ASTRO-H

INSTRUMENT CALIBRATION REPORT
SXS MID RES SECONDARY PHA CORRECTION
ASTH-SXS-CALDB-SECPULSE

Version 0.1

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ISAS/ GSFC

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1 Introduction

1.1 Purpose

This document describes the Astro-H secpulse caldb file for SXS midres secondary PHA correction, ah_sxs_secpulse_yyyymmddvnnn.fits, what the caldb data are and how they were determined.

1.2 Scientific Impact

The midres secondary events when appropriately corrected can improve spectral statistics within a limited observation period.

2 Release CALDB 20160606

Filename	Valid data	Release data	CALDB Vrs	Comments
ah_sxs_secpulse_20140101v003.fits		2016-06-03	3	SXS Secondary Pulse

2.1 Data Description

The secpulse caldb file is used by *sxsseccor* to correct PHA values for midres secondary events before gain correction after event grade assignment. Its file structure is shown in Table 1. This caldb file contains 10 normalized average pulse waveforms in 1024 bins of 80 μs for each pixel, one each for a specified energy range, plus other parameters listed in Table 1. The cal pixel (pixel 12) has only two average pulse waveforms covering two energy ranges around MnKα and MnKβ.

Table 1 SECPULSE caldb file structure

Column names	Description
PIXEL	Pixel number (0-35)
ENERANGE	Energy group index
PHAMIN	Minimum PHA value for the energy group
PHAMAX	Maximum PHA value for the energy group
OFFSET	Time offset in 80 us used in the correction (bin index at the pulse peak)
PULSE	Array of pulse amplitudes (pulse waveform of record length 1024 bins)

Data in this caldb file, ah_sxs_secpulse_20140101v003.fits, were derived from measurements taken during the SXS instrument level calibration campaign at JAXA Tsukuba Center in March 2015. The specific data came from the XRSGSE experiment, 15-03-11.16.24.16Z.pxp, for a gain scale measurement at 50 mK, using fluorescence sources. Spectral peaks used to identify photon energy range and therefore for average pulse waveform calculation are listed in Table 2

below in a descending order. The flight gain scale derived from ground calibration data, ah_sxs_gainpix_20140101v001.fits (also known as RTS_50mK_2015_03_12b) using the optimal filter templates SHPTEMPL=2015-03-10, was applied for spectral identification. Primary events (200 or more) with PHA close to each selected spectral peak were used in the average pulse waveform calculation. The PHA ranges were split evenly between the selected spectral peaks. The average pulse in the energy range above BrKα is set to be the same as that for the BrKα range at this time.

Table 2 Target energy lines.

Fluorescence target	Kα1 (eV)	Kα2 (eV)
Br	11924.2	11877.6
As	10543.7	10508
Ga	9251.7	9224.8
Cu	8047.8	8027.8
Co	6930.3	6915.3
Fe	6403.8	6390.8
Mn	5898.8	5887.7
Cr	5414.7	5405.5
Ti	4510.8	4504.9

2.2 Data Analysis

The pulse shape processor (PSP) determines the PHA value for a midres secondary event by template fitting to without first subtracting the preceding pulse waveforms (either parent primary or another secondary). As a result, adjustment in PHA is needed to correct for the arrival time of the secondary event relative to the preceding events. As the pulse shape changes with x-ray photon energy, the secpulse caldb file provides a set of discrete average pulse waveforms, essentially a look-up table for PHA adjustment, to cover the SXS instrument's entire spectral range.

The XRSGSE experiment was replayed while keeping all pulses from UT 20:27:00 03/11/2015 to UT 01:23:00 03/12/2015. Filters were set up in XRSGSE to average only hires primary events. Correction for the midres secondary event PHA is done by the algorithm below where PHA1 is the PSP pulse height for the secondary event, and PHA0 the corrected for the preceding event (no correction needed for the parent primary event). Time(pha1) is the arrival time as number of 80 μs bins for the secondary event, and TIME(pha0) for the preceding event. The offset is the bin position for the peak in the average pulse waveform, AvrPLs. [TIME(pha1) – TIME(pha0) + offset] provides the bin index where the pulse peak of the secondary event is superimposed on the preceding event waveform as shown in Figure 1. The appropriate average pulse waveform is normalized to the preceding event pulse height before subtraction correction. This process starts with the secondary event right after the parent primary event through the last secondary event in the same family adjusting for all preceding events accumulatively. Orphan events are excluded in the process.

