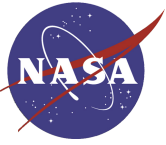# Example Science Cases and AORs for SPIRE I: Photometer

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List of Contents

- SPIRE Photometer AOT Overview
  - Large Map
  - Small Map
  - Point Source (7-Jiggle) (less efficient and noisier than small map, not recommended)
  - SPIRE/PACS Parallel Mode (separate AOT)
- Examples (HSpot demo)
  - Map of Arp220 (small map)
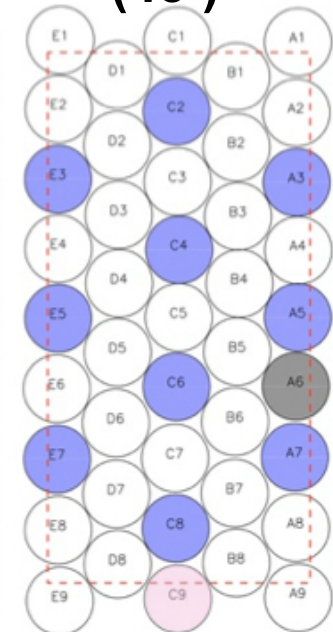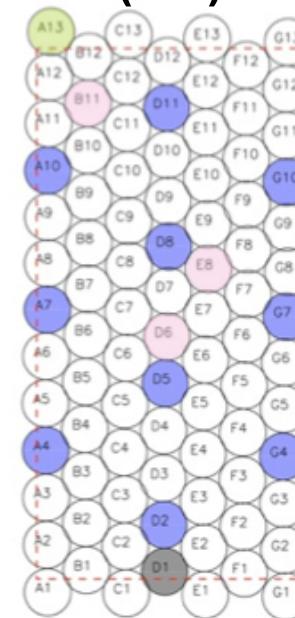 - A large field near Galactic Center (large)

SPIRE Photometer Arrays

- 3-band imaging photometer

  - 250, 350, 500 μm (simultaneous)
  - λ/Δλ ~ 3
  - 4 x 8 arcmin field of view
  - Diffraction limited beams (18, 25, 36")

PSW 250 μm (139) **PMW 350 μm (88)** **PLW 500 μm (43)**

8 arcmin 45 mm

4 arcmin 23 mm

- Slow
- Noisy
- Dead
- Overlap

Large Scan Map

Uniform scan speed distance
(speed: 30"/sec or 60"/sec)

348"

―――――― Scan leg

―――――― Map area covered to uniform sensitivity (user required area)

