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Plasma Wakefield Acceleration of Positrons

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Recent particle beam and laser-driven plasma wakefield experiments have produced high-quality electron beams accelerated by a GeV or more in less than a meter. Efforts are underway to put these beams to work as sources for free-electron lasers. By contrast, little work has been done to demonstrate the tractability of plasma wakefield acceleration (PWFA) of positron beams. The reasons for this are threefold: 1) positron beams are only useful for high-energy physics experiments, whereas electron beams are also useful as light sources, 2) there is a dearth of positron sources for PWFA experiments, and 3) the dynamics of accelerating positron beams in plasma is fundamentally different than that of electron beams. This talk will focus on the physics of accelerating positrons in plasma and contrast the dynamics of electron and positron beam-driven nonlinear plasma wakes. We describe recent experiments at the FACET test facility at SLAC National Accelerator Laboratory that for the first time demonstrate high-gradient acceleration of a positron beams in plasma. We also discuss an alternative acceleration technique called hollow channel acceleration that aims to symmetrize the dynamics of electron and positron beam-driven wakes.