Role of positron beam emittance for self-driven plasma wakefield hollow channel acceleration

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Particle accelerators and linear colliders are key to unveil mysteries of physics beyond the high energy-density frontier. In particular, plasma based electron [2] and positron [3] wakefield accelerators are promising candidates to explore such extreme regimes because they support high accelerating gradients beyond the material breakdown threshold [1].

We propose a scheme in which a tightly focused relativistic positron drive bunch is sent into a homogenous electron and ion plasma. In it, as the ions are repelled by the drive bunch a plasma hollow channel, where the emittance growth of trailing particle bunches is mitigated, is formed. Moreover, as plasma electrons are first attracted by the drive bunch and then repelled by their own space charge structure they generate and sustain accelerating and focusing wakefields that are ideal for positron acceleration [6]. In the present numerical work, we analyze the influence of the positron drive bunch configuration, mainly its emittance and longitudinal profile, on the excited plasma hollow channel and wakefields and on a trailing test particle positron bunch final properties. The numerical simulations are done using fully relativistic particle in cell code OSIRIS [8].

References