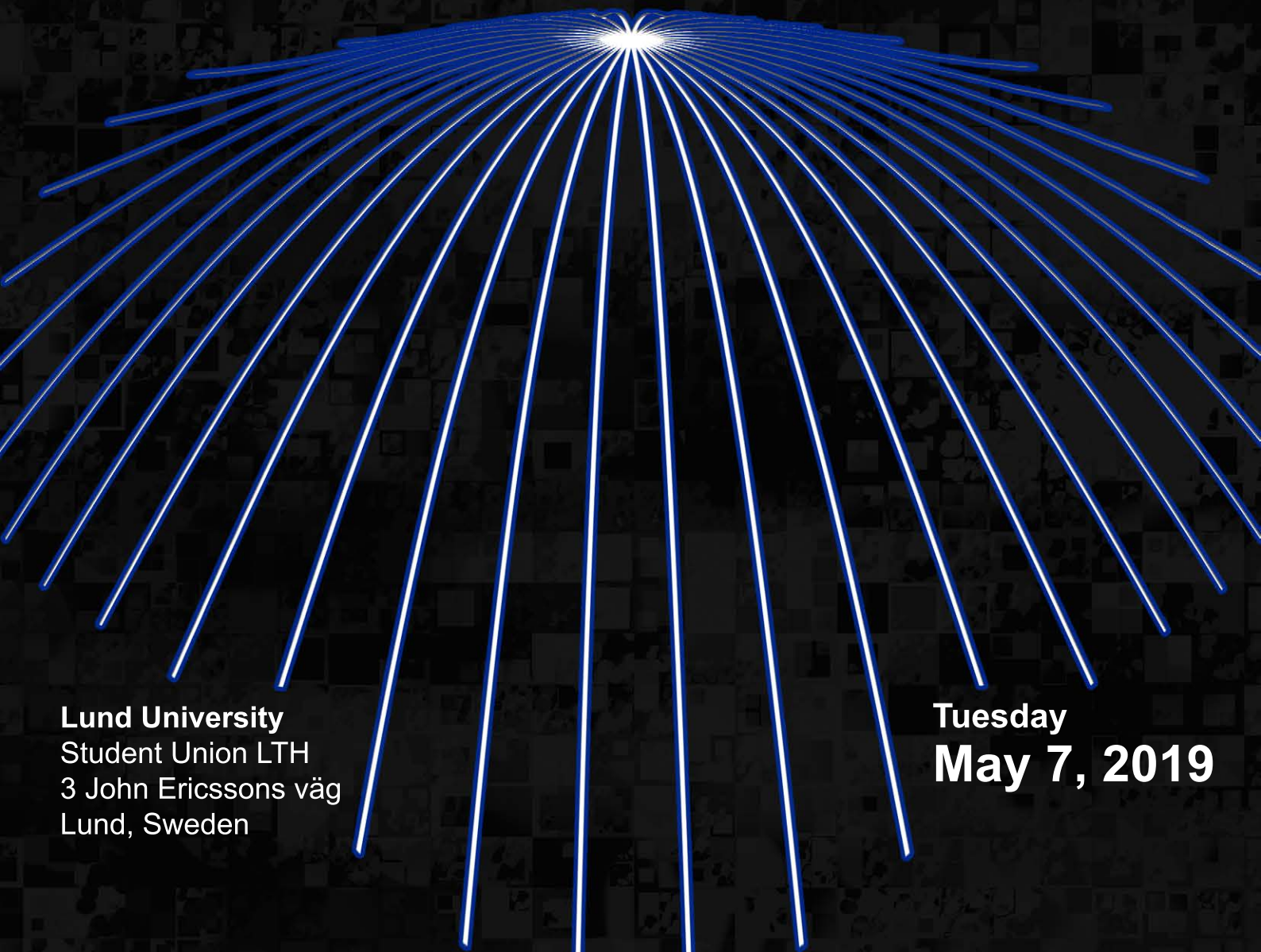
2019 AMTA/IEEE Regional Symposium Event

5G – An Antenna and Measurement Perspective



Lund University
Student Union LTH
3 John Ericssons väg
Lund, Sweden

Tuesday
May 7, 2019

Conference Agenda

May 6, 2019

18:00 to 20:00 MAX IV Laboratory Technical Tour

May 7, 2019

08:00 On-Site Registration

09:00 AMTA/IEEE Welcome

09:15 **DTU-ESA Spherical Near-Field Antenna Test Facility - Past, Present, and Future Activities**
Professor Olav Breinbjerg, Technical University of Denmark

