

Teravolt-per-meter plasma wakefields from low-charge, femtosecond electron beams

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Abstract

Recent initiatives in ultra-short, GeV electron beam generation have focused on achieving sub-fs pulses for driving X-ray free-electron lasers (FELs) in single-spike mode. This scheme employs very low charge beams, which may allow existing FEL injectors to produce few-100 as pulses, with high brightness. Towards this end, recent experiments at SLAC have produced ~ 2 fs rms, low transverse emittance, 20 pC electron pulses. Here we examine use of such pulses to excite plasma wakefields exceeding 1 TV/m. We present a focusing scheme capable of producing < 200 nm beam sizes, where the surface Coulomb fields are also \sim TV/m. These conditions access a new regime for high field atomic physics, allowing frontier experiments, including sub-fs plasma formation for wake excitation.