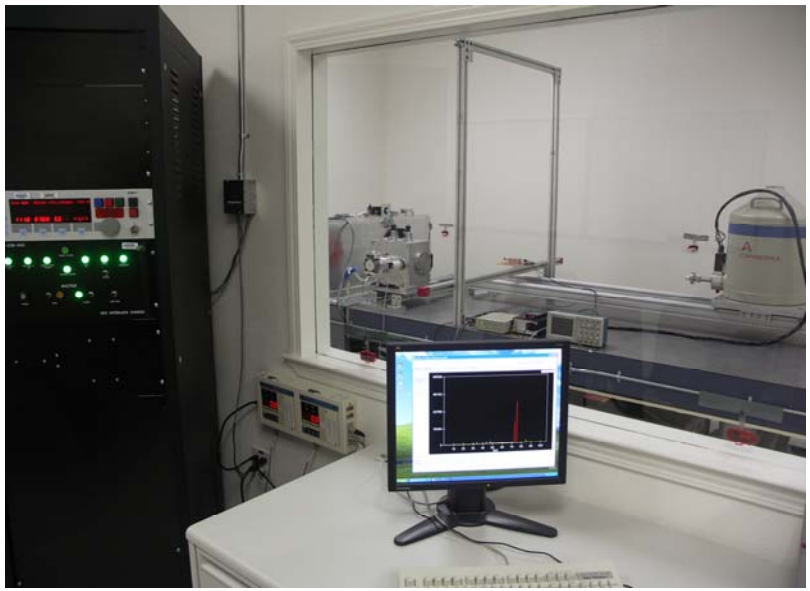
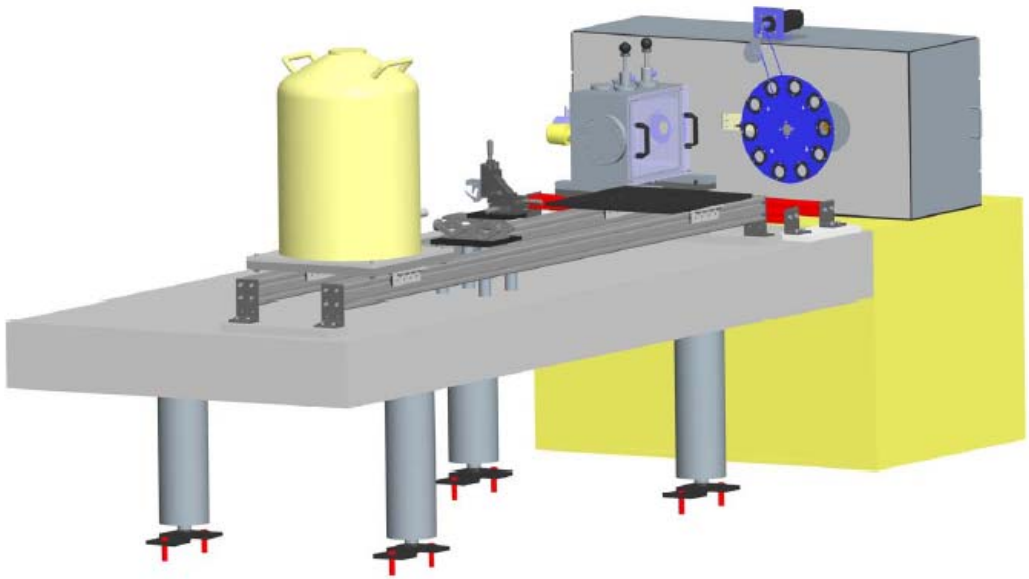
Plasma Diagnostic Calibration and Characterizations at the National Security Technologies' High Energy X-ray Calibration Facility





Zaheer Ali

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National Security Technologies' High Energy X-Ray (HEX) Calibration Facility provides calibration capabilities that are unique in the US.

- The HEX source currently uses an X-ray tube to fluoresce a target producing line radiation over a range of 2 keV – 100 keV.
- The X-ray tube voltage and current are continuously adjustable, which, combined with external edge filtering, allows the HEX to provide clean energy lines.
- The HEX can be put into radiographic mode for different types of experiments.
- Already the HEX has been used to calibrate various instruments.

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Contributors

M. J. Haugh, R. A. Buckles, M. Cardenas, A. J. Traille
National Security Technologies, LLC (NSTec)

B. R. Maddox, C. D. Chen, E. L. DeWald
Lawrence Livermore National Laboratory

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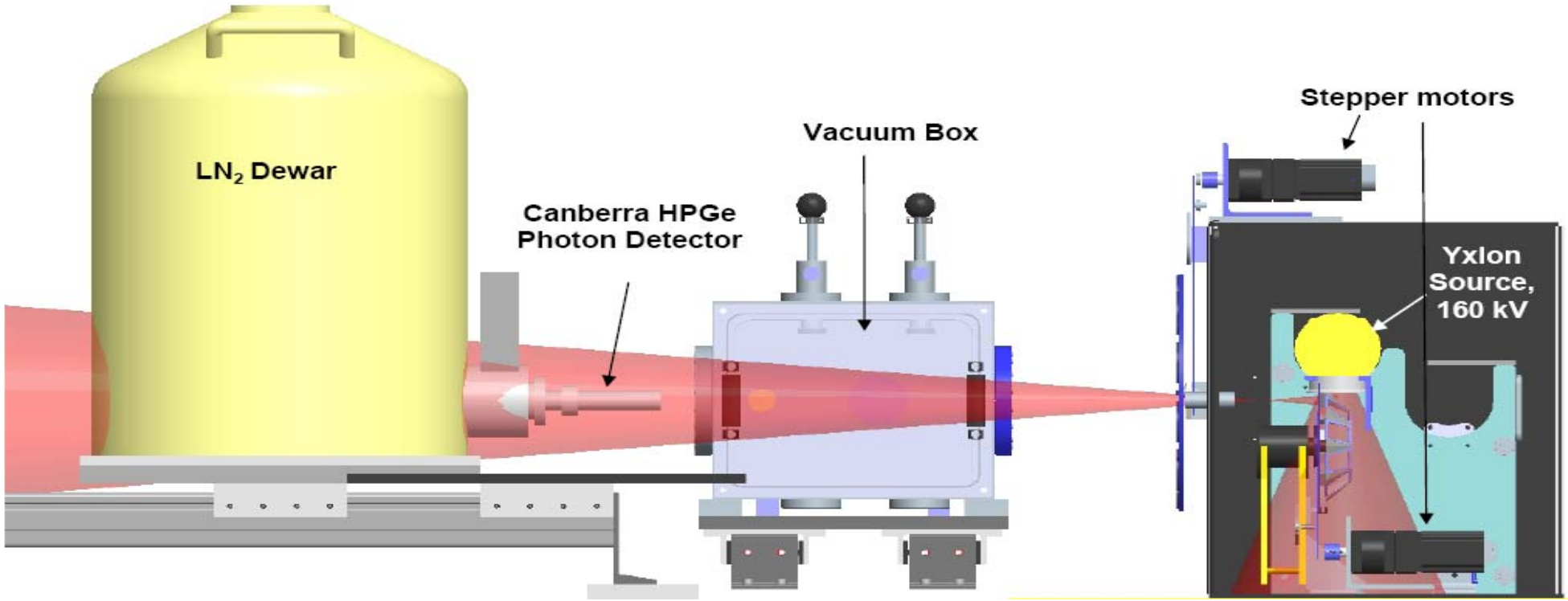
The HEX is a versatile experimental facility.

