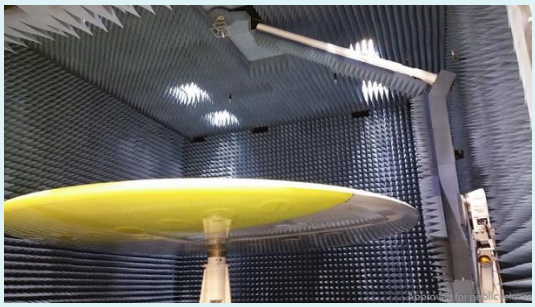
SC03 - Spherical Near-Field Antenna Measurements Theory and Practical Implementation



Abstract:

The spherical near-field antenna measurement technique is unique in combining a range of fundamental advantages that render it the most accurate technique for experimental characterization of antenna radiation. This technique, based on the comprehensive and well-established theories of the spherical vector wave expansion and the antenna scattering matrix, can be implemented in numerous different types of measurement facilities, and today it is used globally for testing of wireless technology from miniscule hearing aid antennas to giant satellite antennas. This tutorial course will overview the theoretical background for the spherical near-field antenna measurement technique and deal with the careful practical implementation that is essential in realizing the potential of high-accuracy testing. The tutorial will present several challenging calibration and measurement project and also review recent research in spherical near-field antenna measurements

Recommended pre-requisites:

The course requires knowledge and understanding of electromagnetics and antennas at M.Sc. level; participants who already have experience with antenna measurements will also be able to benefit from the course.

Learning Objectives:

The active course participants will be able to account for:

- the theory of the spherical wave expansion
- the theory of the antenna scattering matrix
- the theory of the spherical transmission formula
- the mechanical alignment requirements for spherical near-field antenna measurements
- sampling and scanning schemes for spherical near-field antenna measurements
- range probe requirements for spherical near-field antenna measurements
- measurement procedures for spherical near-field antenna measurments
- uncertainty estimation for spherical near-field antenna measurements
- the relationship between theory and practice of spherical near-field antenna measurements
- the fundamental advantages of spherical near-field antenna measurements over other types of antenna measurements.

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Course Outline:

The 3-hours course will consist of a lecture, small exercises, discussions, and a multiple-choice test.

The course contents is structured as follows:

Theory (1,5 hrs)

- Introduction to spherical near-field antenna measurements
- Spherical wave expansion and spherical vector waves
- Antenna scattering matrix
- Derivation and solution of spherical transmission formula

Practical Implementation (1,5 hrs)

- Mechanical positioning configurations
- Sampling criterion and scanning schemes
- Practical measurement considerations
- Misc. topics (modal filtering, SNF system alignment, near-field probes)
- Range uncertainty evaluation

Instructors:

Olav Breinbjerg was born in Silkeborg, Denmark, in 1961. He received the M.Sc. and Ph.D. degrees in electrical engineering from the Technical University of Denmark (DTU) in 1987 and 1992, respectively. He was on the Faculty of DTU's Department of Electrical Engineering as an Assistant Professor from 1991 to 1995, Associate Professor from 1995 to 2005, and Full Professor from 2006 to 2021. From 1997 to 2021 he was also Head of the Electromagnetic Systems Group and the DTU-ESA Spherical Near-Field Antenna Test Facility, and he founded the DTU Electromagnetic Test Centre. He resigned his position at DTU in May 2021 and founded ElMaReCo for independent research consultancy. Olav Breinbjerg was a Visiting Scientist at Rome Laboratory in 1988, a Fulbright Research Scholar at the University of Texas at Austin in 1995, and a Visiting Professor at the University of Sienna in 2011 and 2022. He has been the main supervisor of 17 Ph.D. students. His research is generally in applied electromagnetics - and particularly in antennas, antenna measurements, computational techniques, and scattering - for applications in wireless communication and sensing technologies. He is the author or co-author of more than 75 journal papers, 250 conference papers, and 250 technical reports. Dr. Breinbjerg was a recipient of a U.S. Fulbright Research Award in 1995, the 2001 AEG Elektron Foundation's Award, the 2003 DTU Student Union's Teacher of the Year Award, the 2013 and 2015 European School of Antennas Teacher of the Year Awards, the 2020 Hans Christian Ørsted Award, and the 2023 AMTA Distinguished Achievement Award. Dr. Breinbjerg is the 2024-2025 AMTA Distinguished Speaker. He is Fellow of AMTA and IEEE and Knight of the Order of Dannebrog.

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Patrick Pelland is a Senior Applications Engineer with NSI-MI technologies, based in Atlanta, Georgia. In this role, he works with the engineering, business development, and sales organizations to grow NSI-MI's global footprint, with a focus on near-field technologies. Patrick also manages NSI-MI's online and in-person short course offerings and regularly contributes to the company's research and development activities. Patrick has spent his professional career working in the antenna measurement field with an emphasis on spherical near-field theory and uncertainty analysis. Prior to working at NSI-MI, Patrick worked with the Canadian Space Agency's Radio Frequency Qualification Group as a contract employee during his time as a graduate student at the University of Ottawa.Patrick has been an active member of the Antenna Measurements Techniques Association (AMTA) since he was a graduate student in 2010. Patrick has authored and co-authored a number of papers for a variety of international technical conferences, including AMTA, APS, EuCAP, EuMW, and and ANTEM. Patrick holds a Master of Applied Science in Electrical and Computer Engineering and a Bachelor of Applied Science in Electrical Engineering, both from the University of Ottawa in Ontario, Canada. In conjunction with the Canadian Space Agency, Patrick developed an automated error evaluation procedure for spherical near-field antenna measurements. This research was presented in his master's thesis, titled "Automated Error Assessment in Spherical Near-Field Antenna Measurements". Several technical papers were written as a follow-up to this research in the years since Patrick's graduation.

Key Bibliography:

J. E. Hansen (ed), "Spherical Near-Field Antenna Measurements", Peter Perigrinus Ltd., London, UK, 1988.

O. Breinbjerg, "Spherical Near-Field Antenna Measurements – The Most Accurate Antenna Measurement Technique", Proceedings of IEEE International Symposium on Antennas and Propagation, Fajardo, Puerto Rico, USA, June/Juy 2016.

O. Breinbjerg, "High-Accuracy Spherical Near-Field Measurements for Satellite Antenna Testing", Proceedings of European Conference on Antennas and Propagation 2017, Paris, France, March 2017.

O. Breinbjerg, K. Kaslis, and J.M. Nielsen, "An Experimental and Computational Investigation of High-Accuracy Calibration Techniques for Gain Reference Antennas", Proceedings of the Antenna Measurements Techniques Association Symposium, Atlanta, Georgia, USA, October 2017.

J.M. Nielsen and O. Breinbjerg, "DTU-ESA Spherical Near-Field Antenna Test Facility – 2017/2018 Upgrade and Validation Measurements with the DTU-ESA VAST12 Antenna", Proceedings of the Antenna Measurements Techniques Association Symposium, Williamsburg, Virginia, USA, November 2018.