

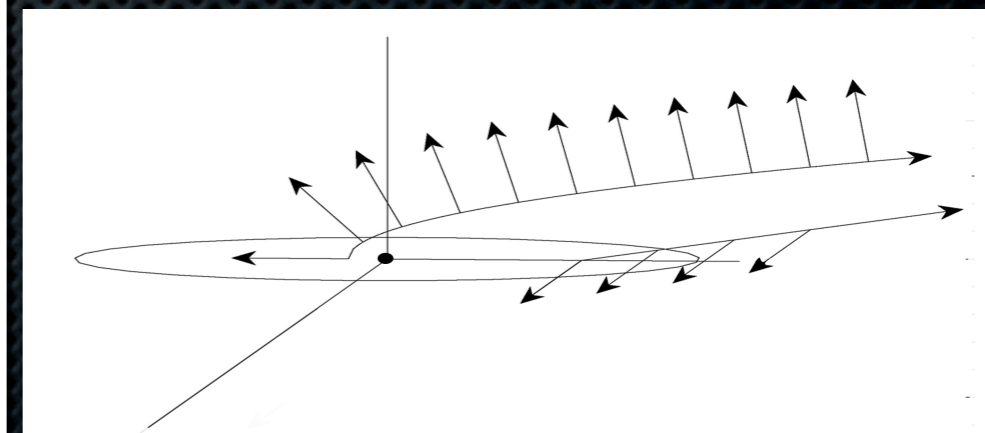
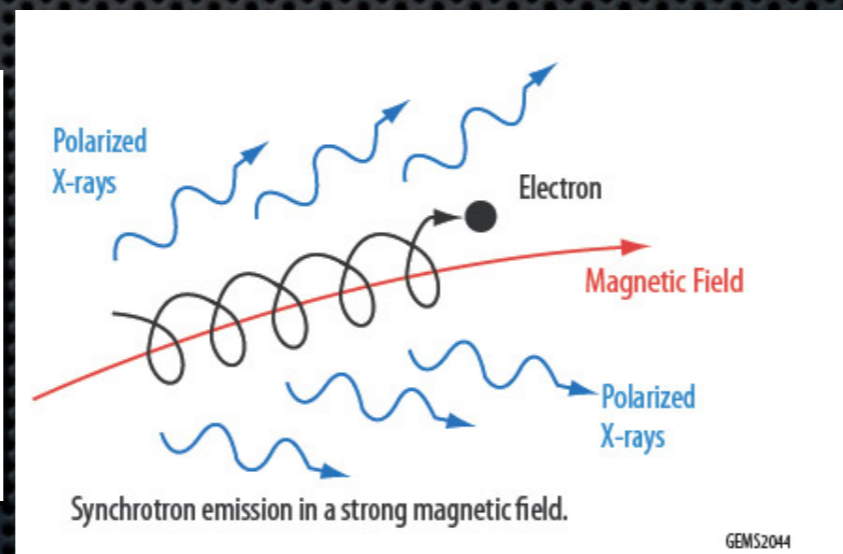
