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Contents

In Brief

This volume of the LLE Review, covering July–September 2003, features "The Coherent Addition of Gratings for Pulse Compression in High-Energy Laser Systems" by T. J. Kessler, J. Bunkenberg, H. Huang, A. Kozlov, C. Kelly, and D. D. Meyerhofer (p. 207). This article describes the conceptual development and experimental demonstration of the coherent summation of multiple gratings to form a larger grating. The most-promising reflection-grating technology for short-pulse, high-energy petawatt-class laser systems utilizing chirped-pulse amplification (CPA) is a holographically formed grating combined with a multilayer dielectric (MLD) coating. The aperture size and damage threshold of such gratings determine the ultimate short-pulse energy capability of these laser systems. Current state-of-the-art gratings would limit a laser such as OMEGA EP to an energy of less than 1 kJ per beam. While it may be possible in the future to manufacture very large gratings, tiling the MLD gratings available today represents an extremely attractive alternative for the OMEGA EP. The key result presented in this article is the conclusive demonstration of subpicosecond pulse compression using tiled gratings. This is truly an enabling technology for the high-energy, short-pulse lasers planned for the coming decade.

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

- S. Skupsky, J. A. Marozas, R. S. Craxton, R. Betti, T. J. B. Collins, V. N. Goncharov, P. W, McKenty, P. B. Radha, T. R. Boehly, J. P. Knauer, F. J. Marshall, D. R. Harding, J. D, Kilkenny, D. D. Meyerhofer, T. C. Sangster, and R. L. McCrory (p. 212) examine the feasibility of using the x-ray-drive beam configuration at the National Ignition Facility (NIF) to achieve direct-drive ignition. The baseline x-ray-drive beam configuration was designed to illuminate a vertically oriented hohlraum with beams arrayed symmetrically around the polar regions of the target chamber. The authors realized that nearly symmetric direct-drive illumination could be achieved by repointing some of the polar beams toward the equator of the capsule and adjusting the beam-spot sizes and energies. This new drive concept is called polar direct drive (PDD), and the authors describe the current status of their work focusing, in particular, on the beam-pointing strategy. The long-term impact of this work within the national ICF program is potentially of great importance if ignition conditions can be achieved on the NIF using the PDD concept.

- T. R. Boehly, T. J. B. Collins, E. Vianello, and D. D. Meyerhofer of LLE along with D. G. Hicks, P. M. Celliers, J. H. Eggert, S. J. Moore, and G. W. Collins of LLNL (p. 220) provide the latest experimental results on the equation of state (EOS) of hydrogen at pressures of a few megabars, temperatures of a few electron volts, and compressions of up to several times liquid density. A better understanding of the hydrogen EOS is important for the accurate simulation of direct and indirect ignition target designs on the NIF. At present, there are several different models for the hydrogen EOS, and it is exceptionally difficult to measure experimental observables with sufficient accuracy to discriminate among the models. The experimental results reported here are based on a new re-shock technique that is more sensitive to differences between the EOS models.

- V. Bagnoud and J. D. Zuegel (p. 225) describe a method to modulate both the phase and amplitude of a laser beam with a single-phase-only spatial light modulator (SLM) using a carrier spatial frequency and a spatial filter. With this technique, the authors show that dynamic corrections to a laser-beam profile are possible.

- V. Yu. Glebov, C. Stoeckl, S. Roberts, T. C. Sangster along with J. A. Frenje and R. D. Petrasso of PSFC-MIT and R. A. Lerche and R. L. Griffith of LLNL (p. 230) report on the implementation of an important new diagnostic system for direct-drive-implosion studies on the OMEGA laser system. The proton temporal diagnostic (PTD) was designed to measure the fusion reaction history in capsule implosions containing D^3He fuel. By measuring the temporal emission history and final energy spectrum of this high-energy proton, it is possible to study the areal-density evolution of the shell during the shock and compressive burn phases of an implosion. Existing range-filter spectrometers routinely measure the high-energy proton spectra from both D_2 and D^3He implosions. This data can now be combined with the temporal emission history of the new PTD to provide new constraints on the multidimensional hydrocodes used to understand implosion performance on OMEGA.

- J. DeGroote, H. J. Romanofsky, I. A. Kozhinova, J. M. Schoen, and S. D. Jacobs (p. 239) report on the use of conventional magnetorheological finishing (MRF) techniques to improve the surface finish and figure of several standard polymer optics. Since these optics are generally soft with high linear expansion coefficients and poor thermal conductivities, they are typically used as manufactured even though, in some instances, it would be desirable to have much better surface finishes. In this article, the authors show that the rms surface roughness of four different optical polymers can be reduced significantly using MRF.

- This volume concludes with a summary of LLE's Summer High School Research Program (p. 250), the FY03 Laser Facility Report (p. 252), and the National Laser Users' Facility and External Users' Programs (p. 254).

T. Craig Sangster
Editor