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Acceleration of relativistic beams using laser-generated terahertz pulses

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Here we present the first demonstration of THz-driven acceleration of a fully relativistic electron beams. The experiments were carried out with the 35MeV bunches of the CLARA research facility at Daresbury Laboratory. The electrons were injected into a dielectric-lined waveguide simultaneously with a quasi-monochromatic laser-generated THz pulse with a longitudinal electric field containing mode. Interaction with long-duration chirped electron bunches gives rise to an enegy spectrum modulation with 90% visibility, demonstrating potential for THz-driven bunching of relativistic beams. Single-bucket injection and acceleration of short duration bunches is observed. We further demonstrate time-energy phase-space characterization of the electron beam thorough its interaction with the THz pulse. These results pave the way to unprecedented control over relativistic electron beams, providing bunch compression for ultrafast electron diffraction, synchronized and compressed bunches for injection into alternative novel accelerator schemes, energy manipulation for bunch diagnostics, and ultimately delivering high-field gradients for compact THz-driven particle acceleration.

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