The *Suzaku*/XIS: Calibration Status

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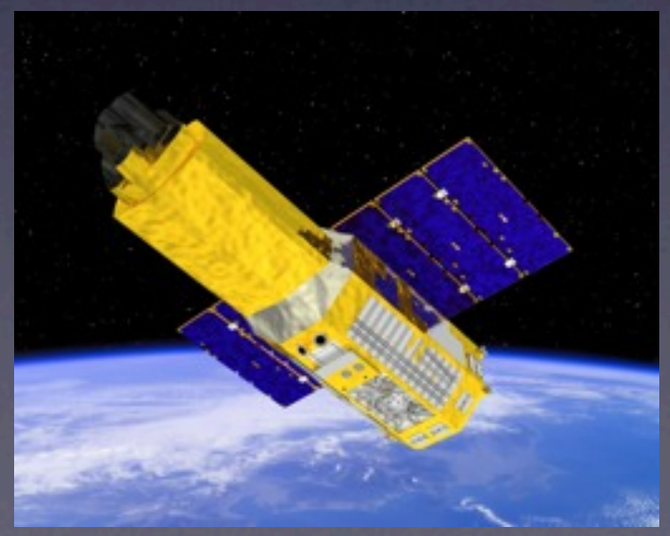
Masayoshi Nobukawa (Kyoto University)

for the *Suzaku*/XIS Team

7th IACHEC Meeting, Napa, 2012

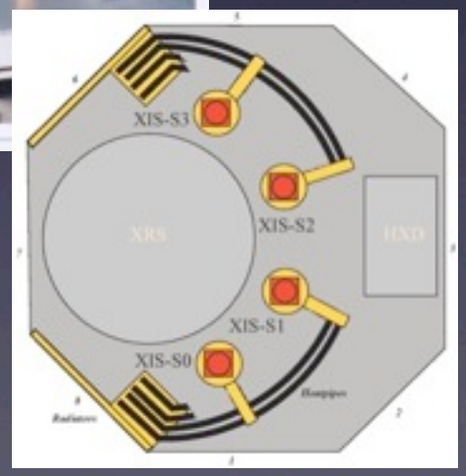


Outline

- 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



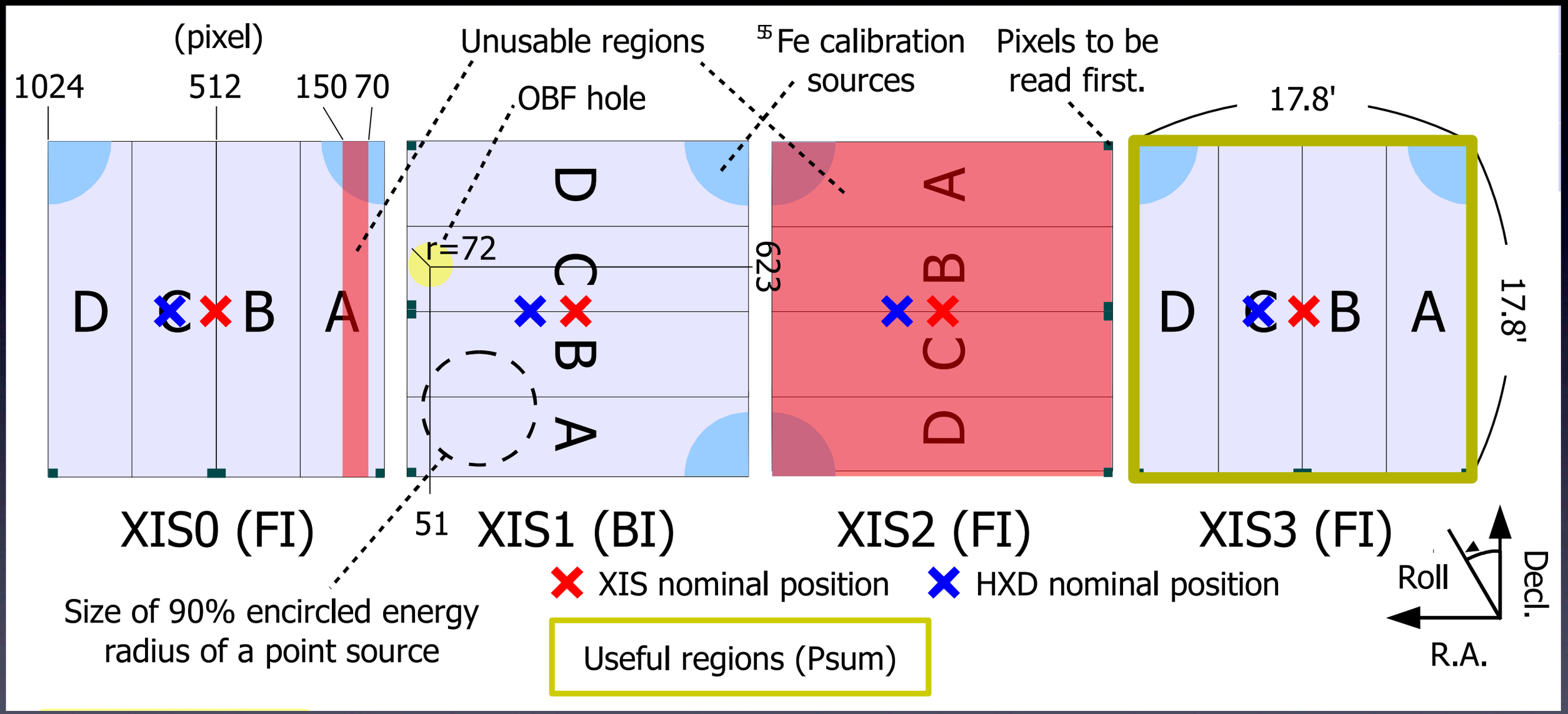
Field of view	17.8' x 17.8'
Energy range	0.2-12 keV
Energy resolution	~180 eV @6keV
Effective area	340 (FI)/390 (BI) cm^2 @1.5keV
Time resolution	8 s (Normal) - 7.8 ms (Psum)

from Tsujimoto's "pocket guide"

Major XIS Events

2005 July 10	launch of *Suzaku*
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

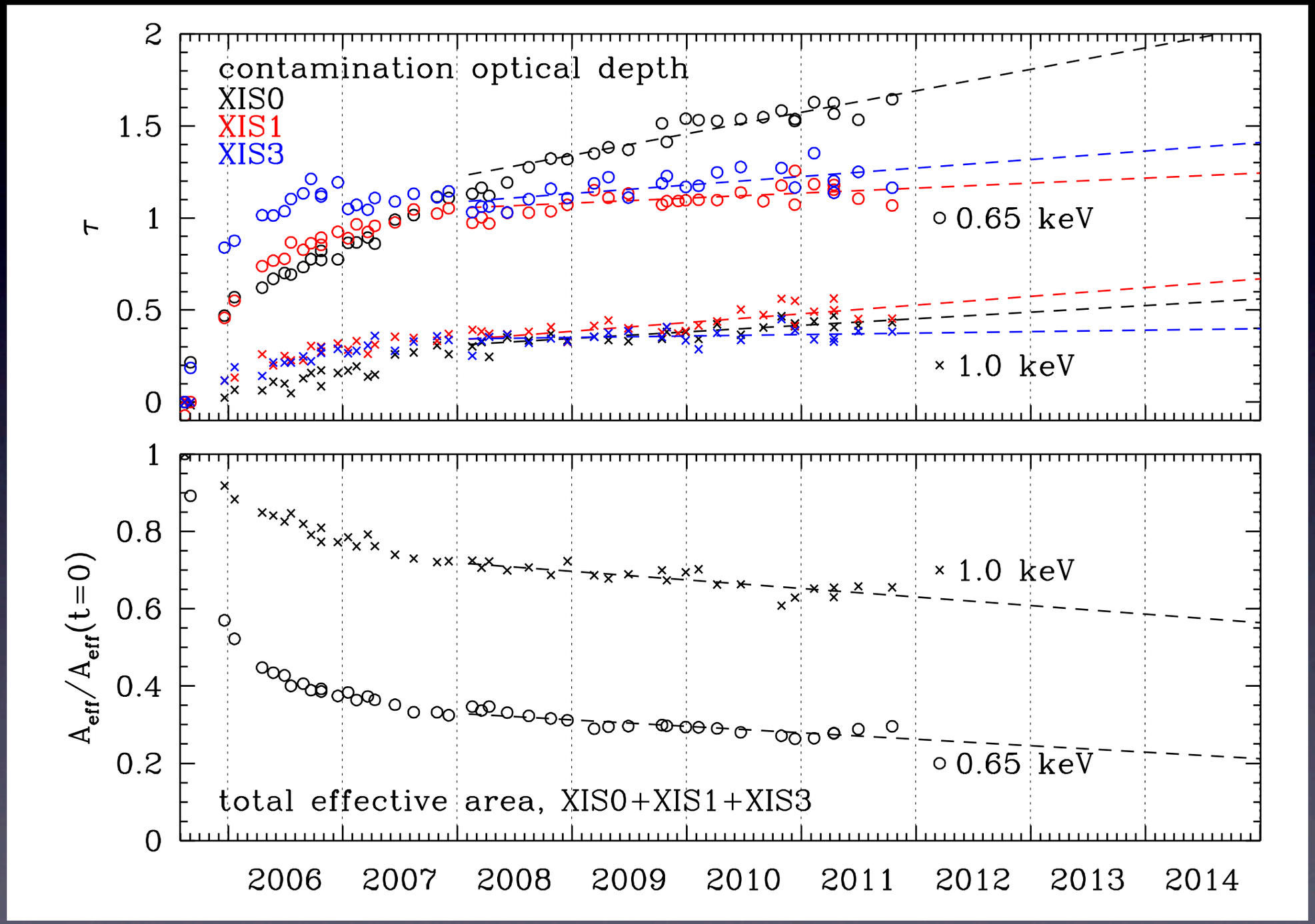
XIS Status



from Tsujimoto's "pocket guide"

