Anglo-French Physical Acoustics Conference 2026

21–23 January 2026
Doubletree by Hilton Cadbury House,
Bristol, UK

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IOP Institute of Physics

AFPAC Programme

Wednesday 21 January 2026

10:00 AM - 10:30 AM	**Registration and Arrival Refreshments**
10:30 AM - 10:40 AM	**Welcome**
10:40 AM - 11:10 AM	**Invited Speaker: Bertrand Dubus**, University of Lille, CNRS Space-time phononic crystals
11:10 AM - 12:30 PM	**Morning Session 1** **11:10 AM - 11:22 AM Jennifer Jobling**, Rolls-Royce Quantitative Phase Characterisation of Nickel-Based Superalloy Inconel 718 Using Ultrasound **11:22 AM - 11:34 AM William Lucas** Ultrasonic Interferometry for the characterization of localized porosity in stratified composites **11:34 AM - 11:46 AM Wanqi Zheng**, University College London A simulation framework for optimising Fabry- Pérot fibre optic hydrophones **11:46 AM - 11:58 PM Nicolas Leymarie**, Université Paris-saclay, Cea, List Numerical Characterisation of Elastic Wave Propagation in Fibre-Textured Polycrystals: Example of Complex-Valued Stiffness Evolution with Microstructural Parameters **11:58 AM - 12:10 PM Lisa Justiniany**, Laboratoire De Mécanique Et D'acoustique X-ray and Ultrasound-Based Multiphysical Study of Bone' Breakage and Archaeozoology Application **12:10 PM - 12:22 PM Lynda Chehami** Lamb Wave Imaging and Estimation of Defect Scattering Response via the Analysis of Reverberating Coda Waves in Thin Elastic Plates
12:30 PM - 1:30 PM	**Lunch**
1:30 PM - 3:30 PM	**Afternoon Session 2** **1:30 PM - 1:42 PM Junsun Hwang**, EPFL Small-scale actuators powered by sound waves travelling through air **1:42 PM - 1:54 PM Soma Mochizuki** Manually reconfigurable phased array **1:54 PM - 2:06 PM Joshua Mukherjee**, University College London AcousTools: A Python Library for 'full-stack' acoustic holography **2:06 PM - 2:18 PM Yusuke Koroyasu**, University Of Tsukuba Experimental Demonstration of Acoustic Levitation in High-Pressure Regions Using Zero-Order Bessel Beams **2:18 PM - 2:30 PM Martin Weber**, University Of Helsinki Sound-matter interaction in acoustic 3D printing

	2:30 PM - 2:42 PM Barnaby Emmens Reconfigurable Phased Array Acoustic Tweezers for Manipulating Biomedical Samples in Petri Dishes **2:42 PM - 2:54 PM Sandy Cochran**, University of Glasgow A Dexterous Integrated Ultrasonic Array for High Intensity Beamforming in Water **2:54 PM - 3:06 PM Dmitrii Nikolaev** Acoustophoretic guidance of particles in air using an airborne phased array **3:06 PM - 3:18 PM Juliette Pierre**, Institut D'alembert – Cnrs Origin of the sound produced by a newborn bubble
3:30 PM - 4:00 PM	Afternoon Break
4:00 PM - 5:30 PM	**Afternoon Session 3** **4:00 PM - 4:12 PM David Shaw**, University Of Strathclyde Enhanced Transduction in ZnO SAW Devices via Metallic Zn Seed Layer **4:12 PM - 4:24 PM Juan Pablo Escudero**, CNRS LAUM Using Wiremesh Gratings to mimic Anechoic Environments **4:24 PM - 4:36 PM Elmergue Germano** Characterisation and Performance Analysis of Pz29-Based 4 MHz Ultrasonic Transducers for Through-Metal Communication **4:36 PM - 4:48 PM Kirill Horoshenkov**, University Of Sheffield Basic physics rules behind a successful sustainable acoustic absorber **4:48 PM – 5:00 PM Antton Goicoechea**, Sorbonne University Propagation of Acoustic Waves in Correlated Systems **5:00 PM - 5:12 PM Florent Dorlot**, Institut Langevin – ESPCI Reconfigurable and active time-reversal metasurface turns walls into sound routers **5:12 PM - 5:24 PM Andrea Achilleos**, University College London Omnidirectional Wave Control Using Polyhedral Acoustic Metasurfaces
7:00 PM - 10:00 PM	**Dinner**

Thursday 22 January 2026

9:00 AM - 9:30 AM	**Invited Speaker: Katy Tant**, University of Glasgow Ultrasonic Travel-Time Tomography for Approximating the Local Elastic Tensor in Complex Media
9:30 AM - 10:20 AM	**Poster Flash Talk Session** **9:30 AM - 9:32 AM Xuan Li**, University Of Southampton Precision bone surgery with an adhesive-free class IV flextensional transducer **9:32 AM - 9:34 AM Mia Brely** Development, control and testing of a serial low intensity pulsed ultrasound (LIPUS) device for cell stimulation **9:34 AM - 9:36 AM Julien Bustillo**, INSA Centre Val de Loire Ultrasonic ToF Technique for SoC Estimation in LiIon Batteries **9:36 AM - 9:38 AM Fangyuan Wan**, University of Bristol Tomographic Reconstruction of the Internal Grain Structures in Polycrystalline Materials using Full-Waveform Inversion of Ultrasonic Array Data **9:38 AM - 9:40 AM Samuele Martinelli**, University Of Strathclyde Optimizing the COMSOL computation for Ultrasonic through-metal communication (UTMC) simulation **9:40 AM - 9:42 AM Michel Darmon**, Cea List, University Paris-saclay Fast analytical models for the non-linear scattering of elastic waves at a contact interface **9:42 AM - 9:44 AM Yongxing Cai** Statistical Classification of Cracks on Corroded Surfaces in Ultrasound Images **9:44 AM - 9:46 AM Josephine Hoare**, University Of Edinburgh The Development of New Tissue Mimicking Materials for the Assessment of Nonlinear Imaging Techniques **9:46 AM - 9:48 AM Tanguy Bertels**, Institut Jean le Rond d'Alembert, Sorbonne Université Numerical simulations of elastic wave propagation in solid materials containing a random distribution of spherical particles **9:48 AM - 9:50 AM Nesrine Houhat**, INSA centre Val de Loire Experimental monitoring of polyethylene viscosity during rotomolding by ultrasonic nondestructive method **9:50 AM - 9:52 AM Eric Ducasse,** Arts et Metiers Institute of Technology, Université Bordeaux Domain decomposition method for coupling semi-analytical form and finite element models of wave propagation: validation and convergence study **9:52 AM - 9:54 AM Sandy Cochran**, University of Glasgow High-Frequency Medical Ultrasound Array made with Textured Piezoceramics **9:54 AM - 9:56 AM Paul Dryburgh**, King's College London Coherent multi-transducer ultrasound imaging in harmonic mode

	9:56 AM - 9:58 AM Simon Pointeau, Institut Jean le Rond d'Alembert - Sorbonne Université Guided waves in a viscoelastic bilayer structure **9:58 AM - 10:00 AM Hasan Koruk,** National Physical Laboratory A robust indentation methodology for reproducible characterisation of the mechanical properties of soft materials **10:00 AM - 10:02 AM Reza Haqshenas** Acoustic Cavitation Classification: A Machine Learning Approach Using Multiple Bubble Dynamics Models and Stability Criteria **10:02 AM - 10:04 AM Benson Chen** Ultrasound mediated nanodrug delivery for pancreatic cancer **10:04 AM - 10:06 AM Alain Lhémery**, Université Paris-saclay, Cea-list SH wave imaging with synthetic arrays of magnetostrictive patches **10:06 AM - 10:08 AM Dmitrii Nikolaev** Dual-liquid acoustic fountain towards creating core-sheath structures
10:20 AM - 11:00 AM	**Morning Break and Poster Session**
11:00 AM - 1:00 PM	**Morning Session 4** **11:00 AM - 11:12 PM Elias Rabbat**, Imperial College London Quantitative Measurement of Defects in Pipes using Guided Wave-based Full Waveform Inversion **11:12 AM - 11:24 PM Quentin Baudis**, CEA LIST Calibrated and Temperature-Compensated Guided Wave Method for Non-Invasive Liquid Level Measurement **11:24 AM - 11:36 PM Daniel Dobrowolski**, Cuaa Strengthening the UK Acoustic Technology Pipeline **11:36 AM - 11:48 PM Salah Eddine Hebaz**, Laboratoire Satie, Cy Cergy Paris Université Nonlinear guided wave propagation analysis for subwavelength damage imaging **11:48 AM - 12:00 PM Garance Sauderais**, Satie, Cergy Paris Université Multi-mode Tomographic Approach using a Sensor Network for Structural Health Monitoring **12:00 AM - 12:12 PM Alverède Simon**, ONERA – DMAS Thermoplastic composite adhesion monitoring using pulse-echo ultrasound **12:12 AM - 12:24 PM Jordan Barras** Improving defect detection of nuclear welds using adaptive imaging based on uncertain material parameters optimization **12:24 AM - 12:36 PM Alain Lhémery**, Université Paris-saclay, Cea-list From the simulation of guided wave propagation in rolled plates subjected to stress to the tomographic reconstruction of stress distributions **12:36 AM - 12:48 PM Konstantinos Kondylidis** Theoretical and experimental investigation of elastic wave propagation in a multi-wire cable
1:00 PM - 2:00 PM	**Lunch**

2:00 PM - 2:30 PM	**Invited Speaker: Vitalyi E. Gusev**, Le Mans University Generation and detection by lasers of GHz - sub-THz surface, surface skimming and bulk acoustic waves in cleaved superlattices
2:30 PM - 3:45 PM	**Afternoon Session 5** **2:30 PM - 2:42 PM Parisa Abbasi**, University College London Non-Invasive Modulation of Microglia by Focused Ultrasound: Exploring a Potential Therapeutic Pathway for Alzheimer's Disease **2:42 PM - 2:54 PM Navya Nayak**, University College London Effect of focused ultrasound on retinal pigment epithelial cells and its application in early dry age-related macular degeneration **2:54 PM - 3:06 PM Qifeng Xia** Towards Physiologically Interpretable Acoustic Analysis for Voice-Based Detection of Respiratory Tract Infections (RTIs) **3:06 PM - 3:18 PM Daniel Silva**, University College London Therapeutic Ultrasound on Biomimetic Models of Cancer **3:18 PM - 3:30 PM Veerle Brans**, University of Oxford Combatting implant-related orthopaedic infections with therapeutic ultrasound and shockwaves **3:30 PM - 3:42 PM Max Au-yeung**, University College London Combined Unsupervised Machine Learning and Wavelet Packet Analysis for Characterising Acoustic Cavitation Data
3:45 PM - 4:15 PM	**Afternoon Break**
4:15 PM - 5:30 PM	**Afternoon Session 6** **4:15 PM - 4:27 PM Oliver Wright**, The University Of Osaka Mining picosecond ultrasonic echoes for information on strain pulses **4:27 PM - 4:39 PM Marion Caumartin**, Institut Langevin, ESPCI Paris, Université PSL, CNRS Laser-Based Control of the Acoustic Field **4:39 PM - 4:51 PM Theodosia Stratoudaki**, University of Strathclyde Spatially Encoded Ultrasonic Generation for Laser-Induced Phased Array Imaging **4:51 PM - 5:03PM Mohammad Ali Fakih**, University of Bristol Experimental Validation of 2D Laser-Induced Phased Arrays with Poisson-Disk Layouts **5:03 PM - 5:15 PM Samuel Raetz**, Laum, Umr 6613, Cnrs, Le Mans Université Three-dimensional mapping of nonhydrostatic pressure in a diamond anvil cell using isotropic mHEMA as the pressure-transmitting medium by time-domain Brillouin scattering
7:00 PM - 10:00 PM	**Pre-Dinner Drinks, Talk, Conference Dinner and Ceilidh**

Friday 23 January 2026

9:00 AM - 9:30 AM	**Invited Speaker: Elly Martin**, University College London Transcranial ultrasound for spatially-precise modulation of the deep brain
9:30 AM - 11:10 AM	**Morning Session 7** **9:30 AM - 9:42 AM Xuan Li**, University of Southampton A miniature ultrasonic surgical device based on a flextensional configuration with a pre-stressed PZT stack **9:42 AM - 9:54 AM Faraz Amini** A Cymbal Transducer as a Single Element Device for Enhanced Cavitation Generation **9:54 AM - 10:06 AM James An** Measurement of Fracture Parameters from Ultrasound Images Using Convolutional Neural Networks **10:06 AM - 10:18 AM Alexandr Kiyashko** Assessing the Variability of Textured Piezoceramics: Comparison with Hard Piezoceramics for High-Power Ultrasonic Applications **10:18 AM - 10:30 AM Liuyu Chang** A Piecewise Random Walk Model for Hydrogen-Induced Cracks **10:30 AM - 10:42 AM Matt Chandler**, CFMS Bounce: An HPC-scale elastodynamic finite element solver for ultrasonic non-destructive testing applications **10:42 AM - 10:54 AM Hasan Koruk**, National Physical Laboratory Estimation of phase response and uncertainty in ultrasonic hydrophones
11:10 AM - 11:30 AM	**Morning Break**
11:30 AM - 1:00 PM	**Morning Session 8** **11:30 AM - 11:42 PM Ben Cox**, University College London Fourier-Neumann Numerical Models of Acoustic Propagation **11:42 AM - 11:54 PM Philippe Lasaygues**, Cnrs-Ima Insights into a multi-frequency coded excitation method for enhanced morphometric ultrasound computed tomography **11:54 AM - 12:06 PM Oscar Bates**, Imperial College London Skull template registration from acoustic data by manifold optimisation and full-waveform inversion **12:06 AM - 12:18 PM Arthur Jaccottet**, University College London Development of a Capacitive Sensor for Shear Wave Elastography of Prostate Tissue **12:18 AM - 12:30 PM Andre Victor Alvarenga**, National Physical Laboratory Uncertainty of Shear Wave Speed Measurements in ARFI Ultrasound Elastography **12:30 AM - 12:42 PM Romann Fernandes**, Greman Insa Cvl Characterization of functionnal bio-based polymers for high frequencies medical imaging

	12:42 AM - 12:54 PM Damien Kuntz, Cea List Paris-Saclay Self-adaptive extraction of the geometric and acoustic properties of the skull for transcranial ultrasound imaging
1:00 PM - 1:30 PM	**Lunch (grab and go) and Depart**

Invited Speakers

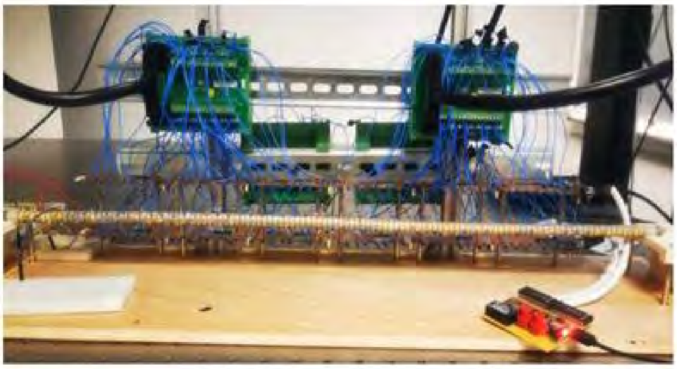
Space-time phononic crystals

Bertrand Dubus[1], S. Tessier Brothelande[1], F. Allein[1], J.O. Vasseur[1], C. Croënne[1]
[1]*University of Lille, CNRS, France*
Invited Speaker: Bertrand Dubus, University of Lille, CNRS, France
January 21, 2026, 10:40 - 11:10

Space-time metamaterials exhibit wave properties resulting from the temporal variation of their physical parameters. They allow to manipulate the temporal and spatial spectra of waves far beyond the simple dependency over time of their static physical properties. Although a large number of canonical space-time media may be conceptualized [1], the vast majority of the research focuses on one-dimensional media submitted to a uniform velocity travelling-wave modulation of their properties. This description includes several categories of metamaterials according to their initial properties in the absence of modulation [2]. Among them, spacetime crystals are pre-existing periodic structure constituted by two homogeneous media with different refractive indices separated by spacetime modulated interfaces [3].

The first part of this presentation describes the fundamental properties of spacetime interfaces and spacetime crystals with an emphasis on the dispersion properties of uniform-velocity spacetime crystals in the subsonic, sonic an supersonic regimes. The experimental tranposition of this concept is presented in the second part. It takes the form of a one-dimensional piezoelectric phononic crystal whose periodic electrical conditions are modulated in time and space through external circuits prescribing grounded or floating potential conditions [4]. The design and realization of the piezoelectric crystal and the experimental method for measuring its dispersion properties are described in detail. The experimental results finally are compared with theoretical predictions from the literature in the three modulation regimes (subsonic, sonic, and supersonic). Some effects specific to the piezoelectric nature of the propagation medium are also discussed.

1. C. Caloz et al, Spacetime metamaterials , part II: Theory and applications, IEEE Transactions on Antennas and Propagation 68, 1583 (2020).
2. A. Bahrami, et al, Electrodynamics of accelerated-modulation space-time metamaterials, Physical Review Applied 19, 054044 (2023).
3. Z.-L. Deck-Léger et al, Uniform-velocity spacetime crystals, Advanced Photonics 1, 056002 (2019).
4. S. Tessier Brothelande et al, Experimental evidence of nonreciprocal propagation in space-time modulated piezoelectric phononic crystals, Applied Physics Letters 123, 201701 (2023).



Generation and detection by lasers of GHz - sub-THz surface, surface skimming and bulk acoustic waves in cleaved superlattices

<u>Vitalyi Gusev</u>[1], Serhii Kukhtaruk[2], Changhiu Li[3]

[1]Laboratoire d'Acoustique de l'Université du Mans (LAUM), UMR 6613, Institut d'Acoustique-Graduate School (IA-GS), CNRS, Le Mans Université, France, [2]Department of Theoretical Physics, V.E. Lashkaryov Institute of Semiconductor Physics, Ukraine, [3]Deutsches Elektronen-Synchrotron DESY, Germany

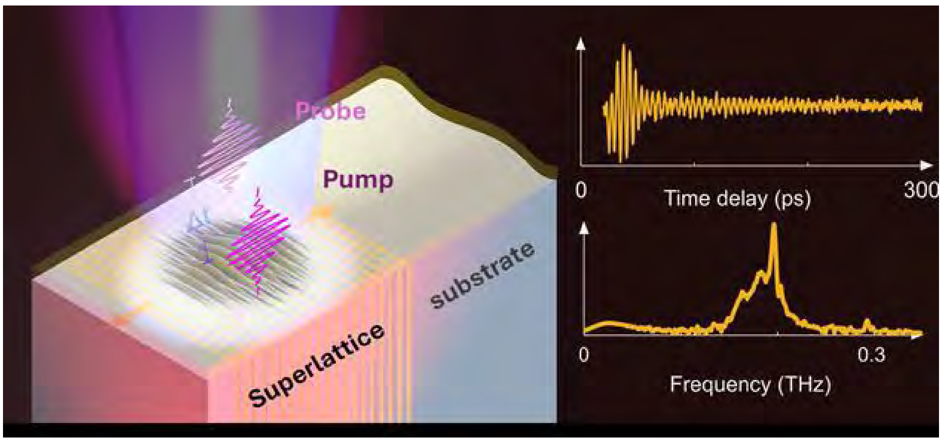
Invited Speaker: Vitalyi E. Gusev, Le Mans University, France, January 22, 2026, 14:00 - 14:30

An existing interest in coherent surface acoustic waves (SAWs) is due to their well-known numerous applications in non-destructive testing, sensing, scientific research as well as in the information and communications technologies. Among of the current goals in the advanced experiments on SAWs is development of reliable laser-based techniques for their manipulation, i.e., generation and detection, in the GHz frequency range and the extension these techniques to sub-THz frequency range. The sub-picosecond to femtosecond lasers are favorable for manipulations of SAWs up to the highest possible single-digit THz frequencies because the spectra of their pulses intensity envelopes contain the required frequencies for launching in the material [1]. They also provide potential opportunity to detect SAWs up to THz frequencies in the time-domain by the pump-probe measurements of the transient optical response of the materials. However, for an efficient monitoring of GHz-THz SAWs the laser radiation should also provide opportunity to monitor corresponding high lateral (along the surface) wave vectors of SAWs. With lasers in the near UV – visible – near IR domains this can be achieved by pumping and probing the material surfaces, which parameters are structured with nanometers spatial periodicity.

A platform of cleaved superlattices was recently suggested for laser-based SAWs and proof-of-concept experiments were reported [2,3]. In [2] a reliable simultaneous monitoring of SAWs, surface skimming transverse and longitudinal acoustic waves was demonstrated at frequencies ~40, ~50 and ~70 GHz, respectively. In [3], in cleaved superlattices with ~4 times shorter period (~20 nm) the first ever monitoring of SAWs at sub-THz frequencies (~0.16 THz) was achieved together with surface skimming transverse and longitudinal waves at frequencies up to ~0.2 and ~0.3 THz, respectively.

In this presentation the theoretical backgrounds for the generation and detection of coherent acoustic waves in cleaved superlattices will be discussed.

1. V. Gusev and A. Karabutov, Laser Optoacoustics, AIP, New York, 1993.
2. C. Li, N. Chigarev, T. Thréard, K. Zhan, N. Delorme, V. Tournat, S. Raetz, H. Lu , and V. E. Gusev, ACS Nano, 18(13), 9331 (2024).
3. C. Li, A. Lemaitre, N. Chigarev, M. Morassi, S. Raetz, J. Gandhi, A. Maznev, D. Lanzillotti-Kimura, and V. E. Gusev, Ultrafast Phenomena and Nanophotonics XXVIII (p. PC128840J). SPIE (2024, March).



Transcranial ultrasound for spatially-precise modulation of the deep brain

Elly Martin[1]
[1]UCL, United Kingdom
Invited Speaker: Elly Martin, UCL, United Kingdom, January 23, 2026, 09:00 - 09:30

Development of therapeutic applications of ultrasound has been increasing for many years. Currently, one of the most rapidly growing areas of research in this field is transcranial ultrasonic neuromodulation, which has potential as a noninvasive, targeted therapy for treatment of neurological and psychiatric disorders, and as a tool for increasing our understanding of the brain.

We developed a system for spatially precise ultrasonic neuromodulation of small regions in the deep brain. This work aimed to increase the accuracy and specificity of targeting over many alternative ultrasound systems, as well as other non-invasive brain stimulation modalities. I will give an overview of the physics and rationale behind the design of the system, the testing and validation used to assess its performance. The first study in healthy human participants performed with the system, showed robust modulation of activity in the visual system in both online and offline protocols.

Ultrasonic Travel-Time Tomography for Approximating the Local Elastic Tensor in Complex Media

<u>Katy Tant</u>[1]

[1]University of Glasgow, United Kingdom

Invited Speaker: Katy Tant, University of Glasgow, United Kingdom
January 22, 2026, 09:00 - 09:30

Ultrasonic non-destructive evaluation (UNDE) is essential for assessing the integrity of safety-critical components, yet imaging in complex, anisotropic materials such as austenitic steel welds remains challenging. Traditional methods assume homogeneity and isotropy, leading to inaccuracies when wave paths are distorted by heterogeneous microstructures. This talk introduces a probabilistic framework for reconstructing spatially varying elastic properties from ultrasonic travel-time data using stochastic Stein Variational Gradient Descent. By parameterising anisotropy through three intuitive variables—orientation, strength, and scaling—we approximate the local elastic tensor at each point in our domain, while accounting for uncertainty. Results demonstrate that travel-time data alone cannot fully constrain high-dimensional domains; however, incorporating prior knowledge on at least one parameter significantly improves reconstruction accuracy. The approach offers a computationally efficient alternative to MCMC and has potential applications across NDE, medical, and seismic imaging.

Pre-dinner Speaker

Langevin in Bristol

Dr Francis Duck[1]
[1]*independent, United Kingdom*

Pre-Dinner Talk, Conference Dinner and Ceilidh, January 22, 2026, 19:00 - 22:00

Paul Langevin was called 'the originator of the science and art of modern ultrasonics' by American physicist Walter Cady, writing in his book Piezoelectricity in 1946, the year Langevin died. When Langevin visited Bristol in 1927 to receive an honorary degree from the university, he was approaching the end of his contributions to ultrasonics, commenced in January 1915 during WWI for submarine detection and communication. This presentation will give an overview of Langevin's ultrasonics, justifying Cady's claim on his behalf. It will also summarise his contributions to the 1927 Bristol degree ceremony, which honoured, additionally, his colleagues William Bragg and Ernest Rutherford, both involved with war-time ultrasonics. Since the end of the first war, Langevin had maintained his activities in the basic science and technological exploitation of ultrasonics. In 1923 he had devoted his course at the Collège de France to ultrasonics. This was the first ever course on the subject, and included not only fundamentals of acoustic generation and transmission, but also thermo-viscous loss mechanisms, radiation force and non-linear shock generation. At the same time, he concentrated his efforts on exploiting ultrasonics for echo-sounding, and by 1927 the French company S.C.A.M. was fitting Langevin quartz sandwich transducers to commercial shipping. Langevin was a consultant, and in that capacity he pioneered ultrasonic metrology, filing a patent in 1926 that covered several innovative devices [1] which included a broadband quartz hydrophone with integral amplifier and a resonant quartz contact probe for evaluating source oscillations. He also included two developments in emitters, an array for apodisation, and a multilayered 'Langevin stack'. A further commercial device was 'le phare ultrasonore de Calais', a combined ultrasonic and radio guidance system to allow ferries to dock in the fog, also reported in 1927. When proposed for the 1933 Nobel Prize in physics, together with the American ultrasonics pioneer Robert Wood, the nomination was declined and Dirac and Shrödinger were selected instead. From then on, Langevin's time became increasingly committed to politics, about which he said "unless the political work is done there will be no science at all" [2].

Langevin was awarded an honorary degree at Bristol University on 21 October 1927, following the opening of the newly-built H.H. Wills physics laboratory. The citation referenced his work on gas ionisation and his electron theory of magnetism. There was no mention of ultrasonics, still a fledgeling science with few practitioners. After the evening dinner, Langevin spoke on behalf of the new honorary doctors, a speech so impressive that "the English, so proverbially phlegmatic.... gave him an indescribable, unforgettable ovation."

1. Duck FA. Langevin's ultrasonic metrology. IEEE Trans UFFC. 2023;70(2):173-180. (doi: 10.1109/TUFFC.2022.3222085)
2. Bensaude-Vincent B, Duck F. 2025. Paul Langevin, physicist and social activist. Springer Nature. DOI 10.1007/978-3-031-95260-9

Oral Contributed Talks

Non-Invasive Modulation of Microglia by Focused Ultrasound: Exploring a Potential Therapeutic Pathway for Alzheimer's Disease

Parisa Abbasi[1], George Sideris-Lampretsas[2], Reza Haqshenas[1], David Attwell[2], Nader Saffari[1]
[1]Mechanical Engineering Department, University College London, United Kingdom, [2]Department of Neuroscience, Physiology and Pharmacology, University College London, United Kingdom

Afternoon Session 5, January 22, 2026, 14:30 - 15:45

Alzheimer's disease (AD) is characterized by amyloid β (Aβ) plaques, tau tangles, and reduced cerebral blood flow. While monoclonal antibodies targeting Aβ provide modest clinical benefits, their high cost and associated risk of microbleeds highlight the need for alternative strategies. Focused ultrasound (FUS) has recently emerged as a non-invasive modality capable of modulating brain function and enhancing Aβ clearance, yet the underlying mechanisms remain poorly defined.
To address this, we focus on microglia, resident brain immune cells expressing several mechanosensitive ion channels with a well-established role in AD pathogenesis. We investigated whether FUS could affect microglial surveillance and structure in homeostasis. Acute brain slices from CX3CR1-GFP mice were exposed to thirty-minute FUS at a centre frequency of 2MHz, pulse repetition frequency of 40Hz, and peak positive pressure of 1.2MPa. FUS stimulation induced a reduction in microglial surveillance, process length, and ramification, highlighting that FUS can directly affect microglial properties. A similar reduction in ramification was observed following PIEZO1 (highly mechanosensitive ion channel) agonist application, suggesting that PIEZO1 may contribute to the FUS-induced effects. Modelling and temperature measurements indicated that no thermal effects should be induced by ultrasound application, implying that the observed alterations in microglial behaviour were primarily mediated by mechanical rather than thermal stimuli. These findings support the potential involvement of the PIEZO1 ion channel in mediating the mechanotransduction effects of FUS on microglial cells. Given that PIEZO1 is upregulated in plaque-associated microglia, we hypothesise that FUS may exert therapeutic effects by enhancing Aβ clearance through the activation of PIEZO1 in plaque-associated microglia, a hypothesis under investigation.

Omnidirectional Wave Control Using Polyhedral Acoustic Metasurfaces

Andrea Achilleos[1], James Hardwick[1], Ryuji Hirayama[1], Sriram Subramanian[1]
[1]*University College London, United Kingdom*

Afternoon Session 3, January 21, 2026, 16:00 - 17:30

Acoustic metasurfaces (AMs) are specially designed structures that shape how acoustic waves propagate, enabling functions like sound absorption, beam steering, and acoustic holography. Conventionally, AMs are flat and control waves in only one direction, which restricts the size and placement of target acoustic fields. We introduce a design and fabrication method for omnidirectional AMs that can create user-defined acoustic fields anywhere in three-dimensional space. Drawing inspiration from Goldberg polyhedra, we develop a spherical tiling approach that arranges custom phase-shifting unit cells to form 3D metasurfaces. The metasurface's sphericity and resolution are maximized to achieve diffraction-limited fields with no aliasing. We further design, optimize, and fabricate a spherical acoustic source, which provides the acoustic input to the metasurface. We test the function of our metasurfaces both numerically and experimentally achieving focal points and complex acousto-holographic patterns in multiple directions simultaneously. Overall, this work introduces the first acoustic analogue of spherical light displays and opens new possibilities in areas such as noise control, multi-user haptics, multifunctional materials, and compact acoustic systems.

