

International Workshop on Medical Ultrasound Tomography



October 14-15, 2019
Detroit, Michigan
USA

P R O G R A M



Welcome

Dear colleagues,

It is a pleasure to welcome you to Detroit, also known as the Motor City, and home of the music movement known as Motown. We are thrilled to host the Second International Workshop on Medical Ultrasound Tomography (MUST II).

Ultrasound Tomography is an emerging technology for medical imaging that is rapidly approaching clinical utility. Multiple research groups around the globe are engaged in research, spanning theory to practical clinical applications and commercialization. This two-day MUST workshop is designed to be interactive and bring together the growing ultrasound tomography community for the purpose of discussing and exchanging new ideas and research results with each other and with researchers from related fields.

Topics of the workshop include:

- Theory and practical application of methods, including image reconstruction, image and signal processing.
- System and transducer design.
- Clinical and preclinical applications of ultrasound tomography.

We are happy to announce that this workshop will include invited talks covering the spectrum from the early history of ultrasound tomography to modern clinical applications.

We are very excited to host this workshop and would like to sincerely thank all the colleagues involved in the scientific and local organizing committees for their hard work in the planning process. We gratefully acknowledge the support of Wayne State University, Wayne State College of Engineering, and Karmanos Cancer Institute.

Welcome to Detroit!

J. Gelovani, N. Duric, R. Maev, and K. Fiscus



Scientific committee

Neb Duric, Chair
Wayne State University, US
Delphinus Medical Technologies, US

Torsten Hopp
Karlsruhe Institute of Technology, Germany

Nicole V. Ruiter
Karlsruhe Institute of Technology, Germany

Christian Böehm
ETH Zurich, Switzerland

Mark Anastasio
University of Illinois, US

Local organizing committee

Juri Gelovani, Chair
Wayne State University, US

Neb Duric
Wayne State University, US
Delphinus Medical Technologies, US

Roman Maev
University of Windsor, Canada

Kierstin Fiscus
Wayne State University, US



Practical information

Language

English is the official language of the workshop.

Registration and information desk

The registration desk is located in the lobby of the Integrative Biosciences Center. The registration desk is open

- Monday, Oct. 14: 7:30 a.m. – 5:00 p.m.
- Tuesday, Oct. 15: 7:30 a.m. – 12:00 p.m.

Should you have any questions, do not hesitate to contact us at the registration and information desk.

Registration fee

The registration fee is \$625.00 USD, \$325.00 USD for students. It includes access to all scientific sessions, breakfast and lunch, coffee breaks, and conference dinner.

Certificate of attendance

If you wish to obtain a certificate of attendance, please contact the registration and information desk or send an e-mail to kfiscus@wayne.edu.

Oral presentations

Please upload your presentation slides to the presentation laptop in the seminar room during the break before your presentation at latest. Oral presentation time slots are 20 minutes including 5 minutes for discussion.

Posters

Posters are located in the Atrium. Posters are to be displayed during the entire workshop. Please put up your poster upon arrival and leave displayed until the afternoon break on Tuesday, October 15.

Coffee breaks

Coffee, tea, and snacks will be served in the atrium of the Integrative Biosciences Center.

Lunch

Lunch will be served in the Atrium at 12:00 noon both days of the workshop. Vegetarian options are available.

Internet access at workshop venue

Wi-Fi is available in the Integrative Biosciences Center for free. Please connect to the network “WSU-Public”.

Book of abstracts



The book of abstracts is available for download at the workshop web page:
<https://indico.scc.kit.edu/event/543/>

Workshop proceedings

Workshop proceedings will be open access and have an ISBN key allowing citation. They will be available online and by print-on-demand two to three months after the workshop.

Venue address

Integrative Biosciences Center
6135 Woodward Ave.
Detroit, MI 48202 (USA)

Parking

If you need parking arrangements, please contact Kierstin Fiscus at kfiscus@wayne.edu.

