p-Type algebraic multigrid for high order hierarchical FEM for Maxwell's equations

BSc-thesis, MSc-thesis or project/internship work
Electrical engineering / Computational engineering / Accelerator physics / Finite Element Methods

TECHNISCHE UNIVERSITÄT DARMSTADT

1. Context

Classic multigrid methods are not applicable to the curl-curl equations resulting from the discretization of the time harmonic Maxwell equations with conforming finite elements. Algebraic multigrid (AMG) methods are known only for low order approximations. In the high order case, the usual approach is based on a Schur-complement preconditioner (pMUS method). This approach becomes inefficient for very high approximation orders. On the other hand, the hierarchic nature of the curl-conforming basis functions offers a natural way do develop multilevel/multigrid methods based on a proper decomposition of the approximation space. A typical application where very high approximation orders are needed are accelerator cavities that are typically bounded by a few smooth boundaries.

Institut für Teilchenbeschleunigung und Elektromagnetische Felder

http://www.temf.de
PD Dr.rer.nat. habil Erion Gjonaj
gjonaj@temf.tu-darmstadt.de
Raum: S2|17 230
Schlossgartenstraße 8
64289 Darmstadt

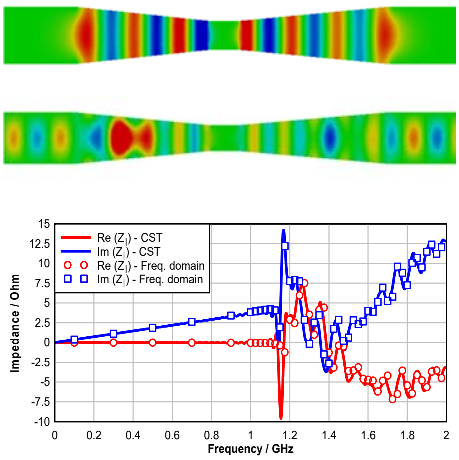

Fig. 1: Electromagnetic field patterns computed at two different frequencies and the resulting broadband impedance for a collimator structure for accelerator applications.

2. Task

In this work, a novel p-type AMG formulation for the solution of Maxwell's equations will be developed. The method will be based on the high order hierarchic approximation space of Zaglmayer in order to derive appropriate smoothing, restriction and interpolation operators. The method is to be implemented in parallel the platform, PETSC. Furthermore, the numerical performance of the method will be analyzed for relevant applications in a HPC environment.

3. Prerequisites

Strong background in Maxwell's equations, basis knowledge of FEM, some experience with programming in C/C++, interest in electromagnetic field simulation.