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Topic: Laser Beam Aberrations

Type of work: BSc. Thesis

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Topic description:

Lasers are an indispensable tool for many fields of scientific research. The success of these investigations is often contingent on the quality of the laser beam – spatial quality being one aspect. Optical aberrations are distortions, blurring, or other effects that often have a negative impact on the spatial quality of a laser beam, and understanding their forms, causes, and effects, is crucial to eliminating or controlling their presence in experiments.

This project will be a theoretical, computational, and experimental investigation into laser beam aberrations. The student will first conduct a literature review of optical aberrations and become familiar with the mathematical formalism, including material on Gaussian optics and Zernike polynomials. Secondly, the student will investigate how aberrations appear in laser experiments, their causes and effects, methods of treatment, associated challenges and technological solutions. Lastly, the student will create simple MATLAB scripts to visualize the theoretical descriptions of aberrant laser wavefronts and simulate how these evolve as the laser propagates.

This project will be conducted in collaboration with ELI Beamlines and contribute to the research operations occurring there. In particular, the student will work with the High Harmonic Generation (HHG) team and contribute to the optimization of this beamline. The student will have the opportunity to work with world-class laser systems and cutting-edge technology, especially through the operation of an adaptive optics deformable mirror and wavefront sensor.