ACIS Special Topics

Catherine Grant

1. Detection efficiency evolution
2. ACIS/XIS performance evolution comparison study
3. ACIS as its own radiation monitor

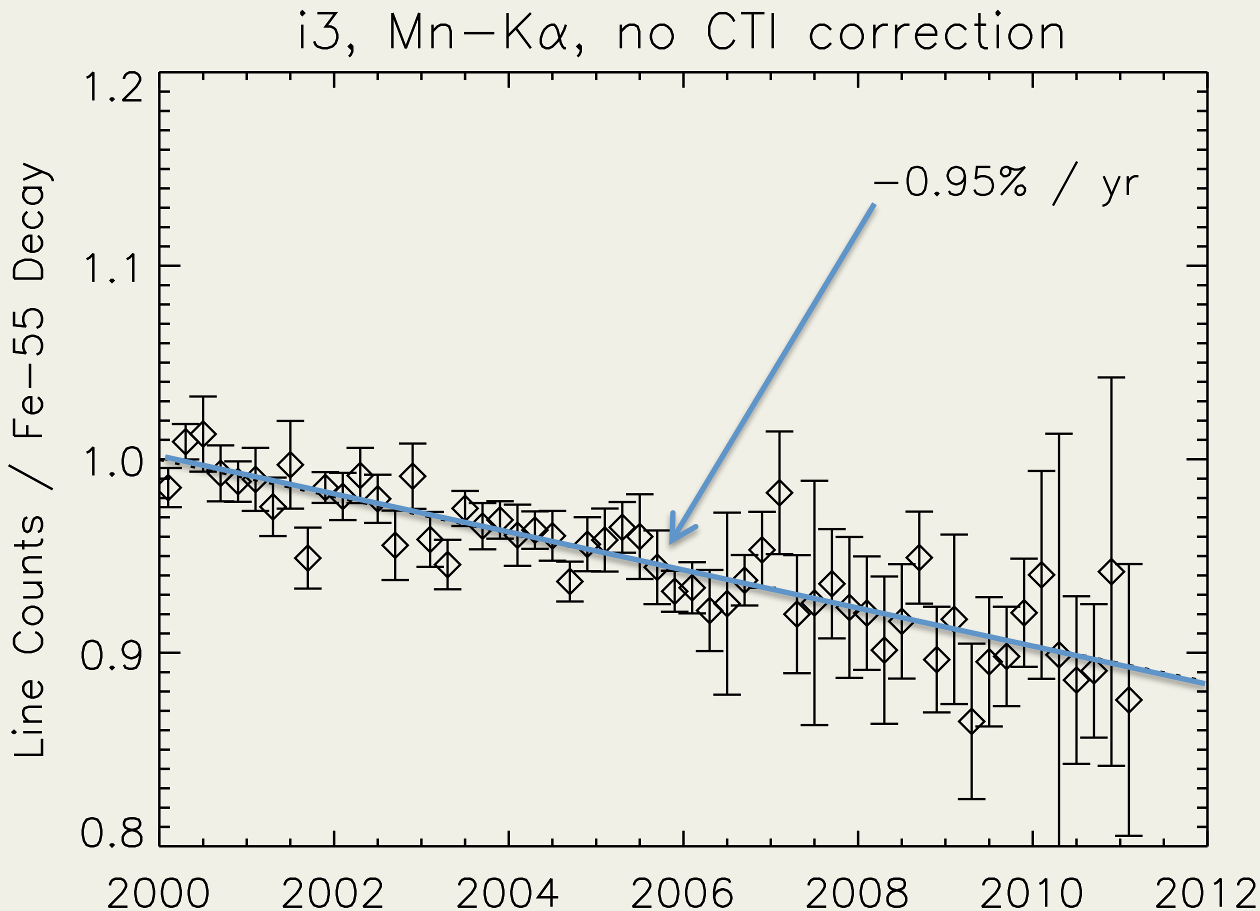
QE Evolution

- As CTI increases so does grade morphing, which can lower the effective QE, primarily at high energies and far from readout.
- Currently, changing CTI is corrected by time-dependent gain shifts, which do nothing for any CTI-induced QE change.
- CCD detection efficiency calibration is split into three parts:
  - Contamination (time, position, energy)
  - CCD QE (before CTI) and OBF transmission (energy)
  - QE Uniformity map (position, energy)
    - CTI losses go here, but currently no time dependence

