PACS photometer mapping

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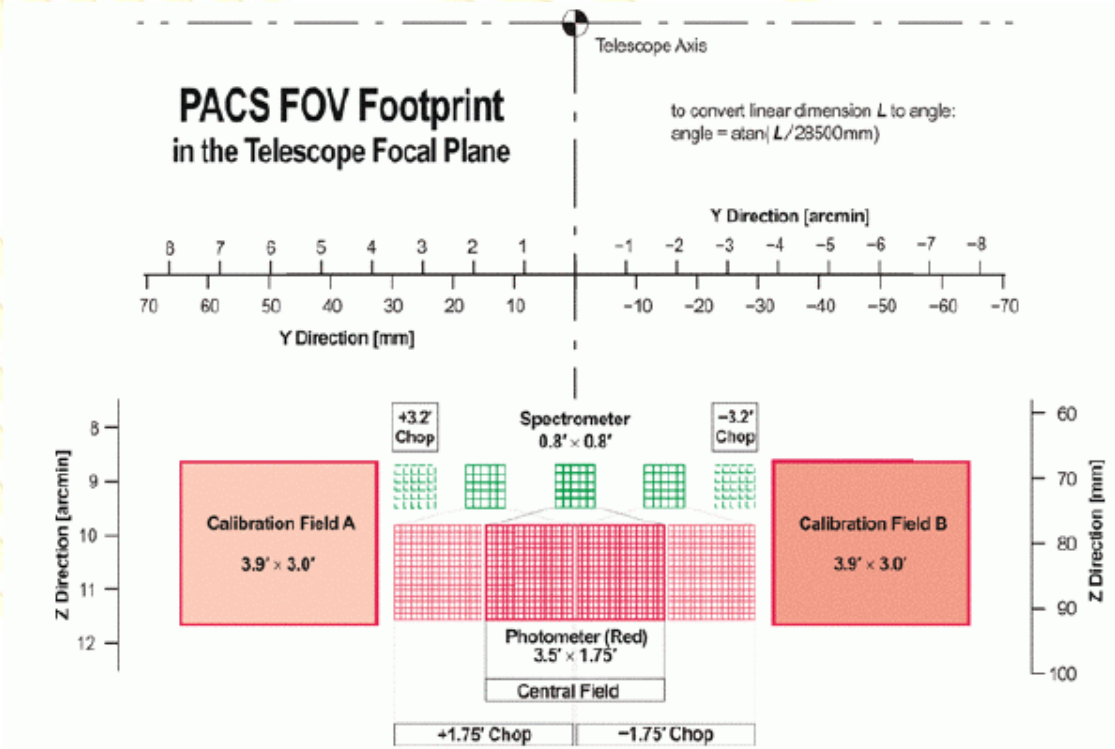
HERSCHEL SPACE OBSERVATORY

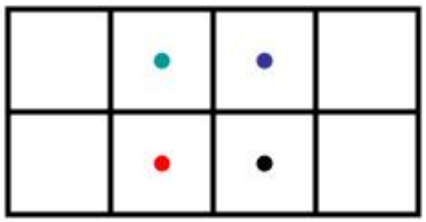
PACS photometer

- 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**

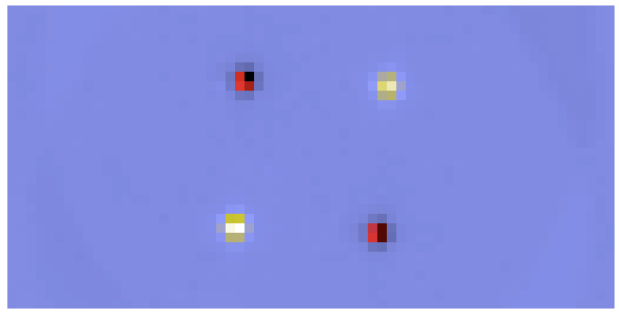
- **On-board readout frequency : 40Hz**
- **On-board averaging, downloaded frequency : 10Hz**



