

# The Suzaku/XIS: Status Report



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for the *Suzaku/XIS* Team

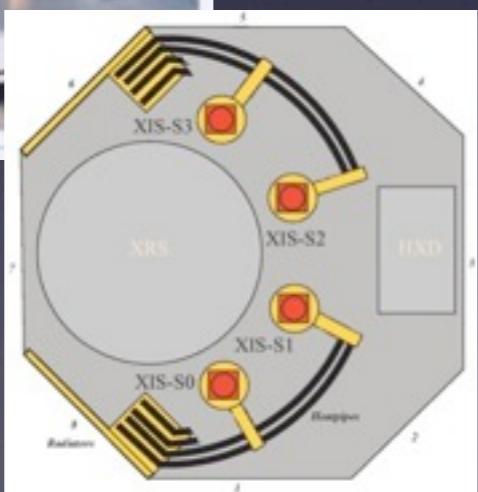


# Outline

- instrument health and status
  - spacecraft and instrument anomalies
  - gain and effective area tracking
- calibration status
  - normal, window, burst, timing modes
  - specific issues
- OBF contamination

# Suzaku/XIS - Overview

- 4 CCDs with independent X-ray telescopes (XRTs)
- 3 front-illuminated (FI) XIS0 XIS2 XIS3  
1 back-illuminated (BI) XIS1



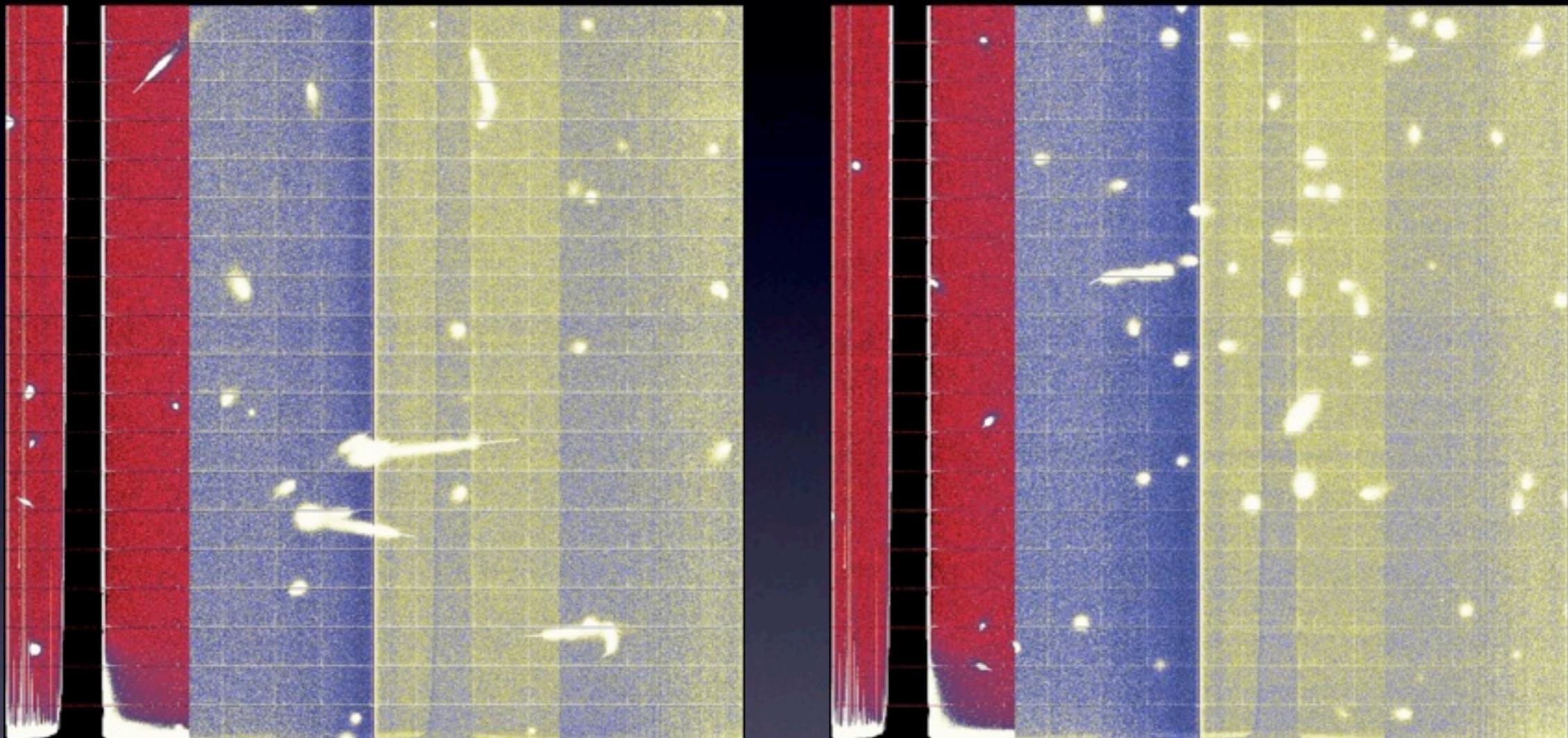
Field of view	17.8' x 17.8'
Energy range	0.2-12 keV
Energy resolution	~180 eV @6keV
Effective area	340 (FI)/390 (BI) cm <sup>2</sup> @1.5keV
Time resolution	8 s (Normal) - 7.8 ms (Psum)

from Tsujimoto's “pocket guide”

# Major XIS Events

July 10, 2005	launch of <i>Suzaku</i>
August 13, 2005	XIS doors open, start of observations
November 9, 2006	anomaly ( $\mu$ -meteorite?) in XIS2; 2/3 of chip affected, <b>stop using XIS2</b>
January 30, 2008	CPU board malfunction in MPU; switch to redundant board
June 23, 2009	anomaly ( $\mu$ -meteorite?) in XIS0; 1/8 of chip affected, <b>XIS0 safe for normal ops</b>
December 18, 2009	anomaly ( $\mu$ -meteorite?) in XIS1; no CCD damage, <b>likely hole in XIS1 OBF</b>

# XIS0 Anomaly - Frame Data



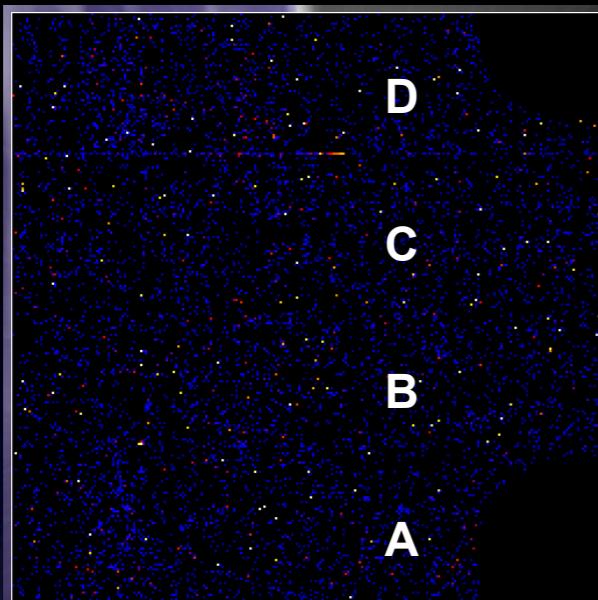
charge injection on

charge injection off  
(but sequencer still on)

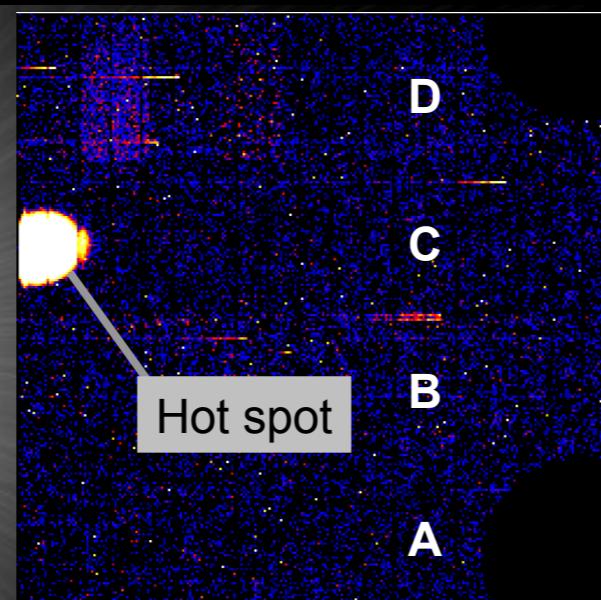
# XIS0 Anomaly - Summary

- apparent micro-meteorite causing charge leakage, saturation
- ~50 columns of XIS0 segment A unusable
  - eliminated on-board with area discriminator
- most of XIS0 is usable, not in danger under supported modes
  - burst mode is safe, but perhaps not useful in XIS0
  - P-Sum mode is no longer supported for XIS0
- calibration changes minor at XIS aimpoint (seg B,C)
  - gain change ~ few eV at 6 keV, no change at 1 keV
  - no FWHM change

# XISI Anomaly - Observations



2009-12-17 (Event; FESI1)  
day-earth

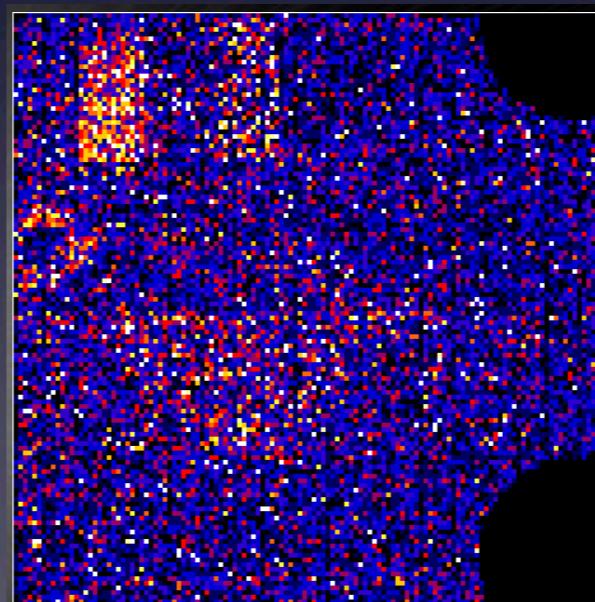


2009-12-18 (Event; A76 East)  
day-earth [all grades]

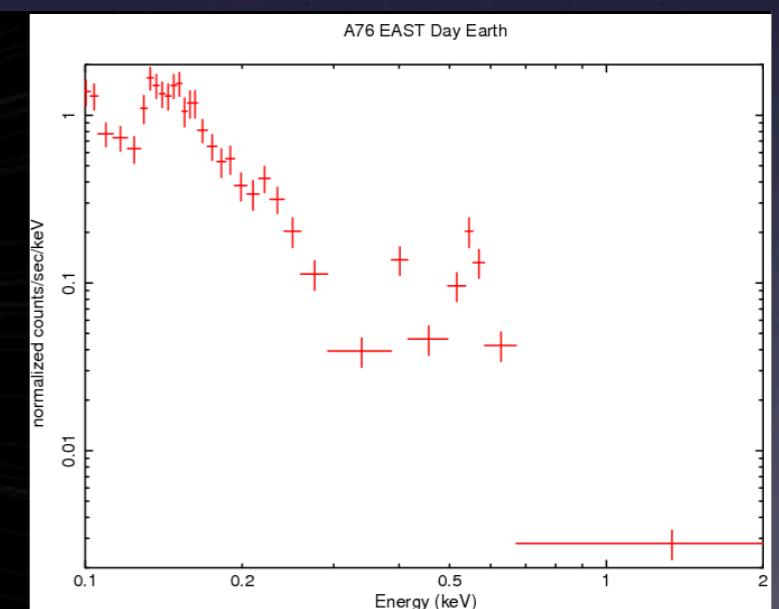


2010-01-04 (Frame)  
night-earth

- persistent bright spot
- hole in OBF from  $\mu$ -meteorite;  
**light leak**
- no CCD damage
- grade selection removes most  
spurious events



