

The *Suzaku*/XIS: Calibration Status

Eric Miller, Beverly LaMarr (MIT)
Masayoshi Nobukawa (Kyoto University)

for the *Suzaku*/XIS Team



7th IACHEC Meeting, Napa, 2012

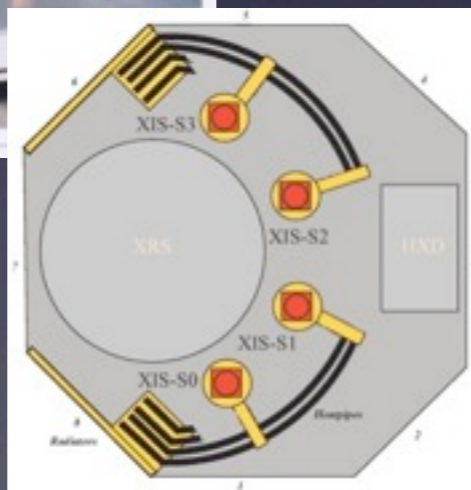
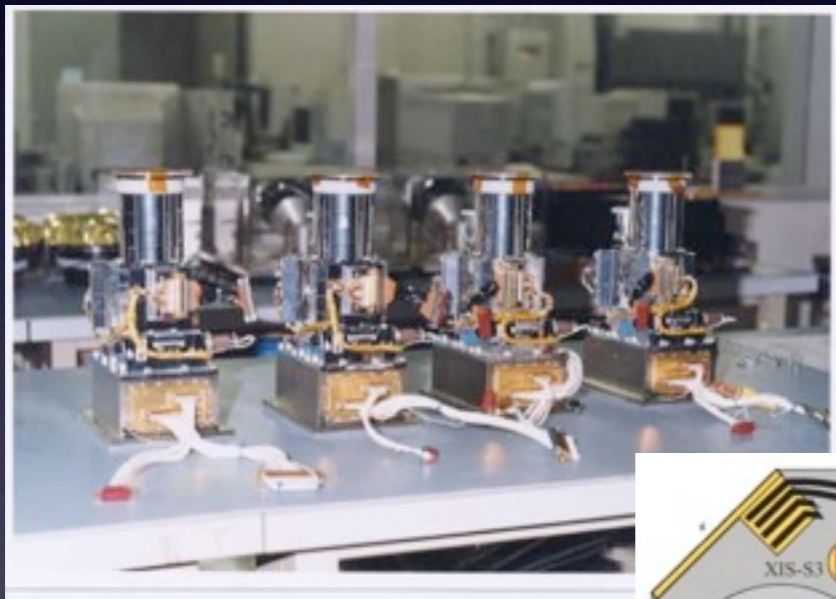


Outline

- E. Miller
 - instrument health and status
 - effective area (contamination) tracking and calibration
- B. LaMarr
 - changes in charge injection
- M. Nobukawa
 - CTI and gain correction
 - Si edge correction
- open issues

Suzaku/XIS - Overview

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



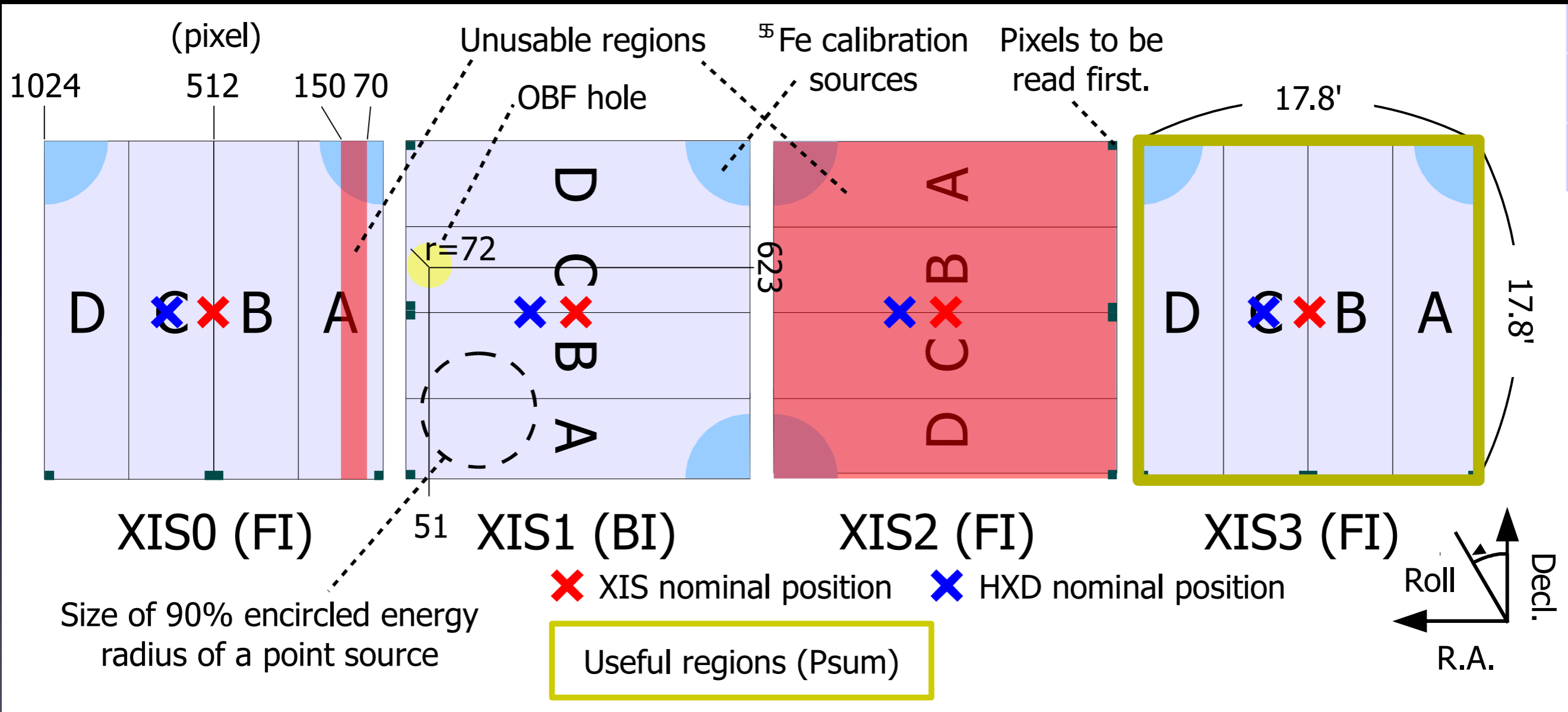
Field of view	17.8' x 17.8'
Energy range	0.2-12 keV
Energy resolution	~180 eV @6keV
Effective area	340 (FI)/390 (BI) cm ² @1.5keV
Time resolution	8 s (Normal) - 7.8 ms (Psum)

from Tsujimoto's "pocket guide"

Major XIS Events

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

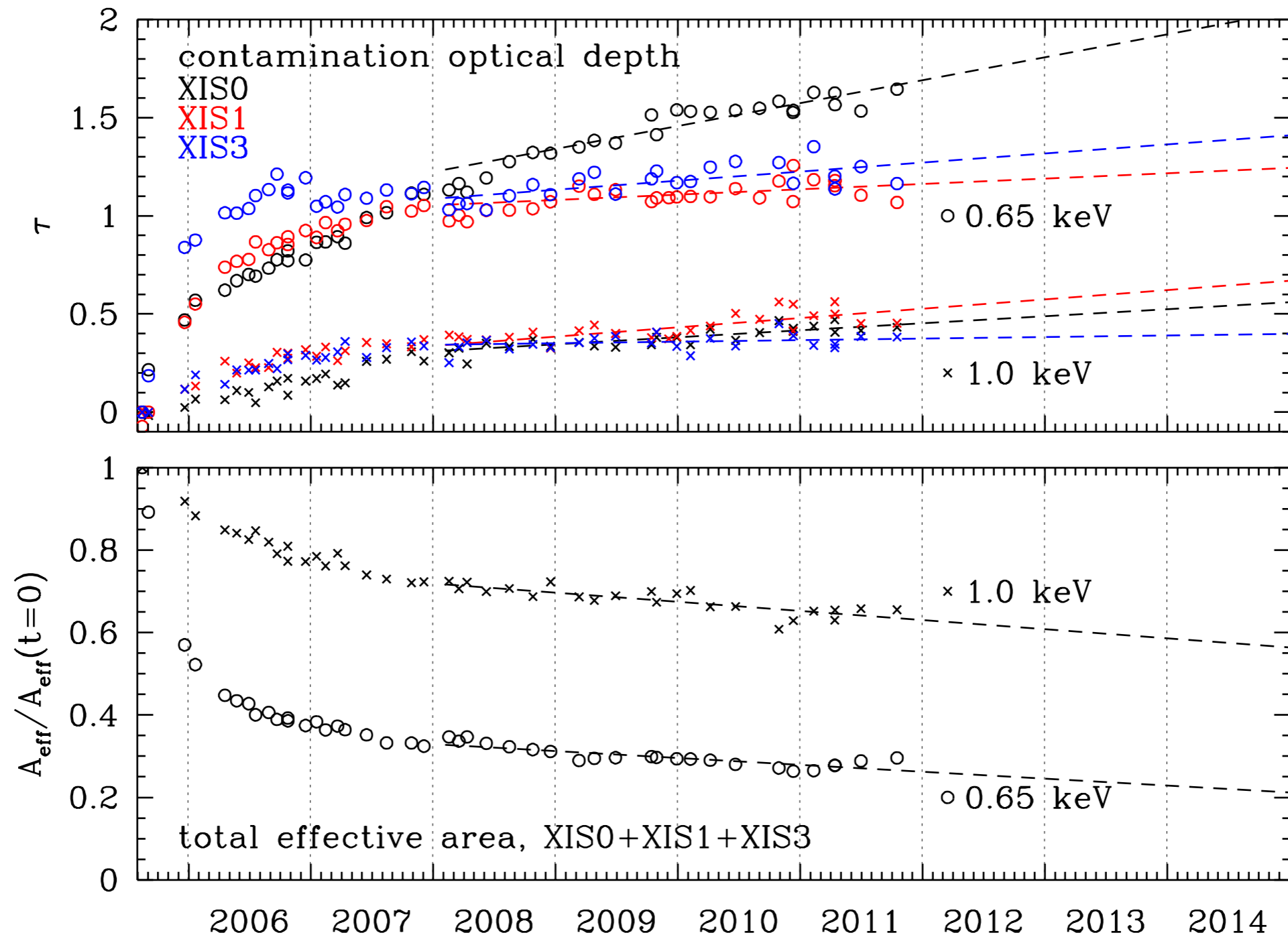
XIS Status



from Tsujimoto's "pocket guide"