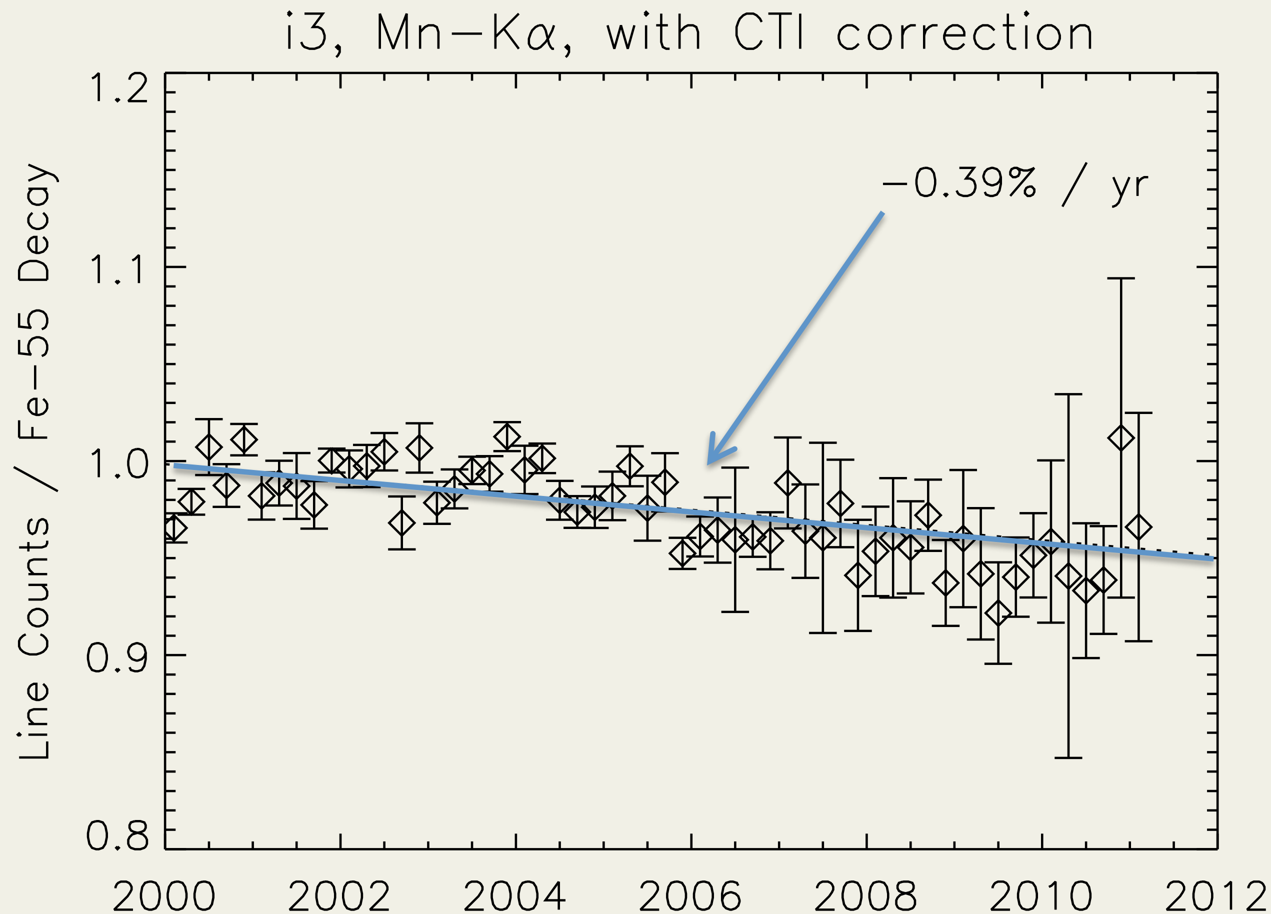
QE Evolution: Data and Analysis

- Filtered by grade (G02346), temperature
- Eventlists combined into time bins (0.2 yrs)
- I3 and S3 used a proxies for all FI and BI CCDs
- 8 x 8 regions per CCD, 128 x 128 pixels
- Al-K (1.5 keV) and Mn-K (5.9 keV) lines
- Count rate from Gaussian norm and width
- Fe-55 decay and contamination are removed
  - Using the CALDB contamination model (N0006)