Point-source and small-sources modes

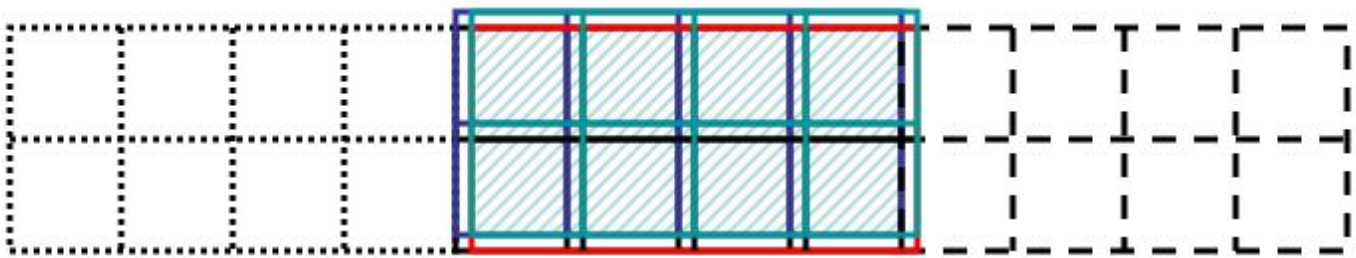


Nod 1 chop A
Nod 1 chop B
Nod 2 chop A
Nod 2 chop B



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

Chopper axis



chopped
off-source
nod1 chop B

on-source
nod1 chop A
nod2 chop B

nodded
off-source
nod2 chop A

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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

