Initial Shell Convergence Measurements Using OMEGA's 60 Unsmoothed Beams

One metric commonly used to evaluate the performance of inertial confinement fusion (ICF) targets is the ratio of the measured neutron yield to that predicted by a one-dimensional hydrodynamic simulation. When plotted versus the calculated convergence ratio of the implosion, this ratio [referred to as the YOC (yield-over-clean)] provides an indication of the nonuniformity present in the implosion [when targets that experience Rayleigh-Taylor (RT) similar growth factors are compared]. The convergence ratio is defined as the ratio of the initial and the final radii of the fuel/pusher interface. A concern, however, is that early experimental results never produced discernible, limb-brightened, stagnated cores. An example of this is displayed in Fig. 66.1, where azimuthally averaged radial profiles of early OMEGA implosions (driven by 24 unsmoothed beams, circa 1986) are compared with results from our one-dimensional hydrodynamics code *LILAC*. [These profiles were produced from time-integrated images obtained with a Kirkpatrick-Baez (KB) microscope.] In four such implosion experiments, we found little agreement with the position and spatial extent of the stagnated shell as predicted by the simulations. All of the experimental results indicated a broad, center-peaked, and somewhat nebulous core, whereas the *LILAC* results predicted a well-defined stagnated shell. As a result, the YOC-convergence comparisons required the use of the calculated convergence ratios. Figure 66.2 shows a similar comparison for the 1986 data.

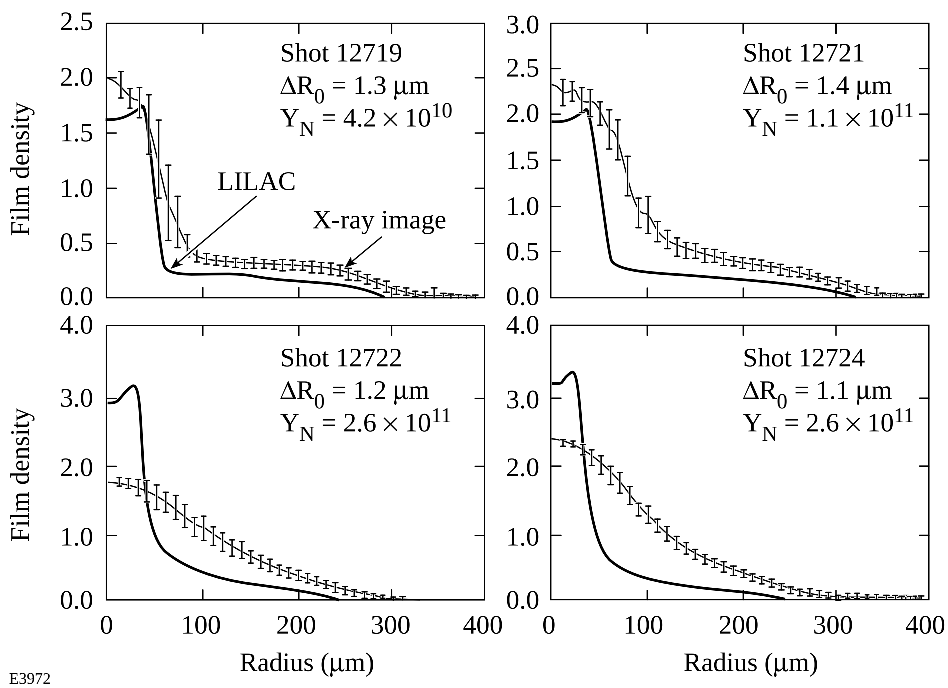

Figure 66.1
Azimuthally averaged radial profiles determined from time-integrated x-ray micrographs of early (circa 1986) target implosions. The *LILAC* simulations take into account the response of the microscopes and film. (These images were taken with KB microscope optics coated with nickel and hence were limited to $E \lesssim 4.5$ keV.)

