The SPIRE Photometer and its Observing Modes

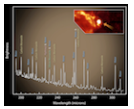
Bernhard Schulz (NHSC/IPAC)

on behalf of the
SPIRE ICC, the HSC and the NHSC

Your SPIRE Workshop Team

NHSC-SPIRE / IPAC

Bernhard Schulz   

Nanyao Lu  

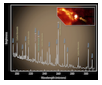
Joan Xie 

Kevin Xu  

Lijun Zhang 

Expertise Legend:

Photometer 

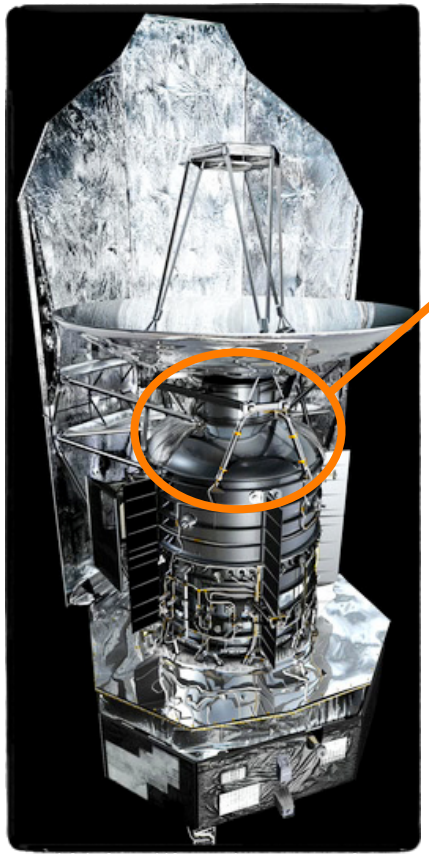
Spectrometer 

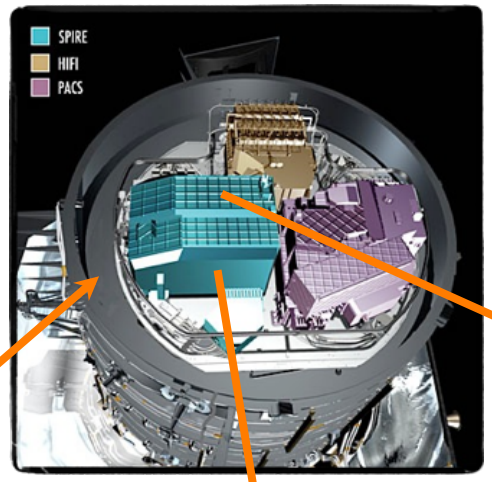
Software 

Contents

- SPIRE Introduction
- SPIRE Science examples
- SPIRE Instrument basics
  - Footprint, focal plane geometry, wavelength coverage
- Photometer observing modes (AOTs)

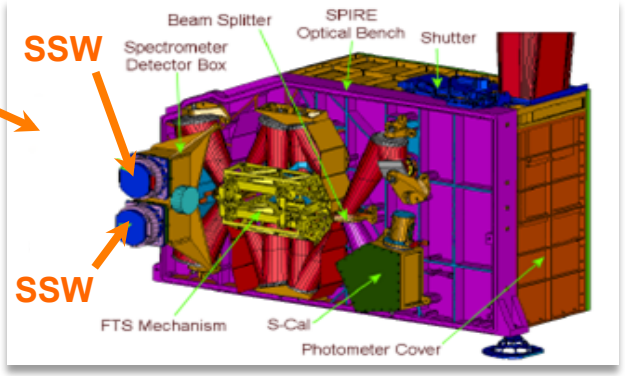
The SPIRE Instrument

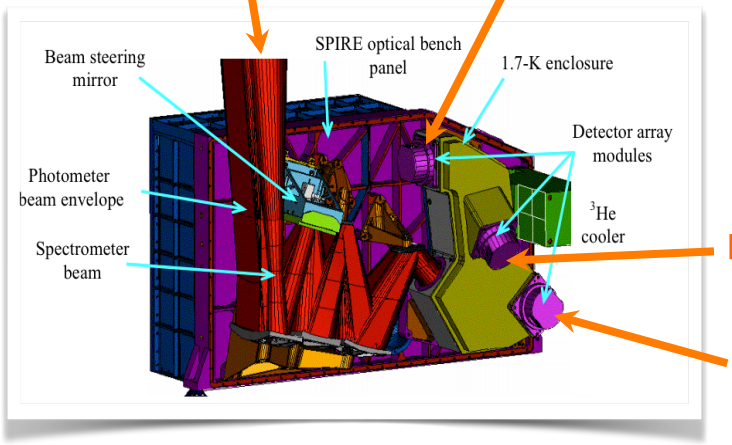




Imaging Fourier Transform Spectrometer

Simultaneous imaging observation of the whole spectral band
37 and 19 pixels
Wavelength Range: 194-313, 303-671 μm
(447 – 989 GHz, 959 – 1545 GHz)
Resolution: 24.98, 7.207, 1.193 GHz
Circular FOV 2.0' diameter, beams: 17-21", 29-42"