Ground Transportation

Transportation between Motor City Casino Hotel (MCCH) and the workshop venue is provided as part of your registration fee. If you need additional transportation options, the organizing committee recommends using Uber or Lyft.

What to see and do in Detroit

- River Walk
- Detroit Institute of Arts (www.dia.org)
- Detroit Historical Museum (www.detroithistorical.org)
- Museum of Contemporary Art (www.mocadetroit.org)
- Museum of African American History (www.thewright.org) – closed October 14th
- Henry Ford Museum (www.thehenryford.org)

An interactive map of Detroit that lists arts, entertainment, and retail venues can be found on the conference website and at: www.detroitchamber.com/econdev/data/investment-maps/



Social events

Gala Dinner


Monday, October 14, 2019, 5:30-8:30 p.m.

The conference dinner will be held at The Whitney, located at 4421 Woodward Avenue, Detroit. After the last workshop session of the day on Monday, we will meet at 5:15 p.m. in the lobby of the Integrative Biosciences Center and will take a shuttle to the restaurant.

Upon arrival at The Whitney, we will enjoy a cocktail reception from 5:30-6:30, with the formal dinner starting at 6:30 p.m. Upon conclusion of the dinner at 8:30 p.m., guests staying at the Motor City Casino Hotel will take a shuttle back to the hotel.

Note: Pre-registration for attendees and accompanying persons is mandatory. If you do not take the shuttle to The Whitney, please make sure to be at the restaurant on time at 5:30 p.m. Valet parking is available for \$10.00 USD per vehicle.

Dress code: Business/Country Club casual attire throughout The Mansion is recommended. The Whitney does not require jackets for gentlemen, but we do not allow open toe shoes for gentlemen, athletic wear, ball caps or tattered jeans. Gentlemen are asked to wear collared shirts with sleeves and check their caps and backpacks when entering in the Mansion. Ladies, no athletic wear, yoga pants, sweatshirts, backpacks, or ball caps.



Keynote Talk

Ancient Ultrasound Tomography and MRI Perspectives of Breast Cancer

Gary Glover, Ph.D., *Stanford University, USA*

Monday, Oct. 14th 8:30-9:20 a.m.

Gary H. Glover received his PhD in Electrical Engineering from the University of Minnesota in 1969. He joined GE's Corporate Research & Development (CR&D) Labs in Schenectady, New York and studied solid state devices, computed ultrasound tomography and X-ray computed tomography until 1976, when he moved to GE's Medical Systems in Milwaukee to help transition fan-beam CT technology from CR&D. In 1980, he began the development of MRI as one of a team of five, and was thus instrumental in defining both the CT and MR products for GE. He joined Stanford's Radiology Department as Professor in 1990 and founded the Radiological Sciences Laboratory, dedicated to advancing biomedical imaging. His field of research is in MRI physics in general, and specifically in the development and application of functional MRI (fMRI) methods since 1993. His students' recent contributions include optimized techniques for acquisition and analysis of fMRI data, characterization of the dynamics of brain networks, development of real-time fMRI bio-feedback methods, and multimodal neuroimaging using fMRI combined with EEG, fNIRS, fPET and functional MR Elastography, as well as with neuromodulatory transcranial electrical and magnetic stimulation.

He is a member of the US National Academy of Engineering and a Fellow of the American Institute for Medical and Biomedical Engineering (AIMBE) as well as the International Society for Magnetic Resonance in Medicine (ISMRM), for which he is also Past President. He holds a number of other awards including RSNA's Outstanding Researcher Award and ISMRM's Gold Medal, as well as Distinguished Investigator of the Academy of Radiology and the International Academy of Biomedical Engineers.

He has authored approximately 50 patents and published some 400 papers on his research.

Invited Talks

Transcranial Ultrasound Brain Imaging (TUBI) Solution for Point-of-Care Diagnosis of Traumatic Brain Injuries

Eugene Malyarenko, Ph.D., *University of Windsor, Canada*

Monday, Oct. 14th, 10:40-11:20 a.m.

