Homogenization Technique for the Thermal Simulations of Hollow Conductors

TECHNISCHE UNIVERSITÄT DARMSTADT

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

Hollow conductors have been widely employed in many electrical devices such as electrical machines, transformers, induction heaters and in fast ramping magnets in order to facilitate the flow of electrical current while enabling efficient thermal cooling [Mol+24]. Simulation wise, hollow conductors are very challenging to compute as they impose a multi scale problem, both geometrically and physically. The goal of this work is to develop an efficient homogenization technique for the thermal simulation of a single hollow conductor. The resulting surrogate model shall be embedded in a so-called unit-cell method, where every hollow conductor in a device is modeled as a homogenized cell, leading to an efficient numerical method for the simulation of hollow conductor coils.

Work plan

- Get acquainted to the **in-house code**, the **physical model** and the **unit-cell model** of hollow conductors.
- Construct a **thermal model of 2D** hollow conductor using the finite element method.
- Derive and compute a corresponding **homogenized model**.
- **Conclude** on the **validity** and **reliability** of the homogenization technique.

Prerequisites

Good MATLAB programming skills, interest in numerical methods and field simulation and basic knowledge of the electromagnetic field theory.

References

[Mol+24] D. Moll, J.-M. Christmann, H. De Gersem, F. Boattini, L. D'Angelo, L. Bottura, and M. Breschi. "JACOW: Transient finite-element simulations of fast-ramping muon-collider magnets". In: *JACoW IPAC* 2024 (2024), TUPR54.

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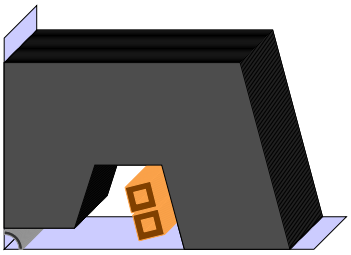

Figure 1: One quarter of an hourglass type dipole magnet