PHA1NEW=PHA1 - {AvrPLs[TIME(pha1)-TIME(pha0)+offset]} * pha0/32767

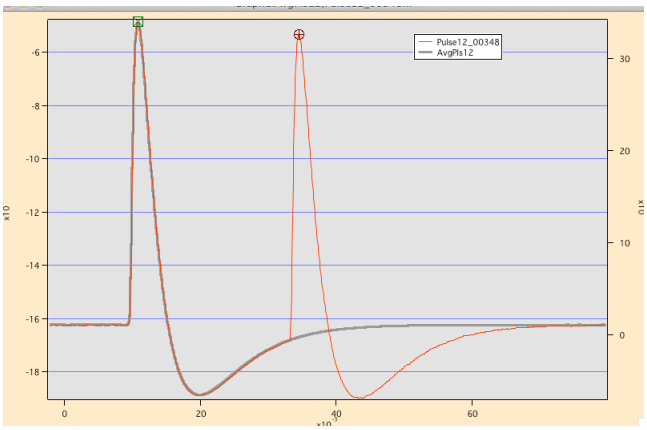

Figure 1 An example of a midres secondary event following a primary

2.3 Results

Before PHA correction, the secondary events show a low-energy tail as shown in Figure 2 as they arrived on the undershoot of the preceding pulse. Once corrected, the secondary event shows no dependence on its relative arrival time, and a sharper and tighter histogram grouping. Figure 3 shows a comparison of the cal pixel resolution between hires primary events, midres primary events, secondary events before and after correction from measurements during instrument level ground testing, 15-03-18.13.18.16Z.pxp. It is possible to get 1-2 eV improvement in resolution with the secondary PHA correction, but still not as good as the resolution from midres primary events.

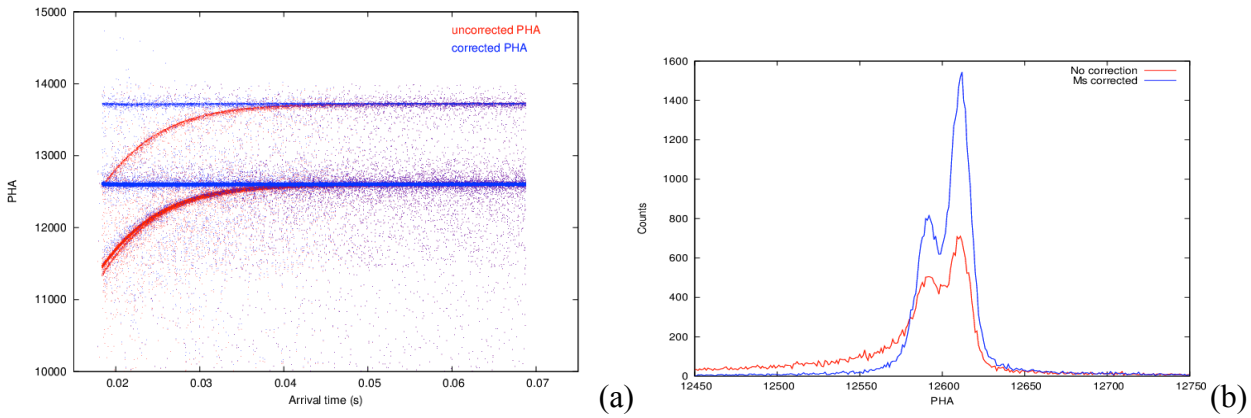

Figure 2 Comparison plots of secondary PHA before and after correction, (a) relative to the secondary event's arrival time, and (b) histogram.

