

The *Suzaku*/XIS: Status Report



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for the *Suzaku*/XIS Team

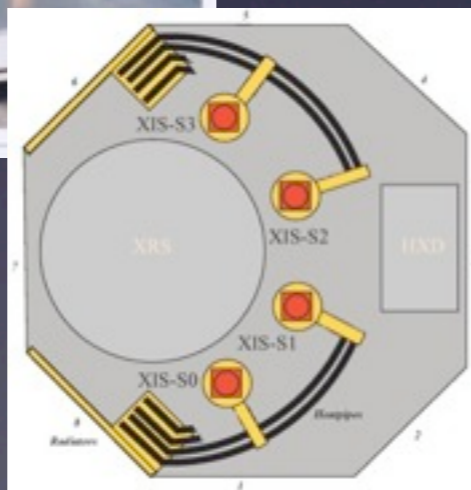
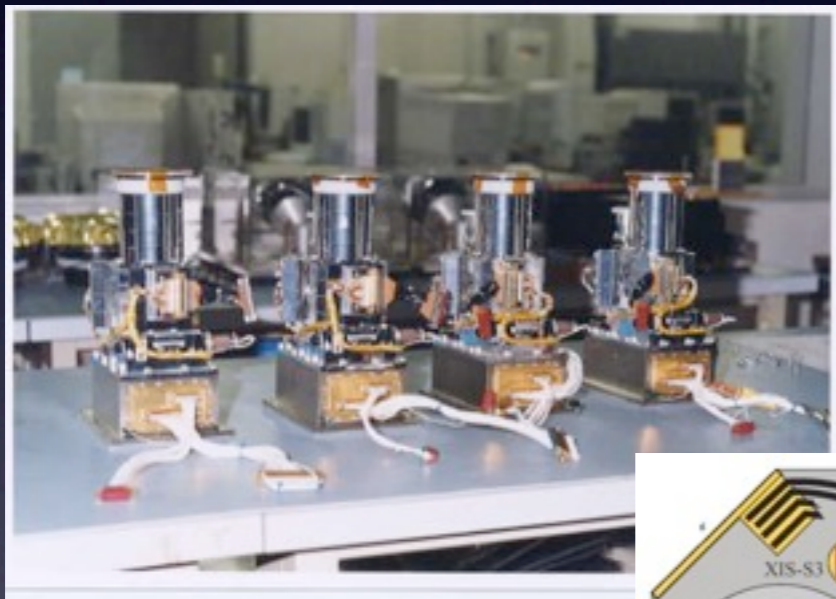


Outline

- 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



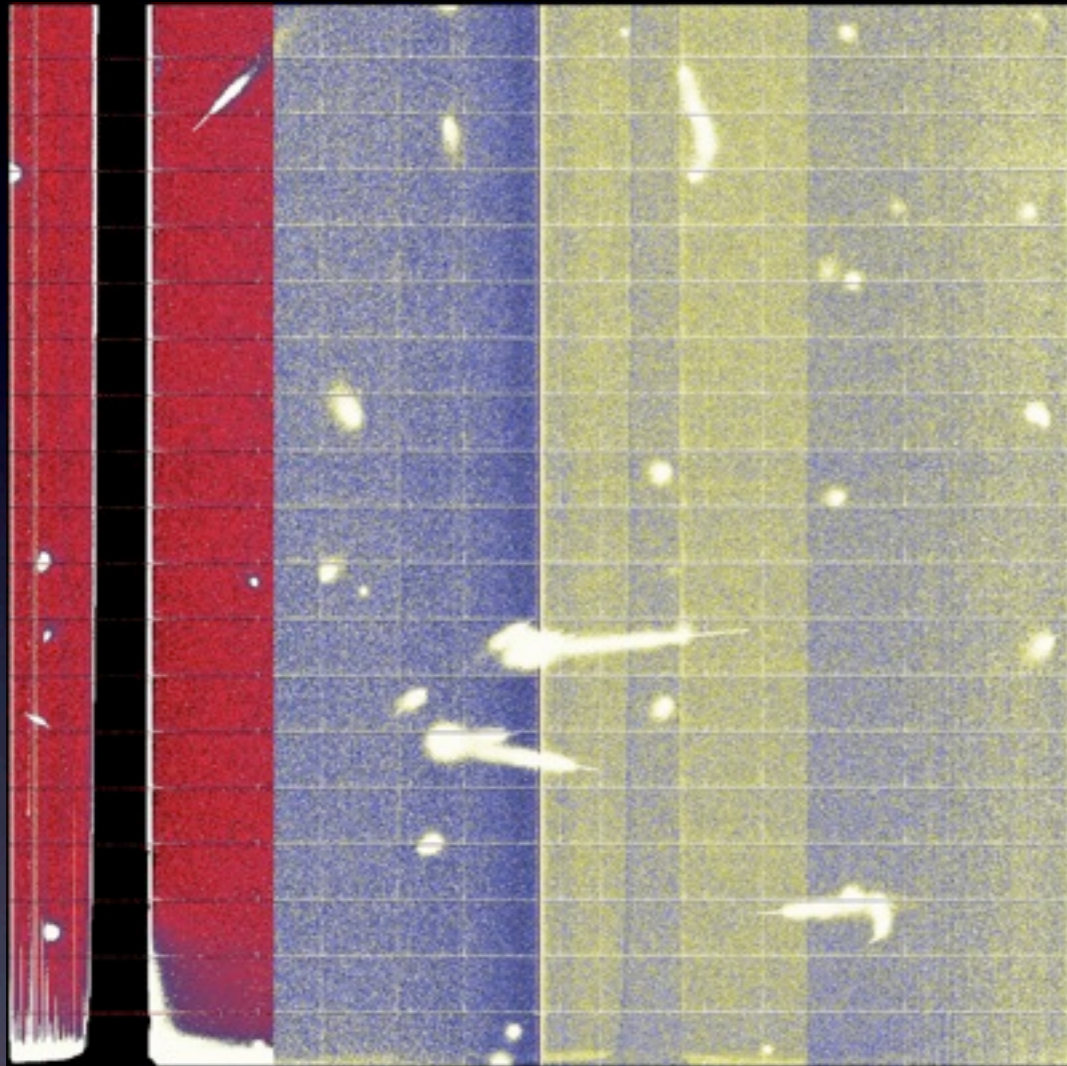
Field of view	17.8' x 17.8'
Energy range	0.2-12 keV
Energy resolution	~180 eV @6keV
Effective area	340 (FI)/390 (BI) cm ² @1.5keV
Time resolution	8 s (Normal) - 7.8 ms (Psum)

from Tsujimoto's "pocket guide"

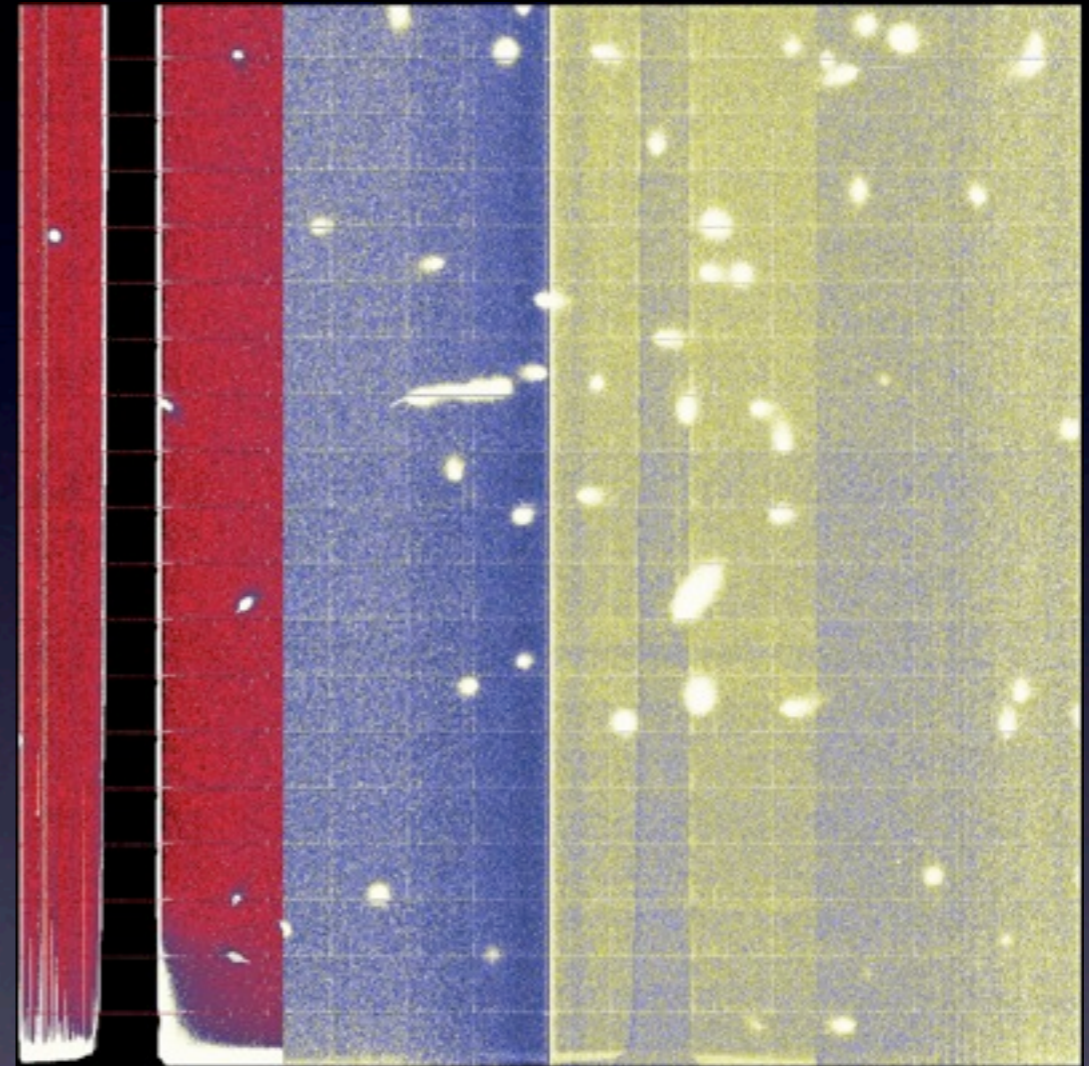
Major XIS Events

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

XIS0 Anomaly - Frame Data



charge injection on

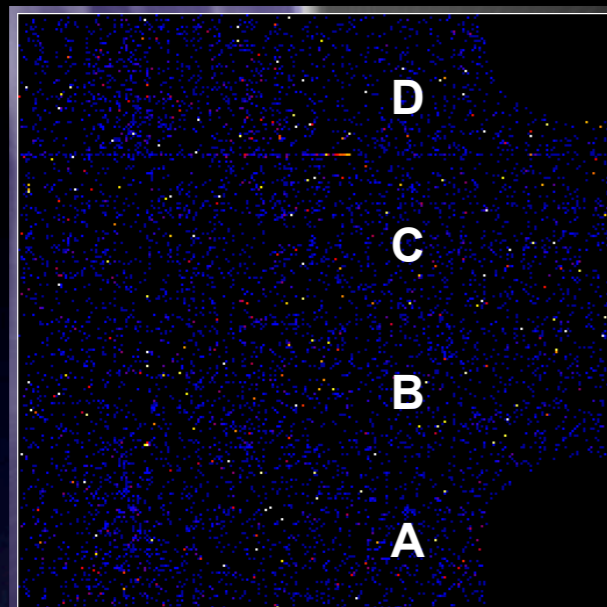


charge injection off
(but sequencer still on)