ABSTRACT ▪ Full-waveform inversion (FWI) is an imaging technique developed in the field of seismology that exploits all available information in the data, phase and amplitude, by solving a local optimisation problem based on the numerical solution of the wave equation. This technology was first translated to medical breast imaging over a decade ago. It has dramatically improved the potential of ultrasound as an imaging tool for breast cancer diagnosis due to its ability to produce high-resolution images and to provide quantitative information of several tissue properties such as acoustic speed, density, impedance or attenuation.



Despite its many challenges, breast imaging with FWI benefits from the low tissue heterogeneity of the target and from adequate instrument access to provide sufficient illumination. Brain imaging, on the other hand, presents a more challenging problem due to the presence of the skull. The high-contrast bone tissue surrounding the imaging target, i.e. the brain, requires full 3D data acquisition as well as some a priori knowledge of the geometry and acoustic properties of the skull. Under the right circumstances, however, brain imaging with FWI is possible and has the potential to impact the diagnosis and monitoring of a wide range of neuropathologies like stroke, brain cancer or head trauma.

Clinical Implications of Screening Breast Ultrasound: Past, Present, and Future

Rachel Brem, M.D., *George Washington University, USA*
Monday, Oct. 14th, 1:00-1:40 p.m.

ABSTRACT ■ This presentation will discuss the importance and clinical implications of dense breast tissue, how screening breast ultrasound can improve the detection of breast cancer, the challenges of implementing screening breast ultrasound and what the future holds in terms of technological improvement in breast ultrasound in detecting mammographically occult breast cancer as well as the increasingly important role of ultrasound and ultrasound based technologies in individualized breast cancer risk assessment.

A History of US Transmission Tomography Emphasizing Approaches out of the Mainstream

Paul Carson, Ph.D., *University of Michigan, USA*
Monday, Oct, 14th, 3:00-3:40 p.m.

ABSTRACT ■ As head of the second group to present on ultrasound transmission tomography (UTT), I switched from emphasizing speed of sound (SOS) imaging to attenuation and pulse echo imaging. Confocal, 19 mm diameter transducers in translate-rotate geometry performed better in those roles than did small diameter transducers used in the Mayo Clinic and General Electric efforts designed primarily for SOS imaging. While bent ray SOS imaging was being explored in the mainstream, phase insensitive receivers were considered for less edge enhancement and other artifacts in attenuation imaging. This simpler approach to quantitative attenuation imaging has only recently been revived for medical imaging. Other body parts than breast were considered, as well as imaging of other tissue characteristics. In the mid 80's, clinical trials of commercial automated breast imaging systems were judged by radiology leaders to be unsuccessful and research funding of quantitative imaging and "oversold" tissue characterization went down with those systems. S. Johnson's Techniscan worked consistently through two down decades and UCT improved considerably with good bent-ray and then full wave migration or inversion imaging. Competition from the simpler, but well sampled ring array of Delphinus Medical Technologies has moved UTT close to clinical acceptance. We began work on limited angle transmission tomography in the mammographic geometry, leading to use of pulse echo information to fill in missing data. The concept of bulk attenuation coefficient was introduced to minimize domination of attenuation images by losses at major boundaries delineated in pulse echo and transmission modes. With less than full apertures, the distinction between transmission and pulse echo imaging becomes less distinct and tomography of bulk tissue properties by pulse echo systems is again worth consideration, as is combination of transmission data with other ultrasound modes and thermoacoustic imaging.



Ultrasound Imaging with FWI: From Breast to Brain

Lluís Guasch, Ph.D., *Imperial College of London, England*

Tuesday, Oct. 15th 8:30-9:10 a.m.

