The *Suzaku*/XIS: Status Report

Eric Miller
MIT Kavli Institute

for the *Suzaku*/XIS Team

Outline

- instrument health and status

  - anomalies since the last SUG meeting

  - gain and effective area tracking

- calibration status

  - normal, window, burst, timing modes

  - specific issues

- contamination

- pile-up

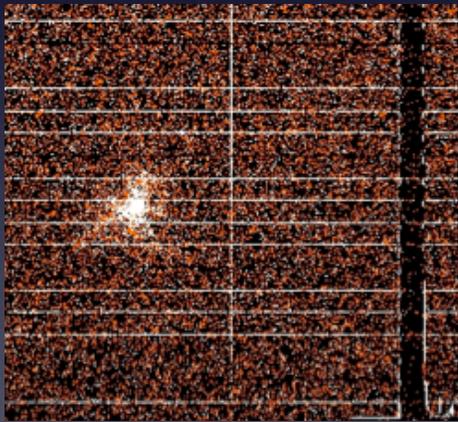- runaway CLEANSIS problem

Major XIS Events

Jul. 10, 2005	Launch of Suzaku
Aug. 12-3, 2005	XIS door open. Start of observations
Jan. 18, 2006	Software update
Oct., 2006	Start of regular usage of SCI.
Nov. 9, 2006	Anomaly (μ meteorite?) in XIS2. Most of the image area is affected. We stopped using XIS2.
Dec. 8, 2007	XIS0 pixel processor (PPU) temporary hung-up due to particle event.
Jan. 30, 2008	Trouble in a CPU board of the Main Processor unit (MPU). We switched to the redundant board.
Jun. 23, 2009	Another μ meteorite hit (?) on XIS0. Only ~1/8 image area is affected.

Dec. 2006
Kyoto

Dec. 2007
Sandiego

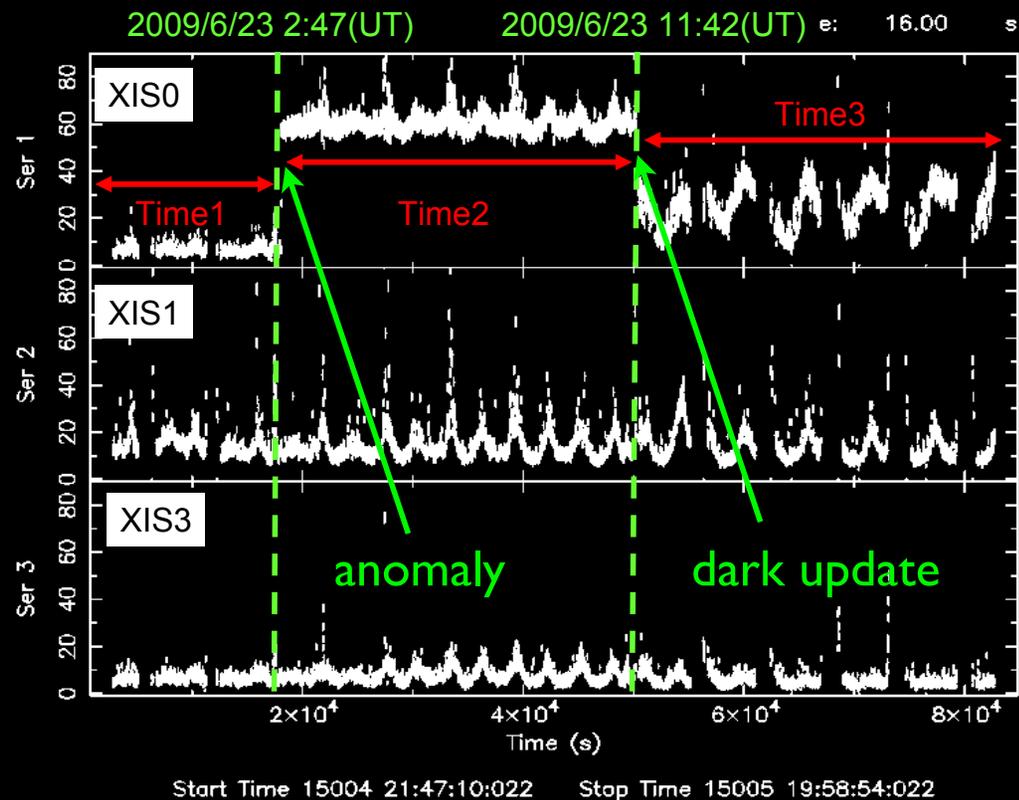Jun-Jul. 2009
Otaru

from Mitsuda-san

XIS0 Anomaly

- occurred 23 June 2009

- sudden increase in event rate

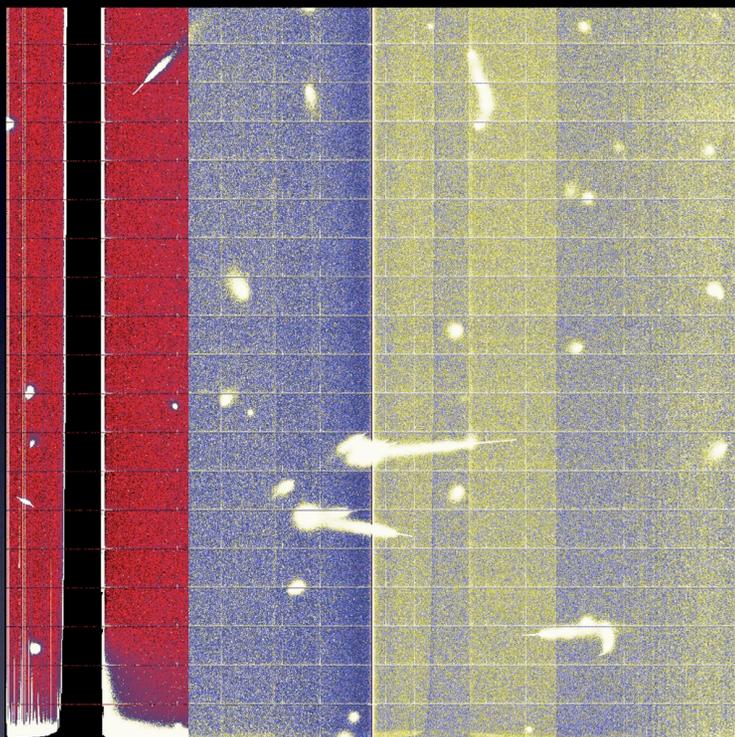 - blanks columns + noisy edges

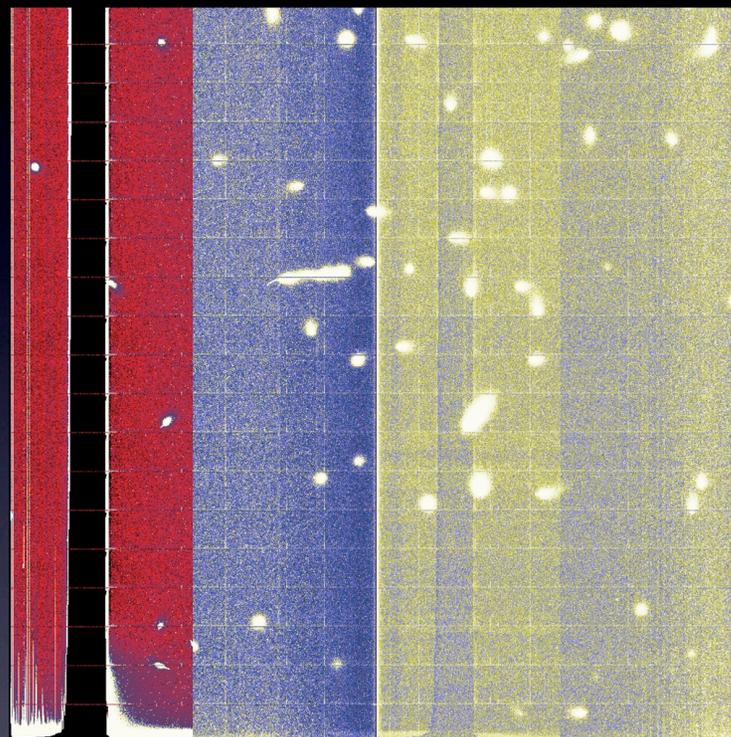Events (all grades), Time 2

DETX 887-944

Count Rate (all grades)

2009/6/23 2:47(UT)   2009/6/23 11:42(UT)   e: 16.00   s

XIS0   Time1   Time2   Time3

XIS1

XIS3   anomaly   dark update

Start Time 15004 21:47:10:022   Stop Time 15005 19:58:54:022

Suzaku Users' Group Meeting 2009 - XIS
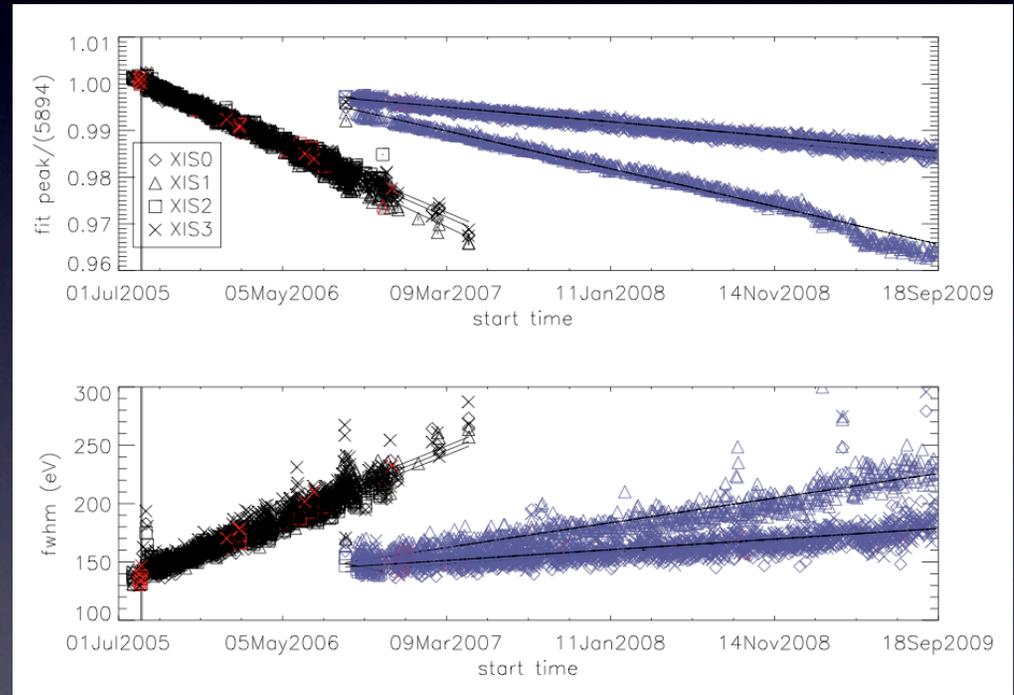
XIS0 Anomaly - Frame Data

SCI on

SCI off
(but sequencer still on)

