Circuit Coupling for CERN's Finite Element Quench Simulation (FiQuS) Framework
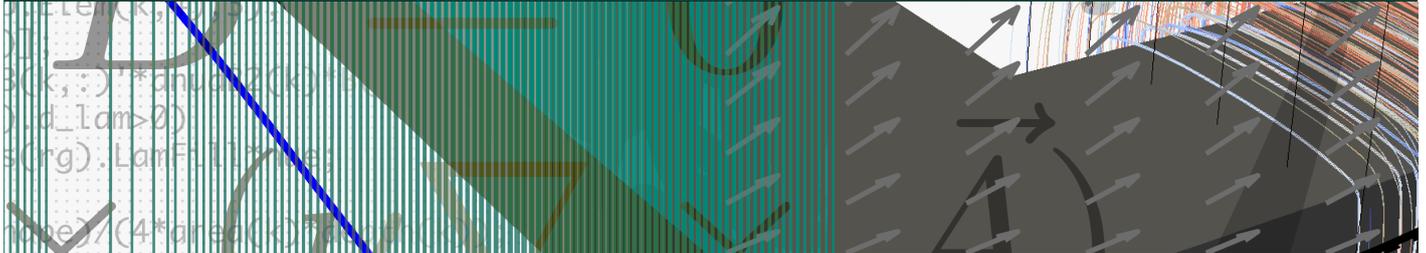
Proposal for a bachelor's or master's thesis
Study field: Computational Engineering | Electrical Engineering | Applied Physics | Mathematics
January 10, 2023

Description

CERN started a project last year to build a comprehensive open-source quench simulation tool called FiQuS (**Fi**nite Element **Qu**ench **S**imulation). It is based on the finite element (FE) framework ONELAB and written mostly in Python. The idea is to build a flexible tool which allows users to build and simulate complex models from human-readable inputs hiding the complexity of the FE kernel.

In order to simulate real-world accelerator magnet circuits, this project aims at coupling FE magnet models from FiQuS with electric circuits [1], which can then be solved by circuit simulators such as Xyce. A key aspect will be to hide the complexities of this coupling from the users who are typically not FE experts.

Work plan

- Extension of FiQuS by FE-circuit coupling based on previous work [2]

- Verification of FiQuS FE-circuit models against reference solutions

- Development of comprehensive test cases to ensure code quality

Prerequisites

Basic knowledge of programming in Python is desirable

Basic knowledge of the finite element method and/or circuit simulation is beneficial but can also be learned in the introductory phase of the project

References

[1] I. C. Garcia et al. "Optimized Field/Circuit Coupling for the Simulation of Quenches in Superconducting Magnets". In: *IEEE Journal on Multiscale and Multiphysics Computational Techniques* 2 (2017), pp. 97–104

[2] A. Krimm. "Coupling of Electromagnetic Fields with Electric Circuits Using Onelab". Bachelor's Thesis. Technische Universität Darmstadt, 2015

Contact:
Erik Schnaubelt, M.Sc.
CERN & TU Darmstadt
`erik.schnaubelt@cern.ch`

Contact:
Prof. Dr. Sebastian Schöps
TU Darmstadt
`sebastian.schoeps@tu-darmstadt.de`
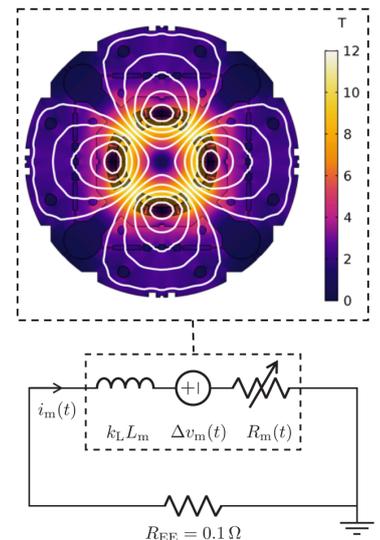
Figure 1: FE-circuit coupling of an accelerator magnet.