Overview of the latest experimental advances in electron and positron beam-driven plasma accelerators

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Plasma accelerators driven by particle beams promise high electric fields and high efficiencies, and are increasingly considered as a mean to make future electron-positron colliders more compact and affordable. Beam-driven plasma acceleration of electrons and positrons has recently seen a rapid experimental progress, in particular with experiments conducted at the FACET facility (Facility for Advanced Accelerator Experimental Tests) at SLAC National Accelerator Laboratory.

I will present an overview of the key results for plasma acceleration of both electrons and positrons, obtained by the E200 collaboration during the 2012-2016 FACET experimental runs. For electrons, the acceleration of a distinct bunch was achieved with high energy efficiency [1], and the field structure of the highly nonlinear plasma wake has been characterized [2]. Very high fields in a beam-ionized high-ionization-potential gas were also generated, unveiling important physical processes such as particle beam self-focusing [3]. The more challenging problematic of positron acceleration will also be reviewed. A new regime where energy is efficiently transferred from the front to the rear within a single positron bunch was discovered. The self-loading of the wake leads to the formation of a narrow energy spread bunch of positrons [4]. The acceleration of a distinct positron bunch in a plasma wake was also demonstrated at the culmination of the five-year campaign, in an experiment spanning nonlinear to quasi-linear regimes and unveiling beam loading effects. Finally, the use of hollow plasma channels for positrons was also investigated [5], and positrons have been successfully accelerated in these tubes of plasma.

References

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