PACS photometer pipeline status

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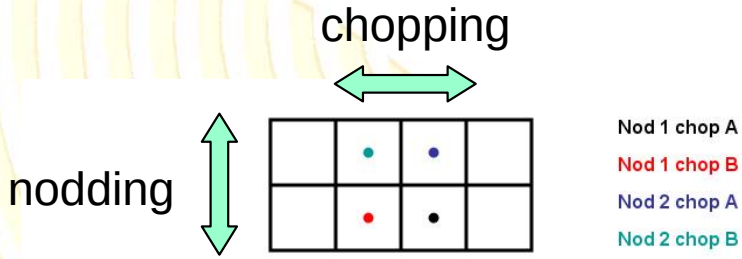
HERSCHEL SPACE OBSERVATORY

PACS photometry processing

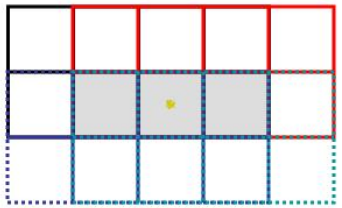
- General presentation of the “PACS Photometry Data Processing and Calibration: Processing up to Maps” from the first DP workshop (Dec. 2008) by P.Popesso available on the web :
  - http://herschel.esac.esa.int/DP_wkshop/3A_Popesso_v3b.pdf
- Chapter 13 of PACS User’s Manual
  - PDF version on DP workshop ftp area.

Point-source mode

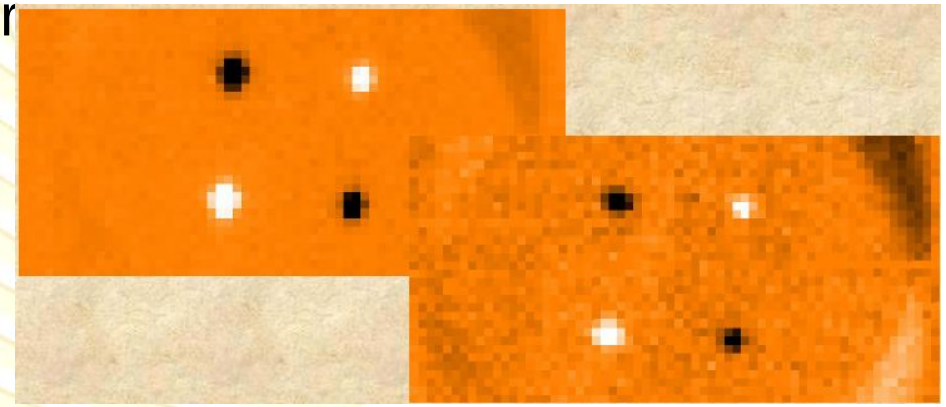
- Targeted at observations of sources which are completely isolated and point-like or smaller than one blue matrix.
- Uses chopping and nodding, both with amplitude of 1 blue matrix, and dithering with a 1 pixel amplitude, keeping the source on the array at all times.
- Possibility of dithering with chopper
- Minimum execution time: 5.5min (incl. 3min for slew)
- Predicted sensitivity (5σ):
  - 70/110 μm : 15mJy
  - 170 μm : 22 mJy



(nod1 chop A – nod1 chop B) – (nod2 chop A – nod2 chop B)



