



esac

European Space Astronomy Centre  
(ESAC)  
P.O. Box, 78  
28691 Villanueva de la Cañada, Madrid  
Spain

# DOCUMENT

## PACS Spectrometer HPDP: The Blue Edge

<b>Prepared by</b>	<b>Katrina Exter</b>
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## 1 INTRODUCTION

PACS spectroscopy observations processed by the standard pipelines and provided via the Herschel Science Archive cover the range 55–190  $\mu\text{m}$ . The range  $>190 \mu\text{m}$  is provided as a “Red Leak” HPDP: these data required a particular flux calibration and pipeline method, and are calibrated for the line emission only. In the blue end, the data in the range 50–55  $\mu\text{m}$  cannot be flux calibrated as they lie at the edge of the blue filters bandpass where the flux calibration is completely unreliable. However, these data *can* be processed and provided to the users in an uncalibrated form. These data conform the “Blue Edge” HPDP.

## 2 HPDP PIPELINE PROCESSING

The pipeline scripts used to process these data are based on the Standard Product Generation (SPG) pipeline scripts used for the unchopped and chop-nod data. The differences with these scripts are:

- Level 0.5 - Masks are created by the task `waveCalc` and are used to flag out the data that are “out of band”, whose limits vary according to band:
  - B2A = [51.5, 72.0]
  - B3A = [53.0, 72.0]
  - B2B = [68.0, 105.0]
  - R1 = [101.6, 220.0]

This masking is enabled in the task `pacsSliceContext` by the parameter `removeMasked`, which was changed from True to False.

- All of the calls to the masking task `activateMasks` were modified, to specifically not activate the OUTFORBAND mask.
- Level 1.0 - As data are uncalibrated in flux, the pipeline scripts made use of the internal calibration sources and RSRF, regardless of the chopping mode of the observations (chop-nod or unchopped). The tasks `specDiffCS`, `rsrfCal`, and `specRespCal` were not run.
- Level 2.0 - The flatfield task used for the instrument mode (line/range) was adapted to extract the blue edge data within the following limits for the correspondent task parameter:



	<b>specFlatFieldLine (maxRange [μm])</b>	<b>specFlatFieldRange (selectedRange [μm])</b>
<b>Chop-nod</b>	[50.0, 55.0]	[50.0, 55.0]
<b>Unchopped</b>	[50.0, 60.0]*	[50.0, 60.0]*

Table 1 \*Before creating mosaic cubes from the rebinned cubes, the data were further cut to the 50-56 micron range.

The units appear as “V/s” for the unchopped data and “Uncalibrated” for the chop-nod. Regardless, the data are *uncalibrated*, both on an absolute level and a relative (spaxel-to-spaxel) level.

### 3 HPDP PRODUCTS

#### 3.1 What products are provided?

The blue Edge HPDP entails products at Level 2 (unchopped and chop-nod observations) and Level 2.5 (only also provided for the unchopped ranges scan on-source observations). The range and organisation of the data is similar, but not the same, as that provided in an SPG download. The subsets of SPG products provided for chop-nod and unchopped observations are:

- Rebinned cubes: one per wavelength range and, for mapping observations, per raster position.
- Rebinned cube tables: one per raster position for mapping observations.
- Mosaic cubes: those provided by the SPG for chop-nod observations (detailed in the [PACS Products Explained](#)), and a single type of mosaic cube and its equidistant mosaic cube version for unchopped observations.
- PACS Cubes only for chop-nod observations.

Note that as these HPDP data are not calibrated, the point source calibration – which is normally advised for observations of point sources – is invalid. For this reason no point-source calibrated tables have been provided for the pointed observations, unlike for the SPG products gotten from the HSA.

The type of mosaic cube provided for the unchopped case depends on the observing mode:

- Pointed observations: interpolated cubes with 3" spaxel size
- Mapping observations: cubes with 3" spaxel size, being projected cubes for Nyquist and oversampled mapping observations, and interpolated cubes for undersampled mapping observations
- Tiling observations: interpolated cubes with 3" spaxel size
- Tiling observations with disjointed pointings (a jump of at least 44" between



pointings): projected cubes with 1.5" spaxel size (this was to avoid “stretching” between the disjointed FoVs)

Most of the (un-gzipped) FITS files are up to a few Mb in size.

The product-use recommendations are given in the [Quick-Start Guide](#) and this [product decision tree](#), and the various products themselves are explained in the [PACS Products Explained](#).