A Cymbal Transducer as a Single Element Device for Enhanced Cavitation Generation

Faraz Amini, Andrew Feeney, Paul Prentice
[1]*Center for medical and industrial ultrasound (C-MIU), University of Glasgow, United Kingdom*

Morning Session 7, January 23, 2026, 09:30 - 11:10

Cavitation induced by low-frequency ultrasound is a well-established technique for transdermal drug delivery; however, challenges persist regarding the size and efficiency of existing sonicators. The cymbal transducer has emerged as a promising candidate for such applications [1]; however, the conventional design is limited by its relatively low power output and challenges for consistent manufacturing, limiting its success in arrays and for extended treatment times [2]. This study presents a modified cymbal transducer engineered to deliver higher acoustic output at 66 kHz, while simplifying fabrication, maintaining a compact form (outer diameter = 36 mm, thickness = 6 mm). The transducer consists of a titanium endcap connected to a ring-shape stainless steel backmass via a threaded feature on the endcap (M33×0.5). A piezoelectric ceramic ring (PZT4) is sandwiched between the backmass and the endcap as the active element, where the mechanical coupling is further reinforced through epoxy resin. The transducer was then characterised in terms of its vibration mode shape, acoustic pressure field, acoustic power, and cavitation performance captured through high-speed imaging and acoustic detection of bubble collapse shockwave emissions. The improved design achieved a peak negative pressure (PNP) of up to 3.4 MPa at its focal region and a spatial-peak temporal-average intensity (ISPTA) of 2.88 W/cm^2 which significantly exceed those of comparable devices [3]. High-speed shadowgraphic imaging further demonstrated enhanced cavitation activity not previously reported. Consequently, the modified cymbal transducer proves to be not only a robust and compact sonicator suitable for sonophoresis but also a viable source for compact high-power ultrasonic applications.

References

[1] L. Shams and T.-B. Xu, “Underwater communication acoustic transducers: a technology review,” Sens. Smart Struct. Technol. Civ. Mech. Aerosp. Syst. 2023, vol. 12486, pp. 59–79, 2023.
[2] E. Maione, K. K. Shung, R. J. Meyer, J. W. Hughes, R. E. Newnham, and N. B. Smith, “Transducer design for a portable ultrasound enhanced transdermal drug-delivery system,” Ieee Trans. Ultrason. Ferroelectr. Freq. Control, vol. 49, no. 10, pp. 1430–1436, 2002.
[3] C. Yu et al., “A conformable ultrasound patch for cavitation-enhanced transdermal cosmeceutical delivery,” Adv. Mater., vol. 35, no. 23, p. 2300066, 2023.


Endcap
Piezoceramic ring
Backmass
Epoxy
Electrode

(a) (b) (C)


40
30
20
10
0 mm

Measurement of Fracture Parameters from Ultrasound Images Using Convolutional Neural Networks

James An[1]
[1]University of Bristol, United Kingdom

Morning Session 7, January 23, 2026, 09:30 - 11:10

Structural health monitoring (SHM) is critical for the safety, reliability, and long-term performance of engineering structures. This study introduces an innovative machine learning-driven framework for predicting key fracture parameters—crack length, stress fields around the crack tip, and crack mouth opening distance (CMOD)—directly from ultrasound images. The ultrasonic data were acquired using a permanently installed, low-cost, low-profile ultrasonic array, which provides a much lower signal-to-noise ratio than conventional systems and therefore presents additional challenges for data interpretation. Various types of machine learning models were built and trained using Total Focusing Method (TFM) images paired with corresponding stress and strain fields obtained via Digital Image Correlation (DIC). This pairing provided explicit crack-related information, enabling predictions of critical fracture metrics. Substantial parameter tuning was undertaken to identify optimal model configurations and explore the relative advantages and trade-offs of various architectures. These comparisons provided valuable insights into how model structure and hyperparameters influence predictive performance.

Experimental validation confirmed the reliability of this framework. By integrating low-cost ultrasonic imaging and machine learning, this work underscores the potential of leveraging data-driven techniques to transform SHM practices. The findings pave the way for scalable, cost-effective, and computationally efficient solutions to monitor structural integrity in real-time, offering significant benefits for infrastructure management and maintenance.

Combined Unsupervised Machine Learning and Wavelet Packet Analysis for Characterising Acoustic Cavitation Data

Mr Max Au-yeung[1], Reza Haqshenas[1]
[1]*UCL ultrasonics group, United Kingdom*

Afternoon Session 5, January 22, 2026, 14:30 - 15:45

Acoustic cavitation refers to the formation and growth of bubbles under the effect of a sound field. It is an important effect of biomedical ultrasound and is responsible for a large variety of bioeffects under a wide range of ultrasound parameters in both imaging and therapeutic settings.

This project aims to monitor and classify bubble dynamics (stable and transient) for live therapy guidance by measuring the sound that is emitted by cavitation. These emissions contain periodic and transient features that are linked to stable and transient cavitation; appearing in the frequency domain as fundamental, harmonics, and subharmonics and a broadband noise.

A signal processing method is devised combining multi-resolution time-frequency analysis, feature extraction, and clustering to split and classify the signal into periodic and transient components. Multiresolution analysis of acoustic emissions was carried out before [1]. This work adds unsupervised machine learning for automated classification of spectral features. We have also developed a new metric for quantifying the broadband component, and a novel and efficient decomposition algorithm which guides the decomposition to extract components of interest.

The signal is decomposed using the discrete packet wavelet transform (DWPT) and unsupervised machine learning is used to classify these signal components. The method quantitatively characterises the frequency bandwidth and energy of broadband emissions. The method is tested on simulated single bubble dynamics and experimental data from both passive and active cavitation detection. It is implemented as an open-source Python library [2].

[1] S. R. Haqshenas and N. Saffari, “Multi-resolution analysis of passive cavitation detector signals,” Journal of Physics: Conference Series, vol. 581, no. 1, p. 012004, jan 2015.

[2] https://github.com/USonixGroup/Bubble-Cavitation-ML

Improving defect detection of nuclear welds using adaptive imaging based on uncertain material parameters optimization.

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Morning Session 4, January 22, 2026, 11:00 - 13:00

In the nuclear industry, welded components often pose significant challenges for defect characterization. The filler metal solidifies into a complex, variably oriented anisotropic material, which complicates analysis. This complexity is further amplified by variations observed not only between different specimens but also between transverse slices of the same weld. The lack of precise knowledge regarding the exact elastic properties of the material leads to poor performance of conventional imaging techniques.

The basic assumption—that the specimen can be represented as a homogeneous, isotropic material—is highly limiting in these cases. Defect echoes, additionally to being diminished by structural attenuation, are often split into two parts, wrongly located or barely visible. This inconsistency is what we aim to correct.

To improve imaging in nuclear welds, we propose to build upon the work conducted during C. Ménard's Ph.D. thesis [1]. Our approach involves identifying the parameters of a physical model that optimize an imaging criterion (here the maximum of amplitude of an echo). In other words, the goal is to achieve results as close as possible to those that would have been obtained if exact material properties were known. The procedure only requires assumptions about the material's symmetry and the law governing crystal orientation. These assumptions help define the parameters and their probable range of variation. With the aim of going beyond the laboratory code to offer an industrial demonstrator, additional features have been added and evaluated on the study case proposed during the iWeld european project. It includes echoes identification and optimization on sub-zones in order to equally balance the chosen metric between the different echoes.

[1] C. Ménard, S. Robert, R. Miorelli and D. Lesselier, "Optimization algorithms for ultrasonic array imaging in homogeneous anisotropic steel components with unknown properties," NDT & E Int. 116 (2020).

Skull template registration from acoustic data by manifold optimisation and full-waveform inversion

Oscar Bates[1], Carlos Cueto[1], Ciaran Coleman[2], Lluis Guasch[1], Oscar Calderon Agudo[1]
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Morning Session 8, January 23, 2026, 11:30 - 13:00

Transcranial ultrasound typically requires a p-wave velocity (sound speed) template to perform aberration and distortion correction. This template is usually derived from prior MRI or CT data and must be registered into position. When MRI guidance is available, image-to-image registration is used. However, in its absence, tomographic and therapeutic applications rely on stereotactic reference frames and manual intervention - methods that are time-consuming and prone to error.

We show that Lie Groups can linearise the Full-Waveform Inversion (FWI) gradient and automatically position the skull template. By analogy with rigid registration, the template's coordinate system is parameterised by the Special Euclidean group (SE(3)). Unlike traditional rigid registration, which calculates the loss between the skull template image and a guidance image, we compute the loss between observed and predicted acoustic data. The acoustic data loss is backpropagated to the template domain using FWI and the FWI gradient is projected onto the Special Euclidean group using (the vector-Jacobian product method in) automatic differentiation.

We present in-silico and in-vitro results showing that skull templates can be accurately positioned using only ultrasound data, eliminating the need for additional imaging or manual alignment. This method will simplify and improve the accuracy of template positioning in transcranial ultrasound applications.

Calibrated and Temperature-Compensated Guided Wave Method for Non-Invasive Liquid Level Measurement

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[1]*CEA LIST, France*

Morning Session 4, January 22, 2026, 11:00 - 13:00

Measuring liquid levels in tanks is a major challenge for many industries, particularly in the aerospace sector, where precision, reliability, and lightweight systems are essential. The development of non-invasive gauging strategies significantly reduces maintenance costs and intervention risks while improving equipment operational availability.

It is now established that guided elastic waves can be used in order to measure the level of a liquid at a solid–liquid interface. We propose here a gauging method based on the use of piezoelectric sensors placed on the external wall of the tank, thus avoiding any intrusion inside the container, with several operational advantages (easy maintenance of sensors, less constraints due to explosive atmosfere environment, etc.).

The originality of this study lies in an advanced signal processing technique that jointly exploits the phases and times of flight of the guided modes of interest for a calibration method, combined with a temperature compensation algorithm used to correct for thermal effects on wave propagation. This approach achieves a measurement accuracy of about one millimeter.

These results pave the way for a new generation of compact, accurate gauging systems that are compatible with the constraints of aeronautics.

Combatting implant-related orthopaedic infections with therapeutic ultrasound and shockwaves

Dr Veerle Brans[1], Sara Keller[1], Ramon Garcia Maset[1], Abtin Alvand[2,3], Michael Gray[1], Dario Carugo[3], Constantin Coussios[1], Robin Cleveland[1], Eleanor Stride[1,3]
[1]Institute of Biomedical Engineering, University of Oxford, United Kingdom, [2]Nuffield Orthopaedic Centre, United Kingdom, [3]Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, United Kingdom

Afternoon Session 5, January 22, 2026, 14:30 - 15:45

Orthopaedic implant infections from biofilm-forming bacteria have risen, constituting major healthcare and economic burdens due to increased revision surgeries, hospital stays, and rehabilitation. The biofilm matrix acts as a protective barrier limiting antibiotic/antiseptic penetration and immune infiltration, necessitating alternative therapies. Prior studies show cavitation, facilitated by endogenous or exogenous cavitation nuclei, can remove biofilms in various therapeutic models. However, most existing approaches rely on low-frequency or invasive ultrasound devices, coating-activated shockwave systems, laser-based methods with limited penetration depth, or simplified dental/flushable models that do not reflect in situ orthopaedic implant environments. Thus, there remains a need for a non-invasive, clinically relevant cavitation strategy capable of disrupting biofilms on implant materials.

This study evaluates therapeutic ultrasound (US) and shockwaves (SW) for treatment against S. aureus biofilms on clinically relevant implant materials, both stand-alone and combined with antibiotics. S. aureus strains obtained from osteomyelitis were cultured on ~12-mm discs made of implant (stainless steel and titanium) or bone-mimicking (hydroxyapatite) materials, in synthetic wound fluid to recapitulate in vivo conditions.

Treatments included scanning US (0.95 MHz, 2.5 MPa peak negative pressure, 500 Hz pulse repetition frequency, 10% duty cycle, 10 s per location across ten positions; 2×10^2 J incident acoustic energy over the inner 10-mm disc diameter) delivered in the presence of in-house fabricated protein-based cavitation nuclei. SW exposures comprised stationary SW (3 MPa PNP, 0.5 Hz, 50 SW; 7×10^{-2} J incident energy, no nuclei) and scanning SW (3.5 MPa PNP, one SW per location across six positions; 5×10^{-3} J incident energy, no nuclei).

Passive cavitation detection (PCD) characterised cavitation dynamics during each exposure. For US treatments, cavitation emissions were recorded with a single-element receiver confocal with the therapy beam, and the detected total electrical energy was used as a quantitative cavitation metric. For SW treatments, a dual-element PCD configuration was employed, with detection paths crossing at the centre of the disc. Cross-correlation of the paired signals enabled estimation of the collapse time of the SW-induced bubble cloud. Biofilm disruption was assessed by fluorescence imaging and quantified by colony-forming unit (CFU) counts to measure viability of bacteria released from the biofilm.

Both US and SW significantly reduced biofilm burden, measured as log-10 reductions in CFU recovered from the discs. The stationary 50-SW treatment resulted in a 3.8-log reduction (95% CI: 3.1–4.5), the scanning 6-SW in a 2.5-log reduction (95% CI: 1.8–3.2), and the scanning US in a 1.2-log reduction (95% CI: 0.8–1.6). Released bacterial aggregates were then exposed to a concentration series of vancomycin and rifampicin at clinically relevant cell densities (10^4 CFU/mL). The minimum inhibitory concentrations (MICs) were 1 μg/mL for vancomycin and 7.5 ng/mL for rifampicin, indicating susceptibility patterns comparable with the MIC against planktonic bacteria.

These findings show that cavitation-mediated detachment not only reduces biofilm burden on implant substrates but also yields bacterial populations susceptible to clinically relevant antibiotics. Overall, this work supports US- and SW-driven cavitation as a promising minimally invasive adjunct in treating implant-related orthopaedic infections.

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Laser-Based Control of the Acoustic Field

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Afternoon Session 6, January 22, 2026, 16:15 - 17:30

Laser ultrasonic techniques provide a unique tool to observe guided elastic waves without contact to the sample. By identifying the measured guided modes, it is possible to assess the mechanical properties of materials in a non-destructive manner. For elastic-wave generation, a laser beam is commonly focused down to a point source that emits waves in all directions and simultaneously excites several modes. However, some modes of interest might not be excited well with this procedure. Increasing the total deposited energy would lead to a better excitation of these modes, but the energy density is limited in order to avoid damaging the material.

One way to overcome this limitation is by carefully adapting the laser source to optimize the generation of a given mode. To that end, we use a continuous-wave (cw) laser whose intensity is modulated at an arbitrary-controlled frequency. We then select the generated wavenumber by shaping the source using a spatial light modulator (SLM). This combination allows us to select specific frequency-wavenumber pairs on the dispersion curves of the sample, thereby concentrating energy into the mode of interest.

In this talk, we present a study on stiffness anisotropy using this setup. In an anisotropic plate, the dispersion curves depend on the propagation direction. With our approach, we control the propagation direction and select specific modes on the corresponding dispersion curves. This will be demonstrated on steel and titanium sub-millimetric-thick plates.

Bounce: An HPC-scale elastodynamic finite element solver for ultrasonic non-destructive testing applications

Matt Chandler[1]
[1]CFMS, United Kingdom

Morning Session 7, January 23, 2026, 09:30 - 11:10

While ultrasonic inspection is a well established and mature modality for non-destructive evaluation, it remains an active area for research and development arising from challenges facing engineers in the current technological landscape. In the aerospace and energy industries, for example, bespoke components are produced for use in situations where safety is critical. Technicians must therefore have a high confidence that any flaws which are introduced in manufacturing or during service will be identified, which requires large quantities of high fidelity data to qualify inspection methods. Further, with an increasing interest in deploying data-intensive processing methods such as machine learning to automate the inspection process, this requirement is compounded.

CFMS have been developing Bounce, an explicit elastodynamic finite element solver to simulate the ultrasonic inspection process. This has been deployed for HPC-scale simulations, evaluating large models on the scale of metres. This has also been used for the generation of large quantities of ultrasonic data for use with ML methods, and to study ultrasonic scattering with embedded flaws. In this talk, an overview of these applications will be discussed.

A Piecewise Random Walk Model for Hydrogen-Induced Cracks

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[1]*University of Bristol, United Kingdom*

Morning Session 7, January 23, 2026, 09:30 - 11:10

As hydrogen becomes increasingly important in global clean energy strategies, ensuring the safety of storage containers and pipelines has become a critical challenge. Hydrogen-induced defects can develop through various mechanisms, including embrittlement, blistering, hydrogen-induced cracking, and high-temperature hydrogen attack. These defects often show complex, branched, and irregular shapes that are quite different from typical fatigue or manufacturing cracks. This paper introduces a procedure to simulate the surface profiles of hydrogen-induced cracks (HICs) using a piecewise random walk model. The procedure first extracts the statistical parameters of the step angle from several realistic HIC profiles across multiple segmented areas. These parameters are then used to simulate numerous crack surface profiles within defined variation ranges. Compared to simplified geometric models, this approach more accurately represents the variability and complexity of HICs. The generated crack profiles can be directly used in finite element models for ultrasonic simulations to investigate how morphological variations influence scattering behaviour and imaging performance. The proposed method offers an efficient and flexible way to build extensive HIC datasets, thereby supporting future studies on structural integrity assessment and the in-situ monitoring of hydrogen storage systems.

Lamb Wave Imaging and Estimation of Defect Scattering Response via the Analysis of Reverberating Coda Waves in Thin Elastic Plates

Elie Farha[1], Lynda Chehami[1], Emmanuel Moulin[1], Nikolay Smagin[1]

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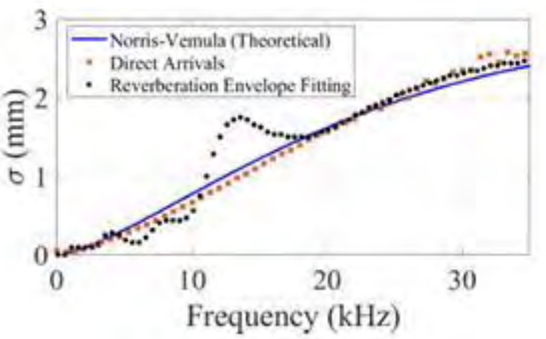
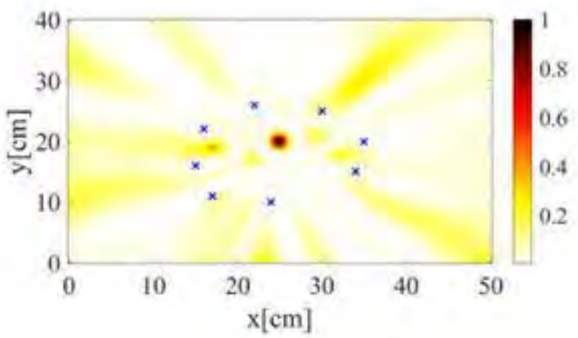
Morning Session 1, January 21, 2026, 11:10 - 12:30

The propagation of acoustic waves in a finite medium with low attenuation results in long-duration measured signals (reverberation). In conventional non-destructive testing and imaging techniques, only the first wave packets are exploited, thus losing the information potentially carried in the reverberation part of the signal. The work presented here aims to exploit the overall behavior of the codas recorded in plate-like structures in order to extract useful information from a limited number of sensors. In previous works, we developed a statistical model that relates the scattering properties (in particular, the scattering cross-section) of a local heterogeneity in a thin elastic plate to the statistical properties of the scattered and reverberated flexural waves. In particular, we showed that the theoretical expression for the average reverberation envelope of the differential signals (with/without defect) is obtained as a function of the scattering cross-section of the heterogeneity (σ). Furthermore, we developed an imaging algorithm for defect localization in plates, taking into account the dispersion of Lamb waves. The work presented here unites these two works and aims to characterise defects using only two parameters: their scattering cross-section obtained from the statistical model and the Weber contrast of the localization image. Numerical validations were performed on cylindrical defects of few millimeters size, exhibiting anisotropic scattering behavior (angle-dependant scattering). To perform the imaging, ultrasonic signals (10-30 kHz, A0 Lamb mode) were also collected at N points placed at arbitrary but known positions on the plate surface. First, the cross section was estimated from the statistical model by applying nonlinear curve fitting over the mean of the envelopes of the reverberated signals (obtained from Finite Element Simulations of elastic wave propagation in the plate) and compared to a theoretical formulation derived from Norris and Vemula's works as well as the classical approach using only direct paths. Next, the Weber's contrast was calculated from the localization images. Finally, a characterisation approach is proposed and addresses the inverse problem by exploiting the scattering response of the defect and the corresponding imaging properties (contrast) by defining a contrast ratio relative to an isotropic defect. Encouraging preliminary results were obtained for several defects of different diameters





A Dexterous Integrated Ultrasonic Array for High Intensity Beamforming in Water

Mary Dysko[1], Iain Sutherland[1], Maryam Basij[2], Holly Lay[2], Martha Turvey[3], Oksana Trushkevych[3,4], Rachel Edwards[3], Paul Reynolds[2], Sandy Cochran[1]

[1]James Watt School of Engineering, University of Glasgow, United Kingdom, [2]Acoustiic Inc., United States of America, [3]Department of Physics, University of Warwick, United Kingdom, [4]School of Engineering, University of Warwick, United Kingdom

Afternoon Session 2, January 21, 2026, 13:30 - 15:30

The spatial light modulator (SLM), a two-dimensional (2D) array of miniature reflective devices used with a laser as a source of energy, holds a key position in photonics through its remarkable ability for beam formation. The closest capability in ultrasonics, combining the functions of the SLM and the laser, has been provided by 2D assemblies of individual air-coupled transducers of the type used commonly in the automotive industry forming phased arrays[1]. Other devices originating in the therapeutic ultrasound domain have also demonstrated interesting results in water [2]. However, these have lacked the element numbers required for truly dexterous beam formation at high intensity for diverse potential applications in fluids and soft solids including acoustic tweezing, exploration of the physics of fluid flows and therapeutic applications such as transcranial treatment.

Here, we report recent work with a prototype commercial phased array (Acoustiic Inc., Bellevue, WA, USA) suitable for many different purposes in beam formation. The array has approximately 5,000 rectangular elements with dimensions close to half the acoustic wavelength at approximately 1 MHz in water. The elements are arranged in modules in a straightforward, flat 2D pattern. Aiding its general applicability, only external DC power supplies are required beyond the device itself, with all the other electronics integrated within a convenient small package ideal for use in many different experimental configurations. With a design intended for therapeutic ultrasound, the output intensity is also in the range needed for acoustic tweezing and intervention in fluid flows.

The intensities of various element configurations were first recorded in water using a radiation force balance (RFB, Precision Acoustics Ltd, Dorchester, UK) with surface displacements recorded in air with laser Doppler vibrometry (MSA-100-3D, Polytec Ltd, Coventry, UK). Subsequently, beam patterns were mapped with thermochromic polylactic acid (PLA) plates and novel liquid crystal films [3]. These patterns were generated using simulations based on simple analytic expressions and algorithms for acoustic holography [4] and included multiple foci, vortices and arbitrary intensity distributions. They were validated using measurements with a needle hydrophone (Precision Acoustics, Dorchester, UK) in a bespoke robotic scanning tank and with particle image velocimetry (PIV).

The results show that the prototype commercial array provides the first practically viable acoustic equivalent of the photonic SLM. It is particularly well matched with the requirements for therapeutic ultrasound and acoustic tweezing, providing a step change in the potential for research in dexterous interventional ultrasonic applications in fluids.

References

[1] A.Marzo and B.W.Drinkwater (2019) “Holographic acoustic tweezers” Proceedings of the National Academy of Sciences 116(1) 84–89

[2] C.E.M.Demore, P.Dahl et al. (2014) "Acoustic tractor beam" Phys. Rev. Lett. 112 (17) Article 174302

[3] O.Trushkevych, M.Turvey et al. (2024) “Acoustic field visualisation using local absorption of ultrasound and thermochromic liquid crystals” Ultrasonics 140 (5) Article 107300

[4] K.Melde, A.G.Mark et al. (2016) “Holograms for acoustics” Nature 537 518-522

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Fourier-Neumann Numerical Models of Acoustic Propagation

__Ben Cox__[1], Bradley Treeby[1], Antonio Stanziola[1], Simon Arridge[1], Jiri Jaros[2]
[1]University College London, United Kingdom, [2]Brno University of Technology, Czech Republic

Morning Session 8, January 23, 2026, 11:30 - 13:00

Computationally efficient single-frequency acoustic solvers have many applications, including in therapeutic and diagnostic biomedical ultrasound. I will describe numerical models we have recently developed based on Neumann series.

Strengthening the UK Acoustic Technology Pipeline

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[1]The Centre for Underwater Acoustic Analysis (CUAA), United Kingdom, [2]The Durham Institute of Research, Development, and Invention (DIRDI), United Kingdom, [3]Coltraco Ultrasonics, United Kingdom

Morning Session 4, January 22, 2026, 11:00 - 13:00

This talk provides a strategic overview of the United Kingdom's acoustic technology landscape, examining the strengths of its research base alongside the opportunities and challenges facing UK industry. It highlights how the UK's world-leading academic work in acoustics can be translated into resilient, sovereign capability that supports key national priorities in defence, offshore energy, infrastructure, and environmental monitoring.

Emerging technologies of particular strategic importance are discussed, including micro-electromechanical (MEMS) hydrophones, acoustic metamaterials, advanced piezoceramic materials, and distributed acoustic sensing (DAS) using fibre-optic cables. Each of these areas exemplifies the UK's strong research and innovation culture, supported by an active network of university spin-outs and specialist small and medium-sized enterprises (SMEs). The talk will consider how these developments can be commercialised more effectively through targeted investment and stronger industry-academia collaboration.

Although the UK now possesses a small but growing on-shore capability in piezoceramic manufacturing, most notably through emerging producers of PZT materials, many components for large-scale instrumentation and systems continue to be sourced from overseas suppliers. Nevertheless, the country benefits from globally recognised testing and validation infrastructure, particularly at the National Physical Laboratory (NPL), which provides world-class metrology and calibration services essential for the qualification of new acoustic systems.

The speaker will propose practical measures to strengthen the UK's position across the full technology pipeline. These include expanding support for small-scale sensor and transducer manufacturing, enabling the scaling up of both established and emerging technologies, and enhancing access to testing facilities in laboratory and operational environments. By aligning academic excellence with industrial capability and supply-chain resilience, the UK can build a sustainable foundation for future leadership in acoustic science and technology.

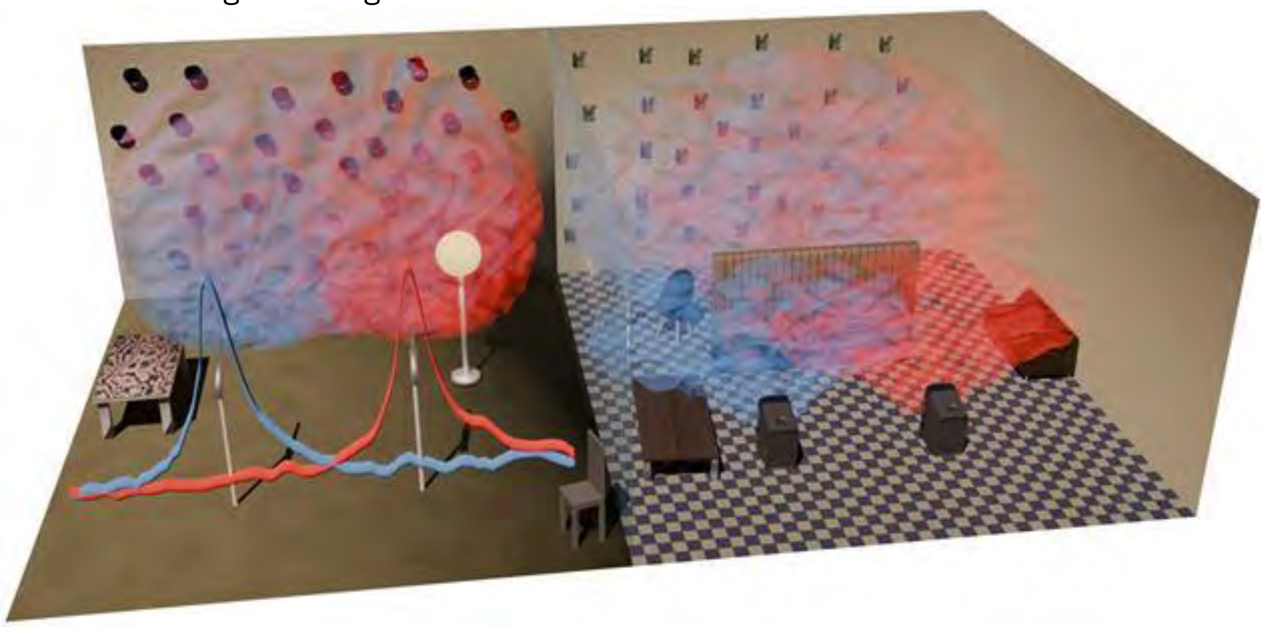
Reconfigurable and active time-reversal metasurface turns walls into sound routers

Florent Dorlot[1], Constant Bourdeloux[1], Fabrice Lemoult[1], Mathias Fink[1]
[1]*Institut Langevin - ESPCI, France*

Afternoon Session 3, January 21, 2026, 16:00 - 17:30

Sound control in noisy or reverberant spaces is crucial for applications ranging from communication to immersive audio, yet existing methods often struggle to deliver sound selectively to specific listeners without interference. We introduce an active acoustic metasurface composed of programmable elements, each functioning as an individual sensing, processing, and emitting unit, that enables precise and adaptive targeting of audio in complex environments. Each unit cell operates as a real-time convolution filter, using prerecorded Green's functions between the emitter, the metasurface, and the receiver to compute temporal filters based on reciprocity and time-reversal symmetry in wave propagation.