Point-source AOT footprint on the sky



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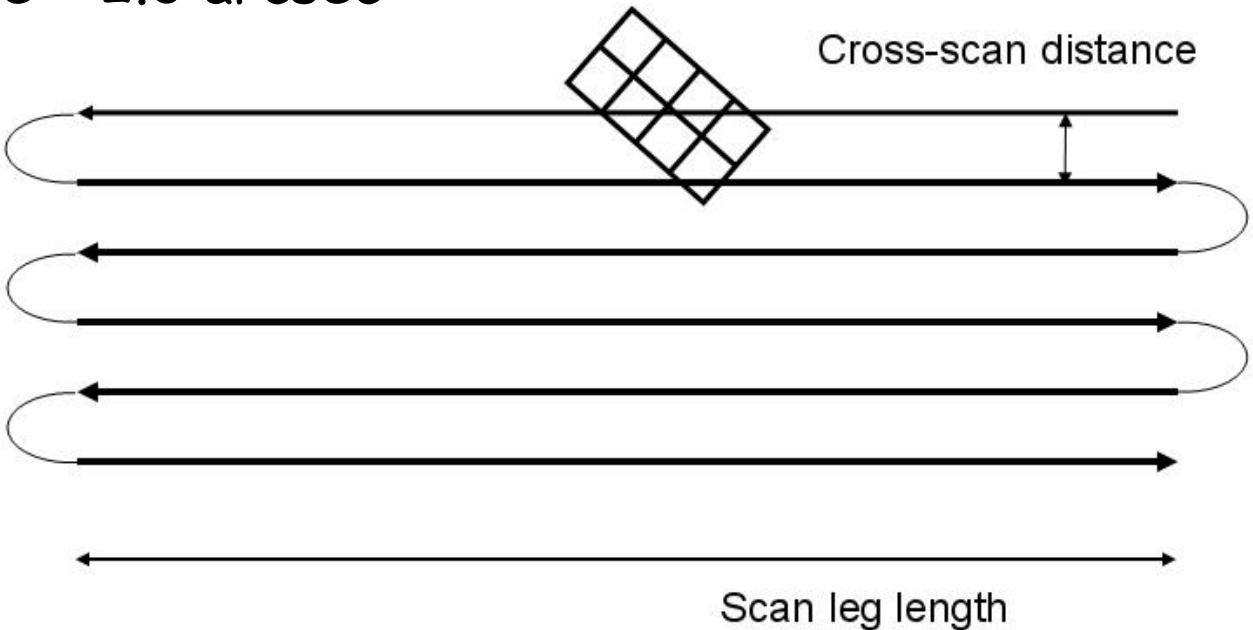
Scan mapping

- For large areas up to several square degrees, no-chopping
- 3 scan speeds
  - Slow : 10"/s, for extragalactic mapping/surveys
  - Medium: 20"/s, for larger areas >1 sq.deg
  - High: 60"/s, for galactic surveys
- PSF degradation :
  - Shift and broadening of the PSF because of electrical (and thermal) time constants and 10 Hz averaging: minimal at slow and medium speed
  - Significant impact at the high speed, broadening by a factor 2.
- SRPE along a line = 2.0 arcsec



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Summary of the Photometry processing steps

1. access the HSA or a local store and retrieve the Frames of a given observation and the related pointing product
2. identify the structure of the observation and identify the main block (Calibration and Science blocks)
3. pre-process the calibration block and extract useful information for the further calibrations
4. perform data cosmetics: flag bad/saturated pixels and flag/correct cross talk and glitches
5. convert signal from digits to volts
6. convert chopper position from engineering units into angle
7. satellite pointing info are added to frames (sky coordinates of reference pixel for each readout)
8. the astrometry is calculated on the basis of spatial calibration files (spatial distortions are taken into account)
9. in case of chopped observation the chop-nod cycle is reduced to remove sky and telescope background
10. the flat field and flux calibration are applied and corrected for possible drifts
11. The spacecraft on-board time is converted to UTC
12. in case of scan map observation, the signal is filtered to remove 1/f noise
13. A stack/mosaic of frames is constructed

Note : 12 &13 can alternatively be done with a MADmap wrapper.

