Abstract Submitted
for the DPP14 Meeting of
The American Physical Society

Single-shot visualization of evolving laser wakefields using an all-optical streak camera[1] ZHENGYAN LI, HAI-EN TSAI, XI ZHANG, CHIH-HAO PAI, YEN-YU CHANG, RAFAL ZGADZAJ, XIAOMING WANG, VLADIMIR KHUDIK, GENNADY SHVETS, MICHAEL DOWNER, University of Texas at Austin — We visualize ps-time-scale evolution of an electron density bubble, a wake structure created in atmospheric density plasma by an intense ultrashort laser pulse, from the phase "streak" that the bubble imprints onto a probe pulse that crosses its path obliquely. Phase streaks, recovered in one shot using frequency-domain interferometry, reveal formation, propagation and coalescence of the bubble within a 3 mm long ionized helium gas target. 3D particle-in-cell (PIC) simulations validate the observed density-dependent bubble evolution, and correlate it with generation of a quasi-monoenergetic $\sim$ 100 MeV electron beam. The results provide a basis for understanding optimized electron acceleration at plasma density ne $\sim$ 2e19 cm^{-3}, at which the bubble formed and persisted until the jet exit, enabling acceleration over a distance slightly exceeding the dephasing length. In contrast, at lower density, electrons accelerated inefficiently due to weak laser self-focusing and late bubble formation. At higher density, overly strong self-focusing also led to low quality electrons due to early bubble formation and strong dephasing. Bubble coalescence due to beam loading further degraded electron acceleration.

[1]This work was supported by DOE grants DESC0011617 and DE-SC0007889 and by the NSF-DOE Partnership in Plasma Science program.

Zhengyan Li
University of Texas at Austin

Date submitted: 11 Jul 2014 Electronic form version 1.4