2009-12-18 (Event; A76 East)  
day-earth [g02346]



2009-12-18 (A76 East)  
spectrum of "the bright spot"

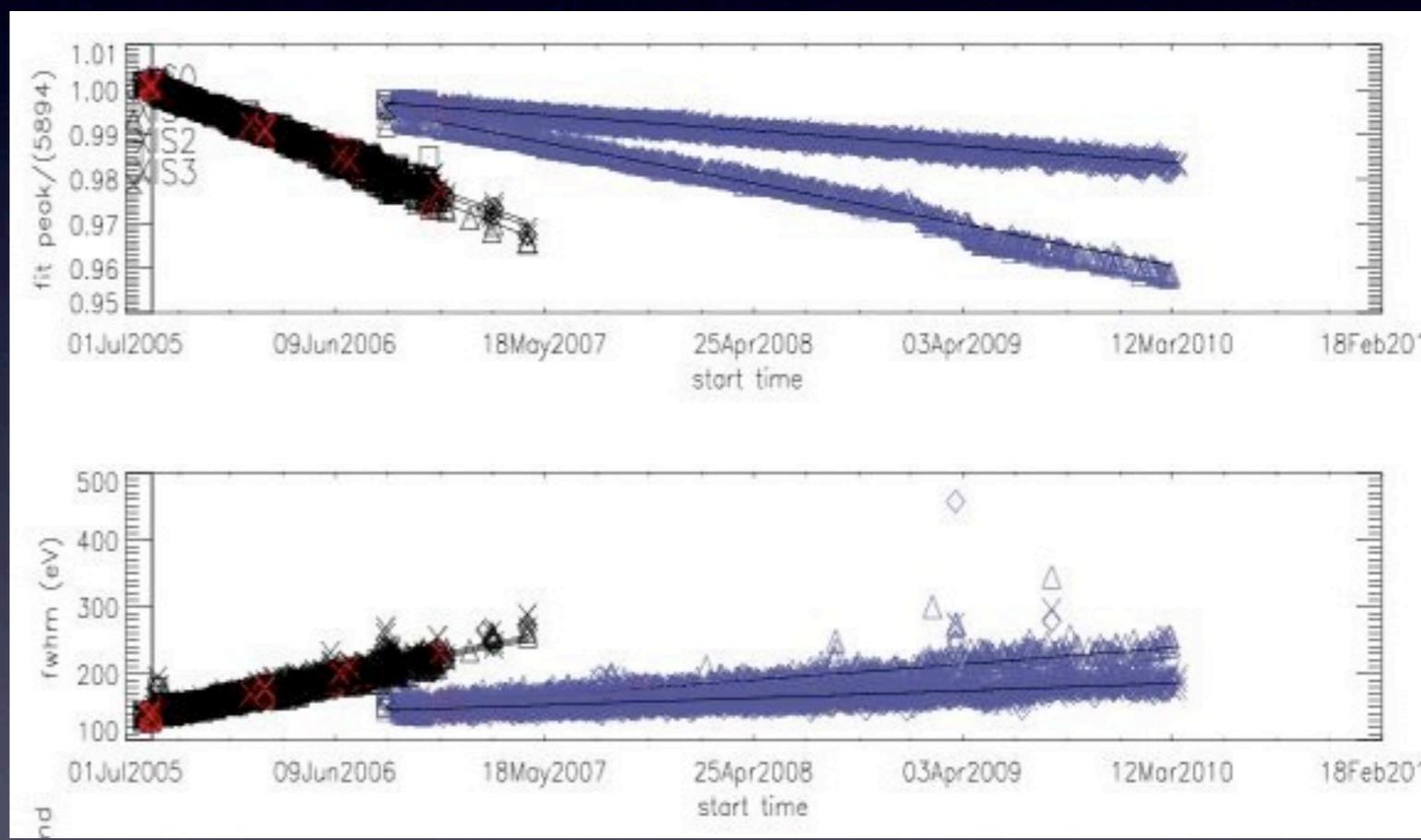
# XIS I Anomaly - Issues

- calibration uncertainty increases at “spot”
  - soft extended sources affected
  - on-axis point sources unaffected
- dark level increase if optically bright source at spot
- more stringent day-Earth elevation limit (?)
- excessive dose of UV from bright Earth (?)
- OBF contaminant “leaking” through hole (?)
- observation of RXJ1856 on and off hole....
- no change in supported observing modes

# Gain and FWHM Tracking

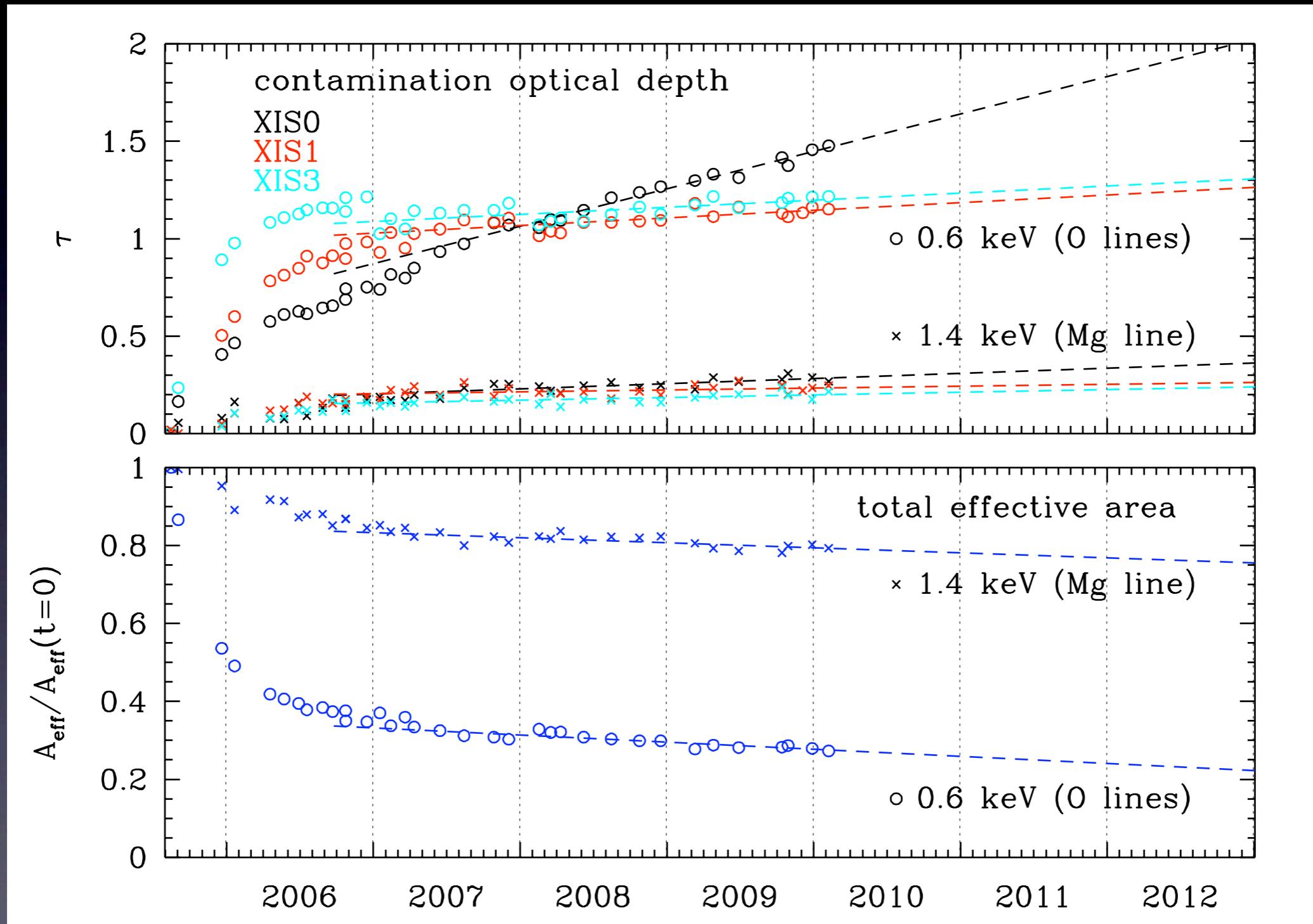
- $^{55}\text{Fe}$  cal sources  $\rightarrow \text{Mn K}\alpha$  at 5.9 keV  
raw data, no CTI correction

- gain change  
with SCI on  
(% per yr)  
 $\text{XIS0 } -0.399 \pm 0.001$   
 $\text{XIS3 } -0.376 \pm 0.001$   
 $\text{XISI } -0.979 \pm 0.001$

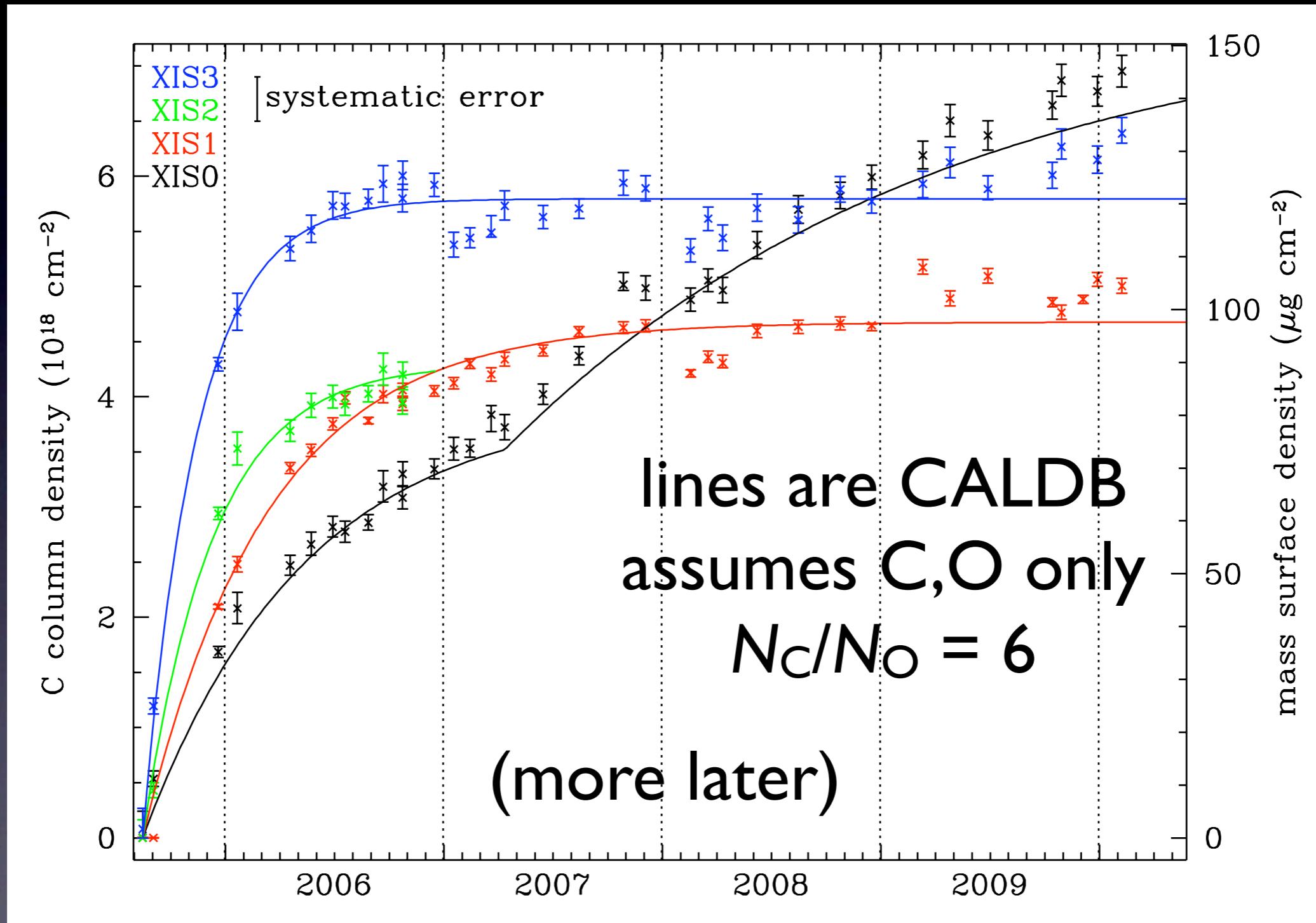


- FWHM change  
with SCI on  
(eV per yr)  
 $\text{XIS0 } 13.1 \pm 0.5$   
 $\text{XIS3 } 11.5 \pm 0.3$   
 $\text{XISI } 25.4 \pm 0.4$

