

# *Suzaku* Operation & Calibration Status

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8th IACHEC Meeting, Leicestershire, UK – 2013

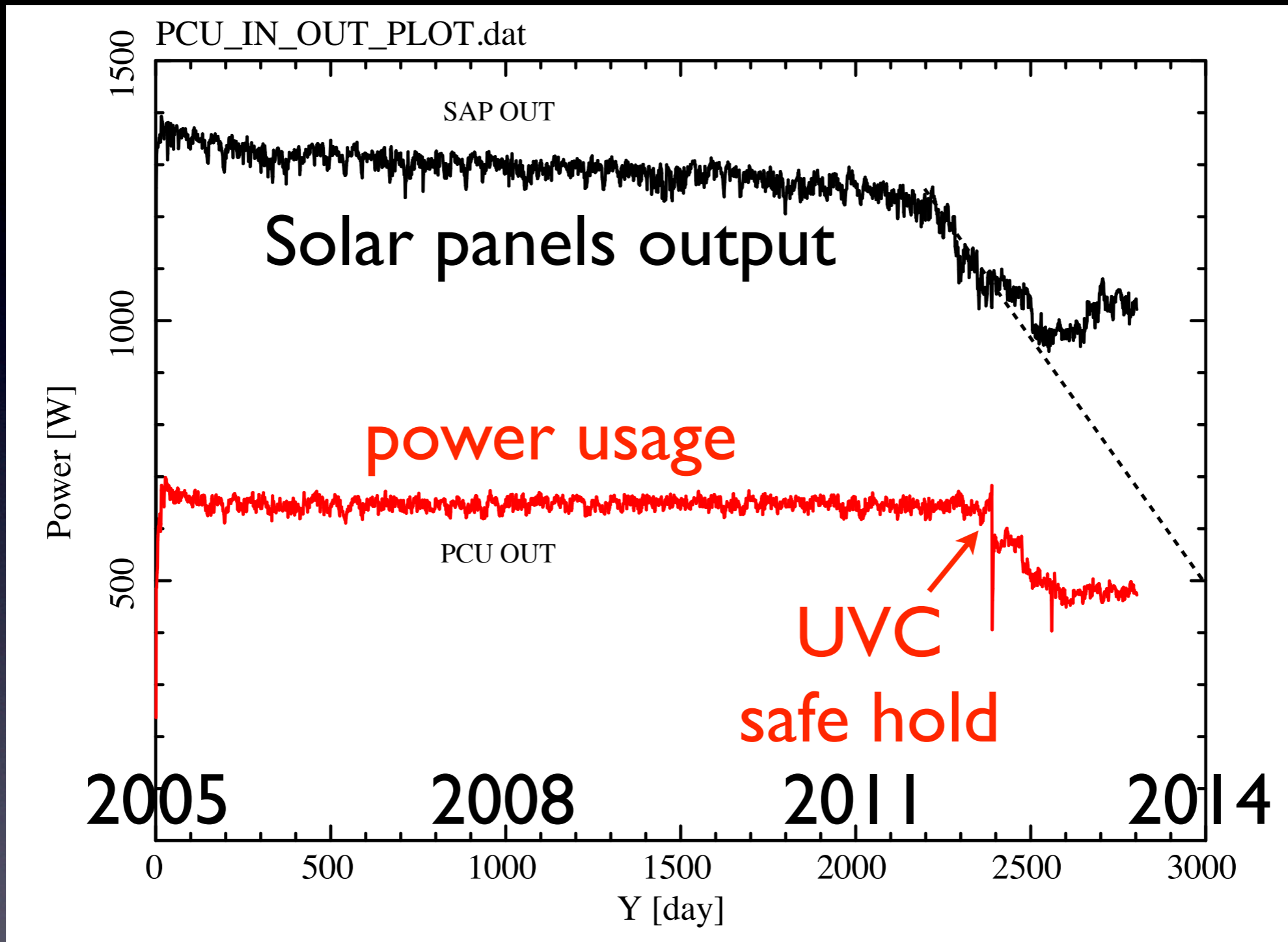


# Outline

- *Suzaku* operations
  - solar panel power production
- XIS calibration status
  - effective area (contamination) tracking and calibration
  - background changes
- HXD calibration status
  - Crab cross-calibration
  - response feature

# *Suzaku* Operations

# Suzaku Power Balance

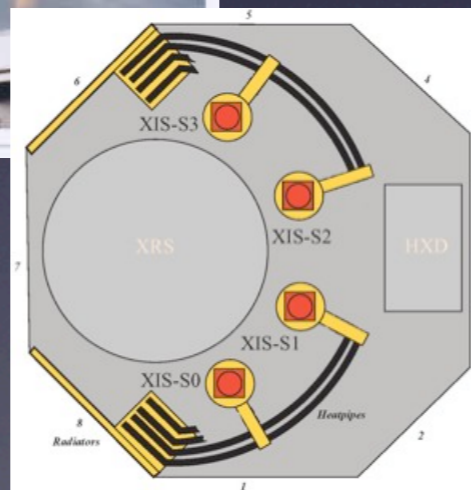


Stable since May 2012 – SR2014, AO9? (April 2014-2015)

# XIS Calibration

# Suzaku/XIS - Overview

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



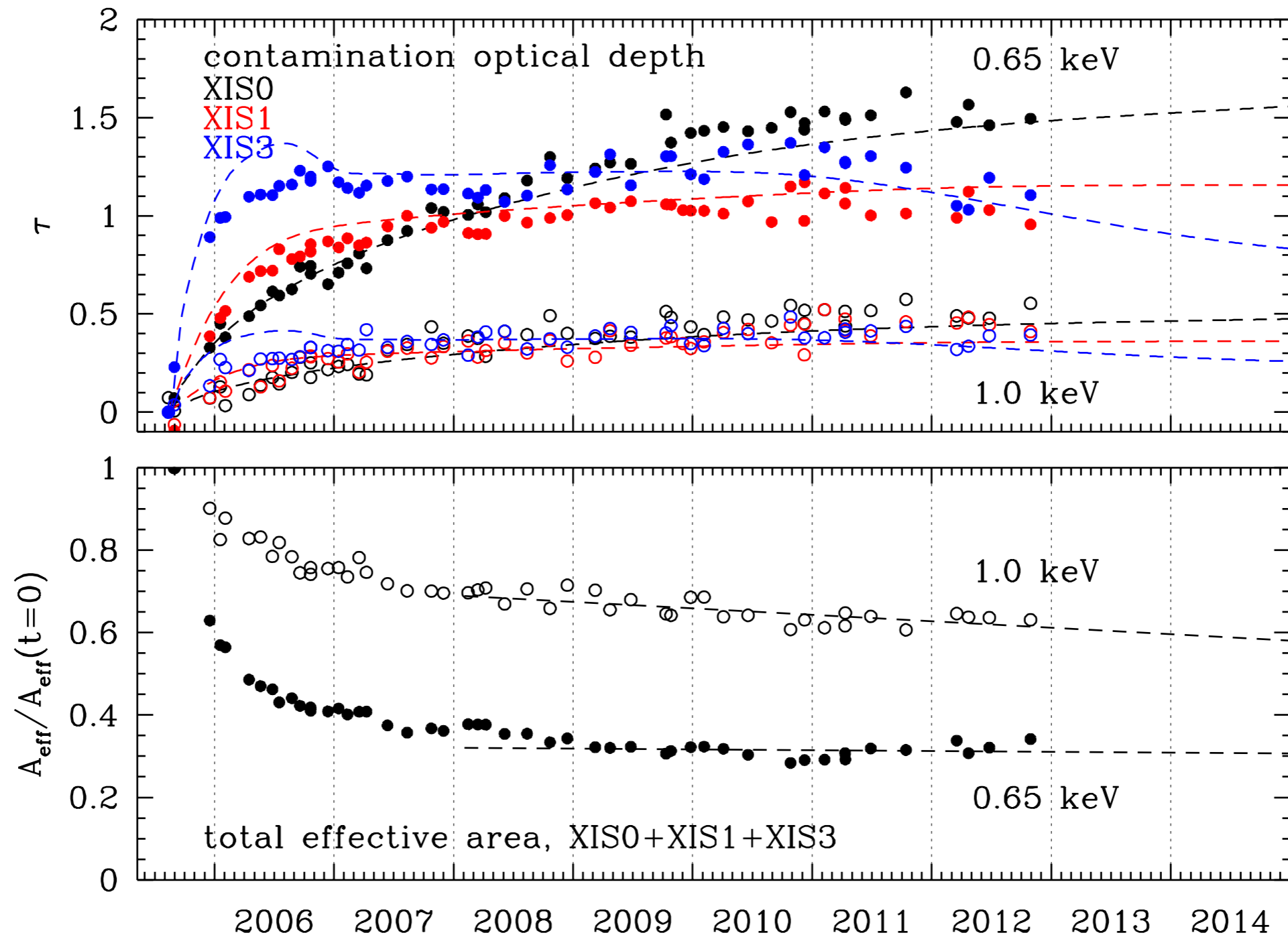
Field of view	17.8' x 17.8'
Energy range	0.2-12 keV
Energy resolution	~180 eV @6keV
Effective area	340 (FI)/390 (BI) cm <sup>2</sup> @1.5keV
Time resolution	8 s (Normal) - 7.8 ms (Psum)

from Tsujimoto's "pocket guide"

# Major XIS Events

2005 July 10	launch of <i>Suzaku</i>
2005 Aug 13	XIS doors open, start of observations
2006 Nov 9	anomaly ( $\mu$ -meteorite?) in XIS2; 2/3 of chip affected, <b>XIS2 switched off</b>
2009 June 23	anomaly ( $\mu$ -meteorite?) in XIS0; 1/8 of chip affected, <b>XIS0 safe for normal ops</b>
2009 Dec 18	anomaly ( $\mu$ -meteorite?) in XIS1; no CCD damage, <b>likely hole in XIS1 OBF</b>
2011 June 1	XIS1 charge injection level raised for routine observations