Example: CCD-I3, Far from readout

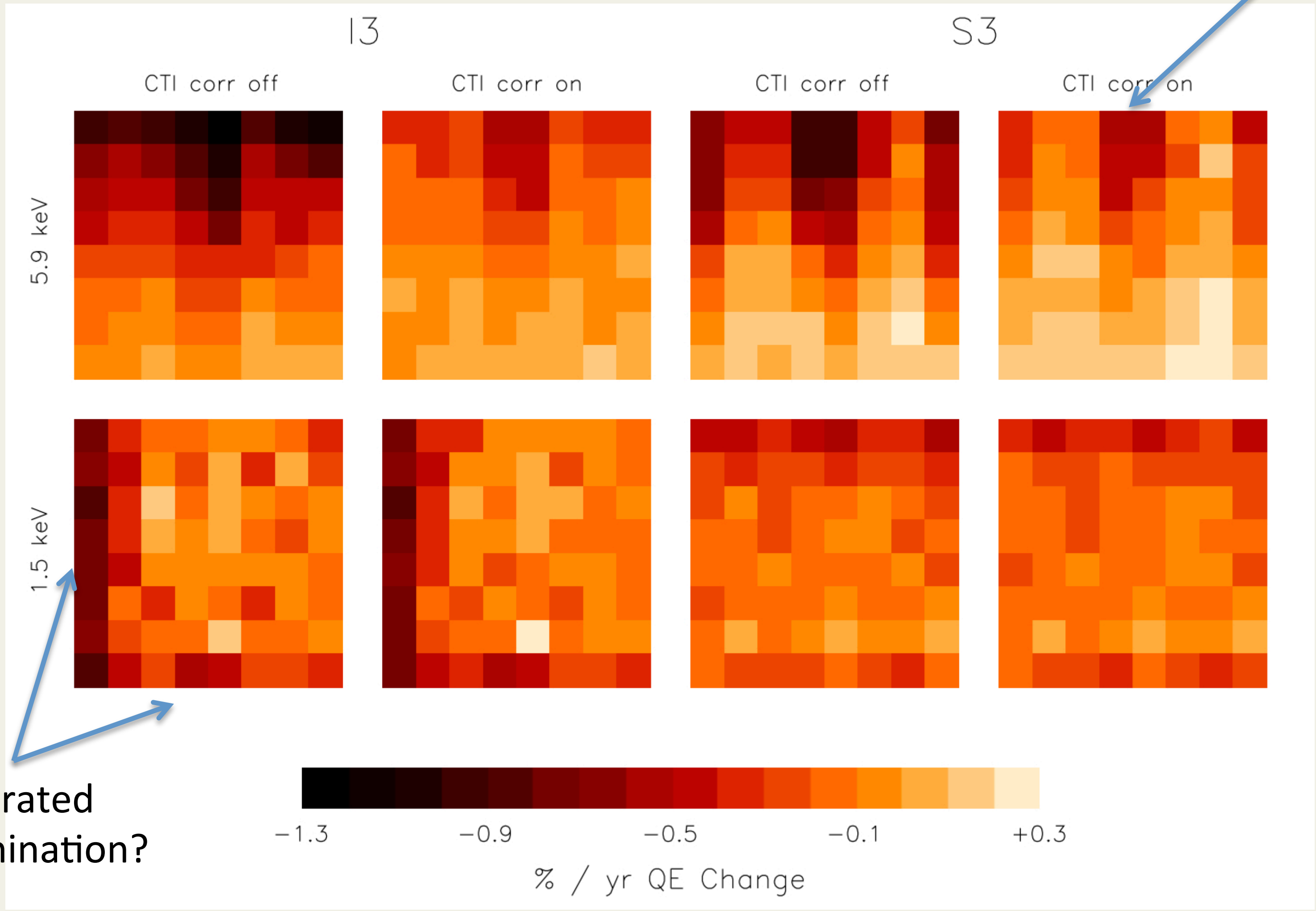


Example: CCD-I3, Far from readout



QE Evolution

QE change due to CTI

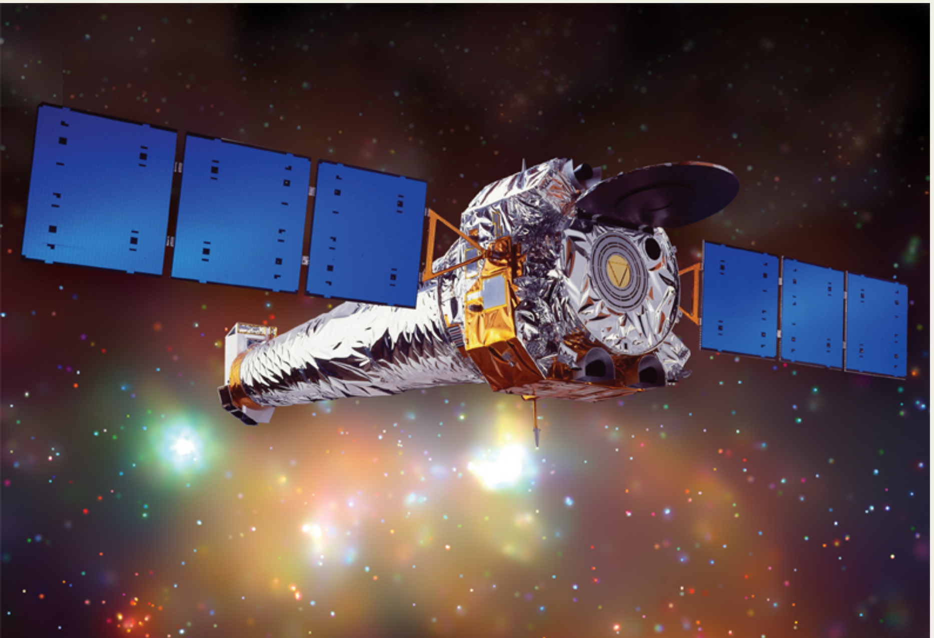


uncalibrated contamination?

