Volume 17, Issue 1 Winter 2007

# Vibrations

Ultrasonic Industry Association

## Symposium Final Schedule and Program

**The time on Big Ben reminds you to make your plans for the UIA Symposium**

With the holidays over, it's time to focus on the 36th Annual UIA Symposium to be held at the National Physical Laboratory in Teddington, Middlesex, England. In this issue you will find the complete presentation schedule for the three day symposium, detailed information about the evening events on Monday and Tuesday and other planning hints to make your visit to the UIA Symposium a successful one.

**More Sessions Added**

The interest in this symposium is significant and presentations represent the advances in ultrasonics occurring throughout the world. So many presentations were received that two poster sessions have been added on Tuesday, 20 March. There will be seven posters presented on transducers Tuesday morning, to be followed by general poster sessions before and after lunch. Tuesday afternoon features the HIFU Industry Council, chaired by Robert Muratore, and a tour of the National Physical Laboratory, our host for the symposium.

There is still time to submit presentations for the general poster session. Please go to www.ultrasonics.org for the Call for Posters. Deadline for posters is 28 February 2007.

Our sessions will be held at the NPL facility. Located inside the M25 beltway which surrounds Greater London, NPL is 30 minutes away from Heathrow Airport. The Teddington Adelaide Road station is the closest to NPL . The entrance to NPL is now on Hampton Road. Please see the article inside for more information on getting to NPL.

NPL and UIA has a list of hotels close to NPL for UIA participants. Please see the article inside for more information.

**Exhibit and Sponsor Information** is now available on the UIA website for companies wishing to reach the symposium participants.

### Symposium Information inside

- Visit the Royal Society of London with UIA on Tuesday evening. Space is limited - register on-line for tickets
- See pages 2 - 3 for the complete listing of presentations for Monday and Wednesday and the Tuesday schedule
- Use the articles on page 4 when planning your trip to England

## Award Competition Deadlines Fast Approaching

**5 January 2007** is the deadline for entries for the **New Ultrasonic Products and Applications Competition**. If your company has a new ultrasonic product or application that was introduced in 2006, this competition is a great way to gain additional recognition for yournewest entry in the marketplace. Go to www.ultrasonics.org to download your application.

The deadline for the **Graduate Paper Award Competition** is **26 January 2007.** If you are working with university graduate students in the field of ultrasonics, please encourage them to enter this competition. The prize is $1,000, sponsored by **Precision Acoustics**, the UK manufacturer of needle and membrane hydrophones, single element pvdf and piezo ceramic ultrasound transducers. The winner is invited to present the paper during the UIA Symposium. This is a great opportunity for a graduate student to interact with the ultrasonics community.

### Inside this issue:

# Symposium Presentation Schedule

NPL recommends arriving at least 15 minutes before the start of the session.

## Monday, 19 March 2007 *Industrial Session* Co-chairmen: Karl Graff/Leo Klinstein

| | |
|---|---|
| 8:25 - 8:30 am | Welcoming Address to UIA 2007 Symposium by Foster Stulen |
| 8:30 – 9:30 am | Timothy J Mason (Invited Speaker) ***Ultrasound in Environmental Protection - Some Recent Developments*** |
| 9:30 – 9:55 am | ***An Investigation of the Threshold Pressure for Inertial Acoustic Cavitation Generated within a Cylindrical Sonochemical Reactor Operating at 25 kHz*** Bajram Zeqiri |
| 10:00 - 10:25 am | ***Towards a Measure of Inertial Cavitation—The NPL Cavimeter*** Mark Hodnett and Bajram Zeqiri |
| 10:30 – 11:00 am | Refreshment break in Exhibit area |
| 11:00 – 11:25 am | ***Investigation of Sound Fields in Ultrasound Cleaning Baths and Correlation with the Erosion Effect*** Klaus-Vitold Jenderka |
| 11:30 – 11:55 am | ***Acoustical Characterization of a Cylindrical Resonator for Multi-bubble Sonoluminescence Experiment***s Gianluca Memoli |
| 12:00 – 1:00 pm | Luncheon |
| 1:00 – 1:25 pm | ***Patent Portfolio Development Strategies for Attracting Investors for Industrial and Medical Applications,*** David Carter, Carter, DeLuca, Farrell & Schmidt |
| 1:30 – 1:55 pm | ***Ultrasonic Metal Welding of Advanced Materials*** Karl Graff |
| 2:00 – 2:25 pm | ***Implementation of Ultrasonic Metal Welding on an Aluminum Vehicle Structure*** Janet Devine, Susan Ward et. al. |
| 2:30 – 2:55 pm | ***A Modular 250 Kilowatt High Power Through-feed Fluidsonic Processor using a Concentrated 20 kHz Ultrasonic Field for Chemical and Biological Applications*** Dr Frank F Rawson |
| 3:00 – 4:00 pm | Refreshment break in Exhibit Area |
| 4:00 – 4:25 pm | ***iQ Series Ultrasonic Power Supply*** Leo Klinstein |
| 4:30 - 5:00 pm | ***Finite Element Analysis of Ultrasonic Cutting in One and Two Directions*** Dr. M.J. Nategh |
| 5:00 - 5:30 pm | ***Advances in the Development of Power Ultrasonic Technologies based on the Stepped-plate Transducers*** J. A. Gallego-Juarez, G. Rodriguez, E. Riera and V. Acosta |
| 5:45 - 7:00 pm | Wine and Cheese Reception, Bushy House |