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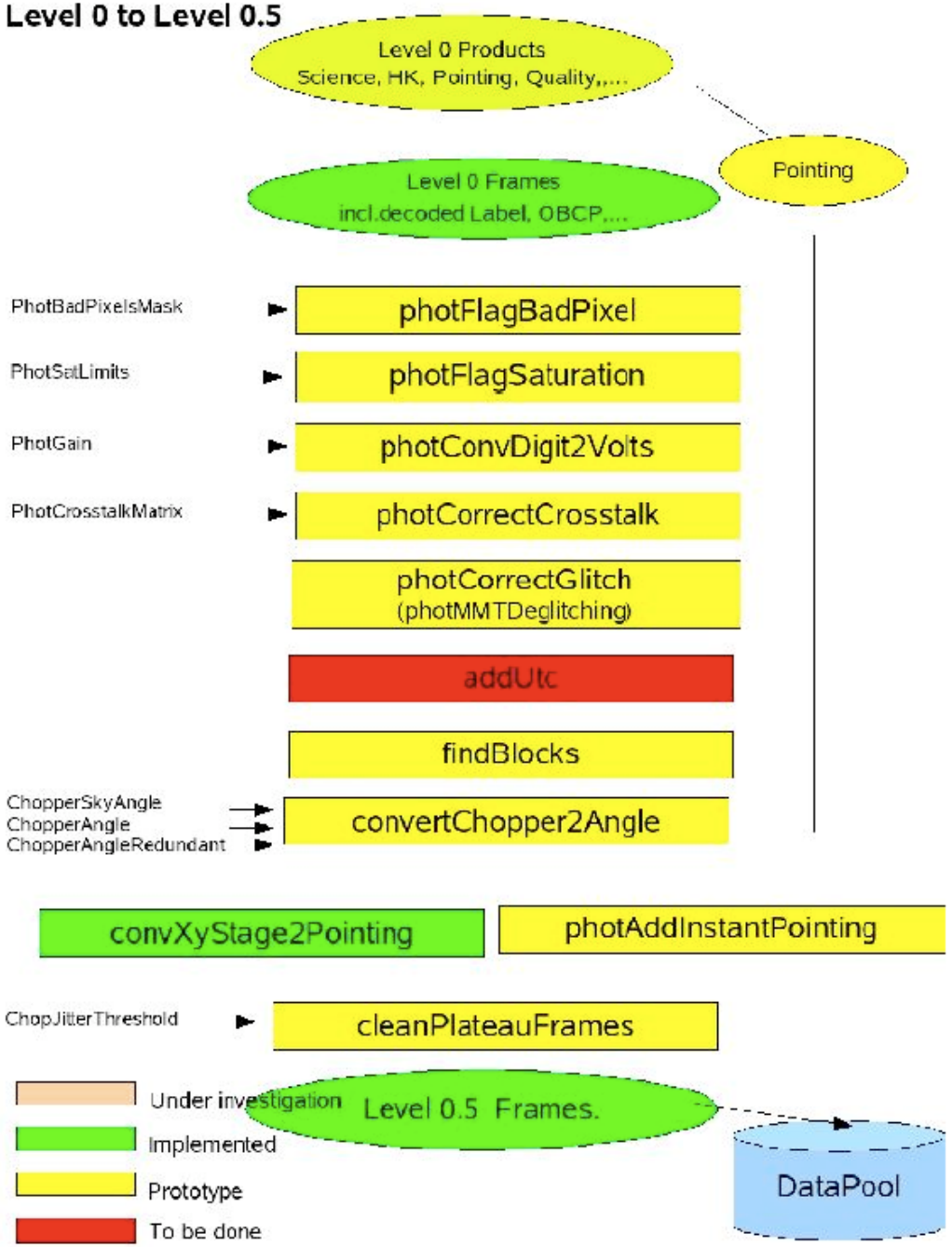
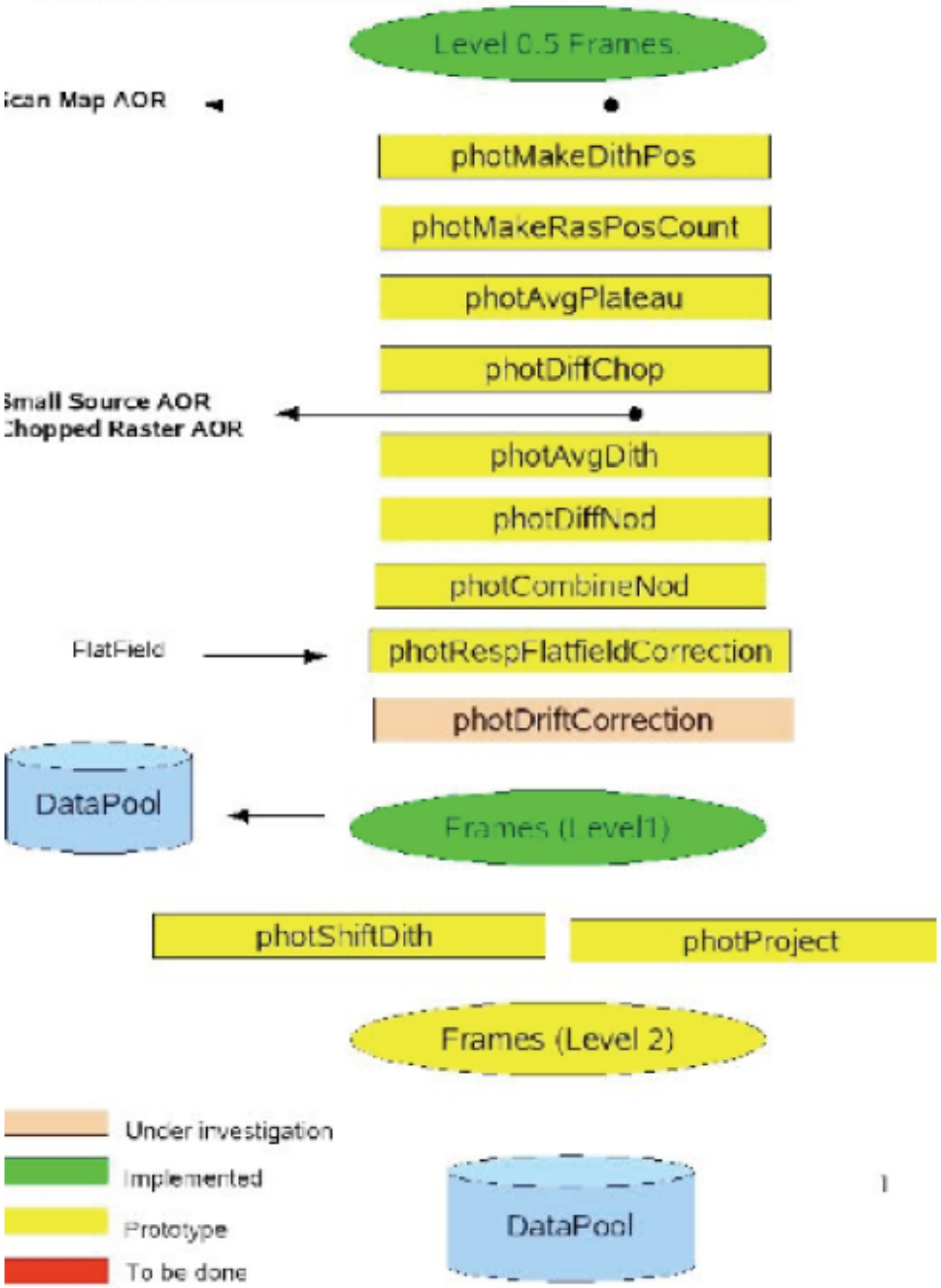
Level 0 to Level 0.5