―――――― SPIRE 250 μm array size
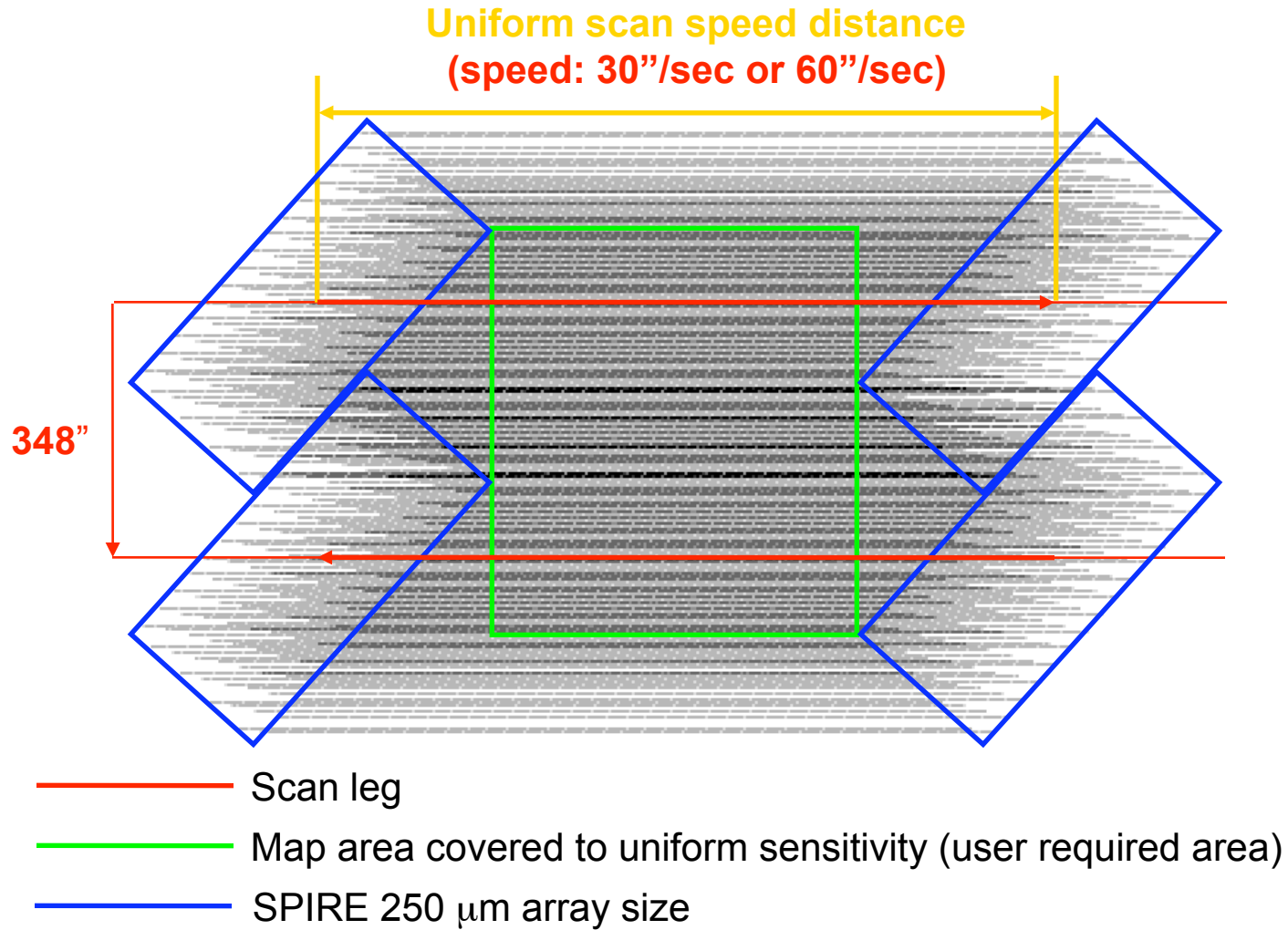
Two Pre-fixed Scan Directions

(250 μm array)

Z-axis

B: Orthogonal (-42.4° w.r.t. Z-axis)   **A: Nominal (42.4° w.r.t. Z-axis)**

Cross-Linking Example

A:

A & B:

B:

This facilitates de-striping.

