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In Situ Measurement of Electron Energy Evolution in a Laser-Plasma Accelerator

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Plasma acceleration enables the acceleration of electrons to high energies over short distances as high electric fields on the order of 100 GV/m can be sustained in plasma. A precise knowledge of these fields is necessary for the stable and reliable operation of plasma accelerators. We report on a noninvasive method applying Thomson scattering to measure the evolution of the electron beam energy inside a laser-plasma accelerator with high spatial resolution. The determination of the local electron energy enabled the in-situ detection of the acting acceleration fields without altering the final beam state. Our experiments show the evolution of the accelerating fields from 265 ± 119 GV/m to 9 ± 4 GV/m in a plasma density ramp. Our data show excellent agreement with particle-in-cell simulations and demonstrates the new possibilities of this method for detecting the dynamics of plasma-based accelerators and their optimization.

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