10:00 Break

10:30 **Near-Field Measurement Technique for Electromagnetic Exposure of 5G Devices**
Professor Mats Gustafsson, Lund University

11:15 **5G: Challenges for Human Exposure Assessment and Virtual-Drive Over-the-Air Testing**
Dr. Christian Bornkessel, Technische Universität Ilmenau

12:00 Lunch

13:30 **5G Over-the-Air Conformance Testing**
Dr. Jonas Fridén, Ericsson Research

14:15 **Far-Field OTA Testing of User Equipment Using Plane Wave Generators**
Mr. Lars Foged, Microwave Vision Group (MVG)

15:00 Break

15:30 **High-Resolution Dynamic Characterization of Mm Wave Channels**
Professor Fredrik Tufvesson, Lund University

16:15 Closing Remarks

16:30 to 19:00 Reception with Speakers and Exhibitors

Technical Program Abstracts

DTU-ESA Spherical Near-Field Antenna Test Facility – Past, Present, and Future Activities
By: Professor Olav Breinbjerg

The DTU-ESA Spherical Near-Field Antenna Test Facility is an ESA (European Space Agency) external reference laboratory for high-accuracy antenna calibration and measurement located at and operated by DTU (Technical University of Denmark). Satellite science missions in ESA's Earth Observation Programme are often very demanding in terms of antenna performance with measurement uncertainty requirements at the level of 0.05 dB for peak directivity. For such high-accuracy requirements, the spherical near-field measurement technique is clearly advantageous. The DTU-ESA Facility supports ESA missions such as SMOS, SENTINEL, BIOMASS, JUICE, and MetOp SG, and also undertakes development and research in areas such as probe antennas, probe correction techniques, and gain calibration techniques. This presentation will review the historic development, outline present activities and state-of-the-art, and discuss future activities and challenges for the DTU-ESA Spherical Near-Field Antenna Test Facility.

Near-Field Measurement Technique for Electromagnetic Exposure of 5G Devices
By: Professor Mats Gustafsson

Accurate and efficient measurement techniques are needed for EMF compliance testing of 5G mm-wave devices. Radio frequency electromagnetic field exposure limits are expressed in terms of the incident power density above 6 GHz. The short wavelength of mm-waves combined with the rapid increase of the power density close to its sources requires an accurate evaluation of the electromagnetic fields at mm distances from the radiating antenna. Here, a near-field measurement technique based on open waveguides combined with source reconstruction and numerical calculations is used to estimate the power density. A small aperture with a well-defined radiated field is used to calibrate the measurement setup. Results for 28 GHz and 60 GHz antenna arrays show that the estimated power density agrees well with simulations.

5G: Challenges for Human Exposure Assessment and Virtual-Drive Over-the-Air Testing
By: Dr. Christian Bornkessel

5G is a key enabler for radio based automated and connected driving. TU Ilmenau operates a VISTA laboratory (Virtual Street - Simulation and Test Area) equipped with RF absorbers, an antenna arch and a car dynamometer. In VISTA, virtual-drive over-the-air tests of vehicles are performed. The present and future test activities in VISTA are presented. Besides automotive antenna testing and emulation of the radio environment, a special focus is laid on human exposure to RF electromagnetic fields. 5G radio base stations are subject to national certification procedures and have to meet limit values with regard to human exposure. Measurement and calculation exposure assessment methods used for conventional 2-4G mobile radio systems with static beams can no longer be used for 5G Massive MIMO beamforming antennas. The presentation describes the most important exposure relevant differences between conventional 2-4G base station antennas and Massive MIMO 5G antennas and derives challenges and first concepts for a correct exposure assessment.

5G Over-the-Air Conformance Testing
By: Dr. Jonas Fridén

Over-the-Air (OTA) testing has been standardized by 3GPP Rel. 15 (5G) for both radio and radiating performance for integrated active base stations. Conformance requirements are set to guarantee co-existence and minimum performance. For systems using passive antennas, the radio requirements are tested conductively, which is not possible for integrated systems. Therefore, radio requirements have been moved to the OTA interface and merged with radiated requirements. The new requirements are divided into directional, non-directional and co-location requirements. Directional requirements are related to Equivalent Isotropic Radiated Power (EIRP) and the new metric Equivalent Isotropic Sensitivity (EIS). Non-directional requirements are typically measured as Total Radiated Power (TRP) and include radiated emissions up to 60 GHz. Co-location is tested by introducing a co-location reference antenna, which transforms the measurement from the OTA interface back to a conducted interface. For each test requirement there is also a target measurement uncertainty standardized, aimed for reasonable implications on cost and time of testing as well as product requirements.

