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Particle-Driven Wakefield Dynamics in a Confined Plasma Channel

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Plasma wakefield accelerators driven by a beam of charged particles usually rely on a pre-formed plasma, such as a narrow channel of optically pre-ionized ambient gas utilizing a powerful laser system. While this method enables to provide plasma lengths and thus accelerating distances on the meter-scale, the width of the channel potentially, deliberately or inadvertently, varies significantly. When the channel's transverse extent is on the same order as the blowout radius, small variations in the plasma channel width strongly affect the blowout dynamics, particularly its size and strength. Investigating the influence of the channel dimensions on the wakefield provides important key insights for designing and realizing a particle driven plasma wakefield accelerator with stable acceleration conditions on meter scales. Furthermore, sophisticated optical plasma generation offers precise control over the plasma channel shape and thus enabling to deliberately tune the electromagnetic field configuration along the acceleration. We report on our insights gained during the E210 experimental campaign at FACET/SLAC accompanied by particle-in-cell simulations.

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