PACS Photometer AORs

How to Prepare an Observation with HSpot:
2 Science Use Cases

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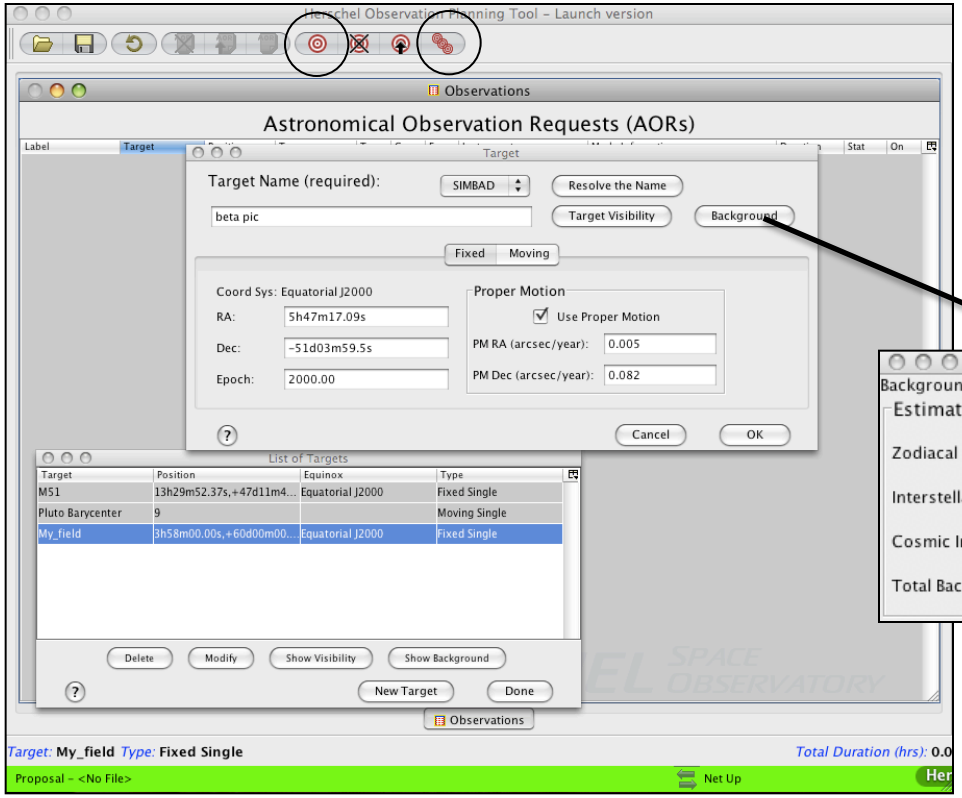
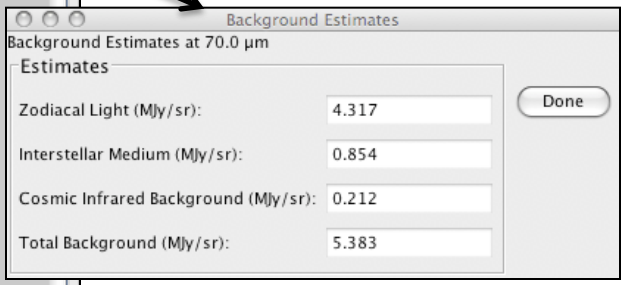
Quick Introduction to HSPOT for PACS Photometry – I: Define a Target and Target List

