The Suzaku/XIS: Status Report

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for the Suzaku/XIS Team
Outline

• instrument health and status
• spacecraft and instrument anomalies
• gain and effective area tracking
• calibration status
• normal, window, burst, timing modes
• specific issues
• OBF contamination
Suzaku/XIS - Overview

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

<table>
<thead>
<tr>
<th>Field of view</th>
<th>17.8' x 17.8'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy range</td>
<td>0.2-12 keV</td>
</tr>
<tr>
<td>Energy resolution</td>
<td>~180 eV @6keV</td>
</tr>
<tr>
<td>Effective area</td>
<td>340 (FI)/390 (BI) cm² @1.5keV</td>
</tr>
<tr>
<td>Time resolution</td>
<td>8 s (Normal) - 7.8 ms (Psum)</td>
</tr>
</tbody>
</table>

from Tsujimoto’s “pocket guide”
## Major XIS Events

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 10, 2005</td>
<td>launch of Suzaku</td>
</tr>
<tr>
<td>August 13, 2005</td>
<td>XIS doors open, start of observations</td>
</tr>
<tr>
<td>November 9, 2006</td>
<td>anomaly (μ-meteorite?) in XIS2; 2/3 of chip affected, stop using XIS2</td>
</tr>
<tr>
<td>January 30, 2008</td>
<td>CPU board malfunction in MPU; switch to redundant board</td>
</tr>
<tr>
<td>June 23, 2009</td>
<td>anomaly (μ-meteorite?) in XIS0; 1/8 of chip affected, XIS0 safe for normal ops</td>
</tr>
<tr>
<td>December 18, 2009</td>
<td>anomaly (μ-meteorite?) in XIS1; no CCD damage, likely hole in XIS1 OBF</td>
</tr>
</tbody>
</table>

IACHEC 2010 - Suzaku/XIS
XIS0 Anomaly - Frame Data

charge injection on
charge injection off (but sequencer still on)
XIS0 Anomaly - Summary

- 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 modes
  - burst mode is safe, but perhaps not useful in XIS0
  - P-Sum mode is no longer supported for XIS0
- calibration changes minor at XIS aimpoint (seg B,C)
  - gain change ~ few eV at 6 keV, no change at 1 keV
  - no FWHM change
XIS I Anomaly - Observations

- persistent bright spot
- hole in OBF from μ-meteorite; light leak
- no CCD damage
- grade selection removes most spurious events
XIS I Anomaly - Issues

- calibration uncertainty increases at “spot”
- soft extended sources affected
- on-axis point sources unaffected
- dark level increase if optically bright source at spot
- more stringent day-Earth elevation limit (?)
- excessive dose of UV from bright Earth (?)
- OBF contaminant “leaking” through hole (?)
- observation of RXJ1856 on and off hole….
- no change in supported observing modes
Gain and FWHM Tracking

- $^{55}$Fe cal sources $\rightarrow$ Mn Kα at 5.9 keV
  raw data, no CTI correction

- gain change with SCI on (% per yr)
  XIS0 $-0.399 \pm 0.001$
  XIS3 $-0.376 \pm 0.001$
  XIS1 $-0.979 \pm 0.001$

- FWHM change with SCI on (eV per yr)
  XIS0 $13.1 \pm 0.5$
  XIS3 $11.5 \pm 0.3$
  XIS1 $25.4 \pm 0.4$
Effective Area Tracking

contamination optical depth

- XIS0
- XIS1
- XIS3

○ 0.6 keV (0 lines)
× 1.4 keV (Mg line)

total effective area

× 1.4 keV (Mg line)
○ 0.6 keV (0 lines)
Contamination Tracking

lines are CALDB assumes C,O only $N_C/N_O = 6$

(more later)
Outline

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XIS Observing Modes

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

- Normal
- Full
- Window
- Burst

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

- 8 s
- 5x5
- 1-2 s
- 3x3
- > 0.1 s
- 2x2
- > 7.8 ms
- Timing

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Normal Mode - Energy Scale

**Mn Kα**
5.9 keV

**O VIII Kα**
0.65 keV

5 eV systematic deviation

+15 eV deviation during last year

CTI corrected with makepi parameters from 2009-06-15
Window Mode

- updated xispi FTOOL, makepi CALDB (20091202) 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
P-Sum + Timing Mode (XIS3)

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

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 (XIS3)

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55Fe spectrum

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55Fe spectrum

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E0102 in 128-row P-Sum

P-Sum mode response files are soon to appear
2x2 Editing Mode - Gain

- 2x2 gain corrected by 10-20 eV to equal 5x5 gain
correction depends on energy and epoch

- no practical differences in FWHM and detection efficiency between 5x5 and 2x2

- XIS0, XIS3 similar; XIS1 is not operated in 2x2

before correction
after makepi_20091202
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
Calibration Near Si Edge

PKS2155 2005Nov

Mrk501 2006Jul

Mrk421 2006Apr

Mrk421 2008May
Calibration Near Si Edge (CXO)

“extra” Si edge in ACIS-I spectra of Abell 1689
E = 1.77 keV, $\tau = 0.12$

Peng et al. 2009
OBF Contamination (On Axis)

assumes C,O only

$N_C/N_O = 6$

current CALDB

systematic error
OBF Contamination (On Axis)

source of “wiggles” remains unknown
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

The graph shows the contamination levels of H, C, and O over time, with days from launch on the x-axis and Varabs equivalent NH/1e22 cm^-2 on the y-axis. The data suggests an increase in contamination over time, with the levels of C and O rising more significantly than H.
HCO Contaminant

contamination update forthcoming
XIS Status - Summary

- XIS0 has lost ~ 10% of area but is operating safely
- XIS1,3 are operating normally