Appendix B:

The Conference

Appendix A to L are compiled from the conference web at: http://ewh.ieee.org/conf/ius_2008/
(The web is also in DVD with ISBN: 978-1-4244-2480-1 and IEEE Catalog No. CFP08ULT-DVD)

2008 IEEE International Ultrasonics Symposium Proceedings

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I. General Chair Message

***Jian-yu Lu*, Ph.D.**

Welcome to Beijing!

The 2008 IEEE International Ultrasonics Symposium (IUS) will be held in the Beijing International Convention Center (BICC), Beijing, China, from ***November 2-5, 2008***. This will be the first time the IUS goes to Beijing, the capital of China. Beijing is a city of a long history and a great culture. It has served as the capital of China for long periods of times. Therefore, Beijing will be a great tourist attraction for the conference attendees and their guests besides the technical program. As we know, the 2008 Summer Olympics and Paralympics will be held in Beijing in August and September 2008, respectively. Beijing is preparing for this event by building and improving a lot of infrastructure and cleaning up the environment, and is welcoming hundreds of thousands of visitors. Thus, Beijing will become more beautiful after the Olympics. The 2008 IEEE IUS will take advantage of the improved transportation and vastly increased hotel capacity of Beijing after the Olympics. The BICC is located within the Olympic Complex and thus will be convenient for the conference attendees to visit the complex.

The 2008 IEEE IUS will also bring together more closely the ultrasonics communities around the world with the communities of China and East Asia to further the research and development of ultrasonics theories and applications. The 2008 IEEE IUS is expected to be another success in the history of this annual conference that started in the early 1960s and has grown to have more than 1000 attendees in recent years.

***Jian-yu Lu*, Ph.D.**
General Chair
2008 IEEE International Ultrasonics Symposium

Department of Bioengineering
The University of Toledo
Toledo, Ohio 43606, U.S.A.
jilu@eng.utoledo.edu

II. Message from the Technical Chair

***Keith A. Wear*, Ph.D.**

This year, the IEEE International Ultrasonics Symposium will be held at the Beijing International Convention Center in Beijing, China, November 2-5, 2008. On behalf of the Technical Program Committee, I would like to invite you to join us for this annual event.

The first day will feature short courses on topics of current interest in ultrasonics. The next three days will include parallel oral and poster sessions covering 1) Medical Ultrasonics, 2) Sensors, NDE & Industrial Applications, 3) Physical Acoustics, 4) Microacoustics – SAW, FBAR, MEMS, and 5) Transducers & Transducer Materials. Awards will be given to the top student presentations.

In addition to the technical program, the social and guest programs will allow attendees to explore the rich history and culture of Beijing. There are many interesting sites in Beijing, including Tiananmen Square, the Forbidden City, the Great Wall of China, the Summer Palace, the Temple of Heaven, and the Ming Tomb.

I hope you will join us for this important international event of the ultrasonics community. See you in Beijing in November 2008.

***Keith A. Wear*, Ph.D.**
Technical Chair
2008 IEEE International Ultrasonics Symposium

Food & Drug Administration
Silver Spring, MD 20993, U.S.A.
keith.wear@fda.hhs.gov

III. Organizing Committee

General Co-Chair
Overall Management:
***Jian-yu Lu*, Ph.D. (General Chair)**
Department of Bioengineering
The University of Toledo
Toledo, Ohio 43606, U.S.A.
jilu@eng.utoledo.edu

General Co-Chair
China Relationship:
***Hailan Zhang*, Ph.D.**
Institute of Acoustics
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zhanghl@mail.ioa.ac.cn

Technical Chair:
***Keith A. Wear*, Ph.D.**
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keith.wear@fda.hhs.gov

Finance:
***Jan Brown*, Ph.D.**
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Jan.brown@ieee.org

Short Course:
***Roman Gr. Maev*, Ph.D.**
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marks@sonictech.com

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sorah.rhee@ieee.org

Publicity:

Asia and Pacific:

***Ji Wang*, Ph.D.**
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wangji@nbu.edu.cn

Proceedings:

***Kendall R. Waters*, Ph.D.**
SVMI
Fremont, CA 94539, U.S.A.
kendall.waters@ieee.org

IV. Opening Session and Awards

Date, Time, and Location:

- 8:00 a.m. – 10:00 a.m.
- Monday, November 3, 2008
- Convention Hall No. 1, Beijing International Convention Center (BICC), Beijing, China

Agenda:

Welcome:

- ***Jian-yu Lu***, Ph.D., General Chair, 2008 IEEE International Ultrasonics Symposium (IUS)
- ***Jacqueline Hines***, Ph.D., Vice President of the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society (UFFC-S) for Ultrasonics
- ***Keith Wear***, Ph.D., Technical Program Committee (TPC) Chair, 2008 IEEE IUS
- ***Susan Trolier-McKinstry***, Ph.D., President of the UFFC-S

Awards and Recognitions (Presenter: ***Helmut Ermert***, Ph.D., Awards Chair of the UFFC-S)**:**

- **IEEE Awards:**
  - ***IEEE Fellow Award 2008 Recipients*:**

- **Raymond L. Filler, Ph.D.**
  US Army Communications Electronics Research
  Lebanon, NJ, USA
  Citation: *For contributions to frequency control and timing in military systems*

- **Takeshi Inoue, Ph.D.**
  NEC Corporation
  Sagamihara, Kanagawa-Pref., Japan
  Citation: *For contributions to bulk wave piezoelectric devices and applications*

- **Pai-Chi Li, Ph.D.**

National Taiwan University
Taipei, Taiwan

Citation: *For contributions to ultrasonic imaging technologies*

- **Jian-yu Lu, Ph.D.**

The University of Toledo
Toledo, Ohio, USA

Citation: *For contributions to medical ultrasonic imaging*

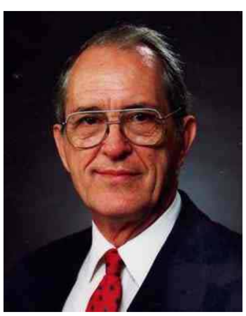
- **IEEE UFFC Society Awards:**

- ***Achievement Award 2008 Recipient*:**

Mack A. Breazeale, Ph.D.

University of Mississippi
University, MO, USA

Citation: *For a five-decade-long career of major contributions to non-linear ultrasonics* (Laudation During Award Presentation: Dr. James G. Miller)

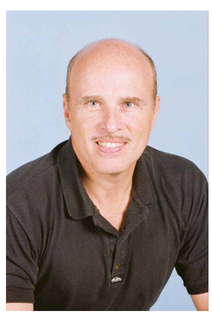


- ***Distinguished Service Award 2008 Recipient*:**

Donald C. Malocha, Ph.D.

University of Central Florida
Orlando, FL, USA

Citation: *For his outstanding dedication and service to the IEEE UFFC-Society in numerous positions including President and his sustained Symposia and Technical Committee leadership* (Laudation During Award Presentation: Dr. Gerry Blessing)

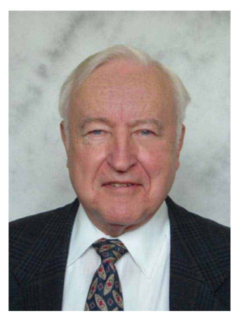


- ***Distinguished Service Award 2008 Recipient*:**

Allen H. Meitzler, Ph.D.

AHM Consulting
Ann Arbor, MI, USA

Citation: *For over 50 years of sustained technical contributions and services to the IEEE UFFC Society at many levels* (Laudation During Award Presentation: Dr. Susan TrolierMcKinstry)



- ***Outstanding Paper Award 2007 Recipient*:**

Clark T.-C. Nguyen, Ph.D.
Paper: "MEMS Technology for Timing and Frequency Control," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 54, no. 2, February 2007, pp. 251 – 270

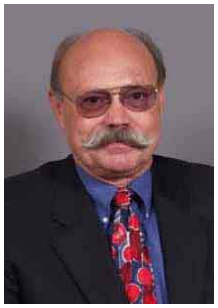
- ***2008-2009 Distinguished Lecturer Award Recipient*:**

Peter Burns, Ph.D.
University of Toronto and Sunnybrook Health Sciences Centre
Toronto, Canada
Lecture Title: Bubbles and ultrasound: A new partnership for medical imaging

- **Ultrasonics Awards:**
  - ***Rayleigh Award 2008 Recipient*:**

- **William D. O'Brien, Ph.D.**

University of Illinois at Urbana-Champaign
Urbana, IL, USA
Citation: *For pioneering contributions in acoustics and medical diagnostics research and education and for devoted service to the IEEE UFFC Society (Laudation During Award Presentation: Dr. K. Kirk Shung)*



V. Plenary Speaker

Title of Presentation:

Acoustics of Traditional Chinese Theatrical Buildings

The Author:

Jiqing Wang, Institute of Acoustics, Tongji University, Shanghai, China 200092, E-mail: wongtsu@126.com

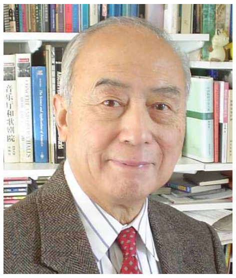
Abstract:

The traditional Chinese theatrical building is a unique form in the architectural world. The Chinese opera matured as early as the Song and Yuan Dynasties, 11th–14th Centuries, and Chinese theatrical buildings developed accordingly. As the Chinese opera plays on the principle of imaginary actions, no realistic stage settings are required. But since ancient times, Chinese audiences have placed great demands on vocal performances; therefore, the acoustic effect of a theatre is a major concern to the audience as well as the performers.

Pavilion stages, that are small in area, open on three sides, and thrusting into the audience area, are commonly found in traditional Chinese theatres, both in the courtyard type and the auditorium type. Numerous theatres of the kind built in the Qing Dynasty, 17th–19th Centuries still exist, and in fact at the present day, some are still functioning in good condition. A study on the sound effects of the traditional Chinese theatres has been conducted with the knowledge of modern architectural acoustics.

As the courtyard theatre was a popular type of traditional Chinese theater at that time, its acoustic phenomenon is quite different from that of an enclosed space due to the absence of a roof. Therefore, the classic room acoustics, such as Sabine reverberation formula, is no longer applicable. It is well known that the parameter of reverberation time T60 shows the decay rate only, however it cannot properly characterize the prominent change in the fine structure of the echogram, particularly in case of a large reduction of reflections from the ceiling during the decay process. The sense of so-called 2.5D reverberation time in a courtyard space would differ from that of the equivalent 3D reverberation time in an enclosed space. Based upon the characteristic analysis of the sound field in an open-top space, a preliminary study on the acoustics of the courtyard theatre, both objectively and subjectively, will be introduced.

Professor Jiqing Wang:



Professor Jiqing Wang

Jiqing Wang is a Professor of Acoustics, Institute of Acoustics, School of Science (1981-present), and was also once the Director of Graduate Program on Architectural Science, School of Architecture and Urban Planning (1985-2002), Tongji University, Shanghai, China. He is a Fellow of Acoustical Society of China and a Fellow of Acoustical Society of America. He has served as the Chairman of the National Building Science Committee (1996-2000), President of the Acoustical Society of Shanghai (1987-1991), executive member of the Acoustical Society of China (1988-1998), technical member of the Acoustic Standardization Committee of China since 1980, and editor-in-chief for the Chinese journal of Technical Acoustics (1990-2004). He was the author and co-author of five books on architectural acoustics in Chinese, and published over 130 papers. He has also delivered several plenary, keynotes, invited and professional lectures worldwide.

External Links for Viewing Beijing Opera That Is Related to the Talk:

Huguang Guild Hall: http://www.frommers.com/destinations/beijing/N20119.html
Zhengyici Theatre: http://en.wikipedia.org/wiki/Zheng_Yici_Peking_Opera_Theatre
Beijing Opera Places: http://www.beijingmadeeasy.com/beijing-arts/where-to-see-opera-in-beijing
Beijing Opera in Wikipedia: http://en.wikipedia.org/wiki/Beijing_opera

Slides and Movie Clip Presented During the 2008 IEEE International Ultrasonics Symposium on November 3, 2008:

Slides of the Plenary Talk (102 slides)
(PDF file - 17 MB)
(PowerPoint file - 36 MB)

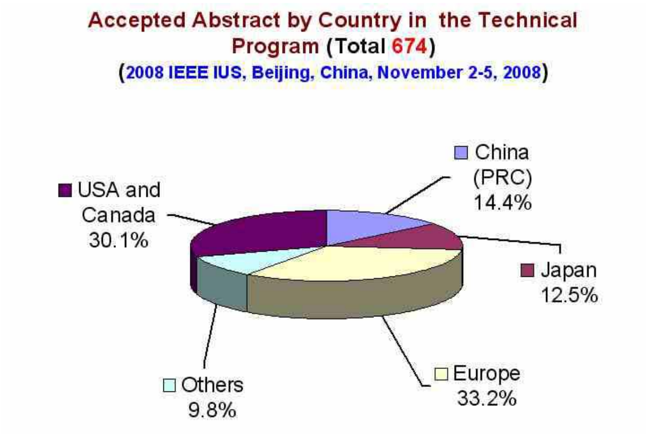
Movie Clip of the Plenary Talk
(MPEG movie - 25 MB, 64 seconds)

VI. Conference Statistics

Introduction:

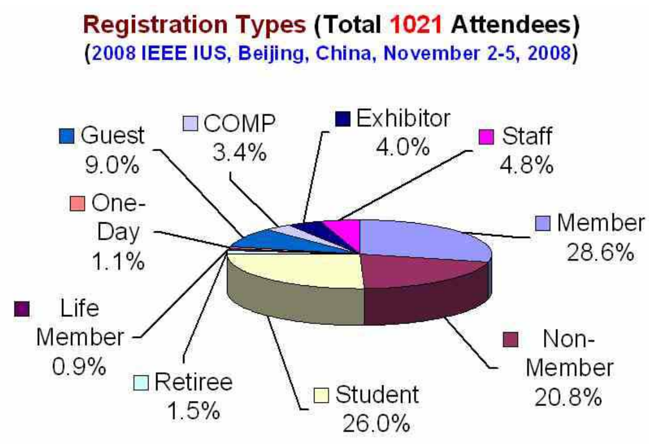
The following are statistic charts related to the technical program, attendance, registration, proceedings, and short courses of the conference. Despite of recent global economic downturn and long traveling distances to China for many attendees, the total number of attendees of the 2008 IEEE International Ultrasonics Symposium (IUS) is still larger than 1000.

1. Abstract Accepted by Country:
(Posted July 4, 2008)

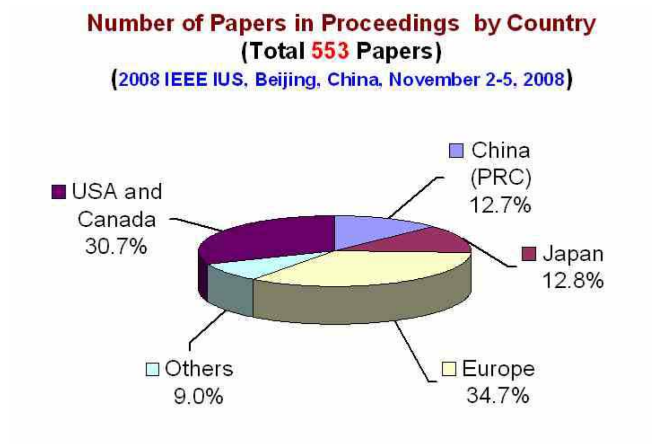


2. Conference Registration by Country:
(Posted November 12, 2008)

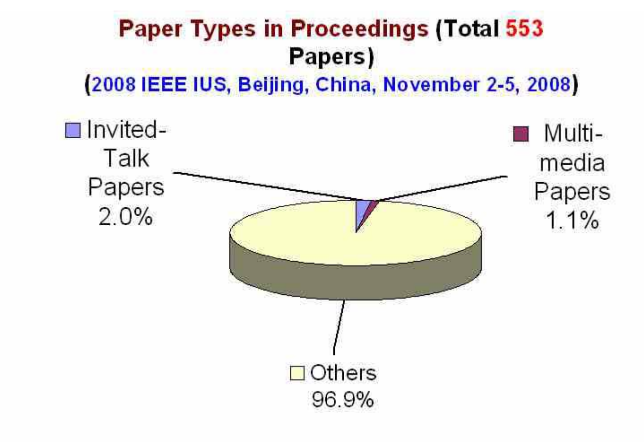
3. Conference Registration Types:
(Posted November 12, 2008)



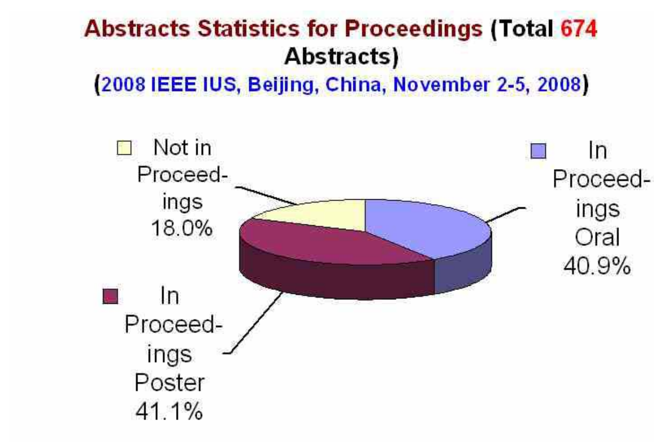
4. Proceedings Papers by Country:
(Posted December 1, 2008)



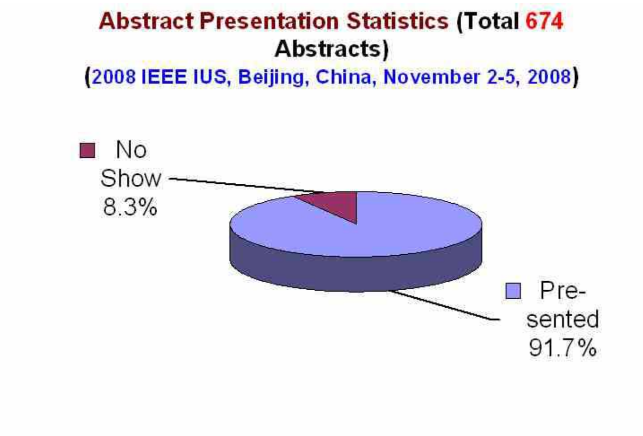
5. Paper Types in Proceedings:
(Posted December 1, 2008)



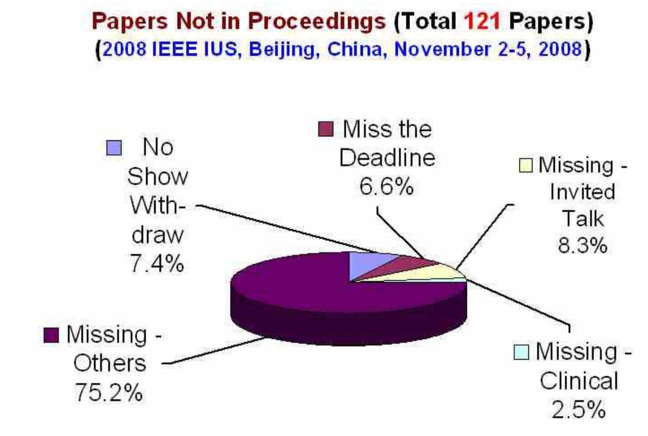
6. Abstract Statistics for Proceedings:
(Posted December 1, 2008)



7. Abstract Presentation Status:
(Posted December 1, 2008)

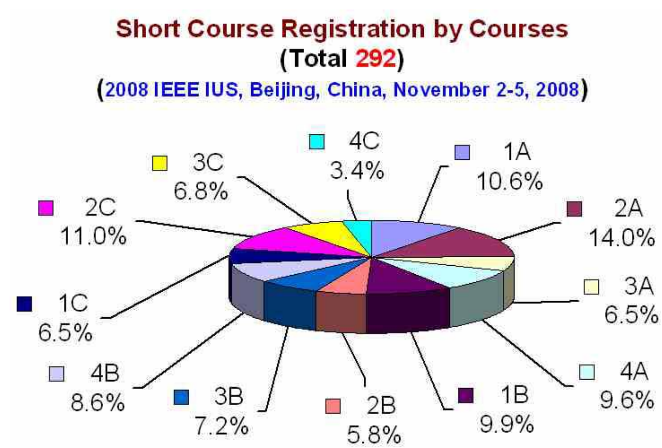


8. Papers Not in Proceedings:
(Posted December 1, 2008)



9. Short Course Registration Types:
(Posted November 12, 2008)

10. Short Course Registration by Courses:
(Posted November 12, 2008)



VII. Technical Program Committee (TPC) (136 Members)

Group 1: Medical Ultrasonics

Vice Chair of TPC:

Stanislav Emelianov, Ph.D.
University of Texas at Austin
Austin, Texas, U.S.A.

Members:

1. **Olivier Basset:** *CREATIS, Université Lyon I, France*
2. **Geneviève Berger:** *National Centre for Scientific Research (CNRS), France*
3. **Ayache Bouakaz:** *INSERM, Université Tours, France*
4. **Charles Cain:** *University of Michigan, USA*
5. **Richard Chiao:** *Siemens Medical Solutions, USA*
6. **Jan D'hooge:** *Catholic University Leuven, Belgium*
7. **Paul Dayton:** *UNC Chapel Hill and NC State University, USA*
8. **Emad Ebbini:** *University of Minnesota, USA*
9. **David Evans:** *University of Leicester, UK*
10. **Kathy Ferrara:** *University of California Davis, USA*
11. **Stuart Foster:** *University of Toronto, Canada*
12. **James Greenleaf:** *Mayo Clinic College of Medicine, USA*
13. **Anne Hall:** *General Electric Medical Systems, USA*
14. **Christopher Hall:** *Philips Research North America, USA*
15. **Peter Hoskins:** *The University of Edinburgh, UK*
16. **John Hossack:** *University of Virginia, USA*
17. **Kullervo Hynynen:** *University of Toronto, Canada*
18. **Michael F. Insana:** *University of Illinois, Urbana-Champaign, USA*
19. **Jorgen Jensen:** *Technical University of Denmark, Denmark*
20. **Nico de Jong:** *Erasmus Medical Centre and University of Twente, The Netherlands*
21. **Hiroshi Kanai:** *Tohoku University, Japan*
22. **Jeff Ketterling:** *Riverside Research Institute, USA*
23. **Michael Kolios:** *Ryerson University, Canada*
24. **Chris de Korte:** *Radboud University Nijmegen Medical Centre, The Netherlands*
25. **Nobuki Kudo:** *Hokkaido University, Japan*
26. **Pai-Chi Li:** *National Taiwan University, Taipei, Taiwan*
27. **Jian-yu Lu:** *University of Toledo, USA*
28. **Leonardo Masotti:** *Università degli Studi di Firenze, Italy*
29. **Tom Matula:** *University of Washington, USA*
30. **James G. Miller:** *Washington University in Saint Louis, USA*
31. **Kathy Nightingale:** *Duke University, USA*
32. **William O'Brien:** *University of Illinois, Urbana-Champaign, USA*
33. **Georg Schmitz:** *Ruhr-Universität Bochum, Germany*
34. **Ralf Seip:** *Philips Research North America, USA*
35. **Mickael Tanter:** *Laboratoire Ondes et Acoustique, ESPCI, France*
36. **Tom Thomas:** *Boston Scientific, Inc., USA*

37. **Kai Thomenius:** *General Electric's Corporate R&D, USA*
38. **Hans Torp:** *Norwegian University of Science and Technology, Norway*
39. **Piero Tortoli:** *Università degli Studi di Firenze, Italy*
40. **Ton van der Steen:** *Erasmus Medical Center, The Netherlands*
41. **Keith Wear:** *US Food and Drug Administration, USA*

Group 2: Sensors, NDE, and Industrial Application

Vice Chair of TPC:

Jafar Saniie, Ph.D.
Illinois Institute of Technology
Chicago, Illinois, U.S.A.