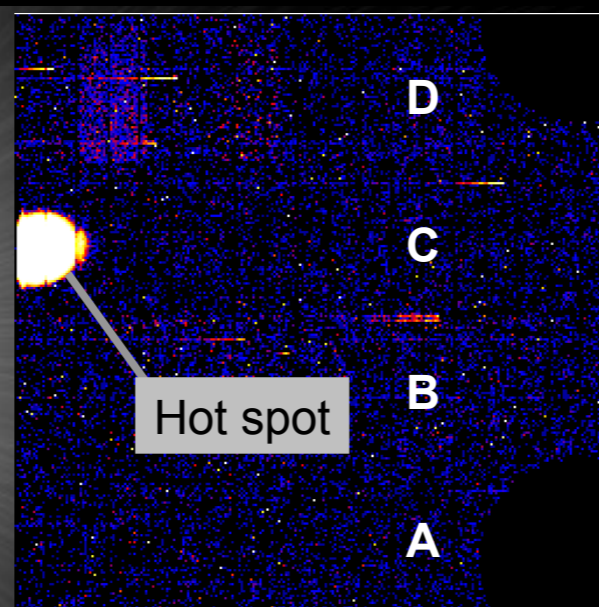
XIS0 Anomaly - Summary

- 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

XIS I Anomaly - Observations



2009-12-17 (Event; FES11)
day-earth

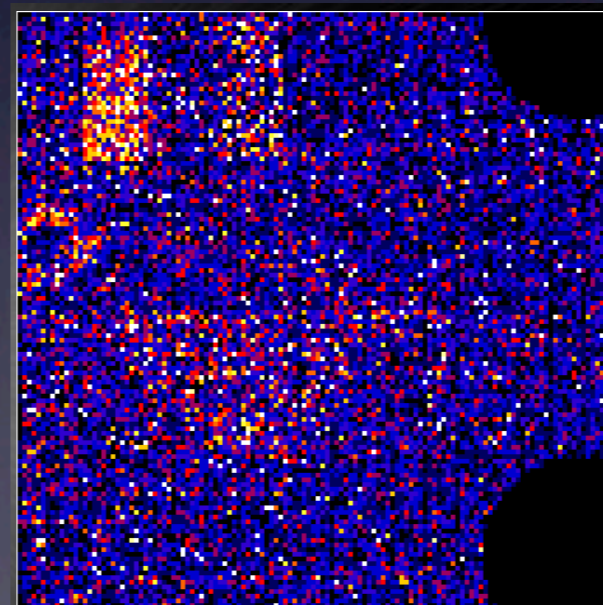


2009-12-18 (Event; A76 East)
day-earth [all grades]

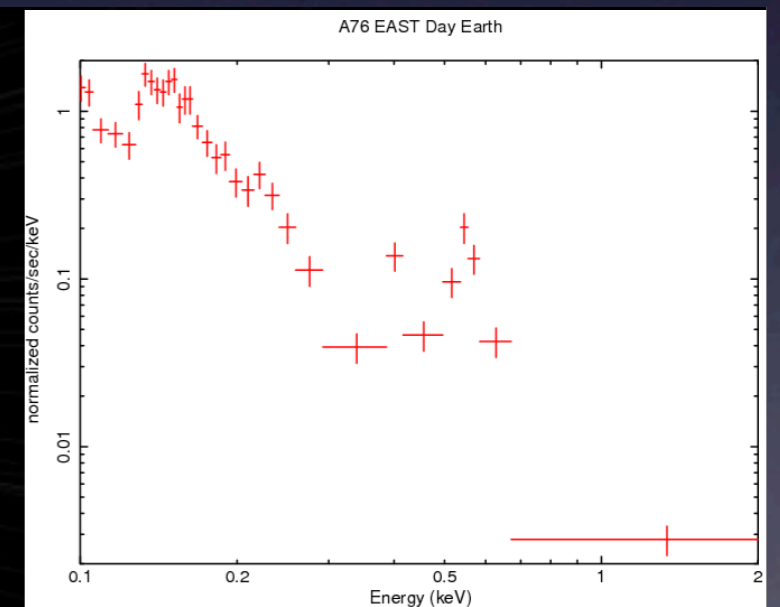


2010-01-04 (Frame)
night-earth

- persistent bright spot
- hole in OBF from μ -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"

XISI 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}Fe cal sources \rightarrow Mn $K\alpha$ at 5.9 keV
raw data, no CTI correction

- gain change
with SCI on
(% per yr)

XIS0 -0.399 ± 0.001

XIS3 -0.376 ± 0.001

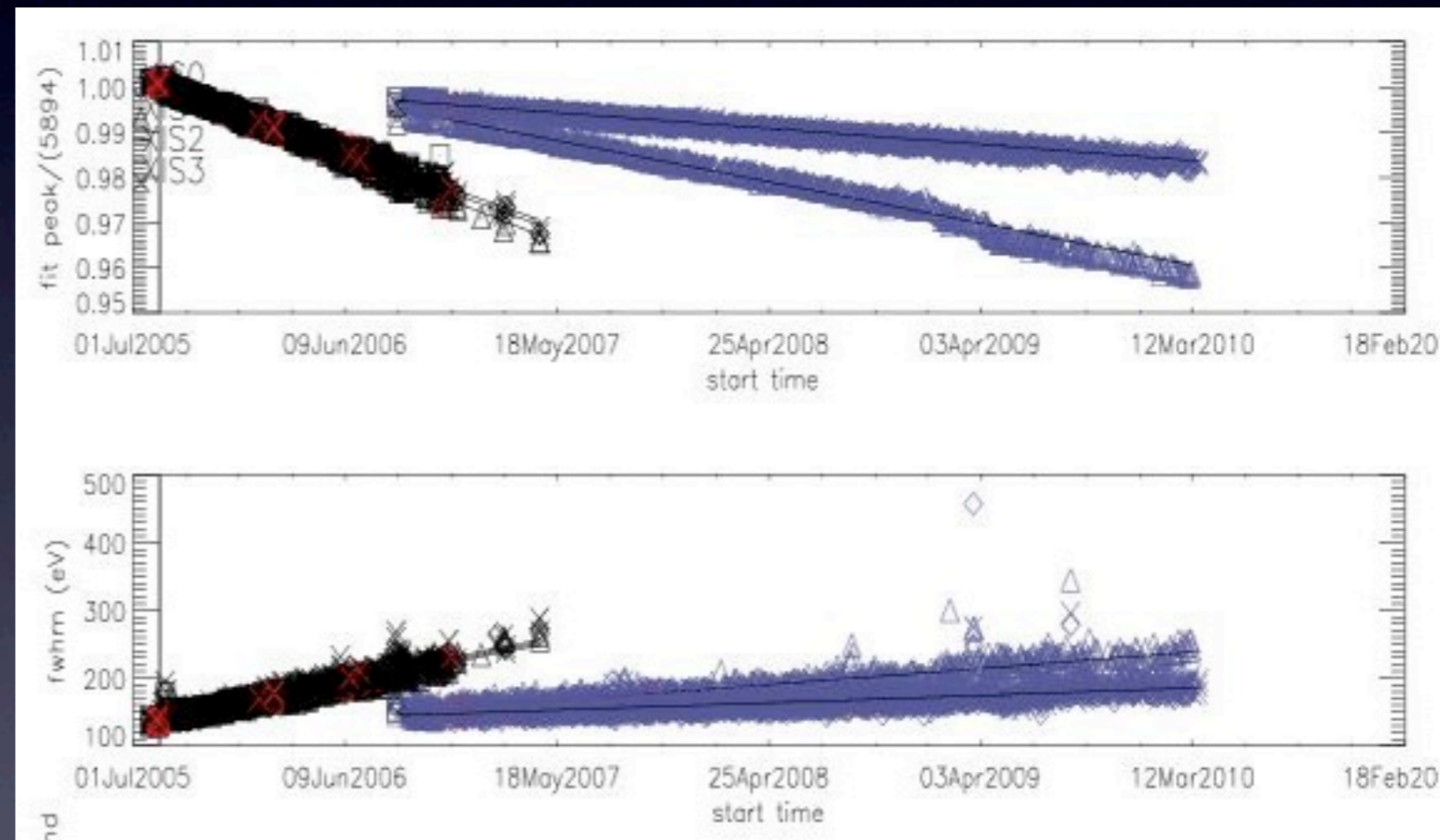
XIS1 -0.979 ± 0.001

- FWHM change
with SCI on
(eV per yr)

