



UNIVERSITÀ
DI PAVIA

**Ph.D. Program in Electronics, Computer Science and Electrical Engineering
National PhD in Micro- and Nano-Electronics**

SEMINAR

Model-Based Systems Engineering in Magnet Design

Stephan Russenschuck
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Friday 29th May 2026, 11:00 a.m.
Magenta seminar room

Abstract: We review the challenges of high-field superconducting magnets, which require coupled electromagnetic, mechanical, thermal, and electrical simulations from the outset of the design process. We outline the design steps and the tools required for numerical field computation and optimization. We often encounter coupled physical subsystems, extreme nonlinearities, and uncertainties in material parameters. We present Model-Based Systems Engineering (MBSE) as a methodology that enables data-driven modeling and traceable design workflows for magnets and field transducers. The aim is to create models that are updated by magnetic measurements, enabling the extrapolation of performance parameters across different powering cycles while accounting for 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.

Bio: Until his retirement in 2026, Stephan Russenschuck held the position of Principal Applied Physicist in the Accelerator Technology Department of the European Organization for Nuclear Research (CERN), Geneva, Switzerland. He is currently associated with the GSI Helmholtz Centre for Heavy Ion Research (GSI) in Darmstadt, Germany, as an Honorary Associate with CERN, and as a University Lecturer for the Theory of Electromagnetic Fields with the Technical University of Vienna, Austria.

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Seminar duration: 2x45 minutes, with CFU
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