- The HEX systems are operated remotely in the control room. Users can also stage control systems there for remote operation of experiments.
- 10 filters and 10 fluorescers can be loaded into the sample wheels, allowing experiments to be conducted with minimal interruption.
- Two energy dispersive detectors are available – HPGe, CdTe.



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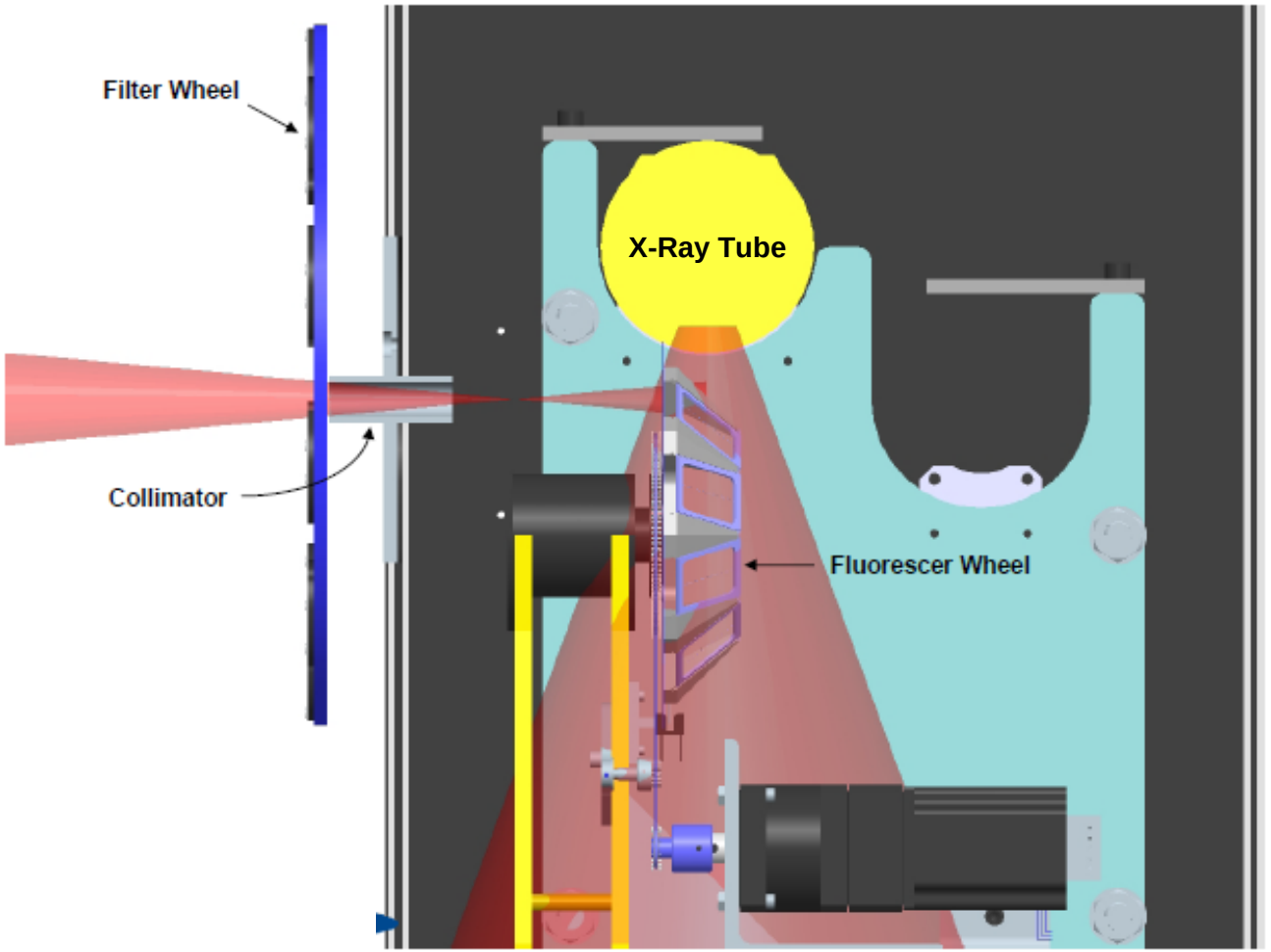
The HEX source is a two stage system, with an X-ray tube causing materials to fluoresce.



This arrangement of the source minimizes bremsstrahlung background.

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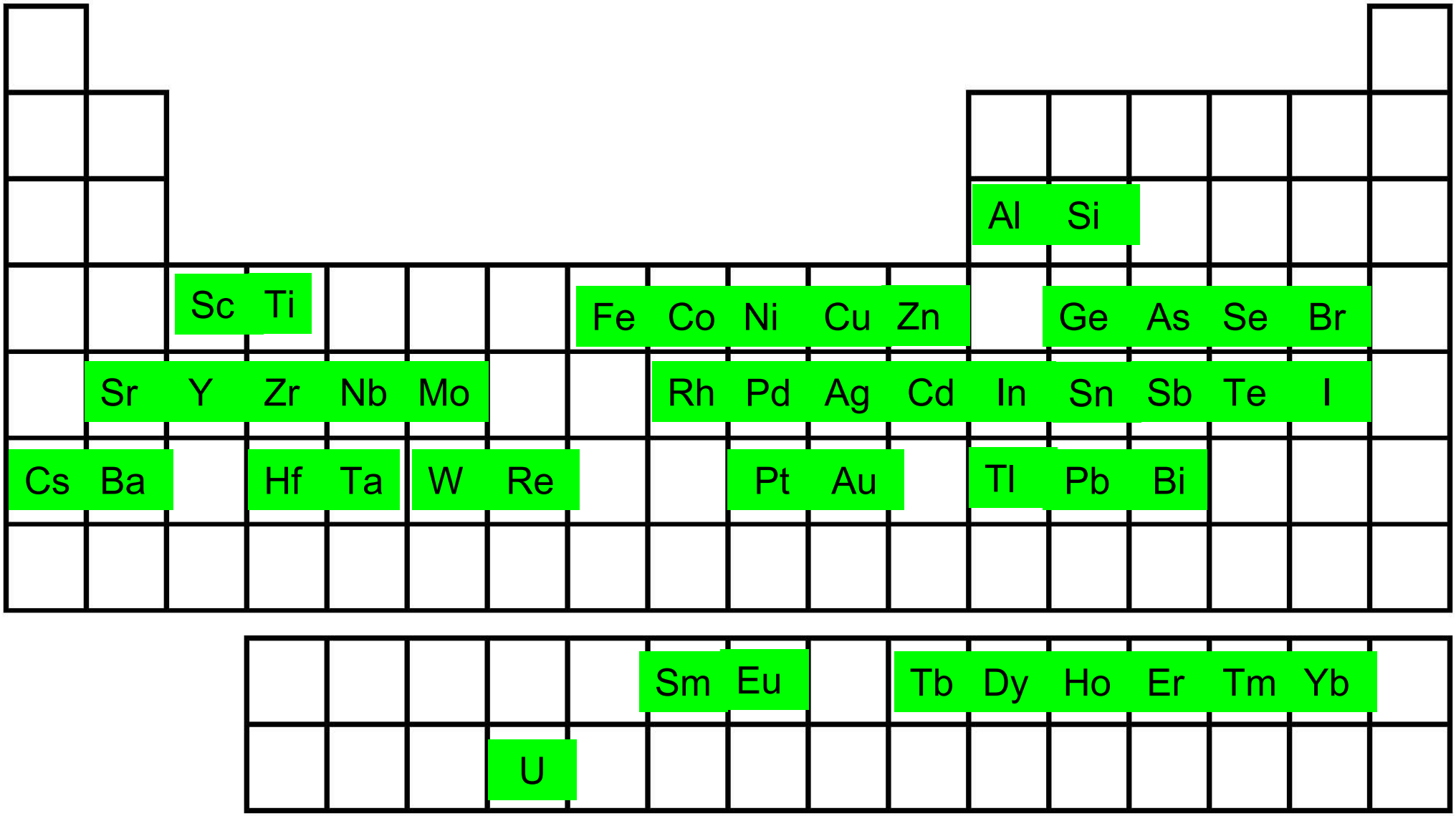
A wide range of materials is available for use in the HEX



