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Beam head erosion in self-ionized plasma wakefield accelerators
MIAOMIAO ZHOU, CHRIS CLAYTON, CHENGKUN HUANG, CHAN JOSHI, WEI LU, KEN MARSH, WARREN MORI, UCLA, TOM KATSOULEAS, PATRIC MUGGLI, ERDEM OZ, USC, MELISSA BERRY, IAN BLUMENFELD, FRANZ-JOSEF DECKER, MARK HOGAN, RASMUS ISCHEBECK, RICHARD IVERSON, NEIL KIRBY, ROBERT SIEMMAN, DIETER WALZ, SLAC — In the recent plasma wakefield accelerator experiments at SLAC, the energy of the particles in the tail of the 42 GeV electron beam were doubled in less than one meter [1]. Simulations suggest that the acceleration length was limited by a new phenomenon – beam head erosion in self-ionized plasmas. In vacuum, a particle beam expands transversely in a distance given by beta*. In the blowout regime of a plasma wakefield [2], the majority of the beam is focused by the ion channel, while the beam head slowly spreads since it takes a finite time for the ion channel to form. Beam/plasma parameter scan in a large range using simulations shows that in self-ionized plasmas, the head spreading is exacerbated compared to that in pre-ionized plasmas, causing the ionization front to move backward (erode). A theoretical analysis on the erosion rate dependence on beam/plasma parameters and its implications on future afterburner relevant experiments will be provided. [1] I. Blumenfeld et al., Nature 445, 741(2007) [2] J. B. Rosenzweig et al., Phys. Rev. A 44, R6189 (1991)

Miaomiao Zhou
UCLA

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