To evaluate the performance of this reconfigurable metasurface, we conduct experiments with airborne audible sound inside a reverberant room. The active cells, each integrating a microphone, a speaker, and a microcontroller, implement the predesigned filters in real time to shape the acoustic field dynamically. Our results show that this approach can create clear, individualized sound channels while suppressing unwanted noise, even in highly reflective and cluttered environments. This work expands the possibilities for adaptive sound delivery in crowded or dynamic settings, with potential applications in conferencing, entertainment, and assistive listening technologies.



Reconfigurable Phased Array Acoustic Tweezers for Manipulating Biomedical Samples in Petri Dishes

Barnaby Emmens[1], Bruce Drinkwater[1], Adrian Barnes[1]
[1]*University of Bristol, United Kingdom*

Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Many of the devices that are used to perform acoustic manipulation in the MHz regime use phased arrays and driving electronics designed for imaging. These devices are expensive and have features such as damping/backing layers that make it harder to generate acoustic traps efficiently.

This work describes an accessible, reconfigurable, acoustic tweezing system that can trap and manipulate biological samples in standard laboratory containers such as a petri dish.

A petri dish can be placed on top of the device and is acoustically coupled to a phased transducer array through the device's water chamber (Figure 1). The device requires no specialist tools to assemble and only has two non-standard parts: a single 1--3 piezo-composite plate, with a grid of independent electrodes forming the phased array, and a printed circuit board which manages the electrical connections from the chip to the array controller. The whole device costs less than £500, and the piezo-composite is not soldered into the device making it easy to disassemble, modify and reuse. The device is compatible with holographic acoustic lenses which may be used to modify or improve the fidelity of the native field, which is under-sampled by necessity. The device uses standard connectors so can be integrated with most phased array driving electronics. Here a commercial array controller is used, with a discussion of its limitations and benefits.

The acoustic field generated by the system was measured with a fibre-optic hydrophone and the system's manipulation capabilities were demonstrated by trapping and moving polyethylene microspheres (Figure 2) and SKOV3-GFP spheroids. Furthermore, the forces on the sample are measured by oscillating the petri-dish at different frequencies and tracking the sample as it is dragged through the trap. By comparing the motion of the sample with and without the acoustic trap the drag forces can be balanced against the acoustic forces.

This proof-of-concept work shows how MHz acoustic manipulation can be performed in an adaptable and accessible way and that such devices can be used to handle organic samples, such as the spheroids commonly used in tissue engineering.

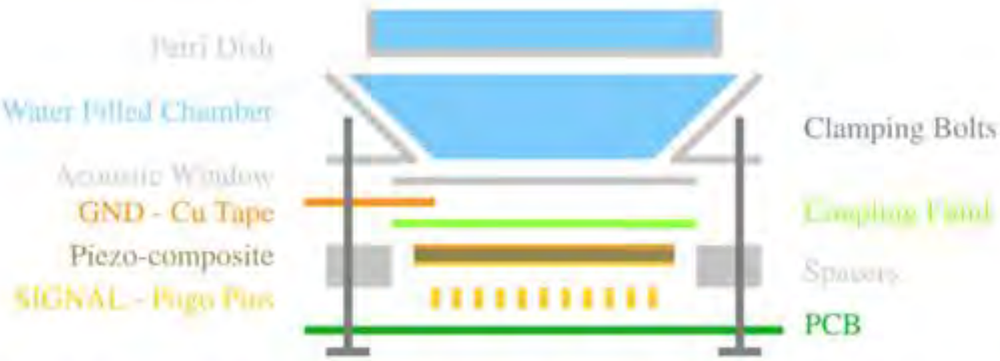


Figure 1: *Exploded view of the transducer and sample container assembly.*

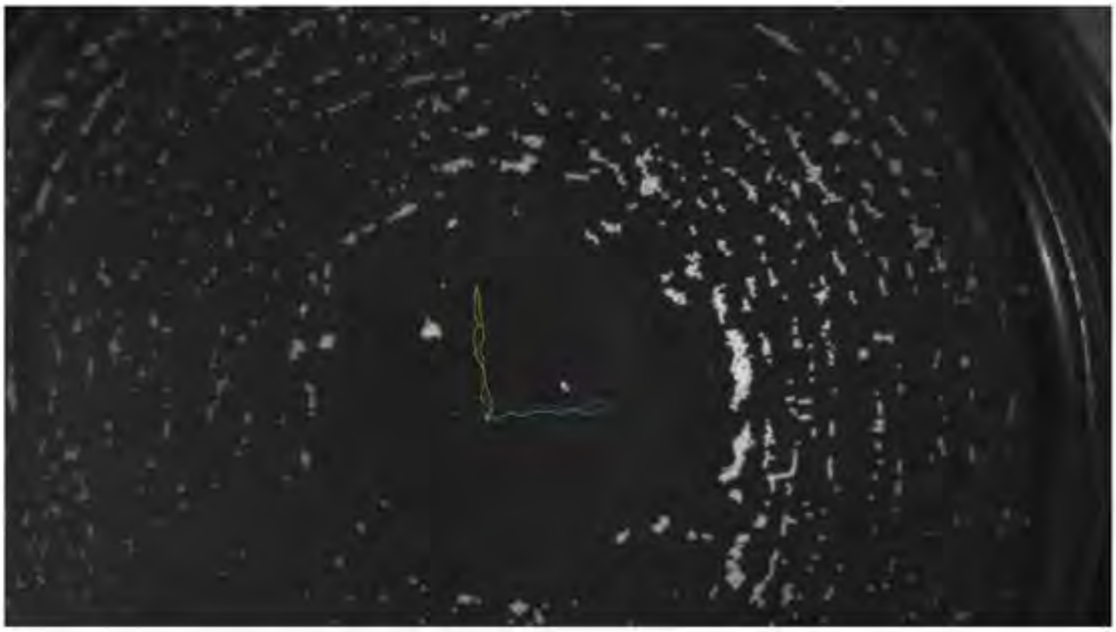


Figure 2: *Trajectory of a trapped polyethylene particle (110µm diameter, 1.05g/cc) as it is moved along the x- and y-axis in 0.5mm steps.*

Using Wiremesh Gratings to mimic Anechoic Environments

Juan Pablo Escudero[1], Jean-Philippe Groby[1], Vincent Pagneux[1]

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Afternoon Session 3, January 21, 2026, 16:00 - 17:30

Anechoic chambers are developed to recreate free-field wave propagation inside a controlled space [1]. These rooms are mainly used to study acoustic phenomena and to characterize sound sources in a precise and reproducible manner [2]. The design challenge of anechoic rooms involves the reduction of material usage while preserving close-to-unity absorption [3]. Additionally, the extension of the cut-off frequency to the lowest possible frequency is challenging due to the poor absorption performance of passive solutions [2, 3, 4]. In this context, the development of acoustic metamaterials has enabled a novel approach to address the low-frequency problem, whereby the absorber size is reduced to a subwavelength scale [5, 6, 7]. In this work, we examine the creation of anechoic environments by using a metamaterial attached to the walls of a room. The metamaterial under consideration is constituted by a periodic layer of an inclined ultrathin resistive sheet [8]. The analysis is conducted with regard to two rooms shapes; square and circular. Furthermore, we study the extension of the room cut-off frequency by using this structure when possessing subwavelength absorption. The study is conducted through numerical computations where the real structure is replaced by an anisotropic medium with effective parameters obtained from the homogenization of the metamaterial. The analysis of the obtained results revealed that the utilization of a circular room design resulted in the most significant outcomes. Moreover, we show that the subwavelength metamaterial absorption extends the cut-off frequency, thereby creating a wide spatial area where the free-field condition is achieved, regardless of the source position. As next step, the enhancement absorption properties of a porous material by embedding a metamaterial will be tested.

References

[1] Leo L Beranek and Harvey P Sleeper Jr. The design and construction of anechoic sound chambers. The Journal of the Acoustical Society of America, 18(1):140–150, 1946.
[2] D Habault, E Friot, Ph Herzog, and C Pinhede. Active control in an anechoic room: Theory and first simulations. Acta Acustica united with Acustica, 103(3):369–378, 2017.
[3] Changyong Jiang, Shangyu Zhang, and Lixi Huang. On the acoustic wedge design and simulation of anechoic chamber. Journal of Sound and Vibration, 381:139–155, 2016.
[4] Xiang Duanqi, Wang Zheng, and Chen Jinjing. Acoustic design of an anechoic chamber. Applied Acoustics, 29(2):139–149, 1990.
[5] J-P Groby, Olivier Dazel, Aroune Duclos, L Boeckx, and Luc Kelders. Enhancing the absorption coefficient of a backed rigid frame porous layer by embedding circular periodic inclusions. The Journal of the Acoustical Society of America, 130(6):3771–3780, 2011.
[6] Vicent Romero-Garcia, Georgios Theocharis, Olivier Richoux, Aurelien Merkel, Vincent Tournat, and Vincent Pagneux. Perfect and broadband acoustic absorption by critically coupled subwavelength resonators. Scientific reports, 6(1):19519, 2016.
[7] Jesus Carbajo, Shahrzad Ghaffari Mosanenzadeh, Seok Kim, and Nicholas X Fang. Sound absorption of acoustic resonators with oblique perforations. Applied Physics Letters, 116(5):054101, 2020.
[8] Juan Pablo Escudero, Jean-Philippe Groby, and Vincent Pagneux. Broadband-omnidirectional absorption using inclined wiremesh gratings. JASA express letters, 5(8):088101, 2025.

Experimental Validation of 2D Laser-Induced Phased Arrays with Poisson-Disk Layouts

<u>**Dr Mohammad Ali Fakih**</u>[1], Sergio Cantero-Chinchilla[1], Anthony J. Croxford[1], Paul D. Wilcox[1]

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Afternoon Session 6, January 22, 2026, 16:15 - 17:30

There is a growing demand for reliable non-contact, non-destructive evaluation techniques that can be operated by machines or robots in remote locations and risk-associated environments. This work presents a novel ultrasound scanning method for large-area inspections using 2D laser-induced phased arrays (LIPAs). The goal is to achieve a desired detection sensitivity with minimal measurements, thereby reducing scan times and data volume. A continuous scanning strategy is adopted, where a detection laser is scanned over a 2D pattern of points that can be extended indefinitely over arbitrarily large inspection surfaces. At each detection point, the generation laser scans a fixed pattern of points within a finite-sized region, referred to as the physical aperture. An A-scan measurement is recorded for each generation-detection combination before the next laser movement. Poisson disk (PD) sampling is employed to define both the physical aperture, relative to a single detection point, and the detection points across the inspection surface. For imaging, all transmit-receive pairs within a certain radius from a region of interest, referred to as the computational aperture, are used to reconstruct the image using the matched-filter total focusing method. Ray-tracing simulations were used to evaluate the approach while comparing PD sampling with regular-shaped grids (square and triangular). PD layouts demonstrated superior performance by maintaining a prescribed level of detection capability with fewer measurements. The results were experimentally validated to confirm the method's effectiveness. During experiments, the scanning paths of both lasers were optimised using heuristic Travelling Salesman Problem approaches to minimise travel distance, therefore, save time and energy. Future work will focus on aperture optimisations and further experimental studies.

Keywords: 2D Laser-Induced Phased Arrays; Large-Area Inspection; Poisson-Disk; Simulation; Experimental Validation.

Characterization of functionnal bio-based polymers for high frequencies medical imaging

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Morning Session 8, January 23, 2026, 11:30 - 13:00

In the context of developing polymer materials for medical imaging, organogels represent a promising alternative for ultrasonic sensors. These materials, used in the form of thin coupling layers, reduce the acoustic impedance mismatch between the transducer and biological tissues, ensuring good transparency to high-frequency ultrasound, which is necessary for obtaining high-resolution medical images. In recent years, polyurethane-type materials have been the subject of a growing number of studies due to their diversity of applications . Their ability to incorporate plasticiser-type additives gives polyurethanes the capacity to modulate their mechanical (elasticity, Shore hardness) and acoustic properties for the intended application. Our work has therefore focused on a polyurethane, used as the matrix for our materials, into which various bio-based plasticisers are incorporated, in line with our eco-responsible approach.

Beyond potential applications, the aim of the work presented is to understand the impact of the formulation of these polymers on the control of thin film properties. This study specifically aims to establish a relationship between the structure of plasticisers and the acoustic and physicochemical properties of materials. To this end, two structural parameters will be studied: i) the length of the central chain (denoted R1) and ii) the length of the side chains (R2).

These variations provide a means of adjusting the microstructure of materials and thus their acoustic properties. Acoustic measurements (impedance, velocity, attenuation) and spectroscopic analyses (FTIR) will help explain the interactions between the matrix and the plasticiser. These results should pave the way for the design of innovative, high-performance and sustainable materials specifically adapted to the needs of ultrasound imaging.

Characterisation and Performance Analysis of Pz29-Based 4 MHz Ultrasonic Transducers for Through-Metal Communication

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Afternoon Session 3, January 21, 2026, 16:00 - 17:30

Achieving reliable data transmission through metallic and other barrier materials remains a significant challenge across multiple domains, including structural health monitoring in aerospace and nuclear systems, as well as secure communication in defence and industrial environments. Traditional electromagnetic-based wireless methods are fundamentally limited by severe signal attenuation due to the Faraday shielding effect, and susceptibility to electromagnetic interference (EMI) in harsh environments. Ultrasound has emerged as a compelling alternative. Acoustic waves can propagate through metallic barriers without physical feedthroughs and are inherently immune to EMI-related disturbances. This work employed custom-designed ultrasonic transducers for ultrasonic propagation through metallic barriers.

This work explores how custom transducer design can maximise acoustic bandwidth and, consequently, data throughput through metallic barriers. Four Pz29-based 4 MHz 35×37 mm2 aperture ultrasonic transducers, two of which incorporated custom-designed matching and backing layers, were characterised through electrical impedance and pulse-echo measurements. The electrical impedance characteristics were measured using an Keysight E4990A impedance analyser. The pulse-echo response was acquired using a 5052PR pulser receiver interfaced to an Agilent Infiniium 54820A Oscilloscope, with the transducers coupled to a 41.04 mm thick planar aluminium test specimen. To address the impact of the ultrasonic transducers on bit-loading performance during signal propagation through metallic barriers, a comprehensive impulse response analysis was performed using a through-transmission configuration in both finite-element simulation, through COMSOL Multiphysics, and experimental studies.

The impedance magnitude and the phase angle spectra exhibited well-defined responses, with the two piezoelectric wafer transducers indicating a clear resonance near 4 MHz, and corresponding phase variations ranging from approximately -84.6° to 81.8°. The pulse-echo analysis revealed well-defined behaviour in both the time and frequency domains. The subsequent evaluation, analysing the impulse response, showed that the simulated results were in good agreement with the experimental data. This work suggests the importance of transducer engineering for next-generation ultrasonic data links in shielded or safety-critical environments.

Propagation of Acoustic Waves in Correlated Systems

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Afternoon Session 3, January 21, 2026, 16:00 - 17:30

Multiple scattering occurs when waves propagate through disordered media. Two distinct components can generally be distinguished: the coherent part, corresponding to the ensemble averaged field, and the incoherent part, corresponding to fluctuations. The coherent wave propagates in the medium as if it was an homogeneous one with effective properties. More precisely, the presence of scatterers results in a modification of the wave speed and additional attenuation (from scattering and absorption). The incoherent part of the wave obeys the diffusion equation if the scattering is not too strong. If the latter augments, then the wave can be localized spatially, a phenomenon known as Anderson localization. Both coherent and incoherent components therefore depend on the scattering strength, which itself depends on the distribution of the scatterers.

There is a growing interest in studying disordered media with structural correlations by introducing position correlations between scatterers. Indeed, it has been shown that correlations can reduce or increase the scattering strength of a disordered medium, with a major focus on two dimensional photonic systems. One of the most exciting type correlated media are called stealth hyperuniform. These media have a scatterer distribution whose structure factor vanishes in the long wavelength limit. This property leads to a transparency regime below a cut-off frequency and the appearance of band gaps above the Bragg frequency. Designing such structures is thus valuable to control the propagation of waves.

In this work, we investigate the influence of spatial correlations between scatterers on different properties of wave transport with numerical simulations. These simulations have shown remarkable agreement with experiments, making them a powerful tool to understand these systems and guide experimental research. We will study both 2D and 3D media, the latter having received much less attention thus far. We will first present studies about the coherent component of the waves, and then discuss the incoherent part by extracting the diffusion coefficient for different degrees of correlations.

Nonlinear guided wave propagation analysis for subwavelength damage imaging

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Morning Session 4, January 22, 2026, 11:00 - 13:00

This work presents numerical and experimental investigations on the generation and the propagation of nonlinear guided waves in isotropic elastic plates, as well as their interaction with a crack-type defect. The study focuses on the second harmonic guided wave (SHGW) of the fundamental symmetric mode in an aluminium plate. Numerical simulations allowed a detailed examination of the influence of excitation parameters and intrinsic material nonlinearity on the SHGW, independent of spurious nonlinearities arising from the instrumentation. Experimentally, excitation was achieved using a calibrated piezoelectric wafer transducer bonded to the plate surface, and detection was performed with a 3D scanning laser vibrometer to enable direct full-field measurement. This allows simultaneous observation of the normal and tangential surface displacements, enabling reliable isolation and analysis of the second-harmonic wave. Both studies confirmed that secondary mode generation is feasible, provided that the phase velocity matching condition is fulfilled and that sufficient power flux exists at the selected frequency for the primary mode. Furthermore, the results demonstrate that high-energy, narrowband excitation signals are required to produce a detectable amplitude above the noise level and to clearly isolate the corresponding signature. In a pristine structure, the secondary mode is considerably weaker than the primary mode. However, this behaviour is reversed in the presence of a defect. The SHGW's energy increases while the fundamental component decreases, in proportion to the severity of the damage. This phenomenon constitutes a highly sensitive indicator for the early detection and characterisation of defects, particularly when examining the tangential displacement component or its combination with the normal component. Moreover, the shorter wavelength of the SHGW, compared to the primary mode, enables it to carry valuable additional information about subtle structural changes and incipient subwavelength damage. These features could enhance the use of nonlinear responses for advanced high-resolution imaging techniques.

Basic physics rules behind a successful sustainable acoustic absorber

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Afternoon Session 3, January 21, 2026, 16:00 - 17:30

There is a growing bulk of research that develops and tests sustainable porous acoustic absorbers made from natural or recycled materials. However, a considerable proportion of this research can be described as 'Acoustic Alchemy', i.e. there are no clear physical rationale presented and/or process followed to achieve the desired absorption for a given layer thickness, material density and formulation. Most of these works are highly empirical and not based on underpinning physics to explain the acoustical performance attained. It is seldom the new sustainable absorbers are benchmarked against commercial products. As a result, so few of these sustainable absorbers have been integrated into mainstream construction practices. This presentation proposes a set of basic physical rules that can, if followed, maximise the absorption performance of any novel material developed from man-made recycled or natural waste. An example is provided to demonstrate how the microstructure of a natural wool mixture can be tuned to achieve the maximum performance with a 30 mm thick porous layer. The Johnson-Champoux-Allard model was used to predict the acoustical properties of the new material. The acoustic absorption coefficient of the wool mixture was compared against a successful commercial product to demonstrate that the new sustainable material is competitive in terms of its optimal layer thickness, density and absorption performance.

Small-scale actuators powered by sound waves travelling through air

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Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Acoustic actuation holds great potential for small-scale robotics, offering advantages such as wireless, non-invasive, material-independent, and biocompatible control. Recent advances in 3D printing have enabled the fabrication of complex microstructures with high precision, opening the door for the development of acoustically powered robotic devices. Cavity structures, such as bubble-based resonators, have been widely used to enhance acoustic actuation through resonance and enable diverse propulsion mechanisms. Spatial selectivity through beam focusing and frequency selectivity allow dexterous micromanipulation and swarm control. However, current research has primarily focused on actuation in water, and the development of airborne devices remains largely unexplored.

This study investigates the feasibility of harnessing acoustic waves propagating in air for small-scale robots. Specifically, we revisit the concept of Helmholtz resonance, wherein the resonant vibration of air within a cavity generates forces that can be exploited for frequency-selective acoustic actuation of objects in air. We propose several strategies for the design and control of small-scale resonators based on a theoretical understanding of acoustic phenomena in air, and validate these concepts through analytical modelling, numerical simulations, and experimental demonstrations. Using advanced 3D printing techniques, including two-photon lithography, we fabricated complex resonator structures from centimetre to micrometre scales. Preliminary results show the feasibility of untethered and controllable motion in air, highlighting the potential for future applications.

Development of a Capacitive Sensor for Shear Wave Elastography of Prostate Tissue

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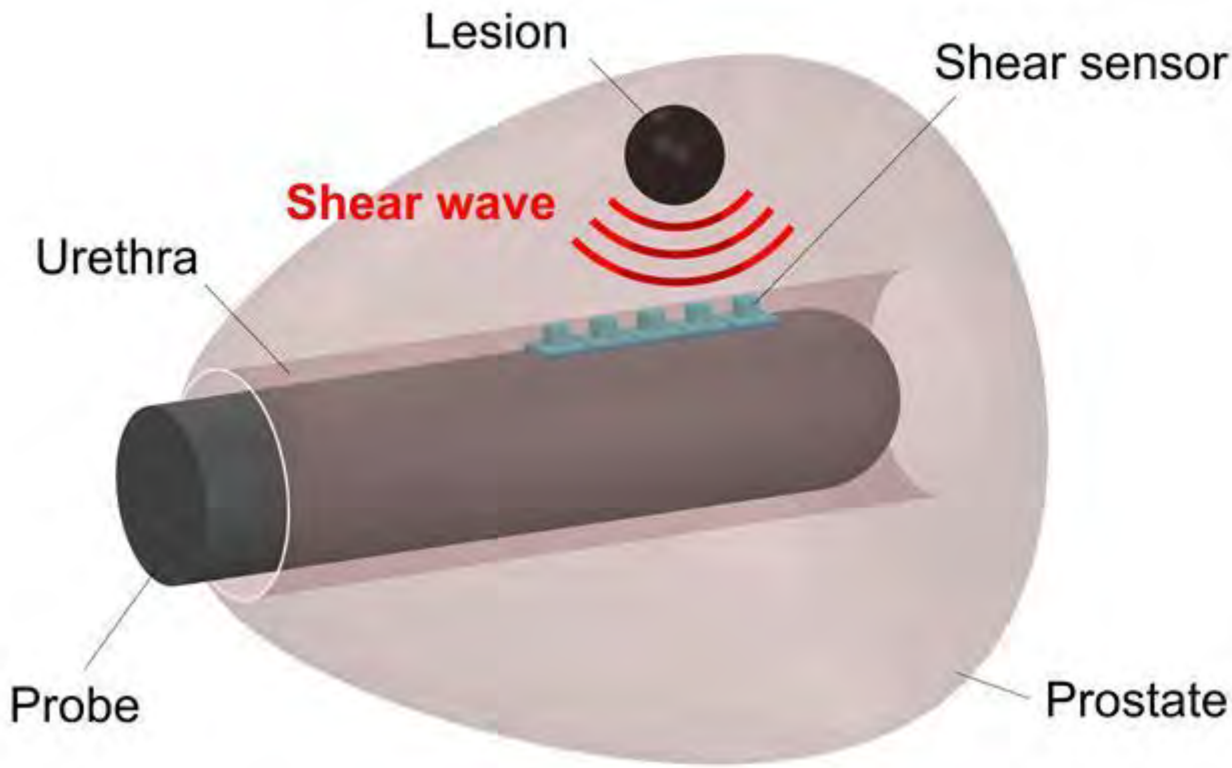
Morning Session 8, January 23, 2026, 11:30 - 13:00

Prostate cancer remains a major global health challenge, ranking as the most common cancer in men in the UK. Current diagnostics and focal therapy monitoring methods face limitations in accuracy, imaging quality, and affordability. Transurethral shear wave elastography (SWE) represents a promising alternative, where both shear wave (SW) generation and sensing occur from within the urethra. Compared with existing transrectal ultrasound approaches, transurethral SWE provides direct access to glandular zones that are otherwise difficult to image, while leaving the rectal canal free for therapeutic procedures such as high-intensity focused ultrasound ablation. Additionally, the reduced acoustic path length lowers attenuation, enabling higher excitation frequencies, thereby improving spatial resolution. Furthermore, the urethral geometry opens the possibility for real-time 3D imaging of the entire gland. To implement this approach, sensors capable of detecting SW at the urethral wall are required.

This work presents the development of a novel capacitive sensor designed to detect SW-induced displacements at soft tissue interfaces. The sensor captures shear motion through a polydimethylsiloxane (PDMS) block, a biocompatible polymer offering acoustic impedance well-matched to biological tissue. This block transmits the lateral motion to the transduction elements, which consist of two parallel-plate capacitors with movable upper electrodes embedded in deformable PDMS and static counter-electrodes fixed on a rigid substrate. When shear strain occurs, one capacitor gap decreases while the other increases, generating a differential capacitive signal proportional to the applied shear displacement. To the authors' best knowledge, this is the first capacitive sensor developed for dynamic shear sensing at soft interfaces.

A proof-of-concept sensor with a 2×2×1.5 mm PDMS interface block was fabricated using simple microfabrication techniques and a modular approach that enables each component of the sensor to be produced independently. The device was dynamically characterised using a mechanical shaker in direct contact with the sensor block, applying continuous sinusoidal excitations from 0 to 1000 Hz with displacement amplitudes between 5 and 200 µm, corresponding to the ranges encountered in SWE. The sensor output tracked the excitation signal across the full frequency range with a linear response to displacement amplitude. Sensitivity showed minimal frequency dependence, with a moderate increase at higher frequencies due to inertial effects. The sensor also reliably captured both multifrequency driving signals, accurately retrieving their spectral content, and transient pulses representative of SWE excitation signals.

These results demonstrate the strong potential of the sensor for SW detection. The sensor's miniaturisable design, tissue compatibility, and dynamic response characteristics make it particularly suitable for transurethral SWE of the prostate. Beyond prostate cancer, this technology holds promise for other transluminal SWE applications, including intravascular tissue assessment and gastrointestinal wall evaluation, as well as direct surface measurements on exposed ocular and cutaneous tissues. Future work will focus on validating the sensor's ability to capture shear waves propagating through tissue-mimicking phantoms and on further miniaturisation of the device.


Lesion
Shear sensor
Shear wave
Urethra
Probe
Prostate

Quantitative Phase Characterisation of Nickel-Based Superalloy Inconel 718 Using Ultrasound

Dr Jennifer Jobling[1], Edward Saunders[1], Stacy Moore[3], Mark Hardy[1], Tim Barden[1], Michael Lowe[2], Bo Lan[2]
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Morning Session 1, January 21, 2026, 11:10 - 12:15

Nickel-based superalloys are widely across the engineering industry, due to their superior mechanical properties at elevated temperatures, and excellent resistance to creep and fatigue under harsh working conditions. The microstructure of the material, influenced by phase composition and grain size, greatly affects these characteristics. Existing methods for material characterisation are destructive, expensive and time-consuming (such as SEM and EBSD), as are techniques for determination of fatigue life of components (which require surface preparation for hardness testing); hence it would be highly beneficial to develop a non-destructive, rapid and reliable method enabling quick inspections for characterising a material's microstructure to assess its suitability for a particular application, or to tailor the properties to optimise a component's design.

A key nickel-based superalloy is Inconel 718, widely used for disc rotor applications in the compressor and turbine of aircraft engines, as well as the disc itself, due to its high strength, fracture toughness, and resistance to corrosion and oxidation. Ultrasound has been shown to have sensitivity to the phases through its wave speeds in a previous qualitative feasibility study (Jobling, et al., 2024). This paper demonstrates the capability of ultrasonic wave speed (UWS) measurements for the quantitative characterisation of delta (δ) phase in the nickel-based superalloy Inconel 718, which is fundamentally due to the zeroth spherical harmonic coefficient of velocity, V00, being sensitive to changes in microstructure. A variety of samples having undergone different processing histories were used for the UWS measurements, alongside extensive metallurgical investigations – including advanced microscopy techniques such as high-speed atomic force microscopy (HS-AFM), as well as hardness testing to fully understand the microstructures of each sample and corroborate the UWS results. By combining the data from these experimental techniques, and through an iterative parameter search, it was confirmed that the V00 measurements could be used to deduce the δ phase content in the Inconel 718 samples; more significantly, the strength of a combined materials characterisation framework – incorporating UWS measurements, hardness testing and microscopy – was demonstrated, establishing a powerful tool for the phase characterisation of nickel-based superalloys for the future.

References

Jobling, J. H. et al., 2024. A feasibility study on phase characterisation of nickel-based superalloys using ultrasound. NDT&E International, Volume 145, p. 103120.