# Effective Area Tracking



# Contamination Tracking



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# XIS Observing Modes

## Clock modes + options

(exposure time, exposure region, time resolution)

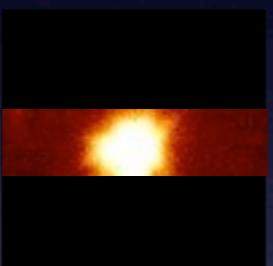
Normal

Full



8 s

Window



1-2 s

Burst



> 0.1 s

## Editing modes

(event detection, event grades, telemetry format)

5x5  
3x3  
2x2

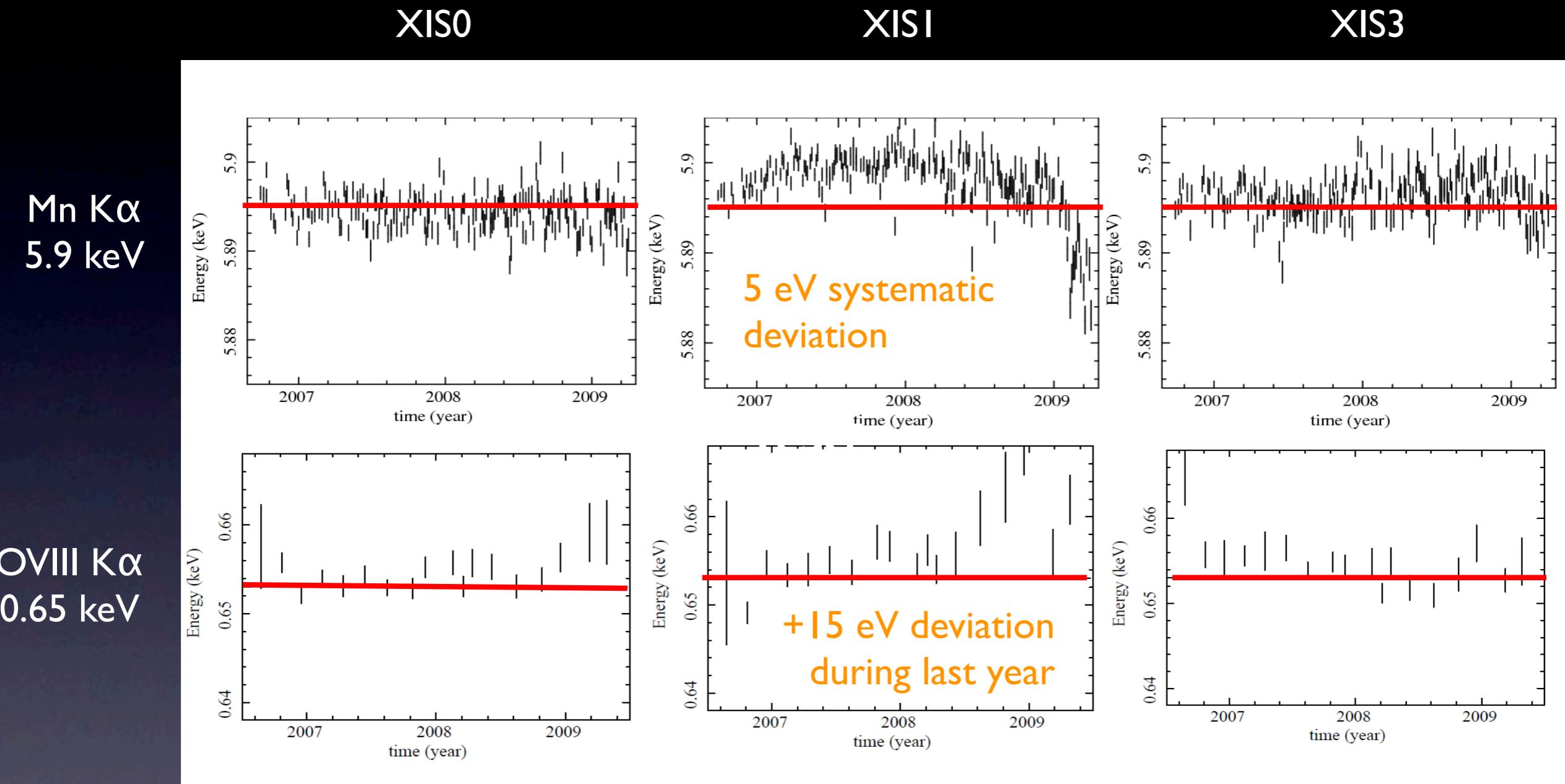
P-Sum



> 7.8 ms

Timing

# Normal Mode - Energy Scale

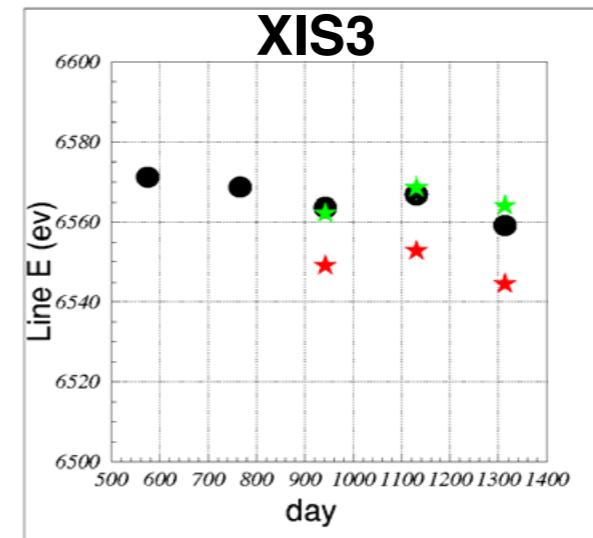
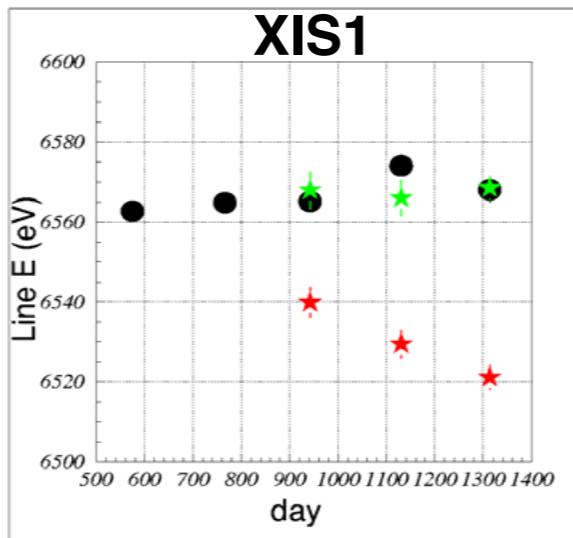
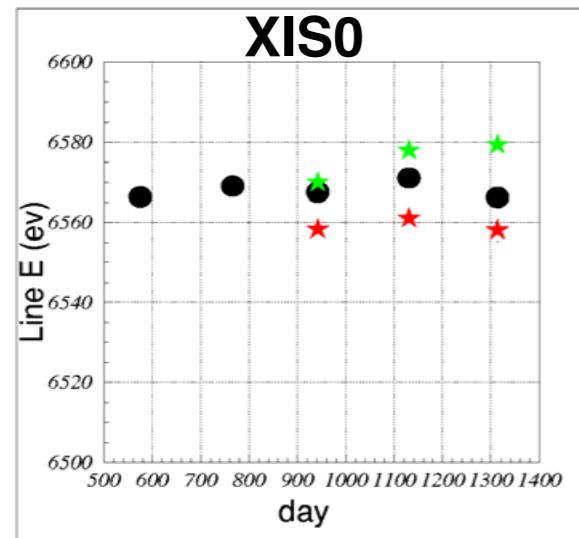


CTI corrected with makepi parameters from 2009-06-15

# Window Mode

- updated xispi FTOOL, makepi CALDB (20091202)  
improve energy scale vs. full window
  - SCl-on: < 10 eV at Fe K (1/4 window)
  - SCl-off: < 20 eV at Fe K (1/8 and 1/4 window)

