

# SPIRE Spectrometer Band Edge Calibration Products

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## 1.1 Reference Documents

SPIRE Observers Manual, v2.4 (June 2011)	HERSCHEL-DOC-0798
Herschel SPIRE FTS relative spectral response calibration	Fulton et al. 2014, Experimental Astronomy, 37,381
Calibration of the Herschel SPIRE Fourier Transform Spectrometer	Swinyard et al. 2014, MNRAS, 440, 3658
In-orbit performance of the Herschel/SPIRE imaging Fourier transform spectrometer: lessons learned	Naylor et al. 2014, SPIE

## 1.2 Introduction

This technical note describes the calibration products related to the spectrometer band edges. The first is the SCalSpecBandEdge product which is used in the pipeline to remove the out-of-band data in the final spectrum. The second is the SCalPhaseCorrLimits calibration product, which is used by the Phase Correction Task to calculate the range over which to evaluate the phase.

## 1.3 Spectrometer Band Edges

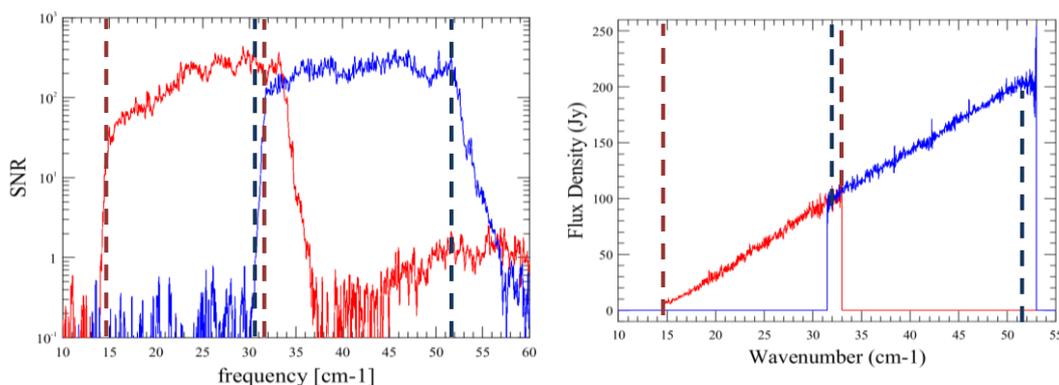
In the initial version of the SPIRE Observers Manual, the band edges were set to be:

- SLW: 14.9–31.6  $\text{cm}^{-1}$
- SSW: 30.9–51.5  $\text{cm}^{-1}$

In the release of the point source AOT, these were adjusted to improve the cross-over region between the bands:

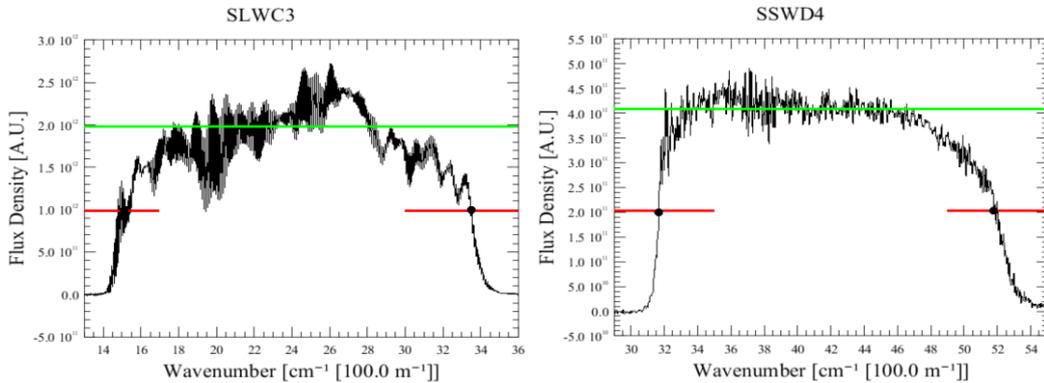
- SLW: 14.9–**33.0**  $\text{cm}^{-1}$
- SSW: **32.0**–51.5  $\text{cm}^{-1}$

This was due to the fact that the original cutoff points did not accurately reflect the crossover region. This is shown in Fig. 1, which is taken from the Spectrometer Point Source AOT release meeting presentation (4 December 2009). The SPIRE Observers Manual was updated, and these are the values currently contained in v2.4 of the manual (stated as the spectral range over which FTS data can currently be calibrated).



