ASTRO-H

# Instrument Calibration report
# HXI Fluorescence Line
# ASTH-HXI-CALDB-LINE

Version 0.1

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**JAXA / GSFC**

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# Introduction

## 1.1 Purpose

This document describes how the Fluorescence Line 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 Fluorescence line escape events

The HXI Camera part consists of a vertical stack of four double-sided Si detectors (DSSDs) and one double-sided CdTe detector (CdTe DSD) each of which has 128 separated readout channels on both sides of the sensor chips. When an X-ray is detected within the HXI Camera, electrical signals from the two sides of a sensor chip should be merged to determine a two dimensional detection position and incident energy, and hxievtid FTOOL implements this task. In the energy band covered by the HXI, almost all (~97-98%) events are detected as a single photo absorption. While, a small fraction of events are detected as a fluorescence escape event where an X-ray is photo absorbed by CdTe DSD and a fluorescence line photon from Cd or Te escapes the detector followed by a photo-absorption detection in one of the upper DSSD. Such a fluorescence-escape photo-absorption events should be recognized and specially treated in the event reconstruction process to determine the detection position on the CdTe DSD and an incident energy (the sum of energy deposits in the CdTe DSD and the DSSD).

For enabling the fluorescent-escape-event reconstruction, the Fluorescence Line CALDB defines energy ranges within which energy deposit in DSSD is treated to be caused by a fluorescence line from Cd or Te. Having this CALDB, the reconstruction implements the following algorithm:

**Algorithm of Fluorescence Escape Reconstruction sub-task**

1. A double-hit event having one hit in the CdTe DSD and the other in the DSSD, as an example shown in Figure 1, is recorded.
2. Based on acceptable energy ranges defined in the Fluorescence Line CALDB, judge whether an energy deposit in the DSSD is consistent with K-shell fluorescence line of Cd or Te.
3. If true, this event is accepted. Sum the energy deposits of the two hits in the CdTe DSD and the DSSD, and treat CdTe DSD hit position as the detection position of this event. If false, this event is rejected.

Although the fluorescence line energies (from Cd and Te) are constant and not time variable, the defined energy range may be updated based on the potential long-term temporal degradation of the energy resolution of the DSSD.

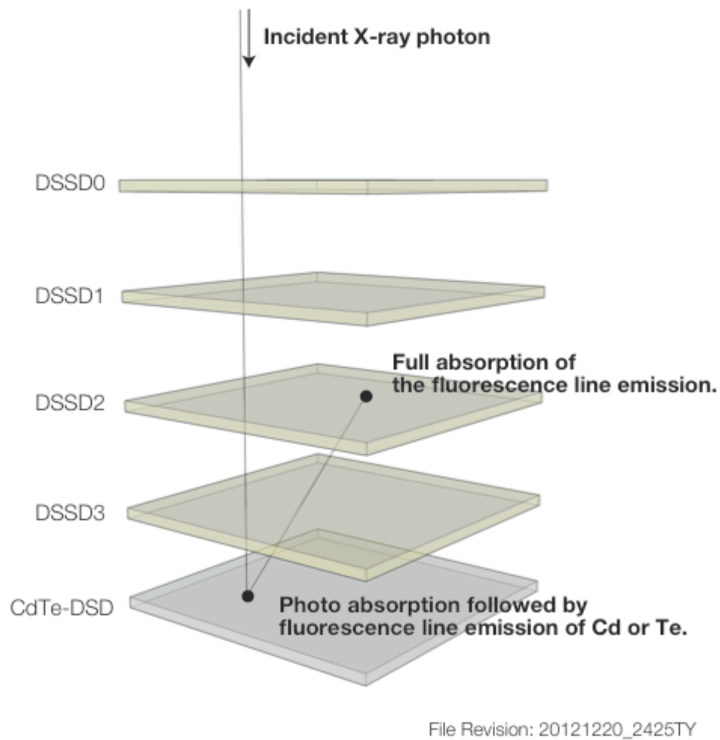


Figure 1. An example fluorescence escape event where an escape line photon is absorbed by the DSSD.

### 1.3 Scientific Impact

The Fluorescence Lien CALDB can in principle affect the quantum efficiency of the HXI Camera and therefore the effective area of the HXI.

## Release CALDB 20160310

| Filename | Valid date | Release date | CALDB Versions | Comments |
|---|---|---|---|---|
| ah_hxi_line_20140101v001.fits | 2014-01-01 | 20160310 | 001 | |

### 2.1 Data Description

Table 1 summarizes line energies relevant to the HXI.

Table 1. Energies of the Cd and Te fluorescence lines.

| Line | Energy | Line | Energy |
|---|---|---|---|
| Cd Kα1 | 23.1737 | Te Kalpha1 | 27.4724 |
| Cd Kα2 | 22.9842 | Te Kalpha2 | 27.2018 |
| Cd Kβ1 | 26.0947 | Te Kbeta1 | 30.9951 |
| Cd Kβ2 | 26.6443 | Te Kbeta2 | 31.7036 |

To reduce the number of entries in the CALDB, the fluorescence line energies of Kalpha1/Kalpha2, and Kbeta1/Kbeta2 are averaged and stored. The min/max values are first calculated for Kalpha1/2 and Kbeta1/2 separately, using a range (-2.76 keV, +1.27 keV) centered on the individual line energies listed above. This range is set to include the (typical) energy resolution of the DSSD, and tail caused by the charge share among adjacent readout channels in the detector. Then, the smaller value of the two min values for Kalpha1 (or Kbeta1/2) and the larger value of the two max values are chosen to be filled to the LINEMIN/LINEMAX columns. This is 'merging' was recommended by the Software Calibration Team based on the fact that the energy ranges from LINEMIN to LINEMAX almost overlap for Kalpha1/alpha2 (and Kbeta1/Kbeta2 as well).

Table 2 lists resulting averaged line energy center and the minimum/maximum energy limits of the energy range contained in the current release.

| | **Average (keV)** | **Min (keV)** | **Max (keV)** |
|---|---|---|---|
| **Cd Kα** | 23.0790 | 20.2242 | 24.4437 |
| **Cd Kβ** | 26.3695 | 23.3347 | 27.9143 |
| **Te Kα** | 27.3371 | 24.4418 | 28.7424 |
| **Te Kβ** | 31.3494 | 28.2351 | 32.9736 |

### 2.2 Data Analysis

Not applicable.

### 2.3 Results

Not applicable.

### 2.4 Comparison with previous releases

Not applicable.

### 2.5 Final remarks

Not applicable.