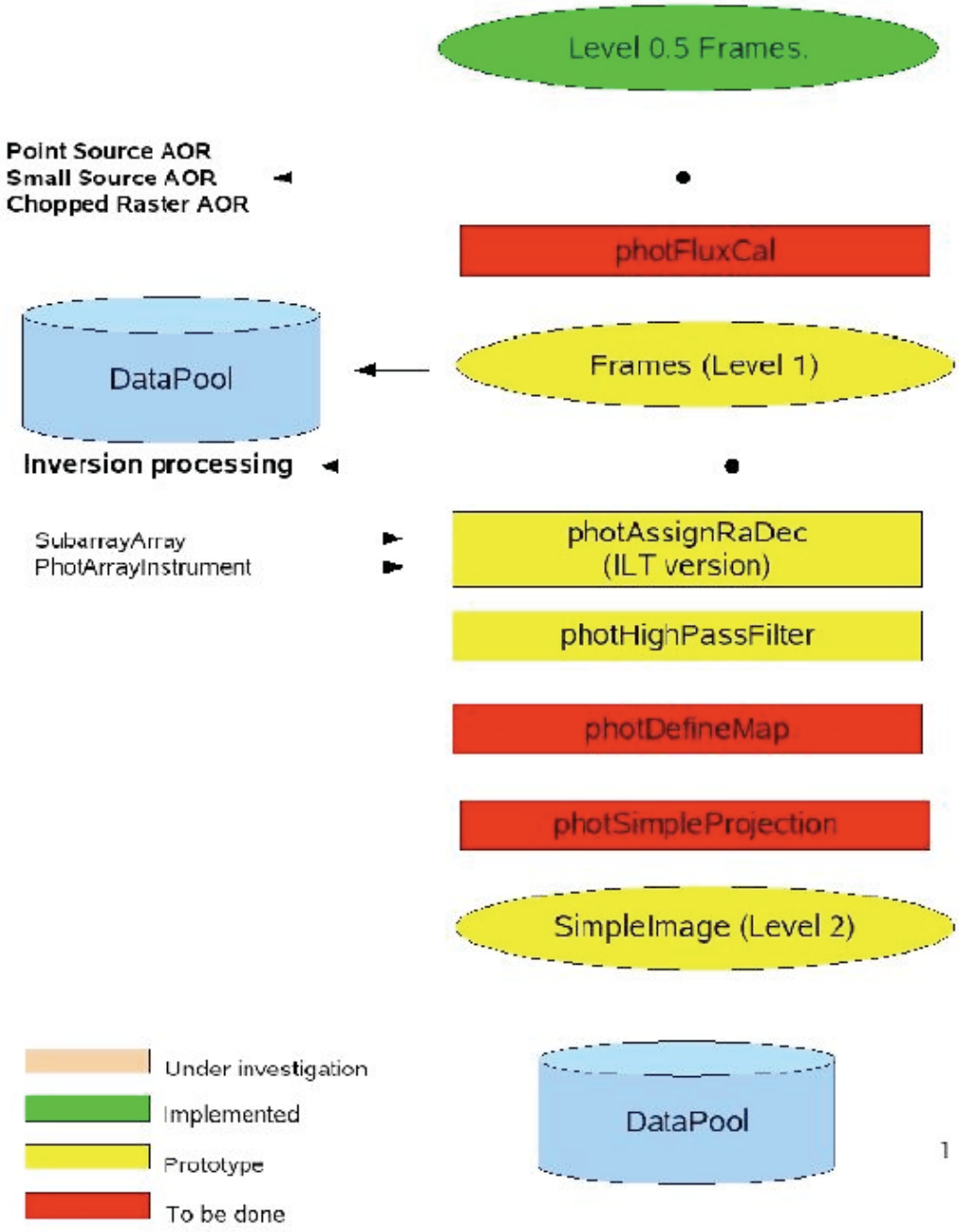
SPG pipeline chart level 0 to 0.5

Level 0.5 to Level1 and Level 2 : Point Source AOR



