Cryogenic Target Implosions: In a recent OMEGA experiment, the fusion neutron yield from a D_2-filled cryogenic target implosion (shot 28900) was near 100% of the 1-D *LILAC* hydrodynamic code prediction. This remarkable result followed many weeks of intense engineering study to determine the origin of a targeting offset that had severely degraded the implosion performance in previous cryogenic capsule experiments. Based on analysis of past cryogenic implosions and studies of stalk-mounted cryogenic surrogate capsules, it was determined that the sapphire windows on the layering sphere introduced an optical targeting offset with a typical magnitude of 60 to 120 μm. After modifying the window-mounting procedure, a cryogenic D_2 capsule with an ice thickness of 95 μm and an rms surface roughness of approximately 6 μm was imploded using a 1-ns square pulse. Based on an analysis of pinhole camera images after the shot (see Fig. 1), the center of the capsule was located approximately 17±7 μm from the common pointing location for all the beams. The absolute yield on shot 28900 (1.27×10^{11} neutrons) was nearly four times higher than any previous OMEGA cryogenic implosion under comparable laser and target conditions. The average capsule fuel areal density was measured via secondary proton slowing down (see Fig. 2) and was nearly a factor of 2 higher than the average of past 1-ns cryogenic implosions. After confirming these 1-ns results during the next cryogenic implosion series, experiments will begin using a low-adiabat (α ~ 4) pulse designed specifically for the current cryogenic capsule design—a 5-μm CH shell surrounding a 100-μm D_2-ice layer.

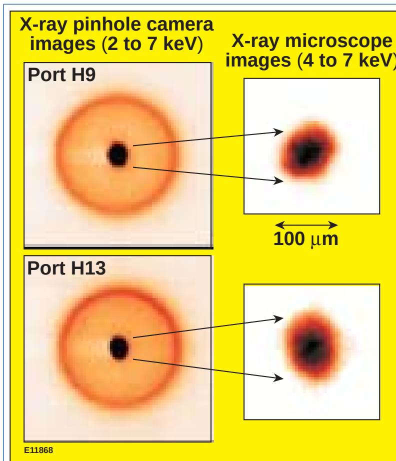

Figure 1. Time-integrated x-ray images from shot 28900 taken along nearly orthogonal directions were used to assess the implosion symmetry and placement precision of the cryogenic capsules. The target for shot 28900 was placed within 17±7 μm of the center of the target chamber.

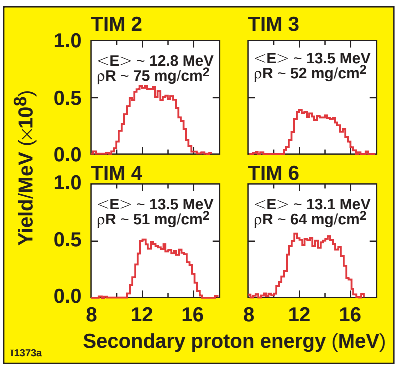

Figure 2. Secondary proton spectra from shot 28900 taken with the wedged-range-filter spectrometers (fielded in collaboration with the MIT Plasma Science and Fusion Center). The proton slowing down is consistent with a total capsule areal density of ~61 mg/cm^2.

Optical Parametric Chirped-Pulse Amplification (OPCPA): A key element of future ultrahigh-intensity lasers is a stable, high-efficiency laser source capable of generating broad-bandwidth pulses that can be amplified by a high-power amplifier system. Optical parametric chirped-pulse amplification (OPCPA) is a novel laser concept that is well-suited for this application.[1] LLE recently demonstrated one of the highest-efficiency OPCPA systems (Fig. 3). The OPCPA concept is based in part on an LLE-invented concept: chirped-pulse amplification (CPA). The CPA idea created a revolution in laser technology by enabling the development of ultrahigh-intensity [i.e., >10^{15} W (petawatt)] lasers. LLE and LLNL are collaborating on the development of the diffraction gratings required for petawatt-scale laser systems.

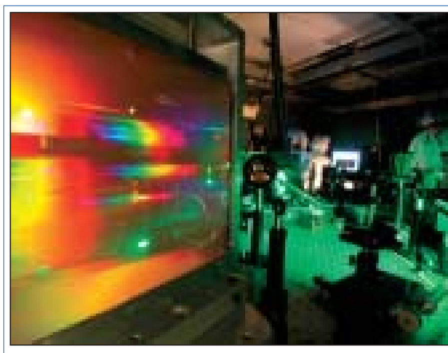

Figure 3. The OPCPA test bed during testing.

OMEGA Operations Summary: During September, a total of 79 target shots were taken on OMEGA. Scheduled system maintenance took place during the second full week of the month. The principal users were LLE (28 shots), the National Laser Users' Facility (NLUF) (15 shots), Commissariat à l'Énergie Atomique (CEA) (10 shots), and Lawrence Livermore National Laboratory (LLNL) (26 shots). The LLE campaigns included integrated spherical experiments (ISE), cryogenic target shots, and the SSP campaign. NLUF experiments included x-ray diffraction studies carried out by a collaboration led by the University of California, Davis, and measurements of density gradients in indirect-drive capsule implosions carried out by a collaboration led by the University of Nevada, Reno. Out of the total 1426 target shots taken on OMEGA during FY02, nearly half were for external users.

1. I. N. Ross *et al.*, Opt. Commun. **144**, 125 (1997).

Contact: Wolf Seka (585) 275-3815; fax: (585) 275-5960; e-mail: seka@lle.rochester.edu
John M. Soures (585) 275-3866; fax: (585) 256-2586; e-mail: jsou@lle.rochester.edu