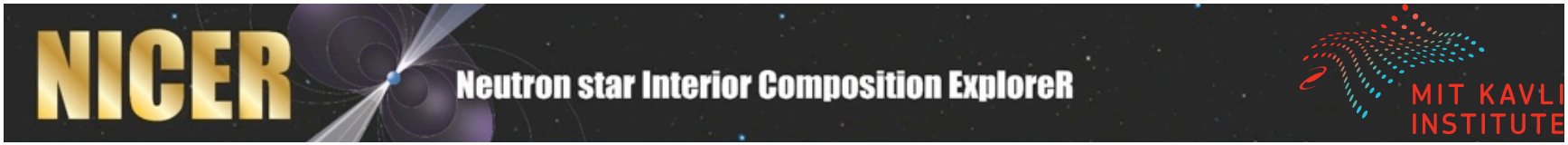


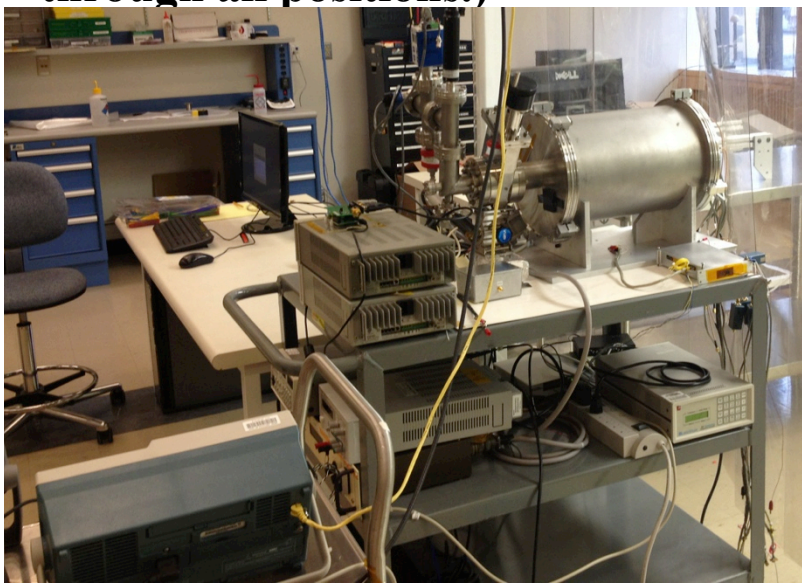
Neutron Star Interior Composition ExploreR
NICER

Bev LaMarr (MIT) for the NICER team.

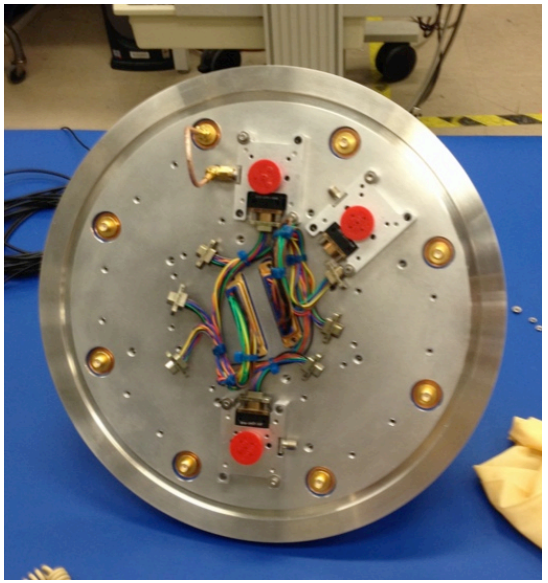
- **NICER Calibration Group**
  - Ron Remillard
  - Craig Markwardt
  - Gregory Prigohzin
  - John Doty
  - Jack Steiner
  - Joel Villasanor
  - Keith Gendreau
  - Kevin Black
  - Luke Winternitz
  - Drew Malonis
  - Michael Vezie
  - Rick Foster
  - Ronald Zellar
  - Steve Kissel
  - Wayne Baumgartner
  - Zaven Arzoumanian

Flight FPM Characterization at MIT

- **Modulated X-ray Source (MXS) from GSFC: pulsed lines from .28 keV to 8.9 keV**
- **The backplate allows 8 detectors at a time (two will be used for reference and present in all sets, one in the same location for all runs, the other will move through all positions.)**