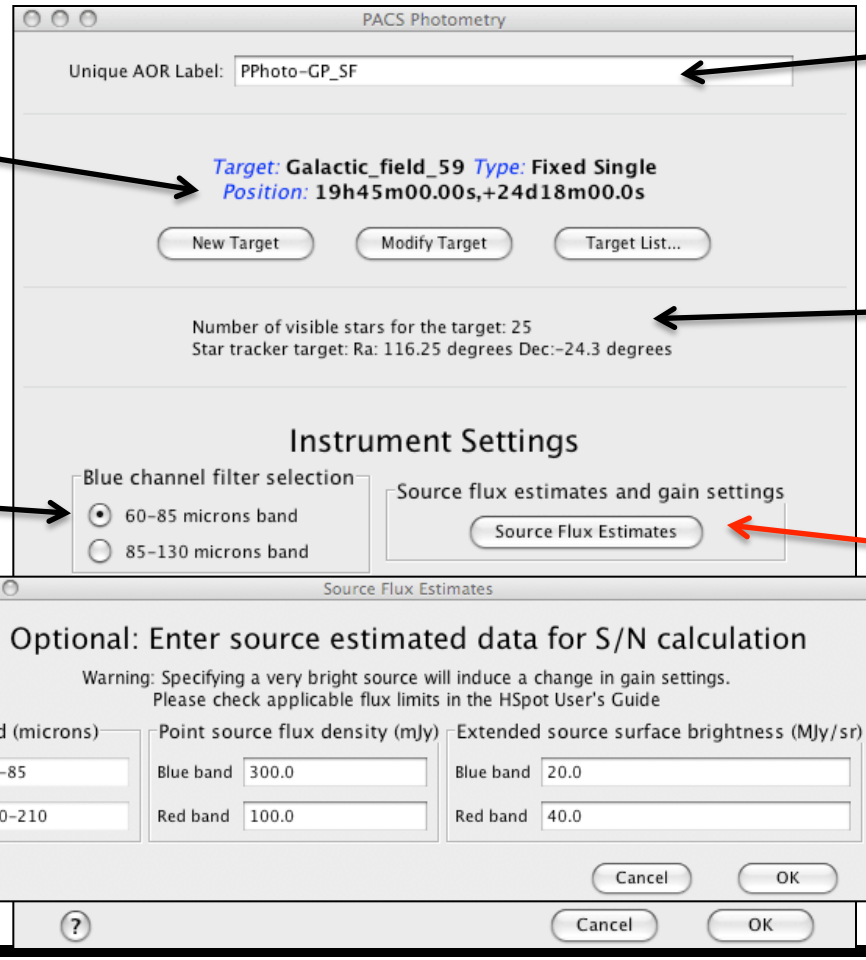
Target Target List





1) Enter target (fixed or moving)
2) Check target visibility
3) Check background

Quick Introduction to HSPOT for PACS Photometry – II: Define PACS Instrument Settings



