ASTRO-H

INSTRUMENT CALIBRATION REPORT
SXI RESPONSE MATRIX FILE
ASTH-SXI-CALDB-RMFPARAM

Version 0.4

08 March 2016

ISAS/ GSFC

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CHANGE RECORD PAGE

DOCUMENT TITLE : SXI Response Matrix File			
ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Version 0.4	March 2016	All	First Release

Introduction

1.1 Purpose

This document describes the data with which the response matrix (the gain and the line spread function) of the Soft X-ray Imager (SXI) is determined, the parameter definition in the CALDB file, and several remarks. The CALDB file structure is defined in the ASTH-SCT-04 and available from the CALDB web page at http:// hitomi.gsfc.nasa.gov.

1.2 Scientific Impact

The events regarded as X-rays are selected with Grade method as same as Suzaku/XIS. The line spread function of good grade events are understood to have several components besides the Primary Gaussian, Secondary Gaussian, Constant components, as well as Si escape and Si Kα line (Figure 1). The CALDB provides the line width and the relative intensity of each component as a function of the incident X-ray energy. The estimation of the line center and line width influence the physical parameters such as redshift and gas motion along the line of sight, respectively. The intensity of the constant component also affects the flux measurement of the continuous emission from astronomical objects.

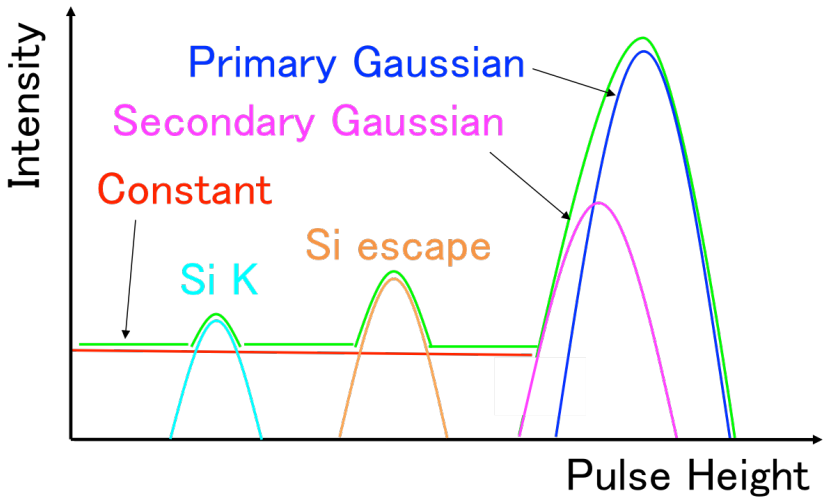

Figure 1 : Schematic line spread function of SXI for monochromatic X-rays

The CCD chips have several regions with relatively low CTE (charge transfer efficiency). The line spread function consisting of the events extracted from these regions different from those in the other regions. We define the border of these regions using the data obtained with the flight model camera (See 2.2). When a user specifies a photon-extracting region across the border, the parameters of the line spread function will be weighted averages according to the number of the X-ray events in each region.

2 Release CALDB 20160310

Filename	Valid data	Release data	CALDB Vrs	Comments
ah_sxi_rmfparam_20140101v001.fits	2014-01-01	20160310	001	

2.1 Data Description

The data are obtained with the following experiments; a calibration experiment of the flight model (FM) camera performed at Kyoto University on August 2014, and an experiment at a beam facility of KEK with the engineering model chips on December 2014. Frame data were taken in the both experiments. During both of the tests, the CCD chips were cooled down to －110℃. Although the incident X-rays were not monochromatic, the gain and the line-spread function of all segments were successfully evaluated. Table 1 shows the list of the X-ray energies used for the analysis.

ID	X-ray energy (keV)	Beam line ID	X-ray energy (keV)
F K	0.6786	KEK BL-11A	0.500
Ge L	1.1880	KEK BL-11A	0.800
^{55}Fe (Mn K α)	5.8988	KEK BL-11B	1.830
Ge K	9.8864	KEK BL-11B	1.850

2.2 Data Analysis

The data were analyzed with the software prepared by SXI instrument team (sxiDL). Pulse height corrections for “charge trail” and “charge trail inefficiency” are applied prior to the analysis. Several key parameters for the event selection and Grading are as follows: “Event Threshold Lower” of 30ch, “Dark Upper/Lower Threshold” of ＋/－15ch, and “Hot Pixel Threshold” of 1000ch. The events with good Grade (02346) are used.