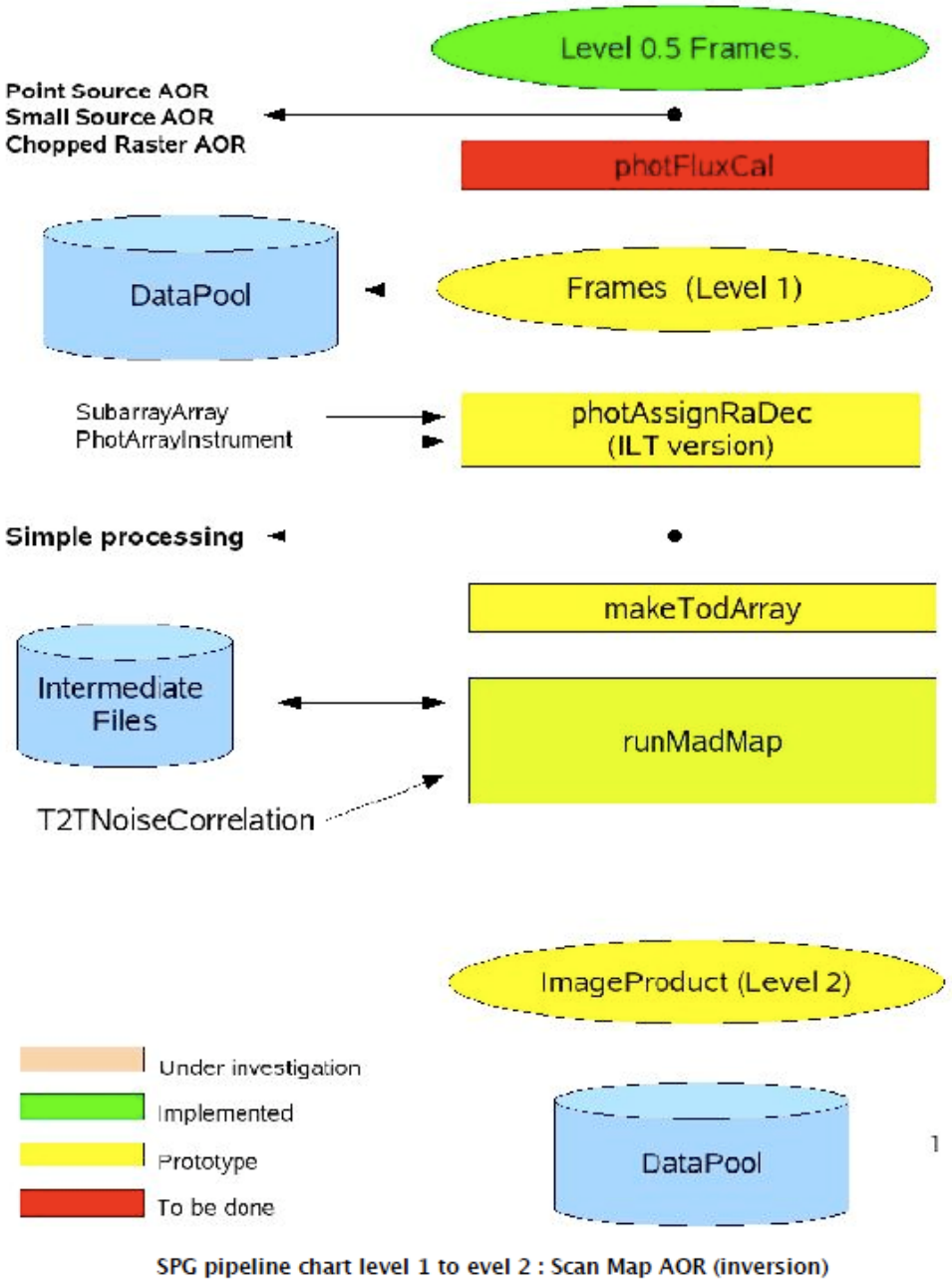
SPG pipeline chart level 1 to level 2 : Point Source AOR