**Bushy House on the grounds of NPL, site of our Monday evening Wine and Cheese Reception**

## Tuesday, 20 March 2007

9:00 – 10:30 am ***Transducer Poster Sessions***

*A Systematic Design and Optimization Approach for Ultrasonic Transducer*, A. Shahidi

*Evaluation of Joint Losses in Langevin Style High Power Transducers*, George Bromfeld

*Optimization of Finite Element Models for Porous Ceramic Piezoelements by Piezoelectric Resonance Analysis Method*, A. Rybianets et al, Ultrashape Ltd. Tel-Aviv, Israel

*Investigation of Sound Fields in Ultrasound Cleaning Baths and Correlation with the Erosion Effect*, Klaus V. Jenderka and Christian Koch.

*Microfabrication of Piezoelectric Composite Ultrasound Transducers (PC-MUT), X. Jiang* et al, ITRS Technologies, Inc., State College, PA, Penn State University, University Park, PA, Boston Scientific, Fremont, CA, Blatek, Inc., State College, PA.

# Inside Story Headline

## Tuesday, 20 March 2007 *continued*

***Transducer Poster Sessions,* continued**

*The Characterization of the Cylindrical Therapeutic Transducers using Acoustic Holography,* Yegor Senelnikov, ProRhythm Inc.

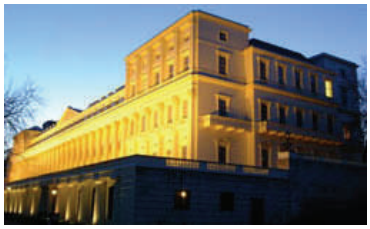
*Acoustic Field Characterization with Schlieren System*, Shmuel Ben-Ezra

*Ultrasonic Field Prediction of a 25kHz Cleaning Vessel using the Finite Element Method*, Pierre Gelat, NPL, Teddington, Middlesex, U.K.

10:30 – 11:30 am ***General Poster Sessions***

(Additional posters to be announced in February 2007)

*Quantitative ultrasound techniques using axial transmission to assess bone fragility* Pascal Laugier



**Royal Society of London**

| | |
|---|---|
| 11:30 am – 12:30 pm | Lunch |
| 12:30 – 1:30 pm | ***General Poster Sessions*** (Posters to be announced in February 2007) |
| 12:30 – 1:30 pm | ***HIFU Industry Council*** Robert Muratore, Chair |
| 2:00 – 4:30 pm | ***Tour of National Physical Laboratory facilities*** |
| 6:00 pm | ***Special Event at London Royal Society*** (separate registration fee required) |