**Figure 1:** *Left:* Signal to noise ratio in an observation of Neptune (0x50002652) before subtraction of the telescope – the original band edges are shown – these do not match the actual overlap region of the arrays. *Right:* Neptune spectrum, with the updated band limits marked. Taken from the Spectrometer Point Source AOT release meeting presentation (4 December 2009).

The dispersion of band edges across the array was investigated for the Spectrometer Mapping mode release, and a slight dispersion in ranges was found. Figure 2 shows the filter profiles for the central detectors with half power point marked in red. This shows that the half power points are within the ranges originally used for the point source AOT release, but allow for a slightly wider coverage.

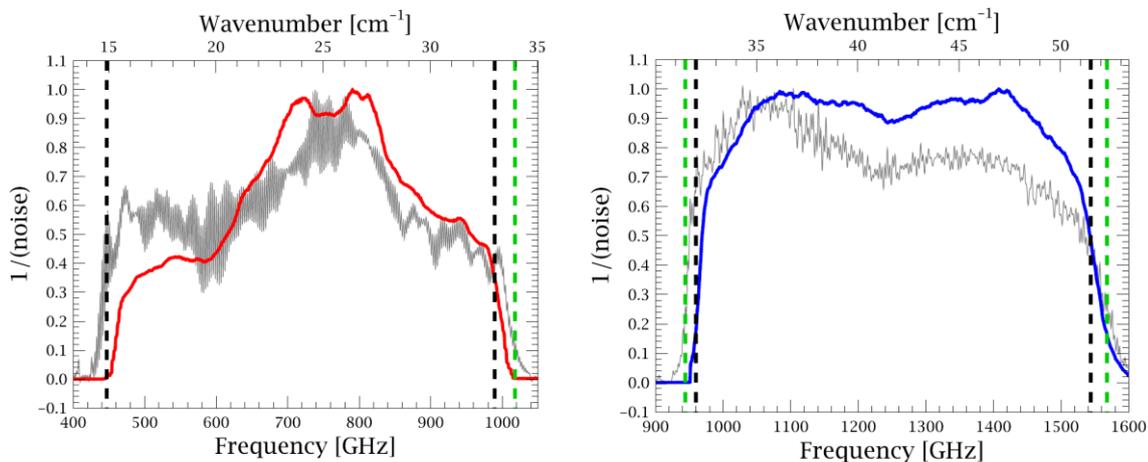


**Figure 2:** Filter profiles for the central detectors, showing the half power point. Taken from the Spectrometer Mapping AOT release meeting presentation (19 April 2010).

These broader band edges were entered into the SCalSpecBandEdge product from calibration tree SPIRE\_CAL\_4\_0, with the same limits for all detectors. This was intended to give observers the maximum possible data, even though the signal-to-noise will degrade towards the edges (to different degrees for different detectors). In the SPIRE Observers Manual, the narrower band edges were still quoted as the range over which the flux accuracy and sensitivity limits apply.

However, the wider limits mean that there are often spikes and extra noise at the band edges, which cause some confusion to observers, as they don't know what is real and what is not. Therefore, from calibration tree SPIRE\_CAL\_8\_0 onwards, it was decided to revert back to the narrower band edges. In addition, the units of the limits were changed to GHz to correspond to changing the final spectra from  $\text{cm}^{-1}$  to GHz.

Subsequent improvements in calibration (Fulton et al. 2014) have meant that the bands can be widened for HIPE v12.1 (SPIRE\_CAL\_12\_3), especially at the high frequency ends. However, the narrower HIPE v8 range is maintained as the basis for the officially validated calibration (Swinyard et al. 2014). See also Naylor et al. 2014.