MXS setup

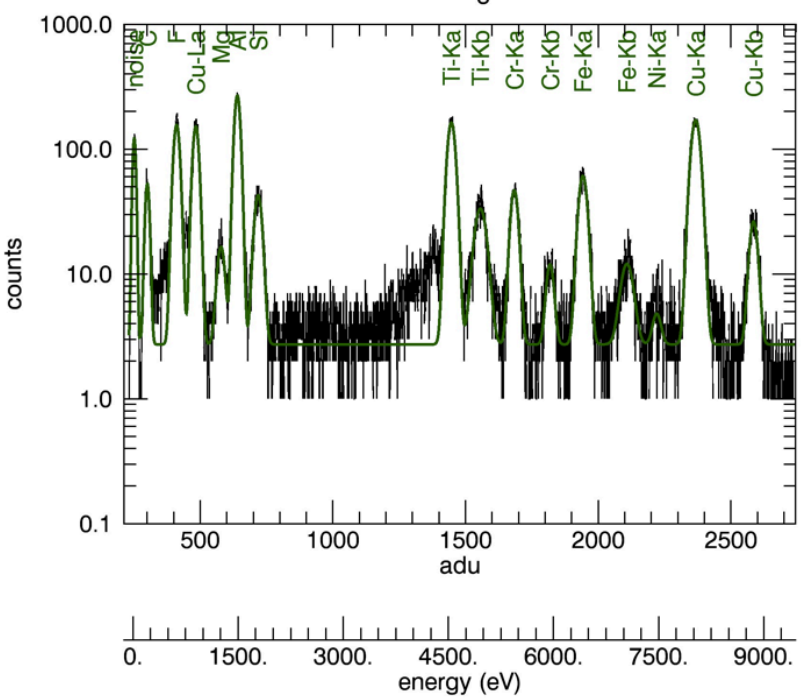


Partially populated backplate

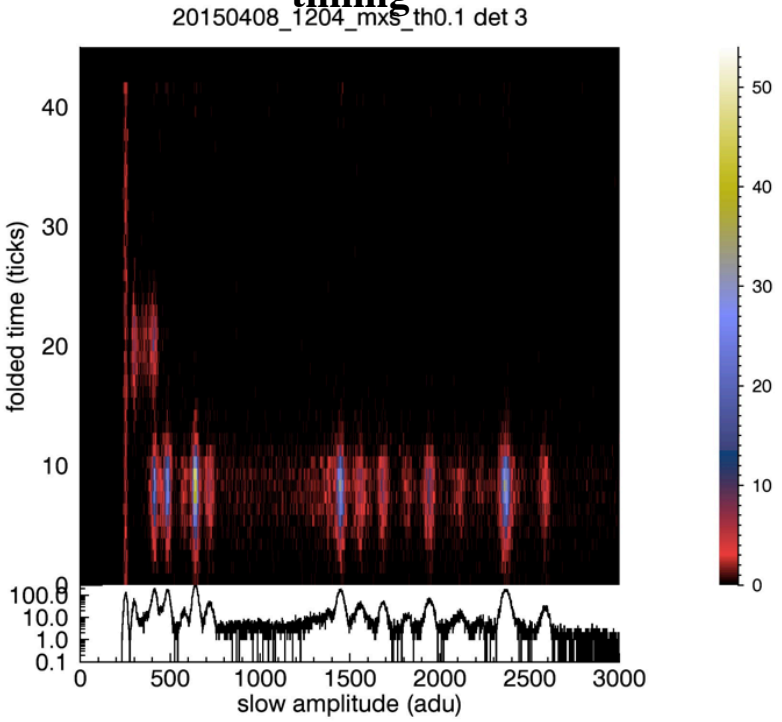
Flight FPM Characterization at MIT

- **Modulate Xray Source provided by GSFC provides multiple lines at 600kHz**

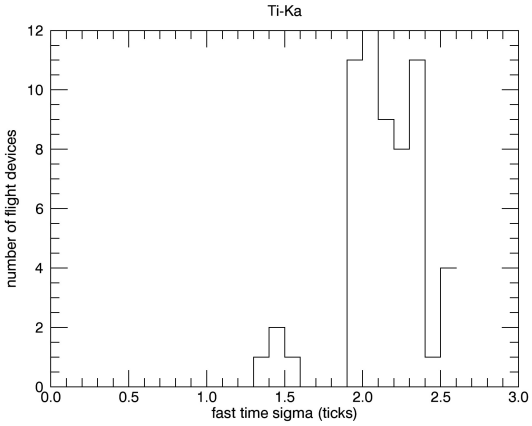
spectrum



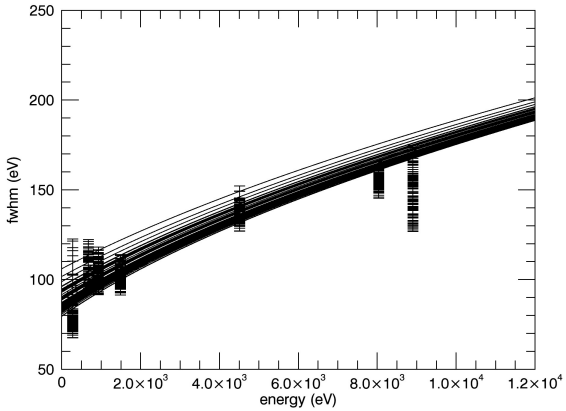
timing



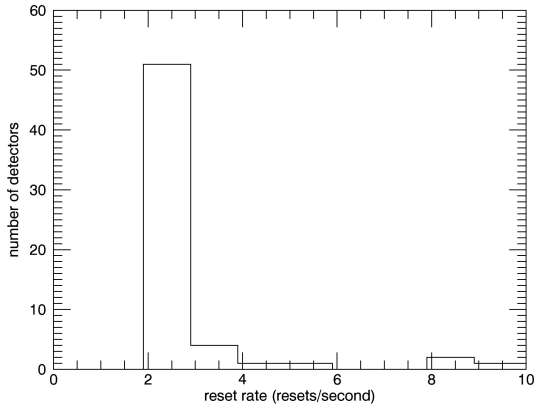