Perseus cluster - Fe line center

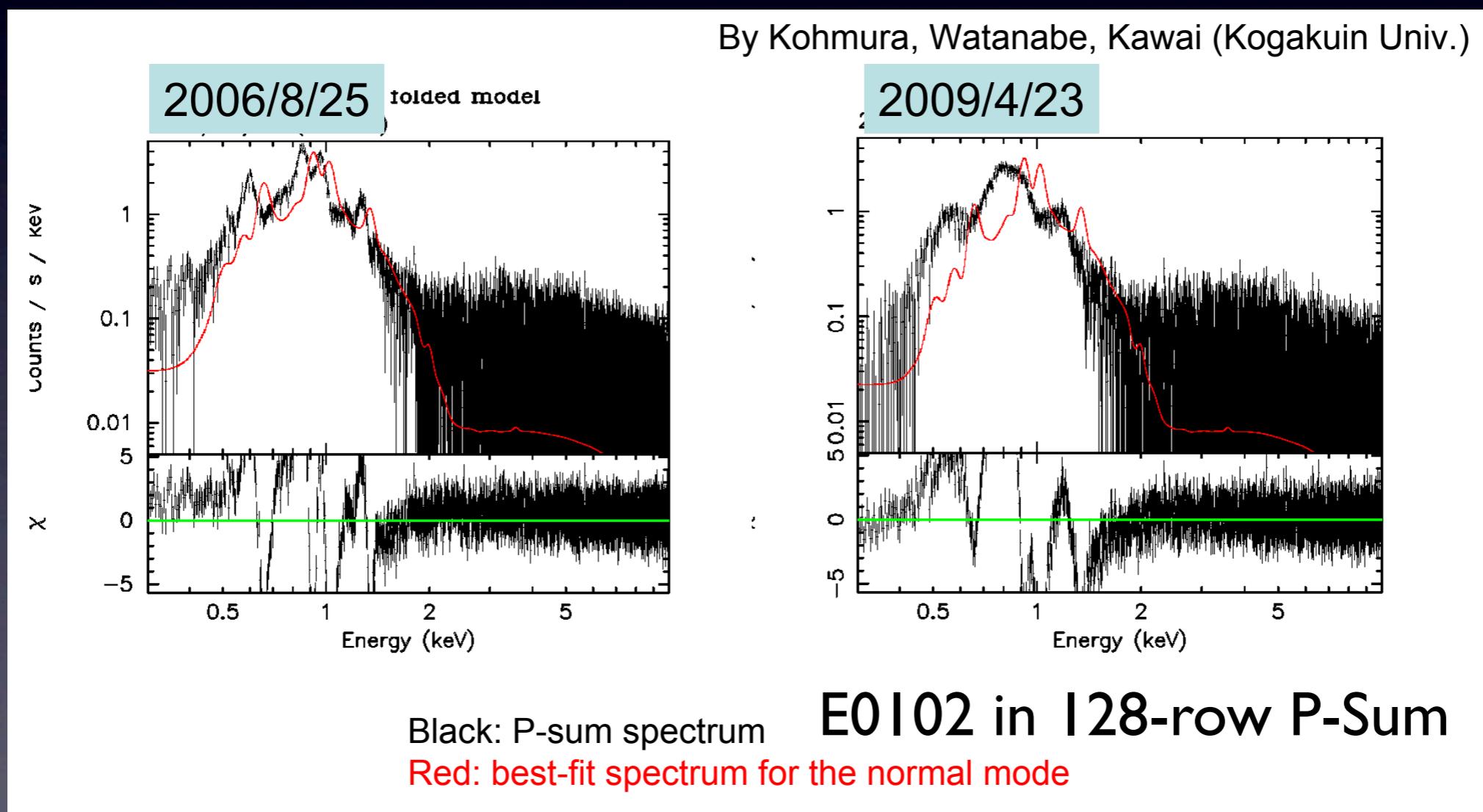


X: elapsed day  
since the launch  
Y: measured  
central energy of  
the Fe line

- data taken with a full window mode (this value should be a reference for comparison)
- ★ data taken with a 1/4 window mode processed with xispi in heasoft 6.6.1 or before & makepi\_20080825
- ★ data taken with a 1/4 window mode processed with xispi in heasoft 6.6.2 or after & makepi\_20090615

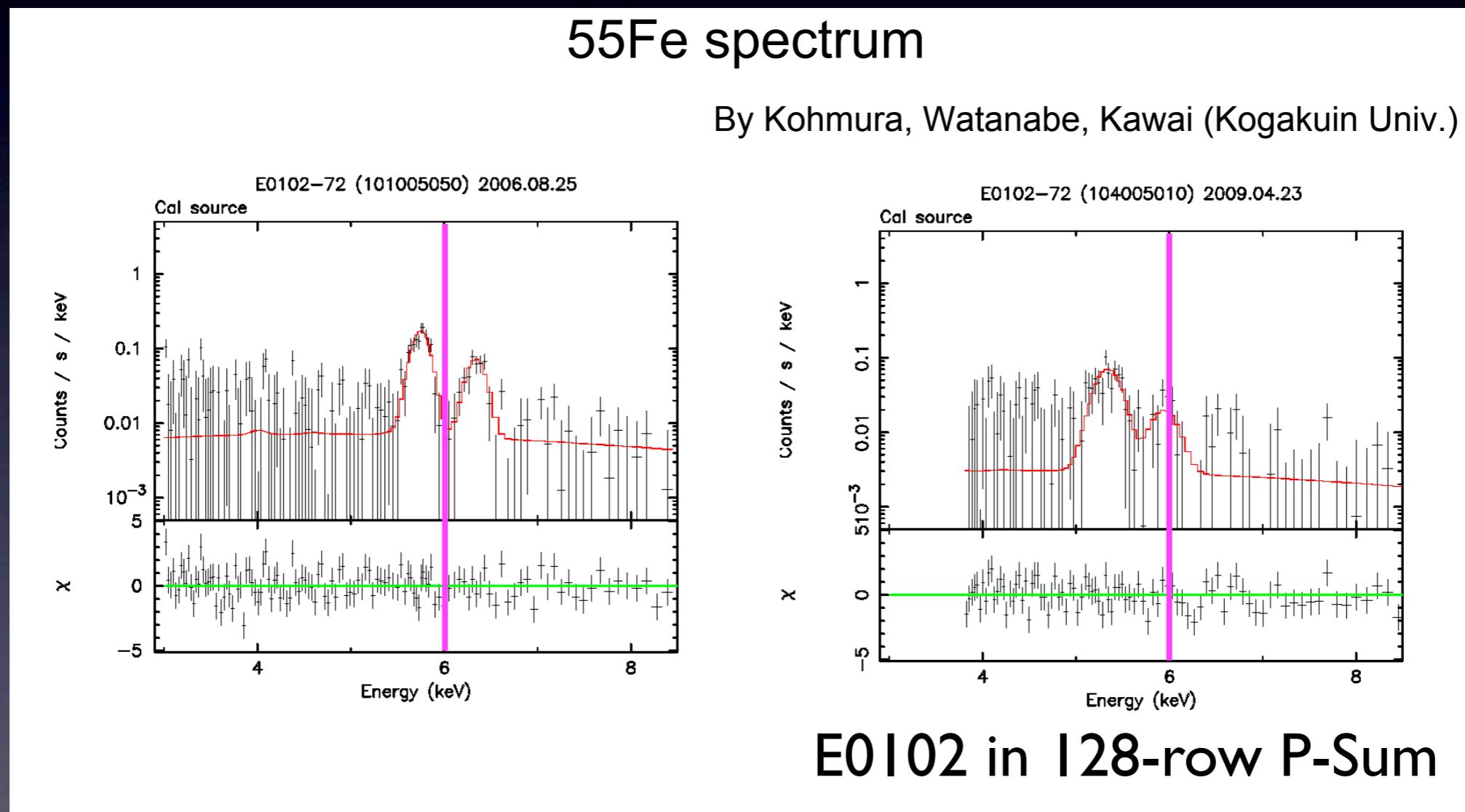
# P-Sum + Timing Mode (XIS3)

- energy scale lower, FWHM broader than normal mode
- CTI correction not done, no charge injection



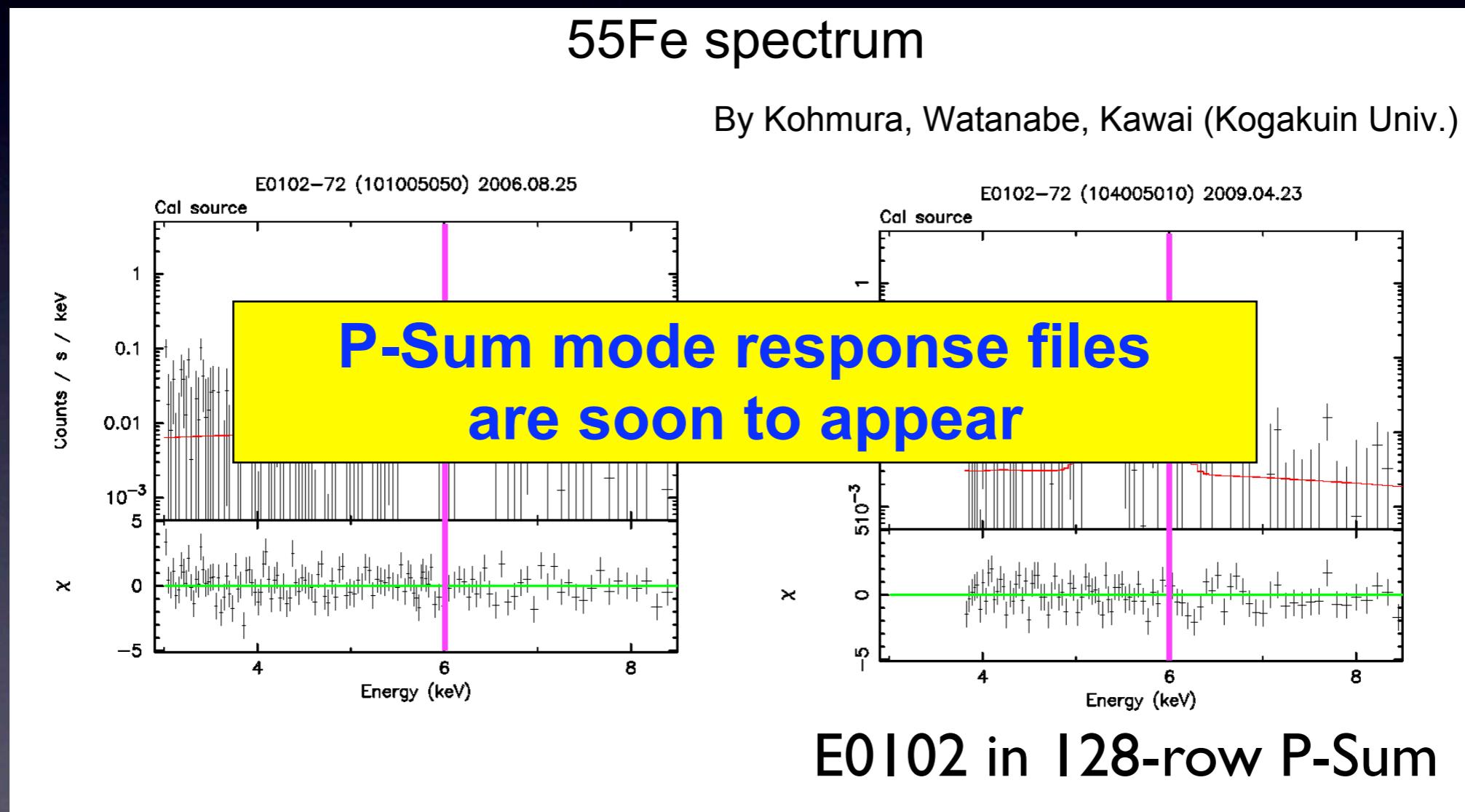
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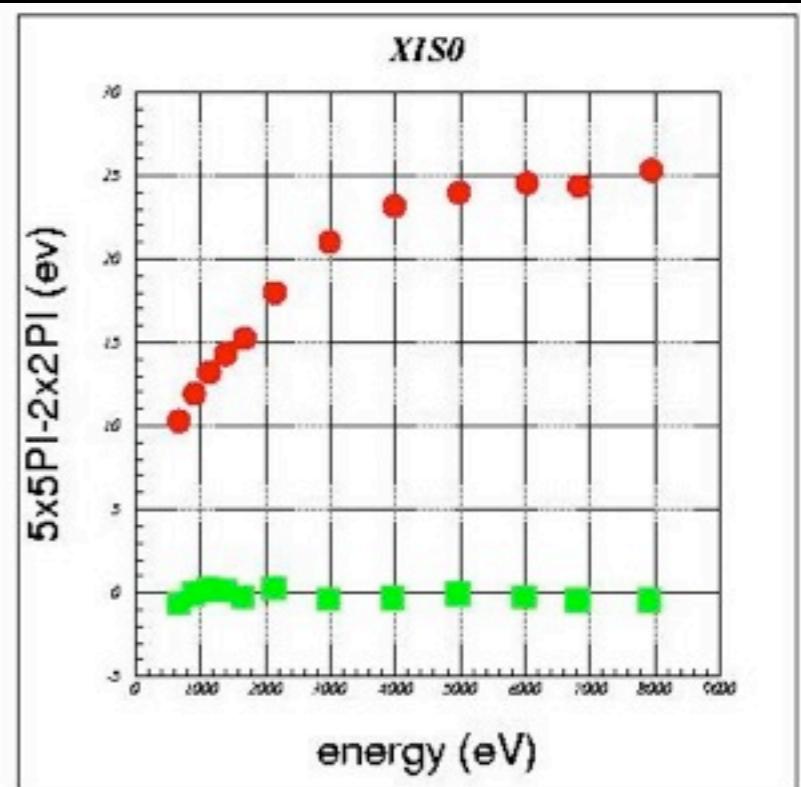
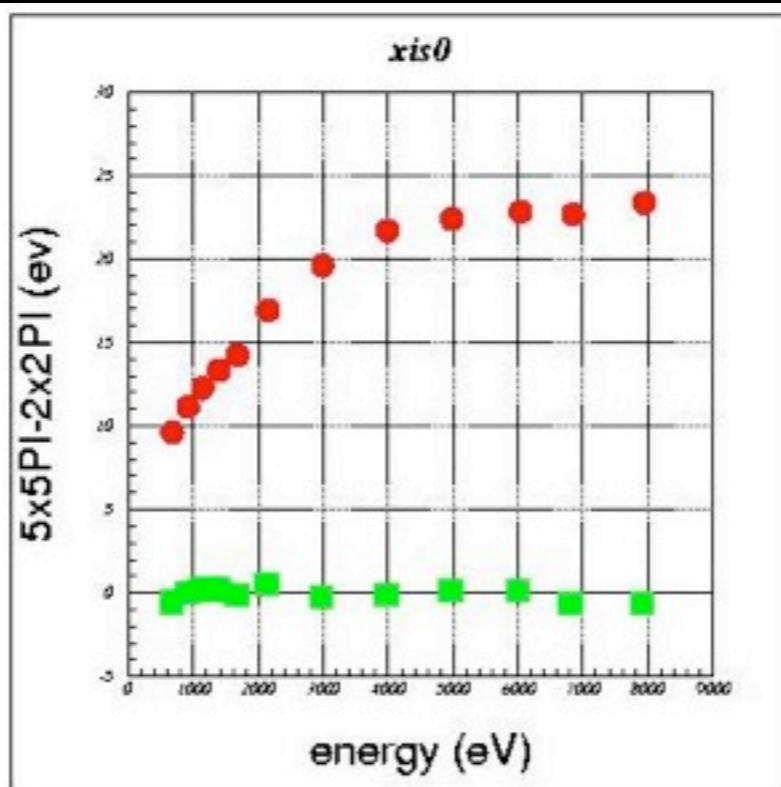
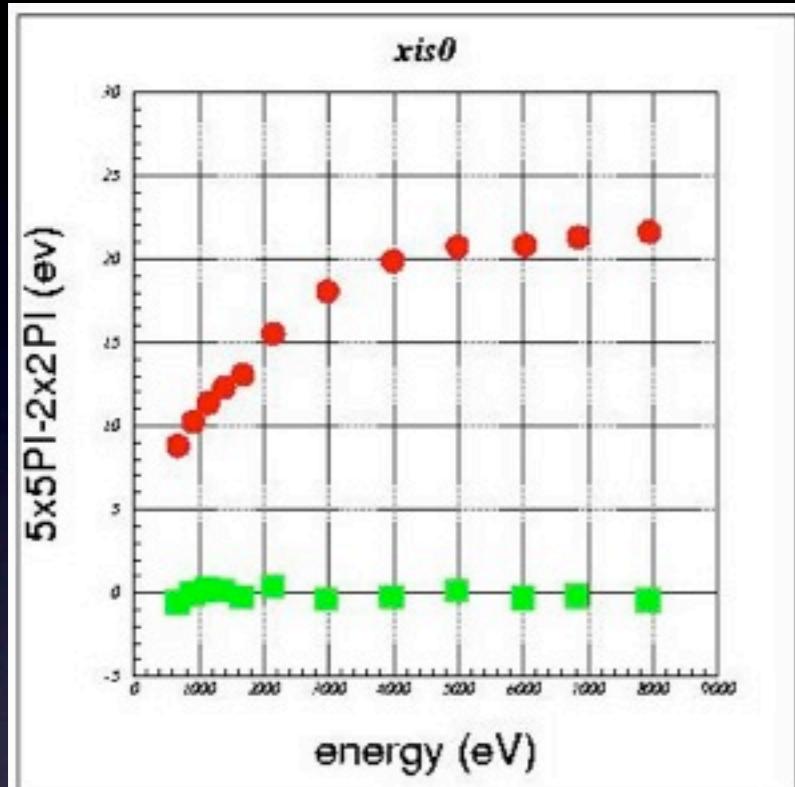


