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Hydrodynamic channel guiding of Helium laser driven wake with downramp injection

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Plasma waveguides improve shot-to-shot consistency of laser wakefield accelerators (LWFAs) and extend acceleration length to multiple Rayleigh ranges. Recent work [1] has explored the use of waveguides down to low $1e17\text{cm}^{-3}$ densities and accelerated electron energies up to 5 GeV. Both experimentally and through simulations we will combine waveguide generation techniques with a separate technique from Ref. [2] that utilizes strong shockwaves to facilitate sharp downramp injection in a plasma inside a guided channel at any arbitrary position inside the waveguide. This technique is achieved by aiming a longer duration (100+ fs), small gaussian focus at the downramp injection location timed before the shorter (40fs) axicon beam. The colder optical field ionized (OFI) plasma from the gaussian focus and the hotter axicon OFI-heated plasma collide to create a sharp shock 10's of um wide to facilitate downramp injection as the 800 nm, 700 mJ, 40fs drive beam propagates through the 3mm long Helium-plasma waveguide.

[1] B. Miao et. al. Phys. Rev. X 12, 031038 (2022)

[2] J. Faure et. al. Phys. Plasmas 17, 083107 (2010)

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