September 1997 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Summary: During the reporting period, OMEGA was used to support the power balance campaign, PP2 spherical implosion experiments, S1/S2 planar foil growth rate and imprinting shots, S3 spherical target instability growth rate and laser imprinting campaign, and NLUF experiments. The Laboratory for Laser Energetics also hosted a meeting on portable diagnostics for OMEGA, NOVA, NIF, the British Helen laser, and the French laser systems LIL and LMJ.

Imprinting Experiments (S2): A study on the effect of irradiation uniformity on target stability was completed in September (Fig. 1). Intensity modulations in the drive laser can produce mass modulations that experience Rayleigh–Taylor growth. Various beam-smoothing techniques have been used, including distributed phase plates (DPP's), smoothing by spectral dispersion (SSD), and distributed polarization rotators (DPR's). DPR's reduce beam nonuniformities instantaneously while SSD requires a finite time to be effective. These effects were clearly seen in the experiments, and the best irradiation uniformity resulting in the smallest imprinting amplitudes was observed for SSD (including DPP's) in combination with DPR's. The experiments were carried out using thin foils accelerated by the laser. The imprinting signature was observed using face-on radiography.

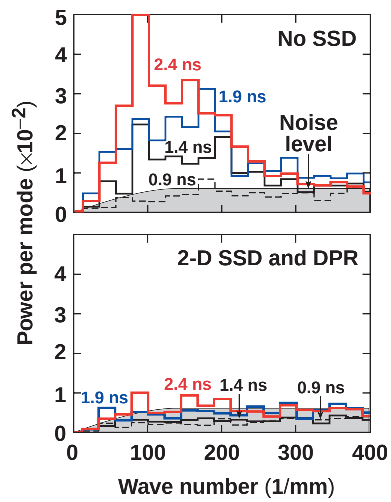

Fig. 1. Fourier analysis of target radiographs shows the beneficial effect of reduced irradiation nonuniformity.

Long-Scale-Length Plasma Generation (PP3): Experiments are underway to generate long-scale-length plasmas with characteristics similar to coronal plasmas anticipated in NIF direct-drive targets. The coronal plasmas are predicted to have temperatures of order 4 keV and density scale lengths of 0.5 to 1 mm. Using up to 40 beams of the OMEGA laser system, staggered in time, plasmas with similar conditions were generated. The plasmas are created with or without critical and quarter-critical surfaces to study the influence that the presence of these density surfaces has on the parametric interaction processes. The plasma conditions were characterized using embedded, high-Z, tracer dots to measure the electron temperature and stimulated Raman scattering to infer the maximum electron densities. The plasmas with and without critical surfaces have very similar characteristics and are close to predictions.

Distributed Phase Plates (DPP's): The fabrication of 60 DPP's for use on the OMEGA laser system is near completion. LLE's advanced development of a surface replication process, involving the ion etching of fused silica coated with patterned photoresist, has resulted in the successful fabrication of 310-mm-diam DPP's. These fully continuous DPP's will enable the OMEGA laser system to irradiate 900- to 1000-μm-diam targets without significant energy loss. The damage threshold for these new optics exceeds the requirements for 30-kJ laser system operation. In addition, these DPP's provide the irradiance distribution necessary to deploy laser-beam-smoothing strategies such as SSD.

Portable Diagnostics Meeting: On 10–11 September, LLE hosted a Workshop on Movable Diagnostics attended by scientists from LLNL, LANL, SNL, LLE, CEA (France), and AWE (Great Britain). The workshop produced a better understanding of the compatibility, control, and design issues associated with portable diagnostic systems for NIF, LMJ (the French 2 MJ laser), LIL (an LMJ predecessor), OMEGA, NOVA, and Helen (the AWE laser system). Additional topics discussed at this meeting included calibration facilities, possible reuse of NOVA diagnostics, and high-dynamic-range streak camera design and performance.

National Laser Users' Facility: NLUF experiments were conducted by a group from the Institute for Plasma Research at the University of Maryland. These experiments are aimed at characterizing the plasma density and temperature and measuring laser-induced electric fields using time-resolved XUV and x-ray spectroscopy.

OMEGA Operations Summary: Short-pulse operation of OMEGA commenced in September with configuration and testing of a new 100-ps pulse shape. A limited number of target shots were used for timing of the neutron temporal diagnostic (NTD). The instrument was subsequently used to obtain the temporal evolution of the neutron emission during implosion experiments. Some of these experiments used "picket-fence" pulses consisting of staggered pulses from different beamlines. In the third week of September OMEGA was used for S2 (beam-imprinting) experiments employing a range of beam-smoothing techniques (DPP's, SSD, DPR's).

Contact: Wolf Seka (716) 275-3815; fax: (716) 275-5960; e-mail: seka@lle.rochester.edu
John M. Soures (716) 275-3866; fax: (716) 256-2586; e-mail: jsou@lle.rochester.edu