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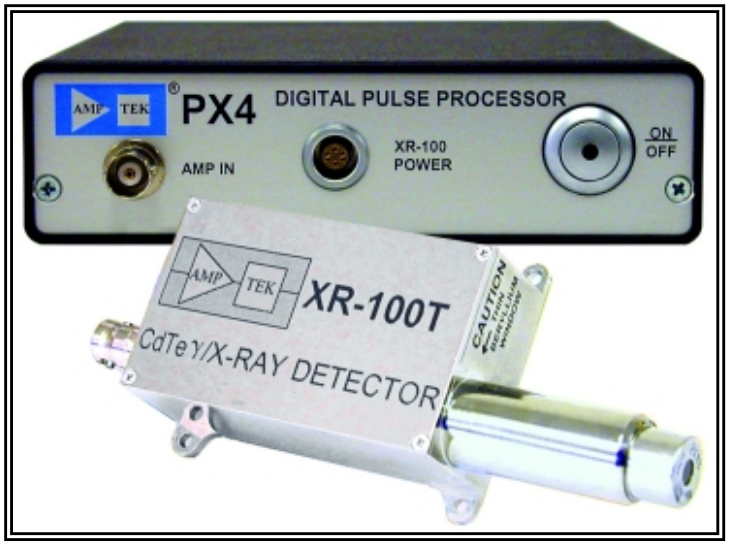
The HEX generates high flux of characteristic radiation.

Typical X-ray Intensities, 1 m from Fluorescer		
Fluorescer Material	**Energy, keV**	**Measured Intensity, photons/cm^2/sec**
Lead	72.8	6.39 x 10^5
Tungsten	59.3	5.12 x 10^5
Samarium	40.1	6.5 x 10^5
Silver	22.3	5.64 x 10^5
Molybdenum	17.5	5.73 x 10^5

- For more or less intensity, both X-ray tube settings can be adjusted, as well as distance from source.

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



- Efficiency curves for both detectors.
- Canberra HPGe provides a intensity measurement (photons/s/cm^2) with 5% uncertainty.
- Amptek CdTe provides a intensity measurement with 10% uncertainty.

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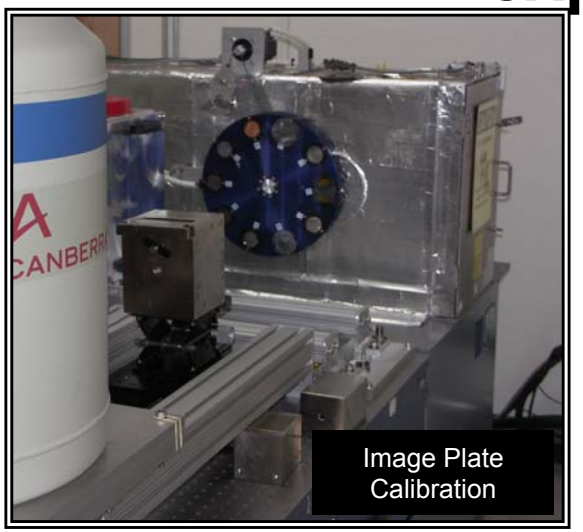
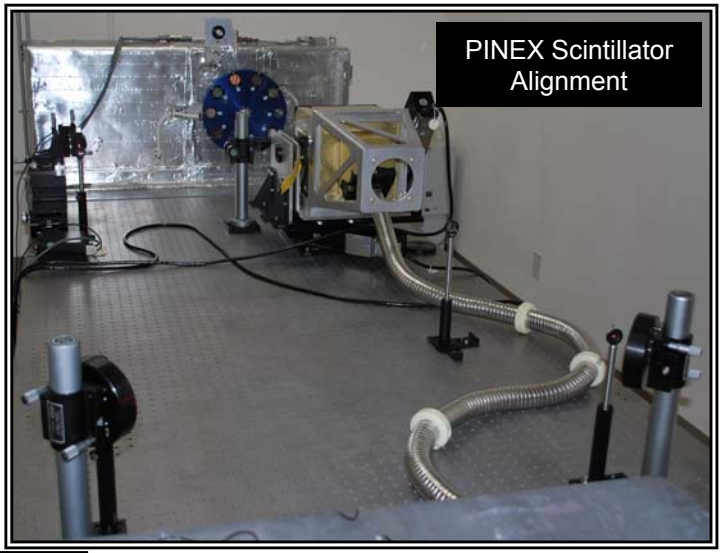
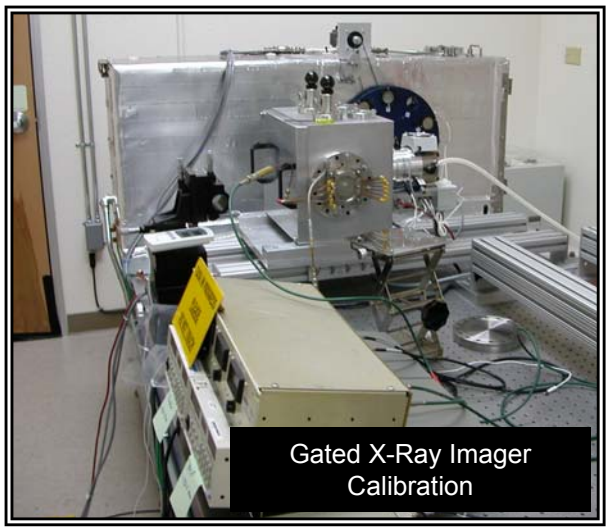
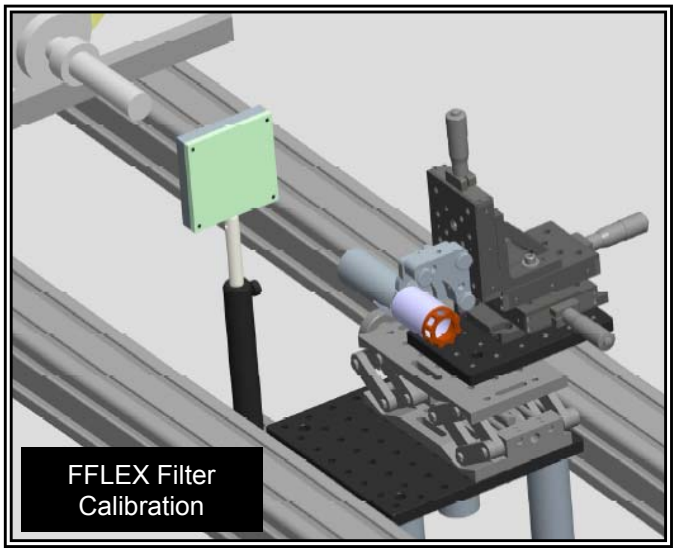
The HEX facility can accommodate multiple types of experiments and calibrations.









The only fixed part of the HEX is the source. Detectors and alignment can be done in exotic geometries.