Molecular OBF Contamination

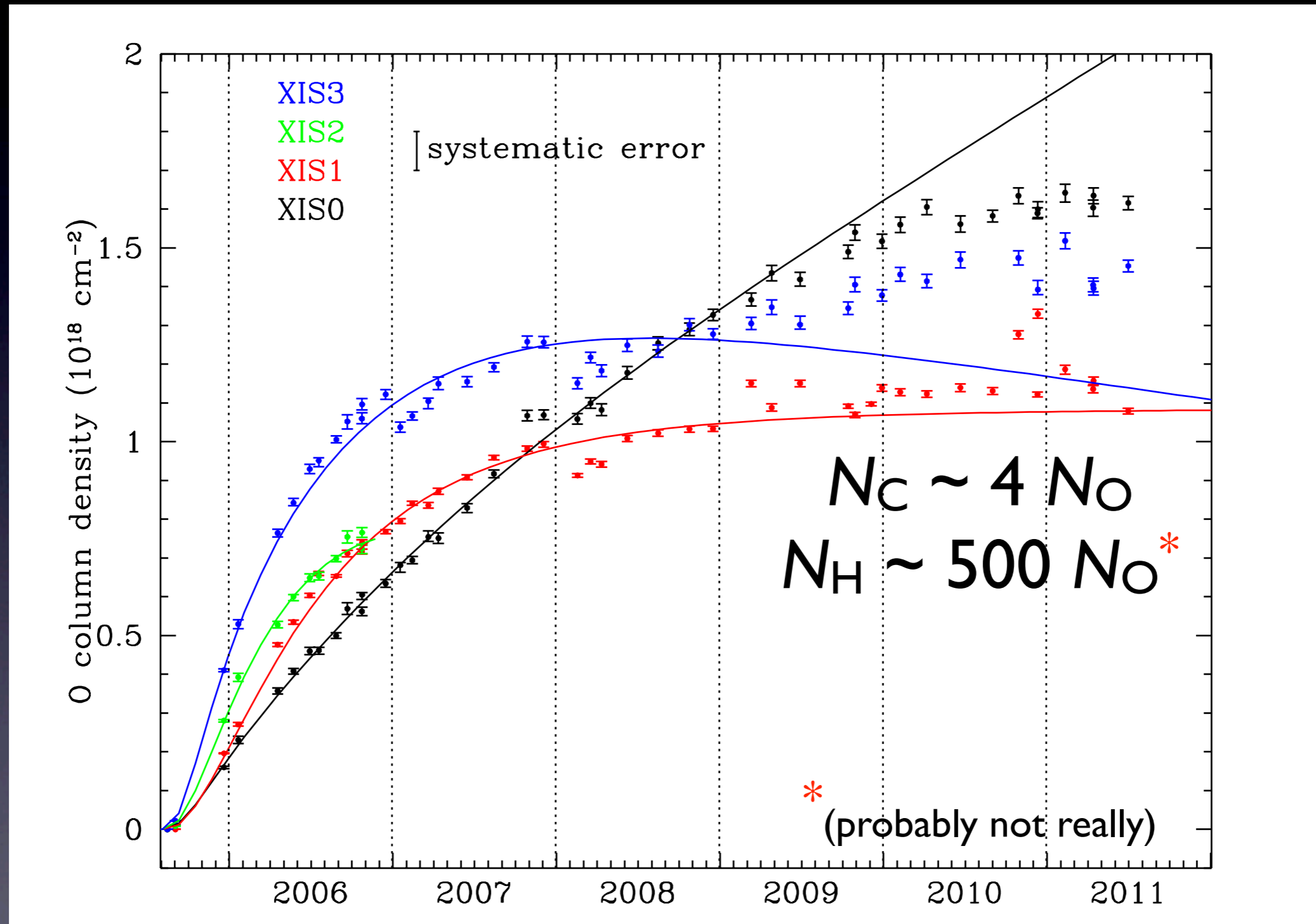
Effective Area Tracking



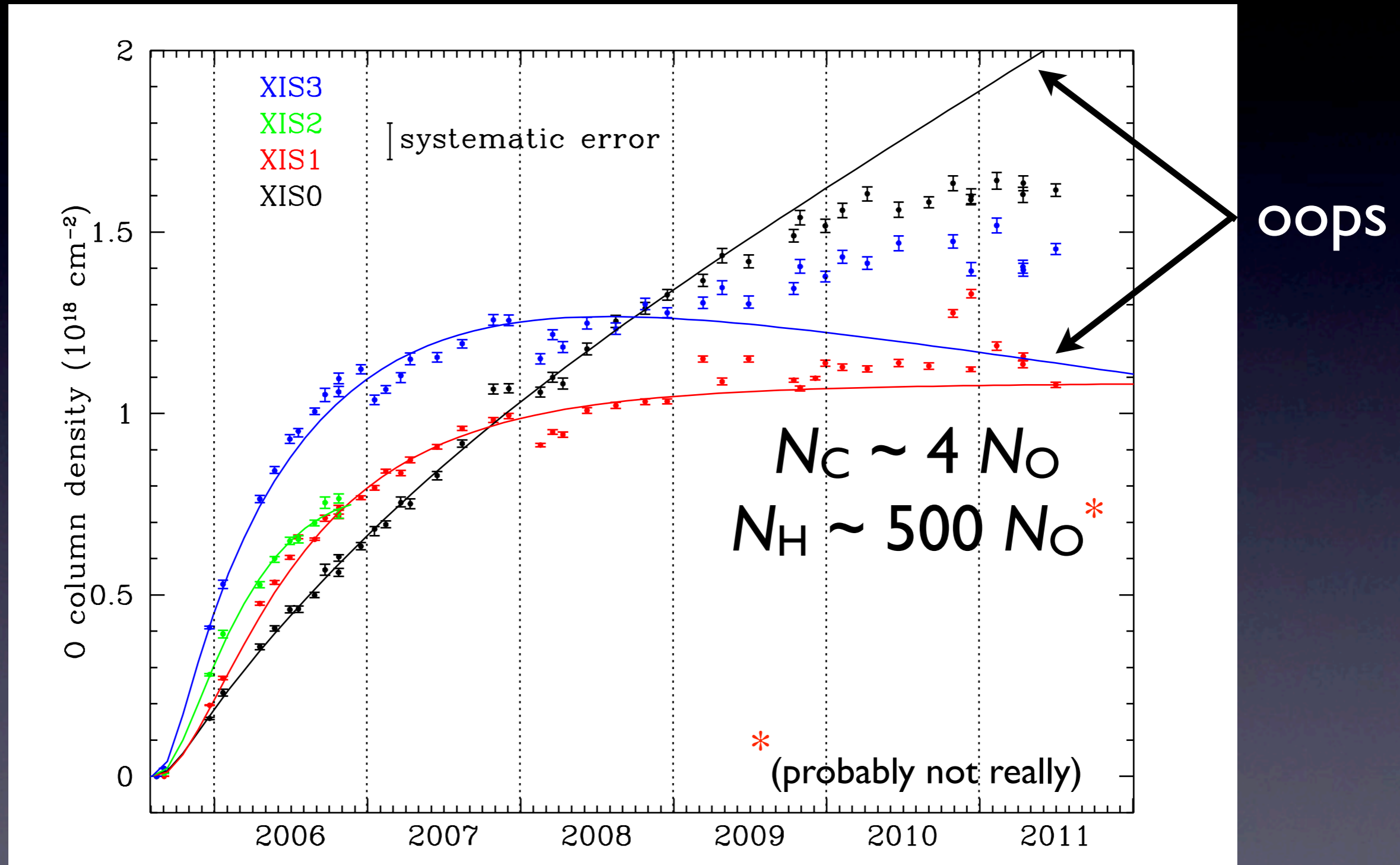
Contamination Model

- 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

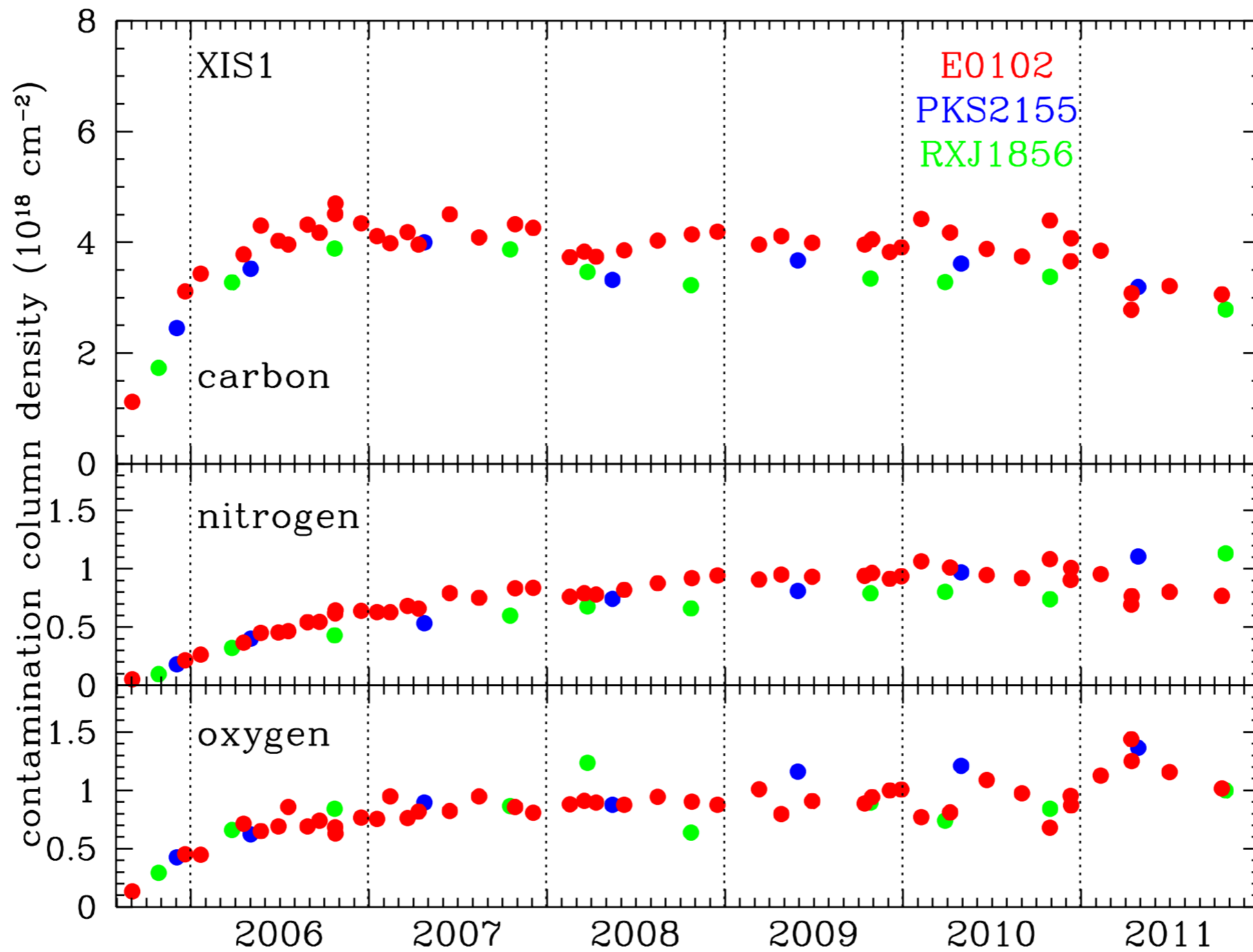
(Current) Contamination Model



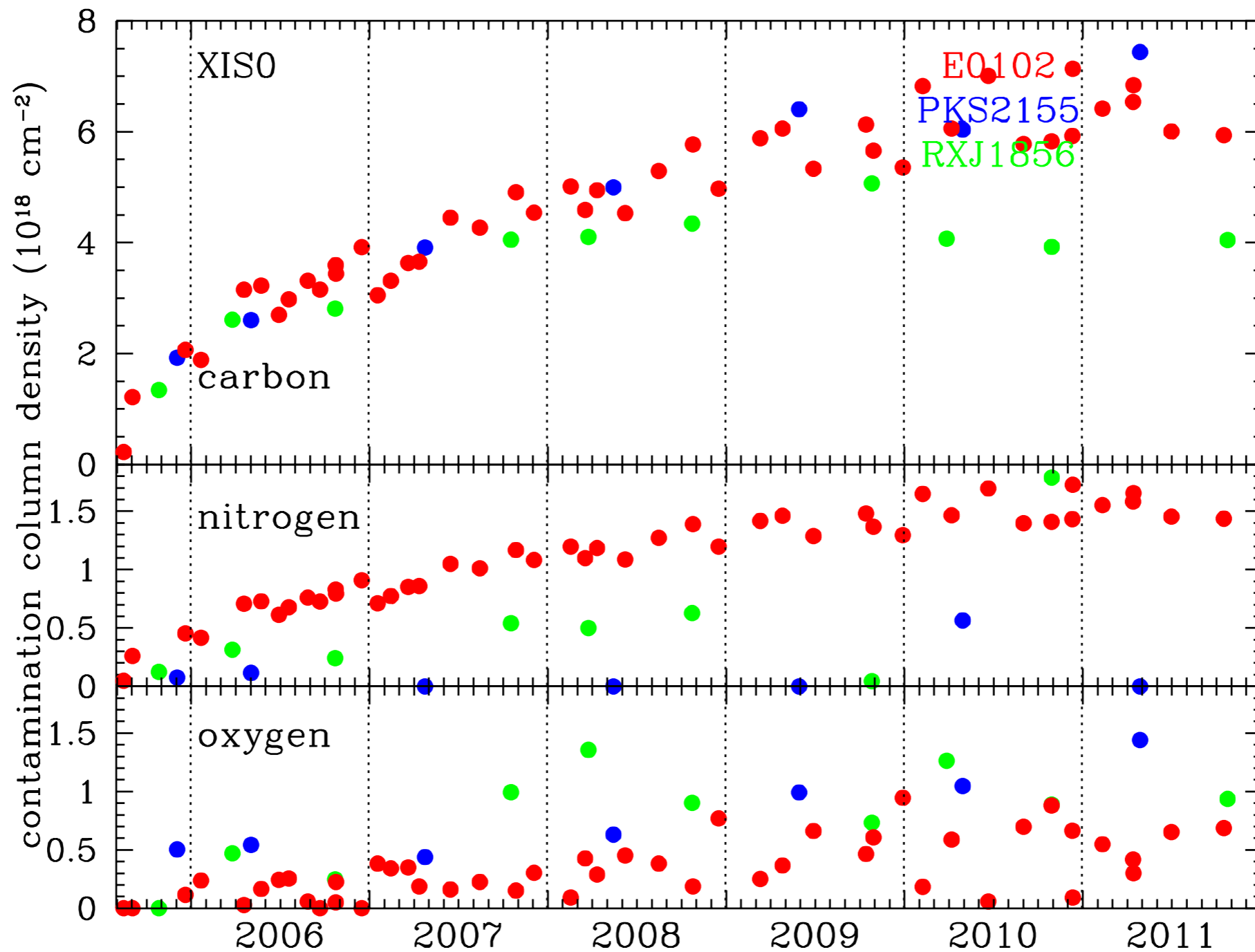
(Current) Contamination Model



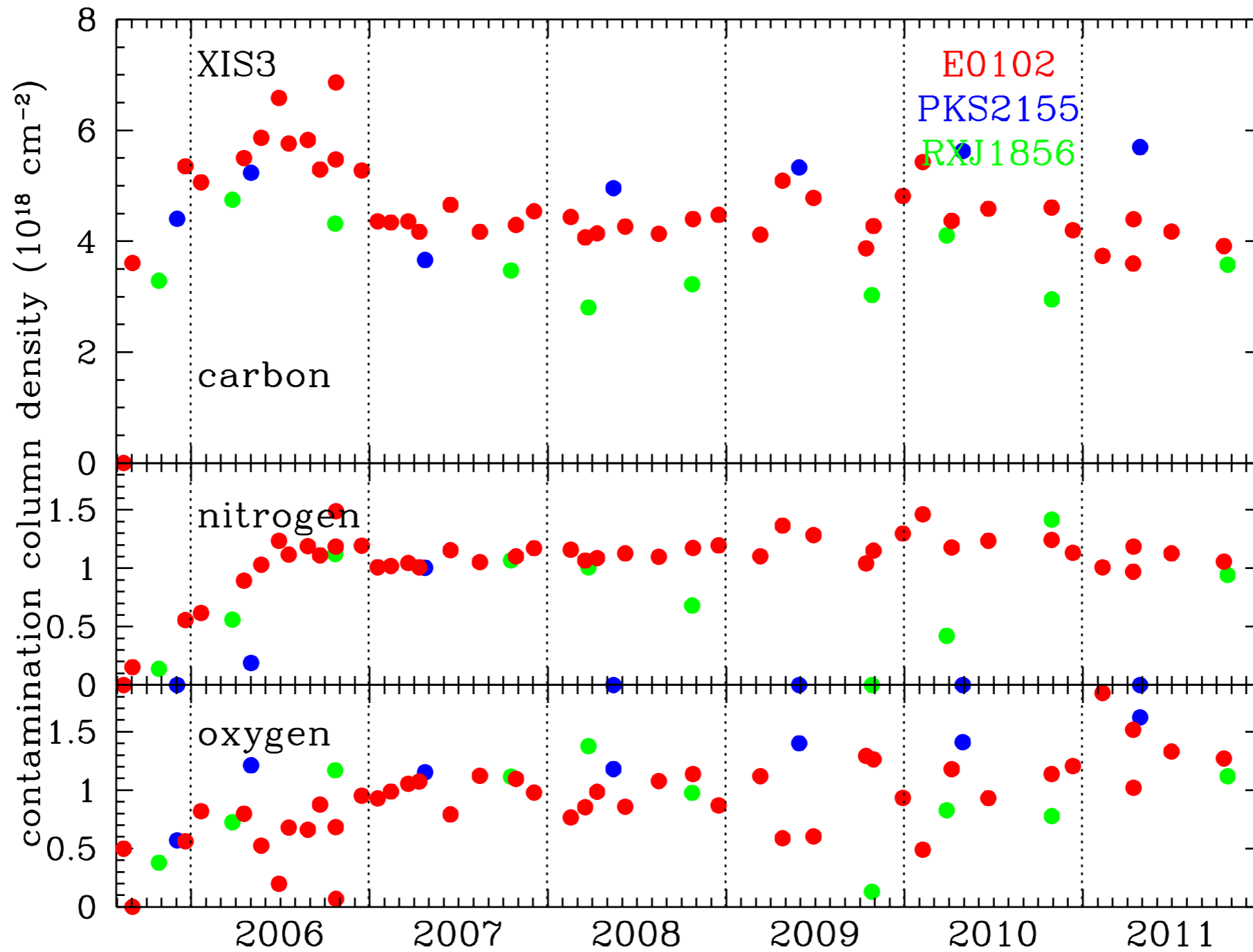
(New) Contamination Model



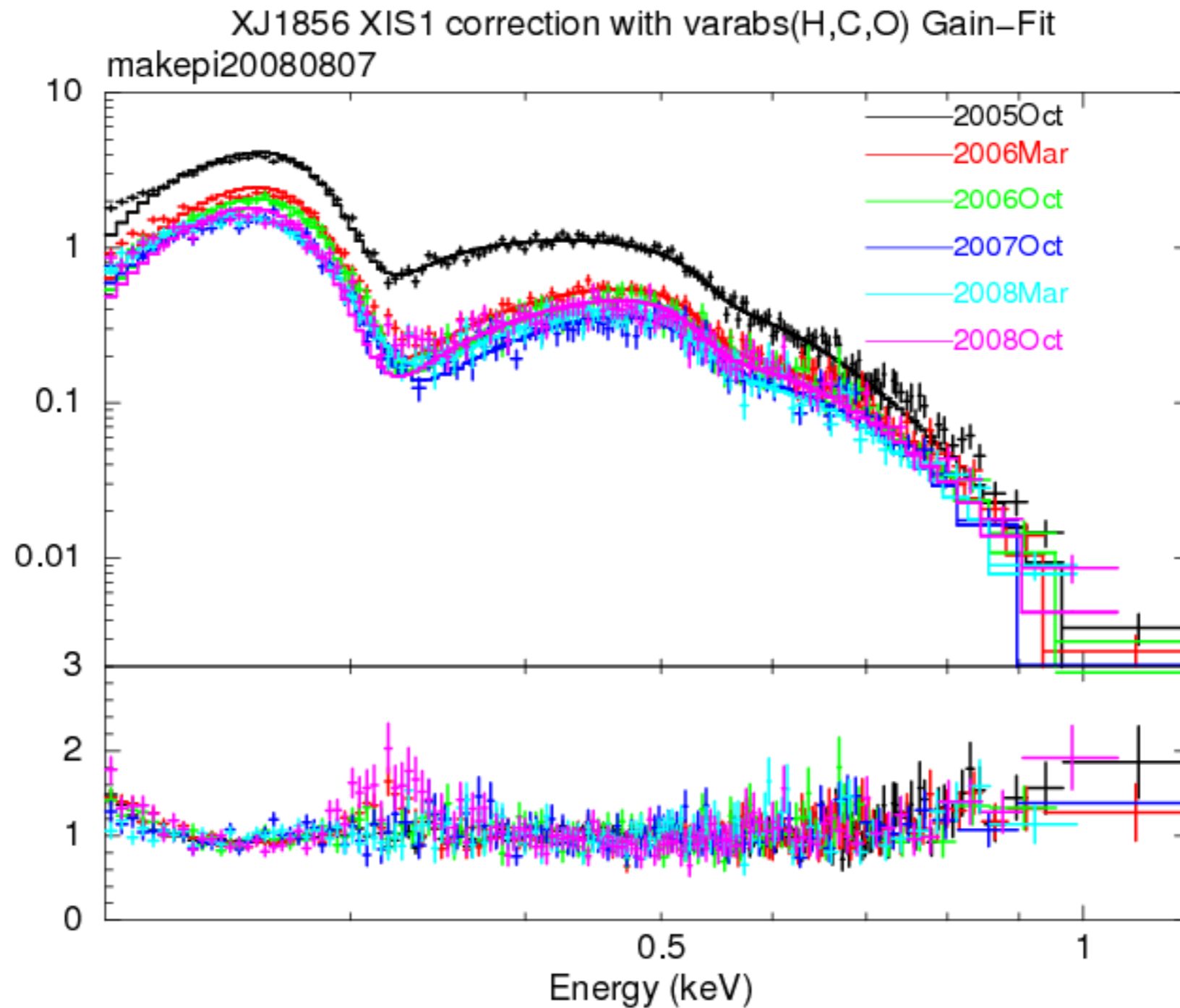
(New) Contamination Model



