

A Review of X-Ray Calibrations in the 2 to 100 keV Region Using the High Energy X-ray Calibration Facility

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High Energy X-ray Calibrations

The precise and accurate measurement of X-rays in the 2 keV to 100 keV region is crucial to the understanding of HED plasmas and warm dense matter in general. With the emergence of inertially confined plasma facilities as the premier platforms for ICF, laboratory astrophysics, and national security related plasma experiments, the need to calibrate diagnostics in the high energy X-ray regime has grown. At National Security Technologies' High Energy X-ray Calibration Facility (HEX) in Livermore, California, X-ray imagers, filter-fluorescer spectrometers, crystal spectrometers, image plates, and nuclear diagnostics are calibrated. The HEX can provide measurements of atomic line radiation, X-ray flux (accuracy within 10%), and X-ray energy (accuracy within 1%).



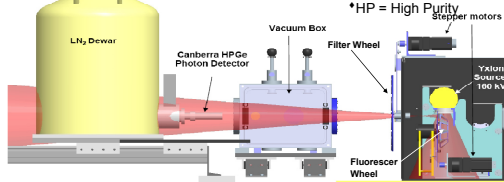
Stewart Crystal Spectrometer

Gated X-ray Imager Calibration (hGXI)

hGXI Spectral Response

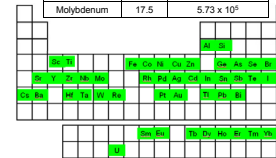
The X-ray Lab

- The HEX source is comprised of a commercial 160 kV X-ray tube, a fluorescer wheel, a filter wheel, and a lead encasement.
- The X-ray tube produces a Tungsten bremsstrahlung spectrum which causes a foil to fluoresce line radiation. To minimize bremsstrahlung in the radiation for calibration we also provide various foils as filters.
- For experimental purposes, a vacuum box capable of 10^{-7} Torr, as well as HPGe* and CdTe radiation detectors, are provided on an optical table.
- Most geometries and arrangements can be changed to meet experimental needs.



Calibration Capabilities

Typical X-ray Intensities, 1 m from Fluorescer		
Fluorescer Material	Energy, keV	Measured Intensity, photons/cm ² /sec
Lead	72.8	6.39×10^6
Tungsten	59.3	5.12×10^6
Samarium	40.1	6.5×10^6
Silver	22.3	5.64×10^6
Molybdenum	17.5	5.73×10^6



- A wide variety of fluorescers is available for use in the HEX.
- For more or less fluence, both X-ray tube settings and distance can be adjusted.

The HEX energy dispersive detectors are calibrated using NIST[†] traceable sources.



- Efficiency curves for both detectors.
- The Canberra HPGe detector provides an intensity measurement (photons/cm²) within 5% uncertainty.
- The Amptek CdTe detector provides an intensity measurement within 10% uncertainty.

A variety of instruments have been characterized or calibrated in the HEX.

Z PINEX

The HEX conducted the Z PINEX neutron imaging system scintillator characterization and alignment.

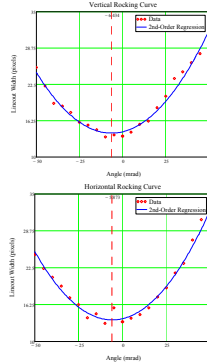
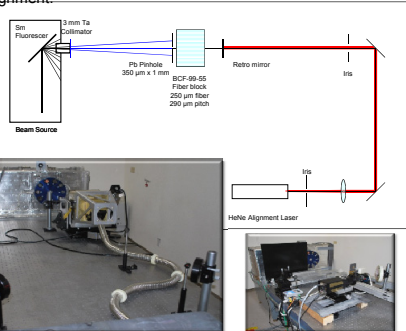
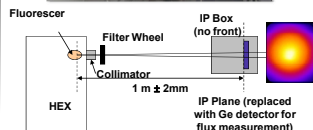
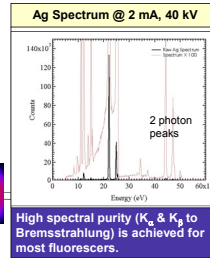
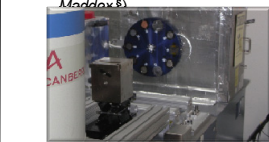
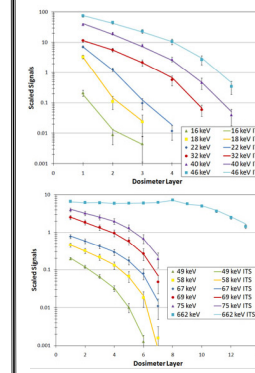


Image Plates

- Image plate energy sensitivity and MTF (Modulation Transfer Function) have been calibrated.
- Fade rate will also be calibrated.
- Data matches simulations (soon to be published separately by Brian Maddox[§]).

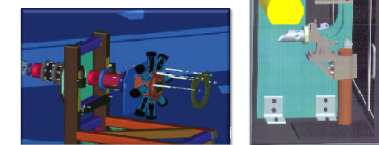


Bremsstrahlung Spectrometer



- The bremsstrahlung high energy X-ray spectro-meter will be used in short pulse and fast ignition experiments on Titan, Omega/EP, and NIF ARC.
- HEX experiments confirmed simulations from 15 to 85 keV.

NIF FFLEX (Filter Fluorescer Diagnostic System)



- FFLEX will provide information on hot electrons in NIF experiments.
- System filter and fluorescer transmission and uniformity are being measured.
- FFLEX fluorescer yield will be measured.
- Photomultiplier Tubes and complete channel measurement will be done as equipment becomes available.

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