# 2x2 Editing Mode - Gain

2008 Aug.

2009 Feb.

2009 Aug.

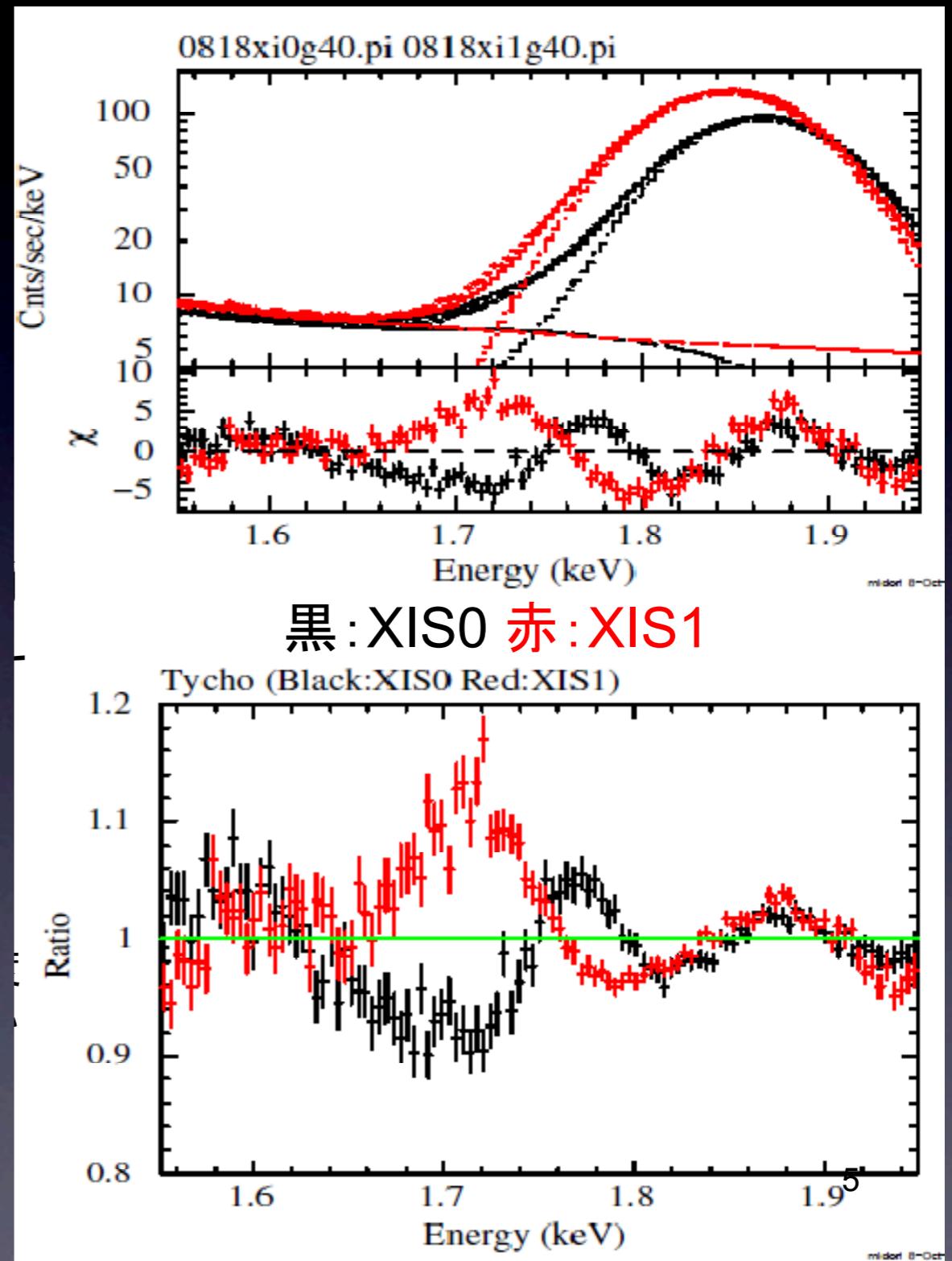


- 2x2 gain corrected by 10-20 eV to equal 5x5 gain  
correction depends on energy and epoch
- no practical differences in FWHM and detection efficiency between 5x5 and 2x2
- XIS0, XIS3 similar; XIS1 is not operated in 2x2

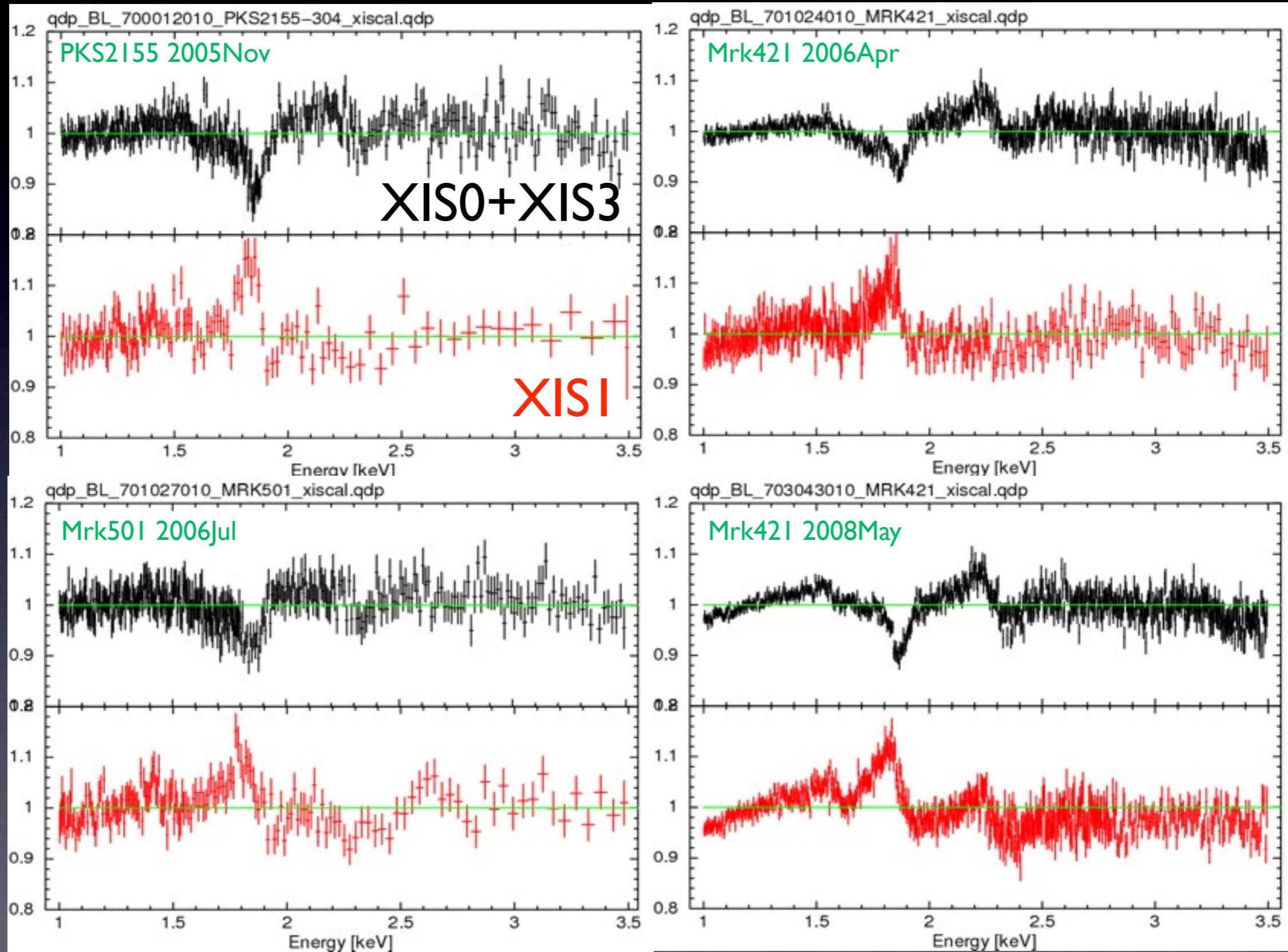
before correction  
after makepi\_20091202