(New) Contamination Model



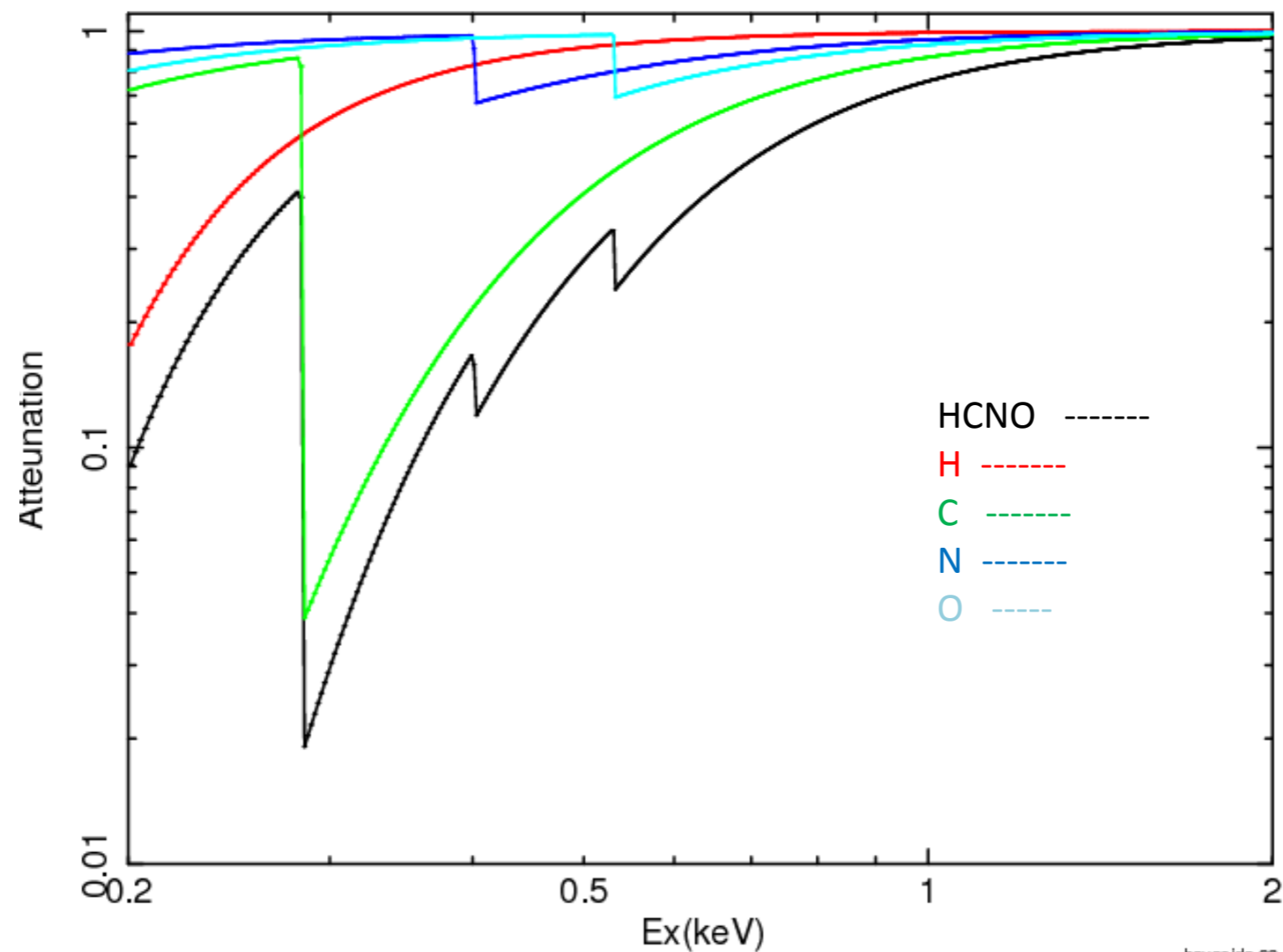
(New) Contamination Model



(New) Contamination Model

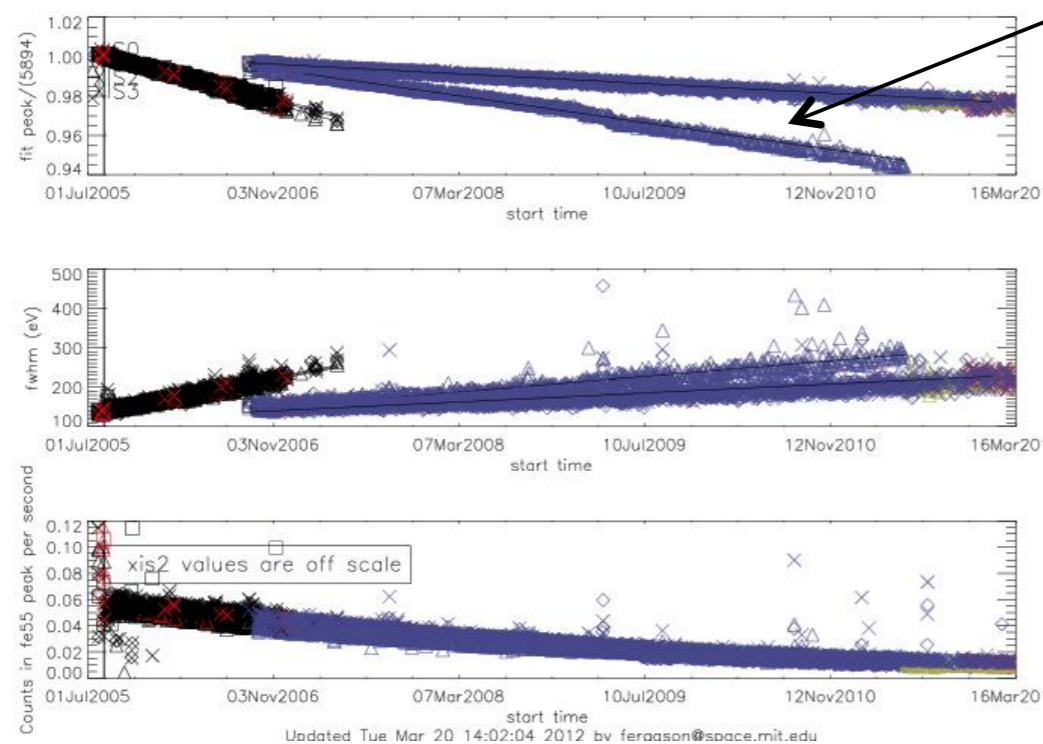
XIS1

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



hayas idla 29-Oct-2011 18:57

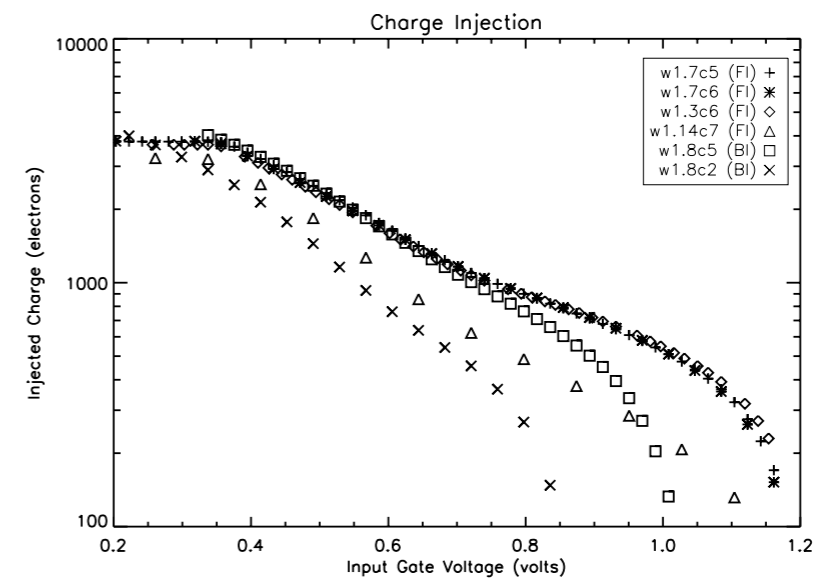
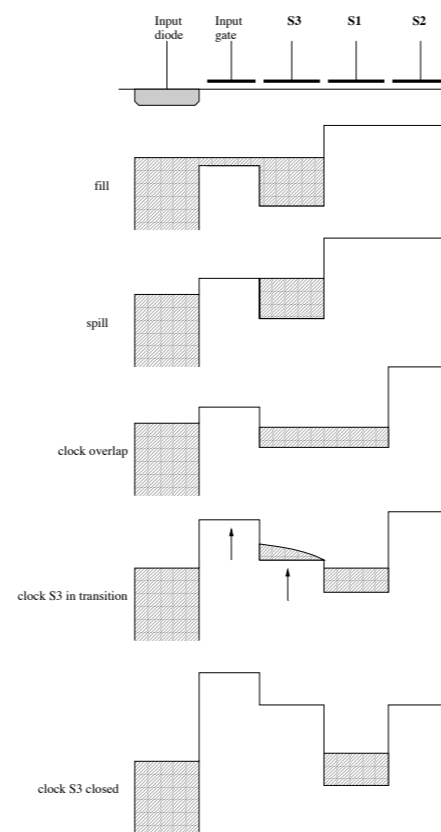
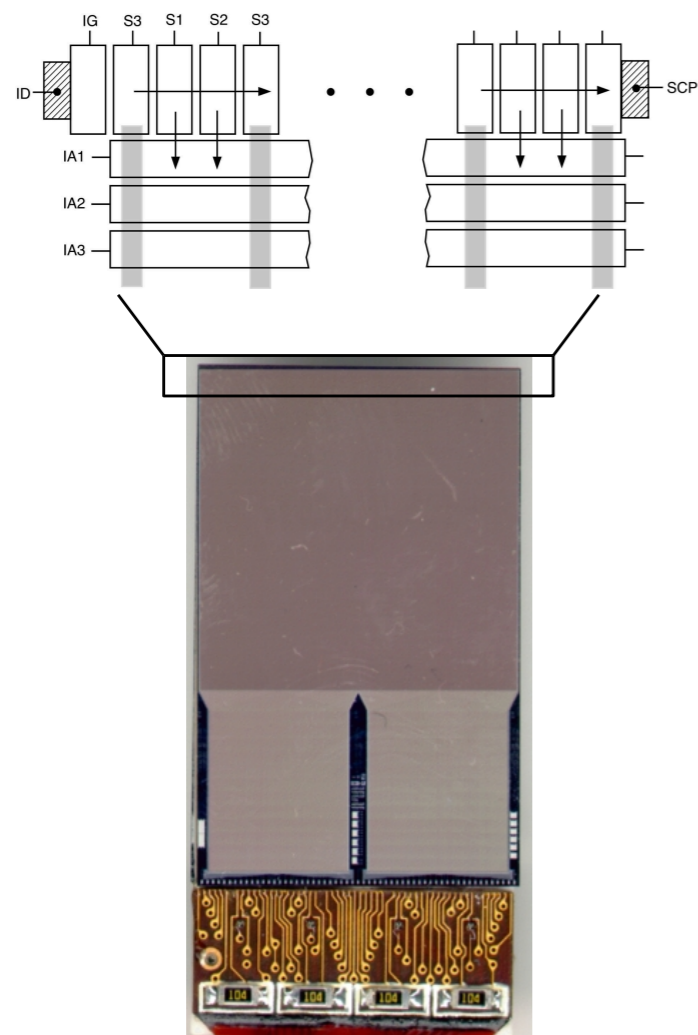
XIS1 Charge Injection Increase



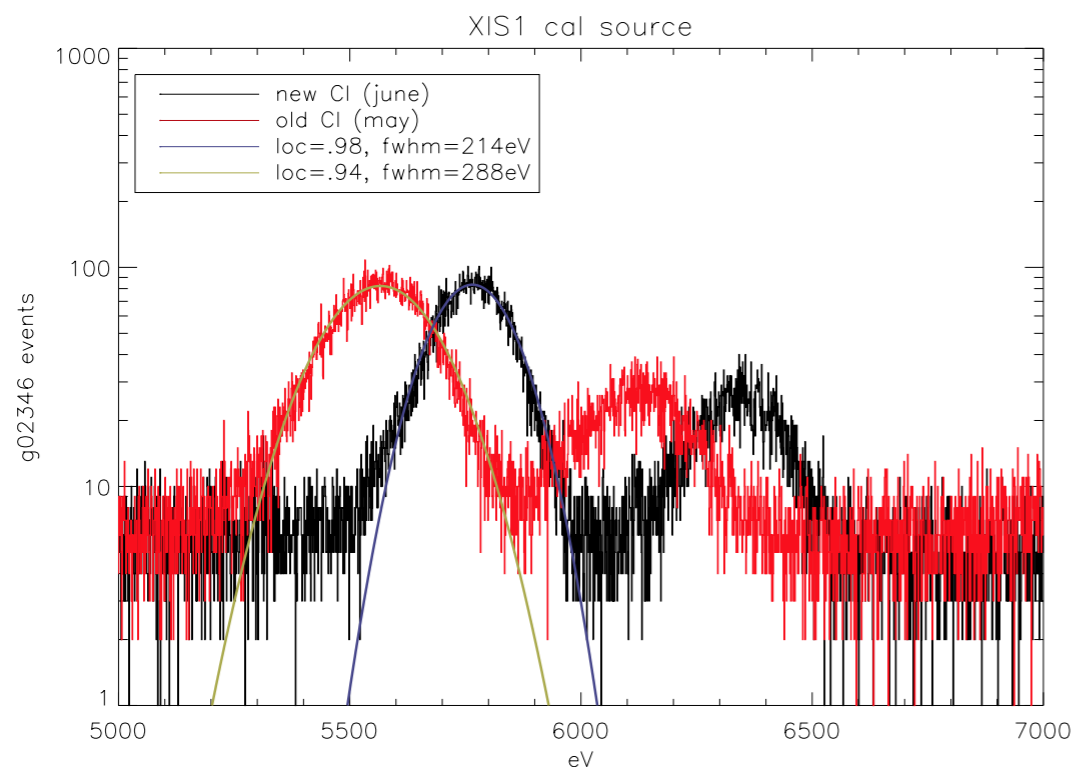
