

Dielectric Gratings for Electron Beam Diagnostics



TECHNISCHE
UNIVERSITÄT
DARMSTADT

Bachelor / Master Thesis
Accelerator Physics
July 22, 2025

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.

Due to the ultra-compact size of the accelerator and very small apertures, the dielectric laser accelerators rely on very high **electron beam quality** and **compact diagnostics** to measure this. In this project, two diagnostics approaches are to be pursued: a **virtual diagnostics** approach by ML based reconstructions and a approach using **radiation generating** dielectric gratings. The phase space properties of the electron beam are then imprinted in the Smith-Purcell radiation spectrum.

This thesis would be part of a three-year project with DESY, FAU Erlangen and TU 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)**.

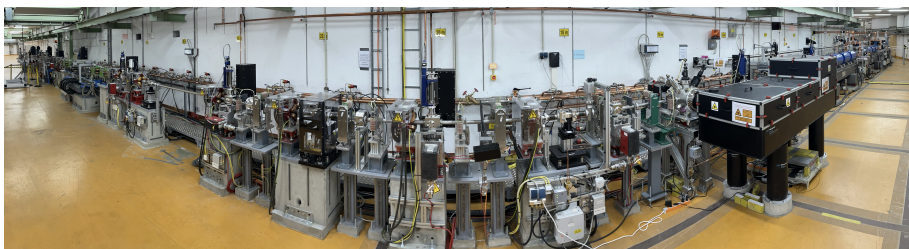


Figure 1: Fisheye-view of the ARES linac¹

Potential research focus

- Modeling and optimizing DLA structures using CST Studio Suite
- Modeling and simulating beam dynamics with the existing code DLATRACK6D²
- Conceptual work on adapting beam diagnostics to the DLA requirements
- Setup of a machine learning tool for the required input data

Prerequisites

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

Institut of Accelerator Science
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Fachgebiet



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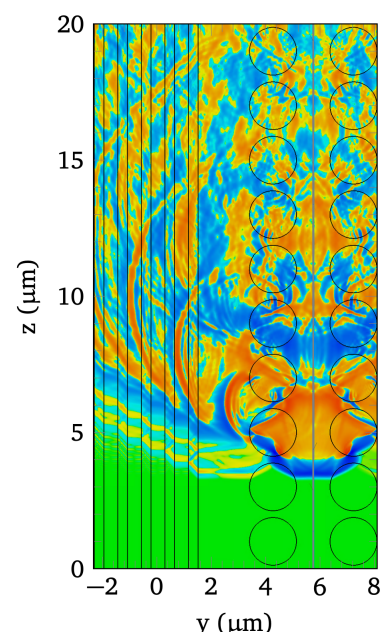


Figure 2: Self-field of an electron bunch in a dual pillar DLA structure³

¹F. Burkart et al., The ARES Linac at DESY, JACoW LINAC2022 (2022), THPOJ001

²U. 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)

³T. Egenolf, Intensity Effects in Dielectric Laser Accelerator Structures, PhD thesis, TU Darmstadt (2020)