## Wednesday, 21 March 2007 *Medical Sessions*

**Co-chairmen: Alan Winder/Robert Muratore**

| | |
|---|---|
| 8:25 - 8:30 am | Welcoming Address to UIA 2007 Medical Session by Foster Stulen |
| 8:30 – 9:30 am | Gail ter Haar (Invited Speaker) ***High Intensity Focused Ultrasound (HIFU) - The Future of Local Control for Cancer Therapy? Techniques and Challenges*** |
| 9:30 – 10:00 am | ***Epicardial HIFU for Treating Atrial Fibrillation*** Jack Sliwa |
| 10:00 – 10:30 am | ***FUSBOTs: Image-guided Robotic Systems for Focused Ultrasound*** Sunita Chauhan |
| 10:30 – 11:00 am | Refreshment Break in Exhibit Area |
| 11:00 – 11:30 am | ***Local Control in Bone and Soft Tissue Malignancies Treated by High Intensity Focused Ultrasound*** Li Min et al, |
| 11:30 – 12:00 noon | ***Transducer Control Algorithms*** George Bromfeld |
| 12:00 – 1:00 pm | **Lunch** ( ***Lord Rayleigh History*** Karl Graff) |
| 1:00 – 1:30 pm | ***The Physical Effects of Bubbles and Cavitation in High Intensity Focused Ultrasound Therapy*** Ronald A. Roy |
| 1:30 – 2:00 pm | ***Quantitative Ultrasound Techniques using Axial Transmission to Assess Bone Fragility*** Pascal Laugier |
| 2:00-2:30 pm | ***Applications of Ultrasound Radiation Force,*** James Greenleaf, Mayo Clinic, Minneapolis, MN |
| 2:30 – 3:00 pm | ***Effect of Ultrasound Microbubble Contrast Agent on Rabbit Liver VX2 Tumor with High Intensity Focused US Therapy*** Ji Xiao-Juan et. al. |
| 3:00 – 4:00 pm | Refreshment Break in Exhibit Area |
| 4:00 – 4:30 pm | ***36 kHz Ultrasonic Surgical Horns for Endoscopic-Nasal Approaches to Brain Tumors*** D. J. Cotter |
| 4:30 – 5:00 pm | ***Tactile Sensitivity and Psychotherapy Treatment*** V.A.Ishinova, E.M.Tsirulnikov |

"We're pleased to present three days of ultrasonic-related presentations representing the latest ultrasonic information from throughout the world." *Ron Manna, Misonix Corporation, 36th Annual UIA Symposium Chair*

# Tuesday Night at The Royal Society

**Marble Hall at the Royal Society of London is the site of the Tuesday evening special event. Register online for this event—$95 per person. Space is limited**

The Royal Society is the **independent scientific academy of the UK and the Commonwealth** dedicated to promoting excellence in science.

The Society plays an influential role in national and international science policy and supports developments in science engineering and technology in a wide range of ways.

Its Marble Hall will be the host to the Tuesday evening event for the UIA Symposium participants who want to dine at this historic location.

Limited seating is available, so please make your reservations early. The cost is $95 per person.

In addition to hosting UIA's Tuesday evening event, the Royal Society invests in excellence by funding more than 1,600 of the UK's best scientists every year, helping them develop the skills and ideas that will improve the quality of our lives.

Dr Phil Purnell of the University of Warwick received the 2003 Brian Mercer Awards for Innovation for developing a new generation of diagnostic instruments for construction materials. Based on the very latest ultrasonic sensor and signal processing technology, these instruments would be able to diagnose the properties of a concrete without even touching the surface.

# Hotels Near National Physical Laboratory

For detailed descriptions of these hotels, go to www.ultrasonics.org and click on the "List of Hotels near Teddington" link on the home page.

All rates quoted as NPL / Serco special rates are subject to availability, and may not be available at certain times of the year. All rates are offered at the hotel's discretion. Please contact the hotel of your choice directly, and indicate that you are attending an NPL conference to get the NPL rate.

For your convenience, each hotel named is linked to its website.

Go to www.Ultrasonics.org to see the NPL/Serco rate.

The Park Lodge Hotel

Liongate Hotel

Chase Lodge Hotel

The White Hart Hotel

Carlton Mitre Hotel

The Popes Grotto

Premier Lodge Twickenham

Hotel Antoinette

Kingston Travelodge

Kingston Lodge Hotel

**Entrance to the National Physical Laboratory**

# Getting to National Physical Laboratory

### Address

Hampton Road
Teddington, Middlesex
TW11 0LW

Please note that the entrance to NPL has moved as of the 20th September 2004 from Queens Road to Hampton Road. Entrance to NPL via Queens Road will not be allowed.

