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Hot electron temperature scaling at $I\lambda^2 > 10^{20}$Wcm^{-2} and implications for fast ignition

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The fast ignition (FI) concept of inertial confinement fusion ignites pre-compressed fuel with laser-generated hot electrons. A laser intensity I$\sim10^{20}$ W/cm^2 is required to deliver 15-20 kJ of electrons in 20 ps into a 40 μm diameter spot. These electrons must have the energy, $\sim$2 MeV, to penetrate to and stop in the compressed core at a density of $\sim$300 g/cc. Ponderomotive scaling theory and experiments have indicated that the required electron energy is produced at Iλ^2 $\sim10^{19}$ Wμm^2/cm^2, necessitating a wavelength shorter than the 1 μm preferred for the ignitor laser. Experimental measurements of the mean electron energy are, however, complicated by the fact that direct measurements of the source electron spectrum are not possible, and indirect measurements, based on K-alpha x-rays, bremsstrahlung radiation, or escaping electrons, are highly dependent on transport modeling for interpretation. Recent experiments on the TITAN laser facility have used multiple-layered planar targets and a combination of these diagnostic techniques to improve the constraints on modeling. The experiments—performed over a range of laser intensities, pulselengths, and pre-pulse levels—together with particle-in-cell modeling suggest that the mean electron energy may be lower than previously considered, which would reduce the necessity in the fast ignition scheme for a short wavelength ignitor laser. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344, and supported by Contract DE-FG02-05ER54834.