PACS photometer mapping

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PACS photometer

- Relatively small rectangular 2x1 footprint, FOV = 3.5’x1.75’
- 2 channels simultaneously imaged:
  - Blue channel 64x32 array, pixel size = 3.2”, 60-85 µm or 85-130 µm
  - Red channel 32x16 array, pixel size = 6.4”, 130-210 µm

- On-board readout frequency: 40Hz
- On-board averaging, downloaded frequency: 10Hz
Point-source and small-sources modes

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

chopped
off-source
nod1 chop B
on-source
nod1 chop A
nod2 chop B
nodded
off-source
nod2 chop A

Chopper axis
PACS large area mapping

• However Herschel was designed to make large scale surveys

• Two ways:
  – Raster mapping
    • Satellite goes through a rectangular grid pattern of points in internal reference frame
  – Scan mapping
    • Satellite slews continuously along parallel lines at constant speeds
raster mapping

- Modulation of signal necessary because of 1/f noise
- Hence chopping imposed at 0.25Hz
  - Given by Allan variance (blue array), probably less later as compromise between blue and red detector
- Duration per raster point fixed at 64s (8 on/off cycles)
- Chopper-throw fixed at 3.5 arcmin, i.e one FOV (long side)

- Raster mapping only allowed in instrument reference frame
  - → orientation depends on position angle of day of observation
  - → to be immune against PA it is advised to define square maps

- Note: in FM ILT tests it has been noted that arrays are tilted by 3 degrees with the instrument reference frame
Raster mapping

- Map centered on the area mapped by the chop/on footprints
- SRPE = Spatial Relative Pointing Error
  - Current performance prediction = 2.5 arcsec,
  - Requirement/goal: 1 arcsec
Raster strategy: 2 cases

• Very small maps always chopping out of FOV
  • \( \Delta x \) = few arcsec
  • High redundancy

• Larger maps chopping inside map
  • Note: if \( \Delta x = 3.5 \) arcmin, chop/nod like
Overheads: raster point slew times

- Observation efficiency limited by the duration of small slews between raster points,
  - typically of the order of 20-30 sec..
  - $\rightarrow \sim 1/3$ of overheads
Raster limitation

• Chopping :
  – introduces negative sources/beams
  – degrades the sensitivity by $\sqrt{2}$ because of differential imaging
  – and another factor $\sqrt{2}$ because if sources seen only in one chop position (as half of the time spent on source).

• Only relatively small areas can be mapped, up to 10’x10’ or 15’x15’

• → For larger area: scan mapping
Scan mapping

- For large areas up to several square degrees
- 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 = 2.5 arcsec
Scan mapping efficiency

- Large overhead for turn-around manoeuvre between scan legs
- Scan legs smaller than 15’ are very inefficient.
scan maps

• With filled array, no fixed magic angle like SPIRE
• Two types of scan maps
  – 1/ in instrument reference frame
    • Advantage: control on the geometry of the scan map
    • Drawback: no control on map orientation, hence maps shall be square
  – 2/ in sky coordinates
    • Advantage: control on map orientation
    • Drawback: limited control on homogeneity of the scan map
    • But ‘magic distance’? With a cross-scan distance of a matrix 51 arcsec: rather homogeneous coverage, whatever the array to map angle
Scan map orientation

- In reference frame “array” in HSpot
  - $\alpha$ fixed, constraint on $\beta$ is possible
  - Selection of homogeneous coverage offered in HSpot.

- Oriented in the sky, “sky” in HSpot
  - $\beta$ fixed, constraint on $\alpha$ possible

- Note: If $\alpha=45^\circ$ then orthogonal coverage has same depth
Scan maps in HSpot
sensitivities

- HSpot returns the mean sensitivity across the map
- Exposure map tool to be made available for phase II entry,
  - under testing.

- HSpot sensitivities are very conservative, correspond to DDCS readout mode, pessimistic case
  - DDCS: to avoid spacecraft electromagnetic perturbations
  - In DM mode factor 2 better and 50% in red band.

- Goal: change sensitivities for KP OT entry June 2007 for the DM case

- KP GT: proposals shall be robust against change of sensitivity by a factor 2.
Data reduction

Not defined yet, neither scan maps or raster maps.

- Direct mapping
- Direct mapping with 1/f noise removal
- MADMap
- MOPEX
- Constrained Map-maker
Questions?

- PACS Observer’s Manual:
  http://herschel.esac.esa.int/ao_kp_documentation.shtml

- Herschel Helpdesk:
  http://herschel.esac.esa.int/esupport/