Visitors should allow 15 minutes for registering and parking before meetings.

### Getting to NPL by car

Please see the map above. You may also want to use an online journey planner such as Michelin, RAC.

### Getting to NPL by public transport

Buses 281, 285 and R68 serve Teddington. Trains from London Waterloo leave regularly, journey time is roughly thirty minutes. Please use the TFL Journey Planner to plan your journey. See the map at www.ultrasonics.org for directions from the station.

### Getting to NPL from Heathrow airport

Approximately half an hour away by Taxi. Bus 285 comes from Heathrow to Teddington. See "Getting to NPL by public transport", above.

# NPL's Acoustics Modelling Facility

NPL's acoustics team provides a finite element (FE) modelling service for manufacturers and designers of acoustic transducers. We are able to assist manufacturers with design, prototyping, production, quality assurance and rework problems.

The facility uses the PAFEC (Program for Automatic Finite Element Calculations) vibro-acoustics package developed by PACSYS Ltd. PAFEC provides NPL with the following:

- The ability to combine the structure with the fluid in a single model
- Finite elements, boundary elements and wave envelope elements for modelling the fluid
- Piezoelectric elements
- Two and three dimensional and axisymmetric models
- Continuous wave and transient excitation of transducers
- Coupling between electrical, mechanical and acoustical behaviour
- The potential to tackle problems with high mesh densities and large *ka* values

Results of FE modelling can be compared with experiment and for compliance with relevant international standards when prototype devices are characterised using NPL's unique acoustic measurement facilities.

The NPL staff are skilled acousticians with a wide range of experience in ultrasonic modelling and measurement problems. They work with the mathematicians at PACSYS Ltd to develop and enhance the vibro-acoustics software. Co-operation with the physics department at the University of Bath and with the Institute of Sound and Vibration Research, University of Southampton, has allowed us to solve challenging modelling tasks, including nonlinear acoustics problems. Below is a list of recent research:

- Design, modelling, manufacture and experimental measurements on a Sonicaid FM800 foetal heart monitoring transducer (Huntleigh Healthcare); assisting design and development of new generation of foetal heart monitoring transducers
- FE modelling of NPL reference cavitation vessel facility
- FE model of the IEC 60318-1 ear simulator including thermo-viscous effects
- Acoustic field predictions when transducers are subject to transient excitation
- Transient modelling of NPL acoustic emission test facility, including acoustic emission transducer and sensor

## Case Studies

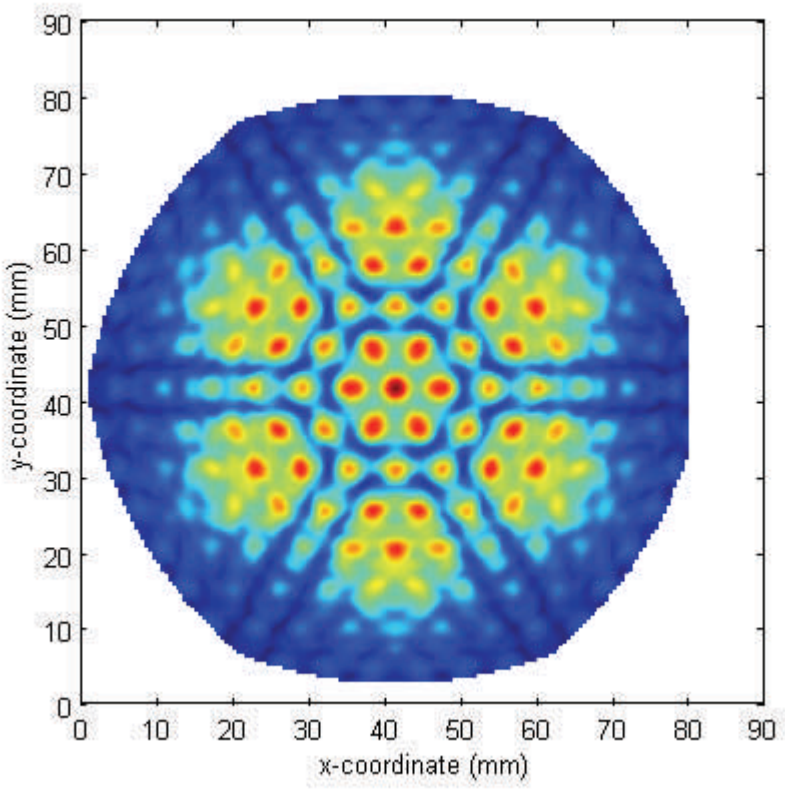
### Case Study 1: NPL's FE Modelling Facility helps develop a new foetal heart monitoring transducer design