# Small Map Mode

Coverage map of 250μm
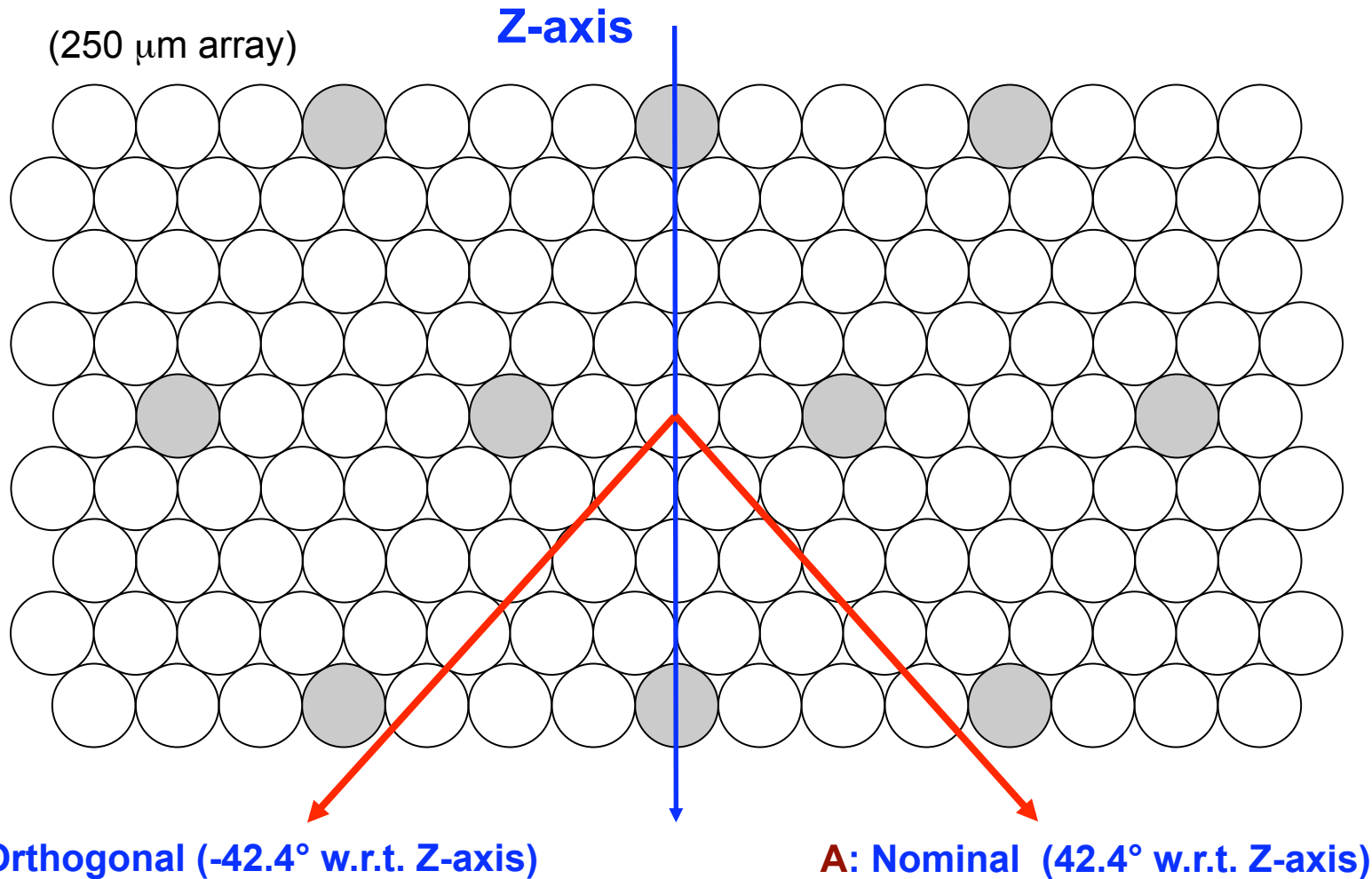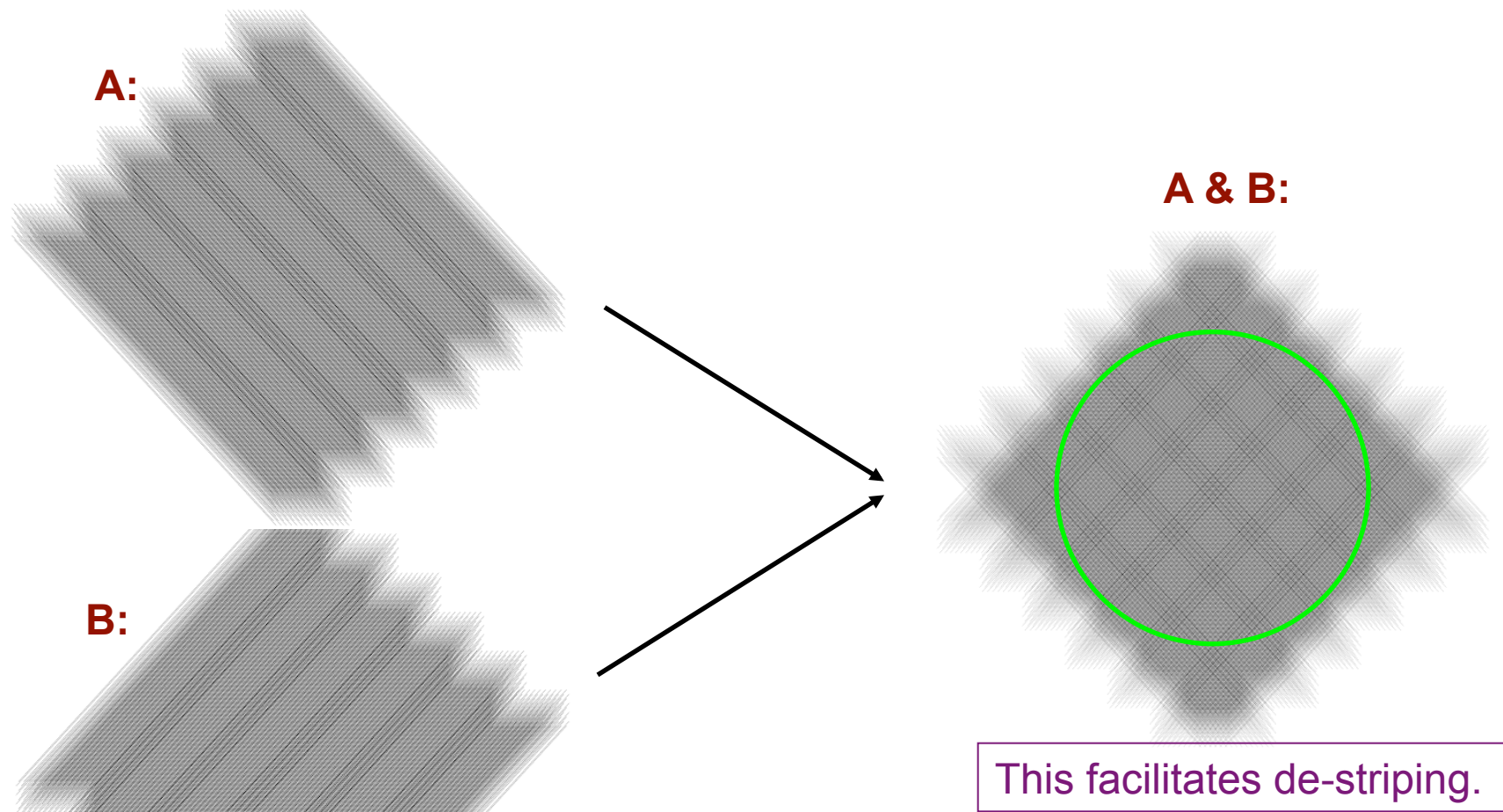
- Cross-linked single scans (A&B scans)
- fixed speed: 30"/sec
- scan length guarantees 5' coverage →
- bright source setting for f > 200 Jy
- allow map center offset (also available for large map):