ABSTRACT ▪ Full-waveform inversion (FWI) is an imaging technique developed in the field of seismology that exploits all available information in the data, phase and amplitude, by solving a local optimisation problem based on the numerical solution of the wave equation. This technology was first translated to medical breast imaging over a decade ago. It has dramatically improved the potential of ultrasound as an imaging tool for breast cancer diagnosis due to its ability to produce high-resolution images and to provide quantitative information of several tissue properties such as acoustic speed, density, impedance or attenuation.

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Full-ring Photoacoustic Tomography: Light and Sound to Enhance Diagnosis of Breast Cancer

Mohammad Mehrmohammadi, Ph.D., *Wayne State University, USA*

Tuesday, Oct. 15th, 1:00-1:40 p.m.

ABSTRACT ▪ Photoacoustic imaging has shown a steadily growth in diagnostic imaging of various pathologies including cancer. Through excitation of the tissue with light, conversion of the light energy to thermal energy, minor but rapid thermoelastic expansion followed by generation of acoustic waves, PA provides a complementary platform to acquire optical signature of breast tumors using the same hardware used for US imaging. In recent years, PA tomography (PAT) imaging of breast cancer has shown a steady growth. We have developed a PAT system based on a ring geometry (both excitation and detection) that can potentially address limitations of existing PAT system. Within this presentation, an overview of PAT application in breast cancer detection and staging as well as initial results from our developed full-ring PAT system will be presented.



Program

Tuesday, October 1st	
7:30 a.m.	Breakfast and Workshop Registration
8:15 a.m.	Welcome and Opening Remarks <i>Speakers: Neb Duric, Wayne State University, Delphinus Medical Technology Chair, Scientific Organizing Committee Juri Gelovani, Wayne State University Chair, Organizing Committee Farshad Fotouhi, Dean, Wayne State College of Engineering</i>
8:30 a.m.	Keynote: Ancient Ultrasound Tomography and MRI Perspectives of Breast Cancer <i>Gary Glover, Ph.D., Stanford University</i>
9:20 a.m.	5-minute break
Session I: Systems, part 1	
<i>Chair: Nicole Ruiter, Karlsruhe Institute of Technology, Germany</i>	
9:25 a.m.	The New Generation of The Breast Ultrasound Tomography Imaging System in HUST <i>Liang Zhou, Huazhong University of Science and Technology, China</i>
9:45 a.m.	Progress Towards an Open-Source, Low-Cost Ultrasound Computed Tomography Research System <i>Morgan Roberts, University College, London</i>
10:05 a.m.	A Low-cost Ultrasound Computed Tomography System using Diagnostic Linear Arrays <i>Preena Patel, University College, London</i>
10:25 a.m.	Networking Break
10:40 a.m.	Invited Talk: Transcranial Ultrasound Brain Imaging (TUBI) Solution for Point-of-Care Diagnosis of Traumatic Brain Injuries <i>Eugene Malyarenko, Ph.D., University of Windsor, Canada</i>
Session II: Systems, part 2	
<i>Chair: Neb Duric, Wayne State University, Delphinus Medical Technologies, US</i>	
11:20 a.m.	Towards 3D Brain Imaging in Small Animals using Full-Waveform Inversion <i>Thomas Robins, Imperial College, London</i>
11:40 a.m.	The Efficiency of an All-Reflective Omnidirectional Illumination for Photoacoustic Tomography with a Ring Ultrasound Transducer <i>Naser Alijabbari, Wayne State University, US</i>
12:00-1:00	Lunch



1:00 p.m.	Invited Talk: Clinical Implications of Screening Breast Ultrasound: Past, Present, and Future <i>Rachel Brem, M.D., George Washington University, US</i>
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1:40 p.m.	5-minute break
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Session III: Clinical Studies
Chair: Peter Littrup, Delphinus Medical Technologies

