Workshop on Antenna Measuring Techniques

Wednesday, Sept. 13, 12:30 h - 16:45 h, Vieweg-Bau 234
Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

Scope:

Advances in computational capabilities allow for the application of numerical techniques such as near-to-far-field transformation and correction algorithms in antenna calibration. This workshop adresses some of the recent advances.

Program:

12:30-13:15 **Thomas Kleine-Ostmann, PTB, New Developments in Antenna Measuring Techniques**

Thomas Kleine-Ostmann is Head of the Department 2.2 – High Frequency and Electromagnetic Fields at PTB.

13:15-14:00 **Zhong Chen, ETS-Lindgren, Recent Advances in EMC Test Site Evaluation Using Advanced Antenna Measurement Techniques**

Calibrating antennas and validating test sites are interdependent processes, as they both mandate accurate antenna measurements in their testing environment. Site VSWR, as specified in CISPR 16-1-4 or C63.25, is used as the figure of merit to qualify test site performance from 1 GHz to 18 GHz. In the CISPR method, the standing wave is measured by sampling scalar fields along several linear paths. However, in an effort to simplify the measurement, test data are severely undersampled. Time Domain SVSWR, as specified in C63.25.1 (1-18 GHz), was developed to address the undersampling issues. For above 18 GHz tests, new challenges emerge, such as the need to test more locations in the Quiet Zone (QZ) and to measure the receive antenna beam coverage. Cylindrical Mode Filtered SVSWR developed as a result, which is now under active consideration in the C63.25.3 (18-40 GHz) and CISPR 16 standards. Participants of the seminar will gain a deeper understanding on technical background (the whats and whys) of the evolution of the test methods, and how advanced antenna measurement techniques are used to help to solve the different technical challenges.

Zhong Chen is the Director of RF Engineering with ETS-Lindgren, located in Cedar Park, Texas. He has over 25 years of experience in RF testing, anechoic chamber design, as well as antenna and EMC field probe design and measurements. He is a past member of the Antenna Measurement Techniques Association (AMTA) Board of Directors and is currently a member of the IEEE EMC Society Board of Directors. Mr. Chen is the Vice Chair of ANSC C63, which is responsible for EMC antenna calibration and test site validation standards. He is also chair of the IEEE Standard 1309 committee responsible for developing calibration standards for field probes, and IEEE Standard 1128 for absorber measurements. He has served as a Distinguished Lecturer for the IEEE EMC Society. His research interests include measurement uncertainty, time domain measurements, and development of novel RF absorber materials. Mr. Chen received his M.S.E.E. degree in Electromagnetics from the Ohio State University at Columbus.

14:00-14:30 coffee break

14.30-15:15 **Dennis Lewis, The Boing Company, Innovative Robotic Antenna Measurements**

Traditional antenna test facilities are typically designed with a specific measurement application in mind, and as a result these facilities tend to be comprised of single fixed measurement geometry. However, modern antenna measurement ranges employing multi-axis robotic positioners provide a near limitless degree of re-configurability in terms of measurement types and scan geometries. This drives an ongoing need to evaluate each unique setup and application. This previously unimaginable flexibility offers new opportunities for the improvement of safety, measurement quality and reduction of measurement uncertainties. These new robotic systems are capable of acquiring large amounts of special data allowing for the implementation of advanced post processing techniques. Model Based Systems Engineering and Development (MBSE/MBD) approaches can be employed to dramatically reduce the time, effort and cost associated with the test development and validation phases of a given program. MBSE tools can also be used to optimize test configurations to greatly reduce measurement uncertainties and simulate measurements. This presentation provides an overview of how these engineering techniques are being harnessed during the implementation of a new dual multi-axis robotic antenna test system.

Dennis Lewis received his BS EE degree with honors from Henry Cogswell College and his MS degree in Physics from the University of Washington. He has worked at Boeing for 34 years, and is recognized as a Technical Fellow, leading the enterprise antenna measurement capability for Boeing Test and Evaluation. Dennis holds eleven patents, and is the recipient of the 2013 and 2015 Boeing Special Invention Award. He is a senior member of the IEEE and several of its technical societies, including the Microwave Theory and Techology Society (MTT-S), the Antennas and Propagation Society (AP-S), and the Electromagnetic Compatibility (EMC) Society. He actively contributes to these societies as a member of the IEEE MTT-S Subcommittee 3 on Microwave Measurements, and as a Board Member and past Distinguished Lecturer for the EMC Society. He is a Senior Member and served as Vice President on the Board of Directors for the Antenna Measurements Techniques Association (AMTA) and chaired its annual symposium in 2012. Currently he is chair of the AMTA 2023 annual symposium. Dennis developed and taught a course on Measurement Science at North Seattle College, and is a past chairman of its Technical Advisory Committee. His current technical interests include aerospace applications of reverberation chamber test techniques as well as microwave and antenna measurement systems and uncertainties.

15.15-16.00 **Roland Moch, RWTH Aachen University, Spherical Near-Field Measurements Using Maximum Determinant Sampling Grids in a Robot-Based Test Range**

Conventional spherical near-field measurements are often performed using equiangular sampling grids. These are well realizable with roll-over-azimuth positioners and, furthermore, allow an efficient transformation into the far field based on Fourier transforms due to the uniform sampling. However, this grid is highly redundant at the poles, resulting in an overall oversampling by a factor of approximately two as well as an extended measurement duration. With steadily advancing computational capabilities, irregular sampling grids, as well as correction techniques such as higher-order pointwise probe correction, increasingly gain importance. In combination with the flexibility of robot-based measurement systems, new possibilities arise, such as the efficient implementation of maximum determinant

sampling grids. Depending on the antenna under test (AUT), this grid can be scaled to the exact amount of AUT modes and is completely non-redundant. Therefore, it requires only half the sampling points of an equiangular measurement for a stable transformation. Furthermore, if required, the typically higher positional uncertainty of robot-based systems compared to roll-over-azimuth positioners can be compensated for each sampling point separately using pointwise probe correction. Thus, modern transformation algorithms in combination with robot-based measurement systems allows to transform the formerly rather theoretical interest in maximum determinant sampling grids into a feasible solution for efficient antenna measurements.

Roland Moch received his degree in Electrical Engineering, Computer Engineering and Information Technology (M. Sc.) from RWTH Aachen University, Germany, in 2015, and is currently pursuing his doctoral degree (Dr.-Ing.) as a research assistant at the Institute of High Frequency Technology at RWTH Aachen University. His research focuses on the optimized use of robot-based systems in near-field antenna measurements, particularly with respect to spline-based measurements, for which he has been a finalist for the Best Measurement Paper Award in the European Conference on Antennas and Propagation in 2022. His contributions on the application of pointwise probe correction for robot-based systems as well as maximum determinant sampling grids using spline-based trajectories have been awarded by the Antenna Measurement Techniques Association (AMTA) in 2021 and 2022. Additionally, he has been a lecturer in the 2022 AMTA short course on the applications of robotics for antenna measurements.

16.00-16.45 **David Ulm, PTB, An overview of near-field antenna measurements**

David Ulm is measurement engineer in the Working Group 2.21 – Electromagnetic Fields and Antenna Measuring Techniques at PTB.

Registration:

Participation is free, however, as space is limited to 30 participants, please register with a mail to Mrs. Pamela Bürger, pamela.**buerger**@ptb.de, Tel. +49 592 2201. Availability on first-come first-served basis.