Experiments using the 60 unsmoothed beams of the upgraded OMEGA laser system show a marked improvement in implosion symmetry as compared with similar, unsmoothed 24-beam experiments. Figure 66.3 shows four images of hard x-ray emission (>5 keV), viewed by a KB microscope, for high-yield targets taken on different 60-beam implosion experiments. The presence of a stagnated shell and/or a well-defined core is evident in each image. Particularly encouraging is the comparison of the azimuthally averaged radial intensity profiles of these images with the corresponding profiles predicted by *LILAC* (see Fig. 66.4). When compared to similar 24-beam results (from 1986), these data clearly indicate an

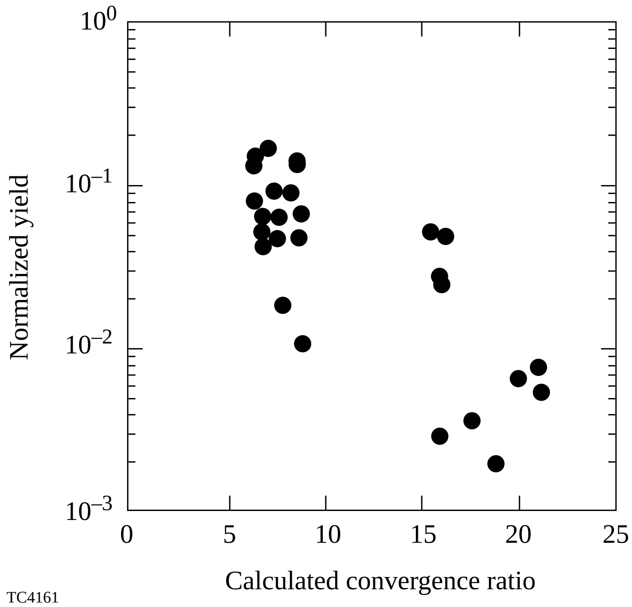

Figure 66.2
Normalized neutron yield (ratio of the experimentally measured neutron yield to the calculated neutron yield, commonly referred to as YOC (yield-over-clean)] versus the calculated convergence ratio (defined as the ratio of the initial to the final fuel/pusher radius). This data was taken in 1986.

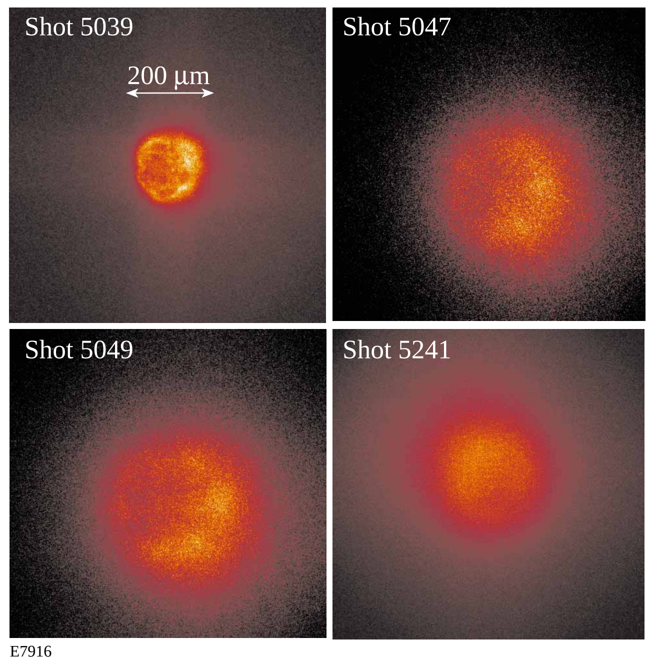

Figure 66.3
KB microscope images of high-yield implosions. These time-integrated images were taken with the latest Ir-coated optics and have an approximate sensitive energy band of 5 to 8 keV.)

