ASTRO-H

Instrument Calibration report
HXI Bad/Threshold
ASTH-HXI-CALDB-BADPIX

Version 0.1

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JAXA / GSFC

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Table of Contents

CHANGE RECORD PAGE

DOCUMENT TITLE : HXI Bad/Threshold			
ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Version 0.1	November 2015	All	First Release

Introduction

1.1 Purpose

This document describes how the Bad/Threshold CALDB of the Hard X-ray Imager (HXI) is prepared. The CALDB file structure is define in the ASTH-SCT-04 and available from the CALDB web page at http:// hitomi.gsfc.nasa.gov.

1.2 Scientific Impact

The double-sided Si detector (DSSD) and double-sided CdTe detector (CdTe DSD) used in the HXI have channels with relatively lower sensitivity, or higher noise level compared to the majority of the remaining channels, of which data cannot be used for scientific analyses. Bad channels defined in the Bad/Threshold CALDB represent such channels so that signals emitted from bad channels will not be used in event reconstruction in HXI FTOOLS (hxisgdpga/hxietid).

Threshold values contained in the Bad/Threshold CALDB of the HXI will be used in the event reconstruction process (hxievtid) to detect valid signals emitted from each readout strip of DSSD and/or CdTe DSD. Signals that have energy deposits, or ADC channels more precisely, larger than the threshold defined in the Bad/Threshold CALDB will be only considered in the event reconstruction. Signals with energy deposits smaller than the threshold value will be discarded.

Temporal degradation of noise level performance in either or both of Si/CdTe sensors and/or signal amplifier ASIC (application specific integrated circuit) in the HXI electronics, in orbit, will require an update of the Bad/Threshold CALDB.

Release CALDB 20160310

Filename	Valid date	Release date	CALDB Versions	Comments
ah_hx1_badpix_20140101v001.fits	2014-01-01	20160310	001	
ah_hx2_badpix_20140101v001.fits	2014-01-01	20160310	001	

2.1 Data Description

Bad channels
Bad channel definition contained in the current release is based on the result of the selection of DSSD and CdTe DSD for flight model sensors of HXI1 and HXI2. Designated bad channels are readout channels that lie on the edge of the DSSD and the CdTe DSD sensor chips (i.e. the first and the last readout channel of each side of DSSD and CdTe DSD); it is commonly known or experienced that the edge readout channels of position-sensitive semiconductor sensor or CdTe sensor are suffered from (relatively) larger noise or dark current compared to the other channels. Each sensor chip has two bad channels on a side and another two on the other side making total four bad channels per sensor chip. Therefore, 20 readout channels in total are flagged as Bad in the current CALDB in one HXI sensor, and signals from those readout channels will be discarded in the pulse-height assignment and the event reconstruction phases.

	READOUT_ID_RMAP of bad channels	Total (ch)
HXI1	0, 127, 128, 255, 256, 383, 384, 511, 512, 639, 640, 767, 768, 895, 896, 1023, 1024, 1151, 1152, 1279	20
HXI2	0, 127, 128, 255, 256, 383, 384, 511, 512, 639, 640, 767, 768, 895, 896, 1023, 1024, 1151, 1152, 1279	20

Threshold

The threshold energies contained in the current release were determined based on the noise level observed during the ASTRO-H spacecraft-level thermal-vacuum (TVAC) test campaign in July 2015. The HXI1 and the HXI2 were cooled down in the thermo-vacuum chamber and were operated under the "read-out all" mode to record pulse heights of all readout channels including those of channels that do not have real energy deposit by X-ray. The pulse heights from non-X-ray-detecting readout channels are used to construct noise energy spectra (distribution of pulse heights created by electrical noise of the readout channel), and then the spectra were fitted with a gaussian function to determine the width of the distribution. To discard most of "highly-possibly noise" events, threshold values are set at four times (DSSD) or six times (CdTe DSD) of the standard deviation of the best-fit gaussian of each readout channel. This threshold provides a 99.9968% rejection probability against the noise being treated as a valid energy deposit by X-ray.

2.2 Data Analysis

Threshold

Event list files analyzed to determine the noise spectrum of each readout channel are the following. These data were obtained during the ASTRO-H TVAC test campaign in July 2015 with HXI in the "read-out all" mode.