Molecular OBF Contamination

Effective Area Tracking

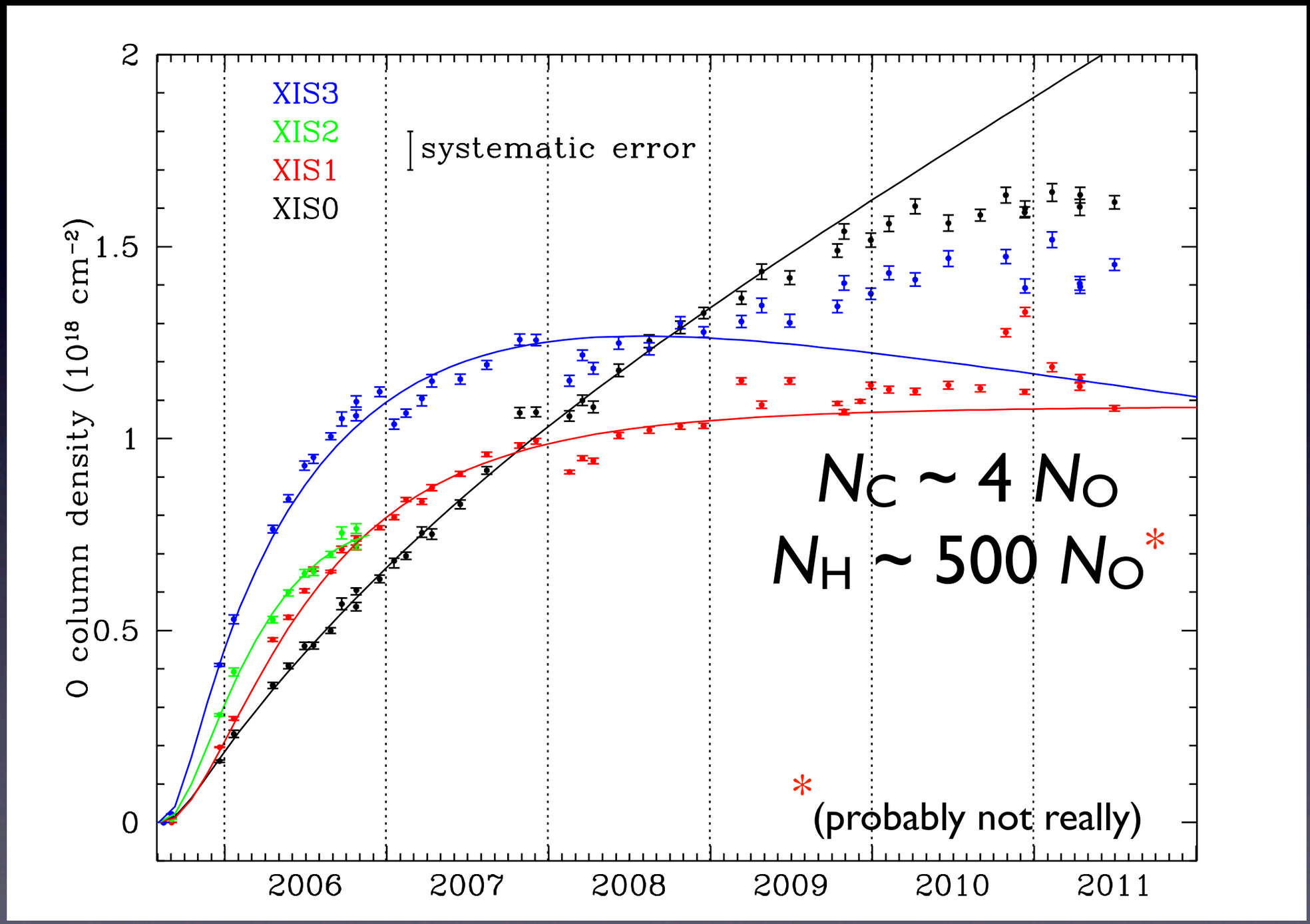


from E0102

Contamination Model

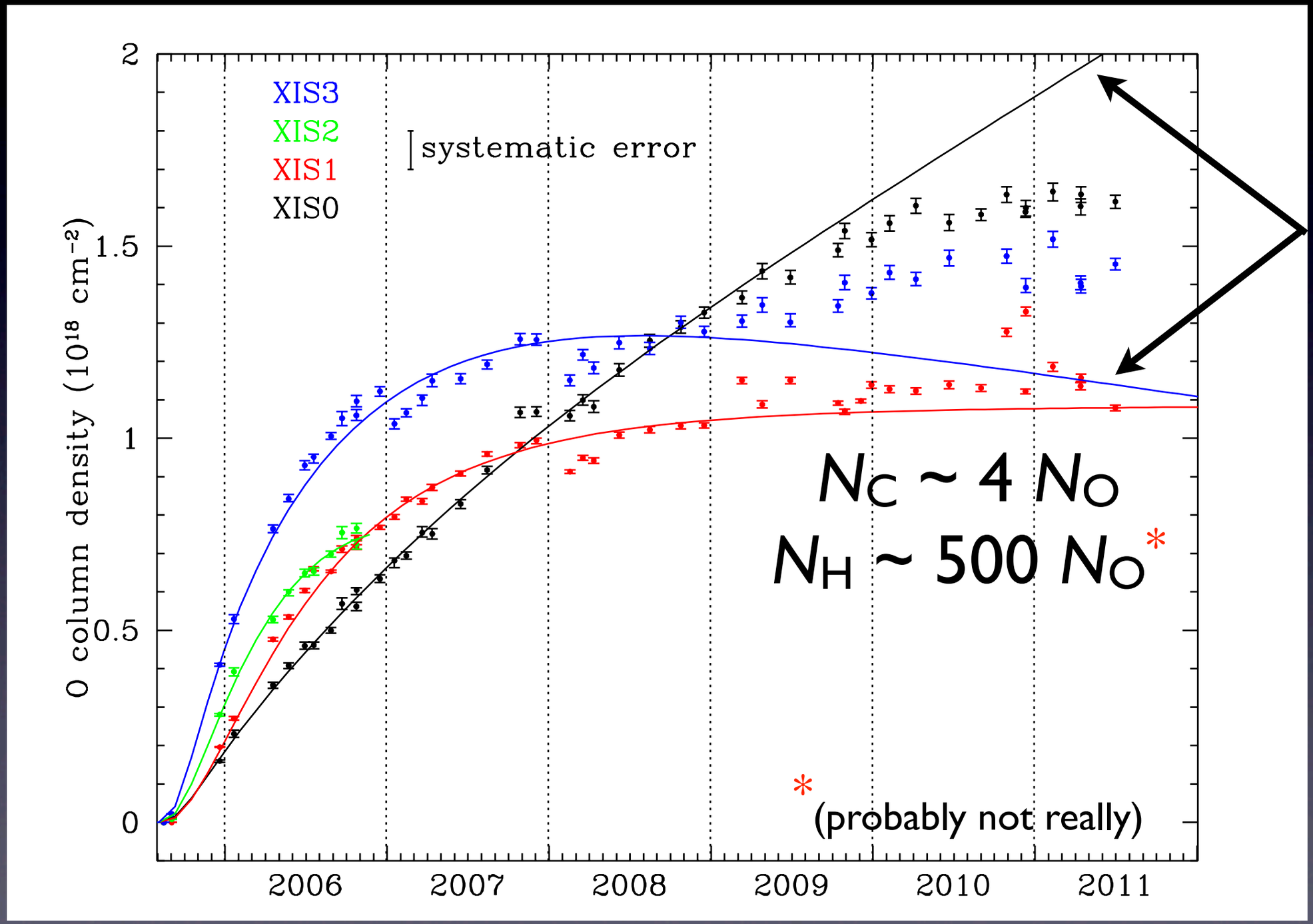
- current model - H,C,O
  - composition from RXJ1856
  - time-dependence from E0102
  - spatial dependence from bright Earth, Cygnus Loop
- new model - H,C,N,O
  - composition, time dependence from E0102, RXJ1856, PKS2155
  - spatial dependence TBD
  - improve trend and improve composition

