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DOCUMENT

PACS Spectrometer HPDP: Observations in the red-leak spectral range

European Space Agency
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APPROVAL

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1   INTRODUCTION

This release note describes the Data Products archive of the PACS Spectrometer observations with wavelengths longward of 190 μm, affected by spectral leakage, or order overlap. These spectral ranges –masked out by the Standard Product Generation (SPG) pipeline- are processed with a non-standard calibration scheme for the chop-nod observations, and a dedicated relative spectral response function. These spectral cubes feature calibrated order 1 emission lines in the 190-206 μm range, while the continuum remains uncalibrated.

2   DESCRIPTION OF THE HPDP

2.1   Scope and method for the HPDP generation

The PACS Spectrometer relative spectral response is affected by spectral leakage (order overlap due to finite steepness of order sorting filter cut-off edges) from grating order n+1 into grating order n. At wavelengths of 70-73 μm, 98-105 μm and 190-220 μm the next higher grating order wavelengths of 52.5-54.5 μm, 65-70 μm and 95-110 μm do overlap, respectively. Continuum shapes and flux densities in these border ranges are therefore incorrect. Contaminated continuum level is irremediably lost, but a correct RSRF can solve the problem for the flux pertaining to only one order (i.e. spectral lines).

In order to disentangle order leakage from the native R1 band, measurements of the Relative Spectral Response Function (RSRF) were obtained during the pre-launch test campaign (ILT) with two different blackbody temperatures. The description of the construction method for the R1 RSRF is provided in the PACS Spectrometer Handbook. In a nutshell, the RSRF is a hybrid response function composed of

- The standard R1 RSRF for wavelengths shortward of 190 μm
- The order 1 RSRF, once corrected for leakage, for wavelengths longward of 190 μm

considering the spectral range between 185 and 188 μm for merging of these two components. The final R1 RSRF (See Figure 1)

- decreases steadily up to ~205-207 μm,
- it is very low for all pixels longward of 205 μm, and
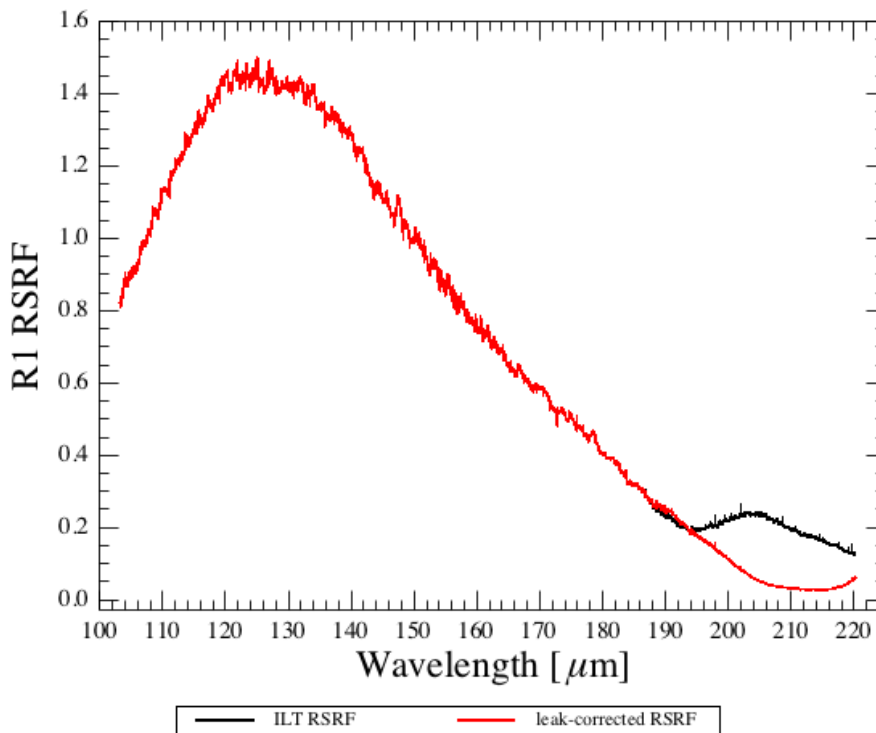- it is unreliable beyond 217 μm

Figure 1 PACS Spectrometer relative spectral response function for detector 8 and module 12 in the R1 band before (black) and after light leakage correction longward of 190 μm (red).

Therefore, the application of the leak-corrected R1 RSRF generally yields a very steep continuum slope in the final spectrum (see Figure 1).
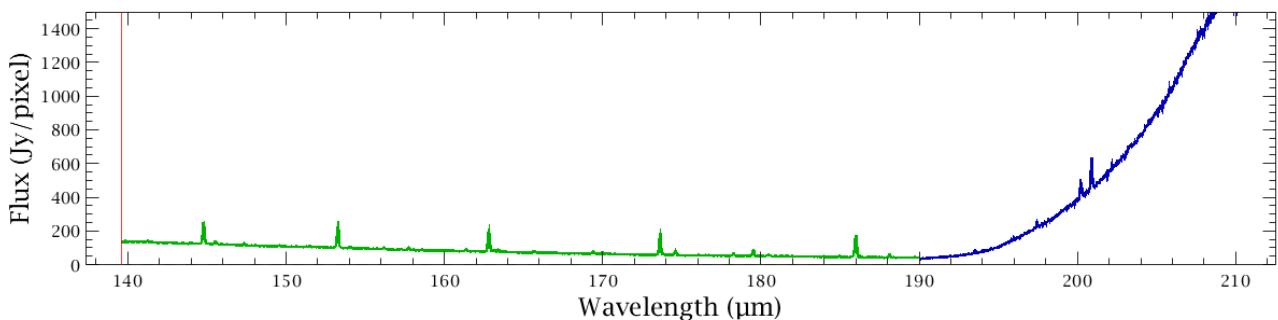

Figure 2 SPG 14.2 generated spectrum (green) and leak-corrected HPDP spectrum (blue).