XIS0 Anomaly

- 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 operating modes

  - burst mode is safe, but perhaps not useful in XIS0

- calibration appears unchanged at XIS aimpoint (seg B,C)
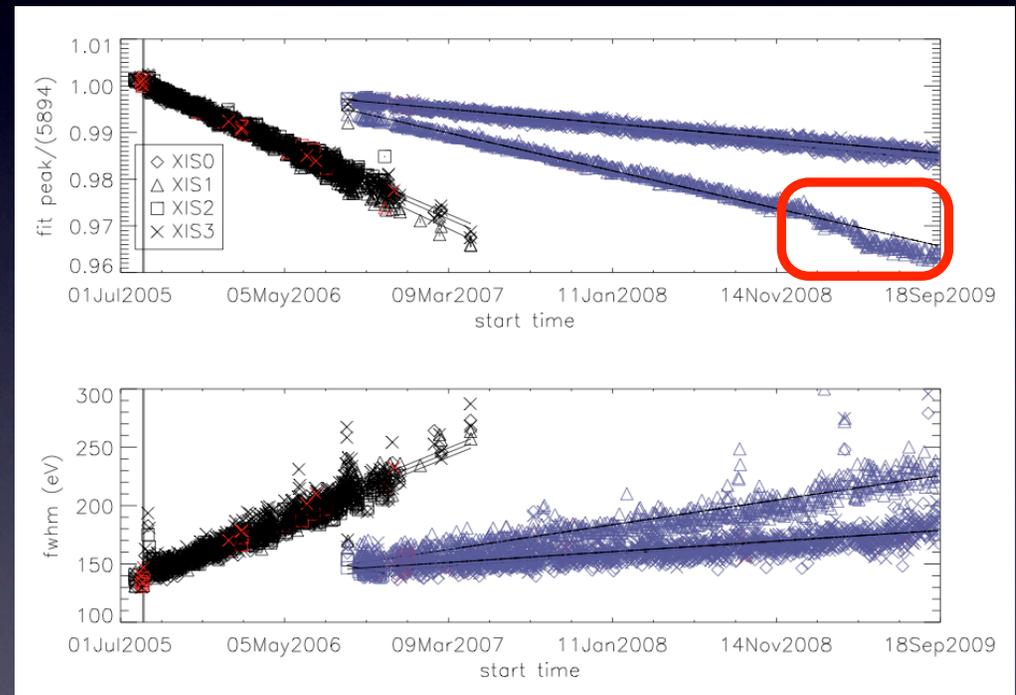
- calibration near segment A edge under study

Gain and FWHM Tracking

- [55]Fe cal sources ➙ Mn Kα, Kβ
  raw data, no CTI correction

- gain change
  with SCI on
  (% per yr)
  XIS0 -0.403 ±0.001
  XIS3 -0.372 ±0.001
  XIS1 -0.958 ±0.001

- FWHM change
  with SCI on
  (eV per yr)
  XIS0 12.2 ±0.6
  XIS3 10.8 ±0.4
  XIS1 25.1 ±0.4

Gain and FWHM Tracking

- ^{55}Fe cal sources ➙ Mn Kα, Kβ
  raw data, no CTI correction

- gain change
  with SCI on
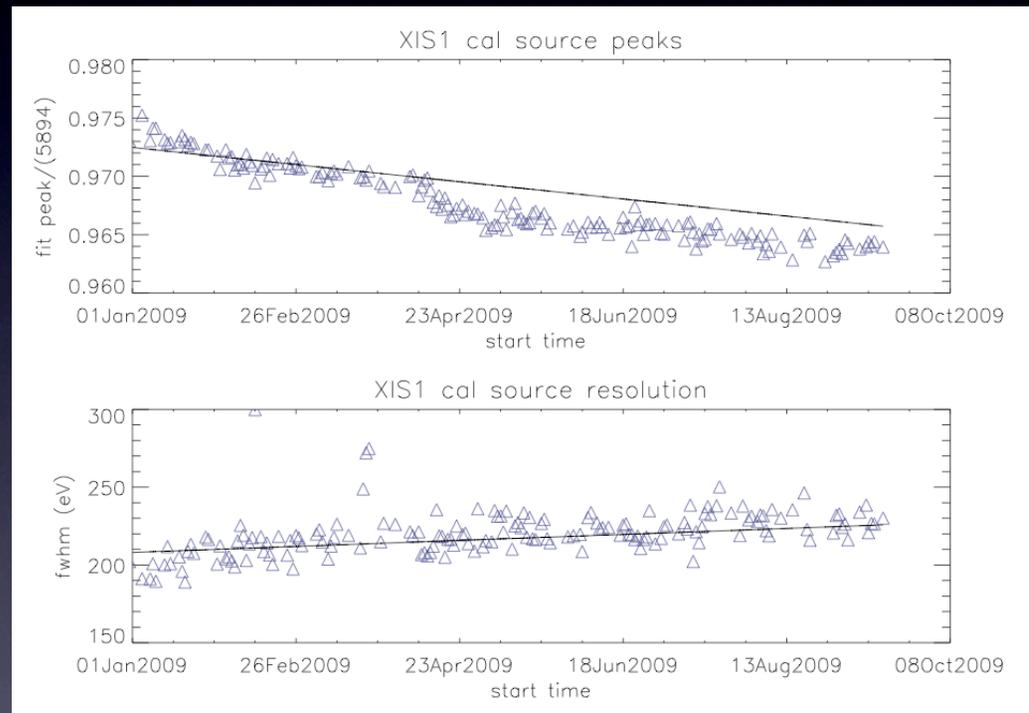 (% per yr)
  XIS0 -0.403 ±0.001
  XIS3 -0.372 ±0.001
  XIS1 -0.958 ±0.001

- FWHM change
  with SCI on
  (eV per yr)
  XIS0 12.2 ±0.6
  XIS3 10.8 ±0.4
  XIS1 25.1 ±0.4

Gain and FWHM Tracking

- ^{55}Fe cal sources ➟ Mn Kα, Kβ
  raw data, no CTI correction

- gain change
  with SCI on
  (% per yr)
  XIS0 -0.403 ±0.001
  XIS3 -0.372 ±0.001
  XIS1 -0.958 ±0.001
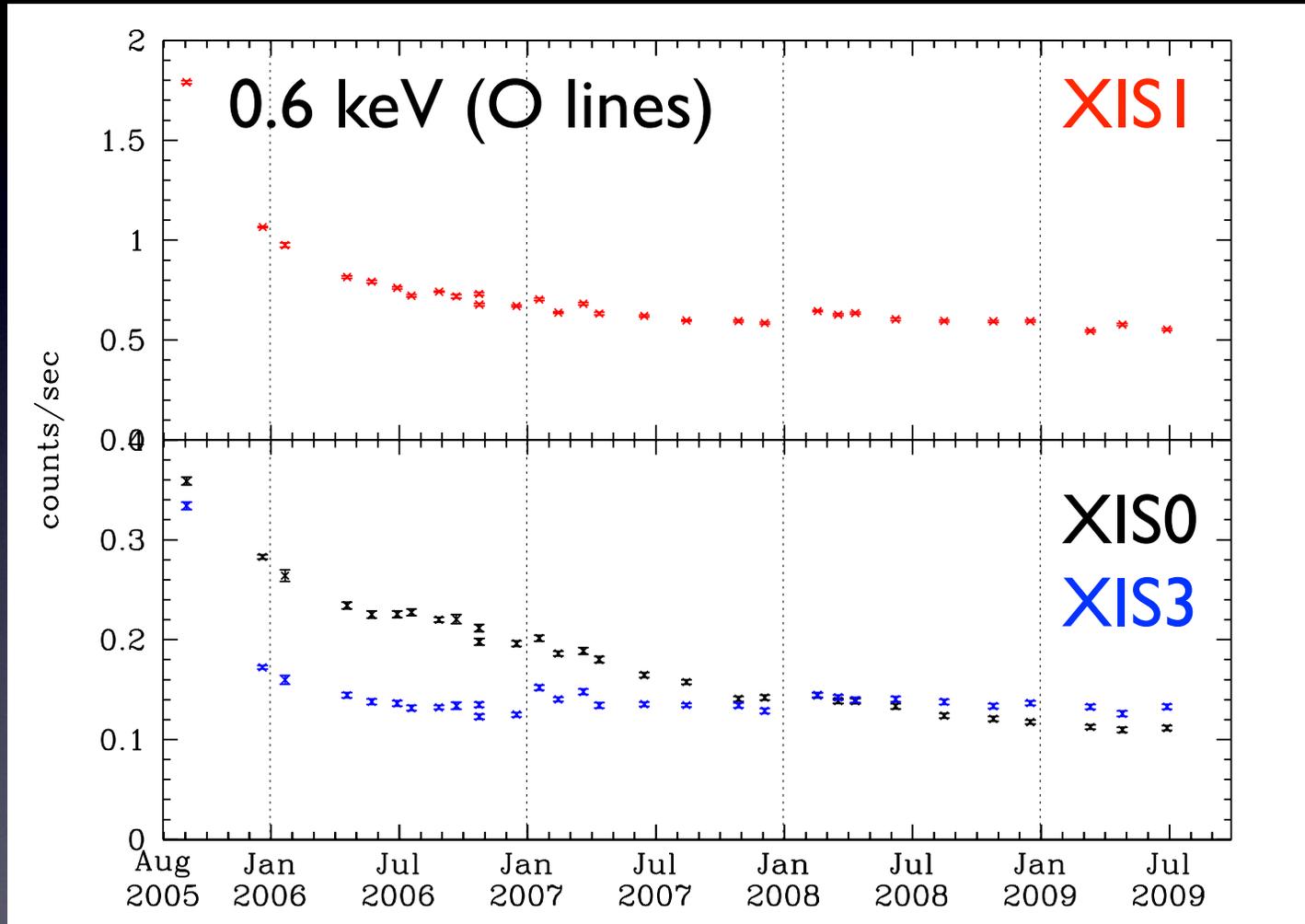
- FWHM change
  with SCI on
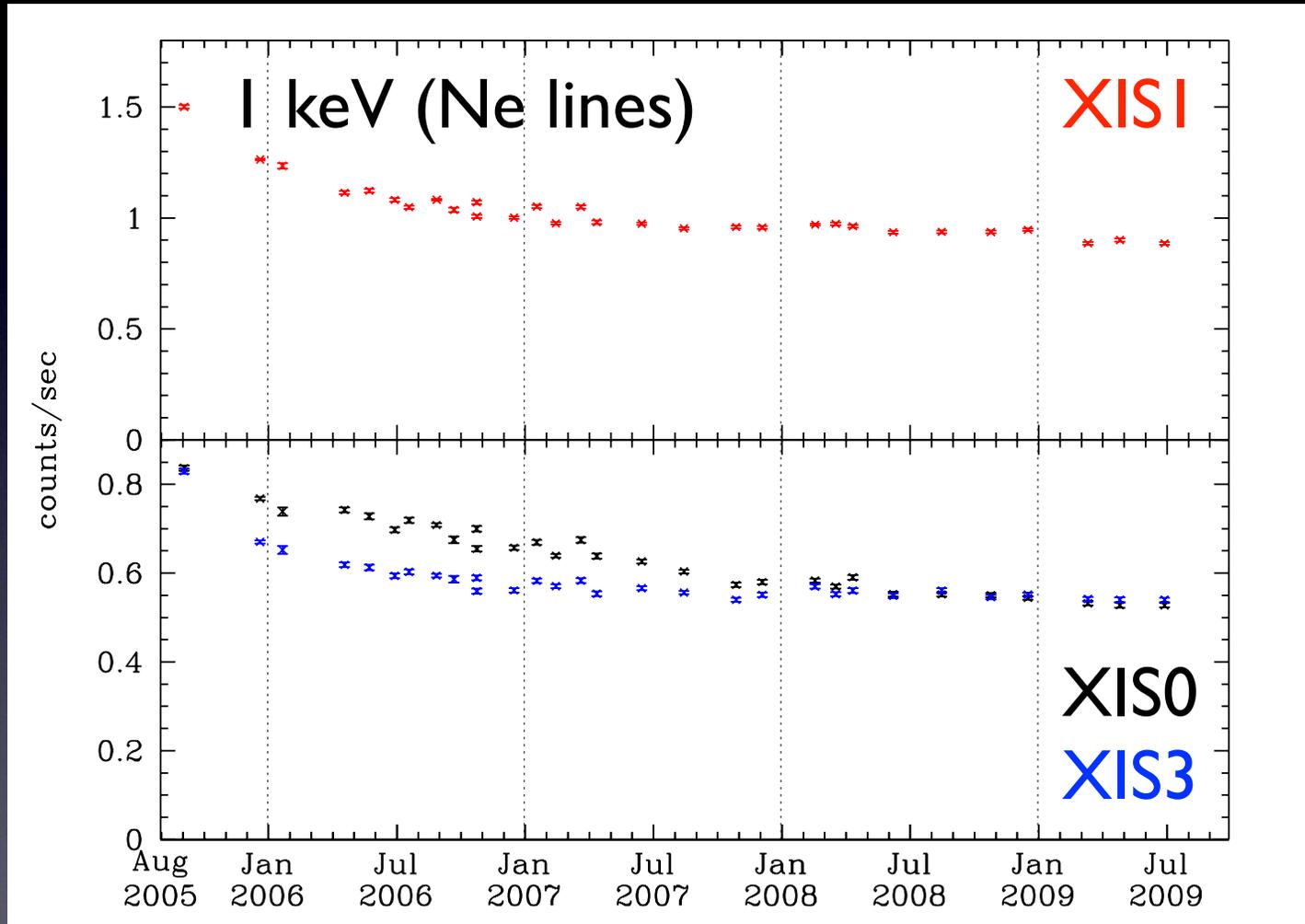 (eV per yr)
  XIS0 12.2 ±0.6
  XIS3 10.8 ±0.4
  XIS1 25.1 ±0.4