(Current) Contamination Model



from E0102

(Current) Contamination Model

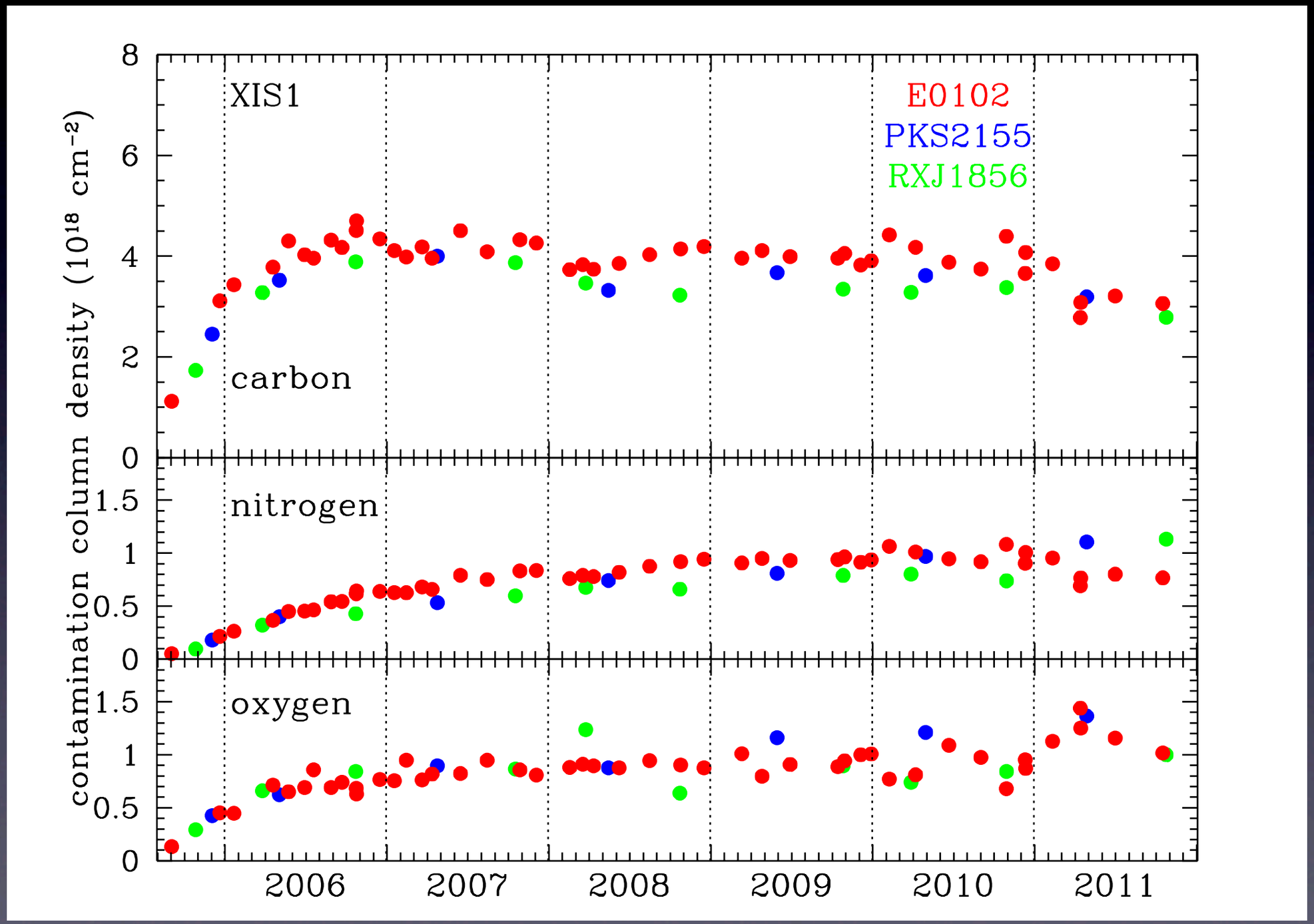


oops

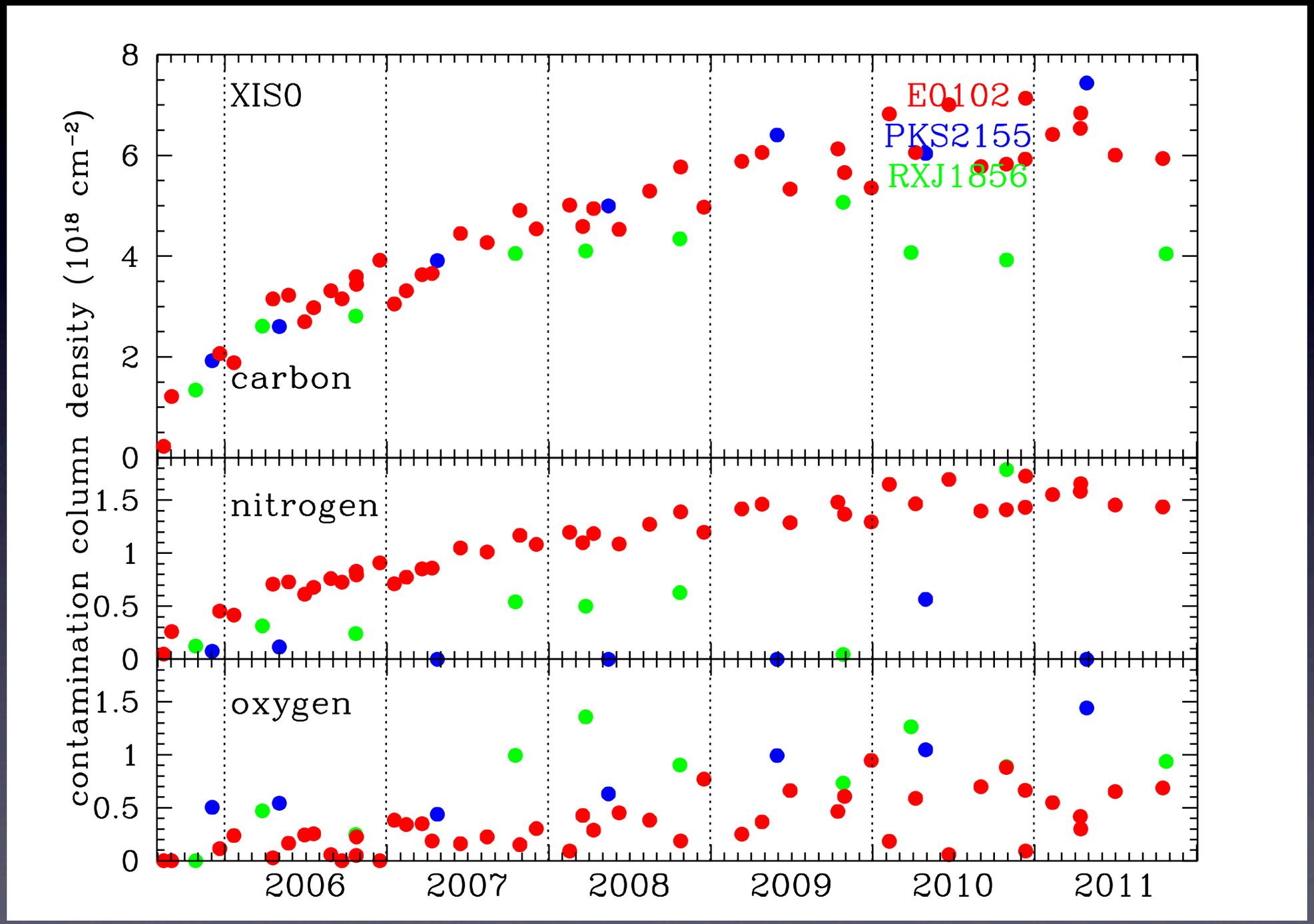
IACHEC 2012 - *Suzaku*/XIS

from E0102

(New) Contamination Model



(New) Contamination Model



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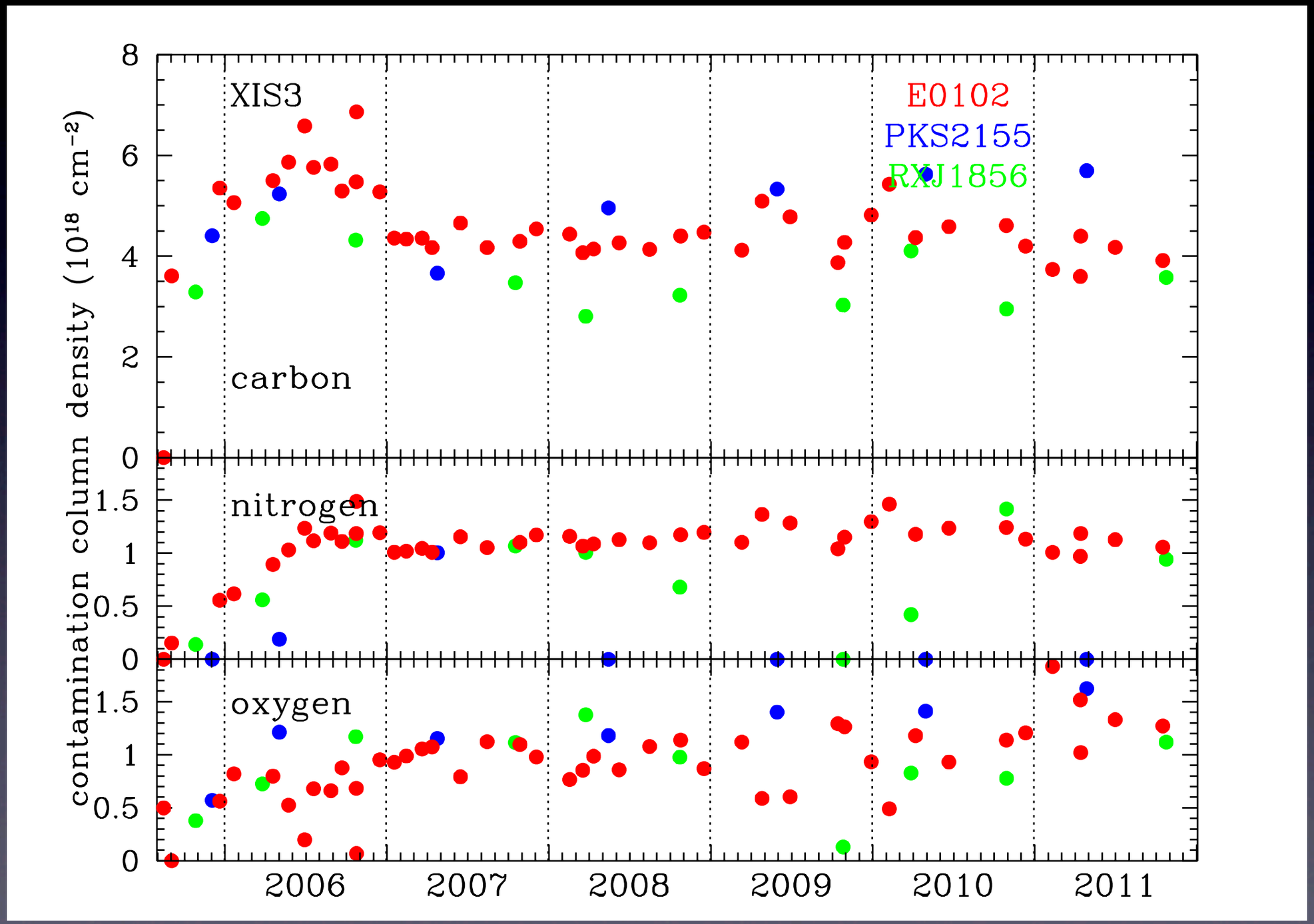

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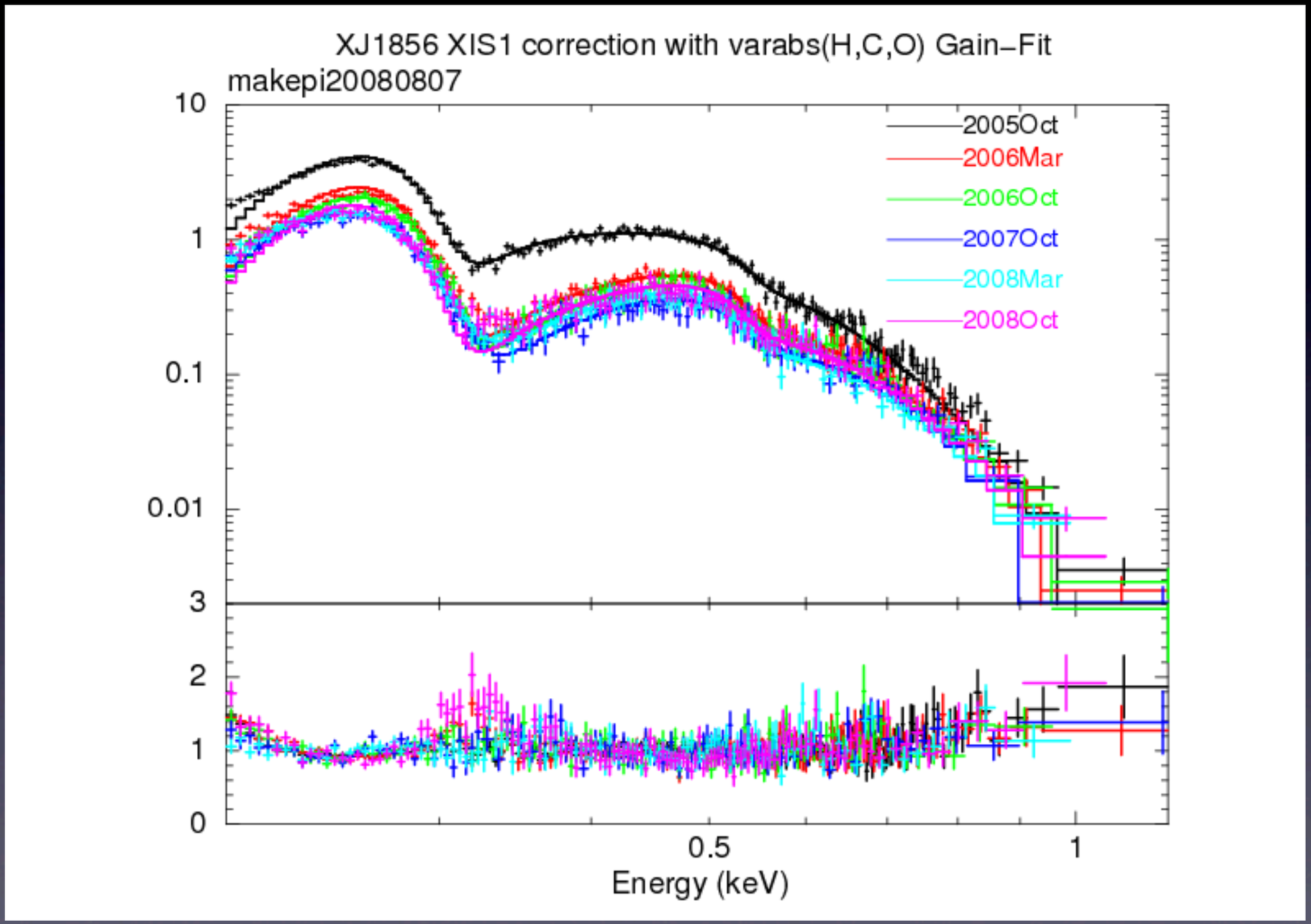
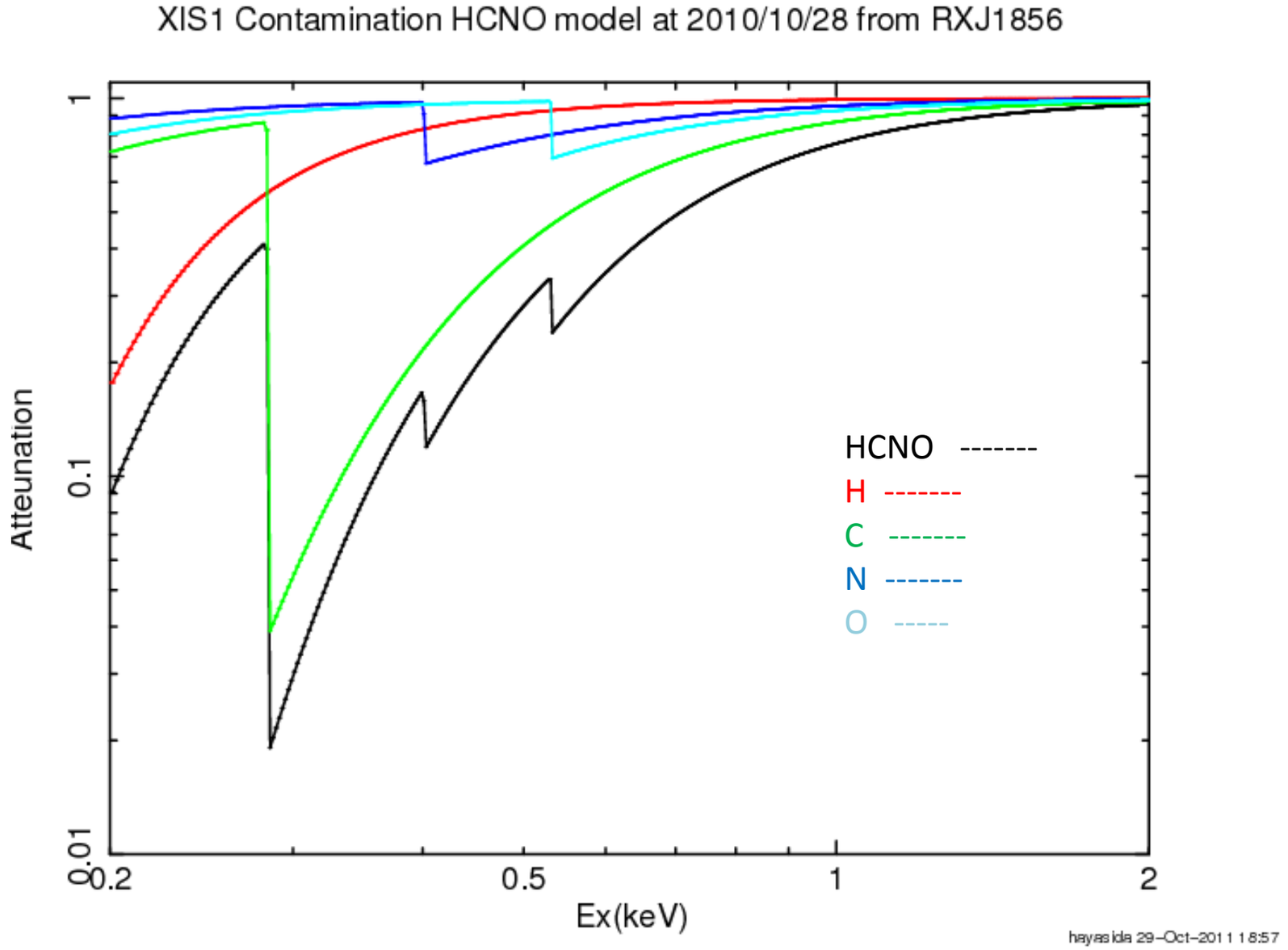
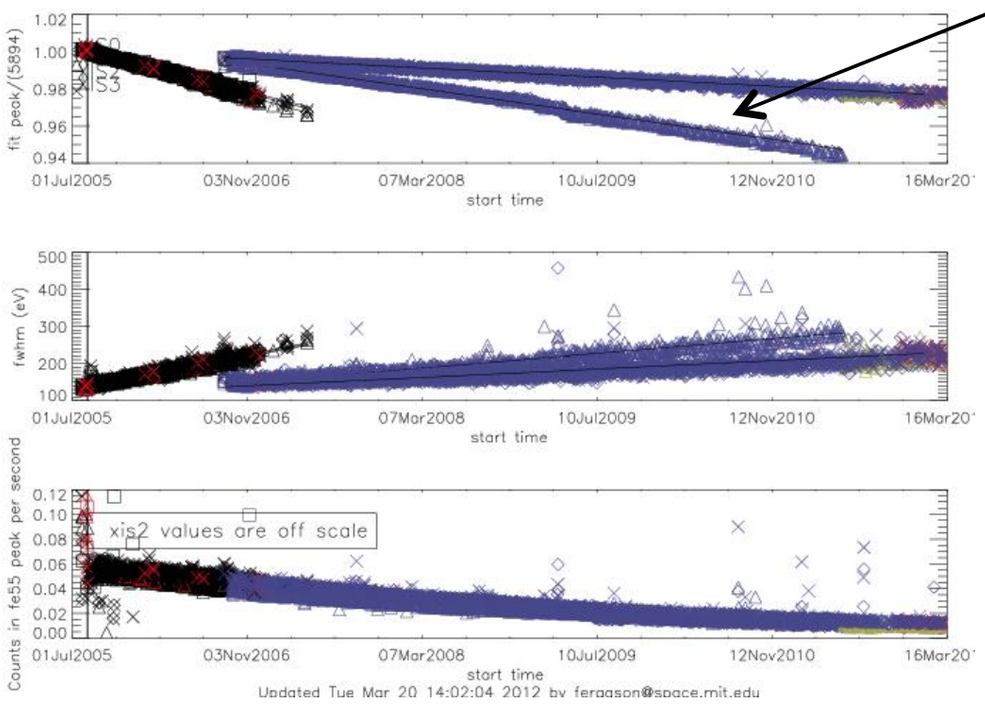


