Abstract Submitted
for the DPP09 Meeting of
The American Physical Society

Electron self-injection and trapping into an evolving plasma bubble[1] S. KALMYKOV, S.A. YI, V.N. KHUDIK, G. SHVETS, Institute for Fusion Studies, The University of Texas at Austin — In the blowout regime of laser wakefield acceleration (LWFA), radiation pressure creates a co-moving bubble of electron density behind the driving laser pulse. Self-injection of initially quiescent electrons into the bubble and their subsequent acceleration are studied both analytically and by particle-in-cell (PIC) simulations. Semi-analytic model treats the bubble as a spherical cavity of electron density moving with a relativistic velocity over an immobile ion background. The non-evolving bubble must be unrealistically large to self- inject quiescent electrons, whereas its slow expansion significantly relaxes this requirement. PIC modeling shows that a defocusing laser may cause self-injection into the expanding bubble, even when a non-evolving pulse would not. This effect is explained in terms of non-stationary Hamiltonian theory. Temporal expansion of the bubble appears to be the dominant mechanism of electron self-injection in rarefied plasmas ($n_0 \sim 10^{17}$ cm^{-3}) relevant to the LWFA with petawatt-class lasers. Combination of bubble expansion and contraction results in monoenergetic electron beams due to the termination of self-injection process and phase space rotation.

[1]Supported by the U.S. Department of Energy under Contracts No. DE-FG02-04ER41321 and DE-FG02-07ER54945.

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Date submitted: 20 Jul 2009 Electronic form version 1.4