

Experimental parameters for plasma wakefield acceleration in a narrow plasma channel

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Recent theoretical advancements propose multiple positron acceleration schemes in plasma wakefield acceleration (PWFA). One of the most promising ideas involves the creation of an electron-driven blowout wake within a finite-radius pre-ionized plasma column. This leads to the formation of an elongated region of sheath electrons at the closing of the first wake period capable of accelerating positrons while simultaneously providing a transverse focusing force. Additionally, the proposed scheme improves the stability of the drive electron beam, making it interesting as a potential means of suppressing instabilities. We present an experimental opportunity to explore the narrow channel PWFA at the Facility for Advanced Accelerator Experimental Tests II (FACET-II): the E333 experiment. As a pivotal first step towards achieving positron acceleration in PWFA, we have planned a precursor experiment utilizing only electrons to study the physics of the narrow plasma PWFA scheme. The experiment will use a low-charge witness electron beam to study the longitudinal and the transverse wakefields in the sheath closure region, where a positron bunch would ideally be loaded. We outline the feasible experimental parameters, including beam and ionization laser parameters, along with the required optics for the experiment. Comprehensive simulations are used to detail our experimental plan.

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