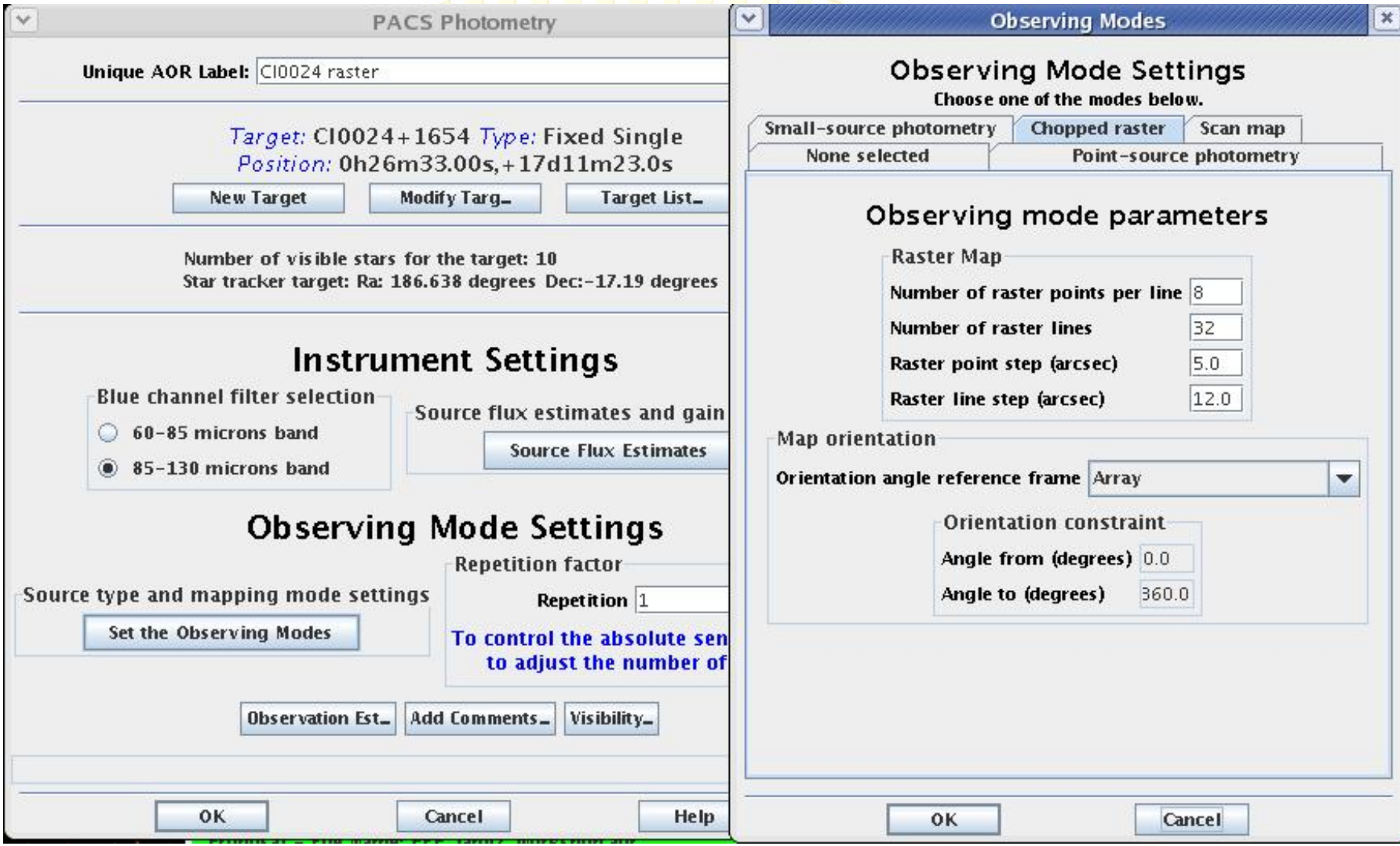
raster mapping

- 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**

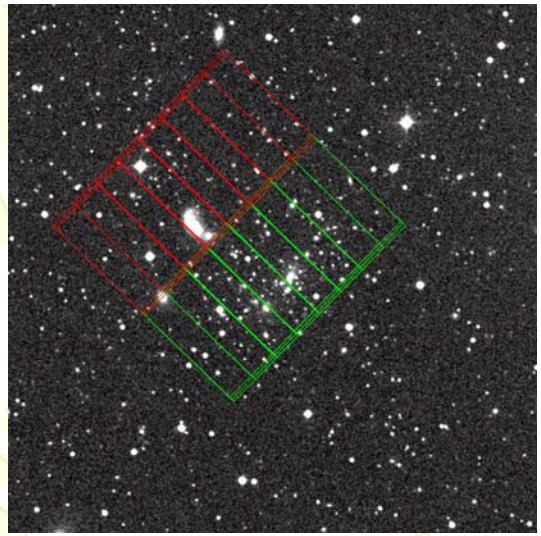
- Note : in FM ILT tests it has been noted that arrays are tilted by 3 degrees with the instrument reference frame

Raster mapping

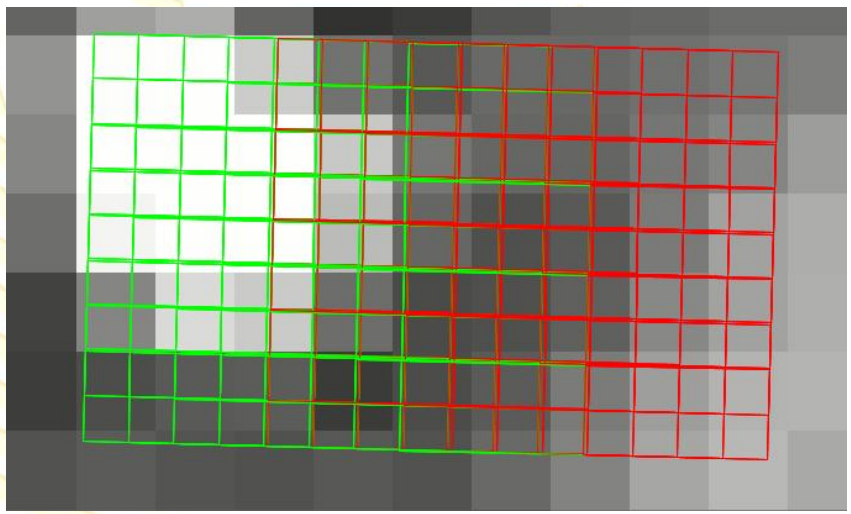


Raster strategy: 2 cases

- Very small maps always chopping out of FOV
  - Δx = few arcsec
  - High redundancy



- Larger maps chopping inside map
  - Note : if Δx =3.5 arcmin, chop/nod like



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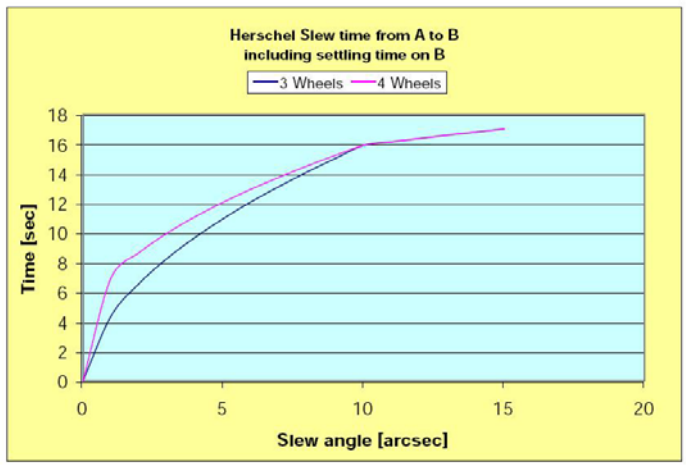
Overheads : raster point slew times