CTI-induced QE Evolution

- Applying standard CTI correction provides some mitigation of QE evolution
- QE change is small, but no longer negligible
- Production of new time-dependent QEU is underway
- Contaminant calibration a continuing project

CTI evolution and its impact on spectral resolution in different orbital environments



The "Leaky Buckets" Group

Catherine Grant, Eric Miller, Bev LaMarr

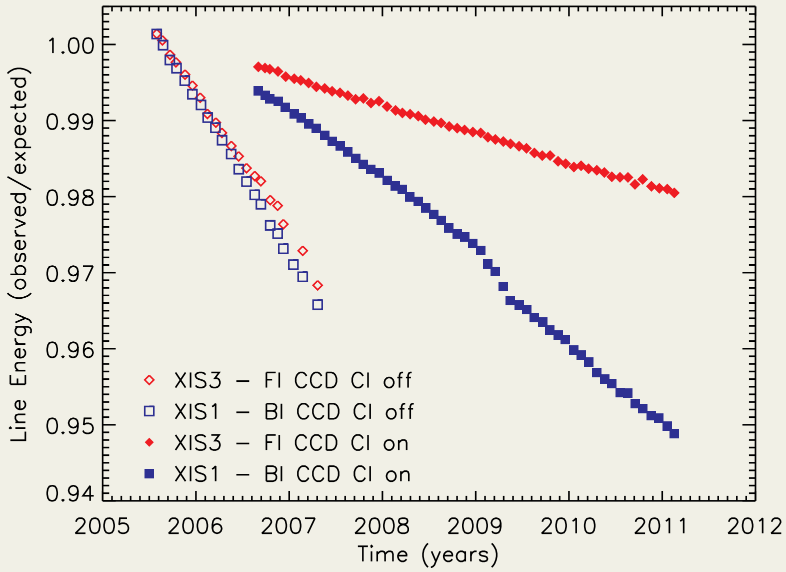
MIT

Outline

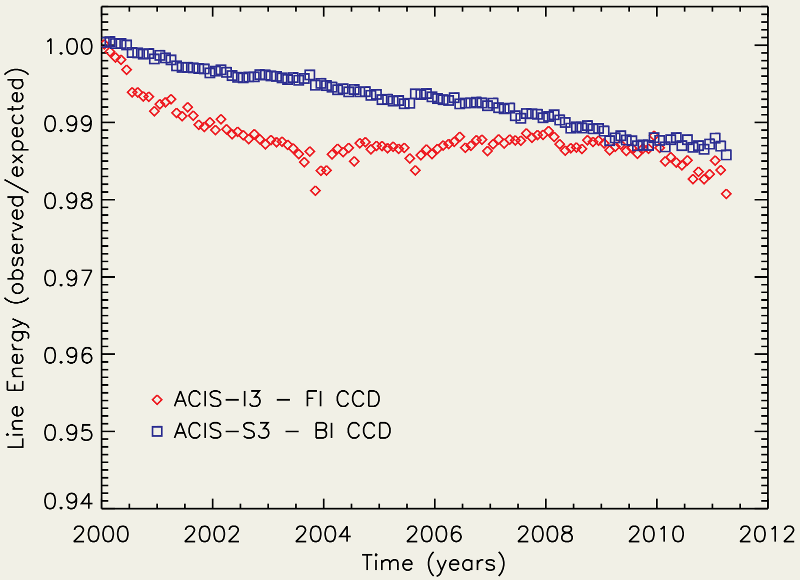
- Compare on-orbit energy scale and FWHM evolution of ACIS and XIS
- Both use related CCDs
  - Pixel sizes, device dimensions
- Operational differences
  - Transfer speeds, frame times (3.2s vs 8s), temperature (-120C vs -90C), charge injection
- Particle backgrounds very different (low vs high Earth orbit)
- Use differences and similarities to help explain CTI and FWHM evolution
- A&A paper in preparation

