ASTRO-H

INSTRUMENT CALIBRATION REPORT
DOCUMENT TITLE
ASTH-SGD-CALDB-RMF

Version 0.1

DATE Dec 2017

JAXA / GSFC

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ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Version 0.1	Dec 2017	All	First release

Introduction

1.1 Purpose

This document describes how the CALDB of response matrix file (RMF) is prepared. The CALDB file structure is define in the ASTH-SCT-04 and available from the Hitomi CALDB web page at https://hitomi.gsfc.nasa.gov/docs/hitomi/caldb/.

1.2 Scientific Impact

The SGD response file (RSP) is generated from this RMF file with multiplying the transmission efficiency of Fine Collimator and BGO shield (generated by sgdarfgen ftool) for each of 6 CCs in SGD1 and 2. Since SGD does not have an imaging capability, there is no need to perform any modification for the RMF by users. The input angle dependency of the source is treated with the ARF by sgdarfgen.

However, due to the limitation of the in-flight data and the high voltage of CdTe detectors of SGD2 CC2 and CC3 is off during Crab observation, the RMF files are prepared for the only 4 CCs of SGD1 CC1, CC2, CC3 and SGD2 CC1.

2 Release CALDB 20171211

Filename	Valid date	Release date	CALDB Versions	Comments
ah_sg1cc1_rmf_20140101v002.fits	2015-01-01	2017-12-11	002	
ah_sg1cc2_rmf_20140101v002.fits	2015-01-01	2017-12-11	002	
ah_sg1cc2_rmf_20140101v002.fits	2015-01-01	2017-12-11	002	
ah_sg2cc1_rmf_20140101v002.fits	2015-01-01	2017-12-11	002	

2.1 Data Description

No observational data are used to generate the RMF files. Only the simulation data written below are the input.

2.2 Data Analysis

The RMF file of SGD are generated by Monte Carlo simulation since Compton scattering and secondary emissions are non-negligible in soft gamma-ray bands. The simulations are performed in following steps:

1. Calculate energy deposits on the detectors by utilizing Monte Carlo simulation for interactions of photons with detectors and passive materials
2. Calculate pulse height from the energy deposits with a simulation of charge transportation in the semiconductor detectors
3. Convolve the pulse height with read-out noise
4. Event reconstruction (algorithm is identical to sgdevtid ftool)

This simulation code is based on an integrated response generator "ComptonSoft" (Odaka et al. 2010; https://github.com/odakahirokazu/ComptonSoft).

The Monte Carlo simulation part is based on the Geant4 toolkit library (Agostinelli et al. 2003; Allison et al. 2006), which is widely used for the particle tracking in high-energy physics. Since the detector geometry strongly affects the detector response, a detailed mass model of the SGD is implemented. Most of the passive materials as well as the main detector module and BGO active shields are included. Since there are no enough information to calibrate the alignment of the Fine Collimators in flight, the ideal setup is assumed. This could result in the measurements of the lower source flux, if there is some misalignment.

To obtain the RMF file, the simulated photons are generated in a horizontal plane with a size of Si-Pad detector (5.4 x 5.4 cm^2) located above the entrance window. All the photons have an initial direction to the detector along the optical axis. The noise parameters are obtained from the experimental data. The spectra for each read-out channel were subtracted from the data after the gain correction with the latest gain CALDB.

The event selection of the RMF file is the same as the celestial source analysis, and the following selections are applied after sgdevtid process.

- 1^{st} hit of the Compton events is required at Si, to reduce the major background.
- Uncertainty of the reconstructed source position from the field-of-view center (OFFSET column in FITS) is within 30 degrees.
- The Compton scattering angle is limited between 50-150 degrees, since the perpendicular scatter is more probable than the forward scattering in the lower energy band.

2.3 Results

Fig. 1 shows the spectral fit result of Crab (ObsID=100044010, exposure of ~5 ks) in 60-160 keV, with the power-law model of Γ=2.1 fixed. The background is subtracted from 1-day before observation (ObsID=100043060) during the same satellite orbit. The obtained normalization is shown in Table 1. They are slightly different among CCs, and lower than the nominal Crab value (the single power-law model of Γ=2.1, Normalization at 1 keV=10) below 10 keV. This could be due to the misalignment of Fine Collimators (current analysis assumes the ideal situation), the simulation uncertainty, and/or Crab might have the softer slope in 60-160 keV than that in the lower energy band.

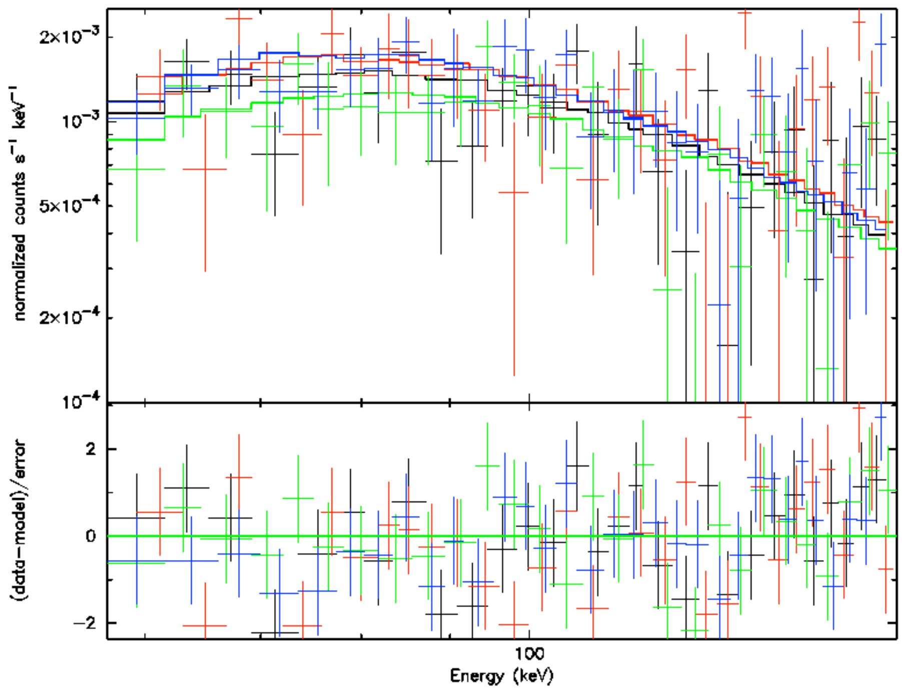

Fig. 1. 60-160 keV spectral fitting results of Crab observations for each of 4 CCs (SGD1 CC1 (black), CC2 (red), CC3 (green) and SGD2 CC1 (blue)). The power-law index is fixed at 2.1.

Detector	Count rates	Normalization@1 keV
SGD1 CC1	0.102 $\pm$0.008	7.52 $\pm$0.56
SGD1 CC2	0.114 $\pm$0.008	8.39 $\pm$0.62
SGD1 CC3	0.089 $\pm$0.007	7.04 $\pm$0.59
SGD2 CC1	0.114 $\pm$0.008	7.93 $\pm$0.52

Table 1. Observed count rate and estimated flux of Crab in 60-160 keV, for each of 4 CCs (SGD1 CC1, CC2, CC3 and SGD2 CC1). The power-law index is fixed at 2.1. The error size is 1 sigma.

2.4 Comparison with previous releases

The previous version (v001) depends on the ground calibration. The current update includes the latest calibration information and is more reliable/calibrated.

2.5 Final remarks

N/A