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Analytic model of electron self-injection in a plasma wakefield accelerator in the strongly nonlinear bubble regime[1] SUNGHWAN YI, VLADIMIR KHUDIK, GENNADY SHVETS, The University of Texas at Austin — We study self-injection into a plasma wakefield accelerator in the blowout (or bubble) regime, where the bubble evolves due to background density inhomogeneities. To explore trapping, we generalize an analytic model for the wakefields inside the bubble [1] to derive expressions for the fields outside. With this extended model, we show that a return current in the bubble sheath layer plays an important role in determining the trapped electron trajectories. We explore an injection mechanism where bubble growth due to a background density downramp causes reduction of the electron Hamiltonian in the co-moving frame, trapping the particle in the dynamically deepening potential well [2]. Model calculations agree quantitatively with PIC simulations on the bubble expansion rate required for trapping, as well as the range of impact parameters for which electrons are trapped. This is an improvement over our previous work [3] using a simplified spherical bubble model, which ignored the fields outside of the bubble and hence overestimated the expansion rate required for trapping.

[1] W. Lu et al., *Phys. Plasmas* **13**, 056709 (2006).
[2] S. Kalmykov et al., *Phys. Rev. Lett* **103**, 135004 (2009).
[3] S.A. Yi et al., *Plasma Phys. Contr. Fus.* **53**, 014012 (2011).

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Sunghwan Yi
The University of Texas at Austin

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