- Since spaced row charge injection was implemented on board, the BI gain has evolved faster than the FI gains.
- The original BI injected charge level was below the FI level.



XIS Charge Injection



High Energy Response Improves

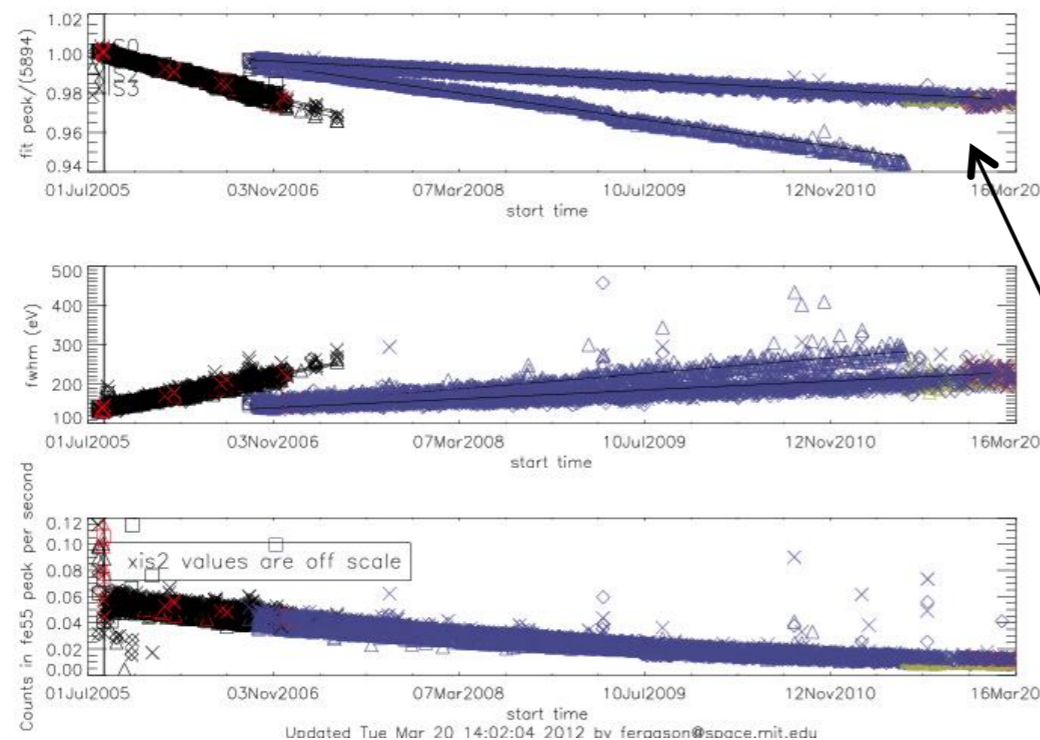


- Raising the injected charge level above the X-ray peak results in improved gain and resolution.



XIS1 Charge Injection Increase

- The current BI injected charge level results in performance evolution similar to the FI devices.