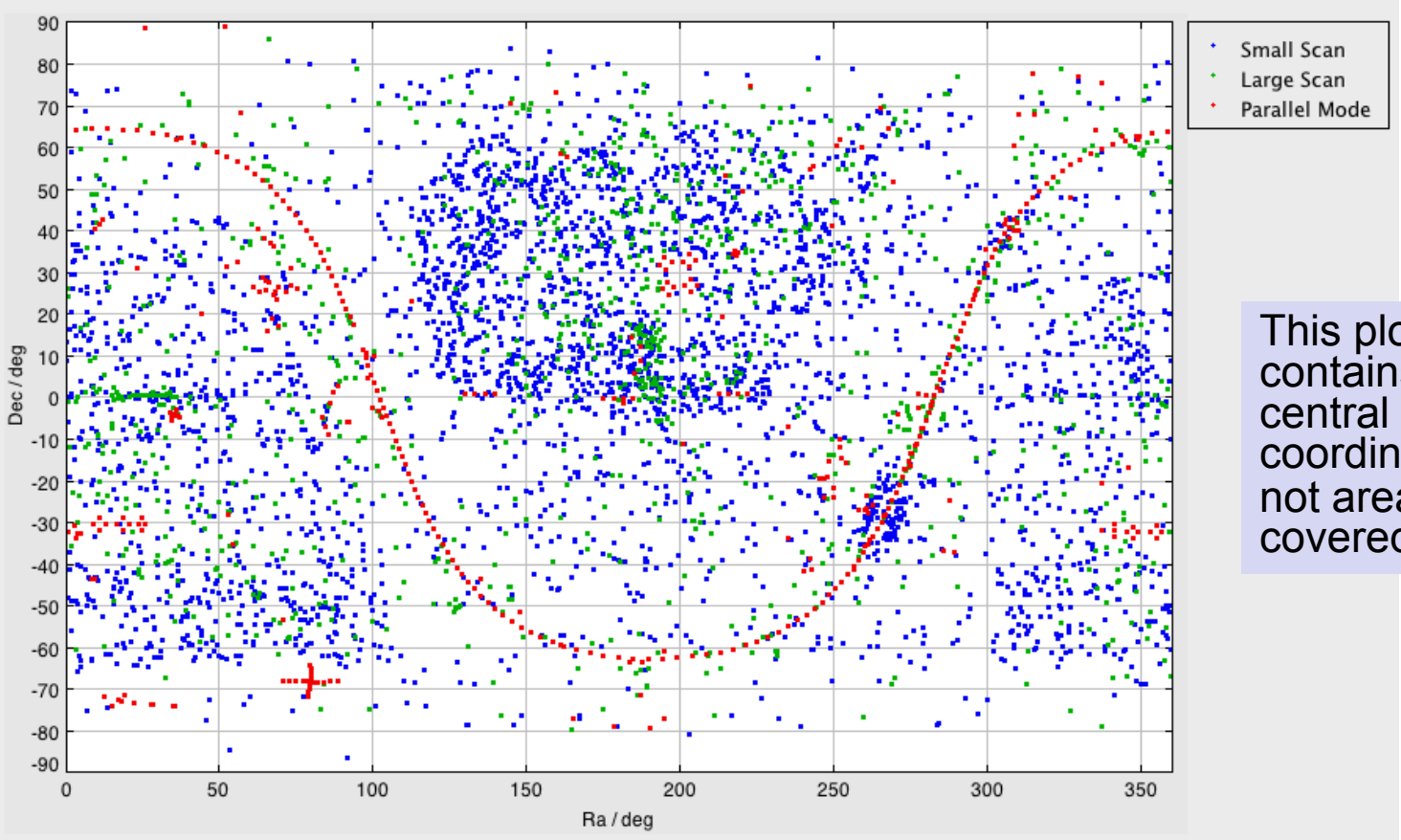




Imaging Photometer

Simultaneous observation in 3 bands
139, 88, and 43 pixels
Wavelengths: 250, 350, 500 μm
$\lambda/\Delta\lambda \sim 3$
FOV 4' x 8', beams 17.6", 23.9", 35.1"

