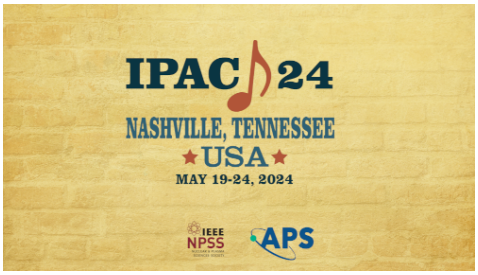

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Optimizing the beam parameters for plasma wakefield acceleration at FACET-II

Sunday, 19 May 2024 16:00 (2 hours)

At the FACET-II accelerator, a pair of 10 GeV high-current electron beams can be used to study a method called Plasma Wakefield Acceleration (PWFA) in a few-cm short laser-ionized gas jet. While PWFAs allow for astonishingly high accelerating gradients of 10s of GeV/m, matching the electron beam into the plasma wake with micrometer precision to maintain beam quality requires precise tuning of linac parameters. 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. These two beam characteristics were investigated with an in-depth model of the FACET-II accelerator using two simulation techniques: i) varying experimental parameters, including plasma density and the strengths of focusing quadrupole magnets, within predefined ranges and examining their impact on beam quality. ii) Numerical optimization of quadrupole magnet strengths to transverse emittance growth. These results demonstrate the importance of simulating beam-transport simulations in tandem with particle-in-cell simulations to get insight into optimizing these two important beam characteristics without the need to devote significant accelerator physics time tuning the FACET-II accelerator.

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