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Laser wakefield acceleration studies with experimental laser profiles using particle-in-cell simulations

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The rapid evolution of advanced accelerator technology calls for high-fidelity computational models that can accurately reproduce experimental observations. Laser Wakefield Acceleration (LWFA) has emerged as a promising method for generating high-energy electron beams among the diverse high-gradient acceleration techniques. To accurately capture the complex physical dynamics observed in LWFA experiments, it is essential to incorporate realistic experimental laser profiles into simulations. In this work, we focus on implementing an experimentally realistic laser profile in the particle-in-cell (PIC) simulation framework SMILEI with azimuthal mode decomposition approximation. In this study, we used experimental input data from the PALLAS laser-plasma injector test facility, including intensity spatial and temporal laser profiles. The open-source Python library LASY is used to import the 3D experimental laser profiles and generate an input file for the PIC simulations. By integrating a realistic laser profile from the experiment, our study aims to bridge the gap between simulations and experimental results, providing deeper insights into the underlying physics of LWFA and trying to provide better tolerancing on laser driver pulse quality and control.

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