  0.1' < offset < 300' (Y and Z axes)
  for:
    (1) dithering;
    (2) on-off observations;
    (3) linking observations with regarding to the scan direction (which is fixed in the Y&Z coor. system).
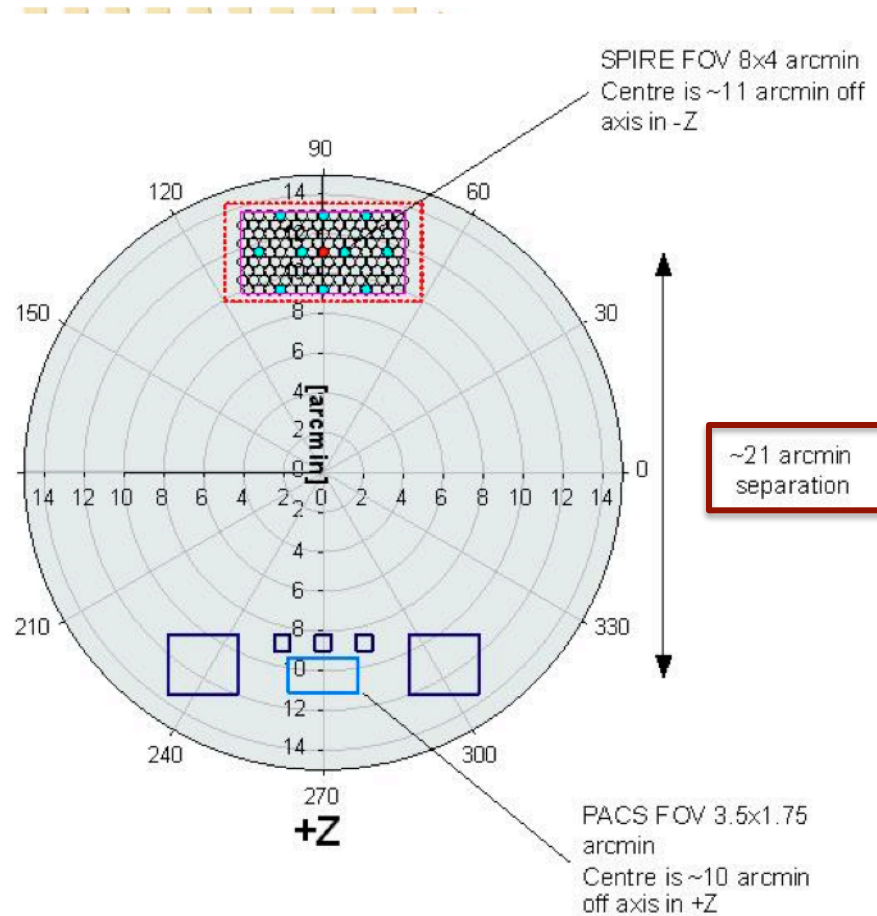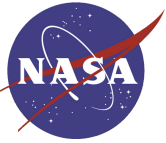