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

Effective Area Tracking

0.6 keV (O lines)

XIS1

XIS0

XIS3

counts/sec

Effective Area Tracking

Contamination Tracking

assumes C,O only
$N_C/N_O = 6$
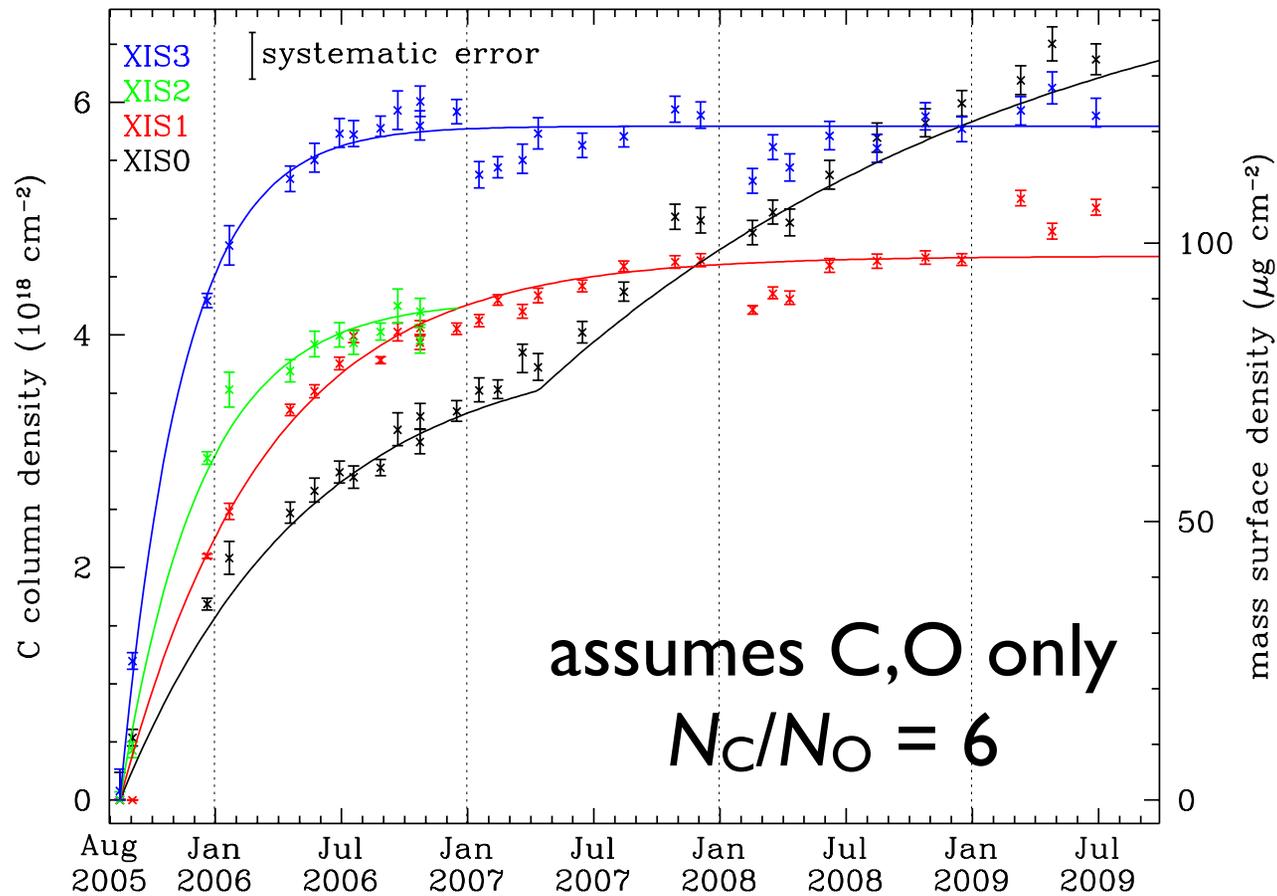
(more later)

Outline

- instrument health and status

  - anomalies since the last SUG meeting

  - gain and effective area tracking

- calibration status

  - normal, window, burst, timing modes

  - specific issues

- contamination

- pile-up

- runaway CLEANSIS problem

XIS Observing Modes

Clock modes + options
(exposure time, exposure region, time resolution)

Editing modes
(event detection, event grades, telemetry format)

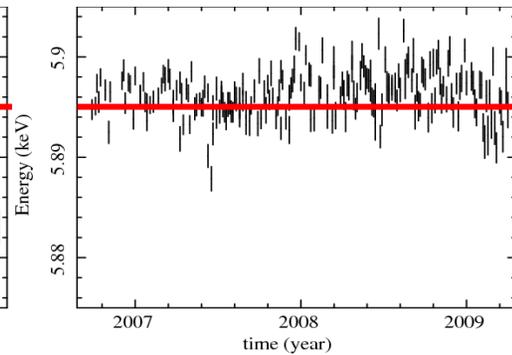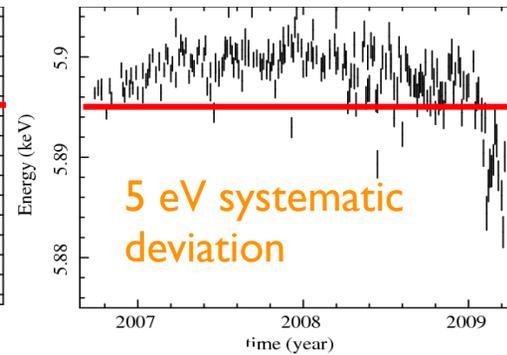|			
Normal	Full	8 s	
	Window	1-2 s	5x5 3x3 2x2
	Burst	> 0.1 s	

P-Sum   > 7.8 ms   Timing

Normal Mode - Energy Scale
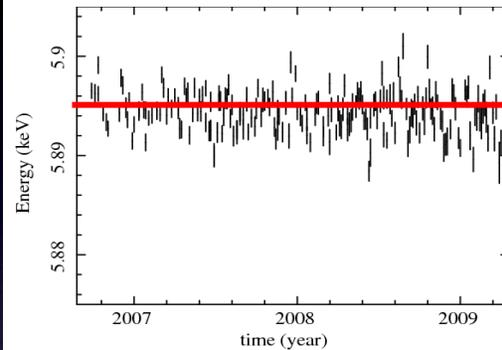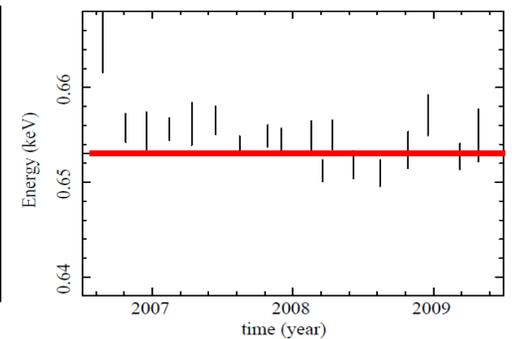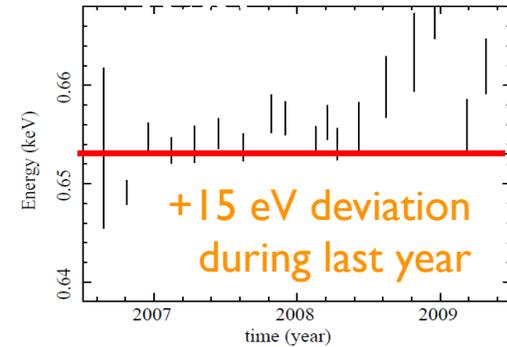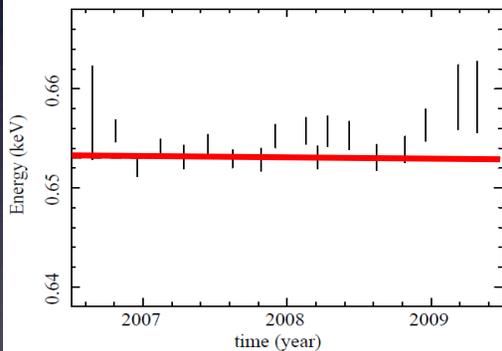
CTI corrected with makepi parameters from 2009-06-15
RMF parameters soon to be updated