X-ray and Ultrasound-Based Multiphysical Study of Bone' Breakage and Archaeozoology Application.

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Morning Session 1, January 21, 2026, 11:10 - 12:15

During the Paleolithic, the bone marrow of herbivores constitutes a vital resource for human groups, especially during cold or periglacial contexts. Break the long bones of their prey (humerus, radius-ulna, femur, and tibia) to extract these essential nutritional and domestic byproducts is a frequent activity in many human societies. This behavior is well documented in many hunter-gatherers' settlement, from Paleolithic to recent time with ethnographic studies. The analysis of bone breakage patterns stands a major data point for identifying game exploitation strategies, including the consumption and processing of ungulates by prehistoric peoples. It allows a better understanding of their cognitive abilities, technical skills, and socio1economic behaviors, as well as a precise determination of site functions. However, to have a better resolution of this breakage process, it is imperative to have a thorough knowledge of the mechanical properties of the exploited material. In this study, we have analyzed 133 fragments of bovine (Bos taurus) from a corpus of 80 fractured long bones as part of an experimentation (IRN 0871 TaphEN) and an archaeological corpus of 56 long bone's remains of Bison from a 161+/-14 kyr site: Coudoulous I level 4 (Lot, France). The fragments were analyzed according to three non-destructive methods: mass density, ultrasonic interferometry and micro-CT scanner. Through these various analytical protocols (LMA, Marseille), quantitative data regarding the morpho-structural properties of bones (density, porosity, acoustic velocity, impedance) have been obtained, highlighting intra- and inter-bone variability depending on different diaphyseal areas or bone portions. First results show that the radius-ulna is the most porous bone with low mass density; while the femur being the opposite: its compact structure promotes cleaner fractures. Archaeological remains are more porous with a significative low ultrasound velocity yet much high mass density, showing the influence of the bone fossilization process. This original and unprecedented multiphysical approaches in this field enhances our understanding of bone breakage. The objective of our study will be to further develop this cross-disciplinary and collaborative work to better understand the breaking techniques used by prehistoric peoples and to better identify taphonomic biases (post-depositional preservation) by analyzing a corpus of fresh, dry, and fossil long bone fragments. The combination of actualistic, quantitative, experimental studies, based on modern and archaeo-paleontological remains, will allow for high-resolution analytics on human subsistence strategies thanks to a better understanding of 'bone' material.

Keywords: long bones, breakage, ultrasound, X-ray micro-tomography, morpho-structural properties

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Assessing the Variability of Textured Piezoceramics: Comparison with Hard Piezoceramics for High-Power Ultrasonic Applications

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Morning Session 7, January 23, 2026, 09:30 - 11:10

Templated grain growth (TGG) used in the manufacturing of textured piezoelectric ceramics provides improved control over the alignment of the grain structure compared to non-textured alternatives [1]. The resulting grain orientation increases the electromechanical coupling factor and reduces internal losses, enabling higher power densities and lower hysteresis, making these materials ideal for high-power applications such as ultrasonic surgical tools.
Whilst offering performance advantages, the TGG process introduces additional complexity into manufacturing. The template distribution, sintering conditions and grain growth process create opportunities for defects, which can lead to incomplete alignment or microstructural heterogeneity. Textured materials may therefore exhibit greater variability in material properties and performance compared to conventional hard piezoceramics, where well-established manufacturing methods are used.
Understanding the material variability is crucial for applications in high-power ultrasonic surgical tools, in which operation requires extremely high quality factors, leading to the need for precise understanding of material properties. Inconsistency can lead to uneven field distribution, localised heating, and mechanical fatigue during operation, reducing device performance and durability. The research reported here focuses on comparing the variability of TGG and conventional hard piezoceramics for high-power applications.
The methodology involved an analysis of piezoceramic ring samples from three suppliers: PBaS-4 (Zibo Yuhai Electronic Ceramic Company Ltd., Shandong, China) and PIC181 (PI Ceramics, Lederhose, Germany) hard piezoceramics, and T4001 textured ceramics (CTS Ferroperm, Kvistgaard, Denmark). All samples were manufactured with consistent baseline dimensions. The dimensional measurements of each specimen were taken using a micrometre and optical measurement techniques to account for geometric variability. The piezoelectric charge coefficient of the samples (d_{33}) was determined using a Berlincourt meter. Impedance spectroscopy was measured using an impedance analyser to evaluate the resonant modes. An optimisation algorithm was developed, which used finite element analysis to determine the effective material constants based on an inversion process using impedance spectra of individual samples. All these data enabled analysis of the variability of the piezoelectric coefficients for each material.
The preliminary results indicated that the textured T4001 ceramics exhibit greater variability in their electromechanical properties than the hard piezoceramics, PBaS-4 and PIC181. The measured material parameters revealed increased variance in elastic compliance, electromechanical coupling and dielectric permittivity among the textured samples. This suggests that the microstructural nonuniformities introduced during the TGG process have a measurable effect on macroscopic consistency. Impedance analysis further showed that the textured ceramics had a higher density of resonant modes in addition to the primary thickness and radial modes. These spurious modes led to more complex impedance spectra, indicating stronger mode coupling and potentially higher losses.
The observations confirm the sensitivity of textured materials to process-induced variability. These effects required further study for high-power ultrasonic transducer applications. Future work will focus on assessing how the variability in material properties influences device performance and long-term stability.
[1] J.Wu, S.Zhang and F.Li (2022) “Prospect of texture engineered ferroelectric ceramics” Appl. Phys. Lett. 121 Article 120501.

Theoretical and experimental investigation of elastic wave propagation in a multi-wire cable

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Morning Session 4, January 22, 2026, 11:00 - 13:00

Metallic multi-wire cables are critical components of modern day infrastructure, including, among others, transmission networks, bridge structures and telecommunication masts. Ultrasonic methods hold significant potential among inspection techniques, as they effectively detect defects even in zones with limited access. However, non-trivial inter-wire contact effects, stemming from the twisting morphology and potential applied tension, complicate the behavior of traveling waves, hindering straightforward measurement interpretation. Accurate wave propagation modeling is therefore essential to capture the underlying mechanics and enhance the effectiveness of these techniques.

Various analytical and Finite Element (FE) modeling methods have been proposed to analyze the behavior of multi-wire cables, with FE dominating primarily due to the non-trivial morphology. The contact state is usually explored in static studies, while dynamic studies stress the significant impact of contact effects on wave propagation. Using the Semi Analytical FE (SAFE) method, that utilizes a discretized cross-section and an analytical in-axis description, experimentally observed effects were successfully captured on the 7-wire strand, the "6 peripheral + 1 core" fundamental building block of more complex assemblies. However, the intricate morphology and non-trivial contact interactions significantly increase numerical cost. Even though some special more complex cases can be addressed, available methods are largely limited to cables comprised of few wires.

More recently, a simplified closed-form alternative was proposed, where wires are treated as masses interconnected via Hertzian springs, in a 2D framework. The present study extends this paradigm, aiming at improved modeling accuracy for elastic wave propagation in the 7-wire strand, emphasizing on contact effects. Longitudinal motion is represented via Timoshenko beam theory enriched with Poisson effects. Resulting dispersion curves exhibit good agreement against a reference FE solution over a useful low-frequency regime (Fig.1), while slashing computational expense by three orders of magnitude. Force and energy diagnostics further partition modal families by their contact dependence, enhancing physical intuition.

The primary source of complexity regarding wave propagation stems from contact effects, with associated parameters, crucial for accurate modeling, currently not fully understood. In order to assess them, comparison with experimental findings is carried out, putting underlying contact-related assumptions to test. The "notch frequency" effect, where complex merging of propagating modes in the strand manifests as a tension-dependent band of missing frequencies, is used as a proxy, compared against simple theoretical predictions. The current model successfully captures certain aspects concerning contact behavior, though no general agreement can be claimed across cases. Modeling accuracy is discussed across frequency regions and tension levels, while different contact scenarios are explored to improve understanding of the underlying mechanisms. Significant dependence on cable conditions (grease/no grease), suggests a modification of the current contact model is likely to improve accuracy. In summary, the method shows promise as a computationally frugal yet accurate platform for guided-wave analysis in multi-wire cables, well-suited to further investigate complex contact effects and dispersion characteristics in more complex assemblies.

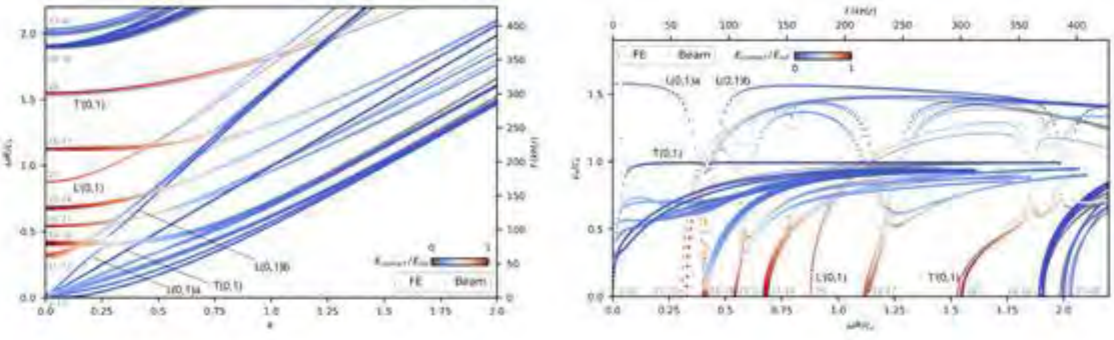

Figure 1: Dispersion relations for the 7-wire strand: *left*: wavenumber - normalized angular frequency, *right*: normalized angular frequency - energy velocity (c_s:shear velocity, R:wire radius). Reference FE solution - gray; simplified method - warm: contact-, cold: strain-dominated. Numbers for lowest 40 cut-off modeshapes, along with labeling of characteristic modes.

Experimental Demonstration of Acoustic Levitation in High-Pressure Regions Using Zero-Order Bessel Beams

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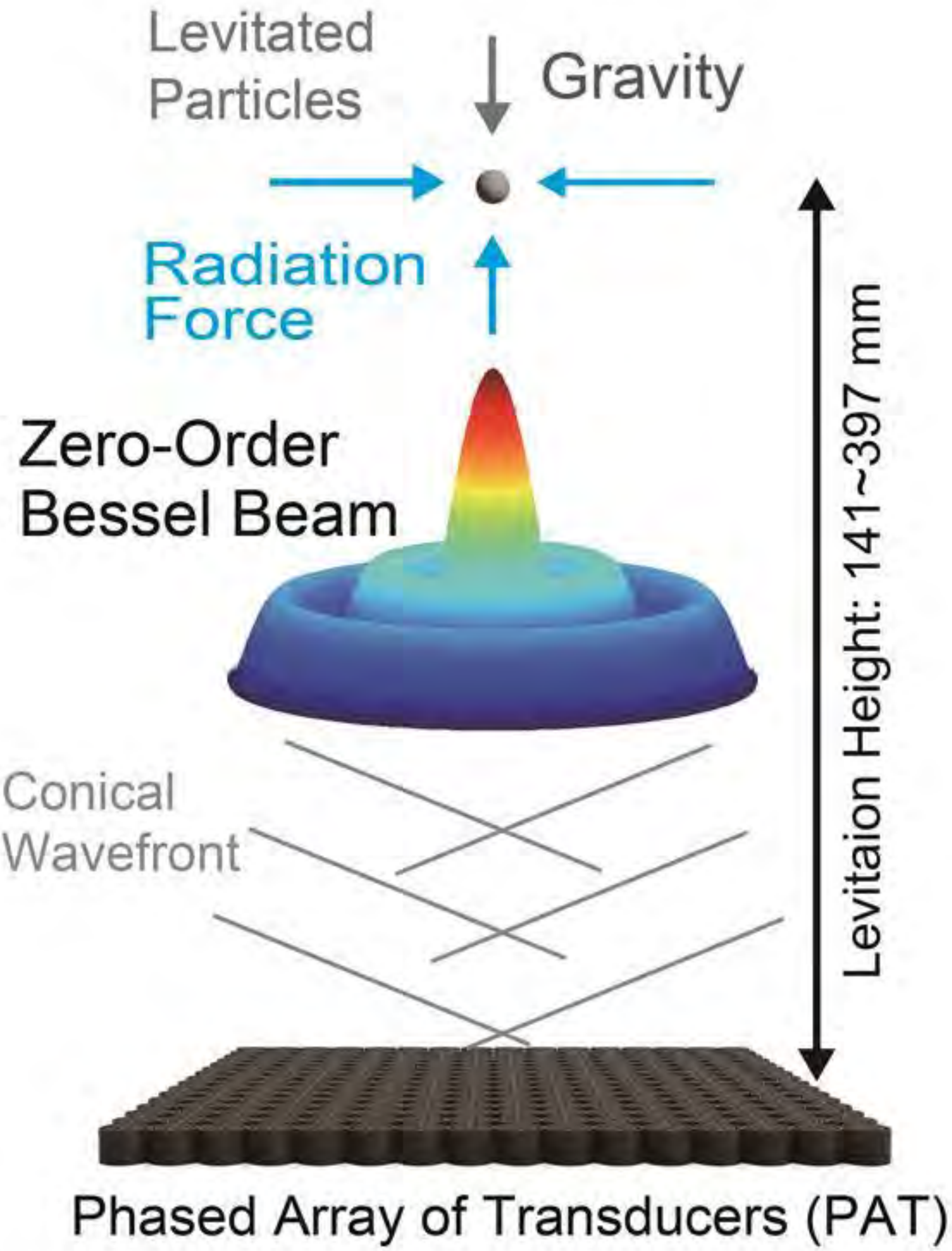
Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Acoustic levitation enables non-contact manipulation using sound waves, benefiting applications from laboratory automation to volumetric displays and additive manufacturing. The prevailing paradigm levitates objects at pressure nodes (zero-pressure regions surrounded by high-pressure) as demonstrated in standing waves and single-sided twin, vortex, and bottle traps. While levitation in high-pressure regions has been theoretically predicted, stable three-dimensional trapping has remained experimentally infeasible. This work presents the first experimental demonstration of stable acoustic levitation within the high-pressure axial core of a single-sided zero-order Bessel beam in mid-air. We generated zero-order Bessel beams using a 16×16 phased array of transducers (PAT) operating at 40 kHz. Numerical calculations revealed that for expanded polystyrene (EPS) spheres (radius 0.75 mm), the transverse force provides lateral confinement despite the on-axis pressure maximum. This restoring force arises when the cone angle falls below a critical threshold (26.8° for EPS in air), where the velocity-gradient term dominates over the pressure-gradient term in the Gor'kov potential. Axially, the upward radiation force counteracts gravity, establishing equilibrium at approximately 192 mm when accounting for radiation force alone, or 207-249 mm when including acoustic streaming effects. Experimentally, particles were stably levitated at 220.4 mm (25.8λ) for the entire 60 second observation period across 15 independent trials. The trap supports real-time three-dimensional position control through beam tilting (horizontal translation at 5.7 cm/s) and cone angle modulation (vertical translation at 4.3 cm/s). The working range extends to 97.7 mm (11.5λ) horizontally and 141-397 mm (16.5-46.6λ) vertically, nearly six times the maximum height of conventional twin traps (67 mm). Multiple particles were simultaneously levitated using acoustic Dammann gratings for parallel trapping and bottle trap configurations for vertical alignment. The Bessel beam's diffraction-free and self-healing properties enabled levitation through a 50 mm cube obstacle, with boundary element method simulations confirming pressure field reconstruction beyond obstructions. The trap also successfully levitated non-spherical objects including dried tea leaves, silica aerogel, and potato starch disks. This work establishes a novel mode of acoustic levitation distinct from conventional low-pressure entrapment, demonstrating that high-pressure regions can provide stable three-dimensional confinement. Our findings open new pathways for long-range acoustic manipulation in open environments, free from the geometric constraints of standing wave configurations. These results challenge the established paradigm that mid-air levitation requires pressure nodes, establishing foundational design principles for future single-sided acoustic manipulation systems.


Levitated
Particles
Gravity
Radiation
Force
Zero-Order
Bessel Beam
Conical
Wavefront
Levitaion Height: 141~397 mm
Phased Array of Transducers (PAT)

Estimation of phase response and uncertainty in ultrasonic hydrophones

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Morning Session 7, January 23, 2026, 09:30 - 11:10

Accurate characterisation of the acoustic output of ultrasound transducers is critical for ensuring the safety and efficacy of medical procedures and meeting regulatory standards. Hydrophones are widely employed in biomedical ultrasound to measure acoustic pressure waveforms. While traditional assessments focus on magnitude response, precise waveform reconstruction — necessary for determining peak compression and rarefaction pressures — requires phase information. However, phase measurements are highly sensitive to variations in source-to-hydrophone path length and water temperature, leading to significant distortions. In linear, time-invariant systems, phase can be inferred from the magnitude spectrum using the minimum phase approach.

This study presents a procedure for estimating the phase response and its associated uncertainty in ultrasonic hydrophones. The phase is computed from a preconditioned magnitude spectrum using the minimum phase method. Uncertainty propagation techniques are applied to quantify phase uncertainty based on magnitude spectrum variability. Additionally, a machine learning model predicts uncertainty introduced by applying the minimum phase approach to band-limited magnitude spectrum.

Results demonstrate strong agreement between predicted and reference phase responses and uncertainties. The proposed methodology enables reliable estimation of phase and its uncertainty, facilitating accurate calculation of key acoustic parameters (such as the mechanical index) and their expected variability, particularly in therapeutic ultrasound applications.

Acknowledgements:
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Reference:
Hasan Koruk, Srinath Rajagopal, William Vale, Andrew M. Hurrell, Predicting hydrophone phase and evaluating its uncertainty using magnitude data and minimum phase approach, Ultrasonics, 159, 2026, 107884, https://doi.org/10.1016/j.ultras.2025.107884.

Self-adaptive extraction of the geometric and acoustic properties of the skull for transcranial ultrasound imaging

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Morning Session 8, January 23, 2026, 11:30 - 13:00

The performance of transcranial ultrasound is limited by the geometric complexity and heterogeneous internal structure of the skull bone, which induce attenuation and distortion of the ultrasound beam. These phenomena reduce resolution and signal-to-noise ratio, thereby affecting the quality of the obtained images.

A first proof of concept for correcting these aberrations was proposed during the H2020 Attract EchoBrain project, using a phased-array transducer with adapted delay laws, assuming a homogeneous and isotropic medium for the skull bone. However, this approach relies on Computed Tomography (CT) of the skull to obtain its geometrical description and to estimate the density and wave speed of the homogeneous medium. Eliminating the dependency on external imaging modalities would enhance the accessibility and portability of this technique, making it more practical for clinical use.

This study presents a self-adaptive approach to directly extract the geometrical and acoustic properties of the skull using Full Matrix Capture (FMC) acquisition, which consists in recording a set of NxN elementary signals Sij(t), where (i, j) is a transmit and receive element combination and N the number of elements. First, the external surface of the skull is reconstructed using the Total Focusing Method (TFM) applied in the coupling medium. TFM is an advanced post-processing imaging algorithm ensuring a coherent summation of FMC signals at every point of a region of interest. Then, to estimate the internal surface of the skull, a second TFM image is reconstructed, taking into account the external surface and assuming a homogeneous and isotropic skull model. An optimization loop is applied to the propagation speed in the skull to maximize the similarity between the reconstructed profile and a reference profile obtained from CT, which serves solely as a gold standard for validation.

To quantitatively evaluate the accuracy of the proposed aberration correction, a reference measurement protocol based on wire imaging is implemented. First, a reference TFM image is reconstructed from a FMC acquisition on a set of thin wires immersed in water, without any skull. Next, the skull is positioned between the probe and the wires to mimic transcranial conditions, and a single FMC acquisition is performed. From this dataset, two images are reconstructed: one ignoring the skull, as if the wires were imaged directly in water, and a second incorporating the skull geometry and acoustic parameters estimated by our self-adaptive method, and a second. Comparing these transcranial images to the reference water-only image allows an objective assessment of the correction performance. Metrics considered include positional accuracy, spatial width at half maximum (SWHM), and signal-to-noise ratio (SNR), providing complementary indicators of beam focusing and overall image quality.

Experiments will be conducted on degassed human skulls immersed in a water tank, using a linear probe (3–5 MHz) and a six-axis articulated arm coupled to a navigation system. The evaluation will focus on the reproducibility of results and the robustness of bone surface reconstruction. Acquisitions will be performed with and without aberration correction, enabling a comparative analysis of performance in terms of resolution, location and signal-to-noise ratio.

Insights into a multi-frequency coded excitation method for enhanced morphometric ultrasound computed tomography

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Morning Session 8, January 23, 2026, 11:30 - 13:00

Medical B-mode ultrasonography is routinely employed for pediatric musculoskeletal assessments. However, despite its clinical utility, the accurate evaluation of bone structures - such as the cortical shell, underlying medullary tissue, or bone marrow - often necessitates the use of more restrictive X-ray imaging modalities. Extensive research has been devoted to ultrasonic imaging of bone [1], primarily aiming to assess cortical thickness in both axial and transverse planes and/or to estimate the speed of sound through the bony structure. The present study focuses on transverse-plane imaging using reflection-mode ultrasound computed tomography (R-USCT), a technique well-suited for soft tissues with comparable acoustic impedances. In the context of bone imaging, however, significant challenges arise due to the high acoustic impedance mismatch at bone interfaces, which alters ultrasonic wave propagation and typically results in a low contrast-to-noise ratio (CNR). These limitations underscore the need for advanced signal processing methodologies. To address this, our group has developed a wavelet-based coded excitation (WCE) technique [2], [3], [4], designed to exploit the full time-frequency information content of ultrasonic signals. The objective of the current investigation is to evaluate the feasibility of the WCE method for enhancing the CNR in R-USCT. The WCE approach is further combined with inverse filtering to improve the visualization of organ morphometry [5]. Experimental validation is conducted using an ex vivo chicken drumstick model and a newborn arm phantom. And the potential benefits of the WCE method are discussed.

[1] P. Laugier and Q. Grimal, Eds., Bone Quantitative Ultrasound: New Horizons, vol. 1364. in Advances in Experimental Medicine and Biology, vol. 1364. Cham: Springer International Publishing, 2022. doi: 10.1007/978-3-030-91979-5.
[2] P. Lasaygues, A. Arciniegas, L. Espinosa, F. Prieto, and L. Brancheriau, “Accuracy of coded excitation methods for measuring the time of flight: Application to ultrasonic characterization of wood samples,” Ultrasonics, vol. 89, pp. 178–186, Sept. 2018, doi: 10.1016/j.ultras.2018.04.013.
[3] M. Loosvelt and P. Lasaygues, “A Wavelet-Based Processing method for simultaneously determining ultrasonic velocity and material thickness,” Ultrasonics, vol. 51, no. 3, pp. 325–339, Apr. 2011, doi: 10.1016/j.ultras.2010.10.006.
[4] K. Metwally, E. Lefevre, C. Baron, R. Zheng, M. Pithioux, and P. Lasaygues, “Measuring mass density and ultrasonic wave velocity: A wavelet-based method applied in ultrasonic reflection mode,” Ultrasonics, vol. 65, pp. 10–17, Feb. 2016, doi: 10.1016/j.ultras.2015.09.006.
[5] E. Doveri, L. Sabatier, V. Long, and P. Lasaygues, “Reflection-Mode Ultrasound Computed Tomography Based on Wavelet Processing for High-Contrast Anatomical and Morphometric Imaging,” Appl. Sci., vol. 11, no. 20, p. 9368, Oct. 2021, doi: 10.3390/app11209368.

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Numerical Characterisation of Elastic Wave Propagation in Fibre-Textured Polycrystals: Example of Complex-Valued Stiffness Evolution with Microstructural Parameters

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Morning Session 1, January 21, 2026, 11:10 - 12:15

The study of elastic wave propagation in polycrystalline media and the modelling of the associated scattering phenomena has experienced renewed interest over the past decade. This resurgence is largely due to advances in computational capabilities, which now allow Finite Element (FE) simulations on microstructures large enough to be statistically representative of the studied material. These approaches have enabled the analysis of complex polycrystalline media with varying anisotropy factors and have allowed comparisons with existing analytical models.

Many studies have focused on estimating the evolution of the wavenumber across frequency regimes for untextured media and for coherent longitudinal waves polarised along the propagation direction. More recently, the extension to shear wave analysis has led to a full numerical characterisation of an effective isotropic medium. At the macroscopic scale, these effective properties can be directly used in numerical approaches (such as high-order FE or high-frequency ray methods) to simulate ultrasonic testing (UT) of components whose dimensions are large compared with the characteristic grain size of the microstructure. However, when applied to textured polycrystalline media, most existing studies remain limited to propagation along a symmetry axis. The modelling and extraction of modal solutions become more complex when three coherent wave fronts can be simultaneously observed. Considering a fibre-textured medium characterised by an Orientation Distribution Function (ODF) following a Gaussian law around the main fibre, we have recently developed an original method to handle such microstructures. Through a characterisation procedure analysing the behaviour of wave fronts in various directions, we have obtained an effective transversely isotropic anisotropic medium that minimises discrepancies with estimated complex-valued wavenumbers. The present work investigates the evolution of the complex-valued components of the stiffness tensor with respect to the Gaussian ODF parameter, and highlights potential applications for determining the properties of austenitic welds and coatings in UT simulations and imaging.

From the simulation of guided wave propagation in rolled plates subjected to stress to the tomographic reconstruction of stress distributions

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Morning Session 4, January 22, 2026, 11:00 - 13:00

A model to predict guided wave (GW) modes in plates subjected to multiaxial stress has been developed, assuming an isotropic initial state of the plate [1]. In this previous study, acoustoelastic effects generated by residual stress were shown to lead to measurable wavespeed variations. By a tomographic inversion on these variations, stresses (in-plane, out-of-plane) could me mapped [2].
The model has been extended to deal with a reference state being elastically anisotropic due to rolling. A SAFE-like calculation allows the prediction of guided modes in a rolled and stressed plate. This model has been further combined with a model of GW radiation by finite-sized sources in anisotropic plates [3] so that transducer diffraction effects and bandwidth effects on the radiated field can be predicted.
First, a comparison of its predictions for several combinations of initial anisotropy and applied stress with finite element simulations [4] is carried out. The two modelling approaches being very different, the perfect superimposition of results obtained using the two models cross-validates them.
Then, the SAFE-like model for GW modes in rolled and stressed plates is used to carry out a parametric study. Specifically, we study the wave speed variations as a function of the direction of propagation (at a given frequency) between the case of a stressed plate and that of an unstressed one. These variations are then fitted by simple analytical functions that can be easily inverted and used as a basis for tomographic reconstruction of stress distributions in a plate. The elastic initial anisotropy due to rolling leading to caustics for SH0 modes, some ranges of propagation direction cannot be used in the tomographic inversion, whereas qS0 and qA0 speed variations can be successfully used (as in the isotropic case) for mapping nonuniform stress distributions.

[1] A. Abderahmane, A. Lhémery and L. Daniel, "The effect of multiaxial pre-stress on Lamb and shear horizontal guided waves," J. Acoust. Soc. Am. 149 (2021), pp. 1724-1736.
[2] A. Abderahmane, A. Lhémery and L. Daniel, "Stress imaging by guided wave tomography based on analytical acoustoelastic model," J. Acoust. Soc. Am. 151 (2022), pp. 2863-2876.
[3] J. Barras and A. Lhémery, "Modal pencil method for the radiation of guided wave fields in composite plates of finite size," NDT&E Int. 126 (2022), 102598.
[4] A. Dalmora, A. Imperiale, S. Imperiale and P. Moireau, "A time-domain spectral finite element method for acoustoelasticity: Modeling the effect of mechanical loading on guided wave propagation," Wave Motion 129 (2024), 103328.