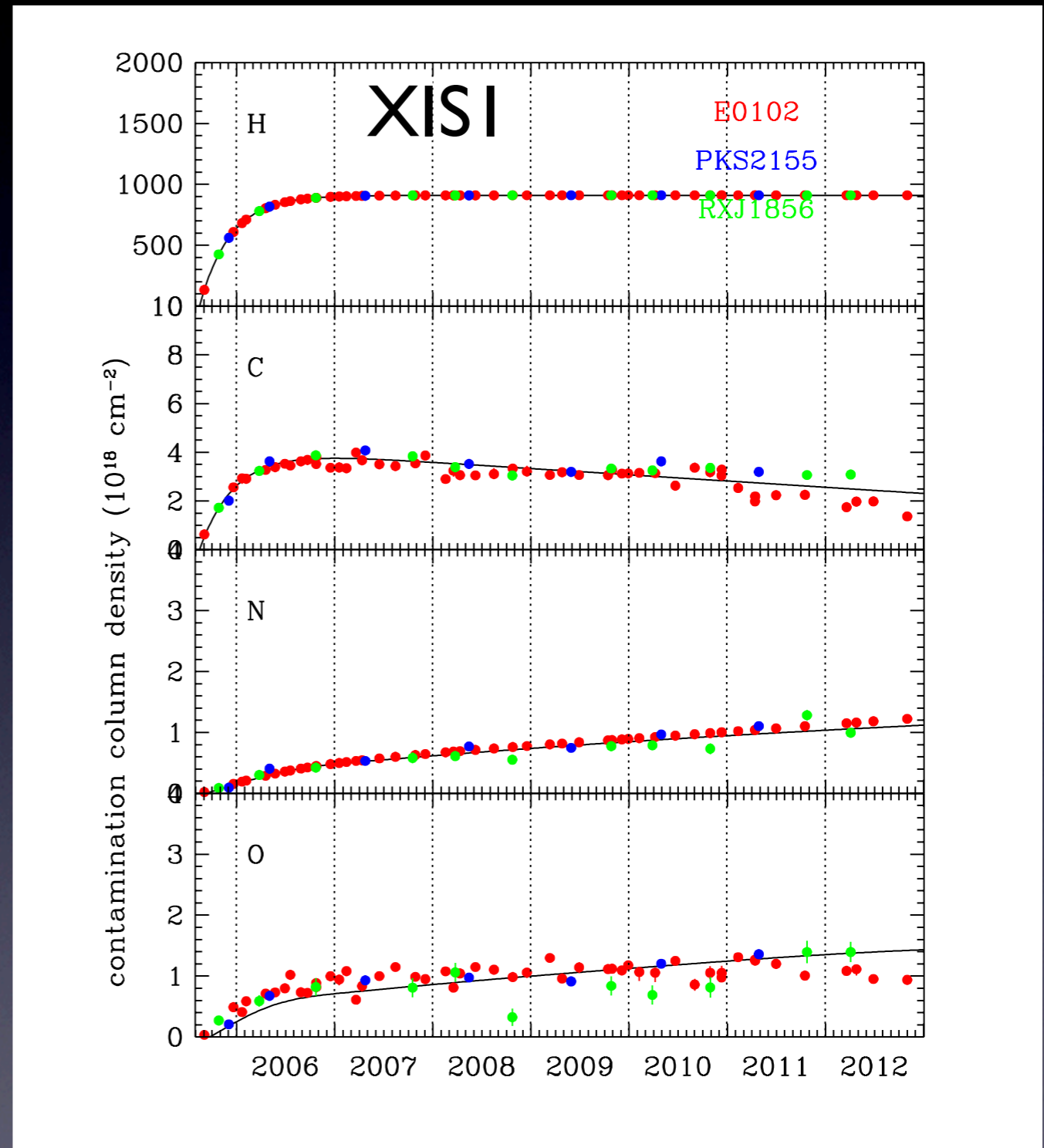
# XIS Contamination Tracking



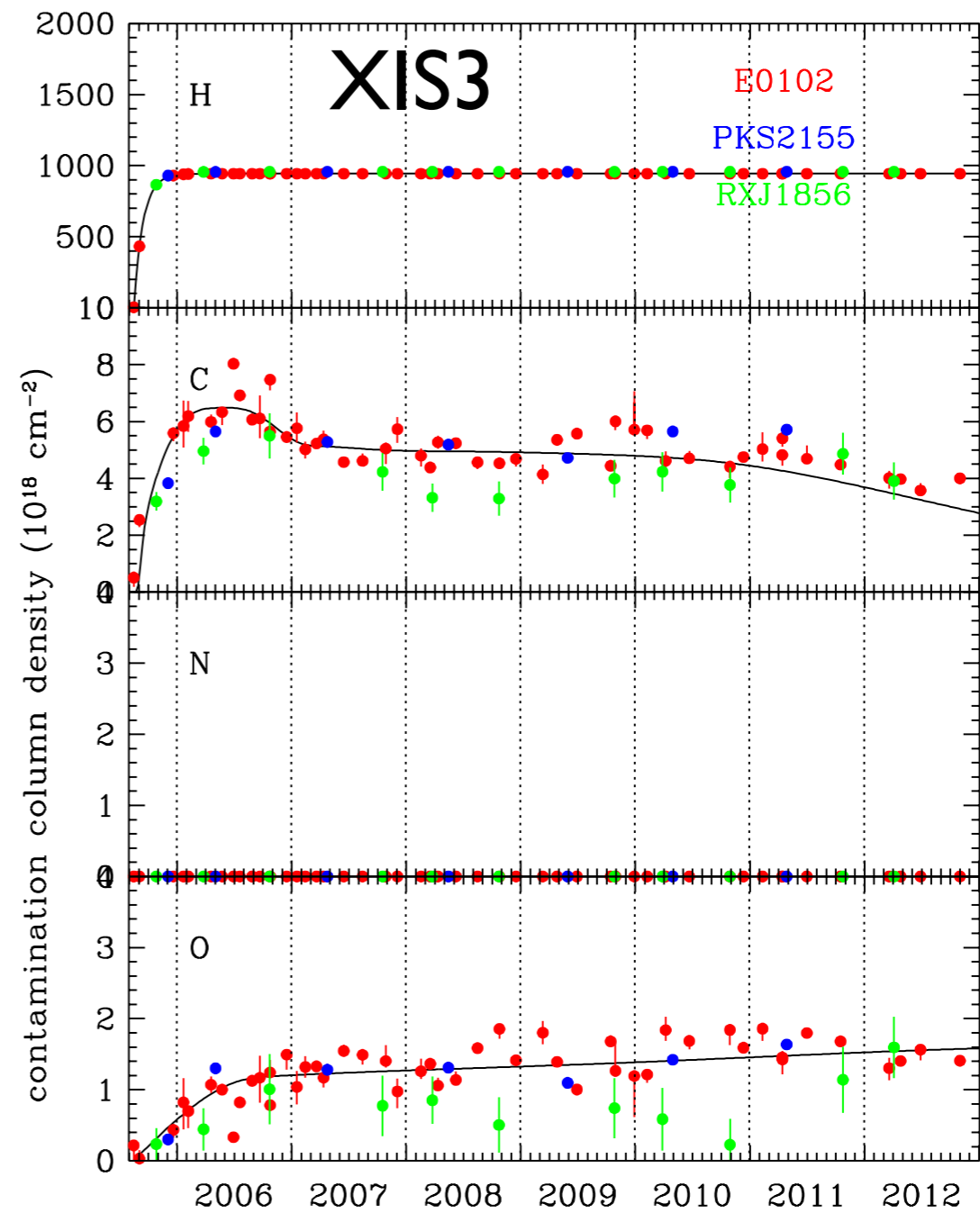
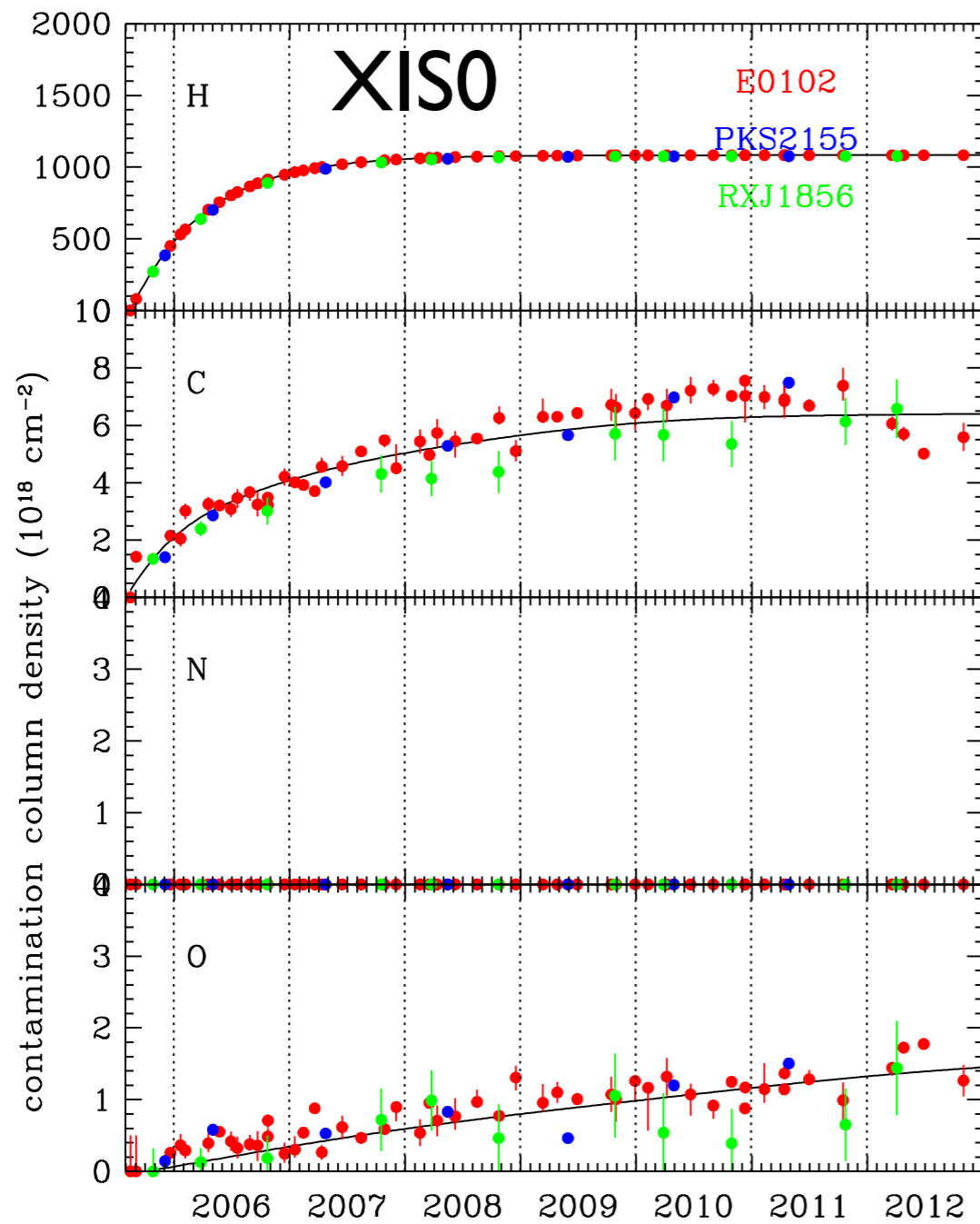