FPM parameters from MIT MXS data



Timing resolution.
A tick is approximately 38 nsec.
Spread due to 20 nsec pulse width and full illumination have not been removed here.



Spspectral resolution.
Better than 120 eV below 1keV.
Better than 200 eV out to 12 keV.

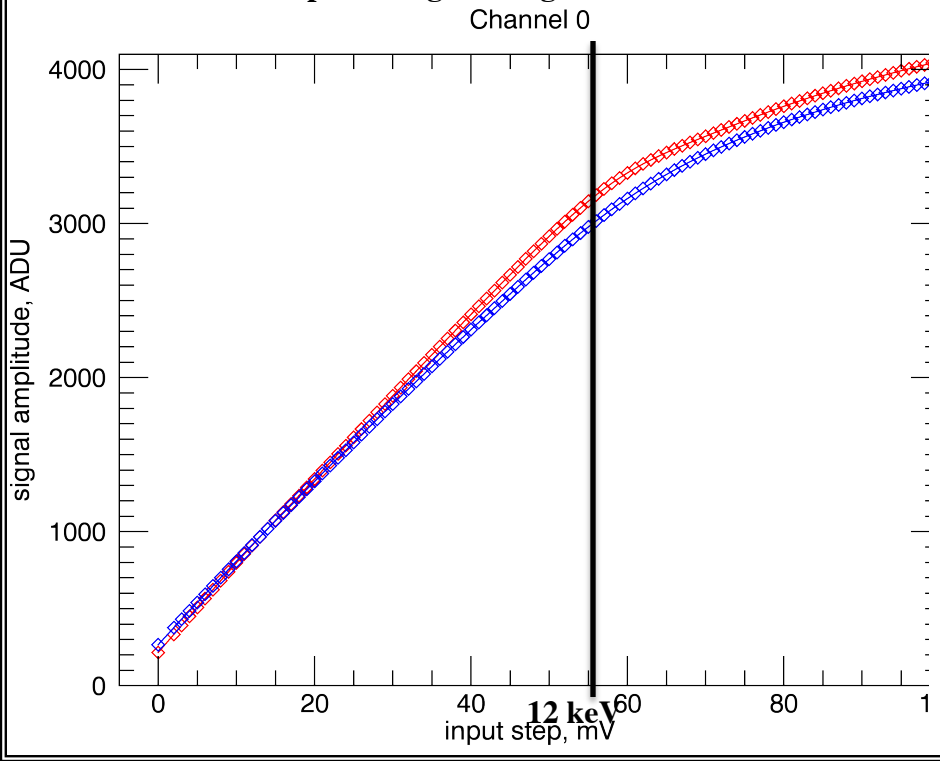


Reset rates.
Typically a few per second at -55C.