Suzaku Users' Group Meeting 2009 - XIS

Window Mode

- updated xispi FTOOL, makepi CALDB (20090615) 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
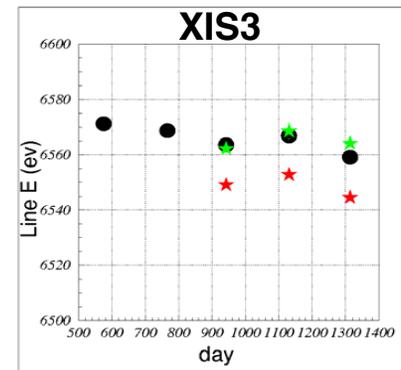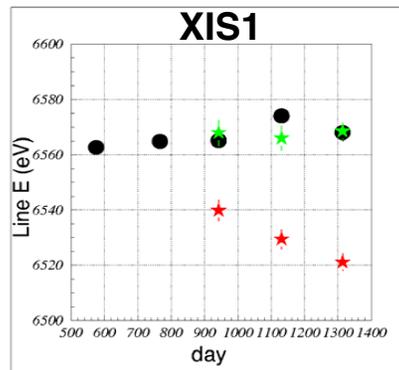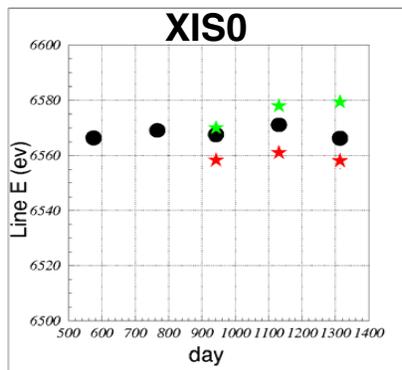
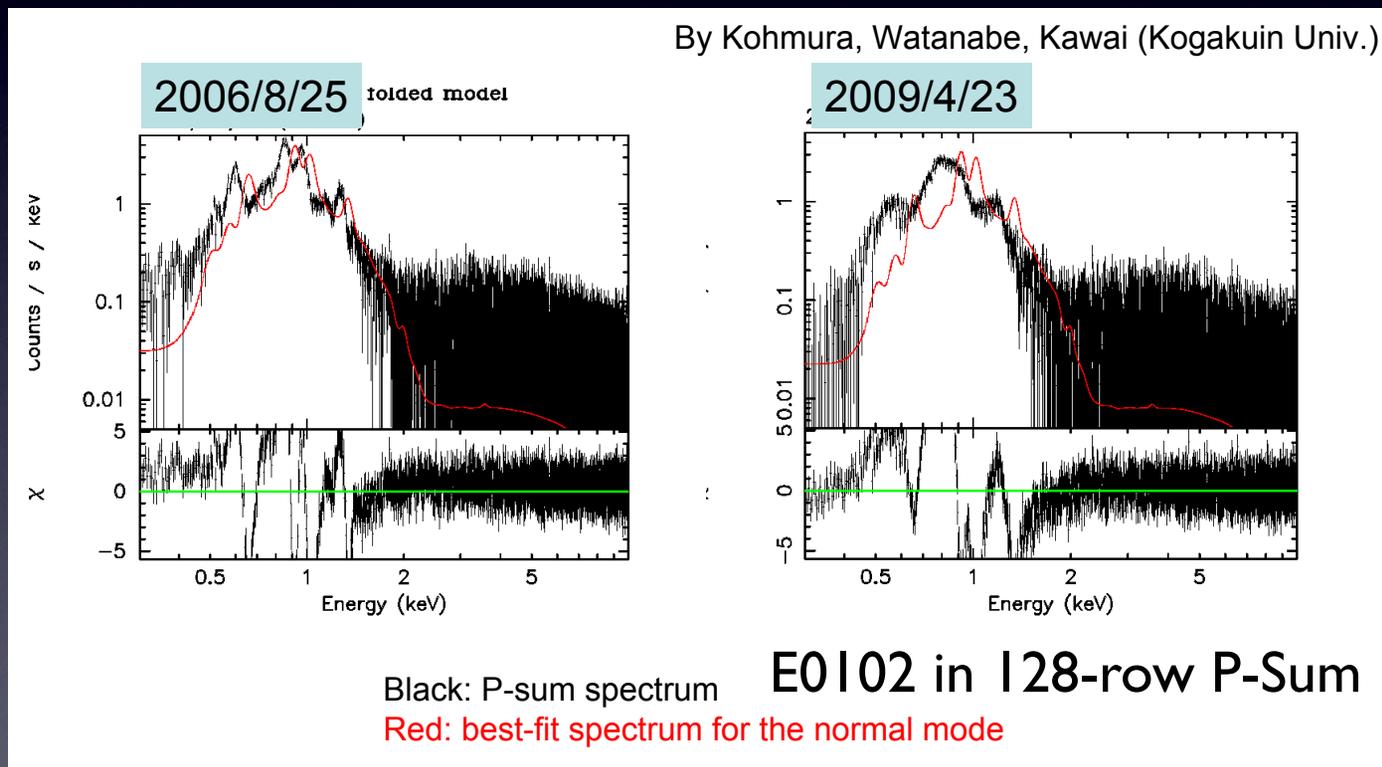X : elapsed day since the launch

Y: mesured 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

Burst Mode

- burst option with $t_{exp} \geq 0.5$ s supported (AO4)

- t_{exp} not calculated in GTI correctly

  - dead time not accounted for
    (e.g. $t_{exp} = 2$ s �켜 4x count rate)

  - work-around on GOF page, FTOOL in works

- $t_{exp} = 0.1$ s timing error

  - should start at $t_{ref} + 7.9$ s, actually 56 ms sooner

  - XIS and HXD timestamps are different by 24 ± 10 ms

  - deal with in CALDB

P-Sum + Timing Mode

- energy scale lower, FWHM broader than normal mode

  - CTI correction not done, no charge injection

By Kohmura, Watanabe, Kawai (Kogakuin Univ.)

2006/8/25   folded model   2009/4/23

E0102 in 128-row P-Sum

Black: P-sum spectrum
Red: best-fit spectrum for the normal mode

P-Sum + Timing Mode

- energy scale lower, FWHM broader than normal mode

  - CTI correction not done, no charge injection

55Fe spectrum

By Kohmura, Watanabe, Kawai (Kogakuin Univ.)
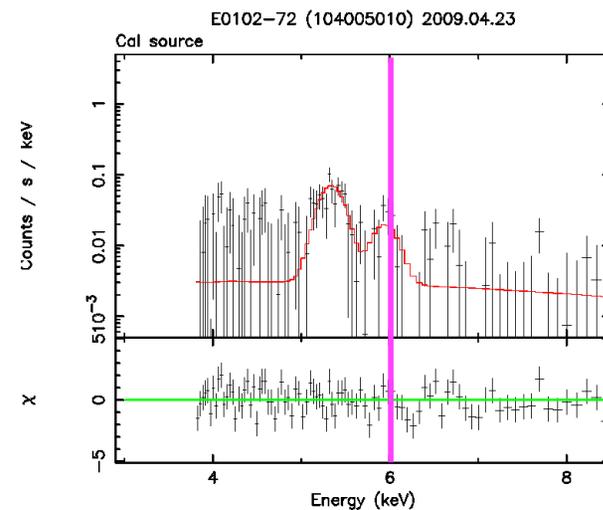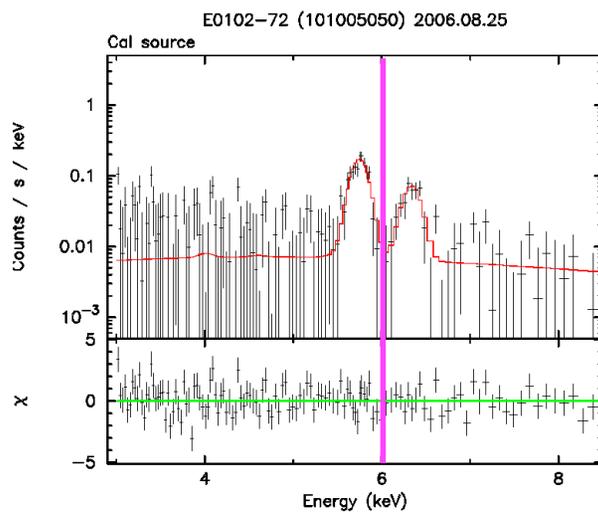
E0102 in 128-row P-Sum

P-Sum + Timing Mode

- energy scale lower, FWHM broader than normal mode

  - CTI correction not done, no charge injection

55Fe spectrum

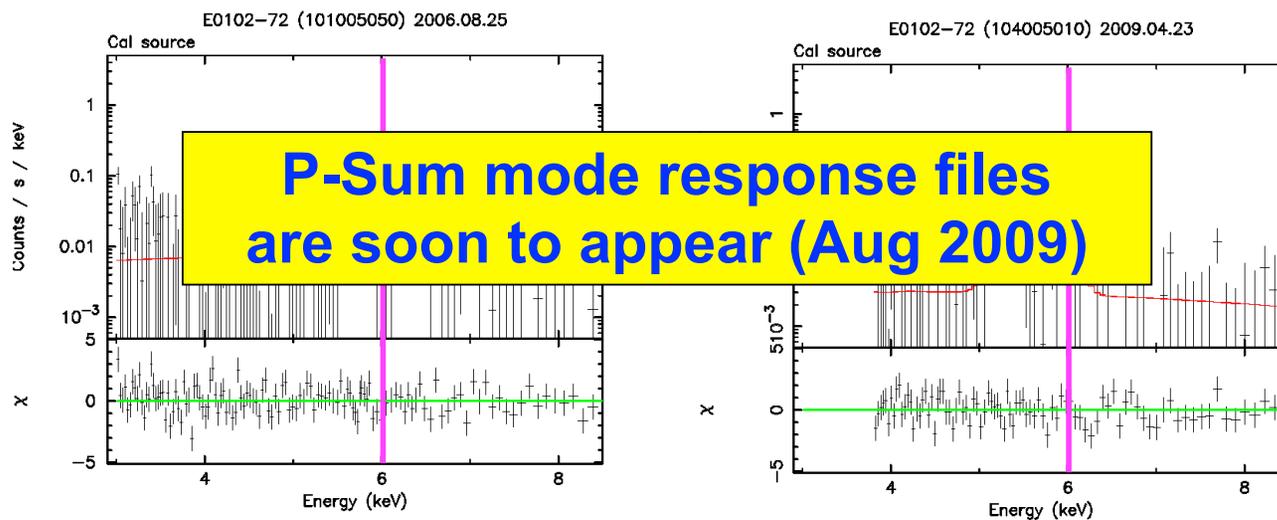By Kohmura, Watanabe, Kawai (Kogakuin Univ.)

