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Modeling GeV-class single-stage laser-plasma electron acceleration in the blowout regime K. BUNKERS, S.Y. KALMYKOV, B.A. SHADWICK, D.P. UMSTADTER, University of Nebraska - Lincoln, A. BECK, E. LEFEBVRE, CEA, DAM, DIF, Arpajon, France, B.M. COWAN, D.L. BRUHWILER, Tech-X Corp., Boulder, CO — Electron density bubble maintained by radiation pressure guides the laser pulse in a rarefied plasma and accelerates (self-)injected electrons to GeV-scale energy. The quasistatic nature of the bubble and quasi-paraxial behavior of the pulse allow us to identify the optimal regime, ruling out continuous self-injection, at minimal computational cost using the quasi-static code WAKE with test particles. The most promising regimes are modeled directly, using fully explicit, 3D PIC codes such as VORPAL (with a perfect-dispersion algorithm) or the quasi-cylindrical code CALDER-Circ with a poloidal-mode decomposition of EM fields [1]. Using this computationally effective strategy, we elucidate the physics of electron self-injection and assess the risk factors associated with the nonlinear evolution of the self-guided driver. It is shown that phase self-modulation and self-steepening transform an initially smooth driver into a relativistic piston, which causes rapid expansion of the bubble followed by continuous injection and generation of polychromatic tails in electron spectra [2]. The work is partly supported by the U.S. DoE.

[1] S. Y. Kalmykov et al., NJP 12, 045019 (2010).
[2] S. Y. Kalmykov et al., Phys. Plasmas 18, 056704 (2011).

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