the sound power radiated from the same source in a cylindrical pipe is constant in the plane wave region. A sharp increase in sound power is then seen to occur when the first high-order mode cuts on; sound power is then seen to decrease as a function of frequency until the second high-order mode cuts on, and so on. It is also found that a wave reflected by a discontinuity placed close to one side of the source will interact with a wave on the other side travelling away from the source. This alters the sound power radiating from the source and has ramifications for the placement of monopole sources in piping systems.

Tue 17:40 Lord RAYLEIGH PU-G01: Physical acoustics

A comparison between measured and predicted complex intensity in a flanged cylindrical pipe – (Contributed, 000586)

W. Duan[a], J. Prisutova[b], K. V. Horoshenkov[b] and R. Kirby[a]
[a]Brunel University, Kingston Lane, Uxbridge, UB8 1PH Middlesex, UK; [b]University of Bradford, Great Horton Road, BD7 1DP Bradford, UK
Corresponding author E-mail: wenbo.duan@brunel.ac.uk

A hybrid finite element method is used to model wave propagation in a flanged cylindrical pipe containing a monopole source. Here, a modal expansion is used to represent sound propagation in the exterior domain and this avoids the use of perfectly matched layers normally found in commercial software packages. Complex intensity in the pipe is then obtained and the real part of the complex intensity is shown to represent the local travelling energy and the imaginary part the local oscillating energy. Results are presented in the plane wave region and at higher frequencies, where the first circumferential mode has cut-on. The predicted complex intensity is then compared to experimental measurements and generally good agreement is observed. From this it is seen that the interaction between the acoustic pressure in the plane wave and the acoustic particle velocity in the first circumferential mode mainly contributes to the transverse flow of energy flow in the pipe, whilst the interaction between the acoustic pressure in the first circumferential mode pressure and the acoustic particle velocity in the first circumferential mode contributes to energy oscillation.

Tue 18:00 Lord RAYLEIGH PU-G01: Physical acoustics

Elasticity of transverse isotropic soft tissues – (Contributed, 000157)

D. Royer, J.-L. Gennisson, T. Deffieux and M. Tanter
Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, Univ Paris Diderot, 75005 Paris, France
Corresponding author E-mail: daniel.royer@espci.fr

Quantitative elastography techniques such as Supersonic Shear Imaging (SSI) have recently been developed to estimate non-invasively the mechanical properties of soft tissues in vivo. Based on the measurement of shear wave velocity Vs, SSI techniques allow to estimate the shear modulus μ from the relation $\mu = \rho(\mathrm{Vs})^2$. In the case of soft isotropic media, this quantity can be related to the Young's modulus E, which corresponds to the physician's palpation or mechanical testing results, as $\mathrm{E} = 3\mu$. In more complex tissues such as muscles, which exhibit a strong transverse anisotropy, two shear moduli ($\mu//$ and $\mu\perp$) and two Young's moduli (E// and E$\perp$) are defined. Moreover, the simple relationship $\mathrm{E} = 3\mu$ doesn't hold anymore. Transverse isotropic medium are commonly described by a stiffness tensor having five coefficients. This model, established for hexagonal crystals, is revisited in the case of soft anisotropic solids. Relationships between elastic constants and Young's moduli are derived and these relations are validated on experimental data found in the literature. It is shown that $3\mu\perp \leq \mathrm{E}\perp \leq 4\mu\perp$ and that E// cannot be determined from the measurements of $\mu//$ and $\mu\perp$ alone. The limits of ultrasonic testing for the mechanical characterization of soft anisotropic media are discussed.

Tue 13:20 Peter BARNETT SP-G01: Sound perception

Effect of the ISI on the asymmetry in global loudness between upramp and downramp sounds in a paired comparison experiment – (Contributed, 000437)

E. Ponsot[a], P. Susini[a] and S. Meunier[b]
[a]Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris; [b]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: susini@ircam.fr

Some recent works about the loudness of dynamic sounds showed that sounds that increase continuously in level (upramps) are perceived with a greater loudness change or global loudness than opposite downramps, although they only differ in direction. The understanding of sensory and cognitive mechanisms involved in the loudness of increasing and decreasing sounds is still a burning issue. In all the studies reporting this effect, estimations were made directly at the end of one ramp in single-stimulus paradigms or using a short ISI (Inter Stimulus Interval) between two ramps in paired-stimulus paradigms. In the present study, global loudness was measured using a paired comparison method. The influence of the ISI was examined for ramps that differed in direction, dynamic and maximum level. Results show that judgments (1) are dominated by the maximum level of a ramp, (2) are mainly independent on the direction of the first ramp of the pair and that, (3) asymmetries between upramps and downramps are reduced with a longer ISI.
The Neuhoff's evolutionary hypothesis explaining these asymmetries by an overestimation of upramps is discussed in regard to these results.

Tue 13:40 Peter BARNETT SP-G01: Sound perception

Perceptual asymmetry in the subjective duration of ramped and damped sounds – (Contributed, 000324)

M. Vannier[a], S. Meunier[a], P. Susini[b] and J. Chatron[a]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris
Corresponding author E-mail: ml.vannier@gmail.com

Time-varying-level sounds that increase or decrease in level are well established to induce auditory perceptual asymmetries, for loudness and subjective duration. Several studies revealed ramped sounds to be perceived louder than equivalent damped sounds using durations from few milliseconds to few seconds. In addition, other studies revealed ramped sounds to be perceived longer than damped sounds for durations from 10 ms to 500 ms. As a consequence, it could be hypothesized that the perceived duration asymmetry may be responsible for the loudness asymmetry. Thus, the aim of the present study was to extend the results about asymmetries in subjective duration for tones above 500 ms, in order to test the plausibility of the hypothesis under these conditions. Using a 2I-2AFC adaptive method, ramped and damped tones were matched in duration to the point of subjective equality. At equal subjective duration, short-damped sounds (< 0.5 s) were matched longer than short-ramped sounds, confirming previous results, whereas long-damped sounds (0.5 to 2 s) were matched to the same duration as long-ramped sounds, which question the hypothesis for durations above 500 ms.

Tue 14:00 Peter BARNETT SP-G01: Sound perception

Smoothing head-related transfer functions for a virtual artificial head – (Contributed, 000233)

E. Rasumow[a], M. Blau[a], M. Hansen[a], S. Doclo[b], S. Van De Par[b], D. Püschel[c] and V. Mellert[b]
[a]Institut für Hörtechnik und Audiologie, Jade Hochschule, Ofener Straße 16/19, 26121 Oldenburg, Germany; [b]Carl von Ossietzky Universität Oldenburg, Ammerländer Heerstraße 114-118, 26121 Oldenburg, Germany; [c]Akustik Technologie Göttingen, Bunsenstraße 9c, 37073 Göttingen, Germany
Corresponding author E-mail: eugen.rasumow@jade-hs.de

The frequency-dependent directivity pattern of a human head (head-related transfer functions, HRTFs) can be synthesized with a microphone array and digital filtering (Rasumow et al. 2011), which may be referred to as a virtual artificial head (VAH). However, in order to synthesize the peaky directivity patterns (especially at high frequencies) with a sufficiently high accuracy, a large number of microphones is required, resulting in an increased sensitivity to gain, phase and positioning errors. Therefore, it is beneficial to smooth the HRTFs in such a manner that they become (spatially) as smooth as possible while still yielding an unmodified individual perception. Since peaky directional characteristics of the HRTF are reflected in the frequency response , smoothing is conducted firstly by

truncating the head-related impulse responses (HRIRs) in the time domain and secondly by smoothing the transfer functions in the frequency domain. The aim of this study is to investigate the limits of these smoothing operations in terms of the truncation length, the relative bandwidth and phase approximations, respectively. Using 3AFC listening tests, the limiting parameters were determined as a function of the angle of incidence in the horizontal plane. The results and their implications for the VAH will be discussed

Tue 14:20 Peter BARNETT SP-G01: Sound perception

A spectral-envelope synthesis model to study perceptual blend between wind instruments – (Contributed, 000751)

S.-A. Lembke and S. McAdams
CIRMMT, McGill University, Schulich School of Music, 555 Sherbrooke St. W., Montreal, Canada H3A 1E3
Corresponding author E-mail: sven-amin.lembke@mail.mcgill.ca

Wind instrument sounds can be shown to be characterized by pitch-invariant spectral maxima or formants. An acoustical signal analysis approach is pursued to obtain global spectral envelope descriptions that reveal these pitch-invariant spectral traits. Spectral envelopes are estimated empirically by applying a curve-ftting procedure to a composite distribution of partial tone frequencies and amplitudes obtained for all available pitches of an instrument. A source-filter synthesis model is designed based on two independently controllable formant filters with their frequency responses matched to the spectral envelope estimates. This is then used in a perceptual experiment in which parameter variations of the synthesis filter are manipulated systematically to investigate their contribution to the degree of perceived blend between the synthesized sound and a recorded instrument sound. The perceptual relevance is assessed through two tasks in which participants either produce the best attainable blend by controlling synthesis parameters or rate the degree of blend for 4 parameter presets. Behavioral data obtained from both experiments investigating common wind instruments across a representative set of pitches suggest the utility of this formant-based model for correlating acoustical description and perceptual relevance, as both formant frequency and magnitude appear to affect perceived blend.

Tue 14:40 Peter BARNETT SP-G01: Sound perception

Perception of musical timbre by cochlear-implant listeners – (Contributed, 000395)

O. Macherey and A. Delpierre
Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: macherey@lma.cnrs-mrs.fr

Improving the perception of music by cochlear implant (CI) listeners remains one of the biggest challenge in this research field. The present study aims to better understand how CI users perceive musical timbre.
Three groups of 10 normally-hearing (NH) listeners and one group of 10 CI users were asked to make dissimilarity judgments between pairs of instrumental sounds. The stimuli were 16 synthetic tones spanning a wide range of instrument families. All sounds had the same fundamental frequency (261 Hz) and were balanced in loudness and in duration. One group of NH listeners listened to unprocessed stimuli while the other two NH groups listened to noise-vocoded CI simulations (with 4 and 8 spectral analysis/synthesis channels, respectively). The dissimilarity judgments were analysed using multidimensional scaling.
We found that (1) for all groups, the first two dimensions of the timbre space were strikingly similar and correlated with the log of the attack time and with the spectral centroid, respectively, (2) NH subjects listening to unprocessed sounds gave relatively more weight to the attack time and less weight to the spectral centroid than the other three groups of subjects, (3) Noise-vocoded simulations appear to be a good model of timbre perception by CI subjects.

Tue 15:00 Peter BARNETT SP-G01: Sound perception

Diesel knock noise from combustion phenomenon to perceived signals – (Invited, 000460)

O. Sauvage[a], A. Laurac[b], M.-C. Bezat[a], V. Roussarie[a] and P. Guillemain[c]
[a]PSA Peugeot Citroën, route de Gizy, DRIA/DSTF VV1402, 78943 Velizy Villacoublay Cedex, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: olivier.sauvage@mpsa.com

Combustion noise still remains a major concern when designing engines for vehicles passenger comfort. Among most efficient strategies for reducing Diesel knock are modifications of engine parameters used for controlling combustion processes. This work aims at giving guidelines when controlling these processes to improve customers' combustion noise perception. A methodology is described, which establish a relation between the engine tuning parameters, directly linked to cylinder pressure evolutions, and their effects on perception. We use cyclic Wiener filters allowing realistic overall Diesel noise re-synthesises from cylinder pressure signals. Cylinder pressures are split into elementary components, leading to different types (and patterns) of physically admissible modifications. A perceptive test is then conducted to establish a perceptive space of Diesel combustion noise based on some different pressure cylinder noticeable patterns. An issue is a better understanding of the subjective effects, particularly rhythmic ones, produced by such pulse trains.

Tue 15:20 Peter BARNETT SP-G01: Sound perception

Do electric cars have to make noise? An emblematic opportunity for designing sounds and soundscapes – (Contributed, 000396)

N. Misdariis[a], A. Cera[a], E. Levallois[b] and C. Locqueteau[b]
[a]Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris; [b]Renault-DAPP-Direction des Prestations Clients, 1, Avenue du Golf, 78280 Guyancourt, France
Corresponding author E-mail: nicolas.misdariis@ircam.fr

Electric cars tend to become the emerging generation of automotive vehicles for the next decades. One of their main features is that they are rather silent and then present issues as: must electric cars be sonified for preventing pedestrians from dangers? If necessary, what kind of sound signal is to be put to fulfill safety rules without contributing to the environmental pollution ?
Moreover, because the starting point of this thought is nearly a blank page, it opens a large field of experimentation on different aspects of sound design: innovative approaches to create sounds in interactive configurations, role of sound to convey functional informations, aesthetics qualities or even emotional feelings, etc.
In the frame of an industrial collaboration, we tried to handle these questions by examining the state-of-the-art in that domain, defining the specifications that sound has to comply with (warning for direction and speed, driver feedback of speed and functionning, various branding components, etc.), prototyping various ideas of interactive sonification, and initiating evaluation experiments especially in terms of primary functions (notification of presence and approaching speed).

Some results from different steps of this work together with overall reflections and perspectives on the general topic will be presented and discussed.

Tue 15:40 Peter BARNETT SP-G01: Sound perception

EVADER: Electric Vehicle Alert for Detection and Emergency Response – (Contributed, 000229)

F. Dubois[a], G. Baudet[a] and J.-C. Chamard[b]
[a]RENAULT SAS, Technocentre Guyancourt - 1, avenue du Golf - 78288 Guyancourt - France; [b]PSA Peugeot Citroën, Centre Technique de Velizy, Route de Gisy, 78 943 Vélizy-Villacoublay
Corresponding author E-mail: francoise.dubois@renault.com

The warning effect of vehicle exterior noise for vulnerable users has recently emerged. Quieter cars could reduce pedestrians' ability to travel safely. One of the objectives of the EVADER project is to propose technologies that will allow the best compromise between the potential risk of quiet vehicles for pedestrians and the quietness of residents. First, we identified critical safety scenarios, considering the safety risks and strategies used by pedestrians. Then, we defined the type of vulnerable people, the minimal reaction times, and visual obstacles. The paper aims at characterizing different soundscapes, in order to choose psychoacoustic maskers and determine acoustic characteristics of a selection of vehicles. Finally, a measurement protocol, in order to evaluate the auditory detectability of electric vehicles by pedestrians, is proposed. This work intended to fill the gap between vehicle exterior noises perceptibility and the accident avoidance.

Tue 16:00 Peter BARNETT SP-G01: Sound perception

Perceptual evaluation of the influence of the estimation of Wiener filters applied to engine noise – (Contributed, 000579)

J. Drouet, Q. Leclere and E. Parizet
Laboratoire Vibration Acoustique, INSA, 25 bis avenue Jean Capelle, 69621 Villeurbanne, France
Corresponding author E-mail: julie.drouet@insa-lyon.fr

Sound source separation in diesel engines can be implemented using a Wiener filter or spectrofilter that can extract the combustion contribution from the overall noise. This filter characterizes the transfer function between a cylinder pressure and a measurement point. Thus, a spectrofilter is computed for each cylinder, which induces that an engine is represented by several filters. Its computation depends on operating conditions, which makes the full characterization of the engine very time consuming. The goal of this study is to determine filter parameters modifying the perception of these sounds. An experiment has shown that the engine timbre is mainly dominated by the cylinder pressure. This allows the use of an averaged filter that can be applied to all operating points without lowering the accuracy of the source separation. To that purpose, modal parameters are identified for several spectrofilters to estimate them in the most efficient way, while allowing a good reconstruction. Perceptual experiments are conducted to analyze the effects of this estimation on the combustion noise.

Tue 16:40 Peter BARNETT SP-G01: Sound perception

How does interior car noise alter driver's perception of motion? Multisensory integration in speed perception – (Contributed, 000726)

S. Denjean[a], V. Roussarie[b], R. Kronland-Martinet[a], S. Ystad[a] and J.-L. Velay[c]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]PSA Peugeot Citroën, route de Gizy, DRIA/DSTF VV1402, 78943 Velizy Villacoublay Cedex, France; [c]Institut de neurosciences cognitives de la méditerranée, 31 Chemin Joseph Aiguier 13402 Marseille Cedex 20
Corresponding author E-mail: sebastien.denjean@mpsa.com

Acoustic feedback inside a car is composed of different sources, which give information on the driver's actions and the dynamic state of the car. This acoustic feedback influences the driver's perception of movement in a multisensory integration. The development of electric motorizations brings new balance between noise sources inside the car, due to the loss of engine sound that is present in traditional internal combustion engine cars. To study the influence of this modified noise source balance on driving, we focused on speed perception. A car simulator was used for this purpose. 24 participants were asked to accelerate up to a given target speed, while the speedometer was hidden. We studied the speed they actually reached with three acoustic feedbacks (engine, electric motor, no sound), in two visual conditions (night and day). We found out that acoustic feedback can alter the driver's speed perception.

Tue 17:00 Peter BARNETT SP-G01: Sound perception

Ventriloquism effect on distance auditory cues – (Contributed, 000132)

N. Cote[a], V. Koehl[b] and M. Paquier[b]
[a]Institute of Electronics, Microelectronics and Nanotechnology, UMR CNRS 8520, ISEN department, 41 boulevard Vauban, 59046 Lille, France; [b]Université de Bretagne Occidentale, 6, avenue Victor Le Gorgeu, CS 93837, 29238 Brest Cedex 3, France
Corresponding author E-mail: nicolas.cote@isen.fr

Even though virtual reality applications are nowadays multimodal, developers focus their efforts on the visual rendering system. Complex visual rendering systems using stereoscopic techniques are employed in order to place visual objects in a three dimensions environment. Similar systems such as binaural rendering through headphones can be used for the auditory modality. However, several studies have shown a visual attractive effect in case of audiovisual object which reduces the benefit of complex auditory rendering systems. A cognitive process combines both auditory and visual cues and gives a higher influence to the visual modality. The resulting multimodal object is thus placed at the position of the visual cue. However, this effect has been less studied in the distance dimension [zahorik2001,lewald2001].

This study investigates the effect of disparate visual and auditory distance cues. For this purpose a binaural rendering is employed for auditory cues and combined to a stereoscopic display for visual cues.

The results show an asymmetrical ventriloquism effect in the distance dimension: the relative position of the auditory cue in comparison to the visual cue has an influence on the perceived position of the audiovisual object. A description and a possible explanation of this asymmetrical ventriloquism effect will be detailed in the article.

Tue 17:20 Peter BARNETT SP-G01: Sound perception

Effect of whole body vibrations on sound localization – (Contributed, 000252)

I. Frissen[a] and C. Guastavino[b]
[a]IRCCyN, 1, rue de la noë, 44321 Nantes, France; [b]McGill School of Information Studies, CIRMMT, 3661 Peel street, Montreal, Canada H3A 1X1
Corresponding author E-mail: ilja.frissen@irccyn.ec-nantes.fr

In order to assist the human operator modern auditory interfaces increasingly rely on sound spatialization to display auditory information and warning signals all around the listener. However, we often operate in environments that apply vibrations to the whole body, e.g., when driving a vehicle. So there is a concern that vibrations impair spatial hearing and thereby the efficacy of sound spatialization. While effects of whole-body vibrations have been found to impair simple front-back discrimination, their effect on sound localization per se has received scant attention. In a series of three experiments we investigated these effects with participants seated on a motion platform. In Experiment 1, participants were asked to indicate the location of sounds presented on a circular array of loudspeakers surrounding them. In the other two Experiments participants engaged in a psychophysical interaural time difference discrimination task. In all experiments, we compared the performance in conditions with and without whole-body vibrations at various frequencies (4 or 8Hz) and intensities along the vertical axis. We did not observe significant effects of vibration on sound localization performance. We conclude that whole-body vibrations do not pose a serious concern to the implementation of spatialized auditory feedback in vehicles.

Tue 17:40 Peter BARNETT SP-G01: Sound perception

Masking effects in vertical whole body vibrations – (Contributed, 000126)

C.R. Hernandez and E. Parizet
Laboratoire Vibrations Acoustique INSA Lyon, 25 bis avenue Jean Capelle, Villeurbanne, F-69621 Lyon, France
Corresponding author E-mail: carmen-rosa.hernandez-yanez@insa-lyon.fr

The existence of masking effects for vertical vibrations of seated subjects was investigated. In a first experiment, detection thresholds of sinusoids at six different frequencies (between 30 and 80 Hz) were estimated using a 3-AFC with a three-down one-up rule. Then, thresholds were estimated in the presence of a vibratory masking stimulus: a band pass noise (10 to 20 Hz) at three different levels (between 0.1 and 0.315 m/s2). The presence of this band-pass noise increased the threshold of all studied frequencies. At detection, the overall level of the signal (masker noise plus sinusoid) was greater than the level of the masker noise alone by a value close to the just noticeable differences in level for this noise. Results suggested that the detection was related to a global energy level discrimination process. Finally, some indicators explaining this phenomenon are presented.

Tue 18:00 Peter BARNETT SP-G01: Sound perception

Perceptual influence of the vibratory component on the audio component of alarms produced by rumble strips, by measuring reaction times – (Contributed, 000380)

O. Houix[a], S. Bonnot[a], F. Vienne[b], B. Vericel[b], L.-F. Pardo[c], N. Misdariis[a] and P. Susini[a]
[a]STMS IRCAM-CNRS-UPMC, 1 place Igor Stravinsky, 75004 Paris, France; [b]Département Infrastructures et Mobilité, 58 boulevard Lefebvre, 75732 Paris Cedex 15; [c]UTAC, Autodrome de Linas-Montlhéry, BP 20212 Montlhery Cedex, France
Corresponding author E-mail: olivier.houix@ircam.fr

The aim of the project ROADSENSE ANR-10-VPTT-010-01 is to define a driver assistance that prevents involuntary out of traffic lanes. A rumble strip producing a vibratory and sound alarm provides this help to get back on the road. Based on an objective measurement using simple reaction time, the perceptual influence of the vibratory component on the audio component of alarms produced by rumple strips was studied. Two situations were compared: the first one with sound only and the second one with sound and vibration. During this experiment, participants were placed in a semi-realistic driving situation and were asked to press a pedal as soon as possible when they perceived an alarm. Audio-vibration alarms were synthesized by extracting a signal pattern from real recordings of sound and vibrations produced by rumple strips. This pattern (vibration and sound) was repeated using three different inter onset intervals (IOI). Values of reaction times show neither an effect nor an interaction of the vibration component on the audio component of the alarm. However, the influence of the IOI is important; shorter is the IOI better is the reaction time. This result is in agreement with previous results from the literature.

Tue 18:20 Peter BARNETT SP-G01: Sound perception

Sonifying drawings: characterization of perceptual attributes of sounds produced by human gestures – (Contributed, 000713)

E. Thoret[a], M. Aramaki[a], R. Kronland-Martinet[a], J.-L. Velay[b] and S. Ystad[a]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]Institut de neurosciences cognitives de la méditerranée, 31 Chemin Joseph Aiguier 13402 Marseille Cedex 20
Corresponding author E-mail: aramaki@lma.cnrs-mrs.fr

Friction sounds produced by the pencil of a person who is drawing on a paper are audible and could bring information about his/her gestures. This study firstly focuses on the perceptual significance of the morphology of such sounds, and to what extent gestures could be retrieved by sounds. Sounds recorded during drawing sessions were used in association tests where subjects had to univocally associate friction sounds with different shapes. Results showed that subjects were able to associate sounds with correct shapes and that the auditory characterization of the shape depended on the velocity profile.
A sonification strategy was then proposed for human drawings using a friction sound synthesis model. Inspired by the work of Viviani et al. (1982) who exhibited a 2/3-power law relation between kinetics and shape curvature for visual perception, experiments were carried out with the synthesis model, where subjects were asked to adjust the power law exponent so that the most realistic sound was obtained. Results revealed an exponent close to 2/3 as previously found in vision and thus highlighted a similar power law in the auditory modality, providing an ecological way to determine velocity profiles from static shapes and to generate sounds coherent with human gestures.

Tue 18:40 Peter BARNETT SP-G01: Sound perception

Tribute to Bertram Scharf – (Invited, 000867)

S. Meunier
Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: meunier@lma.cnrs-mrs.fr

Bertram Scharf, a prominent researcher in psychoacoustics, died on 30 November 2011. This presentation is a tribute which the Groupe Perception Sonore of the SFA wishes to pay to him. Since 1978, Professor Scharf divided his time between the USA and France. He was a professor in psychology at the Northeastern university. In France, he was a visiting scientist until the mid-ninety in the "Laboratoire de Mécanique et d'Acoustique" in Marseille and collaborated with the University of Marseille (Faculté de Médecine) until now. The major contributions of Professor Scharf to the field of psychoacoustics concern the perception of intensity. His major works focused on loudness, loudness adaptation and detection. He was among the first who studied, during the nineties, the auditory efferent system using psychoacoustical paradigms. In this presentation, an overview of professor Scharf's work will be done.

Wed 8:00 Paul LANGEVIN Keynote lecture: Dr. Carl Hopkins

Sound insulation in buildings: linking theory and practice – (000871)

C. Hopkins
University of Liverpool, School of Architecture, Abercromby Square, L69 7ZN Liverpool, UK
Corresponding author E-mail: carl.hopkins@liv.ac.uk

The unavailability of theoretical models to predict direct transmission across all types of building element explains why laboratory measurements remain important at the design stage. However, sound insulation in-situ is determined by both direct and flanking transmission; hence prediction models are essential tools. To indicate the limitations of laboratory measurements, transient and steady-state SEA are used to illustrate how the transmission suite affects structural reverberation times of solid test elements and the inherent errors in structural coupling measurements on isolated junctions of walls/floors. In the field, the 'mid-frequency prediction problem' is considered in heavyweight buildings where structural coupling data from isolated junctions is incorporated in models. Despite decades focussing on steady-state sound pressure levels in buildings, transient sources in buildings cause significant disturbance to building occupants, with regulatory requirements based on maximum sound pressure levels to protect against sleep disturbance. Recent work using transient SEA illustrates the potential for the prediction of maximum levels. Concerning the revision of field sound insulation measurement Standards, new approaches are described to improve repeatability below 100Hz, particularly with lightweight constructions where low-frequency

performance can be problematic and to allow testers to use manual scanning to reduce the amount of equipment needed on site.

Wed 8:00 Lord RAYLEIGH Keynote: Pr. Daniel Pressnitzer

The adaptive auditory mind – (000878)

D. Pressnitzer
CNRS & UPD & Ecole normale superieure, Equipe Audition, 29 rue d'Ulm, 75005 Paris, France
Corresponding author E-mail: daniel.pressnitzer@ens.fr

Through hearing, humans and other animals can recognize a large variety of sound sources, navigate complex acoustic scenes, disentangle messages and assess their behavioural relevance. These remarkable feats are currently beyond our understanding and they still exceed the capabilities of the most sophisticated audio engineering systems. In this talk, I will draw upon recent evidence from our lab and elsewhere to suggest that a key aspect of brain function enabling efficient listening is the ability to rapidly adapt, online, to the sounds and tasks at hand. For instance, sound recognition through timbre can rely on rather complex acoustic features that are opportunistic, in the sense that they can be tailored to specific sound categories such as the human voice. Auditory scene analysis (the ability to follow a sound source in a mixture) recruits a widely distributed brain network that focuses the whole chain of processing on the attended stream. This processing is itself labile, as acoustic context can have a rapid and profound influence on basic auditory features such as pitch or vowel quality. Finally, auditory memory is rapidly established, and thus almost inevitably recruited in many listening task. Taken together, these recent experimental findings suggest that adaptive coding could be an integral part of how the human auditory system deals successfully with natural acoustic scenes.

Wed 9:00 Philip DOAK AH-S01: Wall pressure fluctuations

Sensing wall-pressure fluctuations by particle image velocimetry – (Invited, 000875)

F. Scarano and S. Ghaemi
TU Delft, Aerospace Engineering Dept., Kluyverweg 1, 2629HS Delft, Netherlands
Corresponding author E-mail: f.scarano@tudelft.nl

The use of particle image velocimetry (PIV) to measure the instantaneous pressure field and in particular the pressure at solid boundaries is discussed. The method is based on the use of time-resolved PIV measurements combined with the evaluation of the momentum equation to solve for the pressure gradient and its subsequent spatial integration. In principle, the application of this technique is straightforward, but it requires a careful assessment of error propagation. In exchange, the method offers the potential to measure pressure fluctuations over a very wide range of flow regimes as demonstrated by experiments performed on bluff-body flows (de Kat and van Oudheusden, 2011) and cavities (Haigermoser, 2009). In two-dimensional unsteady flows, the fluctuating pressure distribution evaluated at the surface is used as input for the evaluation of acoustic pressure fluctuations making use of Curle's analogy, in cavity flow experiments (Kostchatzky et al., 2011) and to predict the noise emissions from a rod-airfoil system (Lorenzoni et al., 2009). From recent experiments with tomographic PIV the accuracy and reliability of such approach has also been established for broadband pressure fluctuations as they occur in turbulent boundary layers (Ghaemi and Scarano, 2012) and more prominently at the trailing edge of airfoils.

Wed 9:20 Philip DOAK AH-S01: Wall pressure fluctuations

Identification of the acoustic component in the turbulent boundary layer excitation by the Force Analysis Technique – (Invited, 000271)

D. Lecoq, C. Pezerat, J.-H. Thomas and W. Bi
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: damien.lecoq@univ-lemans.fr

Turbulent flows, due to the presence of obstacles or turbulent boundary layers near the structure, generate vibrations and can be a major source of noise. This kind of excitation have two components: the aerodynamic and the acoustic parts respectively in the high and low wavenumbers. The vibrations and acoustic radiations of the wall

are more sensitive to the acoustic component. Indeed, the wavelengths of the aerodynamic part are very small and they excite modes with low radiation. However, the aerodynamic part has a very high amplitude, so that the acoustic component becomes very difficult to assess by measurement.
The study aims to use the Force Analysis Technique (FAT), also known by its french acronym RIFF (Résolution Inverse Filtrée Fenêtrée), to measure these excitations.
In this work, the acoustic pressure identification is tested by performing a numerical experiment where excitation is obtained by a synthesis method of time signals by Cholesky decomposition of cross spectra matrices.
Thanks to the wavenumber filtering of the Force Analysis Technique, the results show that the acoustic component can be extracted even if its energy level is very small with respect to that of the aerodynamic component.

Wed 9:40 Philip DOAK AH-S01: Wall pressure fluctuations

Vibration and noise radiation from a panel excited by a turbulent flow – (Contributed, 000743)

M. Smith and E. Latorre Iglesias
Institute of Sound and Vibration Research, University of Southampton, University Road, S017 1B Southampton, UK
Corresponding author E-mail: mgs@isvr.soton.ac.uk

Experiments to simulate the flow induced vibration and noise radiation from a car window are described. Two cases are considered: flow over a backwards-facing step and flow over a half-cylinder placed on a flat plate. The first configuration represents the flow separation and subsequent flow re-attachment into a turbulent boundary layer generated by the A-pillar of a car. The second configuration is representative of the turbulent flow over a side window produced by a car wing mirror. Measurements were carried out in an open jet anechoic wind tunnel at ISVR, where a very low noise flow of up to 40 m/s can be achieved. Wall pressure fluctuations were measured using a streamwise array of microphones, from which the frequency-wavenumber spectrum of the pressure fluctuations was obtained. The vibrational response of the test panel was measured on a grid of points and noise radiation was measured using sound intensity mapping and a fixed microphone in the acoustic far-field. The data are analysed to determine the relative importance of acoustic and convective excitation of the panel.

Wed 10:00 Philip DOAK AH-S01: Wall pressure fluctuations

Wavenumber-frequency analysis of the wall pressure fluctuations in the wake of a rear view mirror using a lattice Boltzmann model – (Contributed, 000251)

F. A. Van Herpe[a], S. Vergne[a] and E. Gaudard[b]
[a]PSA PEUGEOT CITROËN, Case Courrier VV1405, Centre Technique de Vélizy A - Route de Gisy, 78140 Velizy Villacoublay, France; [b]UPMC-IJLRDA(UMR 7190), 4, Place Jussieu, Cedex 05, 75252 Paris, France
Corresponding author E-mail: sandrine.vergne@mpsa.com

An emerging method for the numerical prediction of the wind noise inside a car is the coupling of an unsteady Computational Fluid Dynamics (CFD) solver to a Statistical Energy Analysis (SEA) solver. This approach requires the separation between the aerodynamic and the acoustic components of the Wall Pressure Fluctuations (WPF) loading the car greenhouse panels. Those two components correspond indeed in SEA to two different paths of sound transmission: the structure-borne path and the air-borne path. Is has been recently shown using Direct Noise Computation that a wavenumber-frequency Fourier transform of the WPF allows separating the convective aerodynamic component from the propagating acoustic component. We investigate in this paper the ability of the Lattice Boltzmann based CFD code PowerFLOW to capture the low level acoustic component of the WPF in the wake of a rear view mirror over a flat panel. We compare two options in the simulated Mach number setting: The default mode where the Mach number is chosen by PowerFLOW as high as it can in order to reduce the simulation time, and the mode where the simulated Mach number is chosen so that acoustic waves propagate at the same speed as they do in experiment.

Wed 10:40 Philip DOAK AH-S01: Wall pressure fluctuations

Pressure spectra along cylinder computed from RANS simulations – (Contributed, 000303)

S. M. Monte
Institue Jean le Rond d'Alembert, UMR 7190, Université Pierre et Marie Curie, 4 Place Jussieu - case 162, 75252 Paris Cedex 05, France
Corresponding author E-mail: stephane.monte@gmail.com

The present work is about three-dimensional, turbulent flow over a long circular cylinder where the free- stream is aligned with the cylinder axis. A major example of such flow is that of towed sonar arrays. To design correctly the a towed array, it is important to consider among many other things, the pressure fluctuations generated by the turbulent flow around the cylinder. A towed sonar array is a linear cylinder with a very large length to radius ratio. With such a ratio, curvature effects involved in the flow along shall not be neglected and flat plate based models do not describe correctly the pressure fluctuations. Moreover, DNS are not suitable for development stage of a new model, or prediction of the pressure spectra over a towed array for industrial applications.
The present investigation suggests a new way of dealing quickly and accurately with the pressure spectrums. Pressure correlations, and therefore the pressure spectra are computed integrating Poisson's equation using incompressible Reynolds Average Numerical Simulations and modeled velocity correlations. The present model allows to have accurate pressure space/time correlations , and thus wavenumbers spectrum, for a wide range of curvature ratios for Reynolds numbers relevant to underwater applications.

Wed 11:00 Philip DOAK AH-S01: Wall pressure fluctuations

Laboratory synthesis of turbulent boundary layer wall-pressures and the induced vibro-acoustic response – (Invited, 000057)

C. Maury[a] and T. Bravo[b]
[a]Ecole Centrale Marseille - LMA, CNRS - LMA, 31 chemin Joseph Aiguier, 13402 Marseille Cedex 20, France; [b]Centro de Acustica Aplicada y Evaluacion No Destructiva (CAEND), CSIC - UPM, Serrano 144, 28006 Madrid, Spain
Corresponding author E-mail: cedric.maury@centrale-marseille.fr

Theoretical and practical feasibility is considered of synthesizing spatially correlated random pressure fields whose statistical properties are similar to that generated by a fully-developed Turbulent Boundary Layer (TBL) over a panel. Laboratory synthesis of TBL excitation would provide a cost-efficient approach, complementary to in-flight or wind-tunnel measurements, in order to test potential solutions to reduce the TBL-induced noise, of relevance within both the aeronautical and surface transport sectors. Of particular interest is the use of a near-field array of suitably driven acoustic sources with an important question: how many uncorrelated sources are required per correlation length to approximate a TBL excitation and the induced vibro-acoustic response ? Due to the exponential decay of the spanwise correlation length with frequency, real-time TBL synthesis appears to be only feasible in the low frequency range. However, the structural and radiative filtering properties of the panel dramatically reduces the number of sources required, thus allowing a synthesis of the panel vibro-acoustic response beyond the hydrodynamic coincidence frequency using a reasonable number of sources. Such theoretical findings have been confirmed experimentally. Effective methodologies are also proposed for an accurate reproduction of the TBL-induced sound power radiated by a panel when coupled to a cavity.

Wed 11:20 Philip DOAK AH-S01: Wall pressure fluctuations

Experimental investigation of the vibration of a slotted plate and the acoustic field in a plane impinging jet – (Contributed, 000030)

H.H. Assoum[a], A. Sakout[a], M. El Hassan[b], J. Vetel[b], A. Alia[c] and K. Abed-Meraïm[a]
[a]Laboratoire d'Étude des Phénomènes de Transfert et de l'Instantanéité : Agro-industrie et Bâtiment, Bâtiment Fourier Avenue Michel Crépeau F-17042 La Rochelle Cedex 1; [b]Fluid Dynamics Laboratory, Ecole Polytechnique de Montréal, Montréal, Canada QC H3T 1J4; [c]Laboratoire de mécanique de Lille, Bâtiment M6 Bvd Paul Langevin 59655 Villeneuve d'Ascq Cedex
Corresponding author E-mail: hassan.assoum@gmail.com

The impinging jet is a flow configuration in which a fluid issuing from a simple geometry hits a wall (perpendicular or with angle). Impinging jet exhibits rich phenomena in terms of vortex structures and fluid-structure interaction. These phenomena become more complicated if the obstacle (a plate in this study) has a slot and are accompanied in some cases by a high level of noise due to the installation of a loop of self-sustained tones. Several parameters influence these phenomena such as the Reynolds number and the plate to nozzle distance. Therefore, we consider a plane jet issuing from a rectangular nozzle and a slotted plate. The sound pressure and the plate vibration are respectively measured using a microphone and accelerometers mounted on the plate. The spectra of both sound and vibration signal and the corresponding coherences are presented. This study brings out the correlation between the plate vibration and the acoustic field in a plane impinging jet for two Reynolds numbers (Re = 12350 and Re = 18200).

Wed 11:40 Philip DOAK AH-S01: Wall pressure fluctuations

Analysis of the vibracoustic behavior of a plate excited by synthetized aeroacoustic pressure fields – (Contributed, 000687)

D. Ricot[a], A. Hekmati[b] and P. Druault[c]
[a]RENAULT, Research Advanced Engineering and Materials Department, TCR AVA 1 63, 1 av. du Golf, 78288 Guyancourt, France; [b]TECHNOCENTRE RENAULT, TCR AVA 1 63, 1 av. du Golf, 78288 Guyancourt, France; [c]Institut Jean Le Rond d'Alembert, Boite 162 4 place Jussieu 75005 Paris
Corresponding author E-mail: denis.ricot@renault.com

Due to acoustics, comfort has become one of the principal concerns for car manufacturers, it is important to improve: (1) the knowledge of the car panel vibrations which are due to two different components: acoustic excitation and turbulent wall pressure one, and (2)the associated radiation simulation in the car interior.
In this paper, first, we propose to synthetize such aeroacoustic wall pressure field based on Cholesky decomposition. Using analytical expressions of the Cross Power Spectral Density of an acoustic diffuse field and of a turbulent flow (Corcos model), spatial distributions of turbulent and acoustic excitations are determined in term of amplitude and phase in the frequency domain. Then, as a second step, the vibroacoustic behavior of a simply-supported plate excited by these synthetized fields is computed thanks to FEM calculations (ACTRAN software). The radiated field is then successively estimated for the acoustic excitation, the turbulent one and for both aeroacoustic excitations. The effect of flow inhomogeneity on the radiation field has been also regarded. Finally, a statistical analysis between radiated field and excitation fields is performed thanks to the coherence function analysis. It is then confirmed that such analysis presents some limits especially when dealing with uncorrelated sources of noise.

Wed 9:00 Ray STEPHENS EN-S02: Transportation and industrial noise

Evaluation of the acoustical performance and behaviour of a hybrid truck in urban use – (Invited, 000143)

M.-A. Pallas, R. Chatagnon and J. Lelong
IFSTTAR, 25 avenue F. Mitterrand, case 24, 69675 Bron Cedex, France
Corresponding author E-mail: marie-agnes.pallas@ifsttar.fr

Noise emission of mid-sized trucks operating in urban areas for goods delivery and services (for instance waste collect) is crucial, mainly during night and early morning periods. The development of hybrid vehicles is particularly appropriate to urban use since, besides improvements towards energy consumption and pollutant emission, it may also lead to noise reduction, mainly due to the presence of the electric motor. The French research project GEODE (project leader Renault Trucks) gathered several partners for the development of a mid-sized hybrid truck with optimized energy control. One work package consisted in the evaluation of the environmental performance of the vehicle, as compared to an equivalent conventional engine truck. The present paper presents the acoustical part, based on measurements of the acoustic emission under real use conditions: constant speed, acceleration and braking. It includes standard pass-by 7.5 meter noise levels as well as main source analysis, the latter resulting from near-field microphone array measurements, for each vehicle configuration (reference engine truck, hybrid truck under hybrid use, hybrid truck under electrical use). Noise emission laws of the vehicles and of their main noise sources are determined. The electrical mode introduces an undeniable gain at urban speeds, the residual noise resulting mainly from the drive wheel rolling noise.

Wed 9:20 Ray STEPHENS EN-S02: Transportation and industrial noise

Simplified model of a harmonic point source moving above an impedance ground – (Contributed, 000007)

F. Golay[a], G. Dutilleux[a], L. Simon[a], C. Ayrault[b] and F. Poisson[c]
[a]Laboratoire Régional de Strasbourg, 11, rue Jean Mentelin, 67035 Strasbourg Cedex 2, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Innovation et recherche SNCF, 40 avenue des terroirs de France, 75012 Paris
Corresponding author E-mail: francis.golay@developpement-durable.gouv.fr

Transportation noise is an important source in terms of annoyance in urban and suburban area. Modelling sound propagation from these moving sources needs an efficient prediction tool. The classical theory due to Morse and Ingard is limited to free space. A reference model has been proposed for modelling the pressure field generated

by a harmonic point source moving above a flat impedance ground which takes into account the spherical wave reflection coefficient. The complexity of the reference model has resulted in a heuristic model intuitively derived from a model for a motionless harmonic sound source, by including Doppler corrections. However the predictions of this heuristic model are significantly different from those of the reference model. In this paper, we propose a simplification of the reference model, by approximating the variables by constants or by linear expressions on small time intervals. Compared with the reference model, this simplified model is faster. In addition, it makes the physical link between the reference and the heuristic models. Numerical simulations confirm the accuracy of the simplified model.

Wed 9:40 Ray STEPHENS EN-S02: Transportation and industrial noise

Two algorithms for the sorting of unknown train vibration signals into freight and passenger train categories – (Contributed, 000158)

C. J. Sharp, D. Waddington, J. Woodcock, G. Sica, E. Peris and A. Moorhouse
University of Salford, The Crescent, M5 4WT Salford, UK
Corresponding author E-mail: c.sharp@edu.salford.ac.uk

The human response to railway noise is well researched; however, there is a need to further research the human response to freight railway vibration. To facilitate this, two algorithms have been constructed with the aim of sorting unknown train vibration signals into freight and passenger train categories so that they can be further analysed. 307 known train vibration signals measured close to the railway were analysed to determine which signal properties, if any, are identifiably different for freight and passenger train vibration signals. These data were collected within the Defra funded UK study "Human Response to Vibration in Residential Environmentsï conducted by the University of Salford. Several signal properties were found to be statistically significantly different for freight and passenger train vibration signals, all of which relate either to the duration of the signal event or its frequency content. These differences were used to successfully create two algorithms that are capable of sorting unknown train signals into freight and passenger train categories at a relatively high level of accuracy. The methodology used in creating the algorithms, their level of accuracy and recommendations for their use will be presented in this paper.

Wed 10:40 Ray STEPHENS EN-S02: Transportation and industrial noise

Physical and perceptual characterization of road traffic noises in urban areas for a better noise annoyance assessment – (Contributed, 000378)

J. Morel[a], C. Marquis-Favre[b], M. Pierrette[c] and L.-A. Gille[d]
[a]MEDDTL - Mission Bruit et Agents Physiques, Grande Arche, 92055 La Défense Cedex, France; [b]Université de Lyon - ENTPE, rue Maurice Audin, 69120 Vaulx-En-Velin, France; [c]Université Paris Ouest Nanterre La Défense, Laboratoire Psychologie des Processus et des Conduites Complexes, 200, avenue de la république, 92002 Nanterre, France; [d]CETE Ile de France, 319 avenue Georges Clémenceau, BP 505, 77015 Melun Cedex, France
Corresponding author E-mail: julien.morel@developpement-durable.gouv.fr

The work presented in this paper intends to contribute to improve noise maps by a more meaningful characterization of urban road traffic noises. In this aim, in situ recorded pass-by noises, following an a priori physical typology, are submitted to a panel of subjects via a free categorization and free verbalization tasks. This resulted in the proposal of a perceptual and cognitive typology of road traffic pass-by noises that was further confirmed by the results of a pair-wise comparison test. The 7 categories of the perceptual and cognitive typology were then studied separately from noise annoyance point of view. Annoyance indicators were then proposed to characterize each category of vehicle pass-by noises by taking into account their spectral and temporal specificities.

Wed 11:00 Ray STEPHENS EN-S02: Transportation and industrial noise

Design of Electric or Hybrid vehicle alert sound system for pedestrian – (Contributed, 000832)

J.-C. Chamard and V. Roussarie
PSA Peugeot Citroën, Centre Technique de Velizy, Route de Gisy, 78 943 Vélizy-Villacoublay
Corresponding author E-mail: jeanchristophe.chamard@mpsa.com

The arrival of fully or hybrid electric vehicles raised safety problems respect to the other users (pedestrians, cyclists,oe) because of their low emission level. A technical solution to solve this problem is to generate an alert sound. This signal has to improve the interaction of the vehicle with its environment. Thus , the signal must carry relative information to the situation of rolling: speed of the vehicle, stabilized speed, phase of acceleration/deceleration, intentions of the driveroe All this without disturb the resident's quietness. How translate this in term of signal processing and how define the level of emission? We propose to present the results of tests carried out with an aim of answering those questions.

Wed 11:20 Ray STEPHENS EN-S02: Transportation and industrial noise

The French Environment and Energy Management Agency (ADEME) is working to prevent and reduce environmental noise – (Contributed, 000237)

E. Thibier
ADEME, 500 rte Lucioles, 06560 Valbonnne, France
Corresponding author E-mail: emmanuel.thibier@ademe.fr

The French Environment and Energy Management Agency (ADEME) is working to prevent and reduce environmental noise particularly where exposure levels can induce harmful effects on human health. Focusing on road and railway traffic noise, ADEME helps local authorities and stakeholders implement their noise reduction plans.

The national target is to reduce the equivalent noise level near the façades of buildings (housing or apartments, hospitals or schools) to below Lden=63 dB(A).

To reach this target, ADEME has developed two modes of action. Firstly priority is given to reducing the sources of noise, in particular traffic noise, by building noise barriers close to the roads.

The second mode of action is facilitating sound insulation of the façades of buildings.

ADEME's budget for noise reduction is 160 million euros for the 5 year period: 2009-2013.

Wed 11:40 Ray STEPHENS EN-S02: Transportation and industrial noise

Improving existing façade insulation against railway noise – (Contributed, 000641)

J. A.E. Paris-Newton, D. Chapman, C. Luciani and R. G. Mackenzie
Building Performance Centre, 42 Colinton Road, Edinburgh, EH10 7DT Edinburgh, UK
Corresponding author E-mail: j.paris@napier.ac.uk

The Environment Round Table of the French government ("Grenelle de l'environnementï) has focused efforts on the development of alternatives to road transport. A conclusion from these studies has been that railway usage is expected to increase in the future. Departmental noise transport committees were set up in 2001 in order to take an inventory of noise sensitive receivers and to look at technical solutions which could be implemented. A project had been undertaken which studied the insulation offered by existing dwelling facades at 800 properties subject to railway noise. In order to quantify the sound insulation performance, measurements of facade insulation have been carried out and compared to the day and night-time performance targets detailed by the policy document "Circulaire 25 Mai 2004ï. Where necessary, the sound insulation and the ventilation performance of the facades have been improved to meet the requirement of the aforementioned regulations.

Wed 9:00 John TYNDALL MA-S03: Interaction between a musician and his/her instrument

Influence of the fluctuations of the control pressure on the sound production in flute-like instruments – (Invited, 000486)

R. Auvray[a], B. Fabre[a], P.-Y. Lagrée[b], S. Terrien[c] and C. Vergez[c]
[a]Équipe LAM - d'Alembert, 11 rue de Lourmel, 75015 Paris, France; [b]CNRS / équipe FCIH - d'Alembert, 4 place Jussieu, 75005 Paris, France; [c]LMA - CNRS (UPR 7051), 31 chemin Joseph-Aiguier, 13402 Marseille, Cedex 20, France
Corresponding author E-mail: auvray@lam.jussieu.fr

In flutes and flue organ pipes, the supply pressure is often considered as a control parameter at time scales lower than the acoustic time scales. For instance, the typical time of a rise of pressure represents an objective descriptor to analyse attacks (typical time about 20 ms for fast attacks). It has been observed that the supply pressure is also prone to oscillate at time scales of the order of the acoustic time scales. This is due to the acoustic coupling

between the instrument and the pressure reservoir. The present work investigates the influence of such a coupling on the sound production, and its pertinence from a musical point a view. In other words, can the ability of a musician (or an instrument maker) to control this coupling be regarded as a control parameter of the sound production? This paper presents a preliminary experimental study focused on the effects of a pulsating supply pressure on the sound production. The fluctuations of the supply pressure are forced by using a loudspeaker within an artificial mouth. Different effects – such as modifications of the spectral enhancement, shifts in the regime change thresholds or changes in the transients –, resulting from different supply and "coupling" conditions are presented.

Wed 9:20 John TYNDALL MA-S03: Interaction between a musician and his/her instrument

Experimental study of the musician / instrument interaction in the case of the concert harp – (Contributed, 000345)

D. Chadefaux[a], M. Wanderley[b], J.-L. Le Carrou[a], B. Fabre[a] and L. Daudet[c]
[a]Equipe LAM - d'Alembert, 11, rue de Lourmel, 75015 Paris, France; [b]IDMIL / CIRMMT McGill University, 555, Sherbrooke Street West, Montreal, Canada H3A 1E3; [c]Institut Langevin " Ondes et Images "", 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: chadefaux@lam.jussieu.fr

Over the years, a trained musician develops the ability to produce a sound as desired: the player's gestures are precisely executed, in order to control each note. In the case of the concert harp, a previous study had underlined the characteristics of string plucking, both highly reproducible and player-specific. However, the whole harpist's body is obviously also involved in a musical performance. Therefore, the present paper investigates the player / harp interaction, by characterizing the musical gestures in relation to the musical interpretation. We have captured the motion of three skilled harpists playing Debussy's Danse Profane, using a tracking system based on infrared cameras. Acoustical signals have been measured synchronously. A set of acoustical and kinematic descriptors has been extracted from the collected data. They provide features of instrumental gestures (directly related to the sound production) and ancillary gestures (not directly involved in the sound production). Results indicate that instrumental gestures have common characteristics from one player to another, while ancillary gestures are specific to her/him. It is also shown that harpists perform remarkably reproducible gestures. Finally, the analysis of the harpist's strategy highlights the relationship between physical properties and the objectives of harp performance.

Wed 9:00 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

Examples of the use of anemometry and flow visualisation for experimental studies of physical speech production mechanisms – (Invited, 000100)

A. Van Hirtum
Gipsa-lab, UMR CNRS 5126, Grenoble Universities, 38000 Grenoble, France
Corresponding author E-mail: annemie.vanhirtum@gipsa-lab.grenoble-inp.fr

A qualitative and quantitative study of flow variables is a main ingredient of physical studies of human speech production. Nevertheless, the term 'human speech sounds' stands for a large variety of sounds which are produced using different mechanisms and which can be roughly divided into two categories: voiced and unvoiced sounds. Voiced sounds are due to a fluid structure interaction in the glottis between airflow coming from the lungs and the surrounding deformable vocal folds tissues. Unvoiced sounds on the other hand are due to the interaction of a turbulent jet issued somewhere in the upper airways and a quasi rigid obstacle such as tongue or teeth. As such physical modelling of voiced sounds requires qualitative and quantitative knowledge of the mean flow properties and the tissue properties in order to estimate the force distribution on the vocal folds tissues. The study of unvoiced sounds on the other hand requires besides knowledge of the mean flow the qualitative and quantitative characterisation of the fluctuating flow field. Consequently, in case unvoiced sounds are of interest the combined use of flow visualisation and anemometry becomes highly attractive since fluctuations due to vortex generation and/or randomness can be studied qualitatively as well as quantitatively.

Wed 9:20 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

A comparison of vibration analysis techniques applied to the Persian setar – (Contributed, 000140)

H. Mansour[a,b] and G. P. Scavone[a,b]
[a]Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), 527 Rue Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3; [b]Computational Acoustic Modeling Lab, Schulich School of Music, McGill University, 555 Rue Sherbrooke Ouest, Montreal,

QC, Canada H3A 1E3
Corresponding author E-mail: hossein.mansour@mail.mcgill.ca

Modal analysis is a well-known technique and its application to stringed instruments has a long history, yet there is no universal agreement on the measurement setup to be used for this purpose. In this study, measurements of a Persion setar are compared using an impulse hammer or a handheld shaker as excitation and an accelerometer or Laser Doppler Vibrometer to record the response. As well, measurements were made with the setar both suspended, to produce a free-free boundary condition, and clamped at its neck. Natural frequencies, modal damping, and mode shapes are extracted for the first 12 structural modes, covering up to 2 kHz. In our results, both the accelerometer and shaker dramatically affect the structure and thus, depending on the context, they are probably best avoided if possible for the case of the setar and similar instruments. However, the modal map of the free-free setar was in close agreement with the clamped condition; therefore, measurements on the setar (and perhaps other long-necked lutes) can be performed on a clamped instrument unless the accurate damping properties are of interest.

Wed 9:40 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

Objective and subjective characterization of saxophone reeds – (Contributed, 000464)

B. Gazengel[a], J.-F. Petiot[b] and M. Šoltés[c]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Ecole Centrale de Nantes, 1 rue de la noe, BP 92101, 44321 Nantes, France; [c]Department of Physics, Czech Technical University, Technická 2, 16627 Prague 6, Czech Republic
Corresponding author E-mail: bruno.gazengel@univ-lemans.fr

The subjective quality of single cane reed used for saxophone or clarinet may be very different from a reed to another although reeds present the same shape and the same strength. In this work, we propose to compare three approaches for the characterization of reeds properties.
The first approach consists in measuring the reed mechanical response by the mean of a specific bench which gives equivalent dynamic parameters (mass, damping, stiffness) of the first vibration mode and the non linear stiffness of the reed. The second approach deals with the measurement of playing parameters "in vivoï, using specific sensors put on the instrument mouthpiece. These measurements enable us to deduce specific parameters in playing condition, such as the threshold pressure or the spectral centroid. Finally, subjective tests are performed on musicians in order to deduce the independent subjective criteria which characterize the quality of reeds.
Different reeds chosen for their subjective differences (rather difficult and dark, medium, rather easy and bright) are characterized by the three methods. First results show that correlations can be established between "in vivoï measurements and subjective assessments.

Wed 10:40 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

An experimental replica of the vocal folds to study normal and pathological voice – (Contributed, 000629)

X. Pelorson and X. Laval
Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex
Corresponding author E-mail: xavier.pelorson@gipsa-lab.grenoble-inp.fr

In order to test the relevance and accuracy of theoretical models for speech production, validation on in-vitro controlled set-ups is needed. Since the pioneer work of Van Den Berg (1957) numerous mechanical replicas have been built in an increasing effort towards rendering the complexity of the human vocal folds. In this paper we present a new experimental set-up based on a replica of the vocal folds made of several successive layers of liquids and latex. Compared with existing mechanical models, this replica allows that essential parameters such as the degree of abduction, the acoustical loading, the upstream pressure and the elasticity of the replica can be controlled and varied individually. Further, pathological configurations, involving a local alteration of the vocal folds, such as polyps and cysts, can be easily simulated by adding growths of known masses and shapes. Typical examples of measurements performed on this replica will be presented for normal and pathological configurations. The results will be discussed with respect to human phonation and compared to some theoretical predictions using low-order mechanical models.

Wed 11:00 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

Time-Reversal Imaging and Field-Separation-Method applied to the study of the Steelpan radiation – (Contributed, 000653)

E. Bavu[a], C. Auzou[a], M. Monteil[b,c], M. Melon[a], C. Langrenne[a] and A. Garcia[a]
[a]Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03; [b]IJLRDA-UPMC, 4 place jussieu, 75005 Paris, France; [c]UME (Unité de Mécanique), ENSTA - ParisTech, Chemin de la Hunière, 91761 Palaiseau, France
Corresponding author E-mail: eric.bavu@cnam.fr

Time reversal (TR) is a powerful method for the imaging and localization of sound sources. We propose the use of TR imaging in conjunction with a field separation method (FSM) in order to study the radiating sources of a Steelpan.
The TR-FSM method consists in measuring the acoustic pressure on a double-layer hemispherical time reversal mirror (TRM). Outgoing waves are separated from ingoing waves by using spherical-harmonic expansions. The outgoing contribution is then time-reversed and numerically backpropagated, allowing to achieve accurate imaging of acoustically radiating sources. This FSM also allows to separate contributions from noise source outside the region of interest, thus separating the contributions from zones on the instrument. In this study, this imaging method is used for the imaging of radiating sources on a Steelpan played by a performer. The results show that in some situations, the main contribution to the radiation comes from zones that were not mechanically excited by the steelpanist.

Wed 11:20 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

Measuring the effect of the reflection of sound from the lips in brass musical instruments – (Invited, 000662)

J. A. Kemp[a] and R. A. Smith[b]
[a]University of St Andrews, 65 North Street, KY16 9AJ St Andrews, Fife, UK; [b]Smith Watkins Trumpets, Cornborough, YO60 6RU Sheriff Hutton, Yorkshire, UK
Corresponding author E-mail: jk50@st-andrews.ac.uk

The lips of the player are often assumed to perfectly reflect sounds that strike them. Experimental and theoretical calculations of input impedance demonstrate the pressure that would build up if a flat, perfectly reflecting volume velocity source were used to excite the air into vibration. In reality the lips should project slightly into the instrument mouthpiece and absorb a small amount of the energy that strikes them and this study will quantify this effect using wave separation/impedance apparatus. For closed lips it is expected that the strength of resonances will be reduced, but that the correction will be small. The condition for reflection from lips that are not fully closed will differ more significantly from perfect reflection and it is anticipated that this data will be useful for integration into physical models of brass instruments.

Wed 11:40 Peter BARNETT MA-S09: Measurement techniques for instruments and speech (co-organised with 'HS')

Investigation of bassoon embouchures with an artificial mouth – (Contributed, 000669)

T. Grothe
Technische Universität Dresden, Marschner Str. 32, 01307 Dresden, Germany
Corresponding author E-mail: timo.grothe@tu-dresden.de

Playing double-reed woodwinds in tune requires individual embouchure adjustments for each fingering. By pressing his lips to the opposing reed blades, the musician can finetune the amplitude and frequency of oscillation, which is only roughly set by the fingering.
For a controlled study under realistic conditions, an artificial mouth with adjustable lips has been constructed which enables the measurement of the integral force exerted to the reed while playing. Experimental results on a synthetic bassoon double-reed are presented.
The reed's resonance frequency and damping are estimated based on acoustic impedance measurements at the reed outflow end. In the quasi-stationary flow regime, pressure-flow characteristics were recorded with respect to the lip force and lip position on the double-reed. For a lumped reed-model, parameters corresponding to realistic embouchures can be deduced. In the dynamic regime, for all standard fingerings, values for time-averaged lip force and blowing pressure are identified at which the instrument sounds at a fixed nominal frequency (f_0 = 58-620 Hz).
This investigation provides insights into the necessary embouchure corrections of a bassoonist while playing successive notes in tune at a given dynamic level. The obtained parameter ranges might be useful for physical modelling of the bassoon.

Wed 9:00 Pierre CHAVASSE MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Absorbing boundary conditions for anisotropic elastodynamic media – (Contributed, 000654)

H. Barucq[a], L. Boillot[a], H. Calandra[b] and J. Diaz[a]
[a]INRIA, Universite de Pau, Avenue de l'Universite, 64013 Pau, France; [b]Total, Centre Scientifique et Technique Jean Féger, Avenue Larribau, 64018 Pau, France
Corresponding author E-mail: julien.diaz@inria.fr

Most numerical codes modeling wave propagation for seismic imaging are based on isotropic elastodynamic equations. These equations are not appropriate to model complex geophysical media and, to perform more realistic simulations, it is necessary to take into account the anisotropy of the media. Therefore numerical methods should now be adapted to Vertical Transverse Isotropy (VTI) and Tilted Transverse Isotropy (TTI). This extension increases dramatically the number of parameters to be stored in each cell of the mesh and we need to develop efficient techniques to reduce the computational costs. In particular, we wish to develop artificial boundary conditions to reduce the size of the computational domain. This can be done by using Absorbing Boundary Conditions (ABCs) or Perfectly Matched Layers (PMLs). However, ABCs are only adapted to homogeneous and isotropic media. On the other hand, PMLs are unstable in most TTI media. The aim of this talk is to present a new ABC modeling the propagation of anisotropic waves in heterogeneous media. Contrary to PML, this ABC can be applied on arbitrarily shaped convex boundary. Numerical results obtained by a Discontinuous Galerkin method will illustrate the performance of the condition.

Wed 9:20 Pierre CHAVASSE MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Simulation of wave propagation in anisotropic poroelastic bone plate immersed in fluid – (Contributed, 000700)

V.-H. Nguyen and S. Naili
Université Paris-Est, 61 avenue du Général de Gaulle, 94010 Créteil Cedex, France
Corresponding author E-mail: vu-hieu.nguyen@univ-paris-est.fr

This paper deals with modeling of the ultrasound axial transmission technique for in vivo cortical long bone which is known as being a anisotropic solid medium with functionally graded porosity. The bone is modeled as an anisotropic poroelastic medium using the Biot's theory. We develop a hybrid spectral/finite element formulation to obtain the time-domain solution of ultrasonic waves propagating in a poroelastic plate immersed two fluid halfspaces. The numerical method is based on a combined Laplace-Fourier transform which solves the problem in the frequency-wavenumber domain. In the spectral domain, as radiation conditions may be exactly introduced in the infinite fluid halfspaces, only the heterogeneous solid layer needs to be analyzed using finite element method. Several numerical tests are presented showing very good performances of the proposed approach. A preliminary study on the FAS (First Arrived Signal) velocities computed by using equivalent elastic and poroelastic models will be presented.

Wed 9:40 Pierre CHAVASSE MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Experimental identification of a prior tensor-valued random field for the elasticity properties of cortical bones using in vivo ultrasonic measurements – (Invited, 000477)

C. Desceliers[a], C. Soize[a], S. Naili[b] and G. Haiat[b]
[a]Université Paris-Est, 5 bd Descartes, 77454 Champs-Sur-Marne, France; [b]Université Paris-Est, 61 avenue du Général de Gaulle, 94010 Créteil Cedex, France
Corresponding author E-mail: christophe.desceliers@univ-paris-est.fr

A cortical bone layer is a biomechanical system which is difficult to model due to the complexity level of its microstructure. The experimental identification of its effective mechanical properties at the macroscale is usually carried out using the axial transmission technique which is often modeled with a mean mechanical model. In this paper, the mean mechanical model is made up of a fluid-solid semi- infinite multilayer system (skin and muscles/cortical layer/marrow). It is also assumed that the effective elasticity properties of the solid layer (cortical bone) have spatial variations in the thickness (osteoporosis). The uncertainties introduced in the mean mechanical model are taken into account in introducing a prior stochastic model in which the elasticity tensor is modeled by a non- homogeneous non-Gaussian tensor-valued random field. The parameters of the random field are a spatial correlation length, a space dependent dispersion parameter and the values of the elasticity tensor of the simplified mean me-

chanical model. A method and an application are presented for the identification of these parameters using in vivo experimental measurements in ultrasonic range with the axial transmission technique.

Wed 10:00 Pierre CHAVASSE MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Ultrasonic guided waves in cortical bone modeled as a functionally graded anisotropic tube – (Contributed, 000080)

C. Baron
CNRS - Aix Marseille Univ, 163 avenue de Luminy, 13288 Marseille, France
Corresponding author E-mail: cecile.baron@univmed.fr

The human cortical bone is a heterogeneous medium: it is multiscale and multicomponent. It can be seen as a bi-phasic material, pores full of marrow in a bone matrix, with an increasing porosity from the periosteum to the endosteum. This gradient of porosity reveals itself to be representative of the loss of mass, the changes of geometry (thinning) and the variation of structure (porosity) which occur with aging and are the determinants of the bone strength. After a process of homogenization, the cortical bone is considered as an anisotropic functionally graded waveguide. An original method is proposed to study the ultrasonic guided wave propagation in such a structure. Based on an analytical solution, the matricant, explicitly expressed under the Peano series expansion form, this approach allows to deal with a cylindrical geometry and a crystallographic symmetry less than the transversely isotropy. Moreover, a fluid-loading of the waveguide may be taken into account to better mimic the in-vivo conditions.

Wed 10:20 Pierre CHAVASSE MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Investigation of the Plate Theories Accuracy for the Elastic Wave Propagation Analysis of FGM Plates – (Contributed, 000279)

M. Mehrkash, M. Azhari and H.R. Mirdamadi
Department of Civil Engineering-Isfahan University of Technology, Imam Khomeini Street-University Square-University Street, 8415683111 Isfahan, Iran
Corresponding author E-mail: m.mehrkash@cv.iut.ac.ir

The importance of the elastic wave propagation problem in plates arises from application of the elastic waves in non-destructive evaluation of structures. However, precise understanding and analyzing of acoustic guided waves especially in non-homogeneous plates such as functionally graded material ones is so complicated that the exact elastodynamics methods are rarely used in practical applications. Hence, the simple approximate plate theories have attracted much interest in the calculation of FGM plates waves responses. The present paper is an theoretical assessment of the compromise between the simplicity and accuracy of the plate theories for the problem of elastic wave propagation in FGM plates. So, the classical (CPT), first order (FSDT) and third order (TSDT) theories of plates are employed to obtain the transient wave fields due to impulsive loadings in FGM plates. Furthermore, a hybrid numerical method (HNM) is used to examine the accuracy of the plate theories for different plate thicknesses and frequency contents of the wave sources. In all analyses, Fourier transform and modal analysis are applied to get the displacement fields. Comparison of the results shows the reliability range of the approximate plate theories for the acoustic wave propagation analysis in FGM plates.

Wed 10:40 Pierre CHAVASSE MI-S04: Wave propagation in heterogeneous media: modeling and simulation

Using quantitative ultrasound for the assessment of the stability of an implant: a numerical study – (Contributed, 000711)

V. Mathieu[a], F. Anagnostou[b], E. Soffer[b] and G. Haiat[a]
[a]Laboratoire MSME, 61, avenue du Générale De Gaulle, bâtiment P2, bureau 352 C, 94010 Créteil, France, Metropolitan; [b]Biomécanique et Biomatériaux Ostéo-Articulaires,
Corresponding author E-mail: vincent.mathieu@u-pec.fr

Titanium endosseous implants are widely used in oral and maxillofacial surgery for the replacement of missing teeth. Despite their routine clinical use, failures of implant integration still occur. A new experimental ultrasonic methodology has been developed for the estimation of the stability of prototype cylindrical implants inserted in bone tissue. Cylindrical titanium implants were inserted in four groups of rabbit femurs, each group corresponding to a controlled level of stability of the cylinders. The 10 MHz ultrasonic response of the cylinders is significantly correlated with the level of stability ($p < 10^{-5}$). A numerical Finite Difference Time Domain model accounting for mode reflections and conversions was considered in order to understand the origin of the different echoes of the ultrasonic response of the implants. The importance of lateral waves propagation was evidenced. The numerical model also enabled to estimate the sensitivity of the ultrasonic response to variations in the material properties of bone tissue surrounding the implants.

Wed 9:00 Yves ROCARD NV-S09: Acoustic holography

Noise source identification techniques: simple to advanced applications – (Contributed, 000081)

K.B. Ginn and K. Haddad
Brüel & Kjær Sound & Vibration A/S, Skodsborgvej 307, 2850 Nærum, Denmark
Corresponding author E-mail: KevinBernard.Ginn@bksv.com

The number of noise source identification (NSI) techniques available to engineers working on noise, vibration and harshness problems has increased considerably in recent years. The choice of the most appropriate technique depends upon the application and the information required. This paper reviews techniques for noise source identification and quantification ranging from simple hand-held sound intensity systems, hand-held array systems to large ground based microphone arrays. The methods include Beamforming, Spherical Beamforming and Acoustic Holography. Guidelines are given to help the engineer choose a suitable technique based on the frequency range of interest, the distance from the measurement array and the test object and the resolution required. Practical application examples ranging from hearing aids to wind turbines are presented to illustrate the various NSI techniques.

Wed 9:20 Yves ROCARD NV-S09: Acoustic holography

Recovery of the free field using the spherical wave superposition method – (Invited, 000227)

C.-X. Bi, D.-Y. Hu, L. Xu and Y.-B. Zhang
Institute of Sound and Vibration Research, Hefei University of Technology, 230009 Hefei, China
Corresponding author E-mail: cxbi@hfut.edu.cn

As a preprocessing technique of nearfield acoustic holography, sound field separation technique could separate the non-free field into two parts: the outgoing field and the incoming field. Generally, the former is used for sound source reconstruction. In fact, the outgoing field consists of the field radiated by the source in a free-field and the field scattered on the source surface caused by the incoming field. When the scattered field could not be neglected, the reconstruction using the outgoing field would be erroneous. To separate the radiated field and scattered field, a free-field recovery technique using the spherical wave superposition method is proposed. A theoretical description is first given, and then two numerical simulations are used to demonstrate the validity of this technique.

Wed 9:40 Yves ROCARD NV-S09: Acoustic holography

Source identification in small spaces using field separation method: application to a car trunk – (Contributed, 000300)

A. Garcia, Y. Braikia, C. Langrenne, E. Bavu and M. Melon
Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03
Corresponding author E-mail: alexandre.garcia@cnam.fr

Acoustic holography is a powerful tool for the localization and ranking of sound sources. However when dealing with non-anechoic spaces, classical methods have to be modified to take into account reflections on the walls of the testing room and, if necessary, the field radiated by secondary sources. In this paper, the field separation method is used to overcome these problems. The method used here consists in measuring the acoustic pressure on a double layer half-sphere array which base is lying on the surface of interest. Then, by using spherical harmonic ex-

pansions, contributions from outgoing and incoming waves can be separated if the impedance of the tested surface is high enough. Simulations on simple configurations and measurements on a car trunk mock-up are first presented. For the measured cases, the double layer array used is made-up of 2*36 carefully calibrated microphones. Comparison with results obtained with double layer SONAH are also shown. Finally, results obtained with a real car on a roller bench are reported.

Wed 10:40 Yves ROCARD NV-S09: Acoustic holography

Data completion method for the characterization of sound source in confined domain – (Contributed, 000089)

A. Garcia and C. Langrenne
Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03
Corresponding author E-mail: christophe.langrenne@cnam.fr

In the present paper a Steklov-Poincaré formulation is presented to solve the inverse problem of acoustic source reconstruction in confined domain [J. Acoust. Soc. Am. 130 (4), October 2011, 2016-2023]. The solution is obtained by the resolution of the Helmholtz equation applied on an empty bounded domain; the boundary is the union of the measurement surface and the surface of the vibrating structure. The difference between classical methods and the Data Completion Method (DCM) is that Cauchy datum (acoustic pressure and velocity) have to be known on the measurement surface to recovering data on the whole boundary. The DCM allows one to solve the inverse problem with acoustic perturbations due to sources on the exterior domain, or due to measurements in a confined domain, without altering the results. Experimental results are presented.

Wed 11:00 Yves ROCARD NV-S09: Acoustic holography

Characterization of non-stationary sources using three imaging techniques – (Contributed, 000485)

M.-H. Moulet[a], M. Melon[b], J.-H. Thomas[a] and E. Bavu[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03
Corresponding author E-mail: marie-helene.moulet@univ-lemans.fr

Over the last decade, different imaging techniques have been developed to characterize and localize non-stationary acoustic sources. This study focuses on three of them: Time Domain Holography, Real-Time Near-Field Acoustic Holography and Time Reversal Acoustic Imaging.
In the first part of the paper, the principles of these three methods are reminded and the validation technique is presented. Then, the second part deals with the comparison of the results obtained with these three methods for two different kinds of sources: point-like sources (small loudspeakers) and a plate-like acoustic source emission. Advantages and draw-backs of the methods are discussed. Finally, an industrial case is studied: set-ups, measurements and analysis of non-stationary sound sources imaging are presented.

Wed 11:20 Yves ROCARD NV-S09: Acoustic holography

Reconstruction of nonstationary sound fields based on time domain plane wave superposition method – (Contributed, 000138)

X.-Z. Zhang[a], J.-H. Thomas[b], C.-X. Bi[a] and J.-C. Pascal[b]
[a]Institute of Sound and Vibration Research, Hefei University of Technology, 230009 Hefei, China; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jean-hugh.thomas@univ-lemans.fr

A new time-domain plane wave superposition method (TD-PWSM) is proposed to reconstruct nonstationary sound fields. At each time step of this method, the time-wavenumber spectrum of the sound pressure on the virtual source plane is firstly estimated by using the measured sound pressure and the right pseudo-inverse of the time-domain propagation kernel matrix, and then the reconstruction is performed through a superposition of all the time convolutions between the estimated time-wavenumber spectrum of the sound pressure on the virtual source plane and the time-domain propagation kernel at each wavenumber. Since the inverse process at each time step is ill-conditioned, the Tikhonov regularization is introduced to obtain an appropriate solution. The method

proposed provides the ability of continuously reconstructing time-dependent pressure signals and overcomes some errors due to the use of the two-dimensional spatial Fourier transforms, which is avoided. Numerical simulations and an experiment demonstrate that it is feasible to reconstruct the nonstationary sound fields via TD-PWSM.

Wed 11:40 Yves ROCARD NV-S09: Acoustic holography

Enhancing Sound Source Localization with Noise Separation Methods – (Invited, 000618)

L. Lamotte[a], S. Paillasseur[a], K. Janssens[b] and J. Lanslots[b]
[a]MicrodB, 28, chemin du petit bois, 69130 Ecully, France; [b]LMS International - Leuven, LMS International Researchpark Haasrode ZI Interleuvenlaan 68 3001 Leuven
Corresponding author E-mail: jeroen.lanslots@lmsintl.com

Noise source diagnosis is of main importance in many fields such as transport industry, industrial machinery, and household appliancesoe The spatial localization of these sources is a first step before one can take counter measures. But solutions are usually curative ones to cover external sources. It would be more efficient to identify and to treat the associated original phenomenon. Sound source localization methods usually identify area that emits the most sound, but they do not inform about the underlying components that contribute to a source. Noise separation methods split microphone raw data into their contributing signals. Examples are separating pure tones from large bands, correlation techniques, and cyclo-stationary analysis. Combining both localization and separation methods results in a powerful technique enables spatial localization of sources depending on their different contributing phenomena. Three examples are presented. First one is a vacuum cleaner where the diagnostic tries to separate engine noise from aerodynamic turbulence of the nozzle. The second example aims to separate and localize combustion noise from other mechanical noise sources on an engine. The last example last example is on fan noise and shows how to identify noise sources due to cyclic events of blade passing.

Wed 12:00 Yves ROCARD NV-S09: Acoustic holography

Reproduction of random acoustic pressure fields on plane surfaces using wave field synthesis and planar holography – (Contributed, 000179)

O. Robin, A. Berry, S. Moreau and R. Dia
GAUS, Université de Sherbrooke - 2500, Bd de l'Université, Sherbrooke, Canada J1K 2R1
Corresponding author E-mail: olivier.robin@usherbrooke.ca

Vibroacoustic testing of many panel structures such as building partitions, automotive windscreens or fuselage panels, is often performed in coupled reverberant - anechoic rooms under Diffuse Acoustic Field (DAF) assumption. However, an ideal and repeatable DAF is difficult to reach in practice, especially at low frequencies. Moreover, this measurement does not reflect the actual transmission loss of structural parts of a moving vehicle, subjected to complex wall pressure fluctuations linked to Turbulent Boundary Layer (TBL) excitation developing on its external surface. Measurements under this excitation can be performed using wind tunnels or in-vehicle testing, but such measurements are time consuming, costly and show discrepancies. Two sound field reproduction strategies, Wave Field Synthesis and Planar Holography, are proposed here to perform robust laboratory reproduction of DAF and TBL random pressure fields in 2-D (i.e. sound pressure distribution on a plane surface), which are defined using their cross-spectral densities. Numerical simulations of reproduction frameworks are performed for acoustic monopoles as reproduction sources, distributed on a plane facing a virtual panel to be tested. Synthesis results are then analyzed in both spatial and wavenumber domains. We finally present indications to size a practical application, identify some technical constraints and suggest solutions to overcome them.

Wed 9:00 Paul LANGEVIN PU-S06: Ultrasonic imaging

Quantitative assessment of myocardial viscoelastic properties using shear wave imaging – (Invited, 000350)

M. Pernot, M. Couade, W.-N. Lee, M. Fink and M. Tanter
Institut Langevin - Ondes et Images, 10 rue Vauquelin, ESPCI ParisTech, 75231 Paris, France
Corresponding author E-mail: mathieu.pernot@espci.fr

Cardiac pathologies are often characterized by a significant change of myocardial stiffness, re-organization of muscle fiber structure, and the accompanying dysfunction, all of which remain challenging to be quantitatively assessed in vivo. The approach developed in this work is based on Shear Wave Imaging (SWI) a technique developed at the Langevin institute that provides real-time mapping of soft tissues viscoelastic properties. The technique relies on two successive steps: first, a shear wave is remotely induced in the myocardium using the acoustic radiation force of a focused beam, and second, the shear wave propagation is imaged using ultrafast imaging (10,000 frames per seconds). The shear modulus is derived from the shear wave speed. SWI is applied to the evaluation of myocardial stiffness on animal models of cardiomyopathy. The dynamics of change in shear modulus during the cardiac cycle is measured and the relationship between the viscoelastic properties and physiological parameters such as contractility or pathologies such as infarction is investigated. Finally, an imaging technique of the myocardial fiber orientation is developed by exploiting the anisotropy of shear wave propagation. This technique can map the complex distribution of muscle fibers in the myocardium and is compared to MR diffusion tensor imaging.

Wed 9:20 Paul LANGEVIN PU-S06: Ultrasonic imaging

Detection of electrical conductivity interfaces with ultrasonically-induced Lorentz force – (Contributed, 000042)

P. Grasland-Mongrain, J.-M. Mari, J.-Y. Chapelon and C. Lafon
Application des ultrasons à la thérapie, Pôle santé Lyon est, 151 cours Albert Thomas 69424 Lyon cedex 03
Corresponding author E-mail: pol.grasland-mongrain@inserm.fr

An ultrasonically-induced Lorentz force scanner is set up to attempt detecting adipose tissues in biological samples by scanning their electrical conductivity gradients.

A preliminary experiment wass conducted where a 500 kHz transducer generated an ultrasound wave with a peak pressure of 1 MPa. The medium, a fat-layered rib, was placed at the focus, 18 to 24 cm away from the transducer, and inside a 300 mT magnetic field created by a permanent magnet. Two electrodes acquired the current induced by Lorentz force, which is averaged 1000 times. Spatial sampling is performed by moving the transducer perpendicularly to the ultrasound axis with steps of 1 cm. The different measured signals allow visualizing the fat layers of the sample, thanks to the high difference of electrical conductivity between the fat and the muscle. The lateral image-resolution is about 5 mm. It is compared with a picture of the sample.
This method combines the strength of ultrasound imaging with the capacity to have a different way to characterize the properties of the imaged tissues. However it still suffers from the weakness of the signals to be measured.

Wed 9:40 Paul LANGEVIN PU-S06: Ultrasonic imaging

Effect of contact with an elastic wall on the spectral characteristics of the scattered echo of a contrast microbubble – (Contributed, 000079)

A. A. Doinikov, L. Aired and A. Bouakaz
INSERM U930 CNRS ERL3106, Université François Rabelais, CHU Bretonneau, 2 Blvd. Tonnellé, 37044 Tours, France
Corresponding author E-mail: doinikov@bsu.by

A modified Rayleigh-Plesset equation is proposed to model the oscillation of a contrast microbubble attached to an elastic wall. The equation shows that contact with the wall affects the bubble oscillation as if the bubble oscillated in a liquid with a changed (effective) density. As a result, depending on the wall properties, the natural frequency of the attached bubble can be either lower or higher than the natural frequency of the same bubble in an unbounded liquid. Numerical simulations were made to study the spectral characteristics of the scattered pressure of an attached contrast microbubble. It was assumed that the bubble shell properties are described by the Marmottant model and the properties of the wall correspond to walls of OptiCell chambers commonly used in experiments. It has been found that, depending on the value of the driving frequency, the contact with the wall can noticeably increase or decrease the magnitudes of the fundamental component, the second harmonic, and the subharmonic relatively to their values in an unbounded liquid. These findings can be used to distinguish the scattered echoes produced by contrast agents attached to a wall from echoes produced by agents being at a distance from a wall.

Wed 10:40 Paul LANGEVIN PU-S06: Ultrasonic imaging

In vivo monitoring of the corneal collagen cross-linking using supersonic shear wave imaging: feasibility study on porcine corneas – (Contributed, 000286)

T.-M. Nguyen[a], J.-F. Aubry[a], D. Touboul[b], J. Bercoff[c] and M. Tanter[a]
[a]Institut Langevin Ondes et Images, 10 rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France; [b]Centre Hospitalo-Universitaire de Bordeaux, Place Amélie Raba-Léon, 33000 Bordeaux, France; [c]SuperSonic Imagine, 510 Rue René Descartes, Les Jardins de la Duranne - Bât E & F, 13857 Aix-En-Provence, France
Corresponding author E-mail: thu-mai.nguyen@espci.fr

The cornea is the main refractive component of the eye. Defects in corneal shape can reduce the visual acuity. Corneal ectasia is a case of severe deformation, which is characterized by a progressive bulging. It can occur naturally or after LASIK surgery, leading to damaged vision and ultimately blindness. Corneal cross-linking (CXL) has recently been proposed as a minimally invasive treatment to stop the disease progression. It consists in photoreticulating the collagen fibrils to stiffen the cornea. However, this treatment is currently not monitored in real-time. Here, we propose Supersonic Shear Wave Imaging (SSI) to measure the stiffening effect of CXL. SSI elastography consists in generating and tracking a shear wave in tissues using ultrafast (30000 frames/sec) ultrasonic scanners (Aixplorer, SuperSonic Imagine). The tissue elasticity is deduced from the shear wave speed. For corneal applications, we implemented SSI on high-frequency ultrasonic arrays (15MHz). We performed *in vivo* CXL on anesthetized pigs combined with SSI monitoring. We obtained elastic maps after CXL that exhibited significant stiffening in the treated area ($56 \pm 15\%$ of the shear wave speed) compared to the untreated area. These results demonstrated the feasibility of SSI for the *in vivo* and real-time monitoring of CXL.

Wed 11:00 Paul LANGEVIN PU-S06: Ultrasonic imaging

Sparse array techniques for 2D array ultrasound imaging – (Contributed, 000115)

B. Diarra[a,b], H. Liebgott[a], P. Tortoli[c] and C. Cachard[a]
[a]Centre de recherche en applications et traitement de l'image pour la santé, 7 avenue Jean Capelle, Bat Blaise Pascal, 69621 Villeurbanne Cedex; [b]Department of Electronics and Telecommunications [Florence], Via S. Marta, 3 50139 Firenze; [c]Università degli studi di Firenze, Via S. Marta, 3, 50139 Firenze, Italy
Corresponding author E-mail: bakary.diarra@creatis.univ-lyon1.fr

Ultrasound imaging is one of the cheapest and safest diagnostic modalities which are routinely used. An attractive recent development in this field is 3D imaging with 2D matrix probes. The main difficulty to implement this approach comes from the huge number of elements which need to be controlled. To solve this technical problem several methods are proposed in the literature, such as edge elements deactivation, sparse array and row-column addressing.
The sparse array technique presents the best trade-off between the element number and the probe imaging features. However, this technique gives rise to the apparition of high side-lobes compared to the dense array approach. To reduce this drawback we propose a new approach in which the probe elements are randomly placed and separated by a random inter-element distance, and any overlap between them is not accepted. This approach permits a better use of the element sparseness and lowers the side-lobe level. The proposed technique was tested on a 64x16 2D array probe designed for biopsy imaging. Results obtained in terms of acoustical beam characteristics will be presented and shown to favorably compare with the results offered by the classic sparse array method for the same number of connected elements.

