The Suzaku/XIS: Status Report

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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

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

- occurred 23 June 2009
- sudden increase in event rate
- blanks columns + noisy edges

Events (all grades), Time 2

Count Rate (all grades)

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 $\rightarrow$ Mn K$\alpha$, K$\beta$
  - 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
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http://space.mit.edu/XIS/monitor
Effective Area Tracking

0.6 keV (O lines)

XIS I

XIS 0

XIS 3
Effective Area Tracking

1 keV (Ne lines)

Counts/sec

Aug 2005 - Jul 2009

XIS1
XIS0
XIS3
Contamination Tracking

assumes C,O only

$N_C/N_O = 6$

(more later)
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XIS Observing Modes

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

- Normal
- Window
- Burst

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

- Full: 8 s
- Window: 1-2 s
- Burst: > 0.1 s
- P-Sum: > 7.8 ms

Timing

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Normal Mode - Energy Scale

Mn Kα 5.9 keV

OVIII Kα 0.65 keV

5 eV systematic deviation

+15 eV deviation during last year

CTI corrected with makepi parameters from 2009-06-15
RMF parameters soon to be updated
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

- ⚫ ⚫ ⚫: 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

X: Elapsed day since the launch
Y: Measured central energy of the Fe line

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Burst Mode

- burst option with $t_{\text{exp}} \geq 0.5$ s supported (AO4)
- $t_{\text{exp}}$ not calculated in GTI correctly
  - dead time not accounted for
    - (e.g. $t_{\text{exp}} = 2$ s $\rightarrow$ 4x count rate)
  - work-around on GOF page, FTOOL in works
- $t_{\text{exp}} = 0.1$ s timing error
  - should start at $t_{\text{ref}} + 7.9$ s, actually 56 ms sooner
  - XIS and HXD timestamps are different by $24 \pm 10$ ms
- deal with in CALDB
P-Sum + Timing Mode

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

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

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

E0102 in 128-row P-Sum

By Kohmura, Watanabe, Kawai (Kogakuin Univ.)
P-Sum + Timing Mode

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E0102 in 128-row P-Sum

P-Sum mode response files are soon to appear (Aug 2009)
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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
Low-Energy Response Tail

- HMXB with \( N_H \sim 6 \times 10^{23} \text{ cm}^{-2} \)
- 1/4 window mode
- low-energy redistributed counts ("DC component") overestimated
- line response too broad
- all XIS’s
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OBF Contamination (On Axis)

assumes C, O only

$N_C/N_O = 6$

current CALDB

$C$ column density ($10^{18} \text{ cm}^{-2}$)

mass surface density ($\mu$g cm$^{-2}$)
OBF Contamination (On Axis)

new fits

assumes C,O only

$N_C/N_O = 6$
OBF Contamination (On Axis)

assumes C, O only

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source of "wiggles" remains unknown
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
Contamination Composition

Factor of 2 underestimate below 0.3keV

- Unable to improve the fit only with C & O
- Absorption by Heavier Element
- Absorption by H (or He) but too much $\sim 10^{21} \text{cm}^2$
- Constant Factor (Grading Problem at low energy?)

Tune C and O absorption only

Include absorption by H
HCO Contaminant
HCO Contaminant - Summary

- $C/O$ decreases from $\sim 6$ to $\sim 3$ over mission
- $C/H \sim$ constant, but $N_H \sim 10^{21} \text{ cm}^{-2} \rightarrow$ empirical model
- contamination update planned after AO5
Pile-Up

• despite PSF, bright point sources can pile up in XIS
• 2+ photons $\rightarrow$ 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

>8% pile-up
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

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