IMPROVING ENERGY COUPLING IN INTEGRATED FAST IGNITION EXPERIMENTS ON OMEGA VIA IMAGING FAST ELECTRON TRANSPORT*

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Fast ignition (FI), a potential path to achieve high gain inertial confinement fusion, requires efficient energy coupling of a high intensity laser to a preassembled high-density core transferred by laser-produced MeV electrons. Understanding fast electron spatial energy deposition is critical to assessing FI design and forming credible predictions of performance.

In this presentation, we report results from a series of integrated FI experiments conducted on OMEGA visualizing fast electron transport and spatial energy deposition in laser-compressed cone-in-shell targets. We used a new platform combining narrow bandwidth 2D x-ray imaging and spectroscopy measurements with a novel copper-doped shell target[1]. The cone-in-shell target was driven using up to 18 kJ from the OMEGA UV driver with a low-adiabat pulse shape resulting in a compressed core that has been well characterized[2]. The core was then heated by injecting up to 1.5 kJ of short-pulse laser energy from the 10 ps OMEGA EP beam into the gold cone with varied timing delay, laser contrast, and cone-tip diameter. Spatial energy deposition of fast electrons in the compressed target was visualized by imaging copper K-shell fluorescence, from which key information of fast electron beam divergence, source location and temperature can be inferred by directly comparing the experimental results with the simulated fluorescence yield and spatial distribution. With the physics understanding gained from the data and supported by multi-scale modeling, we improved performance, demonstrating up to ~7% short-pulse energy coupling to the core by optimizing target and implosion parameters that minimized preplasma inside the cone and increased core areal density. This is the highest energy coupling efficiency ever reported from the OMEGA-scale FI experiments.

The findings are highly relevant for the further development of FI fusion on existing facilities and present the case for even higher coupling efficiency (above 15%) due to more effective stopping of fast electrons in the high-density core available on future large-scale facilities such as the combined National Ignition Facility and high intensity NIF-ARC laser.

[1] L.C. Jarrott et al., under review by *Nature Physics* (2015).
[2] W. Theobald et al., *Nat. Commun*. **5**, 5785 (2014).

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