5'
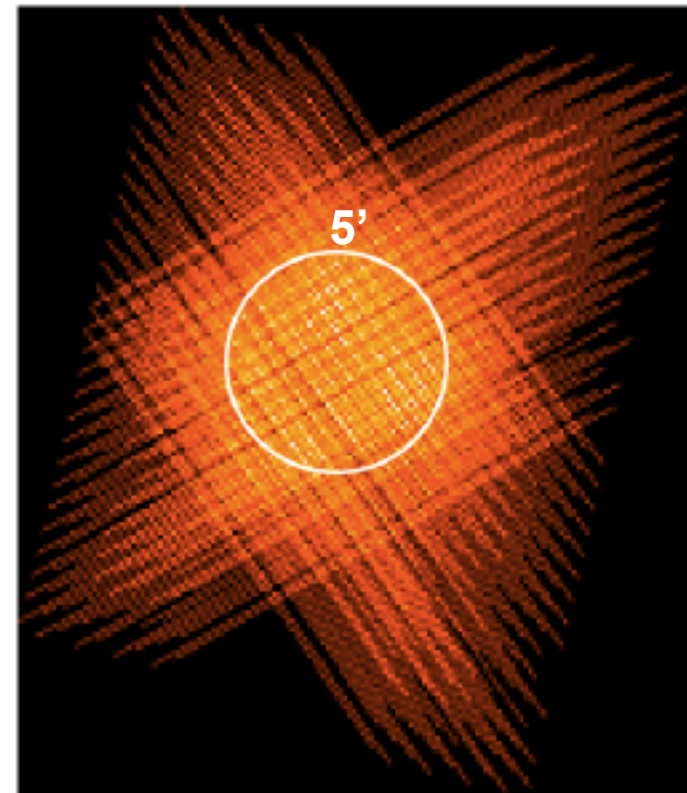
SPIRE/PACS Parallel mode

The PACS and SPIRE photometer footprints are separated by ~21 arcmin along the spacecraft Z-axis

The area that the s/c boresight paints on the sky is larger than the common PACS/SPIRE survey area