Calibration status of XIS Gain and Si-edge

26th March 2012

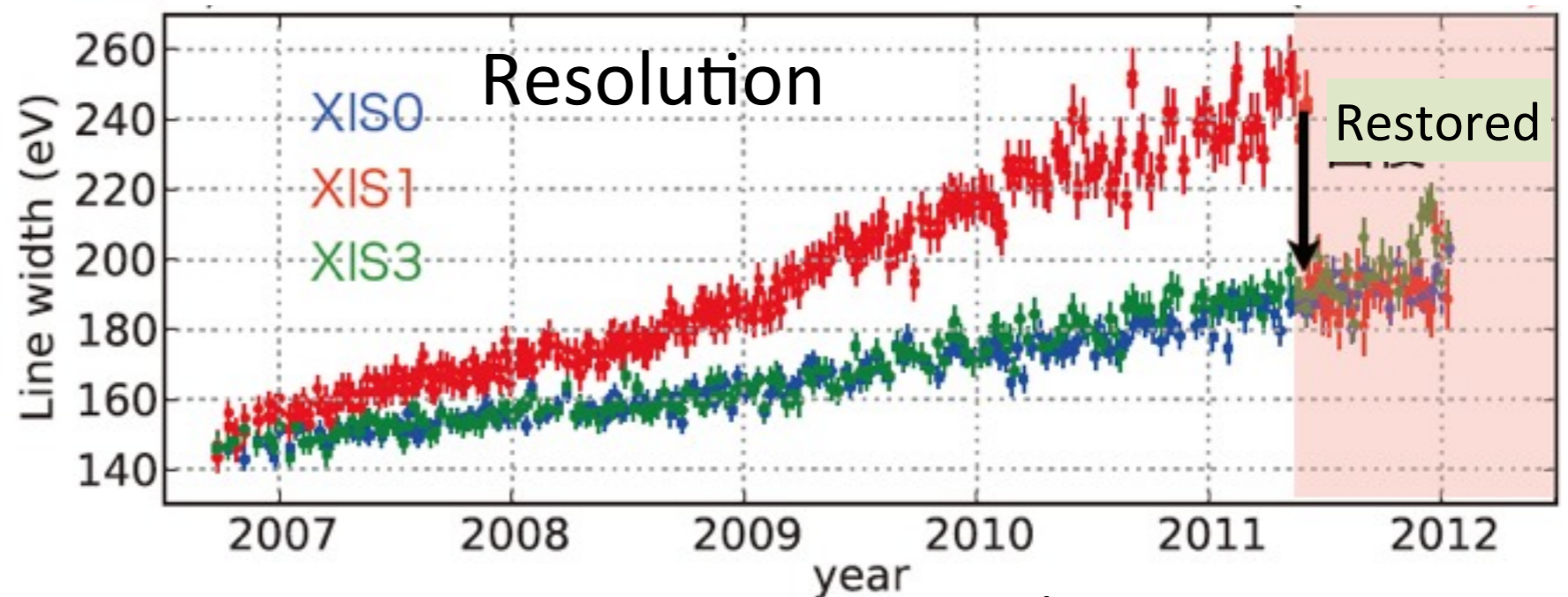
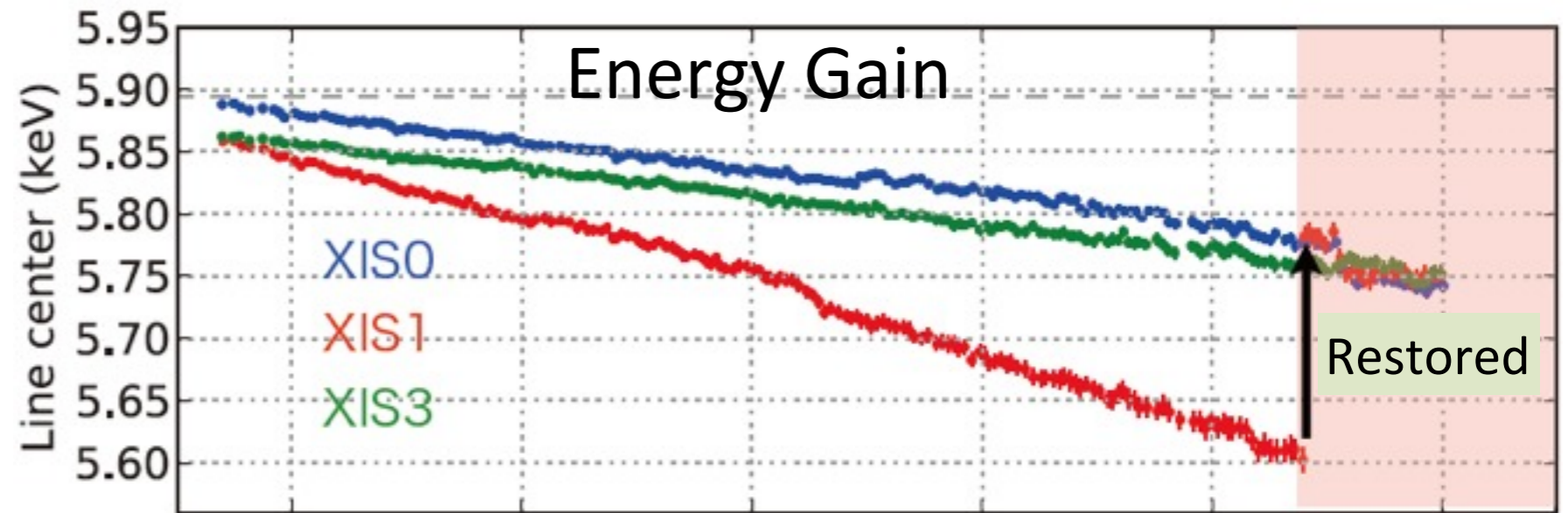
IACHEC2012, Napa, San Francisco

Charge Injection (CI) for Restore of Energy Resolution

- SCI (spaced-row charge injection) started on Sep. 2006.
- Slope of the gain degradation became flatter.
- Discrepancy of FI/BI \Leftrightarrow CI equiv. to 6 keV/2keV

CI value for XIS1 changed from 2 keV to 6 keV on June 2011.

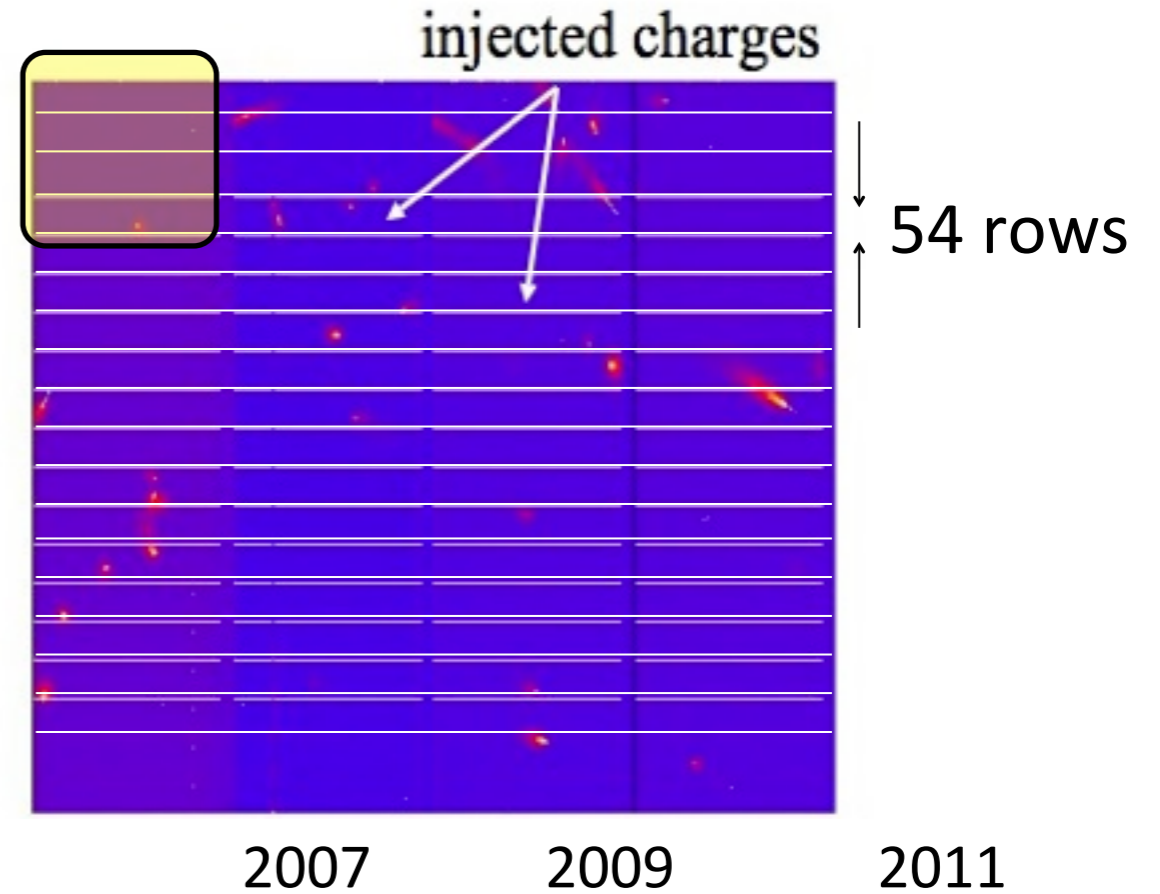
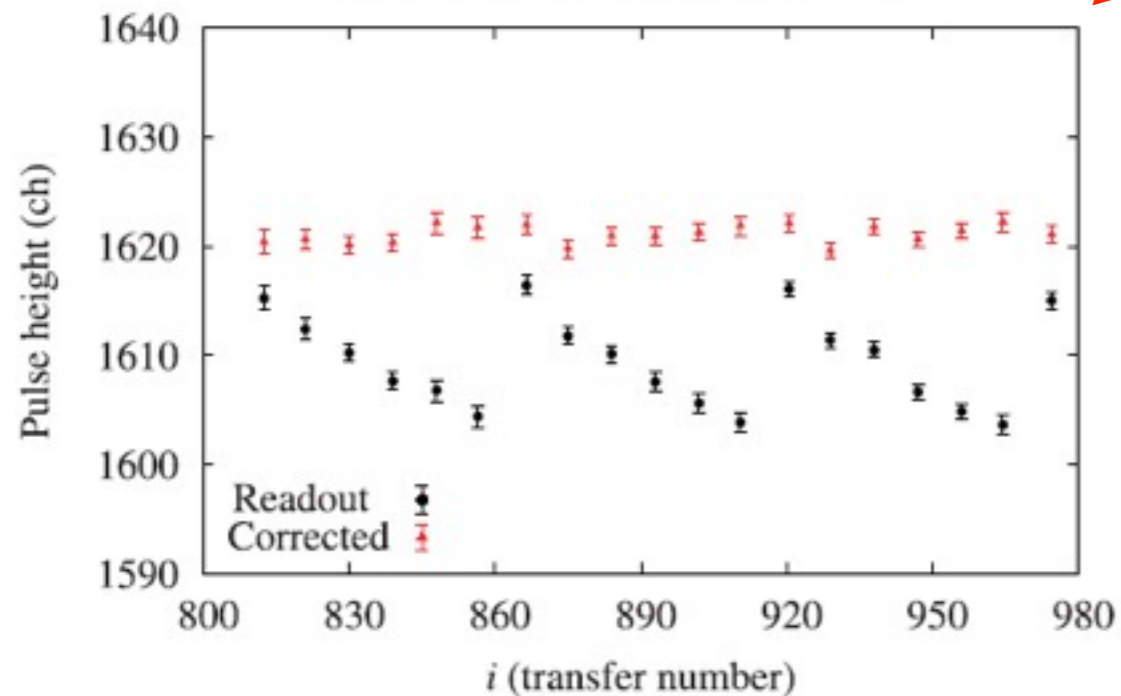
=> Gain and resolution were restored.



*No CTI correction

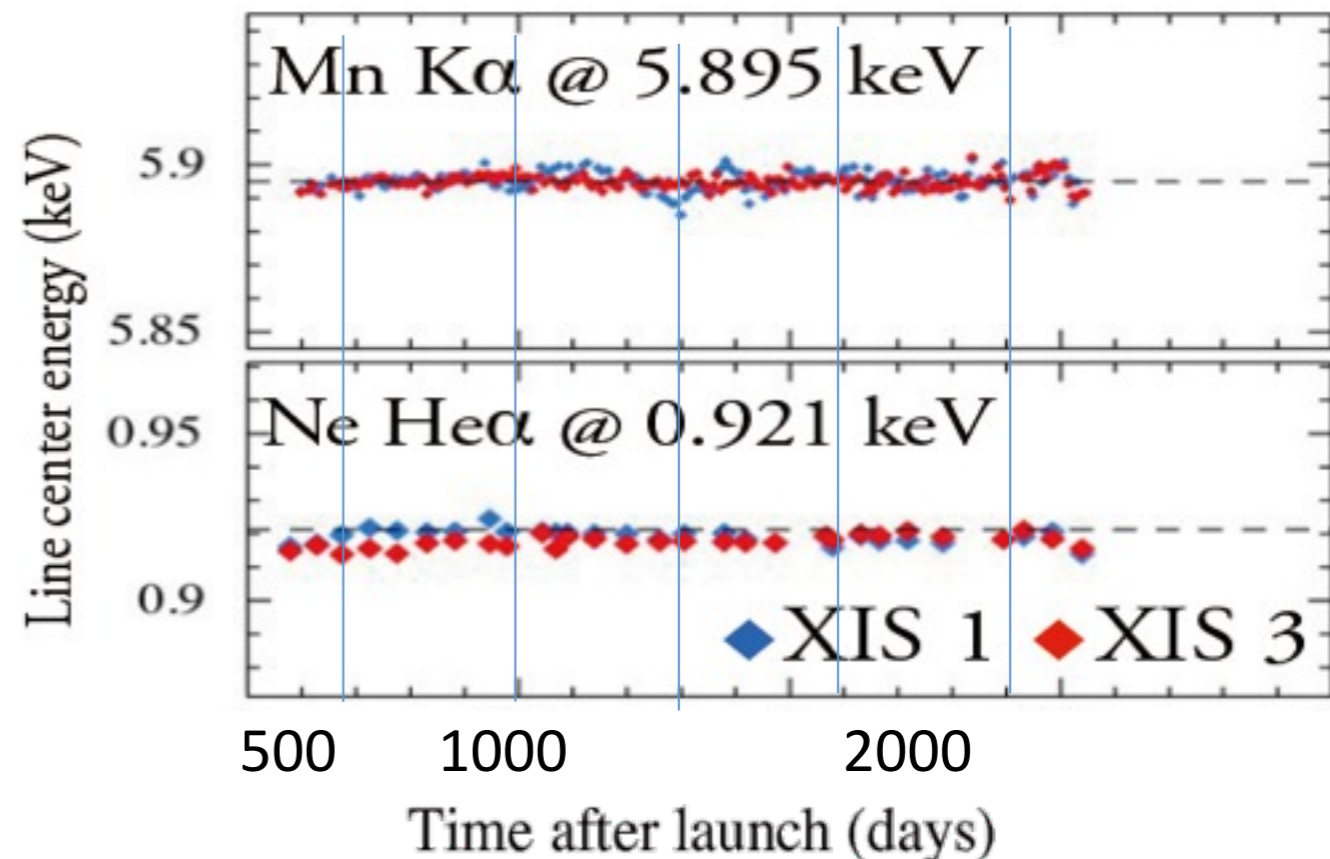
CTI / Gain correction

- Saw-tooth function of CTI:
 - one charge injection per 54 rows
- CTI correction in consideration of the saw-tooth shape