Unique AOR Label

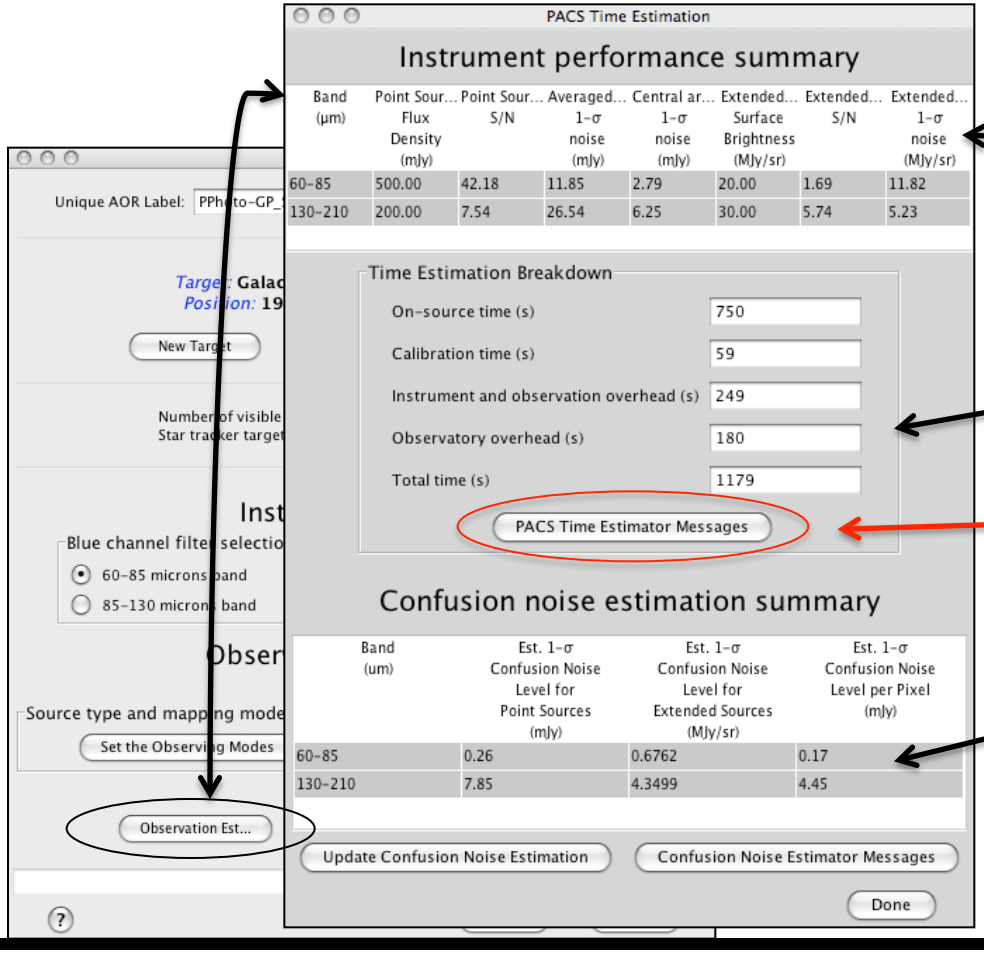
Target information

# of stars in Star Tracker (better be >9)

70 and 160 µm
OR
100 and 160 µm

Warning:
HSpot automatically switches to the low-gain setting if the source estimate exceeds the saturation limits.
Low-gain setting reduces sensitivity.
Saturation limits are very conservative

Quick Introduction to HSPOT for PACS Photometry – III: Check AOR Performance Estimate



Sensitivity estimates:
values for extended emission are conservatively underestimated by ~30%