- Observation efficiency limited by the duration of small slews between raster points,
  - typically of the order of 20-30 sec..
  - → ~1/3 of overheads

Herschel approximate slew times

Herschel approximate slew times



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Raster limitation

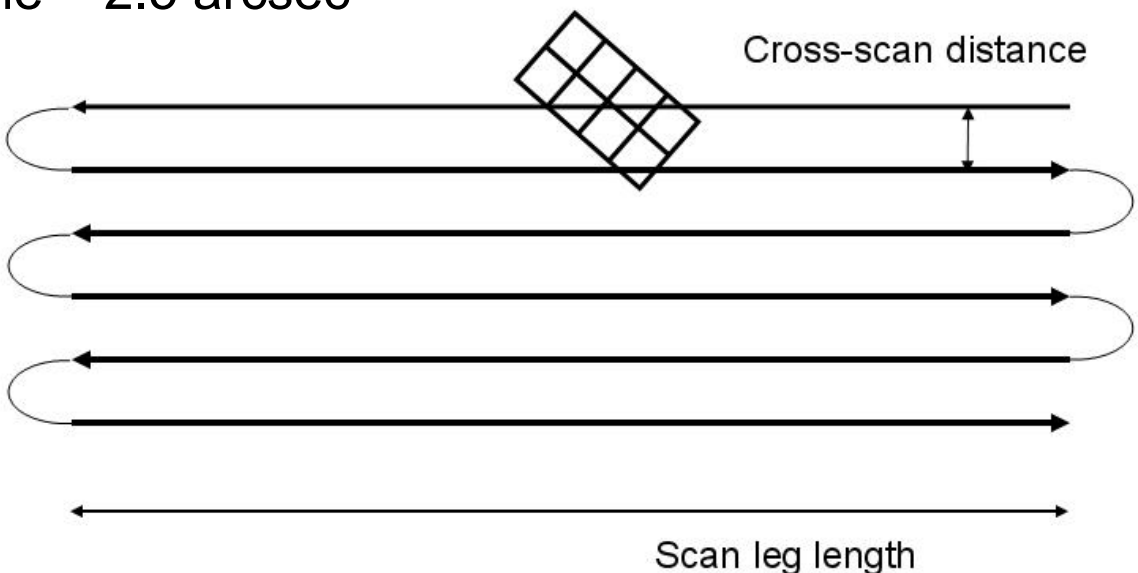
- Chopping :
  - introduces negative sources/beams
  - degrades the sensitivity by √2 because of differential imaging
  - and another factor √2 because if sources seen only in one chop position (as half of the time spent on source).

- Only relatively small areas can be mapped, up to 10'x10' or 15'x15'