# Calibration Near Si Edge

- Tycho SNR
- powerlaw + Gaussian Si K line (center variable)
- line shift between FI, BI
- residuals of  $\sim 10\%$  around Si K edge
- problem with detector Si fluorescence?  
another source?
- still under review



# Calibration Near Si Edge

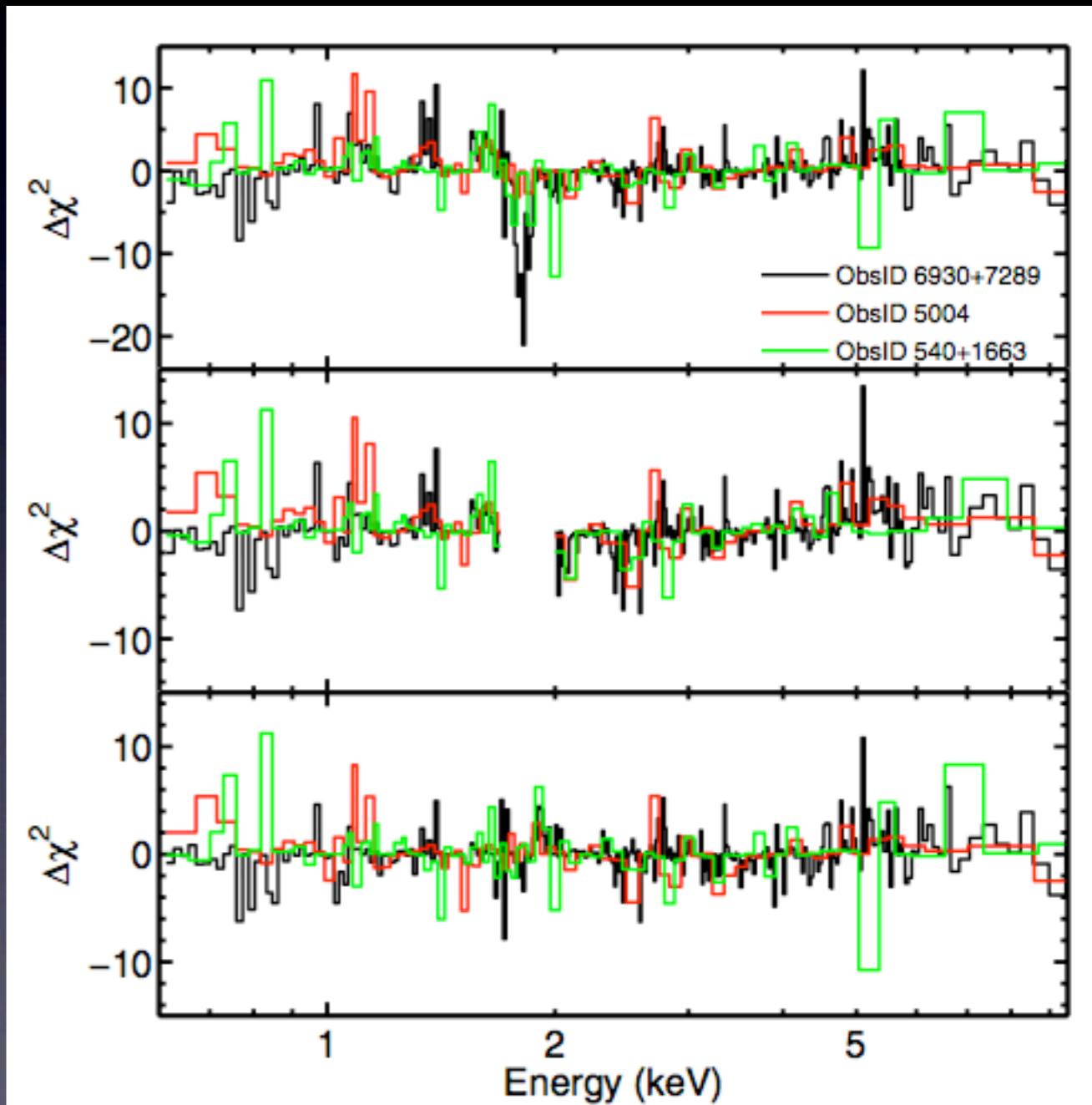
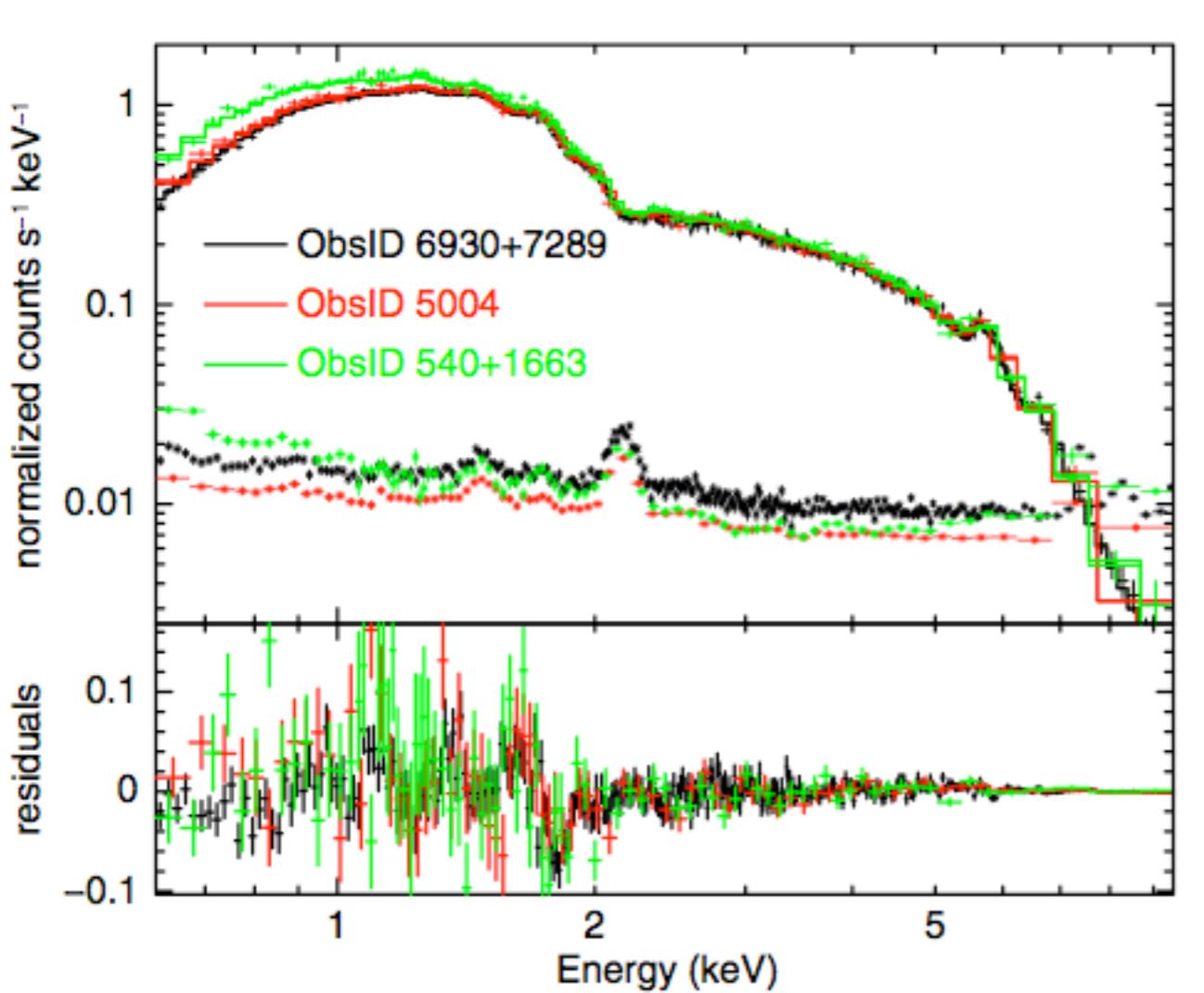


# Calibration Near Si Edge (CXO)

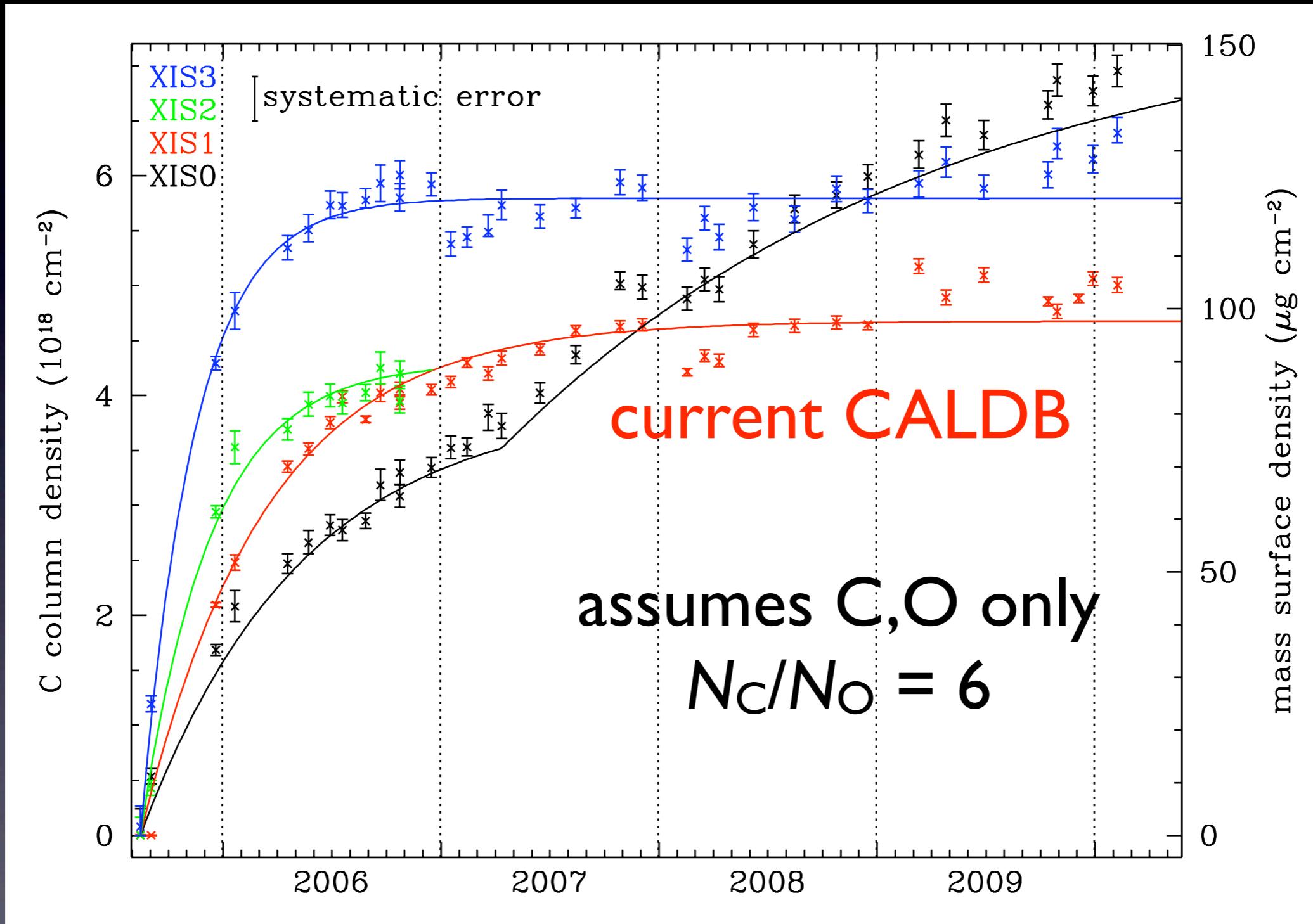
“extra” Si edge in ACIS-I spectra of Abell 1689