**P-Sum mode response files
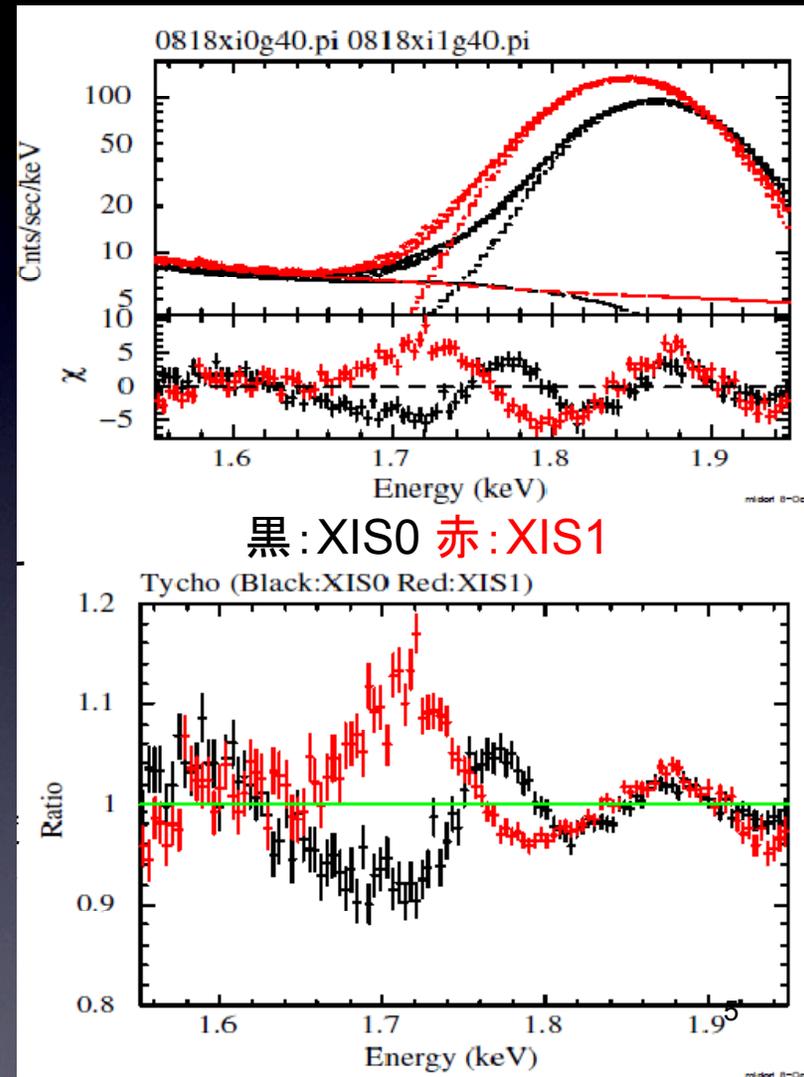are soon to appear (Aug 2009)**

E0102 in 128-row P-Sum

Outline

- instrument health and status

  - anomalies since the last SUG meeting

  - gain and effective area tracking

- **calibration status**

  - normal, window, burst, timing modes

  - **specific issues**

- **contamination**

- **pile-up**

- **runaway CLEANSIS problem**

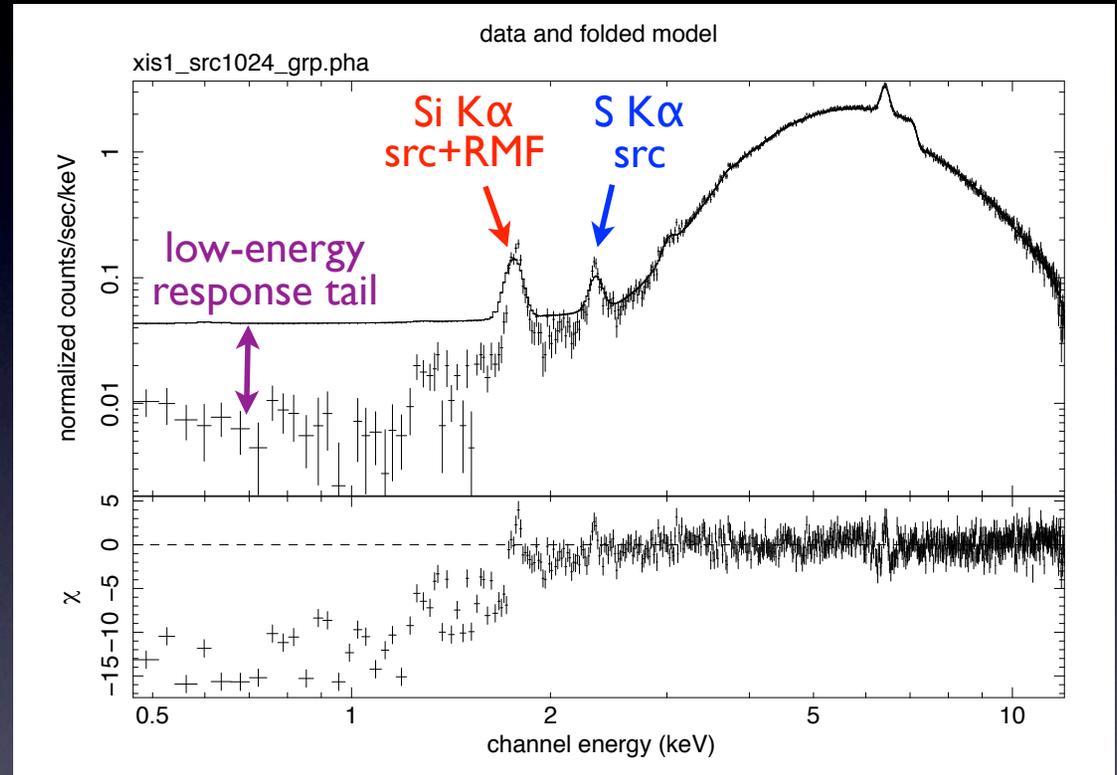# Calibration Near Si Edge

- Tycho SNR

- powerlaw + Gaussian Si K line (center variable)

- line shift between FI, BI

- residuals of ~ 10% around Si K edge

- problem with detector Si fluorescence? another source?

- still under review


黒：XIS0 赤：XIS1

Low-Energy Response Tail

- HMXB with $N_H \sim 6\times10^{23}$ cm^{-2}

- 1/4 window mode

- low-energy redistributed counts ("DC component") overestimated

- line response too broad

- all XIS's

Low-Energy Response Tail

- HMXB with $N_H \sim 6\times10^{23}$ cm^{-2}

- 1/4 window mode

- low-energy redistributed counts ("DC component") overestimated

- line response too broad

- all XIS's

data and folded model

xis1_src1024_grp.pha

Si Kα src+RMF
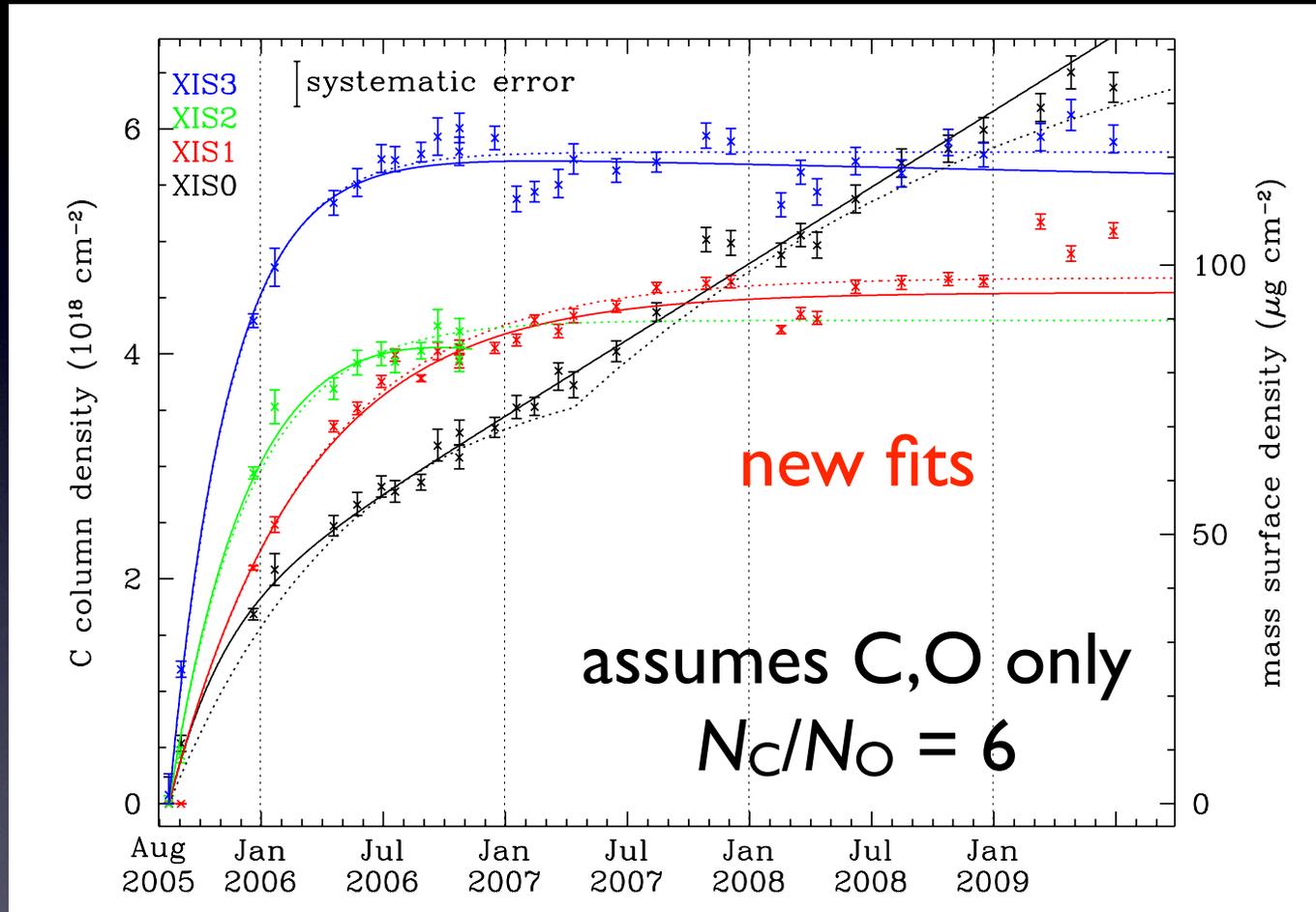
low-energy response tail
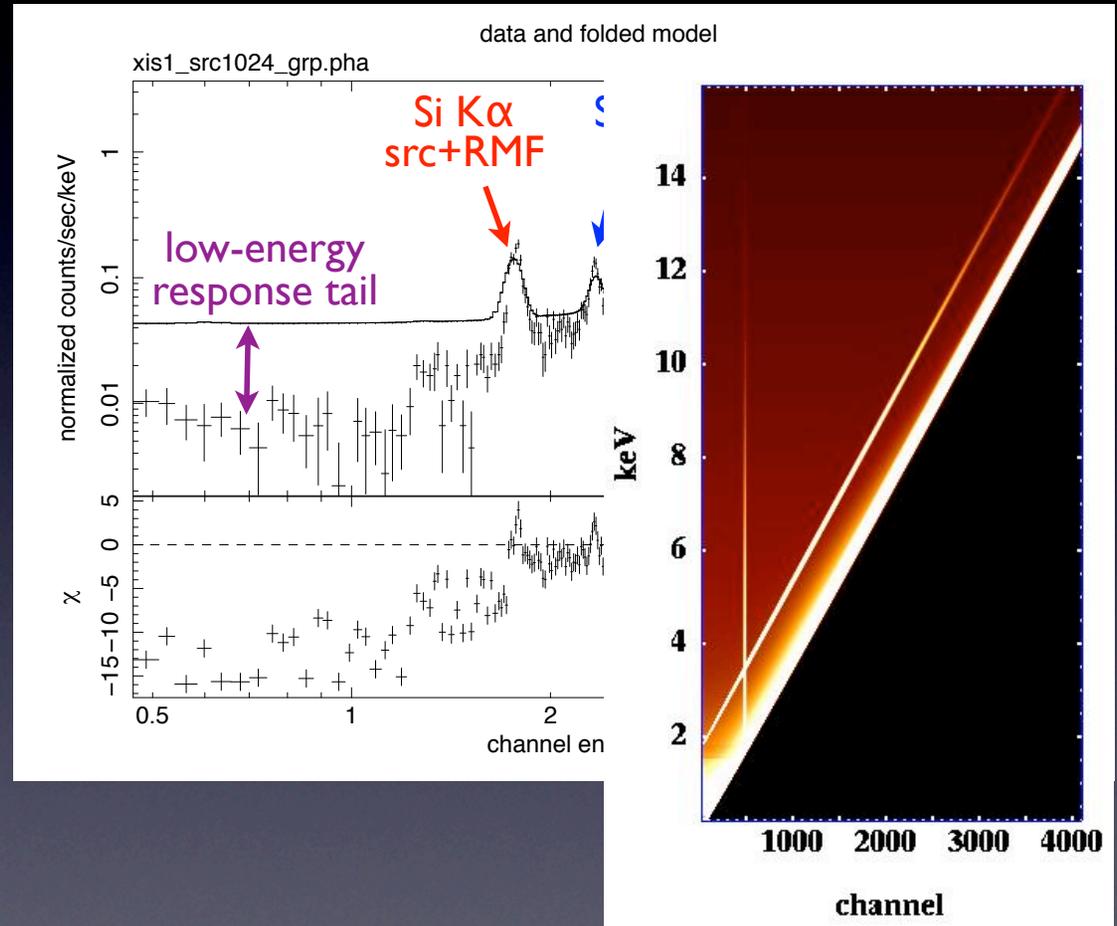
Outline