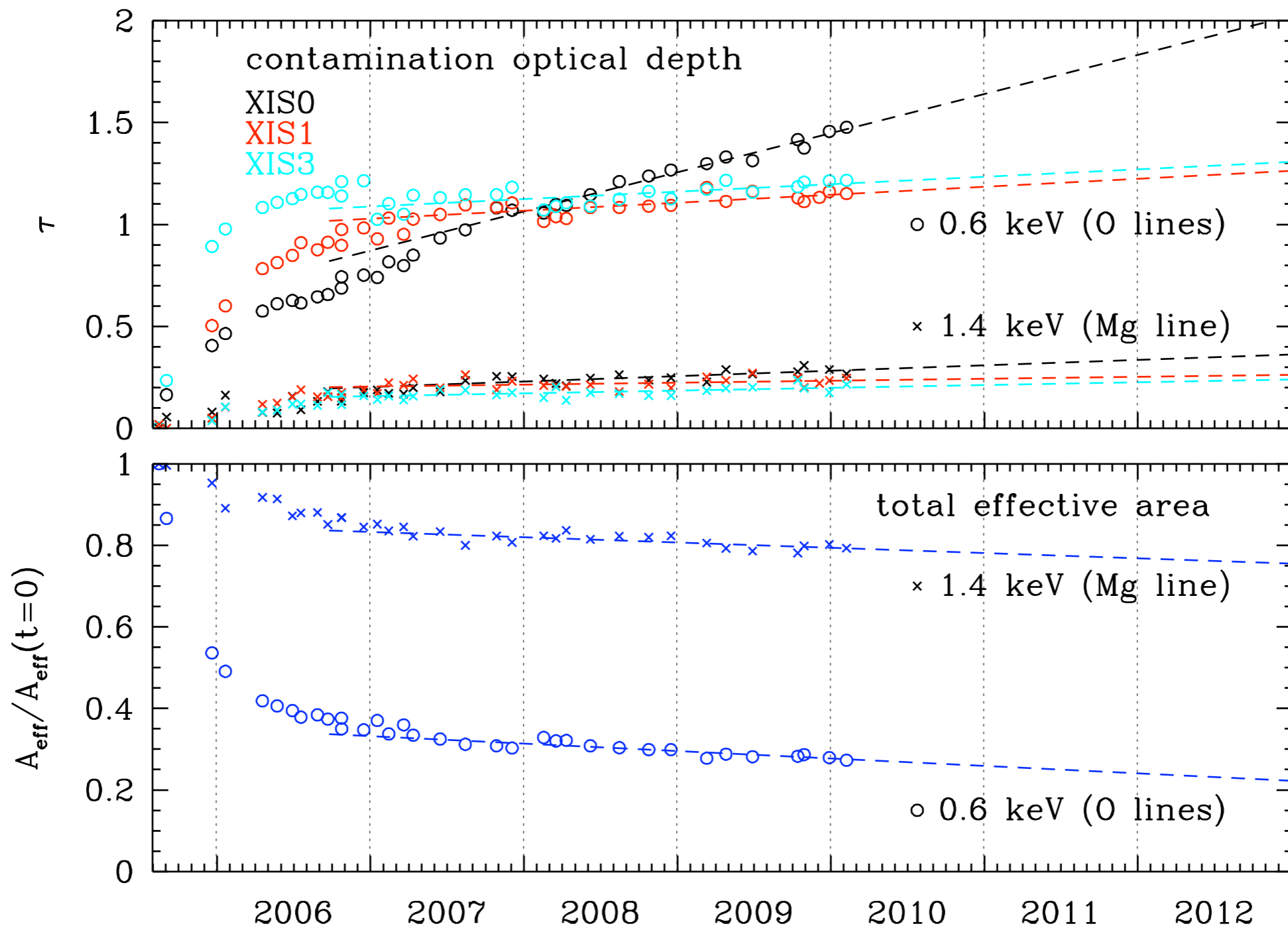
XIS0 13.1 ± 0.5

XIS3 11.5 ± 0.3

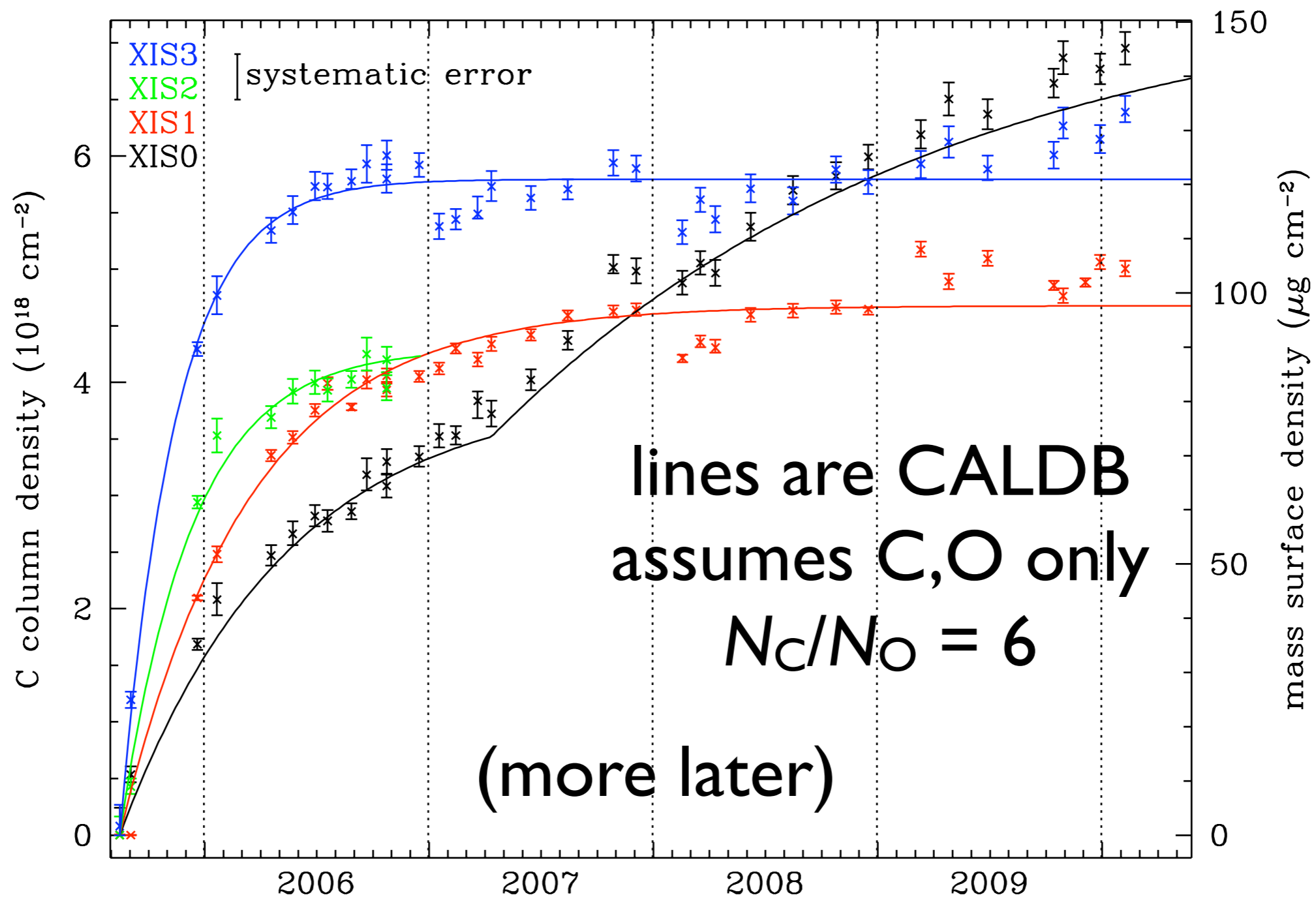
XIS1 25.4 ± 0.4



Effective Area Tracking



Contamination Tracking



Outline

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XIS Observing Modes

Clock modes + options

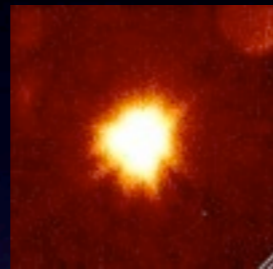
(exposure time, exposure region, time resolution)

Editing modes

(event detection, event grades, telemetry format)

Normal

Full



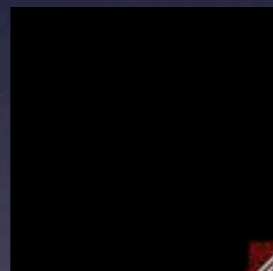
8 s

Window



1-2 s

Burst



> 0.1 s

5x5

3x3

2x2

P-Sum



> 7.8 ms

Timing

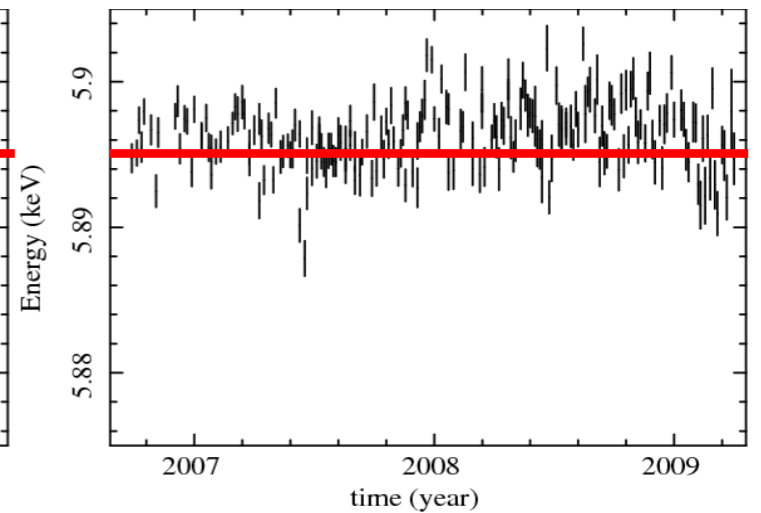
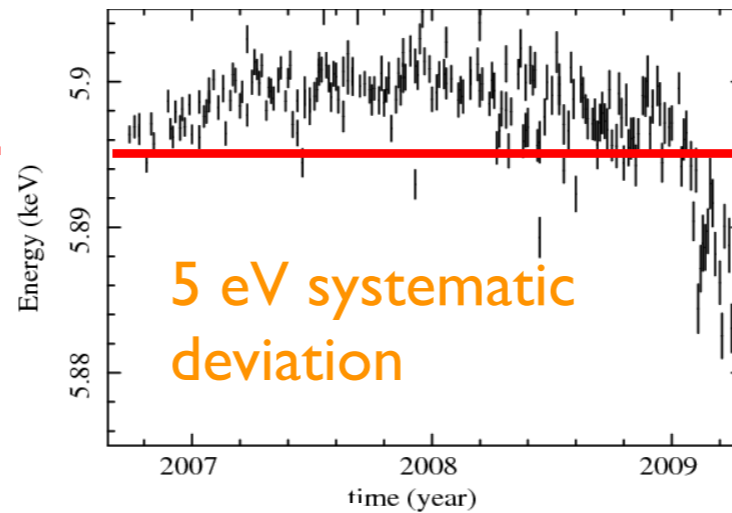
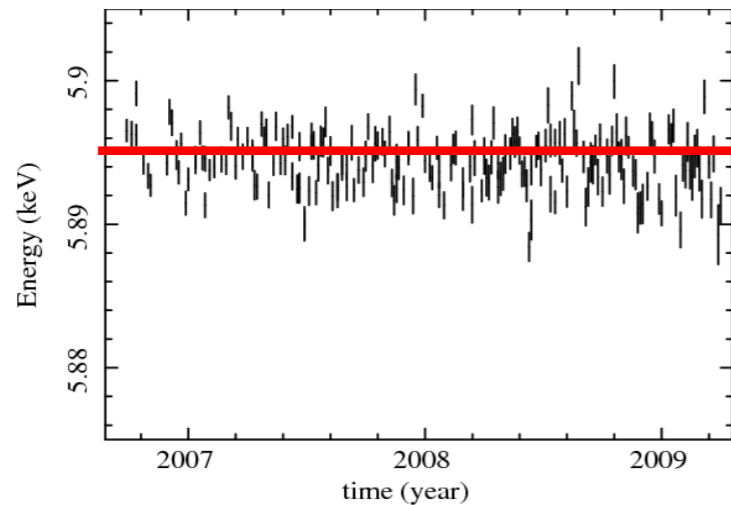
Normal Mode - Energy Scale