SPIRE FOV 8x4 arcmin
Centre is ~11 arcmin off axis in -Z

~21 arcmin separation

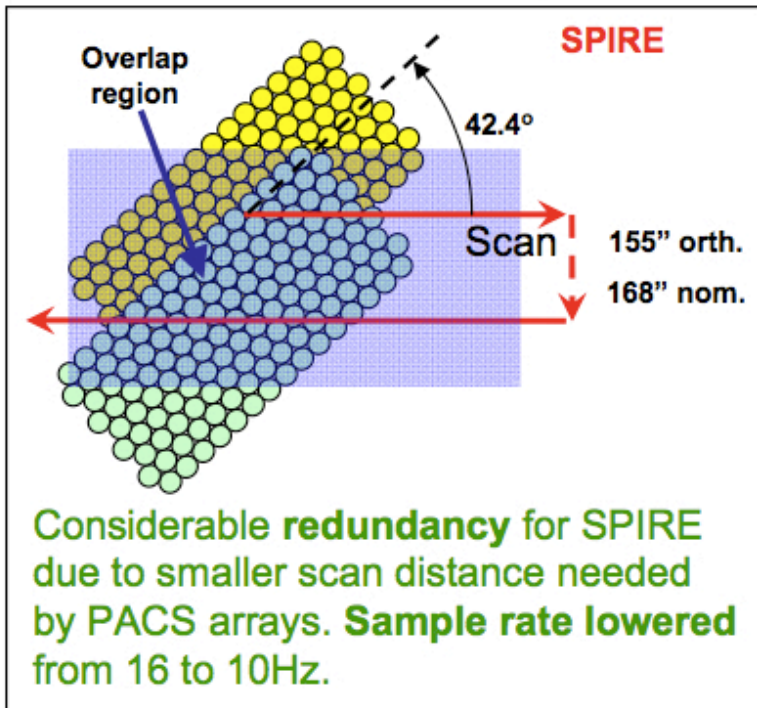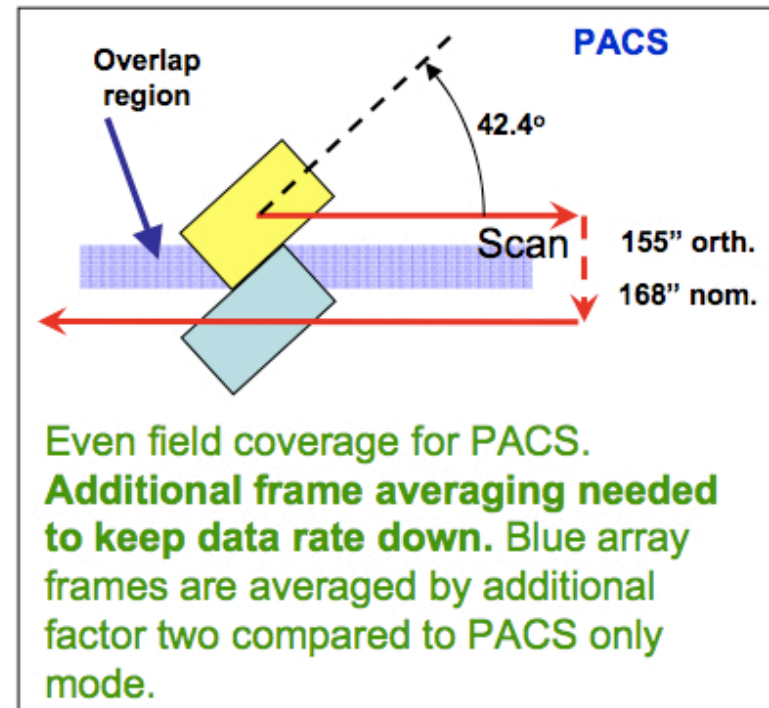PACS FOV 3.5x1.75 arcmin
Centre is ~10 arcmin off axis in +Z

SPIRE/PACS Parallel mode

- Scan maps at speeds of **20** and **60"/sec** with PACS and SPIRE active in parallel are useful for **large-area surveys**.
  - The distance between PACS and SPIRE apertures is 21 arcmin.
  - Two almost orthogonal (**84.8°**) directions for **cross scanning** are available.

SPIRE Geometry

SPIRE

Overlap region

42.4°

Scan — 155" orth.
168" nom.

Considerable **redundancy** for SPIRE due to smaller scan distance needed by PACS arrays. **Sample rate lowered** from 16 to 10Hz.

PACS Geometry

PACS

Overlap region

42.4°

Scan — 155" orth.
168" nom.