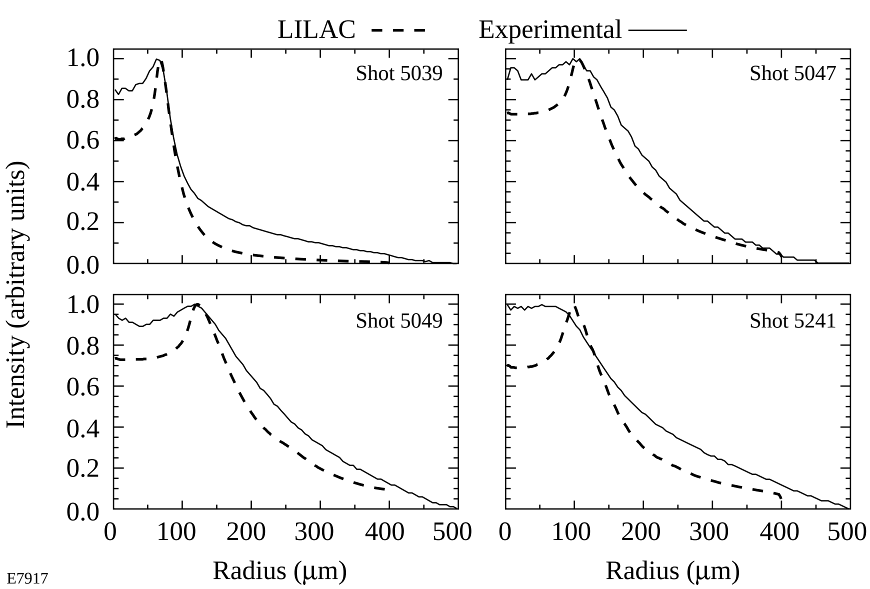

Figure 66.4
Azimuthally averaged radial intensity profiles determined from time-integrated x-ray micrographs of recent target implosions. The *LILAC* simulations take into account the response of the microscopes and film. The overall intensities have been normalized to the intensities at their peak.

improvement in the quality of the experimentally observed compressions due to 60-beam irradiation. While the exact position of the fuel/pusher interface remains clouded within the data (as a result of growing nonuniformities, mix layers, etc.), it may eventually be possible to measure the convergence ratio directly from the experiments.

The improved implosion performance is also demonstrated by the neutron yields as is evident from the YOC-convergence ratio comparison shown in Fig. 66.5. These data show that for implosions with similar convergence ratios, the 60-beam implosions perform significantly better than those driven by 24 beams. This improvement was accomplished with an increase in beam number and without irradiation uniformity schemes such as distributed phase plates (DPP's) or smoothing by spectral dispersion (SSD). Once these uniformity enhancements are implemented, the improvements in the implosion drive may allow experimentally observed convergence ratios to be used in our analysis.

ACKNOWLEDGMENT

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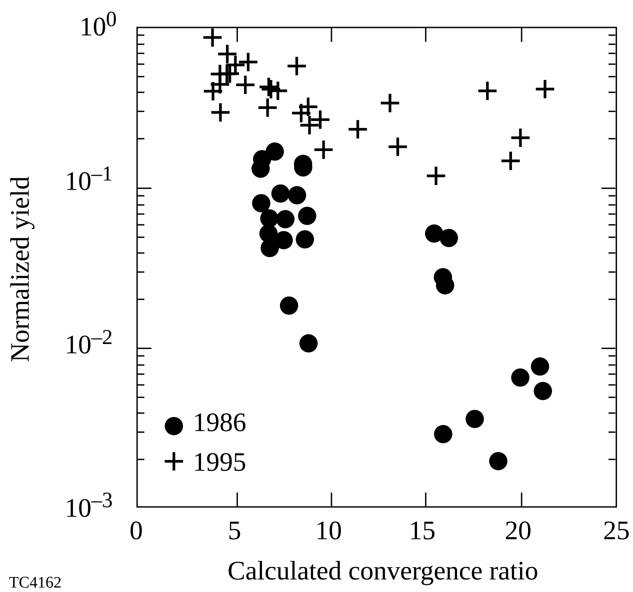

Figure 66.5
Comparison of YOC analyses for the yield data from 1986 to that for the yield measurements taken recently on OMEGA.