- HXI1: HXI1_PedestalHist_20150626.root
- HXI2: HXI2_PedestalHist_20150626.root

Analyses were performed using the ROOT analysis framework internally developed by the HXI team. Pulse-height, i.e. PHA-ASIC_CMN (the common-mode noise of the ASIC of which the readout channel belongs to), recorded for non-X-ray-detecting readout channel (i.e. readout channels except for the self-triggering one) are accumulated into histograms. Figure 1 shows an example noise spectrum of a readout channel in the P-side of the top-layer DSSD. The noise distribution is fitted with a gaussian function, and the standard deviation is derived: for this example, standard deviation for the left panel is 0.41 keV. This number is multiplied by four, and an energy threshold for this particular channel becomes 1.64 keV.

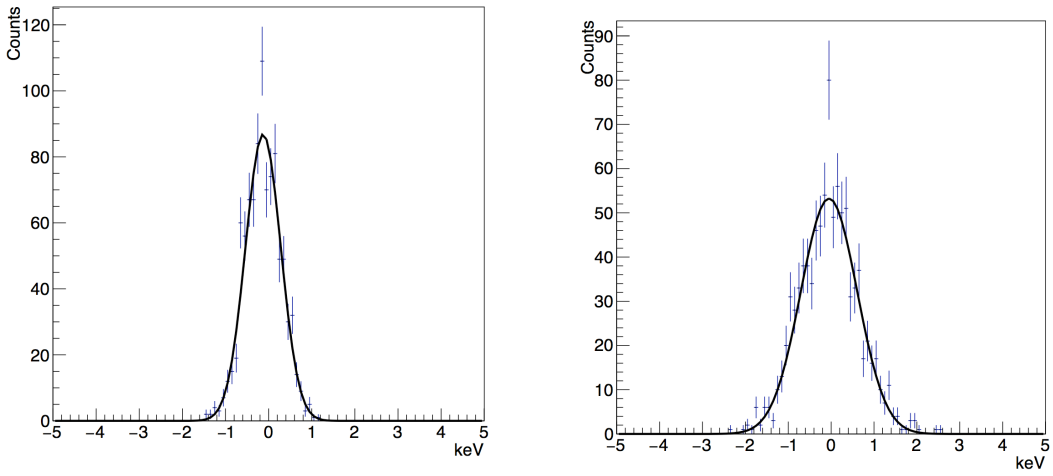

Figure 1. Example noise spectrum of a readout channel of the HXI1; noise spectrum of READOUT_ID_RMAP 32 (left) and that of READOUT_ID_RMAP 1113 (right).

2.3 Results

Figures 2 and 3 present histograms of the energy threshold of the HXI1 and HXI2 for the five layers.

