Backlighter-Intensity Improvements for Radiography of Cryogenic Implosions: X-ray radiography of direct-drive cryogenic DT implosions on OMEGA is challenging because of the low opacity of the DT shell and the very bright self-emission of the hot core. A narrowband (~5-eV), time-gated (~40-ps) crystal imaging system with a Si He_α backlighter ($h\nu$ = 1.865 keV), driven by 1.5-kJ, 20-ps pulses from OMEGA EP was set up to radiograph these implosions.[1] First radiographs of cryogenic implosions were recorded with this configuration ~50 to 100 ps before peak compression,[2] but at peak compression the signal from the self-emission of the hot core was still significantly stronger than the backlighter. A program was started with experiments on OMEGA EP to evaluate options that could improve the backlighter brightness. In the first experiments, three different setups were tested: (1) the effects of a laser prepulse with solid, flat targets; (2) SiO_2 foams of different density; and (3) the use of a thin CH shield to confine the laser-heated Si plasma (see Fig. 1).

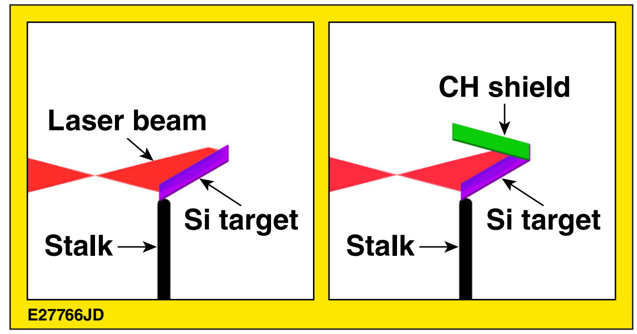

Figure 1. VISRAD renderings of the target illumination geometry for the backlighter improvement shots. (a) Nominal configuration with a solid Si target (violet) and (b) optimized configuration with an additional thin (~10-mm) CH shield (green). The laser illumination is shown in red.

A time-integrated x-ray spectrometer and a time-resolved x-ray streak camera were fielded to measure the brightness of the Si He_α emission. For some experiments the crystal imager was used to check if the Si He_α line emission from the new configurations was still within the narrow spectral acceptance (~5 eV) of the imager. The prepulse did increase the measured Si He_α fluence on the spectrometer, but also showed an emission time larger than the gate width of 40 ps. The SiO_2 foam targets showed a marginal increase in brightness of ~2× with a duration of <40 ps. The targets with the CH shield showed the largest increase in fluence of >5× (see Fig. 2) while maintaining a short emission time of <40 ps. The data from the crystal imager showed a commensurate increase in signal of ~5×, confirming that the Si He_α line emission from these targets stays within the acceptance of the crystal. Further experiments are planned using microstructured Si targets, which have been reported to show a >10× improvement in brightness.[3]

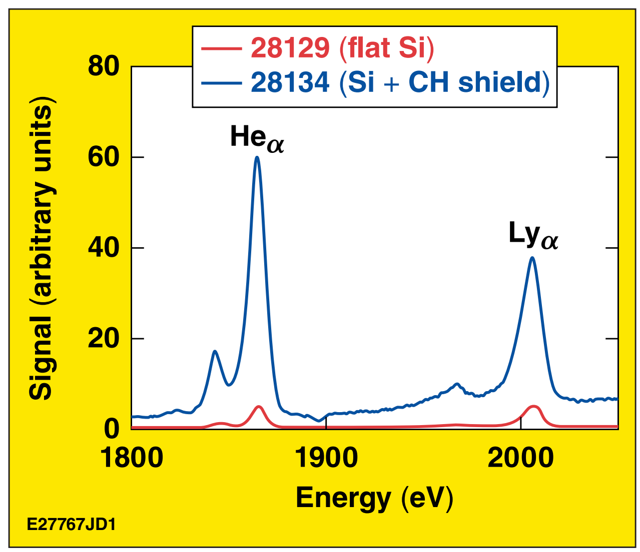

Figure 2. Time-integrated Si K-shell spectra showing the improvement in x-ray fluence from a Si target with a CH shield (blue) compared to a flat Si target (red).

Omega Facility Operations Summary: The Omega Facility conducted 256 target shots in May with an average experimental effectiveness (EE) of 97.5%. The OMEGA laser had 170 shots with an EE of 97.6% and OMEGA EP had 86 shots with EE of 97.1%. The ICF program accounted for 101 of the shots for experiments led by LLNL and LLE, while the HED program had 43 shots for experiments led by LANL, LLNL, and SNL. A total of 64 shots were taken for eight NLUF experiments led by Princeton, the University of California–Berkeley, the University of California–San Diego, the University of Michigan, and the University of Chicago, and two LBS experiments led by LLNL and LANL accounted for 26 target shots. CEA carried out two experiments accounting for 22 target shots.

1. C. Stoeckl *et al.*, Rev. Sci. Instrum. **85**, 11E501 (2014); 2. C. Stoeckl *et al.*, Phys. Plasmas **24**, 056304 (2017); 3. N. F. Neumann, Ph.D. thesis, Technische Universität Darmstadt, 2018.