Members:

1. **Robert C. Addison:** *Rockwell Science Center, USA*
2. **Walter Arnold:** *Fraunhofer Institute for Nondestructive Testing, Germany*
3. **Nihat Bilgutay:** *Drexel University, USA*
4. **Ramazan Demirli:** *Canfield Scientific, USA*
5. **Eric S. Furgason:** *Purdue University, USA*
6. **David Greve:** *Carnegie Mellon University, USA*
7. **Edward Haeggstrom:** *University of Helsinki, Finland*
8. **Jacqueline Hines:** *Applied Sensor Research and Development Corporation, USA*
9. **Fabien J. Josse:** *Marquette University, USA*
10. **Lawrence W. Kessler:** *Sonoscan Inc., USA*
11. **Pierre T. Khuri-Yakub:** *Stanford University, USA*
12. **Mario Kupnik:** *Stanford University, USA*
13. **Jun-ishi Kushibike:** *Tohoku University, Japan*
14. **Roman Maev:** *University of Windsor, Canada*
15. **Kentaro Nakamura:** *Tokyo Institute of Technology*
16. **Massimo Pappalardo:** *University di Roma TRE, Italy*
17. **Tony Sinclair:** *University of Toronto, Canada*
18. **Bernhard Tittman:** *Pennsylvania State University, USA*
19. **Jiromaru Tsujino:** *Kanagawa University, Japan*
20. **John F. Vetelino:** *University of Maine, USA*
21. **Paul Wilcox:** *University of Bristol, UK*
22. **Donald E. Yuhas:** *Industrial Measurement Systems, Inc., USA*

Group 3: Physical Acoustics

Vice Chair of TPC:

Yook-Kong Yong, Ph.D.
Rutgers University
Piscataway, New Jersey, U.S.A.

Members:

1. **Robert Aigner:** *TriQuint Semiconductor, USA*
2. **Art Ballato:** *U.S. Army, USA*
3. **Jan Brown:** *JB Consulting, USA*

4. **Weiqiu Chen:** *Zhejiang University, China*
5. **David Hecht:** *DLH Consulting, USA*
6. **Fred Hickernell:** *Retired from Motorola, USA*
7. **Yonkee Kim:** *U.S. Army, USA*
8. **Amit Lal:** *Cornell University, USA*
9. **C.S. Lam:** *Epson Electronics America, Inc., USA*
10. **John Larson:** *Avago Technologies, USA*
11. **Moises Levy:** *Department of Physics, Naples, Florida, USA*
12. **George Mansfeld:** *Russian Academy of Sciences, Russia*
13. **Vitold Poghar:** *Scientific and Technological Center of Unique Instrumentation of Russian Academy of Science, Russia*
14. **Valeri Proklov:** *Institute of Radio Engineering & Electricity, Russia*
15. **Edgar Schmidhammer:** *EPCOS, Germany*
16. **Susan Schneider:** *Marquette University, USA*
17. **Bikash Sinha:** *Schlumberger-Doll Research, USA*
18. **Ji Wang:** *Ningbo University, China*
19. **Qing-Ming Wang:** *University of Pittsburgh, USA*

Group 4: Microacoustics - SAW, FBAW, MEMS

Vice Chair of TPC:

Peter Smith, Ph.D.
McMaster University
Hamilton, Ontario, Canada

Members:

1. **Sylvain Ballandras:** *LPMO, France*
2. **Kushal Bhattacharjee:** *RF Micro Devices, USA*
3. **Sergey Biryukov:** *Leibniz Institute for Solid State and Materials Research Dresden (IFW), Germany*
4. **Jidong Dai:** *RF Monolithics, USA*
5. **Yasuo Ebata:** *Fujitsu Media Device Ltd., Japan*
6. **Gernot Fattinger:** *Sawtek, USA*
7. **Ken-ya Hashimoto:** *Chiba University, Japan*
8. **Daniel Hauden:** *CNRS_LPMO, France*
9. **Mitsutaka Hikita:** *Kogakuin University, Japan*
10. **Chunyun Jian:** *Nortel Networks, Canada*
11. **Jyrki Kaitila:** *Infineon, Germany*
12. **Jan Kuypers:** *University of California, USA*
13. **Ken Lakin:** *TFR Technologies, USA*
14. **Don Malocha:** *University of Central Florida, USA*
15. **David Morgan:** *Impulse Consulting, UK*
16. **Hiroyuki Odagawa:** *Tohoku University, Japan*
17. **Mauricio Pereira da Cunha:** *University of Maine, USA*
18. **Viktor Plessky:** *GVR Trade SA, Switzerland*
19. **Bob Potter:** *Vectron International, USA*
20. **Leonard Reindl:** *Albert-Ludwigs-University Freiburg, Germany*
21. **Arne Ronnekleiv:** *Norwegian Institute of Technology, Norway*
22. **Richard Ruby:** *Avago Tech, USA*
23. **Clemens Ruppel:** *EPCOS AG - SAW RD SAM, Germany*
24. **Takahiro Sato:** *Samsung, Japan*

25. **Marc Solal:** *Sawtek, USA*
26. **Robert Weigel:** *Friedrich-Alexander University, Germany*

Group 5: Transducers and Transducer Materials

Vice Chair of TPC:

Scott Smith, Ph.D.
GE Global Research
Niskayuna, New York, U.S.A.

Members:

1. **Sandy Cochran:** *University of Dundee, UK*
2. **Christopher Daft:** *Siemens Medical Solutions, USA*
3. **Levent Degertekin:** *Georgia Institute of Technology, USA*
4. **Charles Emery:** *Mirabilis Medica, USA*
5. **John Fraser:** *Philips Medical Systems, USA*
6. **Jean-Francois Gelly:** *GE Healthcare, France*
7. **Reinhard Lerch:** *Friedrich-Alexander-Universität Erlangen-Nuremberg, Germany*
8. **Geoff Lockwood:** *Queen's University, Canada*
9. **Clyde Oakley:** *W. L. Gore, USA*
10. **Omer Oralkan:** *Stanford University, USA*
11. **Paul Reynolds:** *Weidlinger Associates, USA*
12. **Yongrae Roh:** *Kyungpook National University, Korea*
13. **Ahmad Safari:** *Rutgers University, USA*
14. **Mark Schafer:** *Sonic Tech Inc., USA*
15. **Thomas Shrout:** *Pennsylvania State University, USA*
16. **Kirk Shung:** *University of Southern California, USA*
17. **Stephen Smith:** *Duke University, USA*
18. **Wallace Smith:** *Office of Naval Research, USA*
19. **Yasuhito Takeuchi:** *Kagoshima University, Japan*
20. **Vasandara Varadan:** *University of Arkansas, USA*
21. **Jian Yuan:** *Boston Scientific, USA*
22. **Qiming Zhang:** *Pennsylvania State University, USA*
23. **Qifa Zhou:** *University of Southern California, USA*

VIII. Invited Talks (21 in Total)

Topics of Invited Talks:

Notes: To quickly find where the invited talks are scheduled in the conference technical program, please check the Condensed Program and the Floor Plan. You could also see more details of the technical program in the Full Program (Program Book), Abstract Book, and Meeting Planner. (Please use the labels such as "1I-3" to locate the corresponding sessions).

Group 1: Medical Ultrasonics:

- **Talk #1.1** **(1I-3)**: ***Jan D'hooge (Presenter)***, *Piet Claus, Jens-Uwe Voigt, and Frank Rademakers*, **"Functional imaging of the heart,"** Department of Cardiovascular diseases, Catholic University of Leuven, Leuven, Belgium. (Abstract ID: 1185)
- **Talk #1.2** **(1C-5)**: ****Mathias Fink (Presenter)***, **Mickael Tanter, **Jeremy Bercoff, and **Jacques Souquet*, **"Supersonic Shear Wave Elasticity Imaging,"** *ESPCI, Laboratoire Ondes et Acoustique, Paris, France. **Supersonic Imagine, Aix en Provence, France. (Abstract ID: 908)
- **Talk #1.3** **(1B-3)**: ***F. Stuart Foster***, **"Micro-ultrasound Takes Off (In the Biological Sciences),"** Imaging Research, Sunnybrook Health Sciences Centre and University of Toronto, Toronto, Ontario, Canada. (Abstract ID: 590)
- **Talk #1.4** **(1H-3)**: ****Hiroshi Kanai (Presenter)***, ***Junya Ohkohchi, and **Hideyuki Hasegawa*, **"Ultrasonic Imaging of 3-Dimensional Propagation of Electric Excitation and Vibrations in Human Heart,"** *Department of Electronic Engineering, Tohoku University, Sendai, Miyagi, Japan. **Graduate School of Biomedical Engineering, Tohoku University, Sendai, Miyagi, Japan. (Abstract ID: 36)
- **Talk #1.5** **(1F-5)**: ***Richard Prager (Presenter)***, *Andrew Gee, Graham Treece, Joel Lindop, and Nick Kingsbury*, **"Deconvolution and elastography based on 3D ultrasound,"** Department of Engineering, University of Cambridge, United Kingdom. (Abstract ID: 111)
- **Talk #1.6** **(1A-1)**: ****Hairong Zheng (Presenter)*** *and **Robin Shandas*, **"Ultrasound Particle Velocimetry: an Emerging Technique in Cardiology,"** *Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, Guangdong, China. **University of Colorado at Boulder, Boulder, CO, USA. (Abstract ID: 1178)

Group 2: Sensors, NDE, and Industrial Application:

- **Talk #2.1** **(5E-1)**: ***Saul Jacobson***, **"New Developments in Ultrasonic Gas Analysis and Flowmetering,"** 403 Huon Road, TAS 7004, Australia. (Abstract ID: 1017)
- **Talk #2.2** **(5I-1)**: ***Claire Prada (Presenter)*** *and Mathias Fink*, **"Invariants of the time reversal operator and ultrasonic applications,"** Laboratoire Ondes et Acoustique, CNRS, Université Paris 7, ESPCI, Paris, France. (Abstract ID: 1187)
- **Talk #2.3** **(5C-1)**: ****Michael Thompson (Presenter)*** *and **Scott Ballantyne*, **"Ultra High Frequency Acoustic Wave Detection of HIV Antibody,"** *Chemistry, University of Toronto, Toronto, Ontario, Canada. **Maple Biosciences, Toronto, Ontario, Canada. (Abstract ID: 130)

Group 3: Physical Acoustics:

- **Talk #3.1 (6I-1):** ***Eun Kim***, **"Piezoelectric MEMS for Audio Signal Transduction, Microfluidic Management, Resonant Mass Sensing, and Movable Surface Micromachined Structures,"** Electrical Engineering - Electrophysics, University of Southern California, Los Angeles, CA, USA. (Abstract ID: 647)
- **Talk #3.2 (5A-4):** **Bikash Sinha and* *****Vivian Pistre (Presenter)***, **"Applications of Sonic Waves in the Estimation of Petrophysical, Geophysical and Geomechanical Properties of Subsurface Rocks,"** *Mathematics and Modeling, Schlumberger-Doll Research, Cambridge, MA, USA. **Well Placement and Safety, Schlumberger Beijing Geoscience Centre, Beijing, China. (Abstract ID: 304)
- **Talk #3.3 (5A-3):** ***Yue-Sheng Wang***, **"Interfacial Waves and Stability at the Frictional Sliding Interface between Two Solids,"** Institute of Engineering Mechanics, Beijing jiaotong University, Beijing, China. (Abstract ID: 1177)
- **Talk #3.4 (6D-1):** ****Yook-Kong Yong (Presenter)***, **Mihir Patel, and **Masako Tanaka*, **"Theory, and Experimental Verifications of the Resonator Q and Equivalent Electrical Parameters due to Viscoelastic, Conductivity and Mounting Supports Losses,"** *Civil and Environmental Engineering, Rutgers University, Piscataway, New Jersey, USA. **Epson Toyocom, Japan. (Abstract ID: 258)

Group 4: Microacoustics – SAW, FBAR, MEMS:

- **Talk #4.1 (4F-1):** ***Robert Aigner***, **"SAW and BAW Technologies for RF Filter Applications: A Review of the Relative Strengths and Weaknesses,"** TriQuint Semiconductor, Apopka, Florida, USA. (Abstract ID: 405)
- **Talk #4.2 (4J-1):** ****Ken-ya Hashimoto (Presenter)***, **Yiliu Wang, *Tatsuya Omori, *Masatsune Yamaguchi, **Michio Kadota, **Hajime Kando, and **Teruhisa Shibahara*, **"Piezoelectric Boundary Wave Devices: Their Underlying Physics and Applications,"** *Dept. EEE, Chiba University, Chiba, Chiba, Japan. **Murata MFG, Co. Ltd., Yasu, Shiga, Japan. (Abstract ID: 21)
- **Talk #4.3 (4G-1):** ***C.S. Lam***, **"A Review of the Recent Development of MEMS and Crystal Oscillators and Their Impacts on the Frequency Control Products Industry,"** Integrated Device Technology, Inc., Andover, MA, USA. (Abstract ID: 407)

Group 5: Transducers and Transducer Materials:

- **Talk #5.1 (4B-1):** *Sung-Min Lee, Dong-Ho Kim, and* ***Ho-Yong Lee (Presenter)***, **"PMN-PZT Single Crystals and Composites for Transducer Applications,"** Ceracomp Co., Ltd., Sunmoon University, Asan, Chungnam, South Korea. (Abstract ID: 326)
- **Talk #5.2 (4B-4):** *Dan Zhou and* ***Haosu Luo (Presenter)***, **"Vibration Mode and Relevant Ultrasonic Applications of Ferroelectric Single Crystals Pb(Mg1/3Nb2/3)O3-PbTiO3,"** Shanghai Institute of Ceramics, CAS, Shanghai, China. (Abstract ID: 877)
- **Talk #5.3 (4C-1):** ****Wei Ren (Presenter)***, **Peng Lin, *Zheng Wang, *Xiaoqing Wu, *Peng Shi, *Xi Yao, **Qifa Zhou, **Dawei Wu, **Benpeng Zhu, and **K. Kirk Shung*, **"Piezoelectric Thin and Thick Films for Transducer Applications,"** *Electronic Materials Research Laboratory, Xi'an Jiaotong University, Xi'an, Shanxi, China. **NIH Transducer Resource Center and Department of Biomedical Engineering, University of Southern California, Los Angeles, CA 90089, USA. (Abstract ID: 723)
- **Talk #5.4 (6J-3):** ***Stewart Sherrit***, **"The Physical Acoustics of Energy Harvesting,"** Advanced Technologies Group, Instrument Mechanical Engineering Section, Jet Propulsion Laboratory, Pasadena, CA, USA. (Abstract ID: 90)
- **Talk #5.5 (6J-4):** ***Orest G. Symko (Presenter)*** *and Myra Flitcroft*, **"Ultrasonic Thermoacoustic Energy Conversion,"** Department of Physics, University of Utah, Salt Lake City, Utah, USA. (Abstract ID: 1181)

Talk #1.1:

Title: Functional imaging of the heart

Jan D'hooge (Presenter)*, Piet Claus, Jens-Uwe Voigt, and Frank Rademakers*, Department of Cardiovascular diseases, Catholic University of Leuven, Leuven, Belgium.

Abstract:

Background, Motivation and Objective: The function of the heart is to eject blood into the aorta/pulmonary artery during systole (i.e. systolic function) and to refill with blood during diastole (i.e. diastolic function). The heart is able to do so by active contraction and relaxation of the heart muscle (i.e. the myocardium) resulting in changes in wall and cavity dimensions. This in turn results in cavity pressure changes accelerating the blood in or out of the ventricular cavity.

Ultrasound (US) imaging has been the modality of choice for the non-invasive assessment of cardiac function. Traditionally, Mor B-mode derived volume-changes are measured to assess systolic function while blood flow patterns measured using Doppler techniques are used as an index for diastolic function.

Technological developments in ultrasound imaging have resulted in new methodologies for the quantification of cardiac function.

Statement of Contribution/Methods:US approaches for the quantification of cardiac function can be categorized into methods that assess properties of the myocardium and methods that asses characteristics of the blood flow.

In the former approaches, myocardial motion and deformation imaging has taken an important role. Although the original methods were based on Doppler imaging, later developments allowed to measure motion and deformation within the image plane (2D) and recently also in 3D (using volumetric US). These methods have enabled assessing ventricular twist/untwist characteristics – the latter being an interesting parameter for diastolic function. The above measurements in combination with mechanical models of the heart allow estimating the force regionally developed by the cardiac muscle.

Besides of these mechanistic approaches, acoustic properties of the myocardium have also been studied to functionally characterize the heart. Integrated backscatter and its cyclic variation have shown to be of interest in a large number of studies.

3D US systems have allowed a better characterization of ventricular volume changes which has led to the introduction of several new functional parameters.

Color Doppler M-mode imaging of blood flow can be used to estimate intra-ventricular pressure gradients which in turn have been correlated to cardiac function. More recently, speckle tracking approaches have also been applied to characterize (2D) blood flow patterns within the ventricle. It might be an important new approach.

Results: In this review lecture, the above described techniques will be presented from a technical point of view together with the experimental validation and/or clinical findings already available. Pros and contras of the approaches will be discussed.

Discussion and Conclusions: Developments in cardiac US have driven new methodologies to more accurately quantify cardiac function. They provide us with tools to better understand cardiac (patho)-physiology and, as such, better diagnose and treat the individual patient.

Talk #1.2:

Title: Supersonic Shear Wave Elasticity Imaging

***Mathias Fink (Presenter)**, *Mickael Tanter, **Jeremy Bercoff, and **Jacques Souquet*, *ESPCI, Laboratoire Ondes et Acoustique, Paris, France. **Supersonic Imagine, Aix en Provence, France.

Abstract:

Background, Motivation and Objective: This lecture presents a review of the applications of Supersonic Shear Imaging (SSI)modality.

Statement of Contribution/Methods: This technique is based on the combination of a dynamic radiation force induced in tissue by a set of ultrasonic beams and an ultrafast imaging sequence (5000 Images/s) capable of catching in real time the propagation of resulting shear waves. A shear source moving at a supersonic speed is remotely induced in tissues by the use of a special transmit beamforming sequence. It radiated quasi-plane shear waves propagating in a Mach cone. The local shear wave velocity is recovered using a time of fligth technique and enables the two dimensionnal (2D) maping of shear elasticity. This imaging modality is implemented on conventional probes driven by dedicated ultrafast echographic platforms. Consequently, it can be performed during a standard echographic exam.

Results: The preliminary clinical results demonstrate the clinical feasibility of this new elastography technique in providing quantitative assesment of relative stiffness of breast tissues. Experimental results will emphasize the potential of this elastography technique for many others potential applications such as liver, cardiovascular, opthalmologic and muscular applications.

Discussion and Conclusions: Beyond elasticity imaging, a complete in vivo assessment of tissue rheology can be performed using this approach. Dispersion effects affecting the propagation of visco-elastic waves in soft tissues are a key to understanding the rheological behavior of human tissues. New signal processing approaches based on the Supersoinic shear imaging modality were also developed and introduce a new concept of shear wave spectroscopy that could potentially become a great tool in tissue characterization and medical diagnosis.

Talk #1.3:

Title: Micro-ultrasound Takes Off (In the Biological Sciences)

F. Stuart Foster, Imaging Research, Sunnybrook Health Sciences Centre and University of Toronto, Toronto, Ontario, Canada.

Abstract:

Background, Motivation and Objective: Disease models in the mouse have become a central part of modern biomedical research. The next major project following the sequencing of the mouse genome is the coordinated and systematic knocking out of each of the mouse's ~ 30,000 genes and the discovery of the phenotypes associated with these mutations. In addition, subtle gene variations that predispose individuals to disease will be studied in ever increasing numbers. The National Institutes of Health in the United States and other international organizations are betting 100's of millions of dollars that this will lead to critical discoveries needed along the path to better healthcare. Imaging will play a major role in this enterprise and ultrasound will take its rightful seat at the table. The successful development of high frequency mechanical sector imaging has led to an entirely new community of ultrasound users whose backgrounds are not necessarily in imaging or medicine. They are physiologists, cell and molecular biologists, developmental biologists, and animal scientists.

Statement of Contribution/Methods: This talk will describe the path of instrument and applications development for high frequency "micro-ultrasound" for mice. Basic imaging, Doppler, and contrast imaging modes will be reviewed and the current state of the art in high frequency imaging of the mouse will be discussed.

Results: Examples of functional imaging of inflammation, cardiovascular disease, and tumour microcirculation will be used to illustrate the potential and limitations of the current technology. Potential for molecular imaging will be explored in a melanoma xenograft model in which the expression pattern of VEGFR-2 is studied. In contrast imaging, performance improvements will require optimization of the microbubbles themselves, a better understanding of microbubble interactions at high frequencies in both the bound and unbound state, and improved capabilities for nonlinear excitation.

Discussion and Conclusions: One of the barriers to development of micro-ultrasound imaging has always been the lack of high frequency arrays. This barrier is about to disappear. The latest results on the development of composite materials, high frequency linear arrays, and beamformers will be presented. These devices will dominate the next generation of micro-ultrasound imaging systems. Speculation on the future of micro-ultrasound technology and applications will be discussed.

Talk #1.4:

Title: Ultrasonic Imaging of 3-Dimensional Propagation of Electric Excitation and Vibrations in Human Heart

***Hiroshi Kanai (Presenter)**, **Junya Ohkohchi, and **Hideyuki Hasegawa*, *Department of Electronic Engineering, Tohoku University, Sendai, Miyagi, Japan. **Graduate School of Biomedical Engineering, Tohoku University, Sendai, Miyagi, Japan.

Abstract:

Background, Motivation and Objective: If the heart wall vibration caused as the response to the electric excitation is visualized using transcutaneous ultrasound, regional physiological properties in action potential and mechanical properties of the viscoelasticity can be noninvasively revealed. We have already found that the pulsive vibration is excited on the myocardium 15 ms after the electrical stimulation to an isolated heart [Acoustical Science and Technology 24, 17 (2003)]. Base on the fact, we have transcutaneously detected the propagation of minute vibration caused just around R-wave of the electrocardiogram (ECG). However, such visualization was limited to 2-dimentional (2D) plane obtained by scanning the ultrasonic beams. In this study, the propagation of the vibrations caused just around R-wave of ECG is visualized in 3-dimentional (3D) space.