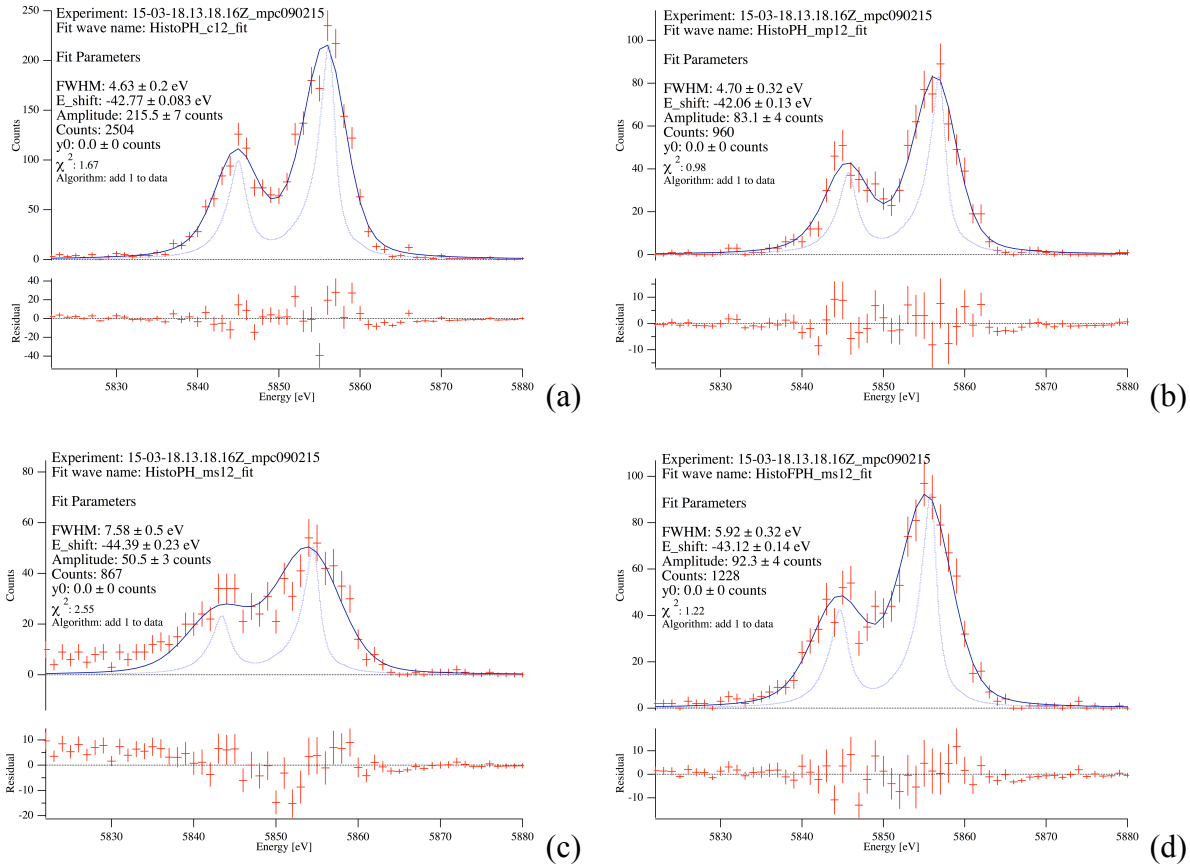

Figure 3 Comparison plots of cal pixel resolution from ground testing, (a) hires primary events, (b) midres primary events, (c) midres secondary events without correction, and (d) midres secondary events with PHA correction.

2.4 Comparison with previous releases

The OFFSET data were updated in ah_sxs_secpulse_20140101v003.fits to the bin index at the peak of the average pulse waveform.

3 Release CALDB 20160510

Filename	Valid data	Release data	CALDB Vrs	Comments
ah_sxs_secpulse_20140101v002.fits		2016-04-22	2	SXS Secondary Pulse

3.1 Data Description

This secpulse caldb file, ah_sxs_secpulse_20140101v002.fits, contains data derived on March 11, 2015 during the SXS instrument ground calibration at JAXA Tsukuba Center. This file is the same as ah_sxs_secpulse_20140101v003.fits except for the offset values.

3.2 Data Analysis

Same analysis as section 2.2.

3.3 Results

Same results as in section 2.3 except that the offset values were inconsistent due to potential difference in timing assignment by XRSGSE software.

3.4 Final remarks

The data in these secpulse CALDB file are based on ground measurements. We did not have data in orbit for detailed comparison.