**Figure 3:** Spectral range of the central bolometers of each array (SLWC3 left and SSWD4 right), determined from in-flight measurements. The normalised telescope RSRFs are shown in grey. The red and blue lines show the normalised reciprocal of the noise. The dashed lines indicate the bandpass limits for HIPE v8 (black) and the new extended HIPE v12.1 limits (green).



## Technical Note

### The Spectrometer Band Edge Calibration Products

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*Table 1: Band edges used in calibration product and given to astronomers*

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<b>SSW</b>	32.0 cm <sup>-1</sup>	51.5 cm <sup>-1</sup>
<b>SLW</b>	14.9 cm <sup>-1</sup>	33.0 cm <sup>-1</sup>

Calibration Trees from **SPIRE\_CAL\_4\_0**, SCalSpecBandEdge v4

<b>SSW</b>	31.2 cm <sup>-1</sup>	51.8 cm <sup>-1</sup>
<b>SLW</b>	14.6 cm <sup>-1</sup>	33.3 cm <sup>-1</sup>

Calibration Tree **SPIRE\_CAL\_8\_0**, SCalSpecBandEdge v5

<b>SSW</b>	959.3 GHz (31.9988 cm <sup>-1</sup> )	1544.0 GHz (51.5023 cm <sup>-1</sup> )
<b>SLW</b>	446.7 GHz (14.9003 cm <sup>-1</sup> )	989.4 GHz (33.0028 cm <sup>-1</sup> )

Calibration Tree **SPIRE\_CAL\_12\_3**, SCalSpecBandEdge v6

<b>SSW</b>	944.0 GHz (31.5 cm <sup>-1</sup> )	1568.0 GHz (52.3 cm <sup>-1</sup> )
<b>SLW</b>	446.7 GHz (14.9 cm <sup>-1</sup> )	1018.0 GHz (34.0 cm <sup>-1</sup> )

### 1.4 Spectrometer Phase Correction Limits

The SCalSpecPhaseCorrLimits calibration product was created out of discussions at the SDAG meeting on 23 April 2009. The extract from the minutes of that meeting is:

*"Note: these are NOT the same as the spectral band edges we quote to the astronomer: need to change the terminology and avoid any possibility of confusion. The suggestion is to rename this product to be 'Phase Correction Limits'"*

This product is used by the polynomial fitting method of the Phase Correction Task in the pipeline to determine the spectral range over which to evaluate the interferogram phase. The values were determined to give the best possible determination of the phase for each array. The final values used version 1 of the calibration product are given in Table 2. This method of phase correction has not been used in the SPG pipeline since HCSS v4 (but is available for interactive analysis). The calibration product is not required for the standard phase correction method used from HCSS v6. The limits were updated to be in GHz units for calibration tree SPIRE\_CAL\_8\_0 in version 2 of the product, without changing the actual numbers (apart from rounding).

*Table 2: Final ranges used in the Phase Correction Limits calibration file.*

	<b>SLW start</b>	<b>SLW end</b>	<b>SSW start</b>	<b>SSW end</b>
<b>SCalSpecPhaseCorrLim v1</b>	15.05 cm <sup>-1</sup>	32.0 cm <sup>-1</sup>	32.0 cm <sup>-1</sup>	50.0 cm <sup>-1</sup>
<b>SCalSpecPhaseCorrLim v2</b>	451.2 GHz	959.3 GHz	959.3 GHz	1499.0 GHz
<i>(equiv. wavenumbers)</i>	<i>15.0504 cm<sup>-1</sup></i>	<i>31.9988 cm<sup>-1</sup></i>	<i>31.9988 cm<sup>-1</sup></i>	<i>50.0013 cm<sup>-1</sup></i>

### 1.5 Non-seeing Detectors

All non-seeing detectors (thermistors, dark detectors and resistors) have their values in the BandEdge and PhaseCorrLim products set to NaN.