- → For larger area: scan mapping

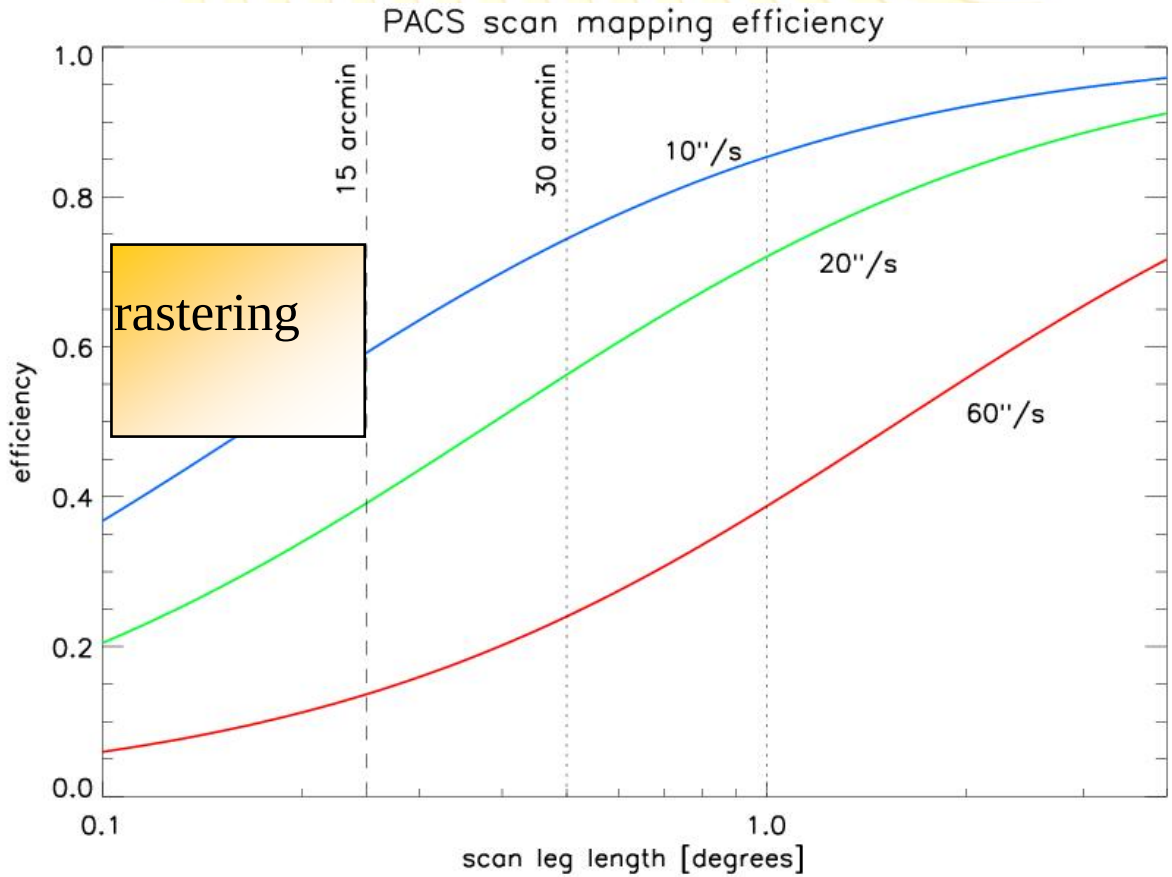
Scan mapping

- 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.



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scan maps

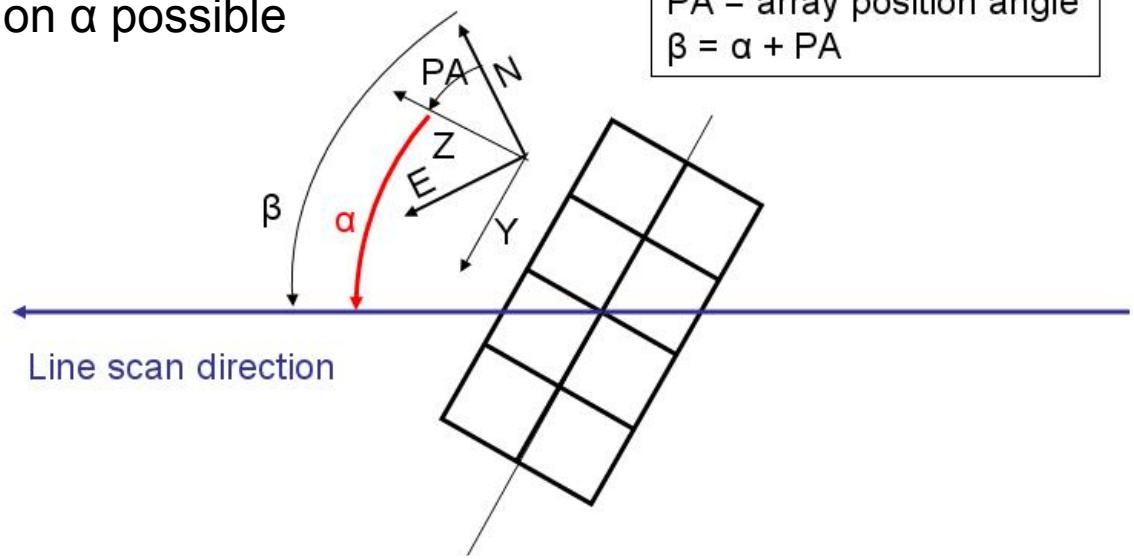
- With filled array, no fixed magic angle like SPIRE
- Two types of scan maps
  - 1/ in instrument reference frame
    - Advantage: control on the geometry of the scan map
    - Drawback: no control on map orientation, hence maps shall be square
  - 2/ in sky coordinates
    - Advantage: control on map 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
  - α fixed, constraint on β is possible
  - Selection of homogeneous coverage offered in HSpot.

