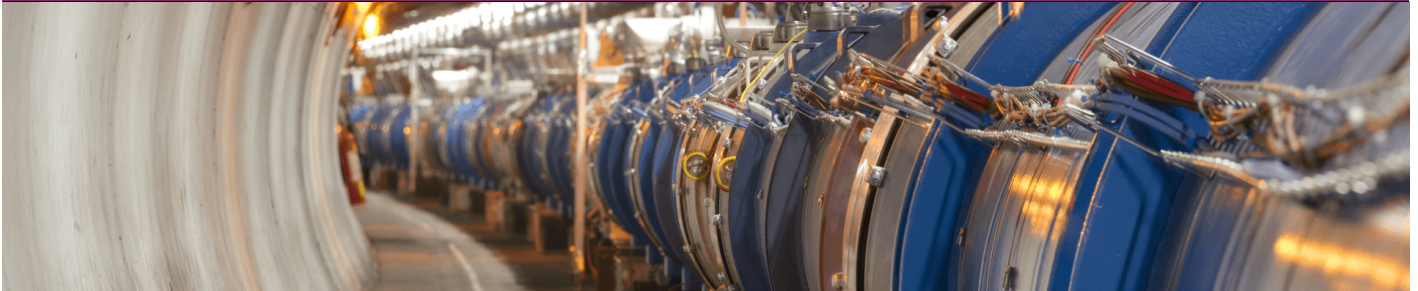


# Finite-Element Electric-Machine Simulations Accelerated by Cheap Surrogates



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT

Proposal for a Bachelor's thesis | Master's thesis | HiWi job  
Study field: Electrical Engineering | Computational Engineering



## Description

The scientific question is whether a surrogate (low-fidelity) machine model (Fig. 1) can be employed to accelerate a computationally expensive (high-fidelity) finite-element machine simulation (Fig. 2). The research hypothesis is that a well-constructed surrogate may perform better than a pure algebraic surrogate for standard machine types. It is expected that an established machine model can be trusted in a region which is substantially larger than a standard quadratic surrogate of the high-fidelity model. In order to preserve accuracy, the surrogate model will be adapted algebraically such that it locally has at least a linear consistency with the finite-element model [1]. This will be achieved by additive or multiplication defect corrections. In particular, an additive correction with quasi-second-order consistency will be set up using Broyden-Fletcher-Goldfarb-Shanno updates for the Hessian of the high- and low-fidelity models.

## Work plan

- Finite-element modelling and simulation of a 3ph induction motor
- Calculating the parameters of the Steinmetz equivalent circuit from the finite-element model
- Implementing a defect correction algorithm for combining both models
- Testing the multi-fidelity model for standard machine simulation runs (steady state, start-up)

## Prerequisites

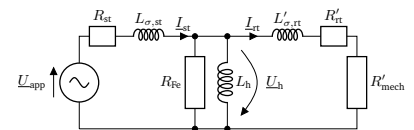
Knowledge in numerical methods, electromagnetic field simulation and electric machines.

[1] M. S. Eldred, A. A. Giunta and S. S. Collis. "Second-order corrections for surrogate-based optimization with model hierarchies". 10th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference. Albany, New York, USA, 2004, AIAA 2004-4457. doi: 10.2514/6.2004-4457.

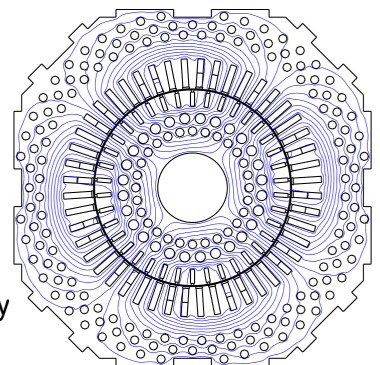
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**Figure 1:** Equivalent circuit of a 3ph induction machine.



**Figure 2:** Magnetic flux lines in the 3ph induction machine.