Statement of Contribution/Methods: Since the propagation speed is several m/s along the heart wall, the necessary temporal resolution is at least 2 ms for the visualization. In our previous study, using a sparse sector scan in 2D plane [IEEE Trans. UFFC. 51, 1931 (2005)], the vibration waves were measured almost simultaneously at about 10,000 points set in the heart wall at a high frame rate but the scanning direction was limited to 10-16. Thus, there is no space to detect the RF data in 3D space with high temporal resolution. In this study, therefore, the multiple 2D data are acquired during consecutive several cardiac cycles and the propagation properties in 3D space are reconstructed. The probe on the chest wall is rotated intermittingly by 15 degrees at each of the relaxation periods during the consecutive 13 cardiac cycles, and RF data are acquired in the 2D plane by sparse scan in 16 directions. Since the direction of the ultrasonic beam at the center of the 2D planes is common in the data acquisition, it is easy to synchronize the time of each cardiac cycle precisely using the detected vibrations, and then the propagation of the vibration of the myocardium can be reconstructed in 3D space.

Results: The method was noninvasively applied to healthy subjects. The consecutive spatial distributions of the spatially interpolated phase of the waves reveal wave propagation along the heart wall. Just after the Q-wave of the ECG, the propagation started at the center of the interventricular septum, where Purkinje fiber contacts with the

myocardium, to the base side and apical side of the heart. Its propagation speed was slow (1 m/s), which shows the propagation of electrical excitation. After the R-wave of the ECG, other pulsive waves started to propagate from the base to the apex. Since its speed was several m/s for about 50 Hz but there was dispersion, this is the shear wave caused by the mitral-valve closure.

Discussion and Conclusions: The method noninvasively reveals the propagation of electrical conduction wave by measuring regional myocardial response to it in human heart, which will be a novel tissue characterization of the heart.

Talk #1.5:

Title: Deconvolution and elastography based on 3D ultrasound

Richard Prager (Presenter)*, Andrew Gee, Graham Treece, Joel Lindop, and Nick Kingsbury*, Department of Engineering, University of Cambridge, United Kingdom.

Abstract:

Background, Motivation and Objective: This talk is in two parts and addresses two ways of getting more information out of the RF signal from a 3D mechanically-swept medical ultrasound scanner. The first topic is the use of non-blind deconvolution to improve the clarity of the data, particularly in the direction perpendicular to the individual B-scans. The second topic is strain imaging. We present a robust and efficient approach to the estimation and display of axial strain information.

Statement of Contribution/Methods: For deconvolution, we calculate an estimate of the point-spread function at each depth in the image using Field II. This is used as part of an EM framework in which the ultrasound scatterer field is modelled as the product of (a) a piece-wise smooth and (b) a fine-grain varying function. In the E step, a Wiener filter is used to estimate the scatterer field based on an assumed piece-wise smooth component. In the M step, wavelet denoising is used to estimate the piece-wise smooth component from the scatterer field.

For strain imaging we use a quasi-static approach with efficient phase-based algorithms. Our contributions lie in robust and efficient 3D displacement tracking, point-wise quality-weighted averaging, and a stable display that shows not only strain but also an indication of the quality of the data at each point in the image. This enables clinicians to see where the strain estimate is meaningful and where it is mostly noise.

Results: For deconvolution we will present in-vivo and in-vitro images and simulations with quantitative performance measures. For example, with the blurred 3D data taken as 0dB, we get an improvement of 5.68dB with a Wiener filter alone, 5.90dB with ForWaRD and 7.45dB with our EM algorithm. For strain imaging we will show images based on 2D and 3D data and show how full 3D analysis can be performed in about 20 seconds on a typical computer. We will also present initial results of our clinical study to explore the applications of our system in our local hospital.

Discussion and Conclusions: We have shown that it is possible to use fast phase-based algorithms to provide accurate, stable images. With appropriate point-wise persistence, sufficiently clear and stable images can be presented in real-time to be of clinical interest. Our study of deconvolution with a spatially-varying point-spread function indicates that such algorithms may soon be fast enough to be a cost effective way of improving medical ultrasound images.

Talk #1.6:

Title: Ultrasound Particle Velocimetry: an Emerging Technique in Cardiology

Hairong Zheng (Presenter) *and* ***Robin Shandas*, *Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, Guangdong, China. **University of Colorado at Boulder, Boulder, CO, USA.

Abstract:

Background, Motivation and Objective: Development and progression of vascular atherosclerosis and aneurysms are modulated by local hemodynamics such as wall shear stress and blood flow recirculation. However, current non-invasive imaging techniques either cannot resolve the multi-component nature of such flows or are too cumbersome for routine clinical use. We have recently developed a novel contrast-based echo particle image velocimetry technique (Echo PIV) to quantify complex blood flow vectors noninvasively. The method is angle independent, possesses excellent spatial and temporal resolution, and is simpler to use than MRI velocimetry. Here we examine the utility of this method to characterize hemodynamics around carotid plaques and abdominal aortic aneurysms using in vitro phantoms.

Statement of Contribution/Methods:A custom-designed Echo PIV system, including a 7.5 MHz 128-element linear array transducer, custom-designed firing sequences, and a velocimetry algorithm for analyzing the backscattered radio-frequency (RF) data, was used along with commercially available ultrasound contrast microbubbles to obtain velocity vectors through models of carotid stenosis and abdominal aortic aneurysms. Both steady and pulsatile flows were used.

Results: Echo PIV was able to resolve and quantify the complex hemodynamics around carotid plaques and abdominal aortic aneurysms, including proximal flow velocity vectors and distal vortex recirculation patterns. The method was also capable of producing time-resolved multi-component velocity, shear stress and vorticity maps. Good agreement between peak velocities found by Echo PIV and those measured by conventional ultrasound Doppler was also found.

Discussion and Conclusions: The Echo PIV method provides an easy, direct and accurate means of quantitatively yet non-invasively characterizing complex vascular hemodynamics with comparable spatial resolution and superior temporal resolution to MRI velocimetry.

Talk #2.1:

Title: New Developments in Ultrasonic Gas Analysis and Flowmetering

Saul Jacobson, 403 Huon Road, TAS 7004, Australia.

Abstract:

Background, Motivation and Objective: Ultrasonic methods have important advantages in the measurement of gas flow, including the ability to measure almost any gas or gas mixture over a wide pressure range and turndown ratio. Ultrasonic gas flowmeters also are capable of measuring bi-directional flow and may be non-intrusive with no pressure loss. In certain cases the sensors may even be clamped on the outside of the pipe. Traditionally the Transit-time method has been used, but more recently interesting developments in Tag Cross-correlation have yielded promising results, particularly for low-pressure clamp-on applications. Ultrasonic flowmeters for gas have been commercially available since the 1980s, and they are widely accepted today for flaregas and stackgas monitoring and for a wide variety of industrial and fuel gas measurements. Highly accurate multi-path meters are approved and commonly used for custody transfer measurement of natural gas. In addition to the many advantages ultrasonic methods have in the measurement of the gas flowrate, ultrasonic propagation characteristics of the gas may also be measured to determine properties of the gas, such as its molecular weight, density or energy content.

Statement of Contribution/Methods: Soundspeed, in conjunction with temperature and pressure measurement were first used in the 1980s to determine the molecular weight and derive the mass flowrate of flaregas. Ultrasonic flowmeters for custody transfer natural gas gained acceptance in the 1990s with the publication of the American Gas Association AGA-9 report, which includes guidelines on the measurement and use of the gas soundspeed. More recently gas soundspeed and other properties such as attenuation have been used for the analysis of binary gases and pseudo-binary gases such as breathing gases, biogas, landfill gas, and process gases. Acoustic impedance has been measured and used to determine the density of high pressure gases.

Results: This paper reviews the methods to analyze binary, ternary and multi-component gases as well as presenting some new results from work conducted by the author and colleagues for biogas, consising primarily of methane and carbon dioxide at 100% RH.

Discussion and Conclusions:A review of the literature finds ultrasonic methods to be an effective means of gas flow measurement and analysis for many applications. The authors experiments found good correlation between ultrasonic methods and gas chromatography for the analysis of "simulated" as well as real biogas.

Talk #2.2:

Title: Invariants of the time reversal operator and ultrasonic applications

Claire Prada (Presenter) *and Mathias Fink*, Laboratoire Ondes et Acoustique, CNRS, Université Paris 7, ESPCI, Paris, France.

Abstract:

Background, Motivation and Objective: It is well known that acoustic time reversal mirrors own outstanding focussing properties in complex media. Used in the pulse echo mode, the time reversal process can be iterated to achieve selective focusing on the most reflective point among a set of scatterers or to enhance and extract the echo from a defect in a noisy structure.

Statement of Contribution/Methods: The iterative time reversal process can be described by the Time Reversal Operator. This process has an ensemble of invariants that can be determined from the measurement of the array inter-element impulse responses and the singular value decomposition of corresponding array response matrix. The determination and analysis of these invariants is the object of the D.O.R.T. method (French acronym for Decomposition of the Time Reversal Operator). It can be used to separate the echoes of several scatterers in an inhomogeneous medium. It also enables the separation of the radiation modes of a solid scatterer, like, for example, the various Lamb waves circumnavigating a hollow cylinder, leading to its characterization. Furthermore, when an estimate of the medium's Green function is available, high resolution and low noise images can be achieved using the back-propagation of the dominant invariants.

Results: This presentation will provide an overview of the different results obtained with the DORT method in the context of non detructive evaluation. Different improvements of the method will be shown, like the acquisition of the array response matrix using the Hadamard basis or focussed transmissions, or the coding of the inter-element impulse responses on 1-bit with little loss of information. Several examples of invariants of the time reversal operator and applications to the detection and characterization of solid scatterers will be presented.

Discussion and Conclusions: The DORT method is a powerfull tool that can be used as a complement to conventional beamforming imaging technique. Furthermore, it allows detection and focusing through aberrating media where conventional beamforming fails.

Talk #2.3:

Title: Ultra High Frequency Acoustic Wave Detection of HIV Antibody

***Michael Thompson (Presenter)** *and **Scott Ballantyne*, *Chemistry, University of Toronto, Toronto, Ontario, Canada. **Maple Biosciences, Toronto, Ontario, Canada.

Abstract:

Background, Motivation and Objective: Screening and detection of HIV disease in patients requires assaying of blood or serum samples for antibody. For rapid screening, the detection of only one antibody is required, but for confirmation of the presence of the disease up to 10 are mandatory. Such assays are highly time consuming and costly, and involve significant skilled labour. It is the specific overall objective of this project to develop an electronic signalling approach to the detection of HIV in biological fluids. The technology incorporates a biosensor methodology which will be designed for the clincal laboratory. The basis is ultra high frequency acoustic wave technology

Statement of Contribution/Methods: Our contribution has three distinct but connected goals. First we have developed a flow through system which incorporates a bulk acoustic wave sensor in an analytical configuration. The sensor is a conventional 20 MHz quartz device which is excited not by the usual electrode technique, but by a flat spiral coil. Secondary electric fields drive the device up to the 50th harmonic thus generating high sensitivity. The second crucial aspect of the project is the attachment of antibody probes to the device surface. These probes which are based on peptide structures bind antibody which is then detected by the sensor. We have designed and developed new linking agents for attaching probes at optimum surface density but also that avoid the vexing non-specific adsorption problem. The thired part of the work involves the use of the whole configuration to analyse real samples such as human serum

Results: We have demonstrated that the sensor can be operated with facility in a flow-injection apparatus. The faces of the device must be extremely parallel and have optimum surface physical nature as shown by AFM. XPS and other surface techniques have been used widely to demonstrate the presence of peptide probes on the quartz surface. The linkers are based on customized silane chemistry and constitute new molecules for the surface bioanalytical chemist. The binding of antibody in the flow system yields signals in the thousands of Hz. In serum we can acheive ratios of signal over nonspecific adsorptive noise at up 5 to 1.

Discussion and Conclusions: The system described above is being developed for commercial application in the clinical lab. Required for the future is the design and implementation of a multiplexed system involving series or parallel flow. Also the prototype instrument requires significant design engineering for non-technical users. The instrument will then be tested in the clinical environment

Talk #3.1:

Title: Piezoelectric MEMS for Audio Signal Transduction, Microfluidic Management, Resonant Mass Sensing, and Movable Surface Micromachined Structures

Eun Kim, Electrical Engineering - Electrophysics, University of Southern California, Los Angeles, CA, USA.

Abstract:

Background, Motivation and Objective: This paper describes (1) piezoelectric microphone and microspeaker, (2) micromachined self-focusing acoustic transducers for liquid droplet-ejection, mixing, pumping and transporting, (3) resonant mass sensors based on film bulkacoustic resonators (FBAR), and (4) piezoelectrically actuated mirror array and tunable capacitor.

First presented will be micromachined microphones and microspeakers that consume very low power, and are small, rugged and highly sensitive. The microphones and microspeakers are built on micromachined diaphragms with a piezoelectric ZnO, and have large dynamic range, no need to have a polarization voltage, and no major performance/reliability problem due to water condensation. The fabrication processes for the transducers are relatively simple and very robust. We have incorporated various types of diaphragms that are cantilever-like, bimorph-type, containing partially-etched holes, corrugated, dome-shaped, etc.

Another line of presentation will be on microfluidic mixers, pumps, transporters and ejectors based on the self-focusing acoustic-wave transducer (SFAT). All the transducers are powered by a piezoelectric film or substrate, and are inherently fast, consume low power, and require no heat. The SFATs do not require any nozzle or acoustic lens, and their fabrications are very simple. Moreover, the SFAT ejector (unlike a nozzle-based ejector) can eject liquid droplets at any oblique angle, and does not have to be moved to ink a spot with different liquids. We have integrated a 2-D ejector array with microchannels, chambers and other microfluidic components on a single silicon chip for a small, portable, affordable DNA synthesis system.

Also described will be FBAR-based highly sensitive, resonant mass sensors that can operate in vapor and liquid. In vapor, the sensor based on an FBAR with Q of about 500 at 1 GHz can detect a mass change of 10-9g/cm2 on its surface. The following FBAR-based sensors will briefly be described: mercuric ion sensor, DNA hybridization sensor, explosivevapor- trace detector, and a 1.5mm long, 250?m wide and 15?m thick polymer probe with an FBAR mass sensor at its tip.

Finally presented will be a piezoelectrically actuated array of cantilevers/bridges (whose facets can accurately be controlled by electrical voltage) for tunable capacitors, RF switches and projection displays. Through the implementation of a simply-supported bridge driven by two 100-?m-long ZnO-actuated cantilevers, a compact surface-micromachined tunable capacitor has been fabricated on a single chip without any warping, and shown to be capable of a 1,400% continuous tuning from 0.13 pF to 1.82 pF. Also shown will be a cantilever array with a pixel size of 100x100 ?m2 that was developed for a projection display. A piezoelectric ZnO film was used to produce 0.116°/V vertical deflection of the cantilever.

Statement of Contribution/Methods: None.

Results: None.

Discussion and Conclusions: None.

Talk #3.2:

Title: Applications of Sonic Waves in the Estimation of Petrophysical, Geophysical and Geomechanical Properties of Subsurface Rocks

Bikash Sinha and* *****Vivian Pistre (Presenter)*, *Mathematics and Modeling, Schlumberger-Doll Research, Cambridge, MA, USA. **Well Placement and Safety, Schlumberger Beijing Geoscience Centre, Beijing, China.

Abstract:

Background, Motivation and Objective: Sonic waves play an important role in estimating rock properties that are crucial in an efficient and safe production of oil and gas wells. An acoustic source in a fluid-filled borehole can generate both nondispersive headwaves as well as relatively stronger borehole guided modes. Processing of waveforms recorded with adequate spatial sampling yields sonic velocities in the surrounding formation over the receiver aperture. These velocities are then transformed into elastic moduli of the propagating medium. Elastic moduli of the formation provide many useful petrophysical, geophysical and geomechanical attributes of porous rocks that

constitute hydrocarbon bearing formations. Petrophysical attributes of hydrocarbon bearing formations include porosity, pore pressure, and fluid mobility. Geophysical attributes of the formation deal with anisotropy characterization of formations on a seismic scale. Geomechanical properties of rock consists of estimating in situ formation stresses and strengths as a function of radial position away from the borehole surface.

Statement of Contribution/Methods: Compressional velocity through a porous rock has been used to estimate porosity using Wyllie time-average equation whereby an interval transit time is decomposed into transit times in the solid and fluid components of the composite structure. Rock porosity can then be estimated using compressional velocity of the rock matrix and pore fluid in conjunction with measured velocity in the composite structure. There are well established correlations that help identify formation lithology in terms of the compressional to shear velocity ratio or the Poisson's ratio of the material. Plots of compressional to shear velocity ratio against compressional transit time help identify intervals containing limestone, dolomite, salt and quartz.

Results, Discussion and Conclusions: Recent applications of elastic moduli of rocks in a reasonably uniform lithology are in the estimation of fluid mobility in porous rocks; formation stresses; and fracture characterization. The presence of a fluid-filled borehole in a tectonically stressed formation causes both radial and azimuthal heterogeneities in rock stresses. Formation stresses are estimated using an acoustoelastic model based on nonlinear continuum mechanics. This model predicts crossing dipole dispersions to be an indicator of stress differential in the borehole cross-sectional plane. In-situ rock strength can be estimated using radial variations of shear velocities obtained from the inversion of borehole dispersions. Estimates of rock stresses and strength help maintain wellbore stability during drilling and production.

Talk #3.3:

Title: Interfacial Waves and Stability at the Frictional Sliding Interface between Two Solids

Yue-Sheng Wang, Institute of Engineering Mechanics, Beijing jiaotong University, Beijing, China.

Abstract:

Background, Motivation and Objective: Interfacial waves play an important role in many fields such as geophysics, seismology and non-destructive evaluation, etc., and thus have received considerable attention. Most of the published papers are concerned with the welded interface. However, contact interfaces, smooth or frictional, are also common in practical cases. The slip dynamics and Rayleigh-Stoneley-wave theory involving frictional contact interfaces are attracting more and more scientists working with experimental, numerical and analytical tools.

Statement of Contribution/Methods: In this paper, the theoretical study is presented on the interfacial waves and stability at a frictional interface between two anisotropic elastic or piezoelastic solids that are pressed together by remote pressure and meanwhile sheared by remote shearing traction and electric load. The external loads may or may not lead to steady rigid sliding between two solids. A perturbation field propagating steadily along the interface is examined by ignoring the details of the perturbation source. The local stick¨Cslip motion at the frictionally contact interface caused by the perturbed slip pulse is studied. The Stroh formalism, together with the concept of the surface impedance tensor is employed. The boundary value problem involving unknown slip/stick zones is cast to a Cauchy singular integral equation with an unknown integral interval.

Results: By solving the singular integral equations analytically, the explicit expressions of interface waves, which could satisfy the boundary conditions and energy balance, are therefore obtained. The explicit solutions are obtained. The existence conditions are given. Particularly, the existence conditions and physical properties of interface waves have been further discussed based on numerical calculations for practical examples.

Discussion and Conclusions: The results show: 1)Slip-stick frictional interface waves might exist in most material combinations. In some specific cases, the waves will involve 1/2 singularity at one end of slip zones while be bounded at the other end, which in the meantime requires enough large frictional coefficient. The wave speed ranges are related to the frictional coefficient. In more general cases, the interface waves will involved singularity weaker than 1/2 at one end of slip zones while be bounded at the other end. 2)Between the anisotropic elastic or piezoelastic media that are steadily frictionally sliding under the applied tractions, there will be no such interface waves that could change the stresses so as to cause the local slip motion at the interface, i.e., self-excited oscillations of instable interface waves will not transformed to the steady slip-stick motion at the interface without separation.

Talk #3.4:

Title: Theory, and Experimental Verifications of the Resonator Q and Equivalent Electrical Parameters due to Viscoelastic, Conductivity and Mounting Supports Losses

***Yook-Kong Yong (Presenter)**, *Mihir Patel, and **Masako Tanaka*, *Civil and Environmental Engineering, Rutgers University, Piscataway, New Jersey, USA. **Epson Toyocom, Japan.

Abstract:

Background, Motivation and Objective: Current finite element software does not allow for the calculation of a resonator Q without apriori assumptions of the resonator impedance or damping. A novel analytical/numerical method for calculating the resonator Q, and its equivalent electrical parameters due to viscoelastic, conductivity and mounting supports losses is presented. Hence the method presented will be quite useful for designing new resonators, and reducing their time and costs of prototyping. There is also a necessity for better and more realistic modeling of the resonators due to miniaturizations, and the rapid advances in frequency ranges in telecommunication.

Statement of Contribution/Methods: We present new three-dimensional finite elements models of quartz resonators and aluminum nitrite SMR's with viscoelasticity, conductivity, and mounting support losses. For quartz the materials losses attributed to electrical conductivity and acoustic viscosity were obtained from Lee, Liu and Ballato[1], and Lamb and Richter[2], respectively. The losses at the mounting supports were modeled by perfectly matched layers (PML's). The theory for dissipative anisotropic piezoelectric solids given by Lee, Liu and Ballato [1] was formulated in a weak form for finite element applications. PML's were placed at the base of the mounting supports to simulate the energy losses to a semi-infinite base substrate. FE simulations were carried out for free vibrations and forced vibrations of AT-cut quartz resonators, and solidly mounted resonators (SMR's). The FEM models for the SMR's employ periodic boundary conditions[3].

Results: Results for quartz thickness shear AT-cut quartz resonators and SMR's are presented and compared with experimental data. Results for the resonator Q and the equivalent electrical parameters were compared with their measured values. Good comparisons were found. Results for low and high Q AT-cut quartz resonators compared well with their experimental values. FEM models with periodic boundary conditions were employed to calculate the Q of SMR's operating in the range of 1.70 to 1.90 GHz. The Bragg layers of the SMR's consist of three alternating layers of W and SiO_2. The resonating element consisted of AlN piezoelectric film with Mo electrodes. Their Q and Keff values showed very good agreement with the measured data. The effect of thermal compensating oxide and Mo electrode resistance on the Q values was studied and compared with the measurement data.

Discussion and Conclusions: Comparisons of the Q and other electrical parameters obtained from the free vibration analysis with their corresponding values from the forced vibration analysis were found to be in excellent agreement. The results were validated by good comparisons with their experimental values. The resulting FE model gives the Q value without prior assumptions of damping factors and impedance. A new method for estimating the Q directly from the frequency spectrum obtained for free vibrations was also presented.

Talk #4.1:

Title: SAW and BAW Technologies for RF Filter Applications: A Review of the Relative Strengths and Weaknesses

Robert Aigner, TriQuint Semiconductor, Apopka, Florida, USA.

Abstract:

Background, Motivation and Objective: The first part of this paper aims to present facts and figures comparing SAW and BAW technologies with regard to

(a) process complexity / cost , size
(b) function, performance and fundamental limitations
(c) simulation methods and design flow

Based on the criteria above the application space for RF filters in wireless communication will be mapped and selected examples will be discussed in detail.

