Investigation of dependence of laser energy coupling on target material and preplasma scalelength for reentrant cone guided fast ignition laser fusion

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In the reentrant cone guided fast ignition (FI) laser fusion scheme [1], high intensity short pulse laser interacts with the cone tip to generate relativistic electrons that travel through the cone into the high density fuel region and deposit their energy there to trigger the fusion spark. Laser to electron energy coupling at the cone tip is controlled by the nature of the interfacial plasma (e.g., atomic number Z and ionization state, density scale-length, etc.). These quantities evolve with time and can have a significant effect on both electron source and transport. Simulations [2,3] with Particle-in-cell (PIC) and Fokker Planck codes have suggested strong sensitivities of generation to plasma density steepening at the interface, and of transport to collision and scattering. We have performed a systematic study of dependence of laser energy coupling on the solid target interface material (Au, Mo, Al) and the preplasma scalelength produced by varying prepulse laser energies (10 – 500 mJ) with both multilayer planar targets and buried cones using the Titan laser (150 J, 0.7 ps, peak intensity of $10^{20}$ W/cm$^2$) at the Lawrence Livermore National Laboratory. High intensity laser produced fast electrons and energy coupling through the cone tip are characterized by measuring fast electron induced K-shell x-ray radiation (spatial distribution and total yield) from the buried Cu fluorescent layer and the bremsstrahlung x-rays from the target as well as the escaped electron spectrum. This study is also extended to higher energy (>kJ) and longer pulses (10 ps) using the OMEGA EP laser to study such material dependence at FI relevant condition. The experiments are modeled using both collisional PIC and hybrid PIC codes. Detailed experimental and simulations results will be presented.

References