Line Energy Evolution

Suzaku XIS

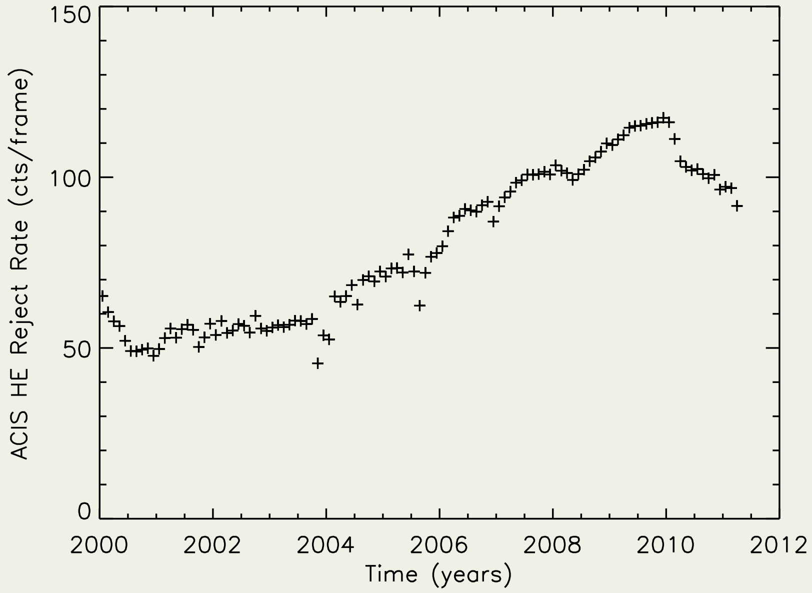


Chandra ACIS

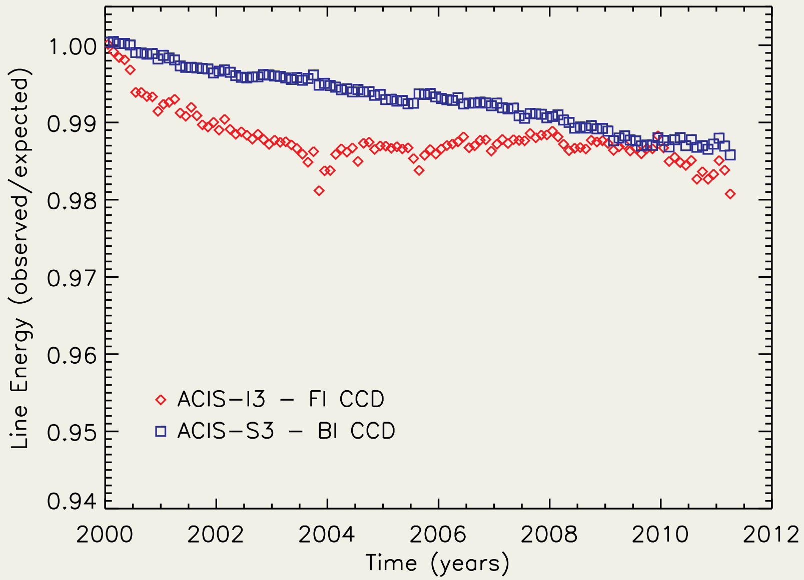


Line Energy Evolution

ACIS Particle Background

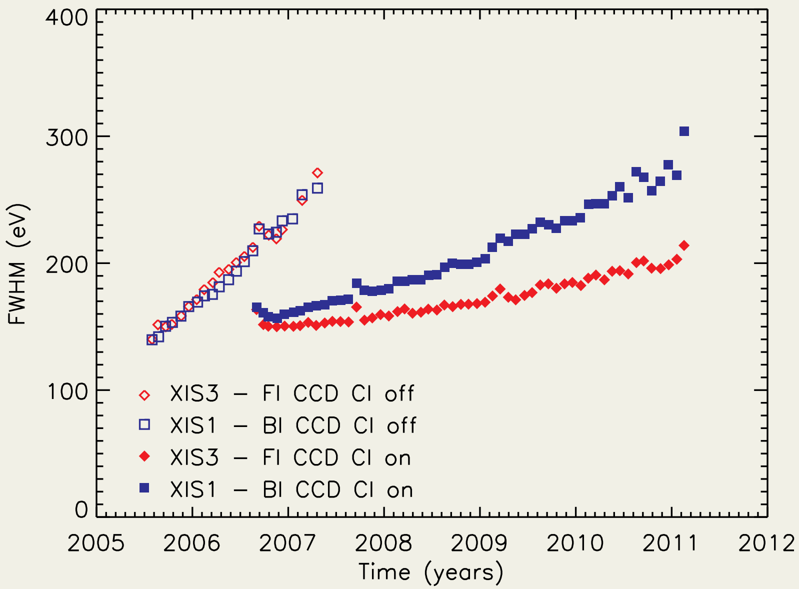


Chandra ACIS

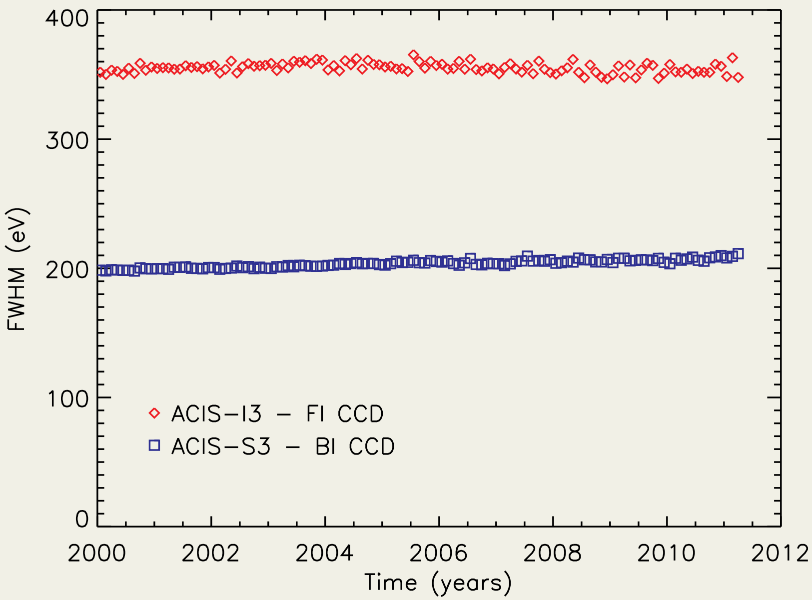


Line Width Evolution

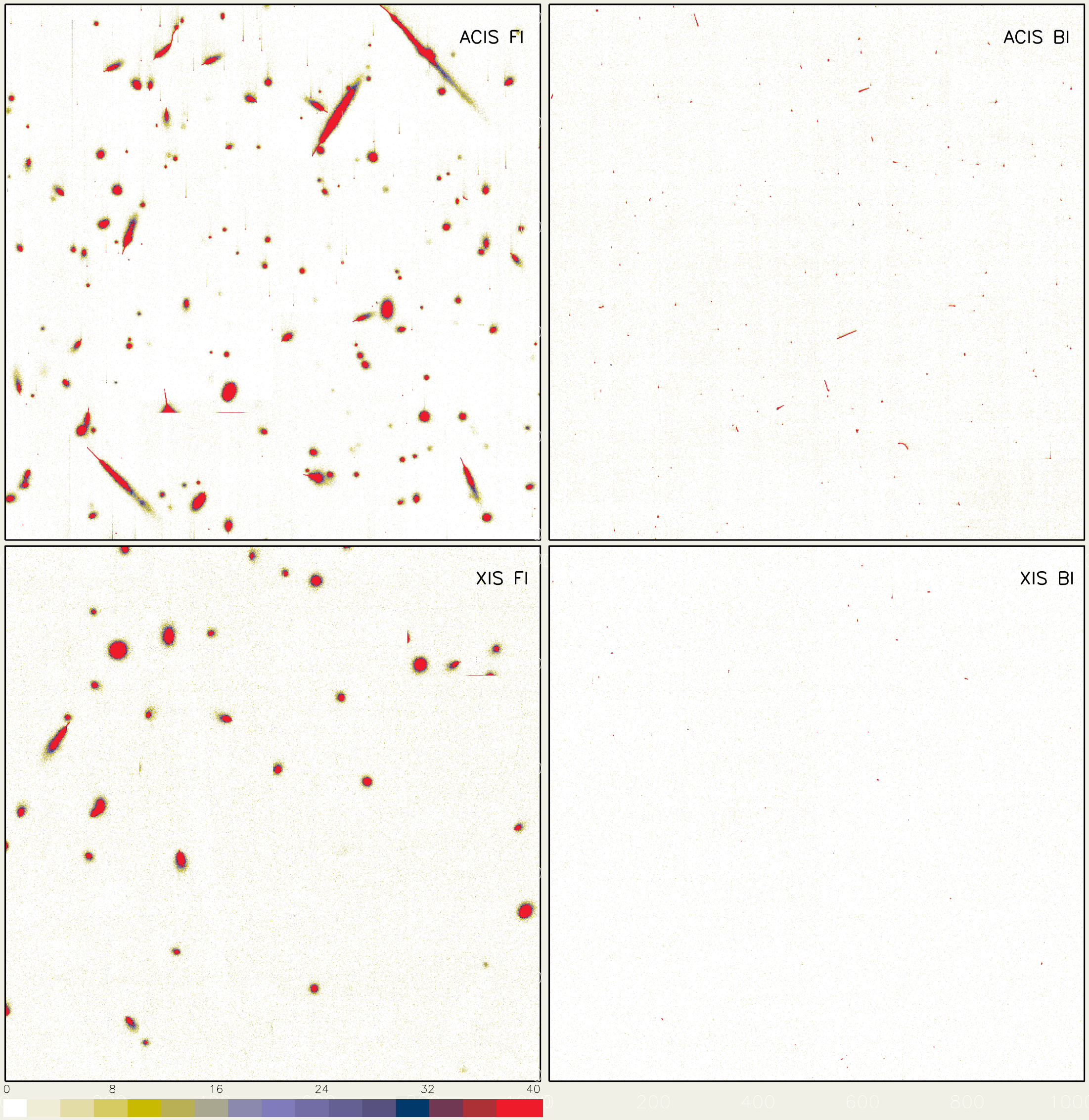
Suzaku XIS



