Band edges of the SPIRE PFM1 spectrometer

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Objective

The goal of this analysis is to determine from the SPIRE Proto-Flight Model 1 (PFM1) data whether the detector bands SLW and SSW have been manufactured to specifications. This is particularly important for the band edges defined by the feedhorns as they have not been measured after production.

Band edge specifications

The cut-on at 15 and 33 cm-1 is defined by the single-mode conical feeds while the cut-off at 31 and 50 cm-1 is defined by high-efficiency filters. The band edges of the spectrometer detectors are specified as follows (see SPIRE-JPL-PRJ-000456, issue 3.2, section 3.4.1):

	Cut-on [cm-1]	50% Cut-off [cm-1]
SLW	14.64 – 15.02	33.00 – 33.67
SSW	30.40 – 31.15	52.08 – 53.19

The filter assembly to define the cut-off for SSW has been measured at Cardiff University and the 50% cut-off value has been determined as 51.92 cm-1 with a resolution of ~ 0.05cm-1 (see HSO-CDF-EIDP-055, Issue 1.0), 0.16 cm-1 below the minimum specification.

PFM1 data

Three high-resolution scans (resolution element of 0.04 cm-1) from March 8, 2005 were analyzed where SCal was switched off, i.e. at ~4.9K, and the Cold Black Body (CBB) was set to 9.5K, 11.5K, and 13K:

File name	**CBB temp. [K]**	**# scans**
SMEC_HR9K_0803_1733_1754	9.5	15
SMEC_HR11K_0803_1808_1829	11.5	16
SMEC_HR13K_0803_1946_1956	13.0	5

The test observations with the CBB at 6.5K and 7.5K were ignored as a contaminating source made it impossible to derive an approximately flat spectral profile to measure band edges.

Method

The measured data were reduced and averaged to one spectrum per pixel per observation. The Planck curves from the two input ports were divided out from the spectrum. The

edge points of the bands were defined as the extrema of the intersection of the measured spectrum and a straight line at half the maximum signal roughly within the SLW and SSW bands (10 – 40 cm-1 for SLW; 20 – 60 cm-1 for SSW). A sample set of spectra is given below:

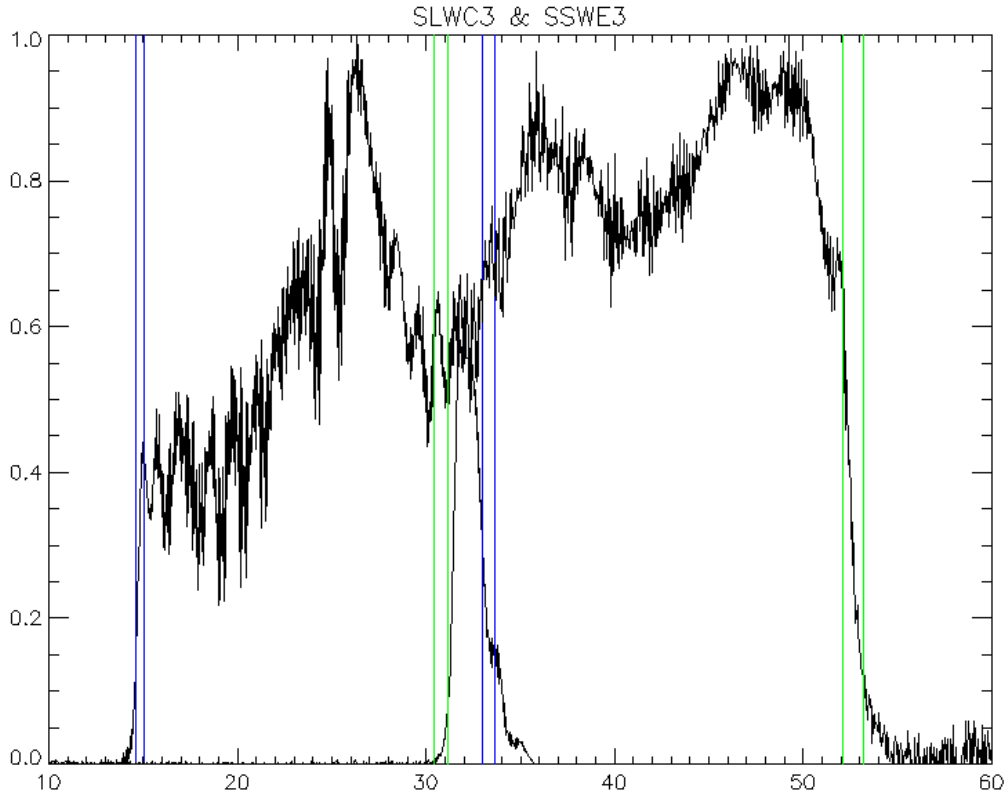

Figure 1: Specified band edges for SLW (blue) and SSW (green) against measured spectra with the CBB at 9K after dividing out the Planck profiles of the two input ports.