- instrument health and status

  - anomalies since the last SUG meeting

  - gain and effective area tracking

- calibration status

  - normal, window, burst, timing modes

  - specific issues

- **contamination**

- **pile-up**
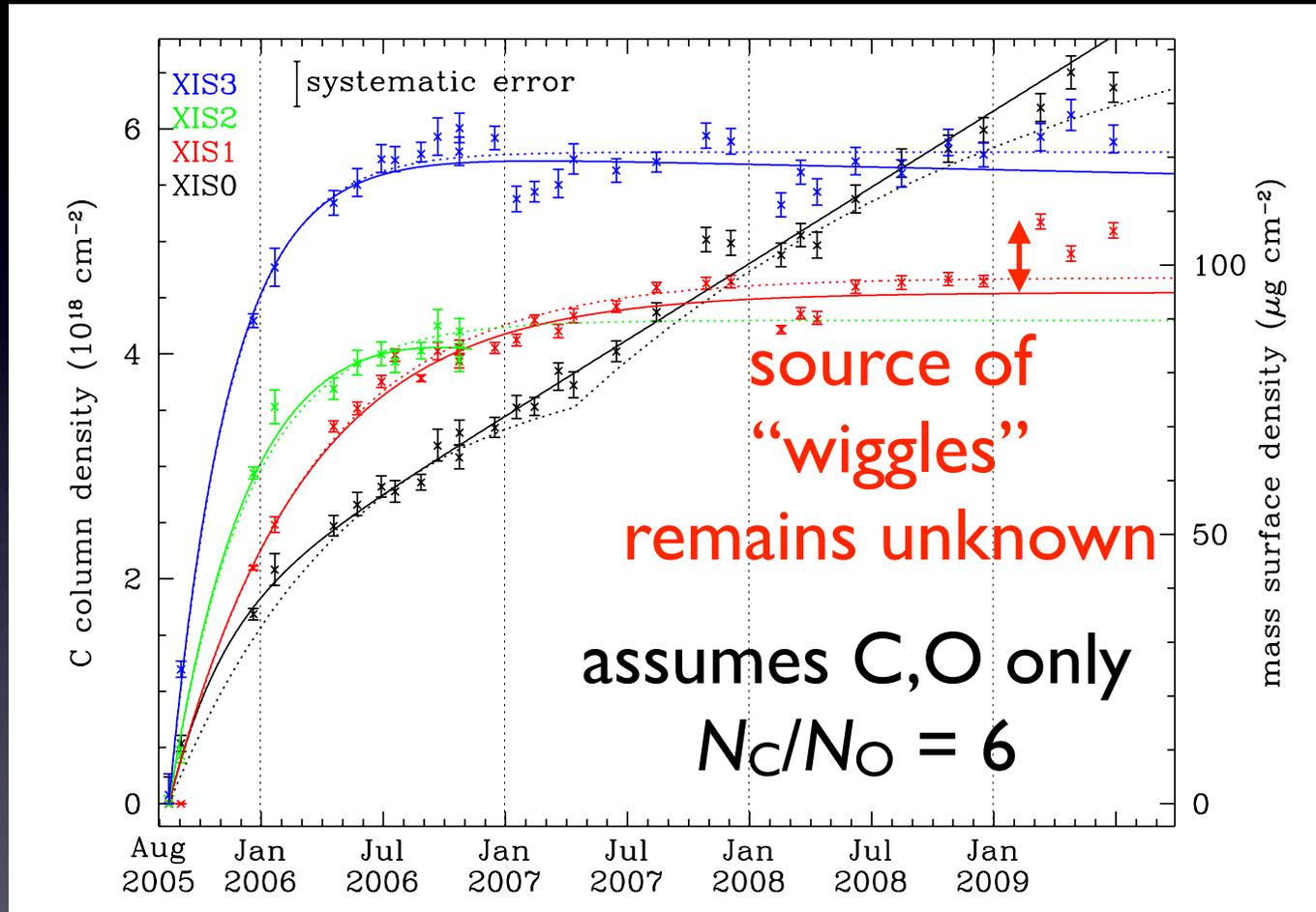
- **runaway CLEANSIS problem**

OBF Contamination (On Axis)
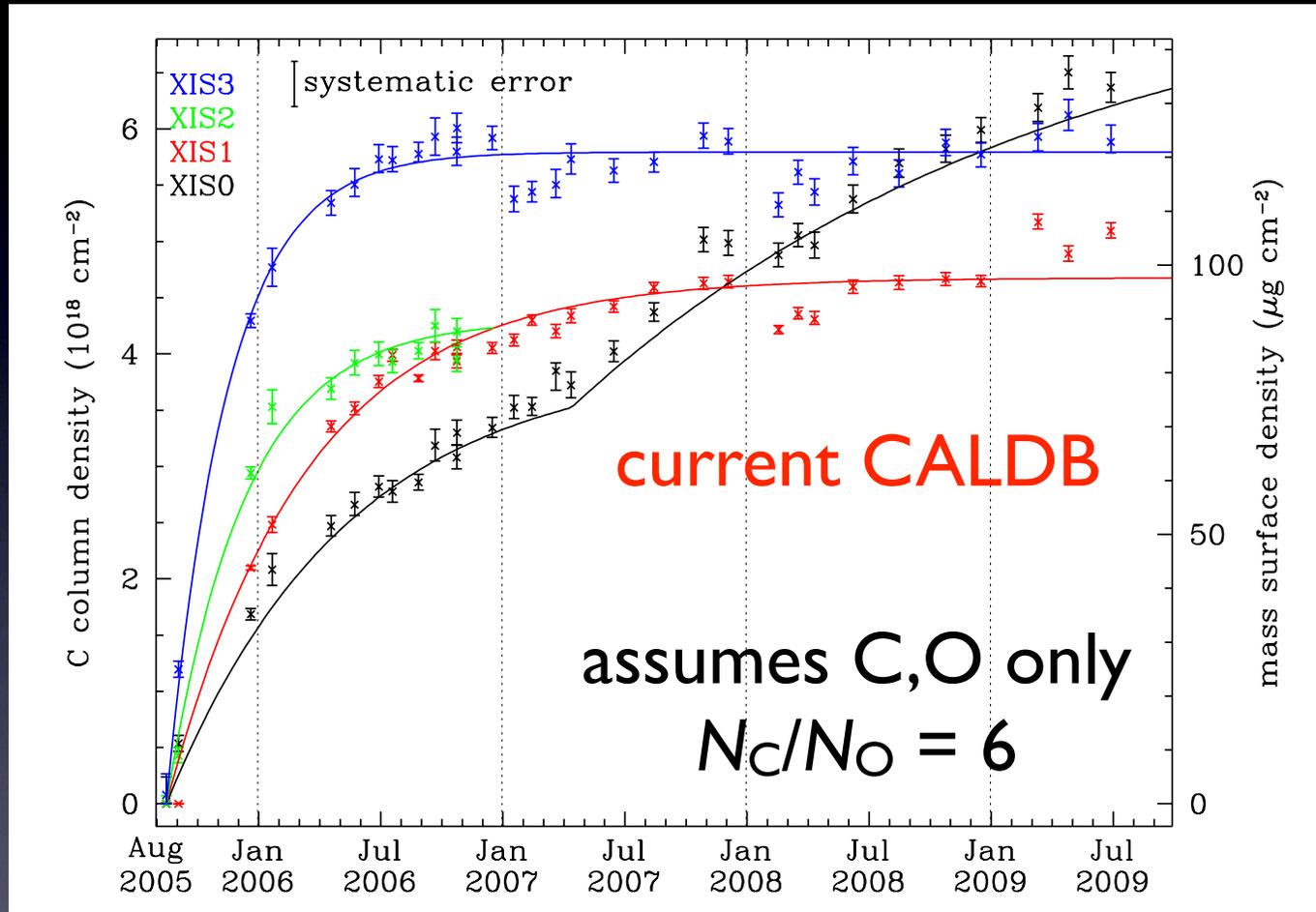
OBF Contamination (On Axis)

OBF Contamination (On Axis)

OBF Contamination (Off Axis)