(New) Contamination Model

XIS1

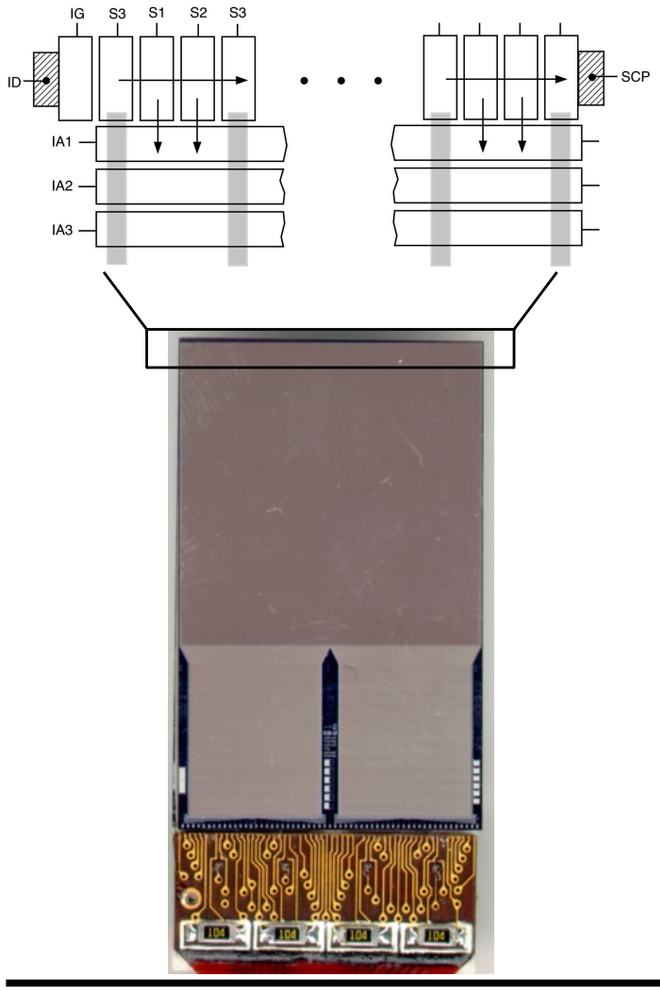


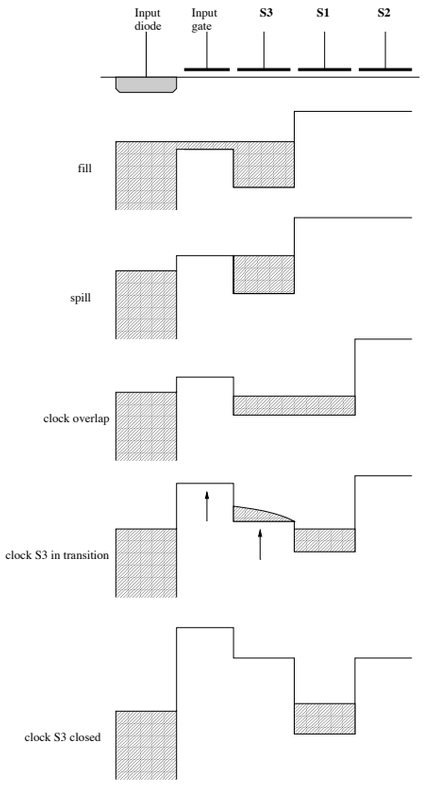
XIS1 Charge Injection Increase

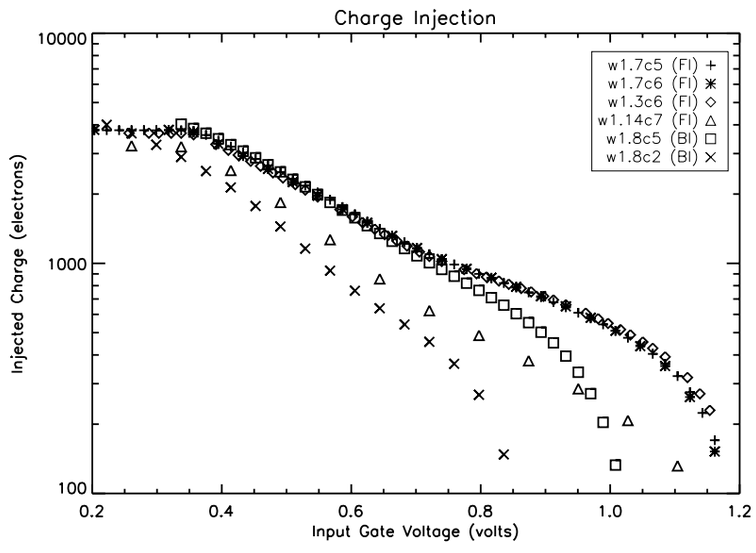


- Since spaced row charge injection was implemented on board, the BI gain has evolved faster than the FI gains.
- The original BI injected charge level was below the FI level.

