Fast-Electron Source Characterization: Intense laser–solid interactions generate high-current electron sources with relativistic energies that are important for advanced ignition experiments. Applications include rapid heating for fast ignition and energy deposition in solid material for flash-radiography and x-ray scattering experiments. The efficient production of hot electrons with relativistic energies that provide the energy transfer is critical to achieving these goals.

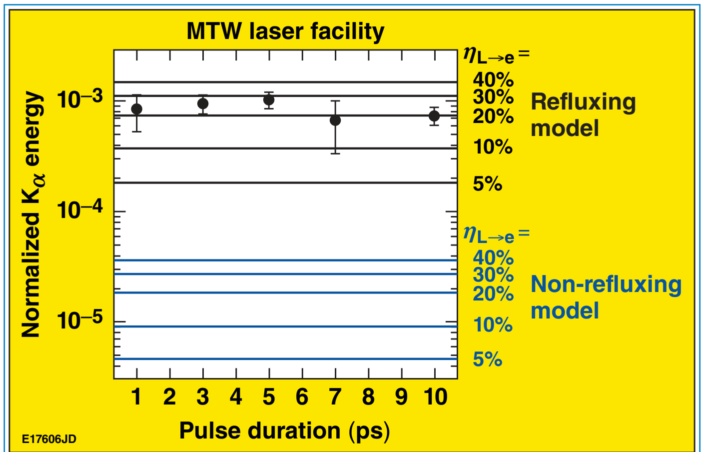

Figure 1. Measured energy in K_α (black circles), normalized to the incident laser energy, as a function of laser pulse duration. K_α-yield calculations assuming a refluxing (black) and a non-refluxing (blue) electron-transport model.

A novel technique using thin-foil targets to diagnose the hot-electron source has been developed and successfully demonstrated.[1–3] This technique relies on target charging, causing the majority of the hot electrons to transfer their energy to the target-bulk material. This occurs during multiple transits through the target—a process known as refluxing. Using this mechanism, and diagnosing the total K_α emission that is generated, the laser-electron–energy conversion efficiency $\eta_{L\to e}$ is determined. Previous measurements indicate $\eta_{L\to e} = 20\pm10\%$ for 1-ps pulses at intensities of $I = 2 \times 10^{19}$ W/cm^2 (Ref. 4). To demonstrate energy coupling relevant to fast ignition, the first conversion-efficiency measurements of 10-ps-long pulses into relativistic electrons were recently conducted.

Foil targets were irradiated in multiterawatt (MTW) laser experiments at a fixed laser intensity of $I = 5 \times 10^{18}$ W/cm^2 with pulse durations of 1 ps $\le \tau_p \le$ 10 ps (Fig. 1). The total hot-electron energy inferred from absolute K_α-yield measurements is a constant fraction $\eta_{L\to e} = 20\pm10\%$ of the laser energy and is independent of the laser-pulse duration. Refluxing is required (Fig. 1, black lines) to account for the experimentally observed, bright K_α emission. This is an important observation, representing the first conversion-efficiency measurements of 1- to 10-ps-long pulses into fast-ignition-relevant electrons without any energy-coupling degradation, where the conversion efficiency is independent of the laser-pulse duration.

Laboratory Basic Science Program: A solicitation was issued in February for proposals for the LLE Laboratory Basic Science (LBS) Program. Under the FY10 LBS program, approximately 10 shot days of the annual operating time of the OMEGA 60-beam laser and 8 shot days of the OMEGA EP laser will be available for basic science experiments to be carried out by scientists from the NNSA ICF program.

OMEGA Operations Summary: The Omega facility conducted a total of 163 target shots in February: 115 shots were conducted on the OMEGA 60-beam laser and 48 shots were carried out on OMEGA EP. The experimental effectiveness averaged 93.7% for OMEGA and 93.8% for OMEGA EP. The NIC accounted for 26 of the OMEGA shots and 33 of the OMEGA EP shots. Non-NIC activity included HED campaigns for LANL (35 shots on OMEGA and 5 on OMEGA EP) and LLNL (21 shots on OMEGA); LBS shots (15 on OMEGA and 10 on OMEGA EP) and NLUF (18 target shots on OMEGA). The NLUF shots were carried out by two teams led by MIT-PSFC and Rice University, respectively.

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