- Current status of energy scale after CTI/gain correction
Uncertainty of energy scale

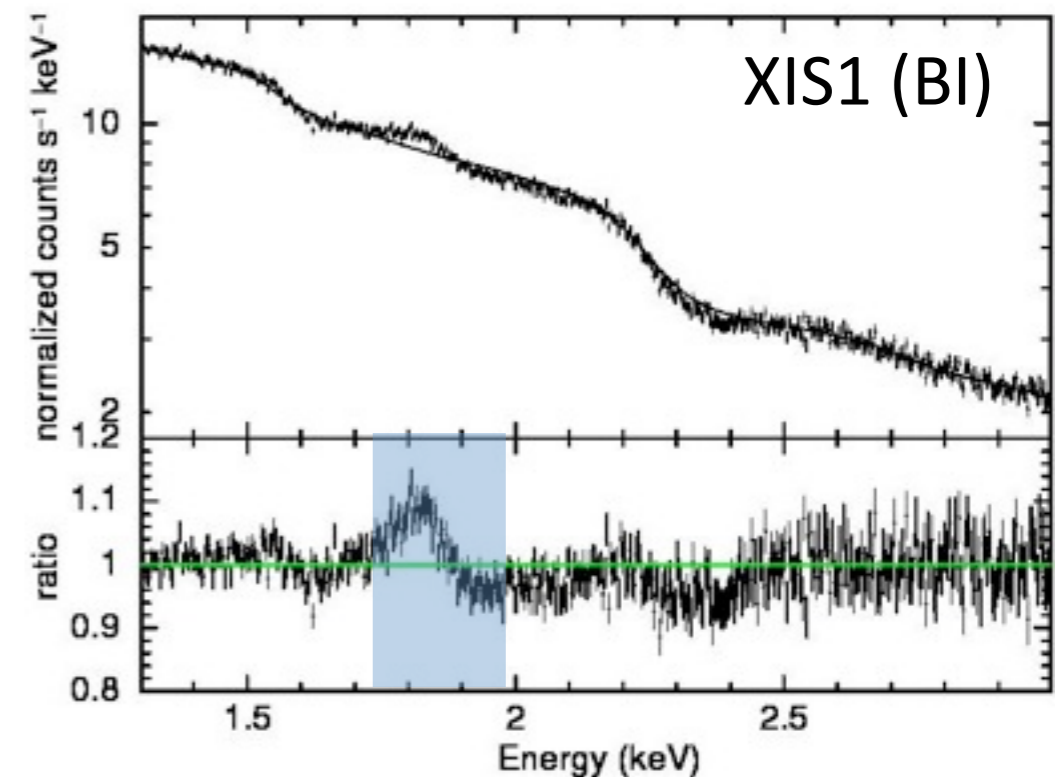
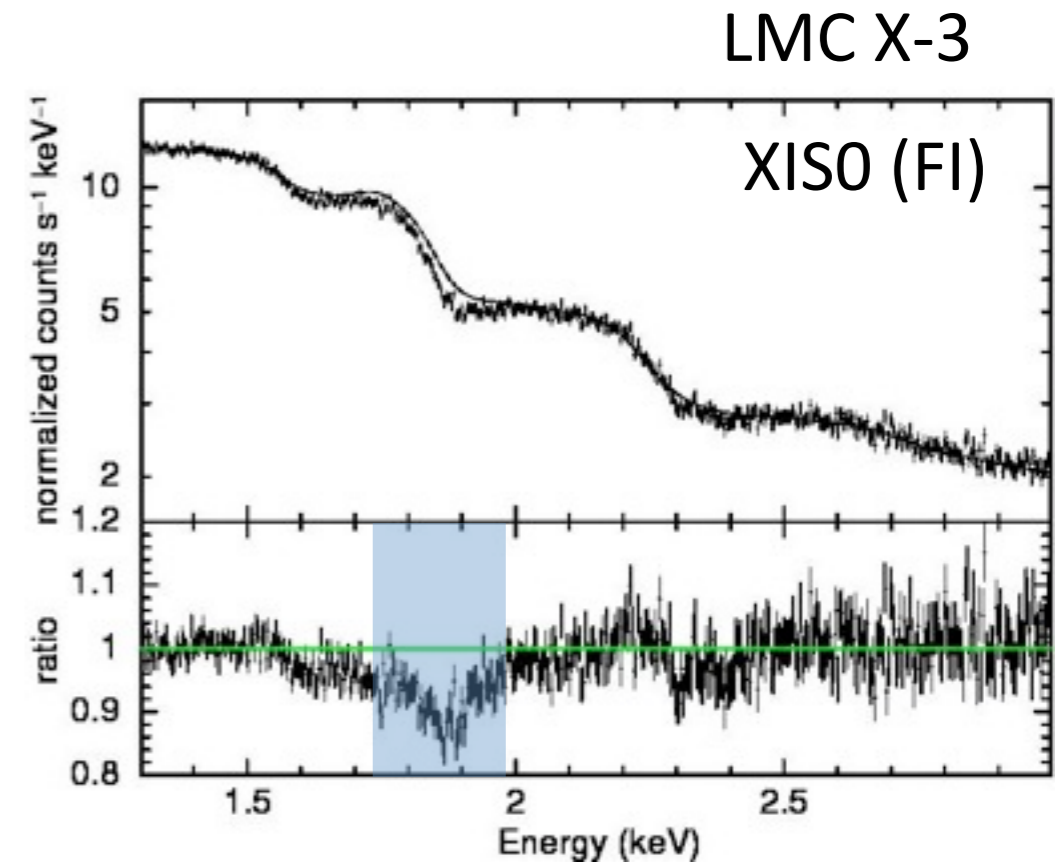
	@1 keV	@6 keV
FI (XIS0/3)	<10 eV	<6 eV
BI (XIS1)	<10 eV	<6 eV



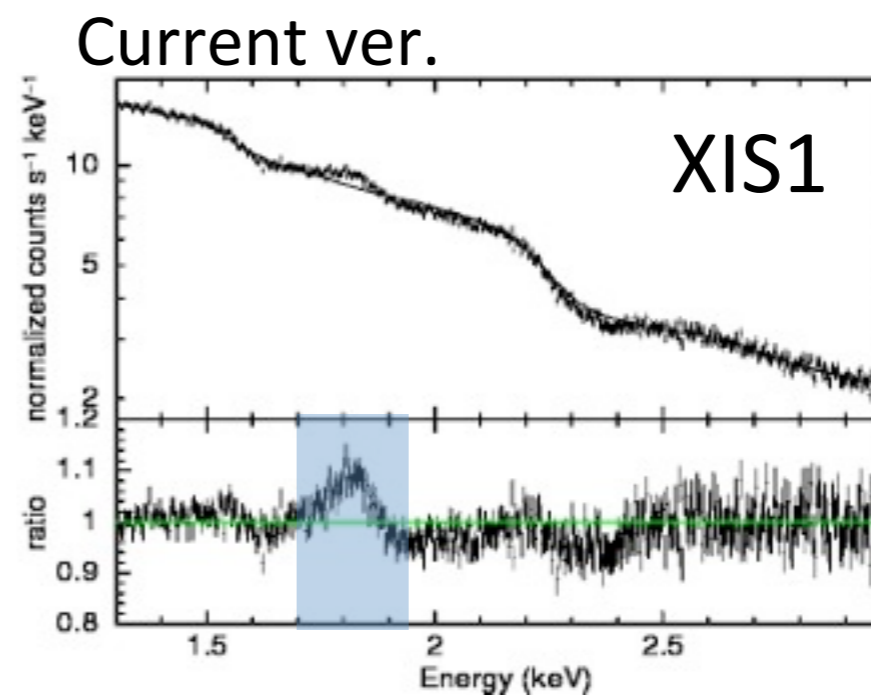
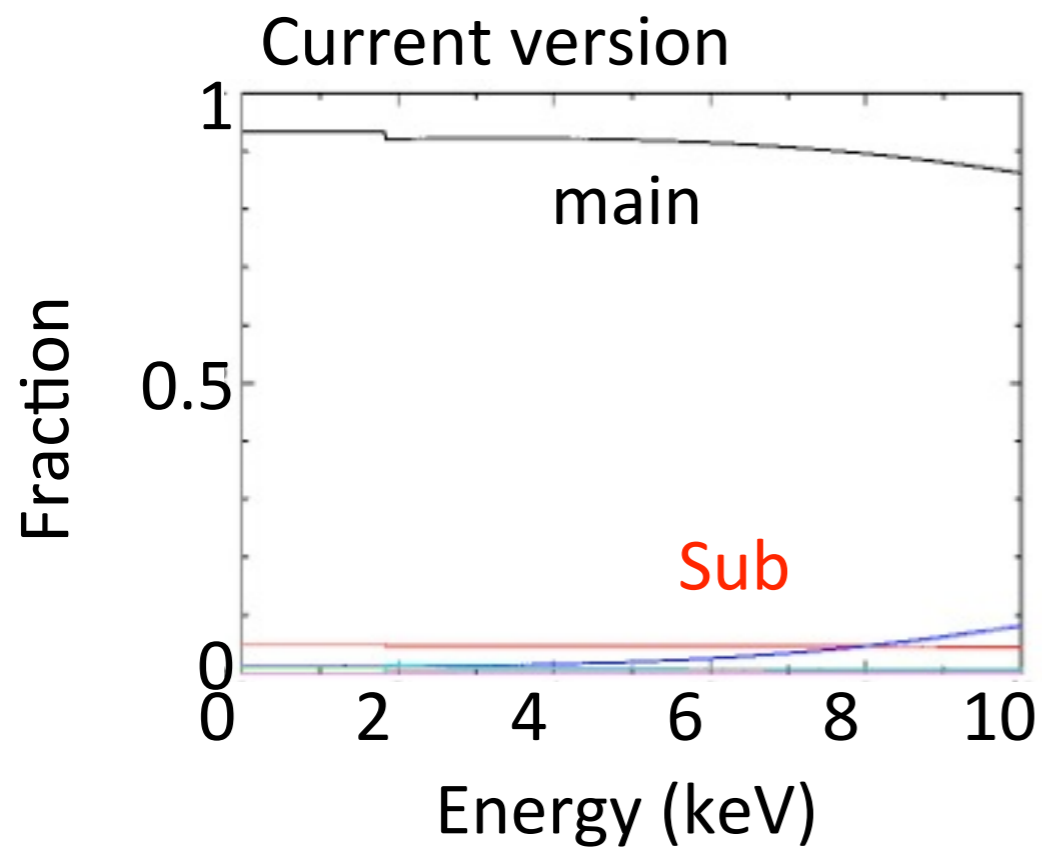
Modification of RMF for Si-edge Problem

- ~10% Residuals at ~1.84 keV (Si-edge)
- Negative/Positive for FI/BI
- We have tried to modify the Si-edge problem by various treatments
 - Neutral Si-K line
 - Energy resolution

