MEASUREMENT OF INFLIGHT SHELL AREAL DENSITY NEAR PEAK VELOCITY USING A SELF BACKLIGHTING TECHNIQUE

L.A. Pickworth[1], B.A. Hammel[1], V.A. Smalyuk[1], A. MacPhee[1], H.A. Scott[1], H.F. Robey[1], M. Barrios[1], S.P. Regan[2], M. Hoppe Jr.[3], T. Kohut[1], D.Holunga[1], C. Walters[1], B. Haid[1], M.Dayton[1]
[1]Lawrence Livermore National Laboratory, Livermore, CA, USA
[2]University of Rochester, Laboratory for Laser Energetics, Rochester, NY, USA
[3]General Atomics, San Diego, CA, USA
pickworth1@llnl.gov

The growth of perturbations in ICF capsules can lead to significant variation in inflight shell areal density (ρR) and ultimately result in poor compression and ablator material mixing into the hotspot. As the capsule is accelerated inward, the perturbation growth results from the initial shock-transit phase and then amplification by Rayleigh-Taylor. Measurements of ρR perturbations near peak implosion velocity (PV) are essential to our understanding because they reflect the integrity of the capsule, after the inward acceleration growth is complete, of the *actual* shell perturbations including native capsule surface roughness and "isolated defects".

Quantitative measurements of shell-ρR perturbations in capsules near PV are challenging and require a new method with which to radiograph the shell: An external backlighter samples both sides of the shell, unless a re-entrant cone is used, perturbing the implosion at higher convergences.

An innovative method is to use the self-emission from the hotspot to "self-backlight" the shell inflight. However, with nominal capsule fills there is insufficient brightness for this method until the capsule nears peak compression. We produce a sufficiently bright continuum "self-emission" backlighter through the addition of high-Z gas (~ 1% Ar) to the Symcap capsule fill. This provides a significant (~30x) increase in emission at hυ~8 keV over nominal fills. "Self backlit" radiographs are obtained for times when the "rebounding" shock from the capsule center is expanding out to meet the incoming shell, providing a means to sample the capsule, though one side, as it converges to PV.

Time-resolved images, in a narrow spectral band (~2 keV), of the hotspot emission transmitted though the perturbed shell is then used to infer the shell-ρR. This is experimentally obtained by use of Ross pair filtering or the narrow energy response of a multilayer mirror Kirkpatrick-Baez Microscope (K-B). Doping internal layers of the capsule with Cu, and measuring the transmission in two spectral bands, above and below the Cu K-edge, enhances contrast.

Using our current time resolved Ross-filtered detector we can infer the growth at PV of small pre-imposed features (e.g. single mode ripples). With the improved solid angle and resolution of the K-B we will measure perturbation growth from native surface roughness.

In addition, time-resolved measurements of the transmitted x-ray spectrum, from a streaked elliptical spectrometer, are used to infer average shell-ρR and the temperature of the hotspot plasma.

This talk will present the results from the first self-backlighter experiments on the National Ignition Facility measuring growth from a pre-imposed perturbation, mode 40 and amplitude 100nm, at radii <200µm as driven by a low-adiabat laser pulse shape.

* Prepared by LLNL under Contract DE-AC52-07NA27344. LLNL-ABS-669822