Suzaku Operations & Calibration Status

Eric Miller (MIT)
Y. Terada (Saitama U.)
Y. Maeda (ISAS/JAXA)

for the Suzaku Team

IACHEC 2015 – 北京香山饭店
Suzaku – Overview

X-ray Imaging Spectrometer (XIS)

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

Hard X-ray Detector (HXD)

- Collimated PIN diode + GSO scintillator detector, 10–600 keV
Operations
The Future of Suzaku

• Power Problems:
  • solar power system has degraded (almost) as expected
  • batteries have degraded in capacity and charging ability
    • two batteries needed, not redundant
  • several prolonged safe-holds, including all of Jan 2015
• It is unclear how long Suzaku will continue observing
  • 1.5 years is the goal, to overlap ASTRO-H
Suzaku Power Supply

July 2005
Apr 2008
Dec 2010
Sep 2013
Now

No corr.
cos θ corr.
The Future of Suzaku

• **Mitigation:**
  • Non-critical systems turned off
  • Battery control changes
  • Heaters turned off in shade, on in Sun light
  • Sun angle range 70–110 deg

• **AO10 planned to last 6 months, May–October 2015**
  • 3 XIS operated as long as power is sufficient/stable
  • HXD turned on during high day-to-night ratio
  • AO10 could be 1.5 years if only 1 XIS is used
XIS Calibration Updates
Loss of Area on XIS0

- Dead region on XIS0, produced by micrometeoroid impact in 2009, has increased from 1/8 to 1/4 of CCD.
- Change occurred while XIS0 was turned off for a UVC in May 2014.
- Also increase of charge trailing behind charge injection rows.
- Increase on-board area discrimination.
- Users must be aware of charge injection trailing rows!
Flickering Pixels in Non X-ray BG

- flickering pixels are identified with *cleansis*, a statistical tool, in science observations
- also run on NXB database, accumulated from night Earth obs.
- far more flickering pixels are identified in typical obs. (~50 ksec) than in NXB database (~ 1 Msec)
Flickering Pixels in Non X-ray BG

- new CALDB file of all historically flickering pixels, plus recipe
- useful for low-surface brightness studies
- removes 6.5% of $A_{\text{eff}}$
- new mission-independent tool `searchflickpix` for ASTRO-H

XIS I

![Graph showing normalized counts vs. energy for XIS I with data points at 20 ksec, 50 ksec, 200 ksec, 600 ksec, and 1200 ksec (all).]
XIS Contamination Trend

on-axis, from E0102
XIS Contamination Model

Cygnus Loop P8 XIS1 with contami model v20130813

0' – 3'
3' – 6'
6' – 9'
9' –

Cygnus Loop P8 XIS1 2013–12–05 with contami model v20140808

v20130813

v20140808

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Q.Wada 2014-08-22
XIS P-sum Observations

- 128 rows stacked
- 8 ms time resolution
- no charge injection
- node-to-node gain variation

<table>
<thead>
<tr>
<th>Object</th>
<th>Type</th>
<th>Date</th>
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<tbody>
<tr>
<td>GRS 1915+105</td>
<td>LMXB</td>
<td>2007.05</td>
</tr>
<tr>
<td>Cyg X-2</td>
<td>LMXB</td>
<td>2008.07</td>
</tr>
<tr>
<td>Her X-1</td>
<td>LMXB</td>
<td>(2006.03), 2010.09</td>
</tr>
<tr>
<td>Cyg X-1</td>
<td>HMXB</td>
<td>2008, 09, 11, 13</td>
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<tr>
<td>SMC X-1</td>
<td>HMXB</td>
<td>2011, 2012</td>
</tr>
<tr>
<td>PSR 1509-58</td>
<td>PSR</td>
<td>2005.08</td>
</tr>
<tr>
<td>1E 1207.4-5209</td>
<td>PSR</td>
<td>2006.07, 2007.02</td>
</tr>
<tr>
<td>G 21.5-0.9</td>
<td>PSR</td>
<td>2007.03</td>
</tr>
<tr>
<td>1E 1547.8-5408</td>
<td>PSR</td>
<td>2009.01, 2010.08</td>
</tr>
<tr>
<td>RXJ 0007.0+7302</td>
<td>PSR</td>
<td>2010.01</td>
</tr>
</tbody>
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…plus ~ 10 E0102 and Perseus observations

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M. Mizumoto 2014-06-26
XIS P-sum Calibration – Gain

Figure 9: Comparison of spectra before calibrations with after calibrations. The left panels show spectra before calibrations, and the right ones show after calibrations. The black, red, green, blue points show XIS0 Segment B, XIS0 Segment C, XIS3 Segment B, XIS3 Segment C respectively. The top and middle panels show E0102–72, the bottom ones show Perseus cluster.

We calculate cross-correlation functions $z_i$ as

$$z_i = \frac{1}{N} \sum_k x_k x_k^* + i,$$

(1)

$\Delta E \sim 5–30$ eV
XIS P-sum Calibration – Time

XIS clock is fast; 24 msec must be subtracted by hand from XIS P-sum times!

Table 2: Timing Offsets

<table>
<thead>
<tr>
<th>Object</th>
<th>Period</th>
<th>Timing offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSR 1509–58</td>
<td>151.358 ms</td>
<td>24.46 ± 0.11 ms</td>
</tr>
<tr>
<td>Crab</td>
<td>33.628 ms</td>
<td>23.19 ± 0.03 ms</td>
</tr>
</tbody>
</table>
HXD Calibration Updates
HXD Update 1

- **Energy response**
  - No major update
  - Next step: tune Gd Kα structure in PIN response
  - on-going Geant4 simulations of Gd K contribution from GSO to PIN, effect of event selection

- **Non X-ray background**
  - NXB systematic errors are 3% (PIN) and 1% (GSO) (Fukazawa et al 2008)
  - PIN NXB model v2.2 released, valid after August 2012
    NXB after 2014 August is under analysis (HXD ops)
HXD Update 2

• Time assignment
  
  • Absolute timing accuracy 270–360 μs for observations before 2012
  
  • Between 2012 and 2014, accuracy is ~3 msec, (cf. IACHEC 2014)
  
  • In Mar 2014, ground station bug fixed, but another error remains.
  
  • Timing accuracy after 2014 is not confirmed yet because of lacking HXD calibration obs; Crab calibration as a top priority for HXD.
Suzaku Status – Summary

- solar panels and battery continue to degrade
- XIS contamination continues to decrease
- if power becomes a problem, detectors will be turned off, but hope to go another 0.5–1.5 years
- Cycle 10 starts May 1, and is perhaps the last!