# XIS Contamination Model

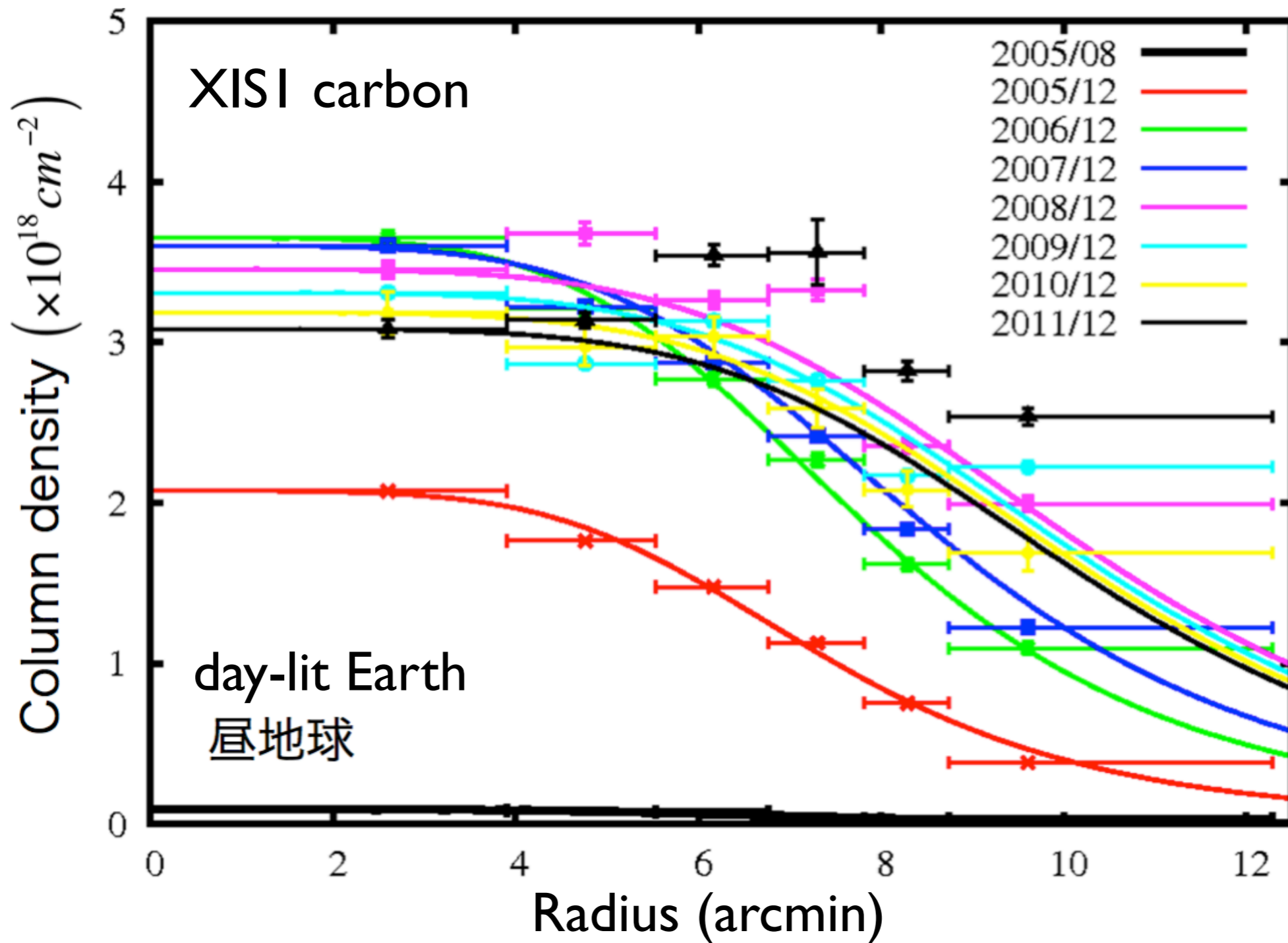
- HCNO composition
- H trend fitted from RXJ1856 then fixed
- $N = 0$  for FI chips
- contami\_20120719 CALDB file, released 2012 Sept 02



# XIS Contamination Model



# XIS Contamination Non-Uniformity

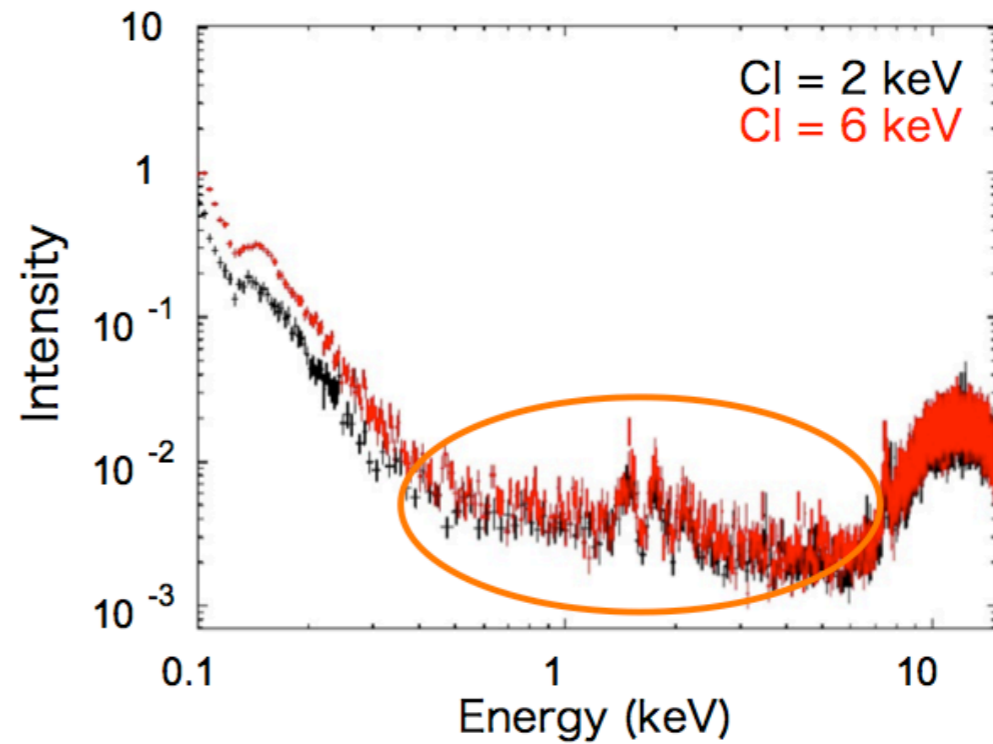
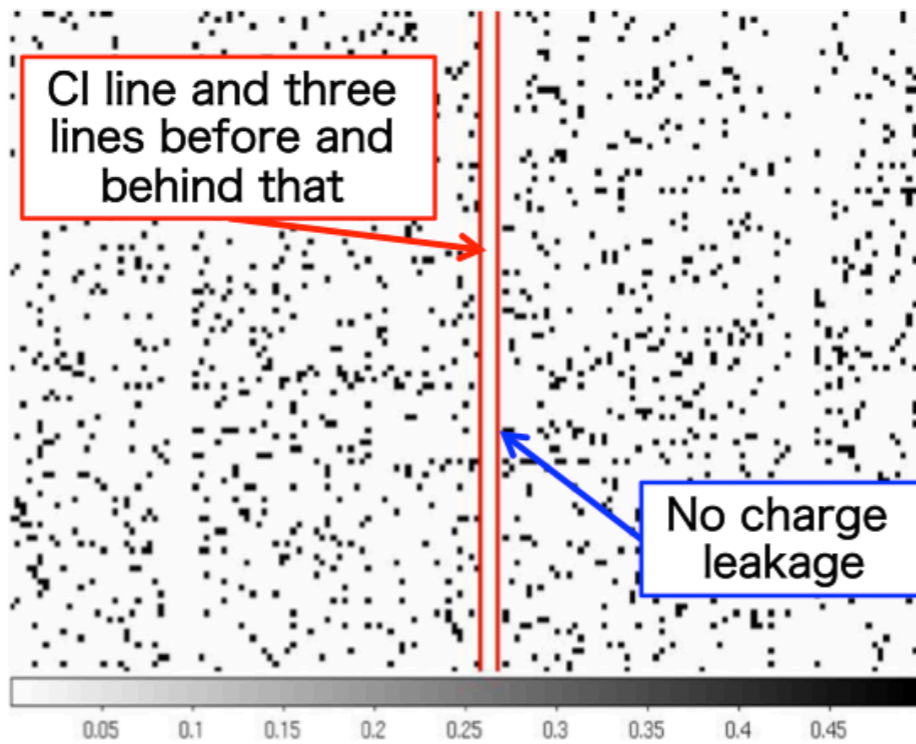
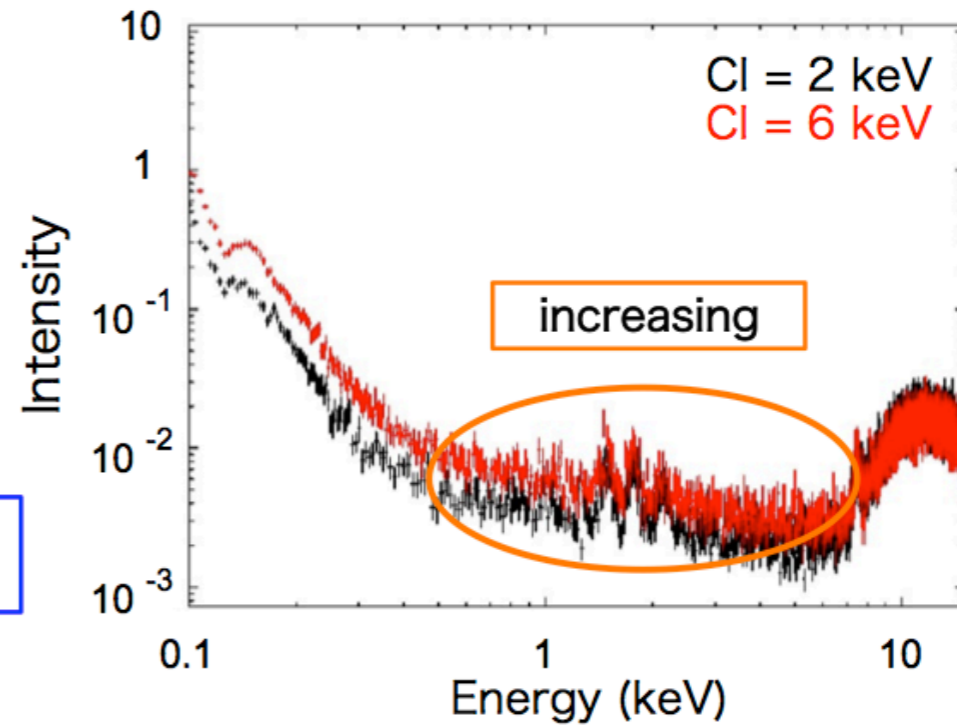
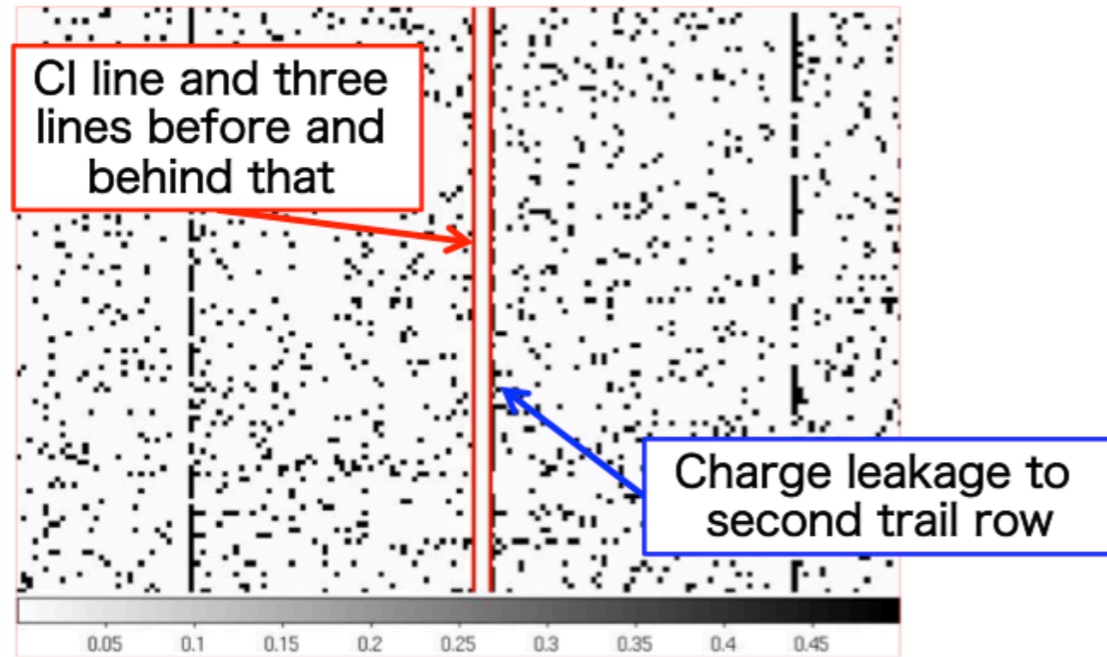