## 3.2 Observations

There are 1114 standard PACS Spectrometer observations included in this HPDP. The list is provided in the coma-separated-values file `obsidList.csv`. The column “mode” encodes the unchopped (mode=0), the chop-nod Line scans (mode=1) and chop-nod Range scans (mode=2). The chop-nod observations (625) include line scans (prime) fully in the blue edge, range scans (prime and parallel) fully or partly in the blue edge and B2A and B3A SEDs in that spectral range. The unchopped observations (489) include line scans (prime and parallel) fully in the blue edge, range scans (prime and parallel) and SEDs in the blue edge. Some line scans with confirmed no-detection have been eliminated from the processing.

## 3.3 File and directory naming convention

The cube filenames include the obsid, instrument, cube type, pipeline level, and camera. In addition, the spectral range of each cube – out of the list of observer-requested wavelength ranges for that observation – is indicated in its filename as a slice number.

The naming convention is the following:

**Chop-nod:** `hpacs<OBSID>_20hps<SUFFIX>_blueedge_s<SLICE NO.>.fits`

**Unchopped:** `hpacs<OBSID>_<20|25>hps<SUFFIX>_BE_<SLICE NO.>.fits`

where:

- `hpacs`: Herschel PACS
- `OBSID`: is the 1342xxxxxx observation identification number. For unchopped range-scan observations, bear in mind that the on-source and off-source data are separate observations. The on-off obsid pairings can be found in this [list](#) provided on the HSC Data Products page. This information can also be found in the FITS keywords `OBSID001` (on-source) and `OBSID002` (off-source) that are in extension 0 of both the on-source and the off-source cubes.
- `<20|25>hps`: from pipeline Level 2.0 or Level 2.5, Herschel-PACS-spectroscopy
- `SUFFIX`: indicates the type of product and the camera. In Level 2 these are:



- 3d is the pacs cube (only for chop-nod)
- 3dib|3dpb|3ddb is the interpolated, projected or drizzled blue cube
- 3deqib|3deqpb|3deqdb is the equidistant interpolated, projected or drizzled blue cube
- 3drb is the rebinned blue cube
- tbrb is the table of the blue rebinned cube data

In Level 2.5 (for unchopped range-scans) the same data but with a “background subtracted” acronym can be found

- 3dibsb|3dpbsb is the background subtracted interpolated or projected blue cube
- 3deqibsb|3deqpbsb is the background subtracted equidistant interpolated or projected blue cube
- 3drbsb is the background subtracted rebinned blue cube
- tbrbsb is the background subtracted table of the blue rebinned cube data
- BE: means Blue Edge.
- SLICE NO.: the different wavelength ranges in any observation are indicated as a “slice” number, and for mapping observations the different raster pointing. The rebinned cubes have separate slices for wavelength range and raster position. For all other products the slicing is only on wavelength range. The wavelength range of the slice can be found either by opening the cube in an appropriate viewer, or looking for the keywords MINWAVE and MAXWAVE in the FITS file (extension o). The raster position can be found in the keywords RASID, or RASSTEPL and RASSTEP (see the [PACS Products Explained](#) for more detail).

If you are getting this HPDP directly from the [HPDP legacy repository](#), then the FITS files will be organised in directories:

- **Chop-nod:** OBSID/HPSXXX
- **Unchopped:** OBSID/<level2|level25>/HPSXXX

where XXX indicates the product class: the same “3dib” etc as described above. If gotten from the HSA, the data are served as a flat set of FITS files for each obsid.

### 3.4 Postcards

The postcard is a jpeg file that contains the spectrum of the brightest spaxel in the field (considering the fluxes in the entire wavelength range of the cube), taken from the mosaic cube (interpolated or projected), and a wavelength-integrated image created also from the mosaic cube. As a general rule, there is one postcard per obsid at Level 2, and for unchopped range scans at Level 2.5 also: for these obsids, this Level 2.5 postcard is the one you will see in the HSA search results. For some observations the spectral range in the blue edge may be marginal and a postcard is not provided.



## 4 Caveats

A few things should be noted before using these products for science. The first is, naturally, that the data are not flux calibrated. The second is that the shape of the continuum is completely dictated by the spectral flatfielding done by the pipeline, and hence is “artificial”. The third is that since these data are of a short stretch and with quite strong curvature (which is especially due to their being uncalibrated), the spectral flatfielding could not perform as well as it does at the other wavelengths. Hence, any “ringing” seen in the spectra is an artefact of this. Finally, many spectra have poor spectral sampling in this range: this is a feature of the observation itself, not the data reduction.