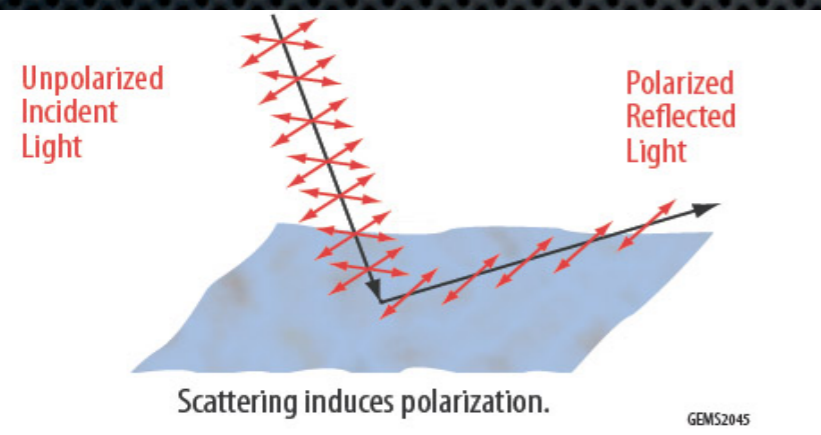
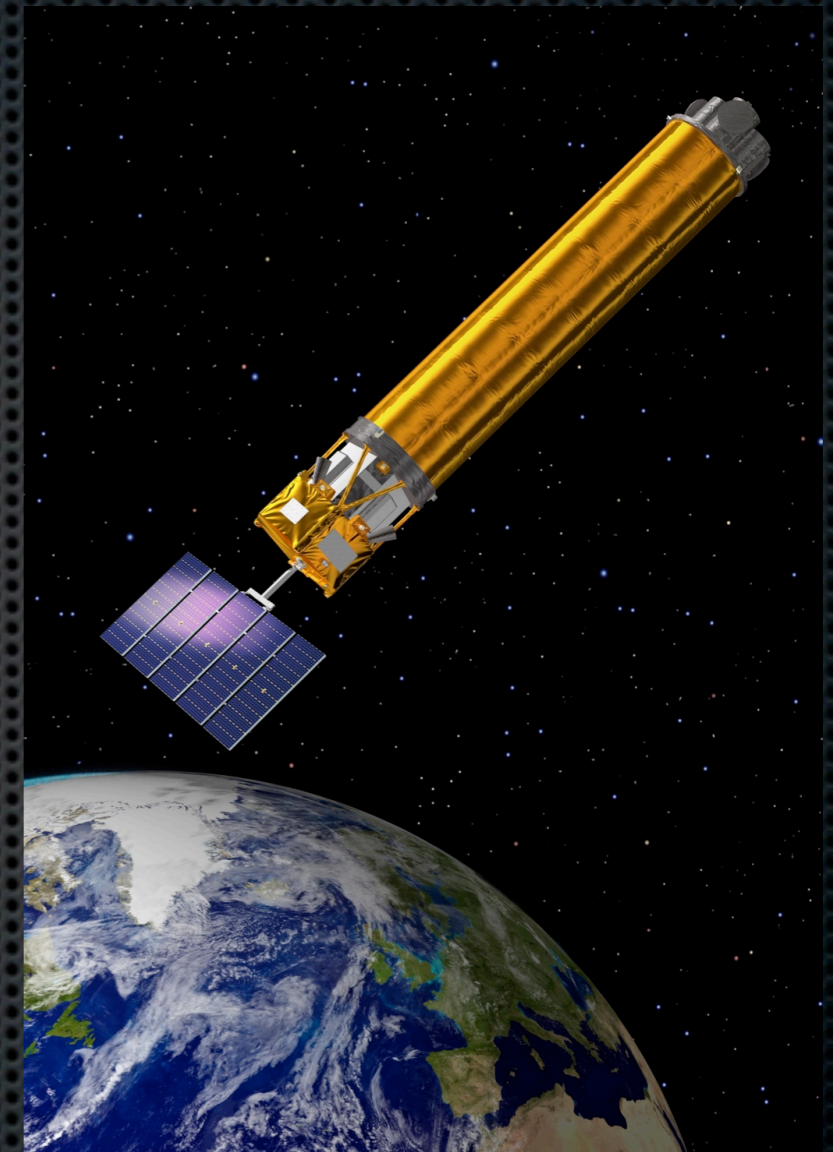
Ground Calibration for GEMS XPI