# XIS Contamination Summary

- decreasing contamination – real? physical?
  - still divergence at recent time, new model needed
- spatial coverage may not be azimuthally symmetric
  - difficult to constrain with current set of calibration targets
- ongoing....

# XIS Charge Injection Trailing

1250120



# HXD Calibration



# HXD calibration updates

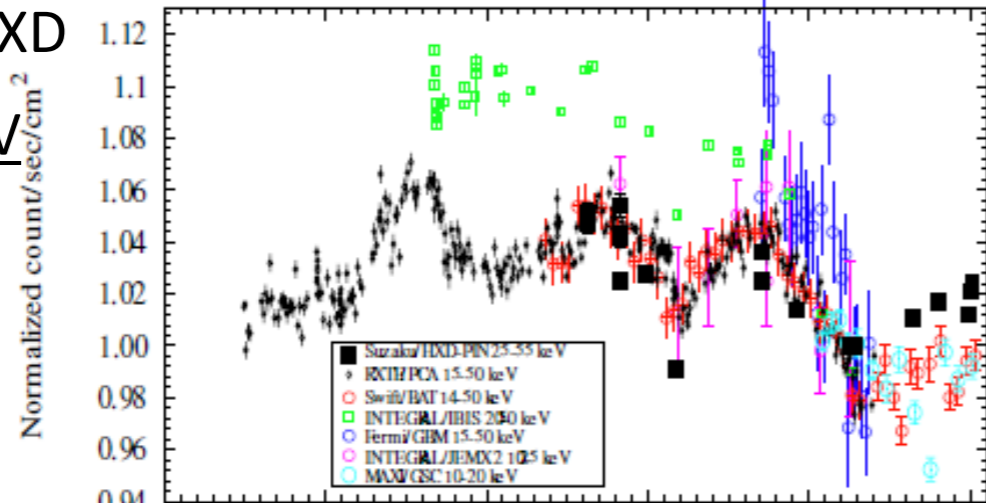


## Variation of Crab Flux (pulsar+nebula)

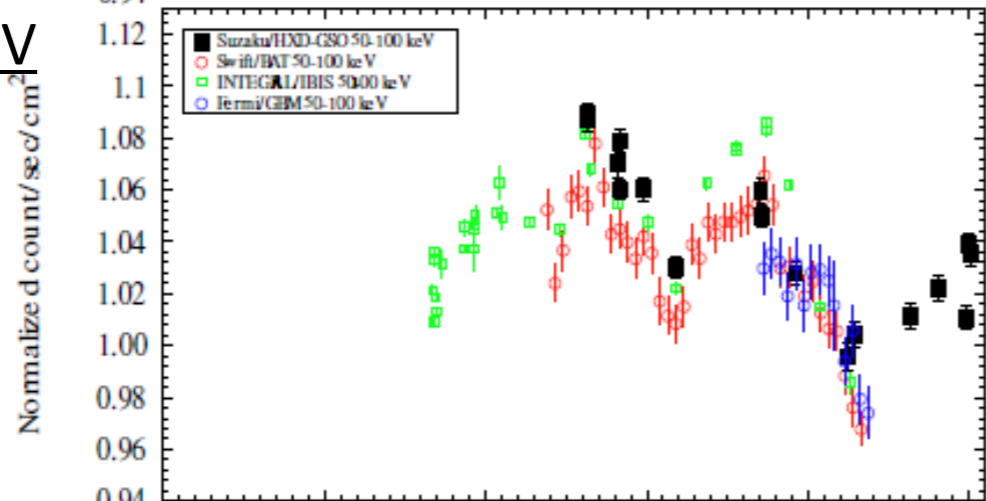
Kouzu et al 2013 PASJ

■ Suzaku HXD

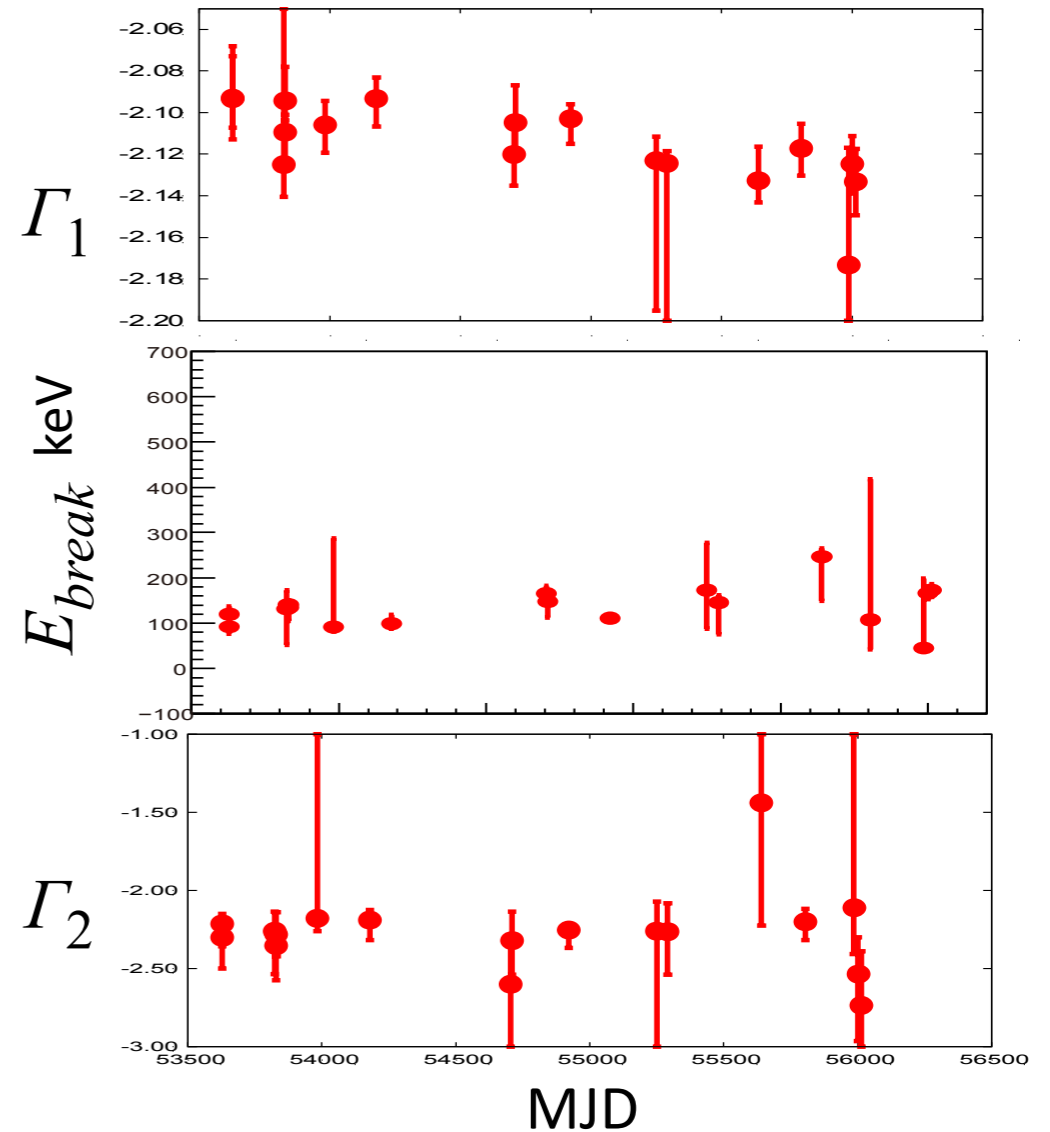
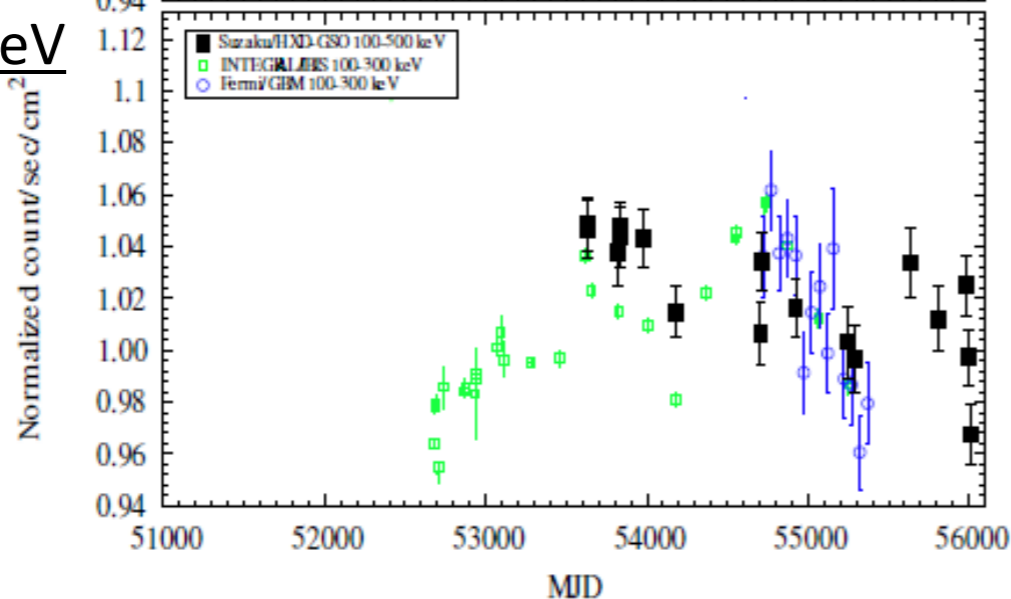
25 – 55 keV



50 – 100 keV



100 – 500 keV



### 1. Cross calibration

- Roughly consistent with others within statistical & systematic errors
- Slight discrepancy found in epoch > MJD5500, (although PIN gain is stable in 0.5% level.)

### 2. Spectral variation

The photon index and break energy varies.

→ *We need Simultaneous observation !!*

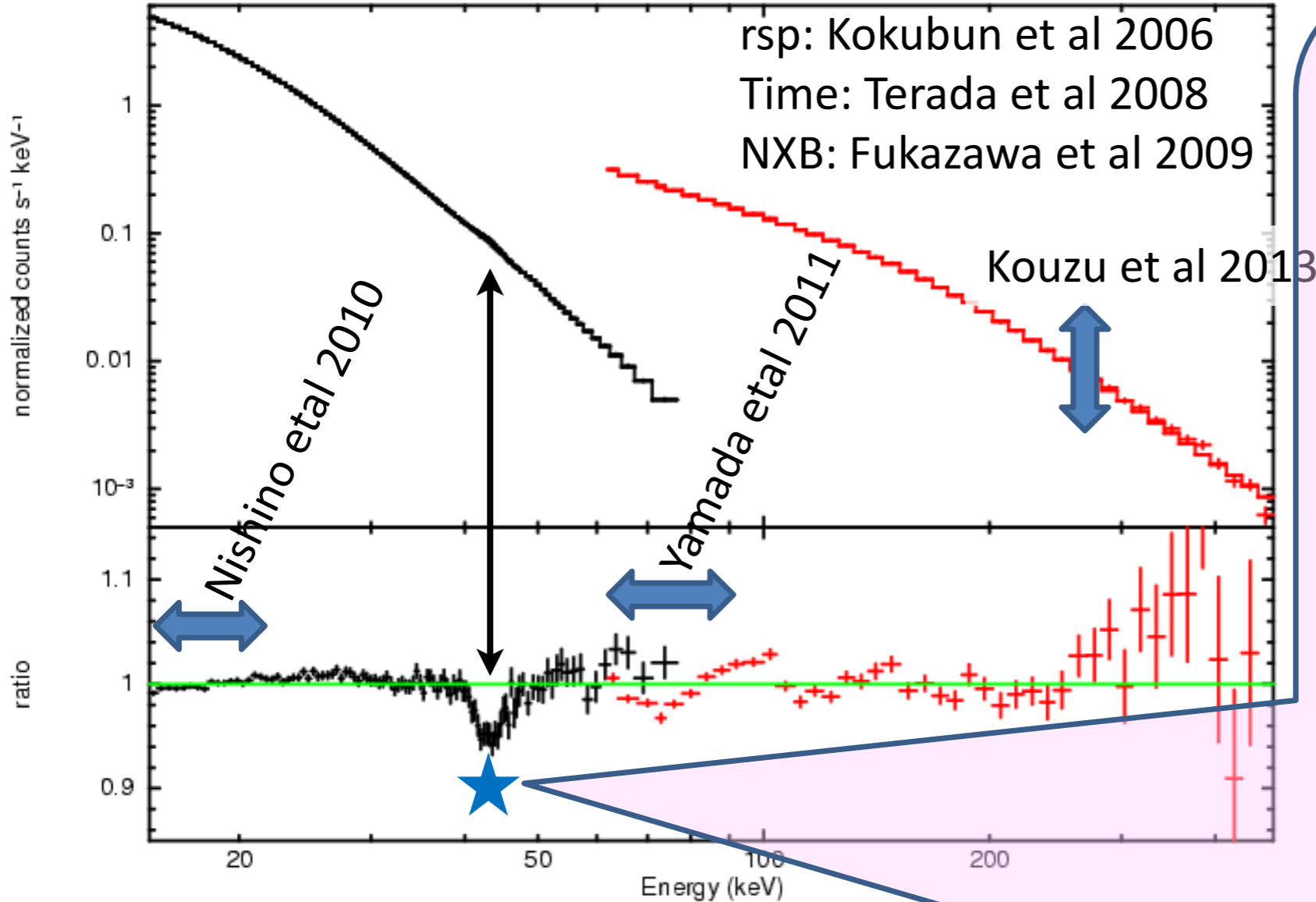


# HXD calibration future prospects



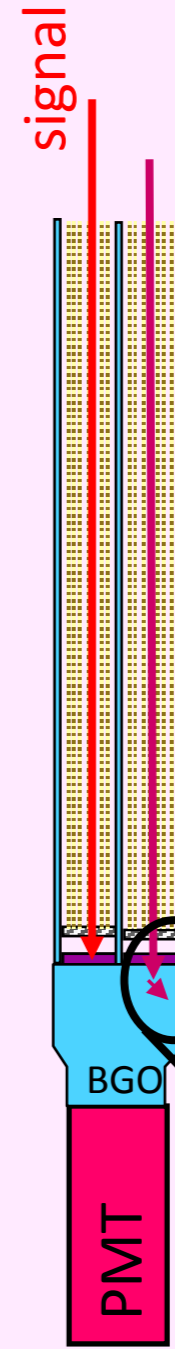
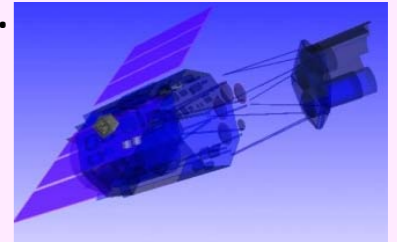
Crab 2005-2011

Broken PowerLaw (2.1/2.2 break@ 134 keV)



## Dip feature in PIN RSP

- Line intensity depends on the incident photon flux.
- RSP is generated by a Monte Carlo simulation (Terada et al 05 IEEE). We have to tune up parameters in the code, such as geometry, digitization, selection criteria.



the HXD WEL unit.

**Next target is to estimate the contamination of Gd K line from GSO to PIN after the selections with standard criteria.  
(gadolinium silicate in GSO detector)**



# Suzaku Status - Summary



- spacecraft power has stabilized
- XIS – OBF contamination remains the most pressing calibration issue
- HXD – no major changes

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

**XIS INFO**  
[HOME](#)  
[NEWS](#)  
[ABOUT](#)  
[PEOPLE](#)  
[GALLERY](#)  
[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](#)

**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 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 E0102).

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

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 MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
 Last updated: Wed May 27 11:11:45 EDT 2009  
 email: milleric@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.