A miniature ultrasonic surgical device based on a flextensional configuration with a pre-stressed PZT stack

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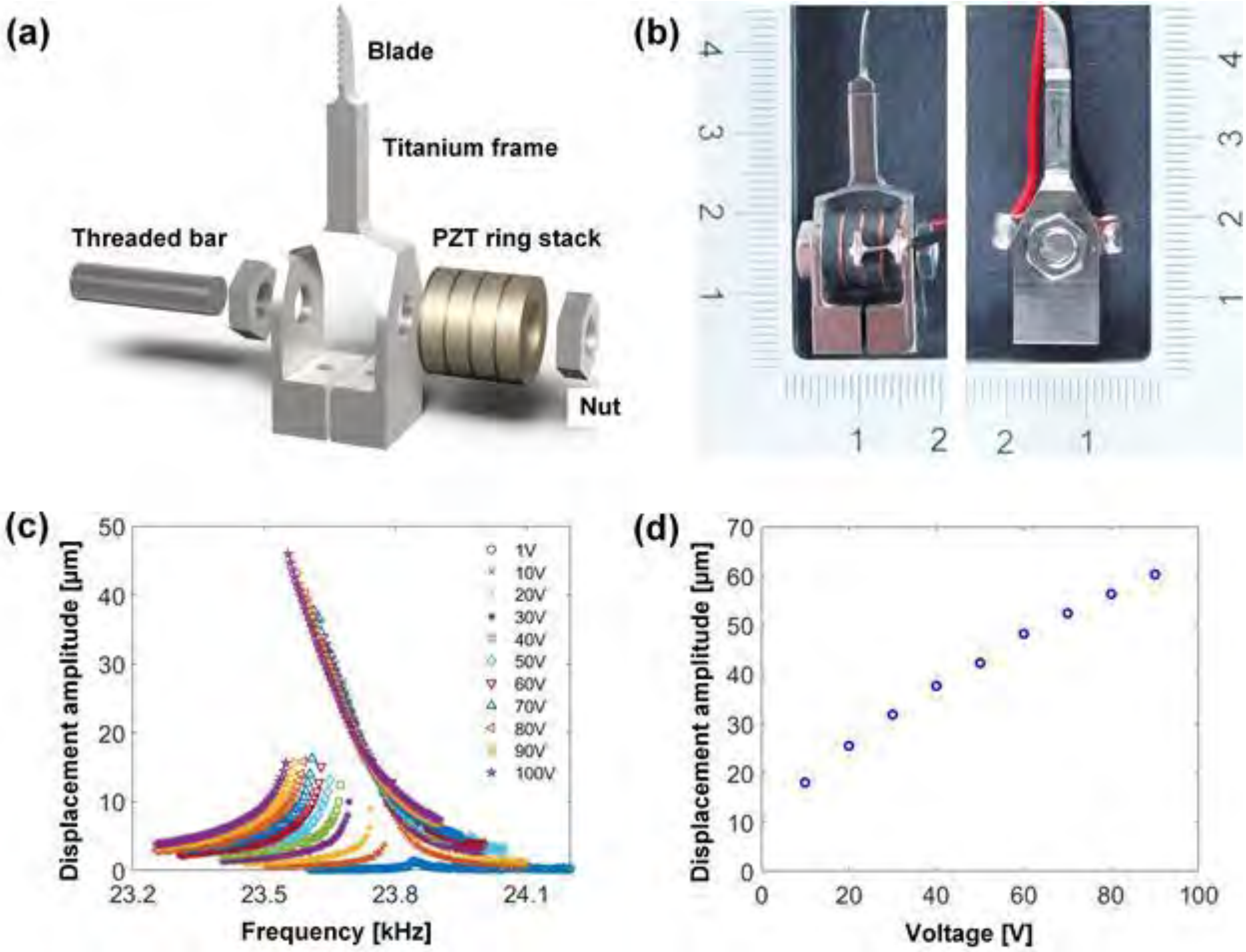
Morning Session 7, January 23, 2026, 09:30 - 11:10

Ultrasonic surgical devices are generally based on a bolted Langevin transducer (BLT), which consists of a pre-stressed piezoceramic ring stack, two end masses and a cutting insert. The BLT device must be operated in resonance to achieve sufficient displacement amplitude at the surgical tip, which imposes geometrical constraints on the design. Flextensional transducers have emerged as an alternative, which additionally have potential to allow for miniaturization of the device for minimally invasive surgeries and integration with surgical robots. However, flextensional transducers generally contain a low volume of PZT and are prone to failure at the bonding layer; both limit the achievable excitation level. This work presents an innovative flextensional transducer configuration of a surgical device, where the vibration amplifying metal caps are excited by a pre-stressed PZT stack.

A surgical device prototype was designed using finite element analysis (FEA) as shown in Fig. 1, aiming for an operational frequency in the region of 23 kHz. The final prototype is created as a single piece frame, with a serrated cutting blade on one side and a balancing back mass (with a cut through) on the other side. The cut ensures that the PZT stack vibrates axially without bending, the blade can achieve required displacement amplitude, and the device can integrate with a surgical robot without loss of vibrational amplitude at the blade. The device is characterized using impedance analysis, experimental modal analysis, harmonic analysis, and measurement of tip vibrational amplitude, facilitated by a resonance tracking device and an impedance matching circuit. Tissue cutting tests on ex-vivo porcine bone material at different displacement amplitudes and cutting speeds were carried out using an automated experimental platform, measuring cutting force, temperature, power, and electrical impedance.

Results show that the vibration response at the tip of the blade exhibits a slight softening nonlinearity but achieves 46 μm peak-peak amplitude at 23.5 kHz at 100 Vrms. With the implementation of an electrical impedance matching circuit, the displacement amplitude under continuous drive conditions is >50 μm at 100 Vp-p. This prototype demonstrated dissection of porcine bone material effectively with performance comparable to a much larger device based on a BLT.


(a)
Blade
Titanium frame
Threaded bar
PZT ring stack
Nut
(b)
(c)
Displacement amplitude [μm]
Frequency [kHz]
1V
10V
20V
30V
40V
50V
60V
70V
80V
90V
100V
(d)
Displacement amplitude [μm]
Voltage [V]

Ultrasonic Interferometry for the characterization of localized porosity in stratified composites

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Morning Session 1, January 21, 2026, 11:10 - 12:15

The use of laminated composites, such as carbon fiber reinforced polymers (CFRPs), is common in the aerospace industry due to their low weight and excellent mechanical performance. However, defects such as porosity may occur during manufacturing. Residual porosity, composed of small randomly distributed pores, is usually estimated through ultrasonic attenuation measurements, which may fail to detect pore clusters that have a stronger mechanical impact due to their local concentration.
To distinguish residual from clustered porosity and ensure structural integrity, this study proposes an ultrasonic interferometry-based approach. Composite samples with controlled defects are manufactured and characterized by ultrasonic transmission in immersion. The measurements are compared with an analytical multilayer propagation model reproducing the ply stacking of a laminate. A degraded layer containing pores is introduced, and its effective parameters are calculated either using a multiple scattering model or with a semi-analytical resolution code, named MuScat3D. Solving the inverse problem then allows estimation of the position and local concentration of pore clusters. Results show strong agreement with X-ray tomography, confirming the ability of ultrasonic interferometry to accurately characterize clustered porosity.

Manually reconfigurable phased array

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Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Phased array systems are vital for technologies ranging from medical imaging and acoustic levitation to wireless communication. Their ability to precisely control wavefronts enables dynamic beam steering and complex field synthesis. However, conventional ultrasonic phased arrays depend on complex electronics with multi-channel signal generation and amplification, resulting in high cost, complexity, and limited availability. Reducing this dependence on active electronics could enable simpler and more physical approaches to acoustic field control.
Here we introduce a manually reconfigurable ultrasonic array in which the acoustic phase distribution is adjusted by the emitters' physical position rather than by digital signal control. We explore two complementary strategies: mechanical height and electrode-pattern modulation. In the mechanical approach, each 40 kHz transducer is mounted on a spring-loaded holder positioned above a shaped conductive phase plate. The transducer height follows the plate's contour, encoding the propagation phase through geometry. By changing or reshaping the plate, arbitrary phase profiles—including those for Bessel-like beams—can be emitted. We further demonstrate a semi-automated system using computer-controlled linear actuators to achieve reconfiguration performance comparable to electronically steered arrays.
In the electrode-pattern approach, transducers remain fixed in position but connect to discrete signal sources through pogo-pin contacts. The plate beneath the array is divided into conductive regions corresponding to specific phases across the $0–2\pi$ range. Each transducer's phase is determined by the electrode region it contacts, providing a mechanically reconfigurable means of beamforming. This configuration enables straightforward physical reassignment of phase patterns and flexible generation of diverse acoustic fields without active electronics.

The generated sound fields were characterized using laser Doppler vibrometry, showing good agreement between measured and simulated pressure distributions for both focused and Bessel-type beams. This approach reduces electronics complexity; moreover, it establishes a low-cost, modular, and mechanically reconfigurable platform for studying and experimentally shaping acoustic holograms. Manually reconfigurable arrays offer an alternative to electronic control for phased modulation, they are a platform for experimental, educational, and physical exploratory applications in wavefront shaping.

AcousTools: A Python Library for 'full-stack' acoustic holography

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Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Acoustic Holography is an emerging field where mid-air ultrasound is controlled and manipulated for novel and exciting applications. These range from mid-air haptics, volumetric displays, contactless fabrication, and even chemical and biomedical applications such as drug delivery. To develop these applications, a software framework to predict acoustic behaviour and simulating resulting effects, such as applied forces or scattering patterns is desirable. There have been various software libraries and platforms that attempt to fill this role, but there is yet to be a single piece of software that acts as a `full-stack' solution. We define this full-stack as the process from abstraction to physicalisation starting with the setup of the overal context; then the modelling of acoustic propagation; solvers, where the transducer activation is computed; sound field analysis where metrics quantifying the sound field are computed; and finally control of the acoustic holographic hardware itself. At each stage of the full-stack, the developer must make decisions and the options the software they use will impose limits on what choices they can make. If their software does not give them sufficient choices, they may be unable to make full-informed decisions. We show that for all of the commonly used acoustic holography software packages, there are numerous areas in the full-stack that those software pieces do not meet.

To address this, we present AcousTools, a Python-based acoustic holography library, designed to support the full suite of acoustic holographic applications and we show AcousTools's ability to meet each step of the full-stack's requirements. AcousTools has the potential to become the standard code library for acoustic holography, with the uniquely complete suite of features wrapped in a language that is known to be easy to use, AcousTools will increase the ability for researchers to develop novel applications as well as accurately review other's work. The full-stack, aside from software, will also be useful for researchers -- providing a way to view and compare methodologies by understanding where they fit into the stack.

Effect of focused ultrasound on retinal pigment epithelial cells and its application in early dry age-related macular degeneration

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Afternoon Session 5, January 22, 2026, 14:30 - 15:45

Age-related macular degeneration (AMD) is a leading cause of vision loss worldwide in people older than 55 years. The prevalence of AMD is anticipated to increase worldwide to 288 million individuals by 2040. Drugs available for treatment are for the late stages of AMD and there is no widely effective treatment for early or intermediate stages of dry AMD. Therefore, there is a significant unmet medical need for safe, affordable, and non-invasive interventions that can be delivered at early stage to preserve vision and improve patient outcomes.

The retinal pigment epithelium (RPE) is a single layer of cells in the eye responsible for removing waste produced by the light-sensing cells. Multiple factors – including aging, inherited risk, and increased oxidative stress contribute to declining efficiency of RPE. As a result, buildup of waste forms deposits and gradually thickens the barrier matrix layer beneath the RPE. To ensure normal maintenance of this barrier, enzymes named MMP-2 and MMP-9 function as matrix clearance tools by breaking down degraded material. If these enzymes are not sufficiently activated, this maintenance process slows down, and the barrier thickens.

Focused ultrasound (FUS) is a technique that uses mechanical waves to precisely target the region of interest. FUS non-invasively delivers mechanical stimulation to targets, triggering beneficial biological responses. Therefore, our research question is if FUS can be used as an intervention to manage dry AMD, especially early and intermediate stages. We hypothesize that FUS can upregulate enzyme activity by modulating RPE function.

To investigate our hypothesis, we established an in vitro model of polarised and pigmented RPE cells, exposed them to FUS treatment and then evaluated enzyme activity changes in the cells. Commercially available ARPE-19 cells were grown on porous inserts to establish cells with apical and basal polarity mimicking in vivo cell structure. Since ARPE-19 cells lack pigment, they were loaded with pigment granules extracted from pig eyes. A precise set-up for FUS treatment mindful of acoustic physics was used to treat the cells. Subsequently, enzyme activity in treated and untreated cells was studied using a technique called zymography.

Our initial results show that FUS at a centre frequency of 7.37 MHz, pulse repetition frequency of 1 kHz, duty cycle of 10% and intensity ISPTA 1 W/cm^2 can significantly increase activation of the enzyme MMP-2 on both sides of RPE cells. Our preliminary results are very promising given a low exposure time of 2 minutes. There was no cell death due to FUS treatment which implies the involvement of mechano-sensitive pathways such as ion channels, integrins, and their subsequent downstream pathways (e.g., MAPK pathway).

Our future work would include investigating the link between mechanical effects of FUS and enhancement in MMP activity post-treatment through simulation and experiments.

Acoustophoretic guidance of particles in air using an airborne phased array

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Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Non-contact particle manipulation using airborne ultrasound is rapidly evolving due to increasing use of phased array of transducers which provide precise control of the acoustic field. One of the notable applications is the non-contact transport of particles in bulk media, which typically relies on dynamically reconfiguring a single acoustic trap to move a particle along a given path [1, 2]. This method is inherently limited to sequential particle transport, making it difficult to scale for handling large quantities of material.

Here we introduce a method for the continuous transport of particles streams along predefined and dynamically reconfigurable 3D paths. This was achieved using an elongated Bessel-like acoustic field (EBAF) that creates an extended trapping region, confining particles along the entire trajectory. This approach significantly advances the capabilities of acoustic manipulation. Functioning as a reconfigurable, massless nozzle, this technology enables the continuous routing of material to specific locations. This can find applications in additive manufacturing, particularly for handling delicate or reactive materials that are incompatible with traditional print heads. Furthermore, this approach could drastically increase printing speeds by enabling faster material distribution compared to the layer-by-layer spreading process in Powder Bed Fusion. It also eliminates the need for slowly moving mechanical nozzles and powder delivery systems typical of Direct Energy Deposition method.

We developed a mathematical method for the synthesis of EBAFs based on the superposition of multiple focalized acoustic vortices distributed along the intended trajectory. The acoustic field was generated using a custom-built phased array of 128 ultrasonic transducers organized on a conical surface and controlled by a field-programmable gate array (FPGA) and custom built multichannel amplifier. The trajectory of the EBAF was dynamically reconfigured in real-time by applying precalculated signals for each realization via the FPGA. To experimentally validate the synthesized fields, a full 3D scan of the acoustic pressure was performed using a calibrated microphone (46DE 1/8'' CCP Pressure Microphone, GRAS, Denmark) mounted on a custom-built 3D scanning stage.

Microphone measurements of the 3D spatial distribution for one realization of the acoustic field confirmed the successful generation of the intended acoustic field (Fig. 1A). We demonstrated that this EBAF can act as a reconfigurable nozzle, capable of precisely guiding both liquid droplets (Fig. 1B) and silica powder particles (Fig. 1C) along predefined trajectories. This resulted in the controlled transport and accurate deposition of these materials onto specific target locations.

References:
1. Marzo, A., Seah, S., Drinkwater, B. et al. Holographic acoustic elements for manipulation of levitated objects. Nat Commun 6, 8661 (2015).
2. Baudoin, M., Thomas, JL., Sahely, R.A. et al. Spatially selective manipulation of cells with single-beam acoustical tweezers. Nat Commun 11, 4244 (2020)

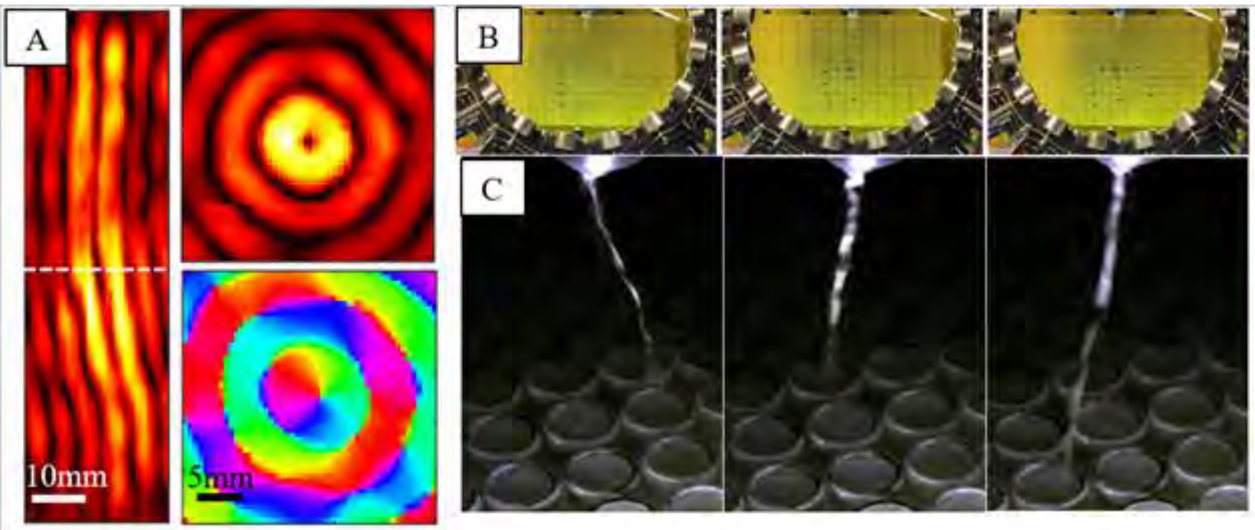

Fig.1 (A) Measured acoustic pressure amplitude in the XZ plane, with corresponding amplitude and phase distributions in the XY plane at the location indicated by the dotted line. (B) Sequence of images demonstrating controlled droplet deposition onto a substrate. (C) Sequence of images showing the guidance of a silica powder stream within the ultrasonic channel at three distinct locations.

Origin of the sound produced by a newborn bubble

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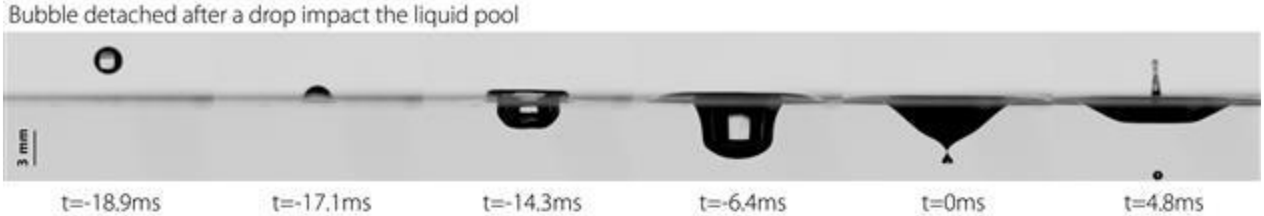
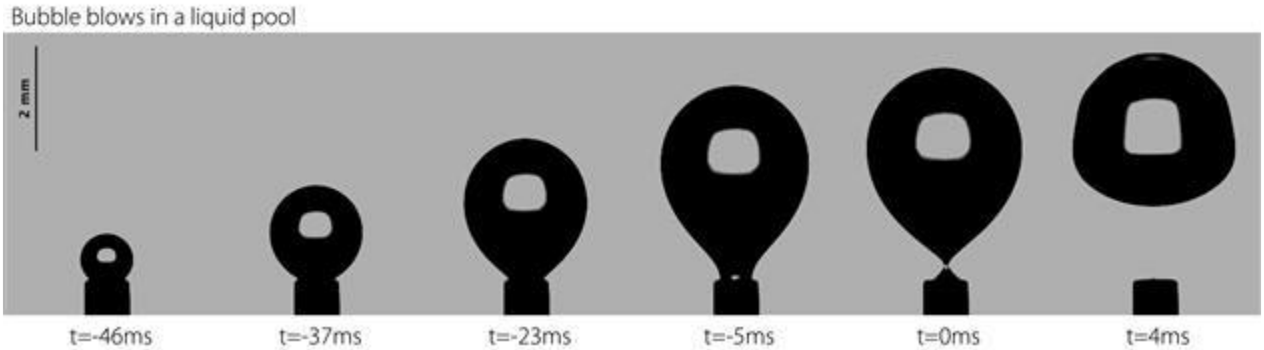
Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Everyone has experienced the sound produced when blowing air into a liquid or the noise generated by a droplet falling onto a liquid surface. In both cases, the sound arises from the detachment of a gas bubble within the liquid. Since the mid-20th century and the pioneering work of Minnaert [1], the resonance frequency of such bubbles and the damping of their oscillations have been extensively studied. However, there is still no consensus regarding what governs the amplitude of the emitted sound.
Several mechanisms have been proposed - based on shape oscillations, the initial radial velocity of the bubble, neck collapse, or Laplace pressure - but none has been experimentally confirmed. In this presentation, I will show that the sound produced by a bubble formed by blowing and that produced by a bubble detaching from the base of a cavity differ by two orders of magnitude. Our experiments demonstrate that the initial-velocity scenario provides a consistent prediction of these amplitudes. I will also show how refining the bubble-resonance model allows us to accurately predict the sound amplitude associated with bubble detachment.

[1] M. Minnaert, Xvi. on musical air-bubbles and the sounds of running water, The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science 16, 235 (1933)





Quantitative Measurement of Defects in Pipes using Guided Wave-based Full Waveform Inversion

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Morning Session 4, January 22, 2026, 11:00 - 13:00

Pipelines play a crucial role in various industries, particularly in the transportation of oil and gas within the petrochemical sector. These structures are vulnerable to in-service damage, with corrosion being a primary concern. Effective management of pipeline integrity requires precise detection and quantification of damage to mitigate risks of unexpected failure or overly conservative maintenance practices. This research explores the application of Full Waveform Inversion (FWI) in the quantification of defects in industrial pipelines that are otherwise physically inaccessible.

Guided waves, capable of efficient long-range propagation while interacting with structural anomalies, are central to this methodology. While they offer significant advantages in detecting the presence of defects, they often struggle to distinguish benign indications from critical flaws without direct access to the region of interest. To address this, we present an inspection framework employing FWI in conjunction with guided waves, leveraging their multi-modal propagation characteristics to achieve enhanced quantification accuracy.

The proposed method iteratively refines an initial finite element (FE) model to closely match the actual pipeline structure. Guided waves are simulated in the model, and the resulting scattered wavefields are captured at carefully positioned receivers. FWI is employed to iteratively reduce discrepancies between the simulated and measured wavefields, updating the model to represent the physical characteristics of defects accurately. The process involves solving the wave equation within the FE model, using the adjoint-state method to compute gradients of the misfit function, and updating nodal geometrical parameters. By incorporating the influence of small perturbations in nodal positions on stiffness, mass matrices, and the resulting wavefield, the model achieves detailed reconstructions of defect geometry.

The approach delivers high-resolution, quantitative assessments of defects such as cracks or corrosion in complex pipeline systems. Notably, the integration of multiple guided wave modes enhances the robustness and accuracy of the defect recovery process. This multi-modal approach enables a more comprehensive characterisation of structural anomalies by capturing diverse wave interactions. Results demonstrate that the combined FWI and guided wave methodology can quantitatively reconstruct the geometry and material properties of surface defects with high precision. This advancement offers an improved understanding of pipeline structural integrity from a single measurement set, addressing critical challenges in pipeline NDE.

Keywords: Full Waveform Inversion, Guided Waves, Non-Destructive Evaluation, Finite Element Analysis.

Three-dimensional mapping of nonhydrostatic pressure in a diamond anvil cell using isotropic mHEMA as the pressure-transmitting medium by time-domain Brillouin scattering

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Afternoon Session 6, January 22, 2026, 16:15 - 17:30

A diamond anvil cell (DAC) is a central tool in high-pressure research, enabling the study of materials under pressure potentially reaching hundreds of gigapascals. Accurate knowledge of the pressure distribution within the sample chamber is essential for interpreting structural, optical, and elastic measurements, particularly when stress gradients develop at high load. Conventional pressure calibration relies on ruby fluorescence, where the wavelength shift provides a local pressure measurement near individual ruby grains [1]. While widely used, this method offers only point-like information and may not capture the full three-dimensional (3D) pressure field, especially in strongly inhomogeneous environments. X-ray diffraction can map pressure with micrometer-scale lateral resolution [2], but axial (depth) resolution is limited by acquisition time and practical constraints, making volumetric characterization difficult. Time-domain Brillouin scattering (TDBS) [3] offers an alternative way to reconstruct 3D pressure distributions. In TDBS experiments, coherent acoustic pulses (CAPs) are launched by an ultrafast pump pulse absorbed in a thin transducer layer. A time-delayed probe pulse monitors CAP propagation through interference between light reflected from stationary interfaces and light Brillouin-scattered by the CAP. The resulting Brillouin oscillations encode the local Brillouin frequency (BF), whose instantaneous value depends on the product of sound velocity and refractive index. Because both quantities vary with pressure, BF provides a highly sensitive probe of local stress states along the CAP path. Asynchronous optical sampling allows rapid acquisition of high-quality signals, while lateral scanning of the sample enables full 3D imaging with optical lateral and sub-optical axial resolution [4].

A key requirement for quantitative pressure reconstruction is that variations in BF arise solely from pressure-dependent changes in acoustic and optical properties, without complications from material anisotropy. For this reason, the DAC in this study is filled with monomer hydroxyethyl methacrylate (mHEMA), a pressure-transmitting medium that remains acoustically and optically isotropic with increasing pressures. Its isotropy ensures that BF shifts reflect pressure rather than orientation-dependent effects, making mHEMA an interesting medium for volumetric TDBS-based pressure metrology. Moreover, mHEMA transparency, stability, and ease of polymerization offer promising perspectives for use as a pressure-transmitting medium and potentially as a ruby-free pressure gauge.

Using TDBS, we reconstructed the relative 3D pressure distribution inside a DAC filled with mHEMA at about 4 GPa. The sample volume was 30 μm thick and 100 μm in diameter, examined with 1.5 μm lateral and 160 nm axial resolution. The 3D Brillouin frequency map revealed clear variations associated with nonhydrostatic stresses, from which the full 3D pressure field was obtained. These results demonstrate that TDBS, combined with an isotropic medium such as mHEMA, enables practical, high-resolution volumetric pressure mapping inside a DAC. This capability opens new opportunities for studying pressure gradients, validating pressure-transmitting media, and performing high-pressure experiments without relying on local ruby fluorescence measurements.

[1] Hk. Mao et al., J. Appl. Phys. 49, 3276 (1978)
[2] H.-P. Liermann et al., J. Synchrotron Rad. 22(4), 908 (2015)
[3] V. E Gusev, P. Ruello, Appl. Phys. Rev. 5, 031101 (2018)
[4] S. Sandeep et al., J. Appl. Phys. 130, 053104 (2021)

Multi-mode Tomographic Approach using a Sensor Network for Structural Health Monitoring

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Morning Session 4, January 22, 2026, 11:00 - 13:00

Techniques for structural health monitoring based on guided waves tomography have proven particularly effective for detecting and characterising damage in slender thin-walled structures. Both active and passive SHM methods rely on the deployment of distributed sensor networks integrated within the structure to record variations in the propagation characteristics of ultrasonic wave signals. However, most existing methods rely on the use of an unique propagating guided mode at relatively low frequencies, which limits their detection capabilities. This work proposes a multi-mode tomographic approach. It uses a wideband pulse for excitation to generate multiple propagating modes. This study is carried out numerically using 3D finite element modelling in the time domain. Reference measurements are performed on a homogeneous isotropic pristine plate. Subsequently, the wave propagation analysis is performed for a localised thickness loss, of progressively increasing depth. This is implemented in the form of a flat bottom hole. The signals are recorded on a set of points simulating a circular sensor network around the monitored area.

A technique originally developed in previous works, based on curvilinear integration along the sensor network, is used to extract dispersion properties of the guided waves. Identification and separation of the contribution of each mode is carried out in both pristine and damaged plates. A probabilistic qualitative reconstruction algorithm is then performed on several modes at different frequencies – wavelengths, to map the propagation characteristics of the medium and localise the damage. This enables the analysis of the structure at several investigation scales.

The results show that the location of the defect can be accurately determined. Furthermore, the energy level of the reconstructions increases in proportion to the severity of the thickness loss. The analysis of high-order modes provides promising results and opens up possibilities for the development of quantitative methods.

Enhanced Transduction in ZnO SAW Devices via Metallic Zn Seed Layer

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Afternoon Session 3, January 21, 2026, 16:00 - 17:30

Surface acoustic wave (SAW) devices are an important component in modern electronics, but their reliance on expensive and rigid single-crystal piezoelectric substrates constrains innovation. While thin films like Zinc Oxide (ZnO) offer a low-cost and versatile alternative for fabrication on cheap substrates like glass, their applications are hampered by a low electromechanical coupling coefficient (K^2), resulting in inefficient energy conversion and performance issues. This research introduces a simple method to overcome this limitation by engineering the substrate film interface. A thin metallic Zinc (Zn) interlayer was deposited onto Soda-lime glass substrates prior to the sputtering of a ZnO film. It is hypothesised this interlayer acts as a crystallographic seed layer, improves film adhesion and functions as an acoustic matching layer. The inclusion of the Zn interlayer led to a substantial enhancement in device performance with electrical measurements showing ZnO/Zn/Glass devices with deeper reflection minima (S11) and stronger transmission (S21) compared to control devices without the Zn layer. Direct physical measurements using Laser Doppler Vibrometry reveals a dramatic increase in SAW amplitudes from ~0.28 pm in control devices to ~4.5 pm in ZnO/Zn/Glass devices (Fig 1.). This work demonstrates that a simple Zn underlayer can provide an accessible and scalable pathway to fabricate high-performance, low cost, thin film SAW devices, advancing their potential in sensing and acoustofluidic applications.

