Abstract Submitted
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Modeling of electron self-injection and acceleration in the Texas Petawatt laser wakefield accelerator experiment[1] XI ZHANG, SUNGHWAN YI, VLADIMIR KHUDIK, NEIL FAZEL, XIAOMING WANG, MIKE DOWNER, GENNADY SHVETS, The University of Texas at Austin — We present a numerical study of the electron self-injection and acceleration process for the parameters of the Texas Petawatt laser wakefield accelerator experiment, using the quasistatic particle-in-cell (PIC) code WAKE [1]. The laser parameters and plasma density are held fixed, while we vary the longitudinal location of the focal spot with respect to the plasma entrance. We also study the effect of varying the density upramp which extends a few millimeters outside of the main plasma body. These simulations are made possible even within a quasistatic PIC framework through the use of non-quasistatic test particles which can become self-injected, in contrast to macroparticles. We find that self-injection and multi-GeV acceleration occurs only when the laser focal point is located a few Rayleigh lengths outside of the plasma entrance, in agreement with experimental observations. The relationship between the location of the laser focal point and the bubble evolution which leads to electron self-injection [2] is presented. Quantitative agreement between simulated electron spectra and experimental results are achieved.

[1] P. Mora and T.M. Antonsen, Jr., Phys. Plasmas 4, 217 (1997).
[2] S. Kalmykov et al., Phys. Rev. Lett. 103, 135004 (2009).

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