3D Homogeneous Finite Element Models for High-Temperature Superconducting Coils

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a bachelor's or master's thesis
Study field: Computational Engineering | Electrical Engineering | Mathematics
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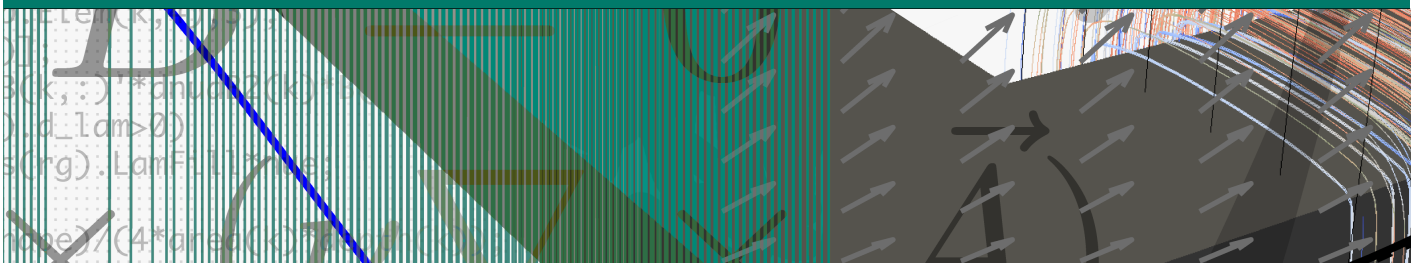

Description

High-temperature superconducting (HTS) materials are expected to enable significant advances in various applications, such as particle accelerator magnets and electrical machines. HTS coils are wound from a flat conductor with a large number of turns. Efficient, application specific, numerical models are needed to accelerate calculations and design processes.

The aim of this project is to develop a homogeneous 3D finite element model for HTS coils. Homogenization aims to simplify the geometry of the coil, while still obtaining results with sufficient accuracy. This in return is expected to reduce the computational cost of the simulations. The models will be implemented using open-source software GetDP [1] and Gmsh [2].

Work plan

- Development of an axisymmetric 2D model for verification purposes
- Development of a homogeneous 3D model for a pancake coil, see Fig. 1.
- Possible further steps include exploring more complicated coil geometries and including the foil conductor homogenization [3] to the models

Prerequisites

Motivation and interest in numerical methods, as well as experience in programming (e.g. Python) are essential. Knowledge of the finite element method is beneficial but not necessary.

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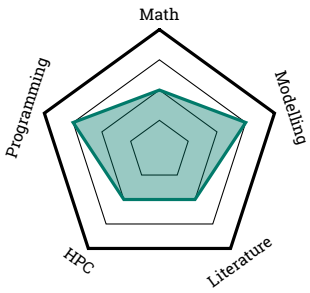

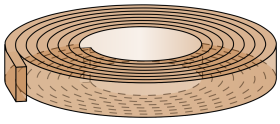

Figure 1: HTS pancake coil geometry.

References

[1] GetDP. https://getdp.info/

[2] Gmsh. https://gmsh.info/

[3] E. Paakkunainen, L. Denis, C. Geuzaine, P. Rasilo and S. Schöps, "Foil Conductor Model for Efficient Simulation of HTS Coils in Large Scale Applications," *arXiv preprint*, 2024.

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