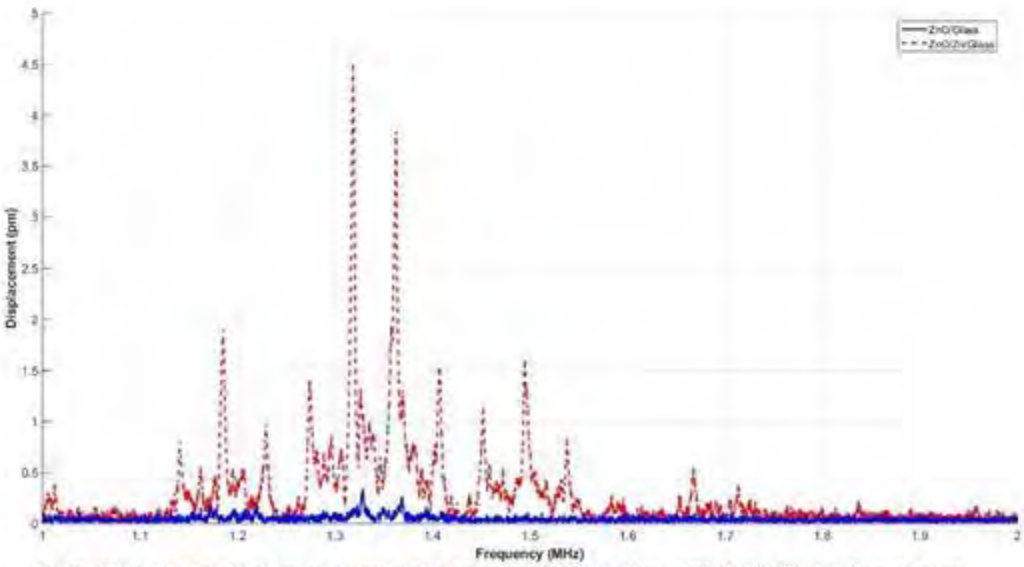

Fig 1. Displacement Frequency Response of ZnO/Glass and ZnO/Zn/Glass Structures

Therapeutic Ultrasound on Biomimetic Models of Cancer

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Afternoon Session 5, January 22, 2026, 14:30 - 15:45

Therapeutic ultrasound has displayed promising results in treating a range of cancer types, providing a contender that overcomes the patient quality of life issues observed in the invasive and systemic nature of conventional cancer therapy. Low-intensity ultrasound (LIUS) has been proposed to selectively eradicate breast cancer cells without harming non-malignant counterparts. This work aims to characterise the LIUS phenomenon and explore it's impact on 3D breast cancer models.

A platform that aims to reduce the influence of conventional culturing vessels was used, opting to utilise mylar film windows placed underwater to achieve homogeneous cell sonication. Using this platform, MCF-7 and MDA-MB-231 breast cancer cells were seeded within collagen gels to form hydrogels, consisting of a central cancer mass surrounded by an acellular stroma. These hydrogels underwent centrifugation for 15 minutes at 4500rpm to physically compress the collagen hydrogel gel into a denser matrix, known as plastic compression. This process establishes natural tissue densities and generates what we call a breast cancer tumouroid. These models were subjected to 10 minutes of ultrasound, at a temporal peak acoustic intensity of 1.36 W.cm-2 characterised at the last axial maximum of the field of a 1MHz 15 mm active diameter planar transducer (Precision Acoustics Ltd, TX_1_15), using a calibrated 0.2 mm needle hydrophone (Precision Acoustics Ltd). Following this, complexity was added further, shifting from an acellular to a healthy stroma consisting of HUVEC endothelial and Mesenchymal stem cells to generate complex breast cancer tumouroids. These were once again subjected to the same ultrasound parameters. At 1 MHz frequency, 20% duty cycle, 100 Hz pulse repetition frequency, reduced cancer cell viability was observed under the current parameters in both breast cancer cell types compared to untreated controls. This was observed in both simple and complex tumouroids. Following treatments, a subset of MDA-MB-231 simple tumouroids underwent rheology and ViciSense imaging to investigate changes in model stiffness and oxygen gradients, revealing LIUS exposure increased stiffness and oxygen availability.

LIUS sonication of breast cancer cells under the current treatment platform induced drops in viability. This agrees with various studies demonstrating that LIUS is able to induce cell death in cancer cell lines without inducing cell death in non-malignant comparisons. However, these studies are limited to 2D cell cultures and provided limited ultrasound parameter reporting, making it difficult to compare results. Additionally, the underlying mechanism resulting in viability changes remains unknown, but likely due to shear stresses or changes in mechanotransduction pathways, which could explain changes in stiffness values and oxygen gradients. Moving forward, investigations will focus on exploring these potential pathways responsible for cellular responses to mechanical stimuli.

Thermoplastic composite adhesion monitoring using pulse-echo ultrasound

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[1]ONERA - DMAS, France

Morning Session 4, January 22, 2026, 11:00 - 13:00

Many industrial sectors, such as aerospace, have observed for several decades the emergence of thermoplastic matrix structural composites (TPC) that compete with metallic materials, mostly because of their suitable mechanical modulus-to-density ratio. These materials have the advantage of being joinable by thermal welding without any addition of adhesive. Understanding the mechanisms involved represents a technical and scientific bottleneck that must be overcome, enabling industry to identify optimal manufacturing conditions and to ensure the mechanical integrity of composite structures.

Estimating the quality of bonding between two composites remains extremely challenging to monitor and to model due to the multi-physical (solid and fluid mechanics, thermal) and multi-scale (micro and meso) nature of this adhesion phenomenon. Furthermore, the emergence of defects, such as matrix degradation, generation and relaxation of stresses, or the appearance of porosity, complicates the issue. To complement the existing models, it appears necessary to quantify the degree of intimate contact (DIC) in situ during the welding process, which is mostly achieved in the literature by monitoring thermal transfers across the thickness. These measurements allow for the derivation of evolutions in thermal contact resistances but do not provide mechanical information.

In this context, inspections based on the use of ultrasound appear promising for carrying out the quantification of DIC during the compaction of thermoplastic samples. Therefore, the study proposes to perform an experimental campaign of ultrasound propagation on T700/LM-PAEK thermoplastic samples heated beyond the melting temperature (335 °C here). To do so, a low-pressure compaction bench has been set up including direct-contact ultrasound probe performing pulse-echo evaluation. The first results show that ultrasound is very sensitive to specific critical temperatures of the material, such as the glass transition temperature and melting temperature, and change in the material properties after the curing cycle. Moreover, ultrasonic signals clearly highlight he exact moment at which adhesion between two samples occurs and the possible appearance of defects at the interface. Finally, these measurements are in good agreement with ex situ C-scan and optical microscopy.

Spatially Encoded Ultrasonic Generation for Laser-Induced Phased Array Imaging

Jakub Trybek[1], Geo Davis[1], Peter Lukacs[1], Stephan Weiss[1], Dr Theodosia Stratoudaki[1]
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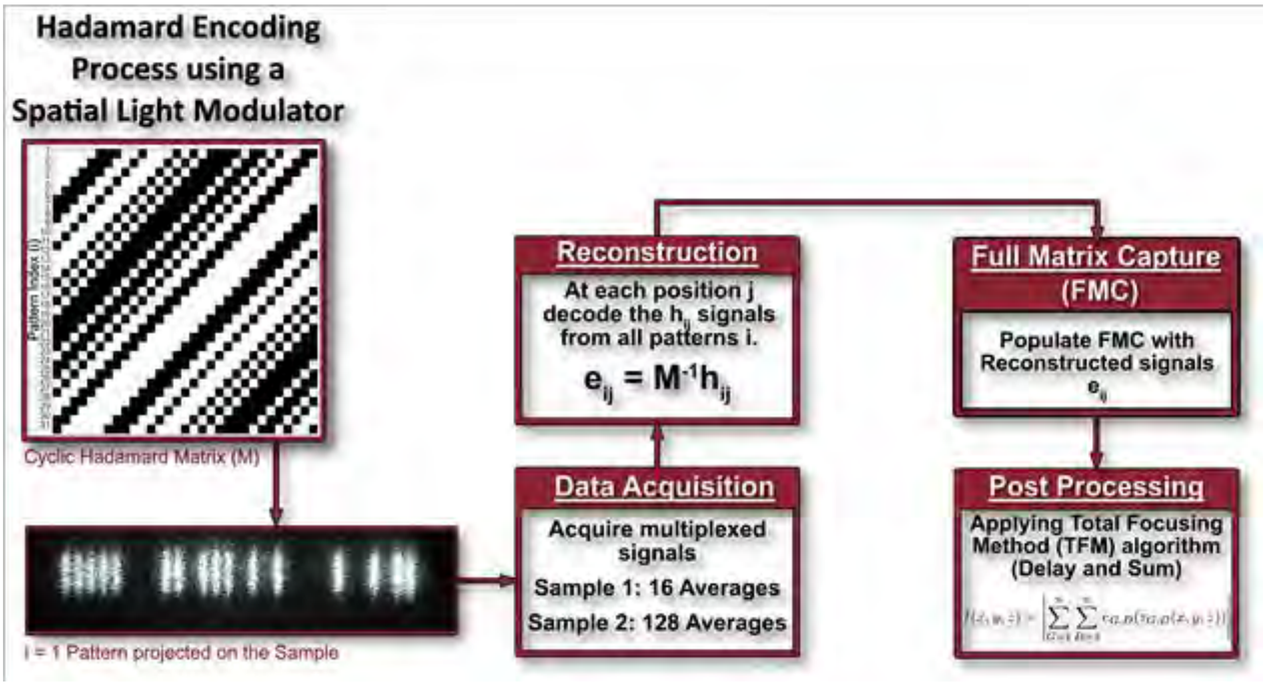
Afternoon Session 6, January 22, 2026, 16:15 - 17:30

Laser ultrasound is a fully optical, remote, and couplant-free technique for generating and detecting ultrasound. Laser-Induced Phased Arrays (LIPAs) are synthesized by scanning a generation and detection laser, with array formation achieved during post-processing. High-quality ultrasonic imaging has been demonstrated using LIPAs in conjunction with Full Matrix Capture (FMC) data acquisition and the Total Focusing Method (TFM) imaging algorithm. However, there exists a trade-off between imaging quality and acquisition speed due to the need for signal averaging versus laser scanning speed. Spatial encoding techniques, such as Hadamard multiplexing, address this by reducing signal-independent noise through parallel averaging of multiple signals with a single detector, thereby enhancing Signal-to-Noise Ratio (SNR).

This study investigates spatial encoding of the laser ultrasonic generation beam using Hadamard multiplexing for LIPA-based ultrasonic imaging. A Spatial Light Modulator (SLM) is used to project a sequence of orthogonal binary patterns onto the sample surface. These patterns modulate the generation laser's spatial intensity to create multiple, simultaneously activated, and uniquely encoded ultrasonic sources. Each binary pattern, derived from Hadamard matrices, consists of "on" (high intensity) and "off" (zero intensity) regions, effectively addressing multiple generation elements in parallel. By sequentially projecting a series of Hadamard patterns, multiplexed or encoded ultrasonic signals are generated. These encoded ultrasonic waves are detected using laser interferometry, and then computationally decoded to retrieve individual element responses.

The study presents the experimental implementation of this technique for imaging an aluminium block containing nine, 1 mm diameter side-drilled holes (SDHs) arranged radially. An N-element (N=31) LIPA is synthesised by projecting N Hadamard patterns. The generated signals are detected using a scanning laser vibrometer, which synthesizes an N-element detection array. The reconstructed signals correspond to signals from individual LIPA elements, forming an FMC dataset. This FMC dataset is processed using the TFM algorithm to image the sample.

Results compare TFM images derived from Hadamard multiplexing with those obtained through conventional acquisition, where each LIPA element is activated individually. The results indicate a multiplexing or Fellgate advantage of over 2.8 for an N=31 element LIPA for the same acquisition time. The findings demonstrate the potential of spatial encoding and Hadamard multiplexing to enhance imaging performance while maintaining acquisition efficiency.


Hadamard Encoding Process using a Spatial Light Modulator
Pattern Index (i)
Cyclic Hadamard Matrix (M)
i = 1 Pattern projected on the Sample
Data Acquisition
Acquire multiplexed signals
Sample 1: 16 Averages
Sample 2: 128 Averages
Reconstruction
At each position j decode the h_{ij} signals from all patterns i.
$e_{ij} = M^{-1}h_{ij}$
Full Matrix Capture (FMC)
Populate FMC with Reconstructed signals e_{ij}
Post Processing
Applying Total Focusing Method (TFM) algorithm (Delay and Sum)

Uncertainty of Shear Wave Speed Measurements in ARFI Ultrasound Elastography

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Morning Session 8, January 23, 2026, 11:30 - 13:00

Uncertainty of Shear Wave Speed Measurements in ARFI Ultrasound Elastography
Andre Alvarenga, Hasan Koruk, Srinath Rajagopal

Abstract

Shear Wave Elastography (SWE) is a widely adopted ultrasound-based technique for quantifying tissue stiffness, a key biomarker in diagnosing conditions such as liver fibrosis and cancer. Central to SWE is the measurement of shear wave speed (SWS), which correlates with tissue elasticity and enables estimation of Young's modulus. However, SWS measurements are influenced by multiple sources of uncertainty, impacting clinical reliability and standardisation efforts.

This study systematically investigates uncertainty in SWS measurements using Acoustic Radiation Force Impulse (ARFI) technology implemented on a Verasonics research ultrasound system. Experiments were conducted on four tissue-mimicking phantoms with known mechanical properties. Shear waves were generated using two ARFI approaches—focused push and unfocused comb-push—and tracked via plane-wave imaging. Displacement estimation employed the Kasai 1-D autocorrelator, complemented by filtering and cross-correlation algorithms to construct SWS maps. Young's modulus was derived under assumptions of isotropy and linear elasticity.

An uncertainty budget was developed in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM), incorporating Type A (statistical) and Type B (systematic) contributions. Key factors included displacement estimator variance, speckle noise, temperature variation, beam position calibration, and ROI variability. Results indicate an expanded uncertainty of 8% for SWS and 16% for Young's modulus, with dominant contributions from displacement estimation and region of interest dispersion. Statistical analysis confirmed that the measured values across all methods (focused push and comb-push) were consistent with the phantom nominal values within the uncertainty bounds. Findings highlight the importance of uncertainty quantification for SWE standardisation and clinical adoption. The proposed framework aligns with Quantitative Imaging Biomarkers Alliance (QIBA) recommendations and International Electrotechnical Commission (IEC) standardisation efforts, offering a baseline for phantom validation and inter-system comparisons. Future work should extend this methodology to in vivo settings, where additional variability from tissue heterogeneity and physiological motion is expected. This research provides critical insights for improving the accuracy, reproducibility, and traceability of elastography measurements in diagnostic practice.

Sound-matter interaction in acoustic 3D printing

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Afternoon Session 2, January 21, 2026, 13:30 - 15:30

Acoustic 3D printing is an additive manufacturing method that uses ultrasound to shape objects. One material that can be utilized is polycaprolactone powder. It is a thermoplastic polymer with a melting point of 60 °C. This temperature can be exceeded in a focused ultrasonic field, causing the powder to fuse together. One precondition is that the powder is mixed with water to replace air, so that the ultrasound can propagate into the material. The conductivity of ultrasound into the material is beneficial, as it allows printing below the surface of the material and inside existing structures. This is one unique property of acoustic 3D printing compared to other additive manufacturing methods, which require a layer-by-layer approach.

As the ultrasound can propagate into the material, the interaction between the material and the ultrasound is crucial. This will be investigated in this contribution, and it will help us to understand how to print objects below the surface of the material.
In the beginning, two transducers using flat piezo discs (⌀ = 35 mm) and an aluminum focusing lens were built. The lenses had different focal lengths and therefore different working distances. A longer working distance would allow deeper printing in the material, but at the cost of a wider focusing of the ultrasonic beam. The acoustic fields of both transducers were characterized by hydrophone measurements to determine the size of the focal zone, the maximum pressure, the minimum pressure, and the energy intensity.

Performing 3D printing inside the material requires that the sound can propagate inside the material with low attenuation and scattering. To investigate this behavior, thin samples of the printing material were prepared. They were placed before the focal zone of the transducer. For a first visualization of the resulting focus zone, Schlieren imaging was used. This gives a visual impression of how the material interacts with the acoustic field. For verification, hydrophone scans were performed, as they provide spatially resolved temporal data.

This data was used to determine the attenuation coefficient of the material. This allows to estimate the maximum printing depth and provide insight into how the material could be optimized to enable deeper prints.

Mining picosecond ultrasonic echoes for information on strain pulses

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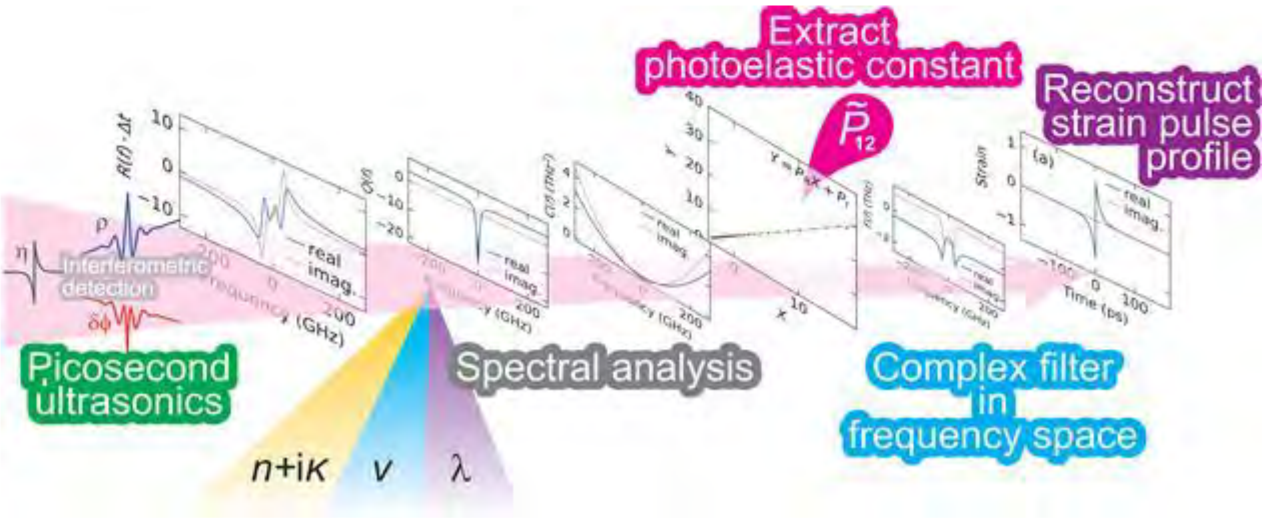
Afternoon Session 6, January 22, 2026, 16:15 - 17:30

Picosecond laser ultrasonics offers a non-contact route to perform pulse–echo experiments in thin films and nanostructures with picosecond time resolution. In the technique, an ultrashort pump pulse launches broadband, gigahertz-range longitudinal strain pulses whose acoustic reflections in a thin film modulate the amplitude and phase of a time-delayed beam of optical probe pulses. When measured interferometrically, these modulations provide a full complex optical signal—containing both amplitude and phase—that encodes the strain dynamics far more completely than conventional transient reflectivity measurements. The problem to date has been how to extract the strain pulse profile in such measurements, which provides a more direct probe of the physics of acoustic generation governed by ultrafast diffusion dynamics, as well as of the associated strain propagation.

In our recent work (Photoacoustics 34, 100566, 2023), we developed a spectral-domain analysis that reconstructs the temporal shape of a longitudinal strain pulse in an opaque thin film directly from optical interferometric data. By treating the complex optical response as a convolution between the acoustic field and a known filter function derived from optical and elastic parameters, and by dividing by this filter function in the frequency domain, we remove the photoelastic weighting to recover the strain pulse itself. The method is demonstrated for chromium films.

Building on this foundation, we extend the approach to obtain not only the strain pulse but also the complex photoelastic constant of the material simultaneously. The real and imaginary parts of the photoelastic constant are extracted analytically from the measured echo spectra, removing the need for iterative fitting or separate calibration to access this constant. With knowledge of the refractive index and sound velocity, both the photoelastic constant and the strain profile can therefore be obtained directly from a single optical interferometric experiment.

This work may open the way to two-dimensional imaging of the photoelastic constant and to broader quantitative applications of picosecond ultrasonics in thin films.



Towards Physiologically Interpretable Acoustic Analysis for Voice-Based Detection of Respiratory Tract Infections (RTIs)

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[1]*University of Southampton, United Kingdom*

Afternoon Session 5, January 22, 2026, 14:30 - 15:45

Respiratory Tract Infections (RTIs) represent one of the most prevalent global health concerns, placing substantial pressure on healthcare systems worldwide (WHO, 2024). RTIs can induce inflammation and airway obstruction, which disrupt airflow and vocal fold vibration, thereby leading to measurable changes in the acoustic characteristics of voice signals (Babu & Kavithadevi, 2024). In recent years, voice analysis has emerged as a promising, non-invasive approach for RTI detection and screening, often combined with deep learning models (Han et al., 2021; Zhang et al., 2024). However, current model decisions rely heavily on the statistical properties of training datasets, which limits accuracy and robustness. Moreover, the "black-box" nature of deep models often leads to a lack of pathophysiological interpretability (Cynthia, 2019).

This study aims to bridge this gap by identifying acoustic features that are both statistically significant and physiologically meaningful, grounded in the physical-acoustic mechanisms underlying pathological voice changes. The selected features were then used to fine-tune deep learning models, improving both model performance and interpretability.

Unlike most existing studies that focus on respiratory, cough, or sustained vowel tasks (Ren et al., 2022; Bartl-Pokorny et al., 2021), the present work centers on natural speech, which is more ecologically valid, information-rich, and suitable for large-scale capture and generalization (Fagherazzi et al., 2021; Alam et al., 2022). A total of 1,486 natural speech samples were analyzed, comprising 734 RTI-positive and 752 RTI-negative recordings.

For vocal-tract filter features, acoustic parameters were directly extracted from the speech signals, and statistical verification was performed using t-tests and effect size (Cohen's d) to evaluate their discriminative power between positive and negative subjects. For glottal-source features, inverse filtering (IAIF) was applied to obtain the glottal flow waveform prior to feature extraction and statistical validation, thereby enhancing the stability and reliability of source-related measurements (Alku, 2011; Drugman et al., 2020).

The results demonstrate that, in natural speech, vocal-tract spectral features (e.g., Alpha Ratio, Hammarberg Index) serve as more sensitive indicators of respiratory health, while certain glottal-source features (e.g., CPP, HNR) also show significant discriminative power between positive and negative subjects.

Through comparative and statistical analysis, this study identifies a set of RTI-sensitive and physiologically interpretable acoustic features, which can be incorporated into deep learning model fine-tuning. The findings highlight the potential of natural speech as a scalable, non-invasive modality for RTI screening and continuous monitoring.

A simulation framework for optimising Fabry- Pérot fibre optic hydrophones

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[1]University College London, United Kingdom

Morning Session 1, January 21, 2026, 11:10 - 12:15

Hydrophone measurements are a primary method for experimentally characterising therapeutic ultrasound fields. However, accurate measurement of high-intensity focused ultrasound (HIFU) transducers under clinical conditions presents significant challenges. Acoustic pressures at the focal region can exceed 20 MPa and damage conventional hydrophones. Moreover, broad bandwidth sensors are needed to capture higher harmonic components arising from the strongly nonlinear propagation of HIFU waves [1], [2]. Furthermore, the development of transcranial focused ultrasound applications introduces additional challenges as large aperture transducer arrays require omnidirectional hydrophones to capture signals from all directions.

Fibre-optic hydrophones (FOHs) have emerged as promising alternatives to piezoelectric sensors. Their micrometre-scaled sensitive elements [3] offer minimal spatial averaging and an inherently omnidirectional response, making them well suited for measurements in tightly focused acoustic fields. Among FOHs, Fabry-Pérot (FP) sensors are of particular interest. These employ an interferometric cavity at the fibre tip, formed by two partially reflective mirrors separated by a spacer. Acoustic pressure modulates the optical path length within this cavity, altering the reflected optical power in proportion to the local acoustic pressure. FP sensors typically provide higher sensitivity than other hydrophone types; however, further optimisation is needed to extend their dynamic range, achieve a more uniform frequency response and ensure robustness to high-pressure fields.

To guide this optimisation, we model FP sensors as elastic glass cylinders immersed in water, allowing prediction of their acoustic response prior to manufacture. We developed a finite element simulation framework in ANSYS and benchmarked it against analytical models. Test cases included scattering of a plane wave by a fluid sphere and an elastic cylinder. The simulated frequency and directivity responses agreed well with analytical results (Figure 1), yielding an RMS error of 5% and a maximum error of 10%. These results demonstrate that ANSYS provides a reliable framework for simulating FOH performance and supporting HIFU system design and characterisation.

References

[1] U. Ankerhold, M. P. Toni, M. Weber, V. Wilkens, G. Xing, and P. Yang, “Review of field characterization techniques for high intensity therapeutic ultrasound,” Metrologia, vol. 58, no. 2, p. 022001, Feb. 2021, doi: 10.1088/1681-7575/ABE02E.

[2] G. R. Harris et al., “Hydrophone Measurements for Biomedical Ultrasound Applications: A Review,” IEEE Trans Ultrason Ferroelectr Freq Control, vol. 70, no. 2, pp. 85–100, Feb. 2023, doi: 10.1109/TUFFC.2022.3213185.

[3] P. C. Beard, A. M. Hurrell, and T. N. Mills, “Characterization of a Polymer Film Optical Fiber Hydrophone for Use in the Range 1 to 20 MHz: A Comparison with PVDF Needle and Membrane Hydrophones,” 256 ieee transactions on ultrasonics, ferroelectrics, and frequency control, vol. 47, no. 1, 2000.

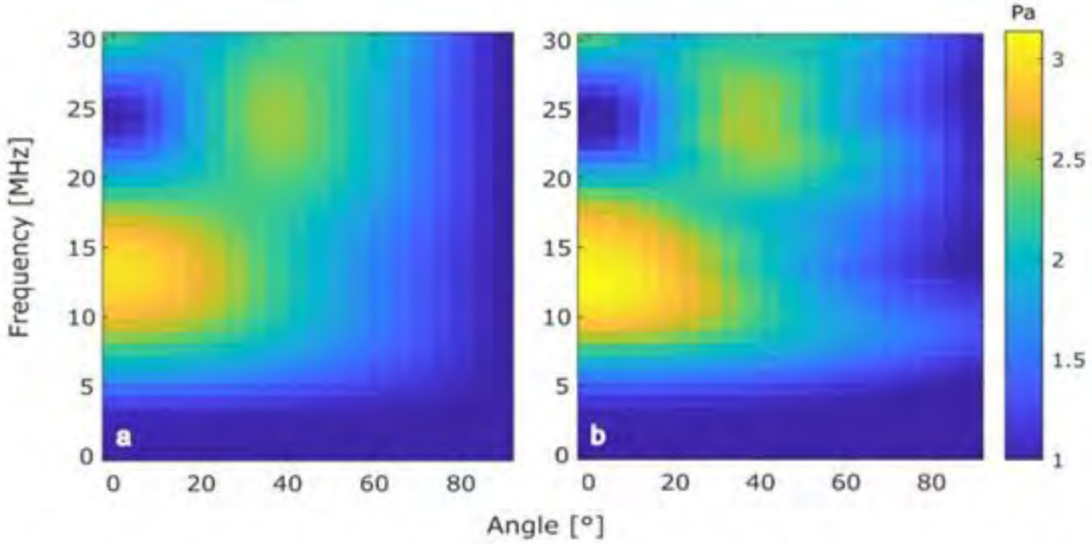

Figure 1. Directivity for the rigid piston between 0° and 90° from 0 to 30 MHz (a) Analytical calculation. (b) Modelled directivity in ANSYS.

Numerical simulations of elastic wave propagation in solid materials containing a random distribution of spherical particles

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

The propagation of elastic waves in multiply scattering solid media is an old problem that has been less studied than the case of acoustic waves in fluids or electromagnetic waves. One of the reasons lies in the existence of conversions between longitudinal and transverse waves at the surface of each scatterer. This work presents a new method for simulating elastic wave propagation in heterogeneous media composed of spherical inclusions embedded in a solid matrix. The MuScat code, initially developed to simulate acoustic wave propagation in heterogeneous fluids [1], is adapted to take into account the vector character of elastic waves in three dimensions. It is based on the analytical solution of the multiple scattering equations using the spherical harmonic expansion of the incident and scattered fields, which allows to consider very large dispersions of particles. We validate the code by comparing the numerical results to experiments performed with samples made of epoxy resin containing tungsten carbide spheres [2]. Then, an alternative method for characterising multiply scattering media is presented. It is based on the measurement of the field within the medium. This numerical approach opens up prospects for the study of the multiple scattering of elastic waves (coherent field, fluctuations).

[1] A. Rohfritsch, J. M. Conoir, R. Marchiano, T. Valier-Brasier, Numerical simulation of two-dimensional multiple scattering of sound by a large number of circular cylinders, The Journal of the Acoustical Society of America, 145, 3320–3329, 2019.
[2] A. Simon, Q. Baudis, R. Wunenburger, T. Valier-Brasier, Propagation of elastic waves in correlated dispersions of resonant scatterers, The Journal of the Acoustical Society of America, 155, 3627–3638, 2024.

Development, control and testing of a serial low intensity pulsed ultrasound (LIPUS) device for cell stimulation

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Low-Intensity Pulsed Ultrasound (LIPUS) is a therapeutic modality arousing growing interest among clinicians to promote bone healing. Bone is a mechanosensitive tissue capable of responding to mechanical loads through a process known as mechanotransduction. However, the underlying mechanisms triggered by ultrasound stimulation remain poorly understood and this lack of knowledge fuels controversy and prevents the development of optimized LIPUS-based therapies. To improve understanding of bone cell mechanotransduction under LIPUS stimulation, in vitro studies on cell culture models are essential. For this purpose, a serial LIPUS stimulator (Figure 1) and its numerical twin have been developed to perform ultrasonic stimulation of cells cultured in Petri dishes while precisely controlling both acoustic and biological conditions.

Based on previous work [1], a 1 MHz divergent-focusing transducer (Imasonic, France) was designed and implemented in the serial LIPUS stimulator to obtain a homogeneous acoustic field across the entire cell culture area. Moreover, to prevent reflections and standing waves inside the culture medium, a dedicated anti-reflection cover [2] was developed to control the acoustic intensity delivered to the cells (Figure 1).

