Numerical Studies of Laser-Plasma Produced Electron Beam Transport in Vacuum*

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Plasma-based accelerators operating in the self-modulated regime have demonstrated gradients in excess of 100 GV/m and the production of multi-nC bunches with a large energy spread. Typical codes for beam propagation in accelerators assume that the electron bunch has a small energy spread. In this case there is a single frame in which all beam particles are non-relativistic, which simplifies the calculation of the electromagnetic self field. Alternative, particle-in-cell codes can handle beams with large energy spreads, but are computationally very demanding. Here, we describe a rapid and innovative method for the calculation of space charge effects, which is capable of handling beams with an arbitrary energy distribution. This method divides the longitudinal momentum distribution into narrow bins, and assumes that the spatial distribution in each bin is ellipsoidal. We have used this code to study the beams emerging from the laser-plasma accelerators in two regimes: (i) the self-modulated regime, in which the electron bunch has a large energy spread, and (ii) the colliding pulse injector, which produces bunches will small energy spread. Comparison with an electrostatic PIC code will be presented.

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