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Fast electron transport and spatial energy deposition in imploded fast ignition cone-in-shell targets[1]

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We report on the first experimental observation and model validation of the spatial energy deposition of fast electrons into the imploded, high-density core of integrated cone-in-shell fast ignition experiments on OMEGA. Spatial energy deposition was characterized via fast electron produced Kα fluorescence from a Cu tracer added to the CD shell. 2-D images of the Cu Kα fluorescence were obtained using a spherically bent Bragg crystal imager. 54 of the 60 OMEGA beams (18 kJ) were used for fuel assembly, and the high intensity EP beam (10 ps, 0.5 - 1.5 kJ, $I_p > 10^{19}$ W/cm^2), was focused onto the inner cone tip to produce fast electrons. Cu Kα emission from a 300 μm region surrounding the cone tip correlated well with the predicted core size from radiation-hydrodynamic simulations of the shell implosion. The emission also emanated from as far back as 100 μm from the cone tip, indicative of an electron source position with a large standoff distance from the cone tip, consistent with the presence of an extended pre-plasma from the EP pre-pulse. We observed a simultaneous increase in both Kα yield (up to 70%) and thermal neutron number (up to 2x) with increasing EP beam energy. Kα yield data also show an improved energy coupling using the high contrast EP pulse. Comprehensive simulations of the electron production within the cone and subsequent transport into the imploded core have been performed using the implicit PIC code LSP and the hybrid-PIC code ZUMA. These simulations explain the observed Kα shape and yield trends and identify parameters that constrain energy coupling into the compressed core.

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