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Injection of collider-quality e-beams in plasma accelerators

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The plasma accelerator community has made significant progress in advancing particle beams, bringing us closer to realizing the dream of replacing the radio frequency (RF) cavities' MV/m fields with the plasma-sustained GV/m fields for collider applications. The beam requirements for realizing this vision emphasize a collider-quality beam featuring hundreds of pC of charge, energy spread less than 1%, and a normalized emittance less than 100 nanometers. Achieving the low-energy-spread of the beam during acceleration involves flattening the accelerating field within the wakefield region occupied by the beam, which can be accomplished if the charge per unit length of the injected electron beam to exhibit a trapezoidal profile. In this study, we demonstrate how novel techniques for controlling the spatiotemporal properties of a focusing laser pulse enable the optical injection of an electron bunch inside a plasma wakefield that meets all the beam requirements for collider applications. 3D particle-in-cell simulations demonstrate the feasibility of this method for producing beams exceeding 200 pC of charge with emittance and energy spread well within collider requirements.

Working group

WG1 : Laser-driven plasma wakefield acceleration

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