Wed 11:20 Paul LANGEVIN PU-S06: Ultrasonic imaging

Back-propagation based beamformer design for Transverse Oscillations in Echocardiography – (Contributed, 000255)

X. Guo, D. Friboulet and H. Liebgott
Centre de recherche en applications et traitement de l'image pour la santé, 7 avenue Jean Capelle, Bat Blaise Pascal, 69621 Villeurbanne Cedex
Corresponding author E-mail: xinxin.guo@creatis.insa-lyon.fr

Transverse oscillation (TO) imaging is a technique that produces ultrasound radiofrequency images featuring oscillations in both spatial dimensions. This is natural for axial direction but necessitates specific beamforming for transverse direction. Conventional TO beamformer design using Fraunhofer approximation (FA) has been properly developed in linear geometry. Using cosine function modulated by Gaussian as a lateral profile, the apodization

function defined as inverse Fourier transform of the profile thus corresponds to the convolution between a Gaussian and two Dirac. This approach works well in linear geometry but is limited for sector scan as in echocardiography. We propose to use back-propagation based on reciprocity theorem, which appropriately takes into account the fact that the expected oscillation profiles are in polar coordinate. To validate with simulations using Filled II, the comparison of PSFs obtained using FA and back-propagation with theoretical profiles is quantified using root mean square error. The result clearly shows that PSFs obtained using back-propagation are more accurate than using FA. But it has declining advantages than FA at larger depth because the transformation from Cartesian to polar coordinate becomes closer for FA. The next step is to validate that the obtained PSF and associated TO allow more accurate motion estimates.

Wed 11:40 Paul LANGEVIN PU-S06: Ultrasonic imaging

Shear elasticity quantification of cancerous tumors in mice, pre and post chemotherapy treatment – (Contributed, 000299)

H. Latorre Ossa[a], J.-L. Gennisson[a], F. Chamming's[b], L. Fournier[b], M.A. Lefevre-Belda[b], O. Clément[b] and M. Tanter[a]
[a]Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France;
[b]Hôpital Européen Georges Pompidou, Service de radiologie, 20 Rue de Leblanc, 75015 Paris, France
Corresponding author E-mail: heldmuth.latorre-ossa@espci.fr

It is believed that tumour development and its response to chemotherapy are highly correlated to variations in the tissue viscoelasticity. The monitoring through ultrasound-elastography imaging of the tumour early response to neoadjuvant chemotherapy would be fundamental to avoid unwanted effects caused by ineffective treatments. The aim of this work is to perform a quantitative analysis using the Supersonic Shear Imaging technique of the behaviour of a human model of breast cancer implanted in mice, pre and post chemotherapy. A xenograft of a characteristic human breast cancer model is implanted on 20 Swiss-nude mice. Elasticity measurements are performed longitudinally for each mouse every 7 days from the day the tumors become measurable and correlated with histopathological results. Chemotherapy begins when tumours reach a minimum diameter of 10 mm. Ultrasound images and their corresponding elasticity maps are obtained for each mouse with a good reproducibility and accuracy. The tumour's mean elasticity value and the heterogeneity increased proportionally with the diameter before chemotherapy begins. Once the treatment starts, the tumour's mean elasticity value and the diameter decrease progressively. Shear elasticity quantification seems to be a useful parameter to monitor the development of breast cancer tumour and its response to chemotherapy.

Wed 13:40 Paul LANGEVIN PU-S06: Ultrasonic imaging

Two Dimension (2D) elasticity maps of coagulation of blood using SuperSonic Shearwave Imaging – (Contributed, 000297)

M. Bernal, J.-L. Gennisson, P. Flaud and M. Tanter
Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France
Corresponding author E-mail: miguel.bernal@espci.fr

Introduction. Deep venous thrombosis affects millions of people worldwide. A fatal complication occurs when the thrombi detach and creating a pulmonary embolism. The diagnosis and treatment of DVT depends on clot's age. It has been shown that the elasticity of thrombi is closely related to its age. Methods. Blood from 9 live pigs was collected and anticoagulated using EDTA. Coagulation was initiated using calcium ions in saline solution. SuperSonic shear wave imaging was used to generate shear waves using 100 μs tonebursts of 8 MHz at 3 different location in the lateral direction. Tracking of the shear waves was done by ultrafast imaging. Results. Two dimensional (2D) map of elasticity were obtained by calculating the speed of shear wave propagation. Elasticity varied with time from 50 Pa at coagulation to 1300 Pa at 120 minutes. Ejection of the serum from the clot showed to decreased the elasticity of the clot next to liquid pool, corresponding to the detachment of the clot from the beaker wall. Conclusion. SuperSonic imaging proved to be useful mapping the elasticity of clots in 2D. It allows the visualization of the heterogeneity of mechanical properties of thrombi and has potential use in predicting thrombi breakage.

Wed 14:00 Paul LANGEVIN PU-S06: Ultrasonic imaging

Investigation into the effectiveness of ultrasound SHI imaging according to static and dynamic parameters of contrast agents – (Contributed, 000258)

F. Lin, F. Varray, C. Cachard and O. Basset
Centre de recherche en applications et traitement de l'image pour la santé, 7 avenue Jean Capelle, Bat Blaise Pascal, 69621 Villeurbanne Cedex
Corresponding author E-mail: fanglue.lin@creatis.insa-lyon.fr

Second harmonic inversion (SHI) is a new method to improve contrast to tissue ratio (CTR) of ultrasound contrast images through reducing tissue-generated 2nd harmonics during wave propagation. Two 90° phase-shifted pulses with the same frequencies and amplitudes are transmitted. The two received RF data are summed and filtered around 2nd harmonic frequency to create SHI image. However, after experimental evaluation on SHI's effectiveness, we found that movements and destruction of contrast agent bubbles strongly affect the results of SHI. Using CREANUIS software, SHI is simulated with various bubble movements (Δd), reflective amplitude (Amp) and medium's nonlinear parameter (β) changes. Amp and β decreasing are two different ways to describe the bubble cloud evolution. The influences are quantified by CTR of SHI images. Simulation results show that CTR improves by 11dB for 100% β destruction and 13dB for 100% Amp destruction. In lateral direction, CTR rises until reaching a stable value when bubble movement increases between the two pulses. In axial direction, CTR exhibits oscillations with increasing movements with respect to transmitted pulse wavelength. The maximum increases are both 16dB. So SHI is expected to be optimized by increasing the power and adjusting pulse repetition frequency (PRF) of transmitted pulses.

Wed 14:20 Paul LANGEVIN PU-S06: Ultrasonic imaging

Sparse reconstruction techniques for near-field underwater acoustic imaging – (Contributed, 000387)

N. Stefanakis[a], J. Marchal[b], V. Emiya[c], N. Bertin[a], R. Gribonval[a] and P. Cervenka[b]
[a]METISS, Campus de Beaulieu 35042 Rennes cedex; [b]Institute Jean Le Rond d'Alembert, 2 place de la gare de Ceinture, 78210 Saint Cyr L'Ecole, France; [c]Laboratoire d'informatique Fondamentale de Marseille, CMI 39, Rue Joliot Curie 13453 Marseille Cedex 13
Corresponding author E-mail: nstefan@mobile.ntua.gr

The use of sparse priors has shown interesting potential in various acoustic or radar imaging applications. In this paper, sparse reconstruction is applied for underwater acoustic imaging using a newly built flexible sonar device. We investigate several models concerning the linear mapping between the image domain and the observation domain. In particular, we define a point-scatterer model in which the apparent back-scatter coefficient of a given reflector varies with respect to the specific emitter and receiver locations. To handle this problem, we adapt a multi-channel version of the orthogonal matching pursuit and we apply it on real data in order to obtain images of an underwater target placed at a small distance from the sonar. The techniques are shown to overcome bottlenecks that are apparent with more standard approaches that assume far-field conditions when building the image.

Wed 14:40 Paul LANGEVIN PU-S06: Ultrasonic imaging

Tissue strain rate estimator using ultrafast IQ complex data – (Contributed, 000389)

R. Ternifi[a,b], M. Elkateb Hachemi[a] and J.-P. Remenieras[a]
[a]UMR U930 CNRS ERL 3106, 10 Bd Tonnelle Batiment Vialle Equipe 5 INSEM, 37032 Tours, France, France; [b]Laboratoire de Biomécanique et Mécanique des Chocs, IFSTTAR UMR_T9406 25 avenue François Mitterrand 69675 Bron
Corresponding author E-mail: redouane.ternifi@etu.univ-tours.fr

Pulsatile motion of brain parenchyma results from cardiac and breathing cycles. In this study, transient motion of brain tissue was estimated using an Aixplorer® imaging system allowing an ultrafast 2D acquisition mode. The strain was computed directly from the ultrafast IQ complex data using the extended autocorrelation strain estimator (EASE), which provides great SNRs regardless of depth. The EASE first evaluates the autocorrelation function at each depth over a set of successive IQ pairs. This estimates the mean change in phase over time, which is proportional to the velocity. A second autocorrelation is evaluated on the results of the first autocorrelation. This estimates the mean change in phase over depth, which is proportional to the strain rate. The developed algorithm was first validated on "in vivoï data acquired at 7.5MHz from the carotid. Tissue velocity and strain rate were estimated on artery wall and adjacent regions. The estimated displacement velocity and displacement of the wall artery were 2.5 cm/s, and 150 μm respectively. The displacement velocity and displacement of the region near the surface were 1 cm/s and 30 μm respectively.

Wed 15:00 Paul LANGEVIN PU-S06: Ultrasonic imaging

Effect of an elastic wall on the behavior of encapsulated microbubbles – (Contributed, 000597)

L. Aired, A. A. Doinikov and A. Bouakaz
INSERM U930 CNRS ERL3106, Université François Rabelais, CHU Bretonneau, 2 Blvd. Tonnellé, 37044 Tours, France
Corresponding author E-mail: leila.aired@etu.univ-tours.fr

The aim of this work is to study how boundaries with different mechanical properties affect the acoustic response of contrast agent microbubbles. To this end, numerical simulations are performed for two types of walls: a polystyrene (OptiCell) wall and a biological tissue. For each wall, the behavior of contrast microbubbles of three sizes is investigated. The spectral characteristics of the scattered pressure produced by the microbubbles are compared for two cases: the bubble oscillates far away from the wall and the same bubble oscillates in the immediate vicinity of the wall. The results of the simulations allow one to draw the following main conclusions. The effect of the OptiCell wall on the acoustic bubble response is stronger than that of the tissue wall. Changes in the bubble response near the wall are stronger when bubbles are excited above their fundamental resonance frequency. Changes are stronger for smaller bubbles and changes in the 2nd harmonic are stronger than those in the fundamental. The results obtained allow one to gain an insight into conditions under which the effect of an elastic wall on the acoustic response of a contrast agent microbubble is easier to be detected.

Wed 15:20 Paul LANGEVIN PU-S06: Ultrasonic imaging

Ultrafast imaging of blood flow dynamics in the myocardium – (Contributed, 000722)

B.-F. Osmanski, M. Pernot, G. Montaldo and M. Tanter
Institut Langevin ESPCI ParisTech - CNRS UMR 7587 - INSERM U979, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: bruno-felix.osmanski@espci.fr

Imaging intramyocardial vascular flows could strongly help to achieve better diagnostic of cardiovascular diseases but no standard imaging modality allows describing accurately myocardial blood flow dynamics with good spatial and temporal resolution. We recently introduced a novel Doppler imaging technique based on compounded plane waves transmitted at ultrafast frame rate. The high sensitivity and framerate of the Doppler technique enable imaging the intramyocardial blood flow and its dynamics. A special demodulation-filtering process achieved to compensate for the large tissue velocity of the myocardium and a signed power Doppler process gives the possibility to discriminate arterial and venous flows. Experiments were performed in vivo in N=5 open chest sheep using a conventional ultrasonic probe placed at the surface of the heart. Results show the capability of the technique to image intramyocardial vascular flows in normal physiological conditions with good spatial (200μm) and temporal resolution (10ms). The flow dynamics over the cardiac cycle was investigated and showed a phase opposition of flow waveform between arterial and venous flows. Finally, the main diagonal coronary artery was occluded and the vascular flows were found to completely disappear in the ischemic region.

Wed 15:40 Paul LANGEVIN PU-S06: Ultrasonic imaging

A beamforming strategy dedicated to post lens ultrasound imaging and ocular biometry using a 20 MHz multi-element probe – (Contributed, 000817)

T. Mateo[a], Y. Mofid[b], J.-M. Grégoire[b] and F. Ossant[b]
[a]Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours; [b]Université François Rabelais de Tours, UMRS Imagerie et Cerveau, 10, boulevard Tonnellé, BP 3223, 37032 Tours Cedex 01, France
Corresponding author E-mail: tony.mateo@etu.univ-tours.fr

Ocular ultrasound imaging of the posterior segment is of clinical importance to diagnose pathologies such as choroidal vein occlusion, detached retina or macular degeneration, when OCT is ineffective.

Currently, there is no beamforming strategy dedicated to ocular imaging in order to overcome ultrasound aberrations mainly generated by the crystalline lens. Actually, lens acts as a defocusing media due to its biconvex geometry where ultrasound celerity is 10% higher than in the surrounding homogeneous media. As a result, classical linear beamforming images suffer from geometrical distortion with a spatial resolution far below the theoretical values in a homogeneous medium and a low SNR especially at high frequencies.

A dedicated beamforming method optimizing post lens imaging is therefore proposed through a linear ultrasound scanning using an ultrasound research scanner in house developed called the ECODERM. The probe consists of a 128 elements linear array working at 20 MHz. The performances of the developed beamforming method were

compared with those of the conventional beamforming by means of a wire phantom. The comparison quantifies both axial and lateral resolution, image contrast, and the spatial mislocalization induced by lens. A great improvement is obtained for both image quality and biometry.

Wed 9:00 Lord RAYLEIGH PU-S10: Health assessment of natural media and food

Numerical modeling in quantitative ultrasonic tomography of standing trees – (Contributed, 000107)

A. Arciniegas[a], L. Brancheriau[b], P. Gallet[b] and P. Lasaygues[a]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]CIRAD-PERSYST/DIR, Avenue Agropolis, 34398 Montpellier Cedex 5
Corresponding author E-mail: arciniegas@lma.cnrs-mrs.fr

The aim of this project is to develop an ultrasonic device for parametric imaging of standing trees. The device is designed to perform both transmission and reflection measurements that can be therefore used for quantitative tomographic imaging. It allows various automatic acquisitions, since the angular position of the transducers could be adjusted. This makes possible to scan the wave propagation occurring in all directions inside the medium. The associated electronic set-up allows mainly measuring the velocity (and therefore the slowness) and the attenuation of the ultrasonic waves. Tomograms were computed by fast algebraic algorithms: (1) using the filtered backprojection algorithm with fan beam geometry, (2) using ART and SIRT methods, (3) using a new algorithm that we are developing based on a "layer-stripping" method. Our first numerical results on academic and realistic phantoms of tree are presented in this paper.

Wed 9:20 Lord RAYLEIGH PU-S10: Health assessment of natural media and food

Kramers-Kronig relationships application on master curves obtained on Honey from a few Hz to GHz: major interest of high frequency ultrasonic methods – (Contributed, 000124)

D. Laux, V. Cereser Camara, J.-Y. Ferrandis, G. Leveque and H. Blasco
Université Montpellier 2 - IES - UMR CNRS 5214, place Eugene Bataillon, cc 082, 34095 Montpellier, France
Corresponding author E-mail: didier.laux@univ-montp2.fr

Viscoelastic properties of biological materials and food are of first interest on an academic point of view (internal structure evaluation) and on a practical point of view: link between rheological properties and macroscopic parameters such as moisture or fat content. Since many years we are working on high frequency ultrasonic approaches dedicated to food and biological materials investigation. We have already shown that investigations of complex reflection coefficients at an interface (elastic solid) / (viscoelastic material) can give accurate information on alpha-transition or glass transition around room temperature for a typical biological material and food: honey. In this new communication we propose to investigate how high frequency methods can give interesting information for Kramers-Kronig relationships application. In particular we will demonstrate that high frequency methods give an asymptotic behavior around glass transition which is fundamental for Kramers-Kronig relationships application. Then using also low frequency behavior (classical rheology) it is possible to deduce G' with G" or G" with G' on a very large bandwith (few Hz to GHz) around room temperature. This allows the determination of the whole master curves when G' or G" are not measured properly. Examples will be given on honey.

Wed 9:40 Lord RAYLEIGH PU-S10: Health assessment of natural media and food

Full elastic caracterization of wood materials by Resonant Ultrasound Spectroscopy – (Contributed, 000250)

T. Delaunay[a], D. Laux[a], O. Arnould[b] and T. Almeras[b]
[a]Institut d'Electronique du Sud UMR CNRS 5214, Université Montpellier 2, Place Eugène Bataillon, CC082, 34095 Montpellier, France; [b]Laboratoire de Mécanique et Génie Civil de Montpellier, Université Montpellier 2, Place Eugène Bataillon, CC048, 34095 Montpellier, France
Corresponding author E-mail: thomas.delaunay@univ-montp2.fr

Wood materials are difficult to characterize because of their anisotropic behaviours, strong variability and heterogeneity. The impossibility or the lack of precision in the determination of their full set of elastic properties leads to underuse and/or misuse these materials due to the difficulty in predicting accurately their behaviour. In

this paper, we propose to combine two approaches to obtain the entire elasticity matrix of wood: Resonant Ultrasonic Spectroscopy (RUS) and classical echography. First, echography applied on a spherical sample allows the determination of the anisotropy directions of the material. Then RUS method is applied on a cube cut from this sphere respecting the identified orientation. We will see that the knowledge of the anisotropy directions is very useful for RUS inverse problem resolution. First results obtained on beech samples are compared to Guitard's model and show that RUS is a very promising approach for wood characterisation or non destructive control.

Wed 10:00 Lord RAYLEIGH PU-S10: Health assessment of natural media and food

Air detection in an oyster – (Contributed, 000639)

Y. Y. Mevel
ISEN brest, 20 rue cuirassé Bretagne, 29200 Brest, France
Corresponding author E-mail: yves.mevel@isen.fr

Air in oysters, Crassostrea gigas, is the result of a shock or pathogenic agent. Often it is dead/this often leads to the death of oysters. The pathogenic agent is dangerous for humans. Air must be detected when we want to export oysters. Oysters are in water. An acoustic transducer, with a frequency of resonance of 2,5MHz, is located 7,5cm above the oysters. A pulse is applied to the transducer. The Transducer converses it to an acoustic wave. The wave is reflected by the upper shell, crosses it can be partly reflected by the flesh; but the wave is above all reflected by the lower shell. One measurement is made every centimeter, (6 to 10 measurements according to the oyster length). For standard oysters, the several echoes with all the points, draw a cut of the oyster. When there is air in the oyster, the difference of the impedance between air and the shell induces a complete reflection, which increases strongly the voltage of the first echo, the second echo is vanished. About forty experiments have permitted to verify this solution.

Wed 9:00 François CANAC PU-S12: Ultrasound and lasers

Scanned laser beam generation of Lamb waves for surface defect detection – (Invited, 000876)

S. Dixon, S. E. Burrows, B. Dutton and Y. Fan
University of Warwick, Dept of Physics, Gibbet Hill Road, CV4 7AL Coventry, UK
Corresponding author E-mail: s.m.dixon@warwick.ac.uk

Previous workers have shown how pulsed laser beams generating Rayleigh waves can be used to detect surface defects, resulting in some interesting changes in the detected signal including a strong enhancement in the generation of higher frequency components. In this paper, a pulsed Nd:YAG laser with an approximately Gaussian beam shape is directed onto the surface of a metal sheet in the thermoelastic regime, generating Lamb waves in the sheet. The laser beam is raster scanned across the surface of the sample and travels omni-directionally outwards from the generation point. In this case, the Lamb waves are detected some distance away by an electromagnetic acoustic transducer, but can and have also been detected by interferometric means. The presence of a crack-like defect on the sheet is detected by either a sudden change in the ultrasonic waveform or by an enhancement in the frequency content of the waveform when the laser beam illuminates directly onto the crack.

Wed 9:20 François CANAC PU-S12: Ultrasound and lasers

Sub-nanosecond laser ultrasonics in micro-layers of liquids – (Contributed, 000049)

N. Chigarev[a], V. Tournat[a] and V. Gusev[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: Nikolay.Chigarev@univ-lemans.fr

The study of the acoustic properties of liquid micro-layers is necessary for biological and micro-technological applications. Laser ultrasonic technique on the basis of subnanosecond pump laser [Appl. Phys. Lett. 93, 181905 (2008)] provides unique opportunity for the contactless and non-destructive evaluation of the materials at spatial scales from micrometer to few tens of micrometers. Here we report on the application of this technique for the study of acoustic properties of liquid layers of micrometric thickness confined between two parallel glass plates. The acoustic pulses are excited by the absorption of a pump laser pulse in a nanometric aluminium film deposited on one of

the plates and are detected by photo-deflection technique. Transient photo-acoustic signals are measured at different separation distances between pump and probe beam spots. Then, this information is used for plotting the dispersion curves [Phys. Rev. Lett. 100, 158003 (2008)]. Numerous acoustic modes have been detected and their physical nature has been explained with the help of the developed theoretical models. The opportunities to extract from the evaluated dispersion curves the information on the elastic and inelastic properties of the liquids and to characterize the adhesion of liquid layer to the surrounding solid are discussed.

Wed 9:40 François CANAC PU-S12: Ultrasound and lasers

Characterization of the contact between solids by laser-generated interface waves – (Contributed, 000351)

T. Valier-Brasier, T. Dehoux and B. Audoin
I2M, 351, Cours de la Libération, 33405 Talence, France
Corresponding author E-mail: tony.valier.brasier@gmail.com

Laser Ultrasonic techniques provide a powerful tool for the remote analysis of adhesion mechanisms at imperfect interfaces. However, the sensitivity of interface waves to the quality of interface is not very well known. In this context, the aim of this work is to study the influence of the contact between solids half-spaces on laser-generated interface waves.
The mechanical boundary conditions at the interface between the solid half-spaces are described by a spring model, implying a discontinuity of the displacement fields across the interface and involving tangential and normal spring constants. To identify the relative amplitudes of the different types of interface waves (skimming, leaky Rayleigh and Stoneley waves), a semi-analytical time-model is derived. In addition, the dispersion curves for the interface waves are calculated to interpret the results of the time-model.

The results demonstrate the influence of the boundary conditions on the attenuation of the leaky Rayleigh wave and on the existence of the Stoneley wave, which should prove to be a powerful tool for the inspection of contacting interfaces. Moreover, characteristic frequencies depending on normal and tangential springs constants are highlighted, suggesting a scaled behaviour of the interface waves.

Wed 10:00 François CANAC PU-S12: Ultrasound and lasers

Combined laser-Doppler vibrometer and needle-hydrophone detection of interface waves – (Contributed, 000282)

K. Van Dalen[a], G. Drijkoningen[a] and C. Glorieux[b]
[a]Delft University of Technology, Stevinweg 1, 2628CN Delft, Netherlands; [b]Slovak Technical University, Radlinskeho 11, 81368 Bratislava, Slovakia
Corresponding author E-mail: k.n.vandalen@tudelft.nl

At the fluid/elastic-solid interface the well-known leaky Rayleigh and Stoneley waves can propagate. The impedance associated with such an interface wave interrelates the corresponding waveforms that can be observed in different components, i.e., the particle motion and fluid pressure. We show that the interface-wave impedance of the leaky-Rayleigh wave, excited at a water/aluminum interface, can be successfully extracted using an experiment in which we simultaneously measure both components at ultrasonic frequencies. In particular, the normal interface displacement is measured using a laser Doppler vibrometer and the pressure with a needle hydrophone. The impedance of the leaky Rayleigh wave can be clearly distinguished in the wavenumber-frequency domain. Any measurement that employs a laser Doppler vibrometer is perturbed by refractive-index changes along its beam once it interferes with acoustic waves. Using a model that accounts for these perturbations, we predict a significant impedance decrease with respect to the plane-wave impedance of the leaky Rayleigh wave. Although this deviation is different for the experimentally extracted impedance, there is very good agreement between the observed and predicted waveforms in both the displacement and fluid pressure. This shows that laser ultrasonic devices and small pressure detectors can be successfully combined in laboratory-scale experiments.

Wed 11:00 François CANAC PU-S12: Ultrasound and lasers

Ultrafast inverse magnetostriction effect in Ni/Co ferromagnet – (Contributed, 000031)

T. Pezeril[a], V. Temnov[a], S. Andrieu[b], V. Gusev[a], T. Hauet[b] and C. Klieber[a]
[a]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Institut Jean Lamour : Matériaux -Métallurgie - Nanosciences - Plasma - Surfaces,
Corresponding author E-mail: thomas.pezeril@univ-lemans.fr

Research upon femtosecond time resolved magnetic processes is part of the ultrafast optics branch known as femtomagnetism [Phys. Rev. Lett. 76, 4250 (1996)] where femtosecond laser pulses are used to switch the magnetisation of ferromagnetic materials. Another trend in modern ultrafast optics is driven by progress in picosecond ultrasonics - a well established research direction dealing with the generation of picosecond acoustic pulses by thermal expansion of acoustic transducers excited by femtosecond lasers [Phys. Rev. B 34, 4129 (1986)]. A novel concept envisioning control of magnetization in ferromagnetic materials on ultrafast timescales using acoustic pulses has been proposed very recently [Phys. Rev. Lett. 105, 117204 (2010); Phys. Rev. B 82, 104422 (2010)]. The results that will be presented combine femtomagnetism and picosecond ultrasonics in order to gain understanding on the inverse magnetostriction effect. Our experimental approach will show that by launching a picosecond phonon pulse through a ferromagnetic material it is possible to measure the phonon-spin interaction time.

Wed 11:20 François CANAC PU-S12: Ultrasound and lasers

Photo-acoustic terahertz phonon detection and generation within a semiconductor superlattice – (Contributed, 000578)

R. Legrand, A. Huynh and B. Perrin
INSP, 4 place Jussieu, 75252 Paris, France, Metropolitan
Corresponding author E-mail: romain.legrand@insp.jussieu.fr

Currently, the development of compact opto-acoustic transducers able to generate and detect acoustic wave in the terahertz wavelength is an active research subject. Superlattice made with a periodic stacking of AlAs/GaAs layers has shown the ability to be used as high frequency acoustic generators and detectors. The excitation by a femtosecond laser leads to a temporally short strain in the pattern which produces quasi-monochromatic coherent phonons up to a frequency of 1 THz related to the multilayer period (excitation near $q = 0$). This superlattice is an effective phonon detector since strain causes a change of reflectivity measured with a probe light. Unfortunately, generation and detection have differents spectrals responses: generation is more efficient around $q = 0$, while detection works with $q = 2k$ (k is the light vector). Therefore a single superlattice cannot be used to detect and generate the same wave vector. However, theory predicts a rise of $q = 0$ **detection** in case of strong reflection at the interface between superlattice and substrate. To check this possibility we design a sample made of a 17 nm period superlattice embedded in an optical micro-cavity. We will present experiments performed at low temperatures on a sample designed to generate and detect 300 GHz acoustic waves.

Wed 11:40 François CANAC PU-S12: Ultrasound and lasers

Nanoacoustical strains in metal films generated by a few cycle femtosecond laser pulses – (Contributed, 000723)

I. Tzianaki[a], E. Kaselouris[a], Y. Orphanos[a], E. Bakarezos[a], D. Zacharioudakis[a], A. Lyras[b], M. Tatarakis[a], C. Kosmidis[b] and N. Papadogiannis[a]
[a]TEI of Crete, Daskalaki 1 Str., 74100 Rethymnon, Greece; [b]University of Ioannina, Panepistimioupoli, 45110 Ioannina, Greece
Corresponding author E-mail: i.tzianaki@chania.teicrete.gr

High frequency nanoacoustical strains are generated in nanometer thick metal films deposited on appropriate substrate by the means of a few cycle femtosecond Ti:Sapphire laser pulses. The nanoacoustical strains are studied utilizing an ultrafast laser-displacement technique. The measured signal exhibits local maxima (or minima) at zero delay and at delays that correspond to the time that the acoustic echo arrives on metal film surface after reflection from metal-substrate interface. Changes on the temporal content of the few cycle femtosecond laser pulses seem to give rise in variations of the temporal characteristics of the laser generated nanoacoustic pulses. The selection of various metal films provides useful results which can be the base for theoretical models evaluation for the generation of this nanoacoustic stains by the extremely short duration laser pulses. In this temporal region, the non-thermal electrons, generated in the first moments of the few cycle femtosecond laser pulse metal surface excitation, seem to play significant role in the lately generated nanoacoutical strains.

Wed 12:00 François CANAC PU-S12: Ultrasound and lasers

Superlattice ultrasonic generation – (Contributed, 000133)

T. E. Wilson[a], M. Oehme[b], E. Kasper[b], H.-J. L. Gossmann[c] and J. Schulze[b]
[a]Marshall University, Department of Physics, One John Marshall Drive, Huntington, 25755, USA; [b]Institut für Halbleitertechnik (IHT), Universität Stuttgart, Pfaffenwaldring 47, 70569 Stuttgart, Germany; [c]None, 29 Brainerd Road, Summit, 07901, USA
Corresponding author E-mail: schulze@iht.uni-stuttgart.de

We present experimental results of the resonant excitation of coherent high-frequency longitudinal acoustic phonons in semiconducting doping superstructures by far-infrared laser radiation. After a grating-coupled delta-doped silicon doping superlattice is illuminated with 10 kW/mm^2 nanosecond-pulsed 246 GHz laser radiation, a delayed nanosecond pulse is detected by a current-biased superconducting granular aluminum/palladium bilayer bolometer, at a time corresponding to the appropriate time of flight for ballistic longitudinal acoustic phonons across the (100) silicon substrate. The absorbed phonon power density in the microbolometer is observed to be 10 μW/mm^2, in agreement with theory. Upon deconvolution, the phonon pulse duration matches the laser pulse duration. The absence of any delayed transverse acoustic phonon signal by the superconducting bolometer is particularly striking and implies there is little or no incoherent phonon generation occurring in the process. Attempts at: (1) 1.04 THz phonon generation and (2) the use of Si:B piezo-phonon spectroscopy to measure the frequency and linewdith of the phonon distribution, will also be described.

Wed 10:40 John TYNDALL MA-S02: Transients in self-sustained musical instruments

How mechanical pipe organ actions work against transient control – (Invited, 000410)

A. Woolley
University of Edinburgh, School of Physics and Astronomy, JCMB, King's Buildings, EH9 3JZ Edinburgh, UK
Corresponding author E-mail: awoolley@staffmail.ed.ac.uk

This paper summarises work published and presented previously, supported by additional material. It can be clearly demonstrated by blowing an organ pipe that its transient can be varied, although the effect is not generally considered ëmusical'. It has been debated for several decades whether mechanical pipe organ actions allow the player to vary the transient by the way in which the key is moved. Opinions vary from transient control being fundamental to organ playing to it not being possible. This work shows that the physical characteristics of mechanical organ actions work against transient control and this is corroborated by measurements of key and pallet movements and pressure changes whilst organists are playing. It also looks at what other methods organists are using in order to play expressively. The paper also considers how transients might vary due to other characteristics of organs that are outside players' direct control but might lead them to believe that variations are due to differences in their key movements.

Wed 11:00 John TYNDALL MA-S02: Transients in self-sustained musical instruments

Decay transients in single reed wind instruments – (Invited, 000822)

P. Guillemain and C. Vergez
Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: guillemain@lma.cnrs-mrs.fr

A classical and dimensionless model of the functioning of single reed instruments such as the clarinet and the saxophone is considered. In this model, the nonlinearity is controlled by two parameters: One linked to the blowing pressure, the other one to the reed opening at rest. Transient commands are applied on this two parameters. In particular, It is shown that a transient decay of the blowing pressure still induces a nonlinear functioning of the system, while a transient decay of the reed opening leads to a free oscillation of the resonator, hence giving a way to estimate the complex frequencies of the impedance peaks. The results are compared to those obtained on natural sounds thanks to a controlled artificial mouth, both in pressure and reed opening. The meaning of the dimensionless control parameters are discussed with respect to the actual command of a musician.

Wed 11:20 John TYNDALL MA-S02: Transients in self-sustained musical instruments

Attack transients in a clarinet model with time-varying blowing pressure – (Invited, 000322)

B. Bergeot[a], A. Almeida[a], C. Vergez[b] and B. Gazengel[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]LMA - CNRS (UPR 7051), 31 chemin Joseph-Aiguier, 13402 Marseille, Cedex 20, France
Corresponding author E-mail: baptiste.bergeot.etu@univ-lemans.fr

Reed instruments are modelled as self-sustained oscillators driven by the pressure inside the mouth of the musician. A set of non-linear equations connects the control parameters (mouth pressure, lip force) to the system output, usually considered as the mouthpiece pressure. Clarinets can then be studied as dynamic systems, their steady behaviour being dictated uniquely by the values of the control parameters. Considering the resonator as a lossless straight cylinder is a dramatic yet common simplification that allows for simulations using non-linear iterative maps. Many important aspects such as the kind of regime (static, oscillating), values of amplitude and periodicity have been predicted from such an approach. However, the existing studies focus mainly on the steady state, disregarding important features such as the attack transient. This presentation discusses transient behaviour of these simplified clarinet models when the control parameters follow simple laws of variation with time. In this case, unexpected behaviour can occur, such as bifurcation delays, meaning that oscillations do not start when the mouth pressure reaches the threshold value predicted by static bifurcation theory. This behaviour will be described and an analytical expression of the early attack transient state will be proposed.

Wed 11:40 John TYNDALL MA-S02: Transients in self-sustained musical instruments

A hybrid reed instrument: an acoustical resonator with a numerically simulated mouthpiece – (Contributed, 000123)

K. Buys and C. Vergez
LMA - CNRS (UPR 7051), 31 chemin Joseph-Aiguier, 13402 Marseille, Cedex 20, France
Corresponding author E-mail: vergez@lma.cnrs-mrs.fr

A study on the development of a hybrid wind instrument is carried out. An acoustical tube interacts with a numerically simulated mouthpiece in real-time, with the aim to propose in the long term both a tool for objective measurements, and a new musical instrument, easily playable, with unique timbral capacities.

This preliminary study focusses on a first prototype, to verify the physical meaningfulness and estimate its potential. A microphone at the tube entrance feeds a numerical model of the reed used to compute the volume flow through the reed channel. This is the output of the numerical part, which is directed to an electrovalve that proportionally modulates the volume flow between the compressed air source and the tube entrance.
The hybrid instrument is characterized by studying its parts separately (evaluation of the electrovalve characteristics, impedance measurement of the resonator), but also as a whole by analyzing its behaviour when the parameters of the mouthpiece are varied. Both transients and steady regimes are compared to a fully simulated instrument.
We observed a coherent functioning for fundamental frequencies sufficiently below the electrovalve's first resonant frequency. The foremost drawbacks are associated to the electrovalve's mechanics and to noisy pressure measurements.

Wed 12:00 John TYNDALL MA-S02: Transients in self-sustained musical instruments

Study of the extinction of a note in reed instruments – (Contributed, 000468)

A. Almeida
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: andre.almeida@univ-lemans.fr

In a musical note, the transient is a starting or ending period in which the sound builds up or is extinguished. Though usually brief, it is important for the recognition of the timbre of a musical instrument. In sustained musical instruments such as wind instruments or bowed strings the transient can be controlled by the actions of the musician, by changing key parameters such as blowing pressure or bowing force. This study focuses on the extinction transients in reed instruments. Firstly, the most relevant methods for characterising the extinction of the note are briefly discussed. The extinction duration of recorded notes using different playing techniques is related to the natural damping coefficient of the resonator with different boundary conditions. Analysis of time-variation of the overall sound intensity and individual partials in recorded note endings will be compared to simulations and theoretical models of reed instruments.

Wed 10:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Slow waves, surface waves and their applications – (Invited, 000056)

K. Attenborough, I. Bashir, H.-C. Shin and S. Taherzadeh
The Open University, DDEM, Maths, Computing and Technology, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: k.attenborough@open.ac.uk

Fluid-saturated porous elastic solids support two compressional wave types, often called 'fast' and 'slow', and a shear wave. Walter Lauriks recognised the commonality of the physical mechanisms which govern the acoustical properties of such media and initiated a great many studies ranging from the acoustical monitoring of marrow filled bone to properties of air-filled bread, soils and snow. The Biot parameter values that create distinct slow waves in transmission experiments are explored. There are two types of surface waves at a poroelastic boundary: a fluid-coupled Rayleigh wave and a wave that depends on the surface impedance. A rough hard surface is also able to generate an acoustic surface wave. Walter Lauriks studied pore-related surface waves and those over a periodically-rough hard surfaces. It is shown that propagation over hard-backed square lattice grating layers modelled previously using modal analysis can be described as that over a square pore layer. Similarly propagation over rectangular grooves or bosses also modelled previously using modal analysis can be modelled as that over a slit pore layer.

Wed 11:00 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Characterization of porous absorbent materials – (Invited, 000098)

P. Leclaire
LRMA-DRIVE, ISAT, 49 rue Mademoiselle Bourgeois - BP 31, 58027 Nevers, France
Corresponding author E-mail: Philippe.Leclaire@u-bourgogne.fr

Over the past twenty years, theoretical and experimental research on the acoustical properties of air-saturated porous materials for engineering applications has considerably progressed thanks to the contributions of many researchers in different institutes in the world. Accompanying the research on the acoustical properties of absorbent materials, new methods and experimental techniques were developed for the measurement of important physical parameters of these materials, necessary for the acoustic models. The attention is focused on the particularly important contributions of two laboratories: the Laboratoire d'Acoustique de l'Université du Maine (LAUM) in France and of Laboratorium voor Akoestiek en Thermische Fysica (ATF) in Belgium. A review of the main methods developed over the year in these two laboratories is proposed. This research has been very important for the validation of the models. The methods developed concern the measurement of porosity, tortuosity, flow resistivity, viscous and thermal characteristic lengths, thermal permeability and also the mechanical properties of porous materials (Young's modulus and the Poisson ratio).

Wed 11:20 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Acoustic characterization of air saturated porous materials at audible frequencies – (Contributed, 000359)

M. Sadouki[a], M. Fellah[a], Z.E.A. Fellah[b], E. Ogam[b] and C. Depollier[c]
[a]Laboratoire de Physique Théorique, Faculté de Physique, USTHB, BP 32 El Alia, Bab Ezzouar, 16111 Bab Ezzouar, Algeria; [b]LMA – CNRS (UPR 7051) / Aix-Marseille University, 31 chemin Joseph Aiguier, 13402 Marseille, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: sad.mus17@yahoo.fr

An acoustic method based on sound transmission is proposed for measuring the thermal permeability, viscous and thermal tortuosity of porous materials having a rigid frame at low frequencies. The proposed method is based on a temporal model of the direct and inverse scattering problems for the propagation of transient audible frequency waves in a homogeneous isotropic slab of porous material having a rigid frame. The acoustic parameters are determined from the solution of the inverse problem. The minimization between experiment and theory is made in the time domain. Tests are performed using industrial plastic foams.

Wed 11:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Large scale modulation of high frequency acoustics fields in porous media – (Contributed, 000471)

C. Boutin, A. Rallu and S. Hans
ENTPE. Université de Lyon - CNRS 3237, Rue Maurice Audin, 69518 Vaulx-En-Velin, France
Corresponding author E-mail: claude.boutin@entpe.fr

We investigate, through a multi-scale asymptotic approach, high frequency acoustic fields of large correlation length in periodic porous media. High frequencies mean local dynamics at the pores scale, and therefore absence of scale separation in the usual sense of homogenization. However, as suggested by [Craster et al, PRSA, 2010], meanwhile the pressure is fast varying in the pores (according to periodic eigenmodes), the mode amplitude can present large scale modulation, hence introduces another type of scale separation on which the asymptotic procedure applies. The principle of this approach is first presented on a network of inter-connected Helmoltz resonators. The equations governing the modulations carried by a given eigenmode, at frequencies close to the eigenfrequency, are derived. Because of the local dynamic state, the number of cells on which the carrying periodic mode is defined, becomes a parameter. In a second part, this "multicellï procedure is extended to porous media saturated by a perfect gas. One obtains the whole family of large modulation phenomena, with a strict use of the "multiï periodicity condition. To conclude, this approach extracts, from the comprehensive Floquet-Bloch modal space, the particular frequency range enabling large modulations, therefore large correlation, of high frequency acoustic perturbations.

Wed 13:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Broadband acoustical characterization in a horn shaped impedance tube – (Contributed, 000200)

J.-M. Coulon[a], F. Chevillotte[b], F.-X. Bécot[b] and L. Jaouen[b]
[a]L&L Products, 1 rue Lindberg ZA Activeum, Altorf, 67129 Molsheim, France; [b]MATELYS, 1 rue Baumer, 69120 Vaulx-En-Velin, France
Corresponding author E-mail: jm.coulon@llproducts.eu

Impedance tube is widely used to characterize acoustical materials, but it is restricted to frequencies corresponding to plane wave mode propagation. Broadband measurements require testing samples within tubes of different cross-sections: the smaller the diameter the higher the maximum frequency allowed. This is a critical issue for materials or multilayer samples (i) with elastic frames for which shape and size affect vibrations (ii) which can not be considered as homogeneous for small diameters. In order to cope with the paradox of testing large samples with a small tube section, an impedance adaptation is necessary. A horn above its cut-off frequency can be a good coupling element. A horn shape portion has been designed using 1D and 3D modeling for the 1.6 kHz-6.4 kHz frequency range. This approach has been validated based on comparisons against "standardï impedance tube measurements for various materials. Selected materials represent a large range of weak to important structural behavior and single to multilayer arrangements. This opens interesting perspectives for the design of broadband frequency impedance tube apparatus.

Wed 14:00 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Nonlocal macroscopic theory of sound propagation in rigid-framed porous materials – (Invited, 000128)

D. Lafarge, N. Nemati and A. Duclos
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: denis.lafarge@univ-lemans.fr

Macroscopic acoustic properties of rigid-framed fluid-saturated porous materials are generally well described by the existing Equivalent-fluid macroscopic theory. This (local) theory, however, is incomplete. Indeed, it describes temporal dispersion but not spatial dispersion. In particular, it is in error when the wavelengths reduce so as to become comparable to the size of an elementary representative volume. This may always be the case at high enough frequencies. This may also be the case at lower frequencies, near resonances, when the material contains structured elements such as Helmholtz resonators. We propose here a new (nonlocal) macroscopic Equivalent-fluid theory that is intended to describe both temporal and spatial dispersion. As such, this theory is expected to be more generally applicable than the conventional one. Here, we solve it by the method of finite elements and compute the wavenumber of the least attenuated mode for a 2D porous medium made of a viscothermal fluid saturating a square array of identical cylindrical-circular rigid solid inclusions. The same least attenuated mode wavenumber is indepen-

dently computed using a direct multiple scattering technique. Excellent agreement betweeen the two is obtained, validating our proposed new nonlocal Equivalent-fluid theory. Finally, this new theory is illustrated for the case of materials with Helmholtz resonators.

Wed 14:20 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Phase velocity and attenuation of leaky interface waves at the fluid/porous-medium interface – (Contributed, 000284)

K. Van Dalen[a], G. Drijkoningen[a] and D. Smeulders[b]
[a]Delft University of Technology, Stevinweg 1, 2628CN Delft, Netherlands; [b]Eindhoven University of Technology, Postbus 513, 5600MB Eindhoven, Netherlands
Corresponding author E-mail: k.n.vandalen@tudelft.nl

At the fluid/porous-medium interface the leaky Rayleigh (LR) and leaky Stoneley (LSt) waves can exist. We show that the relation with the corresponding poles in the slowness plane is not unambiguous but depends on the choice of branch cuts. To this end we compute Green's functions for a point-force excitation using two approaches. When vertical branch cuts are used (approach I), implying that the Riemann sheets of the LR- and LSt-poles obey the radiation condition, a separate leaky interface wave is entirely captured by the corresponding pole residue. In the case of hyperbolic branch cuts (approach II) the poles initially lie on the "principal" Riemann sheet. Then, the loop integrals along the branch cuts necessarily contribute to the LR-wave but do not contribute to the LSt-wave because the pole is identical to that in approach I. However, at a certain frequency the LSt-pole migrates to another Riemann sheet and for all higher frequencies the LSt-wave is even fully captured by the loop integrals. Our results show that the phase velocity and attenuation of a separate leaky interface wave can be obtained from the pole location in approach I, but should be extracted from the full Green's function in approach II.

Wed 14:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Wave propagation in Porous Piezoelectric Layer immersed in fluid – (Contributed, 000498)

P. Khurana[a] and C. Glorieux[b]
[a]Katholieke Universtiteit Leuven, Laboratorium voor Akoestiek en Thermische Fysica, Celestijnenlaan 200D, B-3001 Leuven, Belgium; [b]Slovak Technical University, Radlinskeho 11, 81368 Bratislava, Slovakia
Corresponding author E-mail: poonam.aroraneekhurana@fys.kuleuven.be

In this article, we study the wave propagation in a porous piezoelectric layer which is in contact with fluid on both sides. The reflection and transmission from porous piezoelectric layer immersed in fluid is studied analytically, using transfer matrix technique. The layer is assumed to be made of porous piezoelectric material having 6mm symmetry. An elastic wave is assumed to be incident on the layer which results into reflected wave in upper fluid half space and transmitted wave in lower fluid half space. The analytical expressions of the reflection and transmission coefficients are obtained. The effects of angle of incidence, frequency, porosity, material properties, and thickness of layer on the reflection and transmission coefficients are observed numerically for a particular model.

Wed 15:00 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Ultrasonic investigation on water-saturated porous scatterers under different boundary conditions – (Invited, 000298)

S. Derible and H. Franklin
LOMC, CNRS UMR 6294, Université Le Havre, 25, rue Philippe Lebon, 76600 Le Havre, France
Corresponding author E-mail: serge.derible@univ-lehavre.fr

The goal of the following studies is to inverse the Biot parameters of some manufactured water-saturated porous material (plate or cylinder) under the different cases of boundary conditions presented below. Porous plate with open and sealed pore condition: the normal reflection and transmission coefficients of a given open pore plate are measured. They are compared with the coefficients obtained when the pores of the faces of the plate are sealed with thin quick setting cement. The backscattering coefficient of a porous cylinder is measured. The superficial pores are sealed whether with a thin Teflon® tape or with quick setting cement. In the first case the cylinder behaves like a "softï cylinder. Porous plate with different boundary conditions on its faces: the normal reflected signal onto an

open pore plate is recorded when the plate is completely immersed in water and when its upper face is in the air. These two experiments allow us to separate the fast and slow echoes on the signals.

Wed 15:20 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Biot-JKD model: simulation of 1D transient poroelastic waves – (Invited, 000058)

E. Blanc[a], G. Chiavassa[b] and B. Lombard[a]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]Ecole Centrale Marseille, 38 rue Joliot Curie, 13451 Marseille, France
Corresponding author E-mail: eblanc@lma.cnrs-mrs.fr

We investigate the time-domain numerical modeling of Biot poroelastic waves. The viscous dissipation inside the pores is described by the model of dynamic permeability of Johnson-Koplik-Dashen (JKD). Some coefficients of the Biot-JKD model are proportional to the square root of the frequency. In the time-domain, they introduce shifted fractional derivatives of order 1/2, which involves a convolution product. A diffusive representation replaces the convolution kernel by a finite number of memory variables that satisfy local-in-time ordinary differential equations. Based on the dispersion relation, the coefficients of the diffusive representation are determined by optimization on the frequency range of interest. A numerical modeling based on a splitting strategy is proposed: the propagative part is discretized by a fourth-order ADER scheme on a Cartesian grid, whereas the diffusive part is solved exactly. Comparisons with analytical solutions are proposed, demonstrating the efficiency and the accuracy of the approach.

Wed 15:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Parametric study of a metaporous made of solid inclusions embedded in a rigid frame porous material – (Contributed, 000206)

C. Lagarrigue, O. Dazel, J.-P. Groby and V. Tournat
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: clement.lagarrigue.etu@univ-lemans.fr

With the growing interest for sound absorbing materials, research is brought to optimize porous material whose acoustic absorption coefficient should to remain large across a broad frequency range. Embedding rigid inclusions in a porous plate can enhance its acoustical properties and create an efficient sound insulating material for low frequencies. The excitation of additional acoustic modes when periodic arrangements of inclusions are used can lead to enhanced acoustic energy dissipation due to the viscous and thermal effects in the material pores when the wavelength is comparable with the radius of the inclusions. By acting on the characteristics of individual cells (periodicity, shape, type ...), it is possible to combine absorption related to the medium with additional resonant effects at low frequencies. A parametric study is performed in order to determine the influence of the geometry, orientation and resonance frequency of infinitely rigid inclusions embedded in a porous plate. The behavior of these structured materials is computed by finite element method to determine the "optimal" inclusion in order to obtain an efficient absorbing material.

Wed 16:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

On the use of periodic inclusions embedded in porous lining to enhanced attenuation in waveguides – (Contributed, 000076)

B. Nennig[a], Y. Renou[b] and Y. Aurégan[b]
[a]Laboratoire d'Ingénierie des Systèmes Mécaniques et des MAtériaux, Supméca - 3, rue Fernand Hainaut - 93407 St Ouen Cedex; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: benoit.nennig@supmeca.fr

Acoustic liners are often used to limit noise propagation in acoustic waveguides with a grazing flow such as ventilation, exhaust or aircraft engine. Standard liners are most often made of perforated plate backed by honey comb or with porous material.

The aim of this work is to study the influence of a set of periodic rigid inclusions embedded in a porous lining to

enhanced attenuation. Only an elementary cell of this periodic waveguide is studied using the Bloch waves formalism. This yields a quadratic eigenvalue problem involving the Bloch wavenumber solved with the finite element method.
However these configurations require to investigate parameters often omitted in academic lattice studies: (i) Dissipation; (ii) higher modes interaction; (iii) mean flow convection effect.
These absorbing concepts as well as the computational approach are validated with experimental data and with analytical solution on simple configurations. The influence of the inclusion shape, waveguide dimension and the mean flow impact are illustrated on various examples.

Wed 17:00 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Enhancement of the absorption of a backed rigid frame porous layer using a 2-dimensional periodic multi-irregularities rigid backing – (Contributed, 000517)

B. Brouard[a], J.-P. Groby[a], O. Dazel[a], B. Nennig[b] and L. Kelders[c]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Laboratoire d'Ingénierie des Systèmes Mécaniques et des MAtériaux, Supméca - 3, rue Fernand Hainaut - 93407 St Ouen Cedex; [c]Laboratory of Acoustics and Thermal Physics, KULeuven, B-3001 Heverlee, Belgium
Corresponding author E-mail: bruno.brouard@univ-lemans.fr

The acoustic properties of a porous layer with a medium flow resistivity and backed by a rigid plate containing periodic rectangular irregularities, creating a multi-component diffraction grating, are investigated. It extends the work proposed in [Journal of the Acoustical Society of America 127, 2865-2874, 2010], to a 3D problem involving a 2D grating.
Numerical and experimental results show that the structure possesses possibly total absorption peaks at the frequencies of the modified mode of the layer and/or of the trapped mode associated to the irregularities, when designed as proposed. These results is explained by an analysis of the acoustic response of the whole structure and especially by the modal analysis of the configuration. When more than one irregularity per spatial period is considered, additional higher frequency peaks are observed.

Wed 17:20 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Acoustical properties of macroscopically inhomogeneous porous medium – (Contributed, 000141)

K. V. Horoshenkov[a], S. Masaharanon[a], K. Khan[a], A. Geslain[b], J.-P. Groby[b] and O. Dazel[b]
[a]University of Bradford, Great Horton Road, BD7 1DP Bradford, UK; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: k.horoshenkov@brad.ac.uk

A 140mm thick material sample with a distinctive pore size stratification was produced in the laboratory from polyurethane binder mixed with recycled particulates. This material exhibits a high acoustic absorption across a relatively broad range of frequencies. It was shown that the observed absorption coefficient spectra depend clearly on the sample orientation. The state vector formalism and Peano series expansion were adopted to explain the observed acoustic absorption behaviour of the developed material sample. A Biot-type model was used to link the acoustic pressure gradient with particle velocity in the oscillitary flow in the material pores. The complex dynamic density and bulk modulus of the equivalent fluid in the material pores were predicted using a computationally efficient model based on the Pade approximation. A good agreement between the proposed theory and the obtained experimental data for the acoustic absorption coefficient was observed.

Wed 17:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

A semi-empirical model to predict the acoustic behaviour of fully and partially reticulated polyurethane foams based on microstructure properties – (Invited, 000134)

O. Doutres and N. Atalla
Groupe d'Acoustique de l'Université de Sherbrooke, 2500 Boulevard de l'Université, Faculté de Génie, Sherbrooke, AB, Canada J1K2R1 QC
Corresponding author E-mail: Olivier.Doutres@usherbrooke.ca

This work investigates the links between the microstructure of polyurethane foams and their sound absorbing efficiency, and more specifically the effect of membranes closing the cells. The study is based on the complete characterization of 15 isotropic polyurethane foams with various cell sizes and reticulation rates (i.e. open pore content): (i) characterization of the microstructure properties from SEM pictures, (ii) characterization of non-acoustic parameters from direct and indirect methods. Existing analytical links between microstructure properties and non-acoustic parameters are first applied to fully reticulated materials. Then, they are improved empirically to account for the presence of the closed pore content. The proposed expressions associated to the Johnson-Champoux-Allard porous model allow for a good estimation of the sound absorbing behaviour of all tested polyurethane foams, fully reticulated or not. It is shown that the reticulation rate is an important parameter having a large influence on the acoustic behaviour, i.e. it dominates the cell size influence. The semi-empirical model is applied and validated using 4 new PU foams, not used in the first characterization set. Finally, its practical use is illustrated by optimizing acoustical materials with graded properties.

Wed 18:00 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Inverse method for porous material characterization using the constraint satisfaction problem approach – (Contributed, 000291)

N. Dauchez and P.-A. Yvars
SUPMECA, 3, rue Fernand Hainaut, 93407 Saint Ouen Cedex, France
Corresponding author E-mail: nicolas.dauchez@supmeca.fr

The Constraint Satisfaction Problem (CSP) approach has been used successfully in optimization procedure for several engineering applications [Yvars P.A., A CSP approach for the network of product lifecycle constraints consistency in a collaborative design context, Engineering applications of artificial intelligence, 2009.]. In this paper this method is evaluated in an inverse procedure for recovering porous material parameters from acoustical data. The sought parameters are the five of the Johnson-Champoux-Allard model: porosiy, resistivity, tortuosity, viscous and thermal characteristic lengths. First, the CSP algorithm is presented: it is based on interval arithmetic and domain reducing algorithms. The procedure is applied to one virtual porous material to show its potential. Acoustical input data are the density and bulk modulus of the equivalent fluid to the material at two frequencies (50 Hz and 1000 Hz). Then, the method is applied to one sound absorbing material. Acoustical data are obtained using an impedance tube. Results are compared to those obtained with classical non acoustical methods. The efficiency of the proposed method is finally discussed.

Wed 18:20 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

Estimation of acoustic and elastic properties of plastic foam using acoustic-to-frame coupling – (Contributed, 000746)

H.-C. Shin, S. Taherzadeh and K. Attenborough
The Open University, DDEM, Maths, Computing and Technology, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: h.c.shin@open.ac.uk

Synthetic partially reticulated polyurethane foams are deployed for many situations for noise and vibration control. So understanding the behaviour of these foams when exposed to acoustic and/or mechanical waves is essential. Much progress has been made through identification and non-acoustic measurements of parameters introduced in the seminal works by Biot and, subsequently, by Allard, that describe the acoustical and elastic properties. Conversely, these parameters can be estimated from measurements of vibroacoustical responses. In principle measurements of acoustic-to-frame coupling should be more effective than measurements that focus on either acoustic or frame behaviour separately. This idea has been pursued in many papers co-authored by Walter Lauriks and Jean- Francois Allard. This paper describes recent demonstrations that pore-related and elastic parameters of air-saturated plastic foam can be estimated from data obtained by conjunctive use of microphones and a laser Doppler vibrometer.

Wed 18:40 Lord RAYLEIGH PU-S02: Sound absorbing materials and porous media (In Memory of Walter Lauriks)

A direct link between microstructure and acoustical macro-behaviour of real double porosity foams – (Contributed, 000757)

F. Chevillotte[a], C. Perrot[b], L. Jaouen[a], F.-X. Bécot[a], E. Guillon[c] and G. Houvenaghel[c]
[a]MATELYS, 1 rue Baumer, 69120 Vaulx-En-Velin, France; [b]Laboratoire de Modélisation et Simulation Multi Echelle, 5, Boulevard Descartes 77454, Marne-la-Vallée Cedex 2; [c]Lafarge Research Centre, 95, rue de Montmurier, BP 15, 38291 Saint Quentin Fallavier, France
Corresponding author E-mail: fabien.chevillotte@matelys.com

The acoustical macro-behaviour of mineral open-cell foam samples is modelled from microstructure morphology using a three-dimensional idealized periodic unit-cell (3D-PUC). The 3D-PUC is based on a regular arrangement of spheres, allowed to interpenetrate during the foaming process. Identification and dimensionning of the 3D-PUC is made from X-ray computed microtomography and fabrication process information. In addition, the 3D-PUC used allows to account for two scales of porosity: the interconnected network of bubbles (meso-porosity) and the intercrystalline porosity of a gypsum matrix (micro-porosity). Transport properties of the micro- and the meso- scales are calculated from first principles and a hybrid micro-macro method is used in order to determine the frequency-dependent visco-thermal dissipation properties. The double porosity theory provides the visco-thermal coupling between the meso- and micro- scales [J. Acoust. Soc. Am. **114**, 73-89 (2003)]. Finally, the results are successfully compared with experiments for two different mineral foam samples. The main originality of this work is to maintain a direct link between the microstructure morphology and the acoustical macro-behaviour all along the multi-scale modelling process, without any fitted parameter.

Wed 13:20 Yves ROCARD NV-S02: Acoustic black hole and applications

Potentialities of the acoustic black hole effect for damping plate vibrations – (Contributed, 000542)

A. Pelat[a], J. Cuenca[b], F. Gautier[a] and L. Barguet[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]ISVR, University of Southampton, SO17 1BJ Southampton, UK
Corresponding author E-mail: adrien.pelat@univ-lemans.fr

The lightening of mechanical structures, used in the transport industry is nowadays an important issue because of its consequences in terms of saving energy. The consequent mechanical changes degrade the acoustic performance of components. Some innovating strategies for damping vibrations of structures without increasing their mass should be developed. Some wave traps, using the acoustic black hole effect can be used for this purpose. The acoustic black hole effect is based on a local change of the shape and the thickness of a structure in order to create weak points where the vibration amplitudes are efficiently damped by adding a small local damping layer. The aims of the paper is to investigate the damping capability of acoustic black holes placed on plates of different kinds: elliptical, rectangular plates, polygonal plate, stiffened plates. Mobility measurements on a wide frequency range using are showing that a reduction of 10 to 20 dB can be obtained when the acoustic black hole is active. Measurements of the vibration fields in the acoustic black hole zone using a scanning laser vibrometer are used to check the existence of local non linearities which could explain some parts of the observed damping.

Wed 13:40 Yves ROCARD NV-S02: Acoustic black hole and applications

Analytical solution of parabolically tapered rod flexural vibration equation – (Contributed, 000104)

M. Mironov
Andreyev Acoustics Institute, Shvernik str., 4, 117036 Moscow, Russian Federation
Corresponding author E-mail: mironov_ma@mail.ru

As it was shown earlier the parabolically tapered end of rod does not reflect the flexural waves with frequency high enough. The velocity propagation of waves tends to zero by approaching to the end crossection of the rod and the propagation time appears to be infinite. As a consequence, the wave, propagating to the tapered end of the rod, never reaches the end of the rod. This result was obtained by WKB-approximation analysis of the tapered rod flexural vibration equation. More thorough investigation displays however, that just for parabolic tapering the exact analytical solutions in the form of the linear combination of power functions exist. The indexes of the functions are zeros of fourth degree polynomial. Input impedance matrix of parabolically tapered rod is calculated and new, modified WKB-approximation for rod with arbitrary smoothly varying cross-section is suggested.

Wed 14:00 Yves ROCARD NV-S02: Acoustic black hole and applications

Improving the acoustic black hole effect for vibration damping in one-dimensional structures – (Contributed, 000747)

J. Cuenca[a], A. Pelat[b], F. Gautier[b] and N. S. Ferguson[a]
[a]ISVR, University of Southampton, SO17 1BJ Southampton, UK; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: j.cuenca@soton.ac.uk

Flexural vibrations are highly responsible for noise radiation by thin structures. In the transport industry, the damping of such vibrations is often achieved using thick viscoelastic layers, which leads to an undesirable increase of mass. In this regard, the acoustic black hole effect has received recent attention as an efficient and lightweight method for damping flexural vibrations. An acoustic black hole consists of a thin structure presenting a smooth decrease in its wave velocity along a given direction, thus acting as a wave trap where the vibrations can be efficiently damped. Such decrease of the velocity can be achieved by a variation of the mechanical parameters, namely the thickness or the Young's modulus. The present paper discusses the practical implementation of the acoustic black hole effect in one-dimensional structures. A numerical model of the flexural wave field of a beam with arbitrarily varying properties along its length is developed as a design and prediction tool. Experiments are performed in beams subjected to a variation in thickness or to a variation in Young's modulus obtained by imposing a temperature gradient. The results show an efficient reduction of the vibration level, as well as the suppression of the resonances.

Wed 14:20 Yves ROCARD NV-S02: Acoustic black hole and applications

Damping of flexural vibrations in rectangular plates by slots of power-law profile – (Contributed, 000184)

E. P. Bowyer, V. V. Krylov and D. J. O'Boy
Loughborough University, Ashby Road, LE11 3TU Loughborough, UK
Corresponding author E-mail: V.V.Krylov@lboro.ac.uk

It has been shown in our previous publications that the addition of power-law profiled wedges to edges of rectangular plates or strips results in substantial increase in damping of resonant flexural vibrations in plates or strips due to the acoustic black hole effect associated with power-law wedges. One of the problems faced by this method of damping is having the wedge tip exposed on the outer edge of the plate or strip. One of the solutions to the problems listed above is to move the wedges inside a plate, so that they form edges of power-law slots within the plate. The present paper reports the results of the experimental investigations into the effects of such slots on damping flexural vibrations. Four experimental investigations are described: the effect of power-law tapered slots on vibration damping in steel and composite plates, the effect of positioning of slots in a plate, and finally the effect of a combined slotted plate. The obtained experimental results show that introducing power-law profiled slots within plates is an effective method of damping flexural vibrations, which is comparable with the method using power-law wedges at plate edges.

Wed 15:20 Yves ROCARD NV-S02: Acoustic black hole and applications

Damping of flexural vibrations in composite plates and panels containing one- and two-dimensional acoustic black holes – (Contributed, 000225)

E. P. Bowyer, D. J. O'Boy and V. V. Krylov
Loughborough University, Ashby Road, LE11 3TU Loughborough, UK
Corresponding author E-mail: V.V.Krylov@lboro.ac.uk

In this paper, the results of the experimental investigations into the addition of one-dimensional and two- dimensional acoustic black holes into composite plates and their subsequent inclusion into composite panels are reported. The composite plates in question are sheets of composite with visible one-dimensional or two-dimensional indentations of power-law profile materialising acoustic black holes for flexural waves. A panel is a sheet of composite with the indentations encased within the sample. This makes a panel similar in surface texture to an un-machined composite sheet (reference plate). In the case of quadratic or higher-order profiles, the above-mentioned indentations act as one- or two-dimensional acoustic black holes for flexural waves that can absorb a large proportion of the incident wave energy. For all the composite samples tested in this investigation, the addition of one- or two-dimensional

acoustic black holes resulted in further increase in damping of resonant vibrations, in addition to the already substantial inherent damping due to large values of the loss factor for composites (0.1 - 0.2). Note in this connection that due to large values of the loss factor for composite materials used, no increase in damping was seen with the addition of a small amount of absorbing material to the indentations, as expected.

Wed 15:40 Yves ROCARD NV-S02: Acoustic black hole and applications

Simulation of vibrations of a 2D acoustic black hole placed in an infinite plate using the Finite Difference Time Domain method – (Contributed, 000505)

V. Denis, A. Pelat and F. Gautier
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: vivien.denis.etu@univ-lemans.fr

The acoustic black hole effect is resulting from properties of propagation of flexural wave in beams and plates having non homogeneous thicknesses: if the thickness decreases locally, flexural waves slow down and the amplitude of the displacement field increases, leading to efficient energy dissipation if an absorbing layer is placed where the thickness is minimum. A pit of power law profile placed inside an elastic plate plays the role of a vibration damper and is called 2-dimensional acoustic black hole. Theoretical model of the phenomenon has been developed in the case of beams (1- dimensional configuration) and for linear medium. However, experimental testing on 2D configuration tends to show some unexpected damping effects that are possibly related to local nonlinear phenomena. A numerical model in the time domain based on the finite difference method is proposed to investigate the interaction between an incident wave emitted by a point source and a 2D acoustic black hole placed on an infinite plate. The local nonlinearities are taken into account using Von Karman theory of plate. Perfectly Matched Layer (PML) is used to represent the infinite plate. Numerical simulations permit to quantify the influence of the local non linear effects on the plate damping.

Wed 16:00 Yves ROCARD NV-S02: Acoustic black hole and applications

Experimental study of damping flexural vibrations in tapered turbofan blades – (Contributed, 000226)

E. P. Bowyer, J. M. Lister, V. V. Krylov and D. J. O'Boy
Loughborough University, Ashby Road, LE11 3TU Loughborough, UK
Corresponding author E-mail: V.V.Krylov@lboro.ac.uk

In this paper, the results of the experimental investigations into damping of flexural vibrations in turbofan blades with trailing edges tapered according to a power-law profile are reported. Edges of power-law profile (wedges), with small pieces of attached absorbing layers, materialise one-dimensional acoustic black holes for flexural waves that can absorb a large proportion of the incident flexural wave energy. The NACA 1307 aerofoil was used as a base model for experimental samples. This model was modified to form four samples of non-engine-specific model fan blades. Two of them were then twisted, so that a more realistic fan blade could be considered. All model blades, the ones with tapered trailing edges and the ones of traditional form, were excited by an electromagnetic shaker, and the corresponding frequency response functions have been measured. The results show that the fan blades with power-law tapered edges have the same pattern of damping that can be seen for plates with attached wedges of power-law profile, when compared to their respective reference samples. The resonant peaks are reduced substantially once a power-law tapering is introduced to the sample. The obtained results demonstrate that power-law tapering of trailing edges of turbofan blades can be a viable method of reduction of blade vibrations.

Wed 16:20 Yves ROCARD NV-S02: Acoustic black hole and applications

Immersed acoustic black hole as a travelling wave absorber: understanding artificial cochlear mechanics – (Contributed, 000432)

S. Foucaud[a], G. Michon[a], Y. Gourinat[a], A. Pelat[b] and F. Gautier[b]
[a]Université de Toulouse - ICA - ISAE, 10 av. Edouard Belin, 31055 Toulouse, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: Simon.foucaud@isae.fr

Inner ear is constituted of fluid-filled ducts partitioned with an elastic structure, the organ of Corti. When the ear is excited by sound, travelling waves appear along the organ of Corti and stimulate the sensory cells. A peak of vibration is reached at a particular place depending on the excitation frequency. The waves are strongly attenuated after this place. Due to the complexity of \textit{in vivo} experimentations, some aspects of physiological functions still need to be investigated.
For this purpose, an experimental setup reproducing the passive behavior of the inner ear has been manufactured. Standing waves are usually observed on artificial cochlea devices due to wave reflection on boundaries.
Acoustic black holes are known as vibration absorbers for thin structures. In this paper, an immersed acoustic black hole is used to reduce the reflected wave. Experimental results are compared with a model using the impedance matrix method. Travelling waves can be observed and this device should allow better understanding of artificial cochlear mechanics.

Wed 13:20 Peter BARNETT SP-S01: Soundscape

From soundscape documentation to soundscape composition – (Invited, 000873)

B. Truax
Simon Fraser University, School of Communication, Simon Fraser University, Burnaby, Bc, Canada V5A 1S6
Corresponding author E-mail: truax@sfu.ca

The World Soundscape Project (WSP) was established as an educational and research group at Simon Fraser University during the early 1970s and documented soundscapes in Canada and Europe as part of an over-arching concern to draw attention to the importance of the sonic environment. One unique feature of the WSP collection of recordings is its longitudinal documentation of the Vancouver Soundscape over a 40-year period, with recordings from the 1970s, 1990s and the present day. Over that same period, soundscape composition practices have evolved from a documentary mode to an artistic practice. Multi-channel audio reproduction currently provides listeners with a highly immersive auditory experience that has greatly benefitted the practice of soundscape composition by creating esthetically enhanced experiences that are based in real-world experience but move the listener into an abstracted or even a completely imaginary space. The concept and perception of acoustic space is discussed, as well as issues of creating such spaces electroacoustically, with examples drawn from the composer's practice. The presentation discusses how the artistic use of created acoustic space can relate to (and potentially enhance) our understanding of the human relationships to real-world soundscapes, and hence acoustic ecology.

Wed 13:40 Peter BARNETT SP-S01: Soundscape

A listener-centred approach to soundscape evaluation – (Contributed, 000207)

K. Foale and W. J. Davies
University of Salford, Acoustics Research Centre, Newton Building, University Road, M5 4WT Salford, UK
Corresponding author E-mail: kim@alliscalm.net

I am conducting a Grounded Theory approach to measuring opinions of urban soundscapes. This approach makes it possible to focus on the soundscapes experienced by an individual in their daily life, instead of focussing on the soundscape of a specific location. Participants are given a small portable recording device and asked to keep a sound diary for two weeks. At the end of the two weeks, participants are given a 60-minute interview about their experiences. The methodology is designed to give people time to think about soundscapes in their own words, and record what is important to them, rather than using a researcher-centered environment and vocabulary.
Early data suggests people listen in a multitude of ways that challenge existing ideas of modes of listening, care more about work and home environments than public places, and that the role and importance of soundscape is both quantitatively and qualitatively different in varying environments. I also question the idea of what an "expert listenerï is, with examples of various ways participants have demonstrated very high aural acuity without any acoustics/sound engineering background.

Wed 14:00 Peter BARNETT SP-S01: Soundscape

Listening strategies in a soundscape annotation task – (Contributed, 000752)

R. Van Der Linden and T. A. Andringa
University of Groningen, Nijenborgh 9, 9747 AG Groningen, Netherlands
Corresponding author E-mail: tjeerd@ai.rug.nl

Listeners employ a variety of strategies in carrying out a soundscape annotation task. The soundscape annotation tool we developed is equipped with means to follow and record the behaviour of a subject performing a semantic annotation task. These data, combined with the actual annotations, give insight in the strategies the annotators use in the task. We performed an experiment in which 19 participants annotated two real-world soundscape recordings. Two conditions were tested: one in which the annotators worked under time pressure, and one in which they had enough time to add detailed annotations and sound classes. We give a preliminary explanation of our findings in terms of auditory attention.

Wed 14:20 Peter BARNETT SP-S01: Soundscape

A field study on the subjective evaluation of soundscape – (Contributed, 000372)

A. Ozcevik and Z. Yuksel Can
Yildiz Technical University, Faculty of Architecture, Yildiz Technical, University, Besiktas, +90 34349 Istanbul, Turkey
Corresponding author E-mail: karabi@yildiz.edu.tr

Researches on soundscape are focused on the interactions among the sound source/s, the environment and the receiver/s. While the effects of sound sources and sound environment are relatively easily described by objective means, the subjective nature of human perception, which depends on sociological, psychological and cultural factors, creates the main challenge. This paper is a study on the subjective evaluation of soundscape aiming to create a basis to be used in further soundscape researches. A survey form consisting of two parts; a questionnaire and a semantic differential test, is prepared. The questionnaire part covers categories such as; personal information, usage of field, concordance with the expectations and sound environment evaluation, aiming to investigate the pleasantness of soundscape. Semantic differential test is utilized to examine the quality of sound environment. The pairs of adjectives, which are used in the semantic differential test, are selected accordingly to both the vernacular language of the related community and the soundscape literature. Data held from the field study, which is realized in four areas, is statistically analyzed and the soundscapes of the areas are subjectively evaluated. The information obtained from this study will be used to progress in the next stage which is laboratory studies.

Wed 15:00 Peter BARNETT SP-S01: Soundscape

Prediction and explanation of sound quality indicators by multiple linear regressions and artificial neural networks – (Contributed, 000577)

L. Brocolini[a], C. Lavandier[a], C. Marquis-Favre[b], M. Quoy[c] and M. Lavandier[b]
[a]Université Cergy Pontoise, 5 mail gay lussac, IUT Génie Civil, 95031 Cergy Pontoise, France; [b]Université de Lyon - ENTPE, rue Maurice Audin, 69120 Vaulx-En-Velin, France; [c]Equipes Traitement de l'Information et Systèmes, 6, avenue du Ponceau. F 95014 Cergy-Pontoise Cedex
Corresponding author E-mail: catherine.lavandier@u-cergy.fr

The purpose of this study is to develop a predictive model of urban sound quality from field survey data using multiple linear regressions and artificial neural networks (ANNs).
In order to determine a sound quality indicator, 320 passers-by were asked to assess their environment mainly from an acoustic point of view but also from a global perspective (visual and air quality).
The investigation took place in two large cities in France, and involved 8 different kinds of typical sound environments: park, pedestrian street, boulevard, street and urban transitions such as transition between park and boulevard. In each place, passers-by had to evaluate 26 subjective variables on 10-point scales.

The collected data are analyzed according to two methods: multiple linear regressions and artificial neural networks. The resulting models are compared. The regression model is more self-explanatory about the influence of each variable whereas the ANN model makes it possible to differentiate the influence of each variable depending on the type of the environment.

Wed 15:20 Peter BARNETT SP-S01: Soundscape

Meaning of quiet areas in urban context through people viewpoints – (Contributed, 000078)

P. Delaitre, C. Lavandier, R. Dedieu and N. Gey
Université Cergy Pontoise, 5 mail gay lussac, IUT Génie Civil, 95031 Cergy Pontoise, France
Corresponding author E-mail: pauline.delaitre@u-cergy.fr

Quiet areas in the European Directive 2002/49/EC are characterized with an acoustic level. But since 2002 some studies have shown that quiet areas can be characterized also with other parameters depending on personal or common representations: the meaning of the sound sources, the relative aspect, the visual environment, etc. The Q-methodology has been chosen to reveal the different groups of people who share the same representation of quiet areas. Consequently, a questionnaire has been developed on internet, where people were asked to evaluate their agreement in regard to 47 statements on a Likert scale. From 200 participants, 5 groups have been revealed. For the greatest group of persons, the presence of typical sources, such as water or birds, is the most important characteristic of quiet areas. This profile brings together persons who mostly live in town. Another group gathers people who seek to escape from the daily life. Another group of persons focuses on their psychological rest. These different points of view have to be taken into account by urban planners when they want to preserve or create some quiet areas in an urban context.

Wed 15:40 Peter BARNETT SP-S01: Soundscape

The soundscape of nature areas: assessment and review of research approaches – (Contributed, 000803)

M. Weber
DCMR Environmental Protection Agency, Parallelweg 1, 3112 NA Schiedam, Netherlands
Corresponding author E-mail: miriam.weber@dcmr.nl

The Environmental Noise Directive requires authorities to delineate (nature) areas where the acoustic quality is good, and to protect these areas. In the Netherlands, since decades provinces have delineated so-called quiet areas cf. the Environmental Protection Act. In line with the noise abatement paradigm acoustic parameters were applied as maximum allowed levels (e.g. 40 dB Lday) and specific activities near or in these nature areas were restricted. Underlying reasons for preserving the (acoustics) quality of the quiet areas, such as restoration for humans or effects on animals, were hardly considered. Interestingly, some regional authorities adopted the END as a shift from noise abatement towards soundscape approaches. In the Province of South Holland (acoustic) quality in thee quiet areas is assessed applying insights from international soundscape research. A two step approach is applied; a ëclassic' approach of measuring noise indicators. And parallel to measuring visitors and people living in the vicinity of the areas are surveyed, using a questionnaire on sound perception, overall quality assessment of the area, noise annoyance at home et cetera. The paper will discuss (dis)advantages of the approach applied, and will provide suggestions for standardisation of soundscape research in urban as well as nature areas.

Wed 16:00 Peter BARNETT SP-S01: Soundscape

The sonic atmosphere as a historical object? – (Contributed, 000074)

O. Balaÿ
CRESSON, Ecole Nationale d'Architecture de Grenoble, 60 av. de Constantine, 38036 Grenoble, France
Corresponding author E-mail: olivier.balay@lyon.archi.fr

There would be an absence, a gap in the description of the sound living environment of the past. How can we manufacture the history of the spread and production of an atmosphere, its materiality? The man, who is never passive in his world, can identify his landmarks and create his own arrangements with architectural forms, machines and techniques he meets. He is sensitive to the atmosphere surrounding him and that he makes back, to the modes of communication that are invented, to exchanges, frictions and chills that are emerging. Now the making of the "atmosphere" escapes to the historical strategies and resists to the getting caught of the rules of the description, or even to the approach of the perceptions in situ, those that are corresponding to the heart of the experience.
To find how an acoustic atmosphere is recognized by those who make it, we question the volume of air spaces, their auditory matters; then we explain how those streams flow through the air; at last we ask how they spread and are received. Those informations exist in the archives, although they are few, even if we look for them carefully.

Wed 16:40 Peter BARNETT SP-S01: Soundscape

Reporting physical parameters in soundscape studies – (Contributed, 000434)

T. Gjestland
SINTEF ICT, SINTEF, N-7465 Trondheim, Norway
Corresponding author E-mail: truls.gjestland@sintef.no

Most reports on soundscape studies concentrate on the perceptual aspects of the experiment. It is therefore difficult to extract generic knowledge from these studies due to the lack of a physical description of the situation. A number of soundscape scientists have responded to a small survey and reported on both what kind of measurement procedures they are currently using, and on what kind of data (acoustical and non-acoustical) they would like to see in other studies. Binaural recordings are preferred by many of the respondents, but these recordings are only used for subjective lab assessments and comparative studies. They are not used for any objective measurements or analysis. Simple mono recordings are used to measure standard acoustical parameters like level, level distribution, loudness, roughness, sharpness, etc. The paper will not discuss the relevance of these parameters. Some of the soundscape data requested by the survey respondents can only be found and assessed subjectively, for instance identification of sound sources, signal to background level for individual sources, etc. A proposal for minimum requirements for reporting physical parameters, and in particular acoustical parameters, in soundscape studies will be discussed.

Wed 17:00 Peter BARNETT SP-S01: Soundscape

Perceptual assessment of water sounds for road traffic noise masking – (Contributed, 000675)

L. Galbrun and T. T. Ali
Heriot-Watt University, School of the Built Environment, EH14 4AS Edinburgh, UK
Corresponding author E-mail: l.g.u.galbrun@hw.ac.uk

Due to their inherent positive quality and sound masking properties, water generated sounds are very popular in the context of soundscape design. This paper examines the perceptual assessment of water sounds in the presence of road traffic noise through the use of auditory experiments. The water sounds used in the experiments were generated by waterfalls, streams, cascades and fountains, with most of the sounds obtained from laboratory tests run under controlled conditions. This ensured an accurate and reliable analysis of the water generated sounds, as well as obtaining a wide range of sounds by varying several designs factors such as flow rate, source's height, waterfall's width, waterfall's edge characteristics and impact material. The results obtained from the auditory experiments include the preferred sound pressure levels of a variety of water sounds against road traffic noise, as well as the preferred water sounds used for masking road traffic noise. All preferences were rated in terms of relaxation, and the most significant findings obtained will be presented at the conference.

Wed 17:20 Peter BARNETT SP-S01: Soundscape

Evaluation of noise barriers for soundscape perception through laboratory experiments – (Contributed, 000683)

J.Y. Hong[a], H.S. Jang[b] and J.Y. Jeon[a]
[a]Hanyang University, Department of Architectural Engineering, 133-791 Seoul, Republic of Korea; [b]Laboratoire de Mathématiques de Versailles, 45, avenue des Etats-Unis 78035 Versailles cedex
Corresponding author E-mail: jyjeon@hanyang.ac.kr

In the present study, soundscape qualities have been investigated for the different types of urban noise barriers. Field measurements were performed: the sound pressure levels in front and back of the barriers were measured and the pictures were taken. Accordingly, laboratory experiments were conducted to evaluate the soundscape quality when each noise barrier existed. The experiments consisted of three parts; 1) audio-only condition, 2) visual-only condition, and 3) audio-visual condition. As a result, the soundscape design elements for designing urban noise barriers were derived from the subjective preferences both in aesthetical and spectral characteristics of the noise barriers.

Wed 17:40 Peter BARNETT SP-S01: Soundscape

Constructing ideal soundscapes: a practical study on closing the gaps between soundscape studies and urban design – (Contributed, 000820)

D. Steele[a], N. Luka[b] and C. Guastavino[c]
[a]McGill School of Architecture, CIRMMT, 815 Sherbrooke Street West, Montreal, Canada H3A 0C2; [b]McGill School of Architecture + Urban Planning, 815 Sherbrooke Street West, Montreal, Canada H3A 0C2; [c]McGill School of Information Studies, CIRMMT, 3661 Peel street, Montreal, Canada H3A 1X1
Corresponding author E-mail: dlsteele@alum.mit.edu

Calls are increasingly made for urban design measures that take non-vision sensory modalities into account, such as hearing, but agents capable of making such changes often lack the expertise to do so. The best progress in acoustics so far has been through intentional soundscape design, which considers sound during the urban design process rather than after. Indeed, design teams should understand how complicated factors play out in-situ, such as findings linking increased driving speeds with acoustically treated roads. Armed with this knowledge, they can take action to prevent further harm to urban landscapes. In practice, however, what can happen is that 1) papers in soundscape are written in language not interesting to urban designers; 2) research studies examine the current environment without proposing design updates; and 3) different investigators fail to agree on what constitutes wanted and unwanted noise. Each issue contributes to a built environment that reflects little of our sophisticated understanding. In response, this presentation will 1) demonstrate how soundscape research can fit into current urban design frameworks; 2) review key works in the literature to suggest some small and large acoustically-optimized urban design strategies; and 3) encourage collaboration channels connection soundscape research with urban design practice.

Wed 18:00 Peter BARNETT SP-S01: Soundscape

How some sounds impact on lives – `(Contributed, 000784)`

T. A. Andringa and J. J. Lanser
Rijksuniversiteit Groningen, Nijenborgh 9, 9747 AG Groningen, Netherlands
Corresponding author E-mail: tjeerd@ai.rug.nl

How does sound annoyance influence lives and which factors determine the level of annoyance? Many surveys have investigated the health and well-being correlates of loudness. However these surveys have not focused on the question how some sounds, and not others, impact the lives of individuals. We have conducted a web-based survey with more than 70 questions that investigated this question. The results show that 1) sound annoyance is a multifacetted phenomenon that indicates impaired need satisfaction and 2) that the role of loudness in sound annoyance is less prominent than is often (implicitly) assumed. In fact sound annoyance seems to depend on three necessary conditions: audibility, involuntary attraction of attention, and interference with need satisfaction. We present the main results of the questionnaire and provide a list of recommendations to prevent avoidable sound annoyance suitable for sound producers, exposed public, and local governments.

Wed 18:20 Peter BARNETT SP-S01: Soundscape

A comparative case study of indoor soundscape approach on objective analyses and subjective evaluations of libraries – `(Contributed, 000781)`

P. N. Dökmeci and J. Kang
University of Sheffield, School of Architecture, S10 2TN Sheffield, UK
Corresponding author E-mail: p.dokmeci@sheffield.ac.uk

In this study indoor soundscaping approaches were used to evaluate 3 different libraries in Sheffield, United Kingdom. Acoustic measurement and recordings as well as social survey on indoor soundscapes were carried out in each library. Usage, time spent, evaluation of physical conditions, demographics, sound perception, noise annoyance, and sound preferences were included in the survey. In addition, established frameworks were used for examining the architectural characteristics. The recorded sound files were analysed through ArtemiS software to examine parameters including sound pressure level, frequency spectrum, loudness, roughness, and sharpness. The survey data were evaluated in terms of the correlations between objective parametric results and subjective ratings. Relationships have been revealed between architectural/functional differences and the variances of objective measurements within the indoor sound environment.