XIS0

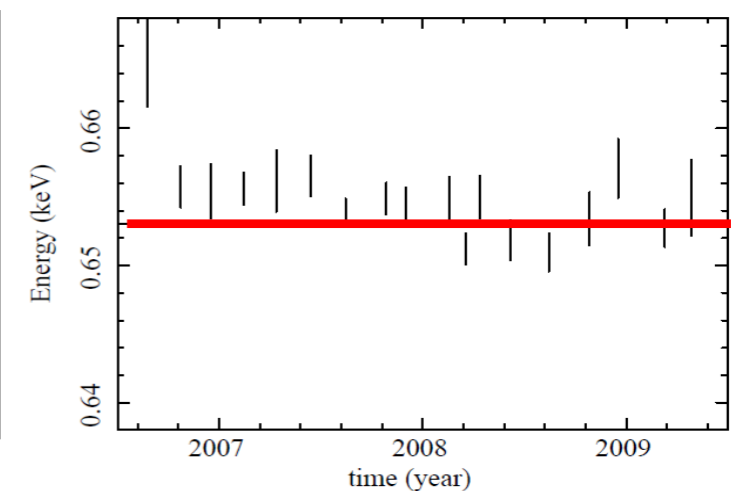
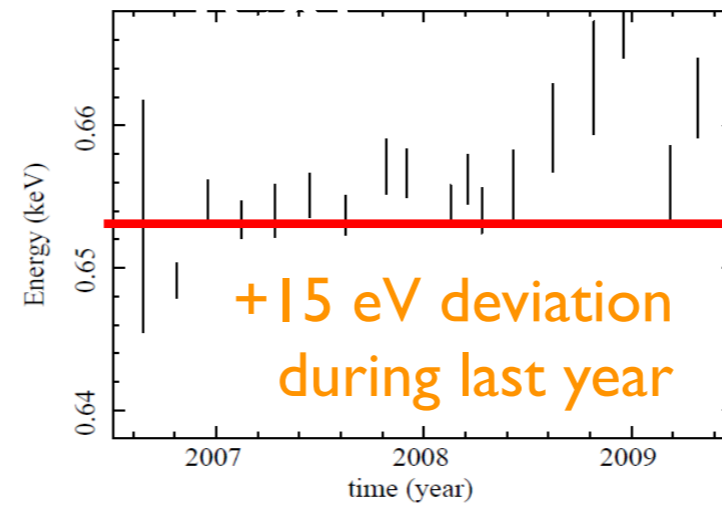
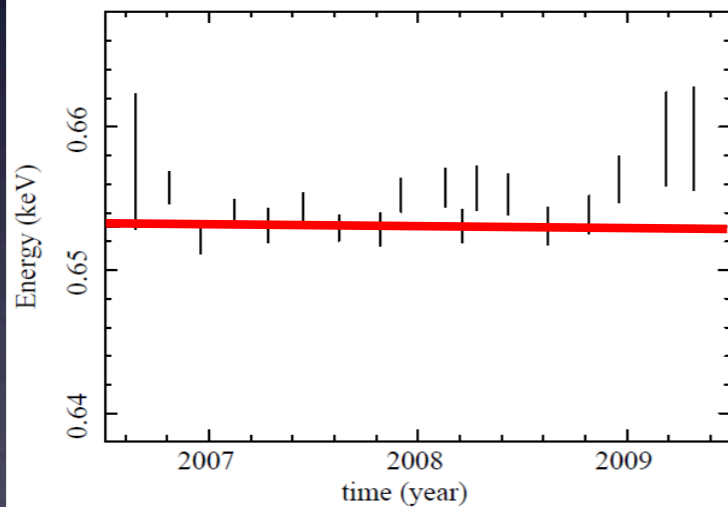
XIS1

XIS3

Mn $K\alpha$
5.9 keV



O VIII $K\alpha$
0.65 keV

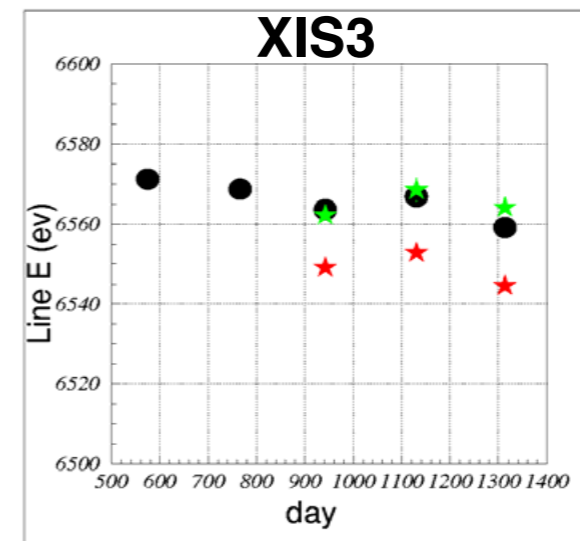
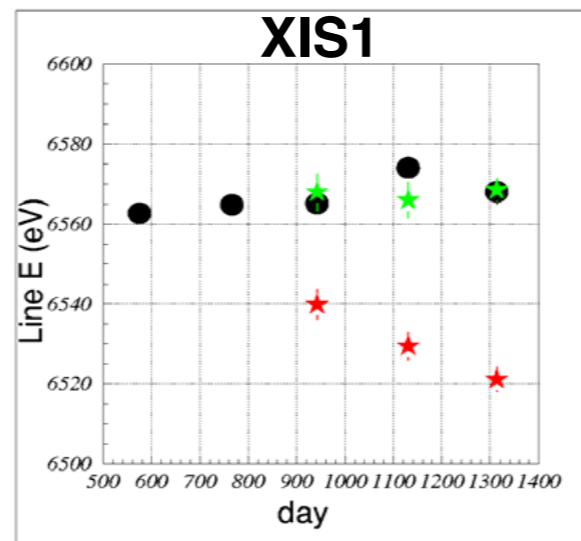
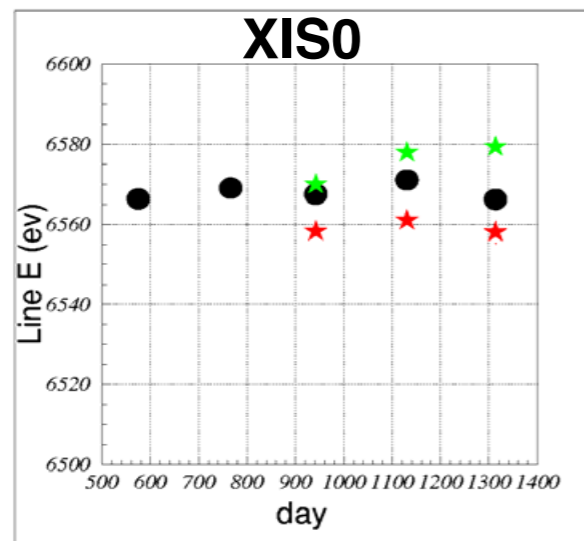


