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High-quality 1 GeV electron beam with a 50 TW laser

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For the last decades, the development of Laser-Plasma Accelerators (LPAs) has attracted tremendous interest thanks to the capacity of plasma to produce and sustain very high electric fields. The accelerating gradients in plasma accelerators can exceed 100 GV/m, which is three orders of magnitude larger than those obtained in metallic-cavity accelerators, thus promising very compact alternatives to conventional linear machines. However, a high field is not the only ingredient required for multi-GeV energy gains, as the accelerated beam has to follow this field over long distances. This point out the need to guide the laser.
Here we will present the first experimental demonstration of the acceleration of quasi-monoenergetic electron beams at the GeV level in a plasma waveguide. The latter is created all-optically by a quasi-Bessel machining beam shaped by an axiparabola mirror. We will also discuss a new acceleration concept that employs an advanced optical shaping of the laser driver that allows a diffraction-free propagation over a long distance while controlling the group velocity of the laser, thus avoiding dephasing, which opens up prospects for producing tens of GeV in single-stage, single-laser beam experiments.

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