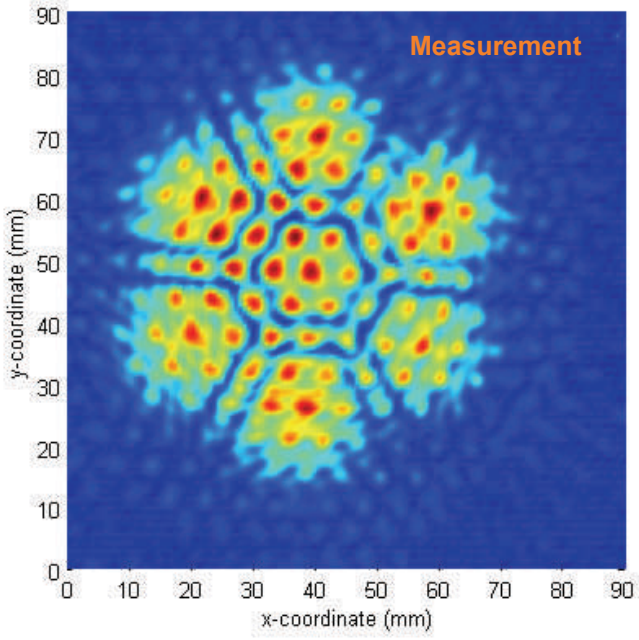
Assessment of the foetal condition by Doppler ultrasonography was introduced in the 1960s and has become an established part of obstetric care. A transducer placed on the maternal abdomen repeatedly transmits short bursts of low-power ultrasound (typically of time duration of 50 ms to 100 ms; centre frequency of 1 to 2 MHz and total acoustic power of 50 mW). Echoes received by the transducer from internal organs are Doppler shifted according to the velocity of the reflecting surface.

Traditionally, optimisation of transducer performance has had to be largely empirical because the equations describing real-world transducers have been either too difficult to solve or make too many simplifying assumptions to accurately predict the outcome of design changes. Recently, the availability of increased computing power has enabled these problems to be tackled numerically.

The purpose of this work was to predict the acoustic pressure field produced by a seven-element foetal heart monitoring transducer for a given sinusoidal voltage input. As each element is nominally identical, an axisymmetric model of the single-element transducers was first produced. The orthotropic and piezoelectric properties of the crystal were accounted for. The fluid loading is modelled using fluid FEs together with a boundary element (BE). The latter enables the modelling of a