$E = 1.77 \text{ keV}$ ,  $\tau = 0.12$

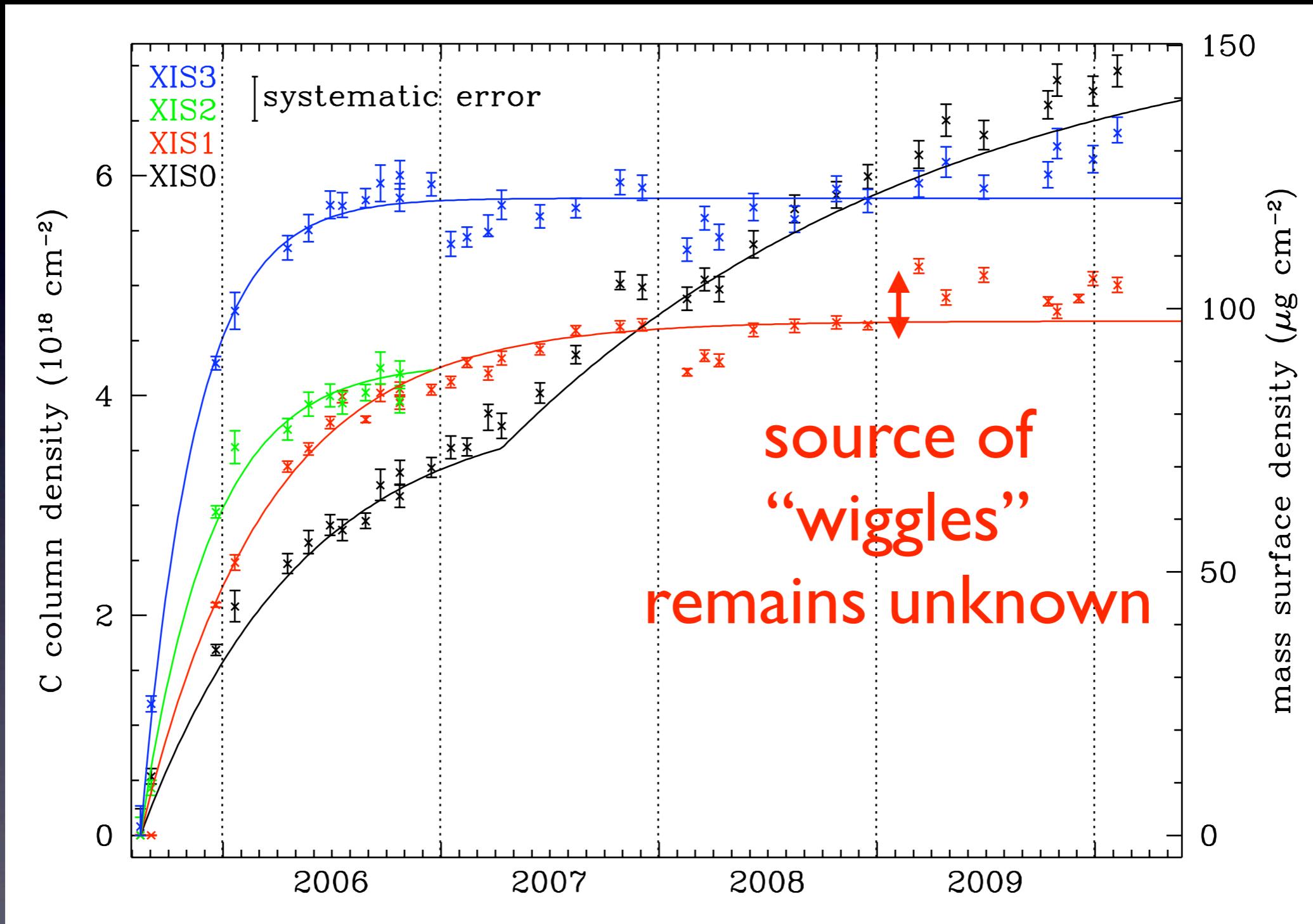
Peng et al. 2009



# OBF Contamination (On Axis)



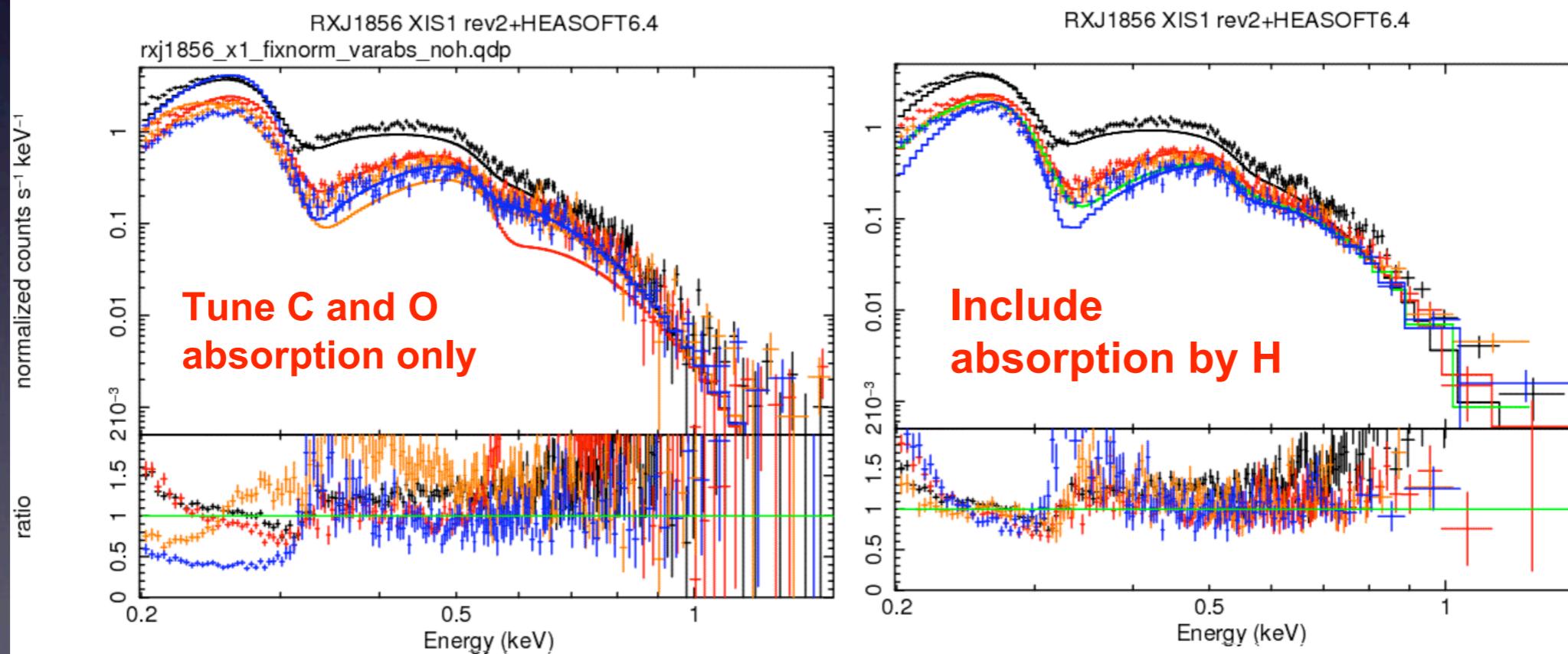
# OBF Contamination (On Axis)