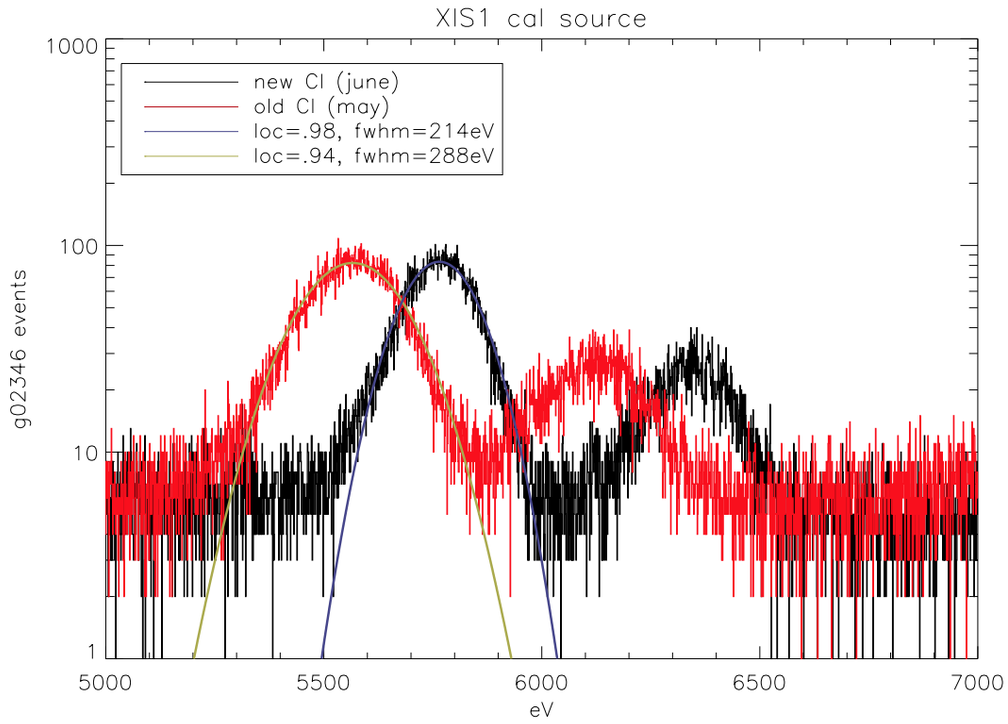
XIS Charge Injection





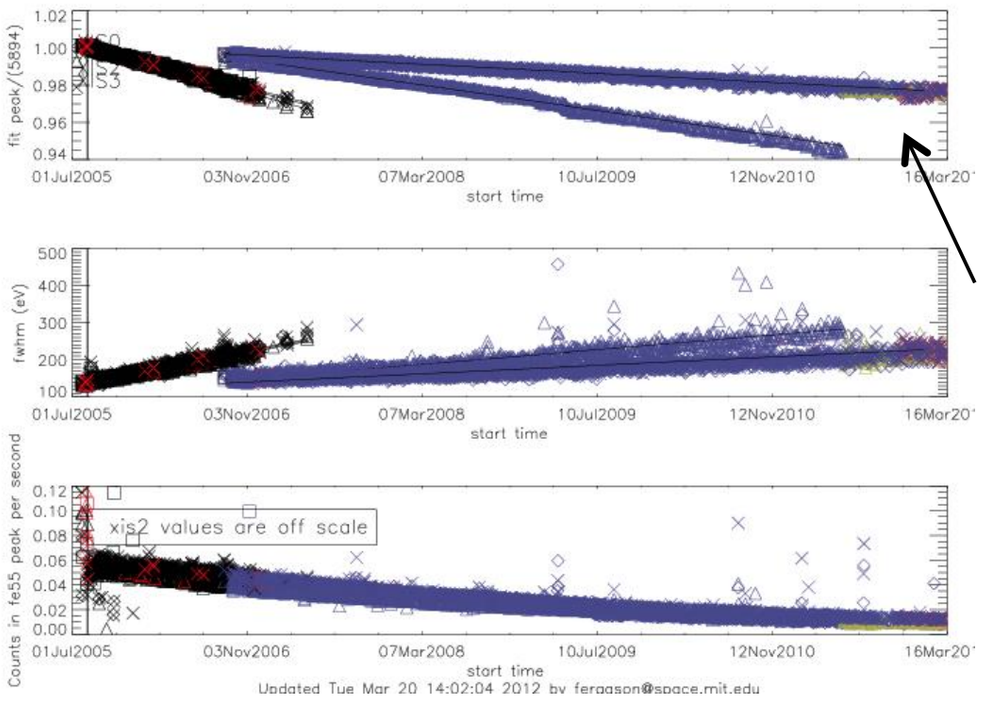


High Energy Response Improves



- 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

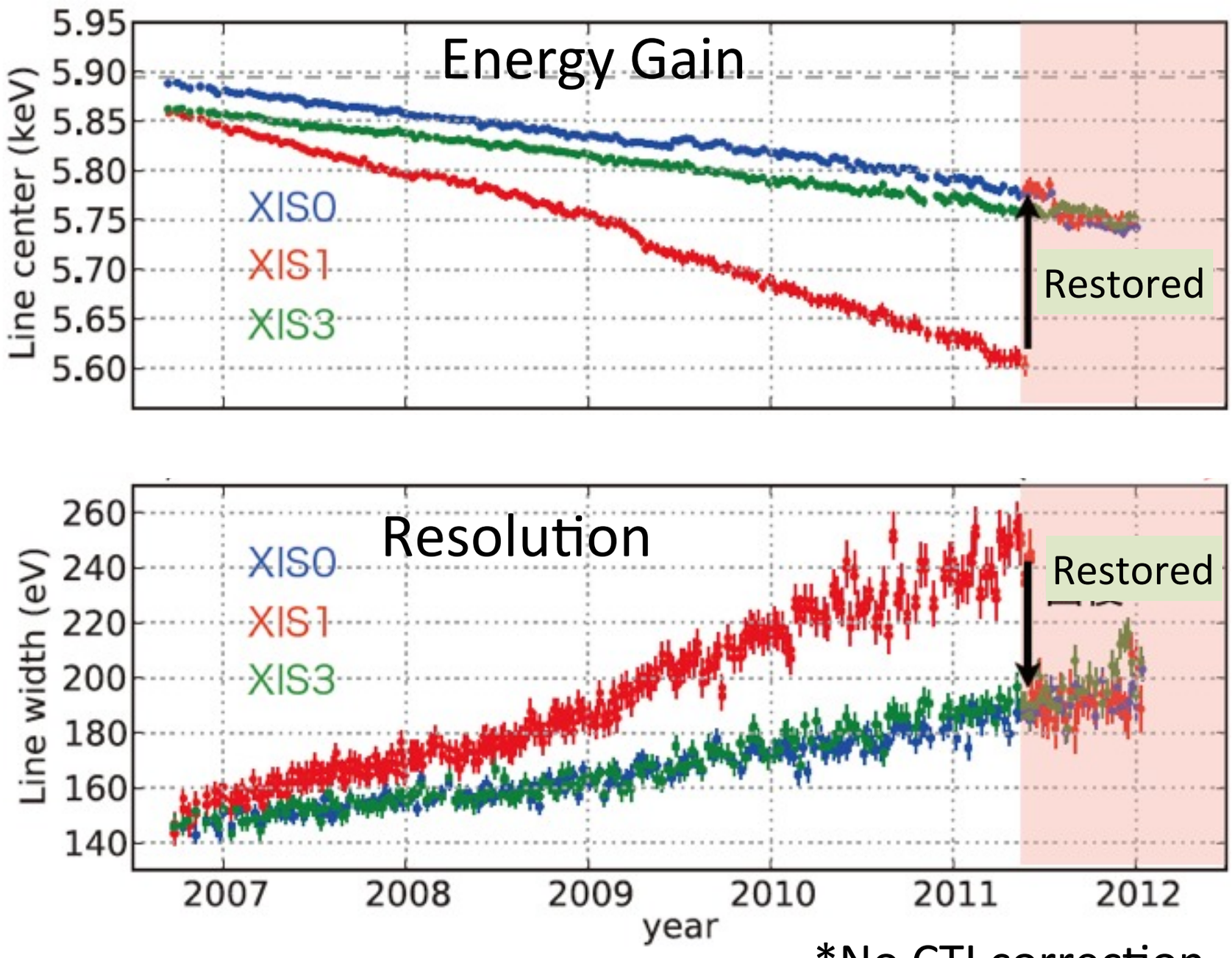
IACHEC2012, Napa, San Francisco

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 ⇔ 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.

