

National Ignition Facility (NIF) X-Ray Spectrometer (NXS):

In collaboration with LLNL, scientists and engineers at LLE designed, constructed, and calibrated a time-resolved x-ray spectrometer operating in the 2- to 18-keV photon-energy range for the NIF (see Fig. 1). The NXS was funded by the Defense Threat Reduction Agency within the Department of Defense. It uses a tilted, elliptical Bragg-reflection geometry.¹ It operates on the diagnostic insertion manipulator imaging streak camera (DISC) that has a temporal record lasting 1 to 20 ns and a corresponding temporal resolution of 8 to 160 ps (Ref. 2). The NXS was absolutely calibrated on OMEGA using laser-driven, spherically symmetric, millimeter-scale x-ray sources of K- and L-shell emission from a variety of metals (Mo, Ag, Si, Ti, Cr, Ni, Zn, Zr). The 2- to 18-keV range is divided into ten discrete spectral windows because of the finite number of spatial-resolution elements in DISC. NXS calibration data recorded on OMEGA are shown in Fig. 2. A time-integrated record of the spectrum on an image-plate detector provides a photometric calibration of the streaked spectrum. The spectral range of the Bragg-reflected beam incident on the DISC x-ray photocathode is defined by the ellipticity and $2d$ spacing of the singly curved Bragg crystal and the tilt angle of the ellipse. The Bragg crystals are cleaved from boules of pentaerythritol (PET), rubidium acid phthalate (RbAP), or potassium acid phthalate (KAP) crystals³ and have a minimum radius of curvature greater than 100 mm. The NXS is designed to have a spectral resolving power (E/dE) greater than 50 for millimeter-scale x-ray sources. Three calibrated NXS snouts were delivered to the NIF in May. A performance qualification shot with the NXS operating on DISC is scheduled for 3 June on the NIF. The NXS is the first streaked x-ray spectrometer operating on the NIF.

Omega Facility Operations Summary: In May, the Omega Laser Facility conducted 235 target shots with average experimental effectiveness of 93.6% (157 on OMEGA and 78 on OMEGA EP with an experimental effectiveness of 93.9% and 92.9%, respectively). The ICF program had 119 target shots, while the HED program accounted for 60 target shots (the ICF and HED experiments were conducted by teams led by LANL, LLNL, and LLE). Two NLUF experiments led by the University of Michigan and General Atomics, respectively, accounted for 18 shots and three LBS experiments (from LLNL and LLE) received 38 target shots.

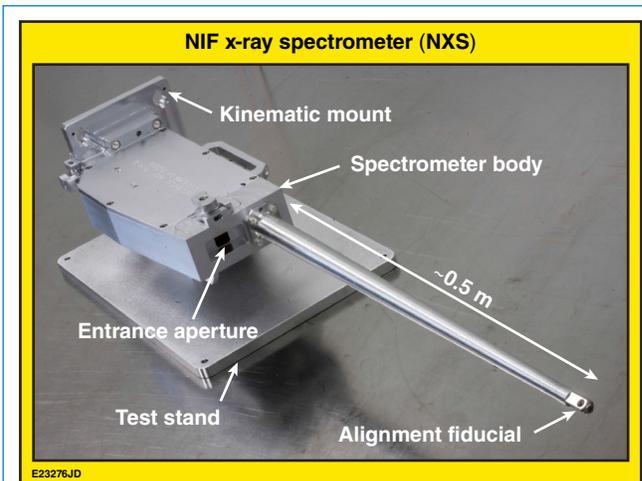


Figure 1. A photograph of one of the three NXS snouts delivered to the NIF. The NXS is secured to the DISC using a kinematic mount. The alignment fiducial guides the positioning of the NXS and DISC combination in the NIF target chamber with the diagnostic insertion manipulator.

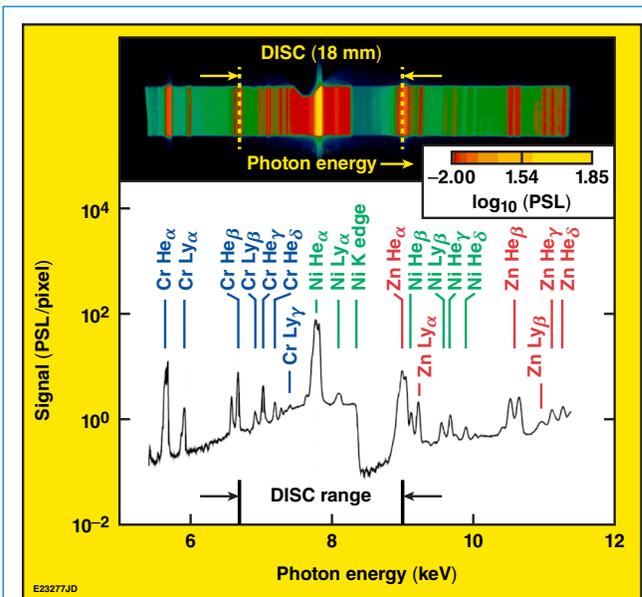


Figure 2. Calibration data recorded on OMEGA with NXS crystal pack #7 on an image-plate detector positioned in the DISC x-ray photocathode plane. Prominent K-shell emission lines are identified in the lineout with the DISC photon-energy range indicated.

1. B. Henke, H. Yamada, and T. Tanaka, Rev. Sci. Instrum. **54**, 1311 (1983).
 2. Y. P. Opachich *et al.*, Rev. Sci. Instrum. **83**, 125105 (2012).
 3. B. L. Henke, E. M. Gullikson, and J. C. Davis, At. Data Nucl. Data Tables **54**, 181 (1993).