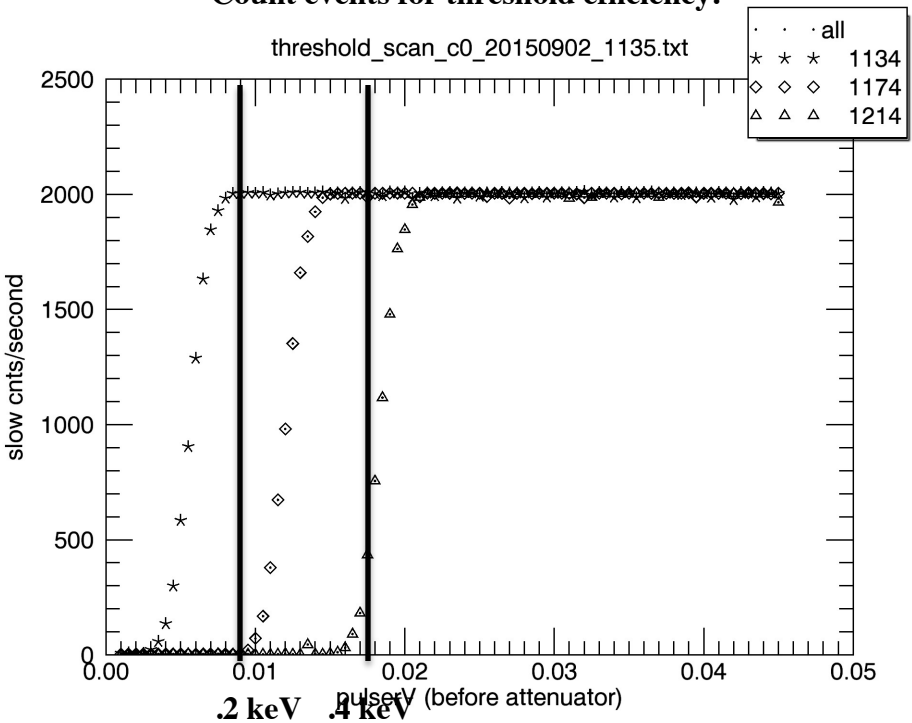
Flight MPU Characterization

- **Replace the FPM with a pulse generator and step through multiple voltages**

Fit pulse heights for gain curves:



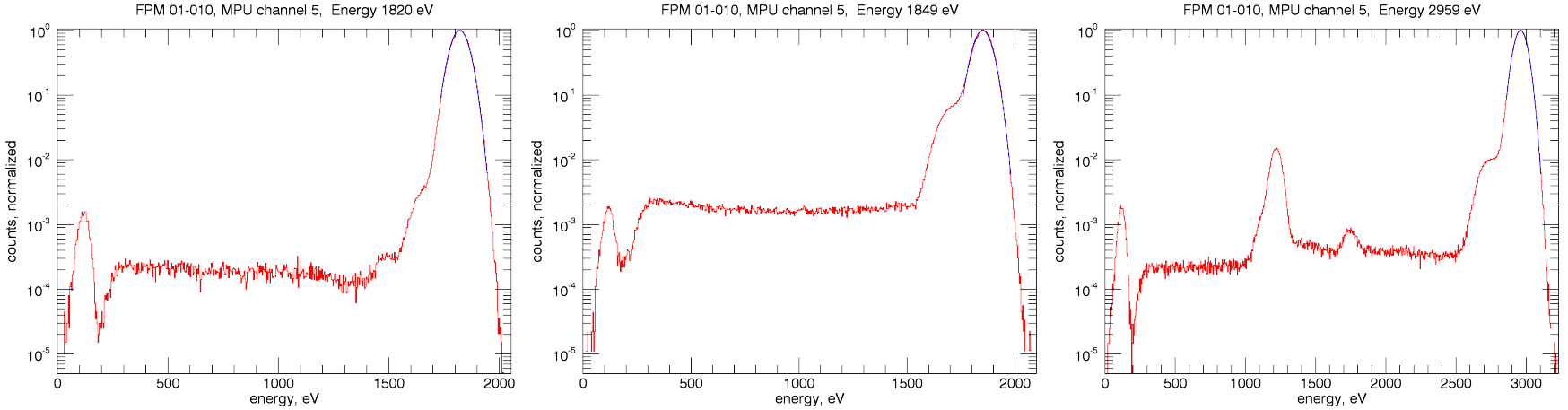
Count events for threshold efficiency:



Reference Detector Characterization at BESSY

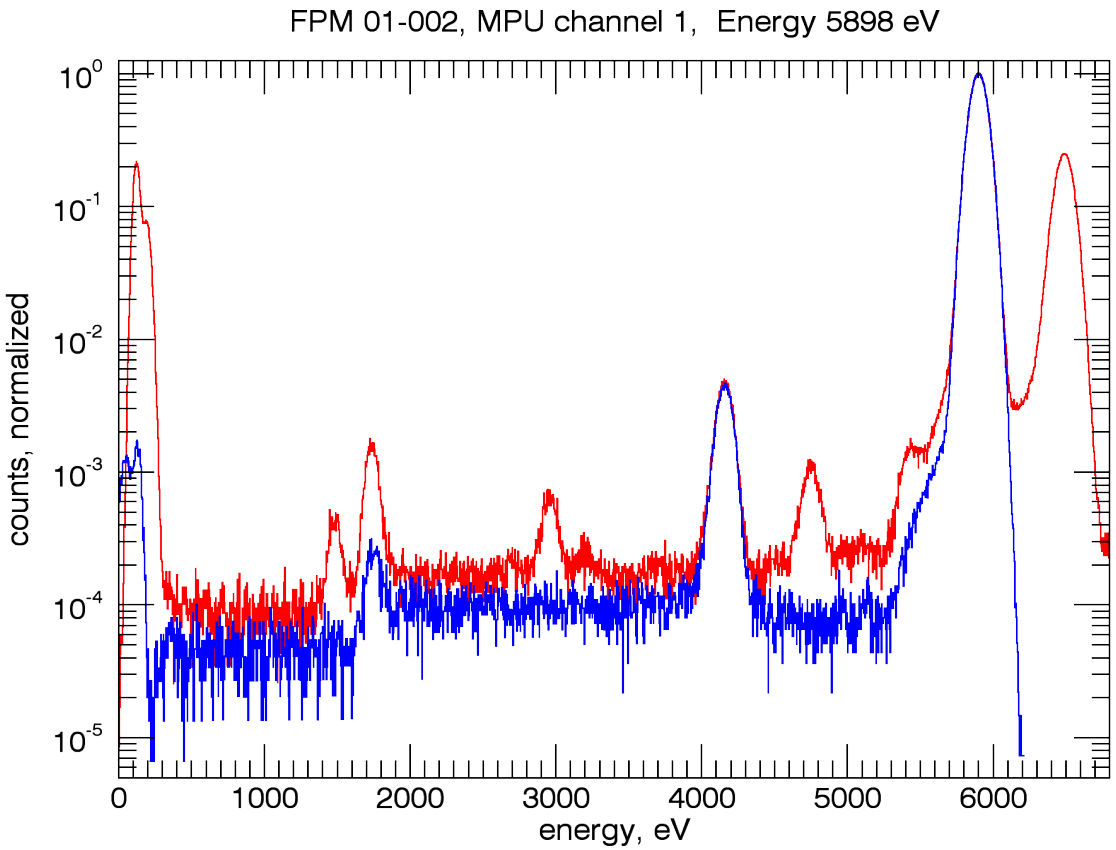
Two FPMs were taken to BESSY for absolute calibration. One of these has since been installed on the focal plane.
SX700 data from 200 eV to 1700 eV, FCM data from 1750 eV to 8048 eV, and white beam.

This selection of sets shows the change in the response as we cross the silicon edge



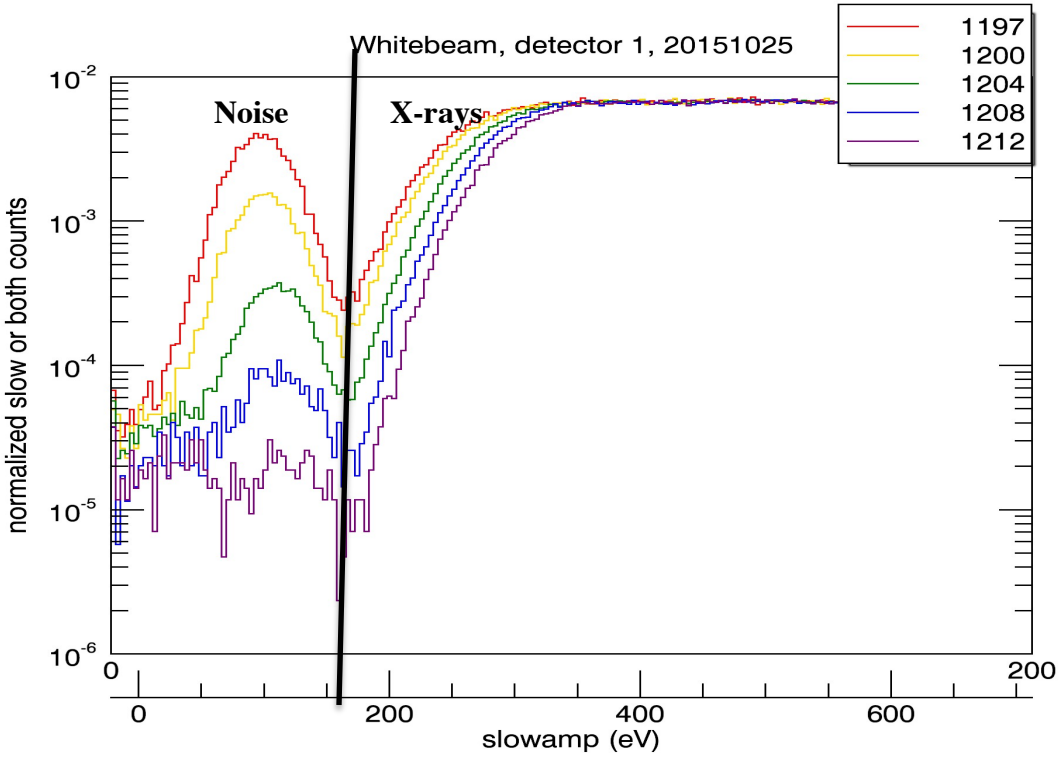
Reference Detector Characterization at BESSY