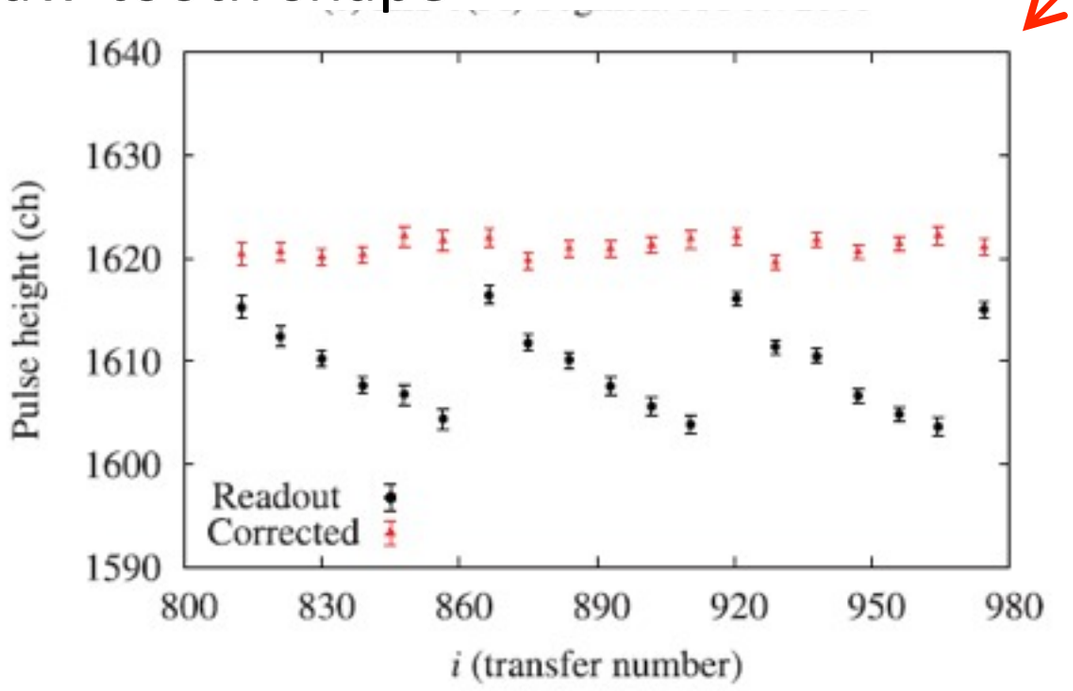


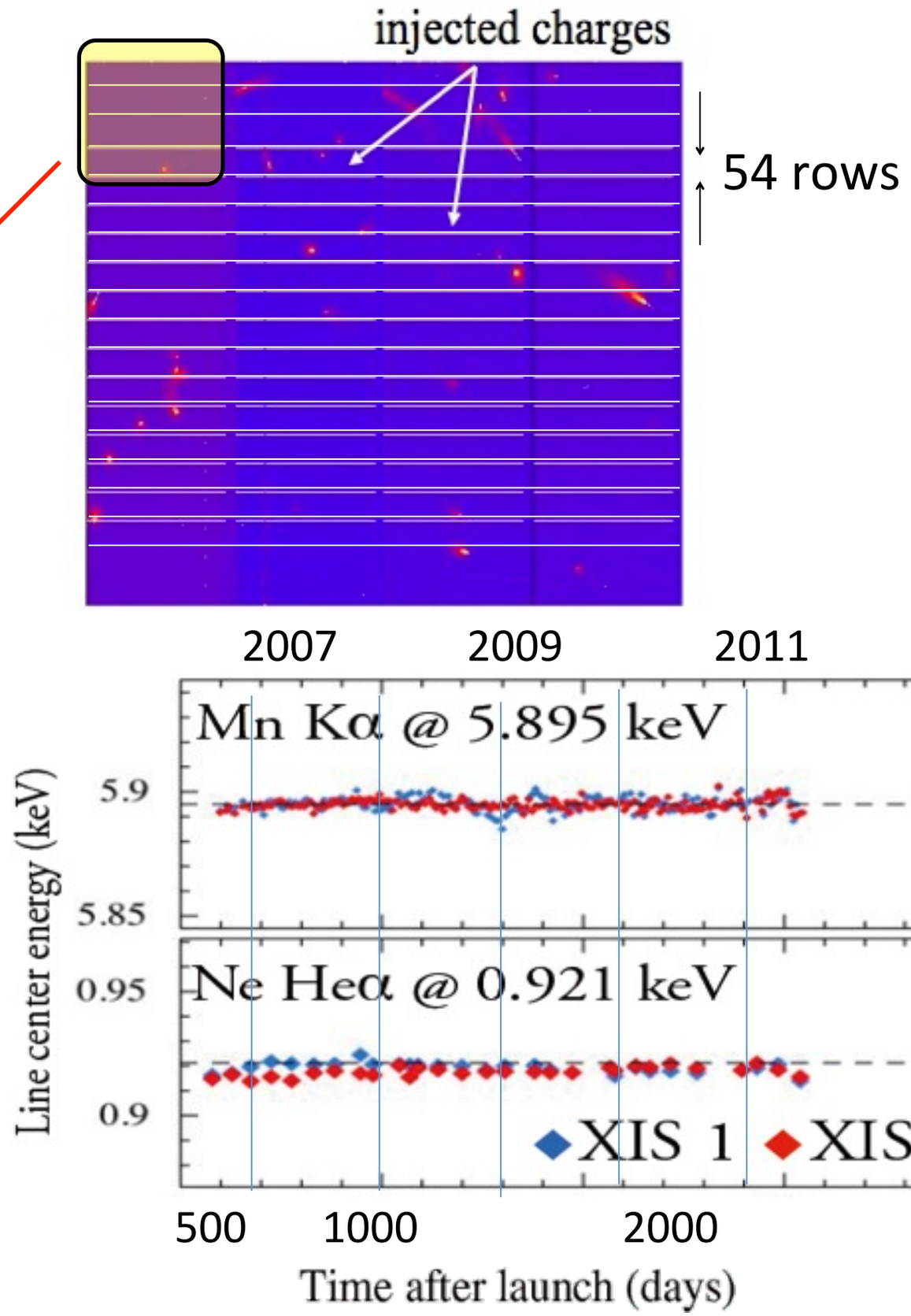
*No CTI correction

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

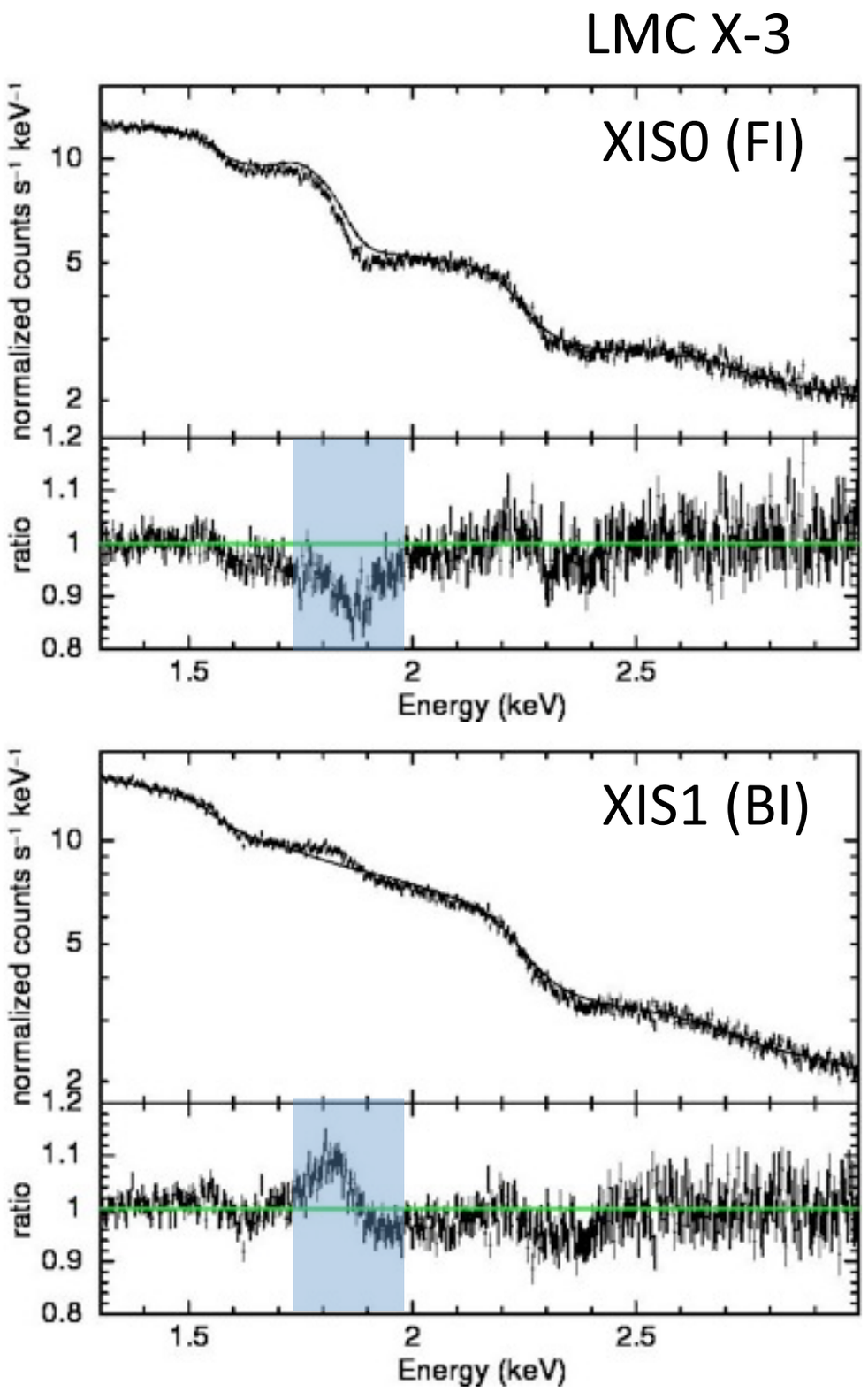
Modification of RMF for Si-edge Problem

- ~10% Residuals at ~1.84 keV (Si-edge)
- Negative/Positive for FI/BI

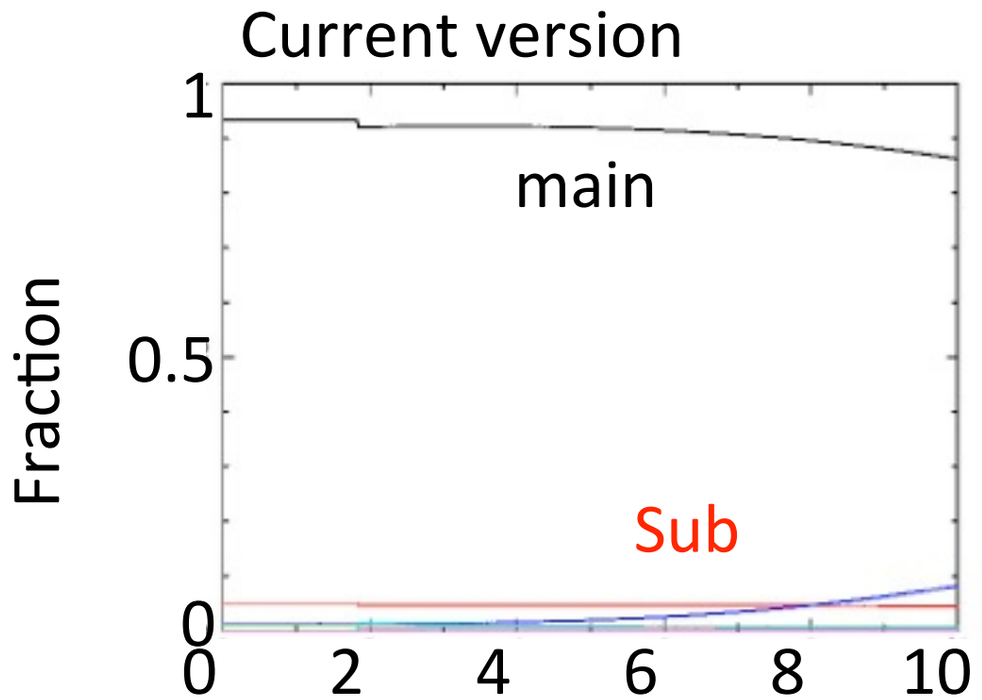
- We have tried to modify the Si-edge problem by various treatments
  - Neutral Si-K line
  - Energy resolution

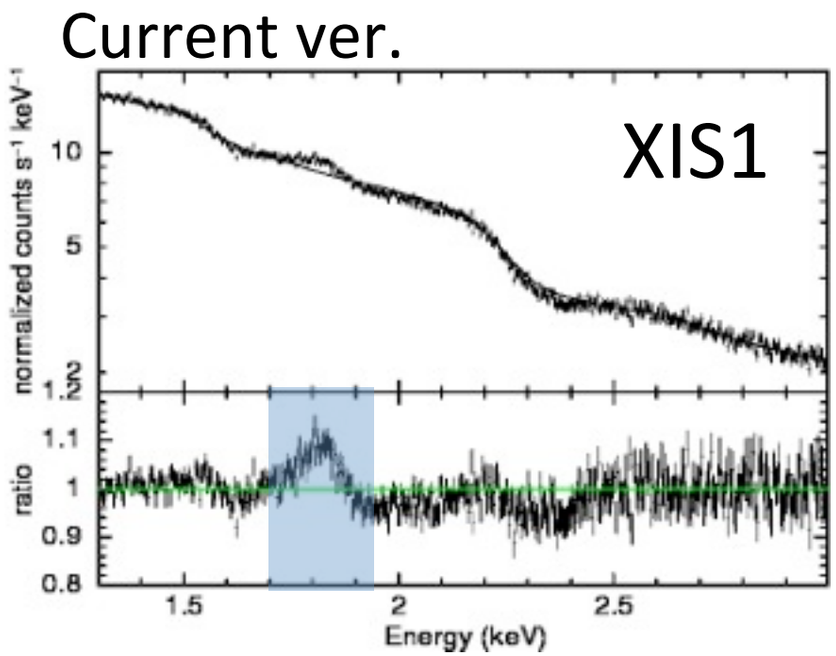
  => Unfortunately failed

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



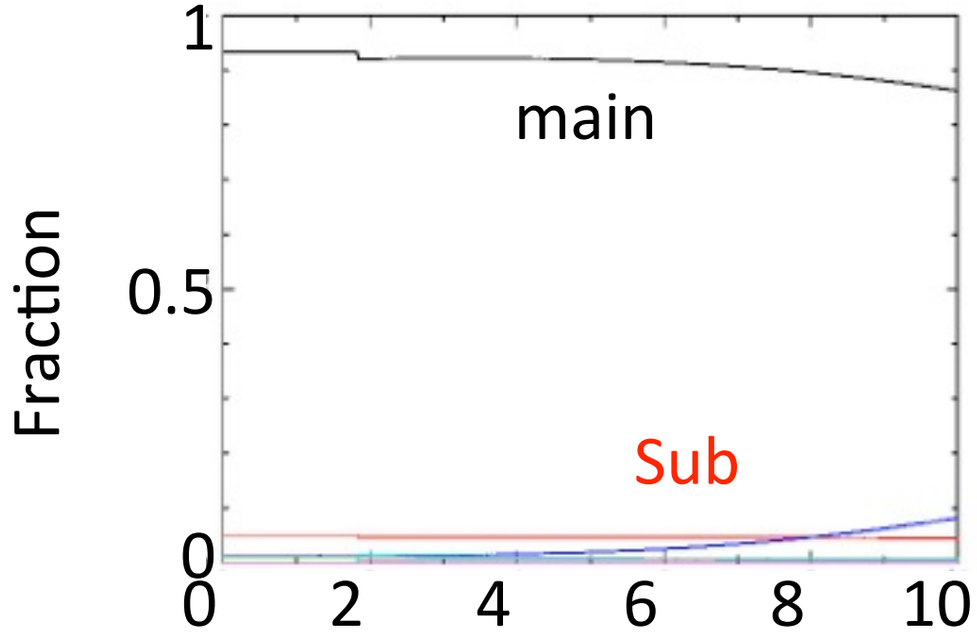
BI: Discontinuous function of Sub/Main ratio at Si-edge