Statement of Contribution/Methods: The second part of this paper will review how both technologies progressed in recent years and will focus on innovations. Both SAW and BAW keep pushing for better performance and at times compete with each other. Despite that there are surprisingly many areas where SAW and BAW face similar challenges on a path to improved performance and/or lower cost. Commonalities and areas where SAW and BAW learn from each other are:

(a) frequency correction “trimming” methods for yield improvement
(b) materials and processes for acoustic layers
(c) wafer-level-packaging

Results: Results of research and development work at TriQuint in both SAW and BAW will be presented. The emphasis will be on temperature compensated (TC) filters and duplexers. TC SAW shows promise to fulfill demanding duplexer requirements for emerging mobile phone bands. Fully temperature compensated BAW filters enable to fix interference issues in emerging wireless applications.

Discussion and Conclusions: The shockwave FBAR/BAW has generated inside the SAW community a few years ago has passed. It generated a lot of pressure while approaching and a lot of traction while dissipating. Several suppliers now have both technologies in their portfolio while others stick to either the one or the other. SAW is recovering lost market share based on cost advantages and innovations which aim to overcome their main weaknesses. BAW on the other side keeps pushing the performance envelope for filters with extreme specifications. In the history of electronics over the past 50 years there are many cases of a new technology challenging established technologies. Examples range from “Transistor vs. Vacuum tube” and “GaAs vs. Silicon” to “CMOS vs. Bipolar”. Which of those best compares to “BAW vs. SAW” will be speculated about in the discussion.

Talk #4.2:

Title: Piezoelectric Boundary Wave Devices: Their Underlying Physics and Applications

***Ken-ya Hashimoto (Presenter)**, *Yiliu Wang, *Tatsuya Omori, *Masatsune Yamaguchi, **Michio Kadota, **Hajime Kando, and **Teruhisa Shibahara*, *Dept. EEE, Chiba University, Chiba, Chiba, Japan. **Murata MFG, Co. Ltd., Yasu, Shiga, Japan.

Abstract:

Background, Motivation and Objective: For SAW devices, bulky and expensive packaging has been one of the vital problems for their further miniaturization and price cuts. Piezoelectric boundary acoustic waves (PBAWs) have long been expected to be one of the possible solutions to break down this problem. Very recently, Kando, et al. proposed the SiO2 overlay/heavy grating electrode/rotated Y-cut LiNbO3 (rot. YX-LN) substrate structure for developing PBAW devices. The remarkable advantage of this device is that the cavity over the chip surface can completely be got rid of. This makes the packaging most simple and enables the packaged device size to be minimized, whilst the device fabrication process is almost identical with that for traditional SAW devices.

Statement of Contribution/Methods: This paper reviews physical properties of PBAWs and their application to miniature and high performance RF filters/duplexers.

Results: First, basic properties of PBAWs are discussed. It is shown that PBAWs are supported in various structures provided that highly piezoelectric material(s) are employed as structural member(s). For example, the Si/SiO2/IDT/rot. YX-LN structure supports PBAWs with a large electromechanical coupling factor and moderate temperature coefficient of velocity. In the structure, the PBAW energy is confined around the relatively thick SiO2 layer, where the wave velocity is relatively small. On the other hand, PBAWs are trapped near the electrode region in the SiO2/heavy grating electrode/rot. YX-LN structure. This means that PBAW properties in the structure are independent of the SiO2 layer thickness. This is a significant advantage for mass production. One may mind the fact with the structure, however, that the PBAW velocity should be smaller than the shear-wave velocity in SiO2, otherwise the PBAW becomes leaky. Rot. YX-LN possesses piezoelectric coupling with Rayleigh-type waves as well as SH-type waves. Responses associated with the former have to be suppressed completely for filter applications. It is discussed how these two waves are dependent on the substrate rotation angle, electrode thickness, and metallization ratio. The PBAW devices employing SiO2/Au electrodes/0-15°YX-LN are now being mass-produced. Because of the removed cavity from the chip surface, the packaged device size can be reduced dramatically. For example, a DMS filter based on PBAWs is developed for GSM900 Rx in a size of 0.8x0.6x0.25 mm3. The minimum insertion loss achieved in the passband (925-960 MHz) is 2.7dB (max), which is comparable to that of conventional SAW filters in a relatively large device size. The SiO2 layer is effective in achieving the improved temperature coefficient of frequency of -30 to -40 ppm/°C.

Discussion and Conclusions: The PBAW devices for various standards such as GSM1800 and GSM1900 have already been developed and are being mass-produced.

Talk #4.3:

Title: A Review of the Recent Development of MEMS and Crystal Oscillators and Their Impacts on the Frequency Control Products Industry

C.S. Lam, Integrated Device Technology, Inc., Andover, MA, USA.

Abstract:

Background, Motivation and Objective: Due to its high Q and temperature-stable properties, quartz crystal based oscillators are important clock sources in consumer, commercial, industrial, and military products The demand for quartz crystal resonators and oscillators continues to rise and the quartz crystal industry has made major progresses in miniaturization, performance enhancement, and cost reduction in the past ten years. The unique fabrication and encapsulation requirements though render quartz crystal resonators and oscillators difficult or close to impossible to be integrated onto the mature silicon based IC platforms. The recent technical breakthroughs of all silicon MEMS (Micro Electro Mechanical Systems) based resonators and oscillators seem to re-ignite the interest in displacing/replacing the quartz crystal technology and to open up again the prospect in clock source integration.

Based on a 2006 review paper by the author[1], this paper expands on the subject by reviewing the development of all silicon MEMS oscillators and crystal oscillators in the past few years and commenting on what challenges they face in the highly competitive frequency control products industry. This paper will also touch on the recent development of CMOS oscillators (without moving parts) and piezoelectric-activated silicon MEMS resonators and oscillators.

[1] "An Assessment of the Recent Development of MEMS Oscillators as Compared with Crystal Oscillators," C.S. Lam, Piezoelectricity, Acoustic Waves and Device Applications- Proc. of the 2006 Symposium, Zhejiang University, China, 14~16 December 2006, ed. Ji Wang and Weiqiu Chen, pp. 308-315 (also in http://www.txccorp.com/download/tech_paper/2006-SPAWDA-3.pdf)

Statement of Contribution/Methods: None.

Results: None.

Discussion and Conclusions: None.

Talk #5.1:

Title: PMN-PZT Single Crystals and Composites for Transducer Applications

Sung-Min Lee, Dong-Ho Kim, and ***Ho-Yong Lee (Presenter)***, Ceracomp Co., Ltd., Sunmoon University, Asan, Chungnam, South Korea.

Abstract:

Background, Motivation and Objective: Crystallographically engineered Relaxor-PT single crystals, specifically PMN-PT and PZN-PT, offer very high piezoelectric and electromechanical coupling coefficients (d33>2,000 pC/N; k33>0.9), promising for next generation electromechanical devices such as ultrasonic transducers and actuators. However, these piezoelectric single crystals exhibit relatively low TC, TRT and EC, and thus have very limited usage range. In contrast to the growth of relaxor-PT single crystals, PZT and relaxor-PZTs can not be readily grown in single crystal form because of their incongruent melting behavior. Attempts to grow single crystals of PZT and relaxor-PZTs have been made by numerous researchers, resulting in crystallites too small (2 ~ 3 mm in size) to allow adequate property measurements. If PZT and relaxor-PZTs materials could be grown in single crystal form, PZT and realxor-PZT single crystals have been expected to have remarkable and wide range of dielectric and piezoelectric properties such as high K3T, TC, TRT and EC.

Statement of Contribution/Methods: The solid-state crystal growth (SSCG) technique is to grow a single crystal in a polycrystalline precursor by continuous grain growth of an external seed single crystals without complete melting of major components. In the SSCG process, no melting of PZT is involved and thus the issue of incongruent melting can be avoided. It is also readily amenable to dopant modifications which give us the family of piezoelectrically "soft" and "hard" PZT and relaxor-PZT single crystals, similar to "soft" and "hard" ceramics we have today. In this investigation, undoped and doped MPB PMN-PZT single crystals were fabricated using the SSCG technique and their dielectric/piezoelectric properties characterized.

Results: The undoped and doped (Fe-, Mn-, and In-) PMN-PZT single crystals of high TC (> 180~300oC) and EC (> 3.5~10 kV/cm) were sucessufully fabricated by the SSCG technique and their dielectric/piezoelectric properties characterized. Especially the temperature dependence of the piezoelectric/electromechanical properties, the dc bias effect on TRT (or the application usage temperature range), the high field unipolar strain, and the development of an internal bias were investigated and compared to PMN-PT single crystals. Piezoelectric single crystal-polymer composites were also prepared by using undoped and doped PMN-PZT single crystals and their dielectric/piezoelectric properties characterized.

Discussion and Conclusions: Compared to PMN-PT single crystals, the high TC/EC PMN-PZT single crystals were found to exhibit a much wider usage range with respect to electric field as well as temperature, and thus are better candidates for application in transducers and actuators. Along with high TCs, the ability for dopant engineering using the SSCG technique has been demonstrated to piezoelectrically "harden" crystals (Qm = 500 ~1,000) via the development of an internal bias.

Talk #5.2:

Title: Vibration Mode and Relevant Ultrasonic Applications of Ferroelectric Single Crystals Pb(Mg1/3Nb2/3)O3-PbTiO3

Dan Zhou and ***Haosu Luo (Presenter)***, Shanghai Institute of Ceramics, CAS, Shanghai, China.

Abstract:

Background, Motivation and Objective: Modern medical ultrasonic imaging relies almost exclusively on piezoelectric transducers to convert mechanical waves to electrical signals and vice versa. The vast majority of these devices incorporate a polycrystalline piezoelectric based on the composition Pb(Zr1-x, Tix)O3, generally known as PZT. These materials offer electromechanical properties k33 of 75% and piezoelectric properties d33 of 600 pC/N. Recently, much research work has been reported on the relaxor ferroelectric single crystals (1-x)Pb(Mg1/3Nb2/3)O3-xPbTiO3 (PMN-PT) with superior properties of k33 (~94%), d33 (>2000pC/N), etc. Such excellent performances will lead to large improvement of sensitivity and resolution in medical ultrasonic imaging systems.

Statement of Contribution/Methods: The electromechanicl factors were measured according to IEEE standards by HP4194A impedance analyzer. The single element PMN-PT transducer was fabricated with the same structure as PZT transducer. The PMN-PT/Epoxy composites and array transducers were simulated with PiezoCAD.

Results: The PMN-PT crystals were investigated of electromechanical factors k33, kt, k33' and piezoelectric constant d33, with different orientation and cuts for various medical ultrasonic applications. Based on the longitude extension mode (k33), the PMN-PT/Epoxy 1-3 composites were modeled and fabricated. The holistic kt (>90%) of the composites far exceeds that of the PZT ceramics (only ~50%). The relatively low acoustic impedance makes the acoustic matching to human tissue much easier. The results will be favorable for single element ultrasonic transducers, such as Doppler blood flow imaging applications. For medical linear and phase array transducers, the coupling factor k33' is a key indicator. The PMN-PT resonators of this vibration mode were studied systematically with orientations and poling conditions. The optimized cut type of PMN-PT for array applications was obtained with k33' of 92%, which is larger than that 70% of conventional PZT ceramics.

Then, ultrasonic transducer devices utilizing PMN-PT were investigated. The PMN-PT pulse wave 2MHz TCD probe was manufactured with 30% broader bandwidth and 4dB higher sensitivity compared with PZT probe. These enhanced performances were induced by relatively high kt (62%) and d33 of PMN-PT. The single element transducer based on PMN-PT/Epoxy 1-3 composites was simulated with broader bandwidth and higher echo response than PZT transducers. The PMN-PT 3.5MHz linear array transducer was also simulated with the similar effects.

Discussion and Conclusions: The PMN-PT were investigated and optimized for various medical ultrasonic transducer applications. The ultrahigh piezoelectric and electromechanical constants were obtained in PMN-PT. Three types of fabricated or simulated medical transducers utilizing PMN-PT all show improved pulse length, bandwidth and sensitivity. So the next generation of high performance ultrasonic transducers is expected.

Talk #5.3:

Title: Piezoelectric Thin and Thick Films for Transducer Applications

***Wei Ren (Presenter)**, *Peng Lin, *Zheng Wang, *Xiaoqing Wu, *Peng Shi, *Xi Yao, **Qifa Zhou, **Dawei Wu, **Benpeng Zhu, and **K. Kirk Shung*, *Electronic Materials Research Laboratory, Xi'an Jiaotong University, Xi'an, Shanxi, China. **NIH Transducer Resource Center and Department of Biomedical Engineering, University of Southern California, Los Angeles, CA 90089, USA.

Abstract:

Background, Motivation and Objective: In recent years, the demands for miniaturized devices integrated with microelectronics have increased significantly, leading to great interests in the design and fabrication of thin/thick film transducers. Lead zirconate titanate (PZT) is an attractive material for transducer applications due to its excellent electromechanical properties. Such devices often require crack-free films with thickness of 1~10 ?m. A polymer-assisted deposition and PZT powders/sol-gel solution composite thick films have been developed to prepare PZT thick films.

Statement of Contribution/Methods: PbZr0.52Ti0.48O3 (PZT) thin and thick films with thickness of 1~10 ?m have been prepared by a metallo-organic decomposition process modified by a polymer, poly(vinyl acetate) (PVAc). It?s found that with an increase of PVAc in PZT solutions, the single-layer thickness of PZT films increases from 0.07 ?m to 0.47 ?m. When PVAc-related organic compounds are decomposed, nano-sized pores are formed and provide space for the structural and stress relaxation. It prevents the crack formation and increases the uncracking critical thickness of PZT films.

In addition, PZT composite thick films up to 30 ?m-thick have been successfully prepared with a spin-coating of PZT powers/sol-gel composite solution. The electric properties of the films were evidently enhanced by infiltration of PZT solgel into composite films and optimization of PZT powders to PZT sol-gel mass ratio in composite solution. Transducer and array at a frequency high than 100 MHz have been fabricated using above PZT thick films by MEMS technology.

Results: Dielectric, ferroelectric, and piezoelectric properties of PZT films have been thoroughly investigated. For PVAc modified PZT films, with the increase of the film thickness from 0.95 ?m to 9.9 ?m, the dielectric constant increases from 1070 to 1600, while the dielectric loss is in a range of 0.03~0.04 at 1 kHz. Remanent polarization increases from 36.1 ?C/cm2 to 55.3 ?C/cm2, while coercive field decreases from 57.3 kV/cm to 40.9 kV/cm. The piezoelectric coefficient d33 increases from 43.9 pm/V to 200 pm/V.

Discussion and Conclusions: Using PZT thick films, high-frequency transducers and kerfless array at a frequency high than 100 MHz will be presented. Meanwhile, the effect of the residual stresses of PZT films on devices has been investigated.

Talk #5.4:

Title: The Physical Acoustics of Energy Harvesting

Stewart Sherrit, Advanced Technologies Group, Instrument Mechanical Engineering Section, Jet Propulsion Laboratory, Pasadena, CA, USA.

Abstract:

Background, Motivation and Objective: Energy harvesting systems based on the transformation of acoustic vibrations into electrical energy are increasingly being used for niche applications due to the reduction in power consumption of modern day electronic systems. Typically these applications involve extracting energy at remote or isolated locations where local long term power is unavailable or inside sealed or rotating systems where cabling and electrical commutation are problematic. This paper will look at some of the limitations of these systems.

Statement of Contribution/Methods:A variety of modes of harvesting electrical power from acoustic vibrations or impacts generated by machines, humans or nature will be presented. These modes can be configured to extract energy from longitudinal, transverse, bending, hydrostatic or shear waves at frequencies ranging from less than a Hz to 10's of kHz. In order to aid in the design and optimization of these devices we have identified common elements of these systems.

Results: These common elements are: the input mechanical power spectrum, the effective matching of mechnical loads, the conversion of the input mechanical energy into electrical energy using piezoelectric or biased electrostrictive transducers and matching the electrical load. Recent results on an acoustic electric feed-through device demonstrated 1 kW power conversions at power densities of 70 W/cm2 and 25 W/cm3 using a pre-stressed stacked PZT ceramics operating at 16 kHz with an efficiency of 84%. In addition a variety of circuits have been designed and are currently available to optimize the electrical impedance matching. These results suggest the conversion and the electrical matching are not the limiting elements of these devices and we will show that the main impediment to increased power is the vibration source amplitude, frequency, inertia and the size limitations of the energy harvesting systems or in the case of human powered systems the requirement that the device remains unobtrusive.

Discussion and Conclusions: Although the power densities of these devices may be limited by the source and the matching of the mechanical loads there are plenty of applications that are feasible within the available power densities due to the wonders of CMOS.

Talk #5.5:

Title: Ultrasonic Thermoacoustic Energy Conversion

Orest G. Symko (Presenter) *and Myra Flitcroft*, Department of Physics, University of Utah, Salt Lake City, Utah, USA.

Abstract:

Background, Motivation and Objective: When heat is applied to one end of a stack of plates inside an acoustic resonator, sound can be generated. This is the basis of a thermoacoustic engine called a prime mover. It consists of a resonator with a working gas, a cold heat exchanger next to the stack and a hot heat exchanger against the other end of the stack; heat is injected to the hot heat exchanger. The device is driven by a temperature gradient across the stack; above a critical gradient the onset for oscillations occurs. Being a resonant system the device size scales inversely with frequency. Certain applications have advantages in reducing device size and hence to operate in the ultrasonic range. The development of the technology dealing with this frequency range and device characteristics is presented here. By coupling a piezoelectric device to the thermoacoustic engine, conversion from heat to electricity is achieved. The unit makes a compact energy converter with essentially no parts. It can be used in energy conversion applications, especially waste heat to electricity conversion.

Statement of Contribution/Methods: In developing such small devices for the ultrasonic range it is important to scale down the critical dimensions from working audio frequency devices. With air as the working fluid the resonator (¼- wave resonator) length is 4.1mm for an operating frequency of 21 kHz. Heat, generated by a flame or other source, is applied to the hot heat exchanger. Above a threshold temperature difference between the hot and cold heat exchangers, acoustic oscillations are generated. Coupled to a piezoelectric device; it converts sound to electricity. Thermal interaction between the sound field and the element of the stack provides the correct phasing for sound production. This is achieved when the condition $\omega\tau \approx 1$ is met; ω is the angular frequency of the sound and τ is a thermal relaxation time given by d2 / 2α where d = an effective distance between stack elements and α = the thermal diffusivity.

Results: Scaling down in size thermoacoustic engines from the audio range led to miniature engines. The devices radiated sound when the injected heat created a temperature gradient above threshold. For devices 4.1mm long sound was radiated at 21kHz. Depending on the alignment of the cold and the hot parts, the temperature difference across the stack for onset of oscillations ranged from 85ºC to 180ºC.

Sound intensities outside the resonator varied with the ΔT across the stack; they reached levels of over 140dB. Generated acoustic energy is converted to electricity by means of a piezoelectric element.

Discussion and Conclusions: Since the acoustic devices are resonant systems, large power density can be achieved with ultrasonic devices for the 20kHz unit. At an acoustic intensity of 160dB, the power density would be ~2 Watts/cm3. To achieve high power levels, an array of such devices can be formed.

The results show the potential of a thermoacoustic-piezoelectric approach in the ultrasonic range for energy conversion from heat to electricity.

IX. Special Clinical Session

Overview of Clinical Session Topics:

The 2008 IEEE International Ultrasonics Symposium will include a special clinical session to show how medical ultrasound technologies are used in clinical practices. This special session consists of the following half-hour invited presentations. (Note: This session is organized by Dr. Stuart Foster, University of Toronto, Canada.)

Notes: To quickly find where the invited clinical session talks are scheduled in the conference technical program, please check the Condensed Program and the Floor Plan. You could also see more details of the technical program in the Full Program (Program Book), Abstract Book, and Meeting Planner. (Please use the labels such as "1E-1" to locate the corresponding sessions).

- **Talk #1** (**1E-1**): ***Peter Burns***, **"Making Microbubbles Work for Ultrasound: Technical and Broader Challenges,"** Dept Medical Biophysics, University of Toronto, Toronto, ON, Canada. (Abstract ID: 957)
- **Talk #2** (**1E-3**): ***Yuxin Jiang***, **"The Clinical Application of Ultrasound Contrast Imaging,"** Department of Diagnostic Ultrasound, Pekin Union Medical College Hospital, Beijing, China. (Abstract ID: 836)
- **Talk #3** (**1E-2**): ***Stephanie Wilson***, **"The Role of Contrast Enhanced Ultrasound (CEUS) in Oncology,"** Department of Diagnostic Imaging, Foothills Medical Centre, Calgary AB, Canada. (Abstract ID: 1189)

Talk #1:

Title: Making Microbubbles Work for Ultrasound: Technical and Broader Challenges

Peter Burns, Dept Medical Biophysics, University of Toronto, Toronto, ON, Canada.

Abstract:

Background, Motivation and Objective: Although it has been 10 years since microbubble contrast agents were first approved for clinical use, adoption has been slow, in spite of considerable technical advances and many successful clinical studies.

Statement of Contribution/Methods: Methods for contrast specific imaging exploit the nonlinear response of bubbles at or near resonant excitation. Simple filtering for higher harmonics has given way to broadband methods using phase and/or amplitude modulation of a sequence of pulses. With suitable detection methods, linear, nonlinear, moving and stationary targets can all be segmented from the echo and shown in real time. The tendency of bubbles to disrupt at low peak negative pressures also offers a potential role for coded excitation on transmit. Deliberate disruption of bubbles with a few high MI pulses can clear the image plane and allow measurement of its replenishment by contrast offering a unique way to quantify microvascular flow and perfusion volume.

Results: At least 3 million clinical contrast studies have been performed: safety and tolerability have proven excellent. Clinical applications have focused on areas in which ultrasound already plays an important diagnostic role. In cardiology, contrast can aid visualisation of the endocardium, especially important in wall motion studies, and has been shown to improve the accuracy of stress echo. It can also image and measure myocardial perfusion in real time,

at rest and with stress, with spatial resolution superior to the current nuclear medicine standard, SPECT. In radiology, perfusion can be imaged in many organs, but work has concentrated on the liver, where contrast can help characterise focal lesions with an accuracy comparable to contrast CT and MRI. It also aids in lesion detection, in real time guidance of interventions such as RF ablation and in monitoring response to tumor therapy, especially using the new antiangiogenic agents.

Discussion and Conclusions: In spite of demonstrated efficacy and safety, widespread adoption into the clinic has been slow. Two reasons are proposed. First, although bubbles are approved for perfusion imaging in more than 60 countries, the US, which has approved no radiology indications, is not among them. Second, while contrast ultrasound is often less expensive than competing modalities, physician reimbursement may be less too, dampening enthusiasm among practitioners. We conclude that future clinical studies should focus on applications unique to microbubbles, exploiting, for example, their confinement to the blood pool and the ability to image them in real time. Approval of a perfusion indication by the US FDA is crucial. Widely available, robust contrast specific imaging modes are needed. The intriguing capacity of bubbles to potentiate therapies, including drug delivery, should be pursued. For diagnosis, translation of microbubble contrast applications to clinical practice may come more quickly in cost driven rather than profit-driven healthcare systems.

