Cover Photos

Upper Left: Foam layers have been the subject of much interest in inertial confinement fusion (ICF) target design. Target designs utilizing foam layers have been proposed for use at LLE on OMEGA, at the National Ignition Facility (NIF), and in reactor-scale ICF fusion facilities. All of these designs make use of laser pulses that launch multiple shocks, which must be well timed. Because a portion of the shock energy is used to homogenize the foam material, the porosity of the foam layer has the potential to change the shock speed and timing. This figure shows a plot of density for a shock propagating through a foam, simulated by the adaptive-mesh refinement code AMRCLAW, in collaboration with Adam Frank and Alexei Poludnenko of the UR's Department of Physics and Astronomy. AMRCLAW is being used to study the effects of porosity on shock timing for wetted-foam layers relevant to OMEGA and NIF target designs.

Lower Left: Thirty-three planar cryogenic target shots were taken on OMEGA in 2002. This photograph was taken on a target shot on which the equation of state (EOS) of liquid deuterium was investigated. These experiments use cryogenic target handling, advanced diagnostics, and the large, uniform laser spots available on OMEGA to provide important data to help clarify previous disagreements between theoretical models and laboratory experiments in this area.

Center: LLE scientists made significant progress in 2002 in developing experimental designs for direct-drive ignition experiments on the NIF. Recent work indicates that it may be possible to carry out high-performance direct-drive implosions on the NIF using the x-ray drive beam configuration. In preparation for future direct-drive experiments on the NIF, a NIF-scale prototype target assembly was demonstrated at LLE and is shown in this photograph. A 3.175-mm-diam spherical target was mounted onto a 125-μm-thick, 7.34-mm-outside-diam Ti ring using four spider silk strands. The target assembly had a resonant frequency of 125 Hz and was compatible with the NIF target chamber geometry.

Lower Center: This image of the on-target laser electric-field intensity was simulated by the parallel, three-dimensional, laser–plasma interaction (LPI) code pF3D. Lawrence Livermore National Laboratory (LLNL) developed the pF3D code primarily for modeling LPI in hohlraum plasmas. LLE scientists are adapting pF3D to simulate direct-drive conditions. The electric-field intensity shown in this figure displays the characteristic speckle pattern produced by distributed phase plates (DPP's). The individual maxima (or "hot spots") can exceed the average incident intensity by several times. Laser-driven parametric scattering instabilities such as stimulated Brillouin scattering (SBS) or decay instabilities like the two-plasmon decay (TPD) are preferentially driven in these hot spots due to the elevated light intensities.

Upper Right: A key element of future ultrahigh-intensity lasers is a stable, high-efficiency laser source capable of generating broad-bandwidth pulses that can be amplified by a high-power amplifier system. Optical parametric chirped-pulse amplification (OPCPA) is a novel laser concept that is well suited for this application. LLE's OPCPA system recently demonstrated one of the highest efficiencies for such systems currently available. The OPCPA concept is based in part on an LLE-invented concept: chirped-pulse amplification (CPA). The CPA idea created a revolution in laser technology by enabling the development of ultrahigh-intensity [i.e., $>10^{15}$ W (petawatt)] lasers. LLE and LLNL are currently collaborating on the development of large diffraction gratings required for petawatt lasers.

Lower Right: This photograph shows an array of capsule core images recorded on an NLUF experiment to study temperature and density gradients in implosion cores of indirect-drive targets. The experiment, carried out by a collaborative team headed by the University of Nevada, Reno, makes use of a new multispectral x-ray imaging diagnostic (MMI-2), which is based on an LLE-developed diagnostic. MMI-2 uses an array of pinholes coupled to a Bragg mirror to record numerous narrowband x-ray images spanning the 3- to 5-keV photon energy range. Each image of the core spans ~75 eV along the spectral axis. Groups of images are combined to produce line-based images. Continuum-based images can also be extracted from the data.

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