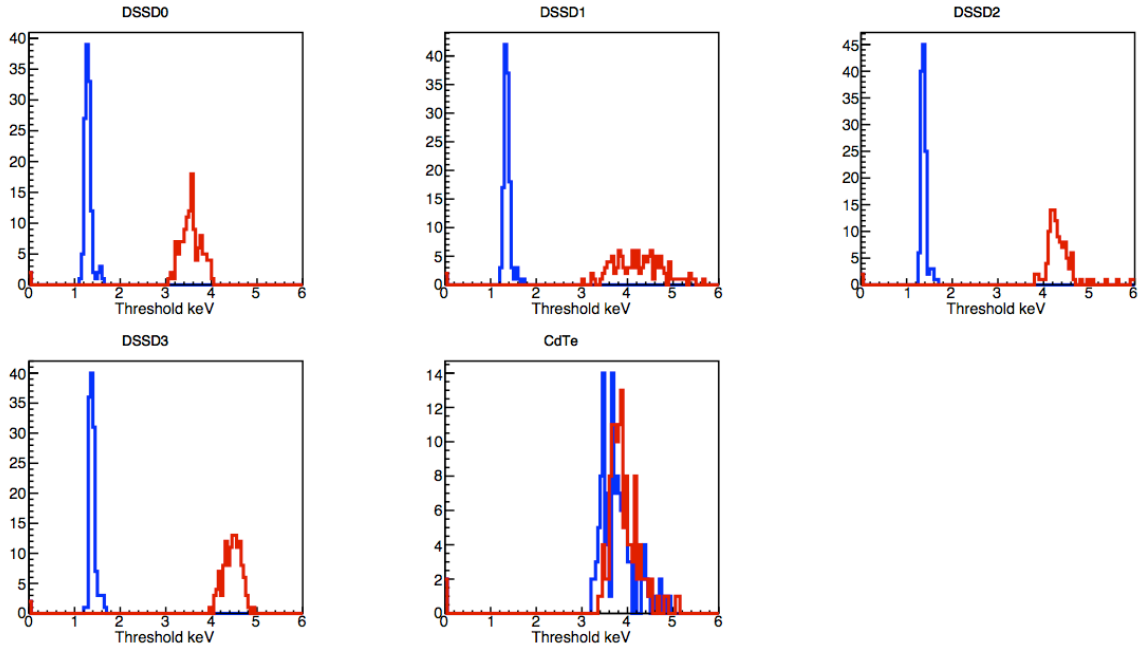

Figure 2. HXI1 energy threshold contained in the current Bad/Threshold CALDB.

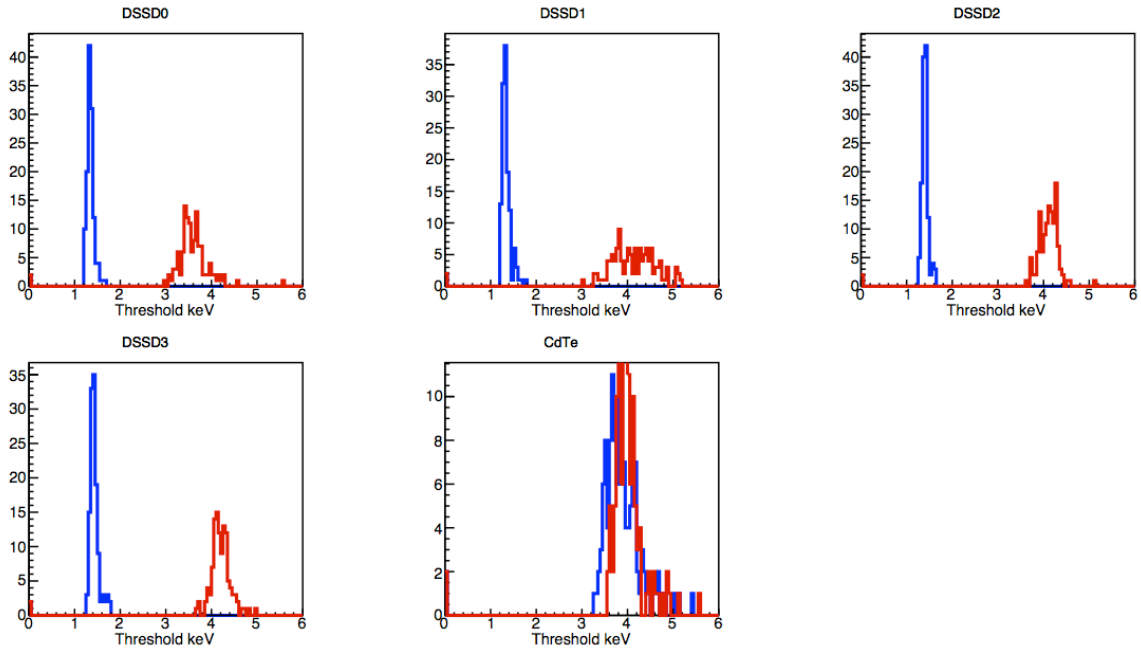

Figure 3. HXI2 energy threshold contained in the current Bad/Threshold CALDB.

2.4 Comparison with previous releases

Not applicable because this is the first release of the Bad/Threshold CALDB file of the HXI.

2.5 Final remarks

The following summarize the current release of the Bad/Threshold CALDB files.

- In each of the HXI sensors, there are 20 “bad” channels of which output signals will be discarded in the pulse-height assignment and the event reconstruction stages (hxisgdpha/hxievtid) are defined. They are located on the edge of the DSSD and the CdTe DSD sensor chips.
- Energy threshold values were determined from the data taken during the on-ground TVAC test in July 2015. Threshold is set at the four times of the standard deviation of the gaussian function fitted to the noise distribution spectrum.