CTI corrected with makepi parameters from 2009-06-15

Window Mode

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

Perseus cluster - Fe line center

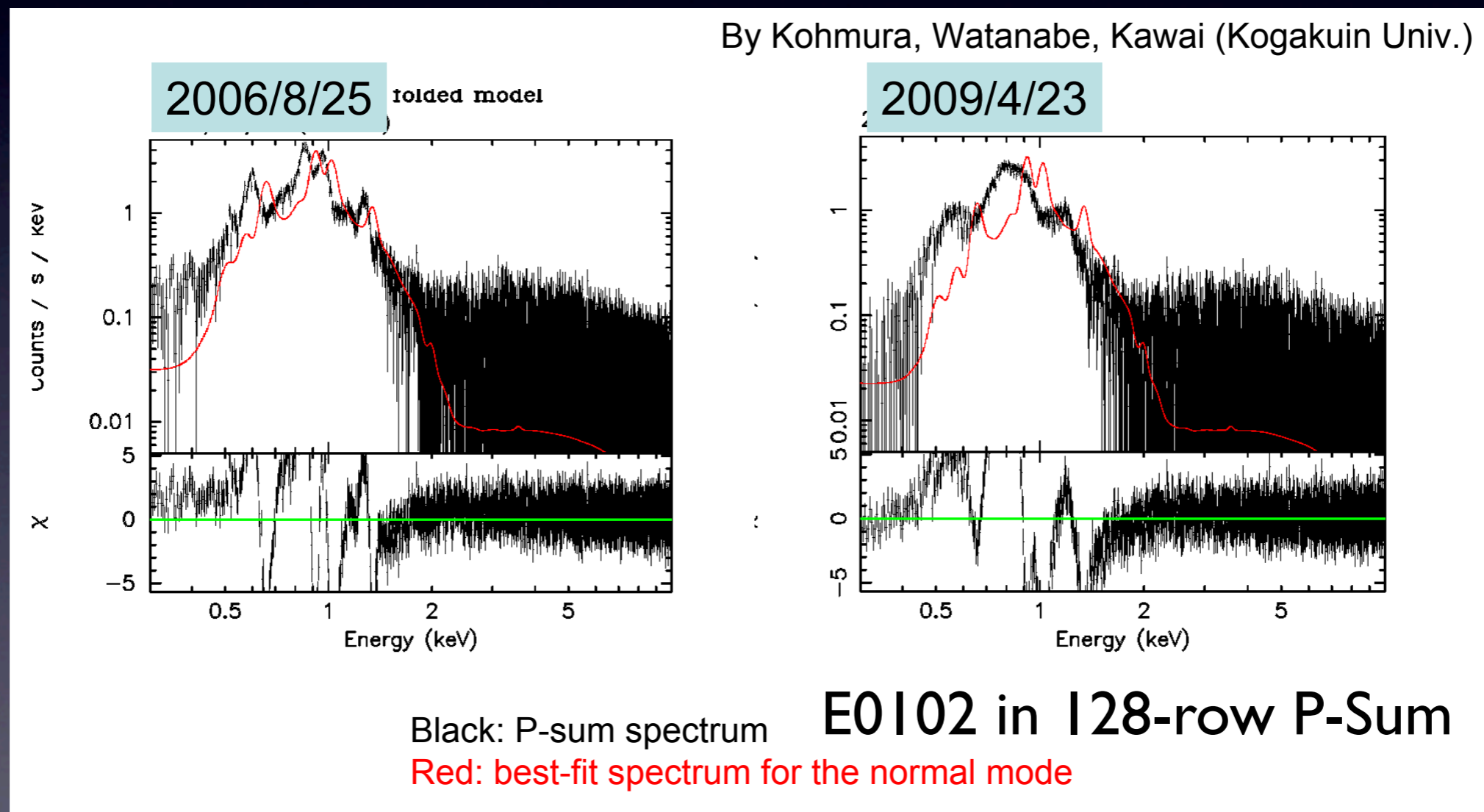


X: elapsed day since the launch
Y: measured central energy of the Fe line

- 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

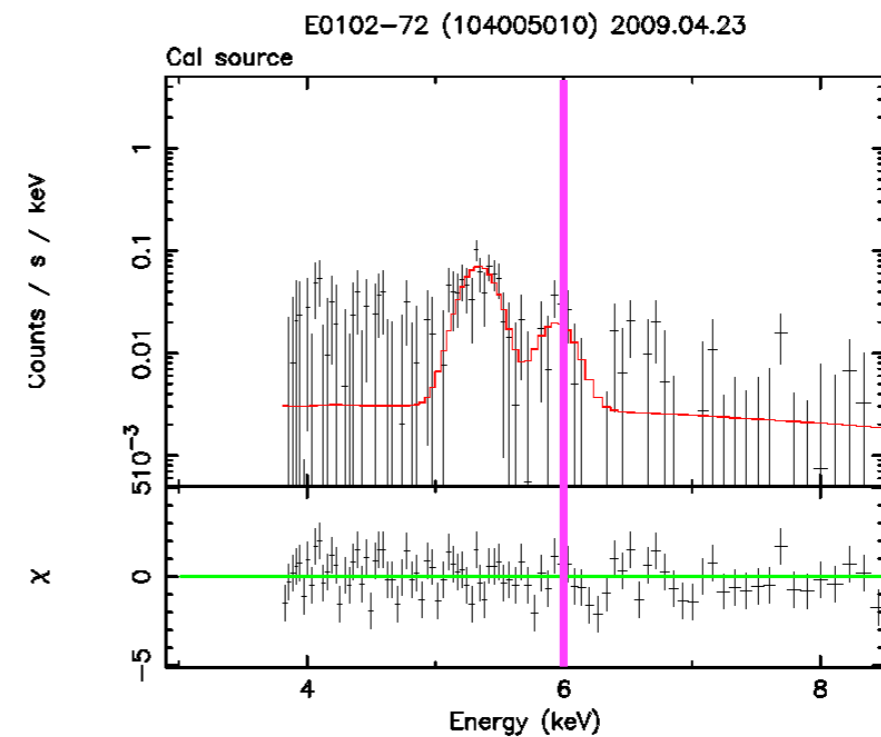
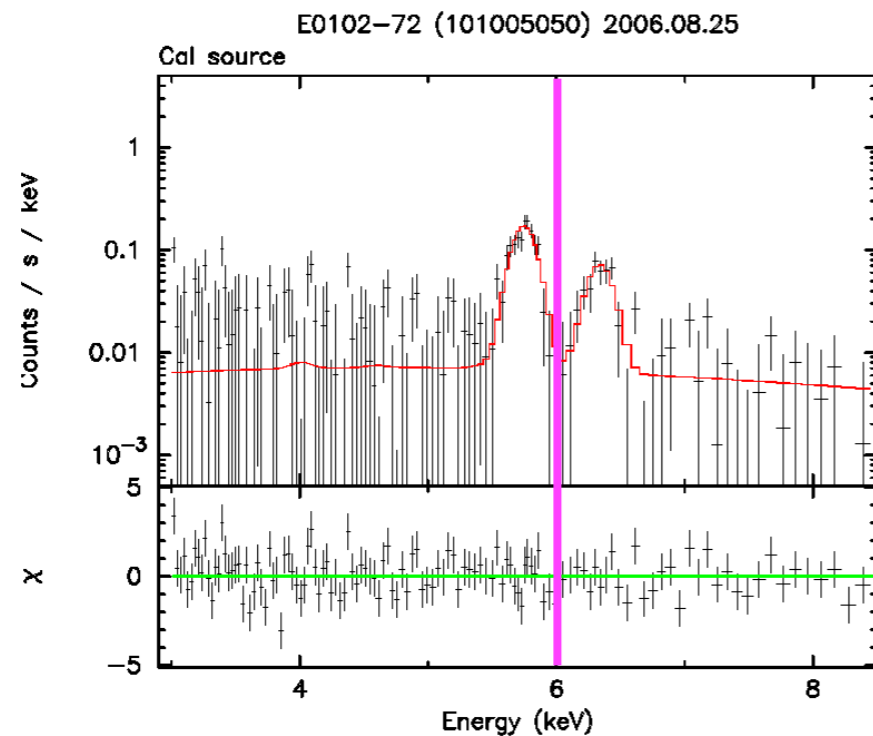


P-Sum + Timing Mode (XIS3)

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

^{55}Fe spectrum

By Kohmura, Watanabe, Kawai (Kogakuin Univ.)



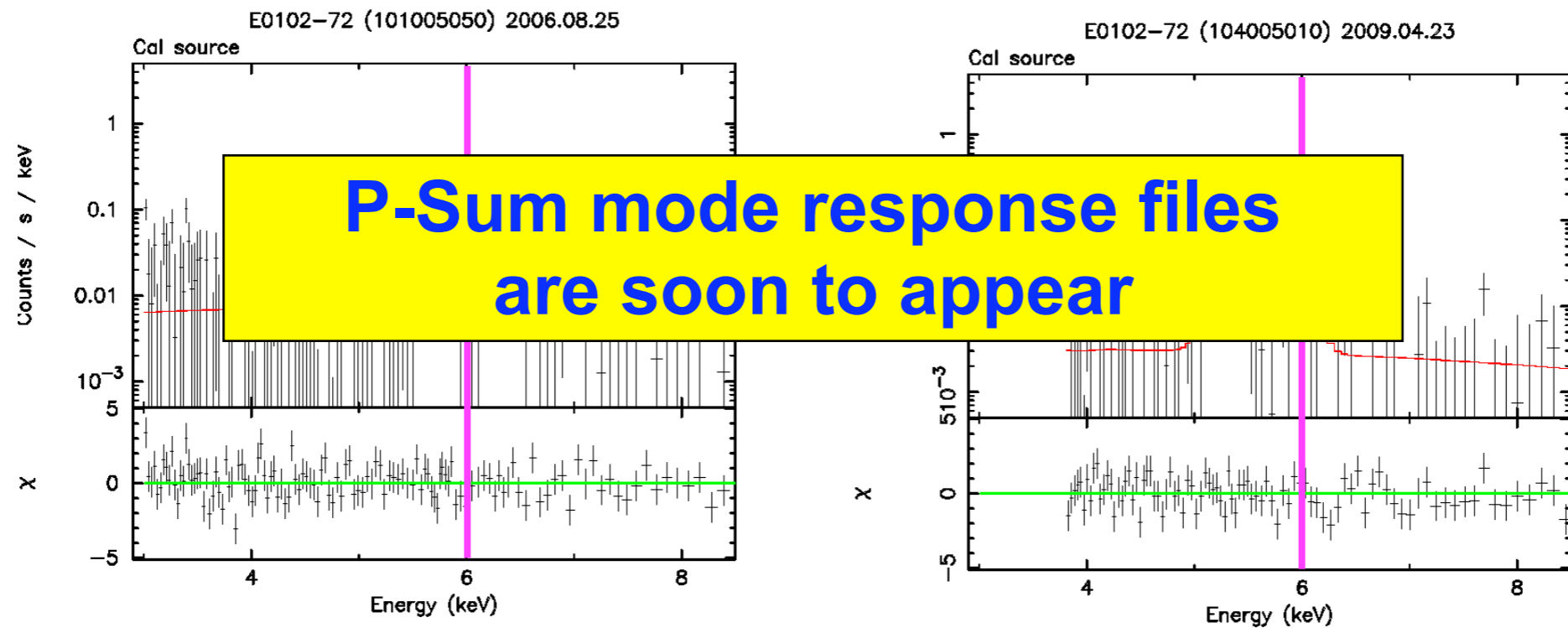
E0102 in 128-row P-Sum

P-Sum + Timing Mode (XIS3)

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

⁵⁵Fe spectrum

By Kohmura, Watanabe, Kawai (Kogakuin Univ.)