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

Current version



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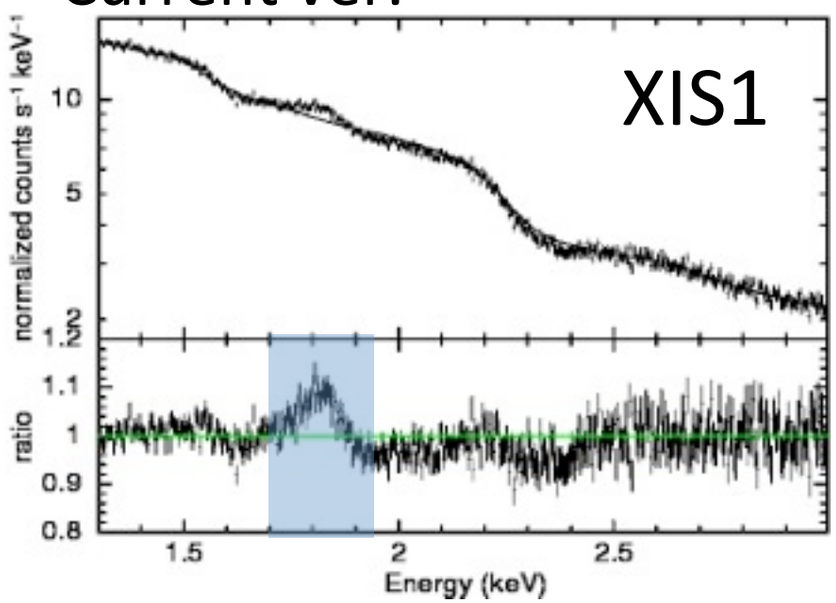
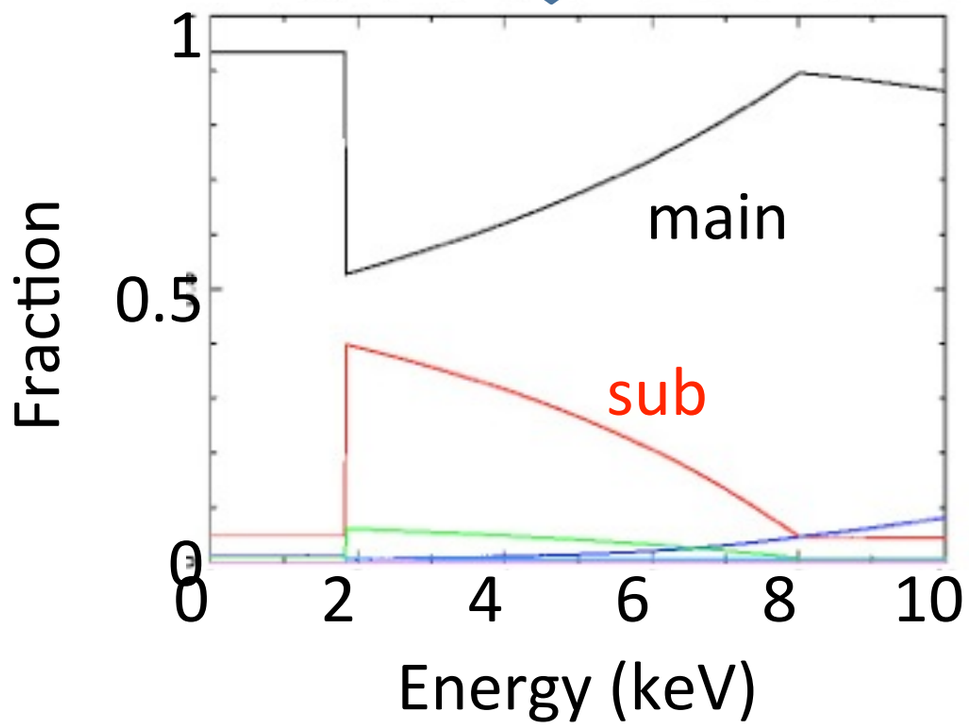


Energy (keV)

New



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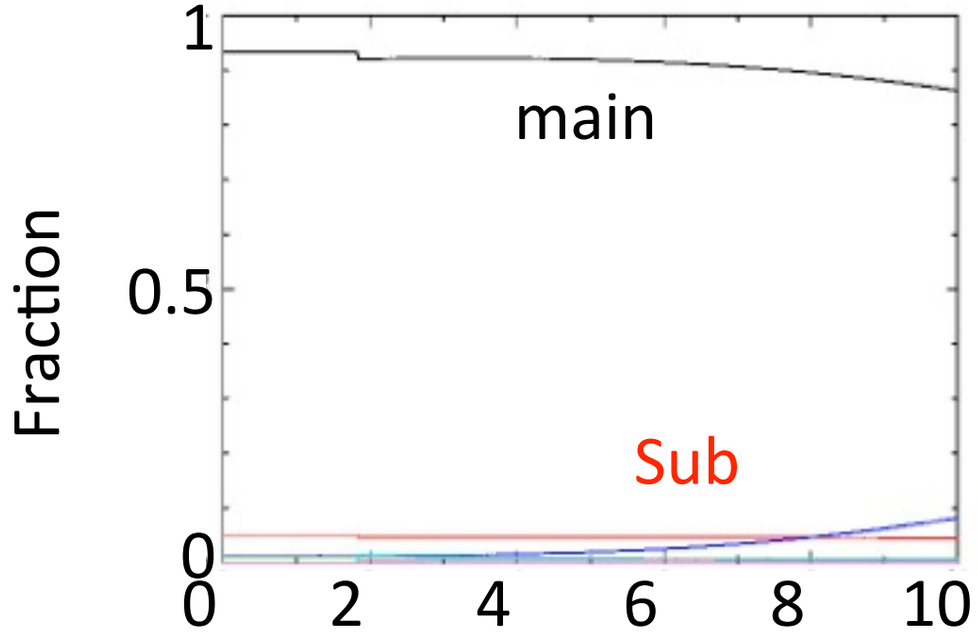

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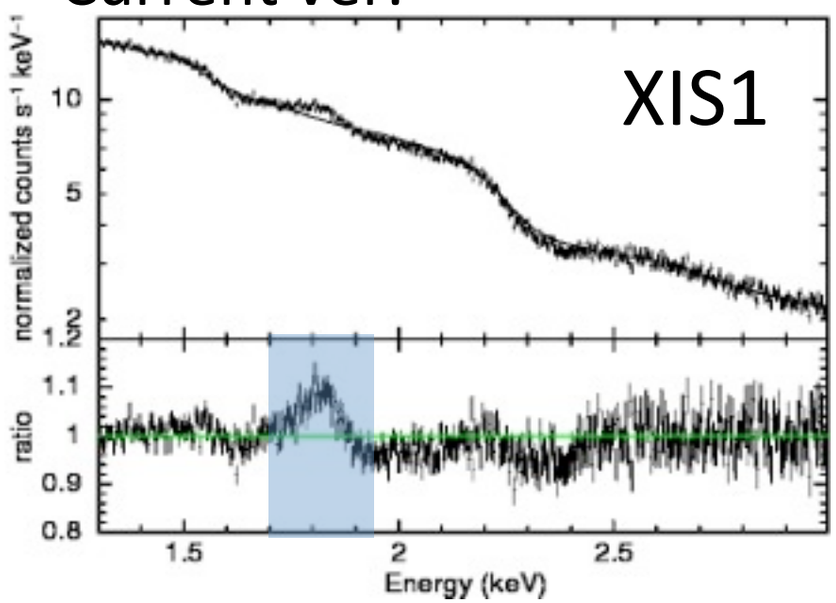
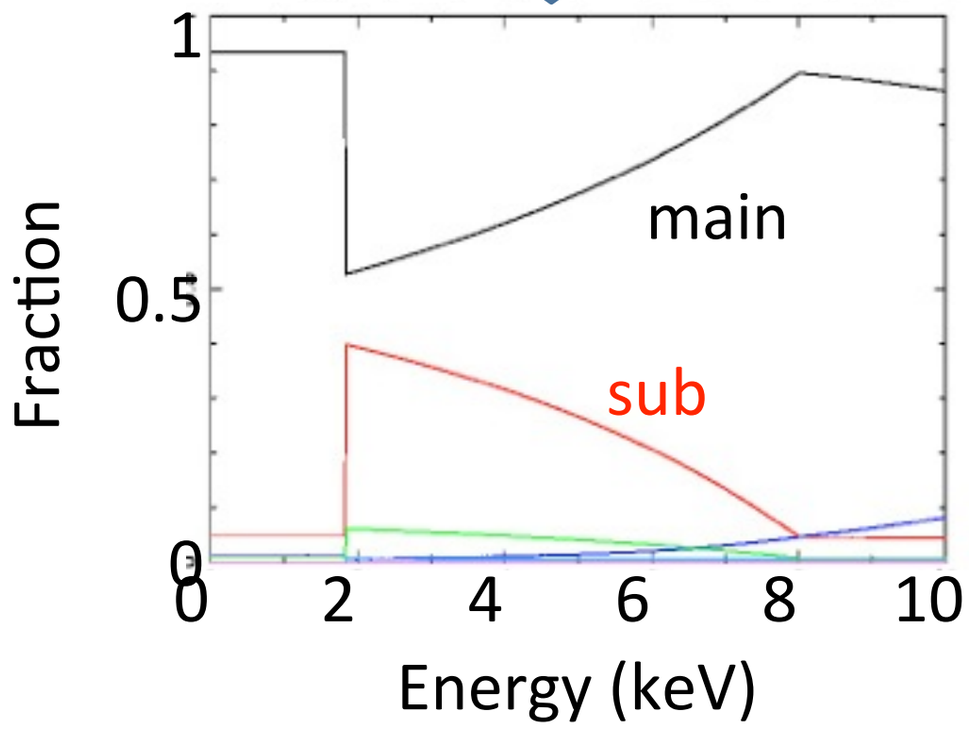
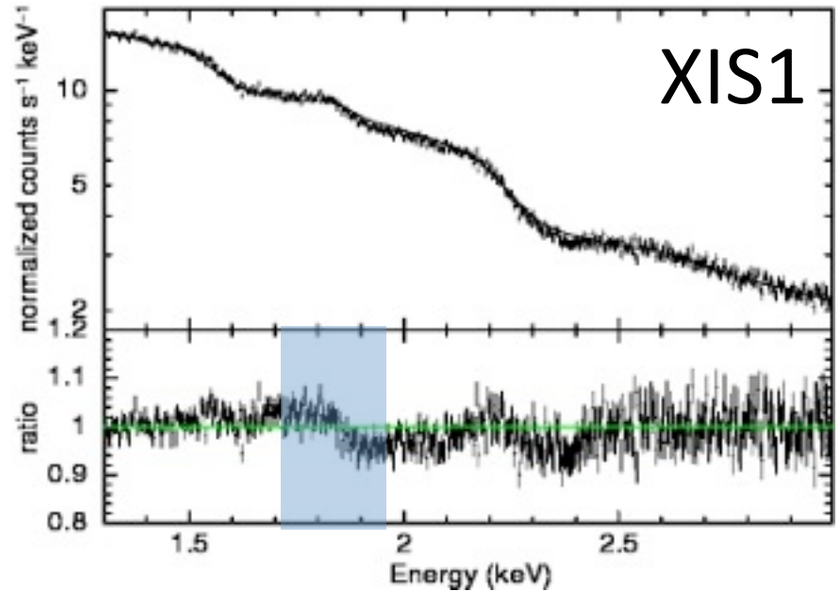


Energy (keV)

