About *Suzaku* version 0.7 processing

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Abstract

Version 0 processing is a temporal version of the Suzaku data processing for the SWG members, before the official pipeline processing (ver 1.0) is established. The major difference of version 0.7 from version 0.6 is that the latest CTI parameters are used for the XIS data. On the other hand, the quality of the HXD data is almost the same as that of version 0.6, and hence, we will not reproduce HXD background files for version 0.7.

1 Flow of Creating First FITS File

1.1 Flow

1. Create RPT file with *astetimeset*, using full data stored in the SIRIUS database. Drift of the clock of the mission data processor is now properly incorporated, though its calibration is under study now. Note that RPT files will never become public. They are just used to create first FITS files and to test mk1stfits software.

   - *astetimeset* version: 2005-08-14

2. Create EHK (extended HK) file with *aemkehk*, with 1 s step, using the latest orbital elements, the commanded Euler angles, and XIS1 telescope definition file (2005-05-25). Note that no aspect correction is performed in Version 0. The orbital elements are those used for the operations (mean elements), not the ones used in the final processing (osculating elements), although the difference is negligible unless you need a timing accuracy of $\sim 20\ \mu$s or better.

   - *aemkehk* version: 2005-12-18

3. In the official processing, attitude determination is performed at this stage. In Version 0, however, it is not performed. Instead, fixed Euler angles are used in the later stages. Hence, **there could be a large error (> several arcmin) in the initial tens of minutes, before the star trackers are available**. It is highly recommended to check the image and/or light curve whether the attitude is stable or not.

4. Create First FITS file with *mk1stfits*.

   - *mkcom1stfits* version: 2005-11-06 or 2006-02-23
   - *mkhxd1stfits* version: 2005-11-09 or 2006-02-23
   - *mkxis1stfits* version: 2005-10-29 or 2006-02-23
   - *mkxrs1stfits* version: 2005-11-06 or 2006-02-23

2 Flow of Creating Cleaned Event File (1): XIS

2.1 Flow

1. Apply critical ftools of XIS (*xisucode*, *xiscoord*, *xisputpixelquality* and *xispi*) and create calibrated (or second) FITS file. At the moment, *xistime* and *xisputhkquality* are not ready, and hence are not applied.

   - *xisucode* version: 2005-10-30
   - microcode list file version: 2006-05-24 (This files is updated as needed.)
   - *xiscoord* version: 2005-12-26 (recompiled on 2006-05-24)
   - XIS0-3 teldef files version: 2006-01-25
   - *xisputpixelquality* version: 2005-12-26 (in XIS ftools package)
   - bad column file version: 2005-12-24
   - cal source mask file version: 2005-11-05
   - *xispi* version: 2005-12-26 (in XIS ftools package)
   - XIS0-3 makepi file version: 2006-05-22

   There are following limitations in the present XIS FITS file.

   - Fine tuning of the event time is not done yet.
   - For burst mode, exposure time has to be corrected manually.
   - Timing mode is not supported yet.
   - STATUS column is based on the information collected in the ground calibration, and newly appearing flickering pixels and bad columns are not marked properly. Users may have to perform cleansis by oneselves to remove residual flickering pixels.

2. Screen with *xselect* (filter column), using GRADE and STATUS information.

   - Criteria: GRADE=0:0 2:4 6:6 STATUS=0:131072

   Calibration source areas are not removed during the processing. SWG members are requested to do by oneselves if needed. If you are using *xselect*, type "filter column STATUS=0:65535".

   After we started version 0.7 processing, it turned out that STATUS=0:262143 should be used instead of STATUS=0:131072. However, since its effect is very small (< 1 % of the total events), we decided to use this criteria for version 0.7.

3. Screen with *xselect* (select hk), using common HK, to discard the data during maneuver.

   - Criteria: AOCU_HK_CNT3_NML_P==1

4. Screen with *xselect* (select hk), using XIS HK, to discard the data during data rate low.

   - Criteria: Sn_DTRATE < 3, where n=0, 1, 2, 3, depending on the sensor ID

   Note that, this is not applied for some initial data, when data rate low was used to obtain meaningful data.

5. Screen with *xselect* (select hk), using EHK, to discard the data during SAA. Note that SAA_HXD is an improved SAA indicator. After 2005 Nov 10, HXD and XIS operations follow SAA_HXD, instead of original SAA.

   - Criteria: SAA.eq.0 && T_SAA> 256 && SAA_HXD.eq.0 && T_SAA_HXD> 256 (before 2005 Nov. 10)
   - Criteria: SAA_HXD.eq.0 && T_SAA_HXD> 256 (after 2005 Nov. 10)
   - Criteria: SAA_HXD.eq.0 && T_SAA_HXD> 436 (after 2006 Jan. 23)

After this selection, the event file is saved as *****.evt, and supplied to SWG members, so that you can use your own criteria for data selection.