Wed 18:40 Peter BARNETT SP-S01: Soundscape

Plural perception of urban soundscapes in public transportation – `(Contributed, 000095)`

C. Semidor and C. Sallenave
GRECAU - ENSAP¨ Bx, 740 cours de la Libération - BP 70109, 33405 Talence Cedex, France
Corresponding author E-mail: catherine.semidor@bordeaux.archi.fr

This paper deals with the study of plural perceptions of the urban landscape during a public transport journey daily lived by users and non-users of electronic devices such as a Walkman, mobile phone... To assess possible cultural appreciations of the public transport users in their representation of soundscapes, this experiment was conducted in the tramway of Bordeaux (France) and in the "tren ligero" of Guadalajara (Mexico). The followed protocol consisted of two phases: a way out with an "electronic device" and a way back without. During these two trips, we provided on the one hand recordings of the soundscapes using the methodology developed by GRECAU allowing having objectifiable data and on the other hand interviews with the subjects from which changes in feelings and behaviors were interpreted.

Wed 13:40 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Aeroacoustic characterisation of single and dual tooth-shaped obstacle replicas in relation to the study of unvoiced fricative speech production – (Contributed, 000092)

Y. Fujiso and A. Van Hirtum
Gipsa-lab, UMR CNRS 5126, Grenoble Universities, 38000 Grenoble, France
Corresponding author E-mail: annemie.vanhirtum@gipsa-lab.grenoble-inp.fr

Unvoiced fricative speech production involves the noise produced by a complex fluid-structure interaction between a moderate bulk Reynolds number ($100<Re<10000$) turbulent jet issued from a constriction somewhere in the vocal tract with a downstream obstacle (i.e. articulators such as lips, tongue or teeth).
To contribute to the physical study of human unvoiced fricative speech production, two types of simplified in-vitro tooth-shaped (single and dual) obstacle replicas are experimentally investigated. Acoustic measurements of the noise emitted by an airflow passing through each of the two replicas are performed at several moderate bulk Reynolds numbers relevant to fricative production in a quasi-anechoic chamber.
In order to characterise and quantify the influence of articulators position and shape on the produced sound, various geometric parameters of the replicas are varied. Furthermore, the effect of initial and boundary conditions are studied as well by varying them. Finally, the influence of the obstacle presence on the acoustics is modelled for different experimental configurations and results are compared to corresponding measurements.

Wed 14:00 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Analytical solution for pressure driven viscid flow in ducts of different shape: application to human upper airways – (Contributed, 000097)

B. Wu[a], A. Van Hirtum[a] and X. Luo[b]
[a]Gipsa-lab, UMR CNRS 5126, Grenoble Universities, 38000 Grenoble, France; [b]Department of Mathematics, University of Glasgow, G12 8QW Glasgow, UK
Corresponding author E-mail: annemie.vanhirtum@gipsa-lab.grenoble-inp.fr

Under the assumptions of steady, viscid and incompressible flow, analytical solutions are presented for fully developed pressure driven flow through uniform ducts with different shapes. The considered geometries cover a wide range of simple shapes - such as circle, ellipse, rectangle, circular sector, triangle and limacon - which are relevant to different portions of the upper airways (e.g. glottis or/and oral tract) in normal or pathological conditions during breathing or speech production. In addition to the duct shape, the cross-section along the duct length can be varied in order to mimic upper airway portions in more detail. Besides the geometry the Reynolds number is varied in a range covering the range relevant to the upper airways and speech production ($0 < \mathrm{Re} < 20000$). The effect of viscosity and unsteady inflow for the different geometries under study is discussed and compared for different input parameters: fixed area, fixed hydraulic diameter and fixed perimeter. The influence of viscosity and duct shape with respect to the upper airways and speech production is outlined.

Wed 14:20 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Investigation of the effect of upstream airways impedance on regeneration of lip oscillations in trombone performance – (Contributed, 000553)

V. Freour[a] and G. P. Scavone[b,c]
[a]CIRMMT, Computational Acoustic Modeling Lab, Schulich School of Music, McGill University, 555 Rue Sherbrooke Ouest, Montreal, Canada H3A 1E3; [b]Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), 527 Rue Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3; [c]Computational Acoustic Modeling Lab, Schulich School of Music, McGill University, 555 Rue

Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3
Corresponding author E-mail: vincent.freour@mail.mcgill.ca

The role of the vocal tract in the regeneration of lip oscillations in brass instruments is uncertain though influence in the high register of the instrument seems plausible. In this study, we have developed a sensor which measures the variations of electrical conductance across the lips in brass instrument performance, and therefore enables the evaluation of the phase of the lip opening area. By combining this value with the phase of the acoustic pressures on the downstream and upstream sides of the lips, we investigate the nature of the coupling between the lips, the downstream air-column and the vocal-tract in trombone performers. This method allows for the study of vocal-tract tuning at the fundamental frequency with a high temporal resolution (within a tone), as well as characterization of the oscillatory mechanism of the lips (dominant outward versus dominant upward striking behaviour). Experimental results from a pool of trombone players are discussed in light of numerical simulations where a two-dimensional model of the vibrating lips is coupled to both a downstream and upstream reflectance.

Wed 14:40 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Acoustical coupling in self-oscillating computational vocal fold models – (Invited, 000592)

S. L. Thomson
1) Brigham Young University, 2) University Erlangen-Nuremberg, 435 CTB, Provo, 84602, USA
Corresponding author E-mail: thomson@byu.edu

One class of synthetic models used to study vocal fold vibration includes models with two layers that are fabricated using different silicone compounds with differing stiffness. It has been demonstrated, however, that unlike the human vocal folds, these two-layer models exhibit acoustic coupling with their subglottal flow supply tubes. A synthetic vocal fold model has been recently developed that may not exhibit this acoustic coupling. The model includes four layers of different silicone materials, including epithelial and very flexible superficial lamina propria layers. Its vibratory response is similar to that of the human vocal folds. To determine whether this new multi-layer model exhibits subglottal tube acoustic coupling, a corresponding finite element model has been developed. The model includes fully-coupled fluid and solid domains for flow-induced vibration simulation. The solid domain includes layers corresponding to each of the synthetic model layers and allows for large strain and stress. The fluid domain is governed by the slightly-compressible Navier-Stokes equations, allowing for exploration of acoustic coupling. In this paper, simulation results for models with varying subglottal tube lengths will be reported and used to predict the extent to which acoustic coupling plays a role in governing the model's flow-induced vibration.

Wed 15:00 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Dynamic mechanical modelling of speech – (Invited, 000516)

A. Barney
University of Southampton, Highfield, SO171BJ Southampton, UK
Corresponding author E-mail: ab3@soton.ac.uk

In voiced speech, the source of sound is the vibrations of the vocal folds within the larynx. The steady flow of air passing out from the lungs is modulated by a complex fluid-tissue interaction in the larynx and excites acoustically the vocal tract downstream of the glottal exit. The system is small and inaccessible and, being situated inside a living person, is unsuitable for many kinds of experimentation. In vitro models offer the opportunity for systematic empirical studies in a controllable environment. This paper describes experimental measurements of the flow and pressure regimes made on a driven mechanical model of the vocal folds and vocal tract. The model has been used in a range of studies to explore jet formation and development downstream from the glottal exit, the effect of small changes in the duct geometry and, latterly, the interrelationship between the vibrating glottal source and a noise source further downstream as found in voiced fricative sounds.

Wed 15:20 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

The effect of wall vibrations on the air column inside trumpet bells – (Contributed, 000478)

V. Chatziioannou[a], W. Kausel[a] and T. Moore[b]
[a]Institute of Musical Acoustics, University of Music and Performing Arts Vienna, Anton von Webern Platz 1, 1030 Vienna, Austria;
[b]Department of Physics, Rollins College, Winter Park, Orlando, Florida, Orlando, 32789, USA
Corresponding author E-mail: chatziioannou@mdw.ac.at

The effect of wall vibrations on the sound of brass wind instruments is reported. There is experimental evidence showing that damping the vibrations of a trumpet bell alters the input impedance and transfer function of the instrument. Numerical simulations suggest that it is the axi-symmetric oscillations of the walls of the instrument that are responsible for the observed effects. Indeed, a finite element analysis of the effects of such oscillations on the air column yields results qualitatively similar to those of experiments. However, due to the complexity of the geometry and boundary conditions of a real instrument, the results of simulations do not agree quantitatively with the measured influence of the wall vibrations on the radiated sound from an actual trumpet. For this reason, straight trumpet bells have been manufactured that are expected to have boundary conditions more consistent with the assumptions of the numerical model. The results of both experimental measurements and numerical simulations of these custom-made bells are presented in this study.

Wed 16:40 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Higher order modes propagation in the human vocal tract – (Invited, 000812)

R. Laboissière[a], H. C. Yehia[b] and X. Pelorson[c]

[a]INSERM U1028, CNRS UMR5292, Lyon Neuroscience Research Center, HEH/U Audiologie & d'Explorations Orofaciales, 5 place d'Arsonval, 69003 Lyon, France; [b]Universidade Federal de Minas Gerais, CEFALA - DELT, Av. Antônio Carlos 6627, 31270-901 Belo Horizonte Mg, Brazil; [c]Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex

Corresponding author E-mail: rafael.laboissiere@inserm.fr

The representation of the vocal tract in terms of its cross sectional area function is useful to obtain an approximation of the acoustics of the vocal tract based on plane waves, which takes into account only for longitudinal resonance modes. However, for frequencies above 4 or 5 kHz (depending on the vocal tract geometry), transverse resonance modes can have a significant effect and must be taken into account. In this paper, we describe a method to calculate the vocal tract acoustics for the case of cross-sectional shapes measured by MRI. Since these shapes are arbitrary, a method to numerically derive the eigenfunctions and eigenmodes has been implemented. Validation of this method has been performed by comparison with analytical solutions for rectangular and elliptical geometry. First a comparison between the results obtained with this new method and the classical approximation using a concatenation of uniform ducts of rectangular or elliptical cross-sections is presented. The effect of higher acoustical modes is illustrated on the basis of not only the transfer function but also on the radiated sound pressure field. Then, the results obtained by numerical simulation are compared with acoustical measurements performed on mechanical replicas of the vocal tract with various shapes.

Wed 17:00 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Considerations on travelling waves in the horn equation and energetic aspects – (Contributed, 000816)

T. Hélie[a], T. Hezard[a], L. Delebecque[b] and R. Mignot[c]

[a]Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris; [b]Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex; [c]Institut Langevin " Ondes et Images "", 10 rue Vauquelin, 75005 Paris, France

Corresponding author E-mail: helie@ircam.fr

The digital waveguide synthesis of wind resonators and of the vocal tract is based on decompositions into travelling waves. Typical ones are planar waves in straight pipes and spherical waves in conical pipes. However, approximating a bore by cascading such basic segments introduce unrealistic discontinuities on the radius R or the slope R' (with acoustic consequences). It also can generate artificial instabilities in time-domain simulations, e.g. for non convex junctions of cones.

In this paper, we investigate the case of the "conservative curvilinear horn equation" for segments such that the flaring parameter R"/R is constant, with which smooth profiles can be built. First, acoustic states that generalize planar waves and spherical waves are studied. Examining the energy balance and the passivity for these travelling waves allows to characterize stability domains. Second, two other definitions of travelling waves are studied: (a) one locally diagonalizes the wave propagation operator, (b) one diagonalizes the transfer matrix of a segment. The propagators obtained for (a) are known to efficiently factorize computations in simulations but are not stable if the flaring parameter is negative. A study in the Laplace domain reveals that propagators (b) are stable for physically meaningful configurations.

Wed 17:20 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Physical modeling of vowel-bilabial plosive sound production – (Contributed, 000377)

L. Delebecque, X. Pelorson, D. Beautemps, C. Savariaux and X. Laval
Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex
Corresponding author E-mail: louis.delebecque@gipsa-lab.grenoble-inp.fr

Vowel-plosives sound production involves a voluntary control by the speaker and a fluid mechanical interaction due to a pressure recovery downstream of the glottis and viscous dissipation through the constriction. Our goal is to investigate the importance of this aerodynamical effect and to model it accurately. In this paper, we will first present results from measurements on a human speaker during production of vowel-bilabial plosive-vowel sequences. These measurements concern Intral Oral Pressure, acoustical pressure, EGG and lips video recording of a male subject. The relative timings between the motion of the lips, the glottal signals and the IOP are analyzed and related with Voice Onset/Offset Times. In order to explain and predict the evolution of the IOP observed on human subject, during bilabial plosive production, a mechanical model which accounts for the expansion of the cheeks is introduced. Lastly, the theoretical model is tested against measurements on a mechanical replica of the vocal tract including a self-oscillating glottis, a controlled moving constriction to mimic the closure of the lips. The vocal folds and the lips replica are connected using rigid or deformable (latex) tubes to account for cheek expansion. Typical examples will be presented and discussed and some synthesis examples will be played.

Wed 17:40 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Description of differences between the sound of trumpets, played by a musician or simulated by physical modelling – (Contributed, 000365)

J.-F. Petiot[a] and J. Gilbert[b]
[a]Ecole Centrale de Nantes, 1 rue de la noe, BP 92101, 44321 Nantes, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jean-francois.petiot@irccyn.ec-nantes.fr

This paper addresses the description and the interpretation of differences concerning the sound of different trumpets, i.e. the sound identity of instruments. Three different trumpets, obtained by geometrical variations of the leadpipe, are considered. After a measurement of the input impedance of the trumpets, they are first simulated using the harmonic balance technique, and second played by a "realï musician. Different playing conditions are considered, either for the simulation (virtual musician defined by the control parameters of the simulation) or for the "realï musician (playing at different dynamics). The two populations of sounds produced are characterized by their spectrum in permanent regime. The differences between the instruments, played or simulated, are next described by data analysis techniques (boxplot, principal component analysis, discriminant analysis). The objective is to discriminate the variability in the sounds due to the musician (virtual or real) to those due to the instrument itself. Results show that a sound identity of the instrument can be defined, in particular for crescendo sounds. Even if the simulated sounds and the sounds played by a musician are obviously very different, similarities in the differences between real and virtual sounds can also be noticed.

Wed 18:00 John TYNDALL MA-S07: Physical modelling of instruments and voice (co-organised with 'HS')

Analysis-synthesis of vocal sounds based on a voice production model driven by the glottal area – (Contributed, 000769)

T. Hezard, T. Hélie, R. Caussé and B. Doval
Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris
Corresponding author E-mail: thomas.hezard@ircam.fr

The source-filter paradigm has been widely used to model, synthesize and analyse vocal sounds. In spite of their efficiency, most of such models neglect some physical phenomena which could significantly improve naturalness. In this paper, we consider a modified source-filter model which includes a simplified aeroacoustic coupling between the glottal airflow and the vocal tract while keeping low-cost computation and efficient analysis methods.

We introduce a glottal area waveform model derived from observations on high-speed video-endoscopic recordings and based on the so-called Liljencrants-Fant (LF) model. The vocal tract is modelled by a concatenation of straight pipes with lossless plane waves propagation. The coupling is ensured by the standard Bernoulli equation, a flow-separation model and continuity constraints for acoustic pressure and flow at the inner end of the vocal tract. This

voice production model is driven by the sub-glottal pressure, the glottal area and the vocal tract geometry. Moreover, we introduce a sound analysis method for this model. In conclusion, we present some synthesis, analysis and transformation examples to evaluate the performances of this model and compare it with a classic source-filter model.

Wed 14:00 François CANAC AA-S07: Variable room acoustics - Diffusion

Modelling of reverberation enhancement systems – (Contributed, 000649)

J. Rouch[a], I. Schmich[a] and M.-A. Galland[b]
[a]Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: jeremy.rouch@cstb.fr

Electroacoustic enhancement systems are increasingly specified by acoustic consultants to address the requests for a multi-purpose use of performance halls. However, there is still a lack of simple models to predict the effect induced by these systems on the acoustic field.
Two models are introduced to establish the impulse responses of a room equipped with a reverberation enhancement system. These models are based on passive impulse responses according to the modified theory of Barron & Lee or to the diffuse stochastic fields approach introduced by Polack. The action of the system is simulated either with an energetic approach derived from Sabine's theory or by solving the frequency equation governing a multivariable loop system (FMLSE).

The acoustic criteria derived from these models are compared with those obtained with a reference method. This method is based on the numerical calculation of impulse responses by asymptotic methods (ICARE software developed at CSTB) and the resolution of the FMLSE.

Wed 14:20 François CANAC AA-S07: Variable room acoustics - Diffusion

Auralization of a virtual orchestra using directivities of measured symphonic instruments – (Contributed, 000758)

S. Pelzer, M. Pollow and M. Vorländer
RWTH Aachen University, Institute of Technical Acoustics, Templergraben 55, 52056 Aachen, Germany
Corresponding author E-mail: spe@akustik.rwth-aachen.de

Room acoustic simulation algorithms have evolved to powerful tools in recent years. Additionally to traditional tasks, such as prediction of room acoustic parameters (e.g. reverberation time, strength etc.), they are commonly used for auralizations nowadays. For a lively and natural virtual representation of real sound sources, it is important to include their individual characteristics in terms of directivity patterns and spatial dynamics.
For a high quality auralization of a full orchestra, the radiation patterns of symphonic instruments were captured using a surrounding spherical array and stored in the free openDaff directional file format. Using a hybrid image sources and ray tracing method, room impulse responses (IRs) were calculated for each orchestra instrument. The player's movements were simulated by applying an artificial ëhumanization' to the position and orientation vectors.

The simulation generates binaural signals as well as spatial impulse responses in spherical harmonics (SH) format, which can then be convolved with anechoic recordings of each part. Using the flexible SH representation and headtracking, a dynamical and immersive auralization can be achieved that reacts on the listeners head movements.

Wed 14:40 François CANAC AA-S07: Variable room acoustics - Diffusion

Scattering sound field prediction over periodic facing walls containing rectangular cavities – (Contributed, 000131)

A. Khanfir[a], A. Faiz[b], J. Ducourneau[b] and J. Chatillon[a]
[a]INRS, 1, Rue Morvan, 54519 Vandoeuvre-Lès-Nancy, France; [b]Faculté de Pharmacie de Nancy, 5, rue Albert Lebrun, 54001 Nancy, France
Corresponding author E-mail: adel.khanfir@inrs.fr

The "Institut National de Recherche et de Sécuritéï (INRS) is interested to reduce hearing risks in industrial workplaces by improving in situ noise conditions. INRS proposes appropriate solutions to improve the acoustic treatment of facings for noise control at workplace. This requires the development of theoretical and experimental methods of acoustic characterization of wall facings present in industrial rooms. These walls which possess periodic or aperiodic reliefs scatter sound waves. This work consists in developing a theoretical model to predict the acoustic pressure field reflected and scattered over a periodic facing containing parallel rectangular cavities. Originally, the model is based on a study of thick slits in electromagnetism. It has been adapted to study the acoustic behavior of a rectangular cavity by blocking the bottom of the slit. Then, the model has been generalized for several joint cavities by taking into account effects of coupling. It has been compared to FEM method and to experimental results obtained in a semi-anechoic room for a periodic facing containing three rectangular cavities insonified by an incident spherical acoustic field. The observed agreement between the numerical and experimental results supports the validity of our model on a wide spectral range.

Wed 15:00 François CANAC AA-S07: Variable room acoustics - Diffusion

Ray-tracing modelling of the diffraction by half-planes and slits based on the energy flow lines concept – (Contributed, 000644)

A. Billon[a] and J.-J. Embrechts[b]

[a]Laboratoire d'Étude des Phénomènes de Transfert et de l'Instantanéité : Agro-industrie et Bâtiment, Bâtiment Fourier Avenue Michel Crépeau F-17042 La Rochelle Cedex 1; [b]University of Liege - Acoustics Labo, Campus du Sart-Tilman, B28, B-4000 Liege 1, Belgium

Corresponding author E-mail: abillon@ulg.ac.be

Geometrical acoustics models are currently the most popular prediction tools in room-acoustics due to their low computing load. However, they seldom take into account the diffraction occurring at free edges or apertures. Moreover, the existing diffraction models implemented in geometrical acoustics algorithms are either limited to specularly reflected paths or either present excessive complexity. Recently, a diffraction model based on an approximation of the far-field direction of the Poynting's vector has been implemented in an acoustic ray-tracing software. This model can handle both diffuse and specular reflections and sets no limit in terms of order of reflection or diffraction by half-planes. Results for single and double diffraction problems are presented here. Moreover, this model is developed to handle diffraction occurring at slits and comparisons with experimental results are shown.

Wed 15:20 François CANAC AA-S07: Variable room acoustics - Diffusion

Measurement of sound diffusion coefficients of scattering furnishing volumes present in workplaces – (Invited, 000162)

A. Faiz[a], J. Ducourneau[a], A. Khanfir[b] and J. Chatillon[b]

[a]Faculté de Pharmacie de Nancy, 5, rue Albert Lebrun, 54001 Nancy, France; [b]INRS, 1, Rue Morvan, 54519 Vandoeuvre-Lès-Nancy, France

Corresponding author E-mail: adil.faiz@pharma.uhp-nancy.fr

Scattering furniture (desks, chairs, cupboards, oe) are often present in workplaces. Predictive software tools like Ray+ for mapping the acoustic pressure field in workplaces employ acoustic characteristics such as the absorption or diffusion of scattering wall facings or furnishing volume. In this work, we used a measurement system for determining the in situ sound diffusion coefficient of scattering furniture. The measurement technic is based on Vorländer and Mommertz method originally operating in free-field conditions. In order to overcome problems of parasite echoes coming from reverberation of the other innerwalls of the building and from noisy sources present on the site, we used a dedicated emission/reception system. An acoustic array using multipolar weighting allows spatial filtering of the parasite echo and an impulsive sound source enables the use of a broad temporal window, resulting in adequate time separation of the different signals received by the antenna. Measurements of sound diffusion coefficient of a desk, chairs, one or several seated persons, cupboards, panels containing one or several cavities, etc, have been carried out for several incidence angles. These measures allow constituting a first database of sound diffusion coefficients per octave of scattering furniture in workplaces.

Wed 15:40 François CANAC AA-S07: Variable room acoustics - Diffusion

Searching for a theoretical relation between reverberation and the scattering coefficients of surfaces in a room – (Invited, 000065)

J.-J. Embrechts
University of Liege - Acoustics Labo, Campus du Sart-Tilman, B28, B-4000 Liege 1, Belgium
Corresponding author E-mail: jjembrechts@ulg.ac.be

The Sabine formula gives an opportunity to relate the reverberation time to the global absorption properties of a room. On the other hand, the scattering properties of surfaces also influence the reverberation. However, if the physical principles governing this influence are already known, there's presently not such a clear link between the "quantity" of scattering, the scattering coefficients of surfaces and reverberation. This link, like the Sabine formula, would help to specify the scattering properties of surfaces in room acoustics projects. This paper does not give a general solution to the problem, but it is rather a reflection based on existing research and a tentative of approach based on the acoustic radiative transfer (or transport) equation. This equation is first of all expressed for room acoustics problems, especially concerning the boundary conditions which explicitly include the surfaces' scattering coefficients. It is then applied to a diffuse sound field, showing that the scattering coefficients do not explicitly influence reverberation under such a strong assumption. In a second application, the transport equation is applied to a room containing a pair of parallel surfaces. In that case, the influence of scattering coefficients is described.

Wed 16:40 Paul LANGEVIN PU-S05: Structural health monitoring

Structural health monitoring using acoustic pressure response – (Contributed, 000093)

V. Arora[a], Y.H. Wijnant[b] and A.D. Boer[b]
[a]University of Stavanger, Kjell Arholmsgt. 41, 4021 Stavanger, Norway; [b]Structural Dynamics and Acoustics, University of Twente, 7500AE Enschede, Netherlands
Corresponding author E-mail: vikas.arora@uis.no

The subject of structural health monitoring is emerging as an increasingly important component of overall nondestructive evaluation programs.Presently, vibration-based and contact acoustic emission techniques have been widely used for structural health monitoring. Both vibration-based and acoustic emission techniques require attaching transducers to structures. In many applications, such as those involving hot structural materials for thermal protection purposes or in rotating machines, non-contact measurements would be preferred because the operating environment is prohibitive leading to potential damage in contact sensors or their attachments. There are some examples of optical techniques, such as laser-based techniques that do not require contact measurements but these non-contact methods are very expensive with respect to hardware and computational effort. In such cases, non-contact acoustics techniques are a very attractive option for determining the location and extend of damage in the structure. In this paper, a new method of SHM using acoustic pressure response is proposed. In the proposed method, the acoustic pressure responses are used to obtain vibro-acoustic mode shapes of the vibrating structure, which are subsequently used for damage detection of the structure. The proposed acoustic-based SHM facilitates less expensive acoustic field measurements and fast data processing. In total, this will lead to an online structural health monitoring system.

Wed 17:00 Paul LANGEVIN PU-S05: Structural health monitoring

Damping analysis in flexural vibration of sandwich beams with debonding – (Contributed, 000353)

I.M. Moustapha, A. El Mahi, R. El Guerjouma and O. Dazel
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: idriss.moustapha.etu@univ-lemans.fr

The paper presents, an analysis of the damping of sandwich composites with debonding. These sandwich composites consist of two thin faces composed of glass fibres and epoxy resin bonded to light weight and weaker core material of PVC foams. Natural frequencies and damping parameters are investigated using beam test specimens and an impulse technique. Modelling of the damping of a sandwich composite with debonding is established considering finite element analysis which evaluated the different energies dissipated in the material directions of the core and the skins. The effects of debonding variable lengths on the natural frequencies and the damping were studied numerically and compared with experimental results. The results show that the natural frequencies and damping are sensible to debonding length. These properties offer the sensitive indicators of damage of sandwich materials during lifetime.

Wed 17:20 Paul LANGEVIN PU-S05: Structural health monitoring

Hilbert-Huang Transform versus Fourier based analysis for diffused ultrasonic waves structural health monitoring in polymer based composite materials – (Contributed, 000427)

S.E. Hamdi[a], A. Le Duff[a], G. Plantier[a], L. Simon[b], R. El Guerjouma[b] and M.H. Ben Ghozlen[c]
[a]Groupe ESEO, rue Merlet de la Boulaye, 49009 Angers, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Faculté des Sciences de Sfax, Rte Soukra km 3.B.P. 1171, 3000 Sfax, Tunisia
Corresponding author E-mail: Seif-eddine.HAMDI@eseo.fr

The use of time-frequency distributions for analysis of diffused signals, which takes into account the non-stationarity of these signals, may be vital for structural health monitoring applications. Although this type of analysis may bring new information into the signals analysis, the interpretation of a time-frequency distribution may not be simple, which may affect the damage identification. In addition, the large number of available tools for time-frequency analysis with different assumptions about the signal features (i.e. assumptions about linearity, stationarity, etc.), may cause a problem when selecting the most appropriate technique for signal analysis, and then may affect the interpretation of results. In this paper, induced holes in a Glass Fiber Reinforced Polymer (GFRP) composite plate, considered as damages, are visualized on different time-frequency representations. In particular, representations obtained from traditional Fourier based analysis methods like spectrogram are compared to that provided by the Hilbert-Huang transform, recently developed. Such a comparison of these techniques can be very useful to justify the accuracy of the HHT and for guiding the choice of the appropriate monitoring strategy of a given process.

Wed 17:40 Paul LANGEVIN PU-S05: Structural health monitoring

Interaction of fundamental Lamb modes with a point impact damaged zone in composite plates – (Contributed, 000601)

D. Singh, R. El Guerjouma and M. Bentahar
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: kahlondilbag@yahoo.com

Due to high specific strength and stiffness for low weight, composite materials are increasingly used in modern industry. However, one weakness of such materials is their sensitivity to impacts, which may cause severe and harmful damages. The crack-like defects created by impacts may lead to local decays in composites properties, i.e., in the vicinity of the impacted zone. Furthermore, the angular spreading of the shock wave produced by the point impact makes the conical shape of impact damage. In this work, we study the interaction behavior of A0 and S0 Lamb waves with a conical damaged zone created during a point impact on the surface of a carbon fiber reinforced composite (CFRC) plate. A 3-Dimensional Finite Element model is used to simulate the scattering by the damaged zone of the above mentioned guided modes. The damaged zone inside the composite plate has been modeled as a conical shaped geometry with decayed material stiffness properties. The directivity pattern of the scattered field for the A0 and S0 modes are predicted from 3D Finite Element simulations and plotted graphically for various positions of the defect. The results will be used as a basis for the quantification of the detection sensitivity for impact zones in CFRC using guided wave sensors.

Wed 18:00 Paul LANGEVIN PU-S05: Structural health monitoring

Carbon nanotubes and graphene-based microsonar for embedded monitoring of microporosity – (Contributed, 000636)

B. Lebental[a], N. Sridi[b], F. Bouanis[c], C.-S. Cojocaru[c], F. Bourquin[a] and A. Ghis[b]
[a]IFSTTAR (ex-LCPC), 58 bd Lefebvre, 75732 Paris Cedex 15, France; [b]CEA-LETI, Minatec Campus, 17 rue des Martyrs, 38054 Grenoble, France; [c]LPICM-Ecole Polytechnique, Route de Saclay, 91128 Palaiseau Cedex, France
Corresponding author E-mail: berengere.lebental@ifsttar.fr

Nanoporosities play a most significant role in the durability of cementitious materials, so that nanoscale features are a promising target for SHM. However, to this day, no sensor features the resolution required to investigate non-destructively these nanofeatures. To fill in this loophole, we are devising a SHM-targeted, carbon nanotubes and graphene based capacitive ultrasonic nanotransducer for microporosity assessment in concrete.

In this paper, we report on the feasibility of the key building block of the proposed sensor: we have fabricated

ultra-thin graphene and single-walled carbon nanotubes membranes. A breakthrough laser vibrometry experiment shows that the membranes can feature above-nanometer amplitudes of vibration over a large range of frequencies spanning from 100 kHz to 5 MHz. A detailed numerical model of the nanotransducer shows that upon embedding in a cementitious material it could determine the volume and content of the porosity in its vicinity. Such information would be invaluable in the evaluation of structural durability.

Wed 18:20 Paul LANGEVIN PU-S05: Structural health monitoring

Creep-rupture prediction by naive bayes classifiers – (Contributed, 000717)

M. Darwiche[a], G. Bousaleh[b], M. Feuilloy[c], D. Schang[c] and R. El Guerjouma[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Université Libanaise, Institut Universitaire de Technologie, 1600 Saida, Lebanon; [c]Ecole Supérieure d'Electronique de l'Ouest, 4, rue Merlet de la Boulaye, BP: 30926, 49009 Angers Cedex 01
Corresponding author E-mail: mohamad.darwiche@eseo.fr

The purpose of this study was to predict the failure of composite materials by developing and evaluating an artificial learning algorithm that could predict their life time. This will be done by predicting whether a specimen will break within 30 seconds or not. Specimens were tested according to the creep test by the traction method. Naive Bayesian classifiers have been developed retrospectively in a group of 90 samples and tested prospectively in a group of 30 samples to evaluate and ensure the performance of this learning method. Each sample was characterized by a number of relevant parameters. During the five cross-validations, the learning machine achieved a mean sensitivity of 78% and a mean specificity of 82%. The mean area under the ROC curve (Receiver Operating Curves) reached 0.88. The study can be regarded as a very important step in the term of prediction of composite material time life remaining.

Wed 18:40 Paul LANGEVIN PU-S05: Structural health monitoring

Non Destructive Evaluation and Structural Health Monitoring of structural materials by means of nonlinear acoustics and acoustic emission – (Contributed, 000815)

R. El Guerjouma, M. Bentahar, J.-H. Thomas and A. El Mahi
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: rachid.el_guerjouma@univ-lemans.fr

Damage characterization of structural heterogeneous materials as concrete, rocks, or composites by classical linear acoustical methods does not generally give the expected sensitivity to early damage detection. As such, acoustical nonlinear methods appear like an interesting alternative. In this contribution we present a NonLinear Resonance Spectroscopy (NLRS) approach and use some NLRS features as Resonance frequency shift, Q-factor change as a function of the peak amplitude and Acoustical Slow Dynamics (ASD) to characterize damage in concrete and polymer-based composite. Materials are characterized at intact and gradually damaged states. Besides, damage was monitored using the Acoustic Emission (AE) generated by the material during the damage process. A classification of the AE signals is proposed to identify the different damage mechanisms and to understand their contribution to the evolution of the NonLinear behaviour of the materials under investigation. In this contribution we report observations of non linear features corresponding to a polymer-based composite sample taken at the intact as well as progressively damaged states. These features are correlated to Acoustic Emission data recorded during the different damage steps. This work shows the relevance of this approach in developing new highly sensitive methods for Non Destructive Evaluation and Structural Health Monitoring purpose.

Wed 17:00 François CANAC AA-S01: Acoustics of offices

Acoustic of open spaces - Overview of standardization work – (Contributed, 000032)

Y. Le Muet
SAINT GOBAIN ECOPHON, 19 RUE EMILE ZOLA, 60290 Rantigny, France
Corresponding author E-mail: yoan.le-muet@saint-gobain.com

NF S 31-199 uses the concepts of discretion. The underlying idea is that ensuring good intelligibility in the scope of communication (the workstation) will reduce the disturbance to distant workstations . Indeed, there is a contradiction inherent in open office areas: voice, useful to transfer knowledge and expertise in the room, turns out to be a disturbance few moments later, a few meters away. The complexity of the acoustics of open spaces brought the commission AFNOR S30 D in 2007 to initiate the drafting of a new document, complementary to NF S31-080.
The central themes are that communication and concentration have declined from a model space analysis distinguished in three zones, each corresponding to different acoustic issues: the workstation, the team and the department. The paper proposes the state already in a number of strategies, including the provision of workstations with issues and interactions between employees, reducing the ambient noise level or the mastery of sound propagation in space. This presentation proposes to make an inventory of the progress of the drafting work for four sub-categories of open space, ranging from call center to open space to the public

Wed 17:20 François CANAC AA-S01: Acoustics of offices

Efficiency of an acoustic table screen between two work stations in open plan offices – (Invited, 000053)

I. Schmich[a], C. Rougier[a], P. Jean[a] and P. Chevret[b]
[a]Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères; [b]INRS, Rue du Morvan, CS 60027, 54519 Vandoeuvre Les Nancy, France
Corresponding author E-mail: isabelle.schmich@cstb.fr

In order to improve the acoustic comfort of the users in open plan offices, several solutions are proposed. One of them consists in the installation of a small absorbing screen between two face to face work stations. The height of this table screen is variable. Nowadays it is difficult to predict accurately the efficiency of this kind of installation. A typical case of an office work station has been modeled and different heights of the table screen have been investigated through simulation. Two simulation methods have been compared: The first one (ICARE software developed at CSTB) uses asymptotic methods and is based on beam tracing including edge diffraction. The second method (MICADO 3D software developed at CSTB) uses the resolution through the Boundary Element Method where the Green function is optimized by the use of a source image technique. The simulation results show the insertion loss for the table screen and permits to determine the most efficient height for the protection between two work stations. Finally, the simulations results are compared to measurement results done in a semi-anechoic room by INRS.

Wed 17:40 François CANAC AA-S01: Acoustics of offices

Objective and subjective assessment of disturbance by office noise - Relevance of the use of the speech transmission index – (Contributed, 000148)

A. Ebissou[a], P. Chevret[a] and E. Parizet[b]
[a]INRS, Rue du Morvan, CS 60027, 54519 Vandoeuvre Les Nancy, France; [b]Laboratoire Vibrations Acoustique INSA Lyon, 25 bis avenue Jean Capelle, Villeurbanne, F-69621 Lyon, France
Corresponding author E-mail: ange.ebissou@inrs.fr

This experiment is part of a study aiming to assess the disturbance experienced by workers in open-plan offices. Previous studies have shown that a sound environment rich with speech sounds can be detrimental to one's performance. The magnitude of this Irrelevant Speech Effect (ISE) depends on the intelligibility of the ambient speech. This has led to the use of the STI to model the induced decrement in performance. However, a decrease in performance is only one aspect of the more general concept of disturbance. When attempting to model the ISE in this regard, other components should be explored. In this first experiment, fifty-six subjects perform a classical seriation task during 10-minutes blocks. They are confronted to sound evironments typical of open-plan offices. In each block, a voice emerges from the noise, with a STI value in the 0.3 - 0.7 range. Both their performance and response times are recorded. A silent condition is used as a reference. After each block, they are presented with the NASA-RTLX questionnaire for a subjective assesment of their workload. Comparisons between speech conditions will be made in order to understand the influence of ambient speech intelligibility on objective and subjective disturbance.

Wed 18:00 François CANAC AA-S01: Acoustics of offices

Sound level prediction in open-spaces: implementation of diffraction in RAYPLUS software – (Contributed, 000149)

P. Chevret and J. Chatillon
INRS, Rue du Morvan, CS 60027, 54519 Vandoeuvre Les Nancy, France
Corresponding author E-mail: patrick.chevret@inrs.fr

This study addresses the problem of diffraction by screens in open-plan offices. A numerical model, based on a ray-tracing method, was implemented. The initial model used was a piece of software whose purpose was to predict sound levels in industrial premises. Diffraction was introduced into the model via the Uniform Theory of Diffraction (UTD). For the purposes of validation, a campaign of tests was conducted in a semi-anechoic chamber. A first series of measurements of diffraction by a single screen and by a low-divider partition on a double desk made it possible to validate the experimental conditions through comparisons with the UTD. In the same experimental context, the predictions of the octave band spectra with the modified model were of good accuracy. In a second series of measurements, a removable ceiling was suspended above the double desk. The acoustic field behind the low divider was then made up of a mixture of the field diffracted by the low divider and of the field reflected by the ceiling. The results of the comparisons between calculations and measurements in this unitary configuration show that the modified model can be an excellent tool for predicting sound levels in an open-plan office.

Wed 18:20 François CANAC AA-S01: Acoustics of offices

Prediction of sound pressure levels at workplaces – (Contributed, 000518)

F. Probst
DataKustik GmbH, Gewerbering 5, 86926 Greifenberg, Germany
Corresponding author E-mail: info@datakustik.com

The sound pressure levels at work places are determined by the sound emission of the noise relevant facilities like machinery and by the acoustic properties of the room. A strategy has been developed to create virtual models of such sources by single point sources with frequency dependent directivity or by acoustically impervious cuboids covered by grids of point sources. In a pre-process the source distribution is developed from the sound power level and the directivity or by levels at defined positions around the source determined by measurements. This emission is coupled to a hybrid propagation calculation that allows to apply absorptive treatment of surfaces as well as screening objects. Low order reflections are calculated deterministic applying the mirror image method, while higher reflection orders are taken into account by a fast ray tracing calculation. The method is applicable to develop low noise layouts in offices, machine halls or other work places on the basis of standardized emission levels according to the machine directive.

Wed 17:00 Yves ROCARD NV-S07: Mid-Frequency

Automatic recognition of the components of a Hybrid FE-SEA model – (Contributed, 000399)

L. Kovalevsky and R.S. Langley
University of Cambridge, Engineering Department, Trumpington street, cb21pz Cambridge, UK
Corresponding author E-mail: lk315@cam.ac.uk

The hybrid finite element/statistical energy analysis (FE/SEA) method [Journal of Sound and Vibration, 288, 669-700 (2005); Journal of the Acoustical Society of America, 122, 3445-3463 (2007)] is a vibro-acoustic analysis approach based on a non-parametric model of uncertainty. It allows the prediction of the ensemble mean and variance of the response of a complex built-up system across a large range of frequencies, with a small number of degrees-of-freedom, and without the use of Monte-Carlo simulations. This approach considers the structure as an assembly of fully deterministic components, modelled using FE, and highly random components which are modelled with SEA, and a diffuse field reciprocity relation is used to model the coupling.
The main difficulty of this method is the choice of the different components. The work presented here addresses this issue. The aim is to develop an algorithm that can automatically recognise the SEA and FE components in a hybrid model based on a relatively coarse-mesh finite element analysis.

Wed 17:20 Yves ROCARD NV-S07: Mid-Frequency

On the usefulness of entropy in statistical energy analysis – (Contributed, 000507)

A. Le Bot, A. Carbonelli and J. Perret Liaudet
Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: Alain.Le-Bot@ec-lyon.fr

Statistical energy analysis is well-known method in the field of high frequencies. This method is founded on an analogy with thermodynamics and is largely inspired from results of statistical mechanics. But nowadays, the method is limited to the prediction of vibrational energies by application of the first principle of thermodynamics that is an energy balance on individual subsystems. In this study, we propose to extend statistical energy analysis by introducing the concept of vibrational entropy. The explicit formula given the vibrational entropies in terms of energies and number of modes is given. The entropy created during the energy echanges between subsystems is also given. Some examples are described which illustrate the meaning of vibrational entropy and vibrational temperature.

Wed 17:40 Yves ROCARD NV-S07: Mid-Frequency

High-frequency acoustic modelling: complex envelope applications to industrial cases – (Contributed, 000264)

A. Carcaterra[a], T. Svaton[a,b], O. Giannini[a] and A. Sestieri[a]
[a]Sapienza University of Rome, Via Eudossiana 18, 00184 Roma, Italy; [b]University of West Bohemia – NTIS, Univerzitní 22, 30614 Pilsen, Czech Republic
Corresponding author E-mail: tomas.svaton@uniroma1.it

In the context of mid- and high-frequency in acoustics and vibrations, the modeling of complex problems generates several difficulties. Part of them are related to the extreme large number of degrees of freedom the analyst must introduce in the discretised model. This makes the problem computationally heavy and very sensitive even to small uncertainties in the data. For this reasons in the last decade a systematic effort has been produced from academic and industrial groups to introduce new methods to deal with mid- and high- frequency problems. Recently several European project have been devoted to this subject and among them MID-FREQUENCY. In this frame, this paper reports significant results in the application of a relatively new model called CEV – Complex Envelope Vectorization, able to solve high-frequency vibro-acoustic coupled problems through the introduction of a suitable variable transformation. The method has been the subject of several prior investigations by the authors in the last years and in the present paper it is applied to real cases met in design of car acoustics. The results are indeed very encouraging and give a new horizon to the application of CEV.

Wed 18:00 Yves ROCARD NV-S07: Mid-Frequency

The Variational Theory of Complex Rays: a predictive computational tool for complex 3-D mid-frequency acoustic problems – (Contributed, 000545)

H. Riou, P. Ladevèze and L. Kovalevsky
Laboratoire de Mécanique et Technologie, Bât. Léonard de Vinci 61 Av du président Wilson 94235 Cachan Cedex
Corresponding author E-mail: riou@lmt.ens-cachan.fr

The Variational Theory of Complex Rays (VTCR) is a predictive computational tool that has been developed to solve mid-frequency problems. This is a wave approach that involves exact solutions of the governing equation, and a non classical variational formulation for handling boundary conditions of the problem. No fine discretization is therefore necessary to find an approximated solution, and the model sizes are consequently drastically reduced in comparison with the element based methods. This results in a more efficient prediction technique for vibration problems, especially in the mid-frequency ranges. This presentation discusses how the VTCR can be used for the analysis of complex 3-D acoustic problems. Its performances will be compared to the element-based methods through validation examples, on order to highlight its superior efficiency over the standard numerical prediction techniques.

Wed 18:20 Yves ROCARD NV-S07: Mid-Frequency

Wave decomposition method for identification of structural parameters – (Contributed, 000320)

M. Ruzek[a], J.-L. Guyader[a] and C. Pezerat[b]
[a]Laboratoire Vibration Acoustique, 25 Jean Capelle, LVA, 69621 Villeurbanne, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: michal.ruzek@insa-lyon.fr

This paper presents a newly-developed inverse method based on decomposition of the vibration field into natural waves. It is adapted for 1D and 2D structures which are described by one equation of motion. The method permits to identify the parameters of the equation of motion. The important feature of this approach is that it does not necessitate any knowledge of the boundary conditions. It is a so-called local method. Several experimental test were performed. Two examples are presented: determination of the axial force in the straight beam and determination of flexural rigidity of the plate.

Wed 11:20 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Quantitative analysis by the ultrasonic method of the effect of fluid of quenching on elastic and acoustical properties of hardened steel – (Contributed, 000028)

A. Markou, H. Nounah, M. Ezzaidi and I. Aboudaoud
Univ. Ibno Zohr Faculty of science Departement of physics, 4 Rue Smara cite amicale des fonctionnaires Inezgane Morocco, 80350 Inezgane, Morocco
Corresponding author E-mail: ahmed-vert@hotmail.com

We have studied by an ultrasonic non destructive testing system the effect of fluid of quenching on acoustical and elastic properties of hardened steel, the measurements are performed by an ultrasonic transducer with 5 MHz in the center frequency, working simultaneously as a transmitter and receiver. The measurements are made for three samples of steel, each of these specimens are hardened according to different conditions of tempering (different durations and fluids of quenching). From the signals backscattered by these samples, we have determined the ultrasonic velocities and attenuations of ultrasonic wave propagating in these specimens. In this study the results show that the tempering is more efficient for the sample which is quenching more times in water and then the acoustical and elastic properties are best than those tempered in air. Then in this work we have able to follow by an ultrasonic system the influence of the fluid of quenching on acoustical and elastic properties of hardened steel.

Wed 11:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Sound characteristics of a pipe with dynamically rough boundary – (Contributed, 000035)

A. Romanova, K. V. Horoshenkov and S. J. Tait
University of Bradford, Great Horton Road, BD7 1DP Bradford, UK
Corresponding author E-mail: a.romashk@gmail.com

Observing the acoustic field in the pipe above a dynamically rough water surface can provide a better understanding of the hydraulic roughness patterns and the change in these patterns which are caused by the hydraulic turbulence interacting with pipe wall roughness. This work presents results from a novel experimental setup, which allows for simultaneous measurements of the acoustic field in the pipe and water surface behavior. The acoustic and hydraulic characteristics were studied under controlled laboratory conditions, where six hydraulic regimes were used with a rough pipe bed condition. The acoustic technique makes use of acoustic Gaussian pulse which is transmitted in air above the turbulent water in the pipe. The scattering of the pulses was recorded on four non-equidistantly spaced microphones. The results obtained for the six flow regimes demonstrate that the statistical properties of the acoustic field are linked to the statistical properties of the dynamically rough water surface. This study demonstrates that the cross-correlation function of the four microphone pairs and the frequency spectrum statistics can be used for the flow water level and surface waves airborne measure. Statistical analysis methodology for the above techniques is briefly described.

Wed 12:00 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Development of a sonic boom measurement system at JAXA – (Contributed, 000043)

K. Veggeberg
National Instruments, 11500 N. Mopac C, Austin, 78759, USA
Corresponding author E-mail: kurt.veggeberg@ni.com

The Japan Aerospace Exploration Agency (JAXA) is actively conducting supersonic transport research toward the realization of civil supersonic aircraft. Technology that precisely measures sonic booms is essential to demonstrating JAXA's sonic boom reduction concept in the planned drop test of a research aircraft. This is a part of the D-SEND Program (Drop Test for Simplified Evaluation of Non-Symmetrically Distributed sonic boom). Capturing detailed multichannel sonic boom histories to validate aircraft design concepts that reduce sonic booms, which is necessary for next-generation supersonic transport.
The first step was the development of a ground based real-time monitoring and data-logging system that measures sonic booms indoors and outdoors as well as the resulting vibration of the windows and walls of the test buildings at the Northern European Aerospace Test range in Sweden. The ground-based measurement system is being expanded to include an aerial measurement system distributed at altitudes up to 1,000 m to reduce the effects of atmospheric turbulence. This system will be based on stand-alone computers controlled via wireless LAN distributed aloft for making high-accuracy audio frequency measurements. The objective is to accelerate the development of civil supersonic aircraft by demonstrating the low-boom design technology in planned drop tests.

Wed 13:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Water distribution measurement in sand using sound vibration and SLDV – (Contributed, 000068)

T. Sugimoto[a], Y. Nakagawa[a], T. Shirakawa[a], M. Sano[a], M. Ohaba[b] and S. Shibusawa[b]
[a]Toin Univ. of Yokohama, 1614, Kurogane-cho, Aoba-ku, 225-8503 Yokohama, Japan; [b]Tokyo Univ. of Agriculture and Technology, 3-5-8, Saiwai-cho, 183-8509 Fuchu, Japan
Corresponding author E-mail: tsugimot@cc.toin.ac.jp

Now in agriculture, it tends to save the agricultural water as much as possible. Therefore, the irrigation method using the minus pressure difference of soil water attracts attention. This method has the nature keeping the water content inside the ground. In other words, when there are crops, it is the mechanism which supplies the water content which is same quantity with the water content that it absorbed. However, effective saving water is not able to be performed, because the water distribution in soil is difficult to grasp. Therefore, we propose a method of monitoring and imaging of the water content in the rooting zone using a sound vibration and the scanning laser Doppler vibrometer (SLDV). From the experimental result, we can confirm that the distribution of the propagation velocity was a very effective method to the water distribution which is in the shallow position near the ground surface. Also, in the experiment which used negative pressure irrigation, we can confirm that it was caught in the water distribution which changes time wise by measuring at both of the vibration measurement.

Wed 14:00 Pierre CHAVASSE MI-G01: Measurement and instrumentation

An additional configuration to standard ASTM E2611-09 for measuring the normal incidence sound transmission loss in a modified impedance tube – (Contributed, 000135)

O. Doutres, R. Panneton and Y. Salissou
Groupe d'Acoustique de l'Université de Sherbrooke, 2500 Boulevard de l'Université, Faculté de Génie, Sherbrooke, AB, Canada J1K2R1 QC
Corresponding author E-mail: Olivier.Doutres@usherbrooke.ca

This paper presents a three-microphone two-load (3M2L) method for measuring the normal incidence sound transmission loss of a noise control system or material in a modified impedance tube. In the standard ASTM E2611-09, the downstream section of the impedance tube includes two microphones flush with the interior surface of the tube and the proposed four-microphone two-load (4M2L) method to assess the normal incidence sound transmission loss requires the use of two arbitrary acoustic terminations. The method presented here is conceptually identical but (i) the downstream section is reduced to a simple movable rigid backing with one microphone flush mounted on it and (ii) the two arbitrary acoustic terminations are replaced by two air cavities. It thus requires one microphone less and fewer transfer functions. The standard switching technique used to correct the variations between microphones is validated on a symmetrical air layer. The proposed 3M2L method is then applied to a non-symmetrical non-homogenous specimen and validated compared to the standard 4M2L method.

Wed 14:20 Pierre CHAVASSE MI-G01: Measurement and instrumentation

An automatic method to detect defaults in the measurement chain of a sound level meter, used for unattended noise measurements – (Contributed, 000210)

E. Aflalo[a], F. Dupont[a], P. Cellard[b] and J.-N. Durocher[b]
[a]01dB-Metravib, 200 Chemin des Ormeaux, 69578 Limonest, France; [b]Laboratoire national de métrologie et d'essais, 29, avenue Roger Hennequin, 78197 Trappes Cedex, France
Corresponding author E-mail: erik.aflalo@01db-metravib.com

The built-in electrical check (multi-frequencies charge injection) allows testing the entire measurement chain, including the microphone. It consists in injecting a sinusoidal charge (1 or 2 levels) into the microphone membrane, at selected frequencies. The principle is to collect reference values (initialisation stage) and to check over time that the deviation between the reference values and the measured values does not exceed a maximum predefined deviation value. A multiple-frequency check offers the advantage of a better assessment of a possible degradation of the microphone membrane as well as the electronic components. The checking procedure lasts from 10 to 30 seconds and occurs between two measurements, so as to make their validation easier. The purpose of the paper is to describe the results obtained for different types of defaults in the measurement chain.

Wed 14:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Designing ultrasound generator for induced crystallization – (Contributed, 000261)

J. Irudayaraj and B. Kanickai Raj
St. Joseph's College, Trichy, GRACE House, 39, 4th CROSS WEST, GOKULAM NAGAR, KATTUR, 620 019 Trichy, India
Corresponding author E-mail: jnaadarsh@hotmail.com

Ultrasound imaging is a modern technique which relies on pezoelectric or qrtz crystal transducers. It converts mechanical waves to electrical signals and vice versa. The characteristics and properties of a crystal can be improved by the influence of ultrasound. We devised an ultrasonic generator which generates 12 or 15 MHz ultrasonic wave The heart of the Ultrasonic circuit is IC MAX 038 which is a wide band oscillator. The frequency is well stabilized by IC 3B. The output of MAX 038 is amplified by operational amplifier and is given to piezo crystal which is sufficient in level to drive the crystal. The micro controller 16f877A reads the frequency and displays on the LCD. Various types of crystal have been grown under the influence of ultrasound and without the ultrasound. It is interesting to note that Ultrasound has an important role to tailor the properties of crystals.

Wed 15:00 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Damage mechanisms identification of polymer based composite materials: time-frequency investigation of acoustic emission data based on Hilbert-Huang transform – (Contributed, 000323)

S.E. Hamdi[a], A. Le Duff[a], G. Plantier[a], A. Sourice[a], L. Simon[b] and R. Feron[a]
[a]Groupe ESEO, rue Merlet de la Boulaye, 49009 Angers, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: Seif-eddine.HAMDI@eseo.fr

Presented in this paper, a time-frequency damage characterization procedure in Glass Fiber Reinforced Polymer (GFRP) composite materials based on the analysis of the acoustic emission (AE)signals by the Hilbert-Huang transform (HHT). It is to be noted that the study of damage by means of AE in polymer composites prompted the possibility of correlating a specific damage mechanism with its acoustic signature. Several studies highlighted the relevance of frequency spectral analysis in order to reconstruct the whole damage process. Thus, the assessment of the time-varying dominant frequencies present in a typical AE signal acquisition, can make easier the assessment of its structural damage potential. The main difficulty in defining a relationship between a specific damage mode and its acoustic signature is that the AE signals in GFRP materials are usually non- stationary and comprise overlapping transients. Signals of this kind require, first of all, a joint time-frequency analysis. In this context, the newly developed HHT is exclusively used in the present work for AE signals waveform analysis to describe the damage behavior as a first step for in situ detection of structural damages in polymer based composite materials.

Wed 15:20 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Self-calibrating method for sound reflection index measurements – (Contributed, 000555)

C. Glorieux[a] and M. Rychtarikova[b]
[a]K.U. Leuven, Celestijnenlaan 200D, 3001 Heverlee, Belgium; [b]Slovak Technical University, Radlinskeho 11, 81368 Bratislava, Slovakia
Corresponding author E-mail: christ.glorieux@fys.kuleuven.be

Different measurement methods exist that can be used for determination of sound reflection from flat surfaces. Diffuse field methods are robust, but require the material/sample of interest to be brought into a reverberant room. In engineering praxis, often measurements in situ are required. Technical norms for sound reflection index measurements in situ are being developed, with a simple and accurate measuring procedure method being one of the main objectives. In classical sound reflection index measurements, the wall reflectivity is obtained by determining the transfer function between a loudspeaker and a microphone placed in front of the wall, and comparing the spectrum of the wall reflection with the one of the signal obtained in a free field situation without wall. This article proposes a self-calibrating method for determining the sound reflection index by exploiting the direct sound information in the transfer function, avoiding the need of a free field measurement. Effects of differences in acoustic shadowing between the direct and reflected waves, of geometrical inaccuracies, of loudspeaker directivity, and of numerical windowing efects on the spectrum of the reflection coefficient, are addressed.

Wed 15:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Visualization and analysis of the vibrations of a human face induced by a bone conduction device using high speed digital holography – (Contributed, 000657)

M. Leclercq, M. Karray, V. Isnard, F. Gautier and P. Picart
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: mathieu.leclercq.etu@univ-lemans.fr

This paper proposes a first attempt to visualize and analyze the vibrations propagating at the surface of a human face's skin induced by a bone conduction device. The proposed method allows qualitative visualization and quantitative measurement of the surface movements illuminated by a coherent laser beam.
To do this, we developed a new approach in a so-called "quasi-time-averaging regime" allowing the retrieval of the vibration amplitude and phase from a sequence of digital Fresnel holograms recorded with high image rate. The experimental set-up is based on off axis digital Fresnel holography and a high power continuous wave laser. The sensor is a high speed CMOS camera permitting recordings with a high spatial resolution (1024×1024 pixels) up to 2.4kHz. The set-up is able to provide full field measurements in the frequency bandwidth 100Hz - 600Hz.
Recording in the quasi-time-averaging regime leaded to the development of a dedicated algorithm able to extract the vibration using only three holograms from the sequence. The design of the algorithm depends on the ratio between exposure time and vibration period. Results exhibit propagation of vibrations at the skin surface, amplitudes being at most at 200nm, and speed velocity can be estimated at each frequency.

Wed 16:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

A new acoustic three dimensional intensity and energy density probe – (Contributed, 000670)

F. Ayme[a], C. Cariou[b], M. Ichchou[c] and D. Juvé[d]
[a]Ecole Centrale de Lyon, 36,Avenue Guy de Collongue, 69134 Ecully, France; [b]Airbus, 316 route de Bayonne, 31060 Toulouse, France; [c]Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex; [d]LMFA Ecole Centrale de Lyon, 36, avenue Guy de Collongue, 69134 Ecully, France
Corresponding author E-mail: fabien.ayme@ec-lyon.fr

The acoustic field inside aircraft cavities is very complex. Indeed, there is often a combination of direct, diffuse and modal fields depending on the measurement point and on the frequency band considered. This is directly linked to the fact that different types of sources are present. In such cavities, like a cockpit, sources can be panels radiating not necessary in a normal way, avionics systems, air vents, etcoe
To find efficient solutions to reduce the noise inside aircraft cavities, a good knowledge of the directivity of the acoustic field in the three dimensions is a great advantage. In this frame, a new intensity acoustic probe has been developed to compute acoustic intensity vector and, acoustic density of energy based on four 1/4" microphones measurements around a small sphere. Its originality consists in the possibility to arrange such probes in an antenna.

Several calculation methods have been studied to compute those quantities. Results are compared with three uni-dimensional intensity measurements, considered as the reference, in different environments. The probe provides acoustic quantities which can be input data for energetic identification methods. Finally, acoustic tests are in progress in a cockpit mock-up, coupling both probe measurements and energetic identification method.

Wed 17:00 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Sound level meter directional response measurement in a simulated free-field – (Contributed, 000672)

G. I. Goulamhoussen and R. A. Wright
Cirrus Research plc, Bridlington Road, Acoustic House, YO14 0PH Hunmanby, UK
Corresponding author E-mail: guillaume.goulamhoussen@cirrusresearch.co.uk

Sound level meter directional response has to be measured in free-field, a condition that is usually met by using an anechoic chamber. However, using one is not always a possible option for cost or availability reasons. This paper describes an automated method that uses a structure, built to provide a simulated free-field, and a time-selective technique to remove the room reflections from the frequency response, thus enabling the directional response of an instrument to be measured without an anechoic chamber. The proposed method is then compared to the classical toneburst method for validation. Finally, the effects of some parameters (i.e. external noise, temperature, microphone positioning, air fluctuations...) on the obtained results are discussed, as well as their associated uncertainties.

Wed 17:20 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Estimation of the primary stability of a dental implant using an ultrasonic device: an in vitro study – (Contributed, 000691)

R. Vayron, V. Mathieu and G. Haiat
Laboratoire MSME, 61, avenue du Générale De Gaulle, bâtiment P2, bureau 352 C, 94010 Créteil, France, Metropolitan
Corresponding author E-mail: guillaume.haiat@univ-paris.est

Dental implants are widely used for oral rehabilitation. However, there remain risks of failure that are difficult to anticipate. The objective of this in vitro study is to investigate the potentiality of quantitative ultrasound (QUS) to assess the amount of bone in contact with titanium dental implant. To do so, the implant is initially completely inserted in the proximal part of a bovine humeral bone sample. The 10 MHz ultrasonic response of the implant is then measured and a quantitative indicator I is derived based on the rf signal obtained. Then, the implant is unscrewed by 2π radians and the measurement is realized again. The procedure is repeated seven times and the indicator is derived after each rotation of the implant. Analysis of variance (ANOVA) (p<10-5) tests revealed a significant effect of the amount of bone in contact with the implant on the distribution of I. The results show the feasibility of our QUS device to assess implant primary stability. This study paves the way for the development of a new approach in oral implantology.

Wed 17:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

On the effects of derivation method on statistical data in environmental noise measurement – (Contributed, 000728)

R. A. Wright and G. I. Goulamhoussen
Cirrus Research plc, Bridlington Road, Acoustic House, YO14 0PH Hunmanby, UK
Corresponding author E-mail: richard.wright@cirrusresearch.co.uk

Statistical Levels (percentiles or Lns) are widely employed for analysis and interpretation of large sets of noise data, and can be obtained either from implementations in Sound Level Meters or by post-processing. The type of source data and the sampling rate are often not specified. Samples can either be regular instantaneous snapshots of time weighted sound pressure level, or short samples of integrated sound level. The choice of sampling rate can vary. Due to the statistical nature of Lns the sample size should be an important consideration in determining the quality of the resulting data. In cases where the noise level distribution is bimodal or multimodal, a simple 'bin-counting' algorithm may result in significant differences in Ln values compared to a more sophisticated algorithm using inter-

polation. Analysis is presented on the effect on Ln data of different choices of source data and sampling rate, with input data including a range of different 'real-world' noise climates and regular electrical signals of varying impulsivity. The inverse relationship between sample size and uncertainty is investigated. The paper describes the test procedure for Lns described in DIN 45657:2005 and suggests alternative tests intended to provide better coverage of potential variation in results due to differences in implementation.

Wed 18:00 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Distributed noise monitoring in intensive care units – (Invited, 000856)

G. Memoli[a], D. Dawson[b], R. Barham[a] and M. Grounds[b]
[a]National Physical Laboratory, Acoustics Group, Hampton road, TW11 0LW Teddington, UK; [b]St Georges Hospital - University of London, Blackshaw Road, SW17 0QT London, UK
Corresponding author E-mail: richard.barham@npl.co.uk

Intensive Care Units (ICUs) can be extremely noisy places, with staff conversation and equipment alarms are often cited as extremely disturbing. These noises are frequently implicated in causing sleep disruption and may have deleterious effects on patient recovery and staff wellbeing alike. This study aims to assess the acoustical environment in the General Intensive Care Unit at St. George's Hospital in London, and produce a longitudinal noise map. The study exploits novel noise measurement instrumentation utilising MEMS microphones, which makes a distributed noise system economically viable. This presents the first ever opportunity to produce detailed noise maps based on measurement in a hospital ward environment. The noise map will identify the areas within the ICU that are systematically noisier than surrounding areas, and provide details about temporal variations which can be correlated to specific activities as well as any systematic link with time of the day or week. As a first step, characterising the performance of the instrumentation, especially the measurement microphone at its installed location, is essential for assuring the accuracy of gathered data. Results of laboratory simulations of the measurement environment are presented, together with some initial acoustic data gathered from the ICU.

Wed 18:20 Pierre CHAVASSE MI-G01: Measurement and instrumentation

Distributed wireless environmental noise monitoring systems – (Contributed, 000045)

K. Veggeberg
National Instruments, 11500 N. Mopac C, Austin, 78759, USA
Corresponding author E-mail: kurt.veggeberg@ni.com

Wireless technology extends the concept of PC based data acquisition beyond the limits of cables and wired infrastructure for new remote or distributed measurement applications. This is an overview of wireless networking basics and how to deploy reliable wireless measurement in a variety of outdoor or harsh environments for reliable and secure data acquisition systems. Case applications of distributed outdoor noise monitoring systems will illustrate networking layers and topologies for specific applications using IEEE 802.11 networks for reliable and secure wireless data acquisition systems. One example is a 10-node autonomous, distributed wireless monitoring system placed in various locations throughout the Historic Center of Mexico City. It takes permanent measurements of the noise levels and streams the data back to a main monitoring station every five minutes along with the measurements of noise produced during takeoff at the International Airport of Mexico City. Another example from France called SAVE (Surveillance of Acoustics and Vibration in the Environment) is a noise and vibration management system for construction site managers. It is based on multiple laptop based front ends placed throughout a construction site and connected wirelessly to a central supervisor for continual monitoring and reporting.

Wed 18:40 Pierre CHAVASSE MI-G01: Measurement and instrumentation

0° and 90° Reference Directions for a Sound Level Meter – (Contributed, 000209)

E. Aflalo[a], M.R. Vaaben[b], P. Pourtau[a], D. Vaucher[a] and P. Pischedda[a]
[a]01dB-Metravib, 200 Chemin des Ormeaux, 69578 Limonest, France; [b]G.R.A.S. Sound & Vibration A/S, Skovlytoften 33, DK-2840 Holte, Denmark
Corresponding author E-mail: erik.aflalo@01db-metravib.com

Unattended noise measurements are more and more common for noise assessment in the environment. Multiple sources are usually measured with a random position with respect to the measurement point. Noise generated by ground transportation, leisure activities, construction sites is coming from all directions, although mainly the horizontal direction. Placed vertically and configured for a reference direction of 90° from its axis, the goal is to meet the requirements of the IEC 61672 standard on sound level meters taking into account noise incidence from the horizontal direction. The main technical difficulty is the criterion for the maximum level difference allowed between two random incidence angles (directivity). The objective can be fulfilled using a cone-shaped device on top of the microphone. When measuring attended noise with the instrument in hand, the sound level meter must be pointed at the source according to standard IEC 60651. The purpose of the paper is to describe the different research & development phases to fulfil IEC 61672 sound level meter standard for 0° and 90° reference directions with the same device.

Wed 13:40 Ray STEPHENS AB-G01: Animal bioacoustics

Crista acustica in insect ears modeled by an inhomogenous granular chain – (Contributed, 000630)

E. Delevoye[a] and V. Tournat[b]
[a]CEA-Leti MINATEC-Campus, 17 rue des Martyrs, F-38054 Grenoble Cedex 9, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: elisabeth.delevoye@cea.fr

Insect ears are found on the thorax (in some Hemiptera), the abdomen (in grasshoppers, cicadas, some moths), or the front tibia (in crickets, katydids). Crista acustica - also named Siebold's organs- is the sensory organ linked to tympanum when located in forelegs. It is a collection of individually-tuned scolopidia -the most fundamental unit of mechanoreceptor organs in insects- that can discriminate frequencies. A remarkable geometrical property of the arrangement of the soma or cell body of hearing sensing cells -the inner hair cells in the cochlea of mammals and human beings and the scolopidia in the hearing organs of invertebrates- has not yet been explored. We will focus on the arrangement of the cells of the scolopidia of crista acustica in the fore tibia of certain Orthoptera (eg, grasshoppers, crickets, katydids). It consists of a collection of perfectly aligned sensory cells which forms a crest on top of a hollow tracheal tube behind the tympanum. Such a crest can interestingly be modeled as an inhomogenous granular chain linked to a substrate. We will show that the dynamical response in both time and frequency domains of this neurally tunable chain also strongly depends on its anatomical pre-arrangement.

Wed 14:00 Ray STEPHENS AB-G01: Animal bioacoustics

Sound reception and radiation in a small insect – (Contributed, 000839)

N. Mhatre[a], F. Montealgre-Z[a], R. Balakrishnan[b] and D. Robert[a]
[a]University of Bristol, School of Biological Sciences, Woodland road, University of Bristol, BS8 1UG Bristol, UK; [b]Centre for Ecological Sciences, Indian Institute of Science, 560012 Bangalore, India
Corresponding author E-mail: natasha.mhatre@bris.ac.uk

Insects are small; this is a fact of their life. In some contexts this is an advantage, such as insects do not injure themselves through the effects of gravity. In other contexts this is a disadvantage, especially in the context of sound production and reception. The wavelengths of sound that insects such as crickets produce and receive are several times larger than their body size. For sound production, this is particularly challenging and inefficient, as sub-wavelength radiation (size to lambda ratio $>$ 1:100) requires great energy expenditure to produce sufficient sound pressure. In receiving sound, they face the reciprocal problem and are inefficient receivers. In addition, because of their size they cannot rely on cues other animals use to detect the direction of sound. Nonetheless, sound is extremely important to these insects as they use it for mate attraction and to evade predators. We investigate this problem by combining the technique of microscanning laser Doppler vibrometry with finite element modelling; and explain some of the biomechanical tricks a tiny tree cricket uses to overcome the disadvantages of size.

Wed 14:20 Ray STEPHENS AB-G01: Animal bioacoustics

Acoustic communication in crocodiles – (Contributed, 000336)

N. Mathevon
Université de Saint-Etienne, 23 rue Michelon, 42023 Saint-Etienne, France
Corresponding author E-mail: mathevon@univ-st-etienne.fr

All species of crocodiles are known for their ability to produce sounds in several communication contexts. However and despite the importance of sound communication in the life of crocodilians, knowledge about their vocal world remains superficial. This paper aims to present recent advances in our understanding of crocodile bioacoustics. Through experiments both in the laboratory and the field , we have brought evidence of the biological role of young crocodilian calls, especially at hatching time and later on during mother-offspring interactions. By analyzing the acoustic structure of emitted signals and by using playback experiments with modified signals, it has also been possible to identify the relevant acoustic cues that elicit behavioral responses of offspring and mothers. It is now time to do more comparative research among crocodilian species.

Wed 14:40 Ray STEPHENS AB-G01: Animal bioacoustics

Skylarks (Alauda arvensis) increase their duty cycle in a territorial context – (Contributed, 000012)

N. Geberzahn and T. Aubin
CNPS CNRS UMR 8195, Université Paris Sud - Bātiment 446, 91405 Orsay, France
Corresponding author E-mail: geberzahn@gmail.com

Birdsong usually serves to attract mates and to repel territorial rivals and is often produced by males only. During territorial conflicts song may provide information on the signaller's physical strength, and on its motivation to fight. Males may vary aspects of their singing behaviour when engaged in territorial interactions, and such variation may be an honest signal of certain traits of the signaller such as body size, condition or motivation. This information may be used by receivers in territorial decisions. We studied contextual variation in the song of skylarks, Alauda arvensis, a songbird with a large vocal repertoire and a continuous and versatile singing style. We challenged subjects with simulated territorial intrusions by broadcasting conspecific song and recorded their vocal responses. When challenged, males increased their duty cycle. Duty cycle was calculated by subtracting all silent pauses within a song (inter-syllable pauses) and dividing the remaining ëon-song-time' by the total song duration. We found no contextual variation in other acoustic parameters (pitch, syllable and inter-syllable duration, song rate and song versatility). Duty cycle might be an honest signal for the competitive ability and might be perceived as such by skylarks - this hypothesis will be tested in the future.

Wed 15:00 Ray STEPHENS AB-G01: Animal bioacoustics

Mother-pup vocal recognition in Australian sea lion: individual signatures and environmental constraints – (Contributed, 000091)

I. Charrier[a], B. J. Pitcher[a] and R. G. Harcourt[b]
[a]CNPS, UMR 8195, Université Paris Sud, bat. 446, 91405 Orsay, France; [b]Macquarie University, Marine Mammal Research Group, GSE, Macquarie University, 2109 Sydney, Australia
Corresponding author E-mail: isabelle.charrier@u-psud.fr

Parent-offspring recognition is essential for species where offspring survival is dependant on maternal care, and there is high risk of confusion between individuals. Australian sea lions (Neophoca cinerea) are colonial breeders, giving birth to one pup and suckling it for 18 months. Mothers alternate periods at sea foraging with periods in the colony, reuniting with their pup every time they return. Both mother and pup vocalisations show individual vocal signatures. We investigated the acoustic parameters involved in the mother-pup vocal recognition using playback experiments with modified calls. Further, we examined the efficiency of these vocal signatures in three habitat types within the colony using propagation tests. Both mothers and pups great attention to amplitude modulations and to the exact frequency values of the call, and only pups use frequency modulations to recognise their mother. Propagation tests revealed that one particular environment was extremely harsh and did not allow accurate transfer of the individual signature components whatever the distance. In two other environments, amplitude modulation was only reliable to a distance of 16m, but both FM and frequency spectrum could be transmitted over 32m. The area in which mother-pup reunions occur is an important factor in the success of individual recognition.

Wed 15:20 Ray STEPHENS AB-G01: Animal bioacoustics

Do dolphins rehearse shows when at rest? Evidence from vocal copying – (Contributed, 000156)

D. Kremers[a], M. Briseño Jaramillo[a], M. Böye[b], A. Lemasson[a] and M. Hausberger[a]
[a]University of Rennes 1, Station Biologique, 35380 Paimpont, France; [b]Planète Sauvage, La Chevalerie, 44710 Port Saint-Père, France
Corresponding author E-mail: dorothee.kremers@univ-rennes1.fr

It is known that delphinidae can associate heard sounds with salient events/objects and mimic these sounds, mostly in the corresponding context. Thus, one can wonder whether dolphins, as other animals and humans, have a sort of sensory memory of events. Here we show that a group of five bottlenose dolphins in the Planète Sauvage dolphinarium (France) produced, during their nighttime resting periods, non-dolphin sounds that they heard during performance shows. In total, 3246 vocalizations were recorded during >120 hours (2588 vocalizations during >100 hours at day, 658 vocalizations during >20 hours at night). Generally in the middle of the night, these animals produced vocal copies of whale sounds that had been broadcast during daily shows. Recordings made before the whale sounds started being broadcast revealed that they have never emitted such sounds before. These unusual vocalizations differ from all other sounds in the dolphins' repertoire. The similarity between the dolphins' copies and the model whale sounds was substantiated by a discriminant function analysis with measured acoustic parameters and a playback experiment with human audience. This is to our knowledge the first evidence for the production of sounds heard during day salient events in a nocturnal resting context in marine mammals.

Wed 15:40 Ray STEPHENS AB-G01: Animal bioacoustics

Anthropogenic outdoor sound and wildlife: it's not just bioacoustics! – (Contributed, 000266)

G. Dutilleux
Laboratoire Régional de Strasbourg, 11, rue Jean Mentelin, 67035 Strasbourg Cedex 2, France
Corresponding author E-mail: guillaume.dutilleux@developpement-durable.gouv.fr

The two last decades have seen the growth of a large body of scientific and technical literature regarding the effects of anthropogenic noise on terrestrial wildlife and their mitigation. These effects range from behavioral modifications like signalling louder, increasing the signalling rate or redundancy, signalling at a higher pitch, signalling outside noisy periods, but also alterations of intraspecific or interspecific interactions. Moreover it is now proven that man-made noise may lead to reduced reproductive success, reduced species richness or reduced density. The careful design of experiments helps avoid methodological biases some more ancient studies in this field may suffer of. This paper reviews the published literature from an engineering perspective. The focus is put on recommendations for impact assessment and mitigation. The analysis carried out emphasizes that more attention paid to anthropogenic noise emission aspects, especially road surfaces, and propagation issues, in particular micro-meteorology and the range of validity of the prediction methods used, would significantly improve the guidance available.

Wed 13:40 Philip DOAK AH-G01: Aeroacoutics

In memory of Phil Doak – (Invited, 000879)

J.S. Bolton
Purdue University, Ray W. Herrick Laboratories, 140 S. Martin Jischke Drive, West Lafayette, Indiana, 47907-2031, USA
Corresponding author E-mail: bolton@purdue.edu

In this presentation, Phil Doak's history will be reviewed from his birth in North Dakota to his retirement in East Meon, Hampshire. Professor Doak had degrees from The Julliard School in New York, and from the University of Oklahoma and studied at MIT before moving to Manchester in the UK, and then Liverpool University, and finally, Southampton University. The reasons for his move from the US to the UK will be described. It was at Southampton University that he became founding Editor of the Journal of Sound and Vibration, in which capacity he served for almost forty years. In addition, the main areas of his research will be highlighted, including room acoustics, aeroacoustics, duct acoustics and sound propagation outdoors.

Wed 14:00 Philip DOAK AH-G01: Aeroacoutics

Jet noise: a perspective on recent developments and future directions – (Invited, 000090)

P. J. Morris
Penn State University, 233 Hammond Building, University Park, 16802, USA
Corresponding author E-mail: pjm@psu.edu

Jet noise predictions can be made based on empirical correlations, methods combining RANS CFD and an acoustic analogy, or by numerical simulation. To make predictions for new designs, only the latter two approaches are viable. Recent predictions based on the RANS-based methods have shown some promise, though they are very

limited in the range of conditions that have been considered. These approaches are described and differences between them are highlighted. How these methods fit into the concept of jet noise generation by two source mechanisms (fine scale and large scale) is addressed. They are also contrasted with ideas based on wavepacket models of noise generation by large scale turbulent structures. Noise predictions based on direct simulation, sometimes coupled with a wave extrapolation method, offer a wealth of information. How this database can be used to identify noise source mechanisms as well provide guidance for noise reduction is discussed.

Wed 14:40 Philip DOAK AH-G01: Aeroacoutics

Indirect Combustion Noise: Experimental Investigation of the Vortex Sound Generation in a Choked Convergent-divergent Nozzle – (Contributed, 000540)

N. Kings, L. Enghardt and F. Bake
German Aerospace Center (DLR), Mueller-Breslau-Str. 8, 10623 Berlin, Germany
Corresponding author E-mail: Nancy.Kings@dlr.de

Combustion noise in gas turbines consists of direct noise related to the unsteady combustion process itself and indirect noise. The latter is produced by vorticity or entropy fluctuations originating from the combustor as they accelerate when passing through the turbine. The sound generation mechanism through the acceleration of vorticity alterations was studied in a model experiment. Within a swirl-free and a swirling tube flow, vorticity fluctuations were generated artificially by injecting temporally additional air into the mean flow which were convected and accelerated in a choked convergent-divergent nozzle. The produced acoustic waves were detected downstream of the nozzle. In addition, the spatial and temporal changes of the velocity field upstream of the nozzle were determined with Hot-Wire Anemometry measurements. Direct and vortex sound was identified and separated by varying the distance between the air-injection inlet and the nozzle. The intensity of the swirling flow and of the vorticity fluctuation was modified. Increasing the air-injection into the mean flow augments the generated indirect noise.

Wed 15:00 Philip DOAK AH-G01: Aeroacoutics

Modeling of combustion noise spectrum from turbulent premixed flames – (Contributed, 000734)

Y. Liu, A. P. Dowling, T. D. Dunstan and N. Swaminathan
University of Cambridge, Department of Engineering, Trumpington Street, CB2 1PZ Cambridge, UK
Corresponding author E-mail: yu.liu@eng.cam.ac.uk

Turbulent combustion processes generate sound radiation due to temporal changes of the total heat release fluctuations within the flame volume. The temporal correlation of the heat release rate fluctuations has not been investigated sufficiently in prior literature due to the difficulty in acquiring heat release rate data from high-fidelity numerical simulations and measurements. In this work, this temporal correlation and its role in the modeling of combustion noise spectrum are studied by analyzing direct numerical simulation (DNS) data of turbulent premixed V-flames. The resulting correlation model is applied to the prediction of far-field combustion noise using different reference time scales. The comparison with recent measurements of open turbulent premixed flames show that the correlation model captures the essential shape of the combustion noise spectrum. Reasonable agreement in the peak frequency and peak sound pressure level (SPL) is also achieved for two turbulent time scales. Further work for the DNS of a Bunsen flame is suggested to study a promising convective time scale L_f/U_{ave} where L_f is the flame length and U_{ave} is the mean flow velocity.

Wed 15:20 Philip DOAK AH-G01: Aeroacoutics

Estimation of whistling of an orifice in a reverberating duct at low Mach number – (Contributed, 000495)

R. Lacombe[a], P. Moussou[a] and Y. Aurégan[b]
[a]EDF R&D, 1, avenue du Général de Gaulle, 92241 Clamart Cedex, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: romain.lacombe@edf.fr

Single hole circular orifices can generate pure tone noise in industrial pipes. This phenomenon results from vortex shedding with lock-in, as a consequence of an acoustic amplification of incipient pressure waves inside the orifice and of an acoustic resonator outside. Key features of this phenomenon are the ability of an orifice to amplify acoustic waves in a range of frequencies and the acoustic feedback mechanism. First, the study deals with the estimation of the whistling ability of an orifice from an incompressible flow simulation. As the studied flow is limited to low Mach number, this kind of simulation fairly describes the hydrodynamic instability. Superimposed harmonic velocity perturbations allow then to identify the impedance of an orifice and so to define the frequency at which amplification occur. The next step of the study deals with whistling features of orifices in a reverberating duct. The extracted impedance is used in a network model, taking into account acoustic propagation and acoustic reflections. A linear stability analysis is then performed and the whistling frequency is predicted. The parameters controlling the whistling amplitude are finally identified. All the results of the study are compared to experiments, showing well agreements for the whole procedure.

Wed 15:40 Philip DOAK AH-G01: Aeroacoutics

Mathematical definition of noise sources: the basic problem in aeroacoustics – (Contributed, 000180)

A. Fedorchenko
Independent Researcher-Consultant, Dm. Ulyanov Street 27/12-1-50, 117449 Moscow, Russian Federation
Corresponding author E-mail: afedorch@gmail.com

Recent advances in the noise control technology were attained for the most part by purely empiric efforts, without due knowledge of the mechanisms of aerodynamic sound emission. This fact is confirmed by the impartial analysis of many publications in which diverse practical means of noise reduction were offered and tested. The newest experimental approaches aimed at identifying the sources of aerodynamic sound, primarily the method of acoustic imaging via using a microphone array, are considered, and their inherent limitations are pointed out. Unfortunately, the family of "acoustic analogies" is still used by many for the mathematical definition of aerodynamic noise sources, though the ineradicable flaws of such models had been lately disclosed. On this weak theoretical basis the current experimental techniques, as well as the methods of direct numerical simulation (DNC, LES,oe), failed to determine the instant distributions of the true multicomponent sources of sound inside the zone of generation. Alternatively, the author's two-medium theory is being suggested to decompose an initial-boundary-value problem posed for the basic system of nonlinear gas-dynamics equations. This theory reveals the physics of sound generation, refutes the delusions brought by acoustic analogies, and opens new promising pathways in the field of flow-noise control.

Wed 16:40 Philip DOAK AH-G01: Aeroacoutics

Experimental investigation of the aerodynamic noise radiated by a three-dimensional bluff body – (Contributed, 000373)

J. Fischer, L.-E. Brizzi, J. Laumonier and V. Valeau
Institut Pprime, CNRS - Université de Poitiers - ENSMA, ENSIP, 6 rue Marcel Doré, Batiment B17, BP 633, 86022 Poitiers, France
Corresponding author E-mail: vincent.valeau@univ-poitiers.fr

The reduction of aerodynamic noise is an important aspect of the development of recent cars in automotive industry. The present work is an experimental study of the aerodynamic noise radiated by a three-dimensional simplified automotive model. This body is investigated through velocity (Particle Image Velocimetry), wall pressure and far-field acoustic measurements in an anechoic wind-tunnel at low Mach number (below 0.15). After an aerodynamic characterization of the generated flow, the goal is to discuss the localization of acoustic sources in the vicinity of the model. Therefore, different methods of acoustic imaging, based on the beamforming technique, are performed by using an Underbrink multi-arm spiral array. The array is successively located laterally and above the model. The techniques used are previously validated numerically and experimentally. Results show the contribution of the different noise sources (leading edge, roof, A-pillar vortex and strut) depending on the frequency.

Wed 17:00 Philip DOAK AH-G01: Aeroacoutics

Stochastic prediction of broadband shock-associated noise including propagation effects – (Contributed, 000428)

C. Henry[a], C. Bailly[b] and G. Bodard[a]
[a]SNECMA, Rond-Point René Ravaud, Réau, 77550 Moissy-Cramayel, France; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: cyprien.henry@snecma.fr

Noise reduction is a major concern for engine manufacturers like Snecma. During the cruise phase, Broadband Shock-Associated Noise (BBSAN) originating from the aft of civil engines has been identified as an important source of noise. Within this framework, Snecma wishes to improve its prediction capabilities of BBSAN. A statistical model which uses a RANS calculation for input is being developed. The model is applicable to both single-stream and dual-stream engines. BBSAN sources are located in the mixing layers between primary and secondary streams and between secondary and flight streams. When the acoustic waves propagate from the sources to the ambient medium, they are refracted by the mean flow gradients. This propagation effect is taken into account using a ray tracing approach. The final paper will present the acoustic results on a dual-stream configuration. It will include thorough comparisons with measurements on the same configuration to assess the validity of the model.