Dr. Peter Burns is Professor and Chairman of Medical Biophysics and Professor of Radiology at the University of Toronto and Senior Scientist at Sunnybrook Health Sciences Centre, Toronto. He received his degree in Mathematical Physics in 1973 and, following a postgraduate fellowship in History and Philosophy of Science, a PhD in Radiodiagnosis in 1983. He subsequently held faculty positions in Radiology at Yale University and Thomas Jefferson University in Philadelphia. He moved to Toronto in 1991. He was part early efforts to detect flow in small blood vessels with Doppler, including the first ultrasonic detection of tumor blood flow. He subsequently worked on Doppler methods for flow detection and hemodynamic measurement in the abdomen and pelvis. In 1988 he began research with microbubbles as ultrasound contrast agents, focusing on the development of nonlinear methods such as harmonic, pulse inversion and amplitude modulation imaging as well as their clinical applications in perfusion imaging of the heart, abdomen and tumors. He has published more than 130 papers, 4 books and holds several patents in diagnostic ultrasound. He received the World Federation of Ultrasound in Medicine and Biology Pioneer Award (1988); the Ian Donald Gold Medal for Technical Achievement (2002); Innovation and Excellence Trophy of the Société Canadienne de Radiologie (2002), was the Euroson Lecturer of the European Society for Ultrasound in Medicine (2005); the Donald McVicar and Brown Lecturer of British Medical Ultrasound Society (2006) and is the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society Distinguished Lecturer for 2008.

Talk #2:

Title: The Clinical Application of Ultrasound Contrast Imaging

Yuxin Jiang, Department of Diagnostic Ultrasound, Pekin Union Medical College Hospital, Beijing, China.

Abstract:

Background, Motivation and Objective: Contrast-enhanced ultrasound imaging is the area of greatest interest in ultrasound medicine currently. The recent improvements of contrast agent and the contrast specific scanning techniques have given new possibilities for the further research and clinical application. We are having researches in the basic theory study and further clinical applications in China, so that ultrasound contrast imaging can be better recognized and widely applied in the clinical practice.

Statement of Contribution/Methods: The introduction of second-generation microbubble contrast agents, such as SonoVue and self-made perfluorocarbon ultrasound contrast agent, and the advent of specialized imaging techniques enabled real-time contrast-enhanced imaging. In our study, Sonovue and the gray scale harmonic imaging technique

were adopted to evaluate the characteristic contrast enhanced pattern of liver, kidney, gynecology, breast and thyroid lesions, etc.

Results: Our clinical research shows that contrast enhanced ultrasounographic imaging can improve the diagnostic potential of sonographic examinations in different clinical applications, including the better observation of small vessels, the real-time assessment of the blood perfusion pattern in an organ or area of interest, with a significantly higher detection rate and diagnostic accuracy especially for the tumor of liver, kidney and gynecology. Otherwise, contrast enhanced ultrasound imaging holds the potential for a better visualization and diagnosis of peripheral vascular and some deep-located vessels, such as carotid, brain arteries and renal arteries, etc. The area of great promise and growth also lies in the clinical research of breast and thyroid.

Discussion and Conclusions: With the fast development and the intrinsic advantages of contrast enhanced ultrasound imaging, it is gainning more and more popularity. Ultrasound doctors should pay efforts to do further research in this state of art technique, which may open a new prospect for the ultrasound medicine.

Dr. Yuxin Jiang is a director of the Department of Diagnostic Ultrasound, Peking Union Medical College Hospital, Beijing, China; Professor of the Chinese Academy of Medical Sciences & Peking Union Medical College in Beijing, China; President of the Society of Ultrasound in Medicine of Chinese Medical Association. Dr. Jiang has lead a team from China to present at ASUM ASM 2006 on topics relating to ultrasound guided therapy, e.g., use of contrast in ultrasound, and various interventional techniques. Dr. Jiang will discuss topics relating to ultrasound guided therapy, e.g., HIFU and Radio Frequency, use of contrast agents in ultrasound, and various interventional techniques now used in China.

Talk #3:

Title: The Role of Contrast Enhanced Ultrasound (CEUS) in Oncology

Stephanie Wilson, Department of Diagnostic Imaging, Foothills Medical Centre, Calgary AB, Canada.

Abstract:

Background, Motivation and Objective: The oncology patient is susceptible to the development of tumor masses in many locations and their detection and diagnosis is usually within the realm of diagnostic imaging. While ultrasound may show tumors, additional imaging with CT and or MR scan is generally required for their confident diagnosis. We address the tremendous contribution of contrast enhanced ultrasound (CEUS) in the imaging of this population.

Statement of Contribution/Methods: Contrast agents for ultrasound are comprised of tiny bubbles of gas in a supporting shell. Their intravenous injection results in tissue perfusion, analogous to that seen on contrast enhanced CT and MR, and also incredible vessel visualization more similar to that seen with angiography. These attributes allow for improved detection and characterization of tumors in many parts of the body.

Results: Characterization of tumors of the liver is the most accepted indication for CEUS where it is complimentary to CT and MR scan. Liver lesion detection and also the difficult question of diagnosis of hepatocellular carcinoma are further accepted strategies for the use of CEUS as the detection of small nodules in the cirrhotic liver on screening sonography is enhanced by the performance of CEUS at the time of nodule detection. Detection of liver masses is also improved by CEUS as the addition of contrast agent increases the conspicuity of liver masses on sonography such that more and smaller masses may be detected than at baseline.

CEUS is also valuable when added to intraoperative liver ultrasound, contributing to management decisions for the patient undergoing surgery. Further, CEUS is a critical component of radiofrequency ablation (RFA) techniques especially when performed at the time of the procedure where it may reduce the requirement for repeat procedures

performed for incomplete ablation. CEUS is suitable for monitoring patients with prior RFA or transarterial chemoembolization (TACE).

CEUS contributes to the characterization of renal masses, especially cystic RCC, where vascularity in septae and nodules is shown with a sensitivity surpassing both CT and MR scan. Further, in other locations such as the pancreas, spleen, ovary, prostate and breast, CEUS may show the presence of vascularity in real-time with the resolution of standard gray-scale ultrasound.

Discussion and Conclusions: CEUS changes totally the role of ultrasound in the evaluation of the patient with cancer. CEUS may be performed on any organ with a suitable acoustic window where the addition of vascular information may contribute to diagnosis. Its performance is independent of renal function making it a perfect first choice for the characterization of all masses in the oncology patient. To confirm that a mass is a malignant tumor or to confirm that it is not, CEUS is an easily performed and readily available technique. For these reasons, CEUS deserves a fundamental role in the future of oncological diagnosis.

Dr. Stephanie R. Wilson was born and educated in Western Canada but has made Toronto her home for the duration of her professional life. In 2007, she relocated to her home province where she is now Professor of Radiology at the University of Calgary and a member of the department of Diagnostic Imaging at Foothills Medical Centre, Calgary, CANADA. Dr Wilson has invested her research, academic and practice pursuits on imaging of the gastrointestinal tract, pancreas and liver. Since 1992, Dr Wilson has collaborated with Dr. Peter Burns from University of Toronto/Medical Imaging Research on the investigation of microbubble contrast agents for the evaluation of their use in Medical Imaging. Their major accomplishments to date include their investigation of the diagnosis and characterization of tumors of the liver. Burns and Wilson shared a grant from the Canadian Institute for Health Research (CHIR) for these investigations.

Apart from her research pursuits, Dr. Wilson has been the recipient of annual prestigious University of Toronto Faculty of Medicine teaching awards including the Colin R. Woolf Award for Excellence in Continuing Education Teaching in 1992, and the Wightman-Berris Academy Award for Individual Teaching Excellence in 2005. She has authored over 100 peer reviewed publications and many book chapters and is an editor of the highly successful two volume reference on ultrasound, entitled Diagnostic Ultrasound, often referred to as the “Bible of Ultrasound”, now in its third edition. Dr Wilson served as the first woman president of the Canadian Association of Radiologists and was also the recipient of their Gold Medal for her contribution to radiology.

X. Short Courses (12 in Total)

Overview of Short Courses:

Notes: To find the short course rooms and their locations, please check the Condensed Program and the Floor Plan. Detailed technical program of the conference can be found in the Full Program (Program Book), Abstract Book, and Meeting Planner.

8:00 A.M. - 12:00 Noon, Sunday, November 2, 2008:

- **Short Course 1A** (**Conference Room 311A/B**): **Medical Ultrasound Transducers**, ***Douglas G. Wildes*** and ***L. Scott Smith***, GE Global Research Center, Niskayuna, NY, USA.
- **Short Course 2A** (**Conference Room 307**): **Ultrasound Imaging Systems: from Principles to Implementation**, ***Kai E. Thomenius***, GE Global Research Center, Niskayuna, NY, USA.
- **Short Course 3A** (**Conference Room 308**): **Photoacoustic Imaging and Sensing**, ***Stanislav Emelianov***, Biomedical Engineering Department, University of Texas at Austin, USA.
- **Short Course 4A** (**Conference Room 311C**): **Estimation and Imaging of Tissue Motion and Blood Velocity**, ***Hans Torp*** and ***Lasse Lovstakken***, Department of circulation and medical imaging, Norwegian University of Science and Technology, Trondheim, Norway.

1:00 P.M. - 5:00 P.M, Sunday, November 2, 2008:

- **Short Course 1B** (**Conference Room 311A/B**): **Ultrasound Elastography: Quantitative Approaches**, ****Jeffrey Bamber*** and *****Paul Barbone***, *Institute of Cancer Research and Royal Marsden Hospital, UK. **Boston University, USA.
- **Short Course 2B** (**Conference Room 307**): **Acoustic Microscopy - Fundamentals and Applications**, ****Roman Gr. Maev***, *****Naohiro Hozumi***, ******Kazuto Kobayashi***, and *******Yoshifumi Saijo***, *Centre for Imaging Research and Advanced Materials Characterization, University of Windsor, Ontario, Canada. **Department of Electrical & Electronic Engineering, Aichi Institute of Technology, Toyota, Japan. ***Honda Electronics Co. Ltd., Aichi, Japan. ****Tohoku University, Sendai, Japan.
- **Short Course 3B** (**Conference Room 308**): **Therapeutic Ultrasound**, ***Lawrence A. Crum***, Applied Physics Laboratory, University of Washington, Seattle, WA, USA.
- **Short Course 4B** (**Conference Room 311C**): **SAW Modeling Techniques**, ***Victor P. Plessky***, GVR Trade SA, Bevaix, Switzerland.

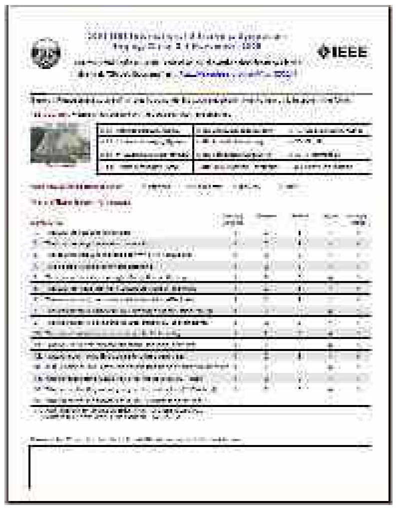
6:00 P.M. - 10:00 P.M, Sunday, November 2, 2008:

- **Short Course 1C** (**Conference Room 311A/B**): **Ultrasound Contrast Agents: Theory and Experiment**, ****Nico de Jong*** and *****Michel Versluis***, *Erasmus MC, The Netherlands. **University of Twente, The Netherlands.
- **Short Course 2C** (**Conference Room 307**): **CMUTs: Theory, Technology, and Applications**, ***B.T. Khuri-Yakub***, ***Ömer Oralkan***, and ***Mario Kupnik***, E.L. Ginzton Laboratory, Stanford University, USA.
- **Short Course 3C** (**Conference Room 308**): **Time Reversal Acoustics**, ***Mathias Fink***, École Supérieure de Physique et de Chimi de la Ville de Paris, France.
- **Short Course 4C** (**Conference Room 311C**): **Acoustical Near-Field Imaging**, ***Walter Arnold***, Fraunhofer Institute for Non-Destructive Testing, Saarbrücken, Germany.

Short Course Evaluation Form:

If you are going to attend the short course(s), please download the Short Course Evaluation Form below, fill it out after each short course, and then return it to the conference registration desk to help us to improve the courses in the future.

Short Course Evaluation Form for Short Course Attendees:
(Posted October 21, 2008)
(Please click on the icon below to download the PDF version and print it out)



Short Course 1A (8:00 A.M. - 12:00 Noon, Sunday, November 2, 2008):

Course Title: Medical Ultrasound Transducers

Douglas G. Wildes and ***L. Scott Smith***, GE Global Research Center, Niskayuna, NY, USA.

Course Description: This course will provide an introduction to the design, fabrication, and testing of medical ultrasound transducers. Starting from an overview of the basic types of phased-array transducers (linear, convex, sector), we will discuss how the design for a probe is derived from its target application and how equivalent-circuit, finite-element, and acoustic field models can be used to optimize the design and accurately predict performance. A discussion of the structure of an ultrasound probe will lead to a survey of the different types of materials used in probes and their critical properties. Typical fabrication processes will be introduced and common problems in probe manufacturing will be summarized. Methods for evaluating completed transducers will be discussed. The course will highlight recent developments in probe technology, including single crystal piezoelectrics, cMUT transducers, catheters, multi-row and 2D arrays, and electronics in probes, and will discuss performance advantages and fabrication difficulties which may be associated with each.

Douglas G. Wildes is a physicist with GE Global Research. He earned an A.B. in physics and mathematics from Dartmouth College and a Ph.D. in low-temperature physics from Cornell University, then joined GE in 1985. Since 1991, Dr. Wildes' research has focused on aperture design, fabrication processes, and high-density interconnect technology for multi-row and 4D imaging transducers for medical ultrasound. Dr. Wildes has 23 issued patents and 19 external publications. He is a member of the American Physical Society and a Senior Member of the IEEE.

L. Scott Smith is a physicist with GE Global Research. He earned B.S. and Ph.D. degrees in physics from the University of Rochester and the University of Pennsylvania respectively. Joining GE in 1976, he developed phased array probes for medical ultrasound. More recently, he examined novel probe materials and led projects on pediatric endoscopes and adaptive acoustics. Dr. Smith has 43 issued patents and over 35 refereed publications. He is a member of the American Physical Society and a Senior Member of the IEEE where he serves as Vice Chair for Transducers on the Ultrasonics Symposium's Technical Program Committee.

Short Course 2A (8:00 A.M. - 12:00 Noon, Sunday, November 2, 2008):

Course Title: Ultrasound Imaging Systems: from Principles to Implementation

Kai E. Thomenius, GE Global Research Center, Niskayuna, NY, USA.

Course Description: The design of medical ultrasound imagers is undergoing important changes brought about by advances in semiconductors and signal/image procession technologies coupled with changes in medical practice and the utilization of medical imaging in general. Unique aspects of data acquisition and processing in the ultrasound scanner enable opportunities not available to other imaging modalities. The goal of this course is to review the system design of ultrasound scanners from a linear systems point of view including transduction, beam formation, and image formation functions. We will discuss analytical methods used in developing the design of a scanner in use today. The key points to be covered deal with methods of analysis of array data, the interaction of transmit and receive beams with clinically relevant targets, and how this interaction is used in the generation of clinically useful images. The means by which these analytical methods contribute to a system design and the trade-offs involved are reviewed. The last several years have seen steady migration of functionality into software; this has enabled significant miniaturization of scanners. The impact of this on system design and the size of ultrasound scanners of the future will be discussed.

Kai E. Thomenius is a Chief Technologist in the Imaging Technologies Organization at General Electric's Global Research facility in Niskayuna, NY, USA. His focus is on Ultrasound and Biomedical Engineering. Previously, he has held senior R&D roles at ATL Ultrasound Inc., Interspec Inc., Elscint Inc., as well as several other ultrasound companies. In addition, he is currently an Adjunct Professor in the Electrical, Computer, and Systems Engineering Department at Rensselaer Polytechnic Institute where he teaches a course in general imaging. Dr. Thomenius' academic background is in electrical engineering with a minor in physiology; all of his degrees are from Rutgers University. His long-term interests have been in ultrasound beam formation and miniaturization of ultrasound scanners, propagation of acoustic waves in inhomogeneous media, and determination of physiological information from the echoes that arise from such beams. Dr. Thomenius is a Fellow of the American Institute of Ultrasound in Medicine.

Short Course 3A (8:00 A.M. - 12:00 Noon, Sunday, November 2, 2008):

Course Title: Photoacoustic Imaging and Sensing

Stanislav Emelianov, Biomedical Engineering Department, University of Texas at Austin, USA.

Course Description: This course is designed to provide both a broad overview and a comprehensive understanding of photoacoustic (also known as optoacoustic and, more generally, thermoacoustic) imaging, sensing and spectroscopy. With a brief historical introduction, we will begin the course by examining the foundations of photoacoustics, including derivations and a discussion of governing equations. We will also review relevant optical properties of the tissues and related topics of laser-tissue interaction. The experimental aspects of photoacoustic imagining and sensing will then be discussed with emphasis on system hardware and signal/image processing algorithms. Techniques to increase contrast and to differentiate various tissues in photoacoustic imaging will be presented. The course will conclude with an overview of several experimental systems capable of photoacoustic imaging, and discussion of current and potential biomedical and clinical applications of photoacoustics.

Stanislav Emelianov received B.S. and M.S. degrees in Physics and Acoustics in 1986 and 1989, respectively, from the Moscow State University, and a Ph.D. degree in Physics in 1993 from the Moscow State University and the Institute of Mathematical Problems of Biology of the Russian Academy of Science. In 1989, he joined the Institute of Mathematical Problems of Biology, where he was engaged in both mathematical modeling of soft tissue biomechanics and experimental studies of noninvasive visualization of the mechanical properties of tissue. Following his graduate work, he moved to the University of Michigan, Ann Arbor, as a post-Doctoral Fellow in the Bioengineering Program and in the Electrical Engineering and Computer Science Department. From 1996 to 2002, Dr. Emelianov was a Research Scientist at the Biomedical Ultrasonics Laboratory of the Biomedical Engineering Department at the University of Michigan. During his tenure at Michigan, Dr. Emelianov was involved primarily in the theoretical and practical aspects of elasticity imaging using ultrasound and MRI. Dr. Emelianov is currently teaching and conducting research in the Department of Biomedical Engineering at the University of Texas at Austin. His research interests are in medical imaging and therapeutics, including ultrasound, photoacoustic, elasticity and multi-modality imaging, photothermal therapy, cellular/molecular imaging and therapy, functional imaging, etc.

Short Course 4A (8:00 A.M. - 12:00 Noon, Sunday, November 2, 2008):

Course Title: Estimation and Imaging of Tissue Motion and Blood Velocity

Hans Torp and ***Lasse Lovstakken***, Department of circulation and medical imaging, Norwegian University of Science and Technology, Trondheim, Norway.

Course Description: This course provides a basic understanding of the physical principles and signal processing methods for estimation of blood and tissue motion. The course begins with an overview of currently used techniques for velocity estimation using pulsed- and continuous-wave Doppler, and color flow imaging. Statistical models for the received signal, as well as commonly used velocity estimators will be developed. Simulation methods for ultrasound signals from moving blood and tissue will be discussed and examples in Matlab will be shown. The suppression of clutter from slowly moving targets is central to all processing schemes and will be given special attention. Also, current methods of tissue velocity and strain rate imaging will be given special elaboration. More advanced topics will also be covered. An overview of current adaptive filter schemes for attenuating clutter will be given, and 2-D / 3-D vector velocity estimation techniques will also be presented. The principles and practical limitations of these methods will be discussed, and potential applications in blood velocity imaging and myocardial velocity- and strain imaging will be shown.

Hans Torp received the MS degree in mathematics in 1978, and the Dr. Techn. Degree in electrical engineering in 1992; both from the University of Trondheim, Norway. Since 1980 he has been working with ultrasound technology applied to blood flow measurements and imaging at the University of Trondheim, in cooperation with GE-Vingmed Ultrasound. He is currently professor of medical technology at the Norwegian Univesity of Science and Technology, and has since 1987 given courses on ultrasound imaging and blood flow measurements for students in electrical engineering and biophysics. His research interests include statistical signal- and image processing with application in medical ultrasound imaging.

Lasse Lovstakken received the Masters degree in Engineering Cybernetics in 2002 and a PhD in Medical Technology in 2007, both at the Norwegian University of Science and Technology, in Trondheim, Norway. He is currently working as a post doctoral research fellow at the Department of Circulation and Medical Imaging at the Norwegian University of science and Technology. His research interests include signal and image processing with applications in ultrasound imaging, with a special focus on imaging of blood and tissue movement.

Short Course 1B (1:00 P.M. - 5:00 P.M., Sunday, November 2, 2008):

Course Title: Ultrasound Elastography: Quantitative Approaches

***Jeffrey Bamber** and ***Paul Barbone**, *Institute of Cancer Research and Royal Marsden Hospital, UK. **Boston University, USA.

Course Description: There is evidence that ancient cultures extending back thousands of years used palpation to assess the mechanical properties of tissues, and thus detect and characterise disease or injury. Simple palpation continues to be of value in modern medicine, both practiced by doctors and as a technique for self-examination, but palpation is limited to a few accessible tissues and organs, and the interpretation of the information sensed by the fingers is highly subjective. Ultrasound elastography aims to display images that are related to a broad range of parameters that describe the spatial and temporal variations in tissue viscoelasticity. It does so by processing time-varying echo data to extract the spatial and/or temporal variation of a stress-induced tissue displacement or strain. In recent years the method early form has emerged as a real-time imaging modality available as an option on several commercial ultrasound systems, and is starting to prove clinically valuable, for example in breast cancer diagnosis. Nevertheless, in its present form it remains a strongly subjective technique and continues, as with palpation, to require considerable interpretive skills to be learnt. There are good reasons to believe that a more quantitative and objective analysis will lead to clinically more valuable measures of tissue composition, function or state, with images that are easier to interpret. This short course will outline some of the limitations and pitfalls of current elastographic methods, and will then introduce the opportunities for, potential value of and challenges for making elastography more quantitative. It will then review work on modeling tissues and their mechanical behavior, the fundamentals of ultrasound elastographic experimental techniques required for quantitative imaging, the use of static, vibrational and impulsive loads, the inverse methods for measurement and image reconstruction, methods for stress measurement, and shear wave propagation methods. This will lead to a discussion of the likely consequences for medical applications and future instrumentation. Examples of results will be presented for a range of medical application areas and for various mechanical characteristics such as shear modulus, nonlinearity, anisotropy, friction at mechanical discontinuities, as well as properties that determine viscoelastic and poroelastic behavior.

