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# Injection and single stage acceleraton of 100 GeV positron beam in plasma wake-field

The wakefield acceleration driven by high-energy particle beams has gradually sparked attention due to its extremely high single-stage gain. In particular, the lack of an effective scheme for the injection and acceleration of positrons has been a persistent issue. In this study, we utilized plasma wakefield acceleration for positron beam, delivering successful positron injection and attaining an energy gain exceeding 100 GeV in a uniform plasma. Three-dimensional particle-in-cell (PIC) simulations revealed that the proton beam led to the formation of an electron string along the axis that can simultaneously focus and accelerate positrons. Concurrently, the transverse and longitudinal fields constantly capture positrons into the acceleration region. Our findings reveal that the evolution of the driver is closely related to its energy, and the use of asymmetric hollow proton beam can effectively suppress its evolution. This maintains a stable hollow structure over a very long acceleration distance, thus enabling positron beam energy gains exceeding 100 GeV under an acceleration gradient of about 20 GeV/m, while keeping the emittance and energy spread at low levels. This work resolves significant challenges related to focusing, injection, and stable long-distance acceleration in positron wakefield acceleration, providing an effective scheme for realizing electron-positron collisions through plasma wakefield acceleration.

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