2.3 Results

We found that some regions exhibit relatively low charge transfer efficiency (CTE), which results in the degraded energy resolution as shown in the solid and dashed light green rectangles (Figure 2). Combining the data of FM calibration and KEK beam line facility, the pulse height and the FWHM are derived as shown in Figure 3. The deviation of the pulse height from the linear function at the energy of ^{55}Fe is about 1ch, corresponding to ～0.1%. The dispersion of FWHM among segments is about 10%. We derived the intensity of each spectral component (Figure 4) as a function of X-ray energy or attenuation length. The fit results for ^{55}Fe data with the latest CALDB is shown in Figure 5.

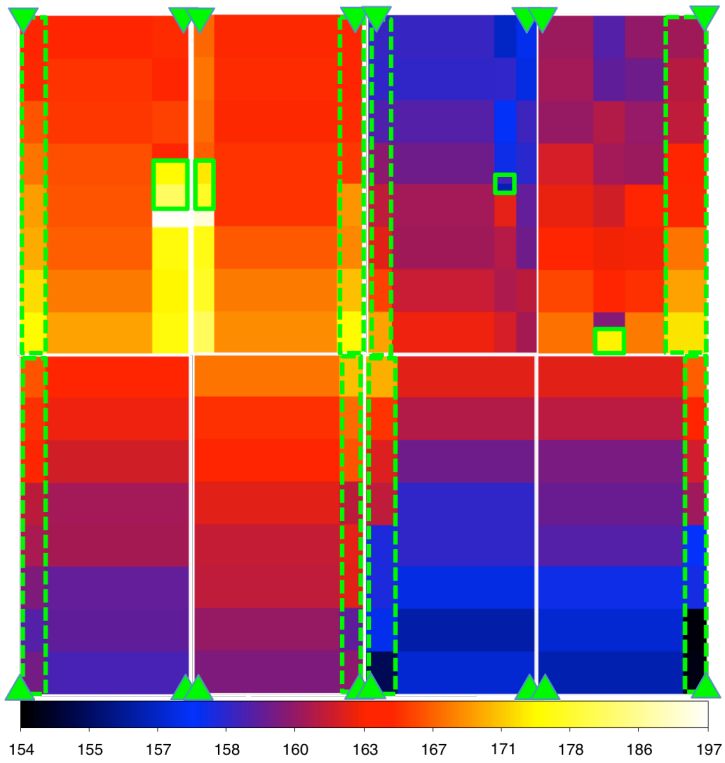

Figure 2 : Distribution of the FWHM @ 5.9keV of the primary Gaussian (Look down view). Rectangles with solid and dashed light-green lines are regions with relatively low CTE. Triangles show the positions of readout nodes.

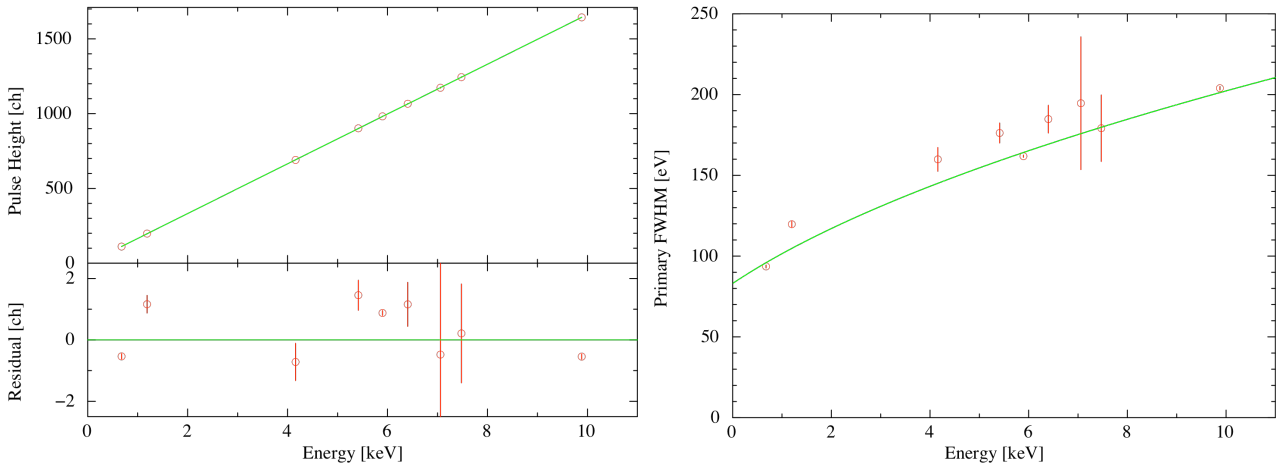

Figure 3 : (Light panel) Relation between pulse height and X-ray energy. (Right panel) FWHM of the primary Gaussian as a function of X-ray energy. The data of CCD2 Segment AB is used for both panels.