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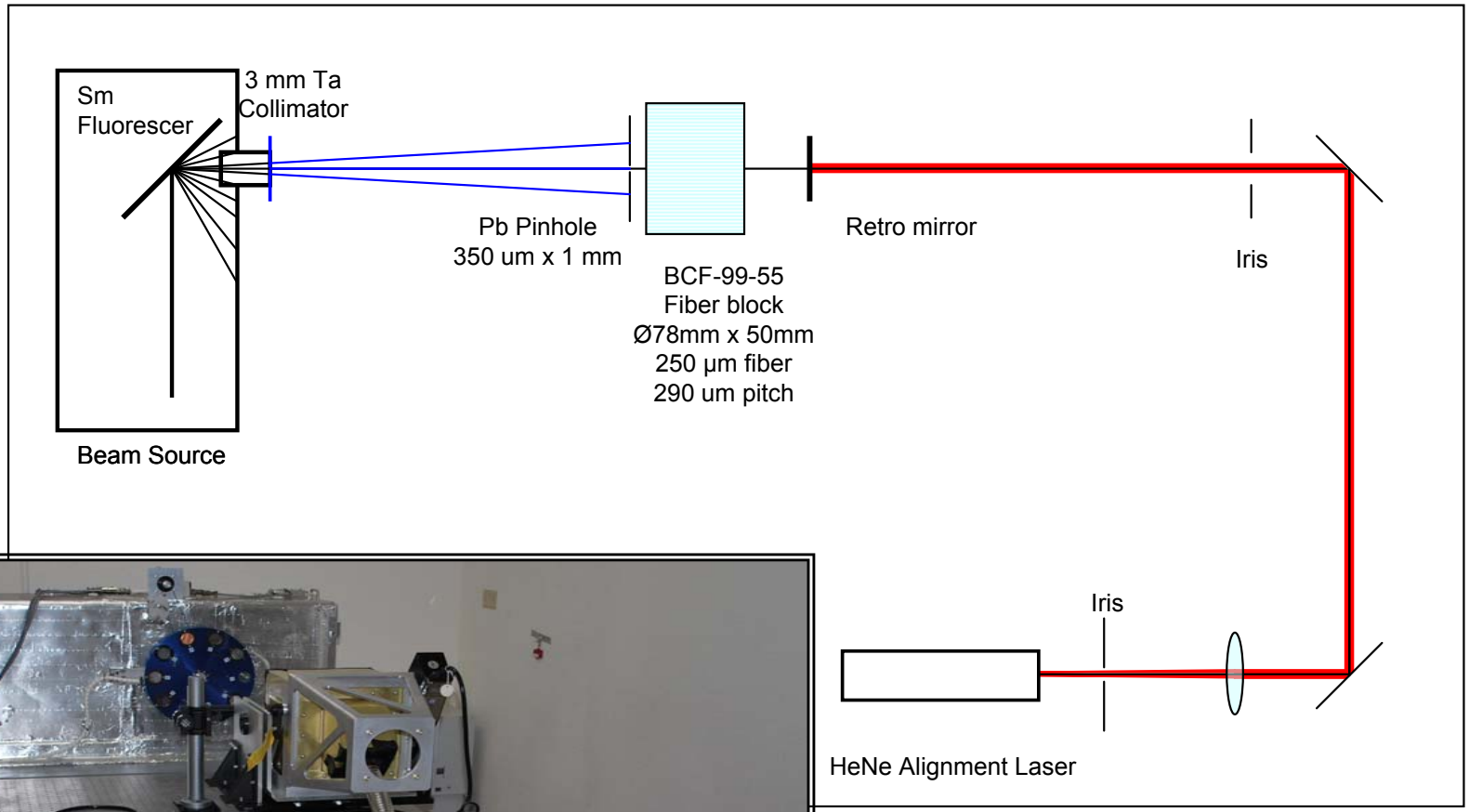
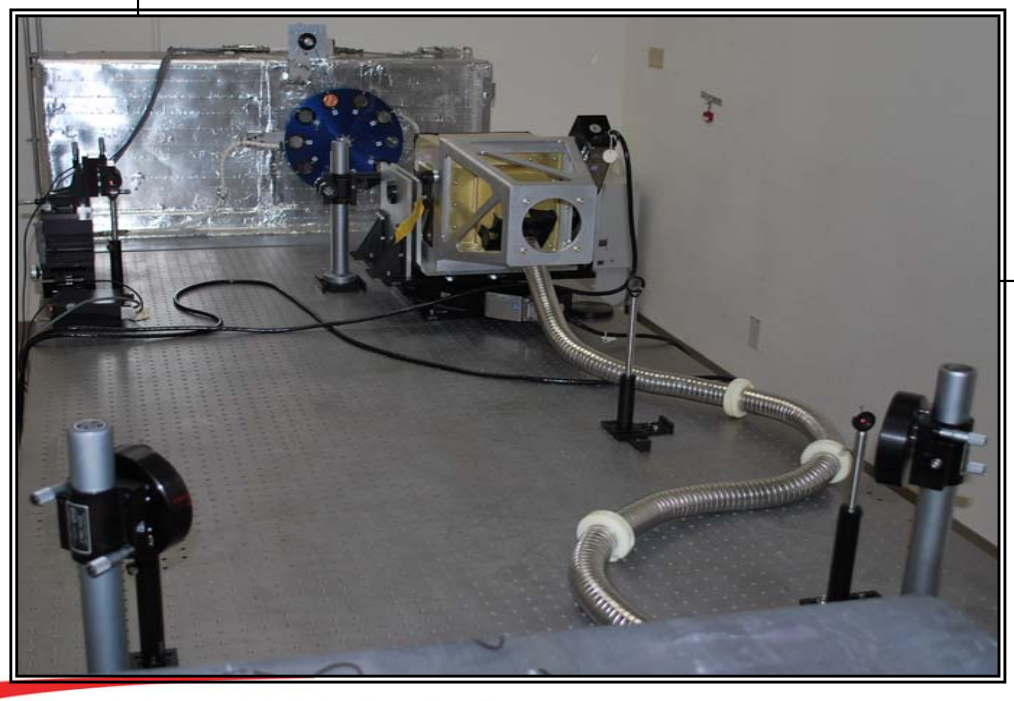
The HEX conducted the Z-Pinex scintillator alignment.





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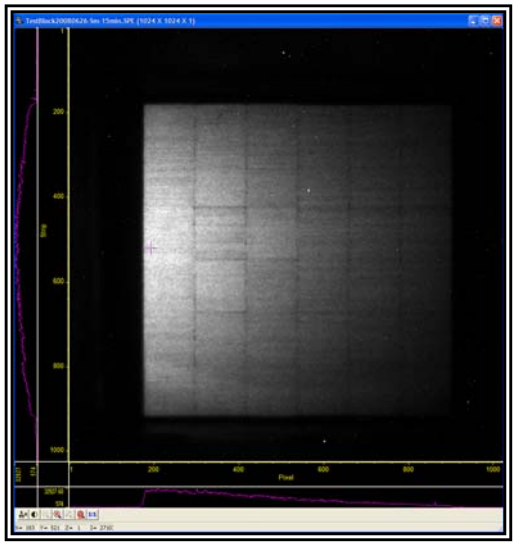
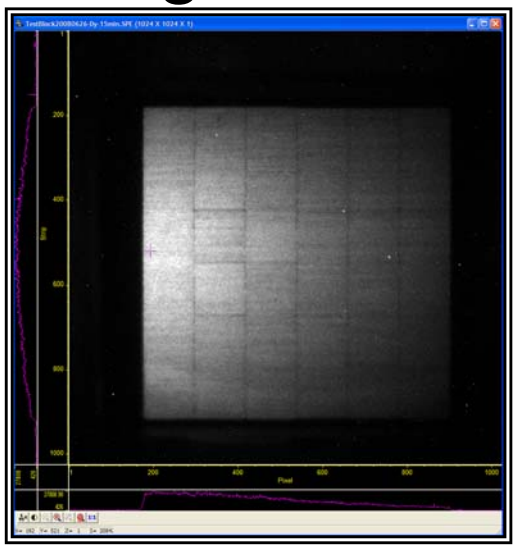
Comparison of Scintillator Fiber Block Illumination at Different Energies