Wed 17:20 Philip DOAK AH-G01: Aeroacoutics

Experimental study of flight effects on underexpanded supersonic jet noise – (Contributed, 000506)

B. André[a], T. Castelain[a,b] and C. Bailly[a]
[a]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex; [b]Université de Lyon, 43 Boulevard du 11 Novembre 1918, 69622 Villeurbanne Cedex, France
Corresponding author E-mail: benoit.andre@ec-lyon.fr

Broadband shock-associated noise is a component of jet noise encountered in imperfectly expanded supersonic jets. It is going to be responsible for a dominant part of cabin noise levels at cruise condition for the next-generation commercial aircraft including composite fuselage. A flight simulating facility has been built in the anechoic room of the Centre Acoustique at Ecole Centrale de Lyon and extensive aero-acoustical measurements have been performed to study flight effects on broadband shock-associated noise. In the final paper, flight effects will first be characterized by far field acoustic measurements. In a second step, the main features will be linked to modifications in the jet dynamics due to the secondary stream, with aid of schlieren visualizations, static pressure measurements and particle image velocimetry. The representation of shock-associated noise as the result of an interaction between vortical structures and shocks will be assessed and modelling will be addressed.

Wed 17:40 Philip DOAK AH-G01: Aeroacoutics

Time reversal method for localization of sources of sound generated in viscous flows – (Contributed, 000535)

R. Marchiano, P. Druault and P. Sagaut
UPMC/CNRS, Institut Jean Le Rond D'Alembert - UMR CNRS 7190, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: regis.marchiano@upmc.fr

Localisation of sources of sound in viscous flows is an important issue in aeroacoustics. That topic interests both academic and industrial communities. Time reversal method is a method widely used in linear acoustics for various purposes such as imaging or synthesizing complex wavefields. Nevertheless, time reversal method cannot be simply transposed to aeroacoustics due to basic assumptions on which it relies. Here, an extended procedure is proposed to deal with the problems of reversing information in presence of flows and dissipation, two phenomena contradictory with the time reversal method. It is theoretically shown that time reversal method can be extended by using both the flow reverse theorem and the properties of the matched filter theory. Three cases have to be distinguished: steady flows with no dissipation, steady flows with dissipation and unsteady flows. For the first two cases, it is shown that time reversal method extension theoretically works. The latter configuration cannot theoretically be correctly treated. Then, numerical simulations supporting these results are presented. A special attention is paid to configurations dealing with viscous unsteady flows, which give good results contrarily to what is predicted.

Wed 18:00 Philip DOAK AH-G01: Aeroacoutics

Scattering of wavepacket by a flat plate in the vicinity of a turbulent jet – (Contributed, 000541)

A. V. Cavalieri[a], P. Jordan[a] and Y. Gervais[b]
[a]Université de Poitiers, 43 route de l'Aérodrôme, 86036 Poitiers, France; [b]Institut Pprime, CNRS - Université de Poitiers - ENSMA, ENSIP, 6 rue Marcel Doré, Batiment B17, BP 633, 86022 Poitiers, France
Corresponding author E-mail: andre.cavalieri@univ-poitiers.fr

We present an investigation on the effect of the presence of a flat plate in the vicinity of turbulent, subsonic jets. Experiments have been performed to measure the changes in the velocity field and in the sound radiation for a number of Mach numbers and distances between the plate and the jet axis. Results show a significant increase of sound radiation at lower frequencies with dipolar behaviour. There is exponential decay of the scattered sound with the plate distance, in agreement with scattering of the evanescent waves in the jet near field. The final paper will present a comprehensive comparison of the experimental results with a model based on Parabolized Stability Equations, with sound propagation calculated using a tailored Green's function.

Wed 18:20 Philip DOAK AH-G01: Aeroacoutics

Aeroacoustic study of a simplified wing-flap system in generic configurations – (Contributed, 000682)

B. Lemoine and M. Roger
LMFA, Ecole Centrale de Lyon, 36 avenue Guy de Collongue, Bât. KCA, 69130 Ecully, France
Corresponding author E-mail: benoit.lemoine@ec-lyon.fr

Airframe noise produced by the high-lift devices of an aircraft significantly contributes to noise exposure around airports. The VALIANT project supported by the EC with this in mind is aimed at providing a reliable experimental database as well as to assess numerical and theoretical models predicting far-field levels and directivity. In this context, the proposed paper is about the interaction of a flat-plate wing and a non-lifting airfoil. Aerodynamic and acoustic measurements performed for several configurations (various streamwise and transverse distances, flow speeds and incident turbulence rates) are described. An original analytical model in an overlapping configuration is developed, based on the half-plane Green's function with uniform flow and an iterative scattering procedure. The model is compared with other analytical approaches from the literature and assessed against the measurements.

Wed 18:40 Philip DOAK AH-G01: Aeroacoutics

Acoustic-vorticity coupling in linear flows using Wentzel-Kramers-Brillouin (WKB) method – (Contributed, 000783)

G. Favraud and V. Pagneux
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: gael.favraud.etu@univ-lemans.fr

The evolution of linear acoustic and vorticity perturbations in incompressible linear flow is studied. In the particular case of the plane Couette flow, two major phenomenons occur: acoustic wave generation by vortexes, and acoustic wave transformations. A straight forward order 1 Wentzel-Kramers-Brillouin (WKB) method is developed to perform a systematic study of all 2D incompressible linear flows. A small correction based on the conservation of a constant quantity is made to avoid non uniformities. All the considered flows are decomposed as a weighted sum of a hyperbolic flow and a solid rotation flows. Three modes naturally come out of such an approach: two acoustic modes with opposite phase velocities, and one vorticity mode. The acoustic mode acquire a vorticial component and are not curl-free. In the same time the vorticity mode are not divergence-free. The two above mentioned coupling phenomenons are also studied. They are due to Landau-Zenner type non-adiabatic transitions, and are of an order exponentially small with respect to the shear rate of the flow. The efficiency of the couplings depending on the flow class is investigated. The hyperbolic flow provides the most efficient coupling.

Wed 16:40 Ray STEPHENS AB-G01: Animal bioacoustics

Hidden Markov Modeling for humpback whale (Megaptera novaeangliae) call classification – (Contributed, 000280)

F. Pace[a,b], P. R. White[a] and O. Adam[c,d]
[a]ISVR, University of Southampton, Southampton, UK, SO17 1BJ Southampton, UK; [b]Baker Consultants, Cromford Station, DE4 5JJ Matlock Derbyshire, UK; [c]Institut Jean le Rond dAlembert - Universite Pierre et Marie Curie-Paris VI, 11 rue de Lourmel 75015 Paris; [d]CNPS, CNRS UMR 8195, Université Paris Sud, Bâtiment 446, 15, rue Georges Clemenceau, 91405 Orsay Cedex, France
Corresponding author E-mail: fp@isvr.soton.ac.uk

This study proposes a new approach for the classification of the calls detected in the songs with the use of Hidden Markov Models (HMMs) based on the concept of subunits as building blocks. HMMs have been used once before for such task but in an unsupervised algorithm with promising results, and they are used extensively in speech recognition and in few bioacoustics studies. Their flexibility suggests that they may be suitable for the analysis of the varied repertoire of humpback whale (Megaptera novaeangliae) calls because they cope well with variations in the call durations, which is a common feature in humpback whale vocalizations. Another attractive characteristic of HMMs is that highly developed tool-set is widely available as a consequence of the widespread use of their employment for human speech analysis.We describe the HMM classification method and show that a high level of performance can be achieved with modest requirements both in terms of computational load and storage. Training stage requires minimal manual input and once trained the recognition process is fully automated. We will present how the classification performance is affected by different amount of training.

Wed 17:00 Ray STEPHENS AB-G01: Animal bioacoustics

A new optimization method of the geometric distance in an automatic recognition system for bird vocalisations – (Contributed, 000105)

M. Jinnai[a], N. Boucher[b], M. Fukumi[c] and H. Taylor[d]
[a]Kagawa National College of Technology, 355 Chokushi-cho, 761-8058 Takamatsu, Japan; [b]SoundID, PO Box 649 Maleny, 4552 Queensland, Australia; [c]University of Tokushima, 2-1 Minami-josanjima, 770-8506 Tokushima, Japan; [d]Wissenschaftskolleg zu Berlin Institute for Advanced Study, Wallotstrabe 19, 14193 Berlin, Germany
Corresponding author E-mail: jinnai@t.kagawa-nct.ac.jp

We have been developing an automatic recognition system for bird vocalisations. Many biologists have been using the early 32 bit version of our system and we have been working on a 64 bit version. The software segments a waveform of the bird vocalisation from the three hours continuous recording and extracts the sound spectrum pattern from the waveform using the LPC spectrum analysis. Next, the software compares the sound spectrum pattern (the input pattern) with the standard pattern (that was extracted in advance) using a similarity scale. We use a new similarity scale called the "Geometric Distanceï. The Geometric Distance is more accurate than the conventional similarities in the noisy environment. In the 64 bit version, the software matches an input pattern with the 40,000 elements of the standard patterns per second and per processor, and it is 2.8 times faster than the conventional cosine similarity. In this paper, we introduce an automatic segmentation method of the bird vocalizations and a new optimization method of the Geometric Distance. The new optimization method offers improvements of an order of magnitude over the conventional Geometric Distance.

Wed 17:20 Ray STEPHENS AB-G01: Animal bioacoustics

Improvements in an automatic sound recognition system using multiple parameters to permit recognition with noisy and complex signals such as the dawn chorus – (Contributed, 000268)

N. Boucher[a], M. Jinnai[b] and A. Smolders[c]
[a]SoundID, PO Box 649 Maleny, 4552 Queensland, Australia; [b]Kagawa National College of Technology, 355 Chokushi-cho, 761-8058 Takamatsu, Japan; [c]University of New England, Armidale, 2350 Armidale, Australia
Corresponding author E-mail: nboucher@ozemail.com.au

We have been studying the problem of automatically recognizing calls in noisy recordings along with those with a complex structure such as the Dawn Chorus (when large numbers of different species call simultaneously in competition). Our aim is to identify and quantify the callers. We demonstrate high accuracy and the ability to quantify the relative call rate of the various species. In particular this technique is ideally suited in situations where the callers are very diverse in call types (such as high frequency parrot calls coexisting with low frequency emu calls). We currently are targeting calls with S/N of 5 dB or better, although noisier calls can be recognized.

Wed 17:40 Ray STEPHENS AB-G01: Animal bioacoustics

A fully automatic wildlife acoustic monitor and survey system – (Contributed, 000269)

N. Boucher[a], M. Jinnai[b] and A. Smolders[c]
[a]SoundID, PO Box 649 Maleny, 4552 Queensland, Australia; [b]Kagawa National College of Technology, 355 Chokushi-cho, 761-8058 Takamatsu, Japan; [c]University of New England, Armidale, 2350 Armidale, Australia
Corresponding author E-mail: nboucher@ozemail.com.au

We describe a fully automated, PC based wildlife monitoring and survey system that is used for diverse species studies. The system uses a wide-area recorder that can record over areas of up to several square kilometres. The recorder can run, unattended for more than a month. The recordings can either be analysed in real time to produce a particular response (e.g. send an SMS if a rare parrot is detected), or can be analysed later on a PC. Any number of different species can be analysed simultaneously. In survey mode, calls can be counted and recognised with a summary of species and call frequency produced. The system has been successfully tested with the dawn chorus and against human surveys.

Wed 18:00 Ray STEPHENS AB-G01: Animal bioacoustics

The effects of antioxidants on metabolic changes under conditions of noise action – (Contributed, 000055)

M. Melkonyan, A. Manukyan, S. Karapetyan, T. Meliqyan and K. Kocharyan
Yerevan state Medical University after M. Heratsi, Koryun str 2, Department of Medical Chemistry, 3741 Yerevan, Armenia
Corresponding author E-mail: chemistry@ysmu.am

The aim of the current study is to investigate the effects of endogenous antioxidant alfa-tocopherol and several bioactive compounds as preventive measures against hazardous effect of noise action on living systems. The previously obtained results testify to the noticeable decrease of the main endogenous antioxidant alfa-tocopherol content, lipid peroxidation processes activity increase both in the tissues of experimental animals under noise action and in the blood (plasma and erythrocytes) of the female employed in high noise level conditions. Correlation of changes of the studied parameters with increase of atherogenic coefficient in the blood of employees, confirms our assumption of the leading role of the disorders in pro- and antioxidant systems in the development of different pathological states, particularly atherosclerosis and heart diseases under the noise action. The introduction of alfa-tocopherolacetate has had a considerably expressed regulatory effect on the studied parameters both in experimental animals and people. Our investigations also revealed regulatory effects of several peptides, possessing adaptogenic and immunostimulating properties on the studied parameters in tissues of white rats under noise action. The results obtained testify that the functional activity of the studied peptides in certain extent depend on their effects on the pro-and antioxidant systems in tissues.

Wed 18:20 Ray STEPHENS AB-G01: Animal bioacoustics

Metabolic changes in the tissues of experimental animals in the conditions of high level noise action – (Contributed, 000024)

M. Melkonyan, L. Hunanyan, G. Zaqaryan, A. Manukyan and L. Ayvazyan
Yerevan state Medical University after M. Heratsi, Koryun str 2, Department of Medical Chemistry, 3741 Yerevan, Armenia
Corresponding author E-mail: chemistry@ysmu.am

The goal of this investigation is to study the anti- and prooxidants balance in tissues in acoustic stress conditions, as we take into account great amount of real facts concerning it's role in the pathogenesis of many diseases. The experimental animals (white mongrel rats) underwent 91 dBA noise level influence with maximum energy in the range of medium and high frequency. Intensity of lipid peroxidation and protein oxidation, the changes in the content of alfa-tocopherol, activity of antioxidant enzymes in different tissues have been studied. Simultaneously structural components of biomembranes and structural and immunological changes in the immunogenesis organs: thymus, spleen and lymph nodes were studied as well. The revealed shifts in the thymus, spleen and lymphatic nodes after the 6 hours influence of noise, are, in our opinion, transient, since the whole syndrome corresponds to a relatively late stage of the stress syndrome tension phase. The data obtained revealed significant changes in the intensity of lipid peroxidation,alpha-tocopherol content in all studied tissues, in the content of phospholipid glycerides in the brain mitochondrial and erythrocyte membranes, depending on both the sex of animals and the duration of noise action.

Thu 8:00 Lord RAYLEIGH Keynote lecture: Dr. Marc Deschamps

Multi-scale characterisations of materials and structures by ultrasonic methods – (000870)

M. Deschamps
Institut de Mécanique et d'Ingénierie de Bordeaux (I2M), UMR CNRS 5295, Arts et Métiers ParisTech, Université de Bordeaux, 351 cours de la Libération, 33405 Talence, France
Corresponding author E-mail: m.deschamps@i2m.u-bordeaux1.fr

The characterisation of materials or structures by using ultrasonic techniques is based on the analyses of wave propagation. These inspections reveal elastic material properties or defects presence in the structure. These last twenty years, many different experimental set-ups have been developed to improve the devices and to extend the frequency range investigations, as large as possible. The different methods of wave generation and detection can be based on the usual piezoelectric sensors, non-contact techniques using air-coupled transducers, and either microwave or laser radiation. This complementary array covers the frequency band from tens of KHz to hundreds of GHz and provides facilities to characterise materials and to detect defects from submicron dimension up to airplane size. From a theoretical point of view, a multifaceted perspective is required for interpreting and extracting a maximum of reliable data from the experiments that are performed with diverse physical and geometrical parameters. As a result, the material models under study can combine anisotropy, continuous heterogeneity, presence of inclusions, viscoelasticity, piezoelectricity, heat conductivity, acousto-optic and opto-acoustic interactions and electromagnetism. Characterization of materials and Non Destructive Testing are areas of application addressing the currently growing industrial demand for materials in aeronautics, transport and civil engineering.

Thu 8:00 Paul LANGEVIN Keynote lecture: Pr. Stuart Bolton

The influence of boundary conditions and internal constraints on the performance of noise control materials – (000877)

J.S. Bolton
Purdue University, Ray W. Herrick Laboratories, 140 S. Martin Jischke Drive, West Lafayette, Indiana, 47907-2031, USA
Corresponding author E-mail: bolton@purdue.edu

Theories governing wave propagation in noise control materials are now well- developed. As a result, it is, in principle, possible to design optimal noise control materials, whether sound absorption or barrier performance is the goal. However, it is now understood that details of the boundary conditions applied to poroelastic materials such as foams have a dramatic impact on their performance. It is important to understand these effects if the best performance is to be obtained under particular circumstances and if the opportunity to achieve enhanced performance in particular frequency ranges owing to these sensitivities is to be realized. Here, these effects will be described and demonstrated. First, the impact of front and rear surface boundary conditions on the performance of layers of foams will be demonstrated and the possibility of enhanced low frequency performance will be discussed. Next, the impact of material inhomogeneity will be discussed as will the effects of segmenting poroelastic materials into finite-sized, constrained pieces. It will be shown, for example, that internal constraints can greatly enhance barrier performance, but that a weight penalty is inevitably incurred. Finally, a connection will be drawn with recently developed cellular metamaterials, whose performance similarly depends on finite length-scales and internal constraints.

Thu 19:00 Lord RAYLEIGH Invited Conference and Concert: Pr. Barry Truax

A soundscape composition concert: real and imaginary spaces – (000874)

B. Truax
Simon Fraser University, School of Communication, Simon Fraser University, Burnaby, Bc, Canada V5A 1S6
Corresponding author E-mail: truax@sfu.ca

Multi-channel audio reproduction provides listeners with a highly immersive auditory experience that has greatly benefitted the practice of soundscape composition by creating aesthetically enhanced experiences that are based in real-world experience but move the listener into an abstracted or even a completely imaginary space. This concert presents three octophonic works by the author that illustrate this potential, beginning with Pendlerdrøm (1997) (Commuter Dream), which takes the listener to Copenhagen train station where a commuter arrives at the end of the day and waits for a local train, lapsing at two points into a daydream in which previous sonic elements return as memories that swirl around the space. Island (2000) takes the listener to an imaginary island where hyper-realistic sounds are accompanied by processed versions of the same sounds, suggesting a magical quality to this space. The

listener progresses from the shoreline up a river, into a watery cavern, then to a windy mountain peak, through a nighttime forest and finally to the opposite shore. Chalice Well (2009) takes the listener to mythical underground caverns beneath Glastonbury Tor in England. All three works were realized with computer-controlled diffusion and digital signal processing techniques such as granular time-stretching, convolution and waveguide resonators.

Thu 9:00 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Synchronization of a standing wave thermoacoustic prime-mover by an external sound source – (Contributed, 000357)

G. Penelet[a] and T. Biwa[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9;
[b]Department of Mechanical Systems and Design, Tohoku University, 980-8579 Sendai, Japan
Corresponding author E-mail: guillaume.penelet@univ-lemans.fr

Since the early observations made by Christiaan Huygens in his experiments with two pendulum clocks placed on a common support, synchronization phenomena have been extensively studied in the field of nonlinear science. Examples of synchronization phenomena are abundant in many fields of science, from mechanical or electrical engineering to chemistry or living systems, provided that a self- sustained oscillator may be driven by an external force or another oscillator. In this study, we investigated the effect of synchronization of a very simple standing wave thermoacoustic oscillator, when it is driven by an external sound source, i.e. a loudspeaker. Experiments are performed by controlling both frequency detuning and driving amplitude in order to draw the Arnold tongues associated to this particular device. The transition from the synchronized to the quasi-periodic regime is also studied, and different kinds of bifurcation are observed depending on the driving amplitude. In our opinion, the experiments performed in this study are of interest for teachers, because they exhibit universal concepts in a particular device which is both very demonstrative and easy to reproduce with minimum equipment.

Thu 9:20 Peter BARNETT AH-S06: Thermoacoustic refrigerators

The influence of stack temperature gradient on the acoustic power – (Contributed, 000690)

M. Abidat, M.Z. Dar Ramdane, M. Hamel, L. Merahi and O. Hireche
USTO-MB University, Faculté de Génie Mécanique,USTO-MB, BP 1505, Oran ElM'Naouer, 31000 Oran, Algeria
Corresponding author E-mail: miloud_abidat04@yahoo.fr

A numerical study of a standing-wave thermoacoustic engine startup is presented. The aim of this work is to study the effect of stack temperature gradient on the acoustic power. The analysis of the flow and the prediction of the heat transfer for different lengths of the heat exchangers are performed by solving the nonlinear unsteady Navier-Stocks equations using the finite volume method implemented in -ANSYS CFX- CFD code. Indeed, increasing the stack temperature gradient contributes to a rise of the amount heat exchanged between the working gas and the heat source and sink. This heat is transported to the stack and therefore more acoustic power is produced. The results show that the increases in the aerothermodynamics parameter of the working gas are proportional to the increase of the stack temperature gradient.

Thu 9:40 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Weakly nonlinear acoustic oscillations in gas columns in the presence of temperature gradients – (Contributed, 000358)

G. Penelet, T. Chareyre and J. Gilbert
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: guillaume.penelet@univ-lemans.fr

This study deals with the description of nonlinear propagation of guided acoustic waves in the presence of temperature gradients. Nonlinear propagation of guided acoustic waves has been extensively studied in the past decades. It is nowadays well-established that, in the frame of weakly nonlinear acoustics, it is possible to derive a Burgers equation describing nonlinear and lossy propagation in tubes, with possible account of the variation of the tube's cross-section. However, the effect of a temperature gradient on non linear propagation has not been studied a lot. This topic may be worth studying in the field of thermoacoustics, where both high amplitude acoustic waves and steep

temperature gradients are present. In this study, the appropriate Burgers equation is first derived, describing the propagation of a single wave in a tube submitted to a linear temperature gradient. This equation can be solved using a frequency domain numerical model, which allows to quantify the impact of temperature gradients in specific cases. The case a weak temperature gradient along a waveguide exhibiting variable cross section, and the case of a strong temperature gradient along a straight duct closed at both ends will be treated in this study.

Thu 10:40 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Investigation on streaming sources in thermoacoustic prime mover – (Contributed, 000800)

R. Paridaens, S. Kouidri and F. Jebali Jerbi
LIMSI-CNRS, BP 133, 91403 Orsay, France, Metropolitan
Corresponding author E-mail: richard.paridaens@imelavi.fr

Thermoacoustic devices either prime mover, heat engines or refrigerators are not known for their high efficiency. Even though these systems have many advantages regarding environmental constraints, they are not yet used in the industrial applications. Energy conversion efficiency improvement of thermoacoustic systems is now in the priority of the thermoacoustic community. One of the reasons of the relative low efficiencies is in the physical understanding which is not well achieved. The appearance of steady mass flow of second order usually called streaming and superimposed to the oscillating flow in these systems is shown as an important dissipating energy phenomenon. From energy consideration and despite their low level, this DC flow involves heat transfer to the wall which is undesirable loss mechanism. This phenomenon which is a quite old topic is still widely investigated experimentally and theoretically. The design, construction and performance measurements of the traveling wave thermoacoustic engine will be presented and discussed. A non-linear acoustic approach has been developed in order to determine the contribution of the different sources of streaming generation. The purpose is to emphasize on the physical interpretation of each source.

Thu 11:00 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Measurements of temperature and velocity fluctuations in oscillating flows using thermal anemometry - application to thermoacoustic refrigerators – (Contributed, 000786)

A. Berson[a], G. Poignand[b], E. Jondeau[c], P. Blanc-Benon[c] and G. Comte-Bellot[c]
[a]Durham University, School of Engineering and Computing Sciences, Science Site, South Road, DH13LE Durham, UK; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: arganthael.berson@durham.ac.uk

This paper summarizes our recent work on the development of thermal anemometry to measure velocity and temperature fluctuations in oscillating flows. First, we demonstrate that velocity cannot be measured accurately by hot-wire anemometry in oscillating flows when the flow reverses its direction. Indeed, there is no unique and well-defined correlation between the flow velocity and heat transfer near flow reversal, which prevents the recovery of velocity fluctuations from the anemometer signal. Second, we detail new procedures for the measurement of temperature fluctuations in oscillating flows using cold-wire thermometry. Thermal inertia alters the response of the sensor to temperature changes. The thermal inertia of the cold-wire (operated by a constant-current or a constant-voltage anemometer) is corrected instantaneously using the same wire but in the heated mode (operated by a constant-voltage anemometer). The new procedures are validated in an acoustic standing-wave where temperature fluctuations amplitudes lower than 0.2K at approximately 1000Hz are successfully measured. Experiments near the edges of the stack in a thermoacoustic refrigerator demonstrate the nonlinearity of the temperature field.

Thu 11:20 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Low Mach number simulation of a loaded standing-wave thermoacoustic engine – (Contributed, 000302)

L. Ma[a], C. I. Weisman[a], D. G. Baltean Carlès[a], P. Le Quéré[b] and L. Bauwens[c]
[a]UPMC - LIMSI, 4 Place Jussieu, 75252 Paris Cedex 05, France; [b]LIMSI, LIMSI - UPR3251, 91403 Orsay Cedex, France; [c]University of Calgary, Dept of Mechanical and Manufacturing Eng., Calgary, Canada AB T2N 1N4
Corresponding author E-mail: malin@limsi.fr

Numerical simulations of a loaded standing-wave thermoacoustic engine are performed using a low Mach number model. This work uses a simplified model based on coupling the nonlinear flow and heat exchange in the heat exchangers and the stack with a linear acoustic model of the resonator and load. The two-dimensional unsteady numerical solution in the heat exchangers and stack region shows the amplification process until saturation is obtained. The influence of the load model on the wave saturation is studied, yielding a specific load range for saturation at levels comparable with experiments. In order to investigate the energy conversion within the standing-wave thermoacoustic engine, the acoustic power developed is calculated and the efficiency is estimated. Finally, the effect of the distance between stack and heat exchangers (with particular consideration of the case where the heat exchangers and stack are directly in contact) is also discussed.

Thu 11:40 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Numerical simulation of a thermoacoustic engine startup – (Contributed, 000695)

M. Abidat, M.Z. Dar Ramdane, L. Merahi, M. Hamel and O. Hireche
USTO-MB University, Faculté de Génie Mécanique,USTO-MB, BP 1505, Oran ElM'Naouer, 31000 Oran, Algeria
Corresponding author E-mail: miloud_abidat04@yahoo.fr

In this paper, a numerical study of a standing-wave thermoacoustic engine startup is presented. The aim of this work is to study the effect of the heat exchangers length on the acoustic power of the thermoacoustic engine (TAE). The analysis of the flow and the prediction of the heat transfer for the different lengths of the heat exchangers are performed by solving the non linear unsteady Navier-Stocks equations using the finite volume discretisation method implemented in the ANSYS-CFX CFD code. The results show that the increase in the local specific work is proportional to the increase of the heat exchangers length. The same method, presented in this paper, can also be applied to thermoacoustic refrigerators.

Thu 13:40 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Experimental and theoretical analysis of a small scale thermoacoustic cooler driven by two sources – (Contributed, 000526)

P. Lotton, G. Poignand, A. Podkovskiy, G. Penelet and M. Bruneau
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: pierrick.lotton@univ-lemans.fr

Being concern by scaling down thermoacoustic coolers to provide practical solutions for thermal heat management, especially in microcircuits, a current architecture has been proposed recently [Acta Acustica 97(6), 926-932, November 2011]. A non-resonant small cavity fitting the stack dimensions is driven by two loudspeakers coupled through the stack. One of them creates the acoustic pressure field inside the stack while the other one creates the particle velocity field.
This cooler has both advantages of being compact and flexible, as the acoustic field in the stack can be controlled to access the optimal field which optimizes thermoacoustic effects. Moreover, the working frequency is not related to resonance conditions, therefore either a quasi-isothermal stack (regenerator) or a quasi-adiabatic stack can be used.

Experimental results, which validates theoretical ones [1], are presented to illustrate the thermal behaviour of a stack and a regenerator in this device. The performances compared with those of classical devices having equivalent stack (standing wave or Stirling devices) show the potentiality of this compact thermoacoustic cooler.

Thu 14:00 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Development of a thermoacoustic travelling-wave refrigerator – (Contributed, 000763)

M. Pierens[a], J.-P. Thermeau[a], T. Le Pollès[b] and P. Duthil[a]
[a]Institut de Physique Nucléaire d'Orsay, IPN - 15, rue Georges Clemenceau - 91406 Orsay Cedex; [b]HEKYOM, 2 rue Jean Rostand, 91400 Osray, France
Corresponding author E-mail: pierens@ipno.in2p3.fr

Thermoacoustic phenomenon deals with the interaction between heat and sound. This physical field is studied from the later seventies to develop heat machines for energy conversion. A thermoacoustic refrigerator uses a mechanical work, induced by an intense acoustic wave, to pump heat from a cold source and rejecting heat to an ambient source. In the framework of the European project called THATEA focusing on energy conversion efficiencies, a thermoacoustic travelling-wave refrigerator has been developed. This system provides 200W of cooling power at a cold temperature of 233 K with a COP of 30% relative to the theoretical Carnot COP. We first explain the working principle of such a system, then we present the device, and finally we give results obtained from experimental campaigns.

Thu 14:20 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Sensitivity of ultra high frequency pulse tube cryocooler from acoustic viewpoint – (Contributed, 000317)

W. Dai, L. Yu, G. Yu, X. Wang and E. Luo
TIPC of Chinese Academy of Sciences, ZhongGuanCun Dong Rd.29, Hai Dian, 100190 Beijing, China
Corresponding author E-mail: dwpeng@yahoo.com

High frequency Stirling type pulse tube cryocooler promises higher specific power which is attractive for many applications. For the past several years, we have been working on a 300 Hz pulse tube cryocooler. At such a high frequency, acoustics plays an important role in determining the cryocooler performance. This paper studies the dependence of cryocooler performance on the dimensions of inertance tube, connecting tube and void volume inside the system from the acoustic viewpoint. While similar influence exists in case of lower frequency systems, the cryocooler are more sensitive to these parameters when the frequency increases up to 300 Hz. Such a study is helpful in guiding the design of the system.

Thu 14:40 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Numerical simulation of a thermoacoustic couple – (Contributed, 000172)

A. I. Abd El-Rahman[a] and E. Abdel-Rahman[b,c]
[a]Department of Physics, American University in Cairo, AUC Avenue, P.O. Box 74, 11835 New Cairo, Egypt; [b]American University in Cairo, Department of Physics - School of Sciences & Engineering, Youssef Jameel Science and Technology Research Centre (YJSTRC), 11835 New Cairo, Egypt; [c]Mechanical Power Engineering Department, Cairo University, 12613 Cairo, Egypt
Corresponding author E-mail: ehab_ab@aucegypt.edu

Here we report a 2D computational fluid dynamics simulation of the non-linear oscillating-flow behavior in a helium-filled half-wavelength standing thermoacoustic refrigerator. The finite-volume method is used, and the solid and air domains are represented by large numbers of quadrilateral and triangular elements. The calculations assume a periodic structure to reduce the computational cost and apply the dynamic mesh technique to account for the oscillating adiabatic equivalent wall boundaries. The simulation uses an implicit time integration of the full unsteady compressible flow equations with a conjugate heat transfer algorithm (ANSYS FLUENT). A Typical run involves 12000 elements and a total simulation time of five seconds. Simulation Results for drive ratios $Dr = 0.28\% - 2\%$ are compared to the Swift linear theory and the numerical analysis of Worlikar et al., and show better agreement with the experimental values of Atchley. A maximum cooling effect of three degrees is predicted at a non-dimensional wave number $kx = 3\pi/4$, measured from the resonator rigid end. This simulation provides an interesting tool for understanding the bulk and micro-structural flow behavior in TAR, characterizing and optimizing their performance, and building models of thermoacoustic flow analysis.

Thu 15:00 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Methods for transfer matrix evaluation applied to thermoacoustics – (Contributed, 000346)

F. Bannwart, G. Penelet, P. Lotton and J.-P. Dalmont
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: flavio.bannwart@univ-lemans.fr

The design of a thermoacoustic (TA) prime-mover partly relies on the knowledge of its *onset* conditions, i.e. the resonance frequency of the self-sustained oscillations and the minimum heat power supply which is necessary for the outbreak phenomenon. These *onset* conditions can be calculated once the transfer matrix of the TA core is determined, whichever by analytical modeling or acoustic measurements. The latter, however, consists in an interesting option to avoid thermophysical or geometrical considerations of complex structures, mainly with respect to the TA

regenerator, as the TA core is treated as a *black box.* Two experimental methods are considered in this work: the Two Loads Method and the Impedance Method. These methods are here presented, discussed and compared on several aspects, taking into account simulated and experimental results for a stack and a regenerator submitted to a steep temperature gradient. Regarding these aspects of investigation, the Two Loads Method was proved to be the best for the stack, meanwhile the Impedance Method for the regenerator. In the second case, important experimental difficulties arise due to intrinsic properties of the regenerator. Therefore, the Impedance Method was conceived towards the investigation into this specific problematic and has succeeded on its purpose.

Thu 15:20 Peter BARNETT AH-S06: Thermoacoustic refrigerators

Amplification and saturation of the thermoacoustic instability in a standing-wave prime mover – (Contributed, 000398)

M. Guédra, T. Devaux, G. Penelet and P. Lotton
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: matthieu.guedra.etu@univ-lemans.fr

In this paper, a thermoacoustic standing-wave device is studied, which consists of a quarter-wavelength straight resonator equipped with a 600 CPSI ceramic stack. Transient regimes leading to steady state acoustic pressure are measured under various heating conditions and for several locations of the stack inside the resonator. Experiments show interesting behaviours such as an "overshoot" for the acoustic pressure before its final stabilization, or a periodic "on-off" of the wave. A discrete time model is proposed to reproduce these transient behaviours. For each time step, the temperature distribution along the device is computed first by solving non-linear diffusion equations, then the amplification rate of the acoustic wave is calculated from the imaginary part of the resonant frequency of the system. Nonlinear saturating acoustic effects such as the thermoacoustic heat flow inside the stack and the Rayleigh's streaming in the resonator are introduced in the model, and their impact on the dynamics of wave amplitude growth are quantified. The results show good agreement between the experiments and theory, in terms of amplification process and final stabilized pressure amplitude.

Thu 9:00 Ray STEPHENS EA-S05: Electroacoustics for room acoustics

Simulation and application of beam-shaped subwoofer arrays – (Invited, 000561)

E. W. Start
Duran Audio BV, Koxkampseweg 10, 5301KK Zaltbommel, Netherlands
Corresponding author E-mail: evert.start@duran-audio.com

This paper discusses the prediction and application of DDS-controlled, directional subwoofer arrays with configurable 3D sound radiation characteristics (e.g. cardioid, hyper-cardioid, dipole etc.). In order to optimise and control the dispersion of beam-shaped sub arrays, an accurate sound radiation model is indispensable. The radiation impedance of the transducers (i.e., the acoustic load) and the cabinet diffraction are determined by the size of the array and the relative position of the loudspeakers in the array. Besides these diffraction and coupling effects, other acoustic boundary conditions can have a significant effect too. The most common one is the ground plane condition. Therefore, the hybrid PSM-BEM model implemented in the DDA software, has been extended with an optional ground plane condition. Measurements show that the improved model yields very accurate results for various array set-ups with different radiation characteristics.

Thu 9:20 Ray STEPHENS EA-S05: Electroacoustics for room acoustics

A method steering a null toward a point in high reverberate non-minimum phase acoustic space – (Contributed, 000549)

K. Fujii[a], T. Yoshioka[a], Y. Kuwahara[a], M. Muneyasu[b] and M. Morimoto[a]
[a]University of Hyogo, 2167 Shosha, 671-2280 Himeji, Japan; [b]Kansai University, 3-3-35 Yamate-cho, 564-8680 Suita, Japan
Corresponding author E-mail: fujiken@eng.u-hyogo.ac.jp

In this paper, we propose a method capable of steering a null toward a point in high reverberate non-minimum phase acoustic space. This method is characterized by applying the cascade connection of recursive and non-recursive adaptive filters to steering the null. The cascade connection completely expresses the structure of the

acoustic paths from a sound source to microphones. The acoustic paths can thereby estimated with high precision. However, as well known, the recursive adaptive filter has two problems. One is that the performance of the recursive adaptive filter is apt to become unstable. We solve this problem by applying the lattice structure to the recursive adaptive filter. The stable performance is guaranteed by limiting the reflection coefficients to less than unity. Another is that the response of the recursive filter diverges when the minimum phase condition is not satisfied. We hence separate the recursive filter into the minimum and the non-minimum phase components. We next transform the latter into a non-recursive filter and connect it to the output of another microphone. The cascade connection can thereby steer the null with high stability and precision even in high reverberate non-minimum phase acoustic space.

Thu 9:40 Ray STEPHENS EA-S05: Electroacoustics for room acoustics

Influence of model parameter variability on the directivity filters of compact loudspeaker arrays – (Contributed, 000706)

A. Mattioli Pasqual[a], M. Pachebat[b] and P. Herzog[b]
[a]Universidade Federal de Lavras, Departamento de Engenharia, Campus Universitário, 37200-000 Lavras, Brazil; [b]LMA, CNRS, UPR 7051, Aix-Marseille Univ, Centrale Marseille, 13402 Marseille, France
Corresponding author E-mail: ampasqual@gmail.com

Sound directivity control is made possible by a number of independently driven loudspeakers mounted on a compact cabinet. Recently, a control system for such a multichannel source based on its acoustic radiation modes has been proposed. These modes form an orthogonal set of velocity patterns on the source surface, and emerge from the eigendecomposition of a free-field radiation operator that depends on frequency. So, since the diaphragm velocities are driven by electrical signals, each directivity filter is a set of voltages giving rise to a radiation mode. Moreover, these filters must take into account the acoustic coupling between the transducers if they interact inside a hollow cabinet. Usually, nominally identical drivers are distributed over a spherical frame in the shape of a Platonic solid, which leads to frequency-independent radiation modes. Furthermore, if the individual drivers possess identical electromechanical features, the directivity filters are frequency independent too. However, the electromechanical parameters of commercial loudspeaker units might present a significant deviation from their nominal values due to their manufacturing process. This work discusses the effects of electromechanical parameter variability on the frequency independence of the directivity filters of Platonic solid loudspeakers. In addition, a dodecahedral loudspeaker array, whose parameters of the individual drivers are experimentally characterized, is investigated as a case study.

Thu 10:00 Ray STEPHENS EA-S05: Electroacoustics for room acoustics

Study on room modal equalization at low frequencies with electroacoustic absorbers – (Contributed, 000430)

E. Rivet, R. Boulandet, H. Lissek and I. Rigas
Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: etienne.rivet@epfl.ch

In closed spaces, a recurring problem at low frequencies is the occurrence of standing waves, thus creating annoying acoustic resonances. Such unwanted phenomena are likely to affect the frequency response of rooms such as offices, concert halls or home theaters. Due to large wavelengths, the low-frequency treatments require the embodiment of heavy enclosure, large barriers, or bulky silencers. To that purpose, electroacoustic absorbers, based on conventional loudspeakers with shunt synthetic electric loads, can be used to improve sound rendering and meet acoustic quality specifications. Electrodynamic loudspeakers are good candidates for this type of noise control applications. Their mechanical resonance, typically of the order of tens of Hertz, is within frequency range where acoustic modes are to be controlled. The interactions between these dynamic systems are significant, and some of the acoustic energy of the sound field can be dissipated passively through internal damping in the loudspeaker. This paper investigates the optimized design and placement of electroacoustic absorbers in a recording studio so as to damp the low-frequency acoustic resonances.

Thu 9:00 John TYNDALL MA-S05: Instrument making and acoustics

Mutual benefits of collaborations between instrument makers, musicians and acousticians – (Invited, 000119)

D. Sharp
Open University, DDEM, MCT Faculty, Open University, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: d.sharp@open.ac.uk

Effective collaboration between instrument makers, musicians and acousticians can be of great benefit to all parties, leading to improved instrument designs, greater understanding of an instrument's playing characteristics, and an improved knowledge of the physical processes that occur within an instrument. As a working relationship develops between an instrument maker, a musician and an acoustician, the trust that builds up can facilitate increasingly more detailed investigations. Through a series of case studies involving brass and woodwind instruments, this paper charts the development of several maker/player/acoustician collaborations, showing how they have evolved over the years and highlighting the benefits experienced by all the different partners involved.

Thu 9:20 John TYNDALL MA-S05: Instrument making and acoustics

Physical and perceptual differences between two trumpets of the same model type – (Contributed, 000127)

A. Mamou-Mani[a], L. Placido[b] and D. Sharp[c]
[a]IRCAM, 1 place Igor Stravinsky, 75004 Paris, France; [b]Université Paris 1 CES/CNRS, 106-112 boulevard de l'Hôpital, 75647 Paris Cedex 13, France; [c]Open University, DDEM, MCT Faculty, Open University, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: adrien.mamou-mani@ircam.fr

For large-scale musical wind instrument manufacturers, the ability to produce instruments in a repeatable fashion is essential. In this paper, two mass-produced trumpets of the same model type are compared in terms of physical and perceptual differences. Input impedance and bore profile measurements show significant acoustical differences due to the presence of a tiny leak in the bore of one of the two instruments. Psychophysical tests demonstrate that these acoustical differences do not necessarily result in perceptible differences in the playing characteristics of the two trumpets. Only a small number of trumpet players successfully distinguish between the instruments when subjected to a playing test, although those that do are shown to be able to provide distinct and consistent quality assessments for each one.

Thu 9:40 John TYNDALL MA-S05: Instrument making and acoustics

Dense and hard woods in musical instrument making: comparison of mechanical properties and perceptual "qualityï grading – (Contributed, 000198)

E. Fouilhé[a], A. Houssay[b] and I. Bremaud[c]
[a]LMGC Montpellier 2 University, CNRS UMR 5508, CC048, Place Eugène Bataillon, F-34095 MONTPELLIER Cedex 05, 34095 Montpellier, France; [b]Laboratoire du musée de la musique, Cité de la musique, 221 Avenue Jean Jaures, 75019 Paris, France; [c]Wood Laboratory, Empa-Swiss Federal Laboratories, for Materials Science and Technology, CH-8600 Dübendor, Switzerland
Corresponding author E-mail: ericf26@gmail.com

Musical instruments are composed of parts which have different functions, and call for particular wood characteristics. Besides the lightweight "resonance woodï for soundboards, dense hardwoods appear in many parts: xylophone keys, drum barrels, woodwinds, bows, back, sides and necks of string instruments, and their fittings: bridges, tail-pieces and pegs, etcoeCan the mechanical/acoustical properties of these woods be correlated to the perceptual "qualityï choice made by instrument makers? The study is based on a sampling of 214 wood pieces from 60 species, classified in 3 groups: (i) tropical woods used in classical/modern making, such as ebonies and rosewoods; (ii) European hardwoods with historical and/or traditional uses; (iii) potential alternative woods, which might overcome current shortage in the supply of appropriate quality of preferred woods. Density and dynamic mechanical properties (modulus of elasticity and "quality factorï or damping) are measured by vibrational and ultrasonic methods, at the scale of the laboratory or of the workshop. We compare choices made by two makers, one of xylophones, and one of violin accessories, first between these two empirical grading, then by confronting them with measured mechanical properties. It appears that the "perceptualï selections by these two makers are different.

Thu 10:00 John TYNDALL MA-S05: Instrument making and acoustics

Towards a steelpan making model - Residual stress field effects on dynamical properties – (Invited, 000202)

M. Monteil[a,b], O. Thomas[c], J. Frelat[a], C. Touzé[b] and W. Seiler[d]
[a]IJLRDA-UPMC, 4 place jussieu, 75005 Paris, France; [b]UME (Unité de Mécanique), ENSTA - ParisTech, Chemin de la Hunière, 91761 Palaiseau, France; [c]LMSSC-CNAM, 2 rue conté, 75003 Paris, France; [d]Laboratoire PIMM, Arts & Métiers Paristech, 151 boulevard de l'hôpital, 75013 Paris, France
Corresponding author E-mail: melodie.monteil@gmail.com

The steelpan is a tuned percussion instrument from Trinidad and Tobago. It is made of oil barrels that are subjected to several stages of metal forming that stretch and bend the structure. The top of the barrel is pressed, hammered, punched and burnt in order to obtain a sort of main bowl within which convex substructures are formed. Due to the thickness of the metallic structure, geometric nonlinear vibrations are a key feature of the peculiar tone of the instrument.
We are interested in developing a numerical model accounting for all the transformations encountered by the structure during the steelpan making. Simultaneously, a real pan is built by a panmaker and numerous measurements (geometry, modal analysis, stress measurements) are realized after each step.

The first step (the sinking) has thus been studied. A special attention is paid on the effects of the prestresses on dynamical properties of the thin curved structure. Analytical-numerical models with simplified geometry (beams and plates) are used to quantify the effects of the prestresses on the eigenfrequencies. Then, a finite element model is derived for a quantitative comparison with measurements at several surface points. All these data allows fine modeling of the know-how of the pan maker for the sinking.

Thu 11:00 John TYNDALL MA-S05: Instrument making and acoustics

Quantitative evaluation of the curvature induced mistuning in long wind instruments – (Contributed, 000321)

S. Félix[a], J.-P. Dalmont[a] and C. J. Nederveen[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Acacialaan 20, Acacialaan 20, 2641 AC Pijnacker, Netherlands
Corresponding author E-mail: simon.felix@univ-lemans.fr

The present work attempts to quantify, both theoretically and experimentally, the effect of the curvature of the air column of wind instruments on their acoustical properties. The curvature-induced mistuning, that is, the change in resonance frequencies compared with a straight tube having the same axis length, is characterized as a length correction, that can be deduced from a direct calculation of the resonance frequencies, or from the input impedance. This length correction exhibit a strong frequency dependence, denoting a complex inharmonicity, that can be, in some cases, musically significant. Details are given on the inharmonicity as a function of the curvature of the waveguide axis, and quantitative results are given on various example of bent portions of real wind instruments.

Thu 11:20 John TYNDALL MA-S05: Instrument making and acoustics

Correlating differences in the playing properties of five student model clarinets with physical differences between them – (Contributed, 000340)

P. M. Kowal, D. Sharp and S. Taherzadeh
Open University, DDEM, MCT Faculty, Open University, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: paulina.kowal@open.ac.uk

This paper reports work that is part of a larger project concerned with correlating differences in the perceived playing characteristics of musical wind instruments with physical differences between them. Here we focus on five different student model clarinets. Some of the practical difficulties of (i) directly measuring the bore profiles of the clarinets and (ii) measuring their input impedances are discussed. Results are presented which show significant differences in bore profile between the five instruments, leading to clear differences in the frequencies and magnitudes of their resonance peaks. In addition, the initial findings of playing tests designed to establish clarinettists' perceptions of the instruments are described.

Thu 11:40 John TYNDALL MA-S05: Instrument making and acoustics

A vibro-acoustical and perceptive Study of the neck-to-body Junction of a solid-body electric Guitar – (Contributed, 000348)

A. Paté[a], J.-L. Le Carrou[a], B. Navarret[b], D. Dubois[a] and B. Fabre[a]
[a]Equipe LAM - D'Alembert, 11, rue de Lourmel, 75015 Paris, France; [b]CICM Univ Paris 8 MSH Paris-Nord / Equipe LAM UPMC, 11, rue de Lourmel, 75015 Paris, France
Corresponding author E-mail: pate@lam.jussieu.fr

The string motion of the solid body electric guitar is captured by an electromagnetic transducer sending an electrical signal to an amplification system, providing the sound to be perceived. Transducer and amplification have been so far well investigated, but the vibrational aspect of the instrument in connection with lutherie has been rarely considered. The aim of the present study is to analyse mechanically and perceptually the own influence of a single construction parameter on the vibrational behaviour of the whole instrument and on the perceived sound.
Nine guitars, whose single difference is the neck-to-body junction, were made specially for this study: three necks are screwed to the body, three are glued and three guitars have a neck-through construction. The guitars have been studied using vibro-acoustical methods: modal analysis and conductance measurements at the frets and at the bridge. They have been then played by twenty-two professionnal guitarists along with semi-directed interviews. As expected, we could not observe no greater differences in the modal behaviours between two different constructions (neck junction) than between two identical constructions. However a pyscholinguistic analysis of the interviews shows that the musicians discriminate more subtle differences between the guitars.

Thu 13:40 John TYNDALL MA-S05: Instrument making and acoustics

About the electric guitar: a cross-disciplinary context for an acoustical study – (Contributed, 000349)

A. Paté[a], B. Navarret[b], R. Dumoulin[c], J.-L. Le Carrou[a], B. Fabre[a] and V. Doutaut[d]
[a]Equipe LAM - D'Alembert, 11, rue de Lourmel, 75015 Paris, France; [b]CICM Univ Paris 8 MSH Paris-Nord / Equipe LAM UPMC, 11, rue de Lourmel, 75015 Paris, France; [c]GRANEM - UMR MA 49 - Université d'Angers, 13, allée François Mitterrand BP 3633, 49036 CEDEX 0 Angers, France; [d]ITEMM, 71, avenue Olivier Messiaen, 72000 Le Mans, France
Corresponding author E-mail: pate@lam.jussieu.fr

The electric guitar was born in the 1930s from the will of guitarists to be heard while playing in orchestras including louder instruments. It then became the broadly-spread instrument that we know.
Because of its mass-production and of the imitation-like learning methods, it appears that only a few models (shape, woods species, construction parameters) of electric guitar have stood out and have been the master copies of most of the other electric guitars all around the world. These models are few but each of them strongly differs from the others organologically or sociologically speaking. A new research topic is emerging at LAM, which is about the vibro-acoustical study of the electric guitar in connection with lutherie. In this article, this topic is put back in an organological, scientific, musicological, sociological and economic context context.

Thu 14:00 John TYNDALL MA-S05: Instrument making and acoustics

How far can the resonance frequencies give informations about the playing frequencies? The trumpet example – (Contributed, 000381)

P. Eveno[a], B. Kieffer[a], J. Gilbert[b], J.-F. Petiot[c] and R. Caussé[a]
[a]IRCAM, 1 place Igor Stravinsky, 75004 Paris, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Ecole Centrale de Nantes, 1 rue de la noe, BP 92101, 44321 Nantes, France
Corresponding author E-mail: pauline.eveno@ircam.fr

Measurements and calculations of the input impedance of wind musical instruments are now well mastered. The purpose of this work is to study experimentally how far the resonance frequencies of brass instruments, taken from their input impedance, are able to give informations about the playing frequencies. Three different trumpets, obtained by changing only the leadpipe of the same instrument, were considered for the experiment. After a measurement of the input impedance of these trumpets, four musicians were asked to play the five first playable notes (regimes 2 to 6), for four different fingerings. This exercise was done for three nuances and was repeated three times. Finally, these $3\times4\times5\times4\times3\times3=2160$ notes allow us to make a quantitative assessment of the relations between the resonance frequencies and the playing frequencies. Results show first, a limited influence of the musician on the overall intonation of the instrument. Second, the pitch of the notes does not vary much with the nuances. Finally,

the results confirm the fact that variations of the resonance frequencies lead to variations of the playing frequencies of the same order.

Thu 14:20 John TYNDALL MA-S05: Instrument making and acoustics

Scraping technique for clarinet reeds derived from a static bending simulation – (Contributed, 000425)

P.-A. Taillard[a] and J.-P. Dalmont[b]
[a]Schola cantorum basiliensis, Cerisier 16a, 2300 La Chaux-De-Fonds, Switzerland; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: taillard@hispeed.ch

Reed scraping is an art mastered only by a few clarinetists. The published empirical methods do not agree on how to determine where to scrape. In order to understand the problematic more clearly, a purely mechanical and simplified approach is attempted. The reed is modeled by finite elements and a simulation of free static bending shows that the longitudinal flexural stress dominates the problem. By targeting a stress field on different areas of the reed, it is observed that the strain is mainly longitudinal and only slightly lateral, due to the strong anisotropy of the cane. Thus, a bending moment imposed on the axis of the reed causes almost no translation of the edges of the reed. A local decrease in thickness causes a localized increase in curvature, when the stress field remains constant. With this result, a series of Claripatch^{TM} was developed to impose a localized decrease in curvature on the mouthpiece's lay. Using these patches and assuming some hypotheses based on observations, simulations and on the viscoelastic properties of the reed, one can deduce how to scrape it, according to the musical preferences of the clarinetist.

Thu 14:40 John TYNDALL MA-S05: Instrument making and acoustics

An optimization algorithm for the design of woodwind instruments – (Contributed, 000463)

A. Lefebvre[a] and G. P. Scavone[b,c]
[a]McGIll University, 555 Sherbrooke Street West, Montreal, Canada H3A 1E3; [b]Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), 527 Rue Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3; [c]Computational Acoustic Modeling Lab, Schulich School of Music, McGill University, 555 Rue Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3
Corresponding author E-mail: antoine.lefebvre2@mail.mcgill.ca

Most of the playing characteristics of woodwind instruments are controlled by their geometry, that is, by the shape of the bore and the dimensions and positions of the toneholes. An optimization algorithm is proposed to determine the geometry that minimizes the tuning and harmonicity error for all fingerings. The estimation of the error for a specific configuration of the geometry is at the heart of the method. At each iteration, the transfer-matrix method is used to calculate the reflection coefficient at a number of frequencies for each of the fingerings to determine the first few resonance frequencies. As an instrument grows in complexity, this operation becomes costly. The choice of the optimization variables, bounds and the criteria are presented. This approach is applied to a number of instruments including flutes, clarinets and saxophones. The results reveal the importance of bore shape deviations and tonehole diameter variations in obtaining instruments with good intonation. The geometries obtained with our method depend critically on the model of the excitation mechanism and must be specified as accurately as possible. Results are presented that display the differences in the geometry obtained for varying excitation models.

Thu 15:00 John TYNDALL MA-S05: Instrument making and acoustics

Modal analysis comparison of two violins made by A. Stradivari – (Invited, 000496)

S. Le Conte[a], S. Le Moyne[b] and F. Ollivier[b]
[a]Cité de la musique, 221 avenue jean jaures, 75019 Paris, France; [b]Institut jean le rond d'alambert, 2 pl de la gare de ceinture, 78210 Saint Cyr L'Ecole, France
Corresponding author E-mail: sleconte@cite-musique.fr

The Music Museum in Paris keeps in its collection five violins made by the maker Antonio Stradivari, names Stradivarius (1644-1737). Two of them, called the Davidov and the Tua have been made according the same mould, at the same period and the most important using the same wood - not only the same specie but also using the wood coming from the same tree. Indeed it has been shown thanks to a dendrochronological study of these two violins

that the wooden plates are the same. Even though the violins has not the same history there are kept in their integrity. To evaluate the difference in the making process of this two musical instrument an experimental modal analysis of the soundboard was performed by processing its sound field. A non intrusive method, the Impact Planar Nearfield Acoustic Holography, was used. This technique, developed by the authors, implements the well known inverse method NAH on the basis of the acoustic impulse response field and is well adapted to modal analysis. To quantify the shift between the two responses a comparison has been made with a reproduction of another famous violin called the Allard.

Thu 15:20 John TYNDALL MA-S05: Instrument making and acoustics

Comparison of the vibroacoustical characteristics of different pianos – (Contributed, 000522)

X. Boutillon[a], K. Ege[b] and S. Paulello[c]
[a]Laboratoire de Mécanique des Solides, Ecole Polytechnique, 91128 Palaiseau, France; [b]Laboratoire Vibrations Acoustique, INSA de Lyon, 25 bis Avenue Jean Capelle, 69621 Villeurbanne, France; [c]Stephen Paulello Piano Technologies, 32 rue du sabotier, Hameau de Coquin, 89140 Villethierry, France
Corresponding author E-mail: boutillon@lms.polytechnique.fr

A recently proposed vibro-acoustical model of the piano soundboard (X. Boutillon and K. Ege, "Vibroacoustics of the piano soundboard (part 2): reduced models, mobility synthesis, and acoustical radiation regime", submitted to the JSV) predicts the modal density, the point-mobility at different locations, and whether the acoustical radiation in the far field is efficient (beyond a coincidence frequency) or not. This model is potentially valid up to several kHz; it is based on the wood elastic properties and on the geometry of the soundboard (overall dimensions, thickness, rib spacing, rib and bridge dimensions, cut-off corners). A hypothetical rule has also been devised for the equivalent dynamical rigidity of the ribbed zone of the soundboard. This rule will be discussed and the predictions of the model will be compared for pianos of various types and sizes. Consequences in terms of piano manufacturing and instrument making will be given.

Thu 15:40 John TYNDALL MA-S05: Instrument making and acoustics

Analysis of mechanical admittance of violins in the mid- frequency range – (Contributed, 000567)

B. Elie[a], M. Curtit[b], B. David[c] and F. Gautier[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]ITEMM, 71 Avenue Olivier Messiaen, 72000 Le Mans, France; [c]Telecom ParisTech LTCI - UMR CNRS 5141, 37-39 rue Dareau, 75014 Paris, France, Metropolitan
Corresponding author E-mail: benjamin.elie.etu@univ-lemans.fr

In the 60's, Schelleng proposed a simple model describing the mechanical behavior of violins using lumped circuits. The interest of such modeling is to reduce the complexity of musical instruments by describing them in the low frequency range using a few parameters. We propose in this study a method to globally quantify the mechanical behavior of violins on a larger frequency range, using only a few parameters. Bridge mobilities (or admittances) are important characteristics of the instrument, which describe the level of coupling between the strings and the instrument body. These admittances have complex variations versus frequency because of modal overlap. Modal density and damping factors can be computed in the mid frequency domain using adapted signal processing techniques: they can be estimated accurately from measured impulse responses by using the high-resolution ESPRIT method. An average admittance, computed by means of a moving average, is also used for highlighting the underlying tendency of the coupling level between the strings and the instrument body. Characteristic parameters of the bridge admittance are used to compare instruments and characterizations of instrument's tuning. This study is a part of the PAFI project, aiming to develop a set of tools dedicated to instrument makers.

Thu 16:40 John TYNDALL MA-S05: Instrument making and acoustics

Analysis of dead tones of classical guitars – (Contributed, 000582)

H. Ricateau[a], B. Elie[b], M. Curtit[c], J.-C. Valière[a], B. David[d] and F. Gautier[b]
[a]PPRIME CNRS - UPR 3346, Bâtiment B17 6 rue Marcel Doré, 86022 Poitiers, France, Metropolitan; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]ITEMM, 71 Avenue Olivier Messiaen, 72000 Le Mans, France; [d]Telecom ParisTech LTCI - UMR CNRS 5141, 37-39 rue Dareau, 75014 Paris, France, Metropolitan
Corresponding author E-mail: benjamin.elie.etu@univ-lemans.fr

The dead tones are phenomena frequently occurring on classical guitars, even on high quality guitars. It is perceived as a tone decaying much faster than its closest neighbors. The present study aims to propose global parameters enabling the identification of singular guitar tones, such as dead tones. It is based on the estimation of energy decay curves (or EDC) of a set of different notes recorded on different guitars. The EDC of tones perceived as "pathological" by guitar makers are found to be significantly larger that the EDC of "normal" tones. The mechanical admittance of the bridge is measured for each studied configuration. It is shown that large values of EDC are associated to a strong coupling between the strings and the soundboard. An analysis of each partial, based on the high resolution method, ESPRIT, enables to study the relationships between the partial decay times with the level of coupling. The analysis is intended to be performed from measurements realizable in the workshop of an instrument maker. The present study is a part of the PAFI project, which aims to develop a set of tools dedicated to instrument makers.

Thu 17:00 John TYNDALL MA-S05: Instrument making and acoustics

What do we know on " resonance wood "" properties? Selective review and ongoing research – (Contributed, 000602)

I. Bremaud
Wood Laboratory, Empa-Swiss Federal Laboratories, for Materials Science and Technology, CH-8600 Dübendor, Switzerland
Corresponding author E-mail: iris_bremaud@hotmail.com

Amongst the many different wood species used in musical instrument making, the term "resonance wood" usually refers to material for soundboards of strings (in Western classical instruments, principally softwoods and mostly spruce: *Picea abies* or spp.). As material properties of soundboards are believed to play a significant role in the acoustic behaviour of a completed instrument, many references have dealt with "resonance wood" for nearly one century. This paper aims at depicting this landscape, focusing on wood vibrational properties, their natural variability and microstructural determinants, and how they are influenced by external factors. Some characteristics of "resonance wood" are quite well known (ranges of density, of specific dynamic modulus of elasticity and viscoelastic damping along the grain), whereas others are still not fully characterised (anisotropy and frequency dependence). The interactions with hygrometry or various "treatments" (biological, chemical, thermal or "ageing") are also the object of ongoing research. Finally, although "resonance wood" may be essentially defined by the fact that it is selected by a maker and effectively used for building instruments, this viewpoint has been little studied. It calls for interdisciplinary approaches connecting the empirical criteria of evaluation used by luthiers, with wood science, material perception studies, and acoustics.

Thu 17:20 John TYNDALL MA-S05: Instrument making and acoustics

Measuring leakages in flute pads – (Invited, 000724)

B. Fabre[a], R. Auvray[a], M. Curtit[b] and J.-Y. Roosen[c]
[a]UPMC - Lutherie, Acoustique, Musique, IJLRA, 11 rue de Lourmel, 75015 Paris, France; [b]ITEMM, 71 Avenue Olivier Messiaen, 72000 Le Mans, France; [c]Flutes Roosen, rue Simart, 75018 Paris, France
Corresponding author E-mail: benoit.fabre@upmc.fr

The fine adjustment of pads in modern flutes is crucial to the player. Craftsmen need several years of experience to reach a point where they can do a fine and rapid adjustment of all the flute pads. Pad adjustments can have a compensating role for small geometrical defects of the flute chimney or keys. They are also expected to be efficient under severe mechanical and moisture conditions, and during several years. Many pad types are developed by instruments and pads makers to match those requirements, resulting in different inner structures, skins or fastening means. We present a simple experimental setup to measure the leakages associated with different types of flute pads. The quasi-static measurements allow us to compare the different types of pads. The different values of the acoustic resistance associated with these leakages are then used to feed an acoustic model, in order to discuss the significance of the results in terms of the acoustic response of an instrument. This acoustic response can then be compared to actual measurements of input admittances of instruments equipped with different pads.

Thu 17:40 John TYNDALL MA-S05: Instrument making and acoustics

Characterization and modelling tools for bow making – (Contributed, 000741)

F. Ablitzer[a], J.-P. Dalmont[a] and N. Dauchez[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]SUPMECA, 3, rue Fernand Hainaut, 93407 Saint Ouen Cedex, France
Corresponding author E-mail: frederic.ablitzer.etu@univ-lemans.fr

The aim of this work is to supply bow makers with dedicated characterization and simulation tools. As the possibility to tighten the bow and evaluate its behavior comes at the end of the making process, a tool helping the maker to validate conception choices earlier would be usefool. To this purpose, a model of bow taking into account prestress and geometric nonlinearity is developed. A nondestructive method for determining mechanical properties of the stick and hair is proposed. The needed equipment is affordable and easily transferable in a workshop. Once the bow properties determined, the model is able to predict the static behavior of the tightened bow and allows to calculate bow properties that are difficult to measure directly. The interest of the developed model and experimental method with regards to bow making are discussed.

Thu 18:00 John TYNDALL MA-S05: Instrument making and acoustics

The three-mass model for the classical guitar revisited – (Contributed, 000749)

B. E. Richardson, H. R. Johnson, A. D. Joslin and I. A. Perry
Cardiff University, School of Physics and Astronomy, 5 The Parade, CF24 3AA Cardiff, UK
Corresponding author E-mail: RichardsonBE@cardiff.ac.uk

Input admittance and sound-pressure response functions for the guitar show several prominent peaks in the low-frequency range. The lowest three peaks can be modelled very effectively using a coupled three-mass model describing the interaction between the lowest modes of the soundboard and back plate and the air-cavity resonance. Whilst there has been considerable qualitative or speculative discussion of the frequency placement of these modes, there have been very few quantitative studies which have attempted to identify the important acoustical features of these peaks. It is known that the frequency placement of strong peaks influences the "localï response of the played instrument, but psychoacoustical studies have shown that the "residual responseï of these peaks has a "globalï influence at frequencies above the resonances. In this study, we are using a three-mass model for the guitar coupled to a lossy string. The model generates plucked-string sounds which are then used for psychoacoustical evaluation of the relative influence of parameters such as plate mass, stiffness, damping and radiativity on the perceived sound quality of the guitar. The results of this work-in-progress will be presented at the conference.

Thu 18:20 John TYNDALL MA-S05: Instrument making and acoustics

Spectral enrichment and wall losses in trombones played at high dynamic levels – (Invited, 000754)

J. P. Chick[a], S. M. Logie[b], M. Campbell[b] and J. Gilbert[c]
[a]University of Edinburgh, School of Engineering, King's Buildings, Mayfield Road, EH9 3JL Edinburgh, UK; [b]University of Edinburgh, School of Physics and Astronomy, JCMB, King's Buildings, Mayfield Road, EH9 3JZ Edinburgh, UK; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: john.chick@ed.ac.uk

The characteristic spectral enrichment in the radiated sound of a brass instrument played at high dynamic levels is primarily a result of two closely coupled effects: the nonlinearity at the input to the tube, ie the lip aperture/mouthpiece effect; and the gradual nonlinear distortion of the wave form as it travels along the length of the instrument. In an instrument such as a trombone, which is largely comprised of cylindrical tube, the nonlinear distortion of the wave form can be dramatic, to the point of developing into a shock wave. The higher frequency components of the sound wave suffer more from viscothermal wall losses than do the lower frequency components. These losses act to damp the high frequency components to some extent. Experiments using cylindrical tubes of length and diameter representative of those of a trombone, have been carried out. The results of these experiments are compared with numerical simulations based on weakly nonlinear shock theory in an attempt to better understand the relationship between nonlinear distortion and the effect of the viscothermal losses.

Thu 18:40 John TYNDALL MA-S05: Instrument making and acoustics

Flue organ pipe operating regimes and voicing practices – (Contributed, 000814)

D. Steenbrugge
Ghent University College, Prinses Clementinalaan, 15, 9000 Gent, Belgium
Corresponding author E-mail: dirk.steenbrugge@hogent.be

A combination of certain pipe voicing parameters, including wind pressure, sets up a specific feedback cycle operating regime when the pipe is blown. It is the most important voicing adjustment. In most blowing conditions maximum energy is expected to be transferred to the acoustic field inside the pipe when the jet injects air in phase with the acoustic pressure, the phase delay on the jet then being about half a period and the pipe sounding at its fundamental passive resonance frequency. In this study the relationship between this optimum concept and voicing practices is investigated. A procedure to determine the operating regime of pipes from various registers and organs using data from in situ acoustic and flow measurements was developed. Correlations were sought with pipe scaling, pitch range and tonal architecture. Principal pipes turn out to usually operate at pressures above this theoretical optimum, and acoustic power is traded for spectral richness, leading to different voicing styles. As a general rule, voicers appear to intuitively attempt to put forth the distinctive acoustic features of the resonators. Erratic variations in operating points throughout pipe ranks were also observed, the resulting differences being more or less successfully compensated by other voicing parameters.

Thu 9:00 Pierre CHAVASSE MI-S03: Signal processing

Ultrasound material backscattered noise analysis by a duo wavelet-regression analysis – (Contributed, 000094)

F. Bettayeb
Research center on welding and control, CSC, Route de Dely Brahim, Bp:64, Cheraga, 16800 Algiers, Algeria
Corresponding author E-mail: fairouz_bettayeb@email.com

Internal material defects detection by ultrasound non destructive testing is widely used in industry, ultrasonic data are obtained from traveling waves inside the matter and captured by piezoelectric sensors. The natural inhomogeneous and anisotropy character of steel made material causes high acoustic attenuation and scattering effect. This adds complexity to data analysis. In this research we address the non linear features of back scattered ultrasonic waves from steel plates and welds.Indeed structural noise data files captured from specimens, and processed by a wavelet energy filtering approach, show significant insights into the relationship between backscattered noise and material microstructures. This algorithm along with correlation coefficients, residuals and interpolations calculations of processed ultrasonic data seems to be a well-adapted signal analysis tool for viewing material micro structural dimension scales. Experiments show a challenging 3D interface between material properties, calculations and ultrasonic wave propagation modeling. As well as they indicate a quasi linear signal energy distribution at micro structural levels. It suggests probable incidence of microstructure acoustic signatures at different energy scales of the material phases. Multi polynomial interpolations of the processed noise data exhibit an attractor shape which should involves chaos theory noise data modeling.

Thu 9:20 Pierre CHAVASSE MI-S03: Signal processing

Audio convolution by the mean of GPU: CUDA and OpenCL implementations – (Contributed, 000117)

D.A. Mauro
Laboratorio di Informatica Musicale (LIM), Dipartimento di Informatica e Comunicazione (DICo), Università degli Studi di Milano, Via Comelico 39/41, 20135 Milano, Italy
Corresponding author E-mail: mauro@dico.unimi.it

This paper focuses on the use of GPGPU (General-Purpose computing on Graphics Processing Units) for audio processing. This is a promising approach to problems where a high parallelization of tasks is desirable. Within the context of binaural spatialization we will develop a convolution engine having in mind both offline and real-time scenarios, and the support for multiple sound sources. Details on implementations and strategies used with both dominant technologies, namely CUDA and OpenCL, will be presented highlighting both advantages and issues. Comparisons between this approach and typical CPU implementations will be presented as well as between frequency (FFT) and time-domain approaches. Results will show that benefits exist in terms of execution time for a number of situations.

Thu 9:40 Pierre CHAVASSE MI-S03: Signal processing

Optimal control by transmit frequency in tissue harmonic imaging – (Contributed, 000185)

S. Ménigot and J.-M. Girault
Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

Ultrasound imaging systems usually work in open loop. The control of the system is thus a sine wave whose frequency is often fixed around two-thirds of the center frequency of the transducer in tissue harmonic imaging. However, this choice requires a knowledge of the transducer and does not take into account the medium specificities. Our aim is to seek the command which maximizes the tissue harmonic contrast. We proposed an iterative optimization algorithm that automatically saught for the parameters of the optimal control. To simplify the problem of optimal control, we looked for the optimal frequency of the command. Both experimentally and in simulation, its value did not correspond to the usual value. The contrast can be improved by 2 dB to 5 dB depending on the level of pressure. By providing a closed loop system, the system automatically proposes the optimal control without any *a priori* knowledge of the system or of the medium explored.

Thu 10:40 Pierre CHAVASSE MI-S03: Signal processing

Ultrasound contrast agents modeling using an extended Volterra model – (Contributed, 000240)

F. Sbeity[a], J.-M. Girault[a], S. Ménigot[a] and J. Charara[b]
[a]Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours; [b]Université Libanaise,
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

Harmonic imaging has historically occurred with the introduction of ultrasound contrast agents such as microbubbles. These agents, due to their nonlinear behavior, have provided a great increase in the contrast of ultrasound images. Although this modality has revolutionized the clinical practice, it still suffers from the presence of harmonics in the echo of the tissue that reduce its efficiency. One way to overcome this problem was to turn to the sub-harmonic imaging based on the reception of sub-harmonics generated by microbubbles at high pressure levels. Modeling of the signals backscattered by microbubbles was performed with nonlinear models such as Volterra series. These models have exhibited high efficiency in modeling harmonics. However, they are inadequate to model sub- and ultraharmonics. In this paper, we propose an extension of the Volterra series in order to model these sub- and ultraharmonics. Results showed that signals backscattered by the medium infused with microbubbles can be accurately represented by the derived model. The gain achieved with our method was 2.3 dB compared to the standard Volterra modeling. In the frequency domain, the spectrum of the simulated signal has described perfectly that of the microbubble.

Thu 11:00 Pierre CHAVASSE MI-S03: Signal processing

The maturity characterization of orange fruit by using high frequency ultrasonic echo pulse method – (Contributed, 000263)

I. Aboudaoud[a], B. Faiz[a], E.H. Aassif[a], A. Moudden[b], D. Izbaim[a], D. El Abassi[a] and M. Malainine[a]
[a]Univ. Ibno Zohr Faculty of science Departement of physics, BP 8106 cité Dakhla Agadir Morocco, 80350 Agadir, Morocco; [b]Ecole Supérieure de Technologie d'Agadir, B.P 33/S Agadir, Maroc, 80000 Agadir, Morocco
Corresponding author E-mail: aboudaouddriss@hotmail.fr

In this present work, our objective is to study the feasibility of the control of the maturity of orange fruit by the ultrasonic echo pulse method with immersion in water. This study relates to two varieties of orange (Navel and Mandarin) which are the most harvested particularly in the region of Souss-Massa-Drâa in Morocco. Contrary to the works already published in this field, we worked in the high frequencies by the means of a focusing transducer with 20MHz as a central frequency. By taking into account the strong attenuation of the ultrasounds in the texture of fruits and vegetables, we limited our study only to the characterization of the external layer called the flavedo characterized by its very small thickness. The use of the high frequencies will allow us a characterization of high resolution of the orange peel with a high space resolution. This control is based mainly on the measure of the ultrasonic parameters eventually velocity and attenuation in order to check the aptitude of this ultrasonic method to detect the degree of maturity of the fruit without passing by penetrometric and biochemical measurements which are mostly correlated with human perception concerning the firmness of the fruit but they are generally destructives.

Thu 11:20 Pierre CHAVASSE MI-S03: Signal processing

Quadratic approximation in focusing with linear arrays – (Contributed, 000113)

P. Cervenka
CNRS UMR 7190, UPMC (P6) Institut Jean le Rond d'Alembert, 2, place de la gare de ceinture, 78210 Saint-Cyr-L'Ecole, France
Corresponding author E-mail: pierre.cervenka@upmc.fr

Imaging systems based on linear arrays with delay-and-sum beamforming require estimating the path differences between each pixel and the array elements.

Considering the quadratic approximation, the linear part is related to the steering direction whereas the quadratic term refers to the curvature of the wavefront. The several ways for handling this approximation are presented, e.g., closest second order development for each pixel, paraxial development, Fresnel approximation, down to the Fraunhofer (linear) approximation. The domains of validity of these developments are scarcely described in the literature. They are estimated here by considering the largest error encountered on the array in the path differences. The quadratic approximation is usually considered as not enough efficient in terms of either the computation savings, or the extent of the domains of validity. It is shown that settings of practical interest can be found by optimizing the quadratic coefficient as a function of range. This procedure yields the computation saving of the paraxial approximation, still keeping quite large angular domains of validity. The solutions are conveniently displayed with general graphs where ranges are counted in array lengths, and array lengths are given in wavelength units.

Thu 13:40 Pierre CHAVASSE MI-S03: Signal processing

Empirical optimization of frequency parameters in chirp inversion imaging – (Contributed, 000273)

A. Zaylaa[a], S. Ménigot[a], J.-M. Girault[a] and J. Charara[b]
[a]Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours; [b]Université Libanaise,
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

Contrast ultrasound imaging is become a significant imaging technique for the last ten years. Physiological and pathological information are accessible thanks to microbubble injection and nonlinearity detection. To improve both resolution and penetration, frequency modulated (FM) signals called chirps combined with compression filter have been utilized by radar technology. Recent studies applied the use of chirp in harmonic imaging. However, the setup parameters of the chirp are important to enhance the microbubble nonlinearities and thus the contrast. The present study aimed to empirically optimize the harmonic energy backscattered by the microbubble through polynomial FM law. Two imaging techniques were implemented: harmonic chirp imaging (HCI) and chirp inversion imaging (CII). In simulation, the frequency parameters of chirps were saught for microbubbles of different sizes (1 μm and 2.5 μm). PII was preferable over SHI for contrast enhancement. Moreover, the use of parabolic chirps with PII was the optimal choice and optimal frequency parameters were selected manually. This work requires a lot of simulation and another advanced technique should be considered to get the optimum settings automatically.

Thu 14:00 Pierre CHAVASSE MI-S03: Signal processing

Random excitation by optimized pulse inversion in contrast harmonic imaging – (Contributed, 000275)

S. Ménigot and J.-M. Girault
Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

Over the past twenty years, in ultrasound contrast imaging, new physiological information are obtained by the detection of non-linearities generated by the microbubbles. One of the most used techniques is the pulse inversion imaging. The usual command of this system is a fixed-frequency sinus wave. An optimal choice of this command requires the knowledge of the transducer and of the medium to obtain the best CTR. However, these information are experimentally inaccessible. Our goal is to seek the command which maximizes the CTR. Among one hundred noise, we identified the one which maximized the CTR. A new suboptimal control was made from the parameters of a nonlinear autoregressive filter and from suboptimal noise. The CTR was then iteratively optimized by the method of Nelder-Mead which adjusted the filter parameters. The gain compared to the case in which we used at the optimal frequency can reach about 1 dB and 4 dB in comparison to the center frequency of the transducer. By adding a closed loop, the system automatically proposes the optimal command without any *a priori* knowledge of the system or of the medium explored and without any hypothesis about the shape of the command.

Thu 14:20 Pierre CHAVASSE MI-S03: Signal processing

Multi-scale sample entropy and recurrence plots distinguish healthy from suffering foetus – (Contributed, 000289)

I. Voicu and J.-M. Girault
Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

Currently, the assessment of the state of fetal well-being using ultrasound is a challenge in the obstetrical world. To assess the fetal well-being, parameters are derived from the fetal heart rate and fetal movements.
We estimated the fetal heart rate using a multi-sensor, multi-gate pulsed Doppler system and we propose to study the complexity of heart rate by calculating the multi-scale entropy and the parameters deduced from the recurrence plots.

The article presents a preliminary study that evaluates the relevance of complexity parameters in assessing the state of fetal well-being. Our results show that complexity parameters can distinguish healthy from suffering foetus.

Thu 14:40 Pierre CHAVASSE MI-S03: Signal processing

Ultrasound medical image deconvolution using CLEAN algorithm – (Contributed, 000290)

L.-T. Chira[a], J.-M. Girault[b], T. Mateo[b], S. Ménigot[b] and C. Rusu[c]
[a]Université François Rabelais de Tours, 10 boulevard Tonnellé, bp 3223, 37032 Tours, France; [b]Imagerie et cerveau, Hôpital Bretonneau 1 Bd Tonnelle 37044 Tours; [c]Technical University of Cluj Napoca, 15 Constantin Daicoviciu, 400020 Cluj Napoca, Romania
Corresponding author E-mail: jean-marc.girault@univ-tours.fr

The problem of reconstruction of ultrasound medical images using blind deconvolution algorithm has been recognized as one of the most important aspect in ultrasound images. The image resolution is deteriorated by many parameters such as the diffusive effect in tissues, which produce the speckle noise. We intend to implement a nonlinear algorithm based on joint use of the well known CLEAN method and the Hybrid Parametric Inverse Filtering method. This method suppose an iterative process for extracting the "brightnessï small objects presents in the image using a "dirty beamï Point Spread Function. The PSF is obtained with HYPIF algorithm, a blind technique for ultrasound medical images. The technique is applied for the 1D signals extracted from RF ultrasound images (simulated and experimental). The results are compared with Wiener filter.

Thu 15:00 Pierre CHAVASSE MI-S03: Signal processing

Power estimation of acoustical sources by an array of microphones – (Contributed, 000344)

J. Lardies, H. Ma and M. Berthillier
FEMTO-ST, Département de Mécanique Appliquée, 24 rue de l'Épitaphe, 25000 Besancon, France
Corresponding author E-mail: joseph.lardies@univ-fcomte.fr

The problem of estimating the strengths of signals arriving at an array of microphones when the arrival directions are known is addressed. The approach taken here is to assume that the signal field at the array is comprised of P independent plane-wave arrivals from known directions. In practice, of course, the directions of arrival are rarely known exactly, however this difficulty can be overcome by using the standard MUSIC (Multiple Signal Classification) algorithm, which constitutes an angular pseudo-spectrum and an indicator of directions of arrival of different signals. The problem then reduces to estimating the signal powers from each of the P directions. Five estimators are presented for power estimation of acoustical sources. The conventional beamformer, the Capon estimator, the robust Capon estimator, the least squares fit estimator of the observed cross-spectral matrix of the array and a new estimator called the covariance vector estimator. Numerical and experimental results are presented showing that the performances of the covariance vector estimator are better than other estimators.

Thu 15:20 Pierre CHAVASSE MI-S03: Signal processing

Choi-Williams time-frequency representation of acoustic signals – (Contributed, 000423)

A. Elhanaoui[a], E.H. Aassif[a] and G. Maze[b]
[a]Université IBN ZOHR, BP 28/S, Faculté des Sciences, 80000 Agadir, Morocco; [b]LOMC, IUT, Université du Havre, Place Robert Schuman, Place Robert Schuman, 76610 Le Havre, France
Corresponding author E-mail: agrgsp@yahoo.fr

This work concerns the study of acoustic signals that are backscattered by thin aluminum tubes. This study is done with the help of Choi-Williams time-frequency method by virtue of its interesting properties. This technique was chosen because it reduces the amplitude of the interferences. This can make the interpretation of time-frequency image easier. However, the resolution of time-frequency image is acceptable if the involved parameter is well chosen. As a result, the determination of longitudinal and transverse velocities of aluminum from Choi-Williams time-frequency technique reveals a good agreement with the theoretical method of proper modes as mentioned in scientific literature.

Thu 15:40 Pierre CHAVASSE MI-S03: Signal processing

Source localisation in an unknown reverberant environment using compressive sampling in the frequency domain – (Contributed, 000459)

G. Chardon and L. Daudet
Institut Langevin, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: gilles.chardon@espci.fr

We introduce a source localisation method dealing with an unknown reverberant environment. The measured acoustic field is decomposed as the sum of a diffuse field and a source field, using a priori knowledge on these field, i.e. structured sparsity deduced from the governing equations of acoustics. Simulations and experimental results in 2D domains, using greedy algorithms as well as optimisation-based methods, show that the method is robust with respect to noise and sensors localisation. Additionnaly, the density of sensors required can be lower than the Nyquist frequency. These facts make this method a interesting alternative to standard localisation methods particularly when a large number of narrowband sensors are deployed.

Thu 16:40 Pierre CHAVASSE MI-S03: Signal processing

A UAV motor denoising technique to improve localization of surrounding noisy aircrafts: proof of concept for anti-collision systems – (Contributed, 000488)

P. Marmaroli, X. Falourd and H. Lissek
Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: herve.lissek@epfl.ch

Unmanned Aerial Vehicles (UAVs) have become very affordable and small in recent years, and are increasingly used in a wide range of monitoring and surveillance applications. A major problem when operating with swarm of UAVs is the risk of mid-air collisions. Sensor technology to detect other aircrafts in order to prevent collisions currently receives a lot of attention in the research community. Therefore acoustic technologies could play an important role in anti-collision systems for small lightweight UAVs. Since most of aircrafts rely on active propulsion using propellers or jets, they emit noise which reveals their presence and position. It is therefore possible to detect the range and the bearing of other aircraft to avoid collisions without relying on active communication within the swarm. Because acoustic sensing is passive, relatively small, cheap, and low power consuming, the work is focused on the design of microphone array and its on-board processing to deliver anti-collision alerts. But tracking acoustic sources in air faces number of substantial challenges because of low signal to noise ratio of the surrounding aircrafts noises compared to the self noise of the equipped listening UAV. In this context we therefore concentrate on self-noise reduction techniques for on board microphone array processing.

Thu 17:00 Pierre CHAVASSE MI-S03: Signal processing

Interpolation of room impulse responses in 3d using compressed sensing – (Contributed, 000688)

R. Mignot[a], L. Daudet[a] and F. Ollivier[b]
[a]Institut Langevin " Ondes et Images "", 10 rue Vauquelin, 75005 Paris, France; [b]UPMC - Institut Jean Le Rond d'Alembert, 2 place de la gare de ceinture, 78210 Saint Cyr L'Ecole, France
Corresponding author E-mail: remi.mignot@espci.fr

In a room, the acoustic transfer between a source and a receiver is described by the so-called "Room Impulse Responseï, which depends on both positions and the room characteristics. According to the sampling theorem, directly measuring the full set of acoustic impulse responses within a 3D-space domain would require an unreasonably

large number of measurements. Nevertheless, considering that the acoustic wavefield is sparse in some dictionaries, the Compressed Sensing framework allows the recovery of the full wavefield with a reduced set of measurements (microphones), but raises challenging computational and memory issues. In this paper, we exhibit two sparsity assumptions of the wavefield and we derive two practical algorithms for the wavefield estimation. The first one takes advantage of the Modal Theory for the sampling of the Room Impulse Responses in low frequencies (sparsity in frequency), and the second one exploits the Image Source Method for the interpolation of the early reflections (sparsity in time). These two complementary approaches are validated both by numerical and experimental measurements using a 120-microphone 3D array, and results are given as a function of the number of microphones.