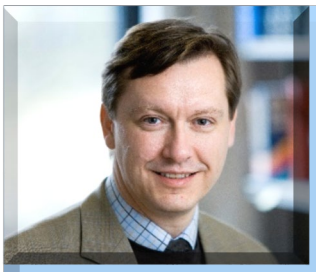
Far-Field OTA Testing of User Equipment Using Plane Wave Generators
By: Mr. Lars Foged

The Plane Wave Generator (PWG) or Plane Wave Synthesizer (PWS) generates an approximate plane wave over a finite testing volume called the Quiet Zone (QZ). It consist**s** of an array of distributed elements with suitably optimized complex coefficients. The PWG enables direct measurements of far-field performance of the Antenna Under Test (AUT) in a controlled indoor environment as an alternative to Compact Antenna Test Range (CATR). PWG testing methods are similar to testing in CATR. However, the PWG require a significantly smaller physical space for the same size QZ thus requiring a much smaller anechoic chamber. This feature becomes more important at lower frequencies as in the case of sub-6GHz bands, typically used in 4G and upcoming 5G applications. In this presentation, we present an efficient implementation of the PWG for sub-6GHz applications including measured examples and comparison with the equivalent CATR system.

High-Resolution Dynamic Characterization of Mm Wave Channels
By: Professor Fredrik Tufvesson

Millimeter wave communication is one of the cornerstones in the upcoming 5G standards. While it is generally accepted that the path loss can be overcome by using array antennas at both the base station and the terminal side, there are still many open topics when it comes to the dynamic behavior of the mm wave channel and details of the multipath structure. In this talk we discuss recent advances in mm wave channel characterization, both with respect to channel sounding techniques and channel characteristics. We treat the dynamic behavior and multipath structure of the mm wave channel and their implications on beamforming strategies and antenna design to achieve reliable and efficient communication.

Speaker Biographies



Professor Olav Breinbjerg

Olav Breinbjerg received the Ph.D. degree in electrical engineering from the Technical University of Denmark (DTU) in 1992. He has since been on the Faculty of the Department of Electrical Engineering where he is now Full Professor and Head of the Electromagnetic Systems Group and the DTU-ESA Spherical Near-Field Antenna Test Facility. His research is in applied electromagnetics - antennas, antenna measurements, computational techniques, and scattering - for applications in wireless communication and sensing. He has been, or is, the main supervisor of 14 Ph.D. projects, and author or co-author of more than 65 journal papers, 175 conference papers, and 100 technical reports. He was the recipient of a 1995 U.S. Fulbright Research Award, the 2001 AEG Elektron Foundation's Award, the 2003 DTU Student Union's Teacher of the Year Award, and the 2013 and 2015 European School of Antenna Best Teacher Awards. Dr. Breinbjerg is AMTA Senior Member and IEEE Fellow.

Professor Mats Gustafsson

Mats Gustafsson received the M.Sc. degree in Engineering Physics 1994, the Ph.D. degree in Electromagnetic Theory 2000, was appointed Docent 2005, and Professor of Electromagnetic Theory 2011, all from Lund University, Sweden. He co-founded the company Phase holographic imaging AB in 2004. His research interests are in scattering and antenna theory and inverse scattering and imaging with applications in microwave tomography and digital holography. He has written over 90 peer reviewed journal papers and over 100 conference papers. Prof. Gustafsson received the Best Antenna Poster Prize at EuCAP 2007, the IEEE Schelkunoff Transactions Prize Paper Award 2010, and the Best Antenna Theory Paper Award at EuCAP 2013. He served as an IEEE AP-S Distinguished Lecturer for 2013-15.

Dr. Christian Bornkessel

Christian Bornkessel got his Dipl.-Ing. Degree in 1990 from Technische Universität Ilmenau and his Dr.-Ing. Degree in 1993 from the University of Karlsruhe. From 1991 to 1995, he worked as a research assistant at the Institute for High Frequency Techniques and Electronics at Karlsruhe University in the field of numerical analysis of Electromagnetic Compatibility (EMC) aspects. From 1995 to 2014, he was with IMST GmbH Kamp-Lintfort, where he worked as head of Test Center since 2010. He was responsible for the planning, implementation, accreditation and operation of the EMC test center. Since 2014, he is with Technische Universität Ilmenau, RF and Microwave Research Laboratory. His current activities involve radio based car communication (V2X) and EMC aspects with a focus on human exposure to RF and LF electromagnetic fields. He is a member of the German Commission on Radiological Protection and the ITG technical committee HF1 "antennas".