Chandra ACIS



Raw Images Comparison



ACIS as its own radiation monitor

- Chandra's particle detector (EPHIN) monitors local radiation environment, provides autonomous radiation protection
- As Chandra ages, its effectiveness is reduced
- Developed a flight S/W patch which examines ACIS data in real time and sends an alert to the Chandra OBC when it detects high radiation
  - No impact to science data
  - No false triggers from bright X-ray sources
  - At least half the historical EPHIN shutdown events would also be detected by ACIS

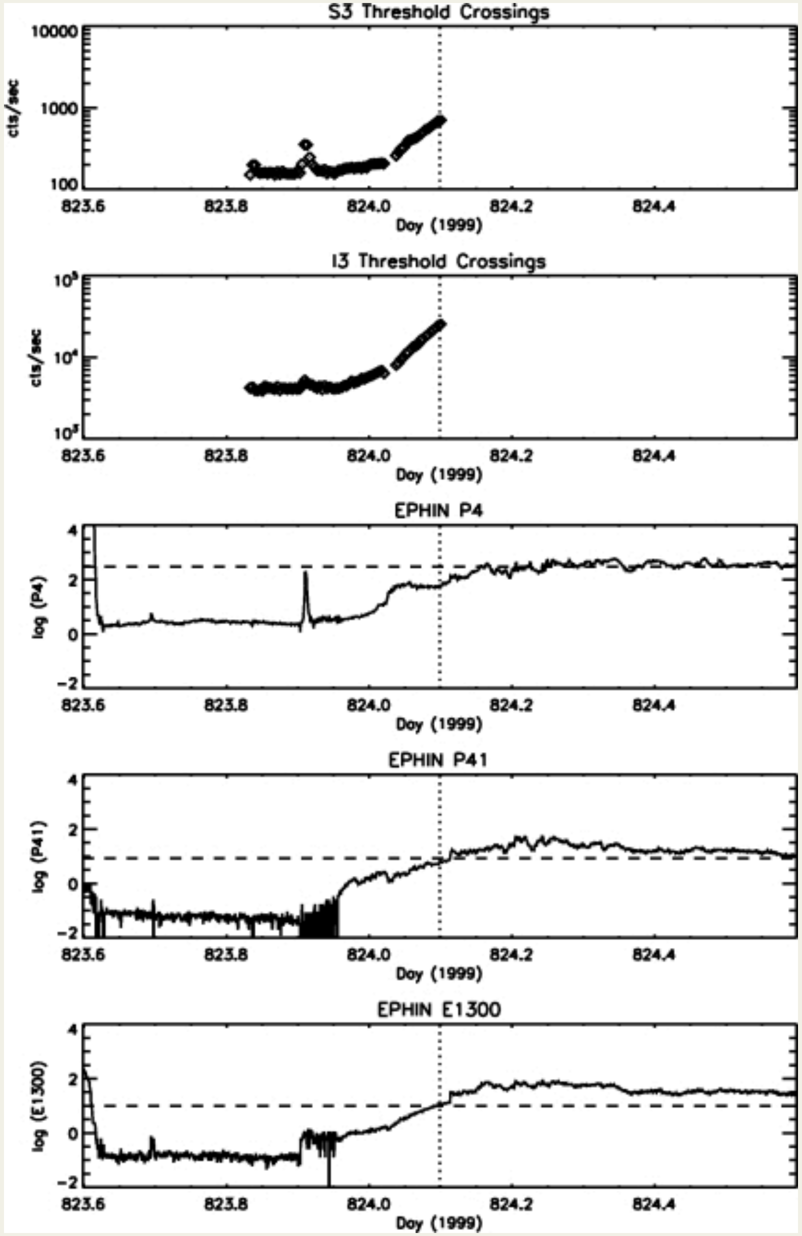
ACIS rates versus EPHIN

ACIS threshold crossing rates and EPHIN particle rates are correlated during a solar storm in 2001.

