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Petawatt laser-driven acceleration of electrons to $> 2 \text{ GeV}^1$ NEIL FAZEL, XIAOMING WANG, RAFAL ZGADZAJ, WATSON HENDER-SON, YEN-YU CHANG, RICHARD KORZEKWA, CHI-HAO PAO, HAI-EN TSAI, ZHENGYAN LI, AUSTIN YI, VLADIMIR KHUDIK, HERNAN QUEVEDO, GILLISS DYER, ERHARD GAUL, AARON BERNSTEIN, TED BORGER. MICHAEL SPINKS, MIKAEL MARTINEZ, MICHAEL DONOVAN, GENNADY SHVETS, TODD DITMIRE, MICHAEL DOWNER, University of Texas at Austin, LPA EXPERIMENTAL TEAM, THEORY & SIMULATION TEAM, THE TEXAS PETAWATT TEAM — We report self-injected laser wakefield acceleration of electrons beyond 2 GeV in a uniform, 6 cm long undoped helium plasma of density 3-5E17 cm-3, driven by 150 fs laser pulses of up to 120 J from the Texas Petawatt Laser. The highest energy beams to date contain > 200 pC charge, with dN/dEpeaking at as high as 2 GeV. At somewhat lower central energy (1.2 GeV), higher quality, dark-current-free beams with < 0.25 mrad FWHM divergence, ~ 10 pC charge and $\pm 25\%$ energy spread were obtained. Self-injected acceleration to > 1 GeV was observed at plasma density as low as 1.7E17 cm-3. Electrons were accompanied by X-rays from the betatron motion of the accelerating electrons. Analysis of shadows cast by tungsten wire fiducials positioned precisely in the paths of the magnetically dispersed electrons and of the betatron X-rays enabled electron energy at 2 GeV to be determined with $\pm 10\%$ accuracy, without ambiguity due to electron launch angle variations. Simulations indicate that, with improvements in laser pulse focus quality, acceleration to 7 GeV is possible with the available pulse energy.

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> Neil Fazel University of Texas at Austin

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