Axisymmetric Finite Element Models of No-Insulation High-Temperature Superconducting Coils

TECHNISCHE UNIVERSITÄT DARMSTADT

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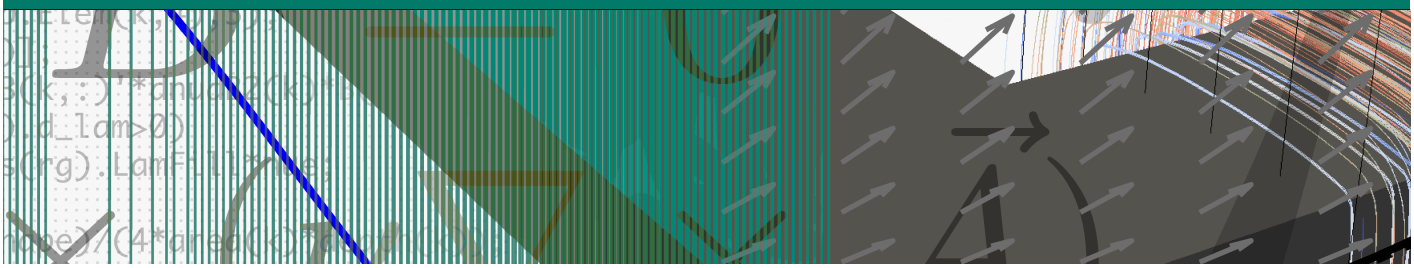

Description

High-temperature superconducting (HTS) materials are a promising technology for high-field magnets in particle accelerators. In particular, no-insulation (NI) coils, i.e., coils wound without turn-to-turn insulation, have gained popularity due to their robustness [1]. Numerical methods such as the finite element (FE) method play a key role in developing HTS-based applications.

The objective of this project is to extend CERN's existing open-source **Fi**nite Element **Qu**ench **S**imulation (FiQuS) framework with 2D axisymmetric FE models of NI coils [2]. Since they are more efficient but less general than existing 3D models, they will complement the latter as an important tool in FiQuS to analyze NI coils. Following FiQuS's ideals, a key aspect will be to hide the complexities of the FE formulation from the users who are typically not FE experts.

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Work plan

- Extension of FiQuS by 2D axisymmetric FE models of NI coils using the FE framework ONELAB including verification against reference solutions
- Development of comprehensive test cases to ensure code quality

Prerequisites

Basic knowledge of programming in Python is desirable

Knowledge of the finite element method is beneficial but not necessary

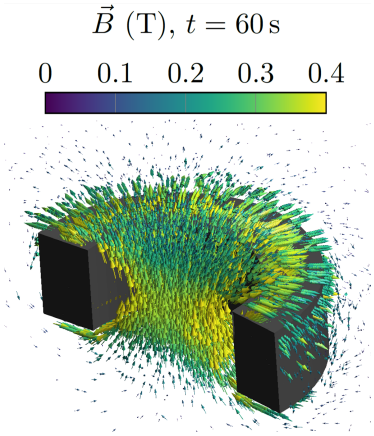

Figure 1: Magnetic field of a NI coil computed with 3D FE.

References

[1] S. Hahn et al. "HTS Pancake Coils Without Turn-to-Turn Insulation". In: *IEEE Transactions on Applied Superconductivity* 21.3 (2011)

[2] R. C. Mataira et al. "Finite-element modelling of no-insulation HTS coils using rotated anisotropic resistivity". In: *Superconductor Science and Technology* 33.8 (2020)

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