Graz University of Technology

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Graz, 15. September 2025

Sehr geehrte Damen und Herren,

hiermit ergeht die Einladung des Instituts für Grundlagen und Theorie der Elektrotechnik mit der Bitte um ggf. Weitergabe in Ihrem Bereich:

GASTVORTRAG von Univ. Doz. Dr.-Ing. Stephan Russenschuck

am Montatg**, 29.09.2025** um **16:15 Uhr** im Seminarraum NT04098, Kopernikusgasse 24, 4.Obergeschoß.

Title:

Model-Based Systems Engineering in Magnet Design

Abstract:

We review the challenges of high-field superconducting magnets that require coupled electromagnetic, mechanical, thermal, and electric simulations from the onset of the design process. We go through the different design steps and the required tools for numerical field computation and optimization. Often, we are confronted with the coupling of physical subsystems and extreme nonlinearities and uncertainties in the material parameters.

We, therefore, present Model-Based Systems Engineering (MBSE) as a methodology that enables data-driven modeling and traceable design workflows of magnets and field transducers. The aim is to create models updated by magnetic measurements, which allow the extrapolation of performance parameters

regarding different powering cycles, manufacturing defects, and varying material parameters.

To enable MBSE processes, we must place six “columns” on a common foundation: the physical objects (magnets and field transducers), data layers (numerical models and measured data), and software tools for design and analysis. Data-driven models (hybrid twins) contain the physical description of a nonlinear dynamical system,
the simulated system's response and observation functions, and a disturbance model derived from measurements.

Stephan Russenschuck is a Principal Applied Physicist in the Accelerator Technology Department of the European Organization for Nuclear Research (CERN), Geneva, Switzerland.
He received the Dipl.-Ing. and Dr.-Ing. degrees in electrical engineering from the Technical University of Darmstadt, Germany, in 1986 and 1990, respectively. In 2000, he was recognized as a University Lecturer (Habilitation) for the Theory of Electromagnetic Fields at the Technical University of Vienna, Austria.
During the LHC construction, Stephan was responsible for the electromagnetic design of the LHC main dipole magnets and later for the magnet polarities and the electrical quality assurance of the LHC machine.
For 15 years, Stephan has headed the Test and Magnetic Measurement section, which is responsible for testing and measuring all normal and superconducting magnets for the CERN accelerator complex. This includes operating and maintaining two large laboratories and developing novel data acquisition and processing techniques.
His research interests include mathematical optimization and field simulation for supporting magnet design, magnetic measurements, and accelerator operation.

Stephan has served as chairman of the Technical and Doctoral Student Committee at CERN and for 25 years as a member of the Board of the International COMPUMAG Society. Since 1998, he has been a member of the organizing committees of the ICAP conferences on computational accelerator physics and the NUMELEC conferences on numerical field computation. Since 2013, he has been a member of the machine advisory committee of FAIR at GSI Darmstadt.