Level 0.5 to Level1 and Level 2 : Scan Map AOR simple



SPG pipeline chart level 1 to level 2 : Scan Map AOR (simple)

Level 0.5 to Level1 and Level 2 : Scan Map AOR inversion



SPG pipeline chart level 1 to evel 2 : Scan Map AOR (inversion)

Data processing documentation

The PACS photometer pipeline document refers to the latest available version and not the DP workshop version (0.6.7.1). We list below all the known bugs and differences of the pipeline DP Workshop version with respect to this documentation :

- the calblock pre-processing tasks are not available in the v0.6.7.1; those tasks can not be used
- the *photMMTDeglitching* task is not producing the MMT_GLITCH mask: this is solved in the latest pipeline version.
- the *photDiffChop* task of the point and small source pipeline is not working properly; it might crash
- due to a known and now solved bug the astrometry is still not accurate; this is due to a wrong treatment of the Position Angle in the *photAddInstantPointing* and *photAssignRaDec* tasks
- the *photDriftCorrection* task is not working due to the missing input (output of cal-block pre-processing tasks); thus, the data can only be partially flux calibrated by the *photRespFlatFieldCorrection* task.
- the *photProject* task is not flux conserving when the output pixel size is different from the input pixel size; this is due to a well known and now solved bug. The astrometry of the output map is not accurate due to a problem (now solved) with the wcs.
- the exposure, coverage and noise maps are not properly propagated through the pipeline steps; the proper treatment is under development
- the use of the masks is still not accurate and the propagation of the masks in the pipeline steps is not appropriate; the proper mask treatment is under development
- the level 2 product of the Point-source pipeline (final image with astrometric calibration) is not yet available in the DP workshop pipeline version. A prototype is available and under testing in the latest version.
- MADmap API (i.e. syntax) is obsolete.

PACS photometry data volume /RAM

- Pacs Photometry Data Volume
- Blue Bolometer: 32 x 64 = 2048 channels
- Red Bolometer: 16 x 32 = 512 channels
- Readout frequency: 40Hz averaged on board to 10Hz
- All data stored as doubles: 8 bytes

- data volume of Level 0 (Level 1) data:
  - Blue bolometer:
    - Signal 2048 x 10 x 8 ~ 164 Kb/s
    - Noise 2048 x 10 x 8 ~ 164 Kb/s
    - Ra 2048 x 10 x 8 ~ 164 Kb/s
    - Dec 2048 x 10 x 8 ~ 164 Kb/s

    ~2.6 Gb/hour
  - Red Bolometer :

    ~0.6 Gb/hour

Most of PACS AORs are much longer than 1h:

memory issue in the data processing!!!

Pacs Photometry Data Volume Memory issue

- Possible solutions:
  - PACS photometry data processing feasible only on very powerful machines: at least 8G of RAM
  - Store Signal, Noise, Ra, Dec as float and not double
  - Chunking of PACS photometry data (on the basis of repetition factor for point/small source aot, scan legs for scan maps aot)
  - Clever memory interaction