OMEGA Areal-Density Milestone: Scientists at the Laboratory for Laser Energetics in collaboration with scientists from PSFC, MIT, have inferred, for the first time, a neutron-averaged areal density in excess of 200 mg/cm^2 from direct-drive cryogenic D_2 implosions on the OMEGA laser. This set of measurements completes an NNSA Level-2 milestone, and demonstrates conclusively that hydrogen can be compressed to ignition-relevant densities. Just two months ago (see the *February 2007 DOE Progress Report*), the Laboratory reported the first observation of significant neutron-averaged areal density in cryogenic D_2 implosions. This previous set of experiments produced a neutron-averaged areal-density ρR of nearly 140 mg/cm^2. Based on these and noncryogenic experimental results, a new ablator design was implemented for the experimental series reported here. The targets consisted of a 10-μm-thick strong CD shell with a 95-μm-thick ice layer. Two identical targets (both with an ice-layer nonuniformity of 2.3-μm rms in all modes) were imploded on the same day using the decaying-shock[1] pulse shape shown in Fig. 1. The neutron-averaged areal density was inferred from the energy loss of the secondary protons produced in the core.[2] Five independent measurements of the secondary proton spectrum were made on each of the shots. On the first shot 47206, the average of the five measurements was 202±7 mg/cm^2. On the second, shot 47210, the picket timing was adjusted by 200 ps and the average of the measurements dropped (as expected) to 182±7 mg/cm^2. Figure 2(a) shows the average secondary proton spectrum measured on shot 47206 (red curve; this is just a normalized sum of the five individual spectra). The black curve represents the spectrum predicted by a 1-D simulation (*LILAC*) weighted according to the experimentally measured neutron burn profile.[3] The 1-D curve is the spectrum predicted if the burn profile in the simulation were identical to that of the experiment. The close agreement between the simulated and the measured spectrum indicates that the fuel assembly proceeded according to the 1-D simulation up to the peak density (140 g/cc in the simulation). Figure 2(b) shows the same comparison for shot 47210. In both shots, the experimental spectrum is affected by the low-energy cutoff of the spectrometers used to measure the proton spectrum. If the unmeasured part of the 1-D spectrum for shot 47206 is neglected, the prediction for the neutron-averaged areal density is 212 mg/cm^2, within 5% of the experimental value; the agreement is somewhat better for shot 47210. These results show that ignition-relevant fuel densities can be achieved under the proper implosion conditions. Near-term experiments will focus on higher-implosion velocity designs based on the thick CD ablator.

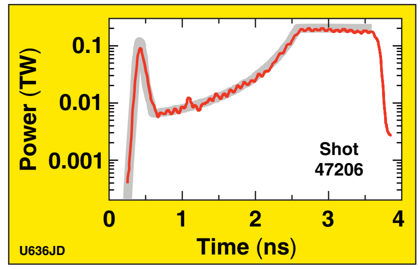

Figure 1. The drive pulse used to achieve a neutron-averaged areal density of 202±7 mg/cm^2 on shot 47206. The pulse (red curve) matches closely with the design specifications (the thickness of the gray curve represents the design tolerances on the drive pulse).

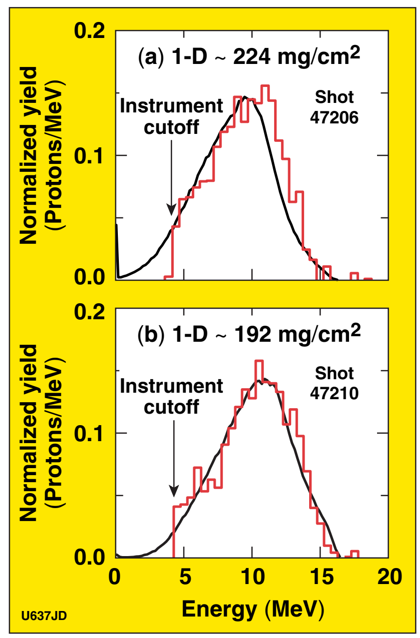

Figure 2. (a) The average secondary proton spectrum from shot 47206 (red) compares favorably with the spectrum (black) predicted by weighting the 1-D areal density profile by the experimentally measured temporal burn profile. (b) The same comparison as in (a) for shot 47210.

OMEGA Operations Summary: OMEGA conducted 112 target shots during April 2007 with an overall shot effectiveness of 97.3%. LLNL carried out 23 target shots for HED campaigns and 28 shots for IDI NIC experiments. LLE conducted a total of 54 target shots for the DDI NIC campaign. The first week of April was a dedicated maintenance week. During this week, the following projects were undertaken: continued integration of the OMEGA EP short-pulse beam; installation of new ASBO ROSS cameras; installation of a new ASBO laser; installation of small-signal-gain/autobalance fiber-optic cables for a new HED system; installation and activation of a new Stage-A near-field diagnostic (SAND); support of the chilled water upgrade to improve environmental control of the laser and target bays; and replacement or refurbishment of selected laser-system optics.

1. V. N. Goncharov *et al.*, Phys. Plasmas **10**, 1906 (2003).
2. F. H. Segiun *et al.*, Rev. Sci. Instrum. **74**, 975 (2003).
3. P. B. Radha *et al.*, Bull. Am. Phys. Soc. **51**, 104 (2006).