Jeffrey Bamber is head of the Ultrasound and Optics Physics Team, and is Senior Tutor for the Research Degrees Program at The Institute of Cancer Research Sutton, U.K. He has an honorary position as a Medical Physicist within the Royal Marsden Hospital, Sutton. He received a BSc in Physics from the University of Kent at Canterbury in 1972, an MSc in Biophysics and Bioengineering from the University of London in 1974, and a PhD in Biophysics in 1980, also from the University London. He continued as a research scientist following his PhD at the Institute of Cancer Research, becoming a team leader in 1986. His research interests have included: acoustic characteristics of tissues, ultrasound image speckle and texture, speckle reduction, ultrasound aberration, psychophysics of perception of information in ultrasound images and movies, ultrasonic methods in breast cancer, measurement of tumor volume and blood flow, ultrasound tissue motion tracking, tissue elasticity imaging, temperature imaging, high frequency ultrasonic imaging and tissue characterization, ultrasound and optical methods in skin cancer, microbubble contrast agents, ultrasound guidance of focused ultrasound therapy and radiotherapy, ultrasound in radiation dosimetry, microbubbles as gene therapy vectors, and molecular imaging. Prizes for work to which he has contributed include 5 best paper awards in peer reviewed journals and 2 book publishing awards for excellence. He is a past vice-president of the International Society for Skin Imaging, a past president of the International Association for Breast Ultrasound, and currently serves on the Council of the British Medical Ultrasound Society.

Paul E. Barbone is Associate Professor of Mechanical Engineering at Boston University. He received Bachelors of Engineering Science and Mechanics from Georgia Institute of Technology in 1986, a Masters of Mechanical Engineering in 1987 from Stanford University, and a PhD in Mechanical Engineering from Stanford University in 1992. He did postdoctoral research at the University of Cambridge (1992-1993) in the Department of Applied Mathematics and Theoretical Physics, served as lecturer at School for Advanced Studies in Industrial and Applied Mathematics, Valenzano, Italy (1992), and was Haddow Fellow and visiting Researcher at the Institute of Cancer Research, Sutton, UK (2000-2001). His research approach is mathematical and theoretical analysis. He works mainly on forward and inverse problems in acoustics and solid mechanics, and sidelines in the analysis of computational formulations. Over the past several years, his research focus has been inverse problems in "Biomechanical Imaging:"

imaging the mechanical properties of tissues in situ and in vivo. His research work has been recognized through prizes from US National Science Foundation, US Office of Naval Research, Acoustical Society of America, and the J. William Fulbright Foundation.

Short Course 2B (1:00 P.M. - 5:00 P.M., Sunday, November 2, 2008):

Course Title: Acoustic Microscopy - Fundamentals and Applications

***Roman Gr. Maev**, ****Naohiro Hozumi**, *****Kazuto Kobayashi**, and ******Yoshifumi Saijo**, *Centre for Imaging Research and Advanced Materials Characterization, University of Windsor, Ontario, Canada. **Department of Electrical & Electronic Engineering, Aichi Institute of Technology, Toyota, Japan. ***Honda Electronics Co. Ltd., Aichi, Japan. ****Tohoku University, Sendai, Japan.

Course Description: The goal of this course is to introduce the fundamentals and major principles of scanning acoustic microscopy. This course aims to describe advanced acoustic microscopy methods for investigating the microstructure and physical mechanical properties of materials of different nature, from crystalline to biomaterials. The materials discussed during this course cover most aspects of physical principles and applications of high-resolution acoustic microscopy and reflects the modern research status in this field. Included are different topics in physical acoustics, ultrasound, solid state physics, materials characterization and nondestructive evaluation. Special attention will be paid to the principle and application of several types of scanning acoustic microscopes for medical and biological use. Progress in digital measurement and pulse technology has remarkably upgraded the performance of these types of microscopes and this will be described within the course. The sound speed microscope which conventionally used tone-burst and analog phase detector was improved in accuracy, stability and operation ability. It can be used for characterization of tissue sliced and mounted on a slide glass. It can visualize not only acoustic impedance but bulk modulus, attenuation constant and density. The acoustic impedance microscope can visualize the acoustic impedance of a cross section in touch with a plastic substrate by transmitting an acoustic beam from the rear side of the substrate. This type of microscopy has an advantage that the measurement can be performed in vivo, introducing no contamination into the target system. With a wide frequency range up to 400 MHz, both types of microscopes can observe with a special resolution as fine as cell structure. Discussed will be the principle of the sound speed and acoustic microscopes driven by a wide band pulse and several examples of observation of cerebella tissue and cultured cells will be shown. In addition, there will be a presentation of recent results in acoustic microscopy technology development achieved by Honda Electronics (Japan) and Tessonics (Canada). The detail of the hardware and software of those microscopes that are commercially available will be described. The prototype microscopes have been improved a lot after being commercialized. The hardware, software and biomedical applications of these microscopes will be described with a large number of examples as additional illustrations. This course will conclude with an overview of the future perspectives of the general principles of microscopic observation using various ultrasound waves as well as the most promising future applications.

Roman Gr. Maev received his Ph.D. from the Physical Institute of the Russian Academy of Sciences in 1973 and his D.Sc. in acoustic microscopy from the Russian Academy of Sciences, Moscow, in 2002. From 1994 to 1997, he held a post as Director of the Acoustic Microscopy Center of the Russian Academy of Sciences, then established a Centre for Imaging Research and Advanced Material Characterization at the University of Windsor, Canada. He is currently a Full Faculty Professor at the Physics Department of the same University and since 2001 the Chairholder of the NSERC/DaimlerChrysler/Industrial Research Chair in Applied Solid State Physics and Material Characterization. Professor Maev's research interests focus on the fundamentals of condensed matter, physical acoustics, ultrasonic imaging, and acoustic microscopy. He has published numerous books, more than 300 scientific papers, and holds twenty patents.

Naohiro Hozumi was born in Kyoto, Japan on April 2, 1957. He received his B.S., M.S. and Ph.D. degrees in 1981, 1983 and 1990 from Waseda University. He was engaged in Central Research Institute of Electric Power Industry (CRIEPI) from 1983 to 1999. He was an associate professor of Toyohashi University of Technology from 1999 to

2006. Since 2006, he has been a professor of Aichi Institute of Technology. He has been engaged in the research in insulating materials and diagnosis for high voltage equipment, acoustic measurement for biological and medical applications, etc. He was awarded in 1990 and 1999 from IEE of Japan for his outstanding research papers. He is a member of IEEE, IEE of Japan and the Acoustic Society of Japan.

Kazuto Kobayashi was born in Aichi, Japan on June 8, 1952. He received B.S. degree in electrical engineering from Shibaura Institute of Technology, Tokyo, Japan in 1976. He is currently a director of Department of Research and Development at Honda Electronics Co. Ltd. in Toyohashi, Japan. His research activities and interests include medical ultrasound imaging, signal processing and high frequency ultrasound transducers.

Yoshifumi Saijo was born in Yokohama, Japan on July 21, 1962. He received the M.D. and the Ph.D. degrees in 1988 and 1993 from Tohoku University. He is currently a Professor of the Department of Biomedical Imaging at the Graduate School of Biomedical Engineering of Tohoku University. He is concurrent with Institute for International Advanced interdisciplinary Research of Tohoku University and the Department of Cardiovascular Surgery of Tohoku University Hospital. His main research interests are assessment of biomechanics of cells and tissues by high frequency ultrasound and clinical ultrasonic evaluation of cardiovascular system with intravascular ultrasound and transesophageal echocardiography. He was awarded in 1997 for his outstanding research paper in Ultrasound in Medicine and Biology, the official journal of the World Federation of Ultrasound in Medicine and Biology. He is a member of The Japan Society of Ultrasonics in Medicine, Japanese Society of Echocardiography and Japan Circulation Society.

Short Course 3B (1:00 P.M. - 5:00 P.M., Sunday, November 2, 2008):

Course Title: Therapeutic Ultrasound

Lawrence A. Crum, Applied Physics Laboratory, University of Washington, Seattle, WA, USA.

Course Description: The use of ultrasound in medicine is now quite commonplace, especially with the recent introduction of small, portable and relatively inexpensive, hand-held diagnostic imaging devices. Moreover, ultrasound has expanded beyond the imaging realm, with methods and applications extending to novel therapeutic and surgical uses. These applications broadly include: Tissue ablation, acoustocautery, body contouring, site-specific and ultrasound mediated drug activity, extracorporeal lithotripsy, and the enhancement of natural physiological functions such as wound healing and tissue regeneration. A particularly attractive aspect of this technology is that diagnostic and therapeutic systems can be combined to produce totally non-invasive, image-guided therapy. This general lecture will review a number of these exciting new applications of ultrasound and address some of the basic scientific questions and future challenges in developing these methods and technologies for general use in our society. We shall particularly emphasize the use of High Intensity Focused Ultrasound (HIFU) in the treatment of benign and malignant tumors as well as the introduction of acoustic hemostasis, especially in organs which are difficult to treat using conventional medical and surgical techniques.

Lawrence A. Crum is currently Principal Physicist in the Applied Physics Laboratory and Research Professor of Bioengineering and Electrical Engineering at the University of Washington. He has held previous positions at Harvard University, the U. S. Naval Academy and the University of Mississippi, where he was F. A. P. Barnard Distinguished Professor of Physics and Director of the National Center for Physical Acoustics. He has published over 300 articles in professional journals, holds an honorary doctorate from the Universite Libre de Bruxelles, and was recently awarded the Helmholtz-Rayleigh Silver Medal of the Acoustical Society of America. He is Past President of the Acoustical Society of America, the World Council on Ultrasonics, and of the Board of the International Commission for Acoustics.

Short Course 4B (1:00 P.M. - 5:00 P.M., Sunday, November 2, 2008):

Course Title: SAW Modelling Techniques

Victor P. Plessky, GVR Trade SA, Bevaix, Switzerland.

Course Description: This course provides introduction to the design techniques of SAW devices. The course includes and will discuss: a) SAW excitation on piezoelectrics by linear charges, elementary theory of the Interdigital Transducer (IDT) with non-reflecting electrodes, design of typical IDTs on quartz and LiNb, delay lines characteristics and matching issues. b) Single Phase Unidirectional Transducer (SPUDT)- design and applications. c) Propagation of SAW in periodic structures, coupling of modes (COM) model, and simulation with COM model of IDTs and reflectors. d) Modeling of SAW devices based on Green's function software. e) CRF/DMS filter design – examples of device simulation; optimization software f) Synchronous resonators, extraction of COM parameters, and ladder filters design. g) Design of SAW-tags. During the lecture, the attendee will see demonstrations of design processes for typical filter specifications. The COM model will be presented in details sufficient for practical use. The course will conclude with a review of unsolved problems and challenges in the SAW devices design area.

Victor P. Plessky was born near Gomel, Belarus. He now lives and works in Switzerland. Before leaving the USSR in 1991, he worked as a head of laboratory in IRE of Academy of Sciences in Moscow region in Russia. He received his Ph.D. degree from the Moscow Institute of Physics and Technology in 1978, and received his Doctor of Science degree in physics and mathematics from the Institute of Radio-engineering and Electronics (IRE RAS, 1987). He received the Full Professor title from the Russian Government in1995. For the last 16 years he has worked in Switzerland, first as a Principal Scientist at the company Micronas SA. He now is an owner and CEO of the consulting company GVR Trade SA. His main spheres of interest are theory of microacoustics, surface acoustic waves (SAW) theory and devices, devices for signal filtering and frequency control, SAW sensors and SAW-tags. A few of his works in periodic structures have received wide recognition. Dr. V. Plessky worked as Visiting Professor in HUT (Finland), Freiburg University (Germany), Uppsala University (Sweden), EPFL (Switzerland). He has authored or co-authored over 200 papers and many patents. For many years he serves ad TPC member of the IEEE Ultrasonics Symposium.

Short Course 1C (6:00 P.M. - 10:00 P.M., Sunday, November 2, 2008):

Course Title: Ultrasound Contrast Agents: Theory and Experiment

****Nico de Jong*** and *****Michel Versluis***, *Erasmus MC, The Netherlands. **University of Twente, The Netherlands.

Course Description: The course consists of 6 topics: a) An overview will be presented of the (clinical and pre-clinical available) contrast agents, including the properties and characteristics of the gas inside the bubble and the shell surrounding it. b) Models of the behavior of small bubbles in an ultrasound field will be discussed. Simple models based on a one dimensional mass-spring system and more complicated models including gas and shell properties. c) Experimental acoustic methods for UCA will be presented for characterizing the bubbles in suspension, including harmonic and sub-harmonic scattering, absorption and attenuation. Also the influence of ambient pressure, temperature and gas concentration will be discussed. d) Experimental optical and acoustical methods for characterizing individual bubbles. e) Imaging methods for contrast agents, e.g. fundamentals, harmonic, subharmonic and superharmonic and multi-pulse methods like the pulse inversion, power modulation etc. and new methods including chirp excitation and radical modulation. f) Molecular imaging and ultrasound mediated drug delivery: Interaction between mammalian cells and ultrasound in the presence of (targeted) bubbles will be discussed.

Nico de Jong graduated from Delft University of Technology, The Netherlands, in 1978. He got his M.Sc. in the field of pattern recognition. Since 1980, he has been a staff member of the Thoraxcenter of the Erasmus University Medical Center, Rotterdam, The Netherlands. At the Dept. of Biomedical Engineering, he developed linear and phased array ultrasonic probes for medical diagnosis, especially compound and transesophageal transducers. In 1986 his interest in ultrasound applications shifted toward the theoretical and practical background of ultrasound contrast agents. In 1993 he received his Ph.D. for "Acoustic properties of ultrasound contrast agents." His current interests are 3D (matrix) transducers, bubble behavior and fast framing camera systems. Since 1996 he organizes, together with the cardiologist Dr. Folkert ten Cate, the annual European Symposium on Ultrasound Contrast Imaging, held in Rotterdam and attended by approximately 175 scientists from all over the world. Since 2003 Nico de Jong is part-time professor at the University of Twente.

Michel Versluis graduated in Physics in 1988 at the University of Nijmegen, the Netherlands, with a special interest in Molecular Physics and Astrophysics. Later, he specialized in the application of intense tunable UV lasers for flame diagnostics resulting in a successful defense of his PhD thesis in 1992. Michel Versluis is now a lecturer at the University of Twente, the Netherlands, in the Physics of Fluids group working on the experimental study of bubbles and jets in multiphase flows and granular flows. He also works on the use of microbubbles as a tool for medical diagnosis and therapy. Dr. Verluis teaches various courses in Fluid Mechanics, one of them focusing on the physics of bubbles.

Short Course 2C (6:00 P.M. - 10:00 P.M., Sunday, November 2, 2008):

Course Title: CMUTs: Theory, Technology, and Applications

B.T. Khuri-Yakub, ***Ömer Oralkan***, and ***Mario Kupnik***, E.L. Ginzton Laboratory, Stanford University, USA.

Course Description: This course provides basic knowledge and understanding of capacitive micromachined ultrasonic transducers (CMUTs) and their applications. After a short background discussion of previous implementations of capacitive ultrasonic transducers, we will provide all the information necessary for the successful design of a CMUT: The simple parallel plate capacitor transducer and its electrical equivalent circuit model will be explained in detail, including the derivation of all essential design equations, and the theoretical device performance limits. An approximate analytical model, that better represents the realizable membrane of a CMUT, will be presented next. By discussing a possible beyond pull-in point operation regime (collapse mode), the motivation for a more sophisticated finite element model is given, and the key techniques of finite element analysis based CMUT designs are explained and demonstrated using brief examples. After explaining these techniques, we compare the two main domains in which a CMUT can operate, i.e. as an airborne device and in immersion. Only for immersed operation the periodic structure of a CMUT array needs to be considered to minimize parasitic cross-talk effects. Two acoustic cross-talk modeling techniques will be discussed for that purpose. Then, the two main CMUT fabrication techniques, i.e. sacrificial release and direct wafer bonding, are explained and compared to each other. Next, we discuss device characterization which will cover optical displacement, electrical input impedance, then acoustical measurements of output pressure, receive sensitivity, impulse response and dynamic range. Then, non-conventional CMUT designs are addressed, such as piston CMUTs, CMUTs with various cell-shapes, and CMUTS with non-uniform cavities. Besides an overview of several CMUT applications, we conclude the course by giving two detailed design examples, one for an airborne device for chemical/biological sensing applications and one for medical imaging applications. A comprehensive copy of the presentation will be made available to the course participants.

Butrus (Pierre) T. Khuri-Yakub is a Professor of Electrical Engineering at Stanford University. He received the BS degree in 1970 from the American University of Beirut, the MS degree in 1972 from Dartmouth College, and the Ph.D. degree in 1975 from Stanford University, all in electrical engineering. He was a Research Associate (1965-19780 then Senior Research Associate (1978-1982) at the E. L. Ginzton Laboratory of Stanford University and was promoted to the rank of Professor of Electrical Engineering in 1982. His current research interests include medical ultrasound imaging and therapy, micromachined ultrasonic transducers, smart bio-fluidic channels, microphones, ultrasonic fluid ejectors, and ultrasonic nondestructive evaluation, imaging and microscopy. He has authored over 400 publications and has been principal inventor or co-inventor of 76 US and International issued patents. He was awarded the Medal of the City of Bordeaux in 1983 for his contributions to Nondestructive Evaluation, the Distinguished Advisor Award of the School of Engineering at Stanford University in 1987, the Distinguished Lecturer

Award of the IEEE UFFC society in 1999, a Stanford University Outstanding Inventor Award in 2004, and a Distinguished Alumnus Award of the School of Engineering of the American University of Beirut in 2005.

Ömer Oralkan received his B.S. degree from Bilkent University, Ankara, Turkey, in 1995, his M.S. degree from Clemson University, Clemson, SC, in 1997, and his Ph.D. degree from Stanford University, Stanford, CA, in 2004, all in electrical engineering. He joined the research staff at the E. L. Ginzton Laboratory of Stanford University in 2004 as an Engineering Research Associate. He was promoted to the rank of Senior Research Engineer in 2007. His past and present research interests include analog and digital circuit design, semiconductor device physics and fabrication, micromachined sensors and actuators, and medical imaging. His current research focuses on the design and implementation of integrated systems for catheter-based medical imaging applications, photoacoustic imaging, and chemical and biological sensor arrays. Dr. Oralkan has authored and co-authored over 80 publications and received the 2002 Outstanding Paper Award of the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society. He is a member of the IEEE, SPIE, and AIUM.

Mario Kupnik is a research associate of electrical engineering at Stanford University. He received his Diplom Ingenieur degree in electronics engineering from Graz University of Technology, Austria in 2000. After working as an Analog Design Engineer for Infineon Technologies AG, he received his Ph. D. in physical measurement techniques at the University of Leoben, Austria in 2004, and then completed a two-year PostDoc at the Khuri-Yakub Ultrasonics Group, Stanford University in February 2007. Mario Kupnik has more than five years teaching experience in the field of electrical engineering, two of these years at the graduate level. His present research interests include the design, modeling, fabrication, and application of micromachined sensors and actuators, with a main focus on capacitive micromachined ultrasonic transducers mainly for air-coupled applications. Examples are transit-time gas flowmeters for hot and pulsating gases, ultrasonic nondestructive evaluation using noncontact ultrasound, nonlinear acoustics, and bio/chemical gas sensing applications (electronic nose). He holds several patents relating to analog front-end circuits for contactless smart card systems, ultrasonic transit-time gas flowmeters, and CMUT fabrication techniques. He serves as a technical program committee member of the IEEE Ultrasonics Symposium.

Short Course 3C (6:00 P.M. - 10:00 P.M., Sunday, November 2, 2008):

Course Title: Time Reversal Acoustics

Mathias Fink, École Supérieure de Physique et de Chimi de la Ville de Paris, France.

Course Description An acoustic Time Reversal Mirror (TRM) refocuses an incident acoustic field to the position of the original source regardless of the complexity of the medium between this "probe" source and the TRM. TRM's have now been implemented in a variety of physical scenarios from MHz ultrasonics with order centimeter aperture size to hundreds/thousands of Hz in ocean acoustics with order hundred meter aperture size. Common to this broad range of scales is a remarkable robustness exemplified by observations at all scales that the more complex the medium between the probe source and the TRM, the sharper the focus. The potential for applications in many areas of acoustics is quite high. The objective of this course is to provide the acoustical physics overview and description of the experimental implementation of time reversal and phase conjugate processes as related to ultrasonics and imaging, nondestructive testing, medical ultrasonics, propagation in random media, room acoustics, waveguides, and ocean acoustics.

Mathias Fink is a Professor of Physics at the École Supérieure de Physique et de Chimi de la Ville de Paris (ESPCI) and at Paris 7 University (Denis Diderot), France. In 1990 he founded the laboratory Ondes et Acoustique at ESPCI. In 2002, he was elected at the French Academy of Engineering and in 2003 at the French Academy of Science. His area of research is concerned with the propagation of waves in complex media and the development of numerous instruments based on this basic research. The domain of applicability of these instruments is vast: medical imaging and therapy, non-destructive testing, underwater acoustics, seismology, telecommunications and instrumentation. He has a long history of collaboration with industry. He works with companies in a wide variety of sectors including medical, aeronautics, underwater acoustics, nuclear, metallurgy, and instrumentation. He pioneered many innovative approaches based on time-reversal mirrors and on the development of a new imaging concept: transient elastography. He has over 40 patents, 300 publications, edited 2 books and supervised 48 PHD students.

Short Course 4C (6:00 P.M. - 10:00 P.M., Sunday, November 2, 2008):

Course Title: Acoustical Near-Field Imaging

Walter Arnold, Fraunhofer Institute for Non-Destructive Testing, Saarbrücken, Germany.

Course Description: Acoustical imaging modes can be classified into near-field, focusing techniques, and holographic techniques. This four hour course discusses, in particular, near-field imaging modes. Examples are ultrasonic force microscopy, atomic force acoustic microscopy, and impedance imaging such as Fokker-bond tests. Their resolution in terms of the antenna size (i.e. probe size) and wavelength employed both at the surface and in the depth of the component to be imaged, are discussed. Besides the underlying contrast mechanism, the course also covers the signal analysis and capture techniques. Finally a comparison is made to classical acoustical imaging based on focusing probes, holographic imaging, and phased arrays principles. The examples are underlined by applications in non-destructive testing.

Walter Arnold has authored and co-authored about 300 publications (200 in Non-Destructive Testing, others in Solid State and Applied Physics and Materials Science), holds 10 patents and has edited two books besides organizing several conferences both on a national and international level. He has guided 140 master theses and 27 PhD theses. Dr. Arnold was the head of the research department at Fraunhofer-Institute for Non-Destructive Testing (IZFP) in Saarbrücken, Germany until his retirement at the end of 2007. Parallel to his position at the IZFP, Dr. Arnold was and still is professor of Materials Science at the Saarland University, Dept. Materials. He is an Honorary Fellow Indian Institute of Non-Destructive Testing, Fellow Institute of Physics, London.