Sm, 46.8 keV
moderate depth
346k γ/cm²/s @1m
38.9M γ/row
32930 peak cts
11.4M peak row sum
15.6 cts/γ

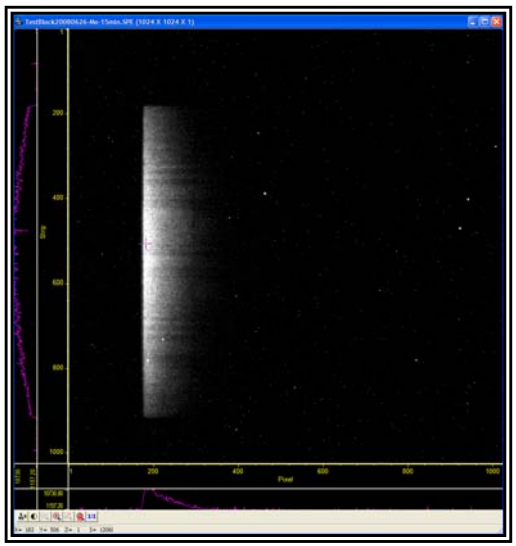


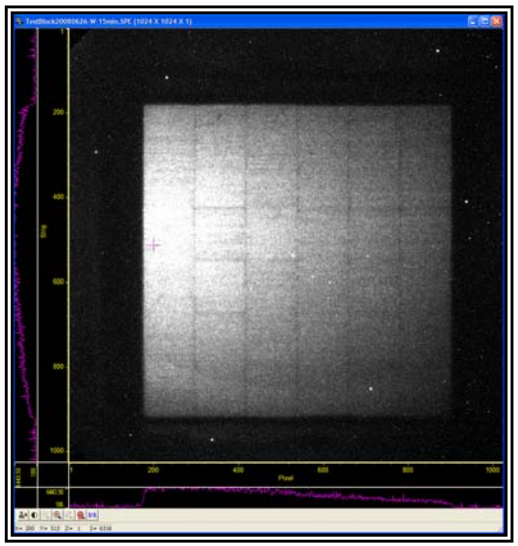


Dy, 53.8 keV
greater depth
similar dose

24065 peak cts
11.0M peak row sum

Mo, 20.0 keV
shallow depth
low dose
249k γ/cm²/s @1m
28.0M γ/row
10730 peak cts
1.43M peak row sum
2.7 cts/γ





W, 69.5 keV
good depth
low dose
164k γ/cm²/s @1m
18.5M γ/row
7030 peak cts
3.67M peak row sum
10.6 cts/γ

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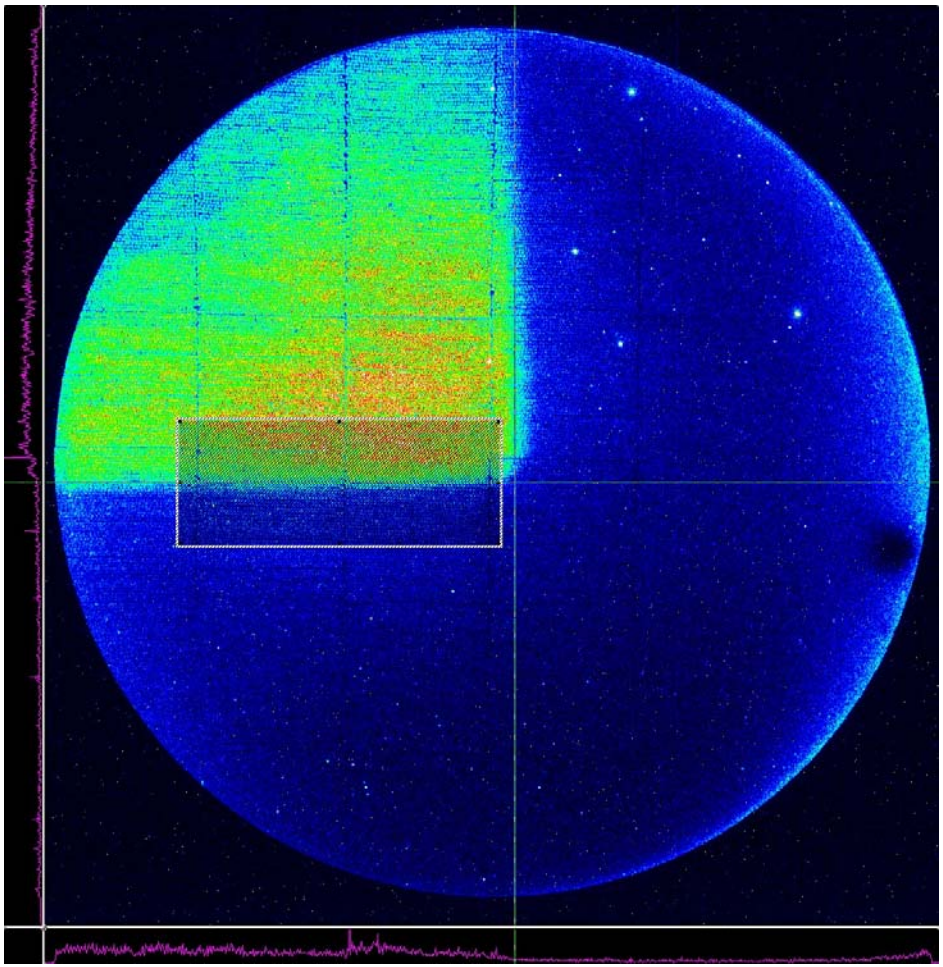
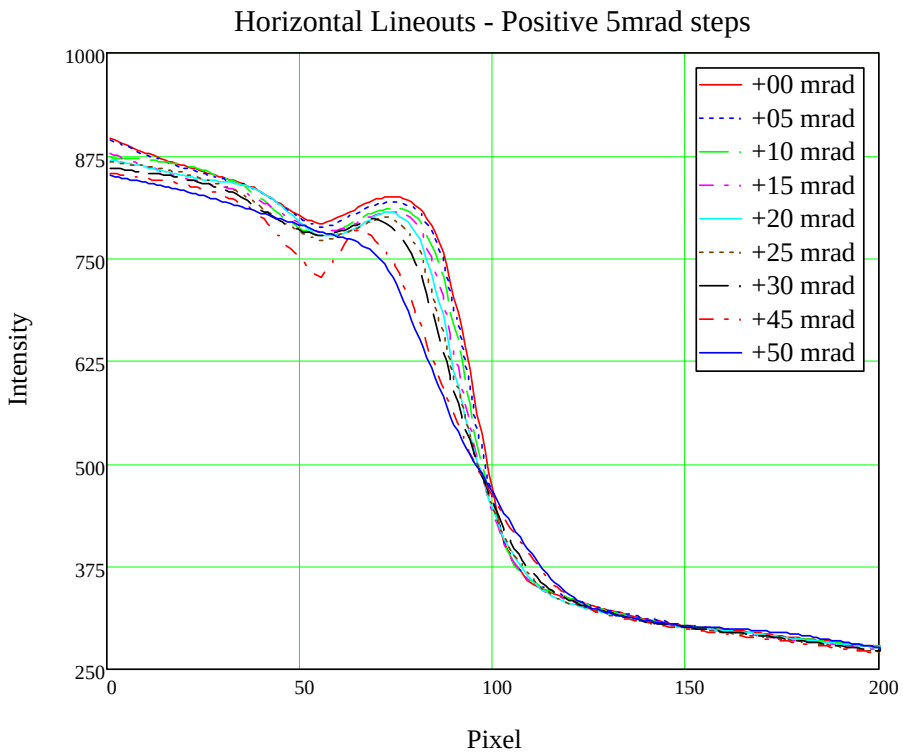
The pointing of the scintillating fibers was determined by looking at edge function images.