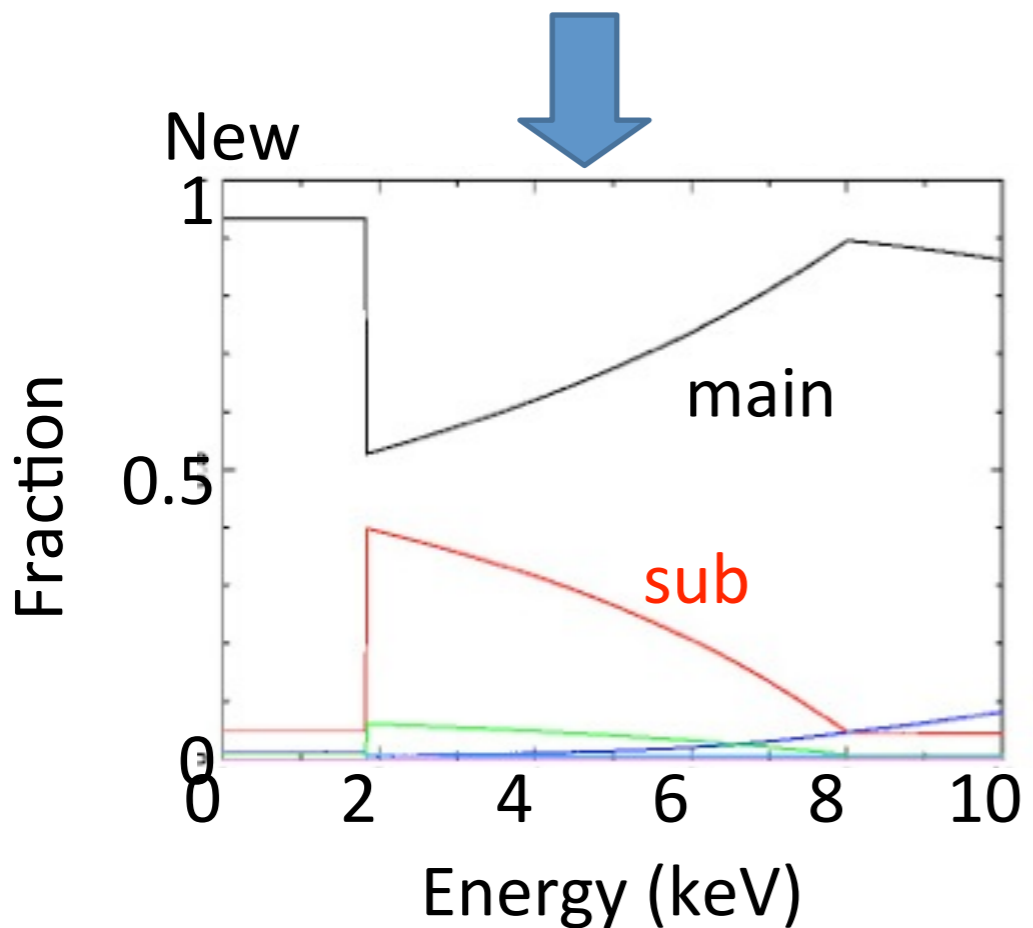
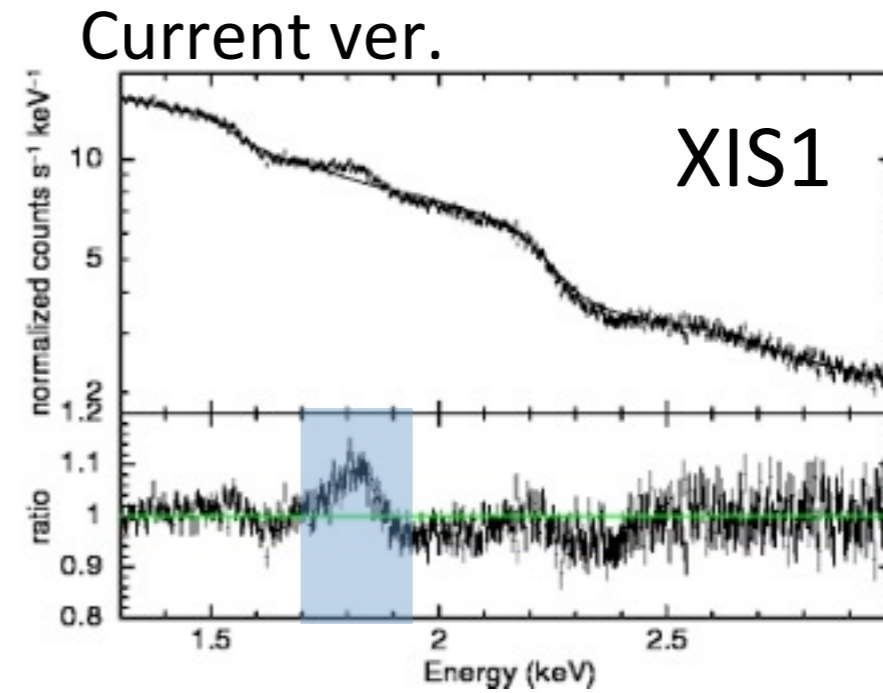
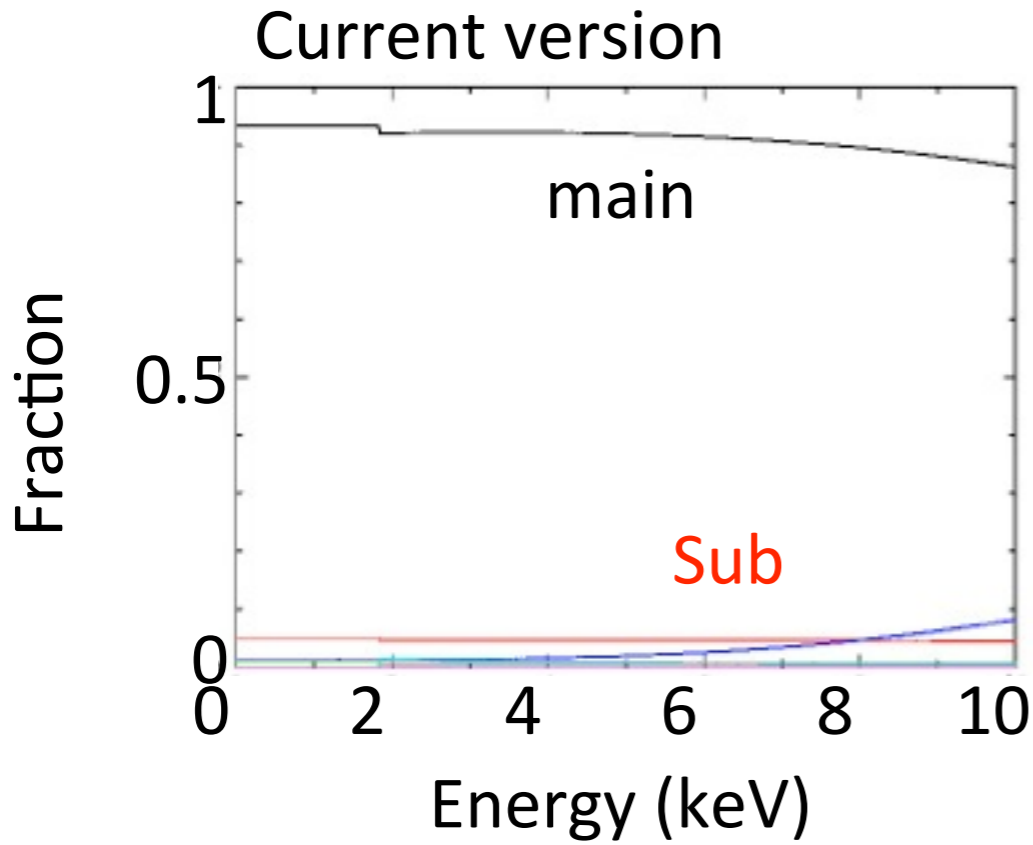
=> Unfortunately failed
- Semi-Phenomenological modifications with physical basis
 - BI: Sub/Main intensity ratio
 - FI: XAFS of Si-edge



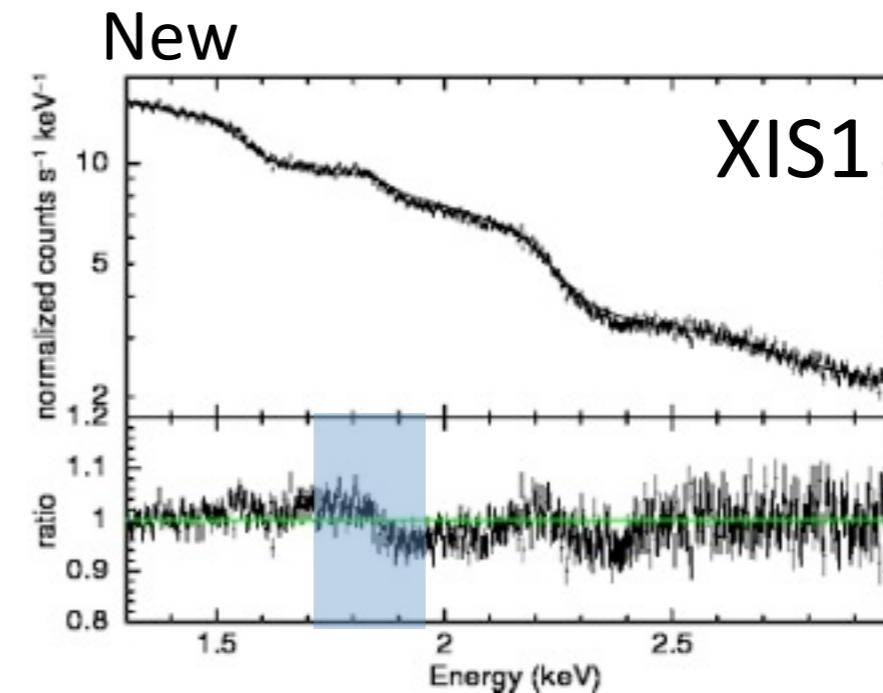
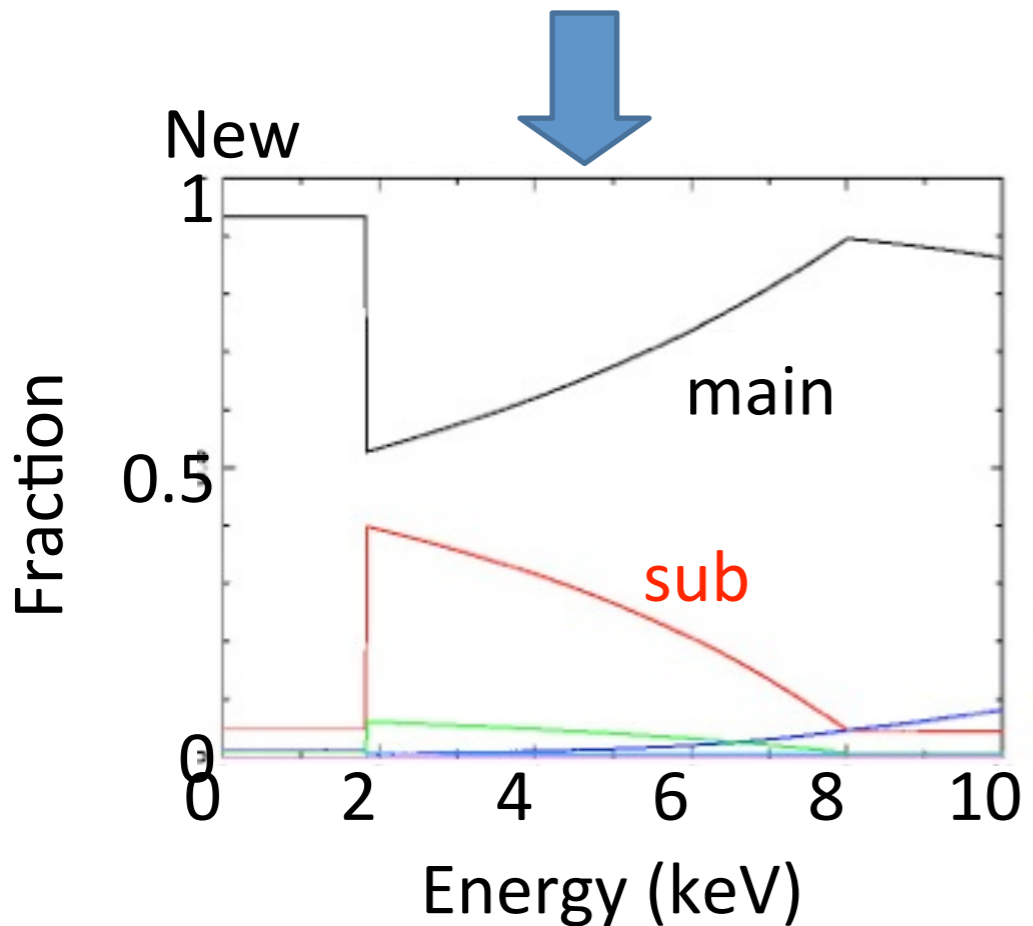
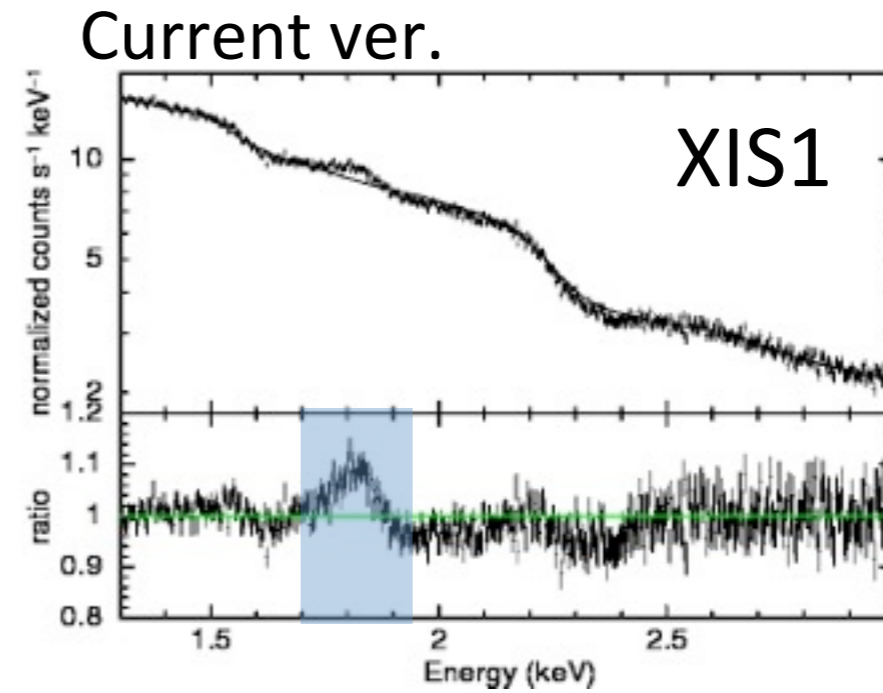
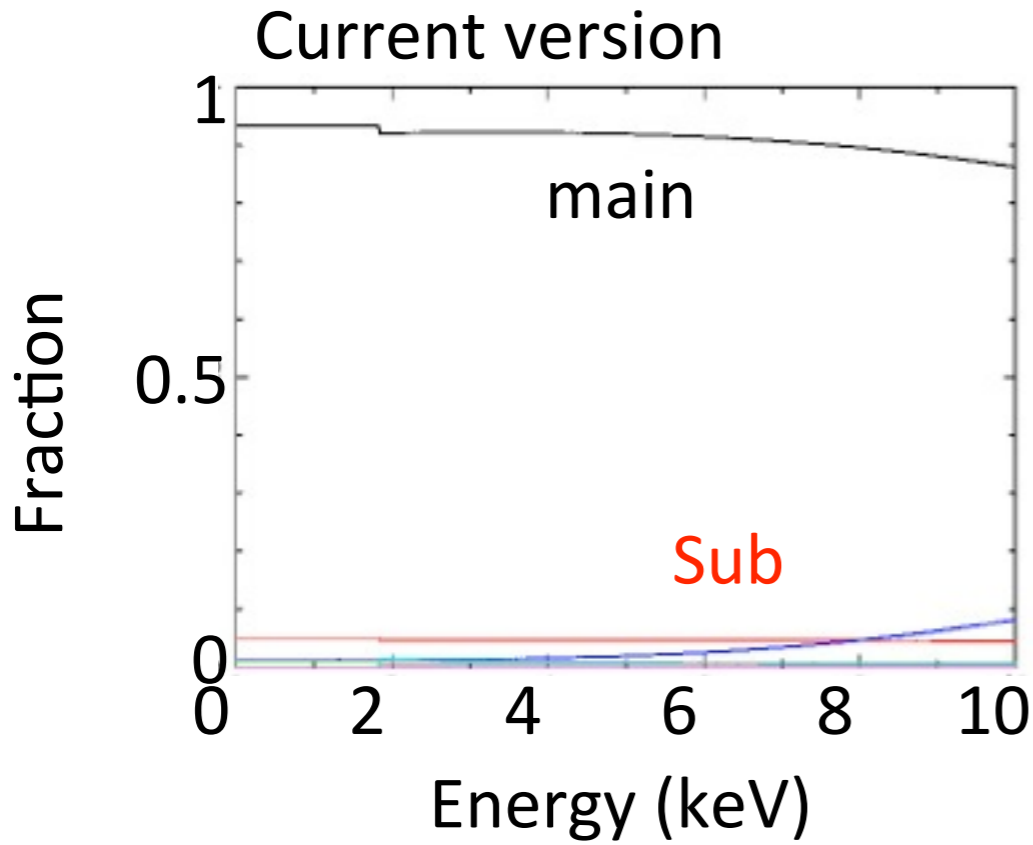
BI: Discontinuous function of Sub/Main ratio at Si-edge



