

Carrier-envelope phase controlled electron dynamics in a laser-wakefield accelerator

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The interaction of an ultra-intense single-cycle laser pulse with an underdense plasma in a laser-wakefield accelerator can lead to an asymmetry in the plasma response that depends on the carrier-envelope phase (CEP) of the laser driver [1]. In our experiment, we use near-single cycle pulses with controlled CEP to accelerate electrons in a laser-wakefield accelerator. We observe that the accelerated electron beam has a beam pointing that oscillates in the laser polarization plane, in phase with the CEP. This effect is very significant, with an oscillation amplitude as high as 15 mrad. Particle-in-Cell simulations explain this observation through highly localized, off-axis injection of sub-fs, ultralow emittance electron bunches triggered by the CEP-dependent asymmetry in the plasma wake [2,3,4]. These observations imply that we achieve sub-cycle control on the injection and subsequent dynamics of the electron beam through the waveform of the laser.

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