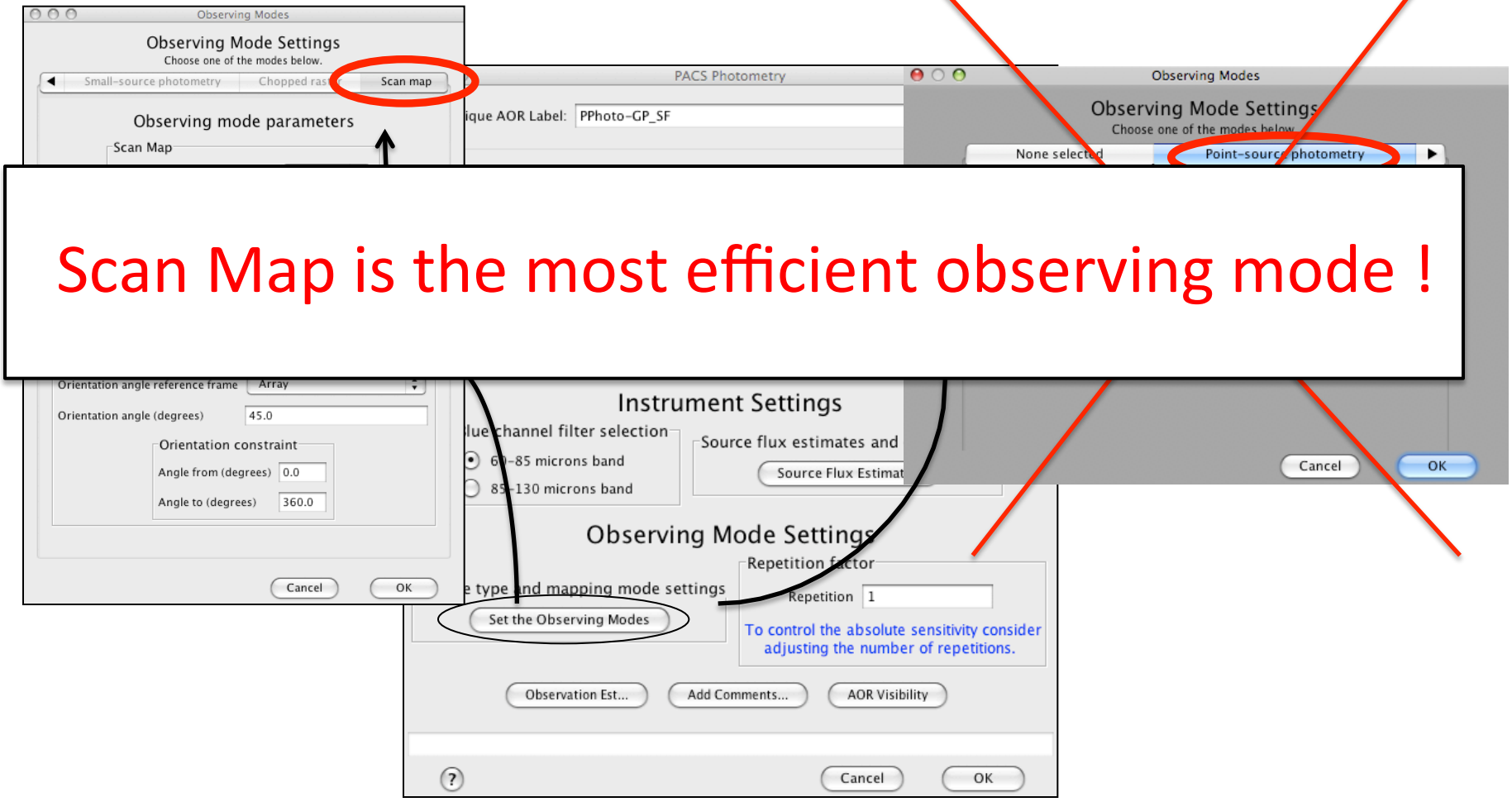
Details of AOR execution time

more details here

Confusion noise estimates

Scan Map

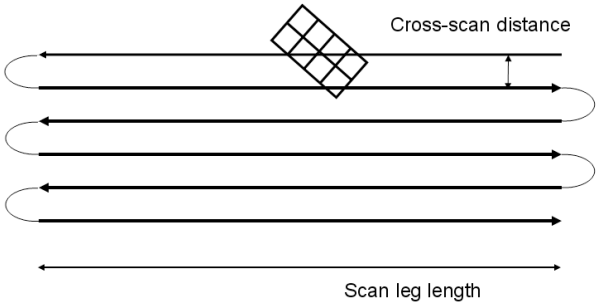
2 AOTs for the PACS photometer



Scan Map is the most efficient observing mode !

Scan-map AOT

Scan maps are performed by slewing at constant speed along parallel lines



Special case: Mini-scan map

- Scan along the diagonal of the array, i.e. at 70° and/or 110° in array coordinates
- 20''/s scan speed
- Concatenate X-scan map at 110°or 70°

→ Allows various kinds of mapmaking techniques, and provide higher quality photometry and better spatial characterization of the near source vicinity

- NO homogeneous coverage, and NO square map
- 8 - 10 scan legs with cross-scan distance of 4''

→ For shallow observations: less legs (but even number to minimize satellite movement) with larger cross-scan distances or skip cross-scan direction

- Scan leg length from 2' to 4':

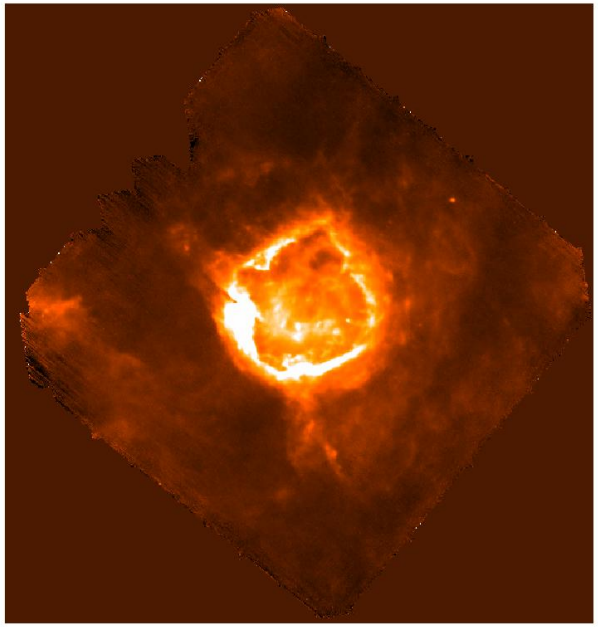
→ 3' length: optimal usage of constant scan speed of 20''/s, but during idle-positions the source is outside the array

→ 2' length: Source is always on-array, but acceleration/deceleration of source on array might require more elaborated processing

