

# Rational Approximation Algorithms for High-Dimensional Surrogate Modeling



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT

MSc Thesis or Project/HiWi Work

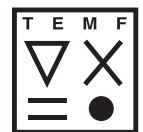
Study field: Computational Engineering / Electrical Engineering / Mathematics

Dr.-Ing. Moritz von Tresckow

February 5, 2026

**The Challenge:** Electromagnetic systems exhibit complex frequency-dependent behavior governed by resonances. Characterizing these systems requires solving parameter-dependent finite element models with millions of degrees of freedom across 10–20 input parameters—a computationally intractable problem for design exploration and optimization.

Modern surrogate modeling techniques (data-driven approximations trained on high-dimensional datasets) offer a solution, but their success depends critically on the quality and structure of training data.



Institute for Accelerator Science  
and Electromagnetic Fields  
Schlossgarten Str. 8  
64289 Darmstadt  
Prof. Dr.-Ing. Herbert De Gersem  
<https://www.temf.tu-darmstadt.de/temf/>

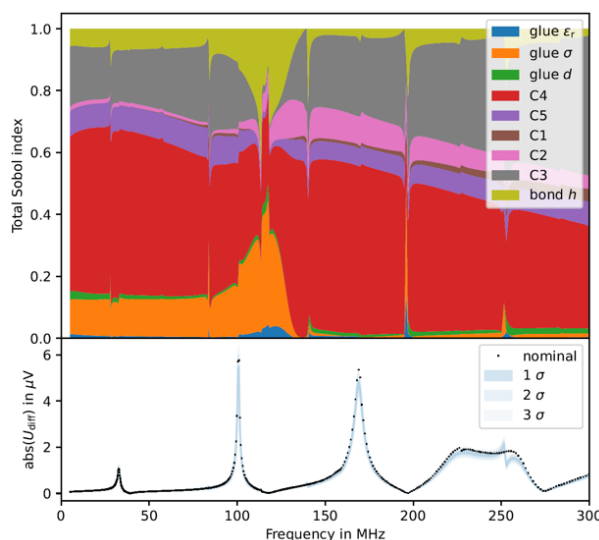
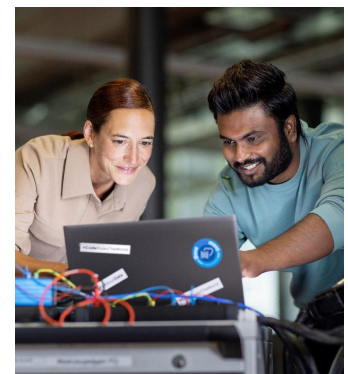


Figure 1: Frequency spectrum and sensitivity distribution of an electric network

**The Approach:** Rather than directly interpolating frequency response functions, we exploit the underlying physics: represent responses via pole/residue expansions and track pole trajectories through parameter space. An example of such a frequency response function and sensitivity distribution is highlighted in Figure 1.

**Your Task:** Systematically evaluate and benchmark rational approximation algorithms for generating training data in high-dimensional surrogate modeling. Assess accuracy, computational efficiency, robustness to noise, and applicability across different problem classes. Develop guidelines for algorithm selection based on problem structure.

**What You'll Gain:** Deep expertise in advanced numerical methods and algorithm development, Hands-on experience with industrial-scale electromagnetic simulation problems (in collaboration with Robert Bosch GmbH). Opportunity to develop novel algorithmic approaches at the intersection of applied mathematics and computational engineering.



## Prerequisites

Solid mathematical foundation, proficiency in Python, interest in numerical methods and optimization