**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)

**Archive** Accepted targets : <http://heasarc.gsfc.nasa.gov/docs/suzaku/tlinfo/>  
 XIS log : <http://darts.isas.jaxa.jp/astro/suzaku/suzakuxislog/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 micro-meteorite 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.

Size of 90% encircled energy radius of a point source: Useful regions (Psum)

**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.

**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	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		
	Win.	Burst	no	1/4	1/8	no	no	no	1/4	1/4	1/4	1/4	1/8	no	no
Opt ion	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 <sup>1)</sup>	12	48	96	48	1.3	1.9	7.1	96	1.9	3.2	7.1	1.9	1.5	10 <sup>2</sup>	10 <sup>2</sup>
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*		

\*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.

**Window option** ... 1/n (n=4 or 8) option reads (1024x1024/n) pixels centered at the aim position in 8/n [s]. (Pros) Photons not lost for the observed area. (Cons) The observed area reduced by 1/n. The calibration sources not observed.

**Burst option** ... m [s] (m=0.1, 0.3, 0.5, 0.7, 2.0) option reads photons arriving in m out of 8 [s] in each image. (Pros) The calibration sources observed. The observation area not reduced. (Cons) A fraction (1-m/8) of photons lost.

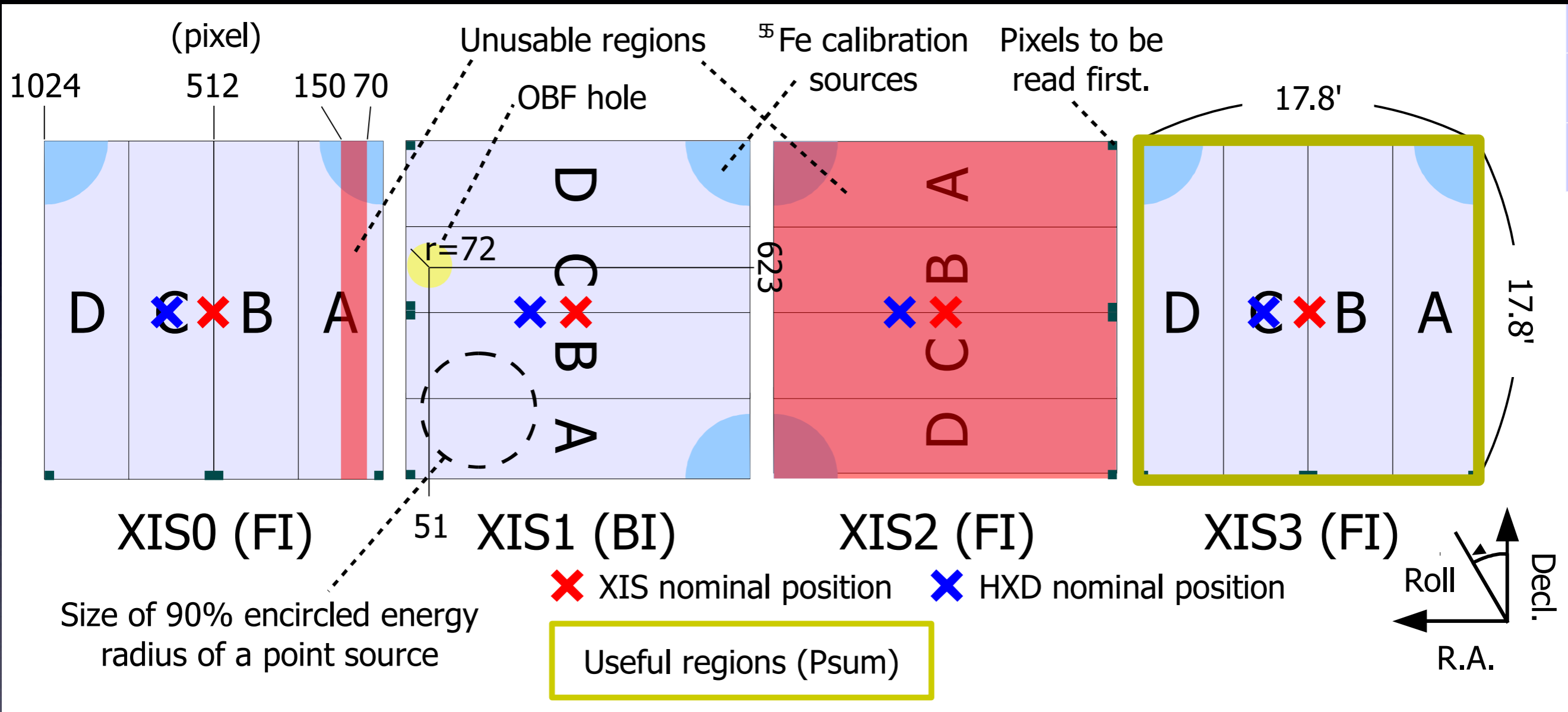
**Psum mode** ... 128 rows are stacked along the readout direction, yielding (1024x8) pixel data. (Pros) High timing accuracy; 7.8 ms in recording event arrival time. (Cons) Spatial information lost along the readout direction. Spectral performance severely degraded due to inefficient noise reduction, the unavailability of the sacrificed charge injection technique, etc.

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

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



# XIS Status

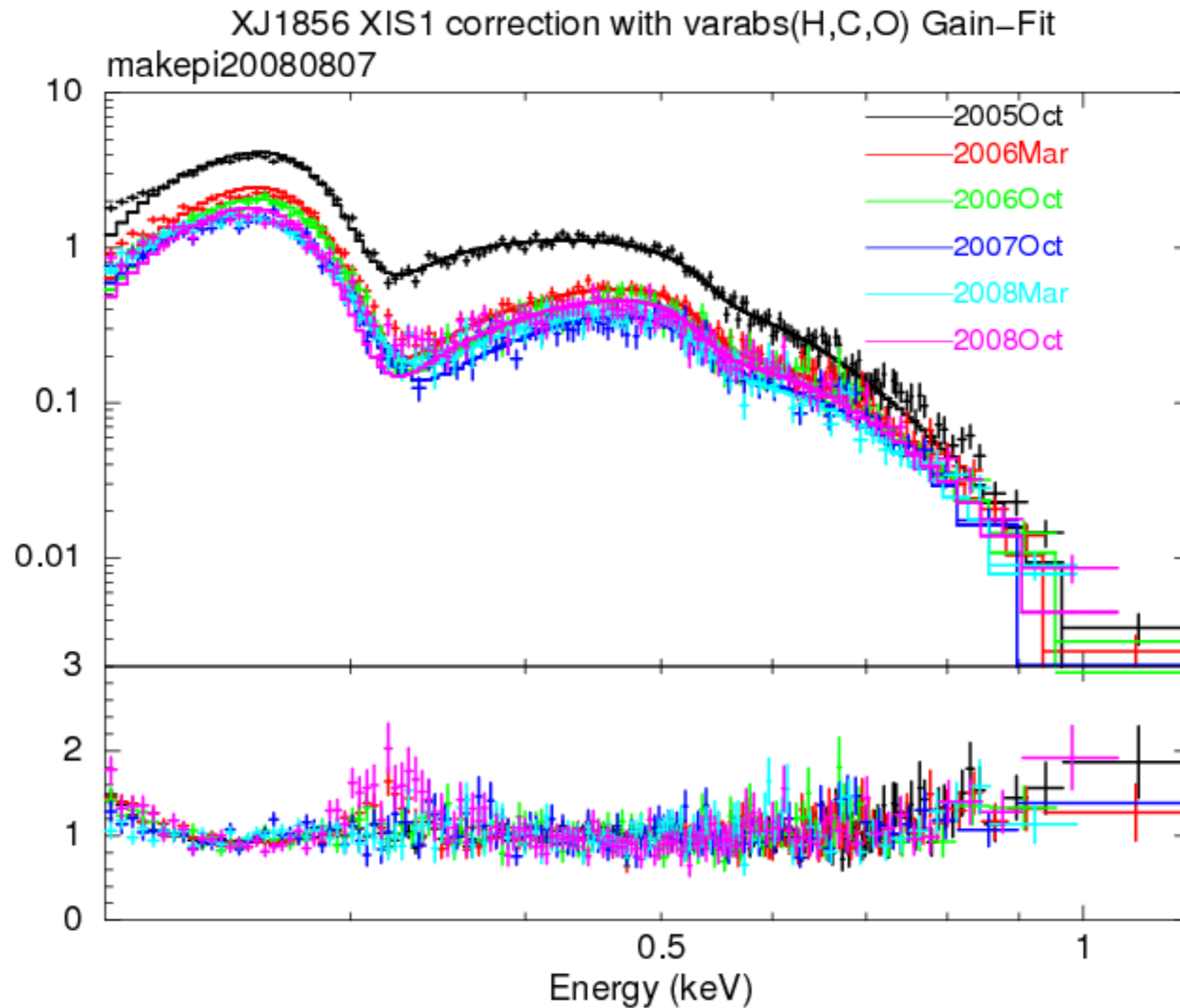


from Tsujimoto's "pocket guide"

# Contamination Model

- current model - H,C,O
  - composition from RXJ1856
  - time-dependence from E0102
  - spatial dependence from bright Earth, Cygnus Loop
- new model - H,C,N,O
  - composition, time dependence from E0102, RXJ1856, PKS2155
  - spatial dependence TBD
  - improve trend and improve composition