Even field coverage for PACS. **Additional frame averaging needed to keep data rate down.** Blue array frames are averaged by additional factor two compared to PACS only mode.

Science Case 1:
Small-Map of Arp220

Ultra-luminous IR galaxy
~2', $f_{250\mu m}$ ~ 50 Jy

HSpot
SPIRE-PHOT: Small-Map

SPIRE Photometer

Unique AOR Label: SPhoto-0000

Target: arp220 *Type:* **Fixed Single**
Position: **15h34m57.12s,+23d30m11.5s**

New Target   Modify Target –...   Target List...

Number of visible stars for the target: 10
Star tracker target: Ra: 53.738 degrees Dec:-23.503 degrees

Input parameters:
- bright source mode: no (default)
- repeats: 1

Instrument Settings

Source type
- ○ Point Source
- ● Small Map
- ○ Large Map

very simple

Repetition factor

Repetition 1

Source Flux Estimates and Bright Source Setting

Source Flux Estimates

Small Map Parameters

Map centre offset Y (arcmin) 0.000

Map centre offset Z (arcmin) 0.000

time estimate

Remember click these two buttons!!!

finish

Observation Est...   Add Comments...   AOR Visibility

(?)   Cancel   OK

HSpot:
Small-Map: time estimator

SPIRE Time Estimation Summary

Band (µm)	Point Source Flux Density (mJy)	Point Source S/N	1-σ instrument n... (mJy in beam)	Extended So... Surface Brightness (MJy/sr)	Extended So... S/N	Extended So... 1-σ instrument n... (MJy/sr)
250			9.0			0.77
350			7.5			0.34
500			10.8			0.24

instrument noise →

On-source time per repetition (s)	37
Number of repetitions	1
Total on-source integration time (s)	37 (=1*37)
Instrument and observation overheads (s)	132
Observatory overhead (s)	180
Total time (s)	349 (=37+132+180)

total time
(t_{obs}+overhead) →

Note: to change the observation time, change the repetition factor on the AOR main screen. It multiplies the on-source integration time per repetition to give the total on-source time.

Confusion noise estimation summary

Note: the predicted confusion noise level is higher than the estimated 1-σ instrument noise level!

Band (um)	Est. 1-σ Confusion Noise Level for Point Sources (mJy)	Est. 1-σ Confusion Noise Level for Extended Sources (MJy/sr)	Est. 1-σ Confusion Noise Level per Pixel (mJy)
250	7.0	1.1957	6.4
350	8.2	0.6793	7.8
500	10.1	0.4308	9.2

With just 1 repeat, the instrument noise is already below the confusion noise at 350µm!!

[Update Confusion Noise Estimation] [Confusion Noise Estimator Messages]

[Details] [OK]

Visualization: AOR on image

foot-prints of scans

Guaranteed uniform coverage

Science Case 2:
Large-Map of a Galactic Center Region

HSpot
SPIRE-PHOT: Large-Map

bright region:
short exposure = fast scan (60"/sec)

cross scan (A&B mode):
better map quality (recommended!)

bright source mode for f>200 Jy!!

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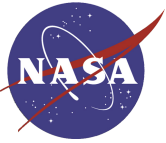
HSpot:
Large-Map: time estimator

fast scan +
brt source mode

= relatively low
sensitivity &
efficiency (36%)

but the obs still hits the
confusion limit (mostly
due to Galactic cirrus)!!

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Visualization: AOR on image

foot-prints of scans (6+6)

Guaranteed uniform coverage

Recommendations

(1) Better to use small map AOT for point source photometry.

(2) Do not put constraints on the AOR unless you absolutely have to.

(3) Don't use SPIRE/PACS parallel mode for fields < 1 deg.

(4) Use Bright Source setting for targets brighter than 200Jy.

(5) For large maps, one can choose to have a single A or B coverage, though the A&B mode (cross-scan) is generally recommended for facilitating better quality maps (i.e. with less strips).

(6) SPIRE is very sensitive, and the confusion noise is high. With ~2 repeats, the observations already reach the confusion limits. Do more repeats won't gain much.

Last Slide

Start the hands-on demo.