Power Balance and Implosion Symmetry: Charged-particle spectroscopy and x-ray imaging were used on OMEGA implosion experiments to investigate the use of a new technique to improve on-target power balance. The charged particle measurements were carried out in collaboration with scientists from the MIT Plasma Science and Fusion Center and involved the acquisition and analysis of spectra of primary 14.7-MeV protons from D^3He-filled capsules. The slowing down of these protons depends on the total areal density (ρR) they traverse, so spectral measurements taken at different angles can provide information about the angular variation in capsule ρR.

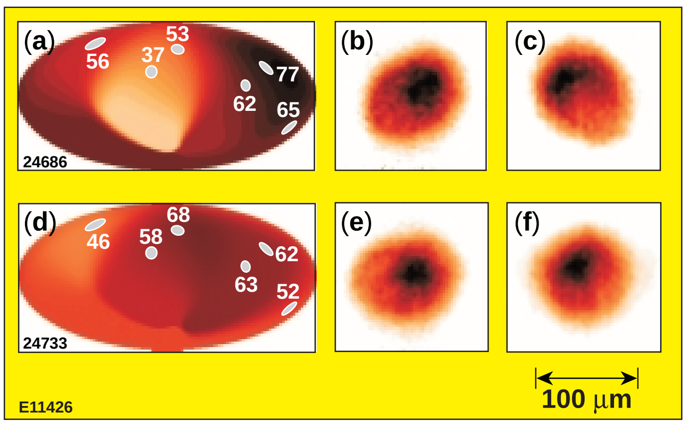

Figure 1. Data from shots 24686 and 24733 taken with "standard balance" and "x-ray balance," respectively. The targets for both shots consisted of 20-μm-thick CH shells filled with 18 atm of D^3He and irradiated with 1-ns, square top, 23-kJ UV laser pulses. Aitoff (equal area) projections [(a) and (d)] of capsule ρR taken with charged-particle spectrometers and x-ray images of imploded cores taken with x-ray microscopes (KB); [(b) and (e)] taken along an axis centered on the projection; [(c) and (f)] taken along an orthogonal axis. The numbers in the Aitoff projections are the capsule ρR in mg/cm^2 as measured at the indicated locations. The projections represent a directionally dependent average computed by weighting each data point by the cosine of the angle from the direction surveyed ($\theta \leq 90°$). The darkest shading corresponds to the highest ρR and x-ray emission areas in the particle and x-ray data, respectively.

In the experiments described here, an array of six charged-particle spectrometers was used, including a magnetically focusing spectrometer (CPS-2) and five wedge-range-filter spectrometers (WRF's).[1] Figure 1 illustrates proton-based ρR measurements as well as the x-ray images obtained at different diagnostic ports on OMEGA during two implosions of D^3He-filled capsules. The data on shot 24686 were taken after the laser-beam energy balance was adjusted by the standard method: measuring the individual beam energies in each beam as well as the optical transmission of each beam to the target and then adjusting the energy of each beam to achieve the best-possible energy balance on target. The mean proton energies are not the same at different angular positions, implying asymmetries in the ρR distribution in the compressed capsules. X-ray images of the same implosion from two different directions are qualitatively consistent with the particle measurements. The data for shot 24733 were recorded after the laser-beam balance was modified by a new technique based on x-ray imaging measurements (x-ray balance).[2] Both the particle data and the x-ray data show improvements in the core symmetry for shot 24733. These data indicate the potential of these diagnostics and energy balance approaches to improve the symmetry of OMEGA capsule implosions.

R&D 100 Award: R&D Magazine recognized the University of Rochester's Center for Optics Manufacturing (COM), the U.S. Army Research Laboratory, and QED Technologies, a commercial spin-off of joint COM and LLE research, for their work in the development of the Q22-Y MRF (Magnetorheological Finishing System). The Q22-Y MRF is a computer-controlled polishing machine capable of figuring high-precision optics in minutes. A key element of this system is the use of magnetorheological (MR) fluids. The MR fluid's shape can be magnetically manipulated and controlled in real-time, making it capable of polishing and correcting any optical surface shape. Recent work at LLNL indicates that MRF may be an important element in a process to improve the damage resistance of NIF optics.

OMEGA Operations Summary: A total of 139 OMEGA target shots were taken during November for LLE and LLNL programs. The LLE shots included 37 for the ISE campaign, 21 for the SSP program, 23 for laboratory astrophysics experiments, 2 for EOS measurements, 12 for RTI experiments, and 8 for diagnostic development. The LLNL shots included 12 for nonideal backlit implosions, 12 for radiation wave propagation experiments, and 12 for pushered shell implosion experiments.

1. F. H. Séguin *et al.*, "Diagnostic Use of Secondary D^3He Proton Spectra for D-D OMEGA Targets," to be published in Physics of Plasmas.
2. F. J. Marshall, J. A. Delettrez, R. L. Keck, J. H. Kelly, P. B. Radha, and L. J. Waxer, Bull. Am. Phys. Soc. **46**, 179 (2001).

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