Fast-Ignition Target Design: The OMEGA EP laser[1] will be used to investigate the physics of the fast-ignition concept.[2] In this concept, high-intensity (~10^{19} W/cm^2) laser beams irradiate the target at a time near peak compression to create a beam of energetic electrons (~1 MeV) that heat a small fraction of the compressed fuel to ignition temperatures (~10 keV). To understand the interaction of the electron beam with the target and its effect on the neutron production, a transport model for the electrons has been added to the two-dimensional hydrocode *DRACO*. The first simulations were carried out for experiments in which one OMEGA EP laser beam irradiates a target imploded on the OMEGA laser facility with an energy of 2.5 kJ in a 20-ps-long pulse and ~10-μm radius spot. A cryogenic target was designed to produce the high densities (ρ > 300 g/cm^3) and the large ρR needed to stop the 1-MeV electrons, and to achieve a sizeable increase in the neutron yield. The target, which consists of DT gas at a density of 5×10^{19} atoms/cm^3 inside a 90-μm-thick DT layer and a 5.8-μm-thick outer polystyrene shell with a radius of 500 μm, is irradiated by a 25-kJ, shaped $\alpha = 2$ pulse.[3] The maximum density at peak compression reaches 500 g/cm^3 for a total ρR of 0.5 g/cm^2. The ion temperature peaks near 5 keV at the center, dropping to about 40 eV in the high-density DT.

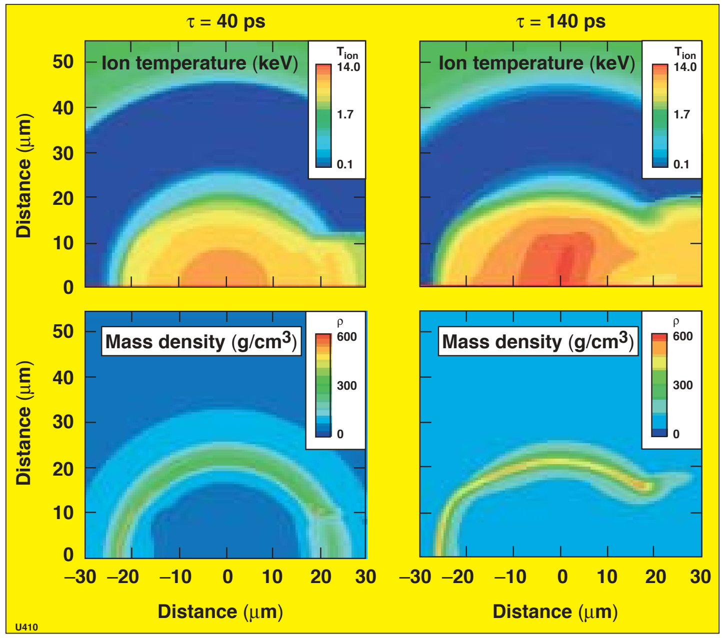

Figure 1. Ion-temperature and mass-density contours 40 ps and 140 ps after arrival of electron beams from *DRACO* simulation of fast-ignition capsule.

The relativistic electrons are transported with a straight-line model and are slowed down using a penetration depth formula of Li and Petrasso.[4] The electron source is a 20-ps, ~1-kJ, monoenergetic, 1-MeV beam deposited in a 10-μm radius spot and directed parallel to the z axis (source at the pole). The electron beam was turned on at 3.92 ns when the peak density is ~250 g/cm^3 and the $\rho R \sim 0.25$ g/cm^2. Figure 1 shows the temperature and mass-density contours of the imploding capsule at 40 ps and 140 ps after the electron beam is turned on. The one-sided heating, from the right, leads to a nonsymmetric final implosion driven by the explosion of the electron-heated shell. The resulting neutron-production rate and final yield for an optimally timed (3.92-ns) electron beam with a total energy of 1 kJ is shown in Fig. 2. When compared to the case with no high-energy electrons, the increase in the fusion burn is quite evident. The calculated neutron yield (in excess of 10^{15}) is large enough to be used for NIF nuclear-diagnostic development.

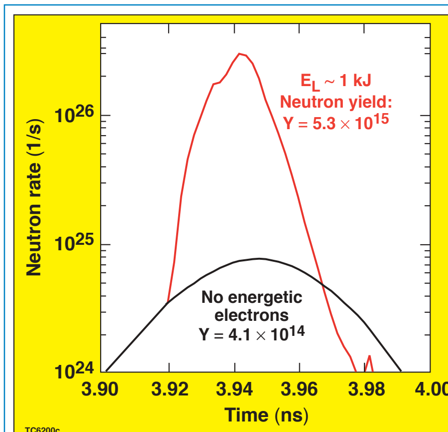

Figure 2. The neutron yield increases by more than an order of magnitude when a properly timed, high-energy electron source irradiates the compressed capsule.

OMEGA Operations Summary: During January, 134 target shots were carried out on OMEGA for LLE and external users. Seventy shots were dedicated to LLE including integrated-spherical experiments, laser–plasma interactions studies, Rayleigh–Taylor instability, and diagnostic development. Scientists from LANL and LLNL took 33 and 22 target shots, respectively, for several campaigns. An NLUF team led by the University of California, Berkeley, carried out nine target shots on experiments to characterize the equation of state of planetary core matter.

1. February 2003 Progress Report on the Laboratory for Laser Energetics, Inertial Confinement Fusion Program Activities.
2. M. Tabak *et al.*, Phys. Plasmas **1**, 1626 (1994).
3. The adiabat α is defined as the ratio of the pressure to the Fermi degenerate pressure.
4. C. K. Li and R. D. Petrasso, submitted for publication.

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