lab spectrum of Fe55 with lines from air and chamber walls in red, with FCM in blue



Reference Detector Characterization at BESSY

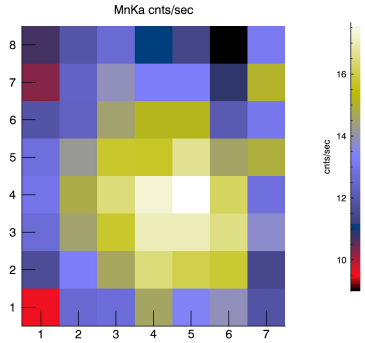
- This selection of whitebeam data illustrates the threshold efficiency.
- Event finding is done in derivative space, so there is a roll off on the low energy side that depends on the threshold.

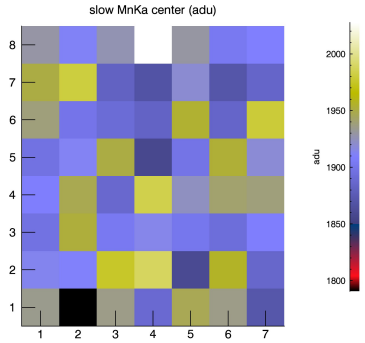


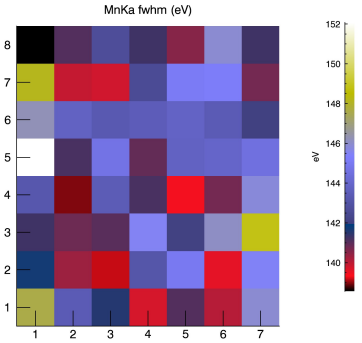
Additional Characterization During Integration and Test at GSFC

- **Fe55 illuminated the detectors during XTI thermal vac testing in September 2015.**

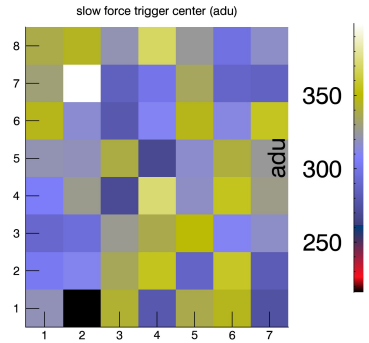
In these 7x8 grids, each square represents one of the 56 detectors in the instrument. Detectors in the same column are attached to the same MPU.

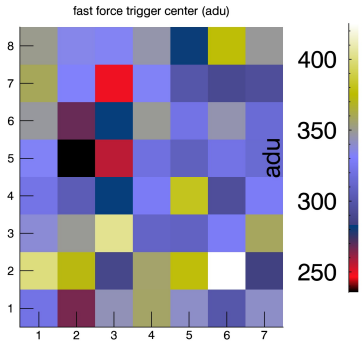


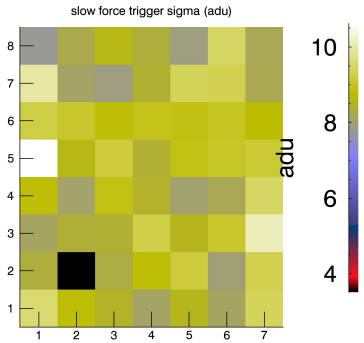


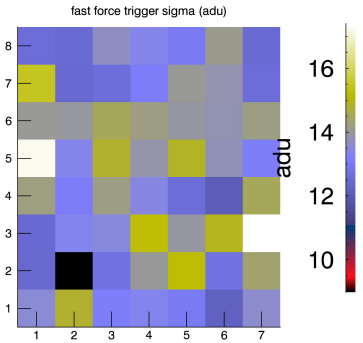


- **Forced trigger, a measure of 0, was run during thermal vac**









- More information available at http://heasarc.gsfc.nasa.gov/docs/nicer
- Look for NICER related talks and posters at the AAS HEAD meeting in April and the SPIE Astronomy meeting in June.
- Guest observer program has been approved