1:45 p.m.	Tissue Sound Speed: A Novel Imaging Biomarker for Measuring Tamoxifen Response <i>Mark Sak, University of Windsor, Canada</i>
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2:05 p.m.	Tissue sound speed is more strongly associated with breast cancer risk than mammographic percent density: A comparative case-control study. <i>Neb Duric, Wayne State University, Delphinus Medical Technologies, US</i>
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2:25 p.m.	Breast cancer development at the fat-gland interface (FGI): Importance of coronal imaging and ultrasound tomography. <i>Peter Littrup, University of Windsor, Canada</i>
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2:45 p.m.	Networking Break
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3:00 p.m.	Invited Talk: A History of US Transmission Tomography Emphasizing Approaches Out of the Mainstream <i>Paul Carson, Ph.D., University of Michigan, US</i>
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3:45 p.m.	Discussion Session Chairs: <i>Scientific Organizing Committee</i>
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5:00 p.m.	END
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5:15 & 5:30	Transportation to Conference Dinner
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5:30-8:30 p.m.	Conference Dinner at The Whitney
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Tuesday, October 15th

7:30 a.m.	Breakfast and Workshop Registration
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8:30 a.m.	Invited Talk: Ultrasound Imaging with FWI: From Brain to Breast <i>Luis Guasch, Imperial College, London</i>
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9:10 a.m.	5-minute break
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Session IV: Methods, part I
Chair: Christian Böehm, ETH Zurich, Switzerland

9:15 a.m.	Multi-Parameter Inversion <i>Ulas Taskin, Delft University of Technology, The Netherlands</i>
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9: 35 a.m.	Acoustic attenuation imaging using phase-insensitive ultrasound computed tomography <i>Daniel Sarno, National Physical Laboratory, London</i>
9:55 a.m.	Ultrasound Transducer Identification Enables High-Resolution Full-Waveform Inversion <i>Carlos Cueto, Imperial College London</i>
10:15 a.m.	Overcoming cycle-skipping in full-waveform inversion of ultrasound data <i>Oscar Calderon Agudo, Imperial College, London</i>
10:35 a.m.	Time-Domain Full Waveform Inversion for High Resolution 3D Ultrasound Computed Tomography of the Breast <i>Felix Lucka, University College, London</i>

11:00-12:00	Poster Session and Networking Break
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12:00-1:00	Lunch
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1:00 p.m.	Invited Talk: Full-ring Photoacoustic Tomography: Light and Sound to Enhance Diagnosis of Breast Cancer <i>Mohammad Mehrmohammadi, Ph.D., Wayne State University, US</i>
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1:40 p.m.	5-minute break
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Session V : Methods, part 2	
Chair: <i>Mohammad Mehrmohammadi, Wayne State University, US</i>	
1:45 p.m.	High-Frequency Full-Waveform Inversion for Ultrasound Transmission Tomography <i>Joaquin Herraiz, Complutense University of Madrid, Spain</i>
2:05 p.m.	Analysis of Linearized Inverse Problems in Ultrasound Transmission Imaging <i>Hongjian Wang, Heidelberg University, Germany</i>
2:25 p.m.	Time-of-Flight Picking for Ultrasound Computed Tomography of the Breast <i>Ashkan Javaherian, University College, London</i>
2:45 p.m.	Regularization by Registration: Utilizing Prior Knowledge to Accelerate Ultrasound Full-Waveform Inversion <i>Christian Böhm, ETH Zurich, Switzerland</i>

3:05-3:35	Data Challenge Chair: <i>Nicole Rüter, Karlsruhe Institute of Technology, Germany</i>
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3:35	Networking Break
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Session VI: Methods, part 3	
Chair: <i>Torsten Hopp, Karlsruhe Institute of Technology, Germany</i>	
3:50 p.m.	A Preclinical Simulation Study of Ultrasound Tomography for Pulmonary Bedside Monitoring <i>Jennifer Mueller, Colorado State University, US</i>
4:10 p.m.	Life-like Phantoms for Biomedical Applications <i>Adrian Wydra, True Phantom Solutions, Inc., Canada</i>
4:30 p.m.	Quantitative Assessment of Skin using High-Resolution Handheld Ultrasonic Scanner <i>Fedar Seviaryn, University of Windsor</i>
4:50 p.m.	High-Resolution Mapping of Changes in Properties in Dermal Collagen Due to Light Damage <i>Fedar Seviaryn, University of Windsor</i>
5:10 p.m.	Discussion Session Chairs: <i>Scientific Organizing Committee</i>
6:00 p.m.	END
6:15 & 6:30	Shuttle to Motor City Casino Hotel



