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Acceleration beyond 10 GeV of a 340 pC electron bunch in a 10 cm nanoparticle-assisted wakefield accelerator

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We present recent results from a proof-of-principle laser-plasma acceleration experiment that reveal a unique synergy between a laser-driven and particle-driven accelerator: a high-charge laser-wakefield accelerated electron bunch can drive a wakefield while simultaneously drawing energy from the laser pulse via direct laser acceleration. This process continues to accelerate electrons beyond the usual decelerating phase of the wakefield, thus reaching much higher energies. We find that the 10-centimeter-long nanoparticle-assisted wakefield accelerator can generate 340 pC, 10.4±0.6 GeV electron bunches with 3.4 GeV RMS convolved energy spread and 0.9 mrad RMS divergence. The nanoparticles control the amount of charge injected in the wakefield. This synergistic mechanism and the simplicity of the experimental setup represent a step closer to compact tabletop particle accelerators suitable for applications requiring high charge at high energies, such as radiation sources producing muon and positron beams.

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