# (New) Contamination Model



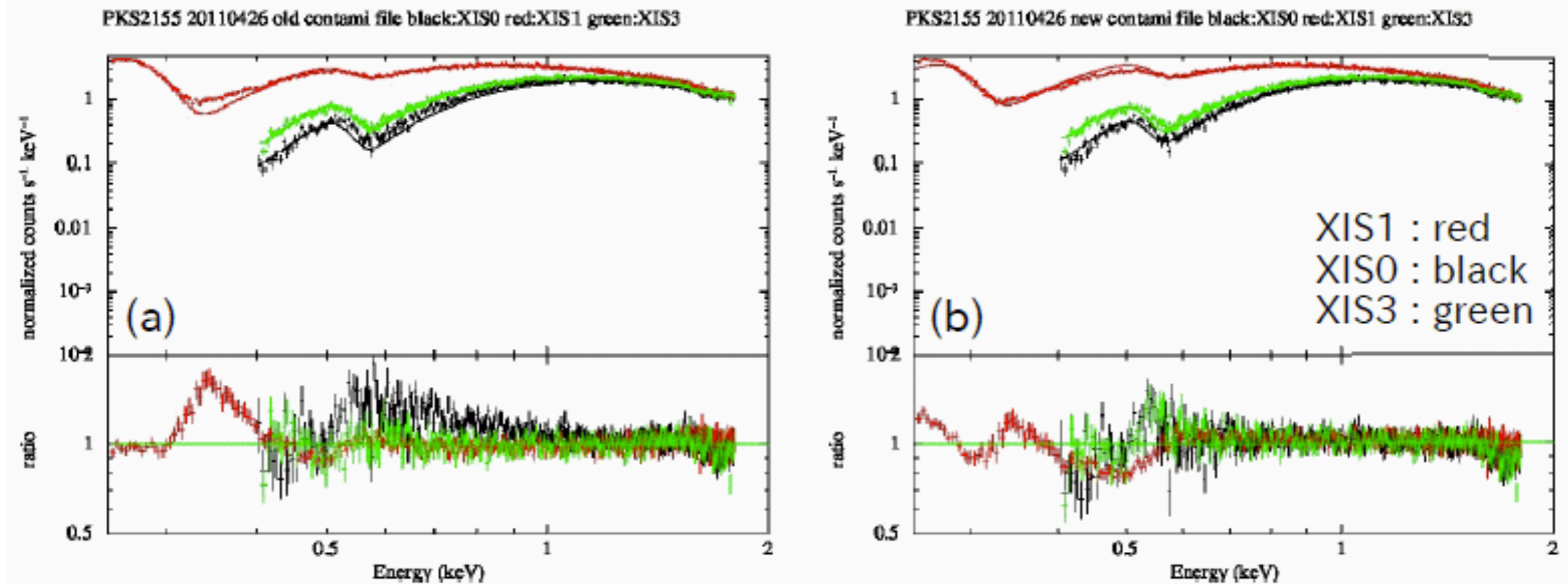


Figure showing 2011 Apr 26 observation of PKS 2155-304 fitted using (a) old and (b) new models of the contaminant.

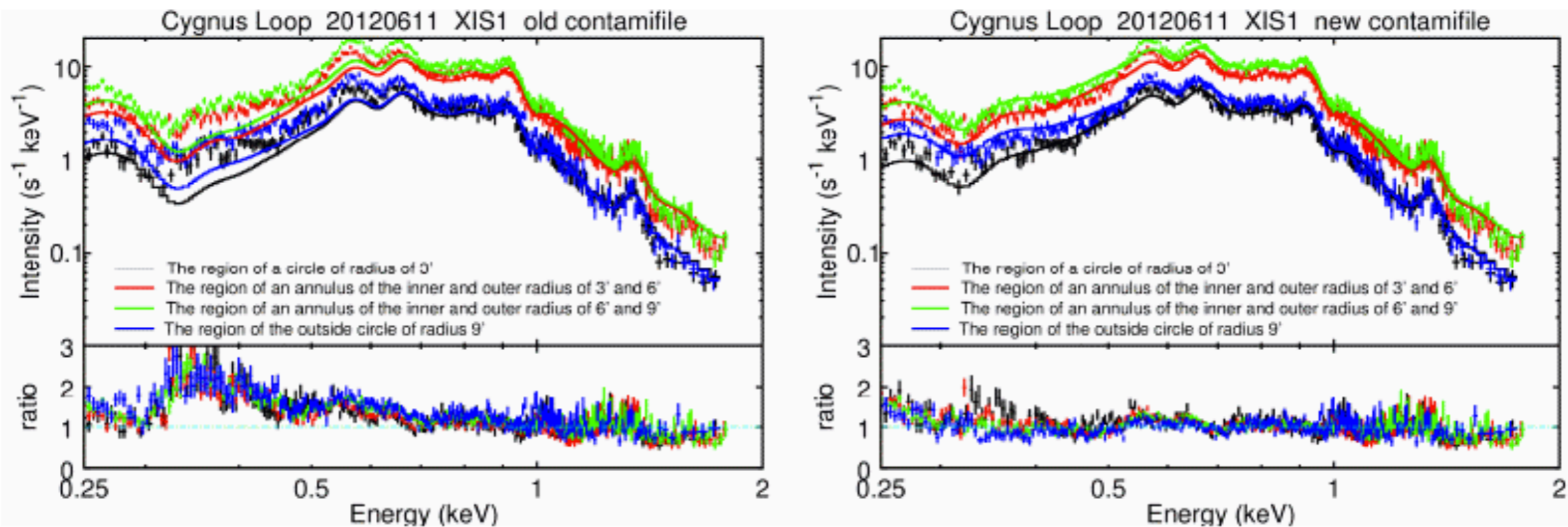
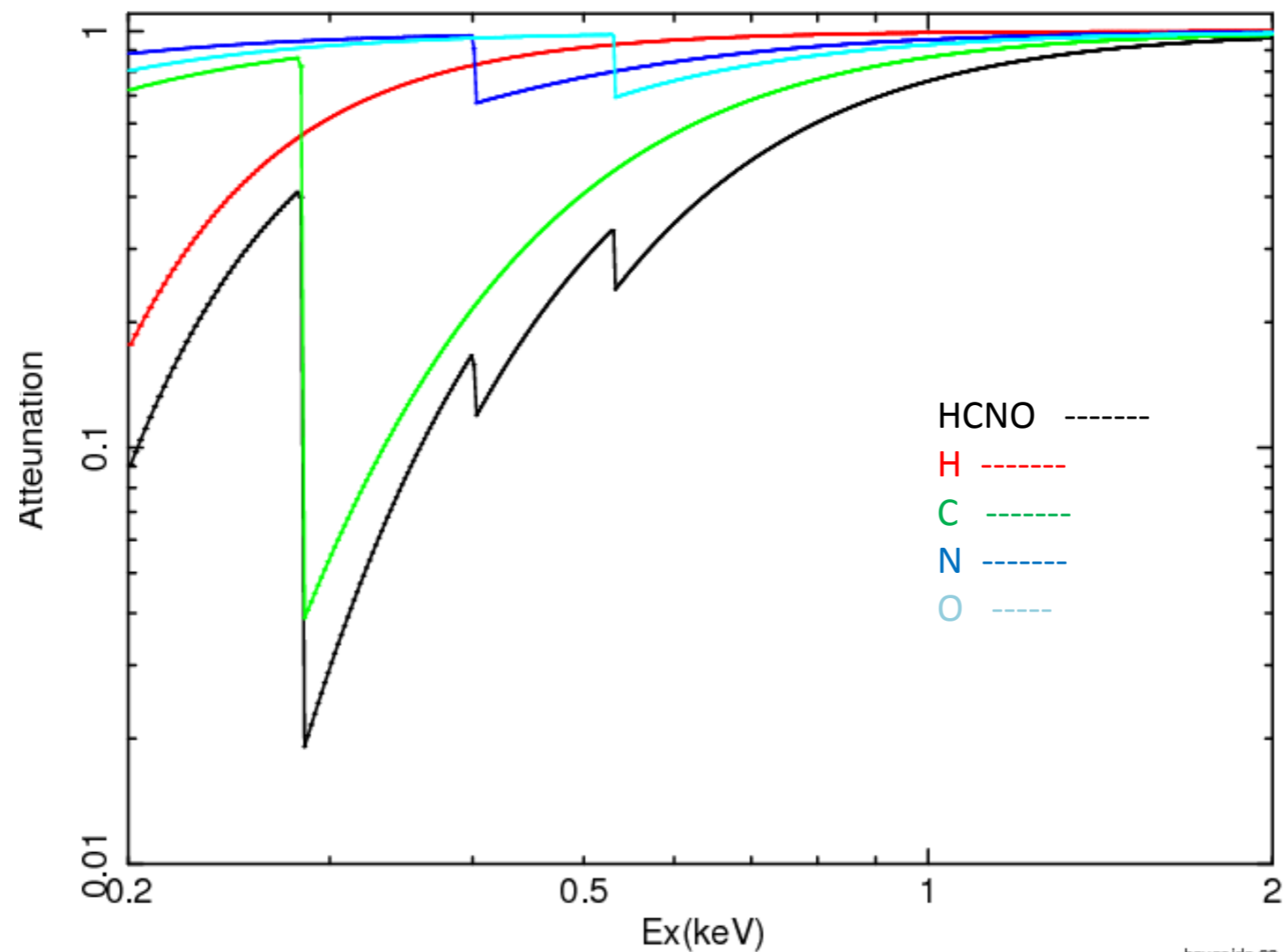


Figure showing 2012 Jun 11 observation of the Cygnus Loop fitted using (a) old and (b) new models of the contaminant.