SPIRE Scan Map Observations



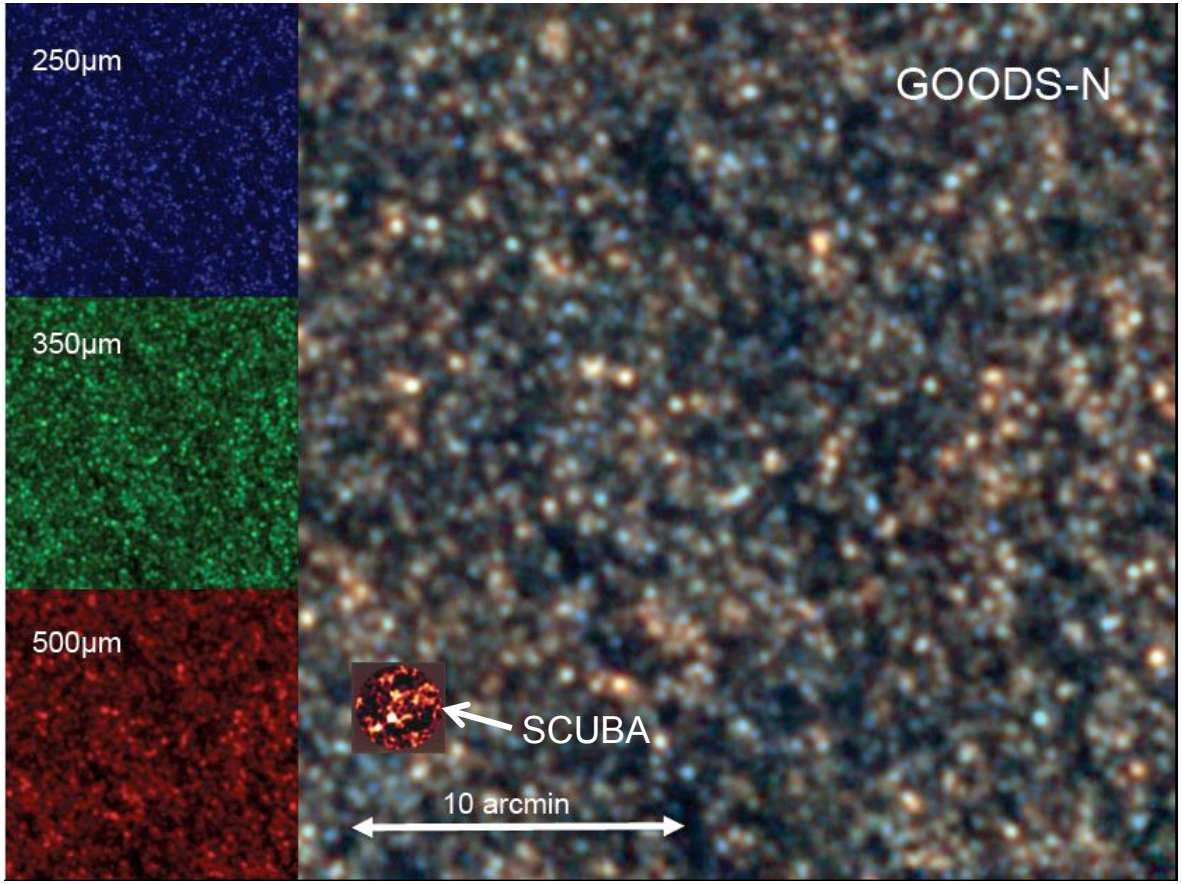
This plot contains only central target coordinates, not areas covered.