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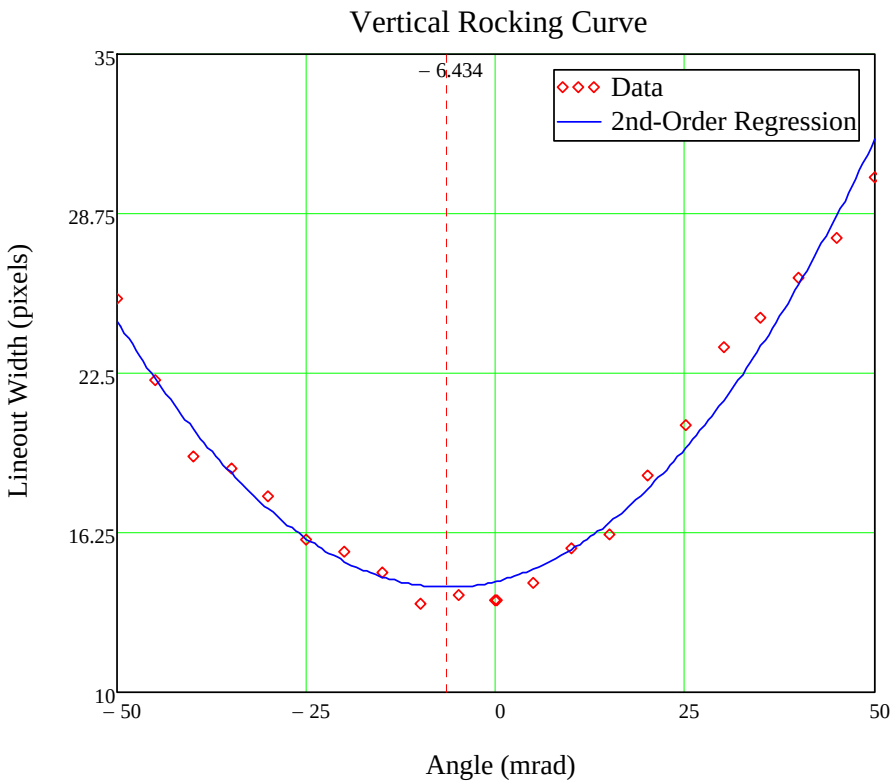
Rocking Curves of the scintillator fiber block were measured.



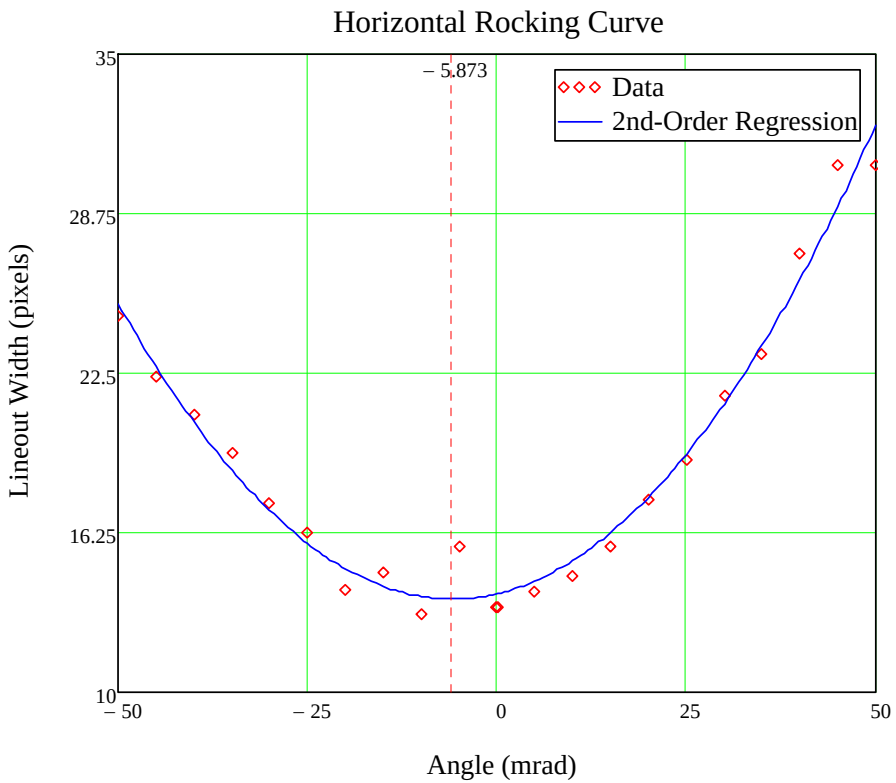


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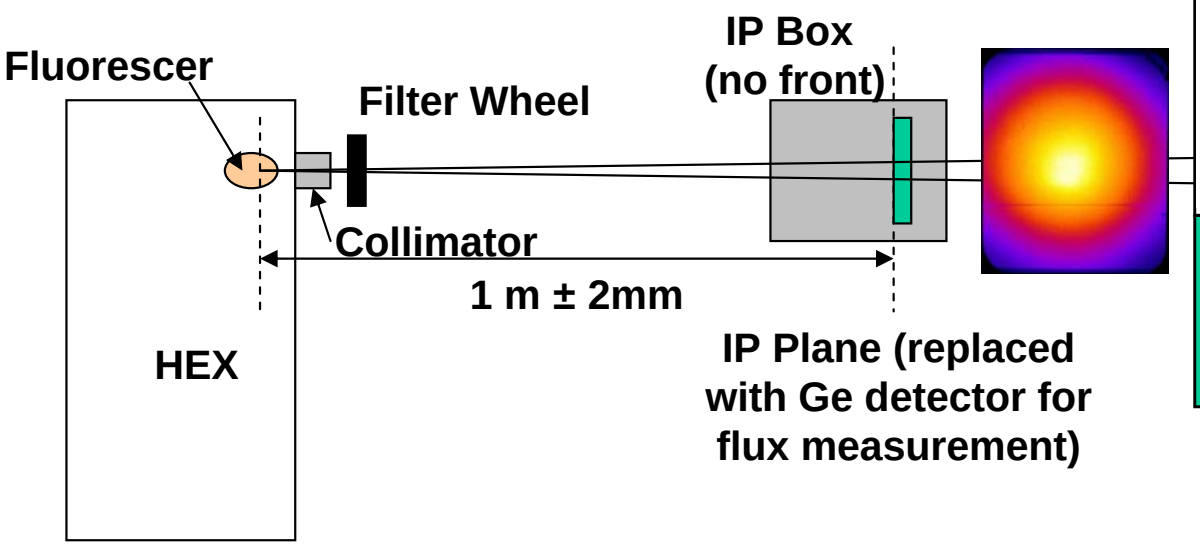
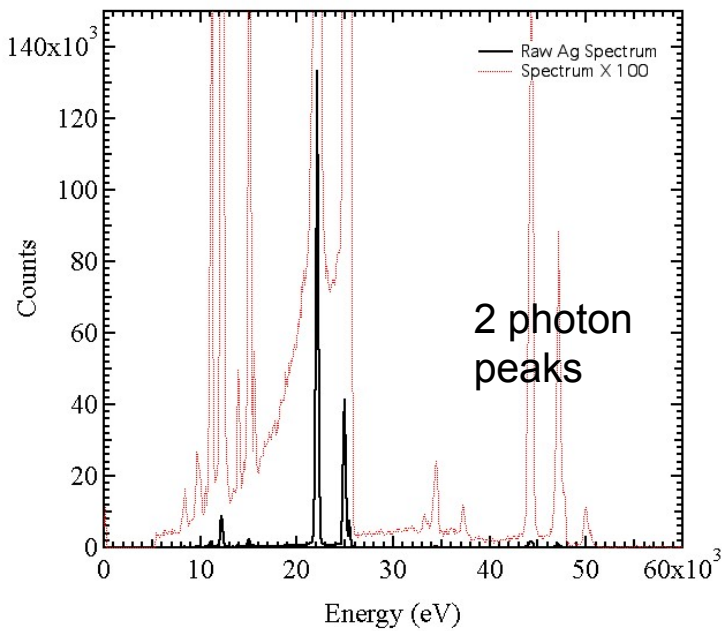
Image plates have been calibrated on the HEX

