The Single-Line-of-Sight, Time-Resolved X-Ray Imager Diagnostic Records the Core Emission from Cryogenic Implosions: The single-line-of-sight, time-resolved x-ray imager (SLOS-TRXI) system was installed earlier this year and was recently used for the first time on cryogenic target implosion experiments. Figure 1 shows the installation of the diagnostic on OMEGA. The multiframe, ultrafast framing camera captures x-ray images of the hot-spot formation for a DT cryogenic layer implosion. SLOS-TRXI is a joint project with General Atomics, Lawrence Livermore National Laboratory, and Sandia National Laboratories. It comprises a new generation of fast-gated x-ray imager that is capable of capturing multiple frames along a single line-of-sight with ~40-ps temporal resolution and ~10 μm spatial resolution. This was achieved by integrating an electron pulse-dilation imager[1] with Sandia's nanosecond-gated burst-mode hybrid complementary metal–oxide–semiconductor (hCMOS) sensors.[2] The combination of these two transformative technologies enables a new class of x-ray imagers that will have significant impact in HED diagnostic applications requiring high temporal and spatial resolution. The nose cone of the prototype diagnostic comprises a pinhole array imager casting multiple images of the hot spot onto the detector. The spatial resolution of the diagnostic is ~10 μm and is currently limited by the pinhole size. In its initial Phase I, the imaging concept was tested under the high background from neutrons and hard x rays in OMEGA cryogenic target implosions. No neutron-induced background and no hard x-ray background were observed in implosions with neutron yields of up to 1.2×10^{14}. Figure 2 shows the core emission from cryogenic target implosion shot 87024. The instrument recorded the hot-spot x-ray emission in the photon energy range from ~6 to 8 keV in four frames. Each frame integrated over ~40 ps and the frame-to-frame delay time was ~30 ps. Multiple pinhole images were averaged for each frame in order to improve the signal fidelity. The bang time was in the fourth frame showing the smallest object. In Phase II, the diagnostic will be further developed with advanced x-ray optics to improve the spatial resolution, improve the frame rate, and provide better temporal resolution.

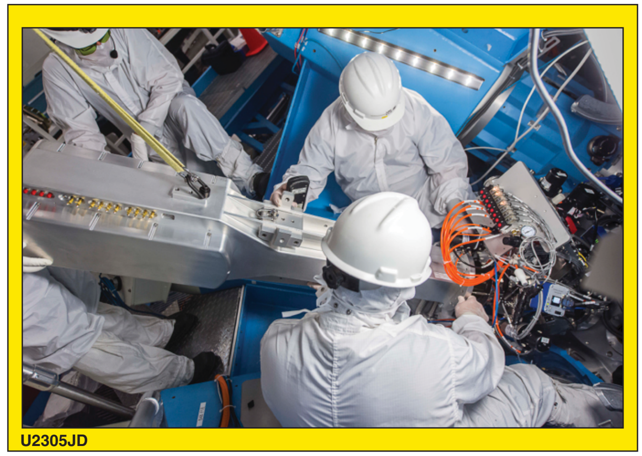

Figure 1. Installation of the SLOS-TRXI diagnostic on the OMEGA target chamber. The x-ray imager is not visible and is located inside the target chamber. The long aluminum housing contains the pulse dilation tube, the hCMOS detector, and various electronic components.

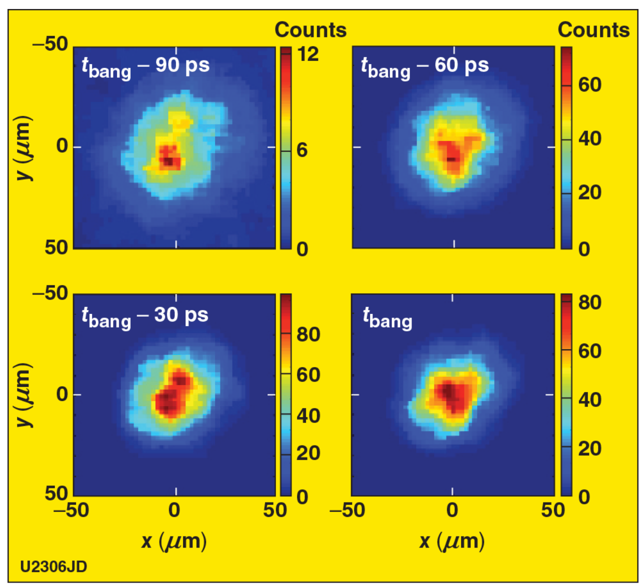

Figure 2. Four frames of the hot-spot x-ray emission (~6 to 8 keV) were recorded in cryo shot 87024 with the bang time occuring in the fourth frame. For each frame, multiple pinhole images were averaged in order to improve the signal fidelity.

Omega Facility Operations Summary: The Omega Laser Facility conducted 136 target shots in September, 2017, with average experimental effectiveness (EE) of 97.4%. The OMEGA laser accounted for 62 shots with an EE of 98.4%, while OMEGA EP conducted 74 shots with an EE of 96.4%. ICF experiments led by LLE, NRL, and SNL had 73 target shots while two HED experiments led by LLE and LLNL, respectively, had a total of 15 target shots. Three NLUF experiments led by MIT and the University of California, Berkeley, accounted for 25 target shots and one LBS experiment led by LLNL had 15 target shots. One OMEGA shot day was used for CEA experiments (8 target shots).

1. T. J. Hilsabeck *et al*., Rev. Sci. Instrum. **81**, 10E317 (2010); 2. L. Claus *et al*., Proc. SPIE **9591**, 95910P (2015).

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