XI. Exhibits

Introduction:

The 2008 IEEE IUS has arranged exhibition booths in the same area as the conference on-site registration, coffee breaks, and poster presentations to attract a maximum traffic to the exhibition booths. To find where the exhibition booths are located and the technical program, please check the Condensed Program and the Floor Plan. (The detailed technical program of the conference can be found in the Full Program (Program Book), Abstract Book, and Meeting Planner.) Due to a space constraint, only a limited number of exhibition booths will be available on the "first come, first serve" basis. Therefore, please register as soon as possible. To include your company name in our Advance Program book and Abstract book that will be distributed to each attendee at the conference, prospective exhibitors should have their registration confirmed by ***July 15, 2008***. In any case, exhibition registration will not be accepted after the final deadline, ***September 15, 2008***.

Notes: In the afternoon of Sunday, November 2, 2008, during the exhibition setup on the 2nd floor foyer of the Beijing International Convention Center (BICC), exhibitors (with exhibitor badges) will be provided a couple of wines by the Organizing Committee for them to enjoy. In addition, on Wednesday, November 5, from 7:10 a.m. - 8:00 a.m. in the Conference Room 311C (on the third floor of BICC), exhibitors (with exhibitor badges) will be provided a breakfast. The breakfast would be a good opportunity for exhibitors to provide feedbacks to the Organizing Committee to help future IEEE IUS to provide better services for exhibitors.

Booth Reservation and Fees:

The official exhibition reservation website provided by the China International Conference Center for Science and Technology (CICCST) for the 2008 IEEE IUS is given below. Please notice that the exhibition registration is not the same as the "Conference Registration" that is for the conference technical program, short courses, and guests. CICCST will help exhibitors to get all their needs for the exhibition. All questions regarding exhibition arrangements (such as equipment shipment, Chinese Custom clearance, selection of booths, special requirements, booth reservation fees, payment methods, and cancellation policy, etc.) should be directly addressed to CICCST with the contacts listed in the links below. (Please REFRESH your browser to view an updated page that contains correct links!)

CICCST Exhibit Registration for the 2008 IEEE IUS: http://cast-meeting.cn/exhibition.htm (Closed)
CICCST Payment Methods: http://cast-meeting.cn/payment.html
CICCST Cancellation Policy: http://cast-meeting.cn/Cancellation.html
CICCST Contact Information for Questions: Phone/Fax: 011-86-10-82116226; Email: *bjsjcenter@sina.com*

Exhibition Schedule:

- The schedule of the exhibition of the 2008 IEEE International Ultrasonics Symposium is as follows:

Monday, November 3, 2008: 8:00 a.m. - 5:00 p.m.
Tuesday, November 4, 2008: 8:00 a.m. - 5:00 p.m.
Wednesday, November 5, 2008: 8:00 a.m. - 12:00 noon.

List of Exhibitors of the 2008 IEEE International Ultrasonics Symposium (IUS), Beijing, China, November 2-5, 2008:

***Exhibitors of the 2008 IEEE IUS*, Beijing, China, November 2-5, 2008** (A total of 20, including IEEE booth):

- **Beijing Zhongxun Sifang Science & Techonolgy CO. LTD:** *http://www.bjzxsf.net*
- **Bossa Nova Technologies:** *http://www.leepipe.com and http://www.bossanovatech.com/*
- **DASEL:** *http://www.daselsistemas.com and http://ultrascope.info/index.asp*
- **Electronics Innovation Ltd:** *http://www.eandiltd.com/*
- **Ferroperm Piezoceramics A/S:** *http://www.ferroperm.net*
- **IEEE:** *http://www.ieee.org*
- **Imasonic:** *http://www.imasonic.com and http://www.imasonic.fr/*
- **Lecoeur Electronique:** *http://www.lecoeur-electronique.com/*
- **Onda Corporation:** *http://www.ondacorp.com/index1.html*
- **Polytec GmbH:** *http://www.polytec.com/*
- **Precision Acoustics Ltd.:** *http://www.acoustics.co.uk*
- **Prosonic:** *http://www.prosonic.co.kr/*
- **Shanghai Apex Electronics Technology Co. Ltd:** *http://www.apex-ultrasound.com*
- **Sonora Medical Systems:** *http://www.4sonora.com/*
- **Sound Technology Inc.:** *http://www.sti-ultrasound.com*
- **Tegal Corporation:** *http://www.tegal.com/*
- **Terason Ultrasound, Division of Teratech:** *http://www.terason.com/index.asp*
- **Texas Instruments Semiconductor Technologies (Shanghai) Co. Ltd:** *http://www.ti.com.cn*
- **The Piezo Institute:** *http://www.piezoinstitute.com*
- **TRS Technologies, Inc.:** *http://www.trstechnologies.com*

List of Exhibitors of the Past IEEE International Ultrasonics Symposia (IUS) from 1996-2007:

***Exhibitors of the 2007 IEEE IUS*, New York, NY, U.S.A.** (A total of 24, not including IEEE-UFFC booth):

- **aixAACT Systems GmbH** *http://www.aixACCT.com*
- **BERCLI , Ultrasonic Phased-Array Solutions** *http://www.bercli.net*
- **Bossanova Tech.** *http://www.bossanovatech.com*
- **CTS Electronic Components, Inc.** *http://www.ctscorp.com*
- **EBL Products Inc.** *http://www.eblproducts.com*
- **Electronics & Innovation Ltd.** *http://www.EandIltd.com*
- **Ferroperm Piezoceramics A/S** *http://www.ferroperm.net*
- **Honda Electronics** *http://www.honda-el.co.jp*
- **Imasonic** *http://www.imasonic.com*
- **LeCoeur-Electronique** *http://www.lecoeurelectronique.com*
- **Nihon Dempa Kogyo Co. Ltd.** *http://www.ndk.com*
- **Onda Corporation** *http://www.ondacorp.com*
- **Polytec Inc.** *http://www.polytec.com*
- **Precision Acoustics Ltd.** *http://www.acoustics.co.uk*
- **Sonora Medical Systems Inc.** *http://www.4sonora.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Tegal Corporation** *http://www.tegal.com*
- **The Piezo Institute** *http://www.piezoinstitute.net*
- **TRS Technologies Inc.** *http://www.trstechnologies.com*
- **Ultrasonix Medical Corporation** *http://www.ultrasonix.com*
- **University of Michigan, Biomedical Engineering** *http://www.bme.umich.edu*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*

- **Weidlinger Associates Inc.** *http://www.wai.com*
- **W.L. Gore & Associates** *http://www.gore.com*

***Exhibitors of the 2006 IEEE IUS*, Vancouver, Canada** (A total of 17, not including IEEE-UFFC booth):

- **Advanced Modular Sputtering** *http://www.amsincorp.com*
- **CTS Electronic Components Inc.** *http://www.ctscorp.com*
- **Ferroperm Piezoceramics** *http://www.ferroperm-piezo.com*
- **H.C. Materials Corporation** *http://www.hcmat.com/Crystal/Crystal.htm*
- **Imasonic** *http://www.imasonic.com*
- **Lecoeur Electronique** *http://www.lecoeur-electronique.com*
- **Nihon Dempa Kogyo Co. Ltd.** *http://www.ndk.com/en/index.cfm*
- **North Crystals America** *http://www.northcrystals.com*
- **Onda Corporation** *http://www.ondacorp.com*
- **Precision Acoustics Ltd.** *http://www.microfine-piezo.com*
- **Sonora Medical Systems, Inc.** *http://www.4sonora.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **TRS Technologies** *http://www.trsceramics.com*
- **Ultrasonics Medical Corporation**
- **Valpey Fisher Corp.** *http://www.valpeyfisher.com*
- **VisualSonics** *http://www.visualsonics.com*
- **W.L. Gore & Associates** *http://www.wlgore.com*

***Exhibitors of the 2005 IEEE IUS*, Rotterdam, The Netherlands** (A total of 20, including IEEE-UFFC booth):

- **Advanced Modular Sputtering** *http://www.amsincorp.com*
- **Acqiris SA-Data Conversion Instruments** *http://www.acqiris.com*
- **Epion Corporation** *http://www.epion.com*
- **HITACHI Medical Systems** *http://www.hitachi-medical-system.de*
- **HONDA Electronics Co. Ltd.** *http://www.dynamic-bv.nl*
- **Ferroperm Piezoceramics** *http://www.ferroperm-piezo.com*
- **IEEE-UFFC Society** *http://www.ieee-uffc.org*
- **Imasonic** *http://www.imasonic.com*
- **Lecoeur Electronique** *http://www.lecoeur-electronique.com*
- **Microfine Materials Technologies Pte Ltd.** *http://www.microfine-piezo.com*
- **Onda Corporation** *http://www.ondacorp.com*
- **Precision Acoustics Ltd** *http://www.microfine-piezo.com*
- **Smart Material GmbH** *http://www.smart-material.com*
- **Sonora Medical Systems, Inc.** *http://www.4sonora.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Trikon Technologies, Inc.** *http://www.trikon.com*
- **Twist Semiconductor** *http://www.twistsemi.com*
- **Ultrasons Technologies** *http://www.ultrasons-technologies.com*
- **Valpey Fisher Corp** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.wlgore.com*

***Exhibitors of the 2004 IEEE IUS - A Joint of 3 Conferences*, Montréal, Canada** (A total of 37, including IEEE-UFFC booth):

- **Advanced Modular Sputtering** *http://www.amsincorp.com*

- **Agilent Technologies** *http://www.agilent.com*
- **CCI/USA Inc.** *http://www.cyberstreet.com/cci/cci.htm*
- **EFG International** *http://www.efg-berlin.de*
- **Ferroperm Piezoceramics** *http://www.ferroperm-piezo.com*
- **Fotofab** *http://www.fotofab.com*
- **Frequency Electronics, Inc.** *http://www.freqelec.com*
- **Fujitsu/Senko** *http://www.senko.com*
- **IEEE-UFFC Society** *http://www.ieee-uffc.org*
- **Imasonic** *http://www.imasonic.com*
- **Kolinker Industrial Equipment** *http://www.kolinker.com*
- **LanFang CDC Dacheng Elect. Co., Ltd.** *http://www.zddc.com.cn*
- **Legacy Technologies Inc.** *http://www.legacytechnologies.com*
- **Locus, Inc.** *http://www.locusinc.com*
- **Microbridge Technologies** *http://www.mbridgetech.com*
- **NoFech Electronics Ltd.** *http://www.nofech.co.il*
- **Panametrics-NDT** *http://www.panametrics-ndt.com*
- **Polaris Electronics Corp.** *http://www.polariselectronics.com*
- **Poseiden Scientific Instr.** *http://www.psi.com.au*
- **Precise Time and Frequency** *http://www.ptfinc.com*
- **Saunders & Assoc.** *http://saunders-assoc.com*
- **Sawyer Technical Materials** *http://sawyerLLC.com*
- **Sensor Technology Ltd** *http://sensortech.ca*
- **Smart Material Corp.** *http://www.smart-material.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Spectra Dynamics, Inc.** *http://www.Spectradynamics.com*
- **Stavely Sensors, Inc.** *http://www.staveleyndt.com*
- **Symmetricom** *http://www.symmetricom.com*
- **Tetrad Corp.** *http://www.tetradcorp.com*
- **Timing Solutions Corp.** *http://www.timing.com*
- **Trikon Technologies, Inc.** *http://www.trikon.com*
- **TRS Technologies** *http://www.trsceramics.com*
- **Unitek Benchmark** *http://www.unitekbenchmark.com*
- **Valpey Fisher Corp** *http://www.valpeyfisher.com*
- **VC America** *http://www.vcamerica.com*, *http://www.npcamerica.com*, *http://www.xeco.net*, *http://www.hoffmanmaterials.com/*
- **VNISIMS** *http://www.vniisims.ru*
- **W.L. Gore & Associates** *http://www.wlgore.com*

***Exhibitors of the 2003 IEEE IUS*, Honolulu, Hawaii, U.S.A.** (A total of 12, not including IEEE-UFFC booth):

- **Advanced Modular Sputtering, Inc.** *http://www.amsincorp.com*
- **Ferroperm Piezoceramics A/S** *http://www.ferroperm-piezo.com*
- **Fraunhofer IBMT** *http://www.ibmt.fhg.de/index_e.html*
- **Humanscan Co., Ltd.** *http://www.humanscan.co.kr/e_index/e-index_main.htm*
- **Imasonic** *http://www.imasonic.com*
- **JSR Ultrasonics** *http://www.jsrultrasonics.com*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Silicon Light Machines** *http://www.siliconlight.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Thales Microsonics** *http://www.temex-tmx.com*
- **TRS Technologies** *http://www.trstechnologies.com*

- **W.L. Gore & Associates, Inc.** *http://www.gore.com*

***Exhibitors of the 2002 IEEE IUS*, Munich, Germany** (A total of 17, including IEEE-UFFC booth):

- **EPCOS AG** *http://www.epcos.com/*
- **Ferroperm Piezoceramics A/S** *http://www.ferroperm.net*
- **Fomos Technology** *http://www.qsl.net/dk1ag/LGS.htm*
- **iBule Humanscan Co., Ltd.**
- **IEEE-UFFC Society** *http://www.ieee-uffc.org*
- **Imasonic** *http://www.imasonic.com*
- **JSR Ultrasonics** *http://www.jsrultrasonics.com*
- **NIH Resource Center for Medical Ultrasonic Transducer Technology** *http://bme.usc.edu/UTRC/*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Silicon Light Machines** *http://www.siliconlight.com*
- **Smart Material Corp.** *http://www.smart-material.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Stavely NDT Technologies** *http://www.staveleyndt.com*
- **Thales Microsonics** *http://www.temex-tmx.com*
- **TRS Technologies Inc.** *http://www.trstechnologies.com*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.gore.com*

***Exhibitors of the 2001 IEEE IUS - A Joint Meeting with the World Congress on Ultrasonics*, Atlanta, Georgia, U.S.A.** (A total of 15, not including IEEE-UFFC booth):

- **MATEC Instruments, Inc.** *http://www.matec.com/*
- **Materials Systems, Inc.** *http://www.matsysinc.com/*
- **NIH Resource Center for Medical Ultrasonic Transducer Technology** *http://bme.usc.edu/UTRC/*
- **Panametrics-NDT** *http://www.panametrics-ndt.com*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Seacor Piezo Ceramics** *http://www.seacorpiezo.com/*
- **Smart Material Corp.** *http://www.smart-material.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Specialty Engineering Associates** *http://www.ultrasonic.com/index2.htm*
- **Stavely Sensors, Inc.** *http://www.staveleyndt.com*
- **Sumitomo USA, Inc** *http://www.sumitomoelectricusa.com/*
- **Sunic System, Ltd.** *http://www.sunic.co.kr/*
- **Thermshield/Goodwill**, *Laconia, NH*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.gore.com*

***Exhibitors of the 2000 IEEE IUS*, San Juan, Puerto Rico** (A total of 11, not including IEEE-UFFC booth):

- **Crystal Technology, Inc.** *http://www.crystaltechnology.com/*
- **MATEC Instruments, Inc.** *http://www.matec.com/*
- **Panametrics-NDT** *http://www.panametrics-ndt.com*
- **Precision Interconnect** *http://www.precisionint.com/*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Sensat Corporation**, *San Jose, CA*
- **Smart Material Corp.** *http://www.smart-material.com*

- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Sumitomo USA, Inc** *http://www.sumitomoelectricusa.com/*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.gore.com*

***Exhibitors of the 1999 IEEE IUS*, Lake Tahoe, Nevada, U.S.A.** (A total of 13, not including IEEE-UFFC booth):

- **Crystal Technology, Inc.** *http://www.crystaltechnology.com/*
- **MATEC Instruments, Inc.** *http://www.matec.com/*
- **Materials Systems, Inc.** *http://www.matsysinc.com/*
- **Panametrics-NDT** *http://www.panametrics-ndt.com*
- **RITEC, Inc.** *http://www.ritecinc.com/*
- **Seacor Piezo Ceramics** *http://www.seacorpiezo.com/*
- **Sensor Technology Ltd** *http://sensortech.ca*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **SPECS, U.S.A., Inc.**, *Sarasota, FL*
- **Sumitomo USA, Inc** *http://www.sumitomoelectricusa.com/*
- **Tetrad Corp.** *http://www.tetradcorp.com*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.gore.com*

***Exhibitors of the 1998 IEEE IUS*, Sendai, Miyagi, Japan** (A total of 9, not including IEEE-UFFC booth):

- **Honda Electronics** *http://www.honda-el.co.jp*
- **Imaging Supersonic Laboratories Co., Ltd.** *http://www1.kcn.ne.jp/~isl/index-e.html*
- **Polytec Inc.** *http://www.polytec.com*
- **RITEC, Inc.** *http://www.ritecinc.com/*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Sound Technology, Inc.** *http://www.sti-ultrasound.com*
- **Sumitomo USA, Inc** *http://www.sumitomoelectricusa.com/*
- **Toyo Techica**, *Japan*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*

***Exhibitors of the 1997 IEEE IUS*, Toronto, Canada** (A total of 18, including IEEE-UFFC booth):

- **Acoustic Imaging, Inc.**
- **ATS Laboratories, Inc.** *http://www.atslabs.com/*
- **Boston Piezo-Optics, Inc.** *http://www.bostonpiezooptics.com/?D=3*
- **Ferroperm Piezoceramics A/S** *http://www.ferroperm.net*
- **Hoffman Materials, Inc.** *http://www.hoffmanmaterials.com/*
- **IEEE-UFFC Society** *http://www.ieee-uffc.org*
- **MATEC Instruments, Inc.** *http://www.matec.com/*
- **Material Systems, Inc.** *http://www.matsysinc.com/*
- **Panametrics-NDT** *http://www.panametrics-ndt.com*
- **Polytec Inc.** *http://www.polytec.com*
- **RITEC, Inc.** *http://www.ritecinc.com/*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Sumitomo USA, Inc** *http://www.sumitomoelectricusa.com/*
- **Tetrad Corp.** *http://www.tetradcorp.com*
- **TRS Technologies Inc.** *http://www.trstechnologies.com*

- **Ultra OPTEC, Inc.** *http://www.ultraoptec.com/*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.gore.com*

***Exhibitors of the 1996 IEEE IUS*, San Antonio, Texas, U.S.A.** (A total of 14, including IEEE-UFFC booth):

- **Boston Piezo-Optics, Inc.** *http://www.bostonpiezooptics.com/?D=3*
- **Echo Cath, Inc.**
- **Ferroperm Piezoceramics A/S** *http://www.ferroperm.net*
- **Hoffman Materials, Inc.** *http://www.hoffmanmaterials.com/*
- **IEEE-UFFC Society** *http://www.ieee-uffc.org*
- **INTEC Research Co.** *http://www.intec-research.com/Interactive/*
- **MATEC Instruments, Inc.** *http://www.matec.com/*
- **Material Sciences, Inc.** *http://www.matsci.com/phoenix.zhtml?c=118547&p=irol-index*
- **NASA Langley Research Center** *http://www.nasa.gov/centers/langley/home/index.html*
- **Panametrics-NDT** *http://www.panametrics-ndt.com*
- **RITEC, Inc.** *http://www.ritecinc.com/*
- **Sawyer Research Products, Inc.** *http://www.sawyerresearch.com*
- **Valpey Fisher Corporation** *http://www.valpeyfisher.com*
- **W.L. Gore & Associates** *http://www.gore.com*

XII. Corporate Sponsors

The Following Companies Have Donated Money to the 2008 IEEE International Ultrasonics Symposium:

Thank You: Shanghai Apex Electronics Technology Co. Ltd.

http://www.apex-ultrasound.com

(Posted July 20, 2008)

(Please click on the icon below to enlarge)

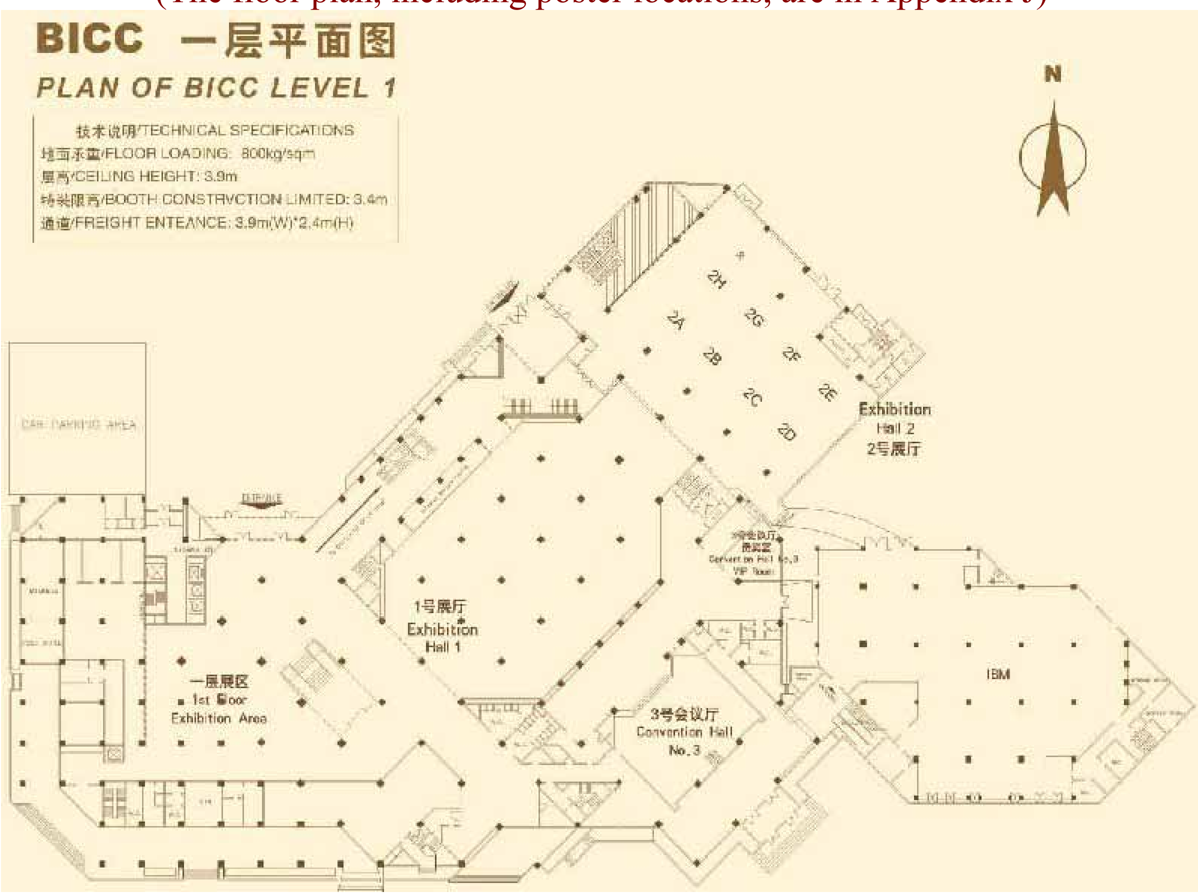
XIII. BICC Floor Plan

Conference Rooms:

A group of rooms of the Beijing International Convention Center (BICC - http://www.bcghotel.com/english/index.asp) have been reserved for the technical program (please see the Condensed Program, Full Program (Program Book), Abstract Book, and Meeting Planner) of 2008 IEEE International Ultrasonics Symposium. These rooms will be located from the 1st to the 3rd floor of the BICC. The BICC is about 400 m from the National Olympic Stadium that will host the opening ceremony of the 2008 Beijing Olympics. The floor plan of the BICC is shown below (please click on images below to view all floors that contain poster board locations and registration desks).