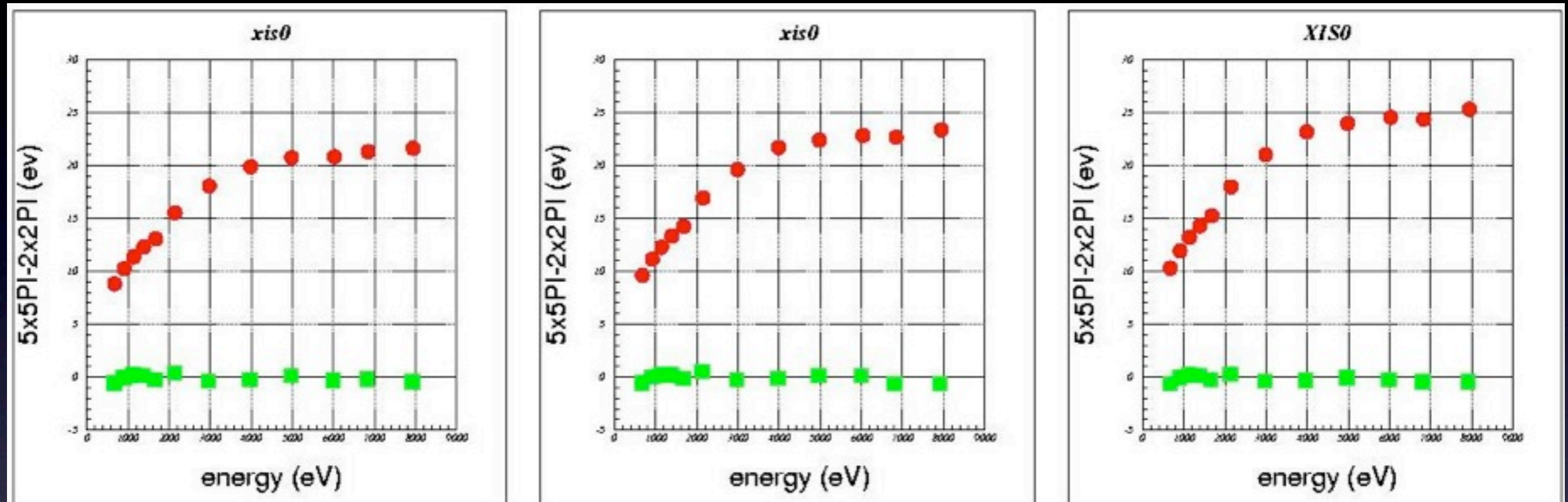
E0102 in 128-row P-Sum

2x2 Editing Mode - Gain

2008 Aug.

2009 Feb.

2009 Aug.

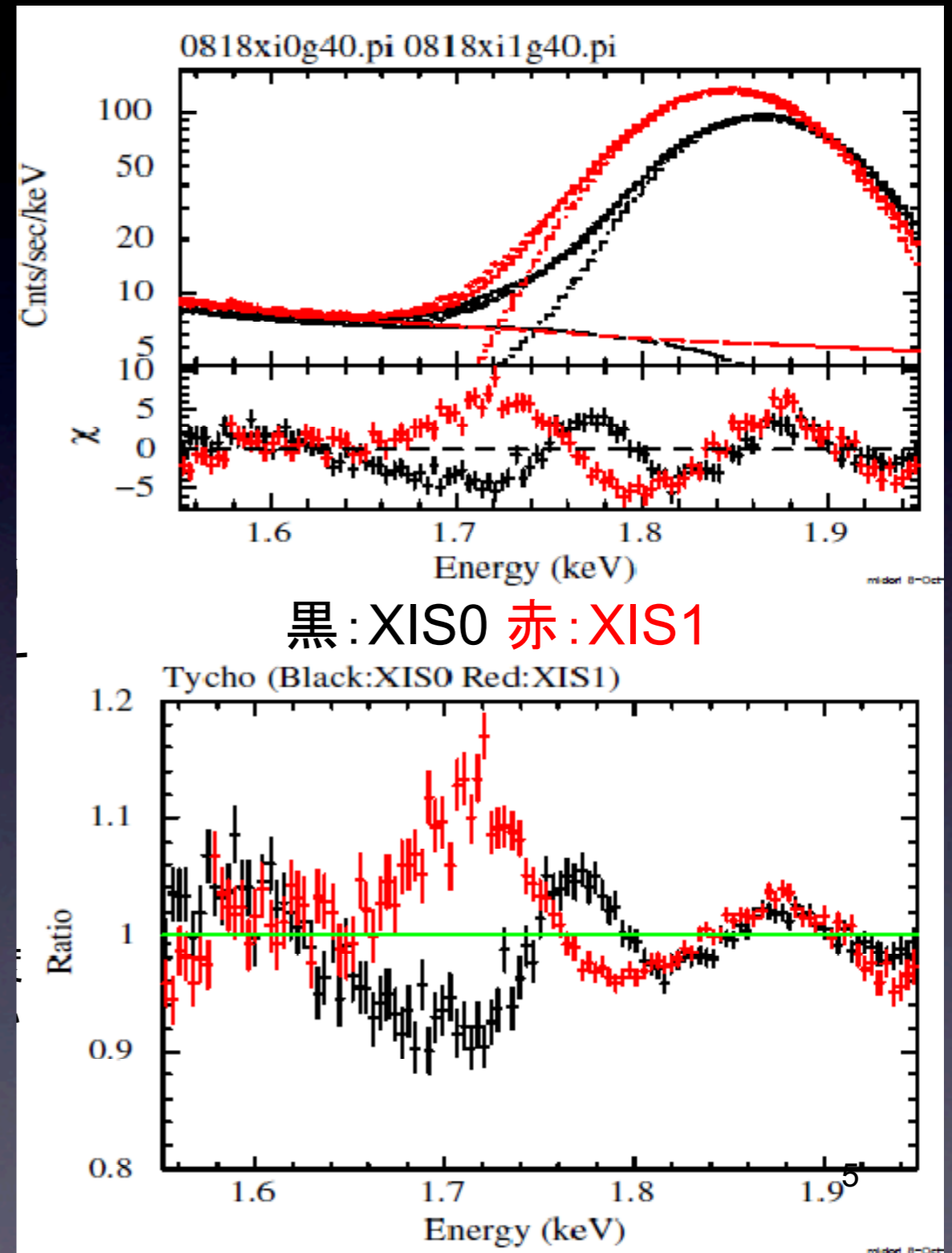


- 2x2 gain corrected by 10-20 eV to equal 5x5 gain
correction depends on energy and epoch
- no practical differences in FWHM and detection efficiency between 5x5 and 2x2
- XIS0, XIS3 similar; XIS1 is not operated in 2x2

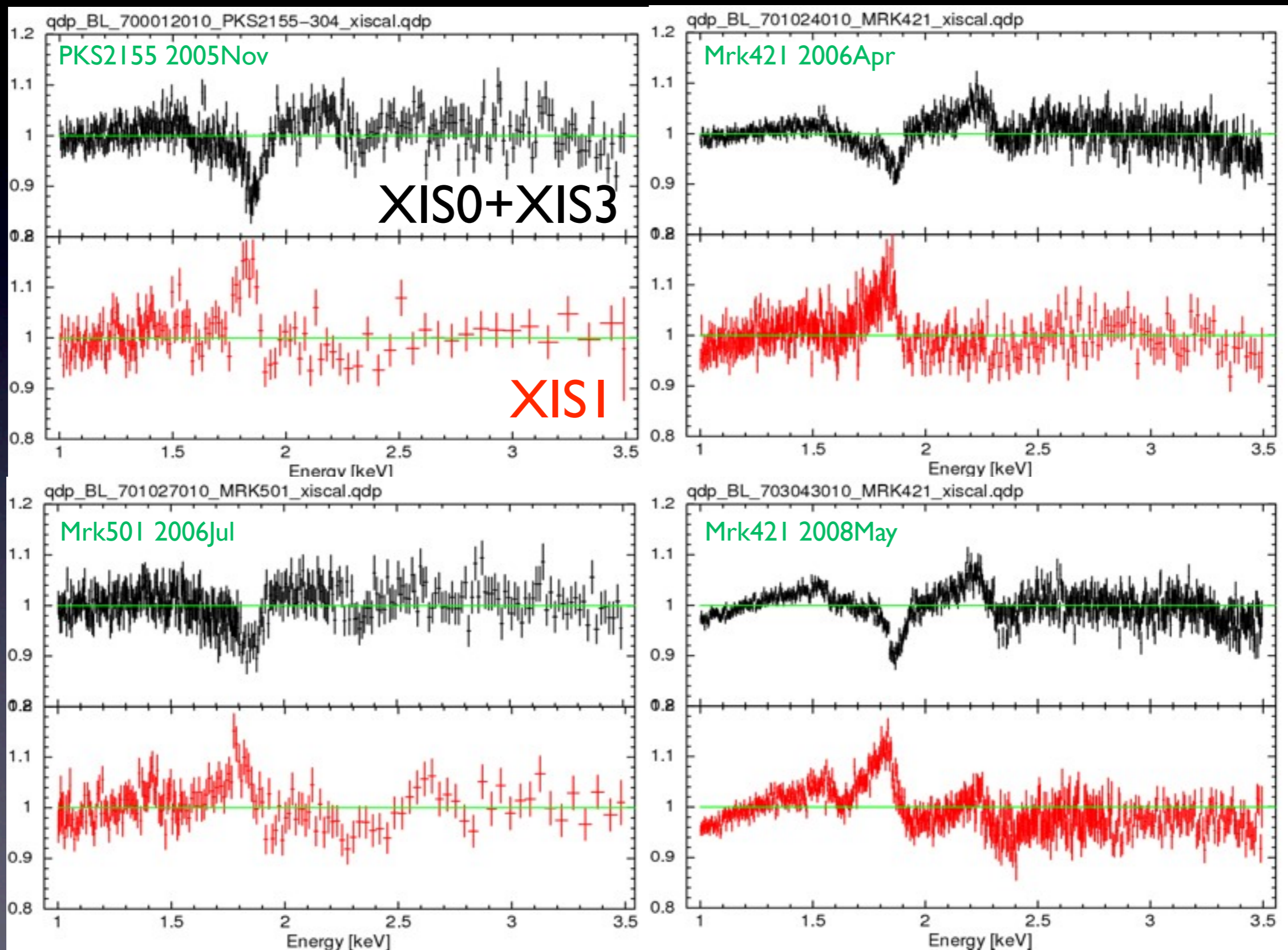
before correction
after makepi_20091202

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

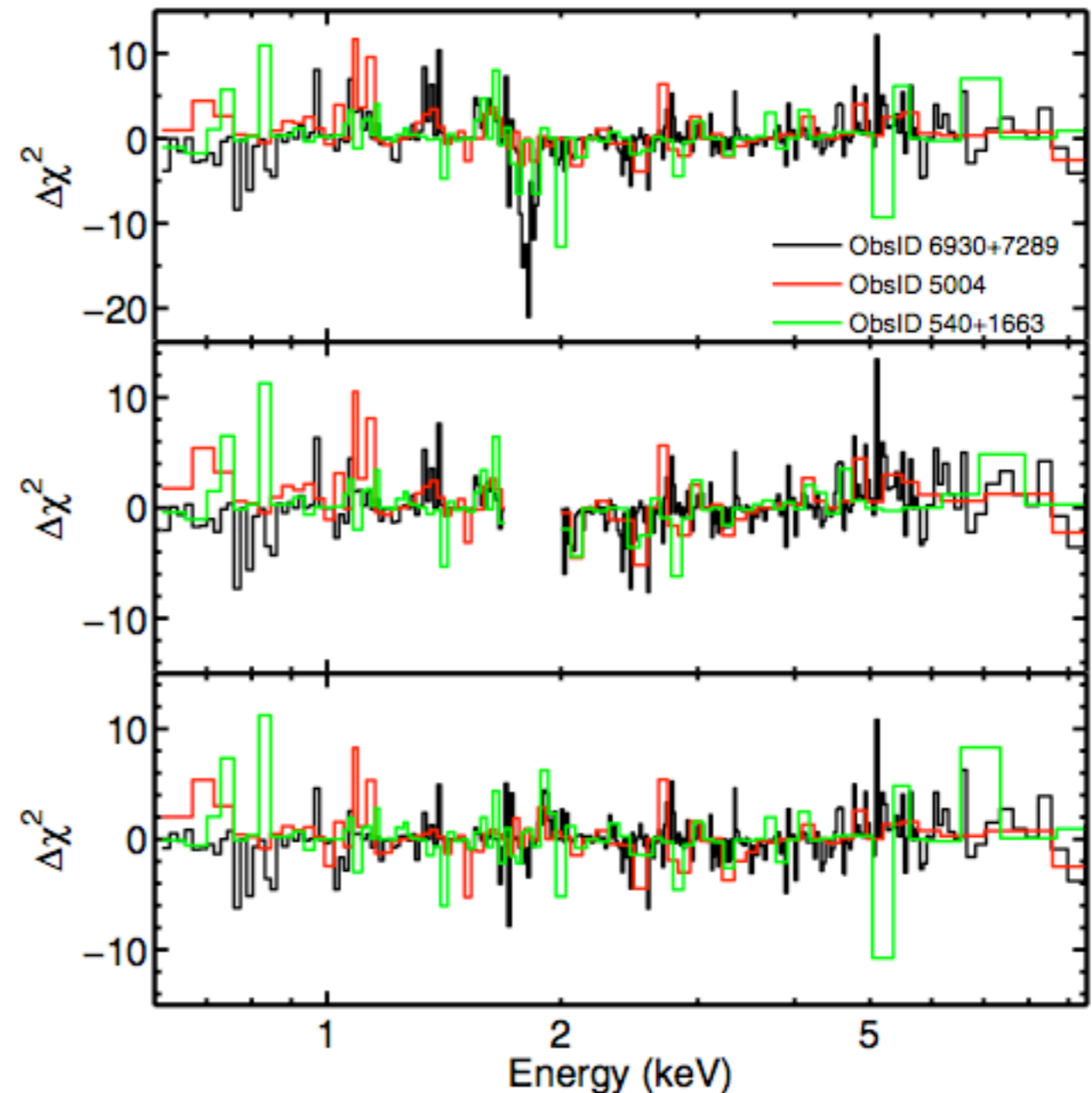
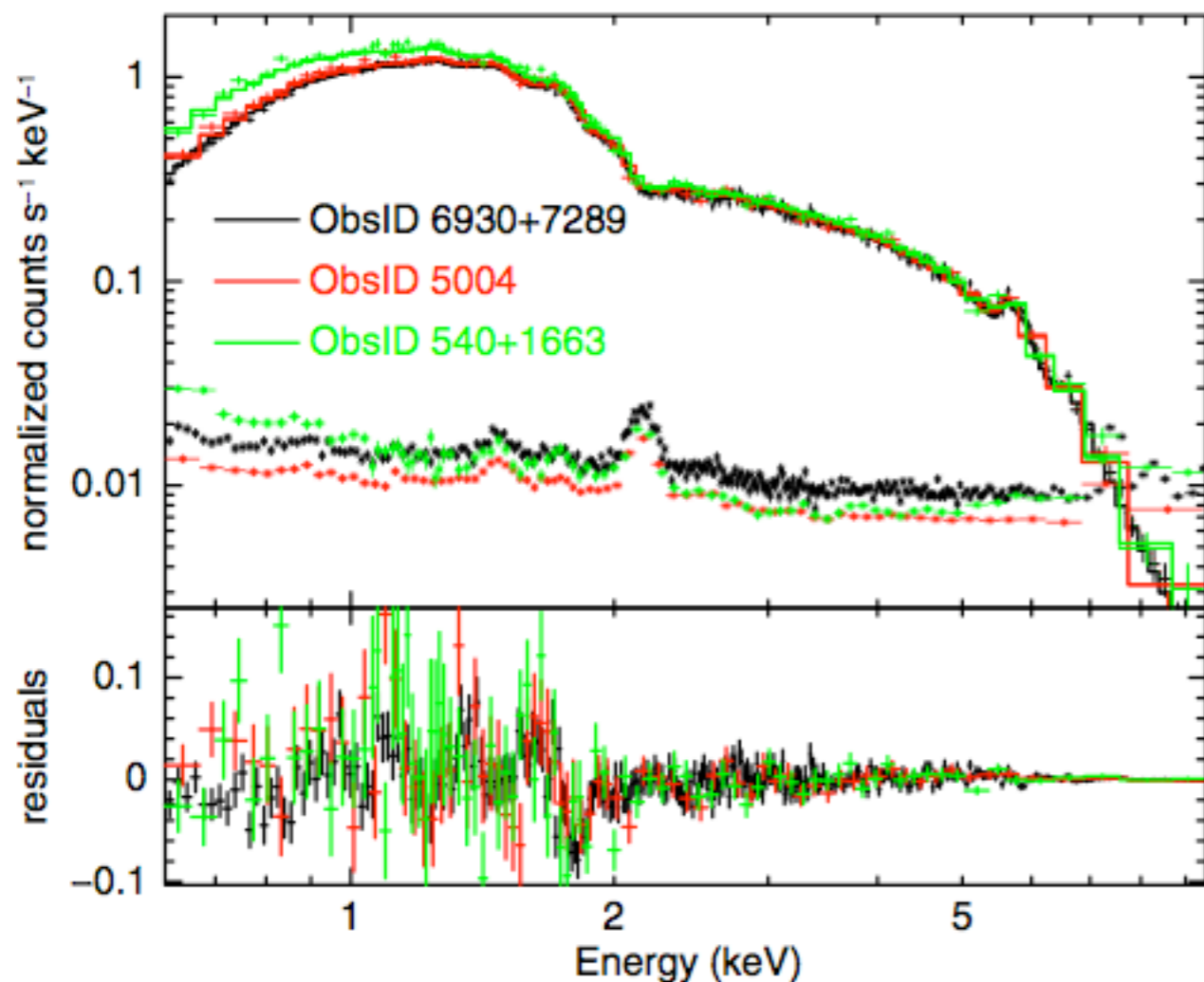