Posters

Abstract#	Title/Authors
71	Whole breast tissue characterization with ultrasound tomography <i>Authors: Neb Duric; Peter Littrup; Cuiiping Li; Rachel Brem</i>
72	Whole breast sound speed measurement from ultrasound tomography correlates strongly with volumetric breast density from mammography <i>Authors: Mark Sak; Neb Duric; Peter Littrup; Rachel Brem</i>
75	A Novel Imaging Biomarker for Monitoring response to Neoadjuvant chemotherapy <i>Authors: Cuiiping Li; Mark Sak; Neb Duric; Di Chen; Peter Littrup; Rachel Brem</i>
78	Parallel calculation of ultrasound computed tomography based on distributed system <i>Authors: Quan Zhou, Shanshan Wang, Xia Sun, Liang Zhou, Qiude Zhang, Mingyue Ding, Ming</i>
80	Random field interferometry for medical ultrasound <i>Authors: Ines Elisa Ulrich; Christian Boehm; Andreas Fichtner</i>
81	Attenuation Image Reconstruction for Ultrasound Computed Tomography using FBP algorithm <i>Authors: Yun Wu; Xiaoyue Fang; Junjie Song; Liang Zhou; Qiude Zhang; Quan Zhou; Kuolin Liu; Zhaohui Quan; Mingyue Ding</i>
82	Refraction corrected transmissions imaging based on Bézier curves: first results with KIT 3D USCT <i>Authors: Franziska Zuch, Torsten Hopp, Michael Zapf, Nicole Ruiter</i>
83	3D Wave-Equation-Based Finite-Frequency Tomography for Ultrasound Computed Tomography <i>Authors: Naiara Korta Martiartu, Christian Boehm, Andreas Fichtner</i>
84	Pseudo-linear-frequency-modulation pulse emission and signal matching in ultrasound computed tomography system <i>Authors: Liang Zhou; Kuolin Liu; Junjie Song; Mingyue Ding; Ming Yuchi</i>
86	A PID controller Approach for regularizing quantitative sound speed imaging using full waveform inversion <i>Authors: Bonghun Shin, Xiang Zhang, Gregory Ely, Jonathan Fincke, and Brian W. Anthony</i>
93	Transceiver ASIC in HVC MOS Technology for 3D Ultrasound Computer Tomography <i>Authors: Roberto Blanco, Richard Leys, Lukas Becker, Michael Zapf, Hartmut Gemmeke, Nicole V. Ruiter, Ivan Peric</i>
96	Fast auto-adaptive gain adaption for improved signal dynamics <i>Authors: Zewei Lu; Michael Zapf; Nicole Ruiter</i>



97	First US performance measurements of next generation 3D USCT 2.5 transducers <i>Authors: Michael Zapf; Martin Angerer; Kai Hohlfeld; Sylvia Gebhardt; Hartmut Gemmeke; Nicole V.Ruiter</i>
100	Compensating for Variable Acoustic and Optical Properties towards Quantitative Photoacoustic Tomography <i>Authors: Alexander Pattyn; Zackary Mumm; Mohammad Mehrmohammadi</i>
101	Deep learning based sound speed image reconstruction in ultrasound tomography for breast cancer detection <i>Authors: Ivana Balic; Pascal Leimer</i>
102	Design and performance of a Tonpilz transducer for low frequency medical ultrasound tomograph <i>Authors: Ely Lopes Filho; Andre Pigatto, Jennifer Mueller; Raul Lima</i>