SPIRE mapped about 11% of the sky in 6917 scan map observations.
833 parallel mode, 1880 large maps, 4204 small maps

SPIRE Science Examples

GOODS-North as seen by SPIRE

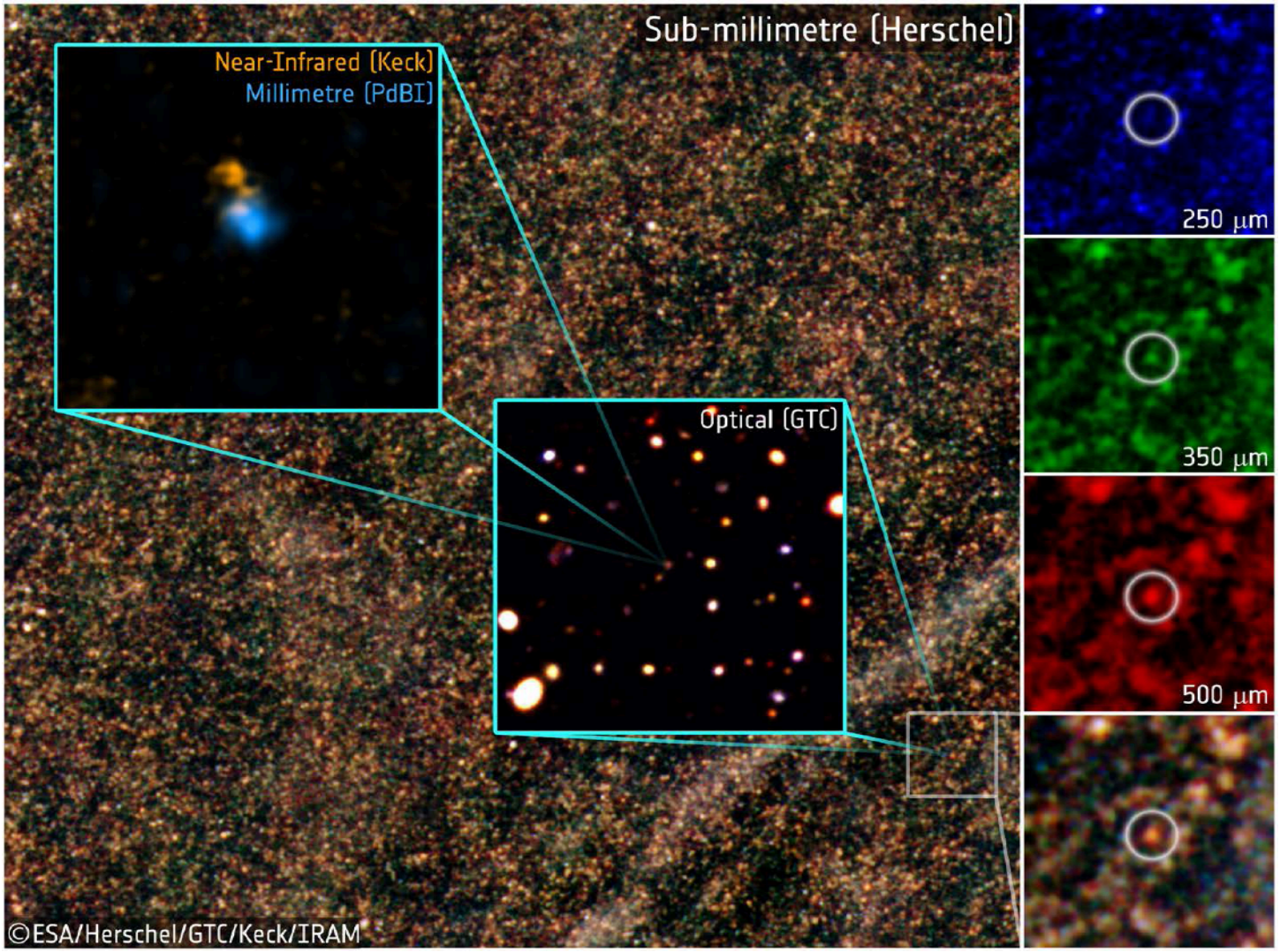
HERMES



esa HiFi ICC nhsc PACS SPIRE

HERMES

Riechers, D.A. et al., 2013.
A dust-obscured massive maximum-starburst galaxy at a redshift of 6.34.
Nature, 496(7), pp. 329–333.



