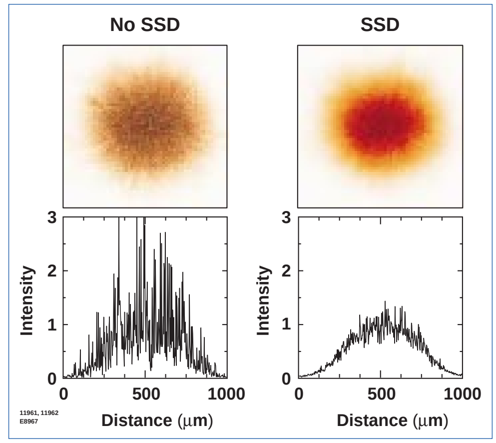
April 1998 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Laser Imprinting: Laser imprinting, the result of target perturbations produced by nonuniformities in the drive laser, is an important seed for hydrodynamic instabilities that can ultimately disrupt the implosion of a direct-drive ICF capsule. Imprinting occurs early in the laser pulse, then becomes less important as the coronal plasma is formed and begins to smooth the laser nonuniformities by thermal conduction. The beam smoothing produced by SSD is time dependent and increases at a rate that is inversely proportional to the bandwidth. To verify that the proper levels of smoothing are obtained with 2-D SSD, we acquired optical equivalent-target-plane (ETP) images using laser pulses of 100- to 200-ps duration. These pulses are used to replicate the initial portion of a longer, 1- to 3-ns pulse. The analysis of the short-pulse ETP images provides a measure of the smoothing that occurs at early times in the pulse. Figure 1(a) shows the ETP image and intensity lineout of a single OMEGA beam produced using a 175-ps pulse without SSD. This image has the typical ~100% rms modulation due to the high-frequency speckle produced by the DPP. Figure 1(b) depicts the ETP image and an intensity lineout when 2-D SSD at 0.25 THz_{UV} was applied. These data show the expected reduction by a factor of 4 to 5 in nonuniformity of the beam. These results support preliminary spherical- and planar-target experiments that indicate that the smoothing rate expected for 1-THz_{UV} SSD should provide sufficient uniformity for pulse shapes of interest for future high-compression experiments.



Indirect-Drive Experiments: One indirect-drive ICF campaign and three high-energy-density experimental science (HEDES) indirect-drive campaigns were conducted by LLNL on OMEGA during the last two weeks of April. The 27-shot ICF symmetry campaign demonstrated excellent time-dependent and time-integrated low-mode implosion symmetry in the first NIF-like multiple-ring hohlraum geometry. The measured P2 asymmetry was low (<10% swing) and consistent with calculations at the level of the azimuthally averaged pointing accuracy (~10 μm). Imploded capsules equipped with both Ge-doped and undoped plastic ablators and with predicted convergence ratios of up to 20 produced near-round cores with neutron yields approaching 2-D calculated yields ignoring mix. The 22-shot HEDES campaigns were designed to complete the validation of OMEGA for weapons physics use. Three shots demonstrated that up to 9-keV point backlighters could be deployed on OMEGA. Seven shots demonstrated the feasibility of performing space- and time-resolved soft x-ray opacity measurements. Twelve shots were devoted to demonstrating an 80-eV, long-duration (12-ns) hohlraum drive required for radiation transport studies in low-density foam. Excellent hohlraum temperature data along with gated and streaked soft x-ray foam burnthrough images were obtained. The ability to perform classified shots on OMEGA was also demonstrated during this second week.

NLUF Steering Committee Activities: During the reporting period, the annual NLUF Steering Committee Meeting was held to review proposals submitted to DOE for FY99 funding. There were 15 proposals—a new record—submitted for FY99, covering a variety of high-energy-density physics research areas. The recommendations of the Committee were forwarded to DOE. During April, 27 target shots were taken for NLUF user experiments carried out by the University of Maryland (principal investigators: H. Griem and R. Elton). These experiments aimed at understanding the density and temperature conditions on the exterior of imploding capsules at early times (during the rising intensity portion of the laser pulse). Also during April Prof. C. Hooper (U. Florida) and Prof. D. Cohen (U. Wisconsin) visited LLE to discuss planning for their future NLUF experiments.

OMEGA Operations: April was a solid shooting month on the OMEGA laser system. A total of 93 target shots were shared between 60-beam spherical (direct-drive) experiments (44 shots) and four indirect-drive campaigns for LLNL principal investigators (49 shots). The indirect-drive campaigns, conducted over a two-week period, used four distinctly different configurations of irradiation conditions. Additionally, the indirect-drive campaign included securing the OMEGA facility (for the first time) to conduct a user's classified experiments. The indirect-drive experiments were declared highly successful with more than 90% of the shots yielding good to excellent data according to the principal investigators. In April, 16 out of 21 business days were designated target shot days, resulting in an average of just over five target shots per day. In May the facility will begin an extended-shift mode with three 12-hour target shot days per week.

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