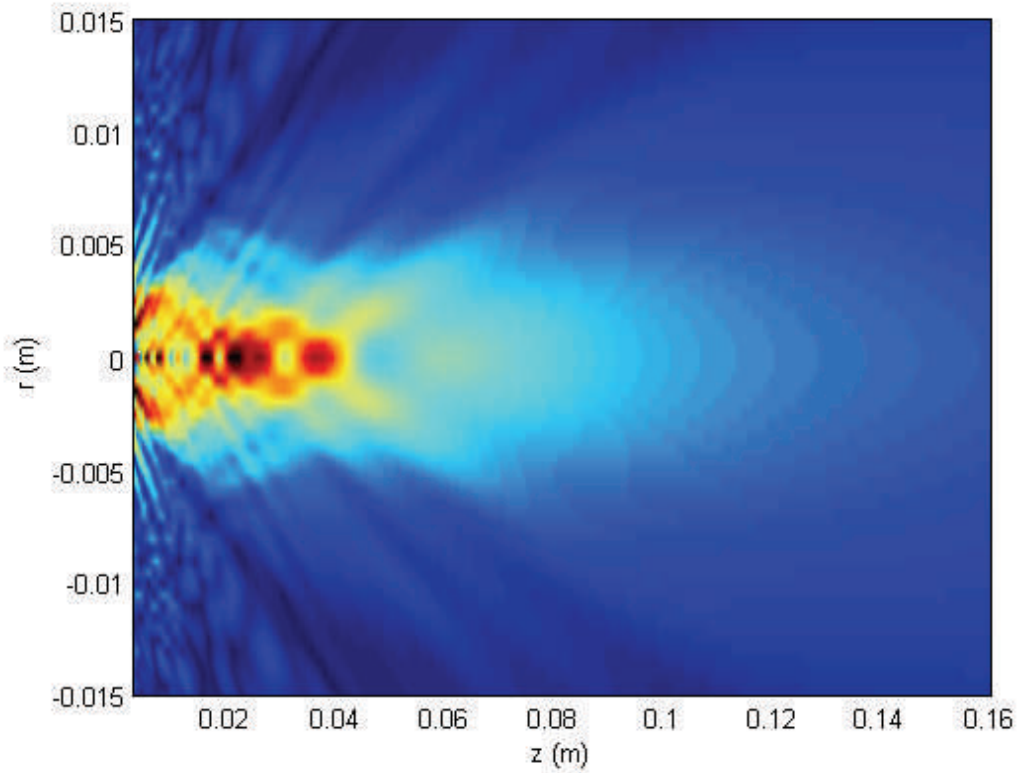
**Pressure grid produced by the Sonicaid FM800 foetal heart monitoring transducer at 90 mm from faceplate, in plane parallel to the transducer face**




semi-infinite region of fluid. A Combined Helmholtz Integral Equation Formulation with six interior collocation points is

**Pressure contour plot of pressure field produced by a single element ultrasonic transducer operating at 1.5 MHz in plane perpendicular to the transducer face, containing the transducer axis of symmetry**




used to solve the BE problem. The acoustic field within the BE, may then be predicted. Based on the assumption that the mechanical vibration of one element does not affect that of the other, the