Thu 17:20 Pierre CHAVASSE MI-S03: Signal processing

A normalization method for life-time prediction of composite materials – (Contributed, 000708)

M. Darwiche[a], G. Bousaleh[b], M. Feuilloy[c], D. Schang[c] and R. El Guerjouma[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Université Libanaise, Institut Universitaire de Technologie, 1600 Saida, Lebanon; [c]Ecole Supérieure d'Electronique de l'Ouest, 4, rue Merlet de la Boulaye, BP: 30926, 49009 Angers Cedex 01
Corresponding author E-mail: mohamad.darwiche@eseo.fr

The objective of this study is to predict the rupture of specimens of composite materials. During a creep experiment, with traction method, the specimens have different time of rupture (130 seconds, 159 seconds, 539 seconds...). The acoustic activity during the test involves three phases (phase 1, phase 2 and phase 3). When we apply our normalization method (cumulative acoustic emission vs. time), we can notice that all tests look very similar, and we can see that there is a proportionality relation between the transition time t_m (phase 1 -> phase 2) and the time of rupture t_r. The technique works significantly better than other recent works. To validate this technique we have achieved a K-cross validation, on 7 specimens. The proportionality between t_m and t_r of the 7-cross validations had a mean value of 0.1218 and a standard deviation of 0.0018. The mean errors that we got is about 8.58% (± 4.65). It is a very important result in life-time prediction.

Thu 17:40 Pierre CHAVASSE MI-S03: Signal processing

Identification of circumferential acoustic waves propagating around the tube by multiresolution analysis and time-frequency representation – (Contributed, 000721)

M. Laaboubi[a], E.H. Aassif[a], R. Latif[b], G. Maze[c], A. Dliou[a], A. Elhanaoui[a] and Y. Nahraoui[b]
[a]Université Ibn Zohr, Faculté des Sciences Laboratoire LMTI, Dpt de Physique B.P 8106 Cité Dakhla, 80000 Agadir, Morocco; [b]ESSI ENSA Ibn Zohr University, ENSA BP 1136, 80000 Agadir, Morocco; [c]LOMC, IUT, Université du Havre, Place Robert Schuman, Place Robert Schuman, 76610 Le Havre, France
Corresponding author E-mail: laaboubi@gmail.com

This paper describes a technique based on Multiresolution Analysis (MRA) of the wavelet transform. This technique is applied for decomposition of the original acoustic signal backscattered by a thin tube. The Multiresolution technique was used as a tool to filter the wave modes contained in the original signal. The time-frequency representation using the Smoothed Pseudo-Wigner-Ville (SPWV) distribution is applied on the decomposed acoustic signal. The results obtained show that this technique of the Multiresolution analysis can identify not only single circumferential wave mode but also multimode effectively. This methodology permits to obtain the interesting results.

Thu 18:00 Pierre CHAVASSE MI-S03: Signal processing

Noise-robust speech recognition system based on power spectral subtraction with a geometric approach – (Contributed, 000794)

J. Cardenas[a], E. Castillo[b] and J. Meng[b]
[a]Fac. Ing. Eléctrica, Universidad Central de Las Villas, Carr. Camajuani KM 5 1/2, 50100 Santa Clara, Cuba; [b]University of New Brunswick, Room C119 Head Hall, 15 Dineen Drive, Fredericton, Canada E3B 5A3
Corresponding author E-mail: julian@uclv.edu.cu

Power spectral subtraction (PSS) is a technique used to improve the signal-to-noise ratio in many applications in the recent years. This paper reports a successful application of a geometric-based PSS algorithm to improve the performance of automatic speech recognition under noisy conditions. The selected algorithm performs significantly better than other traditional spectral subtraction algorithms in the presence of low SNRs with low computational cost for speech enhancement. The performance contribution of the algorithm was assessed with CMU SPHINX-III speech recognition system using TIDIGITS speech corpus. Data was corrupted with seven noise types taken from the NOIZEUS database under seven different noise conditions (SNRs from -5 dB to 20 dB) for clean and multi-condition training setups. After extensive testing, results demonstrate that the selected algorithm is capable of improving recognition performance by 15% over the baseline approach at 0dB SNR when multicondition training is used. The algorithm is particularly robust for noisy environments with low SNRs such as those present in car and airports. The algorithm is suitable to enhance the performance of speech recognition systems in mobile applications.

Thu 18:20 Pierre CHAVASSE MI-S03: Signal processing

Alleviation of uniform ambient noise in underwater acoustic communication receivers using spectral subtraction – (Contributed, 000836)

S. Kamal, S. Menonkattil Hariharan and S. P.R. Pillai
Department of Electronics, Cochin University of Science & Technology, 682022 Ernakulam, India
Corresponding author E-mail: surajkamal@gmail.com

The acoustic medium of the ocean is exceedingly turbid with a multitude of simultaneously active noise sources like water currents, shipping noise, drilling, construction, off-shore oil rigs, marine life, shore waves and other hydrodynamic activities. These inherent mechanisms produces spectrally overlapping acoustic waves that radiate into the depths of the ocean, and the superposition of these signals from across large area of the sea surface cumulatively constitutes a spatially homogeneous uniform ambient noise field. It is often difficult to utilize such a cluttered and exacerbated acoustic channel for communication or other observational purposes. In this paper a method based on spectral subtraction, for alleviating the uniform acoustic ambient noise is presented. Spectral subtraction is a technique used to retrieve the power spectrum of a non-stationary signal of interest in a uniform noise field by subtracting an estimated average of noise spectrum from the originally observed signal spectrum. The noise spectrum is estimated while the signal of interest is absent or silent and will cyclically updated in a periodic manner at intentionally put blanking periods in communication signals. The method can be used with acoustic receiver front ends as a preconditioning stage for improving the overall signal quality.

Thu 18:40 Pierre CHAVASSE MI-S03: Signal processing

High-resolution deconvolution applied to non destructive testing – (Contributed, 000843)

E. Carcreff[a,b], S. Bourguignon[b], J. Idier[b] and L. Simon[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]IRCCyN, Ecole centrale de Nantes, 1 rue de la Noë, 44321 Nantes, France
Corresponding author E-mail: ewen.carcreff@irccyn.ec-nantes.fr

Ultrasonic non destructive testing consists in emitting an acoustic wave in a material and then locating the reflected echoes produced by impedance changes, due to flaws or medium discontinuities. In some cases, echoes can overlap in the A-scan (typically for layered materials), yielding a difficult analysis: techniques such as matched filtering may fail and advanced techniques are necessary to locate the echoes. Sparse deconvolution methods have been recently applied to such problems. The challenge is to estimate a sparse sequence composed by the echoes locations (times of flight) and amplitudes. Usually, deconvolution is addressed by considering restoration at the acquisition sampling scale. This limits the precision of the spike location and may cause spike splitting. In this paper, we consider a high-resolution formulation of the deconvolution problem with a more precise restoration grid. To do so, we extend the approach proposed by Soussen et al. (IEEE Trans. Signal. Process, 2011) which minimizes a data misfit least-square criterion, penalized by a L0-norm term. The method has been tested on synthetic and experimental data. Compared to classical deconvolution algorithms, results show a better estimation of times of flight for a small increase of the computation time.

Thu 9:00 Yves ROCARD NV-S01: Smart vibroacoustics

Design and optimization of a semi-active metacomposite for the control of acoustic interaction – (Invited, 000375)

M. Collet[a], M. Ouisse[a], R. Ohayon[b] and M. Ichchou[c]
[a]Département de Mécanique Appliquée R. Chaléat, 24 chemin de l'Epitaphe - 25000 Besançon; [b]Laboratoire de Mécanique des Structures et des Systèmes Couplés, 292, rue Saint Martin 75141 Paris Cedex 03; [c]Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: morvan.ouisse@univ-fcomte.fr

Based on recent works on application of Floquet-Bloch theorem to periodical mechanical systems including frequency-dependent parameters, we propose in this paper an extension to vibroacoustic behavior analysis of smart structures. The objective is to optimize electronic circuits used to shunt some piezoelectric patches distributed on the structure, in order to minimize the acoustic radiation of the structure. The proposed approach is based on the computation of the multi-modal wave dispersion curves into the whole first Brillouin zone of the structure, and associated propagation characteristics in the acoustic fluid. The impedance of the shunt circuit is then optimized in order to render the acoustic waves evanescent.

Thu 9:20 Yves ROCARD NV-S01: Smart vibroacoustics

A reduced global semi-active vibroacoustic control strategy, statement and preliminary validations: – (Invited, 000845)

T. Loukil, O. Bareille and M. Ichchou
Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: thamina.loukil@ec-lyon.fr

In this talk, a control strategy is presented and numerically tested. This strategy aims to achieve the potential performance of fully active systems with a reduced energy supply. These energy needs are expected to be comparable to the power demand of semi-active systems, while system performance is intended to be comparable to that of a fully active configuration. The underlying strategy is called ïglobal semi-active controlï. This control approach results from an energy investigation based on management of the optimal control process. Energy management encompasses storage and convenient restitution. The proposed strategy monitors a given active law without any external energy supply by considering purely dissipative and energy-demanding phases. Such a control law is offered here along with an analysis of its properties. A suboptimal form, well adapted for practical implementation steps, is also given. Moreover, a number of numerical experiments are proposed in order to validate test findings.

Thu 9:40 Yves ROCARD NV-S01: Smart vibroacoustics

Auxetic transverse isotropic foams: from experimental efficiency to model correlation – (Invited, 000546)

M. Gravade[a], M. Ouisse[a], M. Collet[a], F. Scarpa[b], M. Bianchi[b] and M. Ichchou[c]
[a]Département de Mécanique Appliquée R. Chaléat, 24 chemin de l'Epitaphe - 25000 Besançon; [b]The University of Bristol, Department of Aerospace Engineering, Advanced Composites Centre for Innovation and Science, BS81TR Bristol, UK; [c]Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: morvan.ouisse@univ-fcomte.fr

The wide use of porous materials in vibro-acoustics led up to study a novel material that can exhibit interesting behaviours for vibro-acoustics applications, and possibly improve the efficiency of performances. This paper is focused on the analysis of absorbing foams, which are rendered auxetic (Negative Poisson's ratio) thanks to a specific forming process. It first illustrates the efficiency of auxetic foams compared to melamine samples using experimental results. Then a study is conducted in order to improve the identification of mechanical and coupling modelling parameters for the considered auxetic transverse isotropic foam. The method associates a preliminary parameters sensitivity analysis with an optimization study. A global sensitivity analysis of the outputs of interest is performed using the Fast technique in order to estimate the first-order and total effects of the numerous parameters of the model. The results of the analysis are then used to perform the optimal identification of the parameters by readjusting finite elements analyses results over experimental data. The results and benefits of the preliminary use of parameters sensitivity analysis associated with optimization are finally presented.

Thu 9:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Non contact surface wave measurements for the evaluation of concrete submitted to tidal solicitation – (Contributed, 000810)

O. Abraham[a], F. Benmeddour[b], G. Villain[a], M. Choinska[c] and O. Durand[a]
[a]IFSTTAR, MACS, CS4, Rout de Bouaye, 44341 Bouguenais, France; [b]IEMN, Le Mont Houy, F-59313 Valenciennes, France; [c]CNRS 6183 Université de Nantes et Saint Nazaire, 2 rue de la Houssinière, BP 92208, 44322 Saint Nazaire, France
Corresponding author E-mail: Odile.Abraham@ifsttar.fr

Within the FUI project Mareo several NDT techniques have been tested to evaluate the properties of repaired concrete beam under tidal solicitation. Surface waves are a good candidate to non destructively assess the mechanical properties of cover concrete (the first centimetres). They can provide information on gradient of properties in the first few centimetres if frequencies between 40kHz up to 150kHz are used. In this paper we follow in situ with a laser interferometer robot in this frequency range the evolution of cover concrete properties at three terms separated by several months. This information is confronted with measurements performed on concrete slabs experiencing accelerated tidal solicitations in lab and to the other NDT techniques.

Thu 9:20 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Polymer concrete damage characterization using coda wave interferometry (CWI) and linear resonance – (Contributed, 000605)

S. Toumi[a], M. Bentahar[a], C. Mechri[a], F. Boubenider[b] and R. El Guerjouma[a]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]University of sciences and technology Houari Boumedienne, Laboratory of physics of materials B.P. 32 El Allia- Bab Ezzouar, 16111 Algiers, Algeria
Corresponding author E-mail: charfeddine.mechri@univ-lemans.fr

This work aims to develop an experimental method, which is able to detect the presence of damage in mesoscopic materials using multi-scattered acoustic waves. In particular, we use the coda wave interferometry (CWI) technique in order to detect and locate damage in polymer concrete samples. Concrete samples are locally damaged using quasi-static bending tests. In order to characterize damage, we have experimentally determined nonlinear threshold at resonance (bending resonance modes). Afterward, CWI is applied in the absence and in the presence of the generated linear resonances. Experiments show that CWI doesn't detect any damage even when the excitation level is increased. This result has been confirmed when the acoustic path is parallel and perpendicular to the created bending. However, the presence of linear resonances revealed to be interesting. Indeed, at the same drive levels when CWI is applied simultaneously with the linear resonance, we notice an important sensitivity to damage. Finally, by tracking the effect of damage on the recorded signals along the damaged samples, the proposed original combination offers the possibility to locate damage.

Thu 9:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Probing materials damage at various depths by use of Time Reversal Elastic Nonlinearity Diagnostic: Application to concrete – (Contributed, 000415)

C. Payan[a], T.J. Ulrich[b], P.-Y. Le Bas[c] and M. Guimaraes[d]
[a]Aix-Marseille Univ, LCND, IUT Aix en Provence, 413 Av. Gaston Berger, 13100 Aix En Provence, France; [b]Geophysics Group, Los Alamos National Laboratory, Los Alamos, Los Alamos (nm), 87544, USA; [c]Earth and Environmental Sciences, Los Alamos National Laboratory, MS D443, Los Alamos, NM 87545, USA; [d]Electrical Power Research Institute, Charlotte, Charlotte, 28262, USA
Corresponding author E-mail: cedric.payan@univ-amu.fr

Time Reversal Elastic Nonlinearity Diagnostic (TREND) is based on the use of time reversal to focus energy at a prescribed location. This focused elastic wave energy is then analyzed for nonlinear frequency content. By varying the frequency content of the focused waveforms, the technique can be used to probe different depths relative to the surface, i.e., the TREND will probe the surface and penetrate to a depth defined by the wavelength of the focused waves. We show the validity of this concept by comparing the results obtained from nonlinear resonant ultrasound spectroscopy and the present results in the presence of homogeneously diffused damage in concrete.

Thu 10:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Quantitative linear and nonlinear resonant inspection techniques for characterizing thermal damage in concrete – (Contributed, 000414)

C. Payan[a], T.J. Ulrich[b], P.-Y. Le Bas[c] and M. Guimaraes[d]
[a]Aix-Marseille Univ, LCND, IUT Aix en Provence, 413 Av. Gaston Berger, 13100 Aix En Provence, France; [b]Geophysics Group, Los Alamos National Laboratory, Los Alamos, Los Alamos (nm), 87544, USA; [c]Earth and Environmental Sciences, Los Alamos National Laboratory, MS D443, Los Alamos, NM 87545, USA; [d]Electrical Power Research Institute, Charlotte, Charlotte, 28262, USA
Corresponding author E-mail: cedric.payan@univ-amu.fr

In the context of license renewal in the field of nuclear energy, maintaining in service and re-qualifying existing concrete structures for ten years is a great challenge. The integrity of concrete in the concrete pedestal and biological shield wall in nuclear plants remains unknown. These structures have been subjected to radiation and medium temperature for a long period of time. This paper aims at providing some quantitative information related to the degree of micro-cracking of concrete and cement based materials in the presence of thermal damage. We develop a methodology based on linear resonant ultrasound spectroscopy, numerical simulations and nonlinear resonant ultrasound spectroscopy to get quantitative values of nonlinearity. We show the high sensitivity of derived nonlinearity to thermal damage and its correlation with the evolution of concrete microstructure.

Thu 11:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Locating weak changes in a multiple scattering environment – (Contributed, 000766)

T. Planes[a], E. Larose[a] and V. Rossetto[b]
[a]ISTerre, 1381, rue de la piscine, 38400 Saint Martin D'Hères, France; [b]LPMMC - CNRS, 25, avenue des martyrs, 38000 Grenoble, France
Corresponding author E-mail: vincent.rossetto@grenoble.cnrs.fr

We present an imaging technique allowing to locate a weak perturbation appearing in a multiple scattering environment. This technique is based on the direct dependence in space and time of the coda (diffuse waves) decorrelation resulting from the apparition of an extra scatterer, which one wishes to image. The inverse problem solution - the location and scattering cross section of the defect - is obtained using a maximum likelihood computation. The LOCADIFF technique has been applied to locate a millimeter change in concrete using ultrasounds with a precision of the order of one centimeter. The size of the defect is comparable to the size of the heterogeneities constituting the sample.

Thu 11:20 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Flaw detection on Inconel600® using separation of single and multiple scattering contributions – (Contributed, 000304)

S. Shahjahan[a], A. Aubry[b], F. Rupin[a], B. Chassignole[a] and A. Derode[b]
[a]EDF R&D, Site des Renardières, Avenue des Renardières - Ecuelle, 77818 Moret Sur Loing, France; [b]Institut Langevin, 10, rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: sharfine.shahjahan@edf.fr

Flaw detection using ultrasonic non destructive testing on coarse grain steels commonly found in nuclear power plants is disturbed by a high backscattered noise. This leads to a decrease of the detection capabilities of common ultrasonic testing techniques, particularly at high frequencies and large depths for which multiple scattering dominates. Recent studies have shown that the contribution of single scattering could be extracted from multiple scattering in complex medium. These results were obtained on a model random medium made of parallel steel rods immersed in water. They showed that the ability to detect a target could be significantly increased using a specific filtering method, based on matrix properties, in supplement with the D.O.R.T. method. In this work, this new method is now applied to real materials. Experimental results on a nickel based alloy (Inconel600®) mock-up exhibiting manufactured flaws are presented and compared to other detection techniques. The experimental set-up uses a 64-element ultrasonic array, around 3 MHz. Despite a high backscattering noise due to multiple scattering, the first results show a dramatic improvement of the detection performances.

Thu 11:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Ultrasonic imaging of bubble motion in a fiber preform – (Contributed, 000328)

N. Samet, P. Marechal and H. Duflo
Laboratoire Ondes et Milieux Complexes,
Corresponding author E-mail: samet_naim@yahoo.ca

During the Resin Transfer Molding (RTM) process, bubbles can appear and move between fiber strands and fiber folds. In this study, a monitoring method for the size and velocity of air bubbles using an ultrasonic phased array transducer is proposed. This method is tested in a flow of known viscous silicone oil along a sample of fiber preform. By ultrasonic imaging the fiber preform immersed in a viscous flow, a position-time map (xfl, t) is obtained for each acquisition date tacq. These data could be converted to (xfl, z, tacq) data. The bubble motion is extracted from the raw data by separation of the static component from the dynamic part of the signal. As a result, a modified C-scan is obtained and both the instantaneous position and velocity of a bubble could be extracted in the (x, z) plane. Through these measures, the evolution of the bubbles is related to the processes that generate them in order to consider improvements to the RTM technique.

Thu 12:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Comparison of ultrasonic reflectometry and FTIR analysis for thermal ageing effect detection for paint films on steel plates – (Contributed, 000791)

F. Augereau[a], X. Zhang[a], D. Laux[a], G. Despaux[a], E. Leclezio[a], B. Fayolle[b], Y. Zahra[b] and M. Kuntz[c]
[a]Université Montpellier 2 - IES - UMR CNRS 5214, place Eugene Bataillon, cc 082, 34095 Montpellier, France; [b]ENSAM Paristech, 151 boulevard de l'hopital, 73013 Paris, France; [c]EDF R&D, Material & Mechanics of Component Dpt, Site des Renardières, 77818 Moret Sur Loing, France
Corresponding author E-mail: franck.augereau@ies.univ-montp2.fr

The aim of this experimental work is to provide a non destructive evaluation tool for quality control on paint films used for industrial purpose after deposition and in operation. The most sensitive conditions have to be found for ultrasonic inspection and the measured acoustic parameters have also to be linked to the state of the complex chemical structure of polymers. Ultrasonic reflectometry is tested to investigate the thermal ageing of epoxy coatings. As function of frequency and incident angle, the most sensitive modes have been identified from simulation and validated by experiments using an ultrasonic reflection goniometer system working around 5 MHz. Scanning Acoustic Microscopy has been complementary used to check the bonding quality and the layer homogeneity. The effect of local variations of the coating thickness on the sensitivity of this acoustic reflection method is presented as well as acoustic beam diffraction limitation. Next, these $100\mu m$ thick paint films on steel plates have been submitted to thermal ageing tests up to 110°C for several weeks. Evolutions of the acoustic angular reflection coefficient versus exposure time are presented with the corresponding IR spectra variations to compare the chemical coating oxidation kinetics with the sensitivity of ultrasounds to elastic properties.

Thu 13:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Ultrasonic modeling of a viscoelastic homogeneous plate – (Contributed, 000165)

A. El Mouhtadi, J. Duclos and H. Duflo
Laboratoire Ondes et Milieux Complexes,
Corresponding author E-mail: abdelhak.el.mouhtadi@gmail.com

An ultrasonic method for determination of acoustical and geometrical properties of a viscoelastic plate immersed in a known fluid (water) is presented. The method utilizes plane longitudinal waves that are normally incident upon a homogeneous plate with attenuation obeying a frequency power law and dispersion described by Szabo's model. It requires only the knowledge of the fluid properties and recording of two chirps: one without and one with the specimen inserted between the transmitting and receiving transducers. The transmission coefficient of the plate is measured and compared to the predicted one, in which the diffraction of waves emitted by the transducer is taken into account. An inverse scheme based on a nonlinear least squares algorithm allows then simultaneous determination of the plate thickness, density, attenuation (longitudinal) and phase velocity at a given frequency. The technique involves an estimation of standard errors of parameter estimates. An example is given and discussed for a Plexiglas plate. It is shown that thickness and velocity are estimated with a good accuracy (10^{-3}). Density is estimated also with a reasonable accuracy (10^{-2}), whereas estimated attenuation is less precise.

Thu 14:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Non-destructive characterization of stiffness profile in a solid material – (Contributed, 000759)

T. Tonteri, A. Salmi and E. Haeggström
University of Helsinki,
Corresponding author E-mail: tuomas.tonteri@helsinki.fi

We present work on developing a non-destructive test of stiffness, which could find use in wear evaluation and production quality control of parts, coating and materials. For example characterization of surface corrosion of metals and quality control of functionally graded materials.
We explore a technique, which generates a virtual ultrasound source inside a sample. We measure the sonic time-of-flight (virtual source-receiver) as the virtual source probes increasingly deep into the sample. From this time-of-flight data the sound velocity inside the sample is reconstructed as a function depth. This allows the stiffness profile of the sample to be determined.

In this presentation we show the result of experiments.

Thu 14:20 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Compared performances of Levenberg-Marquardt-like methods vs Genetic Algorithm ones for elastic constants evaluation of orthotropic materials in a non principal coordinate-system – (Contributed, 000574)

P. Guy[a], T. Monnier[a], P.-A. Bodian[a] and B. Chassignole[b]
[a]Matériaux, ingénierie et sciences, Bâtiment Blaise Pascal 7, avenue Jean Capelle 69621 Villeurbanne Cedex; [b]EDF R&D, Site des Renardières, Avenue des Renardières - Ecuelle, 77818 Moret Sur Loing, France
Corresponding author E-mail: philippe.guy@insa-lyon.fr

The evaluation of the elastic properties of an orthotropic material has widely been studied and reported in many papers. In the case of composite materials the principle symmetry axes correspond to those of the sample, and nine constants have to be determined. But in the case of anisotropic polycristals, such as austenitic stainless steel welds, it is not the always the case. Then, the characterization of the elastic properties of the material from time of ultrasonic velocities measurement requires to recover the nine elastic constants allowing to express the stiffness tensor in the material's principal coordinate system but also the three Euler angles related to the sample's coordinate system with respect to the materials one. Moreover, the complexity in the inversion process increases and classical algorithms are often trapped by local minima of the objective function. In this paper, the performances of a classical local inversion algorithm will be compared, on simulated data, with the ones of a Genetic Algorithm. The influence of several parameters, such as noise or initialisation set will be studied and discussed.

Thu 14:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Modelling of the ultrasonic propagation in polycrystalline materials – (Contributed, 000188)

L. Ganjehi, V. Dorval and F. Jenson
Commissariat à l'énergie atomique, Centre de Saclay - PC120, 91191 Gif-Sur-Yvette, France
Corresponding author E-mail: lili.ganjehi@cea.fr

In some polycrystalline materials, ultrasonic non destructive testing is affected by structural noise and attenuation. Those phenomena can cause significant loss in detection performances. Thus, the presence of a microstructure is a limiting factor of ultrasonic inspection capabilities and it must be accounted for when designing new NDE methods. Modelling work has been underway at CEA-LIST in the software CIVA to describe attenuation, structural noise and beam distortions appearing when a wave propagates in a heterogeneous medium such as a polycrystalline material. The objective is to develop new simulation tools based on metallurgical data input. To achieve this goal, a theoretical model relating ultrasonic scattering to properties of the microstructure and its integration to existing algorithms, allowing us to compute structural noise and attenuation from material properties is proposed. Further numerical study and comparisons with experimental results have been performed to study the influence of the type of structure (simple or duplex), the shape (equiaxed or elongated) and the size of grains.

Thu 15:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

An analytical model for the scattering of guided waves by partly through-thickness cavities with irregular shapes in 3D – (Contributed, 000448)

L. Moreau[a], M. Caleap[b], A. Velichko[b] and P.D. Wilcox[b]
[a]UPMC CNRS LIP, 15 rue de l'école de médecine, 75006 Paris, France; [b]University of Bristol, Queen's Building, University Walk, BS81TR Bristol, UK
Corresponding author E-mail: ludovic.moreau@upmc.fr

This paper presents an analytical model for the three-dimensional scattering of Lamb and SH waves by a partly through-thickness, flat-bottomed cavity with an irregular shape. In this model, both the scattered field and the standing field in the thinner plate beneath the cavity are decomposed on the basis of Lamb and SH waves, by including propagating and evanescent modes. The amplitude of the modes is calculated after writing the nullity of the total stress at the boundary of the cavity, and the continuity of the stress and displacement vectors under the cavity. In the boundary conditions, the functions depend on the through-thickness coordinate, z, and on the angular coordinate, θ, because the cavity is not circular. This is dealt with by projecting the z-dependent functions onto the basis of the guided waves displacements vectors, and by expanding the θ-dependent functions in Fourier series.

Example results are presented for the scattering of the S0, SH0 and A0 modes by elliptical cavities of varying depth, and the scattering of the S0 mode by a cavity with an arbitrary shape. Validation is made by comparison with a finite element model.

Thu 15:20 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

3D modelling of Rayleigh wave acoustic emission from a crack under stress – (Contributed, 000593)

W. Ben Khalifa[a], K. Jezzine[a] and S. Grondel[b]
[a]CEA-LIST, Bâtiment 611 - Point Courrier 120, 91191 Gif-Sur-Yvette Cedex, France; [b]IEMN-DOAE, Université de Valenciennes et du Hainaut Cambrésis, Le Mont Houy, 59313 Valenciennes Cedex 9, France
Corresponding author E-mail: warida.ben-khalifa@cea.fr

Acoustic emission (AE) is a non-destructive testing method used in many industrial applications (testing for leaks, or monitoring weld quality, etcoe) for the examination of large structures subjected to various stresses (e.g. mechanical loading) in different domains (aerospace, pressure-vessel industries in general, etc...). The energy released by a defect under stress can propagate as guided waves in thin structures or as surface Rayleigh waves in thick ones. A limited number of sensors are needed to monitor large structure placed at various positions. Then, AE-data analysis is used to calculate the spatial location of the signal origin by using the signal arrival times at a number of sensors. The French Atomic Energy Commission is engaged in the development of a tool for simulating AE examinations. These tools are based on specific models for the AE sources, for the propagation of guided or Rayleigh waves and for the behavior of AE sensors. Here, the coupling of a fracture mechanics based model for AE source model and Green functions of Rayleigh wave is achieved through an integral formulation relying on the elastodynamic reciprocity principle. Predictions computed with this three dimensional model are compared to results from the literature for validation purpose.

Thu 15:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Modeling of the interaction of an acoustic wave with immersed targets for telemetry of complex structures – (Contributed, 000647)

B. Lu[a,b], M. Darmon[a], C. Potel[b], L. Fradkin[c] and S. Chatillon[a]
[a]CEA, LIST, CEA Saclay, Point Courrier 120, 91191 Gif-Sur-Yvette Cedex, France, Metropolitan; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Sound Mathematics Ltd., 11 Mulberry Close, CB4 2AS Cambridge, UK
Corresponding author E-mail: michel.darmon@cea.fr

This study is part of the development of simulation tools for ultrasonic telemetry. Telemetry is a technique chosen for monitoring sodium-cooled fast reactors, which consists in locating various reactor structures using an ultrasonic inspection performed by immersion. In order to model the interaction between the acoustic wave and the immersed structures, classical diffraction models have been firstly evaluated for rigid structures, including the geometrical theory of diffraction (GTD) and the Kirchhoff approximation (KA). These two approaches appear to be complementary. Combining them so as to retain only their advantages, we have developed the so-called refined KA

based on the physical theory of diffraction (PTD). The refined KA provides an improvement of the prediction in the near field of a rigid scatterer. To deal with the scattering from a finite impedance target more representative of the reactor structures, the initial (non refined) KA model is then extended. The obtained model, the so-called "generalï KA model, is compared to a reference model and provides a satisfactory solution for the application to telemetry. Finally, a complete simulation tool for telemetry is built by coupling this general KA diffraction model with a stochastic model developed for wave propagation in inhomogeneous media as sodium.

Thu 16:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Structural noise and coherent backscattering modelled with the ATHENA 2D finite elements code – (Contributed, 000306)

S. Shahjahan[a], F. Rupin[a], T. Fouquet[b], A. Aubry[c] and A. Derode[c]
[a]EDF R&D, Site des Renardières, Avenue des Renardières - Ecuelle, 77818 Moret Sur Loing, France; [b]EDF R&D, 1, Avenue du Général de Gaulle, 92141 Clamart, France; [c]Institut Langevin, 10, rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: sharfine.shahjahan@edf.fr

The ability to detect and characterize flaws is a key element in the structural integrity and safety program of nuclear operators. Ultrasonic propagation in coarse grain steels is hampered by ultrasonic wave attenuation and high backscattered noise leading to a decrease of the detection and characterisation capabilities of common ultrasonic testing techniques. Nevertheless, this structural noise can be considered as a fingerprint of the material as it contains information about its microstructure. Accurate interpretation of experimental data necessitates an accurate comprehension of complex phenomena that occurs in multiple scattering media and thus robust scattering models. In particular, numerical models can offer the opportunity to realise parametric studies on controlled microstructures. However, the ability of the model to simulate the propagation in complex media has to be validated. In this study, the finite element code ATHENA 2D developed by EDF R&D is coupled with a Voronoï tessellation description of the medium. Two different microstructural descriptions of a statistically isotropic bulk material were simulated. The structural noise was characterised by observing the coherent backscattering enhancement (a typical signature of multiple scattering), and by the singular values of the response matrix of the medium. These results were compared to experimental data carried out on nickel based alloys (Inconel 600®).

Thu 17:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

A complete FE simulation tools for NDT inspections with piezoelectric transducers – (Contributed, 000637)

S. Imperiale[a,b], S. Marmorat[a,b], N. Leymarie[a] and S. Chatillon[a]
[a]CEA LIST, Centre de Saclay - point courrier 120, 91191 Gif-Sur-Yvette, France; [b]POEMS, INRIA Rocquencourt, 78153 Le Chesnay, France
Corresponding author E-mail: nicolas.leymarie@cea.fr

An ultrasonic inspection system involves the generation, propagation and reception of short transient signals. Piezoelectric transducers and particularly phased arrays are increasingly used in ultrasonic Non Destructive Testing (NDT) because of their ability to focus or deflect an ultrasonic beam in parts of complex geometries. To accurately model the sensitivity in transmission and reception of such sensors, a transient Finite Element (FE) model has been developed including not only piezoelectric effects but also all electrical elements such as pulser/receiver system and cabling. A particular attention is devoted to the different boundary conditions used to model the emission and reception regimes of the sensor. The definition of the inspection domain is made easier by a decomposition domain technique allowing, in the same time, local time stepping and efficient absorbing layers to optimize calculation cost. In order to illustrate all the capabilities of this simulation tool, several cases of NDT inspections are then presented through the analysis of the ultrasonic beam snapshots and the electrical signal read on the receiver.

Thu 17:20 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Investigation of ultrasonic phased array inspection of a planar crack using finite element method – (Contributed, 000797)

M. Mardani Kharat, S. Sodagar and G.R. Rashed
Petroleum University of Technology, Abadan Institute of Technology, North Bovardeh, Postal code 63165, 0 Abadan, Iran
Corresponding author E-mail: sodagar@mie.utoronto.ca

The characteristics of the ultrasonic field radiated by a linear phased array transducer and the echo information of the inspected area are the main basis of designing a phased array inspection system. In this paper, a theoretical investigation is accomplished on the ultrasonic wave diffraction using the ultrasonic phased array method for evaluation of the planar cracks. For this purpose, the ultrasonic wave field resulting from a phased array transducer and its interaction with the planar crack is modelled using finite element method. The modelling results are employed to study the parameters affecting on the behaviour of the reflected and diffracted waves. To investigate reliability and efficacy of the proposed approach, phased array numerical results are compared with the experimental results.

Thu 17:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Non Destructive Testing of sandwich composites: adhesion defects evaluation; Experimental and Finite Element Method simulation comparison – (Contributed, 000337)

E.B. Ndiaye and H. Duflo
Laboratoire Ondes et Milieux Complexes,
Corresponding author E-mail: elzobarz@hotmail.com

Control and detection of defects like disbond and delamination in sandwich composite material is important today in aerospace industry. For experimental investigation, disbonding was introduced at different locations in sandwich composite by insertion of a Teflon film between honeycomb and the glue film, or by suppression of glue on small area (before curing process). The A0 Lamb mode was excited close to 100kHz frequency. The transmitted and reflected wave signals were detected by velocimetry laser after interacting with the structure, and the boundaries of the honeycomb. A Finite Element Method simulation is also computed to simulate behavior of the Lamb wave in case of disbond area. Good correlation between the experimental and FEM simulation results was observed. The results demonstrate the effectiveness of Lamb waves to detect delamination or disbonding in sandwich composite material.

Thu 18:00 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Comparison of different approaches in characterization of impact defects of composite plates – (Contributed, 000342)

J. Liu and N. F. Declercq
Georgia Tech - CNRS, Metz Technopôle 2-3 rue Marconi 57070 Metz
Corresponding author E-mail: benjamin.jf.liu@gmail.com

Composite plate materials are widely used in almost all branches of modern industries and everyday life. Characterization of impact defects of these composite plates is of great interest in the quality control and safety monitoring. A variety of nondestructive methods are available for this purpose; immersion (water-coupled) ultrasonic testing is one of them and is known for its high reliability and efficiency.
In this paper, several immersion ultrasonic approaches are compared for their application to characterize impact damage of carbon/epoxy plates. Two sample plates with damage caused by controlled impact are tested. Three testing configurations are discussed and several time-domain and frequency-domain data processing methods are applied. The comparison of the results shows that with an optimized combination of testing configuration, transducer and frequency selection and data processing methods, the defects can be more accurately and easily characterized than conventional ways.

Thu 18:20 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Issues concerning using mode conversion of guided waves to size defects in plates – (Contributed, 000608)

P. McKeon[a], S. Yaacoubi[b], N. F. Declercq[a] and S. Ramadan[b]
[a]UMI Georgia Tech - CNRS 2958, Metz Technopole, 2 rue Marconi, 57070 Metz, France; [b]Institut de Soudure, 4 boulevard Henri Becquerel, 57970 Yutz, France
Corresponding author E-mail: peter.mckeon@gatech.edu

Lamb waves have been used for damage detection in plates by measuring what amounts to transmission and mode conversion coefficients. These coefficients are indicative of the size of the defect, and relationships can be measured via numerical simulation. When size constraints do not allow for the modes to separate in time, the two-dimensional

Fourier transform is often employed to resolve the strength of various modes in a single wave packet. However, due to the finite and discrete nature of the simulated signals, various issues arise concerning the detectability of low amplitude converted modes. The impact of using various window functions in the spatial domain will be investigated and compared. A technique will be introduced to help detect smaller amplitude waves when analytical dispersion curves may not be available to predict the abscissa and ordinate, i.e. frequency and wavenumber, locations based on a baseline subtraction technique employed in the two-dimensional frequency space.

Thu 18:40 Paul LANGEVIN PU-S04: Non destructive testing and evaluation

Porosity evaluation of PoSi wafer using a nondestructive ultrasonic technic – (Contributed, 000440)

J. Bustillo[a], J. Fortineau[a], M. Capelle[b], F. Vander Meulen[a], L. Haumesser[a], G. Gautier[b] and M. Lethiecq[a]
[a]Université François Rabelais de Tours, GREMAN, ENIVL, Rue de la Chocolaterie BP 3410, 41034 Blois, France; [b]Université François Rabelais de Tours, GREMAN, 16 rue Pierre et Marie Curie, BP 7155, 37071 Tours Cedex 2, France
Corresponding author E-mail: julien.bustillo@univ-tours.fr

The manufacturing processes of porous silicon (PoSi) by electrochemical etching now allow samples with variable depths and variable degrees of porosity to be obtained. However, thickness and porosity measurement methods of PoSi are generally destructive. Therefore in this study a nondestructive ultrasonic method is investigated. For this, an immersion insertion-substitution technique has been used. Samples with different porosities and depths are studied. The thickness of the wafer (550 microns) and high sound speed in pure silicon (8450 m.s-1) require transducers with high central frequencies (from 15 to 50MHz). The acoustic parameters of the wafer, such as velocity and attenuation are measured. These measurements are compared with those obtained through a one-dimensional multilayer model of the wafer, using a homogenisation approach for the porous layer. An inverse method is used to find the PoSi parameters, such as the thickness of the layers or the porosity.

Thu 9:00 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Ultrasound contrast agents: from imaging to therapy – (Invited, 000625)

A. Bouakaz
INSERM U930 CNRS ERL3106, Université François Rabelais, CHU Bretonneau, 2 Blvd. Tonnellé, 37044 Tours, France
Corresponding author E-mail: bouakaz@med.univ-tours.fr

Contrast agents, consisting of tiny gas microbubbles are currently approved for ultrasound imaging in cardiology and in radiology. The microbubbles have a mean size of about 3 microns and are encapsulated by a thin biocompatible layer. Multiple clinical studies have established the utility of ultrasound contrast agents (UCA) in improving accuracy of echography for the diagnosis of many diseases and in reducing health care costs by eliminating the need for additional testing. Future clinical applications of UCA extend beyond imaging and diagnostic, offering to ultrasound technology a new therapeutic dimension. Since a few years, novel therapeutic strategies are explored using microbubbles and ultrasound. Our current data demonstrate that in the presence of microbubbles, ultrasound waves destabilize transiently the cell membrane allowing the incorporation of drugs, including genes into the cells. Moreover, the microbubbles might be used as a drug vehicle to achieve a spatially and temporally controlled local release. Besides, microbubbles are able to identify diseased targets through specific targeting.

Thu 9:20 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Ultrasound Characterization of Mechanical Properties of Nanometric Contrast Agents with PLGA Shell in Suspension – (Contributed, 000040)

F. Coulouvrat[a], K. Astafyeva[b], J.-L. Thomas[c], N. Taulier[b], J.-M. Conoir[a] and W. Urbach[b]
[a]CNRS, Institut Jean Le Rond d'Alembert - UMR CNRS 7190, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France; [b]Université Pierre et Marie Curie, Laboratoire d'Imagerie Paramétrique, UMR CNRS 7623, 15 rue de l'école de médecine, 75006 Paris, France; [c]CNRS, Institut des NanoSciences de Paris - UMR CNRS 7588, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: francois.coulouvrat@upmc.fr

Dispersion and absorption are examined for dilute suspensions of Ultrasound Contrast Agents of nanometric size (nACUs), with typical radii around 100 nm. This new generation of contrast agents is designed for targeted delivery of drugs. Compared to standard contrast agents used for imaging, particles are of smaller size to pass the endothelial barrier, their shell made up of biocompatible polymer (PLGA) is stiffer to undergo a longer time life and they have a liquid (PFOB) instead of a gaseous core. Ultrasound propagation in dilute suspension of nACUs is modelled by combining i) a dilatational mode of oscillation assuming an incompressible shell with a visco-elastic behaviour of Maxwell type (relaxation), and ii) a translational mode of oscillation induced by visco-inertial interaction with the ambient fluid. Experimental measurements of the dispersion and absorption properties of nACUs solutions over the 1-100 MHz frequency range are performed for various temperatures and concentrations. They allow to fit with good accuracy three unknown parameters of the nACUs shell: the thickness, the Young modulus and the viscosity (or equivalently the relaxation frequency). Obtained values are compatible with literature data and offer insight into the behaviour of PLGA shells in suspension [Work supported by programme Emergence-UPMC].

Thu 9:40 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Ultrasonic neuromodulation in a rat model: in vivo determination of the acoustic pressure threshold and spatial distribution in the brain – (Contributed, 000689)

Y. Younan, T. Deffieux, B. Larrat, M. Fink, J.-F. Aubry and M. Tanter
Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France
Corresponding author E-mail: jean-francois.aubry@espci.fr

The recent discovery that low-intensity pulsed ultrasound can be used to stimulate the brain non-invasively and without any noticeable tissue damage is expected to have a major impact in neuroscience in the coming years. Nevertheless, this emerging field also raised a lot of unanswered questions: how does ultrasound affect neurons on a molecular and cellular level? Does it correspond to a pure mechanical interaction? A controversy even rose on whether an intensity threshold exists for inducing a neurological response or if such an effect always occurs whatever the ultrasonic intensity. In this study, the motor responses of rats (N=6) were investigated as a function of the in situ excitation pressure level and a sharp threshold was observed at 0.5MPa. Moreover a set of micro CT-based simulations were performed in order to investigate the pressure distribution in the cranial cavity. The presence of modes in the cavity was observed thus refuting the hypothesis of a localized excitation in the state of art experiments. The corresponding mechanical stress imposed on brain tissue give new insights for understanding the underlying potential mechanisms.

Thu 10:40 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

In-vitro and in-vivo siRNA transfection by an ultrasonic confocal device – (Contributed, 000355)

J.-L. Mestas[a], N. Grandjean[a], L. Reslan[b], J.-C. Béra[a], C. Dumontet[b] and C. Lafon[a]
[a]INSERM, Université Lyon 1, Unité 1032-LabTAU, Application des ultrasons à la thérapie, 151 Cours Albers Thomas, 69424 Lyon Cedex 03, France; [b]INSERM, Université Lyon1, CRCL-Unité 1052, Centre Léon Bérard, 28 rue Laennec, 69373 Lyon Cedex 08, France
Corresponding author E-mail: jean-louis.mestas@inserm.fr

The internalization of genetic materials, molecules or tracer particles in cells aims at understanding the intracellular mechanisms or can be considered for new therapies. The sonoporation is more and more used for such objective. The goal of this work is to assess the transfection potential of an ultrasonic device which combined 2 focused transducers (1.1MHz; Diameter and radius of curvature: 50mm) placed confocally. In this study in-vitro transfection tests were first carried out. 2ml tubes (Eppendorf) containing 0.5ml of cellular medium (follicular lymphoma RL; RPMI1640+10%SVF; 2x10^6cells/ml) and 45μl/ml of siRNA (20nMol; Qiagen; Allstar Neg Control) were placed at the device focal point. Transfection and mortality rates were evaluated according to the duration of irradiation (8s to 60s), the pulse repetition rate ($\leq$500Hz) and the duty cycle (0.12 to 1%) for the peak intensity Isppa=10.8kW/cm^2. Maximal transfection rates of 60% associated with very low mortality (<5%) were measured. Preliminary tests of tumor transfection (RL; Volume$\sim$1cm^3) implanted subcutaneously in mouse CB17-SCID were performed. SiRNA (7.5 μg/ml) were injected into the tumor before ultrasonic irradiation (PRF=250Hz; DC=1%; Scanning rate 1mm/s; Isppa=10.8kW/cm^2). The transfection rate was determined by flow cytometry after tumor removal and fragmentation. In-vivo transfection rate reached 16% of the studied samples.

Thu 11:00 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Blood-brain barrier disruption with focused ultrasound enhances delivery of dopamine transporter tracer (PE2I) into the brain – (Contributed, 000402)

J.-M. Escoffre[a], S. Serrière[a], S. Bodard[a], A. Novell[a], S. Chalon[a] and A. Bouakaz[b]
[a]Université François Rabelais de Tours, UMR-S930 and ERL3106, 10 ter bd Tonnellé, 37032 Tours, France; [b]INSERM U930 CNRS ERL3106, Université François Rabelais, CHU Bretonneau, 2 Blvd. Tonnellé, 37044 Tours, France
Corresponding author E-mail: bouakaz@med.univ-tours.fr

PE2I is one of the most selective ligands for dopamine transporter. However it is associated with blood-brain barrier (BBB) permeability limitations. The aim of this study was to investigate the use of ultrasound and microbubbles to increase its delivery through the BBB and by determining the optimal experimental conditions that achieve a transient and safe BBB disruption. First, we stablished the ultrasound conditions that achieved a transient BBB disruption in rats using a non-permeant marker, Evans blue. Hence SonoVue® (450μL/kg) and Evans blue (100mg/kg) were intravenously administered. BBB leakage was obtained using ultrasound insonation through the rat skull at 1.6MPa, PRF 1Hz, duty cycle 1%, burst 10ms during 120sec. BBB disruption was observed in all treated animals (N=4) by histological analysis. The same experimental conditions were applied to enhance brain uptake of PE2I. Biological samples were analyzed using a scintillation counter apparatus. The results showed 50% and 20% increase of 125I-PE2I uptake in the striatum and cerebral cortex, respectively, in the treated rats (N=5) versus control (N=4). Similar enhancements were observed using SonoVue® at half concentration. This innovative method provides a great potential for intracerebral delivery of molecular ligands that could be used for the therapy of brain diseases.

Thu 11:20 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Cavitation level-acoustic intensity hysteresis: experimental and numerical characterization – (Contributed, 000199)

P. Labelle[a], C. Inserra[b] and J.-C. Béra[b]
[a]Université Lyon 1 / INSERM, LabTAU - U1032, 151 Cours A. Thomas, 69424 Lyon, France, Metropolitan; [b]Application des ultrasons à la thérapie, Pôle santé Lyon est, 151 cours Albert Thomas 69424 Lyon cedex 03
Corresponding author E-mail: pauline.labelle@inserm.fr

In therapeutic applications such as sonoporation, inertial cavitation is commonly considered as the main candidate inducing membrane poration. Thus, characterizing inertial cavitation, as related to bubble size distribution and medium history, is of great importance. When applying successive ultrasonic shots for increasing acoustic intensities, the inertial cavitation level sharply increases around the inertial cavitation threshold. The curve of the inertial cavitation level versus acoustic intensity is different when decreasing the acoustic intensity: the threshold obtained is lower. This effect, characterized by the area of the hysteresis loop, and attributed to the change in bubble size distribution, is studied experimentally and numerically. In our experiments, when increasing the time off between two shots, the inertial cavitation curve for decreasing intensity tends towards the curve for increasing intensity. Numerically, the main mechanisms responsible for this hysteresis were identified as rectified diffusion and fragmentation during acoustic excitation, and dissolution and rising bubbles when acoustic excitation is off. Starting from a given bubble size distribution, the change in bubble size distribution is obtained for increasing and decreasing acoustic intensity. The hysteresis of inertial cavitation(quantified by bubbles collapse energy)and its dependence on time off show qualitative agreement with experimental results.

Thu 11:40 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Doxorubicin-liposomes loaded microbubbles for ultrasound-triggered doxorubicin delivery – (Contributed, 000159)

J.-M. Escoffre[a], A. Novell[a], B. Geers[b], I. Lentacker[b] and A. Bouakaz[c]
[a]Université François Rabelais de Tours, UMR-S930 and ERL3106, 10 ter bd Tonnellé, 37032 Tours, France; [b]Laboratory of General Biochemistry and Physical Pharmacy, Harelbekestraat 72, 9000 Gent, Belgium; [c]INSERM U930 CNRS ERL3106, Université François Rabelais, CHU Bretonneau, 2 Blvd. Tonnellé, 37044 Tours, France
Corresponding author E-mail: bouakaz@med.univ-tours.fr

Doxorubicin (Dox) is a potent chemotherapeutic whose severe side effects limit its clinical efficacy. Microbubble-assisted ultrasound has become a promising strategy for non-invasive local drug delivery to increase the drug concentration locally and to reduce systemic side effects. The aim of this study is to evaluate the effectiveness of administration of Dox-liposomes loaded on MB combined with ultrasound in human glioblastoma cells. Experiments were carried out with free Dox or Dox-loaded MBs on a cell suspension of U-87MG cells. Ultrasound waves were transmitted at 1MHz frequency with a pulse repetition period of 100μs, 40 cycles per pulse and for 30s. Cell viability was evaluated by Trypan blue assay 24h and 48h later. Using Dox alone, the cell viability was 63±3% and 26±2% at 24h and 48h later, respectively. The combination of ultrasound at 600 kPa and Dox-loaded MBs induced a 2.5-fold decrease of cell viability compared to the incubation of Dox-loaded MBs alone at 24h and 48h after treatment, respectively. At 24h, this combination was 3 times more efficient than the doxorubicin treatment alone. The conclusions drawn from this study show the potential of this strategy for a controlled, efficient, and safe drug delivery.
Project funded by the EU Project SONODRUGS (NMP4-LA-2008-213706).

Thu 12:40 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Noninvasive temperature measurement during High Intensity Focused Ultrasound (HIFU) treatments; What are the problems, and is it really necessary? – (Invited, 000413)

G. Ter Haar, V. Bull, J. Civale and I. Rivens
Institute of Cancer Research, Physics Department, Royal Marsden Hospital, SM2 5PT Sutton, Surrey, UK
Corresponding author E-mail: gail.terhaar@icr.ac.uk

Real-time measurement of temperature is the holy grail of HIFU treatment monitoring as it allows calculation of the delivered thermal dose, an indicator of successful ablation. Much HIFU treatment monitoring research concentrates on improving MR and ultrasound thermometry, although many factors fundamentally limit measurement accuracy for both modalities. Temporal and volumetric averaging of highly localised rapid heating can underestimate peak temperatures. In MR, any attempt to improve temporal or spatial resolution results in lower contrast and compromises temperature resolution. While US imaging offers higher temporal resolution, the relatively low signal to noise ratio is problematic. In both cases, cavitation can significantly impair measurement. In MR thermometry, temperature resolution depends on accurate knowledge of the proton resonance frequency coefficient. Whilst this is easily obtained for water, measurement in tissue is harder. Current ultrasound guided clinical HIFU treatments rely on visualising bubbles created in tissue. Ultrasound thermometry requires accurate knowledge of the temperature dependent speed of sound for the tissue, which is known to be highly variable. Given these confounding factors, it is questionable as to whether it is really temperature we require, or whether improvements in the ability to detect coagulation in tissue might lead to greater success in ablative therapies.

Thu 13:00 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Treatment of liver metastases using High Intensity Focused Ultrasound: clinical results – (Invited, 000311)

D. Melodelima
Inserm U1032, 151, cours Albert Thomas, 69424 Lyon, France
Corresponding author E-mail: david.melodelima@inserm.fr

In this study an ultrasound device that uses a toroidal HIFU transducer guided by ultrasound imaging was evaluated clinically for the treatment of colorectal liver metastases during an open procedure. Our long-term objective is to associate HIFU with hepatic resection. Here we report the first clinical results obtained on six patients with liver metastases and scheduled for elective surgical resection of their tumors. The principal objective was to validate the effectiveness, tolerance and safety of the HIFU parameters defined during preclinical studies. In addition, the response to HIFU was assessed using the ultrasound imaging probe integrated in the HIFU device and compared directly with histological analysis. Twelve HIFU lesions were performed during hepatectomy. The dimensions measured on ultrasound imaging were correlated (r=0.91) with dimensions measured during histological analysis. The average coagulated dimensions obtained from a single 40s exposure were a diameter of 18.7±2.0 mm and a depth of 27.5±6.3 mm. This HIFU treatment using a toroidal transducer is feasible, safe and well tolerated. This device is capable of achieving selective ablation of predefined liver regions. Ultrasound imaging evidence of complete ablation of the target region can be taken to infer histological success.

Thu 13:20 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

High amplitude ultrasound pulse generation using time-reversal through a multiple scattering medium – (Contributed, 000316)

B. Arnal, M. Pernot, M. Fink and M. Tanter
Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France
Corresponding author E-mail: bastien.arnal@espci.fr

In histotripsy, soft tissues can be fragmented using very high pressure ultrasound pulses. Using time-reversal cavity is a way to generate high pressure pulses with a limited number of acoustic sources. The principle was already demonstrated by Montaldo et al. using a solid metal cavity, but low transmission coefficient was obtained due to the strong impedance mismatch at the metal/water interface. We propose here to use a waveguide filled with water containing a 2D multiple-scattering medium made of steel rods (diameter 0.8mm) positioned randomly with controlled density and width. Numerical simulations and experiments performed with a linear probe (1.5MHz) exhibited an amplification of the focal pressure and an enlarged directivity. The optimal density and width of the multiple-scattering medium has been consistently determined both numerically and experimentally. This optimum results from a tradeoff between the gain provided by multiple paths and the losses. The signals recorded by the linear array (total duration of 1.2ms) were time-reversed. After reemission, the beam focused back at the initial location with a gain x12 in amplitude and improved beam steering capabilities. Such a device could become a potential alternative to expensive high power phased arrays.

Thu 13:40 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

a multi-element MR-guided interstitial ultrasound probe for the thermal ablation of brain tumors: initial testing in a canine model – (Contributed, 000556)

M. S. Canney[a], K. Beccaria[b], R. Souchon[a], F. Chavrier[a], P. Merlet[c], C. Lafon[a], J.-Y. Chapelon[a] and A. Carpentier[b]
[a]LabTAU, INSERM and CarThéra, 151 Cours Albert Thomas, 69424 Lyon, France; [b]Neurosurgery Department, Pitie-Salpetriere Hospital, 47-83 Boulevard de l'Hôpital, 75013 Paris, France; [c]SHFJ, DSV, CEA, Paris-Diderot-Paris 7 University, 91420 Orsay, France
Corresponding author E-mail: cyril.lafon@inserm.fr

In this work, an interstitial ultrasound probe, designed for performing thermal ablation of brain tumors under MR guidance, was tested in a canine model. The ultrasound device consisted of a multi-element, interstitial device operating at intensities of 20-30 W/cm^2 and a frequency of 6 MHz. The device was used to perform heating in the brains of 3 healthy Beagle canines. Treatments lasted from 4-6 minutes and were monitored using a 1.5T magnetic resonance imaging (MRI) system to obtain 3D real-time temperature maps. Custom software displayed temperature and thermal dose during exposures. After treatment, contrast-enhanced MR images were obtained and compared with predicted regions of thermal necrosis from real-time temperature maps. Temperatures of greater than 55°C were induced in vivo during heating and regions of ablation of 1-2 cm^3 were visible on post-treatment MR images. Regions of damage on post-treatment images compared well with predicted regions of thermal necrosis using MR thermometry. Interstitial ultrasound applicators, operated under MR guidance, may be a viable, minimally invasive treatment for the thermal ablation of brain tumors. Work supported by the French Ministry of Research, OSEO and CarThéra

Thu 14:00 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Todoidal transducer with two large focal zones for increasing the coagulated volume – (Contributed, 000312)

J. Vincenot[a], D. Melodelima[a], A. Vignot[a], F. Chavrier[b] and J.-Y. Chapelon[b]
[a]Inserm U1032, 151, cours Albert Thomas, 69424 Lyon, France; [b]LabTAU, INSERM, 151 Cours Albert Thomas, 69424 Lyon, France
Corresponding author E-mail: jeremy.vincenot@inserm.fr

In this work, a toroidal High Intensity Focused Ultrasound (HIFU) transducer was developed for the treatment of liver metastases. It generates an enlarged focal zone composed of a first ring-shaped focus (located at the focal plane) and an overlap of ultrasound beams between the transducer and this focal ring. The objective was to combine this toroidal geometry with electronic focusing of the ultrasound beam. This was done in order to create a coagulated volume sufficient for the destruction of a metastasis with a diameter up to 3 cm. The working frequency of the transducer was 2.5 MHz. The transducer is divided into 32 rings of 77 mm^2 each. In vitro tests were conducted and have shown that this toroidal geometry and the use of electronic beam steering allows the creation of lesions

with a diameter of 40 mm and a depth of 38 mm. This treatment was obtained in 10 minutes without any mechanical displacement of the transducer. In conclusion, these results indicate that the treatment of a liver metastasis up to 3 cm in diameter is conceivable with safety margins using a single exposure which is obtained rapidly and without juxtaposing single lesions.

Thu 14:20 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Study of the emissive properties of ultrasound systems for physiotherapy and aesthetic treatments – (Contributed, 000842)

C. Giliberti[a], P. Calicchia[b], A. Bedini[a], R. Palomba[a] and S. De Simone[b]
[a]INAIL ex ISPESL, Via Urbana 167, 00184 Rome, Italy; [b]Institute of Acoustics and Sensors, Via del Fosso del Cavalliere,100, 00133 Rome, Italy
Corresponding author E-mail: c.giliberti@inail.it

The widespread use of ultrasound in physiotherapy and recently in aesthetics (medical and nonmedical) and the variety of devices based on ultrasonic emission at relatively low cost and available to a wide range of users, requires a deep knowledge of the emissive mode of theese equipments. In order to provide a contribution for improving the quality and safety of treatments, a study on the technical performance and emissive characteristics of few devices available on the market was carried out, according to the international standard IEC 61689:2007. Emissive properties were assessed for two systems working at 1 MHz and 3 MHz, respectively, used for physiotherapy and aesthetics; the characterization of the ultrasonic pressure fields of these devices was related to the electronic characteristics of their controls. The results highlighted few critical aspects related to the non perfect accord between control and US transducer, to the effects of internationally-defined parameters values, when they are found out of range, according to the definition of an acceptable systems' quality, and to the need of extensively describe such systems including a suitable set of measurements aiming at their characterization as a whole.

Thu 14:40 Lord RAYLEIGH PU-S07: Therapeutic ultrasound

Ellipsoid fitting for movement tracking and HIFU lesion simulation on mobile organs – (Contributed, 000795)

E. Constanciel[a], J.-M. Mari[a], S. Pichardo[b], F. Chavrier[a] and C. Lafon[a]
[a]Application des ultrasons à la thérapie, Pôle santé Lyon est, 151 cours Albert Thomas 69424 Lyon cedex 03; [b]Thunder Bay Regional Research Institute, 980 Oliver Road, Thunder Bay, Ontario, Canada P7B 6V4
Corresponding author E-mail: elodie.constanciel@inserm.fr

Atrial fibrillation is the most frequent cause of cardiac arrhythmia. In order to treat it in a minimally invasive way, a transesophageal HIFU system is being designed. To predict the shape of the HIFU lesion and design the heating procedure, simulations must be performed on a beating heart model. The complex movements of the left atrium make the displacement estimation difficult. However a simple model fitting, here an ellipsoid, could allow estimating with a reasonable accuracy the tissue movement. A fitting algorithm has been designed and is tested on numerical phantoms of ovoid shape. Fitting ellipsoids at multiple times allows matching their surfaces, deriving the movement and extrapolating to the entire volume. Lesion size with and without movement are then simulated using the Rayleigh model and the Bio Heat Transfer Equation, and compared. Future work will apply this fitting on real atrium data extracted from 4D CT sequences.

Thu 10:40 Ray STEPHENS EA-S06: Miniature transducers

Potential of MEMS technologies for manufacturing of high-fidelity microspeakers – (Invited, 000568)

E. Lefeuvre[a], I. Shahosseini[a], J. Moulin[a], M. Woytasik[a], E. Martincic[a], G. Lemarquand[b], E. Sturtzer[c] and G. Pillonnet[c]
[a]Institut d'électronique fondamentale, bat. 220 Av Georges Clémenceau 91405 Orsay Cedex; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Institut des Nanotechnologies de Lyon - Site de l'UCBL, 6, rue Ampère 69621 Villeurbanne Cedex
Corresponding author E-mail: elie.lefeuvre@u-psud.fr

The use of microspeakers has drastically grown over the past few years in reason of the important increase of mobile electronics devices having sound reproduction functions. Consumer electronics devices such as mobile phones, tablets or camcorders are the most representative exemples of everyday used devices with embedded microspeakers. Since 2009, this market exceeds one billion microspeakers per year. However, in parallel to the sales increase, the performances of these small-size transducers have been only very little improved in terms of sound quality, efficiency and power density over the last decade. Several reasons can explain such stagnation, such as the limits of conventional manufacturing techniques, or the focus put on selling points other than sound reproduction. The proposal made here is to take advantage of Microsystems technologies for improving microspeaker's performances. Indeed, such a technological leap appears as a very promising way to overcome the major shortcomings of micro speakers made using conventional technologies. This paper illustrates, in the case of a silicon microspeaker, the gains that can be expected from MEMS technologies. The design and the microfabrication process of the device will be fully detailed. Experimental acoustic chacacteristics will be compared to that of conventional microspeakers of same size and power range.

Thu 11:00 Ray STEPHENS EA-S06: Miniature transducers

Efficiency optimization of an electrodynamic MEMS microspeaker – (Contributed, 000614)

I. Shahosseini[a], E. Lefeuvre[a], J. Moulin[a], M. Woytasik[a], E. Martincic[a] and G. Lemarquand[b]
[a]Institut d'électronique fondamentale, bat. 220 Av Georges Clémenceau 91405 Orsay Cedex; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: iman.shahosseini@u-psud.fr

This paper presents the optimization of a novel planar structure of MEMS electrodynamics microspeaker. The mobile part of the device is a microstructured silicon membrane suspended by a whole set of silicon springs. Its actuation principle relies on the Lorentz force, exactly like in conventional microspeakers broadly used in mobile electronics devices. The presented structure includes a planar coil electroplated on top of the silicon membrane, and a permanent magnet part based on magnet rings bonded onto the silicon substrate. Four different configurations of the permanent magnet part are studied. In each case, the dimensions of the planar coil are determined in order to maximize the electroacoustic conversion efficiency. The optimization method takes into account technological limits of microfabrication. Simulations based on analytical and finite element modelling show that the efficiency of optimized MEMS microspeaker could be up to ten times greater than that of conventional electrodynamics microspeakers used in mobile phones. The simulation results are confirmed by experimental measurements on MEMS microspeaker prototypes.

Thu 11:20 Ray STEPHENS EA-S06: Miniature transducers

High overtone Bulk Acoustic Resonators: application to resonators, filters and sensors – (Invited, 000705)

S. Ballandras[a], T. Baron[a], E. Lebrasseur[a], G. Martin[b], D. Gachon[c], A. Reinhardt[d], P.-P. Lassagne[d], J.-M. Friedt[a], L. Chommeloux[e] and D. Rabus[b]
[a]femto-st, 26 chemin de l'epitaphe, Equipe CoSyMa, 25000 Besançon, France; [b]Femto-st, 26 chemin de l'Epitaphe, 25030 Besançon, France; [c]Laboratoire PROMES-CNRS, UPR 8521, Rambla de la thermodynamique, 66100 Perpignan, France; [d]CEA LETI, CEA / Léti 17 rue des Martyrs 38054 Grenoble cedex 9; [e]SENSeOR SAS, Parc de Haute Technologie - Lot n°3 694, Avenue du Docteur Maur, 06250 Mougins, France
Corresponding author E-mail: ballandr@femto-st.fr

Acoustelectric devices have been used now for several decade to stabilize oscillators, to filter radio-frequency signals or to allow for physical and even chemical detection and measures.Among all the structures that have been developed in that purpose, one has been revealing particularly interesting for the development of high quality factor resonator on an extended range of frequency. It is based on the generation of high overtones in bulk acoustic wave resonant structure and therefore are currently called HBARs. These devices may be fabricated along various approaches but they always consist of a thin (or thinned) piezoelectric layer deposited or bonded onto a high quality single crystal material. The spectral response of this kind of device exhibit a periodic comb of peaks modulated by the transducer response, yielding resonances on a very large spectrum with various characteristics and properties. We present here the basic principles of such devices, their remarquable properties, the etchnologies required to manufacture them and the various applications they can be applied for. A focus is partcularly dedicated to oscillator stabilization and to wirelss sensor development.

Thu 11:40 Ray STEPHENS EA-S06: Miniature transducers

New electrostatically excited Silicon resonator vibrating in a thickness extensional mode – (Contributed, 000715)

S. Ballandras[a], M. Evan[b], B. Dulmet[b], G. Martin[b] and T. Baron[a]
[a]femto-st, 26 chemin de l'epitaphe, Equipe CoSyMa, 25000 Besançon, France; [b]Femto-st, 26 chemin de l'Epitaphe, 25030 Besançon, France
Corresponding author E-mail: ballandr@femto-st.fr

This paper presents a new micro-mechanical BAW resonator built in Silicon, using an electrostatic excitation. The device is based on a one-port design with a 1μm gap to apply the superimposition of static bias voltage and dynamic excitation to the silicon plate. A thickness extensional mode is exploited, yielding a frequency operation near 10 MHz with a standard 400μm thick Si plate. The resonator presented in the paper is based on a single p-doped (100) Silicon plate bonded onto a Corning® glass substrate by using the anodic bonding technique. The glass layer is machined to create the electrostatic gap mandatory for the electrical excitation. The micro-fabricated resonator was tested in one-port configuration using a network vector analyzer. The electromechanical coupling factor and many resonator features, including the quality factor Q, change with the DC bias polarisation, as expected theoretically. After the static capacitance compensating, the Q factor near 9000 have been observed with a promising coupling w.r.t. quartz resonator values. The resonator was tested in air at different temperatures between 0°C and 100°C and the TCF was found at -28ppm/°C. The stabilization of a RF oscillator using this resonator is still under development.

Thu 13:00 Ray STEPHENS EA-S06: Miniature transducers

Comparison of various models to compute the vibro-acoustic response of large CMUT arrays – (Contributed, 000740)

M. Berthillier, P. Le Moal and J. Lardies
FEMTO-ST, Département de Mécanique Appliquée, 24 rue de l'Épitaphe, 25000 Besancon, France
Corresponding author E-mail: marc.berthillier@univ-fcomte.fr

Capacitive Micromachined Ultrasound Transducers (CMUT) is a promising alternative to piezo-electric transducers for medical imaging. CMUT generally comprises more than 10 thousand unitary cells. When immersed in a fluid the cells are strongly coupled by the fluid, leading to cross talk effects. Accurate simulation tools that take into account properly all these coupling are very much CPU time consuming. From an engineering point of view it will be interesting to use simplified models to conduct parametric studies. We propose in this paper to evaluate various simplified models in term of accuracy and CPU time. As a test case, we chose a typical 1D CMUT array in which groups of several hundreds of cells, called elements, are electrically connected. The reference model takes into account explicitly the contribution of all the cells to compute, in the harmonic domain, the displacement field on the transducer surface and the radiated pressure. A first class of simplified models is built by introducing constraints on the cells displacements of the reference model. A second class of simplified models considers infinite array for which periodic conditions can be defined.

Thu 13:20 Ray STEPHENS EA-S06: Miniature transducers

Phononic crystal slabs: fundamentals and applications – (Invited, 000748)

A. Khelif
Franche-Comté Électronique Mécanique, Thermique et Optique - Sciences et Technologies, 32 avenue de l'Observatoire 25044 Besancon Cedex
Corresponding author E-mail: abdelkrim.khelif@femto-st.fr

We present in this paper theoretical and experimental studies of guided acoustic wave propagating in phononic crystal slabs. By the insertion of scatters or the deposition of pillars on slabs, we are able to built up these artificial crystals. With appropriate choice of the geometrical parameters, we show that these structures can display complete band gaps in silicone membrane based on a Bragg or a local resonance mechanism. Additionally, the introduction of defects inside the perfect crystals allows us to achieve high quality factor acoustic resonators as well as acoustic filters at high frequency regime in the phononic crystal slabs.

Thu 13:40 Ray STEPHENS EA-S06: Miniature transducers

A model to predict baffle effects in linear array of cMUTs – (Contributed, 000764)

A. Boulmé, N. Sénégond, F. Teston and D. Certon
Université François-Rabelais de Tours, 10 Bd tonnellé, 37032 Tours, France
Corresponding author E-mail: audren.boulme@univ-tours.fr

cMUTs are a very promising alternative to the piezoelectricity in echographic imaging probes. Many authors have modeled cMUT arrays but only few works have been dedicated to the simulation of devices working in real configuration, i.e. where each element is made of a finite number of cMUTs. In previous studies, we pointed out that, in such conditions, interactions between cMUTs could cause some strong cut-off frequencies in the useful frequency bandwidth, leading to undesirable oscillations at the end of the impulse response. This phenomenon is comparable with baffle effects in multi-source radiators. Even if origins of these cut-off frequencies are well known in sonar arrays, this phenomenon have poorly been explored for arrays of cMUTs. This paper is a deep theoretical investigation of these interactions. The linear array of cMUTs is modeled like a linear system. Input electrical quantities (voltage applied to each element of the array) are linked to output acoustic quantities (pressure emitted by each element) with a global "transferï matrix. The Eigenvalues decomposition of the transfer matrix is used to discuss and to explain origins of cut-off frequencies in the radiated pressure spectrum.

Thu 13:40 François CANAC AA-S02: Practical aspects of room or building acoustics

Offices and dwellings: what building acoustics for sustainable development? – (Contributed, 000013)

M. Asselineau, A. Gaulupeau and M. Serra
PEUTZ & Associates, 10 B rue des Messageries, 75010 Paris, France
Corresponding author E-mail: m.asselineau@peutz.fr

Sustainability has proved to be a major concern since the beginning of this century. Among the 14 targets for sustainable projects as defined in the French standards, one specifically deals with acoustic comfort. Over the years, those standards have been developed to cope with various kinds of buildings. However, due to the lack of discussion between specialists it has sometimes proved rather hard to be applied. Furthermore, a lack of coherence may sometimes appear between sustainable standards by HQE, national standards by Afnor, and national regulations. This paper aims to submit a few questions on those matters.

Thu 14:00 François CANAC AA-S02: Practical aspects of room or building acoustics

Acoustical standards and criteria documentation of sustainability in hospital design and construction – (Invited, 000276)

J. B. Evans and C. N. Himmel
JEAcoustics / Engineered Vibration Acoustic & Noise Solutions, 1705 West Koenig Lane, Austin, 78756, USA
Corresponding author E-mail: Evans@JEAcoustics.com

The Leadership in Energy and Environmental Design (LEED) rating system, developed by the United States Green Building Council (USGBC) has multiple categories, including a 2009 version for healthcare buildings. Determination and award of Interior Environmental Quality (IEQ) rating points for Acoustics requires theoretical calculation in design phase of ambient sound, privacy and intrusive outdoor noise relative to allowable criteria or performance validation testing after construction. This case study discusses the required acoustical criteria for IEQ Credits 1 and 2. Floor plans showing patient, procedure, consultation and meeting rooms are presented and discussed with regard to the criteria. Design phase calculation procedures undertaken to document conformance are presented with results. Because conflicts between operational requirements and acoustical criteria create design challenges, commentary is offered about design alternatives that aided or inhibited rating success.
Standards and Criteria covered include: Leadership in Energy and Environmental Design (LEED) for Healthcare 2009, a third-party certification and benchmark system created by U.S. Green Building Council (USGBC),Guidelines for Design and Construction of Health Care Facilities, Facility Guidelines Institute (FGI), 2010, referenced in LEED HC 2009 "Sound and Vibration Control,ï ASHRAE Handbook of HVAC Applications, 2007 American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc.

Thu 14:20 François CANAC AA-S02: Practical aspects of room or building acoustics

Facade sound isolation: a few questions – (Contributed, 000014)

A. Gaulupeau
PEUTZ & Associates, 10 B rue des Messageries, 75010 Paris, France
Corresponding author E-mail: a.gaulupeau@peutz.fr

Since 2000 it has been compulsory to use European acoustic criteria in France. This means that requirements as formulated in French regulations must be expressed using those European criteria. The applicable regulation pertaining to façade sound isolation with regards to land based transport noise is dated May 30, 1996. Accordingly it had to be revised. This was an opportunity to make improvements on the following points: clarification of the simplified method, coherence with the thermal regulation, and introduction of isolation requirements with regards to air traffic noise. This paper will submit the modifications introduced by the soon to be published regulation.

Thu 14:40 François CANAC AA-S02: Practical aspects of room or building acoustics

Solid borne noise in buildings: how does one cope? – (Contributed, 000015)

M. Serra and M. Asselineau
PEUTZ & Associates, 10 B rue des Messageries, 75010 Paris, France
Corresponding author E-mail: m.asselineau@peutz.fr

In France there are regulations regarding the sound isolation of the façade with regards to road and rail noise. However, there are no provisions regarding structure borne noise from such sources. For example, should there be a tunnel by the building, on what basis does one decide what the applicable noise level target value should be? Should it really be expressed as a sound level or should it be described as a velocity level? Furthermore, is the end user aware of the problem and ready to implement some solid borne noise control measures? This paper aims to address those matters through a couple of case studies.

Thu 15:00 François CANAC AA-S02: Practical aspects of room or building acoustics

Architects and Acousticians: are they able to understand each other? – (Contributed, 000615)

A. Muckenhirn
AT3E, 43/45 rue Jean Jaurès, 94500 Champigny Sur Marne, France
Corresponding author E-mail: a.muckenhirn@at3e.fr

Good architectural projects need a suitable understanding between the various members of the design team. But can really people as different as an architect and an acoustician reach such an understanding? One is mainly concerned with the appearance of the building (and what it costs too!), while the other one usually happens to be concerned with plenty of non visible items. Does it mean that as long as it does not interfere with the architect's vision of space, it's acceptable? Each member has a goal to reach on the project. And more since regulations and labels are increasingly discerning. So the point is: does the architect really understand and integrate the acoustic elements the acoustician gives to him? And, inversely, does the acoustician know the impact of his recommendations on the architect's work? Through her professional experience as an acoustic engineer and her education as an architect, the author submits in this paper a few illustrations of those points.

Thu 15:20 François CANAC AA-S02: Practical aspects of room or building acoustics

Acoustic treatments for building curved surfaces: practical applications – (Contributed, 000778)

G. Beillard[a] and C. Ramauge[b]
[a]ALHYANGE Acoustique, 60 rue du Faubourg Poissonnière, 75010 Paris, France; [b]ALHYANGE Acoustique, 14 avenue Carnot, 44017 Nantes, France
Corresponding author E-mail: info@alhyange.com

Curved walls are not rare in building architectures. Acoustic reflections by these surfaces may create sound focusing issues damaging the room acoustic qualities [Martijn L.S. Vercammen, Reflection of sound by concave surfaces, Proceedings of 20th International Congress on Acoustics, August 2010, Sydney, Australia]. With the increasing num-

ber of building acoustic norms, acoustic treatments have to be found out and settled in order to guaranty the best acoustic comfort in specific architecture rooms. The aim of this paper is to present practical applications of building focusing problems. Indeed first measurements have been carried out to characterize the phenomenon. Results are then compared with 3D model simulations by image source method. Different acoustic treatments configurations have been also simulated afterwards in order to choose the most appropriate technical solutions respecting architectural constraints and acoustic requirements. Finally, these configurations are settled and checked in last in situ measurements.

Thu 15:40 François CANAC AA-S02: Practical aspects of room or building acoustics

Micro-perforated sound absorbers in stretched materials – (Contributed, 000829)

C. Nocke[a], C. Hilge[a] and J.-M. Scherrer[b]
[a]Akustikbüro Oldenburg, Katharinenstr. 19, 26121 Oldenburg, Germany; [b]BARRISOL S.A.S, Route du Sipes, 68680 Kembs, France
Corresponding author E-mail: nocke@akustikbuero-oldenburg.de

The theory of microperforated panel sound-absorbing constructions has been introduced by D.-Y. Maa in 1975. Since then many variations of micro-perforated sound absorbing devices and materials have been introduced. Materials that have been used to be micro-perforated have been metal, wood, plastics and many others. In 2001 a nearly invisible micro-perforation has been introduced to the stretched material making it highly sound absorptive. Over the last ten years different set-ups made of micro-perforated layers, porous materials as well as plate resonators have been investigated. In this contribution measured sound absorption coefficients of various set-ups with micro-perforated stretched foils and different other acoustic materials will be presented. For these assemblies no closed calculation model exists so far. Theoretical approaches towards layered sound absorbers with micro-perforated components will be suggested. Future developments in the field of micro-perforation in room acoustics will be discussed. Finally applications will be presented.

Thu 13:40 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Time-domain simulations of outdoor sound propagation: experimental validation on a complex site – (Contributed, 000571)

D. Dragna[a], P. Blanc-Benon[a] and F. Poisson[b]
[a]LMFA, Ecole Centrale de Lyon, 36 avenue Guy de Collongue, 69134 Ecully Cedex, France, Metropolitan; [b]Innovation et recherche SNCF, 40 avenue des terroirs de France, 75012 Paris
Corresponding author E-mail: didier.dragna@ec-lyon.fr

Simulations of outdoor sound propagation using a time-domain approach have proved to be efficient to deal with complex situations. Indeed, the main effects on acoustic propagation can be taken into account. In particular, recent works [Dragna et al., AIAA J. 49, 1420-1428 (2011); Dragna et al., AIAA-Paper 2010-3758 (2010)] have shown that impedance of the ground surfaces and topography can be modeled efficiently in time domain. In this paper, results from an experimental campaign carried out near a railway high speed line in 2010 are compared to those obtained with a finite-difference time-domain (FDTD) solver of the linearized Euler equations. During the experiments, the topography of the site and the different surface impedances have been determined. Meteorological measurements have also been performed. A blank pistol is used to obtain impulsive signals. The different measured parameters are used as input data into the FDTD solver. Comparisons are realized in both the frequency domain, and in the time domain.

Thu 14:00 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Time-domain numerical modeling of acoustical propagation in the presence of boundary irregularities – (Contributed, 000482)

O. Faure[a], B. Gauvreau[a], F. Junker[b] and P. Lafon[b]
[a]IFSTTAR Nantes, Département IM, Route de Bouaye, CS4, 44344 Bouguenais Cedex, France; [b]EDF R&D, 1 Avenue du Général de Gaulle, 92141 Clamart Cedex, France
Corresponding author E-mail: olivier.faure@ifsttar.fr

Numerical reference models are necessary to validate engineering methods used for acoustical predictions in realistic situations. These situations include irregular geometries and characteristics that are not accurately known. This can be due to the complexity of the propagation medium, space and time variability of its physical properties, measurements uncertainties, etc. The objective of this work is to compute sound propagation through such complex media using two numerical methods. The first one is based on the resolution of the Linearized Euler Equations with high order finite difference schemes (FDTD). The second one is based on a discrete representation of the Huygens principle using nodes and transmission lines (TLM). The required improvements of the numerical codes are exposed. First examples of numerical studies dealing with irregular geometries and impedance ground properties are presented.

Thu 14:20 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

TLM OpenCL multi-GPUs implementation – (Contributed, 000390)

G. Guillaume, N. Fortin, B. Gauvreau and J. Picaut
Département Infrastructures et Mobilité (IFSTTAR/IM), Route de Bouaye, CS4, 44344 Bouguenais Cedex
Corresponding author E-mail: gwenael.guillaume@ifsttar.fr

Time-domain methods attracts much attention since a few years due to their ability to describe sound propagation in complex environments. However, such approaches requires a substantial computational power and a supercomputer remains still relevant for sound propagation simulations in huge domains. Graphics processing units (GPUs) are massively parallel computing environments, that are more and more used for scientific computations purposes. Among time-domain methods, the transmission line modeling (TLM) method is especially well adapted to this kind of hardware architecture. The paper presents an OpenCL^{TM} implementation of the TLM method, this language being compatible with a wide range of available computational hardware, either with Central Processing Units (CPUs) or with GPUs devices. The algorithm is applied to evaluate the impact of various scenarios of vegetation cover on urban frontages and building roof tops within the framework of the VegDUD project.

Thu 14:40 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Numerical predictions for environmental acoustics: simulation of atmospheric fields and integration in a propagation model – (Invited, 000445)

P. Aumond[a], B. Gauvreau[a], C. Lac[b], V. Masson[b] and M. Berengier[a]
[a]Département Infrastructures et Mobilité (IFSTTAR/IM), Route de Bouaye, CS4, 44344 Bouguenais Cedex; [b]Météo-France CNRM/GAME, Av. Gaspard Coriolis, 31057 Toulouse Cedex 1, France
Corresponding author E-mail: benoit.gauvreau@ifsttar.fr

Outdoor sound prediction is both a societal stake and a scientific issue. Thus this paper deals with numerical simulations of micrometeorological (temperature and wind) fields for environmental acoustics. This is carried out through new developments in the reference mesoscale meteorological model at Météo-France ("Meso-NHï). Meso-NH predictions at very low scales (about 1m) including new developments (drag force approach) are validated both numerically and experimentally under stable, unstable and neutral conditions.
Then, these information can be used as input data for acoustic models. Our time domain acoustic model is based on Transmission Line Matrix method (TLM). Its development has been done in order to be applied to outdoor sound propagation, i.e. in order to take into account topography, ground impedance, meteorological conditions, etc. The numerical validation of the TLM method by comparison with other models shw the relevance of its use in the context of environmental acoustics.
Finally, thanks to these models, simulated noise levels in different propagation conditions were compared to in situ measurements. Satisfying results were obtained regarding the observed phenomena variability. A feasibility study on a more complex experience (LTMS) leads to consider the TLM as an accurate and promising method in the context of environmental acoustics.

Thu 15:00 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Long distance propagation of high level impulsive noises – (Contributed, 000707)

P. Naz, M. Portafax and S. Cheinet
Institut franco-allemand de recherches de Saint-Louis, 5 rue du Général Cassagnou, BP 70034, 68300 SAINT-LOUIS - France
Corresponding author E-mail: pierre.naz@isl.eu

The noises generated by the high level impulsive sources propagate a great distance away, but their characteristics can be strongly modulated by environmental parameters (inhomogeneities in the atmosphere, ground's characteristics). The performances in terms of detection and localization of sources are disrupted by the spatial and time fluctuations in these parameters. This contribution presents the current efforts at ISL to measure, understand and predict this variability. Experimental tests are realized at various propagation ranges. The results illustrate the variabilities in terms of level, spectral content and precision of the angular localization. The metrology, identification and forecast of the relevant environmental parameters to explain these fluctuations in performance will be discussed.

Thu 15:20 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Propagation of spherically diverging N-waves in a turbulent atmosphere: experiment – (Contributed, 000643)

P. V. Yuldashev[a], E. Salze[a], S. Ollivier[a], M. Averiyanov[b], V. Khokhlova[b] and P. Blanc-Benon[a]
[a]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex; [b]M.V.Lomonosov Moscow State University, Faculty of Physics, M.V.Lomonosov Moscow State, University,Leninskie Gory, 119991 Moscow, Russian Federation
Corresponding author E-mail: petr@acs366.phys.msu.ru

Studies on propagation of high amplitude N-waves in turbulent atmosphere are relevant to the sonic boom problem which involves high interest due to development of new civil supersonic aircrafts. In this problem it is important to predict the effect of turbulence on the statistical characteristics of random variations of the wave amplitude and shock rise time. In the present work, in relation to the sonic boom problem, the propagation of high amplitude spark-generated N-waves through a layer of thermal turbulence was studied in a model laboratory-scale experiment which is more controlled and reproducible than field measurements. Evolution of statistical distributions of the wave amplitude and shock rise time was investigated at different propagation distances from the spark source. The results were compared to experimental data known from the literature, where N-waves were propagated through a kinematic turbulence. It was shown that for similar propagation distances, turbulent length scales, and index fluctuations in both experiments, kinematic turbulence leads to stronger distortion of the N-wave field. Moreover, with kinematic turbulence the probability to observe intense focusing at caustics is to 2 or 3 times greater than with thermal turbulence.