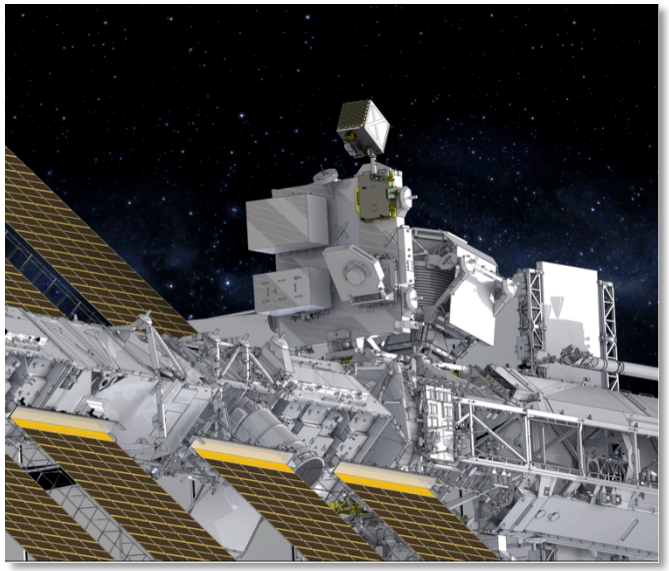
backup

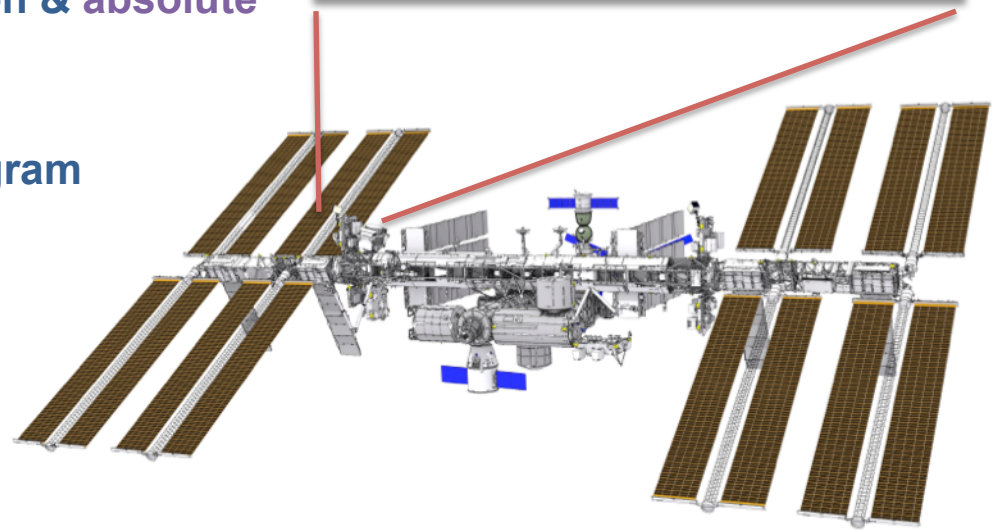
current schedule dates

- Payload thermal vac testing happening now
- Ship to KSC in July 2016
- launch March 2017