Scan Map AOT - We consider 2 science case examples

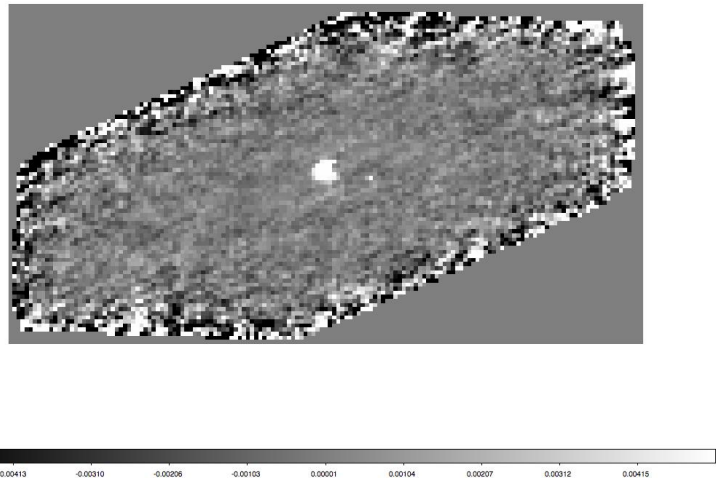
Galactic star formation region: SH104 (scan map)

Proposal = SDP_fmotte_3
Ra = 304.4159 deg
Dec = 36.7789 deg



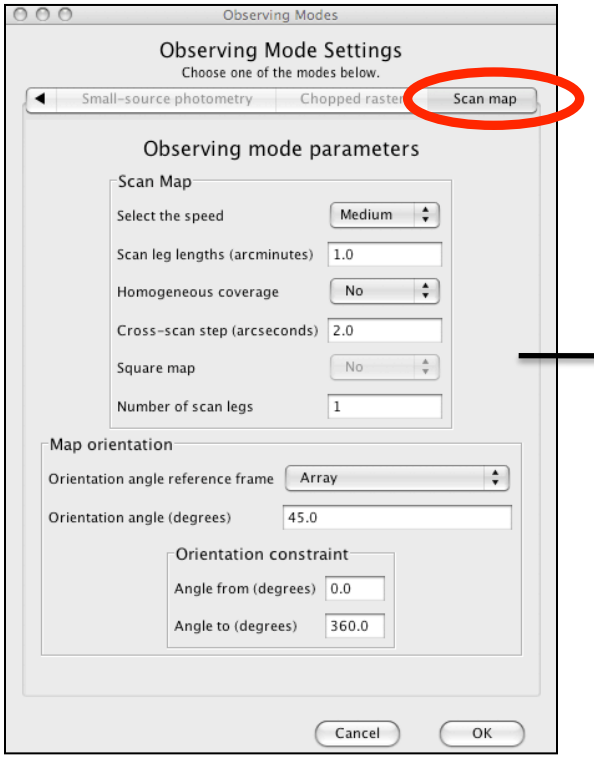
Point source: calibration star delta Dra (Mini-scan map)

Proposal = Calibration_rppacs_5
Ra = 288.1277 deg
Dec = 67.6631



How do we choose the settings in these 2 cases ?

Observing mode → Settings → Values ?



- Filter
- Scan Speed
- Scan Leg Length
- Cross-scan Distance
- Number of Scan Legs
- Square Map
- Homogeneous Coverage
- Orientation Reference Frame
- Orientation Angle
- Orientation Constraint
- Repetition Factor

What are the best choices of parameter values ???

Scan Map AOT Setting: Scan Speed

Options:

- Medium (20”/s) for optimal modulation of the signal from the telescope motion (celestial signal between the 1/f knee and the post-detection low-pass frequency)

- Fast (60’’/s), **for large maps only**, at the expense of degraded PSFs (**10%** - **60%** elongation in scan direction, for the **red** and **blue** channel, respectively) and longer overheads due to longer turnover time

Galactic Star Formation Region: SH104

- Scan speed: 20”/s

(Note: it could have been 60”/s if PSF quality was not critical and region to map was larger than 20’)

Calibration star: Delta Dra

- Scan speed: 20”/s

Scan Map AOT Setting: Map Size Parameters

(1) Scan Leg Length, 2) Cross-scan distance, 3) Number of scan legs, 4) Square map, 5) Homogeneous coverage)

Options:

- Scan leg length: sets dimension of one map side, has to be < 20°
- Cross-scan distance <105'' ensures overlapping between scan legs for all array-to-map angles (in sky coordinates). Note: cross-scan distance of 51'' (~sub-array size) gives relatively flat exposure maps in Sky coordinates, whatever the array-to-map angle
- Square Map makes observation scheduling easier (number of scan legs is set automatically)
- Recommended use of Homogeneous Coverage (cross-scan distance is set automatically)

Galactic Star Formation Region: SH104

- Scan length: 20 arcmin
- Cross-scan distance: 2" (set automatically)
- Square map: 1 scan leg (set automatically)
- Homogeneous coverage
- Cross-scans (extended emission)