complete acoustic field generated by the seven elements is obtained by superposition. Measurements show that the characteristics of the pressure field generated by this type of transducer are successfully predicted using the FE/BE approach.

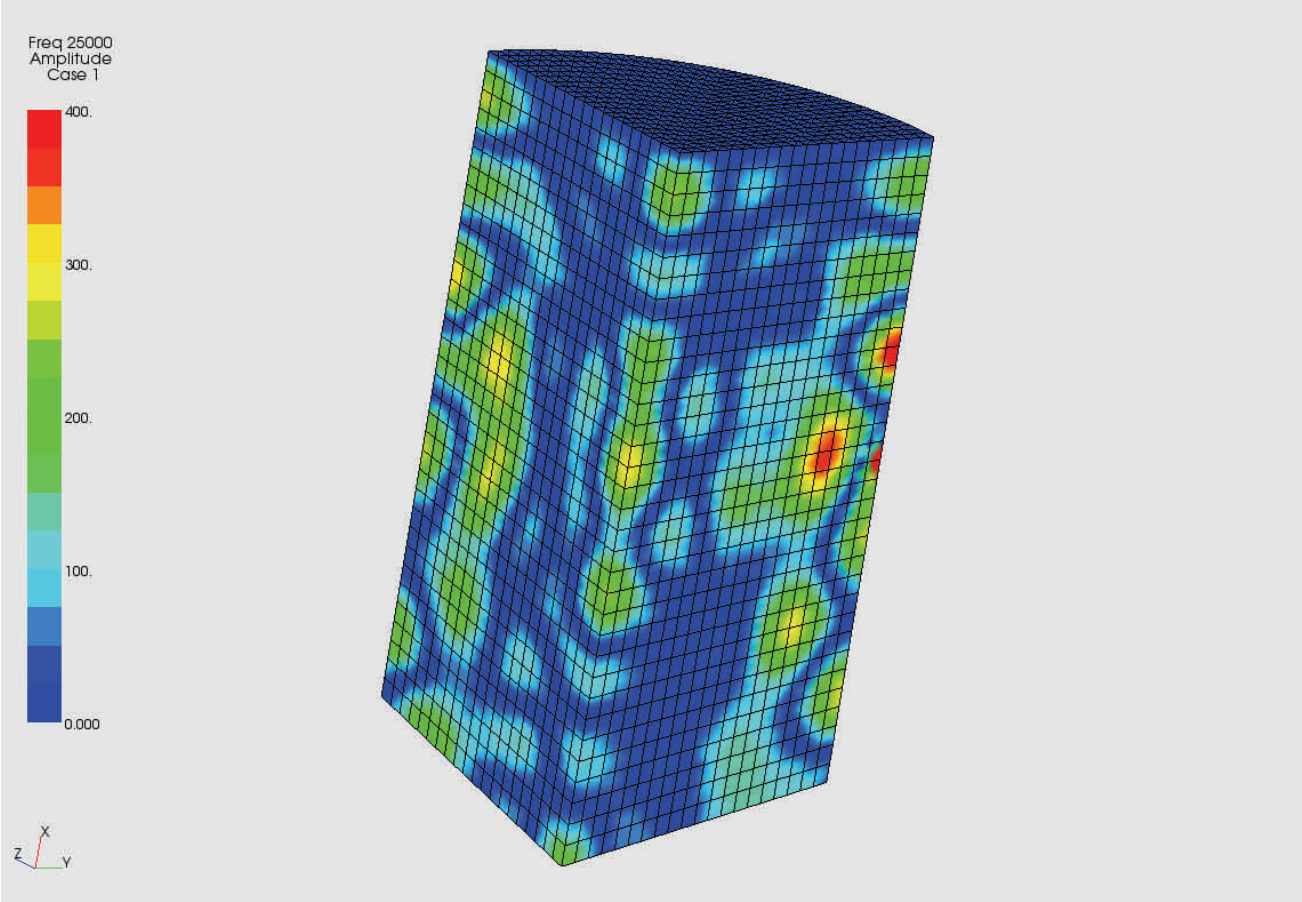
Axisymmetric pressure fields produced by piezoelectric transducers radiating into semi-infinite media can easily be visualised. The transducer configuration and design parameters can then be optimised so that the desired pressure field is produced. The above graph shows the acoustic pressure field produced by a single element transducer, as part of the work on the Huntleigh Healthcare Sonicaid FM800 foetal heart monitoring transducer.