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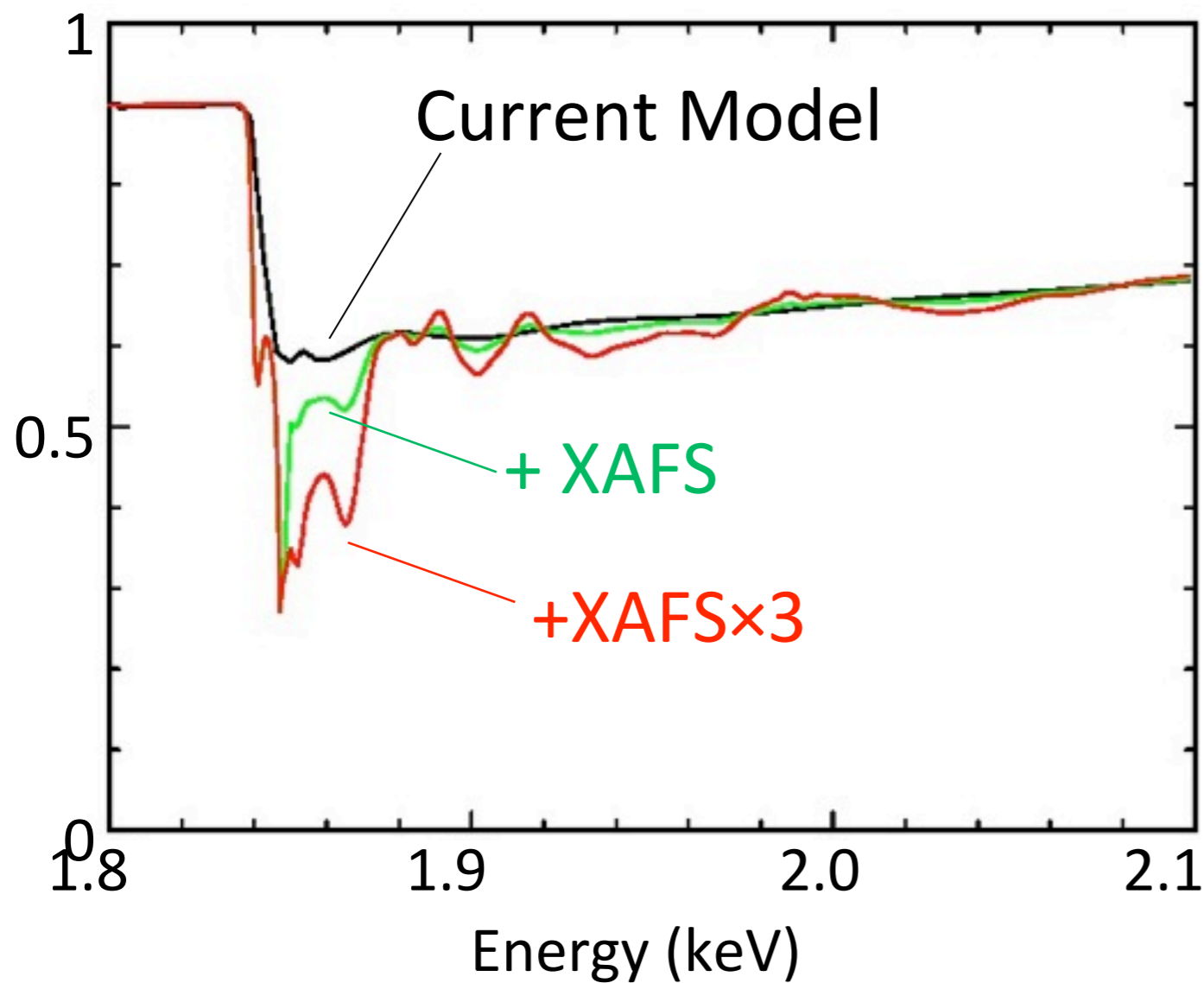
BI: Discontinuous function of Sub/Main ratio at Si-edge



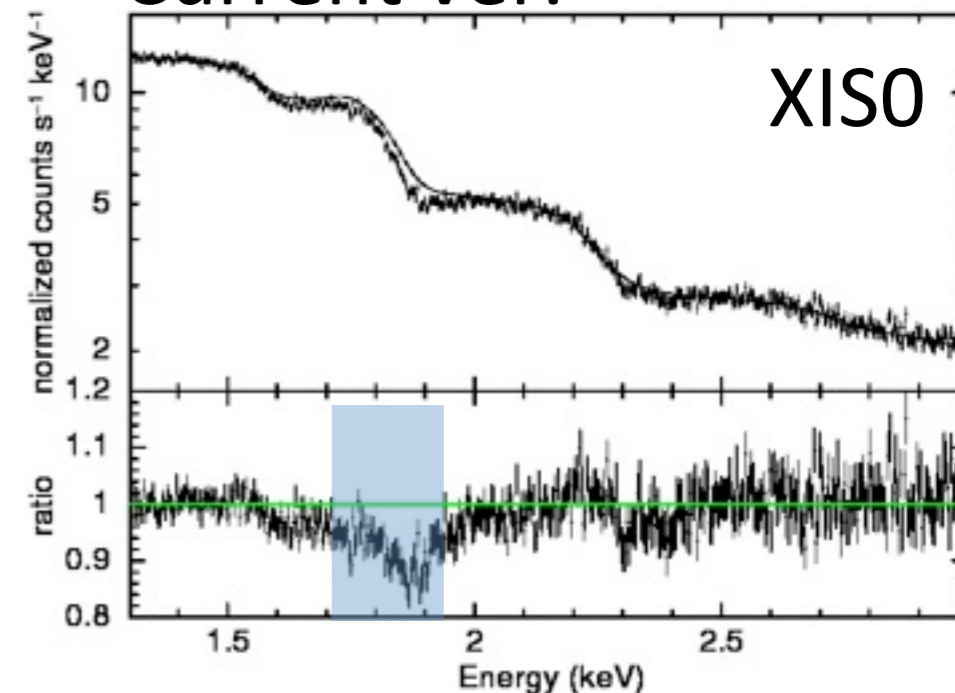
FI: XAFS of Si-edge

- Current QE model does not include XAFS.
- New model: XAFS => XAFS×3
The residuals are significantly modified.

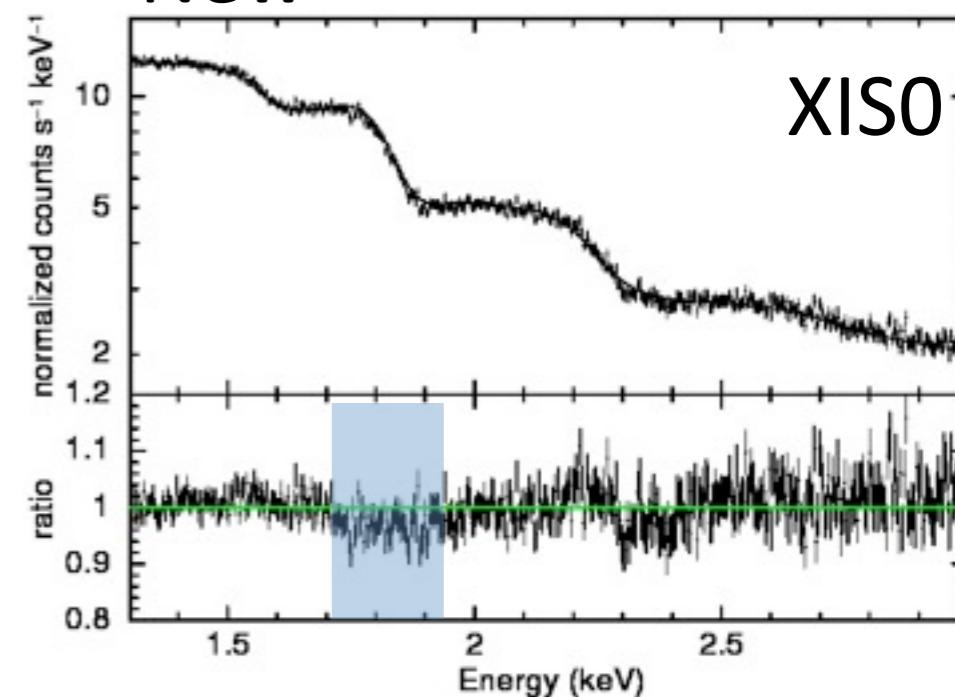
Quantum Efficiency (QE)



Current ver.



New



XIS Status - Summary



- 2.8 out of 4 detectors are operating normally
- charge injection change, Si edge modeling have **greatly** improved performance and calibration
- OBF contamination is the most pressing calibration issue

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 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-B Earth, which emits field-filling O and N emission lines.

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 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 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	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	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 ¹⁾	12	48	96	48	1.3	1.9	7.1	96	1.9	3.2	7.1	1.9	1.5	10 ⁷
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 ⁵⁶Fe 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://space.mit.edu/XIS/monitor>

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