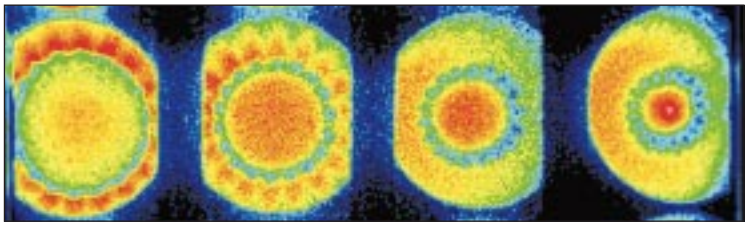
July 1998 Progress Report on the Laboratory for Laser Energetics' Inertial Confinement Fusion Program Activities

Charged Particle Spectrometers: During the reporting period, the second charged particle spectrometer (CPS-2) was installed on OMEGA and brought on-line (see photo). The design, construction, and installation of CPS-2 was challenging due to the neutron-shielding requirements for the new instrument. The full CPS-2 package weighs more than 4000 lbs and is the heaviest diagnostic currently fielded on OMEGA. Measurements of fusion-product charged particles and high-energy ablator ions were carried out during this period with CPS-2, as well as with CPS-1, the first of these two devices. Both CPS-1 and CPS-2 are currently being run with CR-39 track film as the detector medium. In one series of experiments carried out with CPS-1, simultaneous measurements of the capsule areal density and the fuel ion temperature were taken on D-^{3}He–filled capsules. These data are currently being analyzed in preparation for a more extensive series of shots to be taken in September with both spectrometers.

Imprinting Experiments: Planar-target experiments were conducted to investigate the nonlinear saturation of RT growth of imprinting, the target perturbations seeded by laser nonuniformities. In these experiments, initially smooth, 20-μm-thick CH targets were irradiated by 2×10^{14} W/cm^2 in 3-ns square pulses by five overlapping 351-nm laser beams. To enhance the on-target uniformity all five beams had distributed phase plates (DPP's), smoothing by spectral dispersion (SSD), and distributed polarization rotators (DPR's). Imprinting is produced primarily by the laser speckle generated by DPP's and has a broadband spatial spectrum. The RT evolution of these features was measured using x-ray radiography at ~1.3 keV. From these measurements, we found that 20-μm wavelength perturbations exhibit saturation of RT growth, while wavelengths longer than 30 μm continue to grow. These observations are consistent with the predictions of a saturation model developed by S. Haan of LLNL.

Direct-Drive Cylinder Implosions: A second series of experiments to investigate directly driven cylinders was performed during July. Scientists from LANL and LLE used 50 beams to drive CH cylinders and 5 beams to irradiate a Ti backlighter foil. Radiographic images along the axis of the cylinders were used to study the ablative Rayleigh–Taylor instability in convergent geometry for a variety of mode numbers and amplitudes. In addition, framing and streaked images plus time-resolved x-ray spectroscopy were used to understand the behavior of these targets. Initiatives for new studies included deuterated foams that produced neutrons when imploded, chlorine emission spectroscopy, and cylinders with perturbations on their interior surfaces. The latter can be used to study the "feed-out" problem associated with the RT instability. The color-enhanced photograph shows framed x-ray radiographic images of the implosion of a target that had an m = 18 perturbation with a 1.5-μm amplitude machined into its inner surface. The blue-green colored region in the interior of the shell is the region of highest x-ray absorption. By the first frame, the perturbation has already "fed out" to the ablation surface and is growing. Its effect on the imploded shell is readily apparent in later frames.



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*Time from the leading edge of laser pulse.

OMEGA Operations Summary: During July the OMEGA facility operated at 100% availability. A total of 137 target shots were executed in 14 target shot days. These shots were shared between the planar-foil Rayleigh–Taylor campaign (S1: 25 shots), the integrated spherical campaign (ISE: 77 shots), and the LANL-led direct-drive cylinder campaign (35 shots). In addition to target-shot activity the most significant change to the system was the addition of the MIT/LLE charged particle spectrometer (CPS-2). This 4300-lb instrument was installed on the OMEGA target chamber during a weekend between target campaigns. Initial test shots on CPS-2 were taken during the reporting period.

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