New



New

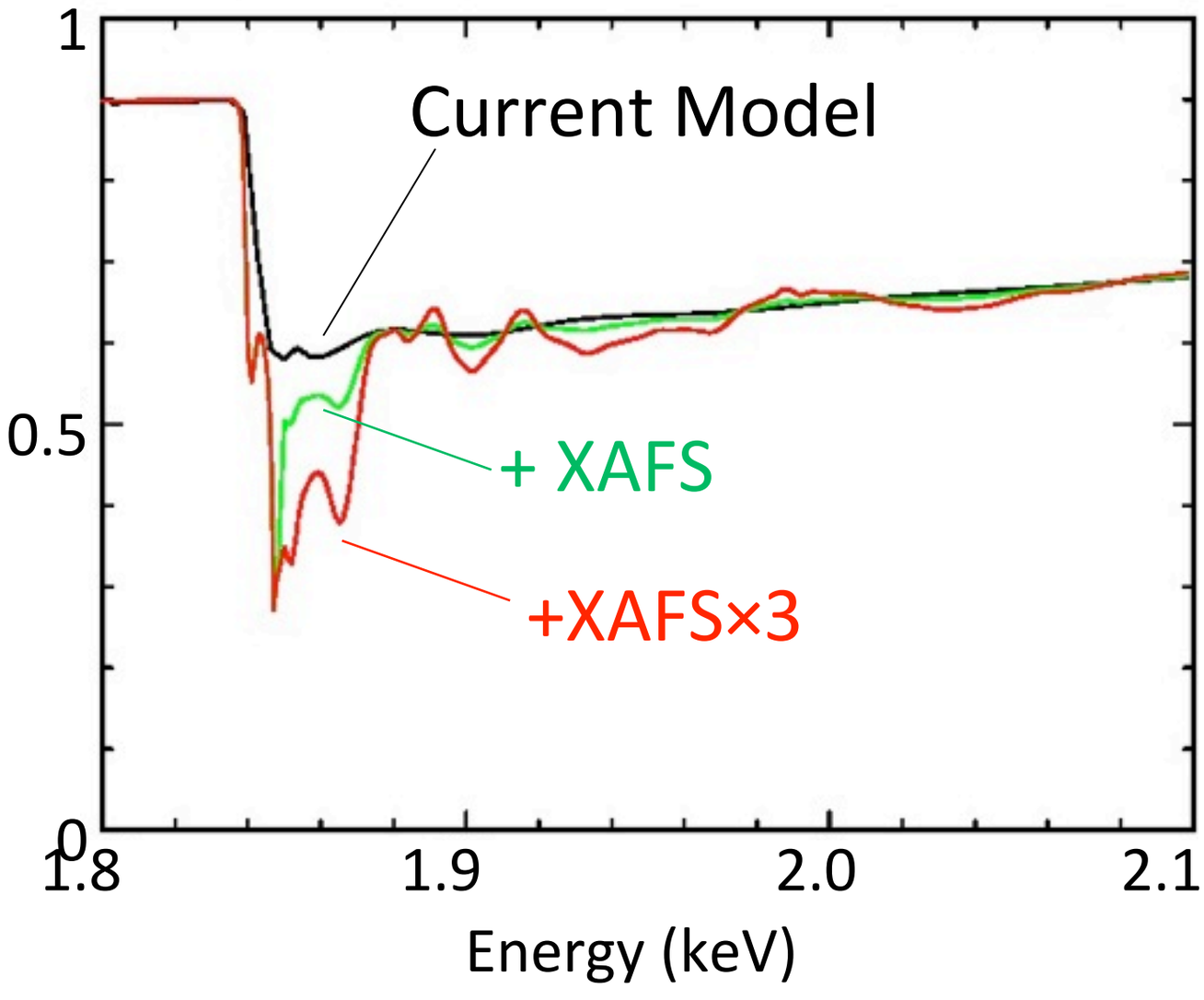


FI: XAFS of Si-edge

- Current QE model does not include XAFS.
- New model: XAFS => XAFS×3

  The residuals are significantly modified.

Quantum Efficiency (QE)



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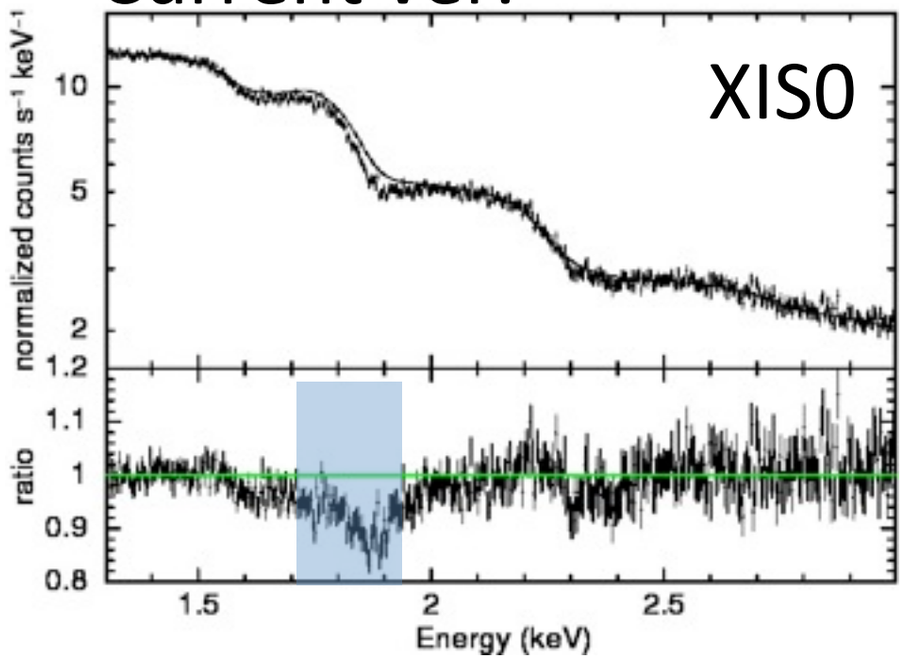

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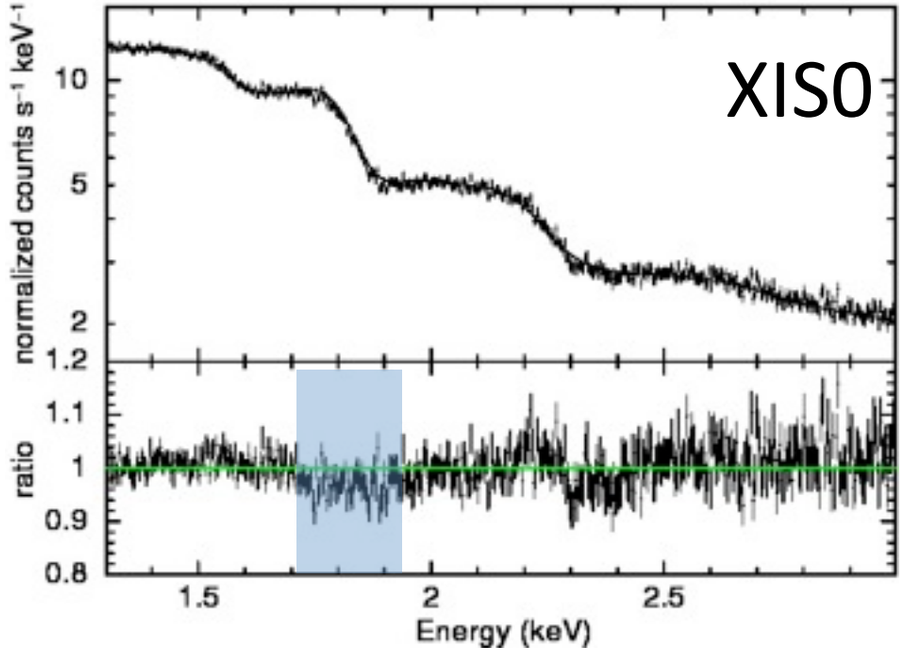
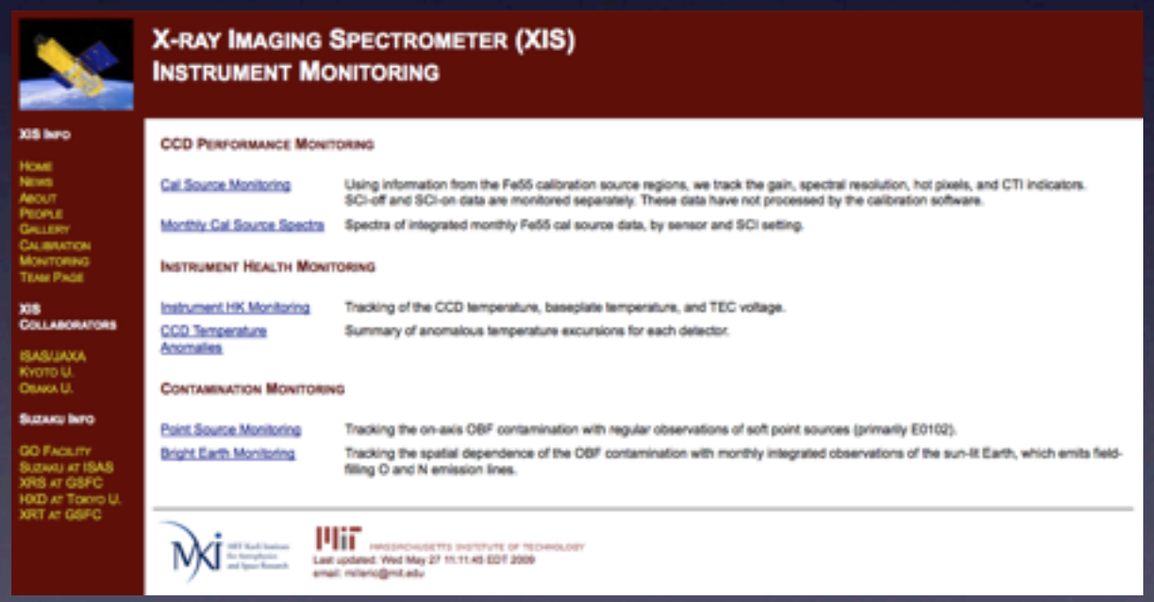
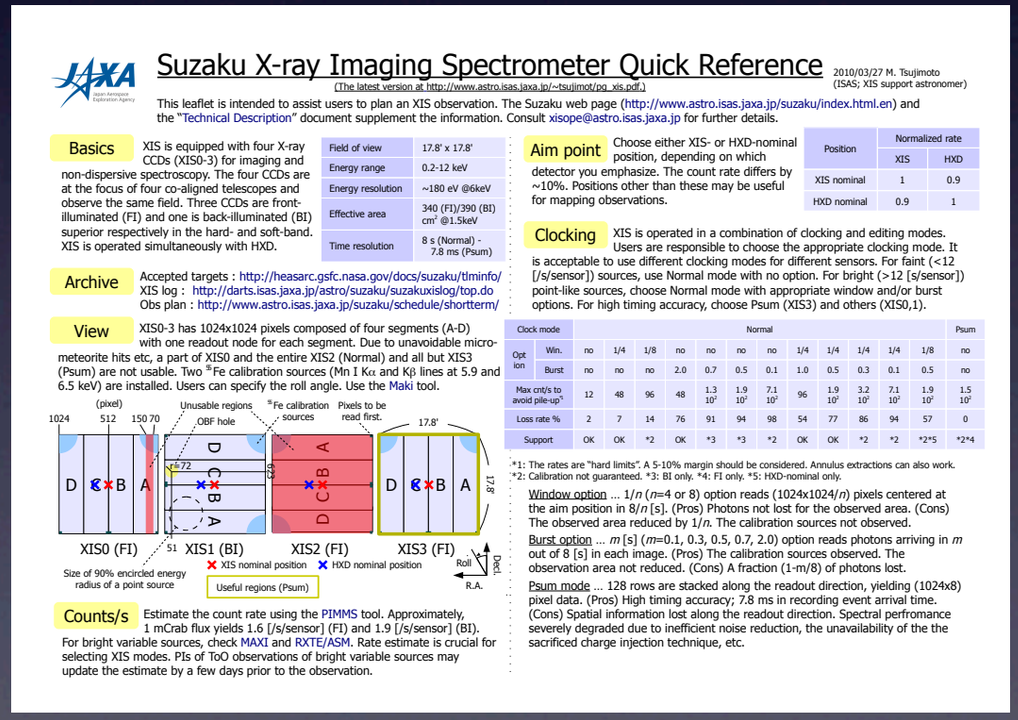


XIS Status - Summary

- 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





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

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