December 1998 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Neutron Diagnostics—MEDUSA: MEDUSA—multi-element detector using a scintillator array—is a single-hit neutron detector array now operational on the OMEGA laser system. It consists of 824 channels of neutron-sensitive plastic scintillators (NE 110, 6.35 × 6.35 × 7.62 cm) coupled to photomultiplier tubes followed by discriminators and time-to-digital converters that enable the measurement of neutron arrival times. One principal function of MEDUSA is to measure the secondary DT neutron yield from pure deuterium fuel as a method to determine fuel areal density ρR for direct- and indirect-drive implosion experiments on OMEGA. An example of the recent ρR measurements with MEDUSA is shown in Fig. 1. In these experiments we investigated direct-drive spherical implosions with varying Ge-doped CH ablator thickness using a 20-kJ foot ramp laser pulse shape. We also studied the effect of 0.25-THz smoothing by spectral dispersion (SSD) on fuel ρR. Our measurements clearly identify increased fuel ρR with SSD and Ge-doped CH ablator thickness.

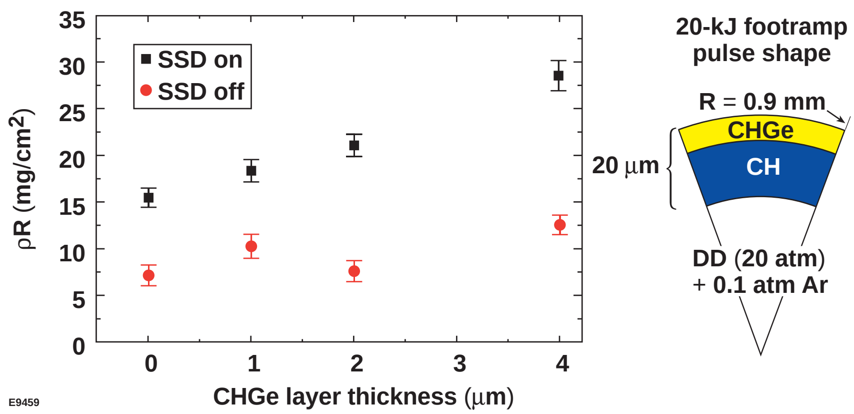

Fig. 1

OMEGA Surrogate Cryogenic-Target Experiments: Results to date from surrogate cryogenic-target implosions on OMEGA (those with low- or zero-pressure-filled polymer shells) have demonstrated the ability to compress targets to shell areal densities of ~60 to 130 mg/cm^2 (Fig. 2). The measurements have been inferred from the x-ray absorption spectra of the hot material at the core of the implosion. These values have been independently corroborated by measurements of the number of secondary neutron fusion reactions (MEDUSA measurements) and by the slowing down of D-^{3}He fusion-produced protons (charged particle spectrometer measurements).

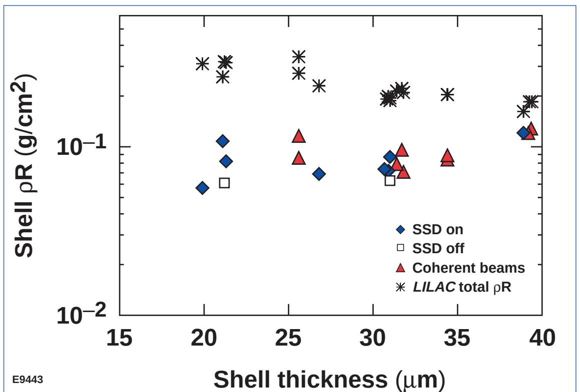

Fig. 2

Distributed Phase Plate Development: Optical characterization and system deployment of several replacement phase plates were completed. This marks the end of production for nearly 150 photoresist masters and 100 ion-etched phase plates for the OMEGA laser system. The final sets include 72 third-order supergaussian DPP's, 16 eighth-order supergaussian DPP's, 4 sinusoidal phase plates, and 4 gaussian DPP's. Each set of phase plates is named according to the irradiance distribution it produces on target. Both types of supergaussian DPP's produce a focal spot that contains 95% of the incident energy within a 900-μm diameter. The sinusoidal phase plates produce a periodic irradiance along one dimension with spatial frequencies of 30 and/or 60 μm. The gaussian DPP's produce smaller focal spots and are used to achieve higher intensities on target. The next phase of DPP development involves the activation and calibration of a new, low-noise mask writer. Improved DPP's will be developed for FY00 production following a major retooling of the photolithographic process.

OMEGA Operations Summary: In December two weeks of system time were allocated to indirect-drive campaigns from LLNL and LANL. During the LLNL week two days were dedicated to cylindrical hohlraum studies and one day to activation of the active shock breakout (ASBO) diagnostic (27 shots). Los Alamos used tetrahedral hohlraums to drive backlit foils while investigating hydrodynamic instabilities (32 shots). During the first week of December LLE continued the internal Rayleigh–Taylor campaign (34 shots) and during the last two weeks, experimentation on the laser.

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