PRE-PLASMA IMPACT STUDIES ON FAST ELECTRON GENERATION WITH THE HIGH-INTENSITY TITAN LASER*

J.L. Peebles[1], C.M. Krauland[1], C. McGuffey[1], A. Sorokovikova[1], R. Hua[1], M.S. Wei[2], S. Kerr[3], C. Curry[3,4], R. Fedosejevs[3], P. Forestier-Colleoni[5], J.J. Santos[5], H. Sio[6], H. Chen[6], H.S. McLean[6], S.I. Krasheninnikov[1], F.N. Beg[1]
[1]University of California – San Diego, San Diego, California, USA
[2]General Atomics, San Diego, California, USA
[3]University of Alberta, Edmonton, Alberta, Canada
[4]SLAC National Accelerator Laboratory, Palo Alto, California, USA
[5]Université de Bordeaux, Bordeaux, France
[6]Lawrence Livermore National Laboratory, Livermore, California, USA
jpeebles@ucsd.edu, ckrauland@ucsd.edu

The interaction of high-intensity (>10^{18} W/cm^2) laser pulses with solid targets is a topic of great interest as an enabling technology for compact particle and radiation sources. The details of laser-electron coupling and electron acceleration are particularly important to fully understand subsequent energy partition into various channels. While the laser intensity and pulse length play important roles in defining the fast electron spectra, recent experiments [1] show that the presence of an underdense, pre-formed plasma at the target surface also has a significant effect. PIC simulations [2] suggest that the electrostatic potential well formed in this pre-plasma during the laser interaction can trap electrons and allow them to be accelerated to very high energy (100s of MeV).

We present new results from an experiment at the Jupiter Laser Facility using the Titan laser system. An early, 3 ns long pulse laser first irradiates a planar Al target with varying energy to create pre-formed plasma of various scale lengths. A following 0.7-3 ps main pulse beam ($I_L \sim 1.7 \times 10^{19}$ W/cm^2) was then injected to generate high energy electrons. The pre-plasma was characterized with interferometry and proton radiography prior to the short pulse interaction. Calibrated magnetic electron spectrometers were used to measure the vacuum electron spectra at various angles, while multiple bremsstrahlung spectrometers were used to record the energy and angular distributions of x-rays. These diagnostics together provide a better picture of the generated electron beam temperatures, coupling and divergence. We present available data and results from these measurements. We saw the addition of a much hotter secondary population of electrons in the presence of pre-plasma. The source of this population is investigated via supporting PIC simulations.

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