6. Then, cleaned events are selected with the following criteria:

   - Criteria: ELV> 5 && DYE_ELV> 20

   Note that these criteria may be too loose or too tight, depending on the spacecraft condition and on your scientific interest. It is recommended to find your own criteria. Also remember that no COR selection is performed. After this selection, the event file is saved as *****_cl.evt. An unbinned DETX/Y image is also created at this stage, for diagnostic purpose.

7. The night earth data are produced with the following tight criteria:

   - Criteria: ELV< −10 && DYE_ELV> 100

   The event file is saved as *****_nte.evt.

8. For the clean event file and the night earth event file, cleansis is applied. A revised version of the cleansis ftool is provided by Dr. Keith Arnaud. See "Notes on analyzing Suzaku data using XSELECT"[1]. This is now included in HEAsoft 6.0.6.

9. Create 8-binned X/Y image, read it with ximage, and save it with smooth/sigma=2 option.

10. For a calibration purpose, event files without CTI correction are also generated, as *****_nocti.ect.

2.2   Final products

The main products of the XIS data are:

- cleaned event file for each mode (_cl.evt.gz)

- 8-binned X/Y image in FITS format (_cl.img.gz)

- smoothed image in GIF format (_cl.gif)

Following products are stored in "more" subdirectory.

- un-binned DETX/Y image of cleaned event file before applying cleansis (_det.img.gz)

- event file before applying elevation selection (.evt.gz)

- cleaned night earth data for each mode (_nte.evt.gz)

- cleaned night earth data for each mode (_nte.evt.gz)

- cleaned event data without CTI correction (_nocti.evt.gz)

Naming convention of the event file has been slightly changed after version 0.3. It is like ae20051016_1620_1531_xis0_2x2 where 2x2 (or 3x3, 5x5) is the editing mode, n (or b) is the clocking mode (normal or burst), and 020 stands for the number of the microcode used in the digital processor.

2.3   How to create PHA files

Use xselect and create PHA file in a similar way with that of ASCA. To keep the consistency with response matrices, it is highly recommended to use a revised xselect.mdb. See "Notes on analyzing Suzaku data using XSELECT".

[CAUTION] Please ignore PI channel 500–504 for spectral fitting. This is because the gain gap due to Si K edge is not properly handled in xispi.

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[1] http://lheawww.gsfc.nasa.gov/users/kaa/xselect/suzaku.html

3 Flow of Creating Cleaned Event File (2): HXD

3.1 Flow

1. Apply critical ftools of HXD (*hxdtime*, *hxdmkgainhist_pin*, *hxdmkgainhist*, *hxdpi*, *hxdgrade*, and *hxdscltime*) and create calibrated (or second) FITS file.

   - *hxdtime* version: 2006-01-19
   - *hxdmkgainhist_pin* version: 2006-01-19
   - *hxdmkgainhist* version: 2006-01-19
   - *hxdpi* version: 2006-01-19
   - *hxdgrade* version: 2006-01-19
   - ae_hxd_gsolin_YYYYMMDD.fits: 2005-12-09
   - ae_hxd_pinlin_YYYYMMDD.fits: 2006-10-11
   - ae_hxd_gsopsd_YYYYMMDD.fits: 2006-01-19
   - ae_hxd_pinthr_YYYYMMDD.fits: 2006-01-19
   - ae_hxd_wampht_YYYYMMDD.fits: 2005-09-16
   - ae_hxd_gsoghf_YYYYMMDD.fits: 2006-05-22 2258

   The quality of the HXD data is almost the same as that of version 0.6.

2. Screen with *xselect* (filter column), using DET_TYPE information.

   - Criteria: DET_TYPE=0:1

3. Screen with *xselect* (select hk), using common HK, to discard the data during maneuver.

   - Criteria: AOCU_HK_CNT3_NML_P==1

4. Screen with *xselect* (select hk), using EHK, to discard the data during earth occultation, SAA, etc.

   - Criteria: ELV> 5 && SAA_HXD.eq.0 && T_SAA_HXD> 500 && COR> 8

5. Screen with *xselect* (select hk), using HXD HK, to discard the data during data rate low (HXD_DTRATE< 3) and high voltages are below 700 V.

   - Criteria: HXD_DTRATE< 3 && HXD_HV_W[0..3]_CAL> 700 && HXD_HV_T[0..3]_CAL> 700

6. Save cleaned event files. The cleaned event files are further split into two files, one is that of PMT events (DET_TYPE=0) and the other is that of PIN events (DET_TYPE=1).

3.2 Final products

- cleaned PIN event file (_wel_pin_cl.evt.gz)
- PIN PHA file (_wel_pin_cl.pha.gz)
- cleaned GSO event file (_wel_gso_cl.evt.gz)
- GSO PHA file (_wel_gso_cl.pha.gz)
- all PIN event file (_wel_pin_all.evt.gz)
- all GSO event file (_wel_gso_all.evt.gz)
- pseudo event file (_wel_pseudo.evt.gz)

3.3 How to create PHA files

If you use *xselect* to create PHA files, you may have to set PHANAME to PI_SLOW (or PI_PIN) for GSO (or PIN) event files, before you bin spectrum.