SPIRE Scan-Map AOT and Data Products

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The SPIRE scan map AOT was initially released for scheduling for observations made with the nominal scan speed (30"/s) and nominal bias settings (optimised for faint or moderately bright astronomical sources). It is now being released for scheduling of SPIRE observations with 60"/s scan speed, and for SPIRE-PACS Parallel mode observations at both 60"/s and 20"/s, also with nominal bias settings. Most of the information and guidance that was provided in the original version of this note also applies. Some additional considerations are summarised in the addendum.

Beam profiles

Basic characterisation of the individual detector beam profiles has been done, and detailed characterisation is underway. For the moment, it is reasonable to assume Gaussian beams with FWHM values as indicated below.

Band (μm)	FWHM and rms deviation over the array (arcsec)	Ellipticity and rms deviation over the array (%)
250	18.1 ± 0.4	8 ± 0.5
350	25.2 ± 0.5	8 ± 0.5
500	36.9 ± 1.0	8 ± 0.5

Flux density calibration

SPIRE's primary flux calibration will be based on Neptune, which has unfortunately been invisible during PV. The most suitable alternatives, the larger asteroids have also been in the wrong part of the sky. Neptune does not become visible until mid-October, when we will start working to establish an updated calibration, but it should not be assumed that this will be available before the end of SD phase.

Current calibration is based on limited observations of Ceres on July 3 during Commissioning Phase, made with different detector settings to the optimal ones now in use. The calibration has been scaled to the optimised detector bias settings now in use using a bolometer detector model and further checked with an observation of Arp 220. We estimate the current absolute calibration accuracy at 30%.

The adopted Ceres flux densities on the relevant observation date (June 24) were derived using the asteroid Standard Thermal model and are as follows:

Band (μm)	Ceres Flux Density (Jy)
250	27.7
350	14.6
500	7.36

Pipeline data and Level-2 maps are calibrated in Jy/beam. Users wishing to convert to surface brightness (Jy/arcsec^2 or Jy/pixel) or determine the flux densities of extended sources will need to take into account the beam area, which can be estimated as π*FWHM^2/(4*ln(2)). The uncertainties involved in this conversion due to beam ellipticity and variation in FWHM across the array are small compared with the overall flux calibration accuracy. For a point source, the flux density is that corresponding to the map pixel at the peak.

For an extended source, the total flux density can be calculated by adding up the values in all pixels and dividing the result by the effective number of pixels per beam, given by (beam area)/(pixel size)^2. The Level-2 map pixel sizes are (6, 10, 14) arcseconds for the (250, 350, 500) μm bands.

Sensitivity estimation

Preliminary estimates of SPIRE's limiting sensitivity for point or compact sources in scan map mode indicate that

(i) the performance predicted by HSpot for instrument noise is a reasonably accurate indication of the in-flight instrument noise levels;
(ii) the extragalactic confusion levels (rms sky fluctuation in a map from which detected point sources have been carefully removed) is on the order of 6 – 8 mJy in all bands, also consistent with pre-flight expectations.

This is subject to caveats concerning the flux density calibration as notes above, and the fact that galactic confusion noise can vary considerably over the sky.

Pointing

Source positions may be off by a few arcseconds due to the spacecraft absolute pointing error of approx. 2" plus another systematic term of 1-3" in the case of SPIRE, which is being investigated.

Pipeline status

The current scan-map pipeline released by SPIRE (HCSS v1.2) provides usable Level-1 and Level-2 products, but has not yet been fully optimised for removal of all instrument and observatory systematics. Further improvements in processing are in development. New calibration files which could improve data quality running the pipeline from Level 0.5 to Level 2 may become available in the coming weeks.

One of the most challenging aspects of operation and data processing will be to remove the effects of instrument and other thermal variations on the data. Active control of the 300-mK detector temperature is being evaluated at present but has not yet been implemented. Processing current scan-map data does require some degree of baseline subtraction. The current Level-2 map data have been processed with a pre-filtering step which removes the median of each Level-1 scan line, with no masking of strong features that can bias the median. This works well, but in the case of intense sources in small fields some shadow effects will occur in the maps.

Raw SPIRE data are affected by glitches due to ionising radiation. These are detected in the pipeline and are currently masked out. Nine samples around the glitch are eliminated (two before, seven after) and replaced by a linear interpolation in order not to generate artefacts in subsequent pipeline modules. Note that the interpolated data are visible in the final Level-1 products, but are not actually used in the mapmaking process. More work remains to be done on low level glitches. While we expect the impact to be small, users should be aware that undetected glitches in the data could affect the noise statistics.

Current maps are produced using a naive mapmaker. The code for MadMap will be available in HCSS v1.2, but uses an out-of-date calibration file for the noise. Effective use of MadMap does require good baseline subtraction, so its use at present requires some care.

Addendum: Release of SPIRE scan map with 60"/s scan speed for SPIRE-only observations 60"/s or 20"/s scan speed for SPIRE-PACS Parallel-Mode AOT

The above information and recommendations apply to these modes with the following additional comments:

Sensitivity for 60"/s scan speed: Full evaluation of the instrument noise has yet to be made. However, as for the 30"/s scan speed, the performance predicted by HSpot for instrument noise is a reasonably accurate indication of the in-flight instrument noise levels.

Pointing: Some astrometric offsets remain in scan maps, possibly associated with the relative timing of detector samples and the spacecraft pointing. The effect is larger for the faster 60”/s scan speed with a systematic shift of 3 – 4” along the scan direction. The current impact is a small degradation of relative pointing within map, and some speed-dependent degradation of effective beam size.

Map coverage: In SPIRE-PACS parallel mode with 60”/s scan rate, the lower detector sampling rate and faster scan speed result in slightly shallower coverage than for the slower scan speed. This effect is compounded by the current scheme for masking rather than reconstructing portions of data timelines affected by glitches. This is only a potential problem for maps made with single sweeps (i.e., without cross scans or repetitions), in which case the map is likely to contain some blank pixels.