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Dynamics of the Electromagnetic Fields induced by Fast Electron Propagation in Near Solid-Density Media

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The propagation of fast electron currents in dense ionized media is a fundamental topic in laser-plasma physics and is of crucial interest for a number of application, among which the Fast Ignitor approach to Inertial Confinement Fusion [1] and the development of compact radiation (e.g. X- and gamma- radiation [2]) and particle (e.g. positron or ion beam [3, 4]) sources. The extreme current densities involved in ultra-intense laser-plasma interactions mean that self-consistently generated electric and magnetic fields play a critical role in the current propagation, possibly leading to electric inhibition [5, 6] and magnetic pinching and filamentation [7, 8], amongst other effects. We present the results of experimental investigations of the propagation of laser-induced fast electron currents in near solid-density media. In the experiment the electromagnetic fields accompanying electron propagation were characterized via proton probing *directly inside* the target. Notably the growth of filamentation instabilities was temporally resolved and the net currents could be reconstructed from the experimental data. Comparison with hybrid simulations (carried out over spatial and temporal scales comparable with the experimental ones) and analytical models shows that resistive field generation and resistive instabilities well explain the magnitude, topology and growth rates of the observed field distributions.

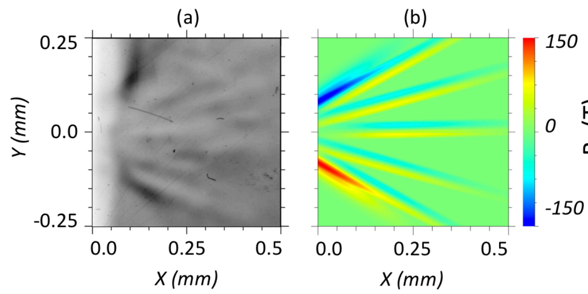

Figure 1. (a) Proton image of a laser-irradiated foam target, showing the development of e.m. fields and filamentation inside the target. (b) Magnetic field distribution reconstructed via comparison with particle tracing simulations.

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