An Astrophysics Mission of Opportunity on the International Space Station

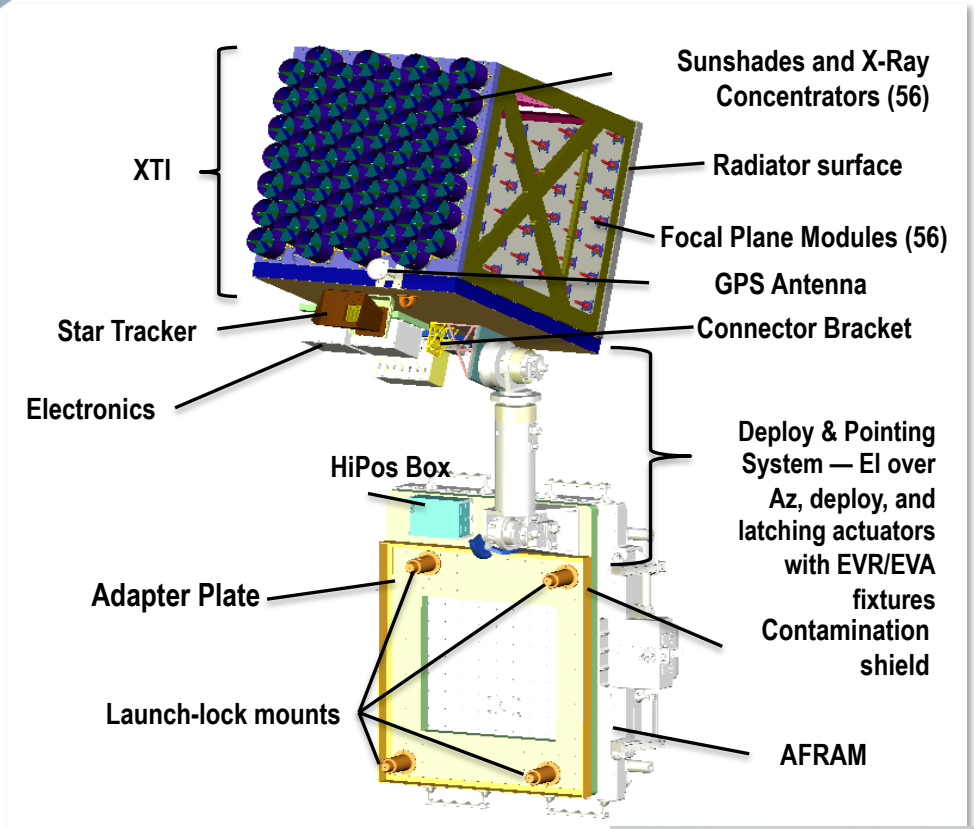
- *Science:* Understanding ultra-dense matter through observations of neutron stars in the soft X-ray band
- *Launch:* March 2017, SpaceX-11 resupply
- *Platform:* ISS ExPRESS Logistics Carrier (ELC), with active pointing over nearly a full hemisphere
- *Duration:* 24 months including Guest Observer program
- *Instrument:* X-ray (0.2–12 keV) "concentrator" optics and silicon-drift detectors. GPS position & absolute time reference
- *Enhancements:*
  - Guest Investigator/Observer program
  - Demonstration of pulsar-based spacecraft navigation
- *Status:*
  - Currently in Payload Thermal Vac

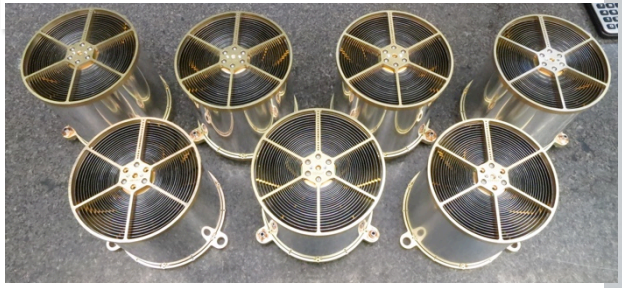


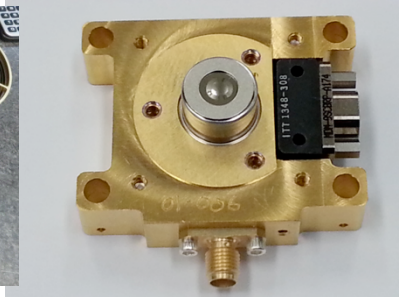


The NICER payload

An innovative combination of high-heritage components







- X-ray Timing Instrument (XTI)
  - Assembly of 56 X-ray concentrators and detectors
  - Detects individual X-ray photons, returns energy and time of arrival
  - Held together in the Instrument Optical Bench
- Thermal system
  - Maintains thermal-mechanical alignment
- Pointing System
  - Composed of high-heritage components
  - Allows the XTI to track pulsars
  - Slews XTI between targets
- C&DH
  - Digital interface to ISS for commands, data
  - Supports pointing system
- Flight Releasable Attachment Mechanism
  - Electrical & mechanical interface to ISS and transfer vehicle
  - Provided by ISS program

Science-enabling capabilities

An unprecedented combination of time resolution, energy resolution, and sensitivity

- **Spectral band: 0.2–12 keV**
  - **Well matched to neutron stars**
  - **Overlaps RXTE and XMM-*Newton***
- **Timing resolution: 100 nsec RMS absolute**
  - **50x better than RXTE**
  - **~1000x better than XMM-*Newton***
- **Energy resolution: 2.5% @ 6 keV**
  - **10x better than RXTE**
- **Angular resolution: 6 arcmin (non-imaging)**
  - **10x better than RXTE**
- **Sensitivity, 5σ: 5.3 x 10^{-14} erg/s/cm^2**
  - **0.5–10 keV in 10 ksec (Crab-like spectrum)**
  - **20x better than RXTE**
  - **3x better than XMM-*Newton*'s timing capability**