Thu 15:40 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Laboratory-scale experiment for the propagation of N-waves in a turbulent and refracting medium with ground effects – (Contributed, 000633)

E. Salze, S. Ollivier, P. V. Yuldashev and P. Blanc-Benon
Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: edouard.salze@ec-lyon.fr

Acoustical propagation in a refracting atmosphere close to the ground leads to the formation of a geometrical shadow zone in which sound can be scattered by turbulence. Laboratory scale experiments allow to control and study separatly ground reflection, refraction and turbulence effects. Therefore, a new experiment which allows quantitative study of outdoor nonlinear propagation has been designed to compare measurements to theoretical models. A spark source is used to generate short duration (~ 20 μs) and high pressure (~ 1500 Pa) N-waves. A convex surface models the effect of an upward refracting atmosphere, and a heating grid generates thermal turbulence (~ 1 % index fluctuations). Previous studies showed that the microphone directivity and limited frequency response have a great influence, leading to distorted measured waveforms and overestimation of the rise time. Acoustical measurements were completed by schlieren visualizations of the shock wave. Without turbulence, the waveforms and pressure levels are measured and compared to calculated solutions, accounting for microphone filtering. Evidence of irregular reflection is given, and scattering of sound into the shadow zone by turbulence is discussed.

This work is supported by the French/Russian International Program for Scientific Cooperation PICS *RFBR 10-02-91062 / CNRS 5603*.

Thu 16:40 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Diffraction-assisted rough ground effects – (Contributed, 000265)

I. Bashir, S. Taherzadeh, T.J. Hill and K. Attenborough
The Open University, DDEM, Maths, Computing and Technology, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: I.Bashir@open.ac.uk

Sound propagation over a smooth hard surface can be significantly altered by introducing roughness. For near grazing sound propagation over a smooth hard surface, the first destructive interference occurs at relatively high frequencies. However, the ground effect dips, corresponding to the first destructive interference, observed in Excess Attenuation (EA) spectra measured over rough surfaces, are at significantly lower frequencies. Sound propagation over periodically spaced roughness elements and randomly spaced roughness elements with different cross-sectional profiles (semi-cylindrical, rectangular and wedge-shaped strips) is investigated. Periodic spacing results in multiple distinct maxima, compared with the single broad EA maxima observed for random spacing. Roughness also causes surface waves. These surface waves are strongest near grazing incidence and their amplitudes and the frequencies at which they occur depend on the roughness height and mean centre-to-centre spacing. Numerical models such as Multiple Scattering Theory (MST) and the Boundary Element Method (BEM) are used to make predictions of the EA spectra which are compared with measurements. [Work supported by European Community FP7 project number 234306].

Thu 17:00 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Use of short range outdoor sound propagation and acoustic-to-seismic seismic coupling to deduce soil state – (Contributed, 000753)

H.-C. Shin[a], S. Taherzadeh[a], K. Attenborough[a] and W.R. Whalley[b]
[a]The Open University, DDEM, Maths, Computing and Technology, Walton Hall, MK7 6AA Milton Keynes, UK; [b]Rothamsted Research, West Common, AL5 2JQ Harpenden, UK
Corresponding author E-mail: h.c.shin@open.ac.uk

In horticulture, the soil structure, moisture content and strength have profound effects on plant growth. When soils are regarded as porous media, sub-surface wave propagation can be indicative of the soil status. Such propagation can be initiated by sources of airborne sound through acoustic-to-seismic coupling. Measurements of the ratio of near-surface sound pressure to acoustically induced solid particle motion can be exploited to estimate the acoustic and elastic properties of soils. Traditional methods of monitoring seismic signals by use of buried geophones are invasive and may affect the soil samples of interest. This paper describes a non-invasive acoustic-seismic technique. A loudspeaker was used to generate airborne sound, and the reflected sound and the subsequent vibration of the soil surface were recorded by microphones and a laser Doppler vibrometer respectively. These data were used to estimate acoustic and elastic soil parameters through an optimisation process minimising the differences between the data and model predictions based on incorporation of a modified Biot theory in a Fast Field Program. Example results of laboratory and field measurements are reported.

Thu 17:20 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Guided inversion procedure thanks to a sensitivity analysis on porous road surfaces – (Contributed, 000318)

G. Benoit[a], E. Gourdon[b] and C. Heinkele[c]
[a]CETE Normandie-Centre - LR de Blois, 11 rue Laplace, CS2912, 41000 Blois, France; [b]Département Génie Civil et Bâtiment, Rue Maurice Audin 69518 Vaulx-en-Velin cedex; [c]Laboratoire Régional de Strasbourg, 11, rue Jean Mentelin, 67035 Strasbourg Cedex 2, France
Corresponding author E-mail: gaelle.benoit@developpement-durable.gouv.fr

Measuring the loss of acoustic performances allows to assess the extent of the clogging of a porous road surface. Here the inversion from in situ measurements on an equivalent fluid model is proposed in order to identify the microstructure related parameters such as porosity or resistivity. To achieve this task, a sensivity analysis of 2 models, based on a bayesian index, has been carried out to dissociate the effects of each parameter of the model. In the following, frequency ranges and conditions under which an inversion has the best chances to be successful is determinated. The models used in this paper are Biot-Allard model and Johnson-Champoux-Allard model, involving respectively 3 and 5 parameters. This analysis showed than on some frequency ranges only one parameter is influent. This helped to build an inversion procedure which will be tested with surface impedance measurements.

Thu 17:40 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

A new design procedure of a half-plane noise barrier with a non-straight top edge – (Contributed, 000139)

T. Hidaka
Takenaka R&D Institute, 1-5-1, Otsuka, 270-1395 Inzai, Chiba, Japan
Corresponding author E-mail: hidaka.takayuki@takenaka.co.jp

This paper introduces noise reduction of the "noise barrier with a non-straight top edge" that has a periodic structural feature on its top edge along the length. The top edge geometry of this noise barrier is created by optimization of the diffracted sound field based on the Maggi-Rubinowicz theory. To further enhance the noise barrier performance, the rear of the top edge is covered with porous sound-absorbing material. The excellence of this complex system is improvement of its noise reduction by over about 3 to 5 dB at the point behind the barrier in frequency ranges from 125 Hz to over 4 kHz compared with an ordinary noise barrier of the same height. It will not create a zone in which sound is augmented, either. Originally designed primarily for temporary hoarding at a construction site, this noise barrier is expected to effectively serve against a wide range of noise sources. This paper reports a case example of use of this noise barrier and outlines the characteristics of its noise reduction performance and mechanism.

Thu 18:00 Philip DOAK EN-S01: Outdoor sound propagation: meteorological, ground effects, uncertainties...

Use of vegetation for abatement of road traffic noise in a 1:10 scale street model – (Contributed, 000651)

J.Y. Jeon[a], H.S. Jang[b] and T.H. Park[a]
[a]Hanyang University, Department of Architectural Engineering, 133-791 Seoul, Republic of Korea; [b]Laboratoire de Mathématiques de Versailles, 45, avenue des Etats-Unis 78035 Versailles cedex
Corresponding author E-mail: jyjeon@hanyang.ac.kr

Sound propagation over the building elements has been evaluated to measure the traffic noise level from the street canyon the adjacent courtyard. In this study, a 1:10 urban scale model was constructed to evaluate the noise abatement by use of vegetation as sustainable means. The model materials were selected by measuring absorption coefficients and ground impedances in a 1:10 and a full scale testing environment; the ground, foot path, low barrier, façade and roof were treated with vegetation. Sound pressure levels and reverberation times were measured in the scale model and were compared with the results of computer simulation.

Thu 14:40 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Dual mode transducers based on cMUTs technology – (Contributed, 000709)

D. Gross[a], A. Boulmé[a], N. Sénégond[a], G. Férin[b], M. Legros[b], B. Roman[a], F. Teston[a] and D. Certon[a]
[a]Université François-Rabelais de Tours, 10 Bd tonnellé, 37032 Tours, France; [b]Vermon, 180 rue du Général Renault, 37038 Tours, France
Corresponding author E-mail: dominique.gross@univ-tours.fr

More and more medical ultrasonic applications are strongly interested by the development of dual acoustic sources enable to emit high frequency ultrasound (echographic imaging) and low frequency pressure field (therapeutic ultrasounds). The use of the piezoelectricity to fabricate such device requires overcoming strong technological bottlenecks. The objective of this paper is to demonstrate that the technology of capacitive micro-machined ultrasonic transducer is able to take up this challenge. To this end a demonstrator was designed and manufactured. The first part of the paper is devoted to the design of the low and high frequency cMUTs. For the low acoustic source, a dedicated time domain model was used, taking into account the nonlinearity of the cMUT. Several simulations were conducted to optimize the emitted pressure field intensity at 1 MHz for a set of diaphragm with different sizes and geometries. The high frequency source was designed on the help of a linear model, where output parameters were central frequency, bandwidth and collapse voltage. The second part of this paper reports a set of characterization results and performances of the fabricated device: electrical impedance, mechanical displacements performed in water and acoustic pressure fields.

Thu 15:00 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Sensor design methodology for downhole sonic measurements – (Contributed, 000558)

H. Hori and Y. Wada
Schlumberger, 2-2-1 Fuchinobe Chuo-ku, 252-0206 Sagamihara, Kanagawa, Japan
Corresponding author E-mail: hori1@slb.com

The first sonic logging tools were mainly used to provide lithology identification in oil wells. Since this time, sonic logging evolved from monopole to multi-pole measurements in order to characterize formations and boreholes for safe and efficient well placement. Sonic tools transmit and receive acoustic waveforms propagating along the borehole. Acquired waveforms are to be processed for extracting interpretable borehole and formation properties. The purpose of such tool hardware is to record quality acoustic waveforms in a wide variety of boreholes and formations for different applications. The challenges lay in designing sensors to acquire signals for new measurements. We initiate and iterate hardware designs by utilizing numerical modeling followed by prototype evaluation, before validating the final design in actual oil wells. This paper presents general methodologies of downhole sonic sensor design based on numerical modeling and prototype evaluation.

Thu 15:20 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Displacement field of the membrane of condenser microphones at high frequencies: Improvement of analytical solution – (Contributed, 000409)

T. Lavergne, S. Durand, M. Bruneau and N. Joly
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: thomas.lavergne@univ-lemans.fr

Condenser microphones are reciprocal transducers whose properties (sensitivity, bandwidth and reliability) make them powerful measurement tools. For their common use under standard conditions they have been appropriately characterised for nearly thirty years. But nowadays, their miniaturisation (using MEMS processes) and their new uses for metrological purposes under non-standard conditions (i.e. in high frequency ranges, in gas mixtures, and at various static pressures and temperatures) require a much deeper characterisation with respect to these new uses.
Though recent literature on this topic [JASA, 128(6), pages 3459-3477 (2010)] leads to satisfying results according to these new requirements, the analytical solution given is not always sufficiently precise to interpret phenomena and must be improved to characterise more accurately the displacement field of the membrane up to high frequencies (up to 100 kHz).
Thus, the aim of the work presented here is to propose an improved analytical solution (especially by taking into account more appropriately the finite surface corresponding to the holes in the backing electrode) and to deduce results of interest, in particular concerning metrology purposes.

Thu 15:40 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Modelling of the electrical admittance of a piezoceramic cube using Ultrasonic Resonance Spectroscopy – (Contributed, 000483)

O. Diallo[a], E. Leclezio[b] and G. Feuillard[a]
[a]Université de TOURS, Enivl Rue de la Chocolaterie, 41034 Blois, France; [b]Université Montpellier 2 - IES - UMR CNRS 5214, place Eugene Bataillon, cc 082, 34095 Montpellier, France
Corresponding author E-mail: oumar.diallo@univ-tours.fr

Ultrasonic Resonance Spectroscopy allows the characterization of piezoelectric materials thanks to the study of their mechanical and electrical resonances. In order to simplify the method, the present work deals with the modelling of electrical admittance of rectangular shaped piezoelectric materials. First, the natural mechanical and electrical resonant frequencies of a piezoelectric cube are calculated from the stationary points of the Lagrangian of the system.
Then the electrical resonances are identified taking into account the short-circuit electrical boundary conditions and the electrical admittance is determined as a function of the frequency from calculations of the charge quantity on both electrodes of the cube.

Experimental measurements are carried out on a PMN-34.5PT ceramic cube. According to properties determined by mechanical velocity measurements, the cube presents a first resonance around 125 KHz. Experimental admittance measurements confirm the electrical modelling of the cube vibrations. To show the valitdity of the method for Non Destructive Evaluation applications, it is then applied to a piezoelectric material with unknown properties in order to determine its properties.

Thu 16:00 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Integration of high frequency piezoelectric transducer for Lab-On-Chip – (Contributed, 000480)

J. Gao[a], J. Carlier[a], S. Wang[a], P. Campistron[a], D. Callens[a], S. Guo[b], X. Zhao[b] and B. Nongaillard[a]
[a]IEMN-DOAE-UMR CNRS 8520, Avenue Poincaré - BP 60069 - 59652, 59650 Villeneuve D'Ascq, France; [b]Wuhan University, Physics department, Wuhan University, 430072 Wuhan, China
Corresponding author E-mail: pandagjm@msn.com

Acoustic wave systems have been widely used for medical diagnosis, non destructive evaluation of materials and viscosity measurements. The amplitude and phase of the acoustic wave is modified through the interaction between the acoustic wave and the propagating medium. For several application such as the detection or characterization of microscopic particles and the measurement of properties of chemical solutions, the choice of high frequency ultrasound allow us to reduce the volume of the analyzed sample and increase the sensitivity and the spatial resolution for the detection of microscopic objects.

We developed a 1GHz integrated microsystem based on longitudinal bulk waves which propagate inside a silicon wafer. In order to develop high frequency acoustic waves characterization in Lab-On-Chip, an heterogeneous technology has been developed based on the use of silicon, silicon dioxide, ZnO, PDMS. Silicon based acoustic mirrors have also been developed to guide the acoustic beam in a plane parallel to the surface of the substrate and through the microfluidic channel. Vertical mirrors not only guide the acoustic wave in the parallel plane, but also eliminate a part of the acoustic noise of the system. The application achieved until now concerns particle detection in water.

Thu 16:40 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Modeling of pseudo-periodic 1-3 piezo-composites for ultrasonic transducers – (Contributed, 000401)

R. Rouffaud[a], A.-C. Hladky-Hennion[b], M. Pham Thi[c], E. Leveugle[c] and F. Levassort[a]
[a]Université François Rabelais de Tours, UMRS Imagerie et Cerveau, 10, boulevard Tonnellé, BP 3223, 37032 Tours Cedex 01, France; [b]IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France; [c]Thales Research and Technology [Palaiseau], Route départementale 128, 91120 Palaiseau
Corresponding author E-mail: remi.rouffaud@univ-tours.fr

For SONAR applications, large area piezoelectric elements with high piezoelectric properties are required. Piezoelectric single crystals deliver high electromechanical coupling factor and the integration of these materials in a 1-3 piezoelectric composite fabrication process in using the standard "dice and fillï method (DFM) allows delivering thickness coupling factor over 80%. But, it is difficult to obtain these materials in large size while keeping homogeneous properties. A recent alternative process by a lamination technique (LMT) is highly appropriate for large area 1-3 piezo-composite samples. In this paper, piezoelectric composites with either PMN-28PT single crystal or PMN-34,5PT ceramic and polymer were characterized and modeled by Finite-Element Method (1 MHz). For comparison, piezo-composites were fabricated by DFM and by LMT. Theoretical and experimental electrical impedances as a function of frequency and electroacoustic responses of transducers integrated these materials were compared. Several differences were observed and have been attributed to a lack of the periodicity for LMT fabrication process, inducing the reduction of spurious resonant modes. In fact, these modes, in many instances, damage significantly the electromechanical efficiency of the 1-3 piezo-composites. The control of this parameter allows us to fabricate optimized samples.

Thu 17:00 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Electrophoretic deposition (EPD) process for lead zirconate titanate (PZT) thick films fabrication and high frequency medical imaging – (Contributed, 000475)

A.-P. Abellard[a], F. Levassort[a], D. Kuščer[b], J. Holc[b], J.-M. Grégoire[a], O. Noshchenko[b], M. Kosec[b] and M. Lethiecq[c]
[a]Université François Rabelais de Tours, UMRS Imagerie et Cerveau, 10, boulevard Tonnellé, BP 3223, 37032 Tours Cedex 01, France; [b]Jozef Stefan Institute, 39 jamova cesta, 1000 Ljubljana, Slovenia; [c]Université François Rabelais de Tours, GREMAN, ENIVL, Rue de la Chocolaterie BP 3410, 41034 Blois, France
Corresponding author E-mail: andre-pierre.abellard@etu.univ-tours.fr

High frequency ultrasonic devices operating over 20 MHz are required for medical diagnostics including skin and eye imaging. The main component in an ultrasonic transducer is a piezoelectric material such as PZT. It is usually surrounded by one or several matching layers, a focusing lens and a backing. Geometric and electromechanical properties of the piezoelectric layer strongly contribute to transducer performance. High-frequency operation requires piezoelectric materials with a thickness of few tens of micrometers that can be obtained by thick-film technologies.

The use of a lens in high-frequency transducers implies a significant decrease of transducer sensitivity due to losses.

So our interest is to use geometrical focusing of the acoustical beam. For this, the piezoelectric layer must be curved. Here, electrophoretic deposition (EPD) is used to deposit patterned piezoelectric structures on curved substrates. A stable suspension and an optimized deposition process have been developed to deliver homogeneous, crack-free deposits with uniform thickness. Deposited films were sintered, functionally and electromechanically characterized. Thickness coupling factors similar to those measured in bulk ceramics were observed.
Finally, the piezoelectric structures were used to fabricate high-frequency ultrasonic transducers which were characterized and integrated in an echographic probe to obtain *in-vivo* skin images.

Thu 17:20 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

High-frequency acoustic imaging with focused transducer for rapid micro echography of interfaces through buried structures non-perfectly planar – (Contributed, 000500)

G. Despaux and C. De Mello
Institut d'Electronique du Sud, Place Eugène Bataillon 34095 Montpellier Cedex 5
Corresponding author E-mail: gilles.despaux@univ-montp2.fr

The high frequency micro acoustic imaging (10MHz - 1GHz) reaches its limits when it is necessary to observe through absorbing or thick layers, not perfectly flat, at high frequency for a good resolution. The objective of this paper is to present a new method of acquisition and signal processing to image with high resolution buried defects through layers not perfectly flat and to reconstruct the topography and see possible delaminations. Typically a displacement of the focused transducer is achieved to maintain a constant temporal position of the echo of the interface to be examined. This allows the creation of an image of the interface, but the acquisition time and complexity of the device is often prohibitive. This method, in the continuity of a paper presented at the 2010 CFA, does not use a hardware control of the transducer, but a software control. Applications of this method allow the imaging of multilayers power electronics devices composed of stacks of conductive substrates or not conductive, with microelectronic circuits. Two types of representations are used: images and 3D reconstruction movies.

Thu 17:40 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Development of Love Wave devices based on delay line configuration for the high detection and monitoring of carbon monoxide – (Contributed, 000573)

M. Vanotti[a], V. Blondeau-Patissier[a] and S. Ballandras[b]
[a]Femto-st, 26 chemin de l'Epitaphe, 25030 Besançon, France; [b]femto-st, 26 chemin de l'epitaphe, Equipe CoSyMa, 25000 Besançon, France
Corresponding author E-mail: virginie.blondeau@femto-st.fr

Carbon Monoxide is produced by incomplete combustion. Its high toxicity and the lack of detection capability of human olfaction render CO a dangerous compound which is known as the "silent killerï. Therefore, there is the necessity to develop a device to detect the presence of low CO concentrations in indoor air. We here report on results obtained for CO detection by using SAW devices functionalized with new materials such as cobalt corroles.
During the tests, CO sensors have been exposed to changes of several experimental parameters (temperature, flow, pressure, presence of analyte gas). In order to exclusively extract the information concerning CO adsorption, we used a specific differential setup comprising two SAW devices

A minimum of 450ppb of CO concentration have been monitored and the experimentations have shown a great repeatability and stability of measurements. The test bench permits the regeneration of the trapping sites of CO allowing the reusability of the devices. These good results pave the way to the detection of other gas and even particles.

Thu 18:00 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

A new spice-like modeling tool for bio- and electro- acoustic systems including thermoviscous effects – (Contributed, 000627)

E. Delevoye[a], P. Honzik[a], N. Delorme[b] and Y. Arthaud[a]
[a]CEA-Leti MINATEC-Campus, 17 rue des Martyrs, F-38054 Grenoble Cedex 9, France; [b]ASYGN, Analog System Design, 445 rue Lavoisier, F-38330 Montbonnot, France
Corresponding author E-mail: elisabeth.delevoye@cea.fr

A dedicated toolbox has been developed within ASYGN a recent software tool that simulates aVLSI circuits at a high-level of modeling. It accounts in both time- and frequency- domain for the specific feature of bio- and electro- acoustic systems especially when some of the constituting elements are very thin or narrow. The models correspond to systems of complex equations in which some of the complex coefficients can be frequency dependent. Results are solved and viewed in real time. The tool was developed to introduce some improvement in the model of the auditory system of the cricket. In 2007 Reeve et al. designed and tested an electrical equivalent circuit based on Michelsen 1994. The latter results from two major simplification namely the absence of thermoviscous effects and of any acoustical role of a septum located in the middle of a transverse acoustic trachea. Thanks to the weak couplings the model can be subdivided into independent elements such as tubes, cavities or membranes simply connected together. Thermoviscous effects and the role of the medial septum can now be fully investigated. Our results were first validated using Matlab. Our model reveals interesting feature compared to its historical counterpart.

Thu 18:20 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Design and fabrication of an acoustic bragg mirror for miniaturized quartz resonators – (Contributed, 000702)

E. Lebrasseur, T. Baron, S. Alzuaga, J.-J. Boy, L. Couteleau and S. Ballandras
Femto-st, Département Temps-Fréquence, 26 Chemin de l'Epitaphe, 25030 Besançon, France
Corresponding author E-mail: eric.lebrasseur@femto-st.fr

The use of a Bragg mirror for the confinement of the energy in the resonator appears nowadays as a promising way to achieve monolithic resonators, with simplified packaging, free of the constraint effects induced by the traditional quartz cases and free of low resonant frequencies disturbances. Moreover, this approach offers the possibility of batch processing on four inches wafers. The expected benefits are a diminution of the quartz layer thickness, a rigid holding from the backside of the device, and the transfer of the electrical connections to the topside only. The packaging is further simplified by the fact that only the topside needs to be encapsulated, for instance by quartz bonding technology. In this work we present the design and fabrication of an acoustic Bragg mirror used to enhance the performances of traditional quartz resonators. The best materials configurations are determined by simulations and the mirror is fabricated by wafer bonding technology based on metallic compression.

Thu 18:40 Ray STEPHENS PU-S13: Sensors, transducers and acoustics microsystems

Modelling of wide frequency range silicon microphone for acoustic measurement – (Contributed, 000862)

D. Ekeom[a] and L. Rufer[b]
[a]Microsonics, 39, rue des Granges galand, 37550 Sain-Avertin, France; [b]TIMA Laboratory, 46, rue Félix Viallet, 38031 Grenoble, France
Corresponding author E-mail: didace.ekeom@microsonics.fr

Microphones are acoustic pressure variation sensors. Their bandwidth and sensitivity range from 20 Hz to 200 kHz and from 0.5 mV/Pa to 1.0 mV/Pa respectively. These specifications are inadequate for aero-acoustic applications, such as characterization of the "N-wavesï generated by supersonic flights that require wide frequency range (up to 1 MHz) microphone with flat response and high-pressure levels (up to 4 kPa).
This work demonstrates with numerical simulations, the feasibility of a wide frequency range and high pressure level piezoresistive microphones based on MEMS technology. An accurate lumped-element model was used to optimize the microphone dynamic response. Mechanical lumped parameters were extracted from structural FEM simulations, while squeeze film fluid parameters were extracted from FEM simulation of linearized Reynolds's equation, finally acoustic radiation parameters were extracted from a weak coupling between the FEM and the BEM.

Microphones with rectangular and circular membrane, vibrating in bending mode and suspended by four beams were simulated. In both cases we were able to achieve the specifications require for aero-acoustic applications: A frequency flat response up to 980 kHz and an electrical sensitivity of about 10.5 μV/Pa. The electrical noise and mechanical thermal signal to noise ratio were 6.4 μV/Pa and 67 dB respectively.

Thu 16:20 Lord RAYLEIGH PU-S08: Bones and ultrasound

Measurement of bone elasticity in the lab with ultrasound: problems, methods and open questions – (Invited, 000600)

Q. Grimal and P. Laugier
Laboratoire d'Imagerie Paramétrique, 15 rue de l'école de médecine, 75006 Paris, France
Corresponding author E-mail: quentin.grimal@upmc.fr

Cortical bone has anisotropic elastic properties determined by the microstructure and the quality of the mineralized collagen matrix. Knowledge of the stiffness coefficients is an issue for phenotyping, analyzing the biomechanical response to local strains or assessment of novel quantitative ultrasound (QUS) methods. Precise measurement methods which can be used routinely are still demanded. Since the work of Lang in the 60's, US methods have been popular to measure bone elasticity because they are mostly non destructive and can be adapted to any size and shape of samples. Traditional mechanical methods do not have this versatility. Adaptability of US stem from the possibility to choose the frequency. However different properties are measured depending on the frequency due to the heterogeneity of bone tissue. In the past years we have implemented a variety of US methods to measure bone. This includes (i) through-transmission and reflection methods dedicated to imaging bone elasticity with a resolution range 30micron-3mm; (ii) assessment of anisotropy from parallelepiped samples with various aspect ratios. We will present the recent developments and discuss the precision and accuracy of the methods.

Thu 17:00 Lord RAYLEIGH PU-S08: Bones and ultrasound

Nonlinear ultrasound monitoring of single microcrack propagation in cortical bone – (Contributed, 000034)

S. Haupert[a], S. Guerard[b], D. Mitton[c], F. Peyrin[d] and P. Laugier[a]
[a]Laboratoire d'Imagerie Paramétrique, 15 Rue de l'école de Médecine 75006 Paris; [b]Laboratoire de biomécanique, 151 Bvd de l'hôpital 75013 Paris; [c]Laboratoire de Biomécanique et Mécanique des Chocs, IFSTTAR UMR_T9406 25 avenue François Mitterrand 69675 Bron; [d]European Synchrotron Radiation Facility, 6 rue Jules Horowitz BP220 38043 Grenoble Cedex
Corresponding author E-mail: sylvain.haupert@upmc.fr

Accumulation of bone microdamage is suspected to lead to severe impairment of mechanical properties with an increase in skeletal fragility and fracture risk. The objective of the study was to evaluate the sensitivity of nonlinear resonant ultrasound spectroscopy (NRUS) measurements to the propagation in cortical bone of a single microcrack induced by 4-point bending mechanical loading. Twelve human cortical bone specimens were machined as parallelepiped beams (50*2*2mm) to unambiguously identify resonant modes for NRUS measurements. A central notch of 600 μm was made to control crack initiation and propagation during four-point bending loading. During stable crack propagation, load and displacement curves were recorded to extract mechanical parameters (J-integral J and stress intensity toughness K). Before and after toughness experiments, the nonlinear ultrasonic elastic coefficient (α_{f}) was monitored by NRUS for all notched samples. Despite substantial between-sample variability, α_{f} increased significantly (up to 50-fold) while no significant variation was observed for linear resonant frequency. Moreover, the crack length, assessed under epifluorescence microscope, was found to be significantly correlated to the nonlinear elastic parameter αf (r^2=0.7, p=0.01). These results strongly suggest that NRUS measurements are sensitive to damage accumulation and can be used as a marker of microcrack length.

Thu 17:20 Lord RAYLEIGH PU-S08: Bones and ultrasound

Measurement of anisotropic elasticity of cortical bone with resonant ultrasound spectroscopy – (Contributed, 000512)

S. Bernard, Q. Grimal, S. Haupert and P. Laugier
Laboratoire d'Imagerie Paramétrique, 15 rue de l'école de médecine, 75006 Paris, France
Corresponding author E-mail: simon.bernard@upmc.fr

Resonant Ultrasound Spectroscopy (RUS) is a method able to precisely characterise all the terms of the stiffness tensor of an anisotropic material from a single measurement of the mechanical resonant frequencies of a sample. A previous attempt to apply this method to bone was unsuccessful due to high mechanical damping of bone which causes resonance peaks to overlap. We built a custom RUS setup and applied a signal processing method which allows retrieving resonant frequencies even in the case of strong peak overlapping. We have tested the system by measuring a sample (about 4*7*8 mm^ 3) of fiber composite material which is a good substitute for bone in

terms of elasticity (anisotropy) and attenuation. Despite the strong damping, we were able to recover 13 different resonant frequencies among the 20 first frequencies predicted by the theory. The elastic coefficients estimated from the measured resonant frequencies were confirmed by time-of-flight elasticity measurement performed in the principal direction of the sample. These results indicate that it should be possible to fully and precisely characterize the elasticity of small cortical bone specimens with a RUS system.

Thu 17:40 Lord RAYLEIGH PU-S08: Bones and ultrasound

Improvement of the precision of Quantitative Ultrasound (QUS) measurements at the calcaneus by tilting of the beam incidence angle – (Contributed, 000768)

R. Barkmann, M. Daugschies, K. Rohde and C.-C. Glüer
Universitätsklinikum S-H, Am Botanischen Garten 14, 24105 Kiel, Germany
Corresponding author E-mail: barkmann@rad.uni-kiel.de

QUS measurements at the calcaneus can be used for the estimation of osteoporotic fracture risk, but the use for therapy monitoring is unclear yet. One reason might be the limited precision of commercial devices. Our intent was to investigate the impact of the beam incidence angle at the calcaneus on the precision of the speed of sound (SOS). We developed a device with an array (120 elements) as receiver (d=100mm) and one single element emitter of the same size. Both are placed on opposite sides of the foot and mounted on a c-arm which can be rotated and tilted. SOS of 6 volunteers was measured three times with repositioning with our device (angles from 0° to 14°, step size 3.5°) and with the commercial device Achilles Insight. The pair of angles used by the Achilles and those yielding the highest amplitude of the first oscillation was analyzed. The precision of the Achilles was 9.4 m/s, the precision of our device at the Achilles angles was 2.9 m/s and 2.0 m/s at the individually defined angles. We achieved a better precision with our device than with the Achilles Insight, which can even be improved by measuring under the optimal tilting angles.

Thu 18:00 Lord RAYLEIGH PU-S08: Bones and ultrasound

Modeling ultrasound interaction with cancellous bone: investigation on the nature of the two compressional waves – (Contributed, 000287)

F. Meziere, M. Muller, E. Bossy and A. Derode
Institut Langevin, 10 rue Vauquelin, 75005 Paris, France
Corresponding author E-mail: fabien.meziere@espci.fr

Although ultrasound might be useful to assess bone quality, the mechanisms of ultrasound propagation in trabecular bone are still poorly understood. For example the propagation of a short pulse that leads, under some conditions, to two transmitted longitudinal waves, a fast and a slow one, is not well explained yet. The objective of this work is to further investigate the nature of these two longitudinal waves in simplified bone model media. The approach is to determine if the fast wave could result from a guided propagation in the solid matrix, the slow wave being due to the propagation in the surrounding fluid (bone marrow). In this context, we studied the propagation of the coherent waves through simplified and customizable binary structures, obtained by a random addition of scatterers, with characteristic dimensions, material properties and anisotropy similar to those of bone. The benefit of such simplified structures is that ultrasound propagation in the entire medium can be theoretically studied from the properties of a single scatterer.

Thu 18:20 Lord RAYLEIGH PU-S08: Bones and ultrasound

Efficacy of bisphosphonate zoledronic acid is substantially improved by low intensity ultrasound in the treatment of breast cancer bone metastases in animals – (Contributed, 000173)

S. Tardoski[a], D. Melodelima[a], J. Ngo[a], D. Goehrig[b] and P. Clézardin[b]
[a]INSERM U1032, 151 cours albert thomas, 69424 Lyon, France; [b]INSERM U1033, 7 rue Guillaume Paradin, 69372 Lyon, France
Corresponding author E-mail: sophie.tardoski@inserm.fr

Breast tumor cells metastasize to the skeleton and stimulate osteoclast-mediated bone resorption, leading to the formation of osteolytic lesions. Bisphosphonate drugs are potent inhibitors of osteoclast-mediated bone resorption. The feasibility of combining the action of a bisphosphonate (zoledronic acid) with low intensity ultrasound was tested

in this study. Mechanical effects (1.24 MHz) were created using pulsed ultrasound (200 μs) at 400 mW/cm2 (SATA) repeated every 1 ms. Thermal effects (2.85 MHz) were produced using 7 acoustic watts in continuous mode. Fifty-eight mice bearing bone metastases were included and randomized into 8 groups. A single dose of zoledronic acid was combined with a single or daily application of ultrasound (repeated for 15 days). Each ultrasound treatment lasted 30 minutes. These treatment strategies were compared with vehicle, ultrasound alone and zoledronic acid alone. Ultrasound alone did not have any inhibitory effect on bone destruction when compared to vehicle-treated animals. As expected, zoledronic acid alone reduced bone destruction compared to vehicle. Most importantly, we found a further statistically significant decrease of bone destruction as well as a reduced skeletal tumor burden in metastatic animals that received a daily treatment with ultrasound (thermal or mechanical) in combination with zoledronic acid.

Thu 18:40 Lord RAYLEIGH PU-S08: Bones and ultrasound

Echographic response of the bone-implant interface: dependence on healing time – (Contributed, 000718)

V. Mathieu[a], R. Vayron[a], E. Soffer[b], F. Anagnostou[b] and G. Haiat[a]
[a]Laboratoire MSME, 61, avenue du Générale De Gaulle, bâtiment P2, bureau 352 C, 94010 Créteil, France, Metropolitan; [b]Biomécanique et Biomatériaux Ostéo-Articulaires,
Corresponding author E-mail: vincent.mathieu@u-pec.fr

The effect of bone healing on the ultrasonic response of coin-shaped titanium implants is investigated. Two groups of eight implants were inserted on the tibiae of New Zealand White rabbits, each group corresponding to a healing duration (7 or 13 weeks). After the sacrifice, a 2-D scanning device was used in order to measure the ultrasonic response of the bone-implant interface in vitro at 15 MHz. The average value of the ratio r between the amplitudes of the echo of the bone-implant interface and of the water-implant interface was determined. Histological techniques were used to determine the fraction of implant surface in contact with bone (BIC). The ultrasonic quantitative indicator r is significantly higher ($p = 2.10^{-4}$) after seven weeks of healing time (r = 0.53) than after thirteen weeks (r= 0.49). The increase of mineralization of newly formed bone tissue and the increase of the BIC (from 27 % to 69 %) are responsible for the decrease of the gap of acoustical impedance at the bone-implant interface.

Thu 16:40 Peter BARNETT AH-S04: Impedance conditions with flow

A review of time domain impedance boundary conditions – (Invited, 000136)

C. Richter
Rolls-Royce Deutschland LTD & Co. KG, Eschenweg 11, Dahlewitz, 15827 Blankenfelde-Mahlow, Germany
Corresponding author E-mail: christoph.schemel@web.de

Over the last 15 years, time domain impedance boundary conditions have been investigated by various authors. In a review, a general framework of time domain impedance boundary conditions is presented and then filled with a set of outstanding mathematical and numerical methods from literature. All of the authors struggled with an instability with grazing flow. Mainly this is linked to the Ingard or Myers model of the sound propagation through a sheared flow. This is reviewed in a broader context including possible applications of impedance boundary conditions (i.e. turbomachinery noise and noise absorber optimization) into this discussion. Stable solutions are presented, that go from simple workarounds which are based on the wave number characteristics of the instability to a completely different modeling of the physics. At one end of the scale are seemingly trivial ideas, as the use of the Ingard/Myers boundary condition on a coarser mesh or a fully resolved flow profile; and at the other end high fidelity DNS simulations of single cells and holes under gazing flow conditions is put the whole idea of macroscopic impedance on test. It is shown, that each solutions has its advantages for some applications and may be infeasible in other cases.

Thu 17:00 Peter BARNETT AH-S04: Impedance conditions with flow

Review of acoustic liner models with flow – (Invited, 000152)

E. J. Brambley
DAMTP, University of Cambridge, DAMTP, CMS, Wilberforce Road, CB3 0WA Cambridge, UK
Corresponding author E-mail: E.J.Brambley@damtp.cam.ac.uk

Acoustic linings are routinely used in the intakes and bypass ducts of civilian aeroengines in order to reduce noise. They are often modelled as a complex impedance, $Z(\omega) = p/v$, where a pressure $p\exp\{i\omega t\}$ gives rise to a fluid velocity normal to the liner of $v\exp\{i\omega t\}$. This presentation will give a review of acoustic lining models, including both physical (empirically derived) models for $Z(\omega)$, and mathematical models for the boundary condition to be applied at an acoustic lining. The application of the boundary condition is complicated by the presence of a mean flow over the lining; a situation typically encountered in aeroengines. The controversy over the stability of flow over an acoustic lining will be explained, together with recent attempts to resolve this controversy, both experimentally and mathematically.

Thu 17:20 Peter BARNETT AH-S04: Impedance conditions with flow

Boundary condition at the interface between air duct and porous material with rigid frame for the lined ducts with a grazed flow – (Contributed, 000806)

Y. Renou and Y. Aurégan
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: ygaal.renou@univ-lemans.fr

In flow ducts such as engine duct systems in aeroplanes, the reduction of noise is usually accomplished by means of materials composed of a perforated sheet backed by honeycomb cavities (also known as SDOF liners). In front of the complexity of modeling with accuracy the acoustic propagation superimposed with a turbulent grazing flow, especially in the sheared boundary layer, an uniform mean flow is widely assumed for the simplication of the computations. The associated boundary condition is well known as the Ingard-Myers condition assuming the continuity of normal particle displacement at the surface of the liner. The failure of this condition associated with uniform flow was recently demonstrated with an experimental approach. The results showed that a mixture between normal acoustic displacement and normal acoustic velocity must apply, depending on the relative importance of the stationnary flow and acoustic boundary layers thicknesses, respectively. The present study aims at providing an experimental identification of the adequate boundary condition at interface between the air duct and a porous material with rigid frame in presence of a grazed flow. The correct boundary condition is deduced by fitting the measured scattering matrix and the predicted scattering matrix computed by a spectral collocation method, the new boundary condition and an accurate mode-matching scheme.

Thu 17:40 Peter BARNETT AH-S04: Impedance conditions with flow

Theoretical and numerical investigation of optimal impedance in lined ducts with flow – (Contributed, 000203)

J. Rodríguez Sánchez, E. Piot and G. Casalis
ONERA - The French Aerospace Lab, 2 av Edouard Belin, F-31055 Toulouse, France
Corresponding author E-mail: Javier.Rodriguez_Sanchez@onecert.fr

Sound attenuation in ducts with flow is an important issue in aeronautics; it might be realized by covering the inner walls with a liner characterized by its acoustic impedance. Usually, the best sound attenuation is achieved when the liner yields the highest insertion loss. In the present study, liners are considered infinite in the direction of sound propagation. Thus the interest lies within the liner with the highest sound absorption. Analytic formulas for the optimal impedance are found in the literature without flow and with a uniform flow.
In this work, a linear stability analysis of the Euler equations is carried out, to find the spatial modes for a rectangular rigid duct but with the lower wall lined. Cases without flow, with uniform flow and with a sheared flow are considered.

The code has been validated against analytical solutions. Without flow, for an impedance very close to the "optimal" one, a saddle point is found in the spectrum, called the double point in literature.

The link between the optimal impedance and the behaviour of modes around the double point is investigated through the group velocities, in both cases without and with flow.

Thu 18:00 Peter BARNETT AH-S04: Impedance conditions with flow

Evaluation of an adjoint-based liner impedance eduction technique – (Contributed, 000217)

J. Primus, E. Piot and F. Simon
ONERA - The French Aerospace Lab, 2 av Edouard Belin, F-31055 Toulouse, France
Corresponding author E-mail: julien.primus@onera.fr

Acoustic liners placed in the aircraft nacelles play a key role in the reduction of turbofan noise. To determine their acoustic impedance, an " eduction method " with grazing flow is developed. It relies on the minimization of an objective function describing the distance between experimental data on one hand and numerical results obtained with 2-D Linearized Euler Equations on the other hand. The gradient of the objective function is calculated thanks to the adjoint equations rather than with finite differences, which gives more accurate results and makes easier a multi-parameter identification. The procedure is intended to be applied in a duct with non-intrusive acoustic velocity measurements obtained as close as possible to a sample liner by Laser Doppler Velocimetry (LDV), contrary to classical methods which use distant wall microphones. The eduction process is validated on results from literature and on LDV measurements performed at Onera, for different frequencies and flow configurations. Access to two-dimensional fields ensured by LDV allows to study the relevance of different objective functions and observation domains.

Thu 18:20 Peter BARNETT AH-S04: Impedance conditions with flow

Sound absorption by perforated walls with bias / grazing flow: experimental study of the influence of perforation angle – (Contributed, 000564)

E. M.T. Moers[a], D. Tonon[b] and A. Hirschberg[b]
[a]Dynamics and Control group, Department of Mechanical Engineering, Eindhoven University of Technology, P.O.B. 513, 5600 MB Eindhoven, Netherlands; [b]Mesoscopic Transport Phenomena, Department of Applied Physics, Eindhoven University of Technology, P.O.B. 513, 5600 MB Eindhoven, Netherlands
Corresponding author E-mail: e.m.t.moers@tue.nl

Perforated walls are encountered in many acoustic dampers. For most of these perforations, the main cause of damping is the interaction of flow with the acoustic field at the perforation. We discuss the effect of changing the angle that the perforation makes with the wall on the acoustical performance.
Experimental data are acquired by impedance tube measurements and a multi-microphone method Hereby we obtain the acoustic response of the perforation and flow to excitation by an external sound source. The accuracy in the measured normal incidence reflection coefficient is of the order of 1% in the frequency range 50Hz-800Hz. The perforations have a slit-shaped cross-section (10mmx50mm). The plate thickness is 15mm. We consider a flow that is either purely grazing along the perforation or a combination of grazing flow and flow through the perforation. Velocities below 20m/s are considered. We concluded that perforations for which the upstream edge (with respect to the grazing flow) makes an acute angle of 30degrees with the wall, have an increased sound absorption at low Strouhal numbers based on the perforation width in flow direction, compared to perforations with a right or an obtuse angle. We explain this qualitatively using the vortex sound theory.

Thu 16:40 Yves ROCARD NV-S04: Structure-borne noise source identification

Prediction of structure-borne vibration for an assembly of three structures in series – (Contributed, 000208)

M.-H. Moulet[a] and V. Martin[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]CNRS, UMR CNRS/UPMC 7190, Institut Jean Le Rond d'Alembert, 75005 Paris, France
Corresponding author E-mail: marie-helene.moulet@univ-lemans.fr

The prediction of structure-borne sound and vibration in an assembly of two structures needs the prediction of the forces applied by the source structure on the host or receiver structure. Often, the source structure excites the receiver through an intermediary structure. Two ways are possible to describe three structures in series: by creating a new receiver as the assembly of the intermediary and receiver structures or by creating a new source as the assembly of intermediary and source structures. A recent study showed in an industrial case that the prediction of forces for three structures in series was better when based on inertance measurements of certain coupled structures rather than of isolated structures.
In the present paper, the numerical coupling (by finite elements) of three beams in series is considered. No rotation degrees of freedom are taken into account. In the first part, three different methods used to calculate forces applied on the receiver beam are recalled. Then, in the second part, simulation results obtained with these three methods are compared and discussed. In particular, if the rotation degrees of freedom are responsible of the differences observed during the measurements, such differences would not occur in the numerical experiments.

Thu 17:00 Yves ROCARD NV-S04: Structure-borne noise source identification

Operational transfer path analysis: theoretical aspects and experimental validation – (Contributed, 000443)

C. Sandier[a], Q. Leclere[a] and N.B. Roozen[b]
[a]INSA - LVA, 25 bis avenue Jean Capelle, 69621 Villeurbanne, France; [b]Delft University of Technology, Faculty of Aerospace Engineering, M2i, P.O. Box 5, 2600 AA Delft, Netherlands
Corresponding author E-mail: celine.sandier@insa-lyon.fr

Operational transfer path analysis (OTPA) is a diagnosis method aiming to identify and rank noise transmission paths in dynamic systems. The particularity of the method is to require no preliminary acquisition of a transfer matrix between excitation and response dofs, as it is the case for classical TPA approaches. OTPA is based on the identification of a transmissibility matrix between some input and output responses measured for various operating conditions. The first difficulty of the method concerns the definition of this transmissibility matrix, from either a theoretical or experimental point of view. The second difficulty is the use of this matrix for diagnosis purposes, requiring some assumptions leading to potential misunderstandings. Theoretical aspects of the method are firstly discussed in this work. Secondly, an experimental validation is carried out on an academic test setup, and OTPA results are compared to the classical TPA approach.

Thu 17:20 Yves ROCARD NV-S04: Structure-borne noise source identification

Operational transfer path analysis applied to a small gearbox test set-up – (Contributed, 000825)

N.B. Roozen[a], Q. Leclere[b] and C. Sandier[b]
[a]Delft University of Technology, Faculty of Aerospace Engineering, M2i, P.O. Box 5, 2600 AA Delft, Netherlands; [b]INSA - LVA, 25 bis avenue Jean Capelle, 69621 Villeurbanne, France
Corresponding author E-mail: n.b.roozen@tudelft.nl

Operational Transfer Path Analysis (OTPA) is very attractive from a practical point of view, as it not requires an expensive measurement campaign in which transfer functions are measured, as is the case in the traditional Transfer Path Analysis (TPA). Instead, transmissibilities are measured from operational data, making the method relatively cheap in terms of measurement efforts. In practice, however, a lot of difficulties have to be overcome. In the paper measurements on a small gearbox are discussed. Both OTPA and the traditional TPA measurements were performed, allowing an objective comparison of OTPA. The difficulties for practical application of OTPA are discussed and conclusion are drawn from these measurements.

Thu 17:40 Yves ROCARD NV-S04: Structure-borne noise source identification

A new technical standard as a reference NVH method for dynamic forces evaluation and prediction at the interface of an active component and a passive structure – (Contributed, 000860)

J.-P. J. Roux[a] and D. D. Scouarnec[b]
[a]CEVAA, 2 rue Joseph Fourier, Technopôle du Madrillet, 76800 Saint-Etienne Du Rouvray, France, Metropolitan; [b]Valeo Systèmes Thermiques, 8 rue Louis Lormand, BP 17, 78321 La Verrière Cedex, France, Metropolitan
Corresponding author E-mail: denis.scouarnec@valeo.com

Component suppliers for the automotive industry have to characterize their products without the vehicle under development. This is currently a major topic of discussion between suppliers and manufacturers during the various stages of validation plan. IACV programs aims to develop a general method of prediction of applied forces at the interface of an active component and a car body, regarding the vibro-acoustics comfort inside the vehicle. This methodological approach is a key research topic mainly due to the difficulty to well characterize interfaces between component and car body. In order to well establish NVH standard for structure-borne noise evaluation and prediction of entering forces into the chassis, a general method for the estimation of the force vector applied by this component on a test bench with the knowledge of mobility characteristics of source and the receiver is established. The present study is introducing this new technical standard as a reference NVH method (Norme IACV) for French car manufacturers and suppliers. In addition, we associate with this general technical specification a presentation of the full process of IACV methodology adapted to the particularity of an innovating active component.

Thu 16:40 François CANAC PU-S03: Phononic crystal and metamaterials

Effects of evanescent waves in phononic crystals with linear defects – (Invited, 000451)

V. Romero-Garcia[a], R. Pico[a], J. Vasseur[b], A.-C. Hladky-Hennion[b], V. Sanchez-Morcillo[a] and L.M. Garcia-Raffi[a]
[a]Universidad Politecnica de Valencia, Paranimf 1, 46730 Gandia, Valencia, Spain, 46730 Gandia, Spain; [b]IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France
Corresponding author E-mail: virogar1@gmail.com

Periodic structures with linear defects have been traditionally analyzed with the $\omega(\vec{k})$ methods with the supercell approximation. The presence of the linear defect introduces guided modes at frequencies in the band gap of the complete structure. This methodology only considers the propagating properties of the periodic system. In this work we report both theoretical predictions and experimental results considering both the evanescent and propagating waves. We obtain the evanescent properties from the complex band structures solving the inverse problem $k(\omega)$ with the Extended Plane Wave Expansion (EPWE). From the Fourier transform of the complex eigenvectors we obtain the acoustic field profile inside the system showing both the evanescent and the propagating properties. A good agreement between both the Multiple Scattering predictions and data with the EPWE simulations is obtained. The presence of evanescent waves is of fundamental interest for the design of devices based on periodicity providing a complete picture of the physical properties of the system.

Thu 17:00 François CANAC PU-S03: Phononic crystal and metamaterials

Tunability of one-dimensional piezoelectric or piezomagnetic phononic crystals – (Contributed, 000077)

S. Degraeve[a], C. Granger[a], B. Dubus[a], J. Vasseur[a], A.-C. Hladky-Hennion[a] and M. Pham Thi[b]
[a]IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France; [b]Thales Research and Technology [Palaiseau], Route départementale 128, 91120 Palaiseau
Corresponding author E-mail: sebastien.degraeve@isen.fr

Phononic crystals (PC) are the elastic counterparts to photonic crystals and consist of periodic arrangements of inclusions in a matrix. Due to their periodic structure and depending on the geometry and composition, PCs may exhibit absolute band gaps where the propagation of elastic waves is forbidden whatever the propagation direction of the incident waves is. We propose a way of conferring tunability to PCs, based on piezoelectric or piezomagnetic inclusions. We demonstrate that the effective velocity in piezoelectric or piezomagnetic elements can be continuously tuned by varying electrical or magnetic boundary conditions. Analytical expressions of the band gaps central frequencies and bandwidths are obtained for a one-dimensional PC. The proposed method provides a continuous control of effective velocities with linear transduction mechanism contrary to previous works which could only switch between two values of effective velocities: when the piezoelectric effect is taken into account or not. Effective velocity variation measured on a PZT disk connected to an external capacitance displays a good agreement with theoretical results.

Thu 17:20 François CANAC PU-S03: Phononic crystal and metamaterials

Directional asymmetry of the nonlinear wave phenomena in a 3-dimensional phononic granular crystal under gravity – (Contributed, 000216)

A. Merkel[a], V. Tournat[b] and V. Gusev[c]
[a]Departamento de Fisica, FCFM, Universidad de Chile, Avenida Blanco Encalada, 2008, 8370449 Santiago, Chile; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [c]Laboratoire de physique de l'état condensé, Faculté des Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: amerkel@ing.uchile.cl

A periodic ordered structure of monodisperse spherical beads forms a granular phononic crystal. The granular crystals combine in their dynamic behavior the effects of the geometrical periodicity (phononic effects), the rotational degrees of freedom (rotational inertia) and nonlinearities. We report the experimental observation of the asymmetry introduced by the gravity in the nonlinear transformation of acoustic waves in granular assemblages. Because of the gravity, the contact pre–compression increases with depth inducing variations with depth of not only the linear and nonlinear elastic moduli but also of the linear and nonlinear dissipation of the acoustic waves. We show experimentally and explain theoretically that the amplitude of the self-demodulated wave (i.e., the amplitude of the wave emitted by a parametric antenna through a frequency-mixing down- conversion process) depends in the granular media on whether the propagation of the pump waves is in the direction of the gravity or in the op-

posite direction. The measurements of the gravity-induced asymmetry in the nonlinear acoustic phenomena allow to compare the in-depth distributions of the contact nonlinearity and of acoustic absorption.

This work is supported by project "STABINGRAM" ANR-2010-BLAN-0927-03.

Thu 17:40 François CANAC PU-S03: Phononic crystal and metamaterials

Transmittivity of 2D graded phononic crystals in the frequency and time domains – (Contributed, 000332)

O. Lenoir[a], K. Zong[a], H. Franklin[b] and M. Predoï[a]
[a]Laboratoire Ondes et Milieux Complexes, Université du Havre, Place R. Schuman, 76610 Le Havre, France; [b]LOMC, CNRS UMR 6294, Université Le Havre, 25, rue Philippe Lebon, 76600 Le Havre, France
Corresponding author E-mail: olivier.lenoir@univ-lehavre.fr

The media of interest are composed of N parallel infinite rows of steel cylindrical shells, periodically spaced, immersed in water. The influence of geometrical perturbations from rows to rows are investigated. Either the inner radius of the shells between two adjacent rows is varied, or the spacing between the rows is changed. The steel rows can also be replaced by steel-polyethylene bilayers. Time domain simulations have been performed using COMSOL® to visualize the spread of wave packets in the structures. In the frequency domain, the stop bands and pass bands of the transmission coefficient in the different cases are compared. The perturbations cause either the appearing of narrow pass bands in the stop bands, or the widening of the stop bands. If a harmonic plane wave is normally incident on an infinite row, we highlight the transmission (resp. the total reflection) of the waves by the phononic crystal for certain frequencies located in pass bands (resp. stop bands). If the incident wave is sent normally to the N rows, deviations or focalizations of the transmitted waves with respect to the incident direction are observed.

Thu 18:00 François CANAC PU-S03: Phononic crystal and metamaterials

Acousto-optic interaction in 2D LiNbO3 phoxonic crystal – (Contributed, 000490)

Q. Rolland, S. Dupont, J. Gazalet, J.-C. Kastelik and Y. Pennec
IEMN, UVHC, IEMN UMR 8520, F-59313 Valenciennes, France
Corresponding author E-mail: Quentin.Rolland@univ-valenciennes.fr

Recently, the possibility to create simultaneously a photonic and a phononic crystal, also called phoxonic crystal, led to a growing interest in the scientific community. Several groups have conducted intensive research to study acoustic and electromagnetic waves in periodic structures in order to find simultaneous bandgaps, these structures commonly consist in arrays of holes drilled in a matrix. Such structures are expected to allow an enhancement of the acousto-optic interaction through the localization of both waves by adding defects in periodic structures.
We investigate in this paper the acousto-optic interaction in LiNbO3 phoxonic crystals. The model is based on a 2D crystal using Finite Element Method. A first work consists in finding out the most suitable filling factor and lattice parameter so as to have simultaneous bandgaps. Afterwards we discuss how the electromagnetic wave is affected by elasto-optic and electro-optic effects. We examine the impact of the defect modes distribution on the acousto-optic interaction, the results show a possible increased modulation efficiency caused by the strong confinement of both waves in the defect. The impact of crystal cuts and wave propagation directions will be discussed.
This work has been carried out within project n°ANR-09-NANO-004 funded by ANR (P3N2009).

Thu 18:20 François CANAC PU-S03: Phononic crystal and metamaterials

Multifonctional solid/solid phononic crystal – (Contributed, 000519)

J. Vasseur[a], N. Swinteck[b], S. Bringuier[b], A.-C. Hladky-Hennion[a] and P. Deymier[b]
[a]IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France; [b]Department of Materials Science and Engineering, University of Arizona, Tucson, AZ 85721, USA
Corresponding author E-mail: jerome.vasseur@univ-lille1.fr

A two-dimensional, solid-solid phononic crystal (PC) made of a square array of steel cylinders in epoxy is shown to perform a variety of spectral, wave vector and phase-space capabilities. Over a range of operating frequencies, the PC elastic band structure shows uniquely shaped equi-frequency contours that are only accessible to excitations of longitudinal polarization. Under this condition, the PC is shown to behave as (1) an acoustic wave collimator, (2) a directional source for elastic waves, (3) a defect-less wave guide, (4) an acoustic beam splitter and (5) a phase-control device. Finite-difference time-domain simulations and experimental demonstrations are used to qualify the above mentioned capabilities.

Thu 18:40 François CANAC PU-S03: Phononic crystal and metamaterials

Phase shift and group delay in phononic crystals of pillars on a surface – (Contributed, 000652)

Y. Achaoui[a,b], M. Addouche[a], V. Laude[a], S. Benchabane[a] and A. Khelif[a]
[a]Franche-Comté Électronique Mécanique, Thermique et Optique - Sciences et Technologies, 32 avenue de l'Observatoire 25044 Besancon Cedex; [b]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20
Corresponding author E-mail: younes.achaoui@femto-st.fr

The last years have seen a significant rise in the number of studies of band gap materials for acoustic waves. Basically, these artificial materials can be classified into two distinct families: phononic crystals and acoustic metamaterials. Indeed, they can both prohibit the propagation of acoustic waves in certain frequency ranges for all directions of incidence, but the physical phenomena behind are markedly different. The key parameter to obtain band gaps in the case of phononic crystals is periodicity, while the local frequency resonance of each basic cell dominates in the case of acoustic metamaterial. Propagation of acoustic waves in phononic crystals has been reported for bulk, Lamb and surface acoustic waves. Most of the experimental studies focused on the attenuation involved within band gaps. The purpose of the present paper is to investigate the phase shift and the groupe delay induced by a periodic structure of pillars on a surface in a wide frequency range owning locally-resonant and Bragg band gaps. The experimental dispersion curves are presented accordingly and a very good agreement between theory and experiment is obtained.

Thu 9:00 Philip DOAK AA-G02: Building acoustics

The acoustical flows of the hydrophobic and anticeptic liquids in porous media – (Contributed, 000010)

V. Tsaplev
North-West State Technical University, 5, Millionnaya Street, Department of Physics, 191186 Saint-Petersburg, Russian Federation
Corresponding author E-mail: valery@convergences-fr.ru

The paper presents the results of the experimental studies of the acoustical flows in the porous or microcrumbling media. Concrete and brick walls being porous media absorb water due to capillary effect. The damp penetrates into the foundation if the waterproofing layer between the foundation and the wall is damaged, the damp comes up the wall due to the natural capillary effect. Just the same, if the protective covering of the concrete or brick wall is damaged, they begin to absorb the damp from the air, growing damp by and by and worsening their protective properties. There exist some ways to restore damaged waterproofing layers. One possible way is to impregnate walls or/and foundations by some special hydrophobic liquid using the ultrasound. Being then dried out, the elements of constructions become water-repellent, do not absorb damp any more and remain dry. The usage of the ultrasound makes the impregnation much more effective and fast, being at the same time the nondestructive method. The speed of the penetration depends on the porosity or microcrack factor. The paper presents the results of the study of the dependence of the velocity of the hydrophobic liquid movement from the average diameter of the capillaries and from the acoustical intensity.

Thu 9:20 Philip DOAK AA-G02: Building acoustics

BEM for the prediction of standardized scattering and diffusion coefficients of diffusers – (Contributed, 000858)

A. Randrianoelina[a], M. Hornikx[b], R. Van Luxemburg[c], S. Van Eijndhoven[a] and A. Dastouri[a]
[a]TU Eindhoven, Department of Mathematics and Computer Sciences, 5600 MB Eindhoven, Netherlands; [b]Building Physics and Services, Eindhoven University of Technology, P.O. box 513, 5600 MB Eindhoven, Netherlands; [c]Level Acoustics, De Rondom 10, 5612 AP Eindhoven, Netherlands
Corresponding author E-mail: ando.randrianoelina@googlemail.com

For the prediction of the scattering and diffusion coefficients of acoustic diffusers, a computational method is used based on the measurement methods as prescribed in standards ISO 17497-1 and AES-4id-200. The numerical calculations concern a 2D implementation of the Boundary Element Method (BEM) in the frequency domain. The modelling approach aimed at reproducing the standardized measurement conditions as well as minimizing computational times. Modelling of the diffusion coefficient is mainly based on geometrical constraints from the standards. The prediction of the scattering coefficient requires to model physical processes during measurements, namely, the diffuse sound field and the specularly reflected energy. Also, the following computational aspects were considered: mesh density and required number of frequencies for broadband predictions, and use of separate and simultaneous sound sources. With the simulation method developed, the scattering and diffusion coefficients as well as the directivity patterns of a Schroeder diffuser and an undulated surface industrially manufactured have been computed.

Thu 9:40 Philip DOAK AA-G02: Building acoustics

Sound absorption coefficient of a porous material covered with a low open area perforated plate under high sound excitation – (Contributed, 000436)

R. Tayong, T. Dupont and P. Leclaire
LRMA-DRIVE, ISAT, 49 rue Mademoiselle Bourgeois - BP 31, 58027 Nevers, France
Corresponding author E-mail: rostand.tayong@u-bourgogne.fr

The sound absorption coefficient of porous materials covered with low open area perforated plate is studied under high sound intensities in the absence of mean flow. The theoretical considerations are based on the equivalent fluid following the Johnson-Champoux-Allard approach and the use of the transfer matrix method. To take into account the high sound levels effects, the air flow resistivity of each layer is modified following the Forchheimer law. Two specimens of perforated plate are built and tested when backed by a polymeric foam and a fibrous material. A specific impedance tube setup is developed for the measurement of the surface acoustic impedance for sound pressure levels ranging from 90 dB to 150 dB at the surface of the perforated facing. To corroborate the validity of the presented method, prediction and measurements are compared for the case where the perforated facing and the porous material are both directly backed by a rigid wall. Good agreement is observed between the simulation and the experimental result.

Thu 10:00 Philip DOAK AA-G02: Building acoustics

Study of the effect of finite extent on sound transmission loss of single panel using a waveguide model – (Contributed, 000142)

I. Prasetiyo and D. J. Thompson
Dynamics Group - ISVR - University of Southampton, University Road, SO17 1BJ Southampton, UK
Corresponding author E-mail: ip1g08@soton.ac.uk

The sound transmission loss (STL) of a panel is often estimated using an infinite plate model. However, some discrepancies are found between these predicted results and experimental ones. One of the sources of such discrepancies corresponds to the finite extent that is naturally found in real structures. In the present study an analytical waveguide model of sound transmission is used to study the effect of finite dimensions in one direction for a panel which is long in the other dimension. The resulting model is used to investigate the effect of the finite width on the STL through a simple case of an infinite plate strip with simply supported boundary conditions. The results obtained are compared with those for the infinite plate. The resulting analytical model can also be used to provide benchmark solutions for validating numerical methods such as waveguide FE/BE. Examples of such benchmark comparisons are also provided.

Thu 10:40 Philip DOAK AA-G02: Building acoustics

Elements for an acoustic classification of dwellings and apartment buildings in France – (Contributed, 000109)

C. Guigou-Carter, R. Wetta, R. Foret and J.-B. Chene
Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères
Corresponding author E-mail: catherine.guigou@cstb.fr

The aim of the study is to present elements for an acoustic classification of dwellings and apartment buildings. The goal would be to have similarly to energy performance of building or dwellings a classification of the acoustic performance from A (very good) to F (very bad) for example that would be easily understandable by a common person. The work carried out in the European COST Action TU0901 "Integrating and Harmonizing Sound Insulation Aspects in Sustainable Urban Housing Constructionsï is concerned with the harmonization of acoustic descriptors used in Europe as the sound insulation classes. Sound insulation classes exist in more than 10 European countries for impact and airborne sound insulation. The different European approaches used to determine the acoustic performance classes are briefly described. A classification that could be implemented in France is proposed for discussion.

Thu 11:00 Philip DOAK AA-G02: Building acoustics

Characterization of metallic studs used in gypsum board single frame walls – (Contributed, 000114)

C. Guigou-Carter, R. Foret, A. Igeleke and S. Bailhache
Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères
Corresponding author E-mail: catherine.guigou@cstb.fr

This work aims to characterize metallic studs used in gypsum board single frame walls. The sound reduction index associated to the direct path (cavity path) of the double wall can be calculated using a wave based transfer matrix approach. In the mid-high frequency range, an SEA approach is preferred to model the frame between the two gypsum leaves, as point connections modeled by punctual springs defined by its translational stiffness located at the screws position on the frame. An experimental setup has been proposed to determine the equivalent stiffness of the stud at the screw positions. Based on these data predicted and measured sound reduction index are in fairly good agreement. In the present work, a finite element model corresponding to the experimental setup is developed to characterize metallic studs in order to perform a parametric study and investigate new studs shape. The effects of the material physical characteristic variations, the dimensions and metal thickness, and the shape of the studs as well as the type and number of gypsum board mounted on the frame are presented and discussed.

Thu 11:20 Philip DOAK AA-G02: Building acoustics

An alternative for intensity measurement at low frequency in small reverberant rooms – (Contributed, 000295)

E. A. Duarte[a], A. Moorhouse[b] and E. B. Viveiros[c]
[a]Federal University of Alagoas, Arquitetura, Av. Manoel Severino Barbosa, s/n - Bom Sucesso, 57309-005 Arapiraca, Brazil; [b]University of Salford, The Crescent, M5 4WT Salford, UK; [c]Federal University of Santa Catarina, Dept Architecture, CxP 476, 88040-900 Florianopolis, Brazil
Corresponding author E-mail: elvira@arq.ufsc.br

Intensity measurement is generally used as a reference method, as it is more accurate then measuring sound pressure levels. However, the conventional two- microphone method only provides good accuracy in acoustically dead room. In this paper, a novel method employing an accelerometer and a microphone was used in order to obtain sound intensity close to a wall in reactive field. The tests were done in a reverberant room, whose conditions are not ideal for normal intensity method because the difference between the two microphone signals is swamped by the reverberant component, which gives a large, in-phase sound pressure. Two different intensity methods were used: the conventional two-microphone method and the microphone-accelerometer method. Firstly, the validation method was tested in a semi anechoic room. Subsequently, the same measurement was repeated in a reverberation room with absorption covering one wall and, finally, the same set up was tested in a reverberation room with no absorption whatsoever. There were found good results in low frequencies in all tests but especially in a reverberant room, which showed differences of around 2 to 4 dB between the two methods.

Thu 11:40 Philip DOAK AA-G02: Building acoustics

Analysis and noise control strategies of rolling noise due to delivery trolley – (Contributed, 000195)

F.-X. Bécot[a], F. Chevillotte[a], W. Wasmine[b] and D. Bozzetto[b]
[a]MATELYS, 1 rue Baumer, 69120 Vaulx-En-Velin, France; [b]ACOUPHEN, 33 route de Jonage, 69891 Pusignan, France
Corresponding author E-mail: fxb@matelys.com

In France and in many western countries, standard housing buildings often include commercial surfaces on the ground floor. While providing appreciated services during day time, this arrangement may cause highly perturbating noise in the upper floors of the building due to delivery operations. In particular, delivering and shelving operations include displacements of trolleys resulting in rolling and impact noise. Contrary to impact noise which is considered in the actual standards, rolling noise is not addressed. This is critical since impact excitation has little similarities with excitation due to e.g. a rolling trolley. Therefore, noise treatments designed with impact sound source may not be suitable for rolling noise sources. Based on measured illustrations of this problematic, the present work aims at designing a general methodology (i) to characterise the rolling noise, (ii) to predict the noise reduction efficiency and (iii) to design/optimise the noise control treatment. Discussion is based on measured data of acceleration spectra obtained for several types of surfaces (flat concrete, tiled/paved floor). Moreover, a model is implemented using characterised material data for several damping materials. This methodology allows to understand mechanisms of noise reduction and offers interesting perspectives for designing improved sound proofing materials.

Thu 12:00 Philip DOAK AA-G02: Building acoustics

Lieux de divertissement ouverts 24 heures aux centres des villes helléniques : dégradation du confort acoustique et lacunes législatives – (Contributed, 000442)

N. Barkas
DEPARTMENT OF ARCHITECTURE, DUTH, VASSILISIS SOFIAS 12, 67100 Xanthe, Greece
Corresponding author E-mail: nbarkas@arch.duth.gr

La communication proposée fait partie d'un grand projet de recherche universitaire (2004 - 2010) qui tente d'évaluer la pollution sonore dans les centres villes en raison du fonctionnement des entreprises de divertissement (cafés, bars, clubs, tavernes). Ce travail de recherche présente les résultats de l'évaluation des bruits de fonctionnement (mesures et sondages subjectifs) dans les zones centrales des différentes villes grecques. Les principales raisons de cette pollution sonore de l'environnement urbain sont liées au niveau élevé des émissions sonores (à cause du rassemblement des installations et des systèmes électroacoustiques) et à l'augmentation du trafic pendant la nuit. En général, il s'agit des constructions de faible capacité d' insonorisation, avec des façades transparentes, qui fonctionnent dans des conditions semi - extérieures, pendant tout le jour et pendant tout l'année. L'enquête est réalisée pour enregistrer les échecs des constructions en matière d'isolation acoustique et pour identifier les principales lacunes du cadre législatif existant. Elle constitue aussi une tentative d'identifier les responsabilités des municipalités locales (qui possèdent le droit exclusif de l'autorisation de fonctionnement des entreprises de divertissement et les avantages des taxes municipales), en explorant la corrélation étroite entre la pollution sonore et la densité urbaine des entreprises des loisirs.

Thu 9:00 François CANAC PU-G02: Underwater acoustics

Shear wave speed and attenuation in water-saturated glass beads and sand – (Contributed, 000023)

N. P. Chotiros and M. J. Isakson
University of Texas at Austin, PO Box 8029, Austin, 78713-8029, USA
Corresponding author E-mail: chotiros@arlut.utexas.edu

The frequency dependence of shear wave attenuation in water-saturated glass beads and sand contains distinguishable frequency bands in which different power laws apply. The bands are separated by relaxation frequencies. This is unlike the case of the dry granular medium, which is known to be proportional to the first power of frequency. The Biot-Stoll model of wave propagation in porous media captures the lower relaxation frequency, which is driven by a relaxation process in the relative motion between the pore fluid and the granular frame. A modification that includes squirt flow at the grain contacts is necessary to capture the higher relaxation frequency, which is a consequence of a relaxation process in the fluid motion within the grain contact region. There is evidence to suggest that the viscosity of the thin fluid film in the grain contacts may deviate from that of the bulk fluid due to ionic forces. Comparisons are made to published experimental measurements. [Work supported by the Office of Naval Research, Ocean Acoustics Program]

Thu 9:20 François CANAC PU-G02: Underwater acoustics

Seafloor characterization by means of nonlinear multi-frequency generation – (Contributed, 000426)

L. Di Marcoberardino, J. Marchal and P. Cervenka
Institute Jean Le Rond d'Alembert, 2 place de la gare de Ceinture, 78210 Saint Cyr L'Ecole, France
Corresponding author E-mail: lucilla.dimarcoberardino@idasc.cnr.it

In the underwater context, it is known that the frequency diversity provides essential information to derive the nature of the seafloor. Actually, the information gathered from each single frequency gives a complementary picture of a particular environment. This presentation deals with the realization of a multi-frequency acoustic surveying tool based on the saturation effect. The transmitter is fed with a high-power single tone-burst: numerous harmonic waves are created by non linear interactions along the propagation. The source is unique in time and space so that the multi-frequency responses are inherently perfectly matched. The receiver is a rectangular multi-element broadband array realized for measurements in the sea environment. Seabed characterization measurements were made in the bay of Brest. First results of sediment backscatter response and seafloor images are presented.

Thu 9:40 François CANAC PU-G02: Underwater acoustics

Geometric decorrelation in acoustic tools for surveying the seafloor – (Contributed, 000106)

P. Cervenka
CNRS UMR 7190, UPMC (P6) Institut Jean le Rond d'Alembert, 2, place de la gare de ceinture, 78210 Saint-Cyr-L'Ecole, France
Corresponding author E-mail: pierre.cervenka@upmc.fr

Geometric decorrelation, also known as baseline decorrelation, is a limiting factor in the performance of interferometers that feature large baselines. This phenomenon can be thus a bottle-neck in the development of new surveying tools, e.g. forward-looking synthetic interferometers or imaging systems based on squint synthetic aperture. The mechanism responsible for geometric decorrelation is put in evidence by using a simple model of surface scattering, with an idealized pair of transmitter-receiver running the 'stop and hop' scenario within a 2D geometry. Geometric decorrelation can be countered in several cases of practical interest. The choice of the transmitted signals and the relevant signal processing at receive that aim at reducing or even cancelling this effect are developed. Numerical examples are given in realistic configurations. The effect of volume scattering and surface roughness is also discussed.

Thu 10:40 François CANAC PU-G02: Underwater acoustics

Geoacoustic characterization by the image source method: a sensitivity study – (Contributed, 000391)

S. Pinson[a], L. Guillon[a] and P. Cervenka[b]
[a]IRENav, BCRM Brest, Ecole Navale, CC 600, 29240 Brest Cedex9, France; [b]CNRS UMR 7190, UPMC (P6) Institut Jean le Rond d'Alembert, 2, place de la gare de ceinture, 78210 Saint-Cyr-L'Ecole, France
Corresponding author E-mail: samuelpinson@yahoo.fr

A new method for measuring the sound speed profile of the seafloor has been recently proposed (JASA, vol. 128, pp. 1685-1693): the image source method. This method is based on a physical model of the acoustic field generated by a point source and reflected by a layered media. Under the Born approximation, the reflected signal can be modeled as a sum of contributions coming from image sources relative to the seabed layers. Consequently, the seabed geometry and sound speed profile can be recovered by exploiting the localization of these images. We present here a study about the sensitivity with the relative noise level and the map mesh size in the localization of the image sources.

Thu 11:00 François CANAC PU-G02: Underwater acoustics

Mathematical modeling of the acoustic radiation by submerged elastic structures – (Contributed, 000125)

S. Iakovlev[a], J.-F. Sigrist[b], C. Leblond[c], H. A.F.A. Santos[d], A. Lefieux[e] and K. Williston[a]
[a]Department of Engineering Mathematics and Internetworking, Dalhousie University, Halifax, Canada B3J1Y9; [b]Département Dynamique des Structures, CESMAN, DCNS research, Indret, 44620 La Montagne, France; [c]LaSIE, Université de la Rochelle, Pôle Science et Technologie, Avenue Michel Crépeau, 17042 La Rochelle Cedex 1, France; [d]Department of Civil Engineering and Architecture, Instituto Superior Técnico, Technical University of Lisbon, Av. Rovisco Pais, 1049-001 Lisbon, Portugal; [e]Department of

Structural Mechanics, University of Pavia, 27100 Pavia, Italy
Corresponding author E-mail: serguei.iakovlev@dal.ca

We consider a number of non-stationary fluid-structure interaction problems that represent several different scenarios of impulse acoustic loading on a fluid-contacting elastic circular cylindrical shell. Both the submerged evacuated and submerged fluid-filled shells are addressed, along with shell systems of higher structural complexity. We discuss the semi-analytical approach that was developed to model such systems, and highlight its advantages and limitations. In particular, we discuss the recent enhancement of the approach that allowed for a much more accurate modeling of the fine structure of the radiated field including the adequate reproduction of all types of the structure-induced waves seen in the experiments. We also address a number of interesting and practically important acoustic effects that we observed in the systems in question. In particular, we discuss the effect of the acoustic phenomena in the internal fluid volume on the structure of the external acoustic field, and analyze the propagation of the waves induced by additional structural elements incorporated into the system.

Thu 11:20 François CANAC PU-G02: Underwater acoustics

Analysis of a sandwich elastic plate structure by means of its transition terms – (Contributed, 000296)

S. Derible[a], F. Coulouvrat[b], M. Rousseau[b], J.-L. Izbicki[a] and A. Tinel[a]
[a]LOMC, CNRS UMR 6294, Université Le Havre, 25, rue Philippe Lebon, 76600 Le Havre, France; [b]CNRS, Institut Jean Le Rond d'Alembert - UMR CNRS 7190, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: serge.derible@univ-lehavre.fr

In order to analyze coupled resonances, the formalism of the transition matrix is used. We measure at normal incidence R and T, the reflection and transmission coefficients of two aluminum plates separated by a very thin water layer. The transition terms are linear combinations of R and T and the coupled resonances appear in separate terms. Under the condition that the previous coefficients have been recorded with a common phase reference, it is possible to isolate the resonances well. The vertical mode and the resonances of the water layer can be easily located on the spectra of the experimental transition terms. The shifts between the resonances of the structure and the resonance frequencies of the symmetric and antisymmetric modes of a unique plate are exhibited as well. The transition terms are very efficient tools for characterizing coupled systems.

Thu 11:40 François CANAC PU-G02: Underwater acoustics

Is received level average sufficient to describe ambient noise in heavy traffic areas? – (Contributed, 000780)

T. Folegot[a], C. Gervaise[b], Y. Stephan[c], D. Clorennec[a] and B. Kinda[d]
[a]Quiet-Oceans, 135, rue Claude Chappe, 29280 Plouzane, France; [b]Grenoble Images Parole Signal Automatique, Gipsa-lab 961 rue de la Houille Blanche BP 46 F - 38402 Grenoble Cedex; [c]Service Hydrographique et Océanographique de la Marine, 13 rue du Chatellier 29200 Brest; [d]Extraction et Exploitation de l'Information en Environnements Incertains, 2 rue François Verny, 29806 Brest cedex 9, France
Corresponding author E-mail: thomas.folegot@quiet-oceans.com

The Marine Strategy Framework Directive imposes to European governments to monitor ambient noise. There are multiple ways of monitoring the ambient noise. Although certainly economical considerations have to be taken into considerations, there is a need to discuss the representativeness of ambient noise measurement by the only means of hydrophones. A hydrophone will only give a local and punctual knowledge. As long as the measurement is not contaminated with self-noise, mechanical noise from the mooring itself or the water flow around the sensor, measurement present the great advantage of providing a ground truth. However, for ambient noise being stochastic by essence, masking effects between numbers of anthropic sources are likely to occur for significant period of times. Hydrophones therefore measure the closest noise events. An ambient noise experiment done in the western part of the British Channel in 2010 has demonstrated such effects, and serves questioning the representativeness of noise monitoring exclusively based on measurement. The choice of the metric and the influence of the geographical configuration of the monitoring scheme on noise characterization will be discussed. Coupling measurement with modeling is foreseen as a solution to bring more representativeness to ocean noise assessment.

Thu 10:40 Yves ROCARD NV-G01: Noise and vibration engineering

Dependence of friction noise of rough surfaces with contact area – (Contributed, 000514)

A. Le Bot, V.H. Dang and E. Bou Chakra
Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: Alain.Le-Bot@ec-lyon.fr

The noise emitted during the friction of rough surfaces is a wide band noise generated by the numerous impacts occuring between antagonist asperites of surfaces. This study presents an experiment which investigates the law between the acoustical power and a varying number of identical sliders i.e. the nominal contact area. It is found that in some cases, the acoustical power is proportional to the number of sliders while the sound is constant in some others. This result is explained by introducing a dissipation law of vibration at the interface of solids. In the regime where this dissipation process dominates, the sound is constant while in the regime where it is negligible compared with other disspation processes, the sound is proportional to the number of sliders.

Thu 11:00 Yves ROCARD NV-G01: Noise and vibration engineering

Automotive friction-induced noises – (Contributed, 000009)

A. Elmaian[a], J.-M. Duffal[a], F. Gautier[a], C. Pezerat[b] and J. Gilbert[b]
[a]Renault, 1 avenue du Golf, API : FR TCR AVA 1 63, 78288 Guyancourt, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: alex.elmaian@renault.com

Friction-induced noises are numerous in the automotive field. They also involve a large number of structures. Wiper squeal, seat squeak or dashboard creak are some examples of these noises. The different names traditionally used to describe these noises allow a first classification, especially based on their acoustic signature.
From an experimental side, an exploratory test-rig has been designed. This can generate friction-induced noises with simple structures and automotive materials. Qualitative sensitivity studies have demonstrated the test-rig ability to produce squealing, squeaking and creaking noises.
From a numerical side, a 3-degrees-of-freedom model has been studied. This model brings together the main physical concepts (stick-slip, sprag-slip, modal coupling) explaining the origin of friction induced noise. Calculations of complex eigenvalues carried out on this linearized model permit to highlight the concept of modal coupling instability. The extreme sensitivity of the vibrational behavior and a fortiori radiated noise towards conception parameters explains why these noises seem to appear randomly. Temporal simulations, in turn, permit to highlight the concepts of modal coupling, stick-slip and sprag- slip. They also permit to obtain qualitatively the vibrational behavior at the origin of the squealing, squeaking and creaking noises.

Thu 11:20 Yves ROCARD NV-G01: Noise and vibration engineering

Tribological origin of squeal noise in lubricated elastomer/glass contact – (Contributed, 000603)

A. Rusanov, D. Mazuyer, J. Perret Liaudet, A. Le Bot, M. Guibert and J. Le Rouzic
Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: anton.rusanov@ec-lyon.fr

This study investigates the tribological conditions in water lubricated elastomer/glass contact which lead to self-excited vibrations and squealing noises. Friction tests were performed using a specific experimental device "Lugï. In the experiments, friction forces and vibrational velocity have been properly measured for a wide range of relative velocities. The resulting friction coefficient as a function of sliding velocity fits well a Stribeck's law. Instabilities appear during the transition between static and hydrodynamic regimes. Actually the negative slope of the friction force as a function of relative velocity in the mixed lubrication regime enables the system to become unstable. Knowing the damping ratio of the oscillator, it is then possible to predict from the friction force measurements the range of velocities that lead to instabilities.

Thu 11:40 Yves ROCARD NV-G01: Noise and vibration engineering

Vibro-acoustic simulation of a car window – (Contributed, 000228)

C. Barras
Hutchinson Centre de Recherche, rue Gustave Nourry, BP 31, 45120 Chalette-Sur-Loing, France
Corresponding author E-mail: christophe.barras@cdr.hutchinson.fr

Waist seals and glass run channel are used for sealing purposes of automotive opening windows. These seals also contribute in the acoustic performance of the system specifically in the 3kHz frequency band known as the coincidence frequency.
In this paper, we present the simulation of the acoustic transparency of a car window with seals around.
In a first stage, the mounting of the seals around the windows is simulated by mean of a 2D non linear static analysis in order to get the deformed and pre-stressed state of the seal. In a second stage, a 3D mesh of the vibro-acoustic model is built. It is composed of the 600x600x4mm glass surrounded by the seals. All components are meshed with volumic elements. A thickness of 10 cm air behind the glass is also meshed in order to get the radiated acoustic power at this distance allowing experimental-simulation comparisons. Infinite acoustic elements are finally added to simulate an infinite space.
The window is excited by a diffused field. The acoustic transparency curves are presented up to 5200Hz. Comparisons with tests show a good correlation and give confidence in the vibro-acoustic model for predictive purposes.

Thu 12:00 Yves ROCARD NV-G01: Noise and vibration engineering

Noise Transmission through a Glass Window excited by Low-Speed Turbulent Flow – (Contributed, 000408)

R. Bessis, Y. Gervais, L.-E. Brizzi and J. Laumonier
Institut Pprime, CNRS - Université de Poitiers - ENSMA, ENSIP, 6 rue Marcel Doré, Batiment B17, BP 633, 86022 Poitiers, France
Corresponding author E-mail: remi.bessis@univ-poitiers.fr

In order to improve on-board automotive acoustic comfort, we investigate the effects of vortex dynamics and unsteady flow separation outside the lateral window of a car (the A-pillar) on the noise transmission through the window. Different mechanisms are expected to contribute to the transmitted aerodynamic noise. One is related to the acoustic excitation mainly generated from the transfer of kinetic energy of the turbulent volumetric flow structures into acoustic energy, then transmitted through the window. A second mechanism consists of direct hydrodynamic (turbulent boundary layer) excitation of the window.
Experiments have been performed in an open low-speed wind tunnel including a forward-facing step geometry in order to generate vortex shedding above a thin glass window. An anechoic cavity under the glass allows capture of the transmitted sound. Surface-pressure fluctuations and outside velocities (PIV) were estimated simultaneously.
Correlation-based signal processing was implemented to link flow structures to acoustic transmission. Attempts to separate the contributions behind noise transmission involving energy-based filters (POD, LSE), along with the variations of timescales and lengthscales on the flow are also presented and discussed.

Thu 13:40 Yves ROCARD NV-G01: Noise and vibration engineering

Numeric and experimental study on several rattle noises from a generic system – (Contributed, 000583)

T. Gardin[a], F. Gautier[b] and C. Pezerat[b]
[a]Faurecia Automotive Seating, Route de Brières les Scelles, 91150 Étampes, France; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: thomas.gardin@faurecia.com

Rattle noises encountered in automotive systems such as seats or front panels are gaining more and more importance in the automotive industry. Recent progresses in noise reduction combined with the emergence of new electrical/hybrid vehicle and the need of mass reduction has emphasized the appearance of this new class of noise which was masked in the past.
Rattle noises are here studied using a vibro-impacting system under forced excitation. An experimental set-up composed of a beam impacting a barrier has been designed in order to reproduce this phenomenon. Periodic and apparent chaotic rattles are occurring at various combinations of environmental parameters such as: excitation frequency, initial presence of clearance or pre-load, contact stiffness and damping. Simulated bifurcation diagrams are also obtained representing the overall behaviour of the vibro- impacting system and are then compared with experiments.

