UNIVERSITY OF ROCHESTER
LABORATORY FOR LASER ENERGETICS

Volume 98
January–March 2004
DOE/SF/19460-527

LLE Review

Quarterly Report

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Contents

In Brief

This volume of the LLE Review, covering January–March 2004, features "Performance of 1-THz-Bandwidth, 2-D Smoothing by Spectral Dispersion and Polarization Smoothing of High-Power, Solid-State Laser Beams," by S. P. Regan, J. A. Marozas, R. S. Craxton, J. H. Kelly, W. R. Donaldson, P. A. Jaanimagi, D. Jacobs-Perkins, R. L. Keck, T. J. Kessler, D. D. Meyerhofer, T. C. Sangster, W. Seka, V.A. Smalyuk, S. Skupsky, and J. D. Zuegel (p. 49). Laser-beam smoothing achieved with 1-THz-bandwidth, two-dimensional smoothing by spectral dispersion and polarization smoothing on the 60-beam, 30-kJ, 351-nm OMEGA laser system is reported. These beam-smoothing techniques are directly applicable to direct-drive ignition target designs for the 192-beam, 1.8-MJ, 351-nm National Ignition Facility. Equivalent-target-plane images for constant-intensity laser pulses of varying duration were used to determine the smoothing. The properties of the phase plates, frequency modulators, and birefringent wedges were simulated and found to be in good agreement with the measurements.

Additional highlights of research presented in this issue include the following:

- V. N. Goncharov (p. 54) considers the contribution of the gradients in the laser-induced electric field to the current flow, heat flux, and electric stress tensor in laser-produced plasmas. The transport coefficients, previously derived in the limit $Z >> 1$, are obtained for an arbitrary ion charge Z. It is shown that the ponderomotive terms significantly modify the thermal transport near the laser turning points and the critical surface.

- C. K. Li, F. H. Séguin, J. A. Frenje, R. D. Petrasso–PSFC-MIT, along with J. A. Delettrez, P. W. McKenty, T. C. Sangster, R. L. Keck, J. M. Soures, F. J. Marshall, D. D. Meyerhofer, V. N. Goncharov, J. P. Knauer, P. B. Radha, S. P. Regan, and W. Seka–LLE (p. 67) study the target areal-density (ρR) asymmetries in OMEGA direct-drive spherical implosions. The rms variation $\langle \delta \rho R \rangle / \langle \rho R \rangle$ for a low-mode-number structure is approximately proportional to the rms variation of on-target laser intensity $\langle \delta I \rangle / \langle I \rangle$ with an amplification factor of ~$1/2(C_r - 1)$, where C_r is the capsule convergence ratio. This result has critical implications for future work on the National Ignition Facility (NIF) as well as on OMEGA.

- M. V. Kozlov, C. J. McKinstrie, and A. V. Maximov (p. 73) use the ion-fluid and Poisson (IFP) equations with phenomenological damping terms and the light-wave equation to describe stimulated Brillouin scattering (SBS) in one- and two-ion plasmas. A computer code is tested by comparing numerical and analytical results in the linear limit. The code is used to compare effects of Landau damping, pump depletion, and ion-acoustic nonlinearities on the saturation of SBS in one- and two-ion plasmas. In the latter, SBS from fast and slow ion-acoustic waves are considered separately. SBS is simulated for hydrocarbon (CH) plasmas with parameters typical for experiments on OMEGA.

- V. A. Smalyuk, T. R. Boehly, V. N. Goncharov, O. V. Gotchev, J. P. Knauer, D. D. Meyerhofer, and T. C. Sangster (p. 90) report measurements of the imprint efficiency in 20-μm-thick plastic foils driven by 351-nm laser light at an intensity ~2×10^{14} W/cm^2. The measured target spatial modulations were imprinted from spatial laser nonuniformities during laser-ablated plasma formation at the beginning of the drive. The laser modulations consisted of broadband nonuniformities from six beams incident at 23° to the target normal and single-mode perturbations from one beam incident at 48° to the target normal. The measurements were performed at a spatial wavelength of 60 μm with

and without smoothing by spectral dispersion (SSD). The measured imprint efficiencies at 60-μm spatial wavelength were 2.5±0.2 μm for the beam with 48° angle of incidence and 3.0±0.3 μm for the beams with 23° angle of incidence. The SSD reduced modulations by a factor of ~2.5 at the same spatial wavelength.

- C. K. Li and R. D. Petrasso–PSFC-MIT (p. 97) present an analytical model of the interaction of directed energetic electrons with a high-temperature hydrogenic plasma. The randomizing effect of scattering off both plasma ions and electrons is treated from a unified point of view. For electron energies of less than 3 MeV, electron scattering is equally important. The net effect of multiple scattering is to reduce the penetration from 0.54 to 0.41 g/cm^2 for 1-MeV electrons in a 300-g/cm^3 plasma at 5 keV. These considerations are relevant to "fast ignition" and to fuel preheat for inertial confinement fusion.

- C. Stoeckl, W. Theobald, and T. C. Sangster; M. H. Key, P. Patel, and B. B. Zhang–LLNL; and R. Clarke, S. Karsch, and P. Norreys–RAL (p. 103) report on shielding strategies to optimize the signal-to-background ratio and to obtain high-quality x-ray spectra. The use of a single-photon–counting x-ray CCD camera as an x-ray spectrometer is a well-established technique in ultra-short-pulse laser experiments. In the single-photon–counting mode, the pixel value of each readout pixel is proportional to the energy deposited from the incident x-ray photon. For photons below 100 keV, a significant fraction of the events deposit all energy in a single pixel. A histogram of the pixel readout values gives a good approximation of the x-ray spectrum. This technique requires almost no alignment, but it is very sensitive to signal-to-background issues, especially in a high-energy petawatt environment.

- R. Betti and K. Anderson (p. 106) present the theory of the adiabat profile induced by a strong shock propagating through a relaxed density profile in inertial confinement fusion (ICF) capsules. The relaxed profile is produced through a laser prepulse, while the adiabat-shaping shock is driven by the foot of the main laser pulse. The adiabat shape is calculated for the cases of intense, short prepulses and weak, long prepulses. The theoretical adiabat profiles accurately reproduce the simulation results to within a few-percent error. ICF capsules with a shaped adiabat are expected to benefit from improved hydrodynamic stability while maintaining the same one-dimensional performances as flat-adiabat shells.

- S. S. Kurebayashi, J. A. Frenje, F. H. Séguin, J. R. Rygg, C. K. Li, and R. D. Petrasso–PSFC-MIT; V. Yu. Glebov, J. A. Delettrez, T. C. Sangster, D. D. Meyerhofer, C. Stoeckl, and J. M. Soures–LLE; and P. A. Amendt, S. P. Hatchett, and R. E. Turner–LLNL (p. 122) investigate models for determining the areal density of hot fuel (ρR_{hot}) in compressed, D_2-filled capsules. Measurements from three classes of direct-drive implosions on OMEGA were combined with Monte Carlo simulations to assess the impact of mix and other factors on the determination of ρR_{hot}. The results of the Monte Carlo calculations were compared to predictions of simple commonly used models that use ratios of either secondary D^{3}He proton yields or secondary DT neutron yields to primary DD neutron yields to provide estimates of $\rho R_{\text{hot},p}$ or $\rho R_{\text{hot},n}$, respectively, for ρR_{hot}.

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Editor