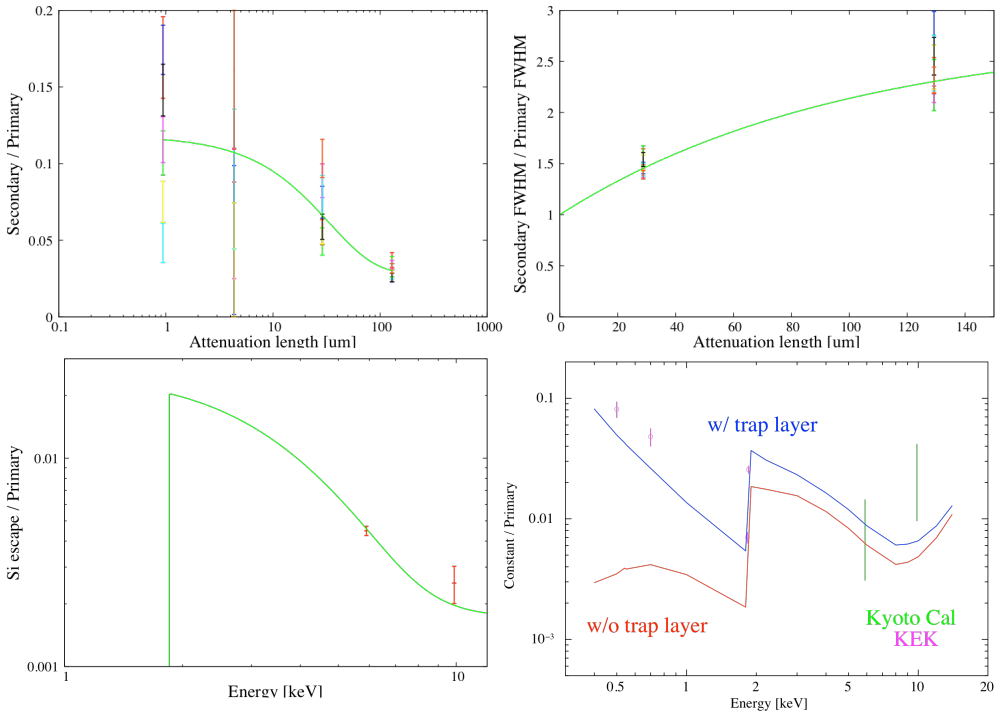

Figure 4 : Ratios of various components in the line spread function as a function of X-ray energy or attenuation length of X-rays. (Top panels) Data of different segments are shown with separate colors. (Bottom left panel) Only the data of CCD2 segment AB is shown. Green line is derived not from the model fit but from a numeric calculation considering the pixel size. (Bottom right panel) A trap layer is needed to reproduce the data of constant component, which is shown with blue and red lines. Only the data of CCD2 segment AB is shown for Kyoto Cal. data.

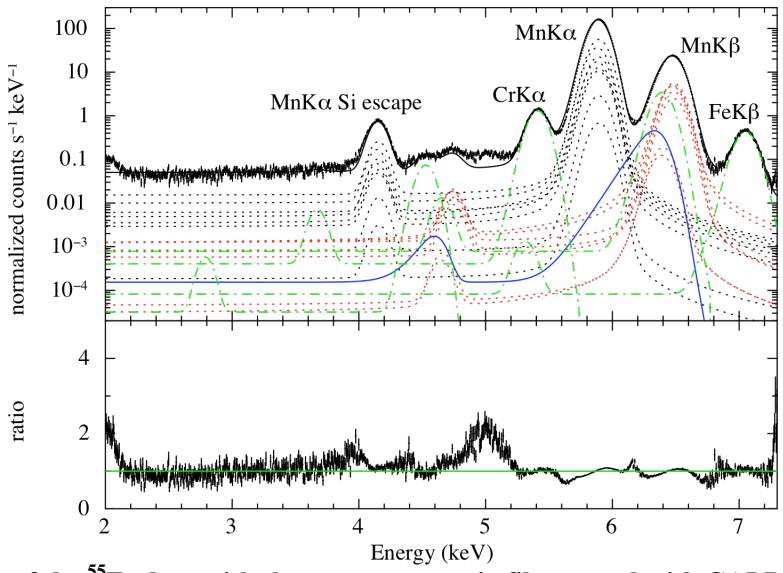

Figure 5 : Fit result of the ^{55}Fe data with the response matrix file created with CALDB ver.2016**. Black and red dotted lines are the model components for Mn K α and K β , respectively. Relations between each line are referred from SXS ground test data. Blue component is also required to explain the test data. Green dotted components reproduce the emission lines from Fe K α , Fe K β , Cr K α , and Ti-K α .**

2.4 Final remarks

This is the first release of this CALDB file based on ground measurements.