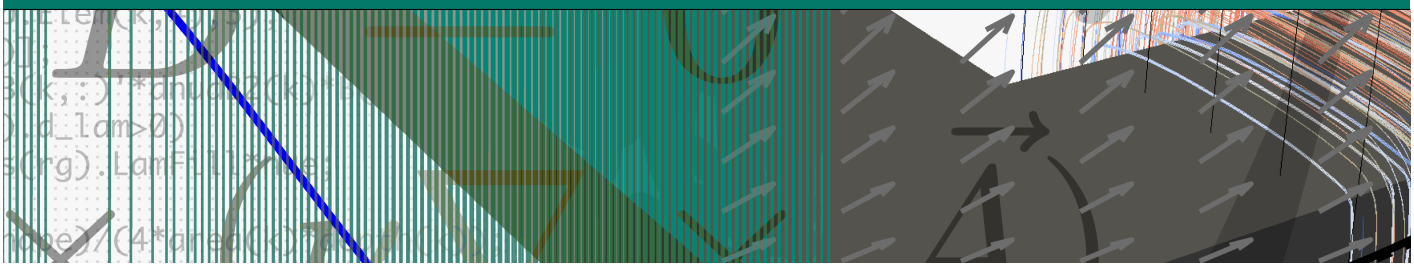
Shape optimization of an electron gun using particle tracking and isogeometric analysis

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a Bachelor's thesis | Master's thesis | Seminar topic
Study field: Computational Engineering | Electrical Engineering | Mathematics



Description

Electron guns represent the first stage of linear accelerators. As such, they have to fulfill a number of criteria: provide a focused beam of high enough energy, abide by space and weight constraints and not interfere with the vacuum conditions of the surrounding chamber. A lot of research has been done to design guns that meet all the above requirements, however these approaches often optimize individual parts separately, unneccesarily constrain the design space or make strong assumptions in order to obtain a more easily solvable problem.

This thesis aims to create a holistic design approach for electron guns that is based on shape optimization using the isogeometric analysis (IGA) package GeoPDEs [1] and the particle tracking code ASTRA [2]. A further point of interest are more advanced optimization techniques (e.g. employing shape derivatives) and increasing the efficiency of the software.

Work plan

- Study literature on IGA and particle tracking, in particular ASTRA.
- Implement the new method and compare it to existing approaches.
- Investigate more advanced techniques and optimize the code.

Prerequisites

Basic knowledge of FEM, particle tracking and MATLAB.

References

[1] Rafael Vázquez. *A new design for the implementation of isogeometric analysis in Octave and Matlab: GeoPDEs 3.0*. 2016.
[2] Klaus Floettmann. *ASTRA: A Space Charge Tracking Algorithm*. 2017.

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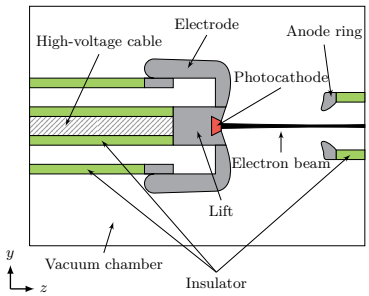

Figure 1: Schematic design of an electron gun.

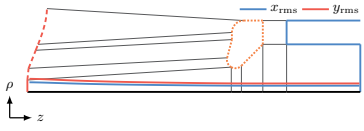

Figure 2: Particle tracking results in relation to gun geometry.

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