esa HIFI ICC nhsc PACS SPIRE

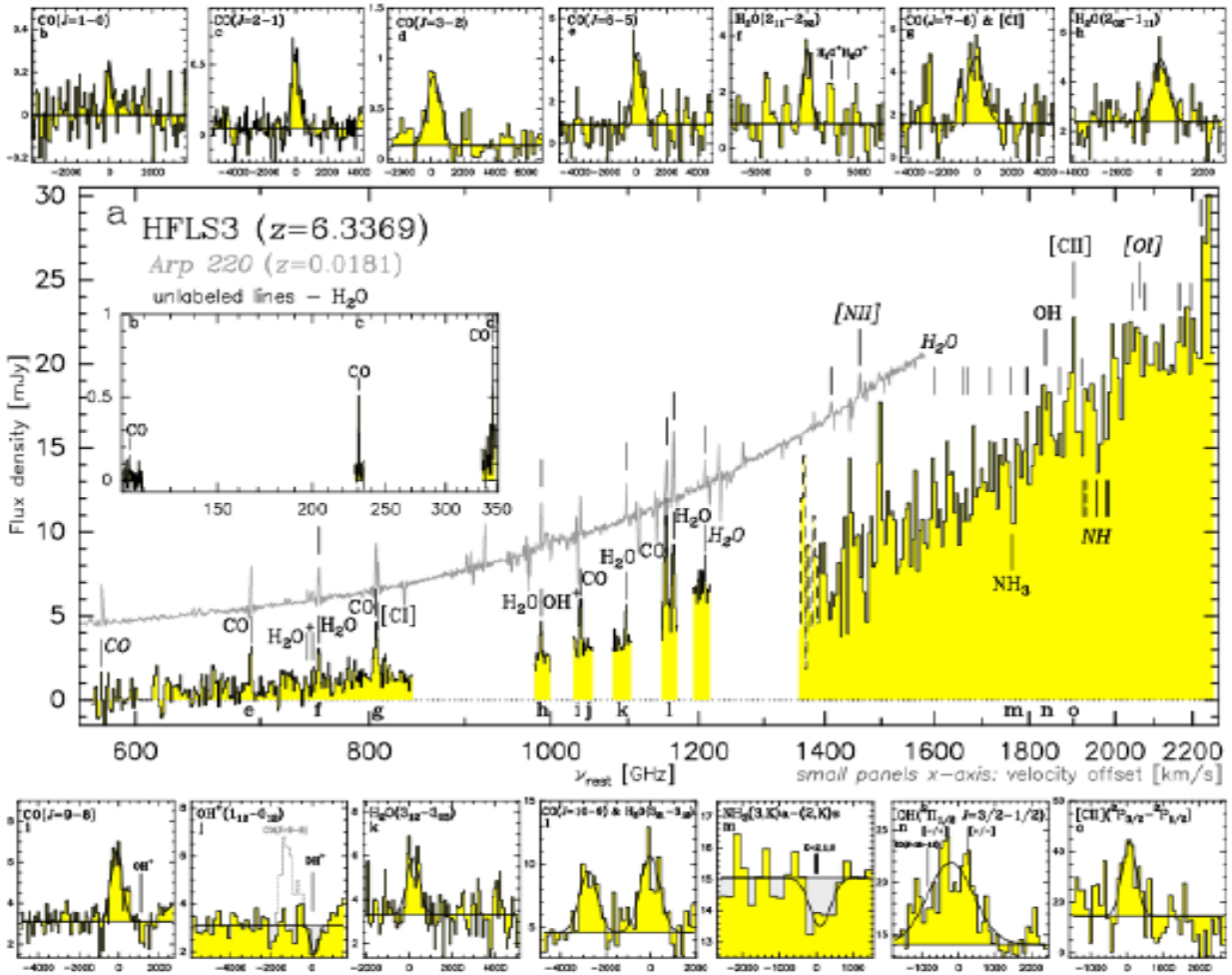
HERMES

Riechers, D.A. et al., 2013. A dust-obscured massive maximum-starburst galaxy at a redshift of 6.34. *Nature*, 496(7), pp.329–333.