Dr. Jonas Fridén

Jonas Fridén was born in 1965. He received the B.S. degree in mathematics and physics and the Ph.D. degree in theoretical physics from the University of Göteborg, Göteborg, Sweden, in 1987 and 1996, respectively. Since 2002, he has been with Ericsson Research, Ericsson AB, Göteborg, Sweden. In 1996 {1999, he was a lecturer with the College University of Borås. In 1999, he was with Ericsson Microwave Systems AB, where he worked with radar antennas, radar system, and radome design. He has also been a member of the European Electromagnetic Data Interface Group. His major areas of research are electromagnetic compliance, OTA measurement techniques, near field retrieval techniques, antenna theory, bandwidth limitations of antennas, and MIMO antenna system performance.

Mr. Lars Foged

Lars Foged received his B.S. from Aarhus Teknikum, Denmark in 1988 and M.S. in Electrical Engineering from California Institute of Technology, USA in 1990. He is Scientific Director of the Microwave Vision Group, and Associate Director of Microwave Vision Italy. Since 2004, he has been the secretary of the IEEE Antenna Standards Committee and has contributed to the development of different standards on antennas and measurements. In 2016 and 2017, he led the Industry Initiatives Committee (IIC), a standing committee of IEEE APS. He is an Edmond S. Gillespie Fellow of AMTA and received the Distinguished Achievement Award from AMTA in 2017. In 2015, he contributed to the foundation of the AMTA Italian node. He has authored or co-authored more than 200 journal and conference papers on antenna design and measurement topics and received the “Best Technical Paper Award” from AMTA in 2013. He has contributed to five books and standards, and holds four patents.

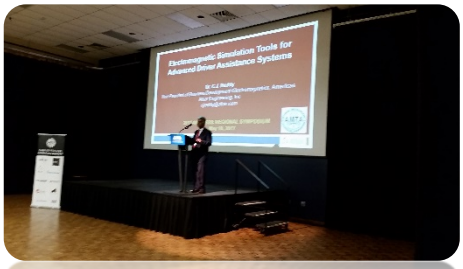
Professor Fredrik Tufvesson

Fredrik Tufvesson received his Ph.D. in 2000 from Lund University in Sweden. After two years at a startup company, he joined the department of Electrical and Information Technology at Lund University, where he is now professor of radio systems. His main research interest is the interplay between the radio channel and the rest of the communication system with various applications in 5G systems such as massive MIMO, mm wave communication, vehicular communication and radio based positioning. Fredrik has authored around 80 journal papers and 140 conference papers, he is fellow of the IEEE and recently he got the Neal Shepherd Memorial Award for the best propagation paper in IEEE Transactions on Vehicular Technology and the IEEE Communications Society best tutorial paper award.

Program Overview

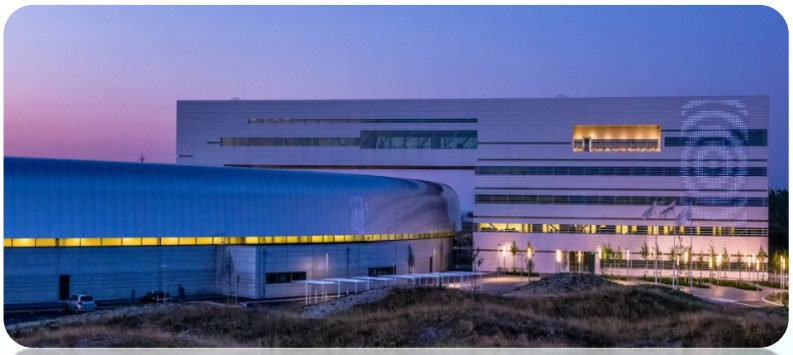
The Program

This program was designed to bring the latest 5G inspired technology, as related to antenna design and measurement, to the local community. Experts in industry and academia organizations will share practical information on various topics in an extended presentation format. This allows a thorough discussion of each topic and provides the opportunity for extended questions and answers. The “hands-on” quality of the presentations enables the registrant to learn useful information that can be used on the job – in the “real world.” The demonstrations provide a unique educational opportunity to see selected presentation material “live”.