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



Ag Spectrum @ 2 mA, 40 kV



High spectral purity (K_α & K_β to Bremsstrahlung) achieved for most fluorescers

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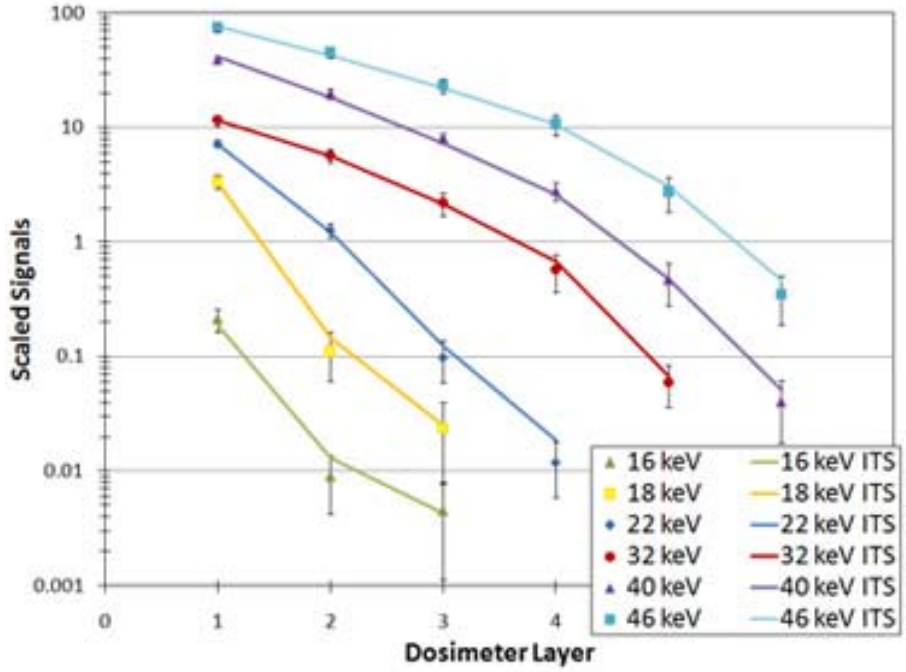
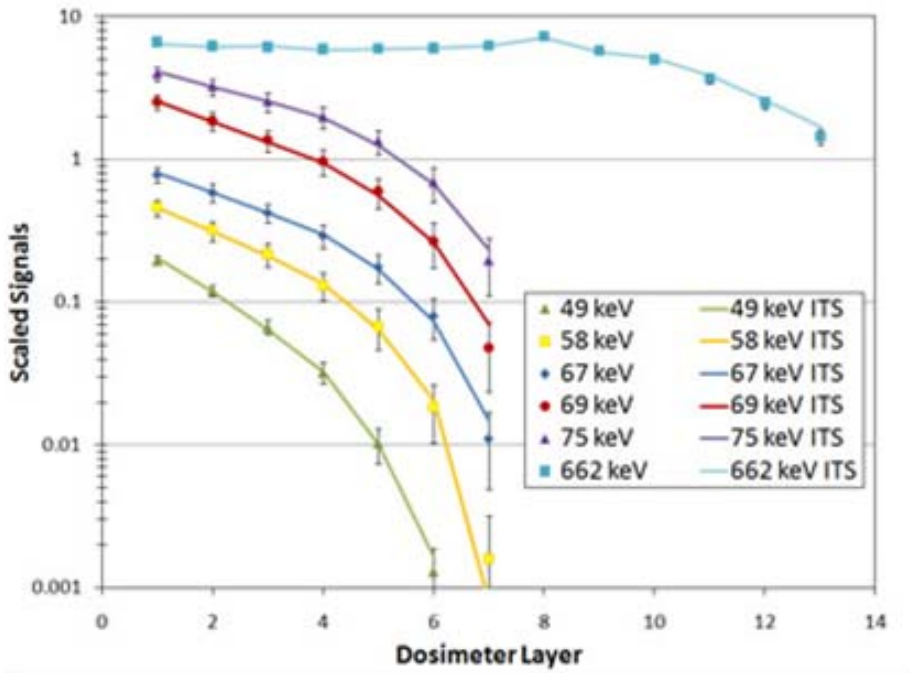
The Bremsstrahlung spectrometer calibration confirms MCNP simulations of expected signal.





Points are measured data, solid lines are simulations.

- The bremsstrahlung spectrometer will be used in short pulse and fast ignition experiments on Titan, Omega/EP, and NIF ARC.
- HEX experiments confirmed simulations from 15 keV – 85 keV.