BICC Floor Plan

(The floor plan, including poster locations, are in Appendix J)

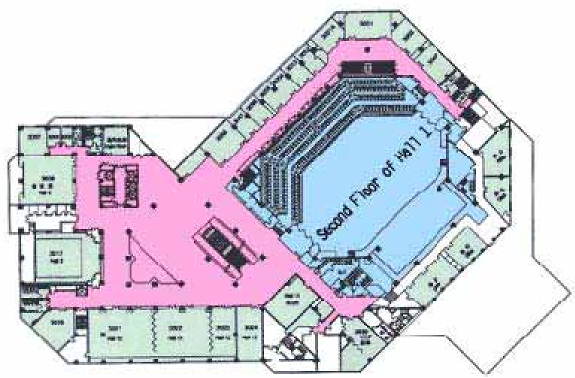


More Photos of BICC:

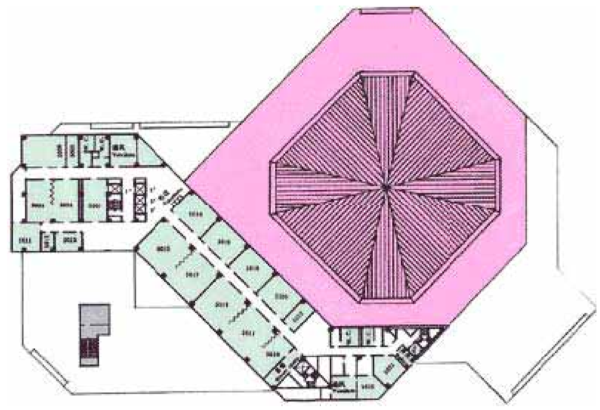
The following are some photos of BICC rooms. They were copied from:
http://www.bicc.com.cn/english/tsjieshao/pinmian.htm and http://www.bicc.com.cn/english/tsjieshao/jieshao.htm.

First Floor

Second Floor



Third Floor



Fifth Floor

Convention Hall #1 (old #1)

Convention Hall #3 (old #2)

Conference Room #201A-#201C (old #6-8)

Conference Room #201C (old #6)

Conference Room #201B (old #7)

Conference Room #201A (old #8)

Conference Room #305A-#305C (old #10-12)

Convention Hall #2 (old #17)

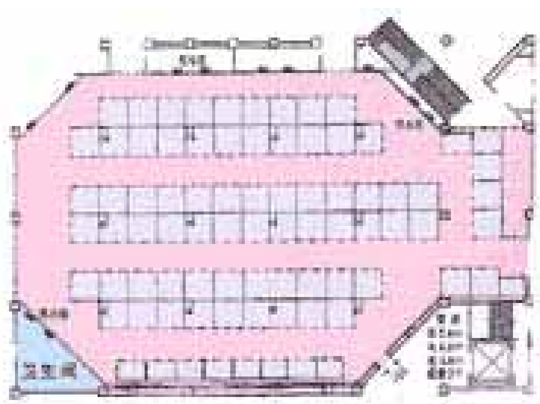
Conference Room #307 (old #3)

Conference Room #308 (old #4)

Convention Hall #5A-#5C
Exhibition Hall #2 (old #5)

Convention Hall #5A-#5C - Floor Plan
Exhibition Hall #2 (old #5) - Floor Plan

Exhibition Hall #1 (old #2)



Exhibition Hall #1 (old #2) - Floor Plan

IBM (old Exhibition Hall #4)

IBM (old Exhibition Hall #4) - Floor Plan

Small Meeting Rooms

VIP Room

XIV. Conference Registration

List of Registration Fees:

Registration Type	By September 12, 2008	After September 12, 2008
(1) IEEE Member:	*$600*	*$700*
(2) Non-IEEE Member:	*$750*	*$850*
(3) Student (Show Student ID at Conference):	*$150*	*$150*
(4) Retiree:	*$150*	*$150*
(5) Life IEEE Member (Show Life Member Card at Conference): **	*$0*	*$0*
(6) One-Day Registration (without DVD Proceedings): *	*$350*	*$350*
A Registrant above May Add: (1) Additional DVD Proceedings: *** (2) Short Courses: (3) Guests:	*$75* / Each *$150* / Each *$50* / Each (Student/Retiree) *$75* / Each	*$75* / Each *$150* / Each *$50* / Each (Student/Retiree) *$75* / Each

Notes:

- "*" **One-Day Registration** includes event tickets for the day of registration only.
- "**" **Life Member** is defined by IEEE as at least 65-year old and the age plus years of IEEE membership should be equal or greater than 100. Life members should show their IEEE Life Member card or evidence of Life Membership when getting registration materials.
- "***" A **Full Registration** (IEEE Member, Non-IEEE Member, Student, Retiree, or Life IEEE Member) will include one DVD conference proceedings. If you need additional DVD proceedings, you may order them when you register. A printed version of the Proceedings will only be available by ordering directly from the IEEE after the Symposium.
- A **Full Registration** will also include Monday lunch (November 3, 2008), Monday evening buffet dinner (November 3, 2008), and Tuesday evening banquet with traditional Chinese shows (November 4, 2008).
- **Guest Registration** includes three guest breakfasts in addition to the three meals above. Guests are NOT allowed to attend any technical sessions except for the Monday morning plenary session.
- For those who register for **Short Courses Only**, they will NOT get a badge or any conference materials such as books and meal/show tickets, and will NOT be allowed to register for guests or to attend any technical sessions. They can only register on-site on either Saturday, November 1, or Sunday, November 2, 2008.
- As indicated in the table above, **students** are required to show their valid identifications (IDs) to the registration desks to qualify for the student rates and get any registration materials.

Introduction:

The deadline for early conference registration with discount registration fees is ***Tuesday, September 12, 2008*** (midnight, Pacific Standard Time). After September 12, 2008, attendees with credit cards (Visa, Master, or American Express) can continue to register at higher fees until the conference ends on November 5, 2008. However, registrations via fax or mail will not be accepted after ***Friday, October 17, 2008*** (5:00 p.m., Eastern Standard Time), and these attendees are requested to register on-site with cash. A full conference registration will include Monday lunch (November 3, 2008), Monday evening buffet dinner (November 3, 2008), and Tuesday evening banquet with traditional Chinese shows (November 4, 2008). Each full conference registrant will also get a bag to hold the advance program and abstract books, and will receive a gift from the 2008 IEEE International Ultrasonics Symposium (IUS). Please pay attention to the "Notes" above for additional information on the conference registration.

To view our technical program, please visit the links, "Condensed Program", "Floor Plan", "Full Program (Program Book)", "Abstract Book", and "Meeting Planner".

Registration Cancellation and Refund Policy:

*There will be a **$25.00 USD** service charge to process refunds for those who have pre-registered but who are unable, for whatever reason, to attend the conference, or those who would like to make changes to the registration resulting in a refund. A letter requesting the refund should state the registrant's name and to whom the refund check should be made payable. No refunds will be given for requests RECEIVED after **Friday, October 17, 2008** (5:00 p.m., Eastern Standard Time). FAX the letter to 2008 IEEE International Ultrasonics Symposium at **(410)559-2217** or send it via email to: 2008IEEEIUS@yesevents.com.*

Online Registration Link:

The official online registration website for the 2008 IEEE IUS is given below. All questions regarding the online registration should be addressed either to the contact below or the contact in the link. (Please REFRESH your browser to view an updated page that contains correct links!)

Important: Because all registration materials will be prearranged sequentially according to your ***Registration Number*** (i.e., the PIN number such as "IEEEIUS-398" in your automatic reply email when you register), to speed up the process for picking up the registration materials, please bring this Number with you to the conference.

Conference Registration of the 2008 IEEE IUS: https://www.yesevents.com/ius/account.asp (Closed)
Questions on Registration: Phone: (800)937-8728; Fax: (410)559-2217; Email: *2008IEEEIUS@yesevents.com*

PDF Registration Form (via Fax or Mail):

If you do not have a credit card or prefer not to register online, you may download the fillable PDF registration form, fill it out, and then fax or mail it to the address given in the form with your payments. Please notice that registrations via fax or mail will not be accepted after ***Friday, October 17, 2008*** (5:00 p.m., Eastern Standard Time), and these attendees are requested to register on-site with cash. (Please REFRESH your browser to view an updated page that contains correct links!)

If you do not wish to register online above, please click on the icon below to download the PDF form:

On-Site Registration (only available from November 1-5, 2008 on the 2nd Floor of BICC):

Date	Beijing Time
Saturday, November 1, 2008:	***6:00 p.m. - 9:00 p.m.***
Sunday, November 2, 2008:	***7:00 a.m. - 7:00 p.m.***
Monday, November 3, 2008:	***7:00 a.m. - 6:00 p.m.***
Tuesday, November 4, 2008:	***7:00 a.m. - 5:30 p.m.***
Wednesday, November 5, 2008:	***7:00 a.m. - 1:00 p.m.***

For those register on-site, please follow the procedures below:

- The on-site registration window is from Saturday, November 1, to Wednesday, November 5, 2008, Beijing Time. During this window, the online registration system (see the "Online Registration Link" above) will allow "Pay Cash On-Site" option, in addition to paying with credit cards.
- During the on-site registration hours shown in the table above, all attendees should register through computers that have dedicated internet connections at the registration desks or computers of their own via the "Online Registration Link" above to enter their personal data and order items such as short courses and additional DVD proceedings. The registration desks will only collect cash and/or distribute registration materials such as badges and tickets according to your registration items. Please make sure that your personal information entered is accurate because it will be used to send DVD proceedings to you.
- After personal data have been entered online, registration fees can be paid in Chinese Yuans (RMB) at the then prevailing exchange rates to the registration desks, or paid by a Visa, MasterCard, or American Express via on-line kiosks (computers) at the registration desks through the "Online Registration Link" above.
- Students are required to show their valid identifications (IDs) to the registration desks to qualify for the student rates and get registration materials.
- Life IEEE Members are required to show their Life IEEE Member Cards or evidence of Life Members to the registration desks to get registration materials.
- **Short Courses Only** registrants can only register on-site on either Saturday, November 1, or Sunday, November 2, 2008. These attendees will NOT receive a badge or any conference materials such as books and meal/show tickets, and will NOT be allowed to register for guests or to attend any technical sessions.
- Please check the "Notes" above for additional registration information.

XV. Conference Hotels

Table of Hotels:

Hotel Names (and Walking Time)	Prices	Deadlines
Continental Grand Hotel (4-star) (Connected to BICC):	Standard: *RMB 828 ** Suite: *RMB 1,188*	*September 15, 2008*
Crowne Plaza Hotel Park View Wuzhou (5-star) (5 minutes):	Standard: *RMB 1,500* Luxury: *RMB 1,700*	*October 5, 2008*
Grand Skylight Catic Plaza Hotel (4-star) (8 minutes):	Standard: *RMB 1,050* Suite: *RMB 1,250*	*October 5, 2008*
Beijing Ao You Hotel (3-star) (10 minutes):	Single: *RMB 350* Standard: *RMB 500* Suite: *RMB 800*	*October 5, 2008*
Ya Yun Cun Hotel (3-Star) (12 minutes):	Standard: *RMB 380* Suite: *RMB 480*	*October 5, 2008*
Celebrity International Grand Hotel (5-Star) (18 minutes):	Standard: *RMB 950* Suite: *RMB 1,100*	*October 5, 2008*
Beijing Tibet Hotel (3-Star) (18 minutes):	Standard: *RMB 650* New Part: *RMB 750*	*October 5, 2008*

- "*" "RMB" means Chinese Yuan (CNY). The currency exchange rates will be determined at the time of transactions. To get a rough idea of the exchange rates of Chinese Yuan, one could check at http://www.x-rates.com/d/CNY/table.html or http://www.xe.com/.
- The prices in the table include ***one breakfast*** and ***all taxes***. Special services such as laundry, room services, and mini-bars are the responsibilities of attendees.
- You could download the addresses (English-Chinese translation) of the hotels above for taxi drivers.
- Please notice that the tap water in China is not drinkable. Please drink water only from boiled thermal bottles, designated drinking buckets, or bottle water.

Introduction and Hotel Reservation:

The China International Conference Center for Science and Technology (CICCST) has prepaid and negotiated with a group of hotels listed in the table above for the 2008 IEEE International Ultrasonics Symposium (IUS) (the list is according to the distance from the hotel to the Beijing International Convention Center (BICC), where our conference will be held). Each hotel may have a different price. All the hotels are reserved on the "first come, first serve" principle. Because each hotel has agreed only to provide a limited number of rooms to the 2008 IEEE IUS, it is advised to book the hotel you would wish to stay as early as possible. (Note: New subway lines, Lines #8, #10, #5, and Airport Lines, which connect BICC with the center of Beijing or the Beijing International Airport (PEK), and have stops in short walking distances from BICC have been built recently for the 2008 Beijing Olympics. Attendees who could not find a suitable room in one of the hotels listed above could find some hotel rooms vacated by the hundreds of thousands of Olympic visitors near the subway stops.)

To obtain the guaranteed hotel room rates listed in the table above, attendees should book the hotels through the hotel reservation website provided by CICCST below, "CICCST Hotel Reservation for the 2008 IEEE IUS". When booking hotels, please follow the procedures below (assuming you do not have password established with CICCST yet):

- Read through the information on the CICCST page regarding the details of hotels via the link "CICCST Hotel Reservation for the 2008 IEEE IUS" below.
- Click the link "here" near the bottom of the CICCST page. (You should also see the "Payment Methods" and "Cancellation and Refund" policy of CICCST before coming back and clicking "here".) The next page will be a "Login" page.
- If you have not established an account on the CICCST page through this page, "Three Local Guest Tours", or "China Tours" before, please click the button "registration" on the page. The next page will be "Your Account" page. (If you have already had the password through the prior registration via CICCST, simply enter your email address and the password. Then, you could proceed directly to fill out the hotel registration form below.)
- On the "Your Account" page, enter your email address, select your password, and then retype your password. Click the "Registration" button at the bottom of the page when you are done. If successful, a message box, "Login Success!", will popup. Click "OK" will return you to the "Login" page.
- Enter your email address and password you have just selected during the "Registration" process. If successful, a message box, "Login Success!", will popup. Click "OK".
- A form will appear after you have clicked "OK" button above. Provide your personal information and fill out this form. If you also need to book tours via CICCST (please follow the links "Three Local Guest Tours" and "China Tours" of the conference web for details), you could also enter information into the form here instead of entering the information in those pages.
- After you have finished with the form, please click "Submit" button near the bottom of the page. Then, a message box, "Success!", will popup after you have successfully submitted the form. An email confirmation of receiving this form will be sent to you within 48 hours (the email will be sent manually to you from CICCST, instead of automatically).
- Then, please send a deposit of $200 USD for each room you have reserved to CICCST using the "Payment Methods" and you will receive another notice after CICCST has received your deposit to confirm that you rooms are now guaranteed.

To check the information you have submitted, you could login to the form page again with your email address and password that you have used when you fill out the form (the form may also contain information of your Beijing local tours and China tours if you have booked them via CICCST). Please notice that the submission of the form only completes part of the hotel booking process. A deposit of $200 USD per room should be paid to and received by CICCST before the rooms can be guaranteed (you will receive another notice when your hotel rooms are guaranteed). Please also notice that CICCST does not take any credit cards when you book hotels (only personal checks, certified bank checks, or wire transfers are acceptable). However, all the hotels listed above will accept major credit cards such as Visa/Master cards when you check out. Your $200 USD deposit will be deducted from your final payments to the hotels. If you experience any problems when booking hotels via the CICCST website, please address your questions directly to CICCST with the contacts listed in the links below (including payment methods and cancellation policy). (Please REFRESH your browser to view an updated page that contains correct links below!)

Alternatively, if you could find lower room rates via internet or other sources than those listed in the table above, you could book hotels directly through your own sources. If you would like to pay credit cards to book hotels, you could search internet or find some travel agencies to book hotels through them directly. Please be advised that due to the Beijing Olympics, hotels that normally have a room rate under $100 USD could be $1,000 to $2,000 USD per room/night during the Olympics, and there will be no guarantee that the room rates will return to normal shortly after the Olympics.

Notes: Please notice that sometimes Macintosh (Apple) computers do not work well with the CICCST websites. In addition, Firefox browser (a free community-based open source software) in Microsoft (MS) Windows might work better than MS Internet Explorer in MS Windows for the CICCST websites. If you experience any technical problems, please do not hesitate to contact CICCST directly.

CICCST Hotel Reservation for the 2008 IEEE IUS: http://cast-meeting.cn/hotel.htm (Closed)
CICCST Payment Methods: http://cast-meeting.cn/payment.html
CICCST Cancellation Policy: http://cast-meeting.cn/Cancellation.html
CICCST Contact Information for Questions: Phone/Fax: 011-86-10-82116226;
Email: *bjsjcenter@sina.com*
Within 48 hours after submitting the hotel reservation form successfully, you should receive an email confirmation. If not, please contact CICCST via email or phone above.

1. Beijing Continental Grand Hotel (4-Star):

The Beijing Continental Grand Hotel (This link is for information only, not for reservation!) is **connected** directly to BICC through an indoor walkway and thus would be most convenient to attendees. It is a 4-star hotel with a total capacity of 527 guest rooms and suites (13 floors with 42000 square meters). However, the hotel has only agreed to provide a limited number of standard rooms for the conference attendees at a discount rate for nights between October 31, 2008 and November 8, 2008. The deadline for this discount rate is ***September 15, 2008***. After the deadline, the rate will not be guaranteed. Attendees who could not get rooms at this hotel could check other hotels listed in the table above.

The address of the Beijing Continental Grand Hotel or the Beijing International Convention Center (BICC) is as follows:

Beijing Continental Grand Hotel or Beijing International Convention Center (BICC)
No. 8, East Beichen Road
Andingmen Wai
North Sihuan Road
Chaoyang District
Beijing 100101, China
Tel. 011-86-10-84985588 or 011-86-10-84980248 or 011-86-10-84973060
Fax: 011-86-10-84970107 or 011-86-10-84980256
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation): http://www.bcghotel.com/english/index.asp

2. Crowne Plaza Hotel Park View Wuzhou (5-star):

The Crowne Plaza Hotel Park View Wuzhou is next to the Continental Grand Hotel and is about **5 minutes** walk from BICC. Its address is as follows:

Crowne Plaza Hotel Park View Wuzhou
NO. 8 North Si Huan Zhong Road
Chaoyang District
Beijing 100101, China
Tel. 011-86-10-84982288
Fax: 011-86-10-84992933
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation):
http://www.ichotelsgroup.com/h/d/cp/1/en/hotel/pegpv?_requestid=395833

3. Grand Skylight Catic Plaza Hotel (4-star):

The Grand Skylight Catic Plaza Hotel is about **8 minutes** walk from BICC. Its address is as follows:

The Grand Skylight Catic Plaza Hotel
No. 18 Beichen East Road
Chaoyang District
Beijing 100101, China
Tel. 011-86-10-64921188
Fax: 011-86-10-64940958 or 011-86-10-64940887
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation): http://www.hoteltravel.com/china/beijing/catic.htm

4. Beijing Ao You Hotel (3-star):

Beijing Ao You Hotel is located in the Asian Games Village sports complex. It is about **10 minutes** walk from BICC. Its address is as follows:

Beijing Ao You Hotel
Entrance 11, Tower B, Huiyuan Apartment, Asian Games Village
Chaoyang District
Beijing 100101, China
Tel. 011-86-10-84105566
Fax: 011-86-10-84105666
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation): http://www.aoyouhotel.com/introduce_en-us.php

5. Ya Yun Cun Hotel (3-Star):

Ya Yun Cun Hotel is about **12 minutes** walk from BICC. Its address is as follows:

Ya Yun Cun Hotel
No. 8 East Beichen Road, Yayun Village
Chaoyang District
Beijing 100101, China
Tel. 011-86-10-64991199, 011-86-10-64993172, or 011-86-10-64992828
Fax: 64991199
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation): http://www.huiyuangongyu.com.cn/eng/jianjie.htm
Web (Chinese) (Not for Reservation): http://www.huiyuangongyu.com.cn

6. Celebrity International Grand Hotel (5-Star):

Celebrity International Grand Hotel is nicely decorated and has comfortable rooms with city-views, in addition to its well-known Aegean Western Restaurant and Minghuang Restaurant. It is about **18 minutes** walk from BICC. Its address is as follows:

Celebrity International Grand Hotel
No. 99 Anli Road

Chaoyang District
Beijing 100101, China
Tel. 011-86-10-58651166 or 011-86-10-64981166
Fax: 011-86-10-64962522
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation): http://celebrityintl.warwickhotels.com/

7. Beijing Tibet Hotel (3-Star):

Beijing Tibet Hotel is about **18 minutes** walk from BICC. Its address is as follows:

Beijing Tibet Hotel
118 Bei Si Huan Dong Road
Chaoyang District
Beijing 100029, China
Tel. 011-86-10-64981133
Fax: 011-86-10-69181904
Link to Hotel Reservation via CICCST: **Please Click Here for Hotel Reservation**
Taxi Ride Help: Handout to Taxi Driver for This Hotel (English-Chinese Translations)
Web (Not for Reservation): http://www.beijinghotelchina.com/tibet_hotel/beijing.html

XVI. Shopping and Food near the Beijing International Convention Center (BICC)

Introduction:

Beijing has more than 100 shopping centers. One of them is the North Star Shopping Center that is located near BICC. The map below may help you navigate around BICC.

Some useful links are provided below for your information (note: if the links below become invalid over time, you could find similar pages with Google search for "Beijing shopping and food"):

Beijing Travel Highlights: http://www.beijinghighlights.com/cityguide/shopping.htm
Food and Shopping around Beijing: http://www.icsst07.buct.edu.cn/html/about%20beijing.html

XVII. Wired and Wireless Internet Access

Internet Access:

Wireless internet will be available to attendees during the conference in the 2nd and 3rd floor foyers of the Beijing International Convention Center (BICC). Tables and chairs will be available on the 2nd floor foyer of BICC for attendees to place their laptops. There will also be a designated internet café that allows attendees to connect Ethernet cables to their computers or use internet-ready conference computers in Conference Room 303 at the third floor of BICC. Since only a few computers are available in the internet café, there may be lines if many people need to use them.

XVIII. Policy on Photography / Recording

Photography or Recording:

To respect the privacy of presenters and minimize interruptions to the conference, photography and sound recording are not allowed in any technical sessions (both oral and poster) except the plenary session.

XIX. Message Boards

Message Boards for Attendees:

There will be message boards for attendees near the registration area. Please check the "BICC Floor Plan / Location" link at the conference website or the floor plan at the end of this booklet for details: http://ewh.ieee.org/conf/ius_2008.