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Electron self-injection in a plasma wakefield accelerator in the strongly nonlinear regime due to inhomogeneous plasma density S.A. YI, V. KHUDIK, T.H. RATLIFF, G. SHVETS, The University of Texas at Austin — We study self-injection into a plasma wakefield accelerator (PWFA) in the blowout (or bubble) regime with an inhomogeneous background plasma density. Using an analytic model and particle-in-cell simulations, we explore an injection mechanism into a PWFA, where a growing bubble causes reduction of the electron Hamiltonian in the co-moving frame, which leads to electron trapping [1]. In contrast to earlier work with steep density gradients, growth of the blowout region is caused by a slow decrease in plasma density along the propagation direction. To demonstrate this trapping mechanism, we generalize an analytic model for the wakefields inside the bubble [2], to derive expressions for the fields outside. With this extended model, we study the trapping of initially quiescent plasma electrons into the growing ultra-relativistic bubble, and show that a return current in the bubble sheath layer plays an important role in determining the trapped electron trajectories. We estimate the plasma density gradients and driver beam parameters required for self-injection, and compare our results with particle-in-cell simulations. This work is supported by the US DOE grants DE-FG02-04ER41321 and DE-FG02-07ER54945.
[1] S. Kalmykov *et al*, *Phys. Rev. Lett.* **103**, 135004 (2009).
[2] W. Lu *et al*, *Phys. Plasmas* **13**, 056709 (2006).

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