Thu 14:00 Yves ROCARD NV-G01: Noise and vibration engineering

Simulation of the dynamic behaviour of a geared transmission on hydrodynamic journal bearings – (Contributed, 000211)

R. Fargere, J.-F. Sigrist, R. Bosio, C. Menard and P. Velex
LaMCoS / DCNS Research - Département Dynamique des Structures, DCNS Propulsion, Indret, 44620 La Montagne, France
Corresponding author E-mail: romain.fargere@insa-lyon.fr

Geared transmissions are inherently noisy but their capacity to match the speeds and torques from one machine to another makes them irreplaceable in a number of high power applications such as marine propulsion. In such systems, stealthiness is often crucial and the prediction and control of the radiated noise is therefore an important research topic. In this paper, an original approach is proposed which combines (i) a mechanical model for gears based on finite elements which accounts for deformable bodies and shafts and (ii) the reaction forces from the journal bearings using the "short bearingï approximation. The equations of motion, the normal contact problem between the teeth, along with the bearing reaction forces are solved iteratively. The procedure is applied to a single stage transmission for various running conditions and gear geometry. The influence of the helix angle is investigated and emphasis is placed on the time and spectral representations of the bearing reactions which largely control the structure-borne noise generated by the gear mesh.

Thu 14:20 Yves ROCARD NV-G01: Noise and vibration engineering

Enhancing targeted energy transfer by using several nonlinear membrane absorbers – (Contributed, 000171)

P.-O. Mattei, R. Bellet, B. Cochelin and R. Côte
LMA, CNRS, UPR 7051, Aix-Marseille Univ, Centrale Marseille, 31 chemin Joseph Aiguier, F-13402 Marseille Cedex 20, France
Corresponding author E-mail: mattei@lma.cnrs-mrs.fr

One of the main drawbacks of the targeted energy transfer (TET) phenomena in acoustics is the relative short existence zone of TET. This communication presents how to obtain an enhanced efficiency of TET by using multiple nonlinear membrane absorbers in parallel. We show this way, mainly thanks to an experimental set-up with two membranes, that the different absorbers have additional effects that extend the efficiency and the possibilities of observation of TET. Different behavior of the system under sinusoidal forcing and free oscillations, characterizing the phenomena for all input energies, as well as frequency responses, showing successive clipping of the original resonance peak of the system, are presented. A model is finally used to generalize these results to more than two NES and to simulate the case of several very similar membranes in parallel which shows how to extend the existence zone of TET.

Thu 14:40 Yves ROCARD NV-G01: Noise and vibration engineering

Propagation of vibrations induced on track: implementation of previsional models for low and high speed trains and comparison with experimental measurements – (Contributed, 000363)

G. Marsico[a], E. Monaco[b], F. Amoroso[b], V. Limone[b], S. Curcuruto[a], D. Atzori[a] and R. Betti[a]
[a]ISPRA, Via Vitaliano Brancati 48, 00144 Rome, Italy; [b]Sonora S.r.l., Via dei Bersaglieri 9, 81100 Caserta, Italy
Corresponding author E-mail: giuseppe.marsico@isprambiente.it

In recent years, the topic of vibrations in homes and workplaces has grown in importance. In order to reduce the vibrations due to road and rail traffic, several actions can be implemented, some of which are economically very costly. As a consequence, before implementing any mitigation measures, the availability of appropriate simulation tools able to characterize the effectiveness of the chosen solutions becomes more and more relevant. As part of this work, the development of a predictive software has been addressed, combined with experimental measurements, in order to assess with acceptable accuracy the vibration levels caused by rail transport - trams, low-speed and high-speed trains. Predictions are obtained by characterizing waves propagation through the ground by the mean of separate approaches for low and high velocity trains. In this paper the results achieved has been presented, as well as the future potential of the activity.

Thu 15:00 Yves ROCARD NV-G01: Noise and vibration engineering

Laboratory investigations of low frequency sound attenuation over combustion flat perforated wall sheet – (Contributed, 000692)

Q. Qin[a], P. Rubini[a], C. Jayatunga[b] and V. Sanderson[b]
[a]The University of Hull, The Acoustics Research Centre, Dept. of Eng., The University of Hull, HU6 7RX Hull, UK; [b]Siemens Industrial Turbomachinery Ltd, PO Box 1, Waterside South, LN5 7FD Lincoln, UK
Corresponding author E-mail: q.qin@hull.ac.uk

Steel perforated liners have been used in turbine combustions for several years. The main purpose of the holes on the chambers is for cooling the combustion wall by inducing cooling air flows through the holes. It would be very useful if the steel perforated liners could be used for attenuating the combustion noise too, especially for the low frequency noise. This paper presents a series of acoustic attenuation measurements which were carried out in a 500 mm (width) × 500 mm (height) × 6000 mm (length) impedance tube on flat perforated steel plates with various geometric parameters. The measured absorption coefficient and impedance show that the steel perforated plates have strong sound attenuation on a certain frequency bandwidth. Experimental data were compared with the predicted data that concerned the effects of air inertia and viscosity in apertures. The results show reasonable agreement with the prediction. The acoustic attenuation properties, inferred from normal surface resistance and absorption coefficient data on perforation panels with different plate thickness, perforation, aperture diameter and aperture distribution are presented. The measurement results and analyses show that with careful design the cooling holes on the combustion wall can be used to attenuate the noise efficiently.

Thu 15:20 Yves ROCARD NV-G01: Noise and vibration engineering

A comparison between the performance of different silencer designs for gas turbine exhaust systems – (Contributed, 000589)

R. Kirby[a], P. Williams[a] and J. Hill[b]
[a]Brunel University, Kingston Lane, Uxbridge, UB8 1PH Middlesex, UK; [b]AAF Ltd, Bassington Lane, Cramlington, NE23 8AF Northumberland, UK
Corresponding author E-mail: ray.kirby@brunel.ac.uk

The dissipative silencers used to attenuate noise emanating from air moving devices such as fans are normally of a simple splitter design, with parallel baffles of absorbent material arranged over the width of a duct. However in more specialist applications, such as the exhaust systems of gas turbines, different silencer geometries are often used. One such geometry is a so-called bar silencer, in which rectangular bars, or bricks, of absorbing material are placed in a lattice arrangement over the duct cross section. The acoustic performance of these bar silencers is investigated here using a finite element based numerical mode matching scheme. The insertion loss of the bar silencers is then calculated and compared against traditional splitter designs in order to investigate the relative efficiency of each design.

Thu 15:40 Yves ROCARD NV-G01: Noise and vibration engineering

Determination of efficiency of anechoic or decoupling hull coatings using water tank acoustic measurements – (Contributed, 000270)

C. Audoly
DCNS Research, CEMIS, 83076 Toulon, France
Corresponding author E-mail: christian.audoly@dcnsgroup.com

External anechoic and decoupling hull coatings are used on ships or submarines to reduce acoustic target strength and radiated noise, respectively. Measurement of test panels in a water tank gives only the reflection and transmission coefficients in free field, with respects to frequency. It is shown using simple models that anechoic and decoupling efficiencies can be derived, providing appropriate modulus and phase measurement of the coefficients. Additionnally, the influence of a non-rigid elastic backing can be simulated without additional measurement. That information is of particular interest for the naval architects and specialists involved in design. In this paper, the theoretical formulation of the problem will be presented, then applied to simulated test cases. Some experimental results on test Panels will also be shown.

Fri 8:00 Paul LANGEVIN Keynote lecture: Pr. Robin Cleveland

Shock waves in medicine – (000872)

R. O. Cleveland
University of Oxford, Institute of Biomedical Engineering, Old Road Campus Research Building, OX3 7DQ Oxford, UK
Corresponding author E-mail: robin.cleveland@eng.ox.ac.uk

Shock waves have been used for more than 30 years for the treatment of kidney stones. In shock wave lithotripsy, focused shock waves are used to fragment kidney stones into pieces that were small enough to be passed naturally and this non-invasive treatment revolutionised kidney stone treatment. Since then shock waves have been used for a number of other indications including: gall stones, plantar fasciitis, bone fracture healing, skin burn healing, and neovascularisation of the myocardium. Shock waves have also been shown to be effective at enhancing drug delivery into cells and assisting with gene transfection. There has been a wide range of success in these areas but none has resulted in the same paradigm shift as occurred in lithotripsy. In addition, shock waves play an important role in focused ultrasound surgery where they result in enhanced heating rates and can therefore accelerate treatment times. The presentation will discuss the principles by which shock waves can induce bioeffects, both desired and undesired, within the body. It will also contrast some of the contradictory results in the literature and discuss the opportunities to exploit shock waves going forward. [Work has been partially supported by NIH, NSF and Whitaker Foundation].

Fri 8:00 Lord RAYLEIGH Keynote: Pr. Murray Campbell

An acoustical history of lip-excited musical wind instruments – (000865)

M. Campbell
University of Edinburgh, School of Physics and Astronomy, JCMB, King's Buildings, Mayfield Road, EH9 3JZ Edinburgh, UK
Corresponding author E-mail: d.m.campbell@ed.ac.uk

From the conch shell and the cow horn to the modern orchestral brass section, lip-excited aerophones have played a central role in human music-making. Until the middle of the twentieth century the evolution and sophistication of brass instruments proceeded through a process of trial and error. In recent decades theoretical, experimental and computational scientific methods have been used to study the dynamics and aeroacoustics of sound production in lip-excited instruments. While considerable advances have been made in understanding the physics of the coupling between the lips of the player and the acoustic modes of the resonating tube, and the effects of bore profile on sound propagation and radiation, success in applying this knowledge in the improvement of brass instrument design has been hampered by uncertainty as to the specification of musically relevant targets for optimisation. This question can be illuminated by considering the relationship between musical function and acoustical behaviour in instruments of earlier periods. The approach is illustrated by brief acoustical histories of two lip-excited instruments: the trombone and the serpent.

Fri 9:00 Yves ROCARD AA-S04: Global approaches of building acoustics

Noise reduction of a double-skin façade considering opening for natural ventilation – (Contributed, 000102)

J.-P. Migneron and A. Potvin
Université Laval,
Corresponding author E-mail: jean-philippe.migneron.1@ulaval.ca

The growing interest in natural or hybrid ventilation systems brings a challenge for good integration of openings in building façades. With a noisy environment, there is an important limitation for the use of direct openings in common building envelopes. As a part of a research project dedicated to this problem, it is possible to evaluate the impact of several double-skin configurations, modifying openings, space between façades or the choice of construction assemblies. Experimental measurements made in laboratory conditions lead to the estimation of usual noise reduction and sound transmission class. Moreover, the airflow at constant differential pressure was assessed as functions of the aperture and compared to sound insulation. Analyzing those parameters together give useful information for the design of passive ventilation with a significant airflow when acoustical performance is an important issue.

Fri 9:20 Yves ROCARD AA-S04: Global approaches of building acoustics

Lightweight ventilated facade prototype: acoustic performance evaluation when the ventilation surface of the air chamber varies – (Contributed, 000245)

A. Niampira Daza and J.L. Zamora I Mestre

Doctorade program Àmbits de Recerca en l'Energia i el Medi Ambie, Universitat Politècnica de Catalunya, Barcelona Tech, Sant Cugat del Vallès, 08173 Barcelona, Spain

Corresponding author E-mail: joan.lluis.zamora@upc.edu

The lightweight facades with ventilated air chambers have advantages as thermal radiation and damp protection, which is added to the aesthetic benefits in new buildings and renovations.

In terms of acoustic performance, this solution can be more efficient than traditional facades rather then solid wall. However, this positive characteristic has not been proven, as ventilation of the air chamber seems to limit potential improvements in acoustic performance.

The goal of this study was to evaluate how much additional noise protection could be achieved with the standard configuration of a lightweight facade and a ventilated air chamber versus a conventional simple solid wall. Standard acoustic evaluations were carried out with different lightweight facade configurations in which the degree of surface ventilation was changed, but the depth of the chamber was constant.

This paper shows the first results obtained for in situ acoustic assays of different kinds of external cladding when the upper and lower open area of the air chamber was varied. The prototypes were installed and tested in a real facade at the ETS Escola Superior Tècnica d'Arquitectura del Vallès (Universitat Politècnica de Catalunya) as part of a research project carried out for a doctoral thesis.

Fri 9:40 Yves ROCARD AA-S04: Global approaches of building acoustics

Natural ventilation and acoustic comfort – (Contributed, 000086)

A. Chilton, P. Novo, N. McBride, A. Lewis-Nunes, I. Johnston and J. Rene

Max Fordham LLP, 42/43 Gloucester Crescent, Camden Town, NW1 7PE London, UK

Corresponding author E-mail: a.chilton@maxfordham.com

Natural ventilation offers the potential for a sustainable, low-energy, low-maintenance solution to providing air to building occupants. When compared to mechanical ventilation systems, it also gives the benefits that occupants feel more connected with the outside world and perceive that they have better control over their environment. These are both factors that improve comfort and well-being. However, natural ventilation relies on larger openings in the façade which can create problems with the ingress of external noise that adversely affects occupant comfort. An overview is given as to how these conflicting issues can be resolved in the design process and several case studies making use of acoustically attenuated natural ventilation are presented. A methodology is proposed for comparing different attenuated ventilation elements using a quantitative rating based on a combination of both their aerodynamic and acoustic performance.

Fri 10:00 Yves ROCARD AA-S04: Global approaches of building acoustics

Impact of floor drain on floating floor acoustic performance – (Invited, 000727)

J.-B. Chene and P. Kerdudou

Centre Scientifique et Technique du Bâtiment,

Corresponding author E-mail: jean-baptiste.chene@cstb.fr

In the context of the new regulation about handicap accessibility, a study on the implementation of italian integrated shower system (flushed with the surrounding bathroom floor) has been performed. In this paper we have investigated the impact of floor drain when integrated in floating floor. We have first used EN ISO 140-8 standard to evaluate this effect on a full scale sample. In a second step, we have used ISO/CD 16251-1 to evaluate only the floor drain decoupling between its two parts. Experimental results are presented and discussed. It is demonstrated that the proposed adapted technique based on the ISO/CD 16251-1 is good in evaluating the decoupling.

Fri 10:20 Yves ROCARD AA-S04: Global approaches of building acoustics

An update on acoustics designs for HVAC (Engineering) – (Contributed, 000880)

K. Marriott
IOA, 29a Ashburton Road, Croydon, CR0 6AQ London, UK
Corresponding author E-mail: ictc@btinternet.com

A person's sense of comfort and their capacity for work and/or their appreciation of leisure activities deteriorate quickly in poor air conditions. More seriously, a person's general health may be impaired in the long term by being subjected to ill-ventilated buildings and enervating climates. The relevant factors to be considered are temperature, relative humidity and air circulation. The main function of the Heating, Ventilation and Air Conditioning (HVAC) engineer is to engineer ways for keeping these factors under control. To produce suitable air changes and cooling within an occupied space entails the need to induce and control airflows which is always associated with some level of noise. This noise can in some cases be just as unacceptable as poor ventilation in as far as it affects the capacity to work and/or concentrate. This paper looks at a set of five typical design cases that arise and methods that can be applied in achieving the HVAC engineer's environmental requirements while minimising noise generated in the process considering standard methods and more recent techniques used in the design of acoustic measures.

Fri 9:00 Peter BARNETT AH-S02: Fan and turbomachinery noise

Simulations on Active Fan Noise Control – (Contributed, 000491)

H. Fischer
EADS Deutschland GmbH, EADS Innovation Works Germany, 81663 München, Germany
Corresponding author E-mail: helen.fischer@eads.net

Noise reduction by active noise control in jet engines and its prediction is of high interest, since the acoustic goals of flightpath 2050 can hardly be achieved by passive acoustic treatments. Numerous former test campaigns showed that significant noise reduction is possible by active noise control. Simulations are needed for further understanding of test results and in order to predict the noise reduction and possibly impact on the performance of future jet engines. Therefore an ANC prediction tool in frequency domain based on a common 3D CAA solver has been developed. The tool is validated by measurements in a simple straight duct with wall mounted sensors and loudspeakers. The primary sound field has one dominant azimuthal mode order. Varying complexity of the control concept leads to significant distinct results in noise reduction and the input signals of control sources. Later application of the tool will be the simulation of jet engines (i.e. inlet, fan, stator and nozzle). The CAA solver does not include the rotation of fan. Established models of fan scattering and sound transmission need to be implemented. The effect of the fan models on the noise control can be assumed by means of the investigated control concepts.

Fri 9:20 Peter BARNETT AH-S02: Fan and turbomachinery noise

Numerical simulation of turbulence interaction noise applied to a serrated airfoil – (Contributed, 000111)

V. Clair, C. Polacsek, G. Reboul and T. Le Garrec
Onera, Département de Simulation Numérique des Ecoulements et Aéroacoustique, BP 72 - 29, avenue de la Division Leclerc, 92322 Chatillon Cedex
Corresponding author E-mail: vincent.clair@onera.fr

Turbulent wakes generated by turbofan blades and interacting with the outlet guide vanes are known to be mainly contributing to broadband noise emission of aeroengines at approach conditions. Analytical approaches, such as the well-known Amiet model can be adopted to estimate the noise generated by turbulent flows impacting thin airfoils, but they are limited by the flat-plate assumptions. The development of numerical methods allowing more complex geometries and realistic flows is required. The method, described in the present paper, is based on a CAA code solving the nonlinear Euler equations. The upstream turbulence is synthesized from a stochastic model and injected into the computational domain through an adapted boundary condition. It is first validated in 2D and 3D against academic flat plate configurations by comparison with Amiet solutions (exact in such cases). Then, 3D computations are applied to simulate the effect of a passive treatment (leading edge serrations) aiming at reducing turbulence interaction noise of an isolated airfoil studied in the framework of European project FLOCON. First calculations on baseline conditions are shown to be able to reproduce the measured spectra and far-field directivities, and the acoustic performances of the serrations (3-4 dB PWL reduction) are fairly well assessed too.

Fri 9:40 Peter BARNETT AH-S02: Fan and turbomachinery noise

A high-resolution preserving sliding-mesh approach based on meshless methods: application to acoustic propagation in presence of rotor/stator features – (Contributed, 000384)

S. Khelladi[a], X. Nogueira[b], M. Solis[a], F. Bakir[a], I. Colominas[b] and J. Mardjono[c]
[a]DynFLuid, Arts Et Métiers-ParisTech 151 bd de l'Hopital 75013 Paris; [b]Universidade da Coruña, E.T.S.E. Camiños, Canais e Portos, campus de Elviña s/n, 15071 A Coruña, Spain; [c]Snecma, Groupe SAFRAN, SNECMA Villaroche - Bâtiment n°7D, 77550 Moissy Cramayel, France
Corresponding author E-mail: sofiane.khelladi@ensam.eu

The acoustic hybrid approach is commonly used in the simulation of turbomachinery flows. In this technique, the aerodynamic field is solved in order to define acoustic sources, and then, these sources are propagated by solving linearised Euler equations (LEE) using a high order finite volume solver based on MLS reconstruction. One of the most widespread numerical techniques used in the numerical simulations of rotor/stator or rotor/rotor interaction flow is the so-called sliding mesh method. This technique allows relative sliding of one grid adjacent to another grid (static or in motion). However, when a high-order method is used, the interpolation used in the sliding mesh model needs to be of, at least, the same order than the numerical scheme, in order to prevent loss of accuracy. In this work we present a sliding mesh model based on the use of Moving Least Squares (MLS) approximants. It is used with a high-order (>2) finite volume method that computes the derivatives of the Taylor reconstruction inside each control volume using MLS approximants. Thus, this new sliding mesh model fits naturally in a high-order finite volume framework for the computation of acoustic wave propagation into turbomachinery.

Fri 10:40 Peter BARNETT AH-S02: Fan and turbomachinery noise

An optimization loop for aero-acoustics fan blade design – (Contributed, 000585)

C. Sensiau, B. Fayard, J.-M. Roux and M. Lebrun
Snecma, Villaroche - Rond point R. Ravaud, 77550 Moissy-Cramayel, France
Corresponding author E-mail: claude.sensiau@snecma.fr

In this paper we will discuss an optimization loop used during the fan blade design phase to get a compromise for the efficiency of the fan and broad band interaction noise at different design points. Indeed the aerodynamicians design constraints differ from the acousticians' ones. To minimize the fuel consumption the fan must be designed for a best efficiency in cruise, but to reach the environmental requirements, the fan blades have to be quiet (and so efficient) during takeoff and landing. In this work, results obtained with an optimization tool will be discussed. The space parameter is defined with design blades parameters such as angle at leading edge, camber, chord, thickness... A special attention will be paid to the efficiency of the fan at high RPM and the interaction broad band noise at off-design points.

Fri 11:00 Peter BARNETT AH-S02: Fan and turbomachinery noise

Acoustic modulation effect of rotating stator/rotor interaction noise – (Contributed, 000305)

A. Gerard, S. Moreau, A. Berry and P. Masson
GAUS, Université de Sherbrooke, 2500 Boul. de l'Université, Sherbrooke, Canada J1K2R1
Corresponding author E-mail: anthony.gerard@usherbrooke.ca

Tonal noise from fans mainly comes from the periodic unsteady blade forces and/or vane forces due to the interaction between the rotor and its environment. To distinguish the different interactions leading to tonal noise in the acoustic spectrum, this paper presents an original method consisting of slowly rotating a quasistatic part (e.g. a stator). An analytical model based on the Lowson model has been developed to take into account relative rotation motions between a number of rotors. This model shows that the acoustic radiation due to the interaction between a rotating stator and the rotor shifts in the spectrum at frequencies $nB\Omega_1 \pm w\Omega_2$, where n is the harmonic order, B is the number of rotor blades, Ω_1 is the angular velocity of the rotor, Ω_2 is the angular velocity of the moving "quasistatic partï and w is the order of the unsteady forces decomposed in circumferential Fourier series. Using this modulation effect, every circumferential mode w radiates at different frequency in the acoustic spectrum. The radiation due to the interaction between the rotor and all the other static components remains at frequencies $nB\Omega_1$. This modulation effect can be used to acoustically optimize stator.

Fri 11:20 Peter BARNETT AH-S02: Fan and turbomachinery noise

Acoustic analogy in an annular duct with swirling mean flow – (Contributed, 000196)

H. Posson and N. Peake
University of Cambridge, DAMTP, Centre for Mathematical Sciences, Wilberforce Road, CB3 0WA Cambridge, UK
Corresponding author E-mail: H.Posson@damtp.cam.ac.uk

The present study aims at developing an acoustic formulation for the sound generated by the interaction of solid surfaces (such as blades) with an unsteady flow in an annular duct with swirl. Indeed, the mean flow in between the rotor and the stator of the fan or of a compressor stage is highly swirling. As a results, in order to properly predict the rotor self-noise radiated downstream of the rotor or the rotor-stator interaction noise radiated upstream of the stator, the swirling mean flow effect must be accounted for, either in the source terms or in the differential operator in an acoustic analogy. The proposed approach here, is to develop an acoustic analogy with an operator accounting for the swirl. It can be seen as an extension of Goldstein formulation in uniform mean flow (Aeroacoustics, 1976). The Navier-Stokes equations are first recast to outline the differential operator and the associated equivalent noise sources in space and time. Then the Green's function tailored to the rigid annular duct with swirl is derived in the frequency domain. Finally, the effect of the swirl is studied on simple dipole sources and finally applied to rotor trailing-edge noise.

Fri 11:40 Peter BARNETT AH-S02: Fan and turbomachinery noise

Reduction of self-noise effects in onboard acoustic receivers of vessels using spectral subtraction – (Contributed, 000837)

S. Menonkattil Hariharan, S. Kamal and S. P.R. Pillai
Department of Electronics, Cochin University of Science & Technology, 682022 Ernakulam, India
Corresponding author E-mail: supriyadoe@gmail.com

The engine noise, the turbulence, cavitation created by the propellers generates severe levels of acoustic noise in the vicinity. The onboard hydrophones of acoustic receivers or other observation systems will essentially pickup these near-filed noise to a greater extent from their immediate surroundings. This will introduce a major challenge in effective listening of signals of interest that are camouflaged by the noise ambience. The paper discusses a method based on spectral subtraction for reducing the effect of these uniform noise field created by engines or propellers in the surroundings of acoustic receivers. Spectral subtraction is a technique used to retrieve the power spectrum of a non-stationary signal of interest in a uniform noise field by subtracting an estimated average of noise spectrum from the originally observed signal spectrum. The noise spectrum is estimated apriori to the actual communication or observation, i.e while the signal of interest is absent or silent. The process will repeat in a cyclical manner, at periodic intervals to adapt with the spectral shifts that may have occurred in the noise field. The method can be used with acoustic receiver front ends as a preconditioning stage for improving the overall signal quality.

Fri 9:00 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Nonlinear losses in electro-acoustical transducers – (Invited, 000019)

W. Klippel
KLIPPEL GmbH, Mendelssohnallee 30, 01309 Dresden, Germany
Corresponding author E-mail: wklippel@klippel.de

The mechanical and acoustical losses considered in the lumped parameter modeling of electro-dynamical transducers may become a dominant source of nonlinear distortion in micro-speakers, tweeters, headphones and some horn compression drivers where the total quality factor Qts is not dominated by the electrical damping realized by a high force factor Bl and a low voice resistance Re. This paper presents a nonlinear model describing the generation of the distortion and a new dynamic measurement technique for identifying the nonlinear resistance Rms(v) as a function of voice coil velocity v. The theory and the identification technique are verified by comparing distortion and other nonlinear symptoms measured on micro-speakers as used in cellular phones with the corresponding behavior predicted by the nonlinear model.

Fri 9:40 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Modeling load-induced aging of loudspeaker suspension – (Invited, 000018)

W. Klippel
KLIPPEL GmbH, Mendelssohnallee 30, 01309 Dresden, Germany
Corresponding author E-mail: wklippel@klippel.de

The mechanical suspension becomes more and more compliant over time changing the loudspeaker properties (e.g. resonance frequency) significantly. This aging process is reproducible and the decay of the stiffness can be modeled by accumulating the apparent power supplied to the suspension part and using an exponential relationship. The free parameters of this model are estimated from empirical data provided by on-line monitoring or intermittent measurements during regular power tests or other kinds of long-term testing. The identified model can be used to predict the load-induced aging for music or test signals having arbitrary spectral properties. New characteristics are being introduced which simplify the quality assessment of suspension parts and separate mechanical fatigue from the initial break-in effect. Practical experiments are performed to verify the model and to demonstrate the diagnostic value for selecting optimal suspension parts providing sufficient long-term stability.

Fri 10:20 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Measurement of subwoofers with the field separation method: comparison of p- p and p-v formulations – (Invited, 000407)

M. Melon, C. Langrenne and A. Garcia
Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03
Corresponding author E-mail: manuel.melon@cnam.fr

Measurement of very low frequency sources is rather difficult to perform because very few testing rooms remain anechoic in the 10-100 Hz frequency range. To overcome this problem, the field separation method has been proposed a few years ago. This technique consists in measuring two acoustic quantities on a closed surface surrounding the tested source. To take advantages of spherical harmonic functions, the measurement surface should be spherical. The acoustic quantities can either be acoustic pressure measured on two concentric (half-) spheres or pressure and velocity measured on a (half-) sphere. Then, by using spherical harmonic expansions, contribution from the subwoofer is separated from reflections on the walls of the testing rooms to recover half or free space conditions. This paper focuses on the choice of the measured data set. Simulations are performed using p-p and p-v data approaches. The effect of microphone spacing for the double pressure layer formulation will be investigated. Finally, measurement results obtained on different subwoofers, i.e., frequency response and directivity, will be shown to highlight simulation results.

Fri 10:40 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

A new impedance sensor for industrial applications – (Contributed, 000063)

J.C. Le Roux[a], M. Pachebat[b] and J.-P. Dalmont[c]
[a]CTTM, 20, rue Thales de Milet, 72000 Le Mans, France; [b]LMA, CNRS, UPR 7051, Aix-Marseille Univ, Centrale Marseille, 13402 Marseille, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jcleroux@cttm-lemans.com

Some years ago, the LAUM, together with the CTTM developed a new impedance sensor based on a controlled volume velocity source. The impedance of a measured system was easily and accurately obtained from 20 to 5000 Hz. Due to the low level of the generated volume velocity, this sensor is mainly devoted to laboratory studies (musical acoustics, porous material characterization...). For this measurement principle to be applied to engineering topics, a new device is conceived, using a recently developed electrodynamic transducer. In particular, leakages between its front and back sides should be reduced to a minimum, and mechanical resonances must be rejected out of the frequency range of interest. To illustrate the capabilities of this new impedance sensor, the characterization and tuning of a loudspeaker bass reflex enclosure is performed. The sensor measures the low frequency acoustic impedance of the enclosure seen from the loudspeaker location. The measured impedance is then compared with a lumped element model. The analysis of the impedance magnitude is used to cancel the acoustic resonances inside the volume and to check the correct tuning of the bass reflex system.

Fri 11:00 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Calibration method for high frequency microphones – (Contributed, 000624)

S. Ollivier[a], E. Salze[a], M. Averiyanov[b], P. V. Yuldashev[a], V. Khokhlova[b] and P. Blanc-Benon[a]
[a]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex; [b]M.V.Lomonosov Moscow State University, Faculty of Physics, M.V.Lomonosov Moscow State, University,Leninskie Gory, 119991 Moscow, Russian Federation
Corresponding author E-mail: sebastien.ollivier@univ-lyon1.fr

In the context of the development of MEMS microphones designed for the measurement of high frequency waves (> 100 kHz) and weak shockwaves in air, it is necessary to define new calibration methods in order to estimate accurately the frequency response of new sensors. For this purpose, we will present the principle of a calibration method based on the measurement of weak shockwaves generated by a spark source. The influence of the sources of error will be discussed. To demonstrate the interest of the method, measured responses of 1/8" microphones will be given for various mountings.

This work is supported by French National Agency (ANR 2010 BLAN 0905 03) and by French/Russian International Program for Scientific Cooperation PICS (RFBR 10-02-91062/CNRS 5063)

Fri 11:20 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Magnet-only loudspeaker motors: linear behavior theory vs. Nonlinear measurements – (Contributed, 000576)

A. Novak[a] and B. Merit[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Orkidia Audio sarl, Estia 2, Technopole Izarbel, 64210 Bidart, France
Corresponding author E-mail: ant.novak@gmail.com

A few years ago, a new concept of magnet-only loudspeaker has been proposed to improve the quality of the reproduced sound. Such a loudspeaker is called magnet-only because its magnetic circuit is totally made of rare-earth permanent magnets. Unlike the classical electrodynamic loudspeaker, no iron is used. According to the theory, the exclusive use of permanent magnets and the absence of iron can lead to a uniform motor parameters (force factor Bl, resistance Re and inductance Le) over the voice-coil displacement and thus to a decrease of the nonlinear distortion and to an improvement of the sound quality. To our knowledge, such motor parameters have not been consistently quantified, neither their variations. In this paper, the variation of the parameters of a magnet-only loudspeaker are measured. The goal is to verify the theory and to show that using a simple measurement procedure one can understand better why a magnet-only loudspeaker improves the quality of the reproduced sound.

Fri 11:40 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Simulation and measurement of loudspeaker nonlinearity with a broad-band noise excitation – (Contributed, 000622)

A. Dobrucki and R. Siczek
Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland
Corresponding author E-mail: andrzej.dobrucki@pwr.wroc.pl

In the paper the method of measurement of nonlinear distortion using broad-band signal as the excitation is presented. It consists in excitation of loudspeaker with an intensive broad-band noise with removed narrow frequency band using band-stop filter. The acoustic signal produced by the loudspeaker is filtered with a band-pass filter with the same bandwidth as previously removed. The content of signal in this frequency band is a measure of nonlinear distortion. The measurement can be realized in successive frequency bands in order to obtain the distortion as function of frequency. The very high steepness of slopes in band-stop and band-pass filters is required. The filters can be realized with a digital technology. Using Simulink software the measurement of actual loudspeakers as well as simulations can be conducted. In the paper the influence of nonlinear parameters: stiffness of suspensions, force factor and inductance are presented and the results of measurements as well.

Fri 12:00 Lord RAYLEIGH EA-S01: Advanced techniques for transducer characterization

Coupled lumped and boundary element simulation for electro-acoustics – (Contributed, 000725)

J. Panzer
R&D Team Joerg Panzer, Raiffeisenstr 5, 87775 Salgen, Germany
Corresponding author E-mail: j.panzer@randteam.de

This paper gives a technical report on a strategy to couple Lumped and Boundary Element Methods for acoustics. The solution makes use of the superposition-principle and the use of self and mutual radiation impedance components. By this, the coupling approach features the convenient property of a high degree of independence of both domains. For example, one can modify parameters and even, to some extent, change the structure of the lumped-element network without the necessity to resolve the boundary element system. This paper gives the mathematical derivation and a demonstration-example, which compares calculation results versus measurement. In this example electronics and mechanics of the three involved loudspeakers are modelled with the help of the lumped element method. Waveguide, enclosure and radiation is modelled with the boundary element method.

Fri 9:00 Paul LANGEVIN EN-S03: Urban acoustics

On the diversity of urban waterscape – (Invited, 000547)

J. Kang
University of Sheffield, School of Architecture, S10 2TN Sheffield, UK
Corresponding author E-mail: j.kang@sheffield.ac.uk

In the last several hundred years the development of Sheffield has been shaped by waterways. In the recent city centre regeneration, starting in the 1990s, great efforts have been made to ensure that the reconnection with the rivers continues to be fostered and their role in the history of the city celebrated. Waterscapes and squares have been embedded into the city for its vibrancy with the respect of the history of Sheffield. This paper examines the soundscape with waterscape along the Gold Route formed in the city centre regeneration project. The changes of waterscape sound levels with frequency and time at different locations of the Gold Route are analysed. Comparisons have also been made between different water features along the Gold Route in terms of psychoacoustic parameters including loudness, roughness, sharpness, and fluctuation strength. A series of field questionnaire surveys in selected locations along the Gold Route have shown that water sounds are the most preferred sounds in the soundscape.

Fri 9:20 Paul LANGEVIN EN-S03: Urban acoustics

Intelligent system for data quality assurance in extensive urban noise monitoring networks – (Invited, 000666)

D. Oldoni, R. Muthuraman, B. De Coensel, S. Dauwe, M. Boes, T. Van Renterghem and D. Botteldooren
Ghent University, Acoustics Group, Department of Information Technology, St. Pietersnieuwstraat 41, 9000 Gent, Belgium
Corresponding author E-mail: damiano.oldoni@intec.ugent.be

Monitoring urban noise by means of extensive measurement networks is nowadays becoming affordable. However, a trade-off between quality and number of sensor units is still needed. Detection of breakdowns, drifts, or critical outliers is a crucial aspect. The simplest models, based on heuristic rules derived by prior knowledge, are able to detect breakdowns mainly. However, detecting every possible kind of malfunction only based on prior knowledge is neither theoretically possible nor practically feasible. The introduction of an intelligent learning system is thus advisable. In this paper, a neural network approach is followed. The proposed method is based on the synergy between different submodels that apply both supervised and unsupervised learning strategies. In particular, the submodel that uses a self-organizing map (SOM) is thoroughly studied. It implements an unsupervised learning algorithm, based on a series of psychoacoustic features encoding spectro-temporal irregularities, and currently used in auditory scene analysis models. The developed methodology has been applied to cheap sensors placed near reference microphones to check the validity of the quality assessment.

Fri 9:40 Paul LANGEVIN EN-S03: Urban acoustics

Supporting acoustic environment design in spatial planning of urban areas – (Contributed, 000181)

W. Paszkowski
Silesian University Technology, ul. Roosevelta 26-28, 41-800 Zabrze, Poland
Corresponding author E-mail: wpaszkowski@polsl.pl

The planned acoustic environment is a significant issue connected with landscaping of urban areas. These spaces are developed in the processes of spatial planning. In general, spatial planning may be oriented towards developing new spaces or adapting already developed spaces. Making use of acoustic environment planning at the early stages of spatial planning permits the environment features to be developed in the best possible way. The acoustic environment of urban areas can be described using data originating directly from these areas. In particular these are data concerning the following: land topography, the layout of spatial structures, the features of the structures and sound sources. A complete description of a sound environment should also include the opinions/judgments of the residents. This article deals with the problems of taking into consideration the subjective impressions of sound reception experienced by the residents in supporting acoustic environment design. The presented method of supporting acoustic environment design as a problem of spatial planning of urban areas includes the use of GIS tools. Design support in this method consists in linking the following problems: acoustic maps, spatial planning and acoustic design.

Fri 10:40 Paul LANGEVIN EN-S03: Urban acoustics

Sound absorption mapping of highway noise barrier – (Contributed, 000192)

A. Grosso
Microflown Technologies B.V, Tivolilaan 205, 6824BV Arnhem, Netherlands
Corresponding author E-mail: grosso@microflown.com

Sound propagation from highway to the urban areas can be reduced using noise barriers.
The general computational modeling takes typically into account sound ray lines, reflection and diffraction, although the absorption distribution over the surface in not considered.
The sound absorption coefficient can be calculated using a PU probe, by the impedance measured ”in situï close by the surface. Well known methods are available on the market for estimating the sound absorption by some smaller sample, which is not always relevant for the real condition.

A new methodology called Scan & paint enable absorption mapping of big surfaces ”in situï, enabling optimization of noise barriers. In the first section of this paper the methodology for the measurement is explained. Furthermore a comparison with an ”in laboratoryï measurement is compared with the results.

Fri 11:00 Paul LANGEVIN EN-S03: Urban acoustics

Sparse representations for modeling environmental acoustic scenes, application to train stations soundscapes – (Contributed, 000244)

B. Cauchi, M. Lagrange, N. Misdariis and A. Cont
Institut de Recherche et Coordination Acoustique/Musique, 1, place Igor Stravinsky 75004 Paris
Corresponding author E-mail: lagrange@ircam.fr

Our daily life happens in a world of dense acoustic environments. This is especially the case in train stations, where soundscapes are usually very complex. In this paper, we will investigate how Non Negative Matrix Factorization methods can be used to obtain a low rank spectrogram approximation, composed of spectral templates that be related to some salients events like footsteps, whistles, etc. We thus assume here that the scene can be characterized by a few salient events that occur several times within the scene. We also assume that even if the acoustic realizations of those events cannot be considered in isolation, those realizations have similar spectro-temporal properties.

We here consider 66 recordings made in French train stations, where individual salient events have been manually annotated. We then assess the ability of the methods to extract meaningful components by comparing the activations of those components within the scene to the manually annotated ones. Experiments demonstrate that enforcing sparsity on the activations, i.e. constraining that only a few components is active at a time, has a positive effect.

Fri 11:20 Paul LANGEVIN EN-S03: Urban acoustics

Characteristics of a spark discharge as an adjustable acoustic source for scale model measurements – (Contributed, 000301)

C. Ayrault[a], P. Béquin[a] and S. Baudin[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9;
[b]LaMCoS, INSA, 18-20, rue des Sciences, F69621 Villeurbanne, France
Corresponding author E-mail: christophe.ayrault@univ-lemans.fr

The simulation of acoustic phenomena using urban street scale models requires the use of a small and powerfull sound sources with a wide frequency bandwidth and omnidirectional radiation. Among different source types able to provide these characteristics, spark discharge in air is an interesting solution. The principle is based on the generation of an electric discharge by applying a high voltage between two electrodes. First the gas becomes electrically conducting, the electric current heats up the gas, causing the formation of an impulsive sound signal. These sources have been also widely used for shock wave propagation, like sonic boom, for which propagation is non linear. However, the behaviour of spark discharges and their acoustic radiation depend greatly on the electrodes gap. As very little investigation has been done of this dependance, this work provides a detailled characterisation of a spark discharge in function of the electrodes gap. Electrical characteristics, repeatability, acoustic characteristics and the limits between linear and non linear propagation domains are studied in function of various electrodes gaps. This experimental study is meant to be a useful resource for experimenters to design a spark discharge adapted to their specific applications.

Fri 11:40 Paul LANGEVIN EN-S03: Urban acoustics

One-way approximation of the sound propagation in a urban canyon with non-flat boundaries – (Contributed, 000334)

J.-B. Doc, B. Lihoreau and S. Félix
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jean-baptiste.doc.etu@univ-lemans.fr

From an acoustical point of view, the urban environment appears as a complex medium of propagation. At the scale of a street, indeed, both the medium (the air) and the boundaries (the façades, the ground and the opening to the sky above the street) can be heterogeneous or may influence the wave propagation in a complex way, inducing multiple reflections and interference effects. To account for these phenomena when modeling the wave propagation in a street, a wave approach is needed. The present work aims at formulating a one-way approximation of the sound propagation in a street, based on the 3D parabolic equation method and taking into account the opening at the upper part of the street and the irregularity of the boundary. Two methods are used, in order to model different kind of morphology of streets: A Kirchhoff approximation, to model an abrupt variation of the section of the street, or a coordinate change that allows to take into account the effect of a continuous variation of the street.

Fri 13:40 Paul LANGEVIN EN-S03: Urban acoustics

Sound propagation in periodic urban areas – (Contributed, 000361)

M. Moleron[a], S. Félix[a], V. Pagneux[a], O. Richoux[a] and J. Picaut[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9;
[b]Département Infrastructures et Mobilité (IFSTTAR/IM), Route de Bouaye, CS4, 44344 Bouguenais Cedex
Corresponding author E-mail: miguel.moleron.etu@univ-lemans.fr

This paper presents an experimental and numerical study of low frequency sound propagation in regular urban areas, under the assumption of periodic distribution of buildings. In studying extended distributions of buildings, such assumption is convenient to model the sound propagation, as much as it describes reasonably well some real situations. Specific properties of periodic media, in particular the presence of bandgaps, are investigated. A particular attention is paid to the influence of the opening and radiation above the periodic lattice. For this purpose, results are compared with an identical lattice, closed at the upper part. The problem is tackled using a coupled modal-Finite Elements method. The main idea is to turn the original unbounded domain into an equivalent waveguiding structure, with the appropriate boundary conditions. The experimental study is performed in a scale model of urban area. Numerical and experimental results are in good agreement and show, notably, that bandgap effects remain in such open periodic lattices.

Fri 14:00 Paul LANGEVIN EN-S03: Urban acoustics

Construction of an average indicator of potential noise exposure, and its sensitivity analysis in Marseilles city (France) – (Contributed, 000435)

A. Bigot[a], C. Boutin[b], A. David[a], A. Bocquier[c], S. Cortaredona[c] and P. Verger[c]
[a]SolData Acoustic, Parc de l'Ile, 21 rue du Port, 92022 Nanterre, France; [b]SolData Acoustic, 4 avenue Léo Lagrange, 79000 Niort, France; [c]ORS PACA, Southeastern Health Regional Observatory, 23, rue Stanislas Torrents, 13006 Marseille, France
Corresponding author E-mail: alexis.bigot@soldata-acoustic.com

The present study work was undertaken by SolData Acoustic and the Health regional Observatory (Southeastern France) within a research project aiming at the study of the links between road noise exposure and psychotropic drug consumption at a small-area level in the city of Marseilles.
First, we built an average indicator of potential road noise exposure (PNEI) for the population living in each census block (the smallest sub municipal division with 1500 inhabitants on average). We calculated noise exposure using CadnaA software according to END method for noise mapping, and applied some improvements: we used observed mean speeds (instead of speed limitations), calculated mean noise level for each building (instead of maximum levels), and took floor levels into account. Second, we performed a sensitivity analysis to evaluate the impact of the variations of several parameters on model outputs. Sensitivity analysis shows that the most influent input parameters, at a global scale, are speed, then traffic flow. Propagation of uncertainties was performed on those parameters.
Finally, uncertainties calculations on the PNEI will be taken into account in the analysis of the links between road noise exposure and psychotropic drug consumption.

Fri 14:20 Paul LANGEVIN EN-S03: Urban acoustics

Indoor noise exposure assessment of primary school children living in a french urban area – (Contributed, 000744)

S. Pujol[a], M. Berthillier[b], J. Defrance[c], J. Lardies[b], R. Petit[d], J.-P. Levain[e], H. Houot[f], C. Masselot[f] and F. Mauny[a]
[a]UMR Chrono-environnement 6249, CHRU de Besançon, 2 place Saint Jacques, 25030 Besançon Cedex, France; [b]FEMTO-ST, Département de Mécanique Appliquée, 24 rue de l'Épitaphe, 25000 Besancon, France; [c]CSTB, 24, rue Joseph Fourier, 38400 Saint Martin D'Hères, France; [d]Inspection académique du Doubs, 26 avenue de l'observatoire, 25000 Besançon, France; [e]Laboratoire de Psychologie EA3188, IUFM de l'Université de franche-Comté, Fort Griffon, 25042 Besançon Cedex, France; [f]Laboratoire ThéMA UMR 6049, 32 rue Mégevand, 25030 Besançon Cedex, France
Corresponding author E-mail: sophie.pujol@univ-fcomte.fr

The recent development of powerful noise mapping softwares allows to assess the exposure to environmental noise at the scale of an agglomeration. However noise levels inside dwellings are still unknown at such scales. To evaluate indoor noise levels and to investigate the factors which determine them, an eight-day noise measurement campaign was carried out in 50 children's home. These children were randomly chosen among 8 or 9-year-old pupils attending the public primary schools of Besançon (France). Microphones were placed in the child's bedroom, outdoor in front of the bedroom's facade, and in the main room. Equivalent sound pressure levels (LAeq) were calculated daily for day, evening and night periods. Standardised questionnaires were distributed to parents to describe dwelling arrangement and family habits as well as to collect noisy events occurring every day. Events were coded by periods of 30 minutes in a time-location-activity diary (TLAD). Analyses were conducted using multilevel linear regressions. A significant part of day and evening indoor noise level can be explained by non acoustic variables, especially those collected by TLAD. The results highlight the chances of improving large scale epidemiological studies based on indoor noise exposure assessment.

Fri 14:40 Paul LANGEVIN EN-S03: Urban acoustics

Some problems of elaboration and utilization of strategic noise maps in Upper Silesian Conurbation – (Contributed, 000848)

M. Komoniewski
Silesian University of Technology, Akademicka 2A, 44-100 Gliwice, Poland
Corresponding author E-mail: Marek.Komoniewski@polsl.pl

The paper deals with the chosen aspects of elaborating of strategic noise maps in one of the strong urban area in Poland - Upper Silesian Conurbation. Presents the author's point of view on the concept of acoustical environmental management in quality aspect. The organizational and technical issues in data gathering for the needs of

preparing of acoustic map is described. Examples of EU financial support for development of innovative activities in range of acoustical environmental protection and improvement is presented. The final part of the paper introduces the conception of implementation of advisory and training system for local government employees in Metropolitan Association of Upper Silesia.

Fri 9:00 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Simulated and experimental force analyses in the bridge-soundboard contact of string instruments – (Contributed, 000020)

E. Ravina
MUSICOS Centre, Univ. of Genoa, Via Opera Pia 15A, 16145 Genoa, Italy, 16145 Genoa, Italy
Corresponding author E-mail: enrico.ravina@unige.it

The paper describes a theoretical and experimental research activity oriented to analysis of static and dynamic forces generated in the bridge-soundboard contact of string musical instruments. This contact area is fundamental for the transmission of mechanical actions generated on the strings by the player and the corresponding vibration response on the acoustic parts of the instrument, like soundboard. In particular static and dynamic forces generated in these contacts areas are analyzed with respect to the generated sound. Forces in bridge-soundboard contact are theoretically modeled and the model is validated by experiments, acquiring the components along the normal to the contact surfaces by means non-invasive thin film micro-sensors, wireless interfaced to PC. The detected forces are significant to investigate on the friction forces generated in the contact. Simultaneously acoustic acquisitions on the played instrument are detected. Different playing techniques are related to several methods of attack on the string by the player. The proposed approach is actually used to study the influence of different kinds of bridges. Different tilt angles of the string on modern and baroque assembling are subjects of analysis. Preliminary correlations between forces and acoustic sound levels have been focused and discussed.

Fri 9:20 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

An extended geometric model for analysis of string crossings in bowed-string instrument performance – (Contributed, 000674)

E. Schoonderwaldt[a] and M. Demoucron[b]
[a]Institute of Music Physiology and Musicians' Medicine (IMMM), Schiffgraben 48, 30175 Hannover, Germany; [b]IPEM, Blandijnberg 2, 9000 Gent, Belgium
Corresponding author E-mail: schoondw@gmail.com

In earlier motion capture studies of fast repetitive bowing patterns across two and three strings it was shown that string crossings were consistently timed earlier than bow reversals. This behavior might have a plausible acoustic explanation: a good attack on the new string requires that bow force is built up before acceleration can take place. An earlier used geometric model of the bow and the violin fails to adequately describe the transfer of bow force between strings because it considers string positions and bow inclination transition angles between strings to be fixed. A new geometric model is proposed that (1) takes the compliance of the strings and the bow hair explicitly into account, and (2) includes a correction of string crossing angles for stopped strings. The model requires knowledge of the tensions of the strings and the bow hair, as well as the depth of the fingerboard below the strings. It will be shown how these quantities can be obtained by a simple calibration procedure. The model allows for an accurate calculation of control parameters to drive a virtual violin, allowing to study the relation between bowing movements and the quality of attacks in complex bowing patterns.

Fri 9:40 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

A real-time acoustic violin emulator for electric violins – (Contributed, 000155)

P. Gaydecki
University of Manchester, School of Electrical and Electronic Engineering, Sackville Street Building, M13 9PL Manchester, UK
Corresponding author E-mail: patrick.gaydecki@manchester.ac.uk

A stand-alone electronic device has been developed that processes the raw electrical output produced by an electric violin, generating an output signal which, when fed to an amplifier, produces a sound that approximates closely the timbre of an acoustic or wooden instrument. The system comprises a high-impedance preamplifier, a 24-bit sigma delta codec and a digital signal processor (DSP) operating at 600 million multiplications-accumulations per second (MMACs). The device holds in its memory the far-field impulse response of a wooden instrument; this is convolved in real-time with the input signal to produce the modified output signal. The unprocessed output produced by an electric violin is typically a saw-tooth waveform, which results from the slip-stick regime created under normal bowing. Similarly, such a waveform is also manifest on the bridge of acoustic violins and for this reason the system may also be used with wooden instruments fitted with pickups mounted on the bridge. The device incorporates a standard line-output for connection to audio amplifiers and an additional headphone driver for silent practice. Additional features include adjustable gain, a parametric equalizer and a facility that enables the user to download and store additional impulse responses in non-volatile memory.

Fri 10:00 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Finite element modelling of the violin with pre-stresses – (Contributed, 000813)

F. Ollivier[a], A. Rodrigue[a], C. Besnainou[b] and J. Frelat[b]
[a]UPMC - Institut Jean Le Rond d'Alembert, 2 place de la gare de ceinture, 78210 Saint Cyr L'Ecole, France; [b]UPMC, IJLRDA, 4, place Jussieu Tour 65/55 5eme case 162, 75005 Paris, France
Corresponding author E-mail: adrien_rodrigue@hotmail.com

We are interested in processes and actions at work in the manufacture and adjustment of the violins. Among these actions, some regulate the dimensions of the instrument and other mechanical state of prestress. The importance of prestressing is well known by the violin makers but little studied; we carried out a model of violin by finite elements method. This model takes into account the state of prestress and allows to study the effects of its variations on the vibration behavior of the instrument. We offer two examples of the inclusion of prestress: setting the forcing of the bass bar and the place of the sound post of a violin model reduced to the case with the loading of the strings through the mediation of the bridge. We give to compare the effects of these two parameters to the impact of changes in thickness fields of the plates and weight of the bass bar. This model does not quantify the impact of setting it proposes to study, but nevertheless it allows to identify trends and precedence. It appears from this study the importance of setting and the need to take into account the state of prestress in the computations.

Fri 10:40 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Bowed strings and sympathy, from violins to indian sarangis – (Contributed, 000071)

M. Demoucron[a] and S. Weisser[b]
[a]IPEM, Blandijnberg 2, 9000 Gent, Belgium; [b]Musée des Instruments de Musique, Montagne de la Cour 2, 1000 Bruxelles, Belgium
Corresponding author E-mail: matthias.demoucron@ugent.be

The sarangi is an indian bowed string instrument that is characterized by a large set of sympathetic strings (sometimes up to over 30), called taraf, going below the three main strings. The tuning of the taraf varies among players, but generally one part is tuned chromatically and diatonically, while the other part is tuned according to the rag of the performance, resulting in a rich and highly reverberant sound when the main strings are bowed. The goal of this research is to determine how the sympathetic strings affect the resulting sound, as well as their possible musical, perceptual and aesthetical implications in classical Indian sarangi music. Starting from the simple case of western classical violins, in which sympathetic vibrations occur because of the interaction with adjacent open strings, we will examine changes occurring in the timbre of the instrument when one string is allowed to vibrate in sympathy. Then, we will present sound analyses of several sarangis played by various musicians, with and without taraf, in order to characterize the role of the sympathetic strings on the resulting sound.

Fri 11:00 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Violins characterization through vibro-acoustic experiments – (Contributed, 000021)

E. Ravina
MUSICOS Centre, Univ. of Genoa, Via Opera Pia 15A, 16145 Genoa, Italy, 16145 Genoa, Italy
Corresponding author E-mail: enrico.ravina@unige.it

An approach of integrated vibratory and acoustic experiments oriented to identify the specific characteristics and peculiarities of violins is presented in the paper. Today the up-level luthery handicraft needs a scientific and methodical supports specifically oriented to underline the acoustic peculiarities of each musical instrument, able to define the "signatureï of a specific instrument. The proposed approach integrates vibration and acoustic non destructive analyses of the musical instrument considered as only copy extant: the approach has been actually developed with regard to the violins family but can be, more in general, proposed. A three-dimensional parametric model of a violin is integrated with a FE model. The theoretical model is validated through experimental analyses of single parts of the violin during the construction or on the complete instrument. Experimental modal analyses based on the use of micro-hammer and micro-accelerometers are applied not only to the finished violin but also during previous significant construction phases like varnishing. Mechanical and thermo-graphic detections in contact areas of relative motion (e.g. string on the bridge) allow acquiring peculiar information. Finally acoustic experiments finalized to the three-dimensional mapping of the sound produced by the played instrument allow defining the vibro-acoustic signature of the violin.

Fri 11:20 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Bridge admittance measurements of 10 preference-rated violins – (Contributed, 000182)

C. Saitis[a], C. Fritz[b], B. L. Giordano[c] and G. P. Scavone[d,e]
[a]Computational Acoustic Modeling Lab, CIRMMT, McGill University, 555 Sherbrooke Str. W., Montreal, QC, Canada H3A 1E3; [b]LAM, Institut Jean le Rond d'Alembert, UMR CNRS 7190, UPMC, 11 rue de Lourmel, 75015 Paris, France; [c]Music Perception and Cognition Laboratory, McGill University, 555 Sherbrooke Street West, Montreal, Canada H3A 1E3; [d]Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), 527 Rue Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3; [e]Computational Acoustic Modeling Lab, Schulich School of Music, McGill University, 555 Rue Sherbrooke Ouest, Montreal, QC, Canada H3A 1E3
Corresponding author E-mail: charalampos.saitis@mail.mcgill.ca

The overall goal of the research presented here is to investigate correlations between measured vibrational properties of the violin and subjective judgments by violinists and to better understand what distinguishes one instrument from another. The novelty of this study is that 10 violins of different make and age were evaluated and preference-rated by 13 experienced musicians in a carefully controlled violin-playing perceptual experiment. Regarding the vibrational properties of the instruments, the classical bridge admittance measurements have been examined so far. The five "signatureï modes below 600 Hz were identified in all of the tested violins. Preliminary results generally show no prominent preference-related trend for mode frequencies or damping. Results of more in-depth comparisons between violins that had significantly different across-players average preference scores will be presented at the conference.

Fri 11:40 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Vibrotactile feedback in the left hand of violinists – (Contributed, 000667)

I. Wollman[a], C. Fritz[a] and J. Frelat[b]
[a]LAM, Institut Jean le Rond d'Alembert, UMR CNRS 7190, UPMC, 11 rue de Lourmel, 75015 Paris, France; [b]IJLRDA-UPMC, 4 place jussieu, 75005 Paris, France
Corresponding author E-mail: wollman@lam.jussieu.fr

The long-term goal of this study is to investigate the differences that can be perceived in the "feelï of a violin across a certain range of instruments. As a first step, we compare the vibration levels in violin necks and the violinists' sensitivity to vibration in their left hand. Absolute vibrotactile thresholds were measured on violinists holding an isolated vibrating violin neck, to mimic normal playing conditions (in particular the pressure and the position of the hand on the neck). A standard alternative forced choice procedure was used and the measurements were done as a function of frequency in the skin sensitivity range 200-900Hz. Vibration levels of the neck (at different positions along the neck) were measured classically across a large set of instruments, using a laser vibrometer and an impulse excitation at the bridge. Results show that the neck vibration levels are above the perceptual thresholds for most violins and most frequencies below 900 Hz, and the relative difference between the two can vary a lot from violin to violin.

Fri 12:00 John TYNDALL MA-S01: Violin-like instruments: from acoustics to perception

Old violins or new: which do players prefer? – (Contributed, 000456)

C. Fritz[a], J. Curtin[b], J. Poitevineau[a] and F.-C. Tao[c]
[a]LAM, Institut Jean le Rond d'Alembert, UMR CNRS 7190, UPMC, 11 rue de Lourmel, 75015 Paris, France; [b]Joseph Curtin Studios, 3493 W. Delhi Rd, Ann Arbor, MI 48103, USA; [c]D'Addario & Company, PO Box 290, 595 Smith Street, Farmingdale, NY 11735, USA
Corresponding author E-mail: fritz@lam.jussieu.fr

Most violinists believe that the instruments of Stradivari and Guarneri 'del Gesu' are tonally superior to other violins - and to new violins in particular. Many mechanical and acoustical factors have been proposed to account for this. However, the fundamental premise of tonal superiority has not yet been properly investigated. We therefore designed a playing test in which 21 experienced violinists each compared three violins by Stradivari and Guarneri 'del Gesu' with three high quality new instruments, under double-blind conditions in a room with relatively dry acoustics. We found that (1) the most-preferred violin was new and the least-preferred was by Stradivari; (2) there was very little correlation between an instrument's age and monetary value and its perceived quality, and (3) most players seemed unable to tell whether their most-preferred instrument was new or old. These results present a striking challenge to conventional wisdom. Differences in taste among individual players along with differences in playing qualities among individual instruments appear more important than any general differences between new and old violins.

Fri 9:00 Philip DOAK MA-S04: Sound synthesis and control

An acoustic model to control an experimental slide flute – (Contributed, 000167)

B. D'Andréa-Novel[a], B. Fabre[b] and J.-M. Coron[c]
[a]Mines ParisTech - Centre de Robotique, 60 bvd Saint-Michel, 75272 Paris Cedex 06, France; [b]UPMC - Lutherie, Acoustique, Musique, IJLRA, 11 rue de Lourmel, 75015 Paris, France; [c]UPMC and Institut Universitaire de France, B.C. 187, 4 place Jussieu, 75252 Paris Cedex 05, France
Corresponding author E-mail: brigitte.dandrea-novel@mines-paristech.fr

We consider the problem of modeling and control of a slide flute: a kind of recorder without finger holes but ended by a piston to modify the length of the resonator. To control dynamical systems, it is important to elaborate a realistic model, so that control laws can be tested efficiently before they are implemented on real size prototypes. The dynamical model we have elaborated takes into account the coupling effects between the jet and the pipe which is a linear acoustic resonator. The jet is obtained by blowing through a flue channel and formed by flow separation at the flue exit, and finally directed towards a sharp edge, called the labium. A modal analysis is then performed using the linearized boundary conditions to compute the suitable blowing pressure and the suitable pipe length to obtain a desired pitch. This will constitute the "feedforward" part of our control algorithm. The Proportional-Integral feedback term is then elaborated to regulate the system to the desired set point, using the length of the piston measured by an encoder and the blowing pressure measured by a pressure sensor. First experimental results, obtained on a "mechatronic" prototype developed at Mines ParisTech will be presented.

Fri 9:20 Philip DOAK MA-S04: Sound synthesis and control

Active control applied to wind instruments – (Contributed, 000362)

T. Meurisse[a], A. Mamou-Mani[a], R. Caussé[a] and D. Sharp[b]
[a]IRCAM, 1 place Igor Stravinsky, 75004 Paris, France; [b]Open University, DDEM, MCT Faculty, Open University, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: thibaut.meurisse@ircam.fr

Musicians have always been interested in the evolution of their instruments. This evolution might be done either to adapt an instrument's quality to musicians' and composers' needs, or to enable it to produce new sounds. In this study, we want to control the sound quality and playability of wind instruments, using modal active control. The modal active control makes it possible to modify the input impedance (frequency, gain and damping) of these instruments. A first experiment is presented here. We control the acoustic resonances of a cylinder, which is considered as a simple "brass instrumentï. Using microphones, speakers and a DSP, we modify its input impedance. We then test the effect of the control on the playability via tests with brass players. Our next goal will be to adapt the control to real instruments, a trumpet at first, and to evaluate it in a musical context with a musician.

Fri 9:40 Philip DOAK MA-S04: Sound synthesis and control

A modal method adapted to the active control of a xylophone bar – (Contributed, 000634)

H. Boutin and C. Besnainou
UPMC, IJLRDA, LAM, 15, rue de Lourmel, 75015 Paris, France
Corresponding author E-mail: charles.besnainou@upmc.fr

In Musical Acoustics, modal control is commonly used to modify the vibration characteristics of musical instruments. The number of transducers used to control the structures of such systems is typically reduced. In addition, their localization is optimized, so that they don't disturb the vibration of the instrument nor the musician playing. In this paper, we suggest a control method adapted to these constraints. It allows modifying the characteristics of the peaks of resonance in the frequency response of the plant. This is achieved using a single pair of transducers. The regulator is composed by a sum of second order resonant filters. First we introduce the theoretical method used to calculate the coefficients of the regulator. Then we apply it to a xylophone bar equipped with piezoelectric transducers, of which the mechanical properties are suitable for active control. To do that, we encode the regulator in a digital signal processor. We succeed to modify the frequency and the maximum gain of the first peaks of resonance of the bar. This method is suitable to study the relationship between the frequency response and the sound quality of the xylophone bar.

Fri 10:40 Philip DOAK MA-S04: Sound synthesis and control

Towards a real-time mapping of Finger Gesture to Sound – (Contributed, 000796)

V. Matsoukas[a], S. Manitsaris[b] and A. Manitsaris[a]
[a]University of Macedonia, Dept of Applied Informatics, MTCG Lab, 156 Egnatia Street, 54006 Thessaloniki, Greece; [b]Laboratoire Signaux, Modèles et Apprentissage Statistique, 10 rue Vauquelin, 75231 Paris cedex 05
Corresponding author E-mail: vmats@uom.gr

The scope of this research is to develop a system for real-time and continuous gesture following and recognition given emphasis to the finger approach of gesture control of sound. The proposed methodology can be implemented in a low cost computer vision system, which provides the means to facilitate an interactive composition of contemporary music. A simple web camera is used to capture finger musical gestures in 3D space without any tangible instrument. Afterwards we use the PianOrasis system, which recognizes simultaneously the gestures of all five fingers by extracting meaningful features from each frame sequence. In order to achieve this in real-time, the "gesture followingï method is applied. Hidden Markov Models are used to update "continuouslyï the gesture descriptors. We choose then to map high-level features of finger motions to low-level audio descriptors given emphasis to the temporal representation of mapping rather than the spatial. This is due to the need of real-time performance.

Fri 11:00 Philip DOAK MA-S04: Sound synthesis and control

Extracting the angle of release from guitar tones: preliminary results – (Contributed, 000048)

B. Scherrer and P. Depalle
McGill University, CIRMMT, SPCL, Schulich School of Music, 555 Sherbrooke Street West, Montréal, Canada H3A1E3
Corresponding author E-mail: bertrand.scherrer@mail.mcgill.ca

On the classical guitar, a performer can impart very distinct qualities upon the sound s/he produces by the way s/he plucks the strings. There is, for example, a clearly audible difference between notes plucked using a rest stroke (a.k.a. "buté") and a free stroke (a.k.a. "tiré"). The difference between these strokes has been shown to stem from a difference in the angle at which the string is released at the end of the finger-string interaction. A sound analysis tool, based on a digital waveguide model that exploits the asymmetry of the guitar body's admittance, has been created to provide an estimate of this angle of release. Some first results on synthetic and real guitar tones are presented. This work is an extension of a previous study in which the plucking position was extracted from an audio recording.

Fri 11:20 Philip DOAK MA-S04: Sound synthesis and control

"Listen to the Picture!ï. The StatSon Sound Sonification System, using VST and DSP – (Contributed, 000041)

M. D. Heath[a] and G. Hunter[b]
[a]Kingston University, 229 Boston Road, Hanwell, W7 2AA London, UK; [b]Faculty of Science, Engineering and Computing, Kingston University, Penrhyn Road, KT1 2EE Kingston Upon Thames, UK
Corresponding author E-mail: martin.dh@o2.co.uk

StatSon is a proof-of-concept C++ plugin for a VST host (for example, the Cubase music production software suite) using digital signal processing (DSP). Its inputs are an audio signal that is converted to the frequency domain using a phase vocoder and an image that is analysed statistically. Selected statistics for the image can become pitch manipulation parameters controlling various transformations of the input signal's loudest frequency. Arbitrary input can be rounded to the closest semitone, scalar tone or tone from a selection of three or four note chords, allowing integration with existing music. A wavetable synthesiser converts the transformed frequency to a monophonic sinusoidal output, changing typically every 10ms, producing an outcome which is sometimes reminiscent of granular synthesis. The output is able to track the input and change recognisably in response to changing the image. The modified audio signal can therefore be regarded as a primitive "sonificationï of the current image. The aim of the work was to create an audio effect for use live or in the studio, whilst exploring this technology and the field of image sonification.

Fri 9:00 Pierre CHAVASSE NV-S05: Railway noise

Wheelflat impact noise prediction using detailed contact model – (Contributed, 000416)

J. Yang and D. J. Thompson
Dynamics Group-ISVR - University of Southampton, University Road, SO17 1BJ Southampton, UK
Corresponding author E-mail: jny1e08@soton.ac.uk

Impact noise, which has a similar excitation mechanism to rolling noise, is caused by rail and wheel discontinuities. However, the requirements for the use of a Hertzian contact model are not fulfilled due to large variations of the contact geometry at the discontinuity such as a wheelflat. Therefore, a detailed numerical contact model is included dynamically in the wheel/rail interaction model to predict the impact noise due to a wheelflat. The contact patch size is discretized adaptively at each time step to ensure that all the contact points are included. The impact force can be predicted up to about 3 kHz. For noise prediction, the equivalent roughness from a linearized frequency domain model is obtained from the predicted impact force. The TWINS model is then used to generate the sound power spectrum from the equivalent roughness. Roughness input data from SNCF field measurements on a wheelflat is used to validate the model in terms of track vibration and pass by noise.

Fri 9:20 Pierre CHAVASSE NV-S05: Railway noise

Experimental assessment of wheel/rail interaction force with rolling noise analysis – (Contributed, 000239)

P.-E. Chartrain[a], P.-O. Mattei[b] and E. Bongini[a]
[a]Innovation & Recherche SNCF, 40 Avenue des terroirs de France, 75012 Paris, France; [b]LMA, CNRS, UPR 7051, Aix-Marseille Univ, Centrale Marseille, 31 chemin Joseph Aiguier, F-13402 Marseille Cedex 20, France
Corresponding author E-mail: estelle.bongini@sncf.fr

The main source of noise from railway at conventional speeds is rolling noise. The wheel and the rail surfaces are not perfectly smooth, but contain small-amplitude roughness. This roughness causes vibration of the wheel and rail which radiate noise. Within the LECAV project (LECture Acoustique de la Voie, i.e. Acoustic reading of railway track) a method is developed to use the sound radiated by the wheel and the rail to characterize acoustics parameters of wheel track system during train running. These parameters will allow estimating rail roughness spectrum and potentially track decay rate. This method requires to have control over the acoustic radiation of the wheel and rail in order to estimate the interaction force between the two elements in the contact zone. The first part of this communication is devoted to the presentation of a measurement campaign that has been carried out on a test train parked on a railway track. The second part of the paper deals with the post-processing method. Results of the estimated excitation force from the simultaneous measurement of the acoustic sound pressure and vibration of the wheel are compared to the measured one to validate the method

Fri 9:40 Pierre CHAVASSE NV-S05: Railway noise

Assessment of the efficiency of railway wheel dampers using laboratory methods within the STARDAMP project – (Contributed, 000253)

B. Betgen[a], P. Bouvet[a], D. J. Thompson[b], F. Demilly[c] and T. Gerlach[d]
[a]VIBRATEC, 28 chemin du petit bois, BP 36, 69131 Ecully, France; [b]Dynamics Group-ISVR - University of Southampton, University Road, SO17 1BJ Southampton, UK; [c]Valdunes SAS, GHH-Valdunes Group, Rue Gustave Delory, 59125 Trith Saint Léger, France; [d]Gutehoffnungshütte Radsatz GmbH, GHH-Valdunes Group, Gartenstraße 40, 46145 Oberhausen, Germany
Corresponding author E-mail: benjamin.betgen@vibratec.fr

Noise is one of the major issues for the expansion of railway traffic. Within a relatively wide speed range, rolling noise is the predominant railway noise source. In recent years, rail and wheel absorbers have been developed by different manufacturers that show to be effective devices for the reduction of rolling noise. STARDAMP (Standardization of damping technologies for the reduction of railway noise) is a Franco-German research project within the DEUFRAKO framework that unites end users, manufacturers and research institutes. The target of STARDAMP is to support the transfer from R&D of wheel and rail dampers to their regular application. A key factor in this context is the development of new testing methods for the assessment of damper performances. Today, such tests are usually performed as field tests that are costly and time consuming. These shall be replaced by standardized laboratory measurement and calculation techniques. The present contribution deals with a proposition for a wheel absorber testing protocol, combining finite element calculations, experimental modal analysis and analytical calculations using TWINS software. Results for different wheels and absorbers are presented.

Fri 10:40 Pierre CHAVASSE NV-S05: Railway noise

Laboratory methods for testing the performance of acoustic rail dampers – (Contributed, 000310)

M. Toward[a] and D. J. Thompson[b]
[a]Consultancy Group-ISVR - University of Southampton, University Road, SO17 1BJ Southampton, UK; [b]Dynamics Group-ISVR - University of Southampton, University Road, SO17 1BJ Southampton, UK
Corresponding author E-mail: mgrt@soton.ac.uk

Several types of rail damper are now commercially available to reduce noise radiated by railway track. These dampers, attached to the rail between sleepers, increase the attenuation with distance of vibration transmitted along the rail (decay rate). Currently, there are no standardized procedures to measure the effectiveness of these dampers without the need for their installation in a track. Track decay rates of damped ëfreely' supported rails have been measured using two proposed methods: (i) for short rails (4-6m length), at low frequency from the modal properties of the rail, and at high frequencies directly from point and transfer response functions (FRFs) at either end of the rail; and (ii) for long rails (15-32m), by integrating decay rates derived from FRFs measured at intervals along the rail.
Results from four test institutes show generally good agreement between the two methods for three different damper designs. However, at some frequencies substantial inter- and intra- method variability is evident. Sources of this variability are identified and are discussed. Further tests conducted on a 32m test track show that decay rates of damped track can be reasonably determined by summing decay rates of the ëfree' damped rail and those of the undamped track.

Fri 11:00 Pierre CHAVASSE NV-S05: Railway noise

Identification of the rail radiation using beamforming and a 2 D array – (Contributed, 000397)

F. Le Courtois[a], J.-H. Thomas[b], F. Poisson[a] and J.-C. Pascal[b]
[a]Innovation et recherche SNCF, 40 avenue des terroirs de France, 75012 Paris; [b]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: florent.lecourtois@gmail.com

Rolling noise is the major contribution to train pass-by noise. Array processing provides noise maps of the source location on the train. The rolling noise contribution is located around the wheels at 2 kHz on those maps and the rail is not well identified as a source, whereas models, like TWINS, estimate that its acoustical contribution can be in the same order of magnitude as the wheel contribution in the medium frequency range (1000 Hz). Flexion wave causes the rail to radiate in privileged direction due to fluid structure interaction. Beamforming processing identifies this acoustical radiation only under particular conditions, which is an explanation to the underestimation of the rail radiation on the global noise map of the train. This article presents a simple radiation model of the rail and the

simulation result provided from beamforming processing to localize the theoretical radiation angle. An experimentation is performed using the classical 2 D adapted for train pass-by source localisation. The rail is excited in the vertical direction using a shaker. The radiation angle is not retrieved: the use of the classical array is not relevant to measure the radiation angle.

Fri 11:20 Pierre CHAVASSE NV-S05: Railway noise

BRAINS - the concepts behind a quick and efficient tool for prediction of exterior and interior railway vehicle noise – (Contributed, 000648)

A. Frid[a], U. Orrenius[a], T. Kohrs[b] and S. Leth[a]
[a]Bombardier Transportation, Östra Ringvägen 2, 721 73 Västerås, Sweden; [b]Bombardier Transportation, Am Rathenaupark, 167 61 Hennigsdorf, Germany
Corresponding author E-mail: anders.r.frid@se.transport.bombardier.com

BRAINS (Bombardier RAIlway Noise Software) is a validated acoustic prediction software for interior and exterior noise of railway vehicles. It was originally developed to meet the specific needs in the industry for quick decision making in tender and early design phases. Over the years the tool has evolved by extending the modelling scope and level of detail now making it a cornerstone of the complete acoustics management process. One key feature is that BRAINS handles exterior and interior noise predictions with the same model input data as basis thanks to an efficient computational framework. It interacts with the Bombardier acoustics source and material database and can also import data from specialised software such as TWINS. For exterior noise BRAINS is well positioned to be used for the emerging field of ”virtual acoustic authorisationï as an alternative to physical testing. It incorporates TWINS rolling noise input as well as other sources represented by 1/3-octave band sound power and directivity. For interior noise the calculations are based on an SEA model for the interior volume into which the injected acoustic power comes from transfer functions derived from analytical, statistical and empirical formulations.

Fri 11:40 Pierre CHAVASSE NV-S05: Railway noise

Investigation of the influence of non-acoustical factors on the estimation of railway induced vibration annoyance using artificial neural networks – (Contributed, 000420)

R. Venegas[a], E. Peris[b], J. Woodcock[b], G. Sica[b], A. Moorhouse[b] and D. Waddington[b]
[a]Acoustics Research Centre, University of Salford, M5 4WT Salford, UK; [b]University of Salford, The Crescent, M5 4WT Salford, UK
Corresponding author E-mail: D.C.Waddington@salford.ac.uk

Groundborne vibration can be a source of annoyance in residential areas situated close to railway lines. Using field data from case studies (N=929) comprised of face-to-face interviews and internal measurements of vibration exposure, this paper aims to investigate vibration annoyance as a function of the vibration level, socio-demographic data, and several individual and situational factors. The influence of these variables on vibration annoyance is investigated through a sensitivity analysis performed on several artificial neural network models. Comparisons are also made with analyses performed using conventional regression or classification techniques. The results show that the vibration annoyance prediction is improved when the non-acoustical variables are considered along with the vibration level. The results further suggest that artificial neural networks could provide an alternative way of calculating vibration exposure-response relationships. The data used in this paper were collected within the Defra funded UK study ”Human Response to Vibration in Residential Environmentsï conducted by the University of Salford.

Fri 9:00 François CANAC PU-S03: Phononic crystal and metamaterials

Effective wave numbers for media sustaining the propagation of three types of bulk waves and hosting a random configuration of scatterers – (Contributed, 000052)

F. Luppé[a], J.-M. Conoir[b] and A. N. Norris[c]
[a]LOMC-GOA, Université du Havre, place R. Schuman, 76610 Le Havre, France, Metropolitan; [b]CNRS, Institut Jean Le Rond d'Alembert - UMR CNRS 7190, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France; [c]Rutgers University, Mechanical and Aerospace Engineering, Piscataway, NJ 08854, USA
Corresponding author E-mail: francine.luppe@univ-lehavre.fr

Wave propagation through an isotropic host medium containing a large number of randomly and uniformly located scatterers is considered at low frequency and for low concentrations of spheres, and the dispersion relation of the coherent waves is obtained. The same problem had been addressed by Lloyd and Berry for spheres in an ideal fluid, and more recently by Linton and Martin for cylinders in an ideal fluid, and by Conoir and Norris for cylinders in an elastic solid. Here, the dispersion relation is derived in the case of spheres, and extended to that of cylinders, from the comparison of the 3d and 2d cases in an elastic solid. The host medium considered may support the propagation of P different types of bulk waves, as for example a thermo-visco-elastic medium or a poro-elastic medium (P=3). As in the previous works mentioned above, the hole correction of Fikioris and Waterman is taken into account, along with the quasi-crystalline approximation.

Fri 9:20 François CANAC PU-S03: Phononic crystal and metamaterials

Upper and lower bounds of low-frequency band gaps – (Contributed, 000260)

A. Krynkin
University of Bradford, School of Engineering, Design & Technolgy, Richmond Road, Chesham Building, BD71DP Bradford, UK
Corresponding author E-mail: a.krynkin@bradford.ac.uk

It is known that periodic structures (PS) exhibit frequency intervals where sound waves do not propagate (i.e. band gaps, BG). The existence of the band gaps is attributed to the periodicity (i.e. the Bragg BG) and the properties of a periodic element. The later substantially enhances the performance of the PS if it supports resonances that generate additional BG (resonant BG). By changing geometrical and physical properties of the periodic element the resonances can be observed below the first Bragg BG (associated with the half of sound wavelength) that makes PS effective treatment in the low frequency regime. The aim of this paper is to approximate the limiting frequencies (lower and upper bounds) of the low-frequency resonant BGs. The PS is represented by an array of thin elastic shells exhibiting multiple low-frequency resonances. In the vicinity of lower bound the approximation is found by means of the Rayleigh Identity which leads to the Foldy-type equation. The upper bound of the resonant BG is approximated with the help of matched asymptotic expansions. This gives an accurate approximation for the upper bound approaching the first Bragg BG where the contribution of higher modes has to be taken into account.

Fri 9:40 François CANAC PU-S03: Phononic crystal and metamaterials

A metamaterial superacoustic absorber: the bubble raft – (Contributed, 000520)

A. Bretagne[a], V. Leroy[b] and A. Tourin[a]
[a]Institut Langevin ESPCI ParisTech - CNRS UMR 7587 - INSERM U979, 10 rue Vauquelin, 75005 Paris, France; [b]MSC - Université Paris Diderot, 10 rue Alice Domont et Léonie Duquet, 75013 Paris, France
Corresponding author E-mail: alice.bretagne@espci.fr

The concept of bubble raft was introduced in 1947 by William Lawrence Bragg (L. Bragg and J. F. Nye, Proc. R. Soc. London Ser. A 190, 474 (1947)) as a dynamic model of a crystal structure. A bubble raft is a compact assemblage of bubbles, a millimetre or less in diameter, floating on the surface of a surfactant solution. Here we show that a bubble raft is also an acoustic metamaterial that can be used to absorb sound in a selective frequency band determined by the bubble size. To form the bubble raft we inject monodisperse small bubbles by blowing air through a 20 μm-diameter capillary at the bottom of a cylindrical container. Reflection measurements are performed by acoustic pulse emission and reception with a couple of broadband air transducers at an incidence larger than 20°, i.e., larger than the critical angle for an air/water interface. Contrary to first intuition, the reflection is not total but is strongly decreased at a frequency that scales with the inverse bubble size. Using an MST calculation (Multiple Scattering Theory) we relate that decrease to absorption in the bubble raft, which exhibits an effective viscosity 250 times higher than that of water.

Fri 10:40 François CANAC PU-S03: Phononic crystal and metamaterials

Omnidirectional graded index sound absorber – (Contributed, 000521)

O. Umnova and B. Zajamsek
University of Salford, The Crescent, Salford, m5 4wt Greater Manchester, UK
Corresponding author E-mail: o.umnova@salford.ac.uk

It has been shown recently that a circular cylindrical layer with dielectric constant, altering as with radius r can capture incident light irrespective of the incidence angle and direct it towards the absorbing core hence achieving the "black holeï effect. If effective and compact acoustical analogues of such structures are developed, they will act as omnidirectional broadband absorbers of sound. Following the approach previously used to design flat gradient acoustic lens and electromagnetic "black holesï, a graded index metamaterial layer has been built using an array of small scatterers with their concentration varying along the structure radius. In an array of small rigid circular cylinders the effective density (which is the acoustical analogue of the dielectric constant) varies with filling fraction. This means that by varying this parameter the desired dependence of effective density on radius can be achieved. A porous fibrous material has been used as an absorbing core. The device has been tested and is shown to provide a nearly total absorption of sound with wavelengths shorter than its diameter.

Fri 11:00 François CANAC PU-S03: Phononic crystal and metamaterials

Discrete breathers and intrinsic energy localization in one-dimensional diatomic granular crystals – (Contributed, 000761)

S. Job[a], N. Boechler[b], G. Theocharis[b], P.G. Kevrekidis[c], M.A. Porter[d] and C. Daraio[b]
[a]Laboratoire d'Ingénierie des Systèmes Mécaniques et des MAtériaux, Supméca - 3, rue Fernand Hainaut - 93407 St Ouen Cedex; [b]Graduate Aerospace Laboratories, California Institute of Technology, Pasadena, 91125, USA; [c]Department of Mathematics and Statistics, University of Massachusetts, Amherst, 01003-4515, USA; [d]Mathematical Institute, University of Oxford, OX1 3LB Oxford, UK
Corresponding author E-mail: stephane.job@supmeca.fr

We report the experimental observation of modulational instability and discrete breathers in a one-dimensional diatomic granular crystal composed of elastic spheres that interact via the nonlinear Hertz potential. Our crystal consists of an alignment of 19.05-mm-diameter steel and aluminium spheres compressed by a static load in the axial direction. We first characterize the linear spectrum of the crystal by analyzing the low amplitudes transmitted vibrations; we observe the existence of acoustic and optical bands separated by a band gap. We then illustrate theoretically and numerically the modulational instability of the lower edge of the optical band. We finally show experimentally that modulational instability leads to the dynamical formation of long-lived and spatially localized breather structures [Phys. Rev. Lett. 104, 244302 (2010); Phys. Rev. E 82, 056604 (2010)].

Fri 11:20 François CANAC PU-S03: Phononic crystal and metamaterials

Effective speed of shear waves in phononic crystals – (Contributed, 000849)

A. A. Kutsenko[a], A. L. Shuvalov[a] and A. N. Norris[b]
[a]i2M - CNRS - University Bordeaux 1, 351 Cours de la Libération, Site Bât. A4, 33405 Talence, France; [b]Rutgers University, Mechanical and Aerospace Engineering, Piscataway, NJ 08854, USA
Corresponding author E-mail: kucenkoa@rambler.ru

The paper is concerned with the analytical and numerical study of quasistatic ('effective') speed of shear waves in phononic crystals. The study involves the plane wave expansion (PWE) and the new method based on the monodromy matrix (MM). It is introduced as a multiplicative integral, taken with respect to one coordinate, of the matrix with components defined as operators acting on the functions of the other coordinates. Using these two approaches, we derive closed-form estimates and develop efficient numerical procedures. It is shown that the MM method provides the best accuracy both of the estimates and of the numerical calculation.

Fri 11:40 François CANAC PU-S03: Phononic crystal and metamaterials

Band structure and transmission of 3D chiral sonic crystals – (Contributed, 000792)

R. Pico, V. Romero-Garcia, V. Sanchez-Morcillo, A. Cebrecos and L.M. Garcia-Raffi
Universidad Politecnica de Valencia, Paranimf 1, 46730 Gandia, Valencia, Spain, 46730 Gandia, Spain
Corresponding author E-mail: rpico@fis.upv.es

We study the properties of a novel type of sonic crystal formed by a periodic array of scatterers with spiral form. Such structures, previously introduced in photonics, present interesting properties related to the symmetry breaking induced by the chirality of its elements. It consists in a 3D periodic structure based on a local geometry

that breaks the mirror symmetry with respect to its centre. The unit cell is composed by three elbow elements connecting all the dimensions in a loop: x-y, y-z and z-x. By periodic translation in the three main directions, the complete structure is generated leading to quasi-spirals arranged in a hexagonal distribution interlaced with different rotation phase. We investigate the phononic band structure of our crystal and the transmission spectrum with the Finite Element Method.

