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Automated emittance and energy gain optimization for plasma wakefield acceleration

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At the Facility for Advanced Accelerator Experimental Tests (FACET-II) accelerator, a pair of 10 GeV high-current electron beams is used to investigate Plasma Wakefield Acceleration (PWFA) in plasmas of different lengths. While PWFA has achieved astonishingly high accelerating gradients of tens of GeV/m, matching the electron beam into the plasma wake is necessary to achieve a beam quality required for precise tuning of future high energy linear accelerators. The purpose of this study was to explore how start-to-end simulations could be used to optimize two important measures of beam quality, namely maximizing energy gain and minimizing transverse emittance growth in a 2 cm long plasma. These two beam parameters were investigated with an in-depth model of the FACET-II accelerator using numerical optimization. The results presented in the paper demonstrate the importance of utilizing beam-transport simulations in tandem with particle-in-cell simulations and provide insight into optimizing these two important beam parameters without the need to devote significant accelerator physics time tuning the FACET-II accelerator.

Footnotes

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North America

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