## Case Study 2: FE modelling of the NPL reference cavitating vessel

A reference high power ultrasonic vessel is being established at NPL in order to generate a cavitation field whose properties are repeatable, so that it can be used as a test bed to compare cavitation detection techniques.

The vessel consists of a 2.5 litre cylindrical cell in which high focal acoustic pressures can be generated with the help of transducers operating at a comparatively low power level, and in which a large range of pressure levels in a given horizontal plane can be produced.

The vessel features thirty peripheral transducers operating at a frequency of 25 kHz, which are operated in three rows of ten.

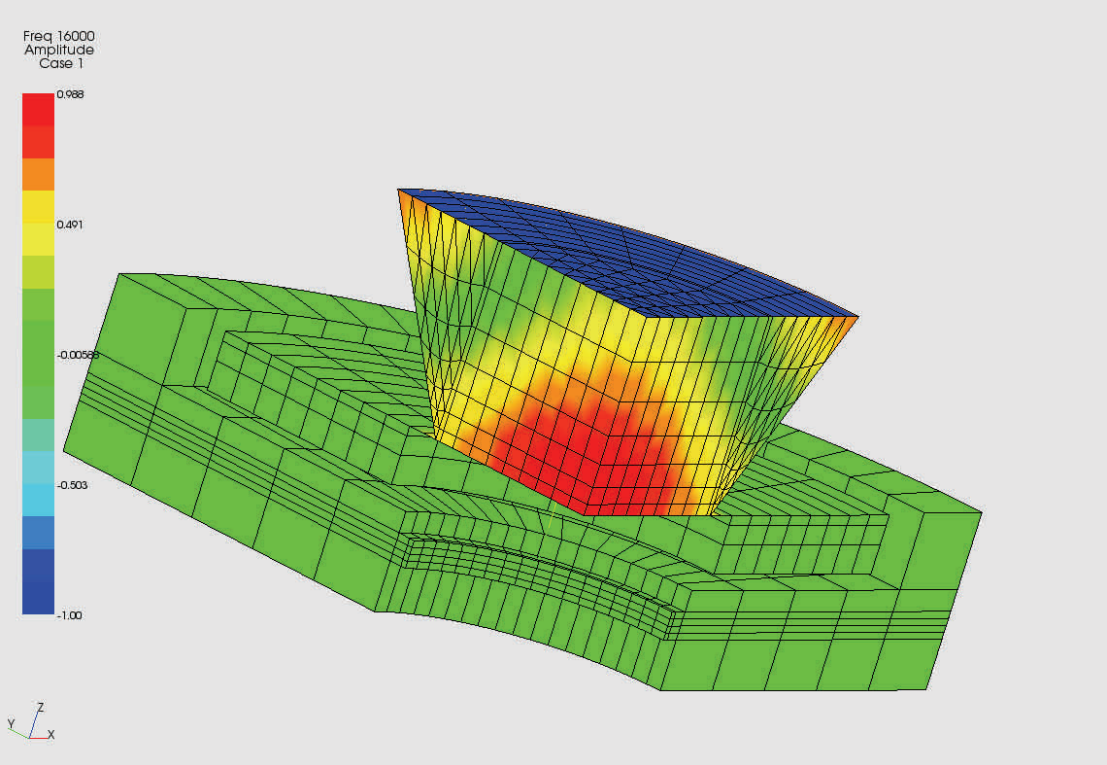



Pressure mapping of NPL reference cavitating vessel

In order to gain better understanding of the pressure field within the vessel and to potentially improve its configuration, a FE model was produced. A quadrant of the vessel is shown here, and illustrates the acoustic pressure distribution. Initial predictions show agreement with measured data using conventional sonar hydrophones.

## Case Study 3: Finite element model of the IEC 60318-1 ear simulator

An ear simulator is a standardised device used for the calibration and characterisation of audiometers, earphones, and telecommunications and audio equipment. Two types of ear simulator are widely used: the artificial ear standardised in IEC 60318-1 and the acoustic coupler standardised in IEC 60318-3. A better understanding of how an earphone interacts with the ear simulator would assist the application of these devices to the calibration of new earphone types. Although the artificial ear can be successfully modelled at low frequencies using a lumped parameter approach, the underlying assumptions become less valid at high frequencies. In order to overcome these limitations associated with lumped parameter models, a three-dimensional FE model of the artificial ear, earphone and microphone has been developed and its response predicted over the audio range. For reasons of symmetry, it is only necessary to model a quarter of the device. Thermo-viscous effects in the narrow slits and tubes are accounted for by using specially developed elements based on a linearisation of the Navier-Stokes equation. A lumped parameter model was used to compare the results yielded by the model at lower frequencies whereas a practical measurement method provided guidelines as to how the artificial ear behaved at higher frequencies.




Pressure mapping of IEC 60318-1 ear simulator at 16 kHz

If you would like more information about the finite element modelling service or would like to request a quotation for FE modelling work, please contact:

Pierre Gélat (Senior Research Scientist)

Tel: 020 8943 6533

*pierre.gelat@npl.co.uk*

## Tour NPL's Facilities on Tuesday, 20 March 2007

You'll have a unique opportunity to see the modelling services and other ultrasonic-related facilities during the tour of the National Physical Laboratories on Tuesday afternoon, 20 March. Be sure to arrange your schedule to spend the entire day at the UIA Symposium on Tuesday. You'll hear poster presentations on transducers and other ultrasonic-related research and be able to participate in the third annual HIFU Industry Council.

P O Box 2307
Dayton OH 45401-2307

Phone: 937.586.3725
Fax: 937.586.3699
Email: uia@ultrasonics.org

ultrasonic industry association
UIA
powering sound ideas

VISIT US AT
WWW.ULTRASONICS.ORG

## Vision:

To be a forum for users, manufacturers, researchers and investors in ultrasonic technology

## Mission

Improve processes, techniques and materials through application of ultrasonic technology

Register on-line by going to

www.ultrasonics.org

**Need more information about the upcoming symposium?** Check out our web site for all this information and more:

- On-line registration
- Hotels near NPL
- Map of NPL and surrounding area
- Sponsorship, Exhibit and Advertising information
- Graduate Research Award Entry Form
- New Products and Applications Award Entry Form
- Call for Posters

Please check our web site regularly for more updates.