Machine Learning for Laser Pulse Shaping

TECHNISCHE UNIVERSITÄT DARMSTADT

Bachelor / Master Thesis
Accelerator Physics / Computational Engineering
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Description

Dielectric laser accelerators (DLAs) are ultra-compact electron accelerators on a microchip with period lengths and apertures in the range of micrometers and maximum acceleration gradients of GV/m.

The dielectric laser accelerators rely on accurately **shaped laser pulses** that drive them. The knowledge on how the laser pulse arrives on each cell of the chip is however limited. In this project, a **virtual diagnostics** approach is to be pursued, running a simplified and fast simulation model in parallel to the continuously running experiment. By matching all inputs and outputs of the **physical and digital twins**, previously hidden parameters can be obtained heuristically, which helps tunning experiments with high dimensions of input parameters.

This thesis would be part of a three-year project with DESY and Universität Hamburg. The simulation tools are developed in close cooperation with the DESY working group conducting DLA experiments at the **Accelerator Research Experiment at SINBAD (ARES)**.

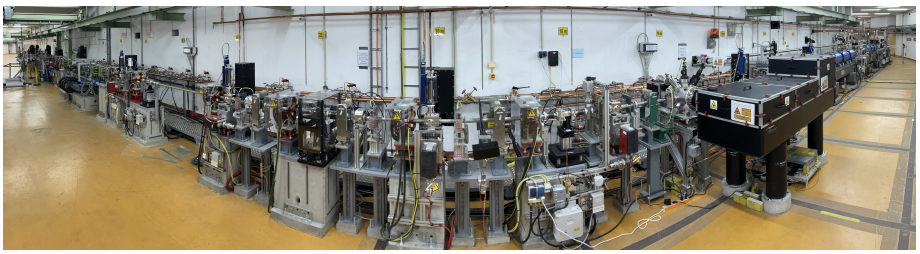

Figure 1: Fisheye-view of the ARES linac[1]

Project milestones

- Modeling and simulating DLAs with the existing code DLAtrack6D[2]
- Upgrade the existing tracking code to faster computing times
- Setup of a machine learning tool for the required input data
- Optimization for maximal charge throughput in the DLA

Prerequisites

Basic knowledge of accelerator physics, numerics and machine learning and basic programming skills (Matlab, Python) are advantageous.

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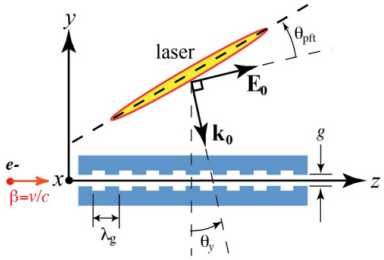

Figure 2: Schematic of DLA structure illuminated by pulse front tilted laser[3]

[1] F. Burkart et al., The ARES Linac at DESY, JACoW LINAC2022 (2022), THPOJO01
[2] U. Niedermayer, T. Egenolf, O. Boine-Frankenheim, Beam dynamics analysis of dielectric laser acceleration using a fast 6D tracking scheme, Phys. Rev. Accel. Beams 20, 111302 (2017)
[3] D. Cesar et al., Enhanced energy gain in a dielectric laser accelerator using a tilted pulse front laser, Opt. Express 26, 29216-29224 (2018)