Calibration star: Delta Dra

- Scan length: 4'
- Cross-scan distance: 4"
- NO square map: 8 scan legs (Note: it could be less for shallow observations)
- NO homogeneous coverage

Scan Map AOT Setting: Map Orientation Parameters

Options:

- All scan directions are possible in array or sky reference frame, with optional constraints
- Orientation constraints translates into scheduling constraints, hence in observing time penalties
- Avoid scanning at array angles of 0° and 90° because of empty inter-module gap
- If scan maps in Sky coordinates without array constraints, the map coverage depends on the exact observation date, and there is a risk that the array-to-map angle is 0° or 90°. Check the AOR overlay on image at given visibility windows

Galactic Star Formation Region: SH104

- Array reference frame
- Array-map angle : 45^0
- Cross-scan angle : 135^0 (spare 2 minutes slew time)

Calibration star: Delta Dra

- Array reference frame
- Array-map angle : 117^0
- Cross-scan angle : 63^0 (provides better characterization of source proximity)

Scan Map AOT Setting: Repetition Factor

Options:

- Sets the sensitivity of the observation once the other parameters are set
- If repetition factor >1, it is recommended to use an even number of scan legs to minimize satellite slew overheads

Galactic Star Formation Region: SH104

- Repetition Factor : 1

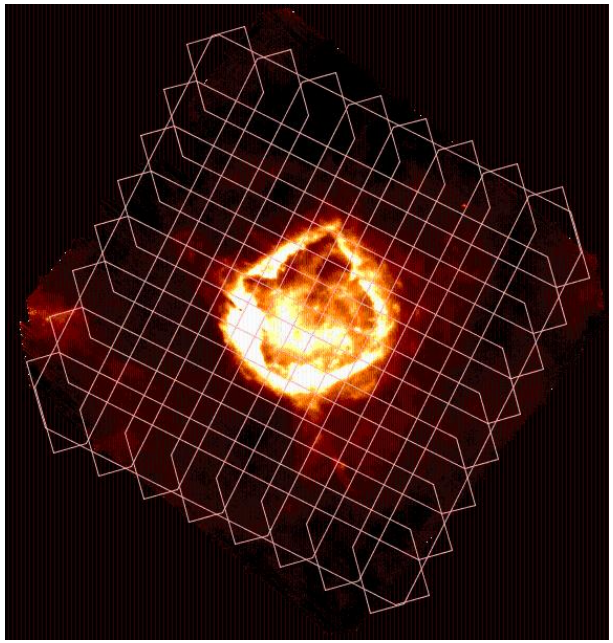
(Note: if RepFactor > 1 and scan at 60"/s, be aware of much longer execution time due to longer turnover intervals between scan legs)

Calibration star: Delta Dra

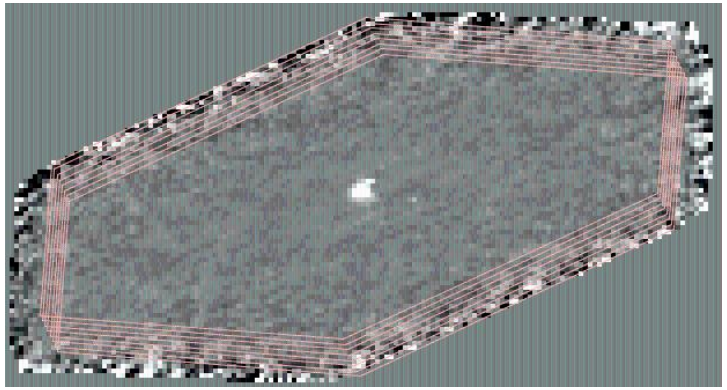
- Repetition Factor : 1

… and this is how your AORs would look like

Galactic star formation region: SH104 (scan map)



Point source: calibration star delta Dra (Mini-scan map)



Tips and Tricks

For deep scan maps and best PSF reconstruction:

- Instead of multiple repeats at the same location, one should dither the entire map by shifting slightly the center and by concatenating pairs of scan/X-scan AORs
- Add follow-on constraints to pairs of scan/X-scan AORs, i.e. repeat scan/X-scan at different epochs to allow the scan direction to rotate, assuming the array reference frame (but it costs 600s extra overheads)

Scenarios that give same sensitivity in final map:

- 1 Scan at 20'' /s versus 3 Scans at 60'' /s :

  AOR execution time is significantly higher in case of fast scan due to longer turnover times between scan legs. It is prohibitive for small maps

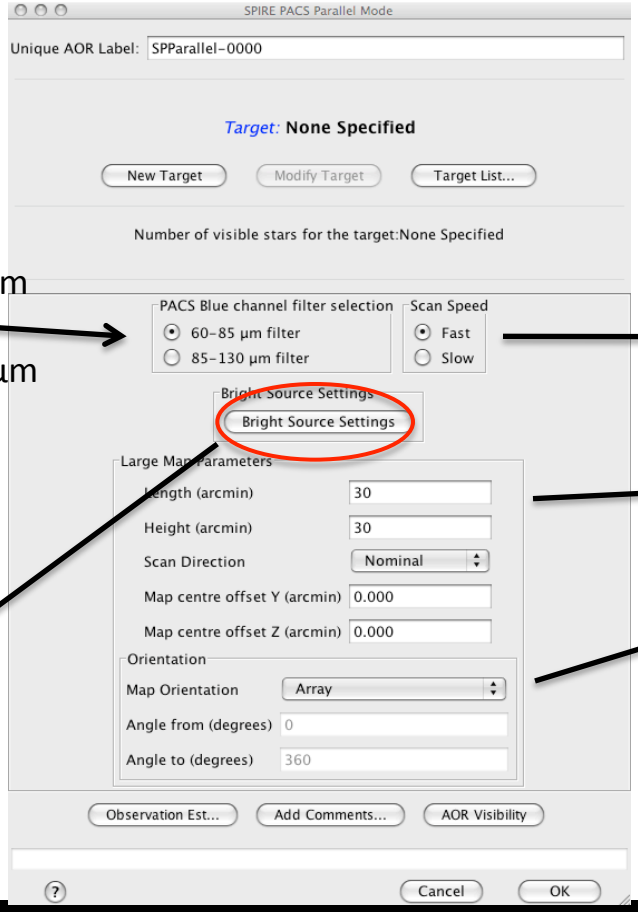
  $overhead_{60''/s} >> overhead_{20''/s}$

- 1 fine Scan (short cross-scan distance) versus 3 loose Scans (larger cross-scan distance) while covering the same area (it requires to un-tick homogeneous coverage):

  AOR execution time is similar, but fine scanning gives more homogeneous coverage

PACS/SPIRE Parallel Mode

Hspot Menu → Observations → PACS SPIRE Parallel Mode



70 and 160 µm
OR
100 and 160 µm

This is a special observing mode that is intended for large area photometric mapping using both PACS and SPIRE simultaneously

Scan speed

"Length" and "Height" set size of the area to map

Direction of scan legs ("Array" or "Sky")

Set gain ("low" or "high" – default is high)

Pros and Cons of PACS/SPIRE Parallel Mode

Pros

- Simultaneous observations in five bands are made possible without significant degradation in instrument performance
- Very efficient for mapping large areas (> 1 deg)
- No evident degradation of SPIRE performance between Parallel Mode and SPIRE-only observations
- More accurate relative PACS/SPIRE astrometry
- Very favorable in terms of science per amount of helium

Cons

- Due to the large offset of the fields of views of SPIRE and PACS (21 arcmin), this mode is very inefficient for small maps : 45 minutes *minimum* execution time for 1 repetition!
- Given that PACS and SPIRE integration times are identical, sensitivities across the bands and between the instruments are different
- if scanning at 60"/s, PACS additional data averaging in blue band (8 by 8 frames instead of 4 by 4) causes PSF elongation
- If scanning at 60"/s, sources in SPIRE bands can appear as glitches, and be mistakenly be corrected for by deglitching algorithms

Documentation:

- Hspot User's Guide:
http://herschel.esac.esa.int/Docs/HSPOT/html/hspot-help.html

- PACS Observer's Manual:
http://herschel.esac.esa.int/Docs/PACS/html/pacs_om.html

- Herschel's Observer's Manual:
http://herschel.esac.esa.int/Docs/Herschel/html/observatory.html

- AOT Release Note:
http://herschel.esac.esa.int/AOTsReleaseStatus.shtml

- Herschel Reserved Observation Search Tool:
http://herschel.esac.esa.int/Tools.shtm#HROST