Measurements where noise interfered with determining the band edge, were disregarded. All valid pixels were grouped and averaged.

Results

SLW
Specifications: 14.64 – 15.02 cm-1 to 33.00 – 33.67 cm-1
Measured cut-on: 15.60 cm-1 with a standard deviation of 0.81 cm-1
Measured cut-off: 32.54 cm-1 with a standard deviation of 0.27 cm-1

SSW
Specifications: 30.40 – 31.15 cm-1 to 52.08 – 53.19 cm-1
Measured cut-on: 31.44 cm-1 with a standard deviation of 0.26 cm-1
Measured cut-off: 52.15 cm-1 with a standard deviation of 0.34 cm-1

Conclusions

For SLW, the measured cut-on edge can only be determined with a rather large standard deviation which places the measurements within specifications, towards the high end of

the specification. The cut-off point is 0.46cm-1 below the minimal specification for SLW with a standard deviation of 0.27cm-1.

For SSW, the measured cut-on edge is 0.29cm-1 above the maximum specification with a standard deviation of 0.26cm-1. The cut-off point lies within specification towards the minimal requirement with a standard deviation of 0.34cm-1. The measured value is in agreement with the qualification measurement of 51.92 cm-1 from Cardiff University, considering the variation in the data.

Overall, the bands are slightly too narrow when compared to specifications. However, the deviation from specifications is of the order of no more than 4%. The effective overlap range of the two bands is ~ 0.9cm-1.

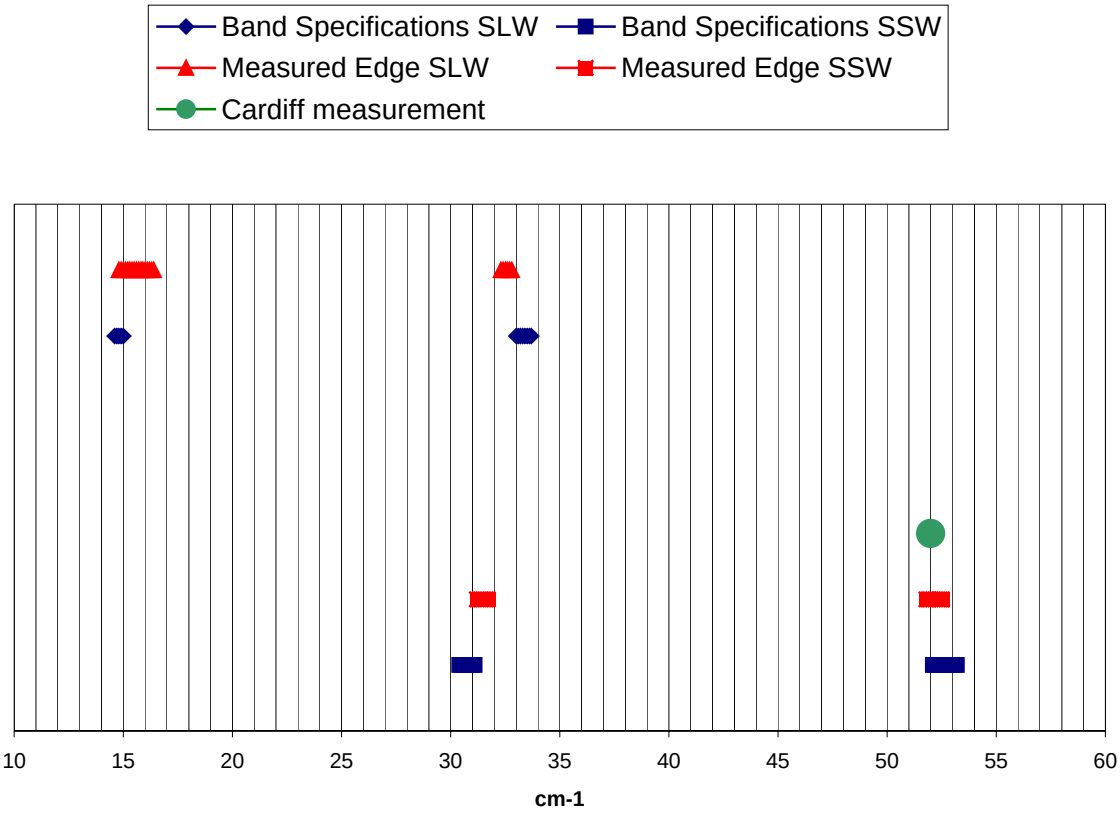

Figure 2: band edge specifications (blue), PFM1 measurements (red), and measurement from Cardiff (green)