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Wakeless and PWFA regime experiments at FACET-II

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In plasma wakefield accelerators (PWFA) we usually assume that the plasma is infinitely wide, a property generally desirable for high-quality high-efficiency acceleration of electrons in the blowout regime of PWFA. Finite-width plasmas have gained a particular attention due to their potential applications for light sources and positron acceleration schemes. When the plasma is narrow transversely, blown-out electrons no longer experience a sufficient restoring force from the ions to be pulled back to the axis. Due to this lack of returning plasma electrons, an ion channel is formed behind the beam without an oscillating wakefield, a regime referred to as the wakeless regime particularly interesting for light sources by providing a purely focusing channel. Right at the transition between standard PWFA and wakeless when plasma radius approximately matches blowout radius, plasma electrons return to the axis but their return position is spread longitudinally, a scheme with high potential for positron acceleration.

At SLAC, we showed that beam-ionized helium plasma can sustain standard PWFA or wakeless regime. The plasma is narrow transversely due to the very high ionization potential of He. I will present observations from FACET and FACET-II where the wakeless nature in beam-ionized helium plasma is revealed by the lack of accelerating field and accelerated electrons, as well as how we can transition between standard PWFA and wakeless by controlling the beam compression and peak current. The data is supported by particle-in-cell simulations that confirm that the beam current is a critical parameter to transition between these two regimes.

Working group

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