- Oriented in the sky, “sky” in HSpot
  - β fixed, constraint on α possible

α = array-to-map angle
β = map orientation angle
PA = array position angle
β = α + PA



- Note: If α=45° then orthogonal coverage has same depth

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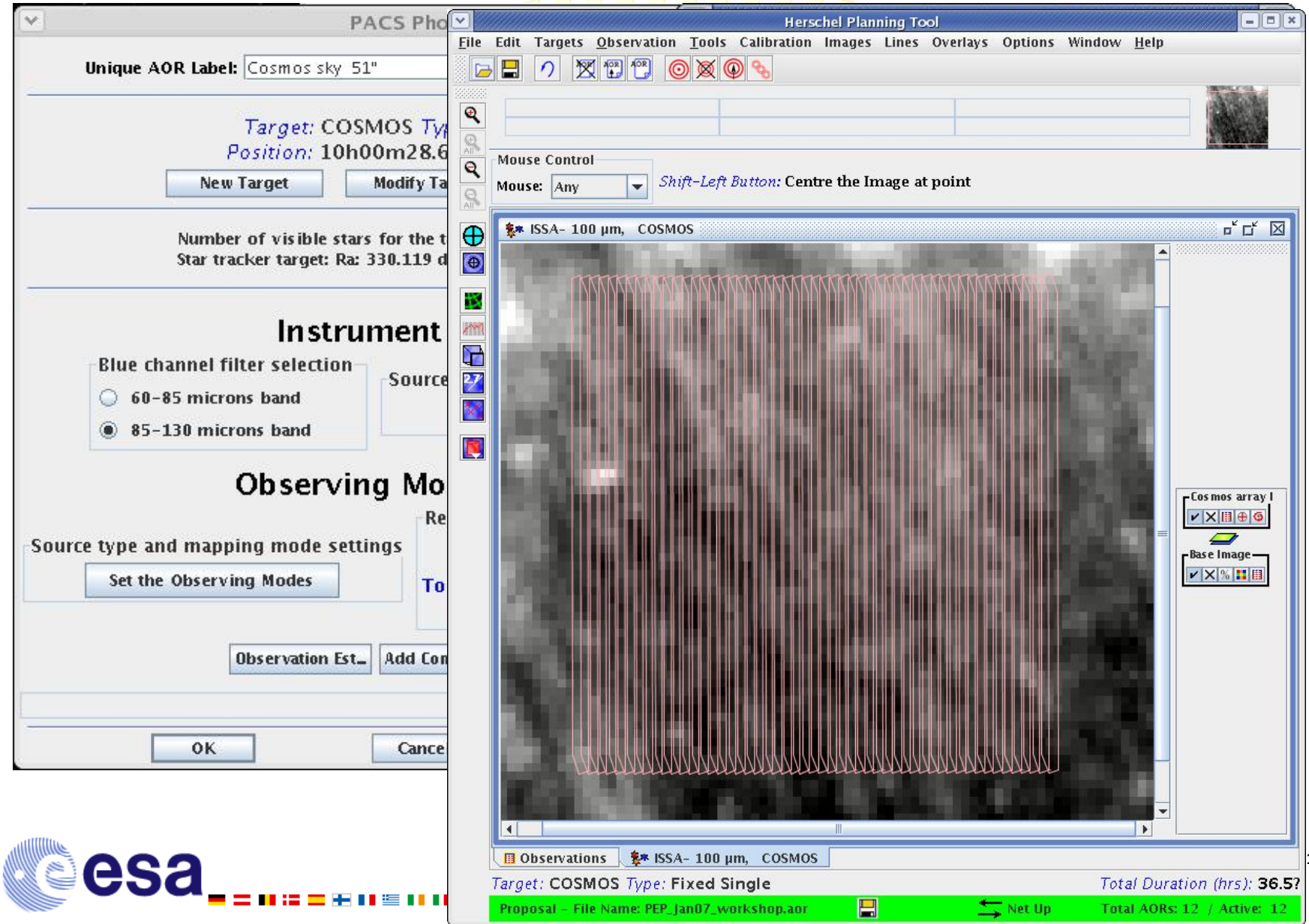
Scan maps in HSpot



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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/

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