Fri 13:40 François CANAC PU-S03: Phononic crystal and metamaterials

Phononic band gaps and waveguide effects of surface acoustic waves in locally resonant structures phononic crystals – (Invited, 000174)

A. Khelif
Franche-Comté Électronique Mécanique, Thermique et Optique - Sciences et Technologies, 32 avenue de l'Observatoire 25044 Besancon Cedex
Corresponding author E-mail: abdelkrim.khelif@femto-st.fr

We present in this paper a theoretical and an experimental study of surface acoustic wave propagations in pillars-based phononic crystal. This artificial crystal is made up of cylindrical pillars deposited on a semi- infinite medium and arranged in a square array. With appropriate choice of the geometrical parameters, this structure can display two kinds of complete band gaps for surface guided waves, a low frequency gap based on locally resonant mode of pillars as well as a higher frequency gap appearing at Bragg scattering regime. In addition, we demonstrate a waveguiding of surface acoustic wave inside an extended linear defect created by removing rows of pillars in the perfect crystal. We discuss the transmission and the polarization of such confined mode appearing in the higher frequency band gap. We highlight the strong similarity of such defect mode and the Rayleigh wave of free surface medium. Numerical simulations are based on the efficient finite element method and consider Nikel pillars on a Lithium Niobate substrate.

Fri 14:00 François CANAC PU-S03: Phononic crystal and metamaterials

Propagation in a periodic succession of slabs with mixed negative/positive index – (Contributed, 000038)

A. A. Maurel[a], A. A. Ourir[a], J.F. Mercier[b] and V. Pagneux[c]
[a]Institut Langevin/LOA, ESPCI, 10 rue Vauquelin, rue de la glaciere, 75005 Paris, France; [b]POEMS-CNRS/ENSTA/INRIA, 32 Boulevard Victor, 75015 Paris, France; [c]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: agnes.maurel@espci.fr

Metamaterials are artificial materials engineered using periodic inclusions of small inhomogeneities to enact effective macroscopic behavior. Until recently, most studies considered only ideal systems and did not address the possible effects of disorder.The first step in this direction was made in [Phys. Rev. B 70, 245102, 2004] where it was shown that the presence of a single defect led to the appearance of a localized mode. Since then, more general model of alternating sequences of right and left handed layers with random parameters have been studied, notably in [M. V. Gorkunov et al., Phys. Rev. E 73, 056605, 2006; Phys. Rev. Lett. 99, 193902, 2007]. The authors have shown that the localization properties differ dramatically from those exhibited by conventional disordered materials. We study wave propagation in such stratified media both experimentally and theoretically. Experiments confirm that the properties of the attenuation length differ dramatically from those exhibited by conventional alternated layer materials, notably in the intermediate value of the wavelength. Analytical prediction of the attenuation length is in good agreement with the observations.

Fri 14:20 François CANAC PU-S03: Phononic crystal and metamaterials

Anisotropic metamaterials for full control of acoustic waves – (Contributed, 000088)

J. Christensen and J. Garcia De Abajo
IQFR-CSIC, Serrano 119, 28006 Madrid, Spain
Corresponding author E-mail: johan.christensen@gmail.com

We show that a holey anisotropic metamaterial can exert subwavelength control over sound waves beyond that achieved with naturally occurring materials [Nature Physics 3, 851 (2007)]. We predict that, for appropriate choices of geometrical parameters, these metamaterials support negative refraction, backward wave propagation along a direction opposite with respect to the acoustic energy flow, and subwavelength imaging [Nature Physics 7, 52 (2011)] with both the source and the image situated far from the material. Acoustic subwavelength control can be advantageous for (bio-)medical ultrasonography and diagnostic imaging, acoustouflidic steering of microparticles and microorganisms, and sonochemistry enhanced by sound focusing.

Fri 14:40 François CANAC PU-S03: Phononic crystal and metamaterials

Negative refraction of waves in an elastic phononic crystal matching density and index of water – `(Contributed, 000187)`

A.-C. Hladky-Hennion[a], C. Croenne[b], J. Vasseur[a], B. Dubus[a], B. Morvan[c] and A. N. Norris[d]
[a]IEMN département ISEN, UMR CNRS 8520, 41 boulevard Vauban, 59046 Lille Cedex, France; [b]Department of Physics and Astronomy, University of Manitoba, Winnipeg, Canada R3T 2N2; [c]Laboratoire Ondes et Milieux Complexes, FRE-3102 CNRS, Place Robert Schuman, 76610 Le Havre, France; [d]Rutgers University, Mechanical and Aerospace Engineering, Piscataway, NJ 08854, USA
`Corresponding author E-mail: anne-christine.hladky@isen.fr`

Left-handed media are artificial media where acoustic waves exhibit unusual properties: phase and group velocities of opposite signs, negative refraction index, and the inverse Doppler effect. These phenomena arise for instance in phononic crystals (PC) and encouraging results have been obtained with a PC made of stainless rods immersed in a fluid. Recently, flat lenses made of elastic left-handed materials have been designed that exhibit negative refraction of elastic waves, but without index matching between the PC and the surrounding fluid medium [C. Croënne et al, Phys. Rev. B 83, 054301 (2011)]. The paper presents new results in the design of left-handed elastic PC using a metal based microstructure with a water like density and very small shear rigidity. In this structure, an isolated negative branch exhibits a quasi-longitudinal behaviour and intercepts the water sound line. At this intersection point phase matching of the velocities in the PC and in the external medium is realized, and the equifrequency contours are circular indicating isotropy of the phase velocity. The paper presents the main theoretical results on this structure. Experiments are under progress on a flat elastic lens. The production of real acoustic images from a point source is under study. This work was supported by the French ANR (SUPREME project).

Fri 15:00 François CANAC PU-S03: Phononic crystal and metamaterials

Flat lens for Lamb waves focusing – `(Contributed, 000116)`

M. Dubois[a], N. Etaix[a], M. Farhat[b], S. Enoch[b], S. Guenneau[b], R.-K. Ing[a] and P. Sebbah[a]
[a]Institut Langevin "ondes et images", 10 Rue Vauquelin 75231 Paris Cedex 05; [b]Institut FRESNEL, Domaine univ. de St-Jérôme 13397 Marseille Cedex 20
`Corresponding author E-mail: marc.dubois@escpi.fr`

First proposal of negative index materials by V.G. Veselago [Sov. Phys. Usp. 10 (4), 509514 (1968)] has triggered interest for flat lens design. In 2000, J.B. Pendry proposed [Phys. Rev. Lett. 85, 3966-3969 (2000)] to take advantage of negative refraction and flat lens geometry to achieve subwavelength focusing. An alternative is based on photonic crystals. Such materials reveal strong anisotropic dispersion relation that may lead to band folding and negative refraction. Flat lens behavior is observable in a narrow spectral range called the All Angle Negative Refraction (AANR), where all incident wave vectors are negatively refracted. Negative refraction in phononic crystal has been recently demonstrated for elastic waves in a solid, and for Lamb waves at high frequencies in a plate with a square lattice of square holes [Appl. Phys. Lett. 96, 101905 (2010)]. This paper presents the experimental study of bending wave focusing by a solid flat lens in a thin plate with a 45°-tilted square lattice of circular holes. The dynamics of the focusing effect is observed below the first stop band in the acoustic dispersion surface at the carrier frequency predicted by theory.

Fri 15:20 François CANAC PU-S03: Phononic crystal and metamaterials

A multiple-scales perturbation approach to mode coupling in periodic plates – `(Contributed, 000274)`

O. Asfar[a], M. Hawwa[b], M. Bavencoffe[c], B. Morvan[d] and J.-L. Izbicki[e]
[a]Jordan University of Science & Technology, Box 3030, 22110 Irbid, Jordan; [b]King Fahd University of Petroleum & Minerals, Department of Mechanical Engineering, 31261 Dhahran, Saudi Arabia; [c]Laboratoire Imagerie et Cerveau, rue de la chocolaterie BP

3410, 41034 Blois, France; [d]Laboratoire Ondes et Milieux Complexes, FRE-3102 CNRS, Place Robert Schuman, 76610 Le Havre, France; [e]LOMC, CNRS UMR 6294, Université Le Havre, 25, rue Philippe Lebon, 76600 Le Havre, France
Corresponding author E-mail: bruno.morvan@univ-lehavre.fr

In this paper, guided ultrasonic wave propagation is analyzed in an elastic plate with sinusoidal surface corrugations. The corrugated area acts as a finite length grating which corresponds to a 1D phononic crystal (PC). The multiple-scales perturbation technique is used to derive coupled-mode equations describing the amplitudes of interacting modes. These equations are solved exactly for the two-point boundary-value problem of the PC. The study involved the coupling of the incident symmetric Lamb Wave S0 to the reflected antisymmetric Lamb wave A0. The influence of the depth of corrugation and length of the PC is studied. Theoretical results are compared with experimental measurements.

Fri 15:40 François CANAC PU-S03: Phononic crystal and metamaterials

Scholte-Stoneley waves on corrugated surfaces and on phononic crystal gratings – (Contributed, 000224)

R. P. Moiseyenko[a], J. Liu[b], S. Benchabane[a], N. F. Declercq[b] and V. Laude[a]
[a]Femto-st, 32 avenue de l'Observatoire, 25044 Besancon, France; [b]Georgia Tech - CNRS, Metz Technopôle 2-3 rue Marconi 57070 Metz
Corresponding author E-mail: rayisa.moiseyenko@femto-st.fr

Sholte-Stoneley waves (SSW) propagate at the interface of a fluid medium and a solid medium. They have a velocity smaller than the transverse and longitudinal velocities in the solid, and smaller than the sound velocity in the fluid. They are thus doubly evanescent and propagate without loss along the interface. They were observed for periodically corrugated surfaces in contact with water, with the periodic corrugation allowing their conversion from an incident plane wave generated by an ultrasound transducer. We consider in this work 1D and 2D silicon-water phononic crystals (PC) and study bulk wave to SSW modal conversion at the PC surface. PC are artificial periodic structures composed of at least two different materials. They are generally considered because of the existence of band gaps, i.e., frequency ranges for which wave propagation through the PC is prohibited. As diffraction gratings, they can also be used for the generation of SSW, as we show by looking for the incidence and frequency conditions for which they are excited.
Financial support by the Agence Nationale de la Recherche under grant ANR-09-BLAN- 0167-01 is gratefully acknowledged.

Fri 10:40 Yves ROCARD AA-S03: Acoustics of light frame buildings (wooden building...)

Predicting and measuring the acoustic performances of lightweight based buildings – (Invited, 000122)

M. Pérez Abendaño[a], M. Fuente De Tecnalia[a] and C. Guigou-Carter[b]
[a]TECNALIA, c/ Geldo Parque Tecnológico Bizkaia Edificio 700, 48160 Derio, Spain; [b]Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères
Corresponding author E-mail: mariana.perez@tecnalia.com

The acoustic performances of buildings made of heavy structures and elements can be predicted from the performances of elements involved using standard series 12354. When designing a lightweight based building, the prediction model has to be reconsidered as there is not a standardized predictive method applied to lightweight building elements. This paper shows different calculations of airborne and impact sound insulation with a new proposed theoretical method. Calculations are compared to final measured results. Other measures from Dvij and impact sound insulation using alternative Japanese ball method are presented in order to discuss how to analyze properly a lightweight based building.

Fri 11:00 Yves ROCARD AA-S03: Acoustics of light frame buildings (wooden building...)

First in-situ experience with impact ball on wood construction – (Contributed, 000610)

N. Balanant
CERQUAL - GROUPE QUALITEL, 82 rue de la Victoire, 75009 Paris, France
Corresponding author E-mail: n.balanant@cerqual.fr

Surfing on sustainable development, the wood construction is developing in France. Environmental and economics benefits are widely promoted, but the acoustics quality needs to be clarified, regarding to comfort and French regulation. We are currently carrying out measurements in-situ on 35 buildings, especially with the impact ball used in Japan and Korea. This impact source is more adapted to lightweight construction than the international tapping machine, and is more correlated to footstep noise or children running or jumping. The purpose of the conference is to show the first results of in-situ measurements with the impact ball, regarding both values and practice aspects.

Fri 11:20 Yves ROCARD AA-S03: Acoustics of light frame buildings (wooden building...)

Geometric simplification of a wooden building connector in dynamic finite element model – (Invited, 000369)

A. Tribaleau, N. Tahani, B. Brouard, J.-M. Génevaux and O. Dazel
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: antonin.tribaleau@gmail.com

The characteristics of boundary conditions of a wood joist floor are critical in the dynamic behavior at low frequency. Furthermore, the properties of junctions between floor and wall are determinant in the vibrational energy transfer (flanking transmission). For this floor system, the junction between the wall and the joist frame is usually done by wood connectors which present a relatively complex form: folded sheet plate with nails or screws fixing). The aim of this study is to replace the complete model of the connector by an equivalent element in term of transfer functions. The identification of the equivalent parameters is build jointly by numeric analysis and experimental study. In the vibro-acoustic domain, this simplified model reduces the number of vertices, and the resolution time of CAD model building. This simplified structural model can thus be coupled to the acoustics of the adjacent rooms.

Fri 11:40 Yves ROCARD AA-S03: Acoustics of light frame buildings (wooden building...)

Prediction of structure-borne noise generated by a water evacuation duct in heavyweight and lightweight frame constructions – (Contributed, 000193)

S. Bailhache and M. Villot
Centre Scientifique et Technique du Bâtiment, 24 rue joseph fourier 38400 Saint martin d'hères
Corresponding author E-mail: simon.bailhache@cstb.fr

This work aims at comparing structure-borne noise due to building service equipment, installed in heavyweight or lightweight buildings. The case of waste water pipes rigidly fixed to a separating wall is considered, and the resulting structure-borne noise in the adjacent room is predicted. The structure-borne sound power injected into the supporting structure is calculated using a source and receiver mobility approach. Characterization measurements are carried out to yield appropriate input data (source free velocity and source and receiver mobilities). Due to the large distance between the duct two fixing points, the duct is considered as two separate uncorrelated vibration sources. The spatial average velocity of the heavy concrete wall is then estimated from the injected power using the well known power balance equation, while an empirical relationship between power injected and wall velocity is established for the wood-framed wall. Radiated noise in the adjacent room is finally computed using an estimated radiation efficiency of the walls. Comparisons between heavy and lightweight walls are made in terms of injected structural power, wall velocity field and sound pressure level radiated.

Fri 12:00 Yves ROCARD AA-S03: Acoustics of light frame buildings (wooden building...)

On the measurement and prediction of the sound absorption coefficient of air-cavity backed perforated plates considering the holes interaction effect under low sound excitation – (Contributed, 000552)

R. Tayong and P. Leclaire
LRMA-DRIVE, ISAT, 49 rue Mademoiselle Bourgeois - BP 31, 58027 Nevers, France
Corresponding author E-mail: rostand.tayong@u-bourgogne.fr

This paper deals with the measurement and prediction of air cavity backed perforated plates considering the holes interaction effect under relatively low sound excitation. A revised expression for the radiation contribution is proposed to properly account for the holes interaction effect. This expression is integrated in the characteris-

tic impedance expression following Atalla and Sgard [J. Sound Vib. 303, 195-208 (2007)] model. Perforated plate specimens with different centre-to-centre holes distances (pitches) are built and tested using an impedance tube. The particular cases of holes interaction effect with constant low porosity and of holes interaction effect with variable high porosity are depicted and discussed in detail. For the case of constant low porosity, the resonance frequency is observed to decrease with the pitch. For the case of variable high porosity, the resonance frequency increases when the pitch diminishes.

Fri 13:20 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

Quantification of freshly-excised human lymph node tissue using high-frequency ultrasound – (Invited, 000681)

J. Mamou[a], A. Coron[b], E. Saegusa-Beecroft[c], M. Hata[c], M. L. Oelze[d], E. Yanagihara[c], T. Yamaguchi[e], P. Laugier[b], J. Machi[c] and E. J. Feleppa[a]

[a]Lizzi Center for Biomedical Engineering, Riverside Research, 156 William St., 9th Floor, New York, 10038, USA; [b]Laboratoire d'Imagerie Paramétrique, 15 Rue de l'école de Médecine 75006 Paris; [c]Kuakini Medical Center and University of Hawaii, 405 N. Kuakini, Honolulu, 96817, USA; [d]University of Illinois at Urbana-Champaign, 405 N. Mathews, Urbana, 61801, USA; [e]CFME, Chiba University, 1-33 Yayoicho, Chiba, Japan

Corresponding author E-mail: jmamou@riversideresearch.org

During lymphadenectomy, 5-20 lymph nodes are excised from cancer patients. These lymph nodes can contain clinically-important metastatic regions that can be missed because conventional histopathology methods do not allow nodes to be examined over their entire volume. In this study, novel quantitative ultrasound (QUS) methods were applied to more than 250 lymph nodes. Individual lymph nodes were scanned in 3D using a 26-MHz ultrasound transducer before histology processing. QUS estimates associated with tissue microstructure were obtained from 3D regions-of-interest. QUS estimates are hypothesized to be different in noncancerous compared to metastatic tissue in lymph nodes. Four QUS estimates were obtained from backscattered spectra and the remaining nine were derived from envelope statistics. Following ultrasound scanning, a 3D histology volume depicting metastatic regions was obtained by performing serial sectioning at 50-μm intervals. Cancer detection based on QUS estimates was performed using linear-discriminant analyses, and areas under ROC curves (AUCs) were estimated. The AUC for the linear combination of four QUS estimates was 0.87 for a dataset of 95 breast-cancer nodes. Similarly, using only two QUS estimates, an AUC of 0.95 was obtained for a dataset of 164 gastrointestinal-cancer nodes. These results suggest that QUS can help guide pathologists towards suspicious regions.

Fri 14:00 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

Experimental ultrasound characterization of tissue-mimicking phantoms with high scatterer volume fractions – (Contributed, 000504)

E. Franceschini

Laboratoire de Mécanique et d'Acoustique,

Corresponding author E-mail: franceschini@lma.cnrs-mrs.fr

Quantitative ultrasound technique is based on a frequency-based analysis of the signals backscattered from biological tissues. This technique aims to estimate the size and concentration of scatterers in order to diagnose and monitor diseases, such as cancer. The Gaussian Model (GM) and Fluid-Filled Sphere Model (FFSM) have been used for many years but are limited to dilute scattering medium, whereas the scatterers can be densely packed (for example the cells in cancer). A model adapted to dense medium is the Structure Factor model (SFM) used in blood characterization. However, the most often used SFM version is the Percus Yevick model (PYM) using the low frequency limit of the structure factor called the Percus Yevick packing factor. The aim of this work is to compare the aforementioned four scattering models with measured backscatter coefficients (BSCs) on tissue-mimicking phantoms.

The tissue-mimicking phantoms consisted of polyamide microspheres (mean diameter 12 μm) immersed in agar-agar gel with different scatterer volume fractions ranging from 1 to 25%. Ultrasonic backscatter measurements were made for frequencies from 5 MHz to 22 MHz. For large scatterer volume fraction, the experimental BSCs agreed with predictions using the SFM in frequency dependence and scattering magnitude.

Fri 14:20 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

An acoustical camera for in vitro characterization of contrast agent microbubbles – (Contributed, 000501)

G. Renaud[a], J.G. Bosch[b], A.F.W. Van Der Steen[b] and N. De Jong[a]
[a]Erasmus Medical Center, Dr. Molewaterplein 50, 3015 GE Rotterdam, Netherlands; [b]Biomedical Engineering - ERASMUS MC, P.O. Box 2040, 3000 CA Rotterdam, Netherlands
Corresponding author E-mail: g.renaud@erasmusmc.nl

We report on a new experimental method, termed acoustical camera, to retrieve the radial response of single microbubbles to a pressure wave by means of a low-amplitude wave called the probing wave. If the frequency of the latter is much higher than the resonance frequency of the microbubble, the relative amplitude modulation observed in the signal scattered by a bubble in response to the probing wave is quasi-equal to the radial strain experienced by a microbubble in response to a pressure wave. An experimental setup allowing the dual-frequency and dual-focused-beam insonification of single microbubbles was developed to demonstrate the feasibility of the technique. A 300μs 11MHz probing wave is employed to investigate the radial response of BR-14 microbubbles (Bracco) to a 100μs 0.5MHz pressure wave. The 100μs parts of the probing signal situated before and after the transmission of the low-frequency excitation provide a reference to calculate the relative amplitude modulation. Therefore asymmetry in the radial oscillation can be assessed. Compression-only behavior is observed for some microbubbles whereas other microbubbles exhibit a symmetric response, in agreement with literature. We believe this technique is a simple and practical approach to measure the response of single microbubbles to a pressure wave.

Fri 14:40 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

Pulsed bi-frequency method for characterization of microbubbles in the context of decompression sickness – (Contributed, 000197)

D. Fouan[a], T. Goursolle[b], P. Lasaygues[a] and S. Mensah[a]
[a]Laboratoire de Mécanique et d'Acoustique, 31, Chemin Joseph Aiguier - 13402 Marseille Cedex 20; [b]BF-systemes, 229, chemin de la Farlède, 83500 La Seyne Sur Mer, France
Corresponding author E-mail: damien.fouan@bf-systemes.fr

During hyperbaric decompression, the absolute ambient pressure is reducing; microbubbles may be generated from pre-existing gas nuclei. An accurate monitoring of the size and of the density of the bubble population will provide a valuable means to understand the nucleation and growth processes in tissues. In this aim, an ultrasonic characterization method based on a dual frequency technique applied on a single bubble is tested.
The method consists in sending two ultrasonic waves on a stationary bubble. One is a low frequency wave (30 kHz$\leq f_{lf} \leq$60 kHz), which excites the bubble near its resonance frequency and the other is a high frequency (f_{hf}=1MHz) wave that measures the changes in the acoustic cross-section induced by the low frequency activation. The resonance frequency, directly related to the radius, can be detected by looking at the spectrum. The development of an optimal sensor embedded on a diver leads to the use of a single transducer acting as an transmitter/receiver of pulsed waves. The straight forward outcome is a higher probability detection and a better radius estimation accuracy. Distinctions in the signal processing allows dedicated detection/sizing processes suitable either for bubbles circulating in the blood flow (larger bubble) or for stationary bubbles in tissues (several microns).

Fri 15:00 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

Contrast enhanced intravascular ultrasound chirp imaging – (Contributed, 000474)

D. Maresca, G. Renaud, N. De Jong and T. Van Der Steen
Erasmus Medical Center, Dr. Molewaterplein 50, 3015 GE Rotterdam, Netherlands
Corresponding author E-mail: d.maresca@erasmusmc.nl

Intravascular ultrasound (IVUS) imaging in combination with a microbubble ultrasound contrast agent (UCA) has the potential to image microvascular networks within the coronary artery wall, also referred to as vasa vasorum (VV). We report the relative performance of three chirp-based UCA detection methods at IVUS frequencies (30 to 60 MHz) for VV imaging: pulse inversion, subharmonic emission and chirp reversal. The contrast to tissue ratio, the contrast to noise ratio and the artifacts of each method were evaluated. A mechanically rotated single element IVUS transducer was mounted in a catheter assembly. Interleaved sequences of coded excitations were transmitted at 1° angular position steps to form images. Imaging targets were coronary artery mimicking phantoms perfused with a commercial UCA.

Fri 15:20 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

Repeatability of a protocol to evaluate the effect of storage on the mechanical properties of the kidney in-vitro – (Contributed, 000755)

R. Ternifi[a,b], J.-L. Gennisson[c], M. Tanter[c] and P. Beillas[b]
[a]UMR U930 CNRS ERL 3106, 10 Bd Tonnelle Batiment Vialle Equipe 5 INSEM, 37032 Tours, France, France; [b]Laboratoire de Biomécanique et Mécanique des Chocs, IFSTTAR UMR_T9406 25 avenue François Mitterrand 69675 Bron; [c]Institut Langevin - Ondes et Images, 10, rue Vauquelin, ESPCI ParisTech, CNRS UMR7587, INSERM U979, 75005 Paris, France
Corresponding author E-mail: philippe.beillas@ifsttar.fr

In biomechanical testing protocols of soft tissue, specimens may have to undergo freezing or other conservation methods, which could affect their mechanical properties. In order to evaluate the effects of conservation techniques, an experimental protocol based on shear wave elastography - which provides an assessment of shear modulus (μ) - was developed and applied to porcine kidneys. First, the organ is pinned onto a polystyrene plate. Then the plate then used to position the organ with respect to an ultrasound probe. This study provides an estimation of the repeatability of μ after repositioning a single kidney, and evaluates the effects of storing 8 fresh kidneys at room temperature for two days. μ were computed rectangular windows centred on the image and moving along the organ depth. When repositioning the organ, μ was more repeatable in the cortex near the capsule than in the central regions of the organ. These regions were also more inhomogeneous and imaging was not always possible due to ultrasound penetration issues. The cortex near the capsule was softer than the central regions including pyramids (e.g. 6.1±2.4kPa at 10% depth vs. 9.3±3.5kPa at 30% depth, n=8). Storage for two days had no significant effect on these values (p>0.25).

Fri 15:40 Pierre CHAVASSE PU-S09: Biomedical and biological ultrasounds

Spatially broad opening of the blood-brain barrier with an unfocused ultrasound transducer in rabbits – (Contributed, 000799)

K. Beccaria[a], M. S. Canney[b], L. Goldwirt[c], C. Fernandez[c], C. Adam[d], G. Autret[e], O. Clément[f], P. Menasche[g], C. Lafon[b], J.-Y. Chapelon[b] and A. Carpentier[a]
[a]Neurosurgery Department, Pitie-Salpetriere Hospital, 47-83 Boulevard de l'Hôpital, 75013 Paris, France; [b]LabTAU, INSERM and CarThéra, 151 Cours Albert Thomas, 69424 Lyon, France; [c]Pitié-Salpétrière Hospital, 47-83 Boulevard de l'Hôpital 75013 PARIS, 75013 Paris, France, Metropolitan; [d]Bicêtre Hospital, 78, rue du Général Leclerc, 94275 Le Kremlin-Bicêtre, France, Metropolitan; [e]PARCC-HEGP, 20 Rue Leblanc, 75015 Paris, France, Metropolitan; [f]Hôpital Européen Georges Pompidou, Service de radiologie, 20 Rue de Leblanc, 75015 Paris, France; [g]Laboratoire de Recherches Biochirurgicales, 20 Rue Leblanc, 75015 Paris, France, Metropolitan
Corresponding author E-mail: kevinbeccaria@voila.fr

The aim of this work was to study the opening of the blood-brain barrier (BBB) over a large volume using an unfocused ultrasound device in the presence of ultrasound contrast agents in rabbits.
A mono-element planar 1MHz ultrasound transducer was used to perform burst sonications in 24 healthy New-Zealand white rabbits after craniectomy and during intravenous injection of Sonovue®. The transducer was operated with a pulse repetition frequency of 1Hz, and a range of pulses lengths and in situ acoustic pressures (10-35ms and 0.3-1MPa respectively). Opening of the BBB was observed in contrast-enhanced images in a 4.7T MRI, through blue dye extravasation and with confocal microscopy. Adverse effects were analyzed on histology.
A significant BBB opening limited spatially to the extent of the ultrasound field was observed. BBB opening appeared during the sonication and lasted for several hours. Monitoring was possible on MRI sequences as a significant gadolinium contrast enhancement (p<0.0001). BBB opening was associated with perivascular blood red cell extravasation and transient vascular spasm.
In conclusion, the BBB can be opened in large areas of the brain with low power unfocused ultrasound, with limited tissue damage, and could permit safe drug delivery in the brain.
Work supported by CarThera and Région Ile-de-France.

Fri 13:40 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

Infrasound transmission of non porous windscreens – (Contributed, 000292)

N. Dauchez[a], M. Hayot[a] and S. Denis[b]
[a]SUPMECA, 3, rue Fernand Hainaut, 93407 Saint Ouen Cedex, France; [b]CEA DIF, CEA DIF F-91297, Arpajon
Corresponding author E-mail: nicolas.dauchez@supmeca.fr

Outdoor measurement of infrasound requires the use of windscreens to reduce the noise due to aerodynamic perturbations. Usual methods are based on a spatial averaging of the pressure using a multiple-inlet pipe network or a wind barrier. The size of such systems is no smaller than several meters, therefore not compatible with portable infrasound measuring chains. To overcome these limitations, a study on nonporous polymer foam windscreens smaller than 1 meter has been carried out [J. Acoust. Soc. Am. 118(3), 1335-1340 (2005); J. Acoust. Soc. Am. 127(6), 3327-3334 (2010)]. However the link between prediction and measurement of infrasound transmission has not been clearly established. In this paper, an analytical vibroacoustic model using the long wavelength hypothesis is proposed. The geometry considered is an elastic nonporous plate coupled with a cavity connected to the pressure sensor. A good agreement with finite element modeling and experimental data is found. Finally, rules to design an optimized system, related to geometry and material properties, are given.

Fri 14:00 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

Explosion energy scaling laws for infrasound propagation analysed using nonlinear ray theory – (Contributed, 000473)

O. Gainville[a], P. Blanc-Benon[b] and J. Scott[c]
[a]CEA, DAM, DIF, F-91297 Arpajon, France; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex; [c]Ecole Centrale de Lyon, 36, avenue Guy de Collongue, 69130 Ecully, France
Corresponding author E-mail: olaf.gainville@cea.fr

Using ray theory, long range propagation of infrasound through the atmosphere is modeled in the framework of the Comprehensive Nuclear-Test-Ban Treaty. In atmospheric propagation, the high frequency hypothesis is based on the assumption that space and time scales of atmospheric properties are much larger than acoustic wave scales. A 3D nonlinear ray tracing code is developed to compute the temporal pressure signature at receivers. These signatures are obtained by solving a generalized Burgers' equation along each ray taking into account nonlinear effects, shear and bulk viscosity absorption and molecular vibrational relaxation mechanisms. The propagation of infrasound emitted by a motionless point source in a realistic atmosphere is analysed. To quantify the validity limits of our approach, we investigate effects of the wind, atmospheric absorption, nonlinearities, refraction and scattering by small atmospheric scales on observed phase kinds, their travel time and their waveform. Nonlinear mechanisms are important to model the evolution of waveform signatures especially to find the N-wave and U-wave shapes of, respectively, thermospheric and stratospheric paths. The relative importance of nonlinear effects are compared for several source energies. Sound exposure level and characteristic frequency are analysed in order to develop scaling laws. Comparisons are made with measurements and results available in the literature.

Fri 14:20 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

Nonlinear effects in infrasound propagation simulations – (Contributed, 000559)

O. Gainville[a] and O. Marsden[b]
[a]CEA, DAM, DIF, F-91297 Arpajon, France; [b]Laboratoire de Mecanique des Fluides et d'Acoustique, 36 Av Guy de Collongue 69134 Ecully Cedex
Corresponding author E-mail: olaf.gainville@cea.fr

In the framework of the Comprehensive Nuclear-Test-Ban Treaty, long range propagation of infrasound through the atmosphere is investigated using numerical models. The study problem is a cylindrical blast in an inhomogeneous atmosphere. Vertical profiles of temperature, wind and density obtained during the Misty Picture High explosive experiment conducted in May 1987 are used. The propagation is modeled using two codes. First, the full 2-D Navier-Stokes equations are solved with a low-dispersion and low-dissipation finite-difference algorithm initially developed for aeroacoustics. Second, a nonlinear ray tracing model based on weak shock and locally plane wave assumptions is used. In this code, the waveform evolves along rays following Burgers' equation. The initialisation of the cylindrical blast wave is described for both codes. A benchmark case of propagation is defined and numerical comparisons are performed. Absorption and nonlinear effects are investigated in detail for both stratospheric and thermospheric paths. Some limits of the ray tracing model are shown and quantified.

Fri 14:40 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

A new magnet and coil digital microbarometer: DMB1 – (Contributed, 000661)

G. Nief, P. Millier and N. Brebion
CEA, DIF, DASE, Bruyères-le-Châtel, 91297 Arpajon Cedex, France
Corresponding author E-mail: guillaume.nief@cea.fr

Since the infrasound technology was chosen to ensure the respect of the Comprehensive Nuclear-Test-Ban Treaty, it has been experiencing a renewal. The development of high-sensitivity, high-resolution, low-noise and low-cost infrasound sensors has thus become a need for installing operational infrasound recording station, as well as for research purpose (study of sources, study of atmosphere as an acoustical propagation medium...). A new model of digital microbarometer, DMB1, is proposed. The pressure sensitive element is a metallic bellows ; a magnet and coil device is used as an electromagnetic transducer. The digitization electronic board is encapsulated, and synchronised by a GPS clock. The sensor's characteristics are detailed and analysed in terms of noise floor, sensitivity, resolution, pass band and full range scale. A model describing the behaviour of the sensor is also proposed.

Fri 15:00 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

Transfer function of the atmosphere over long distances – (Contributed, 000621)

P. Delorme
ONERA/DSNA, 29 avenue de la Division Leclerc, 92322 Châtillon, France
Corresponding author E-mail: philippe.delorme@onera.fr

Propagation in the atmosphere for long range seems to be a complex phenomenon: for instance the experimental observations of signals of Concorde sonic boom to several hundred kilometers where the classical N-waves disappears completely. In fact the transfer function of the atmosphere for the near field is a pure delay (propagation time) with a gain (corresponding to the geometric attenuation).At long range this physical model is not valid. It is well known for high frequency and long range it must be adjusted for the effects of viscosity. But this model must also be corrected at low frequencies because the atmosphere is not homogeneous and therefore diffracts. Based on the linearized Euler, it reveals a dimensionless number g.d /a2 (with g the gravitational constant, d the propagation distance and a the speed of sound). This number is of order 1 when the distance is about 10 km. The purpose of this paper is to show how the transfer function of the atmosphere changes when the propagation distance increases, assuming the latter is a stratified medium.

Fri 15:20 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

Computational method for evaluating meteorites as sources of sonic boom – (Contributed, 000626)

M. Henneton[a], P. Delorme[a], O. Gainville[b], C. Millet[b] and F. Coulouvrat[c]
[a]ONERA, 29 avenue de la Division Leclerc, 92322 Chatillon, France; [b]CEA, DAM, DIF, F-91297 Arpajon, France; [c]CNRS, Institut Jean Le Rond d'Alembert - UMR CNRS 7190, Université Pierre et Marie Curie - 4 place Jussieu, 75005 Paris, France
Corresponding author E-mail: francois.coulouvrat@upmc.fr

Infrasound is one of survey technique monitoring of nuclear explosions. Hence such explosions have to be distinguished from natural sources of infrasounds such as meteorite atmospheric entries. With a view to investigate meteorites as an infrasound source, numerical simulations of Euler equations are performed around a meteorite of diameter one meter entering the atmosphere at Mach 40. This configuration is selected because it corresponds both to a well documented meteorite case and to previous near-field numerical simulations. Because of the very important amount of released energy and to capture the shock, it is necessary to perform the simulations on an adapted mesh. In addition, to obtain the asymptotic weak shock regime and to initialize the nonlinear ray tracing method used to model the long range propagation, simulations have to be performed very far from the meteorite. The output of the CFD simulations are validated by studies on numerical convergence both in the near-field and far-field, and by comparisons with a theoretical model based on the line source assumptions.

Fri 15:40 Peter BARNETT AH-S03: Infrasound: generation, propagation and applications to remote sensing

Sonic boom and infrasound emission from Concorde airliner – (Contributed, 000676)

J. Varnier, G. Ménéxiadis and I. Le Griffon
Onera, Département de Simulation Numérique des Ecoulements et Aéroacoustique, BP 72 - 29, avenue de la Division Leclerc, 92322 Chatillon Cedex
Corresponding author E-mail: jean.varnier@onera.fr

Any phenomenon of an impulsive nature, such as an explosion, a gun shot or a clap of thunder, generates an infrasonic emission which is propagated at very long distance, as the atmospheric absorption has only a limited influence on it. The sonic boom of aircraft, launchers or meteorites obviously belongs to this category. During its propagation, the signal is distorted and becomes a rumble, the duration of which can reach several minutes at a distance of about one thousand kilometers. However, it is often possible to make the distinction between the emission and the natural background noise and to relate it to the sound source of origin by using goniometry and spectrum analysis. In this respect, the recordings of the sonic boom and the flight data of the "Concordeï airliner provide an interesting and complete experimental data base. Examples of exploitation of signals and of numerical simulations (sonic boom shape, direct and reverse propagation taking into account the meteorology of the day) are given for distances of 100, 300, 1000 and 3000 km.

Fri 13:40 Ray STEPHENS EA-S07: Active noise: transducers and metamaterials

Advanced control for modifying the acoustic impedance at the diaphragm of a loudspeaker – (Contributed, 000382)

R. Boulandet, H. Lissek and E. Rivet
Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: romain.boulandet@epfl.ch

Conventional techniques for acoustic impedance control operate either by feedback control of acoustic quantities (pressure and/or velocity) or by plugging an electrical network at the terminals of an electroacoustic transducer, thus modifying the acoustic impedance of its diaphragm. The general idea is to absorb the incident sound energy or to contain it, by simply controlling the dynamics of loudspeakers. The direct application is to better control the low-frequency sound field in enclosed or semi-closed spaces, improve the sound insulation between adjacent rooms or confine the noise emitted by industrial machines. Using a loudspeaker as a noise control device has several advantages: it is readily available at almost low cost, and already well-suited for rudimentary acoustic treatments. It naturally behaves as a damped harmonic oscillator which resonance can be altered through basic electrical means. With active control, sound absorption within the frequency range around the loudspeaker resonance can be significantly improved. The underlying problem often results in performance degradation outside this range, in the form of over-reflections. In this paper we propose means for compensating such undesired effects. For illustrative purposes, computed results and measurements obtained in impedance tube are provided to show the performances of a controlled loudspeaker in terms of absorption and stability.

Fri 14:00 Ray STEPHENS EA-S07: Active noise: transducers and metamaterials

Active Absorbers – (Invited, 000686)

M. Rousseau[a] and J. Vanderkooy[b]
[a]B&W Group ltd., Elm Grove Lane, BN44 3SA Steyning, UK; [b]University of Waterloo, Dept of Physics and Astronomy, Waterloo, Canada N2L 3G1
Corresponding author E-mail: jv@uwaterloo.ca

This paper explores the use of bass loudspeakers as both acoustic sources and broadband absorbers. We develop the theory for a point active absorber immersed in the anechoic field from a point source. This will apply to normal loudspeakers used as either sources or absorbers at frequencies below about 300 Hz, where they act much like points. The result extends the theory of Nelson and Elliott for a point absorber interacting with a plane wave. An extra oscillatory interference term occurs which should largely cancel in rooms due to the varying distances between all the source images and the absorber. Responses were measured in several small rooms from source and absorber loudspeakers to both a few listening microphones and microphones mounted very near the absorber diaphragms. Boundary element calculations are needed to allow optimal absorber signals to be derived from the absorber microphones. We use precomputed absorber signals to avoid the serious stability issues of self-actuated active absorbers. Experimental results are not very clear and we analyze several aspects which might resolve theory and experiment.

Fri 14:20 Ray STEPHENS EA-S07: Active noise: transducers and metamaterials

Active electroacoustic resonators with negative acoustic properties – (Invited, 000083)

H. Lissek and R. Boulandet
Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: herve.lissek@epfl.ch

Acoustic metamaterials constitute a new class of acoustic structures, composed of periodic arrangements of engineered unit-cells, that exhibit macroscopic acoustic properties not readily available in nature. These properties can either be a negative mass density or a negative bulk modulus. However, these artificial behaviours derive from the engineered arrangement of the unit-cells, which do not present individual "meta-properties", rather than from their intrinsic nature. It is although possible to achieve intrinsic metamaterial properties out of a single unit-cell, according to active control techniques, such as direct impedance control. This paper intends to highlight the metamaterial nature of such active concepts, justifying some interesting analogies between the latter and the theory of acoustic metamaterials.

Fri 14:40 Ray STEPHENS EA-S07: Active noise: transducers and metamaterials

Adaptive piezoelectric metacomposite: a new integrated technology to control vibroacoustic power flow – (Contributed, 000838)

M. Collet[a], M. Ouisse[a], M. Ichchou[b], F. Tateo[a] and T. Huang[b]
[a]Département de Mécanique Appliquée R. Chaléat, 24 chemin de l'Epitaphe - 25000 Besançon; [b]Laboratoire de Tribologie et Dynamique des Systèmes, 36 Avenue Guy de Collongue, 69134 Ecully Cedex
Corresponding author E-mail: manuel.collet@univ-fcomte.fr

Research activities in smart materials and structures are very important today and represent a significant potential for technological innovation in mechanics and electronics. In order to realize smart vibroacoustic design, new methodologies are now available which allow active transducers and their driving electronics to be directly integrated into otherwise passive structures. The main research challenge today deals with the development of new multi-functional structures integrating electro-mechanical systems in order to optimize their intrinsic mechanical behavior to achieve desired vibroacoustic goals. The new desired functionalities can also be implemented at the material level to create new "adapative metacompositeï. This paper presents the design and characterization of a specific metacomposite made of a periodically distributed set of shunted piezoelectric material cells to control vibroacoustic power flow into 2D wave guides. The main purpose of this work is to present the usesd numerical approach able to compute the multi-modal wave dispersions curves into the whole first Brillouin zone for damped 2D electromechanical systems. By using specific indicators, we optimize the piezoelectric shunting electrical impedance for controlling energy diffusion into the proposed adaptive distributed set of cells. Particular implantation's problems are also addressed and optimized for taking into consideration electromechanical lack of robustness due to electronic coupling behavior.

Fri 15:00 Ray STEPHENS EA-S07: Active noise: transducers and metamaterials

Active elastic metamaterials with applications in acoustics – (Contributed, 000168)

S. A. Pope[a], H. Laalej[a] and S. Daley[b]
[a]University of Sheffield, Department of Automatic Control and Systems Engineering, Mappin Street, S1 3JD Sheffield, UK; [b]University of Southam, Institute of Sound and Vibration Research, Highfield, SO17 1BJ Southampton, UK
Corresponding author E-mail: s.a.pope@sheffield.ac.uk

Elastic metamaterials provide a new approach to solving existing problems in acoustics. They have also been associated with novel concepts such as acoustic invisibility and subwavelength imaging. To be applied to many of the proposed applications a metamaterial would need to have the desired mass density and elastic moduli over a wide frequency band. To minimise scatter in acoustics applications the impedance of solid elastic metamaterials also need to be matched to the impedance of the surrounding medium. Previous work has looked at the trade-off between achieving the desired mass density and Youngs modulus, combined with an impedance which is matched to the surrounding medium. This paper will focus on extending the bandwidth of the desired properties presented in previous work to an extent where the material could be applied to some of the novel applications. This will include a consideration of the problems which arise when the previously developed theory and simulation is developed into an experimental demonstration. This includes the role which the control system dynamics play on the achievable performance. It will also consider the problems which arise when the previous one-dimensional concept is extended to higher dimensions.

Fri 15:20 Ray STEPHENS EA-S07: Active noise: transducers and metamaterials

Controller architectures for optimum performance in practical active acoustic metamaterials – (Contributed, 000450)

M. Reynolds[a], S. Daley[a], Y. Gao[a], V. Humphrey[a] and S. A. Pope[b]
[a]ISVR, University of Southampton, SO17 1BJ Southampton, UK; [b]University of Sheffield, Department of Automatic Control and Systems Engineering, Mappin Street, S1 3JD Sheffield, UK
Corresponding author E-mail: S.Daley@soton.ac.uk

Over the last decade there has been significant interest in the design and production of acoustic metamaterials with physical qualities not seen in naturally occurring media. Progress in this area has been stimulated by the desire to create materials that exhibit novel behaviour when subject to acoustic waves, such as negative refraction or the appearance of bandgaps in the frequency response of the material. Proposed designs range from locally resonant phononic crystals to arrays of Helmholtz resonators within ducts and past research has investigated both passive and active materials. Much of the research into active acoustic metamaterials remains theoretical, therefore to determine whether such materials are physically realisable and of potentially practical use it is important to understand the physical restraints that may arise in a produced active metamaterial. This paper considers a 1-dimensional active acoustic metamaterial derived from a passive, Helmholtz resonator based design, where the applied control forces produce controllable double negative behaviour. The physical dimensions and active forces required to achieve the desired novel behaviour are explored for different architectures and any trade-offs that might have to be considered when producing a practically useful active metamaterial are identified.

Fri 13:40 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

Scattering of a cylinder covered with an arbitrary distribution of admittance and application to the design of a tramway noise abatement system – (Invited, 000050)

A. Jolibois[a], D. Duhamel[a], V. W. Sparrow[b], J. Defrance[c] and P. Jean[c]
[a]Université Paris-Est - UMR Navier, Ecole des Ponts ParisTech, 6&8 av. Blaise Pascal - Champs-sur-Marne, 77455 Marne La Vallée Cedex 2, France; [b]Graduate Program in Acoustics, The Pennsylvania State University, 201 Applied Science Building, University Park, 16802, USA; [c]CSTB, 24, rue Joseph Fourier, 38400 Saint Martin D'Hères, France
Corresponding author E-mail: alexandre.jolibois@enpc.fr

An urban low-height barrier meant to attenuate tramway noise emission for nearby walking pedestrians or cyclists is studied. A semi-analytical solution for the two-dimensional scattering of a line source by a cylinder covered by an arbitrary distribution of impedance and its image with respect to a vertical baffle is derived. This description is used to model the shadowing due to a semi-cylindrical noise barrier close to a tramway. After validation against the boundary element method, this solution is used in a gradient-based optimization approach of the admittance distribution to maximize the broadband insertion loss in a given receiver zone. First, a hypothetical but passive distribution is found, showing an improvement of more than 20 dB(A) with respect to a purely rigid barrier. Second, a feasible optimized surface treatment made of a porous layer and a micro-perforated resonant panel is proposed, with an improvement of 14 dB(A) with respect to an entirely rigid barrier. The optimization gain with respect to a uniform absorbent admittance is about 8 dB(A). Extra tests with the boundary element method show that this gain is reduced but still significant if more realistic conditions are considered.

Fri 14:00 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

Reuse of textile powder remainders for acoustic applications using the Wet-Laid technology – (Contributed, 000144)

L. Berto, R. Del Rey, J. Alba and V. Sanchis
Universidad Politécnica de Valencia, C/ Paraninf n°1, 46730 Grao De Gandia, Spain
Corresponding author E-mail: lauberca@upv.es

Nowadays, the sound insulation and the acoustic conditioning are problems to raise in the building constructions and in the design of certain enclosures. Last years the legislative scene in terms of noise and vibrations has been changed supposing, the final approval of the DB-HR of the CTE in Spain, the most important change. Within this new legislative framework, besides to increased sound insulation requirements appear new requirements related to the acoustic conditioning of certain enclosures. So that, gradually, has been created the need for look for new materials with acoustic properties which meet the new acoustics requirements. On the other hand, are well known the

economic problems, storage problems and environmental problems that entail the remainders in a production process. Specially, in the textile industry, tones of remainders are generated in the manufacturing processes. Many of these residues are like a powder with difficult recycling, but it can be recycled by means of the wet-laid technology. This work evaluates the feasibility of include, as solutions to the new acoustics requirements, new nonwoven made with textile remainders using the wet-laid technology.

Fri 14:20 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

Sound attenuation by crops and hedges – (Contributed, 000249)

S. Taherzadeh, K. Attenborough and I. Bashir
The Open University, DDEM, Maths, Computing and Technology, Walton Hall, MK7 6AA Milton Keynes, UK
Corresponding author E-mail: s.taherzadeh@open.ac.uk

Although plants and cultivated areas could be a visually acceptable means of noise abatement in urban areas, their effectiveness for reducing sound levels is still an open question. There have been several studies of the attenuation by trees bushes and crops but few theories predict all the observed attenuation spectra fully. It is known that the attenuation due to ground effect alone can account for low frequency (below about 1 kHz) insertion loss spectra while the high frequency behaviour is determined by multiple scattering from the stems/trunks and more importantly surface viscous and thermal absorption by leaves. A simple engineering model for scattering, viscous and thermal losses is proposed based on data in the literature. This model is shown to give reasonable agreement with recent insertion loss data obtained with a winter wheat crop and a laurel hedge.

Fri 14:40 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

A stated preference experiment to value access to quiet areas and other local environmental factors – (Invited, 000259)

A. L. Bristow[a], M. Wardman[b], J. D. Shires[b], P. K. Chintakayala[b] and J. Nellthorp[b]
[a]Loughborough University, School of Civil and Building Engineering, Loughborough University, LE11 3TU Loughborough, UK; [b]University of Leeds, Institute for Transport Studies, University of Leeds, LS2 9JT Leeds, UK
Corresponding author E-mail: a.l.bristow@lboro.ac.uk

The local environment influences people's perceptions of their quality of life and their overall well-being in many different ways. Whilst there are a wide range of local environmental factors that can impact on individuals' well-being, there is relatively little empirical evidence on this subject. In particular, there is a dearth of knowledge on their economic valuation, commonly expressed in terms of how much money individuals are prepared to pay for improved conditions.
The aim of this study was to estimate how much individuals would be prepared to pay, in terms of council tax, to obtain improvements or to avoid deteriorations in a wide range of local environmental factors. These include: urban quiet areas; fly-tipping; litter; fly-posting; graffiti; dog-fouling; discarded chewing gum; trees; light pollution (obscuring the stars); light intrusion (into the home) and odour. This study provides what we believe to be the first value for quiet areas and also indicates how important quiet areas are relative to a range of other local environmental factors.

Fri 15:00 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

Acoustical performance of complex-shaped earth berms – (Invited, 000612)

J. Defrance, S. Lallement, P. Jean and F. Koussa
CSTB, 24, rue Joseph Fourier, 38400 Saint Martin D'Hères, France
Corresponding author E-mail: jerome.defrance@cstb.fr

Earth berms have been used for many years along railways and motorways as noise abatement systems. On one hand their construction is often cheaper than traditional barriers with less negative environmental impacts and better visual integration. On the other hand they need more space to be built and are always proposed with the same global symmetrical, smooth shape. In this work we propose to assess the efficiency of various complex-shaped earth berms dedicated to ground transportation using a 2D Boundary Element Method. For urban roads and tramways innovative low-height berms - no more than 1 m high - are proposed and study. For railways and mo-

torways taller complex-shaped systems up to 6 m high are assessed. The analysis is carried out for 1.5 m high receivers' areas (pedestrians, cyclists) as well as 4 m high ones (buildings). Results are expressed in terms of acoustic gain obtained with the complex-shaped earth berm solution referred to a straight rigid barrier located at the infrastructure's edge.

Fri 15:20 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

Diffusion coefficient of vegetation: measurements and simulation – (Contributed, 000762)

Y. Smyrnova, J. Kang, C. Blackford and C. Cheal
University of Sheffield, School of Architecture, S10 2TN Sheffield, UK
Corresponding author E-mail: y.smyrnova@sheffield.ac.uk

This paper reports the results of an investigation on the diffuse reflection from two typical bedding plants in Europe. This is a part of a lager study on the acoustic properties of vegetation, aiming at reducing noise from urban traffic. Directional diffusion coefficients of the plants have been measured in a semi-anechoic chamber and polar responses that represent sound energy distribution on semicircles surrounding the plants have been obtained. The results show that the plants diffusely reflect sound energy mainly at middle and high frequencies. In parallel, a simulation model based on the finite-element method for predicting diffuse reflections from plants has been developed. The model takes into account impedance of foliage and soil measured in an impedance tube, and their geometric characteristics. There is a good agreement between prediction and measurement.

Fri 15:40 Yves ROCARD EN-S07: Acoustical properties of natural materials and greening for noise control

Field investigation of the effects of vegetation on the performance of roadside noise barriers – (Contributed, 000809)

M. Hodgson and S. Daltrop
University of British Columbia, SPPH - 3rd Floor, 2206 East Mall, Vancouver, Bc, Canada V6T1Z3
Corresponding author E-mail: murray.hodgson@ubc.ca

This paper describes a field experimental investigation of the effects of nearby vegetation on the performance of roadside noise barriers. The effects of nearby vegetation (trees, hedges, vines, etc.) are unclear. It may decrease noise levels behind a barrier, either by back-scattering or absorbing sound. Foliage may also increase noise levels by scattering sound which would normally pass above the barrier into the shadow zone. Field test sites were identified to study these effects. Traffic noise levels were measured simultaneously behind foliage and no-foliage cases and the results were compared. Both increased and decreased noise levels behind the barrier were seen in different frequency ranges, with most effects being less than 5 dB.

Fri 13:40 John TYNDALL MA-S08: Acoustics of historical and archaeological musical instruments

Acoustical evaluation of the Carnyx of Tintignac – (Contributed, 000037)

J. Gilbert[a], E. Brasseur[a], J.-P. Dalmont[a] and C. Maniquet[b]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]INRAP Limoges et UMR 8546 CNRS-ENS, 18 allée des Gravelles, 87280 Limoges, France
Corresponding author E-mail: joel.gilbert@univ-lemans.fr

The carnyx is an instrument which was used by Celtic peoples in various parts of Europe around 2000 years ago. In September 2004 an excavation at Tintignac (Naves, Corrèze district of France) revealed a buried horde of bronze instruments, including a lot of parts of several different carnyxes. Some of the parts have been put together to make an almost complete carnyx which is exposed in Paris nowadays. In 2011, a brass copy of this carnyx has been made by Jean Boisserie. This paper discusses some acoustical aspects of the carnyx brass copy, and presents measurements made on it. The measurements are mainly input impedance, vibrations measurements, and playing frequencies estimations. The question of the bore profile and its influence on the resonance frequencies inharmonicity are particularly discussed. A specificity of the Tintignac carnyx is the presence of thin large ears on its head, their possible influence on the radiated sound is discussed.

Fri 14:00 John TYNDALL MA-S08: Acoustics of historical and archaeological musical instruments

Acoustical and musical properties of the Deskford carnyx reconstruction – (Invited, 000818)

M. Campbell[a] and J. Kenny[b]
[a]University of Edinburgh, School of Physics and Astronomy, JCMB, King's Buildings, Mayfield Road, EH9 3JZ Edinburgh, UK; [b]Royal Conservatoire of Scotland, 100 Renfrew Street, G2 3DB Glasgow, UK
Corresponding author E-mail: d.m.campbell@ed.ac.uk

In 1992 a multidisciplinary team including the musicologist John Purser, the archaeologist Fraser Hunter, the silversmith John Creed and the musician John Kenny undertook a reconstruction of the carnyx, a Celtic lip-excited instrument characterised by a bell in the form of a boar's head. The reconstruction was based on a fragment of a carnyx which was discovered in the early nineteenth century buried on farm land near Deskford in north-east Scotland. Since only the head of the Deskford carnyx has survived, decisions on the length and bore profile of the tube and the nature and orientation of the mouthpiece were guided by images of the carnyx on vessels and coins from the early part of the Christian era, and by acoustical considerations based on calculations and measurements on a prototype. In 2004, excavations at Tintignac in France revealed a collection of bronze tubing including parts of several carnyxes. The present paper reviews the acoustical and musical behaviour of the Deskford reconstruction, and reconsiders the decisions taken in 1992 in the light of the new information from Tintignac and the extensive performing experience of John Kenny over the last eighteen years.

Fri 14:20 John TYNDALL MA-S08: Acoustics of historical and archaeological musical instruments

16th-century trombone mouthpieces and their acoustical significance – (Invited, 000487)

H. Vereecke
University for Music, Vienna, Anton von Webernplatz 1, Insitute for Musical Acoustics, A-1030 Vienna, Austria
Corresponding author E-mail: vereecke@mdw.ac.at

Brasswind instrument mouthpieces are considered by musicians as one of the most important components of their instruments. Tiny changes to the acoustically effective geometry of a mouthpiece will have appreciable effects on playing behavior and radiated sound. 16th-century brasswind mouthpieces feature fundamental morphological differences, in comparison to contemporary ones. One of the most striking of those differences is the inverse-conical backbore. Scholarly references stay brief on this issues, which results in the fact that performers and makers are generally unaware of the relevance of it to "Historical Informed Performanceï. This paper presents the results of a systematic geometrical and acoustical analysis of three surviving 16th-century Nuremberg trombone mouthpieces. One of those has been discovered in the course of this research. Their morphological properties will be discussed and the acoustical meaning of those visualised with computed and measured impedance curves. The outcome of this research clearly shows that the belly-shaped backbore has an important influence on the playing behaviour and intonation of the instrument, and thus should be taken into serious consideration for the performance of 16th-century brasswind music.

Fri 14:40 John TYNDALL MA-S08: Acoustics of historical and archaeological musical instruments

Spectral characteristics of the baroque trumpet: a case study – (Contributed, 000673)

H. Daffern and D. M. Howard
University of York, Audio Lab, Electronics department, Heslington, YO10 5DD York, UK
Corresponding author E-mail: helena.daffern@york.ac.uk

The baroque trumpet like many reconstructed or original historical instruments is very difficult to play compared to its modern day equivalent. It is commonly accepted that historically informed performances need a specialist baroque trumpeter performing on a specialist instrument in order to achieve the desired sound. Particularly, there are certain timbral characteristics and expectations concerning the range of dynamics employed that are highlighted by today's early music conductors and players as being unique to the baroque trumpet. An opportunity arose to record a world renowned baroque trumpeter playing original trumpets from 1780, 1788, 1912 and 1967 in the fully (6-sided) acoustic anechoic chamber at the University of York. Due to his strong instinct as a player that the mouthpiece is the most significant factor dictating the timbre of the instrument, performances on the later two trumpets were recorded using two different mouthpieces. The spectral characteristics of each of the instruments and the impact of changing the mouthpiece are analysed in terms of the spectral correlates of audible timbral differences integral to each instrument and the results discussed in relation to the musical context in which each trumpet might be employed.

Fri 15:00 John TYNDALL MA-S08: Acoustics of historical and archaeological musical instruments

In-depth acoustic modeling and temperament studies of 18th and early 19th century baroque bassoons comparing originals and reproductions by maker, time period, and region – (Contributed, 000314)

B. Hichwa[a] and D. Rachor[b]
[a]Sonoma State University, P O Box 343, The Sea Ranch, 95497, USA; [b]University of Northern Iowa, School of Music, University of Northern Iowa, Cedar Falls, 50614-00246, USA
Corresponding author E-mail: bhichwa@earthlink.net

The researchers developed a non-linear least squares acoustical modeling procedure and precision measurement techniques of physical dimensions to characterize Baroque bassoons. They deduced 1) Natural and playing pitch; 2) Reed equivalent volume; 3) Acoustic length corrections for the tone holes and boot joint double miter bend.
The initial study expanded to 44 original bassoons and 14 reproductions. Original makers included Scherer, Poerschmann and Eichentopf. Multiple bassoons by five makers were compared and measurable differences between period and contemporary makers were noted.
Unique to woodwinds, dimensional measurements determining pitch allowed an exhaustive study comparing 47 temperaments selected from English, French, German and Italian temperaments of the 18th and early 19th centuries. Sensitivity was enhanced by including forked fingerings, E-flat and B-flat. For each instrument results indicated a grouping of 5-7 preferred temperaments, typically meantone. Preferred temperaments exhibited a correlation with region and maker.

Pitch differences by note for every temperament was evaluated for each bassoon. The model demonstrated the proficiency of 18th century bassoon makers. It is also predictive. In about 25% of the instruments, minor changes to the wing joint result in a significantly improved "designerï bassoon. The model also illustrates bassoon evolution leading to changes in mid-19th century bassoons.

Fri 15:20 John TYNDALL MA-S08: Acoustics of historical and archaeological musical instruments

Acoustics radiation and modal analysis of a piano forte and its fac-simile – (Contributed, 000811)

F. Ollivier[a], S. Le Moyne[a] and S. Leconte[b]
[a]UPMC - Institut Jean Le Rond d'Alembert, 2 place de la gare de ceinture, 78210 Saint Cyr L'Ecole, France; [b]Laboratoire de Recherche et Restauration du Musée de la musique, 221, avenue Jean-Jaurès, 75019 Paris, France
Corresponding author E-mail: sylvielemoyne@yahoo.fr

The Music Museum in Paris keeps in its collection a piano forte made in 1802 by the well known piano maker Erard. Historical literature shows that the spreading out of the Erard's instrument was very wide. Indeed this model was acquired by Haydn or Beethoven and by many other pianists and composers in France. As it is a unique witness of this type of process, it was decided to keep the instrument of the museum collection in its original state, and to build a facsimile. In the objectives of increasing our knowledge of this instrument and to compare the original and its facsimile, an experimental modal analysis of the soundboard was performed.The Impact Planar Nearfield Acoustic Holography, was used. This technique implements NAH on the basis of the acoustic impulse response field and is well adapted to modal analysis. The behaviours of the two specimens are compared. Besides a particularity of this piano is that it has a second soundboard, called fake board, added over the strings. A second objective of the measurement is then to understand the acoustical role of this fake board by comparing the sound field with and without it.

Fri 13:40 Philip DOAK NV-S06: Rolling and tyre-road noise

Low frequency road noise decomposition at wheel center on an roller bench – (Contributed, 000701)

A. Gaudin[a] and J.F. Beniguel[b]
[a]PSA Peugeot Citroen, Route de GISY, 78943 Velizy Villacoublay, France; [b]MFPM, Place des Carmes Dechaux, 63040 Clermont Ferrand Cedex 09, France
Corresponding author E-mail: arnaud.gaudin@mpsa.com

Various methods can be used to achieve a better understanding of road noise propagation from the road to passengers'ears. This paper deals with a decomposition of the low frequency structure-borne noise transmission paths at the wheel center in order to assess tire/wheel and vehicle effects. It has been performed jointly by a car and a tire manufacturer. This decomposition involves blocked forces and vibroacoustic frequency response functions, both requiring specific setups to be measured on a roller bench. As road noise is a random process, a principal component analysis has to be performed on tire/wheel blocked forces to properly handle dynamic excitations. Since the inter-

face between wheel and suspension is rather stiff, the quality of tire/wheel blocked forces measurement strongly rely on bench test characteristics. In addition, comparisons between results coming from tire and car manufacturers may be distorted due to differences of road surfaces of rollers. Another difficulty is related to rotating effects that can't be neglected and which can alter the quality of the road noise recomposition. One challenge still remains to measure transfer functions in operating conditions. When handled with care, those items lead to pretty good results. Tire/wheel and vehicle effects on interior road noise can then be separated.

Fri 14:00 Philip DOAK NV-S06: Rolling and tyre-road noise

Tire-Wheel-Cavity dynamic model for Structure-borne road noise simulation – (Contributed, 000698)

J.F. Beniguel[a], A. Gaudin[b], Z. Abbadi[b] and D. Le Pen[a]
[a]MFPM, Place des Carmes Dechaux, 63040 Clermont Ferrand Cedex 09, France; [b]PSA Peugeot Citroen, Route de GISY, 78943 Velizy Villacoublay, France
Corresponding author E-mail: zouhir.abbadi@mpsa.com

Current tire-wheel models used for structure borne noise simulation are valid up to 200Hz. This limit is mainly due to the lack of tire cavity modes as well as wheel flexibility. Both have a strong effect on forced dynamic responses at wheel center in medium frequency range. Even if the current model is efficient regarding comfort simulation, a new one had to be developed to improve road noise forecast. In the scope of a partnership between PSA Peugeot Citroën and Michelin Company, the paper deals with the development of a dynamic sub-structured model of a tire wheel assembly -including the air cavity- and its usage for car and tire manufacturers. This new model is a step forward in tire wheel assembly simulation in mid-frequency range, taken into account the interactions between all fluid and structural components. Unfortunately, some new technical challenges already appear that will be discussed: integration of rotating effects, understanding of the ground excitation in the contact patch area.

Fri 14:20 Philip DOAK NV-S06: Rolling and tyre-road noise

A fast algorithm for computing dynamic tyre road contact forces – (Contributed, 000219)

D. Duhamel[a], R. Meftah[a], J. Cesbron[b] and H.-P. Yin[a]
[a]Université Paris-Est - UMR Navier, Ecole des Ponts ParisTech, 6&8 av. Blaise Pascal - Champs-sur-Marne, 77455 Marne La Vallée Cedex 2, France; [b]LUNAM Université, IFSTTAR, IM, EASE, Route de Bouaye, 44344 Bouguenais, France
Corresponding author E-mail: denis.duhamel@enpc.fr

An efficient contact model is presented for computing tyre road contact forces in the context of tyre noise prediction. Green's functions of the tyres are decomposed on a modal basis allowing fast convolutions for computing dynamic tyre displacements from contact forces. The contact condition involves the continuity of displacements and velocities at contact points between the road and the tyre. The contact forces are then determined from the contact condition at each time step. This method is compared to penalty methods and is found to be more stable, while the modal convolution leads to important reductions in computing times. Different examples of contact forces computations are presented, first for model road surfaces and then for realistic road surfaces. Spectral contents of the forces are compared for these different road surfaces and tyre velocities.

Fri 14:40 Philip DOAK NV-S06: Rolling and tyre-road noise

Influence of the road texture anisotropy on the noise radiated by a slick tyre – (Contributed, 000376)

P. Klein
Ifsttar, 25, avenue François Mitterrand, 69675 Bron, France
Corresponding author E-mail: philippe.klein@ifsttar.fr

The road texture plays a fundamental role in the tyre/road noise generation. Bi-dimensional profiles are often used to evaluate the performances of road surfaces as regards the rolling noise emission. In order to predict noise levels from bi-dimensional longitudinal texture profiles, assumptions concerning the three-dimensional distribution properties of the road surface are required. If these assumptions are not met, a deviation may occur in the noise level evaluation.

This paper aims at providing an insight into the expected radiated noise level variability due to possible texture anisotropy in the case of a slick tyre. The approach used in this paper is based on simulation tools intended to provide texture and noise data which are statistically an-

alyzed afterwards. Three-dimensional gaussian random texture fields are numerically generated from a known bi-dimensional texture power spectral density assuming elliptical anisotropy. These texture fields are used as input of a dynamic rolling model that provides the radial vibration of the tyre belt. The resulting radiated noise levels are evaluated with a BEM model. The relationships obtained between the elliptical anisotropy rating and the calculated noise levels are presented and discussed.

Fri 15:00 Philip DOAK NV-S06: Rolling and tyre-road noise

Low frequency statistical estimation of rolling noise from numerical tyre/road contact pressures – (Contributed, 000084)

G. Dubois[a], J. Cesbron[a], F. Anfosso-Lédée[a] and H.-P. Yin[b]
[a]LUNAM Université, IFSTTAR, IM, EASE, Route de Bouaye, 44344 Bouguenais, France; [b]Université Paris-Est, Laboratoire Navier, ENPC, 6-8, avenue Blaise Pascal, 77455 Marne-La-Vallée, France
Corresponding author E-mail: guillaume.dubois@ifsttar.fr

The paper deals with the relation between numerical contact data and close-proximity (CPX) noise measurements. The noise was measured on several road surfaces together with the texture in three dimensions on two-meter-long sections. A multi-asperity contact model was used to obtain successively the contact forces distribution and the contact pressure distribution between a patterned standard tyre and the road during rolling. The correlation between third-octave contact force levels and noise levels was studied on a set of ten surfaces. A high positive correlation is found at low frequency below 800 Hz, which allows the estimation of noise levels by means of statistical relations for each third-octave band between 315 Hz and 800 Hz. The results of the model are discussed in relation to the standard deviation of CPX measurements.

Fri 15:20 Philip DOAK NV-S06: Rolling and tyre-road noise

A comparative study of time delay estimation techniques for road vehicle tracking – (Contributed, 000462)

P. Marmaroli, X. Falourd and H. Lissek
Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland
Corresponding author E-mail: herve.lissek@epfl.ch

This paper addresses road traffic monitoring using passive acoustic sensing. Recently, the feasibility of the wheelbase length estimation of a road vehicle using one compact microphone array, laid out near the road, has been demonstrated. In essence, the directions of arrival of each incoming sound waves related to the tyre noise are discriminated during the pass-by of the vehicle thanks to a time delay estimation (TDE) technique between signals acquired by distant microphones. The tracking of each DOA is performed thanks to a sequential Monte-Carlo method, also known as particle filtering. This allows the estimation of the trajectory of each wideband moving sound sources; these lasts are identified as axles of the vehicle, the wheelbase length is then recursively estimated. As many TDE techniques are available in the literature, the study investigates their usefulness and their ability to deliver the best tyre noise detection and to feed the tracking algorithm giving kinematics of the axles of the tracked vehicle.

Fri 9:00 Ray STEPHENS ED-G01: Education in acoustics

Cheap acoustics as a learning methodology – (Invited, 000002)

S. Dance
London South Bank University, FESBE, Borough Road, SE1 0AA London, UK
Corresponding author E-mail: dances@lsbu.ac.uk

The master program in Environmental and Architectural Acoustics (MSc) from London South Bank University is taught at the Department of Urban Engineering. This was the first Masters course at the University and has been running for more than 30 years. The MSc program has a real world problem solving in the built environment. The Masters students spend 50% of the time in the laboratory undertaken practical experiments, which culminates with a mini-project to create a cheap solution to an acoustic problem which may or may not meet the requisite standards for compliance. This paper will describe the successes and failures of the students through the use of case studies

Fri 9:20 Ray STEPHENS ED-G01: Education in acoustics

Masters course in Acoustics at London South Bank University - A route on to our PhD programme – (Contributed, 000003)

S. Dance
London South Bank University, FESBE, Borough Road, SE1 0AA London, UK
Corresponding author E-mail: dances@lsbu.ac.uk

The Masters program in Environmental and Architectural Acoustics (MSc) from London South Bank University is taught at the Department of Urban Engineering. This was the first Masters course at the University and has been running for more than 30 years. The MSc program is delivered on a two and five semester basis depending if taken on a full-time or part-time basis with a two semester exemption if the applicant have already been award an Institute of Acoustic Diploma. The course is focused on the application of tools to solve real world acoustic problems in the built environment. The Masters students spend 50% of the time in the laboratory undertaken practicals which either prove or disprove classical acoustic theory using the very latest acoustics equipment. The course culminates with a thesis which the student normally undertakes over the summer. The best dissertations are then put forward for international awards and the students get to go to an national or international conference

Fri 9:40 Ray STEPHENS ED-G01: Education in acoustics

Collaborative learning in an University – (Contributed, 000230)

J.-M. Génevaux and A. Pelat
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: jmgenev@univ-lemans.fr

According to the ICEM movement, several teachers from Université du Mans propose a pedagogy based on a collaborative learning principle between the students. The classical French teaching model has been replaced for 2 years by an alternative method including the four following steps: i) individual silent lecture of the lesson to discover the main concepts, ii) session of questions and answers between the students and the teacher to clarify some unclear points, iii) appropriation of the concepts by solving several short self-correcting exercises called "patentsï, iv) passing individually exercises of increasing difficulty called "beltsï to validate the level of the student in the course when he considers that he is ready to try it. To encourage a collaborative work between the students, for each "patentï is chosen a student referee. Then, during the time dedicated for solving the "patentsï, the students are working in small groups and have a tetrahedron to indicate his status: "i am workingï, "i have a non-urgent questionï, "i need help from the referent-student or the teacherï. The presentation of this pedagogy will be made by the observation of a group of students working during the congress.

Fri 11:00 Ray STEPHENS ED-G01: Education in acoustics

The IOA diploma in acoustics and noise control – (Contributed, 000293)

B. Peters
Institute of Acoustics, 46 Saint Barnabas Road, Sutton, Surrey, SM1 4NS Surrey, UK
Corresponding author E-mail: bobp@aad.co.uk

The IOA Diploma was started in 1975 to satisfy the educational requirements for Associate membership of the Institute. Since then over 2000 candidates have gained the Diploma and have gone on to become corporate members of the Institute. The Diploma is offered currently at six Higher Education Institutions in the UK and through tutored distance learning supported by extensive course materials. The author has a long experience of teaching the IOA Diploma course, is the current Project Examiner and has contributed to the distance learning notes. The main pedagogical features of the course, particularly of the tutored Distance learning version, which relies on printed teaching materials, supplemented by compulsory laboratory sessions (4 days) and a programme of (optional) tutorials, are described. Statistics will be presented to demonstrate the effective of the course, together with examples taken from course materials, assignments, laboratory exercises, examinations and project investigations.

Fri 11:20 Ray STEPHENS ED-G01: Education in acoustics

Two examples of education in Acoustics for undergraduate and young postgraduate students – (Contributed, 000465)

B. Gazengel and C. Ayrault
Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9
Corresponding author E-mail: bruno.gazengel@univ-lemans.fr

This paper deals with two projects dedicated to young students in acoustics. First project is dedicated to undergraduate students and deals with the presentation of general acoustic concepts by means of musical approaches. In this project untitled "scientific concertsï, we present the three characteristics of sound (intensity, pitch, timber) using multimedia animations with scientific presentation supported by music played in real time by professional musicians. The presentation will show examples of animations presented to students. Second project is dedicated to young postgraduate students who are entering the university (semester 1). The aim of this course is to discover the phenomenon of acoustic propagation outdoors and to use the scientific method (question, hypothesis, experiment, prediction, evaluation). This project is a mix between the Problem Based Learning (PBL) method and the classical teaching (course, exercises). The presentation will show the structure of the course and some examples of results obtained by the students.

Fri 11:40 Ray STEPHENS ED-G01: Education in acoustics

Electroacoustic lectures on the web – (Contributed, 000532)

P. Lotton[a], H. Lissek[b], M. Melon[c], P. Herzog[d] and D. Mazzoni[d]
[a]Laboratoire d'acoustique de l'université du Maine, Bât. IAM - UFR Sciences Avenue Olivier Messiaen 72085 Le Mans Cedex 9; [b]Ecole Polytechnique Fédérale de Lausanne, EPFL STI IEL LEMA, 1015 Lausanne, Switzerland; [c]Conservatoire National des Arts et Métiers, 292 rue Saint-Martin 75141 Paris Cedex 03; [d]LMA, CNRS, UPR 7051, Aix-Marseille Univ, Centrale Marseille, 13402 Marseille, France
Corresponding author E-mail: pierrick.lotton@univ-lemans.fr

An educational collaborative project funded by the foundation "Université Numérique Ingénierie et Technologie" (UNIT), has been recently launched. This project aims at creating a set of lectures on electroacoustics fitted to the web media. The aim of these lectures is to constitute free pedagogical resources available on line. Both basic notions (electro-mechanical or -acoustical analogies, transduction principles, etc.) and practical cases (loudspeaker characterisation, enclosures design, etc.) will be presented, making use of available numerical facilities (interactivity, animations, videos, bank of sounds, etc.). Exercises will also be created, allowing the auto-evaluation of the E-learners. All these courses will be presented with a same graphical chart and developed in the SCENARI format. During the presentation, examples of preliminary realisations will be shown and the pros and the cons of this educational approach will be discussed.

Fri 12:00 Ray STEPHENS ED-G01: Education in acoustics

Introducing acoustics to classical musicians – (Contributed, 000857)

G. Zepidou[a] and S. Dance[b]
[a]Bureau Veritas, 180 Borough High Street, SE1 1LP London, UK; [b]London South Bank University, FESBE, Borough Road, SE1 0AA London, UK
Corresponding author E-mail: zepidoug@googlemail.com

Since the enforcement of the UK Control of Noise at Work Regulations in 2006 and over the last five years, the Acoustics Group of London South Bank University has been collaborating with the musicians and management of the Royal Academy of Music (RAM). The aim of the RAM noise project was to protect musicians from excessive sound exposure and the risk of noise-induced hearing loss and has been, from the very start, focused on the education of young and professional musicians. A series of seminars have been prepared for the musicians, explaining basic acoustic principles in more music related terms. Presentations are also enhanced by live musical demonstrations. This paper presents the approach taken in educating musicians in acoustics and audiology to help them understand the dangers and risks of excessive sound exposure and protect themselves from further/future hearing damage. The evolution of educational techniques during the RAM project, as a result of successes and failures, and their application on the professional musicians of the London Philharmonic Orchestra, is also discussed.

Fri 13:40 Lord RAYLEIGH HS-G01: Hearing and speech

Fixed sound source localization in reverberant environments using a multi-microphone set – (Contributed, 000821)

H. Meraoubi[a] and B. Boudraa[b]
[a]CDTA, Cité 20 aout 1956 Baba Hassen, 16030 Algiers, Algeria; [b]USTHB,Laboratoire de Communication Parlée etTraitement du Signal, B.P. 32, El-Alia, Bab-Ezzouar, 16111 Alger, Algeria
Corresponding author E-mail: b.boudraa@yahoo.fr

The aim of this study is the implementation of algorithms for locating a fixed sound source using a set of 4 microphones, arranged in a linear geometry and whose inter-microphone distances are known. The first results concern the duration of treatments to detect the arrival direction of the incident wave in reverberant environments. In the series of tests conducted in this work, we keep constant both the sampling frequency (Fe= 44100Hz) as soon as the distance d between microphones. Then, we vary the angle of incidence of the sound signal. The tests were repeated for different lengths of analysis windows. The tests were carried out in a reverberant room and with a significant background noise. As the most applications are conducted in reverberant rooms, the signals received by a sensor are the sum signals provided by both the direct path and the reflected ones through walls or other obstacles. The present study helps us to rapidly locate a fixed source for treatment times of 1*N to 20*N (N=1024 samples). So, the good detection of a sound source in a reverberating room is obtained by taking only the beginning of the recording files corresponding to the 4 microphones of the array.

Fri 14:00 Lord RAYLEIGH HS-G01: Hearing and speech

Formant frequencies of British English vowels produced by native speakers of Farsi – (Contributed, 000036)

G. Hunter and H. Kebede
Faculty of Science, Engineering and Computing, Kingston University, Penrhyn Road, KT1 2EE Kingston Upon Thames, UK
Corresponding author E-mail: G.Hunter@kingston.ac.uk

In this paper, we discuss issues relating to phoneme (in particular, vowel) production in a subject's second language, focusing on the vowel systems of Standard Southern British English (SSBE) and Farsi (Persian). We describe a study wherein first language Farsi speakers who were experienced second language speakers of SSBE were recorded attempting to produce SSBE vowels in words within a standard carrier phrase. The first and second formants of the vowels so produced were measured, and the results compared with measurements of SSBE and Farsi vowels produced by first language(L1) speakers of each from previous studies.

Fri 14:20 Lord RAYLEIGH HS-G01: Hearing and speech

Prediction of the sound pressure at the ear drum for open fittings – (Contributed, 000154)

T. Sankowsky-Rothe[a], M. Blau[a], H. Mojallal[b], M. Teschner[b] and C. Thiele[b]
[a]Institut für Hörtechnik und Audiologie, Jade Hochschule, Ofener Str. 16/19, 26121 Oldenburg, Germany; [b]Klinik und Poliklinik für Hals-, Nasen- und Ohrenheilkunde, Medizinische Hochschule Hannover, Carl-Neubergstr. 1, 30625 Hannover, Germany
Corresponding author E-mail: Tobias.Sankowsky@jade-hs.de

The fitting of hearing aids requires knowledge of the sound pressure generated at the ear drum. Traditionally, the sound pressure at the ear drum is estimated by the use of a model of an average ear canal (e.g. a coupler), but obviously, such a model cannot account for inter-individual differences. A better practice, but difficult, is the measurement at the ear drum with a probe-microphone. Alternatively, the sound pressure at the ear drum can be predicted by measurements away from the ear drum. Two methods, one of them based on the phase of the reflectance measured at the ear mold, and the other one based on minima of the sound pressure measured in the ear canal a few millimeters away from the ear mold, were investigated for the use with vented hearing aids. The methods to predict the sound pressure at the ear drum for vented hearing aids will be presented. A preliminary validation by probe tube measurements in 20 ears shows that the accuracy of the predictions is close to what could be obtained with closed fittings, with a few excaptions that will be discussed.

Fri 14:40 Lord RAYLEIGH HS-G01: Hearing and speech

Influence of headphone position in pure-tone audiometry – (Contributed, 000472)

M. Paquier[a], V. Koehl[a] and B. Jantzem[b]
[a]Université de Bretagne Occidentale, 6, avenue Victor Le Gorgeu, CS 93837, 29238 Brest Cedex 3, France; [b]Centre Auditif Entendre, 4, square Commandant L'Herminier, 29200 Brest, France
Corresponding author E-mail: mathieu.paquier@univ-brest.fr

Pure-tone audiometry (measurement of absolute thresholds using pure tones) is the main test for the diagnosis of hearing loss. It can be achieved by using either air conduction (with headphones or loudspeakers) or bone conduction (by placing a vibrator on the mastoid bone behind the ear). The HeadPhone Transfer Function (HPTF) describes both the headphone response and the coupling to a listener's ear. Recent papers indicated that modifications of headphone position can lead to changes in HPTF, and that these spectral modifications can be audible. The aim of the present study is to determine whether the headphone placement over a listener's ears has an influence on pure-tone audiometric tests. Audiograms were performed several times on normal-hearing subjects, for different headphone positions (obtained by placing/removing the headphone over the listener's ears), the absolute thresholds measurements being repeated for each headphone position. The dispersions of absolute thresholds with and without modification of the headphone position were compared in order to determine whether the headphone positionning is an issue for audiometric tests.

Fri 15:00 Lord RAYLEIGH HS-G01: Hearing and speech

The impact of vibrato usage on the perception of pitch in early music compared to grand opera – (Contributed, 000789)

H. Daffern, J. Brereton and D. M. Howard
University of York, Audio Lab, Electronics department, Heslington, YO10 5DD York, UK
Corresponding author E-mail: helena.daffern@york.ac.uk

Previous studies on the pitch of long-duration vibrato tones have typically used synthesised frequency modulated tones to assess the perceived pitch in relation to its mean fundamental frequency. In this study a listening test was conducted with expert listener subjects matching recorded vibrato tones sung by professional singers using a method of adjustment within a free response paradigm as employed by van Besouw et al. 2009. Tones from recordings by 16 singers were used in the test, 8 of whom were employed at the Royal Opera House, Covent Garden, and the remaining singers specialised in Early Music Performance. A previous study in the vibrato usage by these singers shows a noticeable difference in the use of vibrato between these performance groups, particularly in extent, throughout long tones (Daffern, 2008). The impact of these differences in vibrato will be assessed in terms of the perception of pitch in long tones as performed by the two groups of singers, and the effectiveness of using real recordings to assess listener perception of vibrato tones will be discussed.

Fri 15:20 Lord RAYLEIGH HS-G01: Hearing and speech

A-M I S-P-EA-K-I-NG C- L- E- AR- L- Y E-N-OU-GH?: An investigation of the possible role of vowel hyperarticulation in speech communication – (Contributed, 000529)

J. Kangatharan, M. Uther, L. K. Kuhn and F. Gobet
Brunel University, Kingston Lane, UB8 3PH Uxbridge, UK
Corresponding author E-mail: lisa.kuhn@brunel.ac.uk

Speech aimed at infants and foreigners has been reported to include the physical exaggeration of vowels, that is vowel hyperarticulation. Although infants have been demonstrated to experience hyperarticulated vowels as improved examples of vowel categories, little research has been done on whether vowel hyperarticulation occurs as a result of foreign appearance, foreign accent or as a consequence of looking and sounding foreign.
The present study therefore explored if appearance and speech separately affect the native speakers' hyperarticulation. Sixty White British adult speakers communicated with one of four different confederate groups to solve three modified DiapixUK tasks. Preliminary results might indicate that vowel hyperarticulation may be generalizable as a didactic instrument used to teach language learners. Vowel space for each target vowel seemed to be significantly larger in speech directed to foreign individuals with foreign accent than to foreign individuals with native accent. Future studies will be conducted to ascertain which speech samples help native speakers to understand speech better.

Fri 15:40 Lord RAYLEIGH HS-G01: Hearing and speech

An open source speech synthesis module for a visual-speech recognition system – (Contributed, 000730)

S. Manitsaris[a], B. Denby[a], F. Xavier[b], J. Cai[a], M. Stone[c], P. Roussel[a] and G. Dreyfus[a]
[a]Laboratoire Signaux, Modèles et Apprentissage Statistique, 10 rue Vauquelin, 75231 Paris cedex 05; [b]Laboratoire traitement et communication de l'information, 46 Rue Barrault 75013 Paris; [c]University of Maryland, University of Maryland, College Park, MD 20742, USA
Corresponding author E-mail: sotiris.manitsaris@espci.fr

A Silent Speech Interface (SSI) is a voice replacement technology that permits speech communication without vocalisation. The visual-speech recognition engine of the proposed SSI is based on vocal tract imaging. The system aims to give the laryngectomised speaker the opportunity to speak with his/her original voice. This paper presents the speech synthesis module of a SSI that uses the open-source MaryTTS (Text-To-Speech). The visual-speech recognition engine of the SSI outputs a text sentence, which is imported to the speech synthesis module in order to synthesise speech in French or English. A new module of phonetic transcription has been developed and integrated into MaryTTS. In addition, English and French semi-HMM (Hidden Markov Models) model voices have been built. The SSI can be remotely controlled using a mobile device and the new voices are installed in a Web Server.

AUTHOR INDEX