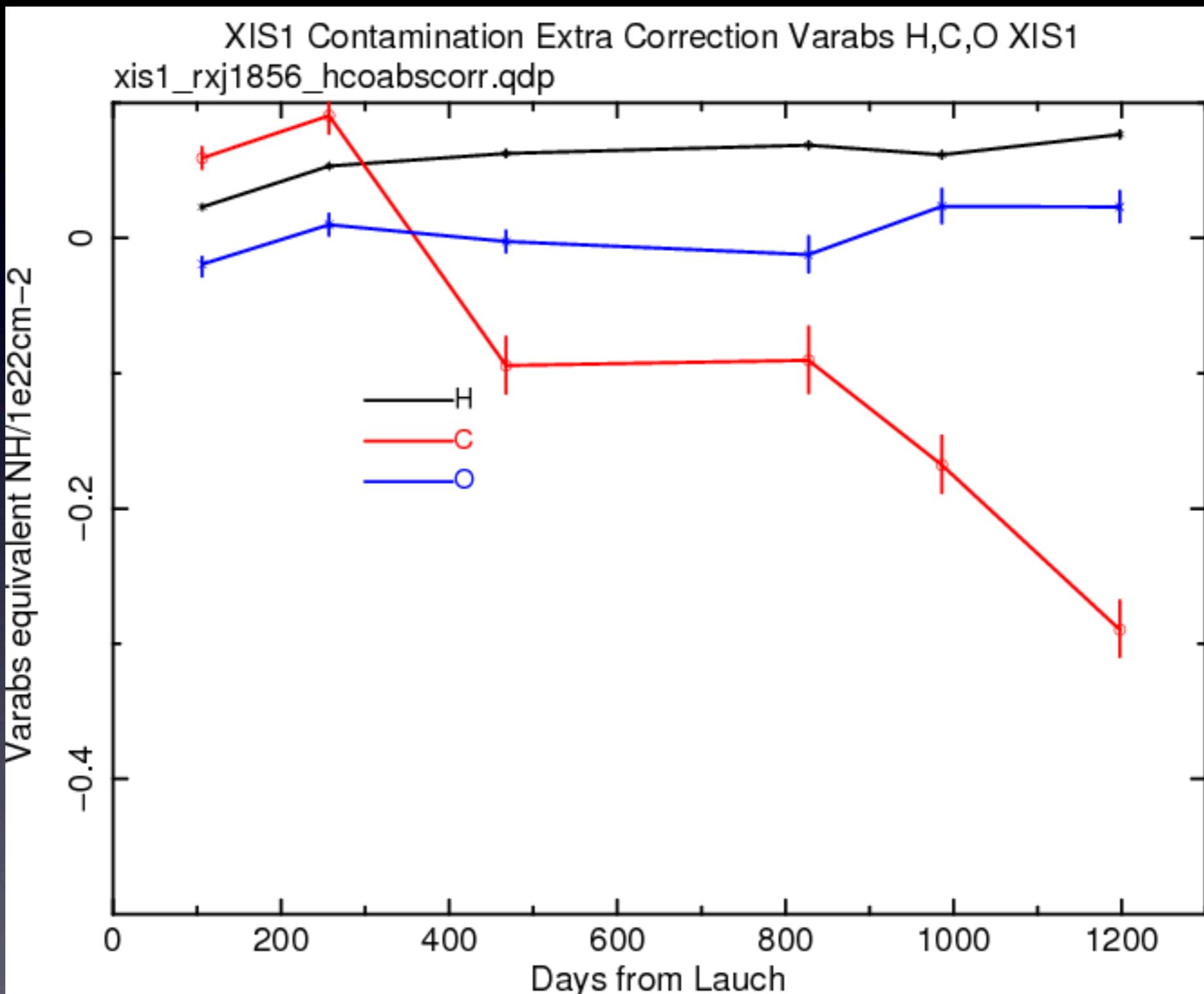
# Contamination Composition

Factor of 2 underestimate below 0.3keV

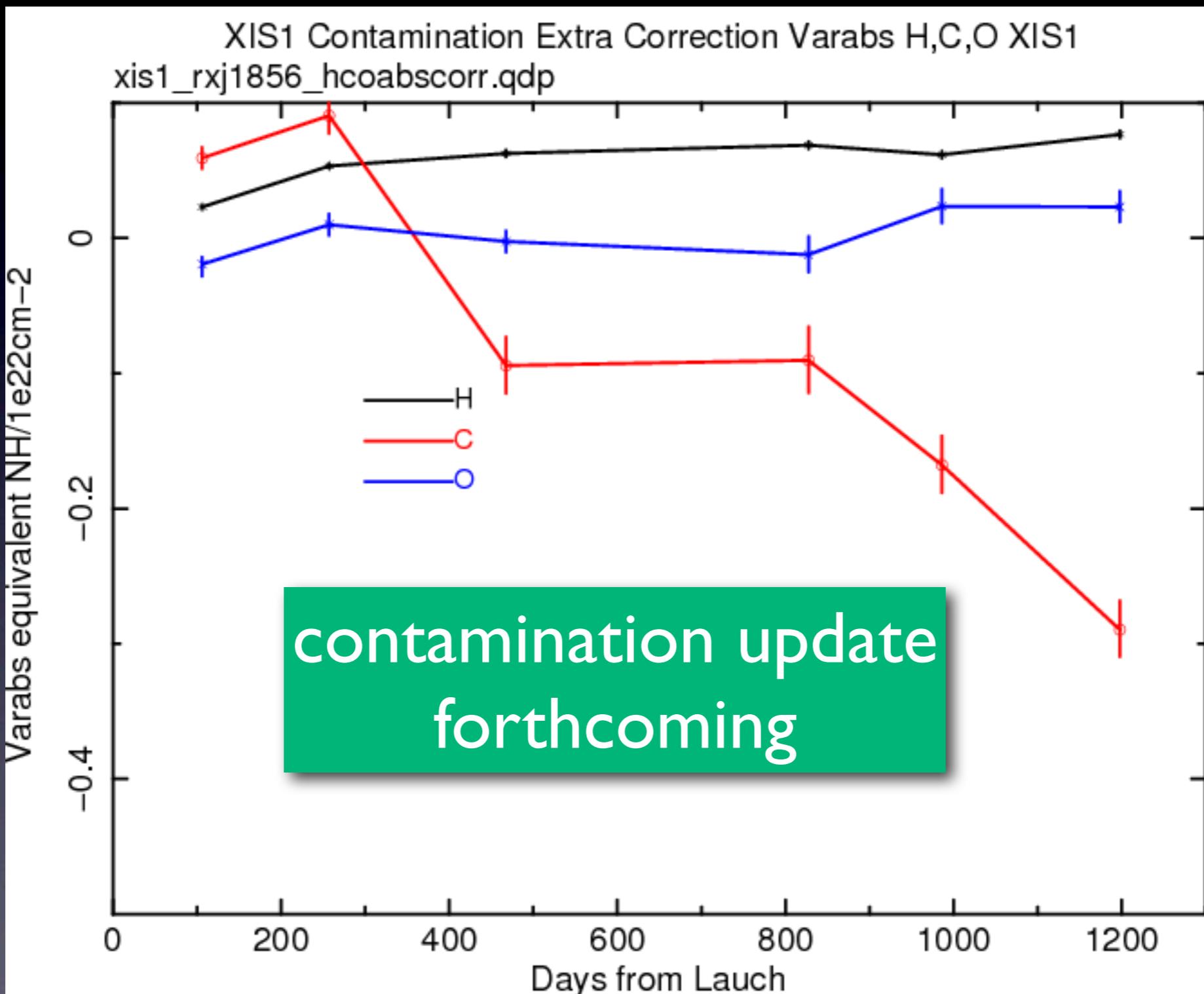
- Unable to improve the fit only with C & O
- Absorption by Heavier Element    No apparent edge found
- **Absorption by H (or He)**    but **too much  $\sim 10^{21} \text{cm}^2$**
- Constant Factor (Grading Problem at low energy?)



# HCO Contaminant



# HCO Contaminant



# XIS Status - Summary

- XIS0 has lost ~ 10% of area but is operating safely
- XIS1,3 are operating normally

**X-RAY IMAGING SPECTROMETER (XIS)**

**INSTRUMENT MONITORING**

**CCD PERFORMANCE MONITORING**

[Cal Source Monitoring](#) Using information from the Fe55 calibration source regions, we track the gain, spectral resolution, hot pixels, and CTI indicators. SCI-off and SCI-on data are monitored separately. These data have not been processed by the calibration software.

[Monthly Cal Source Spectra](#) Spectra of integrated monthly Fe55 cal source data, by sensor and SCI setting.

**INSTRUMENT HEALTH MONITORING**

[Instrument HK Monitoring](#) Tracking of the CCD temperature, baseplate temperature, and TEC voltage.

[CCD Temperature Anomalies](#) Summary of anomalous temperature excursions for each detector.

**CONTAMINATION MONITORING**

[Point Source Monitoring](#) Tracking the on-axis OBF contamination with regular observations of soft point sources (primarily EG102).

[Bright Earth Monitoring](#) Tracking the spatial dependence of the OBF contamination with monthly integrated observations of the sunlit Earth, which emits field-filling O and N emission lines.

**XIS INFO**

- HOME
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- PEOPLE
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- CALIBRATION
- MONITORING
- TEAM PAGE

**XIS COLLABORATORS**

- ISAS/JAXA
- KYOTO U.
- OSAKA U.

**SUZAKU INFO**

- GO FACILITY
- SUZAKU AT ISAS
- XRS AT GSFC
- HXD AT Tokyo U.
- XRT AT GSFC

**MIT** MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
Last updated: Wed May 27 11:11:45 EDT 2009  
email: mitxiso@mit.edu

**Suzaku X-ray Imaging Spectrometer Quick Reference** 2010/03/27 M. Tsujimoto (ISAS; XIS support astronomer)

This leaflet is intended to assist users to plan an XIS observation. The Suzaku web page (<http://www.astro.isas.jaxa.jp/suzaku/index.html.en>) and the "Technical Description" document supplement the information. Consult [xisope@astro.isas.jaxa.jp](mailto:xisope@astro.isas.jaxa.jp) for further details.

		Position		Normalized rate	
		XIS	HXD		
XIS nominal		1	0.9		
HXD nominal		0.9	1		

**Basics** XIS is equipped with four X-ray CCDs (XIS0-3) for imaging and non-dispersive spectroscopy. The four CCDs are at the focus of four co-aligned telescopes and observe the same field. Three CCDs are front-illuminated (FI) and one is back-illuminated (BI) superior respectively in the hard- and soft-band. XIS is operated simultaneously with HXD.

**Field of view** 17.8' x 17.8'

**Energy range** 0.2-12 keV

**Energy resolution** ~180 eV @6keV

**Effective area** 340 (FI)/390 (BI) cm<sup>2</sup> @1.5keV

**Time resolution** 8 s (Normal) - 7.8 ms (Psum)

**AIM point** Choose either XIS- or HXD-nominal position, depending on which detector you emphasize. The count rate differs by ~10%. Positions other than these may be useful for mapping observations.

**Archive** Accepted targets : <http://heasarc.gsfc.nasa.gov/docs/suzaku/tminfo/XIS.log> : <http://darts.isas.jaxa.jp/astro/suzaku/suzakuislog/top.do> Obs plan : <http://www.astro.isas.jaxa.jp/suzaku/schedule/shortterm/>

**View** XIS0-3 has 1024x1024 pixels composed of four segments (A-D) with one readout node for each segment. Due to unavoidable micrometeorite hits etc, a part of XIS0 and the entire XIS2 (Normal) and all but XIS3 (Psum) are not usable. Two <sup>56</sup>Fe calibration sources (Mn I K $\alpha$  and K $\beta$  lines at 5.9 and 6.5 keV) are installed. Users can specify the roll angle. Use the [Maki tool](#).

Clock mode												Normal												Psum
Opt	Win.	no	1/4	1/8	no	no	no	no	1/4	1/4	1/4	1/4	1/4	1/4	1/8	no								
Burst	no	no	2.0	0.7	0.5	0.1	1.0	0.5	0.3	0.1	0.5	no												
Max crt/s to avoid pile-up*	12	48	96	48	1.3	1.9	7.1	96	1.9	3.2	7.1	1.9	1.5	1.5	1.5	no								
Loss rate %	2	7	14	76	91	94	98	54	77	86	94	57	0											
Support	OK	OK	*2	OK	*3	*3	*2	OK	OK	*2	*2	*2	*2	*2	*2	*2								

\*1: The rates are "hard limits". A 5-10% margin should be considered. Annulus extractions can also work.  
\*2: Calibration not guaranteed. \*3: BI only. \*4: FI only. \*5: HXD-nominal only.

**Clocking** XIS is operated in a combination of clocking and editing modes. Users are responsible to choose the appropriate clocking mode. It is acceptable to use different clocking modes for different sensors. For faint (<1.2 [s/sensor]) sources, use Normal mode with no option. For bright (>12 [s/sensor]) point-like sources, choose Normal mode with appropriate window and/or burst options. For high timing accuracy, choose Psum (XIS3) and others (XIS0,1).

**Pixel Map**

The diagram shows the 1024x1024 pixel layout of the XIS CCDs. It is divided into four quadrants labeled A, B, C, and D. A central vertical column contains two calibration sources, indicated by red 'X' marks. The diagram also shows the 'Unusable regions' and 'OBR hole'. The 'Useful regions (Psum)' are highlighted in yellow. The 'XIS0 (FI)', 'XIS1 (BI)', 'XIS2 (FI)', and 'XIS3 (FI)' detectors are labeled along the bottom. A coordinate system with Roll and Declination (RA) axes is shown.

**Counts/s** Estimate the count rate using the [PIMMS](#) tool. Approximately, 1 mCrab flux yields 1.6 [s/sensor] (FI) and 1.9 [s/sensor] (BI). For bright variable sources, check [MAXI](#) and [RXTE/ASM](#). Rate estimate is crucial for selecting XIS modes. Plots of ToO observations of bright variable sources may update the estimate by a few days prior to the observation.

<http://space.mit.edu/XIS/monitor>

[http://www.astro.isas.jaxa.jp/~tsujimot/pg\\_xis.pdf](http://www.astro.isas.jaxa.jp/~tsujimot/pg_xis.pdf)

