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High-Intensity Laser-to-Hot-Electron Conversion Efficiency from 1 to 2100 J Using the OMEGA EP Laser System

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Intense laser–matter interactions generate high-current electron beams. The laser-electron conversion efficiency is an important parameter for fast ignition and for developing intense x-ray sources for flash-radiography and x-ray-scattering experiments. These applications may require kilojoules of laser energy focused to greater than 10^{18} W/cm^2 with pulse durations of tens of picoseconds. Previous experiments have measured the conversion efficiency with picosecond and subpicosecond laser pulses with energies up to ∼500 J. The research extends conversion-efficiency measurements to 1- to 10-ps laser pulses with energies up to 2100 J using the OMEGA EP Laser System and shows that the conversion efficiency is constant (20±10%) over the entire range The conversion efficiency is measured for interactions with finite-mass, thin-foil targets. A collimated electron jet exits the target rear surface and initiates rapid target charging, causing the majority of laser-accelerated electrons to recirculate (reflux) within the target. The total fast-electron energy is inferred from K-photon spectroscopy. Time-resolved x-ray emission data suggest that electrons are accelerated into the target over the entire laser-pulse duration with approximately constant conversion. This work provides significant insight into high-intensity laser–target interactions. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement Nos. DE-FC52-08NA28302 and DE-FC02-04ER54789.

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