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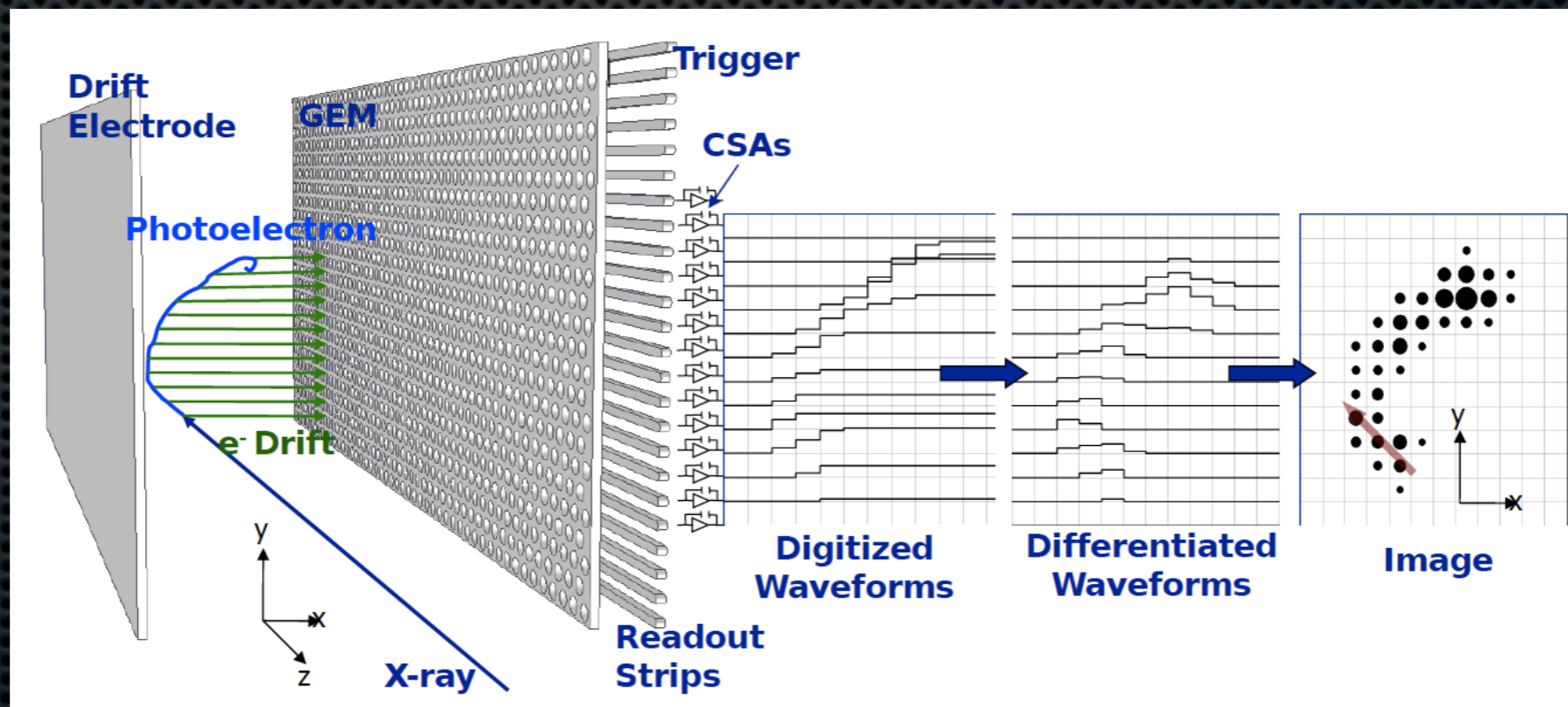
GEMS

