EXPERIMENTAL AND SIMULATED COUPLING AND SPECTRA OF HOT ELECTRONS INTO CONE-WIRE TARGETS*


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Characterizing and optimizing hot electrons accelerated by short pulse lasers is of great interest, especially for Fast Ignition (FI) research. To date, most research on electron source and transport has been done using lasers with intrinsic prepulses. However, even a relatively low amount of prepulse (1-10 mJ in 3 ns) creates an underdense plasma that causes instabilities such as filamentation and relativistic self focusing of the laser before reaching critical density. This will give rise to higher hot electron temperatures and a more divergent beam than is desireable for FI. In this work, we study hot electron acceleration at extremely high-contrast (i.e. no prepulse) so the laser interacts directly with solid density.

We have studied a range of $I\lambda^2$ (where $I$ is the laser intensity and $\lambda$ is the wavelength) by varying both the laser power and wavelength, as well as comparing against lower contrast. The targets consisted of a Au cone attached to a Cu wire. Ka emission from the Cu wire was imaged and total yields were measured. The falloff length of Ka in the wire is primarily determined by 0.2 to 1 MeV electrons, which allows a slope temperature to be inferred in this range. As expected, this temperature is shown to increase as a function of $I\lambda^2$. From the absolute Ka measurements, we determine the electron energy coupled into the wire and infer the laser-to-electron conversion efficiency. The hybrid-PIC code LSP was used to model the transport dynamics that include electrostatic charging, proton acceleration and strong B-field generation. This modeling allows for quantitative characterization of the electron source, which due to the lack of preplasma, can be compared directly with measured on-target laser intensities.

In this study, we show the use of extremely high contrast to enhance the electron energy coupling into the wire by a factor of 3x. We also quantify the relationship between $I\lambda^2$ and electron temperature, which can be used to determine the optimal intensity for Fast Ignition.

* This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory DE-AC52-07NA27344.