Calibration Near Si Edge (CXO)

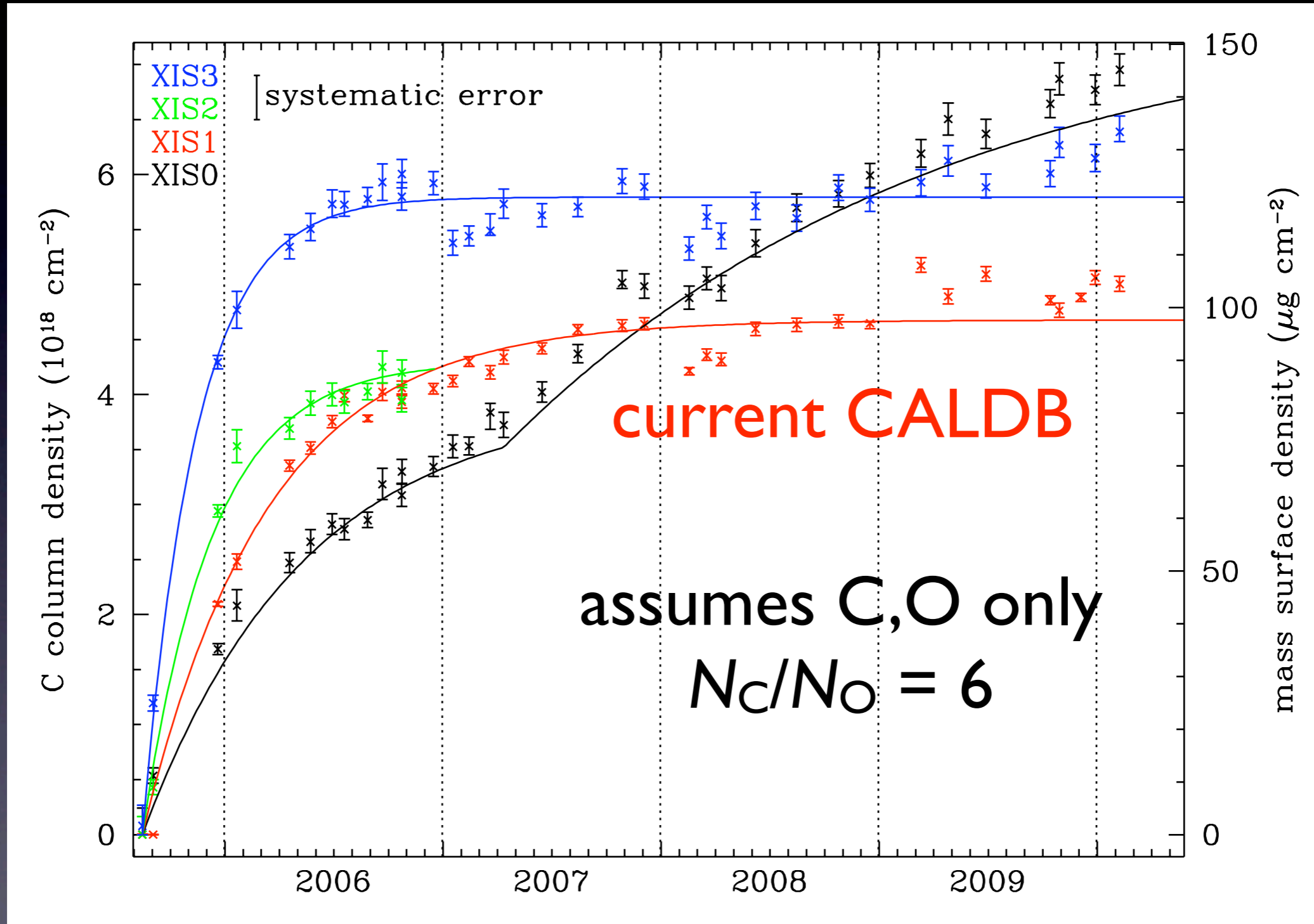
“extra” Si edge in ACIS-I spectra of Abell 1689

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

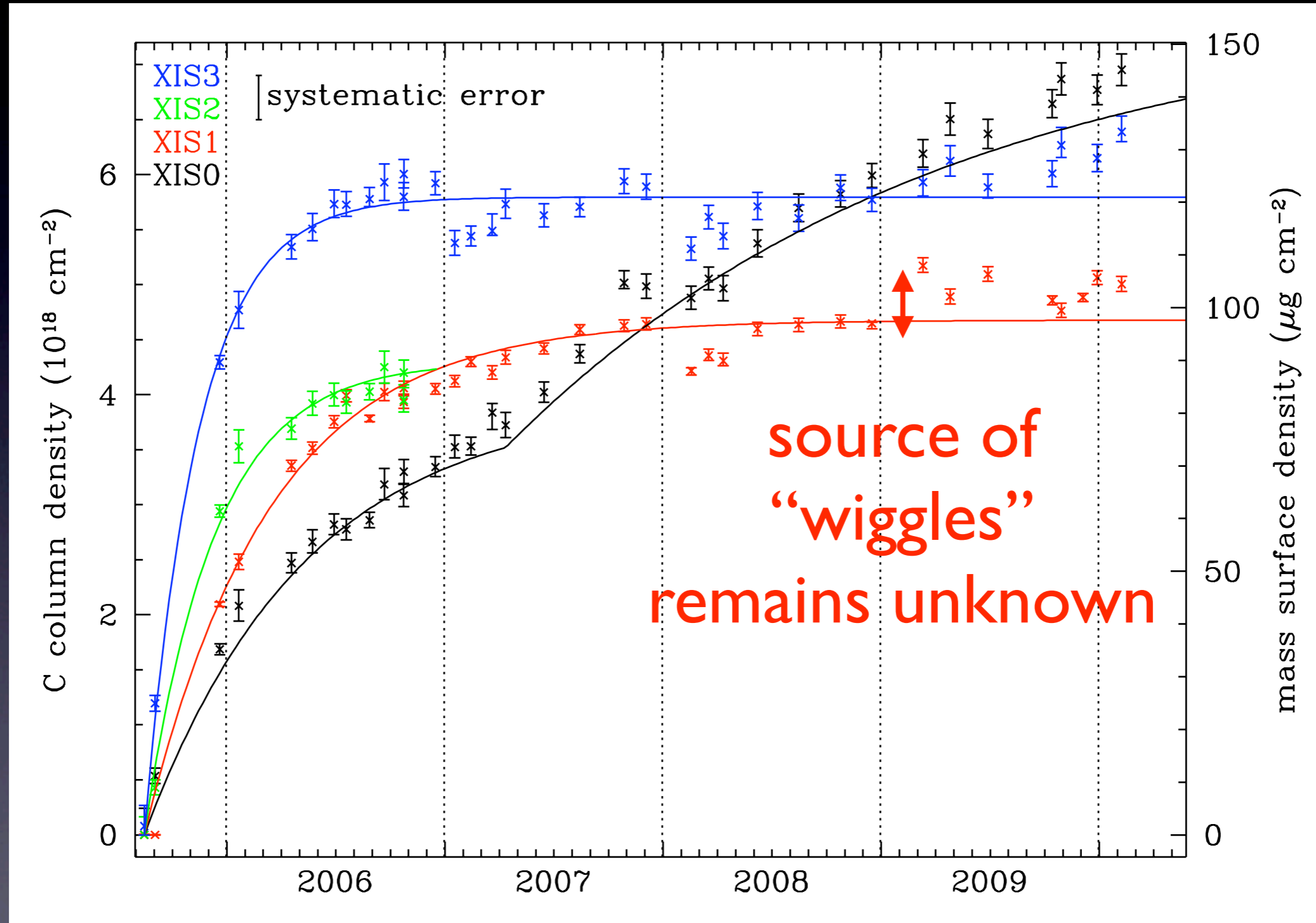
Peng et al. 2009



OBF Contamination (On Axis)