- ✦ Polarization measurements allow us to study:
 - ✦ Scattering
 - ✦ Magnetic fields
 - ✦ Strong gravity
- ✦ GEMS will use polarimetry to study these processes in black holes, neutron stars and SNR



What XPI will measure

- Polarization of X-rays
- Photoelectron is ejected in direction of X-ray E-field
- Photoelectron makes a track of electrons which is imaged by the TPC
- Initial direction of photoelectron gives the polarization of the X-ray



TPC Design and Requirements

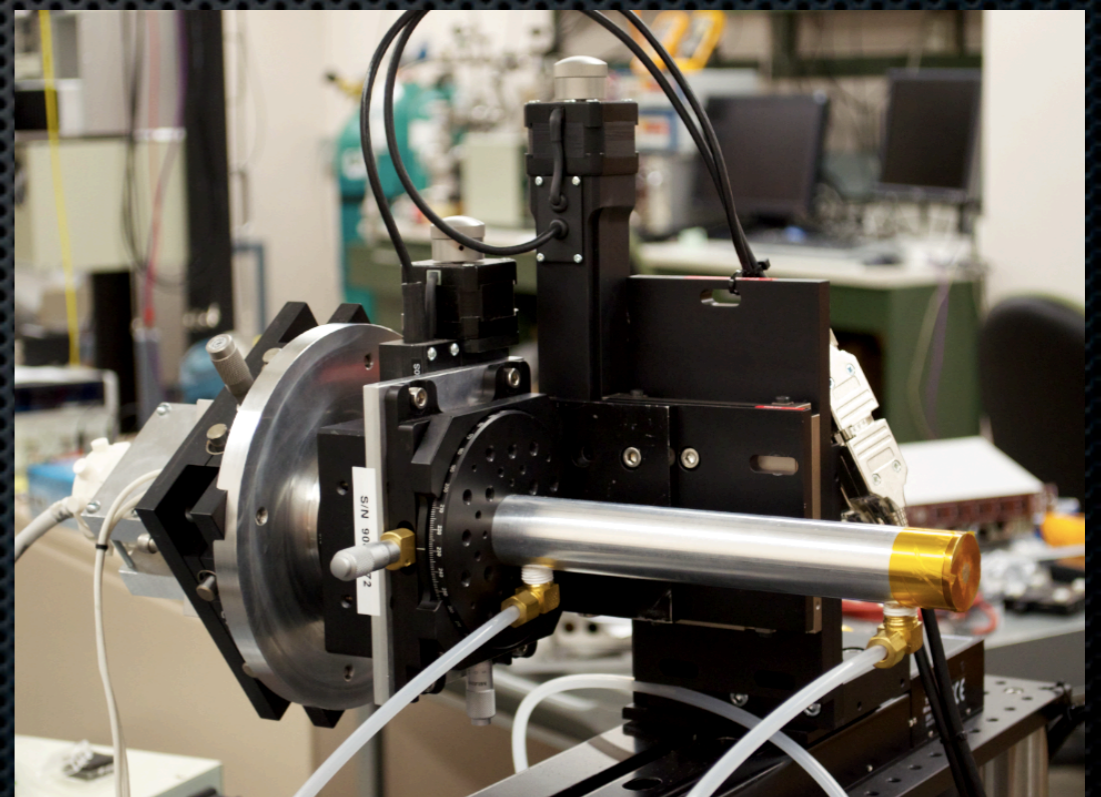
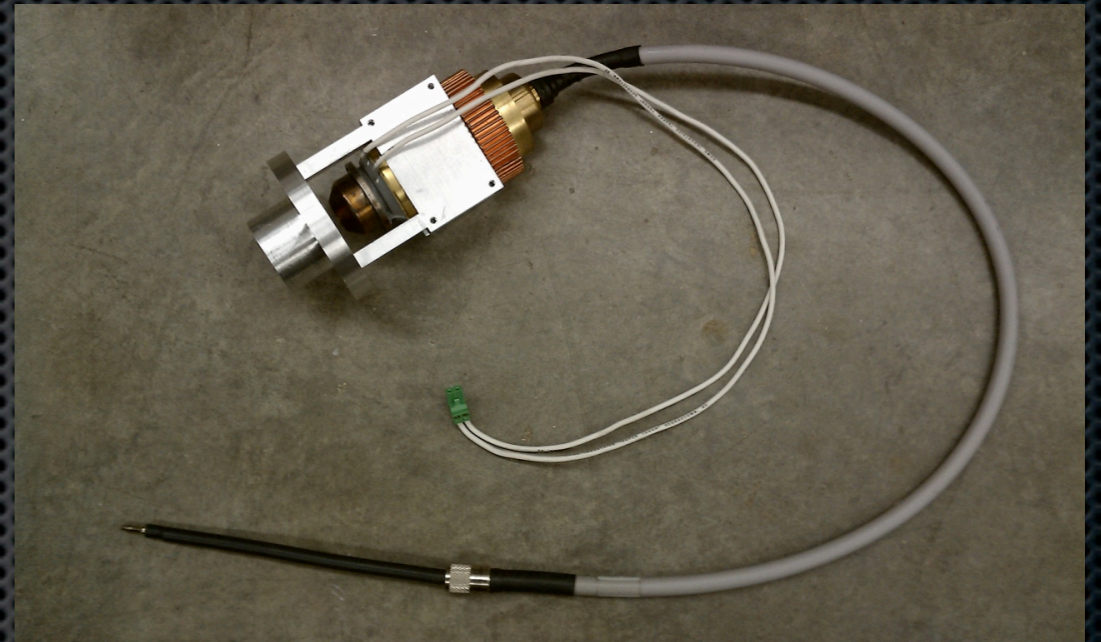
- ✦ The GEMS TPC detectors need to detect 1% polarization with 1.8×10^6 counts.
- ✦ 2 - 10 keV energy response
- ✦ Energy resolution of 1 keV in the 2 - 10 keV band
- ✦ ~ 10 arcmin angular resolution