The Tour – MAX IV

Arrive a day early so you can plan to join us as we take a tour of the MAX IV Laboratory. Opened in 2016, MAX IV is the next-generation synchrotron radiation facility in Lund, Sweden. Including two storage rings and a full-energy linac, MAX IV will be the brightest X-ray source of its kind in the world. Transportation and tour are included in the price of registration. The tour is scheduled for Monday, May 6, 2019 from 18:00-20:00. A bus will pick up participants that have signed up for the tour at Lund C at 17:30. Experts on the MAX IV RF systems will guide the tour.



The Exhibition & Reception

There will be an exhibition by vendors of test and measurement related products and services for antenna and wireless applications in the technical presentation area. These products and services address the needs of the commercial, military, and academic markets.

During the reception from 16:30 - 19:00, heavy appetizers and a hosted bar will be available. AMTA and IEEE members are welcome to attend the reception only at NO CHARGE, provided a registration form is completed and sent in advance. A badge will be available for the reception-only attendees upon arrival at 16:30. *Thus, if you can’t join us for the entire day, drop by for the reception and exhibition to network with AMTA and IEEE.*

The Venue

Lund University was founded in 1666 and it remains one of the country's largest and most respected places to study, with over 40,000 students – many of them international. This, combined with the abundance of classic university buildings and carefully preened parks, makes Lund feel like a Swedish version of England's Oxford.

About Lund

Lund is a small, attractive city that's overflowing with history and charm. Although the city is old and believed to be founded in 990 when this was a part of Denmark, Lund is thoroughly modern. It's here that the huge ESS super-microscope is being built, which will allow scientists to perform multi-disciplinary research using the world's most powerful pulsed neutron source.

Local Hotels

From cozy B&Bs to luxurious hotels, there are some great places to stay within walking distance or a short bus ride to the University. But there is not a surplus of accommodations, so it's best to **make your reservations early**!

About AMTA

The Antenna Measurement Techniques Association (AMTA) is a non-profit professional organization for engineers and other persons active in the fields of antenna, radome, and radar cross-section measurements. The purpose of AMTA is to promote technical exchange between colleagues in these fields; provide a forum for presentations of new techniques and results in antenna and radar cross-section measurement; and offer antenna and radar cross-section measurement equipment manufacturers an opportunity to demonstrate new hardware and software to a significant portion of the market. The membership and activities of AMTA have grown in size and scope each year since the founding of the organization in 1979.

ORGANIZING COMMITTEE

Christer Larsson – AMTA Vice President, Saab and Lund University
Donnie Gray – AMTA President, Microwave Vision Group (MVG)
Michelle Taylor – AMTA Meeting Coordinator, NSI-MI Technologies
Manuel Sierra Castañer – AMTA EurAAP Liaison, Universidad Politécnica de Madrid
Michael Havrilla – AMTA Past Vice President, Air Force Institute of Technology (AFIT)
Fredrik Tufvesson – IEEE Liaison, Lund University
Lars Foged – Microwave Vision Group (MVG-Italy)
Jan Zackrisson – Saab Space AB

PROGRAM SPONSORS

A Special Thank You for Technical Sponsorship and Support to:
IEEE Swedish Chapter
ELLIIT
Lund University

SPONSORSHIPS AND EXHIBITS

For Questions, contact Michelle Taylor, AMTA BoD Meeting Coordinator
Office: +1 678-475-8345, Email: meeting-coordinator@amta.org

REGISTRATION

Please register through the AMTA Website at: www.AMTA.org
For Questions, contact Michelle Taylor, AMTA BoD Meeting Coordinator
Office: +1 678-475-8345, Email: meeting-coordinator@amta.org

AMTA/IEEE Members, if received by **April 6, 2019**	**$155**
AMTA/IEEE Members, after **April 6th and On-Site**	**$275**
Non-Member Additional Charge*:	**$ 50**
Full-time Students with copy of valid Student I.D.	**$ 20**

NOTE: Unemployed/retired attendees will receive a 50% discount off the AMTA/IEEE Member fees above.

*Includes one-year membership in AMTA.

NOTE: *The registration fee includes a flash drive of the colloquium record, continental breakfast, lunch, refreshment breaks, and the reception. The organizing committee reserves the right to substitute speakers, restrict size, or to cancel the colloquium and exhibition. In the event the organizing committee cancels this event, registration fees only will be fully refunded. Individuals canceling their registration prior to April 6, 2019 will receive a full refund, less 10% credit card fee. No refunds will be made to individuals who cancel their registration after April 6, 2019. Substitutions are allowed. Attendance is limited; registration will be confirmed on a first come, first served basis.*