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Single-Shot Diagnosis of Electron Energy Evolution via Streaked Betatron X Rays in a Curved Laser Wakefield Accelerator

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We report a single-shot diagnosis of electron energy evolution in a curved laser wakefield accelerator by using the streaked betatron x rays. The streaking of the betatron x rays was realized by launching a laser pulse into a plasma with a transverse density gradient. In such a plasma, laser wavefront tilt develops gradually due to phase velocity differences in different plasma densities. The wavefront tilt leads to a parabolic trajectory of the plasma wakefield and hence the accelerated electron beam, which leads to an angular streaking of the emitted betatron radiation. In this way, the temporal evolution of the betatron x-ray spectra will be converted into an angular "streak," i.e., having an energy-angle correlation. By controlling the plasma density and the density gradient, we realized the steering of the laser driver, electron beam and betatron x rays simultaneously. Moreover, we observed an energy-angle correlation of the streaked betatron x rays and utilized it in diagnosing the electron acceleration process in a single-shot mode. Our work could also find applications in advanced control of laser beam and particle propagation. The angular streaked betatron x ray has an intrinsic spatiotemporal correlation, which makes it a promising tool for single-shot pump-probe applications.

Working group

WG1 : Laser-driven plasma wakefield acceleration

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