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Effect of Pre-Plasma on Intense Electron Beam Generation by Relativistic Laser Radiation

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Recent experiments [1,2] and modeling [3,4] have shown that the large-scale preplasma significantly affects the laser-plasma interaction (LPI) dynamics and the resultant fast electron energy distribution, where the fast electron energies are much higher than the ones predicted by ponderomotive scaling due to additional stochastic acceleration in the low density region. We have carried out comprehensive numerical simulations using the Large Scale Plasma (LSP) code to investigate the dynamics of LPI and fast electron source generation as a function of laser pulse length, and preplasma density scale length. We confirmed that the most energetic electrons are generated through the synergistic effects of the interaction of electrons with both electrostatic potential well in preplasma and laser radiation. We have performed 2D simulations showing both formation of deep electrostatic well and very energetic electrons with spectra similar to we obtained in 1D simulations. These effects were more prevalent for pulse durations longer than1 ps. We also found filamentation of the laser field causing an increase of the radiation field intensity. However, this increase was insufficient to significantly alter the high-energy part of electron distribution. We have carried out experiments using the Texas Petawatt Laser to validate modeling predictions. In these experiments we used an artificial laser prepulse to create well-defined prepalsma. We used a proton beam produced from a second short-pulse laser to probe the electric field in the extended plasma and its correlation with fast electron energies. Both experimental results and comparison with numerical simulations will be presented at the meeting and its relevance to fast ignition inertial confinement fusion will be discussed.

[1] S. D. Baton et al., Phys. Plasmas 15, 042706 (2008).
[2] T. Yabbuchi et al., Phys. Plasmas, 17, 060704 (2010)
[3] B. S. Paradkar et al., Phys. Rev. E 83, 046401 (2011).
[4] B. S. Paradkar et al., Phys. Plasma 19, 060703 (2012).

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