Crystal and source characterization for the Crystal Backlighter Imager capability at the National Ignition Facility

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X-ray radiography of capsule implosions on the National Ignition Facility (NIF) is presently performed using a pinhole-area-backlighter configuration [1]. This well-established x-ray imaging technique, however, has limited capability to image ICF implosions late in time due to bright capsule self-emission. Close to peak compression, the broadband self-emission from the capsule exceeds the x-ray backlighter source brightness within the bandwidth of filtered pinholes, which can be several to tens of keV. This limitation prevents resolving the evolution of target features, e.g. tent scars or fill-tube perturbations, which modeling [2] suggests can degrade the ICF implosion.

The Crystal Backlighter Imager (CBI) is a very narrow bandwidth (≤10 eV) x-ray radiography system that uses a Bragg reflection from a spherically-curved crystal at near normal incidence. This diagnostic has the capability to image later because it only requires the brightness of the backlighter to be larger than the object brightness in the bandwidth of the spectral line being used to image the object [3]. While the narrow bandwidth is advantageous for this reason, it also requires that the effective energy of the atomic line is known to ~1 eV accuracy for proper crystal alignment. This, in turn, means any Doppler shift in the line energy must be understood for the imaging system to work.

The work presented here details characterization experiments done at the Jupiter Laser Facility with a Si (8 6 2) crystal that will be used with a Selenium backlighter in the NIF CBI diagnostic. We used the spherically-bent crystals to image a ~200 μm He_α spot from the Janus laser on a Se foil. Scanning Bragg angles over multiple shots allowed us to map out the spectral line intensity distribution. This was done with both edge-on and near foil normal Se orientations relative to the crystal, representing two views where the Doppler shift should be minimized and maximized, respectively. All available data and complimentary HYDRA modeling will be presented.

References

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