The line flux ratio between the leak-corrected to the standard RSRF is ~3.0 at 200 μm. The recommendation is to use these HPDP for lines up to 206 μm, and exclusively for line emission.

The PACS Spectrometer standard processing generation pipeline did not contemplate the order-leak processing, masking out systematically the spectral ranges (either in line or range scan mode) above 190 μm.

The spectro-photometric calibration is performed by the PACS Spectrometer SPG pipeline using two different schemes:

- The default calibration for chop-nod observations uses the Telescope Background Normalization method.
- The internal calibration sources and the RSRF are used for the unchopped observations.

Since the calibration of the red leak requires the use of the calibration sources and the R1 leak-corrected RSRF method for all observing modes, it was deemed an "exotic" use of the pipeline and provided as HPDPs.

There are 1353 standard PACS Spectrometer observations that include at least one spectral scan beyond 190 μm. This comprises line scans (prime) fully in the leak range, range scans (prime and parallel) fully or partly in the leak and B2B and B3A SEDs. Since some ranges are marginally longward of 190 μm, the final number of red leak HPDPs is 1331. They are provided in the file observationList.txt

The observations were processed with an analog of the SPG, making a generalized use of R1 RSRF calibration file FM v5, and masking out any spectral scan shortward of 190 μm. The flatfield applied to range observations using splines made use of a nod separation of 2 μm, instead of the default 6 μm for R1.

These observations have been reduced with HIPE versions 15.0.2868 and 15.0.3244, using PACS_CAL_77_0.

2.2   Caveats

These HPDP products are meant exclusively for R1 line emission and up to a maximum wavelength of 206 μm. The R1 continuum remains uncalibrated.

The calibration in the R1 order leakage was estimated by comparison to correspondent line fluxes extracted in HIFI and SPIRE spectra at 200 μm. This yields a fudge factor of 1.3 necessary to be applied to the extracted PACS emission line fluxes.

2.3   Content of the HPDP

2.3.1 Deliverable format and structure

The final products are standard level2 products in the red band for both chop-nod and unchopped observations. We do not provide the rebinned cube table. For each obsid/directory there is a postcard image, when available, and a number of subdirectories with the standard product name acronyms in capitals (cubes and table), that are observing mode dependent and described in the [PACS Products Explained](#) document. The possible directory names are HPS3DR, HPS3DRR, HPS3DPR, HPS3DIR, HPS3DDR, and HPS3DEQXR for cubes, and HPSSPECR for the point-source table.

In the directories, the products are provided as compressed .fits files. We have used the standard naming convention:

- hpacs<OBSID>_20hps3d<SUFFIX>r_redleak_<##>.fits.gz for cubes
- hpacs<OBSID>_20hpsspecr_redleak_<##>.fits.gz for point-source tables

where OBSID is the observation identification number, SUFFIX is empty for the pacsCube and one of [R|P|I|D] for the rebinned, projected, interpolated and drizzled cubes, respectively, while ## is the slice number. Note that the slice number is not preceeded by an s.
The postcard image is a .jpg file named after the convention

- <OBSID>_redleak_postcard.jpg

It provides a view of one spectrum and one cube image per wavelength range longward of 190 μm that was requested in the observation as depicted in Fig. 3. For a detailed description of spectrometer postcards see Sect. 5.3.1 in the PACS Products Explained document.
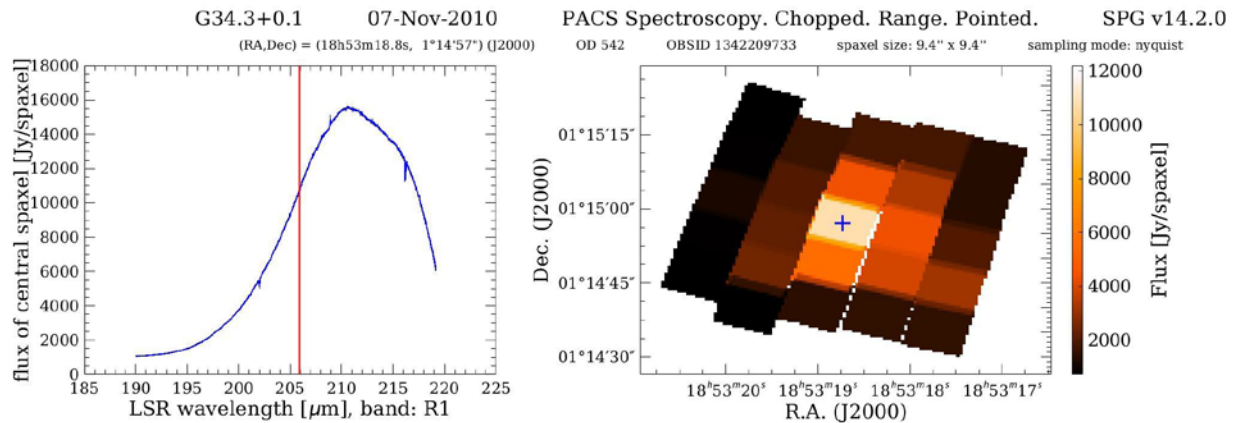
Figure 3 Red leak HPDP postcard example showing spectrum (left) above 190 μm and a cube image (right).

2.3.2   HPDP queries in the HSA

As for any product stored in the HSA, the red leak HPDP can be queried through the HSA interface. For a given obsid, the delivery data-set will consist of all fits files applicable to the observation, together with the postcard. A full download of all red leak HPDP data can be performed, however, users should be warned of the very large size of this data-set (~173 Gb), which could make it prohibitive.

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