Description of the HXD calibration files for the rev 1.0 data

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1 Introduction

This document is intended for guest observers to get minimum required information about the HXD CALDB files in order to analyze the Suzaku HXD data.

1.1 Critical FTOOLS used in the pipe-line processing

`hxdtime`
`hxdpi`
`hxdgrade`

2 Energy Scale Files

2.1 Files

`ae_hxd_pinlin_20051011.fits`
`ae_hxd_gsolin_20051125.fits`

2.2 Description

The `ae_hxd_pinlin_YYYYMMDD.fits` file contains both of the integrated non-linearity (INL) correction table (ADCINL extension) and the energy-channel conversion coefficient for individual PIN detectors (GAIN extension). The ADCINL table is based on the on-ground measurement of the analog electronics, while the energy scale is calibrated based on the in-orbit data.

The `ae_hxd_gsolin_YYYYMMDD.fits` file contains two types of the non-linearity correction table, one is the differential non-linearity (DNL) of the A-D converter (ADCDNL extension), and the other is the integral non-linearity (INL) of the analog electronics (ADCINL extension). Since they are different from channel to channel, both of ADCDNL and ADCINL extension consists of 32 tables for two types of PHAs (Fast and Slow) from 16 well units.

2.3 Where are they used?

Together with the Gain History Files (§3), these are used by `hxdpi` to convert PHA channels into PI channels.

3 Gain History Files

3.1 Files

`ae_hxd_pinghf_20051125.fits`
`ae_hxd_gsoghf_20051126.fits`

3.2 Description

The ae_hxd_pinghf_YYYYMMDD.fits file is required for hxdpi, but is not used in the first HEADAS release version (version 1.0). In case of the long-term trend of PIN gain is found, it will contain the correction table.

The ae_hxd_gsoghf_YYYYMMDD.fits file contains the gain history of GSO. This file is frequently updated by the detector team, about once par month, by adding new time intervals. Since the information is not latest at the time of automatic pipe-line processing, it is recommended to re-process of hxdpi (and hxdgrade after that) with newer ae_hxd_gsoghf_YYYYMMDD.fits in analysis of GSO data. By utilizing the activation peaks in the in-orbit background spectra of GSO, a linear energy scale can be obtained. This table consists of the peak channel of three peaks; 150 keV line from EC-decay of 153Gd (activation of GSO), 350 keV peak from alpha-decay of 152Gd (natural isotope), and the annihilation line at 511 keV (activation of surrounding BGO). Since all of them are extracted from observation averaged spectra, the short-term variability of PMT gains are not taken into account.

3.3 Where are they used?

Together with the Energy Scale Files (§2), these are used by hxdpi to convert PHA channels into PI channels (PI_SLOW, PI_FAST, and PI_PINn; n=0,1,2,3,null).

4 Grade Determination Files

4.1 Files

ae_hxd_pinthr_20050916.fits
ae_hxd_gsopsd_20051116.fits

4.2 Description

The ae_hxd_pinthr_YYYYMMDD.fits file contains the lower threshold channels (PI) for PIN events. Since the interference noises affect the lower energy range of some PIN detectors, these regions should be excluded from the cleaned events. This file is used by hxdgrade to fill the GRADE_PINTRG column.

The ae_hxd_gsopsd_YYYYMMDD.fits contains the selection criteria of pulse-shape discrimination (PSD) for GSO events. The background events caused by cosmic-rays or Compton scattered photons can be distinguished by use of PI_FAST, PI_SLOW and this table. This file is used by hxdgrade to fill the GRADE_PSDSEL column. This consits of 16 tables for individual well units.

4.3 Where are they used?

They are used in hxdgrade to fill GRADE_PINTRG and GRADE_PSDSEL columns.

5 Response Matrices

5.1 Files

ae_hxd_pinhxnom_20051104.rsp
ae_hxd_pinxinom_20051104.rsp

ae_hxd_gsohxnom_20051117.rsp
ae_hxd_gsoxinom_20051117.rsp

5.2 Description

The ae_hxd_pinhxnom_YYYYMMDD.rsp and ae_hxd_pinxinom_YYYYMMDD.rsp are on-axis response matrices for PIN events at the nominal position of HXD and XIS, respectively. Since the lower threshold modeling is not yet optimized, the "20051104" version files are applicable only above 12 keV.

The ae_hxd_gsohxnom_YYYYMMDD.rsp and ae_hxd_gsoxinom_YYYYMMDD.rsp are on-axis response matrices for GSO events at the nominal position of HXD and XIS, respectively. Since there are still large uncertainties of GSO data in rev 1.0 process, especially at lower energy range below 70 keV, these matrices can be used only for trial. Newer version responses are now under verifications for rev 1.1 data.

6 Arf Database Files

6.1 Files

ae_hxd_pinart_20051126.fits
ae_hxd_gsoart_20051126.fits
ae_hxd_teldef_20050908.fits

6.2 Description

The ae_hxd_pinart_YYYYMMDD.fits contains relative PIN effective areas at individual offset angles from the optical axis. They are calculated by use of the GEANT4 Monte-Carlo simulation toolkit, together with a mass-model of an idealized well-type phoswich counter of HXD. Incident energy is separated so as to correspond with the definition of PI for PIN. The calculation is performed at offset angles of 0 to 240 arcmin with a five arcmin separation.

The ae_hxd_gsoart_YYYYMMDD.fits contains relative GSO effective areas at individual offset angles from the optical axis. They are calculated by use of the GEANT4 Monte-Carlo simulation toolkit, together with a mass-model of an idealized well-type phoswich counter of HXD. Incident energy is separated so as to correspond with the definition of PI for GSO. The calculation is performed at offset angles of 0 to 500 arcmin with a five arcmin separation.

The ae_hxd_teldef_YYYYMMDD.fits includes the definition of the HXD nominal position to the optical axis of Suzaku (the XIS nominal position). Since HXD is not an imaging instrument, the DET_X/YSCL are determined so that the one pixel corresponds to the same angular separation as the CCD pixel of XIS. In the table extension, the angular differences between the HXD nominal position to the individual PIN/GSO axes are listed. The information of PIN diodes is based on the alignment measurements of 64 fine collimators (FCs) by the multi-pointing observations of Crab nebula. The axes for GSOs are the average of the corresponding optical axises of 4 FCs.

6.3 Where are they used?

These files will be used by hxdarfgen, which is not included in the first HEADAS release version (version 1.0).

7 WAM Files

7.1 Files

`ae_hxd_wampht_20050916.fits`

7.2 Description

This file contains the setting of on-board PHA binnings of the Wide-band All-sky Monitor (WAM), which can be applied to reduce the data size. It consists of four setting tables which are same as those stored in the HXD-DE (which is the on-board electronics for the HXD). Note that the data reduction utility of HXD-DE is not used in orbit at the time of the first release date of HEADAS.

7.3 Where are they used?

This is used by `hxdwampi`.