Suzaku Operation & Calibration Status

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Outline

• Suzaku operations
  • solar panel power production
• XIS calibration status
  • effective area (contamination) tracking and calibration
  • background changes
• HXD calibration status
  • Crab cross-calibration
  • response feature
Suzaku Operations

Suzaku Power Balance

Solar panels output

Power usage

UVC safe hold

PCU_IN_OUT_PLOT.dat

SAP OUT


0 500 1000 1500 2000 2500 3000

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

The diagram illustrates the contamination tracking from E0102 for XIS detectors (XIS0, XIS1, XIS3). It shows the optical depth and effective area changes over time from 2006 to 2014 for different energy bands (0.65 keV and 1.0 keV). The contamination and optical depth trends are compared for these detectors, highlighting the degradation and stabilization of their performance.
**XIS Contamination Model**

- **HCNO composition**
- **H trend fitted from RXJ1856 then fixed**
- **N = 0 for FI chips**
- **contami_20120719 CALDB file, released 2012 Sept 02**
XIS Contamination Model
XIS Contamination Non-Uniformity

XIS1 carbon

day-lit Earth

昼地球
XIS Contamination Summary

- decreasing contamination – real? physical?
  - still divergence at recent time, new model needed
- spatial coverage may not be azimuthally symmetric
  - difficult to constrain with current set of calibration targets
- ongoing....
XIS Charge Injection Trailing

- CI line and three lines before and behind that
- Charge leakage to second trail row
- CI line and three lines before and behind that
- No charge leakage

Cl = 2 keV
Cl = 6 keV
Increasing

Energy (keV)

Intensity
HXD Calibration
HXD calibration updates

Variation of Crab Flux (pulsar+nebula)

1. Cross calibration
   Roughly consistent with others within statistical & systematic errors
   Slight discrepancy found in epoch > MJD5500, (although PIN gain is stable in 0.5% level.)

2. Spectral variation
   The photon index and break energy varies.

⇒ We need Simultaneous observation!!

Kouzu et al 2013 PASJ
Next target is to estimate the contamination of Gd K line from GSO to PIN after the selections with standard criteria. (gadolinium silicate in GSO detector)

Dip feature in PIN RSP
- Line intensity depends on the incident photon flux.
- RSP is generated by a Monte Carlo simulation (Terada et al 05 IEEE).
  We have to tune up parameters in the code, such as geometry, digitization, selection criteria.

### Dip Feature in PIN RSP

- **Signal**
  - Line intensity depends on the incident photon flux.
  - RSP is generated by a Monte Carlo simulation (Terada et al 05 IEEE).
  - We have to tune up parameters in the code, such as geometry, digitization, selection criteria.

**Normalized counts s⁻¹ keV⁻¹**

**Energy (keV)**

**Ratio**

**Crab 2005–2011**

**Broken PowerLaw (2.1/2.2 break@ 134 keV)**

**rsp: Kokubun et al 2006**

**Time: Terada et al 2008**

**NXB: Fukazawa et al 2009**

**Kouzu et al 2013**
Suzaku Status - Summary

- spacecraft power has stabilized
- XIS – OBF contamination remains the most pressing calibration issue
- HXD – no major changes

X-ray Imaging Spectrometer (XIS) Instrument Monitoring

- XIS is equipped with four imaging CCDs (XIS0-XIS3) for imaging and non-dispersive spectroscopy.
- The four CCDs are front-illuminated (FI) and one is back-illuminated (BI).
- The four CCDs are co-aligned to observe the same field.
- Three CCDs are front-illuminated and one is back-illuminated.

XIS is operated simultaneously with HXD.

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

IACHEC 2013 - Suzaku/XIS
XIS Status

from Tsujimoto’s “pocket guide”
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
(New) Contamination Model

Tuning of the gain-offset significantly improve the fit

offset={-0.4, -4.1, -4.1, -9.7, -12.1, -8.2} eV

~ -10 eV offset remains for SCI-on data even with makepi20080807

RXJ1856
Figure showing 2011 Apr 26 observation of PKS 2155-304 fitted using (a) old and (b) new models of the contaminant.

Figure showing 2012 Jun 11 observation of the Cygnus Loop fitted using (a) old and (b) new models of the contaminant.
(New) Contamination Model

XIS1

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

![Graph showing attenuation versus energy (Ex in keV) for different elements.

- HCNO
- H
- C
- N
- O]
XIS Non-X-ray Background
XIS 1/4 Window Gain Error

- empirical difference in gain correction between 1/4 window and full window
- bug in makepi_20111227 CALDB file
- 1/4- and 1/8-window gain correction incorrect for observations after 2011 Dec 29
- corrected with makepi_20120527, released 2012 July 03
XIS 1/4 Window Gain Error

Fig5. Measured energy of the FeXXV line from observation of the Perseus cluster.