Finite Element Tearing and Interconnect for Maxwell's equations using IGA

BSc-thesis, MSc-thesis or project/internship work
Electrical engineering / Computational engineering /
Accelerator physics / Mathematics

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1. Context

Isogeometric analysis (IGA) is a finite element method (FEM) using splines for geometry description and basis functions such that the geometry can be exactly represented. Recently, an isogeometric mortar coupling [1] for electromagnetic problems was proposed. It is particularly well suited for the eigenfrequency prediction of superconducting accelerator cavities. Each cell, see Fig. 1, can be represented by a different subdomain but may still share the same discretization. The approach leads to a (stable and spectral correct) saddle-point problem. However, its numerical solution is cumbersome and iterative substructuring methods become attractive. The resulting system is available from a Matlab/Octave code. In this project the finite element tearing and interconnect method (FETI) shall be investigated and standard, possibly low-rank, preconditioners implemented and compared.

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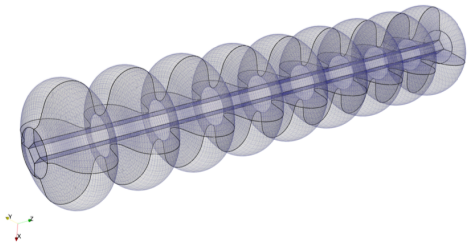

Fig. 1: 9-cell TESLA cavity decomposed into 9 subdomains

2. Task

First, familiarize yourself with Maxwell's eigenvalue problem, the basics of Isogeometric Analysis and the software GeoPDEs [2]. Then understand the ideas behind FETI [3] and implement an iterative solver within the existing software. Finally, experiment with preconditioners to speed up the solution procedure.

3. Prerequisites

Strong background in FEM, basic knowledge of Maxwell's equations, experience with programming in Matlab/Octave, interest in electromagnetic field simulation.

4. References

[1] A. Buffa et al., Isogeometric Mortar Coupling for Electromagnetic Problems, arXiv 1901.00759
[2] R. Vázquez, URL http://rafavzqz.github.io/geopdes/
[3] A. Toselli and O.B. Widlund, Domain Decomposition Methods, DOI 10.1007/b137868