High-Density Cryogenic Implosions: One of the two necessary conditions for initiating a thermonuclear burn wave in a deuterium–tritium plasma has been achieved on the OMEGA laser. These conditions are a minimum fuel areal density (ρR) of approximately 300 mg/cm^2 and an ion temperature of 8 to 10 keV. A ρR of approximately 300 mg/cm^2 was measured on a recent low-adiabat ($\alpha \sim 2$) cryogenic-DT implosion. These experiments are part of the current cryogenic-DT campaign designed to demonstrate ignition hydrodynamic equivalence on OMEGA. Earlier areal-density measurements of approximately 200 mg/cm^2 were highlighted in the *August 2009 Progress Report*. The $\rho R \sim 300$ mg/cm^2 was measured in collaboration with scientists from the MIT Plasma Science and Fusion Center using the magnetic recoil spectrometer.[1] Cone-in-shell shock-timing experiments carried out in September and October (see the *May 2009 Progress Report* for a description of the technique) were used to validate the picket coupling and shock coalescence predictions of this multiple-shock design. Figure 1 shows the new results plotted with the ~200 mg/cm^2 data points from the *August 2009 Progress Report*. The two new points (black boxes) are the highest DT areal densities yet achieved in laboratory-based implosions. The predicted 1-D peak density of the 300 mg/cm^2 implosion is 250 g/cc or ~1000× liquid density. Future experiments will focus on improving the ion-temperature (T_i) performance. Current temperatures are ~1.8 to 2.2 keV; ignition hydro-equivalence corresponding to NIF 1-D marginal ignition with 500 kJ drive will be demonstrated[2] when the T_i is ~3.4 keV (and the ρR is ~300 mg/cm^2).

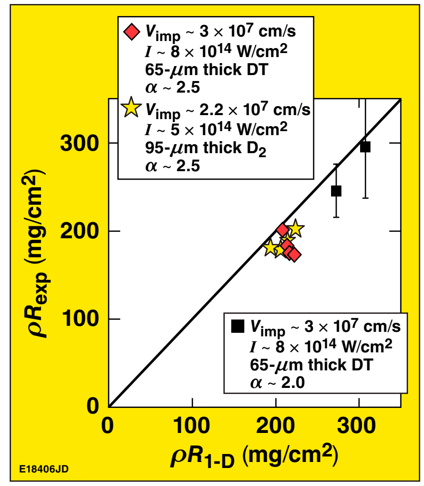

Figure 1. Measured areal density from cryogenic DT and D$_2$ capsules versus predicted (1-D simulation) areal density. The new experiments (black squares) achieved the highest DT areal density measured to date in laser-driven implosions.

OMEGA EP Backlighter Development: Backlighter development shots were taken on OMEGA EP using the long-pulse UV beams. Beams 1, 3, and 4 were tightly focused on an irregularly shaped ~100-μm-diam Sm target supported on the end of a 70-μm-diam SiC fiber. Three OMEGA EP beams with a total energy of ~3.5 kJ and a pulse width of ~2.5 ns were overlapped on the target and produced an intensity of ~10^{16} W/cm^2. This type of backlighter is typically used for Al $1s$–$2p$ absorption-spectroscopy to diagnose[3] shock-heated and compressed Al. Time-integrated x-ray pinhole camera images (6052, 6053, 6054) of the resulting point-source x-ray backlighter taken on three consecutive shots are shown in Fig. 2(a). The view angle was near-normal incidence. As can be seen in Fig. 2(a) the x-ray spot is well centered in the field of view for shots 6052 and 6053, but is slightly off the center for shot 6054. Variations in the shape of the source are attributed mostly to variations in the Sm target shape and size. Time-integrated x-ray spectra of the pseudo-continuum Sm M-shell emission recorded in the 1.35 to 1.65 keV range are shown in Fig. 2(b). Shots 6052 and 6053 produced similar spectra and the lower x-ray brightness of shot 6054 is attributed to a slight misalignment of the target. These shots confirmed that the OMEGA EP UV beams can be configured to meet stringent, long-pulse, x-ray backlighting requirements.

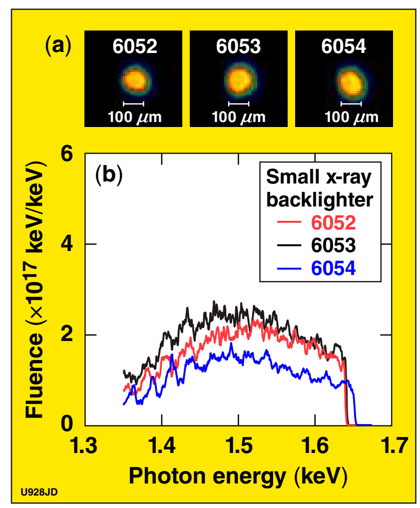

Figure 2. (a) Measured time-integrated x-ray pinhole camera images taken at near-normal incidence and with a fixed camera field of view of the point source Sm x-ray backlighter and (b) measured pseudo-continuum Sm M-shell emission recorded for three consecutive OMEGA EP shots (6052, 6053, 6054).

OMEGA Operations Summary: The Omega Laser Facility conducted a record total of 181 target shots in October: 146 on OMEGA and 35 on OMEGA EP. The experimental effectiveness averaged 93.8% and 97.3%, respectively, for the two lasers. A total of 147 shots were conducted for NIC by LLNL and LLE teams, 13 shots were carried out by LLNL for HEDSE programs, and 21 shots were provided to two LLE and LLNL teams that carried out experiments under the LBS program.

1. J. A. Frenje *et al*., Phys. Plasmas **16**, 042704 (2009).
2. R. Betti *et al*., Bull. Am. Phys. Soc. **54**, 219 (2009).
3. H. Sawada *et al*., Phys. Plasmas **16**, 052702 (2009).