New contamination files (ae_xi[0,1,2,3]_contami_20081023.fits) are released. Radial profile model of contaminant thickness has been updated. The thickness of the contaminant at the FOV center is unchanged from the previous version (ae_xi0_contami_20080427.fits, ae_xi[1,2,3]_20071224.fits), whereas its underestimation at outer side of the FOV in the previous version has been resolved. The improvement is significant particularly for the observation after middle of 2007.
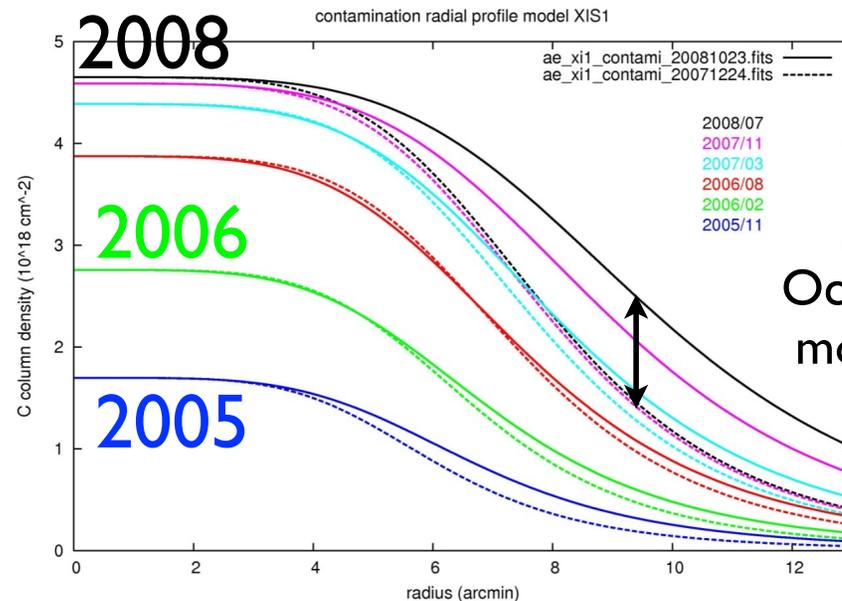
Oct 2008 updated CALDB more contam in outskirts

9

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 $\sim 10^{21}$cm^2
- Constant Factor (Grading Problem at low energy?)

RXJ1856 XIS1 rev2+HEASOFT6.4
rxj1856_x1_fixnorm_varabs_noh.qdp

Tune C and O absorption only

RXJ1856 XIS1 rev2+HEASOFT6.4

Include absorption by H

HCO Contaminant

XIS1 Contamination Extra Correction Varabs H,C,O XIS1
xis1_rxj1856_hcoabscorr.qdp
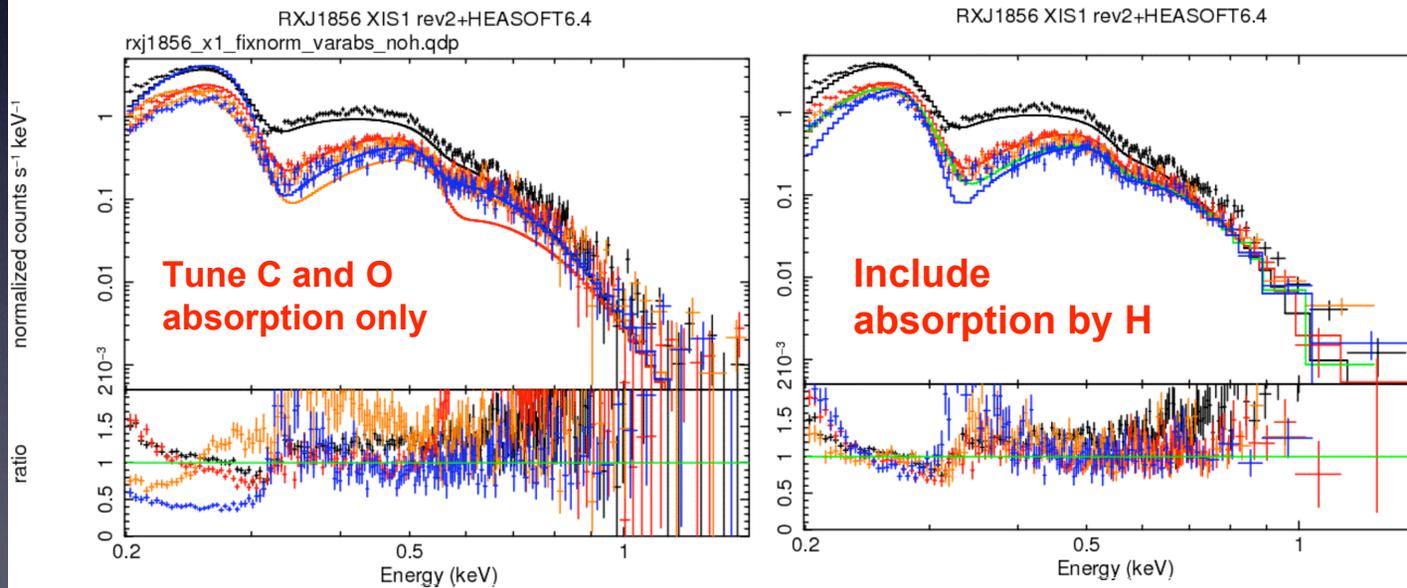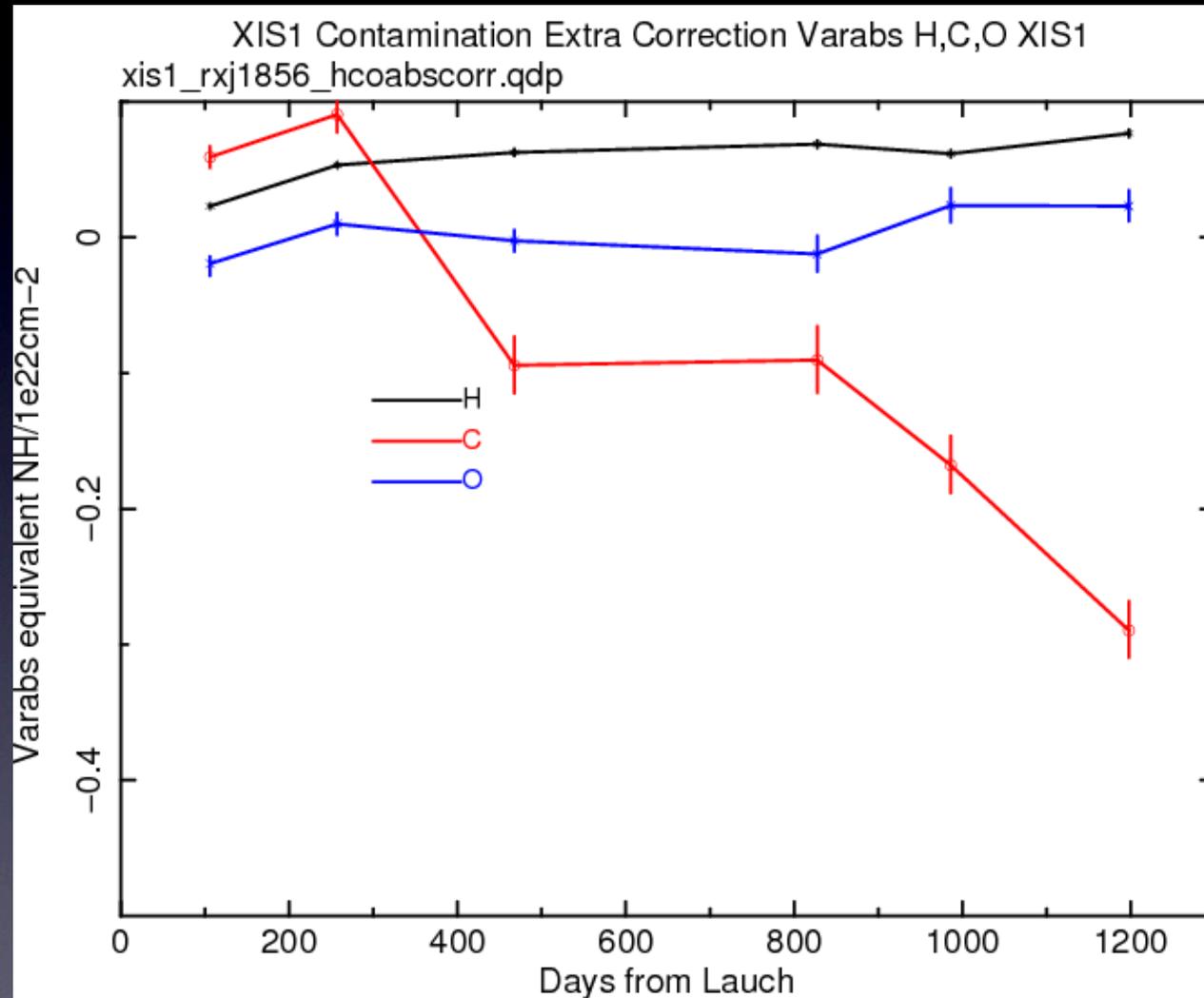
HCO Contaminant - Summary