The acoustic part of the setup was validated both experimentally and numerically [3]. The device is now being tested in an incubator to confirm proper operation under controlled biological conditions (37 °C and 5 % CO_2). A first series of tests on bone cells (MLO-Y4) was carried out to evaluate the influence of different acoustic parameters. Gene expression analysis will allow to identify the effects of LIPUS stimulation on cells.

The results obtained validate the use of the stimulation device for studying the effects of LIPUS stimulation on cells. They also provide initial data on ultrasound parameter optimization in the context of bone regeneration.

[1] Doveri E, Majnooni M, Guivier-Curien C, Baron C, Lasaygues P. Computational model to address lens-based acoustic field aperture in the in vitro ultrasonic cell stimulation. Ultrasonics. 2024 Mar;138:107226.

[2] Majnooni M, Doveri E, Baldisser J, Long V, Houles J, Scimeca J-C, et al. Anti-reflection cover to control acoustic intensity in in vitro low-intensity ultrasound stimulation of cells. Acta Acust. 2022a;6:11.

[3] Majnooni M, Lasaygues P, Long V, Scimeca J-C, Momier D, Rico F, et al. Monitoring of in-vitro ultrasonic stimulation of cells by numerical modeling. Ultrasonics. 2022b Aug;124:106714.

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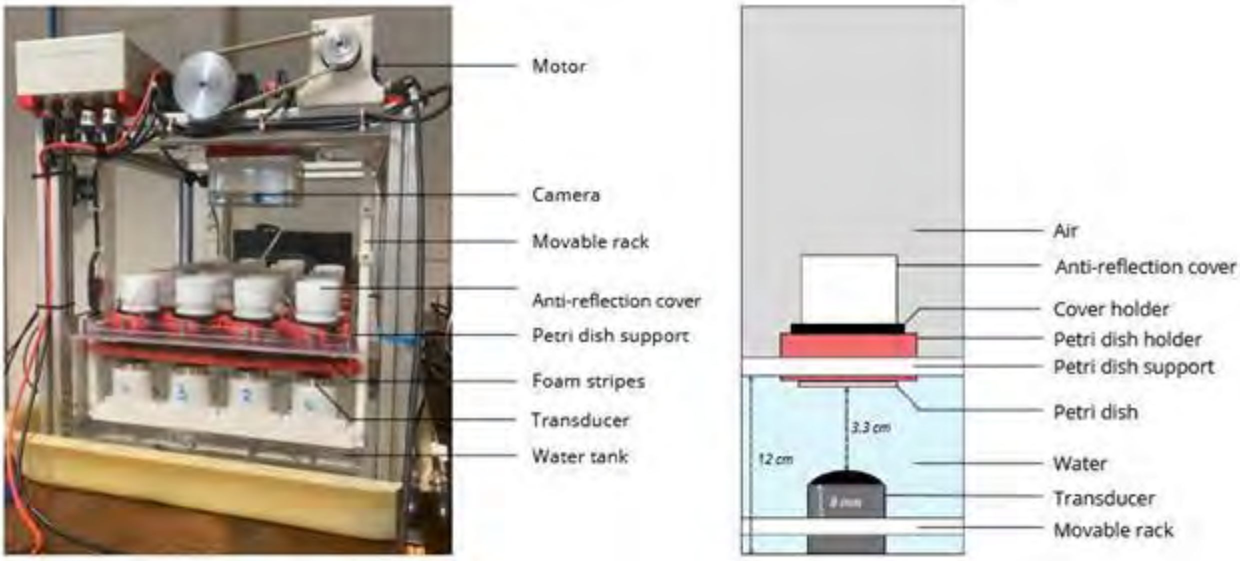

Motor
Camera
Movable rack
Anti-reflection cover
Petri dish support
Foam stripes
Transducer
Water tank
Air
Anti-reflection cover
Cover holder
Petri dish holder
Petri dish support
Petri dish
3.3 cm
12 cm
Water
Transducer
Movable rack

Ultrasonic ToF Technique for SoC Estimation in LiIon Batteries

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Accurate estimation of the State of Charge (SoC) is a key requirement for the safe, reliable, and efficient operation of lithium-ion batteries, especially in electric vehicles and energy storage systems. Conventional estimation techniques based on voltage, current and impedance measurements are often face limitations due to their dependence on complex electrochemical models, hysteresis effects, and temperature variations [1] [2]. To overcome these issues, this study investigates a non-destructive ultrasonic approach for SoC monitoring, based on time of flight (ToF) measurements and the associated variation in acoustic wave velocity during the charge/discharge process [1] [3].

The experimental setup employs a flat lithium-ion pouch cell, whose internal layers (electrodes, separator, etc.) are parallel, providing a well-defined acoustic transmission path for longitudinal ultrasonic waves. The cell is immersed in the oil during measurements to ensure stable acoustic coupling and minimize signal loss at the interfaces. Ultrasonic transducers are positioned on opposite sides of the cell to measure the transmitted signal.

Experimental observations reveal a consistent correlation between the SoC and the ToF of the ultrasonic pulses. As the cell charges, the acoustic velocity increases due to changes in the elastic and structural properties of the active materials, such as density, stiffness, and lithium concentration. These findings confirm that acoustic wave propagation is highly sensitive to the internal mechanical and compositional state of the electrodes.

The proposed ultrasonic method provides a contactless, non-invasive diagnostic tool and capable to provide real time information on the internal mechanical state of the cell. These features make it a promising alternative to traditional electrochemical techniques for SoC estimation. Ultimately, this work contributes to the development of advanced battery management systems (BMS) that integrate ultrasonic sensing for improved SoC estimation and predictive health monitoring of lithium-ion batteries.

Keywords: Lithium-ion battery, ultrasound, time of flight, State of charge SoC

[1] Greg Davies et al 2017 J. Electrochem. Soc. 164 A2746. Doi: 10.1149/2.1411712jes
[2] Purim Ladpli et al 2018 J. of Power Sources. 384 342-354. Doi: 10.1016/j.jpowsour.2018.02.056
[3] Yuanyau Pan et al 2025 Energies. 18 1026. Doi : 10.3390/en18051068

Statistical Classification of Cracks on Corroded Surfaces in Ultrasound Images

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

The accurate identification of cracks within areas of general corrosion on rough surfaces remains a significant obstacle in non-destructive testing. This capability is vital for structural integrity assessment, as the presence of cracks can lead to catastrophic structural failure more rapidly than corrosion alone. To address this, our research explores a segmentation methodology for ultrasonic full matrix capture array datasets, leveraging statistical classifiers to partition images into three classes: pristine, crack/defect, and corrosion. We specifically evaluate the efficacy of the Kolmogorov-Smirnov (K-S) test alongside measures of skewness and kurtosis. The performance of each classifier is quantitatively assessed through receiver operating characteristic analysis, utilizing a combination of simulated and experimentally measured array datasets. This evaluation guides the optimization of classifier parameters and the development of a balanced framework aimed at maximizing defect detection while mitigating false identifications. The findings reveal a distinct performance trade-off: a combined skewness-kurtosis classifier provides excellent crack delineation in isolation but proves unreliable for cracks in close proximity to corroded regions. In contrast, the K-S test demonstrates high sensitivity in detecting both cracks and corrosion, yet exhibits a tendency to confuse genuine defects with the geometrical echoes from corrosion edges. This comparative analysis delineates the specific operational constraints and practical suitability of each statistical method for in-service inspection.

Ultrasound mediated nanodrug delivery for pancreatic cancer

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Pancreatic cancer is the fifth leading cause of cancer-related deaths in the UK, causing more than 8,000 deaths in 2020. It has a five-year survival rate of around 8.3%, according to statistics collected between 2016 and 2020 [1]. This poor prognosis is largely due to the late diagnoses of pancreatic cancers, at either stage 3 (locally advanced) or stage 4 (spread) of the disease, when most surgical therapies are no longer a feasible option. Whilst some surgical options remain available, these are highly invasive interventions that require a very long recovery period. Furthermore, although systemic chemotherapy and radiotherapy are often offered, either option is usually palliative rather than curative and both comes with significant side effect.

Ultrasound-mediated nanodrug delivery has shown promise in reducing systemic effects of toxicity associated with conventional drug administration, whilst enhancing efficacy at the disease site. Whilst trials on this type of therapy have already been conducted for breast, prostate and liver cancer, ultrasound-mediated nanodrug delivery has not yet been explored for pancreatic cancer. Due to the dense stroma and poor vasculature associated with pancreatic tumours, high interstitial fluid pressure can hinder drug delivery, and diffusing drugs into the tumour core will presents challenges. It is hypothesised that the application of ultrasonic acoustic radiation force (ARF) can help overcome these challenges and deliver drugs into the tumour core.

To test this hypothesis, we propose an in-silico platform that combines acoustic modelling with computational fluid dynamics. The geometry of tumour is approximated as nested spheres, the inner-most sphere representing the necrotic core of tumour. The interstitial fluid within each sphere is considered incompressible and homogenous. ARF calculations were carried out using the OptimUS Python library [2], using the total acoustic pressure field. ARF values at each grid point were exported and were subsequently used as input to an ANSYS Fluent model to calculate ultrasound-induced fluid velocity fields. The interstitial fluid flow was modelled by calculating the interstitial fluid pressure (IFP) based on Starling's Law, and by setting the external boundary as a pressure outlet, where the IFP was set to 0 Pa. The combination of the two fluid flow model results in a fluid velocity field map of tumour. The output was further combined with a calculation of drug transportation, enabling a comparison of the variation of drug concentration within the tumour with and without the application of ultrasound.

References

[1] Pancreatic Cancer UK (2024) Pancreatic cancer statistics, Pancreatic Cancer UK. Available at: https://www.pancreaticcancer.org.uk/what-we-do/media-centre/pancreatic-cancer-statistics/ (Accessed: 27 October 2025).

[2] Gélat, P., Haqshenas, S. R., and van 't Wout, E. (2022), OptimUS: A Python library for solving 3D acoustic wave propagation, https://github.com/optimuslib/optimus

High-Frequency Medical Ultrasound Array made with Textured Piezoceramics

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Ultrasonic transducer arrays are employed across diverse medical applications, with performance strongly governed by the choice of piezoelectric material. Single crystal piezoelectrics have exceptional performance, especially for imaging applications, due to their superior electromechanical properties. However, compared to piezoceramics like PZT, their broader deployment is restricted by the high cost of crystal growth and challenges in scaling to large or complex geometries. These limitations have driven interest in finding alternatives, with textured piezoceramics emerging as a promising option.

Textured piezoceramics combine features of both traditional polycrystalline ceramics and single crystals. They exhibit a high degree of crystallographic orientation, typically achieved through a process called templated grain growth [1], resulting in electromechanical properties close to those of single crystals, while maintaining cost efficiency through production processes with potential for the largest quantities of commercial material supply Although still an emerging technology, with only a few companies currently supplying textured material samples, the growing number of research studies and demonstration devices indicates the potential for wider adoption.

In this study, a 64-element one-dimensional linear array utilising textured piezoceramic (QorTek, PA, USA) was designed, simulated (PiezoCAD, Sonic Concepts, WA, USA), and successfully fabricated. The array The array comprises a 2-2 connectivity piezocomposite array, with a 100 μm element pitchtch, requiring lapping to a thickness corresponding to a centre frequency, fC = 15 MHz. A 5 mm-thick backing layer made with alumina-loaded Epo-Tek 301 (Epoxy Technology, Inc., MA, USA) was used to achieve an acoustic impedance, ZB = 6.7 MRayl. Two acoustic matching layers were cast onto the front face: a 30 μm-thick layer of Epo-Tek 301 mixed with 2 – 3 μm silver powder, followed by a 30 μm-thick layer of Parylene C, which also served as a biocompatible waterproof coating.

Preliminary characterisation was conducted, with Figures 1(a) and (b) comparing the simulated and measured impedance magnitude / phase spectra, respectively, for a representative element. The measured impedance spectrum, Figure 1(b), exhibits an electrical resonance frequency, fe ~14.8 MHz and a mechanical resonance frequency, fm ~17.1 MHz. The measured pulse-echo response, Figure 1(d), demonstrates a centre frequency, fC = 15.3 MHz, which is in close agreement with the simulated result, fC = 15.0 MHz, Figure 1(c). Performance analysis shows a theoretical peak-to-peak signal amplitude, Vpp-tex = 13.98 mV/V and -6 dB bandwidth, BWtex = 48.8%. Figure 2(b) shows the simulated two-way insertion loss of the textured material is ILtex = 14.2 dB at 15.5 MHz. In comparison, simulated results with PZT-5H piezoceramic (PZ29, CTS Ferroperm, Kvistgaard, Denmark) and PIN-PMN-PT single crystal (TRS Technologies, PA, USA) show equivalent values, ILpzt = 14.6 dB at 15.3 MHz, Figure 2(a), and ILpin=11.7 dB at 15.9 MHz, Figure 2(c).

These preliminary results indicate that textured piezoceramics hold significant potential as an alternative to single crystals for high-frequency ultrasound transducer applications, with performance exceeding PZT but below PIN-PMN-PT.

[1] G. L. Messing, S. Trolier-McKinstry, et al. “Templated grain growth of textured piezoelectric ceramics,” Critical Reviews in Solid State and Materials Sciences, vol. 29, no. 2, pp. 45–96, 2004

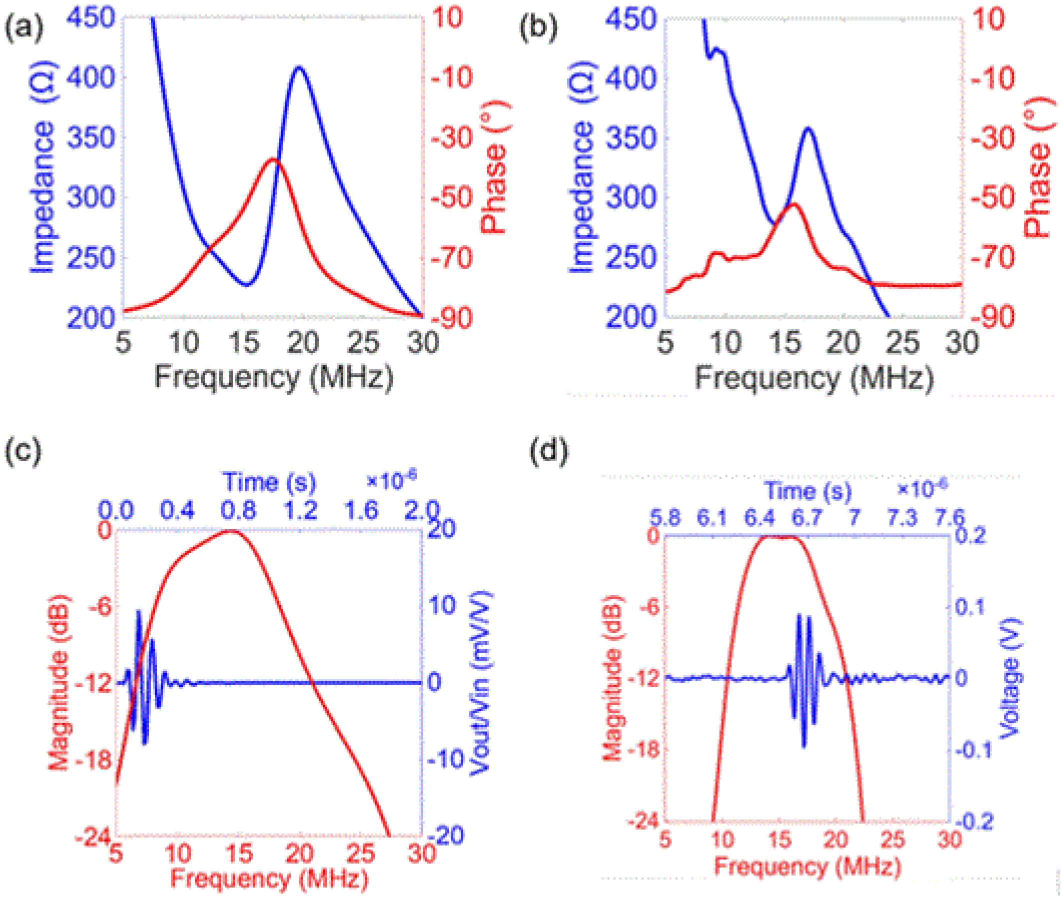

Figure 1. (a) Simulated and (b) measured impedance magnitude / phase spectra and (c) simulated and (d) measured pulse-echo response of a representative array element.

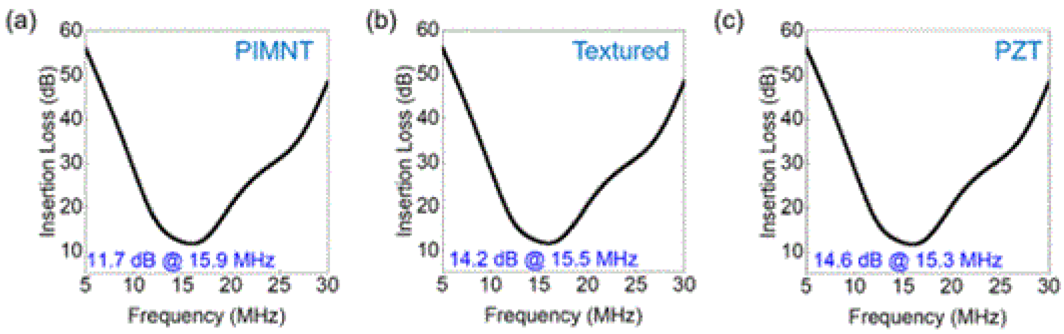

Figure 2. Simulated insertion loss of (a) PIN-PMN-PT single crystal, (b) textured ceramic, and (c) PZ29 ceramic.

Fast analytical models for the non-linear scattering of elastic waves at a contact interface

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Non-Destructive Testing (NDT) of industrial components seeks the early-stage detection of defects occurring during service. Cracks can be notably initiated by fatigue due to cyclic loading or by stress corrosion in components under residual stress in a corrosive environment. For both failure mechanisms, the crack develops progressively, with the crack root opening first, while a portion of the crack tip is still closed.
Conventional ultrasonics require an acoustic impedance contrast at the crack faces to produce an echo and are therefore only sensitive to the opened portion of a crack, which leads to a systematic underestimation of the crack length. Nonlinear ultrasonic (NLUS) methods are able to detect micro-cracks, imperfect interfaces (kissing bonds, closed cracks, etc…) since they give rise to a measurable acoustic non-linearity such as the appearance of higher or lower harmonics.
In order to quantify nonlinear effects generated by closed cracks, it is of great interest to simulate their interaction with ultrasounds. In that goal, several models have been designed. We have shown that a 1D analytical model we have derived from [1] (using a unilateral contact law at a planar interface), and whose algorithm has been optimized is ten times faster than a finite differences model. We have then proposed a 2D preliminary analytical model: it leads to a good agreement with Finite Elements (FEM) [2] for low incident angles. Future works are foreseen to improve the model hypotheses and extend its validity.

[1] J. M. Richardson, « Harmonic generation at an unbonded interface—I. Planar interface between semi-infinite elastic media », Int. J. Eng. Sci., vol. 17, no 1, p. 73-85, janv. 1979, doi: 10.1016/0020-7225(79)90008-9.
[2] P. Blanloeuil, Analyse de la non-linéarité acoustique de contact pour l' évaluation et le contrôle non destructif. PhD thesis Université Bordeaux 1, 2013. Consulté le: 6 janvier 2015. [En ligne]. Disponible sur: http://www.theses.fr/2013BOR14852

Coherent multi-transducer ultrasound imaging in harmonic mode

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Ultrasound is a widely used clinical imaging tool, offering well-established advantages in portability, safety, and cost over other imaging modalities. However, the field of view (FoV), sensitivity and resolution of conventional ultrasound scanners are constrained by the probe aperture size. Coherent multi-transducer ultrasound (CoMTUS) addresses these limitations by coherently combining received signals from multiple arrays to form a large effective aperture, enabling an extended FoV, improved lateral resolution, and higher signal-to-noise ratio.

To date, CoMTUS has been demonstrated mainly for fundamental imaging. However, imaging in high acoustic clutter and low-contrast scenarios using large apertures remains challenging: clutter degrades image quality and the accuracy of inter-array calibration required for coherent imaging. Harmonic imaging, which exploits nonlinear ultrasound propagation, is widely used for its ability to suppress acoustic clutter and enhance spatial resolution. In this work, we unite the CoMTUS paradigm with harmonic imaging, demonstrating coherent combination of harmonic echoes across multiple arrays. The results highlight the potential for enhanced image quality, reduced clutter, and improved inter-array calibration robustness, paving the way for next-generation large-aperture harmonic ultrasound systems.

The proposed transmission sequence and processing pipeline are outlined in Fig. 1(a). CoMTUS was implemented using two synchronized ULA-OP 256 systems driving a pair of 128-element phased arrays. Diverging waves were transmitted at 1.5 MHz in alternating pulse-inversion (PI) sequences, where successive pulses of opposite polarity are transmitted by each array. The corresponding received echoes on both arrays were then summed to cancel the fundamental component and enhance the harmonic signal. Seven steering angles (±8°) were used per array. Data were acquired in a CIRS phantom and in a water–wire phantom with a scattering mesh to simulate clutter. Summed PI signals ($Ti{+}Rj{+}Ti{-}Rj$, where $TiRj$ denotes data received by array j when array i transmits) were band-pass filtered for fundamental (1.5 MHz) and harmonic (3 MHz) modes before beamforming. The calibration process jointly optimized array positions and speed of sound, with separate parameter sets derived for fundamental and harmonic data.

Overall, PI CoMTUS produced marked improvements in spatial resolution and clutter suppression. Fig. 1(b) shows the point spread function, where the CoMTUS lateral full-width at half-maximum (FWHM) improved from 0.86 mm to 0.41 mm in harmonic mode. Fig. 1(c) compares fundamental and harmonic CoMTUS images from the wire phantom with a scattering layer, demonstrating reduced clutter and sharper point targets with harmonic image. In the CIRS phantom (Fig. 1(d)), generalized CNR of the anechoic cysts improved from 0.54±0.23 to 0.88±0.06. Preliminary in-vivo experiments further confirm these gains.

The presentation will conclude with a discussion of remaining challenges for harmonic CoMTUS, including coded-excitation to preserve frame rate, mitigation of aberration, the integration of advanced beamformers within the framework, and perspectives on real-time in-vivo applications.

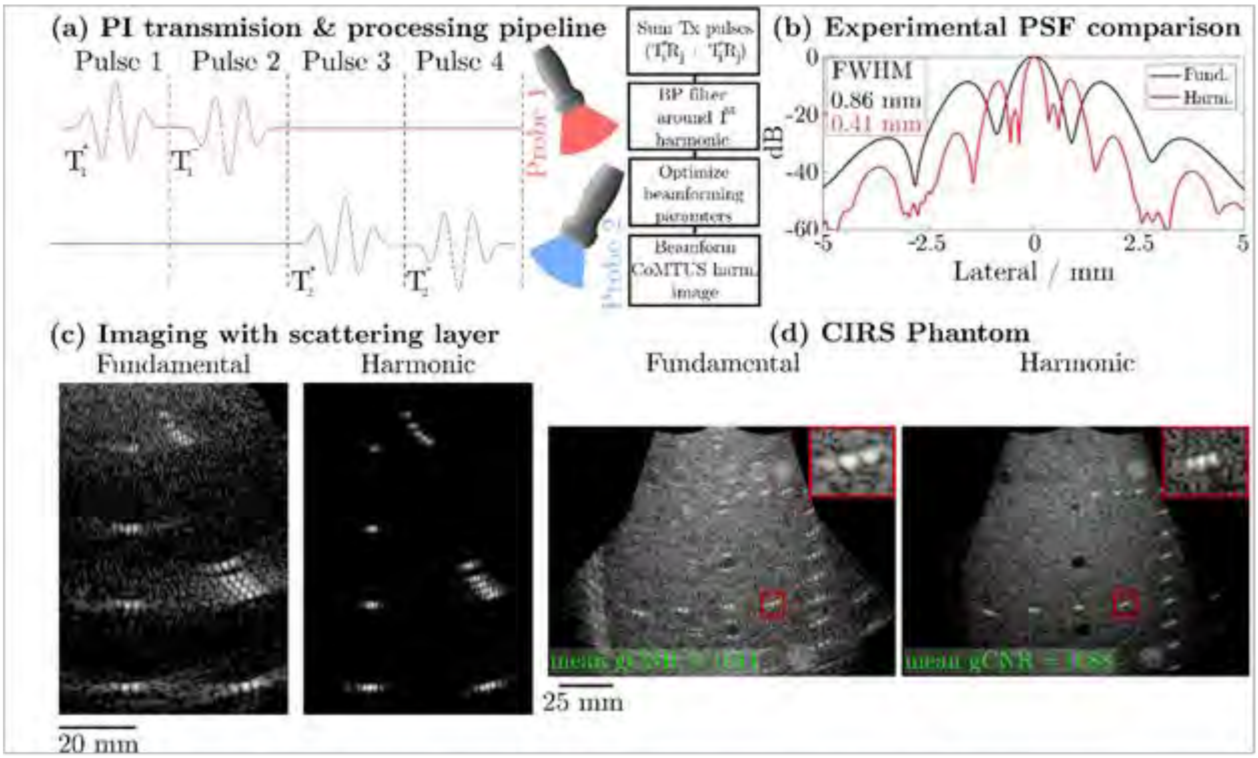

Figure 1: (a) Working principle of CoMTUS harmonic imaging. Arrays take turns to transmit in and out-of-phase pulses, while both arrays receive. (b) Profile showing fundamental (black) and harmonic (red) PSF. (c) B-modes images from phantom with scattering mesh layer in place. (d) B-mode images, and anechoic gCNR results from CIRS phantom.

Domain decomposition method for coupling semi-analytical form and finite element models of wave propagation: validation and convergence study

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

The purpose of the study is to simulate experiments in Non Destructive Testing, Structural Health Monitoring or Imaging involving arbitrarily large layered structures. That structure supports local features of small size (e.g. stiffeners, sensors, other multi-physical entities) which disturb wave propagation. We aim to quantify the effects of these added features on the wave propagation within the main structure. The latter being large, standard 3D numerical methods, such as the Finite Element (FE) method, are prohibitive.

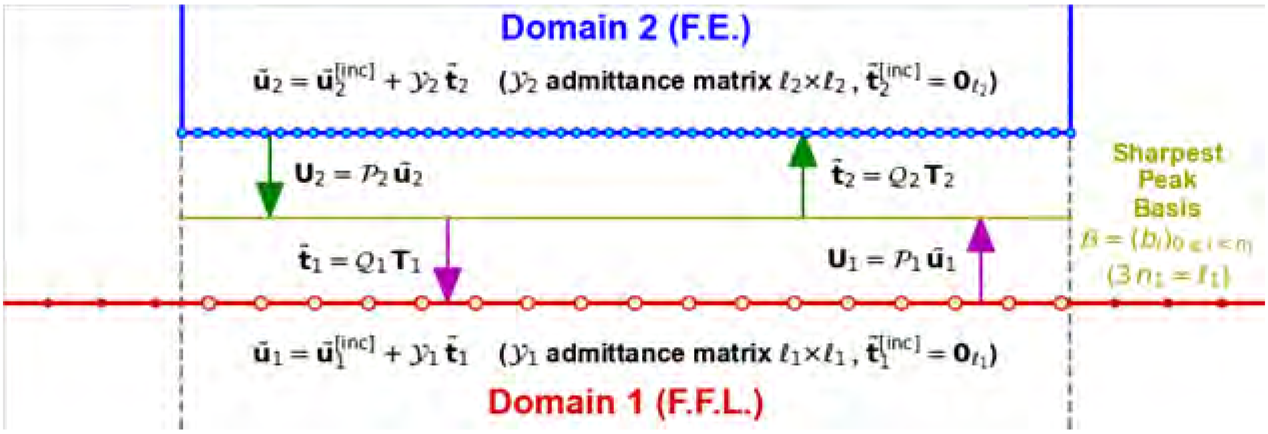
On the other hand, the added features lend themselves well to FE modeling. Furthermore, the in-house Transient Field Computation sofware (TraFiC[1]) based on the Fourier Fourier Laplace (FFL[2]) method can efficiently simulate the propagation in large flat or cylindrical layered waveguides in the absence of features. We thus formulate and implement a hybrid method that combines the (very different) solution methods used for each subsystem and relies on a Domain Decomposition Method (DDM).

We adopt a non-overlapping iterative DDM approach, where the structure and added features are treated as distinct subdomains. Each iteration consists in solving a boundary-value problem in each subdomain. The boundary data on the coupling interface is, at each iteration, defined using the solutions in both subdomains from the previous iteration. Following available research [3] on DDMs for Laplace and Helmholtz equations, we set a sequence of Robin (impedance-like) boundary conditions (BCs) on the coupling interface. The resulting Robin-Robin (RR-DDM) iterations are shown to converge in each subdomain to solutions that satisfy the requisite kinematic and dynamic transmission conditions, and are in this work implemented in hybrid form.

In this communication, following our presentation of the overall methodology at the previous AFPAC, we focus on studying its convergence. To this aim, a non-iterative form of the hybrid coupling providing a comparison numerical solution for the same discretization approaches is built by using (for the FEM subdomain) condensation on the coupling interface; the resulting linear system exploits admittance matrices and Green tensors in an abstract function space regarded as sequences of impulses approaching Dirac distributions (see Fig. 1, where the vectors u and t denote displacement and traction at the interface between the two domains, with incident waves identified by the '[inc]' superscript).
Moreover, the same approach also allows to implement the RR-DDM iterations as a matrix geometric sequence for the interfacial DOFs, whose convergence rate depends on the spectral radius of the iteration matrix and is computationally studied. The foregoing methodology, computationally prohibitive for 3D applications, is
feasible for 2D test configurations, providing tools for assessing and fine-tuning our proposed iterative RR-DDM methodology. Numerical solutions obtained by our hybrid RR-DDM method will additionally be compared to corresponding results yielded by full FEM computations.

