Course Title: Quantitative Acoustic Microscopy - Fundamentals and New Applications from Cells to Airplanes.

***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 provide basic knowledge and major principles of quantitative acoustic microscopy and their diverse advanced applications from biomedicine to aircraft materials and joints. 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 the field, including different topics in physical acoustics, ultrasound, solid state physics, materials characterization and nondestructive evaluation. Progress in digital measurement and pulse technology has remarkably upgraded the performance of these types of microscopes. Special attention will be paid to the principle and application of several types of scanning acoustic microscopes, developed by authors, especially for medical and biological use. The ability of quantitative methods will be described within the course with various examples for investigating the microstructure and physical mechanical properties of materials of different nature, from crystalline to biomaterials. In particular, the new generation of sound speed microscopes which conventionally used tone-burst and analog phase detector are very efficient tool 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. Another, acoustic impedance mode 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 500 MHz, both modes 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 presented. During course we will introduce a new generation of desktop, portable and relatively inexpensive, including hand-held diagnostic imaging devices: there will be a presentation of recent results in acoustic microscopy development achieved by authors and their teams from Honda Electronics (Japan) and Tessonics (Canada). Together with explanation of the hardware, software and quantitative algorithms, which are implemented into those microscopy systems, it will be described a large number of examples as additional illustrations. Moreover, ultrasound has expanded beyond the imaging realm, with quantitative methods and applications extending traditional imaging way. A particularly attractive aspect of acoustic microscopy is in producing totally non-invasive, image-guided analysis of dynamic processes in cells and tissues, such as ultrasound drug activity (phono- phoresis), monitoring of tissue interaction with various physical and chemical factors, tissue regeneration etc. 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 was born in Moscow, Russia and now lives and works in Canada. Dr. 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 in Moscow, and then established a Centre for Imaging Research and Advanced Material Characterization at the University of Windsor, Canada. He is currently Distinguish University Professor at the Physics Department and since 2001 the Chairholder of the NSERC/DaimlerChrysler/Industrial Research Chair in Applied Solid State Physics and Material Characterization. In May 2008 he was appointed as a Director-General of the Windsor Institute for Diagnostic Imaging Research, Ontario, Canada. Professor Maev's research interests focus on the fundamentals of condensed matter, physical acoustics, ultrasonic imaging, and acoustic microscopy. He has published four books, has been the editor of several books, published more than 300 scientific papers, and holds twenty four patents. Dr. Maev since 2001 is Associate Editor of IEEE TUFFC, and since 2007 member of IEEE AdCom.

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.