- C/O decreases from ~ 6 to ~ 3 over mission

- C/H ~ constant, but N_H ~ 10^{21} cm^{-2} ➡ empirical model

- contamination update planned after AO5

Figure: XIS1 contamination ratios from E0102 — H,C,O variable
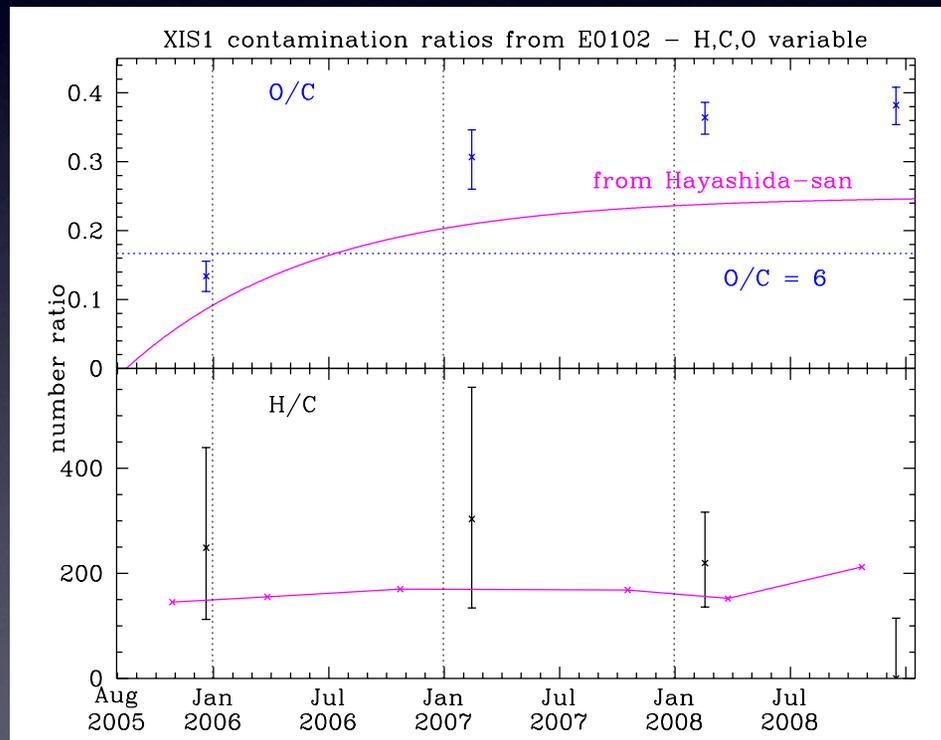
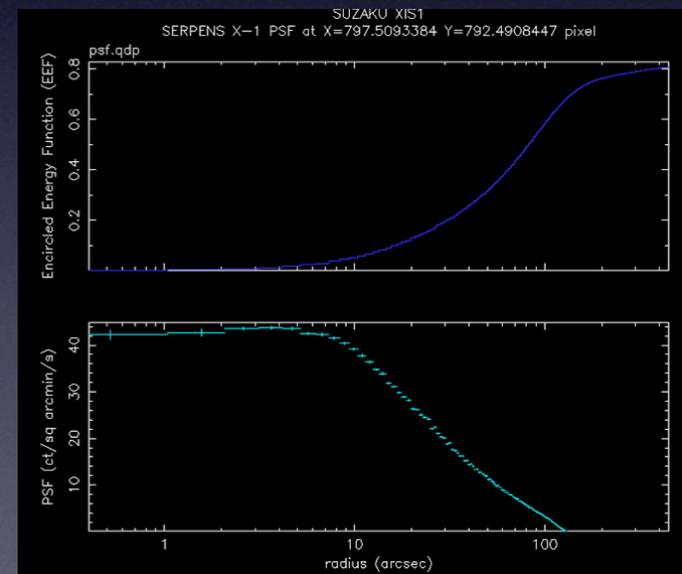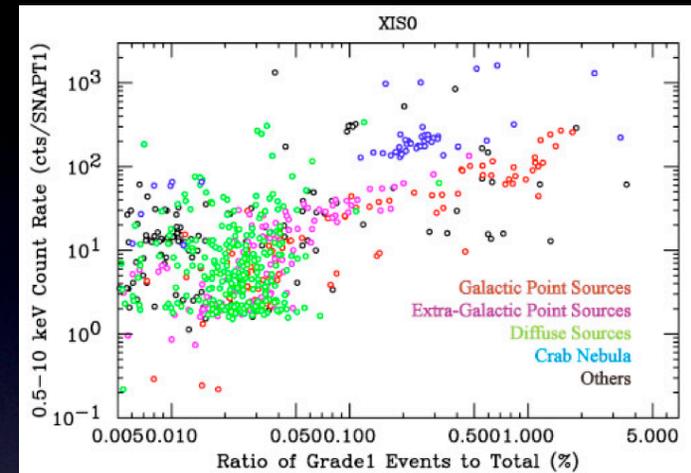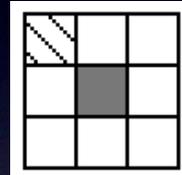# Pile-Up

- despite PSF, bright point sources can pile up in XIS

- 2+ photons ➟ 1 event

- causes migration in event energy and grade

- two pile-up estimation/remediation tools:

  - Yamada (U. Tokyo) & Takahashi (Hiroshima U.)
    http://www.astro.isas.jaxa.jp/suzaku/analysis/xis

  - Nowak (MIT)
    http://space.mit.edu/ASC/software/suzaku

Pile-Up: Method 1

- grade branching ratio

    - grade 1 enhanced by pile-up

    - fraction of grade 1 suggests amount of pile-up

- PSF count rate comparison

    - should be < 36 counts arcmin^{-2} exposure^{-1}

- excise PSF regions thought to be piled up

Pile-Up: Method 2

- two S-Lang/ISIS tools by M. Nowak

- aeattcor.sl

  - corrects attitude for bright point source

- pile_estimate.sl

  - filter based on rate and color

  - assumes model for grade & energy migration

  - model is being investigated by XIS team

before   after

>8% pile-up
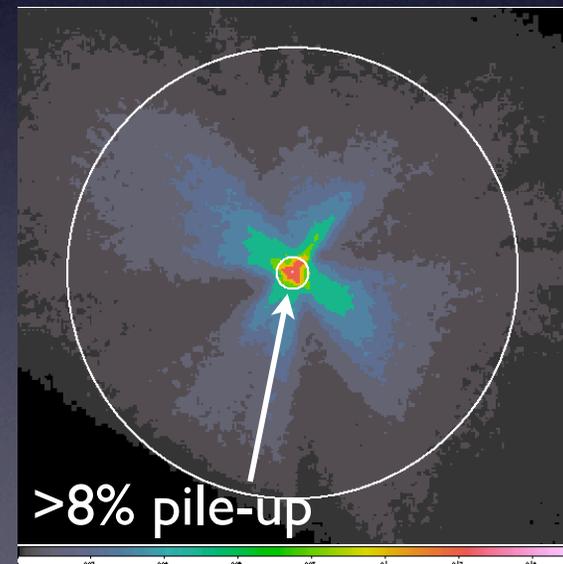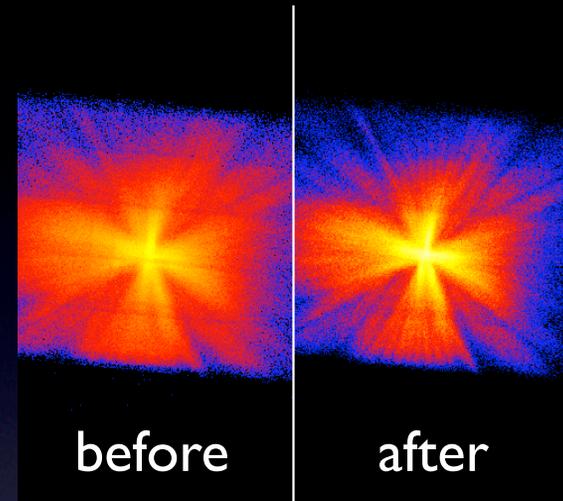
Runaway CLEANSIS problem

Runaway CLEANSIS problem can be recognized by the central hole in the cleaned, but not in the unfiltered, event files.

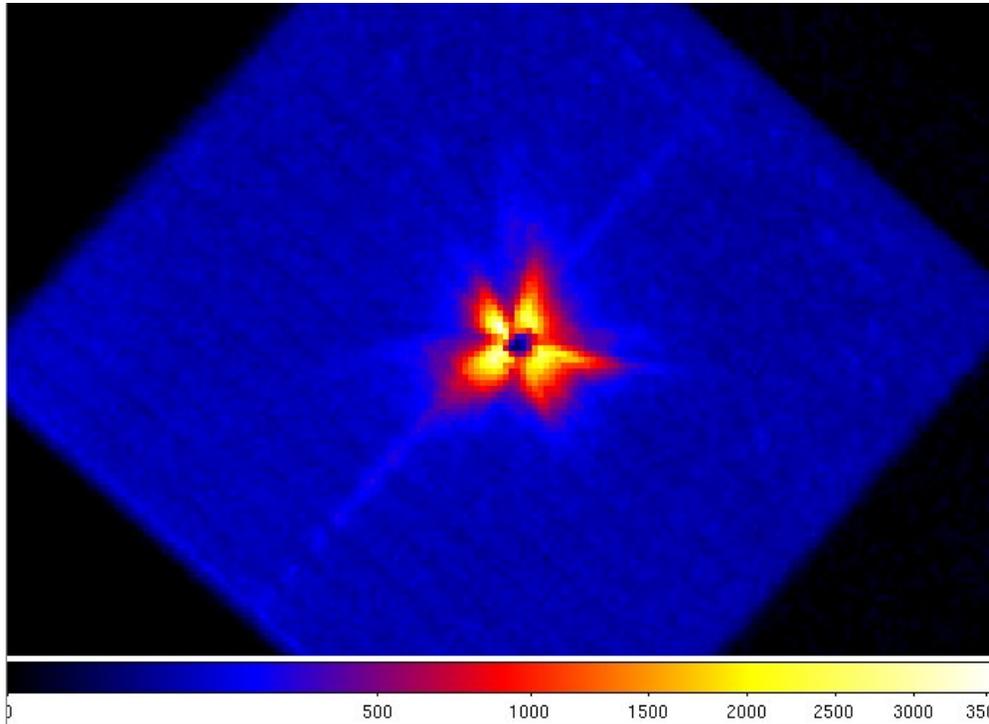Hot/flickering pixels in the XIS data are removed in ground processing using the ASCA FTOOL, CLEANSIS.

Its algorithm is inherently statistical: Pixels with more events than statistically probable are flagged and eliminated. Usually this step is repeated to eliminate additional flickering pixels.

Instances of CLEANSIS (and not pile-up) creating a central hole have been seen in long observations of bright targets.

Workarounds and Solution
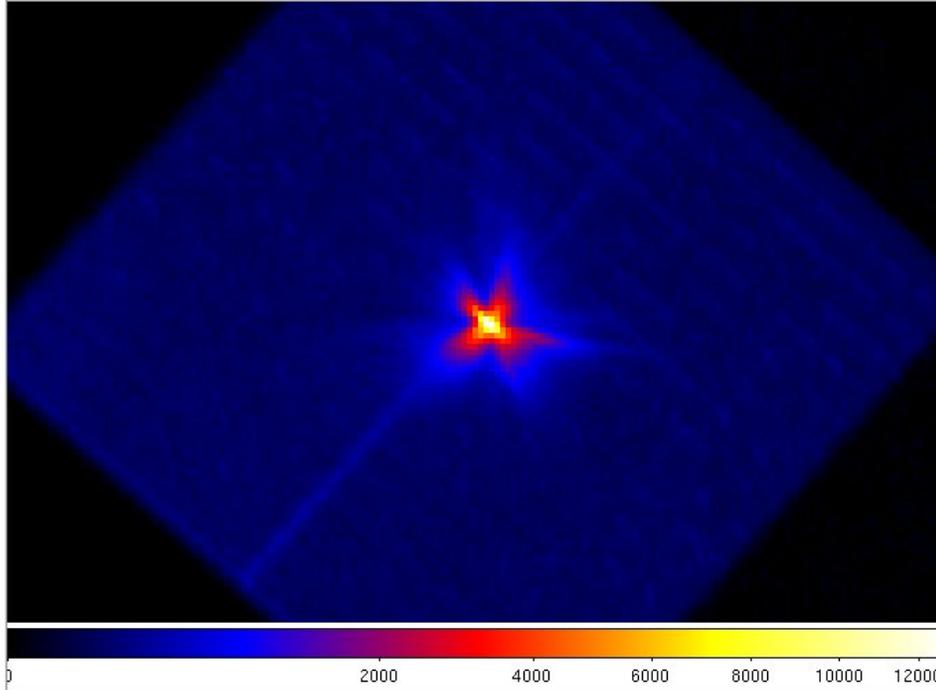
Log(Threshold probability): default value of -5.24 leads to one non-flickering pixel getting eliminated in an XIS segment.

The current release version, once a pixel near the PSF core is removed, is subject to a runaway (neighbors incorrectly flagged). Users can avoid this by lowering log(probability) or by turning iteration off. These steps may result in genuine flickering pixels left uncleaned.

Develop version of CLEANSIS (currently under testing) corrects a deficiency in the algorithm of the existing version, hopefully preventing the runaway elimination of pixels near the PSF peak

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

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.

MIT Kavli Institute for Astrophysics and Space Research

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

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