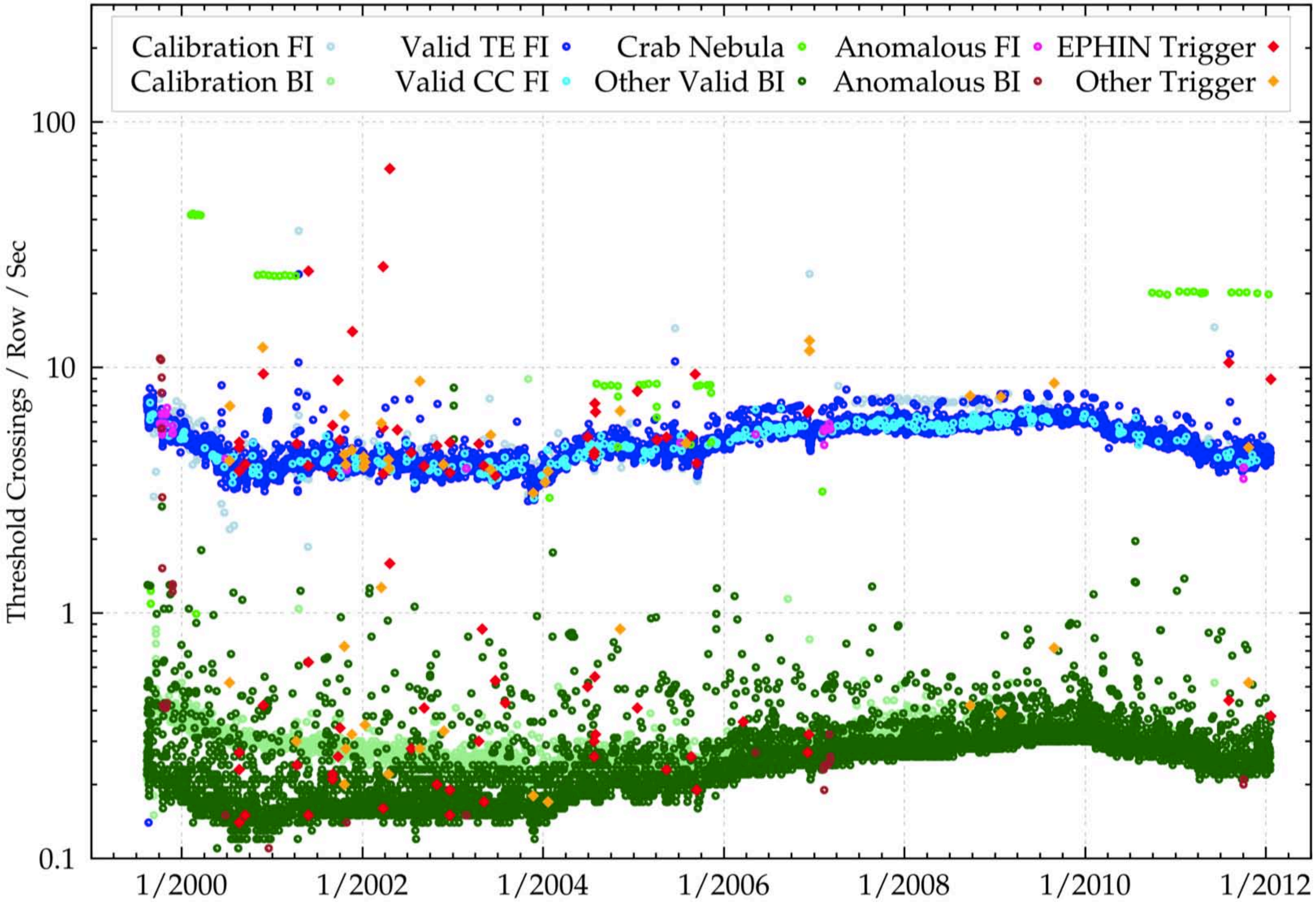
Both FI and BI devices are responding, but not identically.

Dashed horizontal lines are EPHIN radiation trigger levels.

Dotted vertical line is the time of the on-board EPHIN radiation shutdown.



History of ACIS Threshold Crossing Rates



FI and BI rates are averaged over 5-minute intervals. The plot shows one in every 50 “ordinary” values and every anomalous value (see key, above).

ACIS as its own radiation monitor

- ACIS patch has been running on-board since November
- One trigger (Jan 27) due to high radiation environment, no false triggers or anomalies
- Currently running with default (conservative) parameters; plan to update with optimal parameters shortly
- Patch to Chandra OBC to respond to ACIS alerts is in development
- Exploratory study: Grant et al. 2010, Proc. SPIE 7732
- More in two papers at upcoming SPIE (Grant et al. and Ford et al.)