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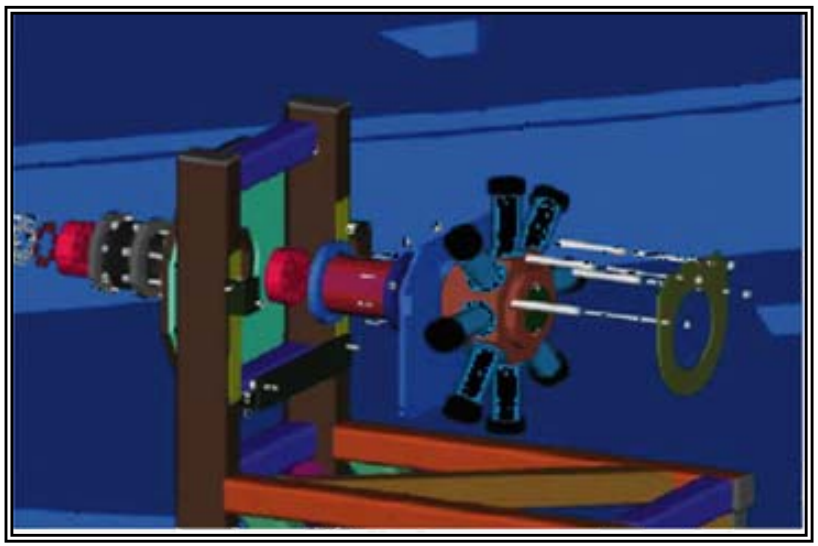
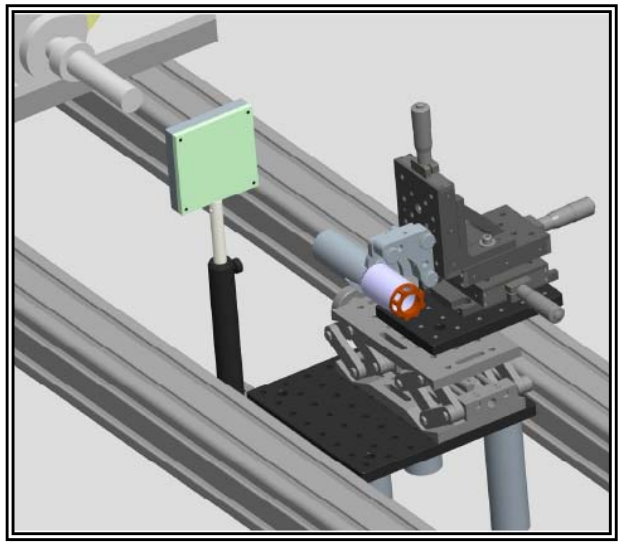
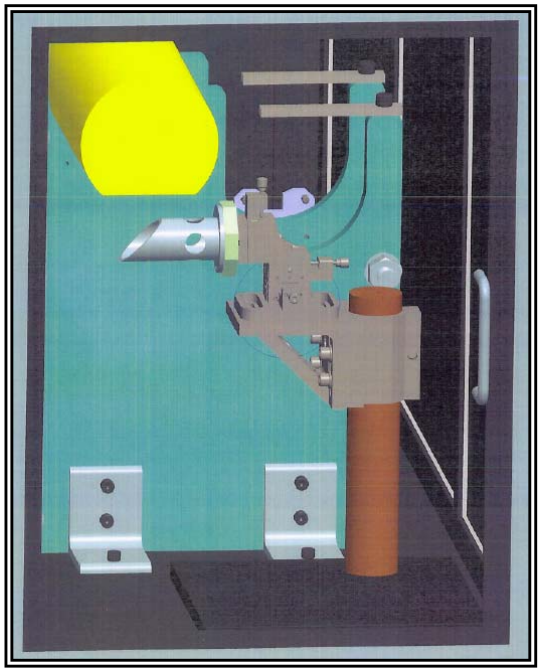
NIF FFLEX will be calibrated on the HEX



FFLEX as installed on NIF.



FFLEX filter calibration in HEX.



FFLEX fluorescer yield calibration setup.

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

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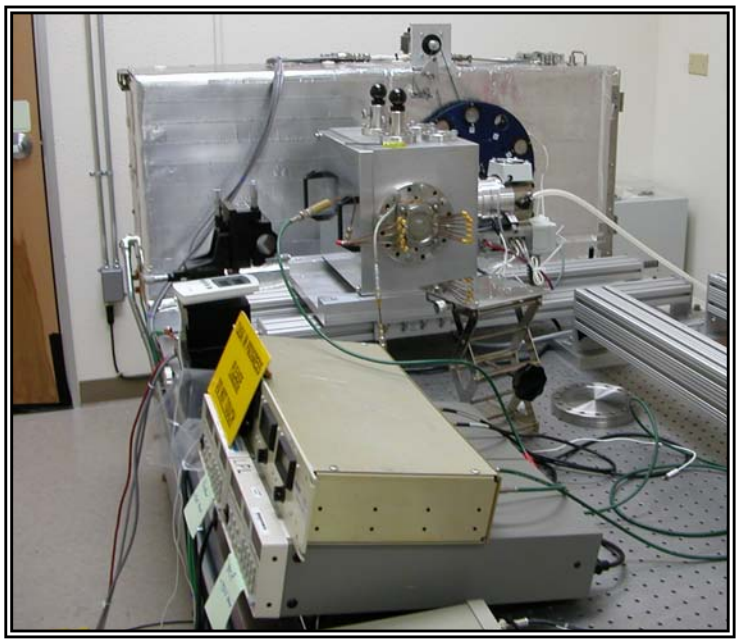
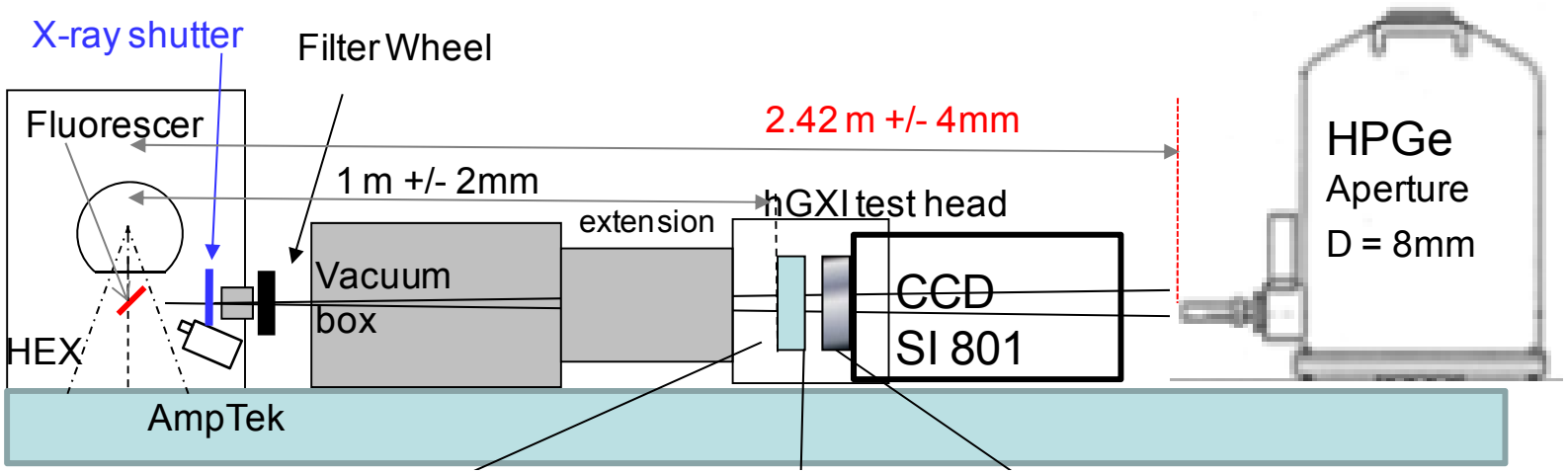
NIF hGXI – hardened Gated X-Ray Imager will be calibrated on NIF.

- NIF hGXI will be a workhorse x-ray imagers at high energies; up to 60 keV.
- The calibration will include:
  - MCP gain slope
  - Relative energy dependence
  - Phosphor gain slope
  - Single photon response





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- The source X-ray tube voltage and current are continuously adjustable, which, combined with external edge filtering, allows the HEX to provide clean energy lines.
- HEX detectors include a high purity Ge spectrometer as well as a CdTe spectrometer. They deliver photons/s/cm^2 with 5% and 10% error, respectively.
- Already the HEX has been used to calibrate image plates, scintillators, and a bremsstrahlung spectrometer with plans to calibrate NIF FFLEX, hGXI, and the NIF/GA HOPG spectrometer.

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Contact Information

Zaheer Ali
Scientist

National Security Technologies, LLC
aliza@nv.doe.gov
925-960-2512

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