# (New) Contamination Model

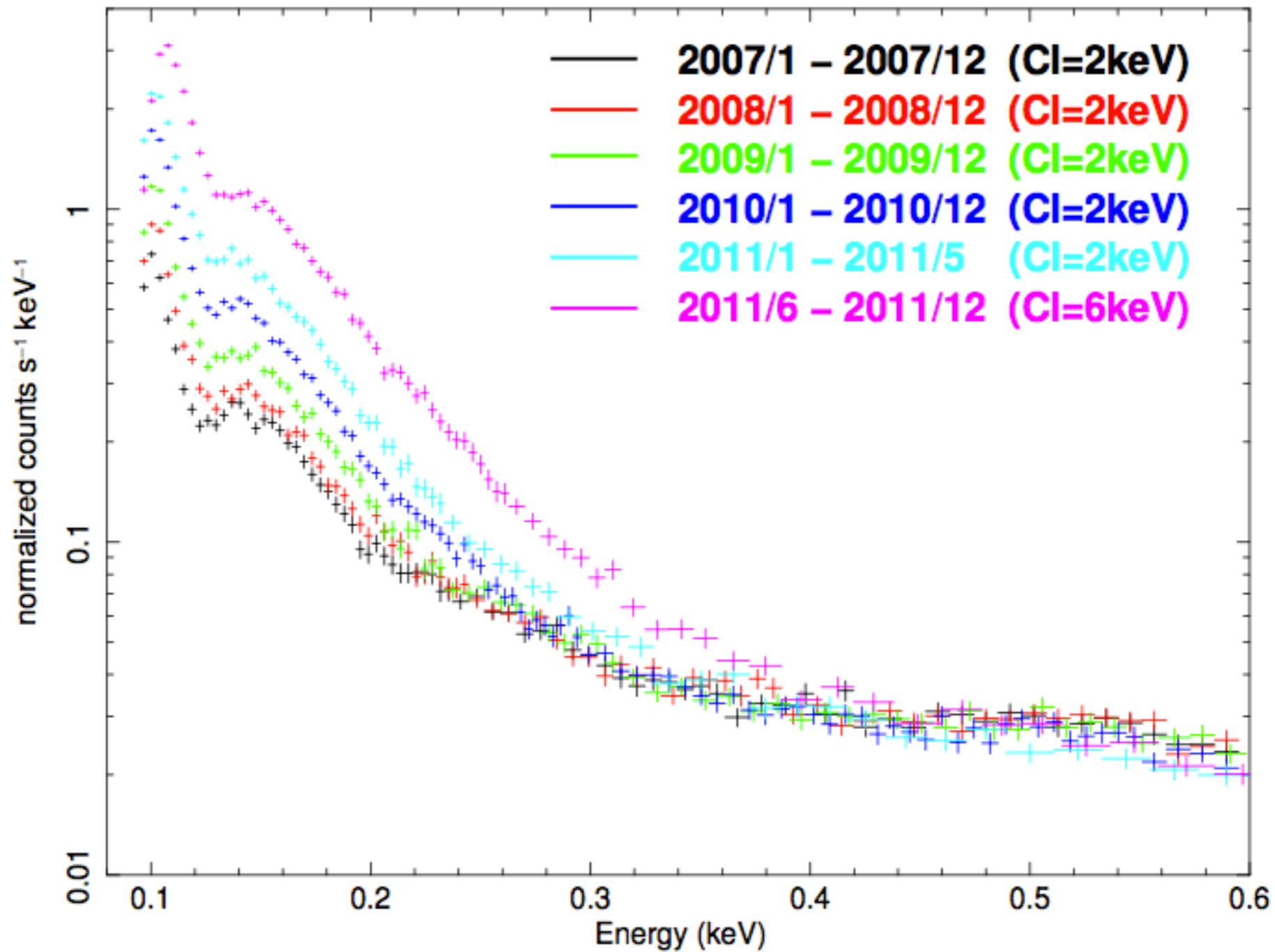
## XIS1

XIS1 Contamination HCNO model at 2010/10/28 from RXJ1856



hayas kda 29-Oct-2011 18:57

# XIS Non-X-ray Background

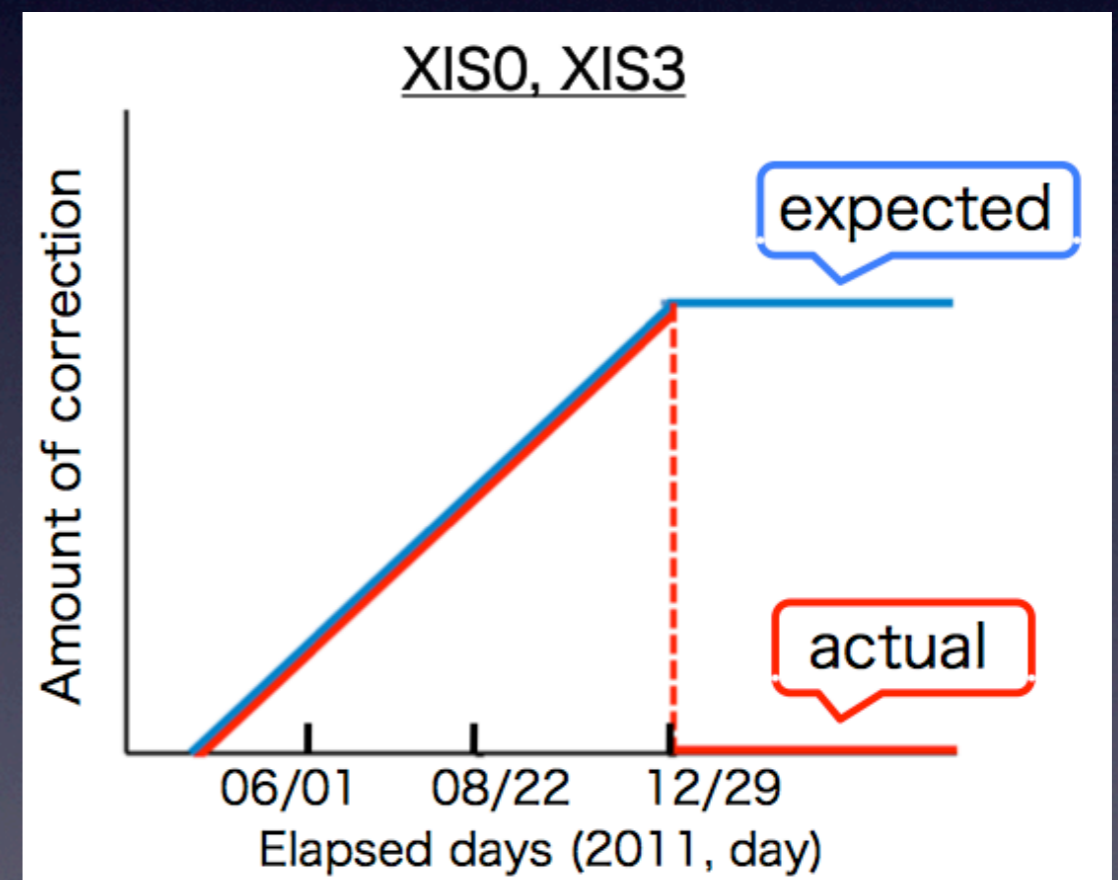


19-Sep-2012 13:52



# XIS 1/4 Window Gain Error

- empirical difference in gain correction between 1/4 window and full window
- bug in makepi\_20111227 CALDB file
- 1/4- and 1/8-window gain correction **incorrect** for observations after 2011 Dec 29
- corrected with makepi\_20120527, released 2012 July 03



# XIS 1/4 Window Gain Error

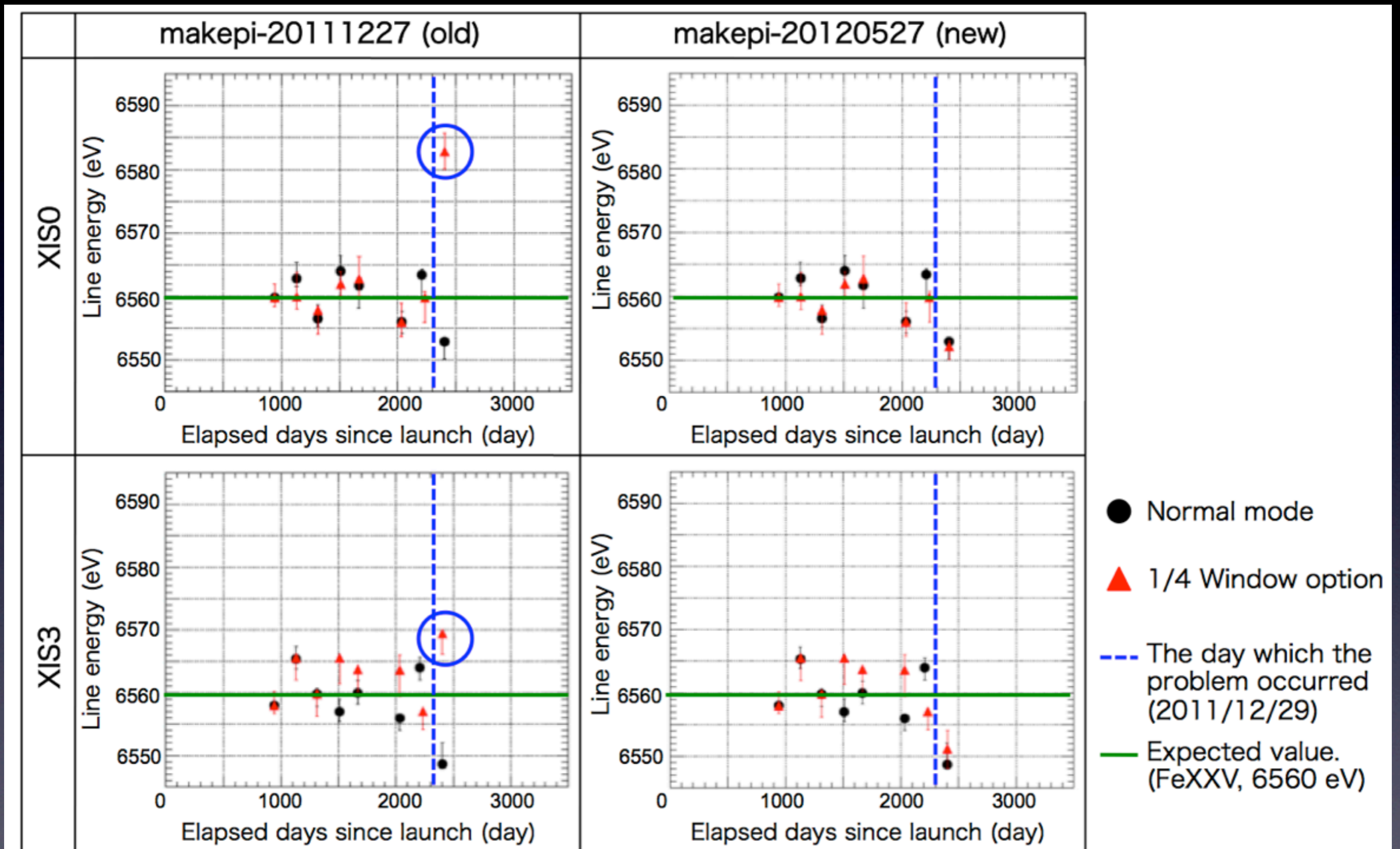


Fig5. Measured energy of the FeXXV line from observation of the Perseus cluster.