Guide to using the AOT table for PACS spectroscopy

When working with PACS data, it is often useful to know which observing mode — which AOT — the proposer requested. This is especially true for spectroscopy, as the range of science-use products provided depends on the observing mode, and the recommended products to use do also. This is less true for photometry, where the majority of the observations in the HSA are one mode: scan-map.

All the relevant AOT details are held in the header keywords of the FITS files. Every FITS file in an HSA download has a complete copy of the keywords, and hence any Level >=2 product can be opened to access the AOT details. Tables containing the definitions of most of the AOT keywords can be found in the PACS Products Explained, which can be found on the PACS section of the Herschel Legacy Library (https://www.cosmos.esa.int/web/herschel/legacy-documentation-pacs). In the PPE, in the Launch Pads, and in the Quick Start Guide (all of which are also available from the Herschel Legacy Library) you can find an explanation of those AOT keywords that are particularly relevant for the archive user.

However, to aid the archive user in their work with PACS spectroscopy data, a spreadsheet containing the relevant FITS keywords — those which identify the AOT and the wavelength range of the data in the product — is provided: AOTMetaDataSpec.csv. The following information is held in this spreadsheet:

- Obsid (1342xxxxxx)

- Spectral mode: Line or Range Spectroscopy

- Background sampling mode: unchopped or chop-nod

- Pointing mode: Mapping or Pointed (some Pointed with Dither which is in fact Pointed

- Mapping mode details: number of raster steps in the two orthogonal directions, and the step sizes in arcsec

- Number of spectral ranges that were requested by the observer. If "sedxxx" then a full SED mode was requested, and the xxx indicated the band that the observer defined the SED in

- Line id that the observer requested when defining their AOR in HSPOT, if they chose the line from the provided line list

- The prime spectral ranges requested by the observer, and the parallel wavelength range that is provided "for free" in the other camera; failed ranges are not listed

- The product (i.e. cube or spectral table) slice numbers and the spectral coverage in that slice, in four columns. Where multiple wavelengths were requested by the observer, multiple product "slices" were created, and these slice numbers ("s##") are contained in the product FITS file names. The four columns contain the slice number and wavelengths for the: blue and red camera for mapping observations, the blue and red camera for pointed observations.

  The reason for distinguishing mapping from pointed observations is the following: for mapping observations the final products to use are the "mosaic" cubes, one or two types of which is provided per observation. For each type of mosaic cube, one per prime and parallel wavelength range can be found. If working with a mapping observation, the type of cube to look at is explained in the above-referenced documentation, and using the slice number—wavelength range information in the spreadsheet, you know which slice number (s##) to look for if you want a particular wavelength range. You will be looking for cubes at Level 2.5 (unchopped range observations) or Level 2 (all others) with the letter combination HPS3D[EQ][I|D|P][BS][R|B].

  For pointed observations the cubes to use are either the "rebinned" or "interpolated" cubes. One of each of these cubes is provided for each prime and parallel wavelength range that is covered in the observation, and the slice number—wavelength range combination given in the spreadsheet refers to these Level 2.5 or Level 2 cubes, which are identified with the letter combination: HPS3D[EQ][R|I][BS][R|B].

For example:
1342186305 is a line spectroscopy, chop-nod, pointed observation. The observer requested three spectral ranges, which were obtained together with three "free" ranges. Slices 1,2, blue camera, cover 102–103 and 88–89 microns and slices 1,2, red camera, cover 176–178 and 121–123 microns : the missing two ranges both fell out of the bandwidth of their respective filters and did not make it to Level 2. If the user wants to look at one of the provided cubes covering 88 microns, they could grab the FITS file of the interpolated cube:
   HPS3DEQIB/herschel.ia…SpectralSimpleCube/hpacs1342186305_20hps3deqib**s_01**_[long number].fits
Yes: the slice number in the filename is one less than the slice number in the spreadsheet.

For example:
1342187235 is a line spectroscopy, chop-nod, mapping observation. The raster pattern was 2x2 steps of 24"x22". The observer requested two spectral ranges of CII, at 158 and 122 microns, and there are therefore four spectral ranges that were observed: 158 and 122 microns, and 79 and 61 microns in the free (in this case blue) camera. Only one blue slice made its way into the final Level 2 (62 microns is out of band for the B2B band that this observation used) and both red slices can be found. If the user is interested in looking at one of the cubes at 122 microns, they can look at the FITS file of the drizzled cube:
   HPS3DEQDB/herschel.ia…SpectralSimpleCube/hpacs1342187235_20hps3deqdr**s_01**_[long number].fits

For more information on the range of cubes provided for the different AOTs, please read the above-referenced documentation.