Calibration Requirements

- ✦ X-ray beams (100% and 0% polarization) at multiple energies will be scanned across the detector window
- ✦ Polarized beams rotated with respect to the detector to produce range of polarization angles
- ✦ Pulse height to energy conversion factor must be measured
- ✦ Must be tested in flight conditions

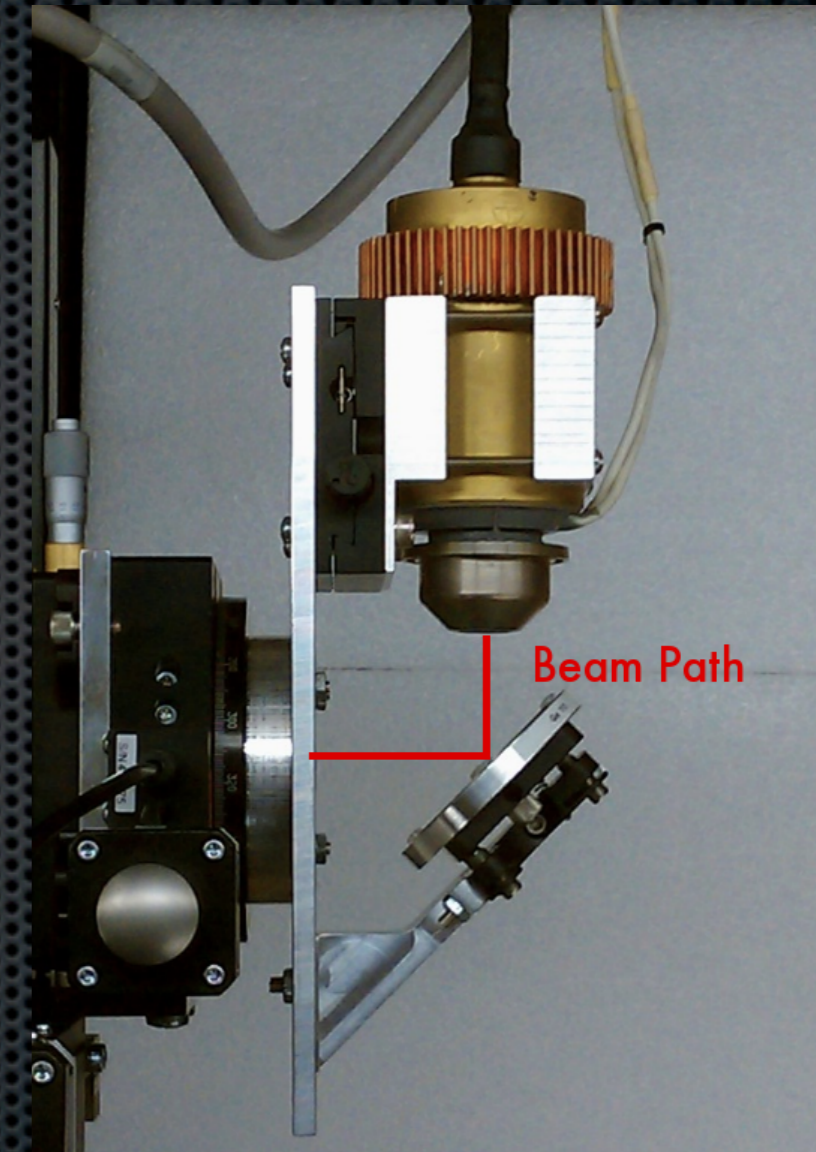
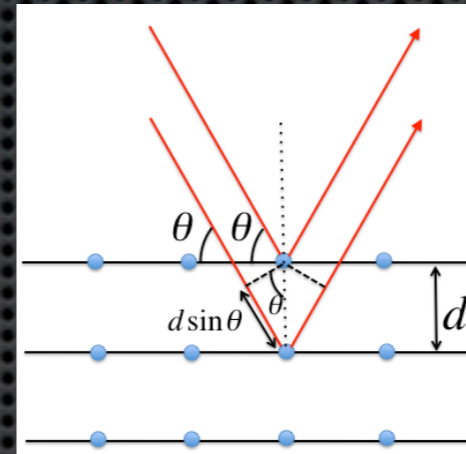
Calibration Facility

- X-ray beamline with 2-axis translation + 1 rotational axis
- X-rays generated by commercial medical X-ray tubes chosen to be cylindrically symmetric for low intrinsic polarization
- Helium filled beamline to improve transmission at low energies