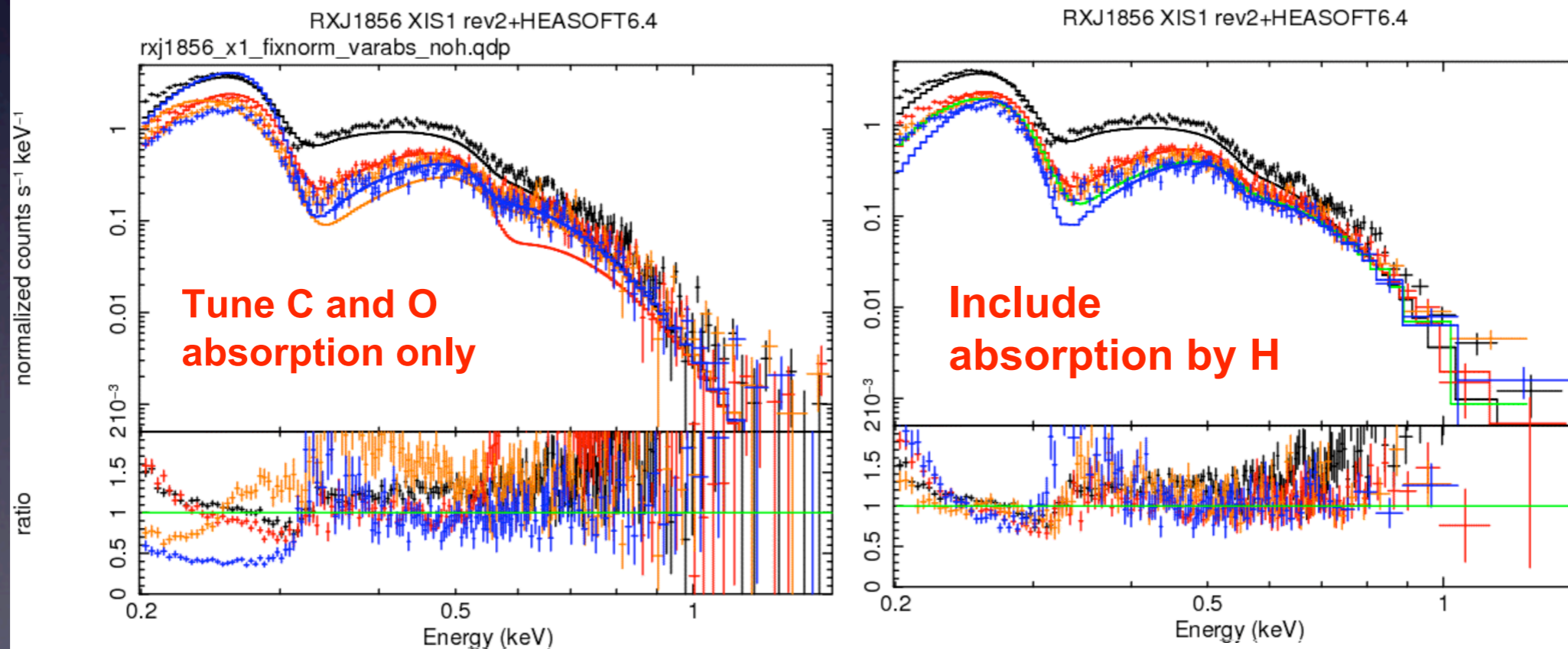
OBF Contamination (On Axis)



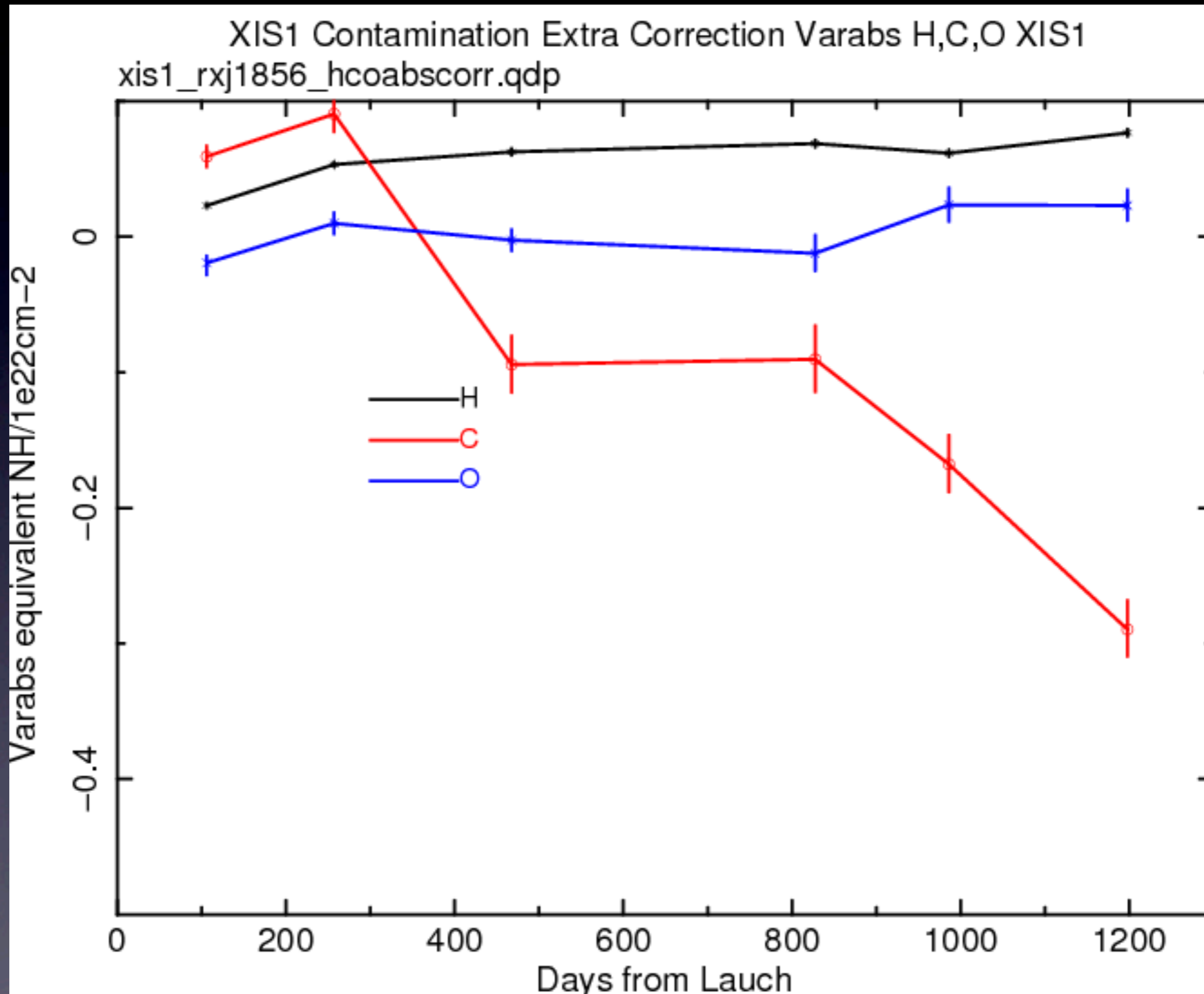
Contamination Composition

Factor of 2 underestimate below 0.3keV

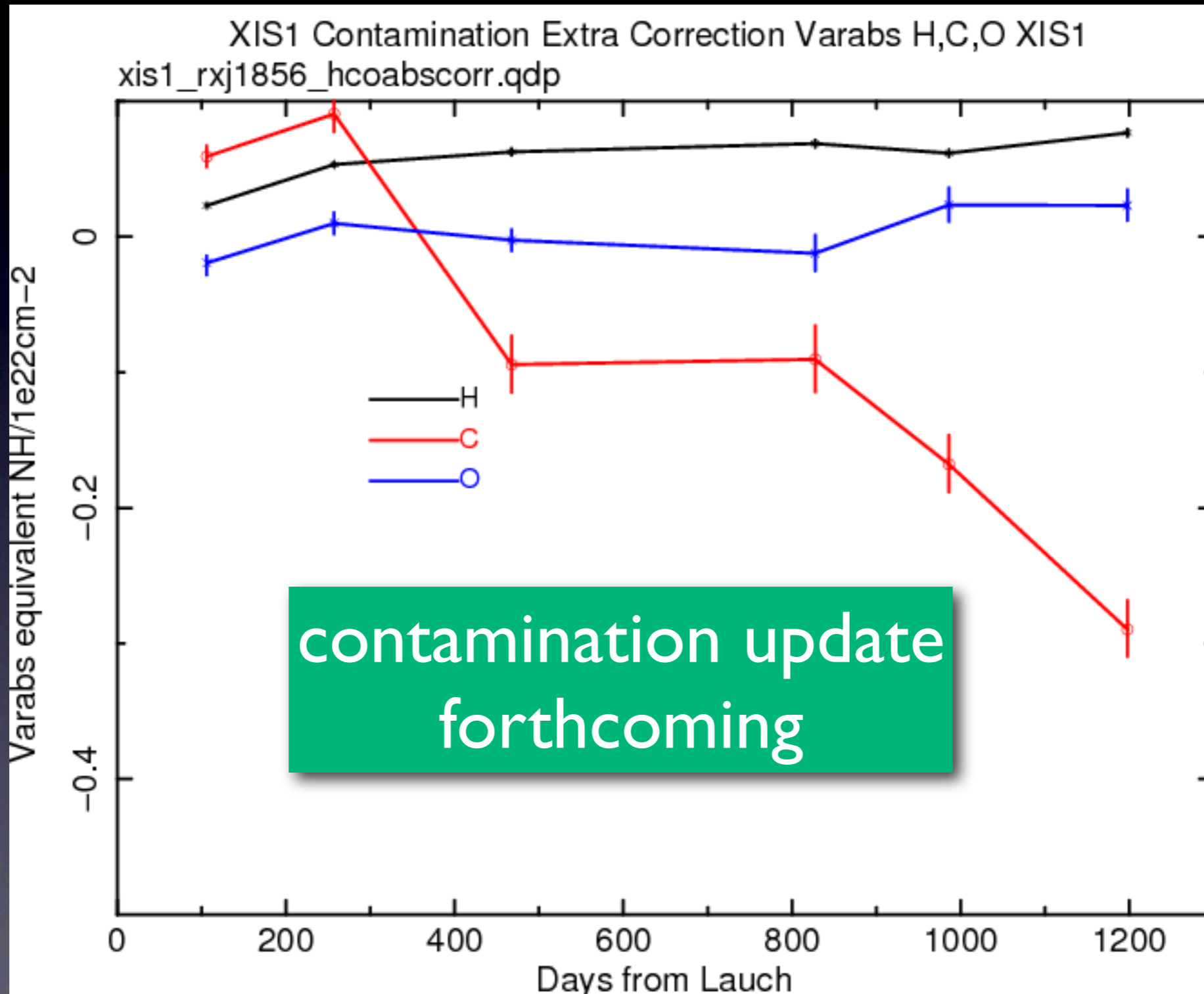
- Unable to improve the fit only with C & O
- Absorption by Heavier Element **No apparent edge found**
- **Absorption by H** (or He) but **too much $\sim 10^{21} \text{cm}^2$**
- Constant Factor (Grating Problem at low energy?)



HCO Contaminant



HCO Contaminant



XIS Status - Summary

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

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

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 ² @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.

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

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 (<12 [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).

Clock mode		Normal								Psum				
Opt ion	Win.	no	1/4	1/8	no	no	no	1/4	1/4	1/4	1/4	1/8	no	
	Burst	no	no	no	2.0	0.7	0.5	0.1	1.0	0.5	0.3	0.1	0.5	no
	Max. cnt'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
	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*

View XIS0-3 has 1024x1024 pixels composed of four segments (A-D) with one readout node for each segment. Due to unavoidable micro-meteorite hits etc, a part of XIS0 and the entire XIS2 (Normal) and all but XIS3 (Psum) are not usable. Two ⁵⁵Fe calibration sources (Mn K α and K β lines at 5.9 and 6.5 keV) are installed. Users can specify the roll angle. Use the Maki tool.

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. Pls of ToO observations of bright variable sources may update the estimate by a few days prior to the observation.

http://www.astro.isas.jaxa.jp/~tsujimoto/pg_xis.pdf