Research project financially supported by the DGA-AID and the CEA.

[1] https://github.com/eric-ducasse/TraFiC
[2] Mora et al., Ultrasonics 2016, doi: 10.1016/j.ultras.2016.03.020.
[3] https://hal.science/cel-01100932v4



Acoustic Cavitation Classification: A Machine Learning Approach Using Multiple Bubble Dynamics Models and Stability Criteria

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Accurate classification of acoustic cavitation regimes, transient and stable, is important for both therapeutic and imaging applications of ultrasound. Conventional cavitation threshold maps typically rely on a single physical model and a single classification metric, making their predictions highly sensitive to modelling assumptions, particularly at high ultrasound intensities or near bubble resonance. This work [1] presents a physics-informed machine learning framework trained on simulation data generated from three canonical bubble dynamics models: the Rayleigh-Plesset, Keller-Miksis, and Gilmore equations, covering a wide range of acoustic and material parameters. Cavitation regimes are classified using four criteria: maximum bubble radius, acoustic Mach number, acoustic emission statistics, and a novel metric based on Flynn's inertial-pressure criterion. The framework also incorporates Lyapunov exponents to distinguish between transient and chaotic behaviour under certain regimes. Ensemble and multi-objective machine learning models achieve over 82% accuracy on test data and exhibit strong generalization beyond the training domain. The resulting cavitation likelihood charts reveal complex, nonlinear dependencies on acoustic pressure, frequency, temperature, and initial bubble radius. This approach offers probabilistic insights into cavitation likelihood, integrating deterministic modelling with data-driven strategies and offering enhanced interpretability through dynamical systems analysis.

[1] Trinidad Gatica, Elwin van 't Wout, Reza Haqshenas; Classifying acoustic cavitation with machine learning trained on multiple physical models. Physics of Fluids 1 March 2025; 37 (3): 037116. https://doi.org/10.1063/5.0255579

The Development of New Tissue Mimicking Materials for the Assessment of Nonlinear Imaging Techniques

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Accurate acoustical characterisation of materials is fundamental to ensuring the reliability and performance of diagnostic ultrasound systems. Quality assurance (QA) programmes rely on tissue-mimicking phantoms with well-defined and stable acoustic properties to verify scanner performance throughout clinical use, during research and development, and to support informed procurement and replacement decisions. The Edinburgh Pipe Phantom (EPP) is one such QA test object, providing a single figure of merit, the resolution integral, that has been extensively validated for assessing ultrasound scanner performance across a wide range of imaging configurations [1].

The effectiveness of phantoms such as the EPP is dependent on the acoustic behaviour of the phantom material replicating that of soft tissues. This requires accurate characterisation of the phantoms tissue mimicking materials (TMM) for key acoustic parameters including speed of sound, attenuation, and the nonlinearity parameter, B/A. The accurate measurement of B/A in particular is essential for evaluating imaging techniques that exploit nonlinear propagation, such as tissue harmonic imaging. Ensuring that phantom TMMs exhibit appropriate nonlinear responses is therefore essential to accurately assess new and emerging ultrasound techniques.

For soft tissues, B/A values are known to increase with fat content [2]. However as, the IEC agar-TMM used in the EPP is water-based, alternative approaches were required to achieve physiologically relevant nonlinear behaviour. Previous studies have shown that increasing the salinity of pure water can increase B/A ~ 5%–20% [3]. These findings have been implemented in the development of a modified salt-based agar-TMM designed to increase B/A values.

Hence building on previous work at the National Physical Laboratory [4] a new measurement system based on the finite-amplitude insertion substitution (FAIS) technique has been implemented, incorporating a 5-axes motorised tank to improve positional accuracy, repeatability, and control over beam alignment. Using the upgraded FAIS system, speed of sound and attenuation measurements were acquired across the 1–20 MHz range for ethylene glycol (a well-established reference material), the standardised IEC agar TMM, and a new salt-based agar TMM. For both ethylene glycol and the standard IEC agar-TMM attenuation and speed of sound values matched those found in literature. For the new salt-based agar-TMM B/A values were found to have increased compared to the typical IEC agar-TMM while maintaining typical soft tissue values for attenuation and speed of sound, indicating that salinity-based modifications offer a viable route to modifying B/A in water-based phantom materials without compromising other key acoustic properties or manufacturability.

Ongoing and future work focuses on comprehensive B/A characterisation of varying levels of salinity in agar-TMM, with the aim of refining their nonlinear properties to better emulate soft tissue behaviour. This will enable the development of improved phantoms capable of assessing both current and emerging ultrasound techniques.

[1]Moran CM, Inglis S, Pye SD. The Resolution Integral for diagnostic ultrasound performance. Ultrasound. 2014;22:37–43. doi:10.1177/1742271X13518202
[2]Duck FA. Nonlinear acoustics in diagnostic ultrasound. Ultrasound Med Biol. 2002;28(1):1–18. doi:10.1016/S0301-5629(01)00463-X
[3]Coppens AB et al. Parameter of nonlinearity in fluids II. J Acoust Soc Am. 1965;38(5):797–804. doi:10.1121/1.1909806
[4]Zeqiri B et al. Acoustic nonlinearity measurement using FAIS. Metrologia. 2015;52(2):406–422. doi:10.1088/0026-1394/52/2/406

Experimental monitoring of polyethylene viscosity during rotomolding by ultrasonic nondestructive method

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

To reduce the global carbon footprint of automotive systems, hydrogen technology is one of the possible ways. Hydrogen storage tanks are mostly equipped with liners manufactured by rotational molding of polyethylene. Actually, the main parameter available for the monitoring of the rotomolding cycle is the internal temperature inside the mold. To ensure high performance for the next generation of storage tanks, new reliable indicators are required. The objective of this work is to propose an in situ and in operando characterization method to monitor the evolution of the polymer's complex viscosity during processing. A particularly attention is paid on the cooling phase, where the polymer changes from a fluid to a solid state.
Previous study has established a relationship between the acoustic properties of molten polyethylene and its viscosity measured by oscillatory rheometer as a function of temperature [1]. In parallel, a dedicated instrumentation system has been developed to monitor in situ and in operando the evolution of the ultrasonic velocity in polyethylene during an industrial rotomolding cycle. In the present work, the evolution of ultrasonic velocity as a function of complex viscosity is determined from rheological measurements conducted under temperature sweeps. These results are then used to obtain the variation of polymer viscosity with temperature throughout a rotomolding fabrication cycle.
This acoustic monitoring highlights, in particular and at an early stage, phase transitions such as the onset of polymer solidification (i.e., crystallization), which play a key role in the final quality of the rotomolded part. The results demonstrate that the proposed method provides a non-destructive tool for controlling the viscoelastic properties of polyethylene during processing. Our method can be extended to other polymer materials.

This work paves the way for optimizing the rotomolding process, through reduced manufacturing time, and energetically optimized cycle.

[1] Houhat, N., Devaux, T., Callé, S., Saengdee, L., Boucaud Gauchet, S., & Vander Meulen, F. (2025). Monitoring of polymer viscosity by simultaneous ultrasonic and rheological measurements at high and varying temperatures. AIP Advances, 15(3).

A robust indentation methodology for reproducible characterisation of the mechanical properties of soft materials

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Characterising the mechanical properties of soft materials, such as biological tissues and hydrogels (elastic modulus typically 1-100 kPa), presents a significant challenge due to considerable measurement variability across different techniques and laboratories. A reliable reference soft material identification technique is especially needed for the robust assessment of ultrasound elastography systems. This study introduces a robust indentation methodology designed to enhance measurement reproducibility through the standardisation of both the experimental setup and the associated mathematical analysis.

The developed approach employs a precision-controlled indentation apparatus, featuring high-resolution force/depth detection and sensitive initial contact detection. A key aspect of this methodology is a rigorous mathematical identification procedure that integrates different tools, including a finite element model. This integration facilitates the development of specific correction factors that address inherent assumptions made by standard analytical contact models.

Experimentally acquired load-displacement data are then utilised to accurately identify the target material properties. The contributions of various sources of uncertainty (e.g., accuracy of the force and displacement sensors) are systematically quantified to determine the overall uncertainty of the identified mechanical properties. The identified mechanical properties were found to be close to those obtained from an ultrasound elastography system but exhibited smaller overall uncertainty levels.

By consolidating these aspects into a single, reliable framework, this protocol substantially improves the reproducibility and reliability of soft material characterisation, offering a robust solution including the assessment of ultrasound elastography systems.

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References:
[1] H. Koruk, Development of an improved mathematical model for the dynamic response of a sphere located at a viscoelastic medium interface, European Journal of Physics, 43, 2022, 025002, https://doi.org/10.1088/1361-6404/ac4647.
[2] A.V. Alvarenga, K.V. Ramnarine, H. Koruk, S. Rajagopal, Assessment of the uncertainty of shear wave speed measurements in ultrasound elastography, Ultrasonics, 160, 2026, 107891, https://doi.org/10.1016/j.ultras.2025.107891.

SH wave imaging with synthetic arrays of magnetostrictive patches

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Magnetostrictive patches (MPs) are an alternative to piezoelectric transducers for emitting/receiving ultrasonic waves in solids. They consist of a strip of highly magnetostrictive material glued to the part (in which we want to transmit/be sensitive to elastic waves) and a coil in which, during transmission, a high-frequency current is circulated, inducing a dynamic magnetic field. The strip is magnetized at a static field level; the magnetostriction induced by the dynamic field around the static operating point creates a mechanical vibration that propagates through the strip and the glue to the part. By adjusting the direction of the static magnetic field, the shape of the coil, and the excitation current (frequency, bandwidth), all kinds of dynamic stresses can be created to generate all types of waves, including transverse horizontal waves. MPs have numerous potential applications in NDT and SHM.
A model has been developed to predict the guided wave field (GW) generated by a MP [1]. Here, the model is extended to deal with array of MPs, and, by reciprocity, with reception by an array of MPs.
A specific coil is considered, designed to selectively radiate SH waves over a large angular spectrum. By moving the coil along the surface of a long magnetostrictive strip, it is possible to obtain any pitch desired and, for example, optimally focus SH waves with a large aperture without any sidelobes. Since a similar approach can be used for reception, it is possible to implement all kinds of imaging algorithms for guided waves using only two magnetostrictive strips and two coils. Examples will be given to exemplify the interest of the overall method.

[1] G. Cousin, A. Lhémery, S. Grondel, “A model to predict the elastic field radiated by a magnetostrictive patch transducer into an omnidirectional waveguide,” J. Phys.: Conf. Ser. 1761 (2021) 012005.

Precision bone surgery with an adhesive-free class IV flextensional transducer

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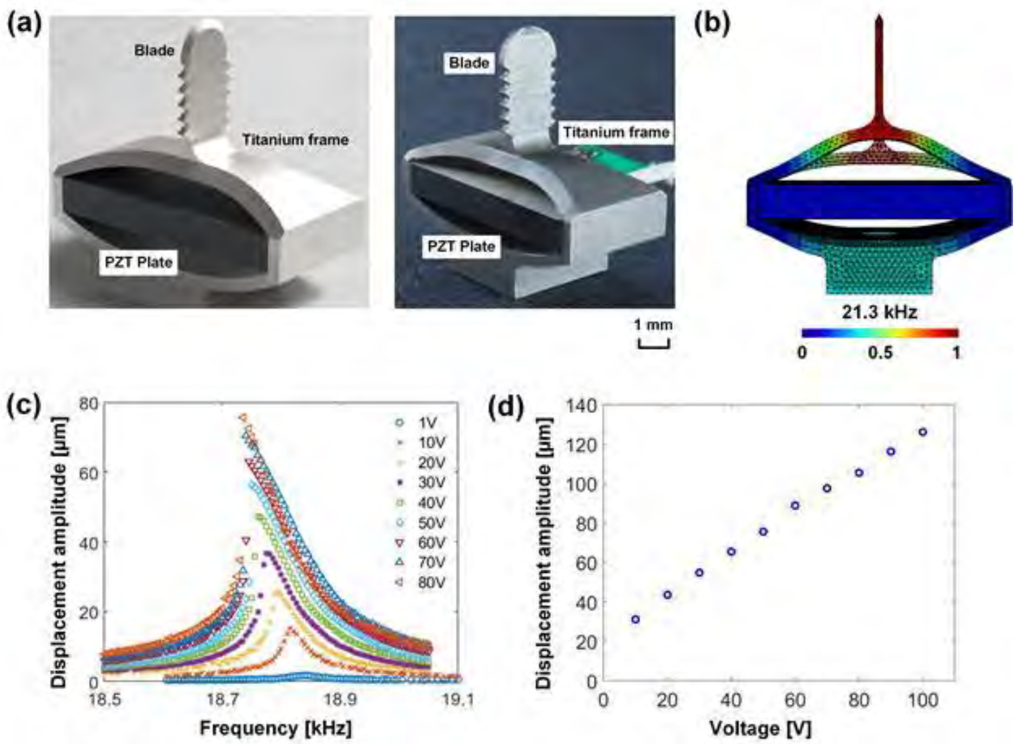
Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Precision bone surgery requires ultrasonic surgical devices capable of delivering large displacement amplitude at the surgical blade, with low cutting force, high surgical precision, minimal collateral damage to surrounding tissue, and being able to differentiate tissue types for selective resection. Conventional design of ultrasonic bone scalpels is typically based on bolted Langevin transducer (BLT) configuration, consisting of two metallic end masses, sandwiching a stack of piezoelectric material with an attached surgical blade. The BLTs must be tuned to resonance to achieve large displacement amplitude at the blade to dissect bone, which presents challenges for minimally invasive robotic surgeries that require miniature size and lightweight ultrasonic surgical devices to be guided through tortuous anatomical spaces within the body.

Flextensional transducers offer a promising alternative, which effectively transform small strains generated from the piezoelectric element into significantly amplified mechanical displacement through the flexure of a metal shell. However, conventional flextensional designs rely on adhesive bonding between the piezoelectric element and the shell, which introduces viscoelastic damping and potential failure at high voltage levels necessary for ultrasonic bone cutting. In this study, we introduce a novel adhesive-free miniature class IV flextensional transducer that employs structural pre-stress within the metal shell to securely house the piezoelectric plate, thereby eliminating the need for bonding layers under high-voltage excitation, as shown in Fig. 1. Ex vivo hand-operated bone cutting experiments were conducted to evaluate the performance. The results demonstrate that the surgical device achieves high surgical precision, generating an over 100 µm peak-to-peak displacement amplitude at the surgical blade, confirming its potential for future integration with surgical robotic platforms.



Optimizing the COMSOL computation for Ultrasonic through-metal communication (UTMC) simulation

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Due to the Faraday cage effect radio waves cannot pass through metals. Therefore, it is not possible to communicate from one side of the metal barrier to the other using conventional wireless communication methods. This is critical in certain applications (e.g., nuclear, aerospace), where the sensor is placed across the metal barrier from where the user would access its data. Usual ways to circumvent this issue involve drilling holes and passing cables through the metal barrier. However, this often disrupts the structural integrity of the metal body, adds the difficulty in re-sealing these holes and increases the cost. An alternative option is to use ultrasound. Ultrasonic through-metal communication (UTMC) interest has increased greatly in the past two decades [1-5], and it allows communication of sensory data from an inaccessible location to the outer world.
COMSOL is a finite element analysis software that can allow us to simulate several changes in parameters before testing them in the real world. Simulations at high frequencies using COMSOL can be very computational expensive. The study focuses on reducing computational cost while preserving model fidelity. By shortening the backing layer by 25% and implementing low-reflecting boundary conditions, simulation time was reduced by nearly half in a single-input single-output (SISO) configuration, with negligible changes to the acoustic response. (Figure 1). While the simulation is not prohibitive to compute in 2D, these methods can effectively be used to save computational power in 3D simulations, parametric sweeps, when including more environmental effects (e.g., temperature variations, vibrations) or multiple input multiple output (MIMO) configurations. Further experiment will include extending this study to these simulation settings and compare the simulation results to the real world.

References

[1] J. Zhang, Z. Yu, H. Yang, M. Wu, and J. Yang, "Ultrasonic Wireless Communication Through Metal Barriers," Sound&Vibration, vol. 53, no. 2, pp. 2–15, 2019, doi: 10.32604/sv.2019.03783.
[2] D. J. Graham, J. A. Neasham, and B. S. Sharif, "Investigation of Methods for Data Communication and Power Delivery Through Metals," IEEE Transactions on Industrial Electronics, vol. 58, no. 10, pp. 4972–4980, 2011–10–01 2011, doi: 10.1109/tie.2010.2103535.
[3] J. D. Ashdown et al., "Multi-channel data communication through thick metallic barriers," in 2012 IEEE International Conference on Communications (ICC), 2012–06–01 2012: IEEE, pp. 4678–4683, doi: 10.1109/icc.2012.6364479.
[4] J. D. Ashdown, L. Liu, G. J. Saulnier, and K. R. Wilt, "High-Rate Ultrasonic Through-Wall Communications Using MIMO-OFDM," IEEE Transactions on Communications, vol. 66, no. 8, pp. 3381–3393, 2018–08–01 2018, doi: 10.1109/tcomm.2018.2805848.
[5] J. Zhang, M. Jiang, J. Zhang, M. Gu, and Z. Cao, "Ultrasonic Through-Metal Communication Based on Deep-Learning-Assisted Echo Cancellation," Sensors (Basel), vol. 24, no. 7, Mar 27 2024, doi: 10.3390/s24072141.

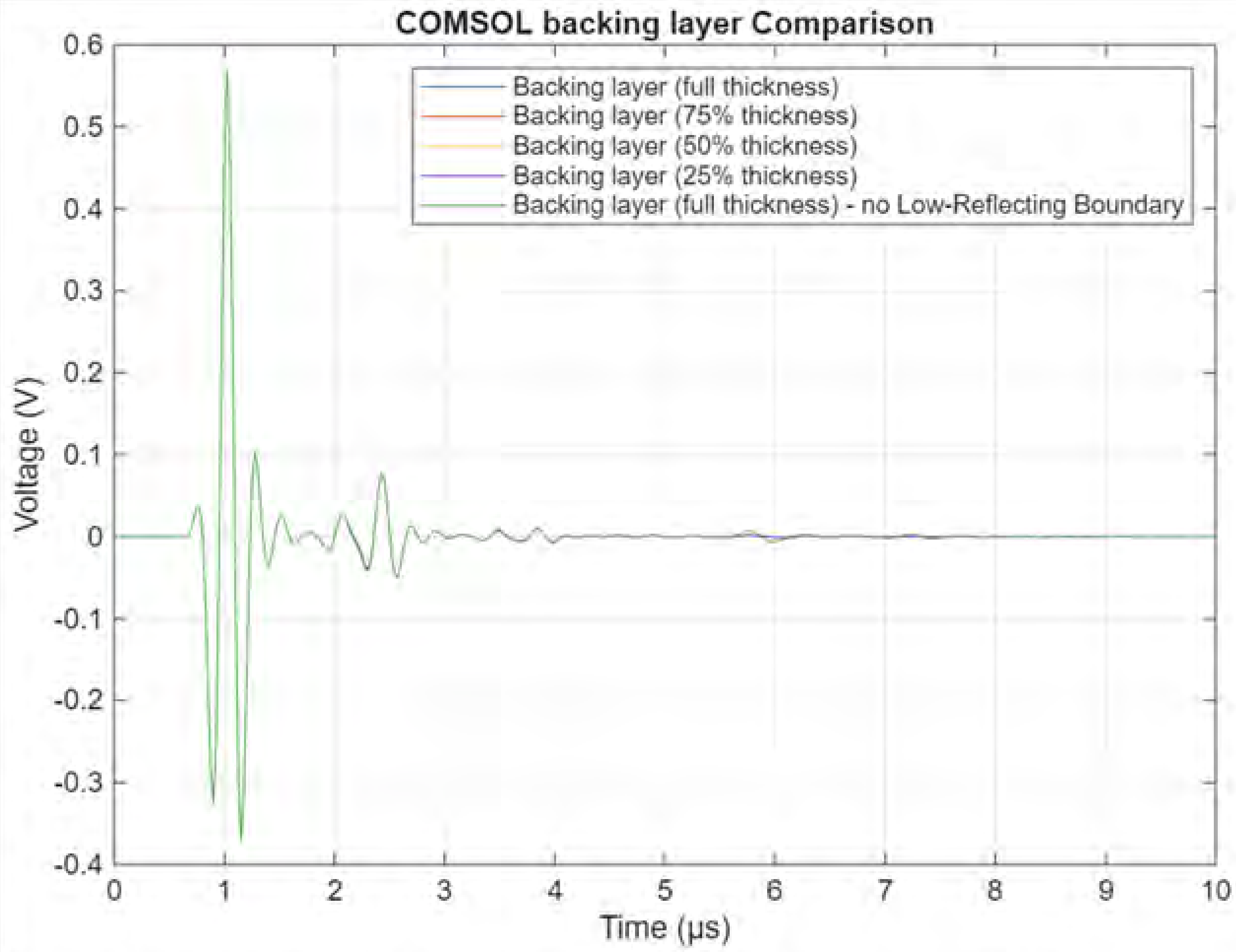

Figure 1: Received signal at the receiver of simulation for different backing layer configurations in COMSOL.

Dual-liquid acoustic fountain towards creating core-sheath structures

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Ultrasound Enhanced Electrospinning (USES) [1] is a type of electrospinning method developed by our group that offers advantages over conventional electrospinning processes. By utilizing an open liquid surface deformed by a focused ultrasound beam, USES eliminates the issues inherent to conventional methods such as electrospinning needle clogging. USES also provides control over nanofiber diameter, fiber mat morphology and electrospinning rate [2]. The process works by creating a controlled deformation at a polymer solution-air interface, from which nanofibers are electrospun, or by ejecting the polymer that is subsequently drawn into fibers.

We envision this technique as a platform for fabricating complex nanostructures, particularly core-sheath nanofibers. Achieving this requires the simultaneous operation with multiple polymer solutions. Therefore, we have modified the USES system to handle a dual-liquid media, as shown in Fig.1 A. We expect that the core-sheath fiber can be drawn from the ejected into the air coaxial dual liquids jet. Thus, our initial investigation focused on the feasibility of generation of acoustic fountain of two weakly soluble liquids using USES operating at 2.41 MHz. We investigated the total ejected volume, and which parameters define the ratio of two liquids in the ejected volume.

Our results demonstrate that the thickness of the top liquid layer is the primary factor controlling the ratio of the two liquids in the ejected material (Fig.1 B-D), while the acoustic pulse length defines the total volume of the ejected liquids. With a low thickness of the top liquid, the bottom liquid volume of the collected sample dominates even with a short pulse length (Fig. 1 D). In the case of the highest top layer thickness (Fig. 1 B), both liquids are ejected only at 5000 cycles with a very small bottom to top liquid ratio. This experiment successfully confirmed two key points: first, the system is capable of simultaneously ejecting two weakly soluble liquids, and second, the relative ratio of these liquids and total ejected volume can be actively controlled.

These results represent a significant step toward the nozzle-free production of core-sheath nanofibers and droplets. In this work, we also present progress from our ongoing efforts to generate these core-sheath structures. The successful development of this approach will significantly expand the application range and versatility of the USES method and overcome persistent challenges in conventional coaxial electrospinning, such as needle clogging and limited parameter control.

References:
1. Nieminen, H.J., Laidmäe, I., Salmi, A. et al. Ultrasound-enhanced electrospinning. Sci Rep 8, 4437 (2018).
2. J. Hunnakko et al., "Towards Chronic Wound Pads: Gradient Nanofiber Structure Generated by Ultrasound Enhanced Electrospinning (USES)," 2019 IEEE International Ultrasonics Symposium (IUS), Glasgow, UK, 2019, pp. 2447-2449.

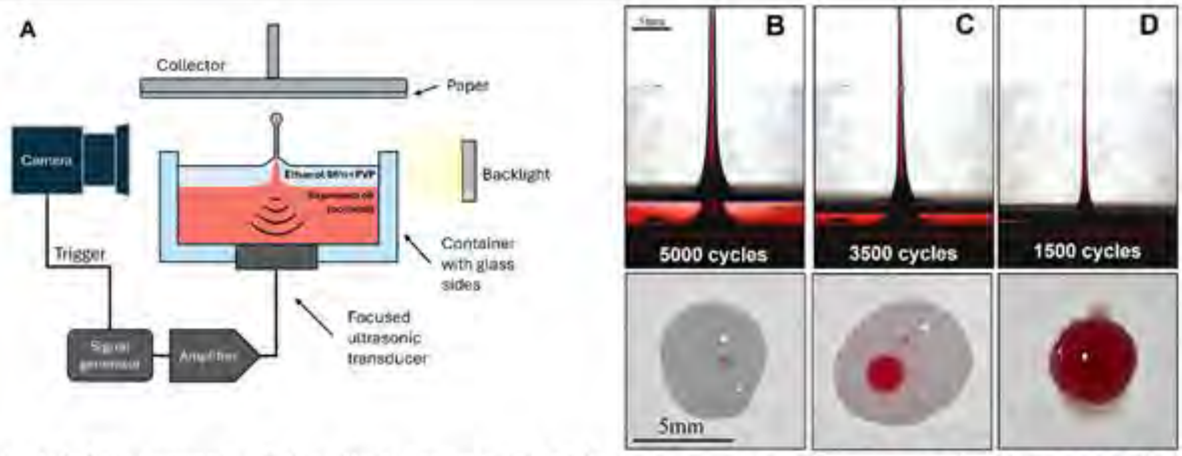

Fig.1 (A) Schematic of the USES setup with a double-layer liquid medium. (B-D) Images of the acoustic fountain (top) and the corresponding collected ejected material (bottom) for different top-layer thicknesses and ultrasound bursts length: (B) 4.1 mm, 5000 cycles; (C) 2.5 mm, 3500 cycles; (D) 0.8 mm, 1500 cycles

Guided waves in a viscoelastic bilayer structure

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

Guided waves are commonly used in ultrasonic Non-Destructive Testing (NDT), particularly for inspecting thin or multilayered structures. Their low attenuation allows propagation over long distances. For bilayer structures composed of a metallic plate and a soft coating, the complexity of guided modes increases due to the elastic contrast between the two materials and the viscoelastic rheology of the coating [1]. This work aims to analyze the behavior of guided modes in this type of dissipative steel-polyurethane structure.

First, we identify the dispersion curves of the guided modes in a steel plate coated with polyurethane [2]. A description of the coupling between Lamb modes and longitudinal thickness modes in the polymer is required to explain the origin of the modal repulsions observed between modes. We then compare the results with numerical simulations performed using the GREW (Generation and Radiation of Elastic Waves) code developed in our laboratory [3]. This semi-analytical code method incorporates the viscoelastic rheology of polyurethane via a fractional Kelvin-Voigt model [4]. The displacement field within the structure is obtained at the desired discretization from the simulations then analyzed to compute the dispersion of the signal. To validate the numerical results, guided-wave measurements are conducted using laser vibrometry on a steel plate coated with polyurethane samples of controlled thickness. Through this study, the objective is to quantify the modal attenuation associated with the dissipation in the coating.

[1] Manconi, Sorokin - On the Effect of Damping on Dispersion Curves in Plates. International Journal of Solids and Structures 50 (11–12), 1966–1973, 2013
[2] Simonetti - Lamb Wave Propagation in Elastic Plates Coated with Viscoelastic Materials. The Journal of the Acoustical Society of America 115 (5), 2041–2053, 2004
[3] Royer, Valier-Brasier - Ondes élastiques dans les solides 2. Collection Ondes; ISTE éditions: London, 2021
[4] Baudis, Valier-Brasier, Wunenburger - Thorough Ultrasonic Rheology of Soft, Visco-Elastic Materials: Example of Crosslinked Polyurethane Elastomer. Ultrasonics 137, 107166, 2024

Tomographic Reconstruction of the Internal Grain Structures in Polycrystalline Materials using Full-Waveform Inversion of Ultrasonic Array Data

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Poster Flash Talk Session, January 22, 2026, 09:30 - 10:20

The tomography of a polycrystalline material's internal microstructure is critical for modern non-destructive testing and the development of additive manufacturing materials, yet accurate in-situ characterization of locally anisotropic metallic materials remains challenging. This paper considers the propagation of a horizontally polarized shear (SH) plane wave in a layered, locally anisotropic medium and demonstrates that the spatially varying crystalline orientation angles can be reconstructed using full-waveform inversion (FWI), where the reconstruction is formulated as a PDE-constrained nonlinear optimization problem. FWI framework comprises forward wavefield modeling, which solves both the forward and adjoint equations, and an inverse optimization process that iteratively updates model parameters using the gradient derived from the adjoint method. We provide an explicit formulation of the adjoint method in FWI for efficiently computing the gradient of the misfit function (local sensitivity kernel) with respect to model parameters by introducing an inner product for the function space of scalar fields. Furthermore, we propose a novel sensitivity kernel with respect to the orientation angles, which can be readily extended to P and SV waves for 2D tomographic reconstruction of crystalline orientation angles. In addition, we investigate the effect of the wavelength-to-layer thickness ratio on FWI performance quantified by the error between the inverted and true orientation maps. Within an appropriate frequency range, the results demonstrate that FWI can deliver high-resolution imaging of the internal material structure for the multi-layered media considered in this study.

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