100% Polarized Sources

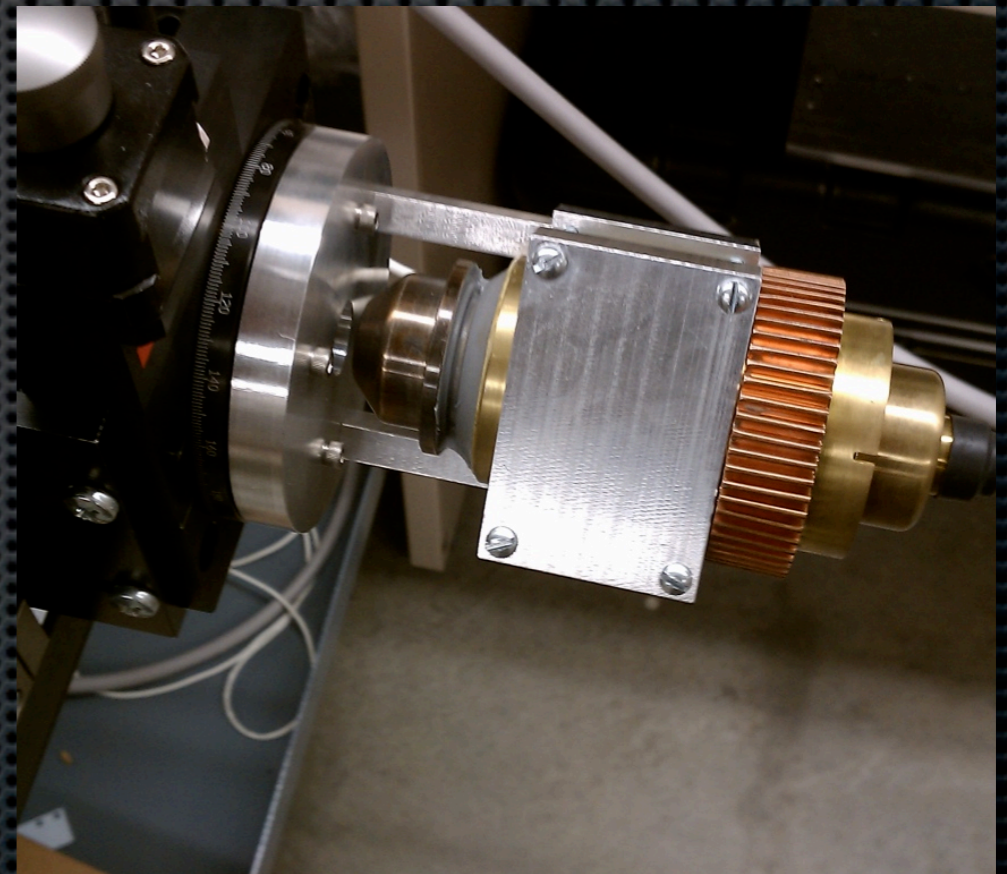
- ✦ X-ray beam Bragg scattered at near 45 deg angle to produce 100% polarized beam
- ✦ Crystals selected that match the Bragg angle of the required X-ray energies



Energy (keV)	Target and Line	Crystal Material	2d Spacing (Angstrom)	E at 45° keV	Bragg Order	Bragg Angle
2.70	Rh-La	Ge (111)	6.532	2.68	1	44.7
2.98	Ag-La	Si (111)	6.271	2.80	1	41.5
4.51	Ti-Ka	Si (110)	3.840	4.57	1	45.7
6.40	Fe-Ka	Sapphire (Al ₂ O ₃)	2.748	6.38	1	44.8
8.05	Cu-Ka	Ge (111)	6.532	2.68	3	45.0
8.40	W-La	Si (111)	6.271	2.80	3	44.9

0% Polarized Sources

- ✦ Cylindrically symmetric X-ray tube with circular filament
- ✦ Tube centered on beam line
- ✦ Low intrinsic polarization removed by continuous rotation to produce 0% net polarization



Pulse Height \rightarrow Energy

- ✦ GEMS is required to find the energy of incident X-rays in addition to the polarization
- ✦ For a given energy, a pulse height distribution will be produced
- ✦ The relation between pulse height and energy will be extrapolated from the measurements with tubes at different energies