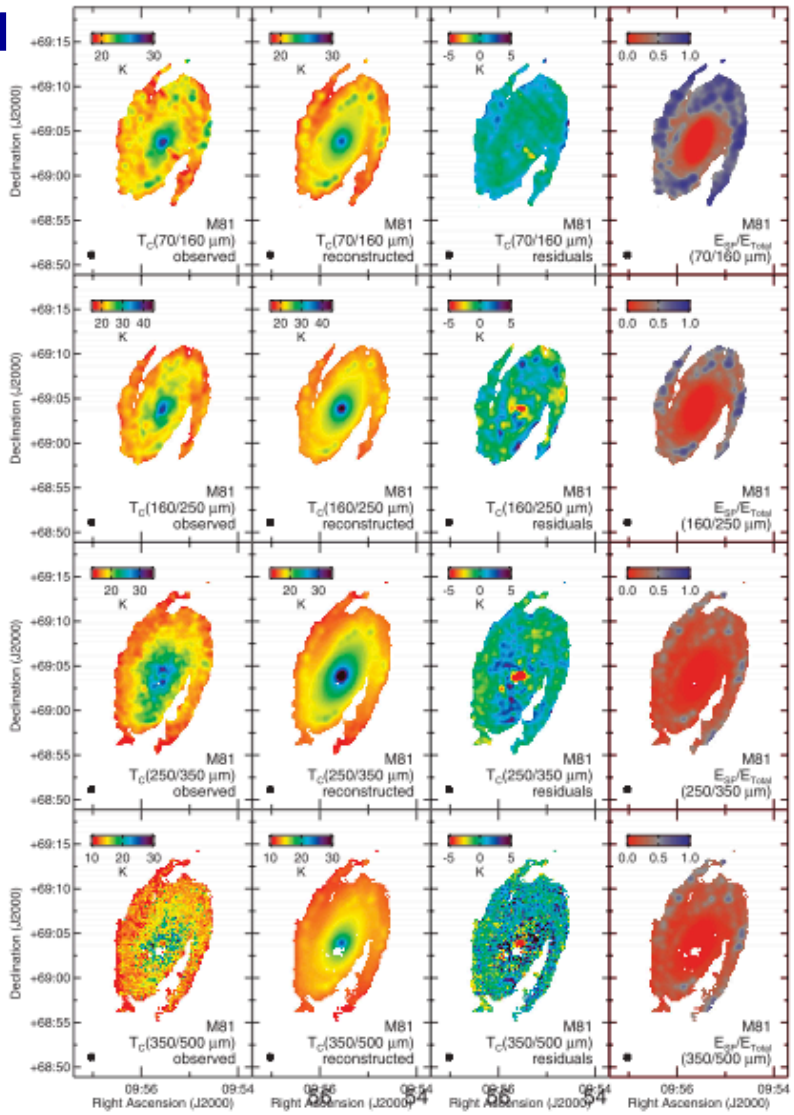
Comparison of HFLS3 with Arp220 and the Milky Way:

- Much larger dust and gas masses at comparable stellar masses.
- In HFLS3 40% of the baryonic mass is in the ISM.
- SFR > 2000 times that of the Milky Way already at only 880 Mil years after Big Bang.

	HFLS3	Arp 220*	Milky Way*
redshift	6.3369	0.0181	-
M_{gas} (M_{sun})[a]	(1.04+/-0.09) x 10^{11}	5.2 x 10^{9}	2.5 x 10^{9}
M_{dust} (M_{sun})[b]	$1.31^{+0.32}_{-0.30}$ x 10^{9}	~1 x 10^{8}	~6 x 10^{7}
M_{*} (M_{sun})[c]	~3.7 x 10^{10}	~3-5 x 10^{10}	~6.4 x 10^{10}
M_{dyn} (M_{sun})[d]	2.7 x 10^{11}	3.45 x 10^{10}	2 x 10^{11} (<20 kpc)
f_{gas}[e]	40%	15%	1.2%
L_{FIR} (L_{sun})[f]	$2.86^{+0.32}_{-0.31}$ x 10^{13}	1.8 x 10^{12}	1.1 x 10^{10}
SFR ($M_{sun}yr^{-1}$)[g]	2,900	~180	1.3
T_{dust} (K)[h]	$55.9^{+9.3}_{-12.0}$	66	~19

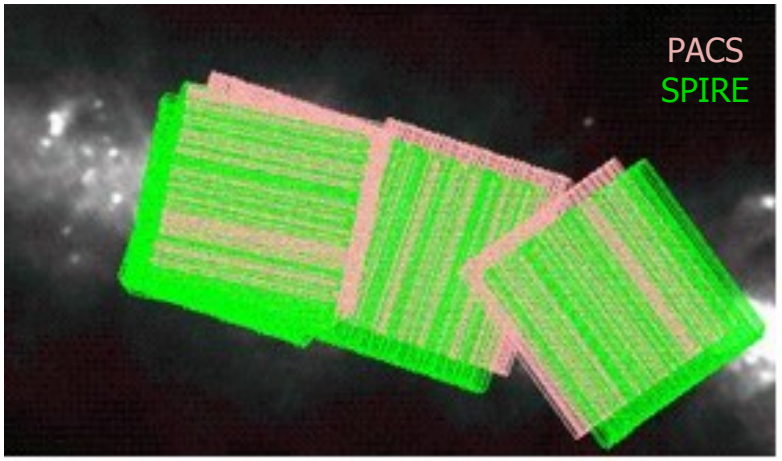


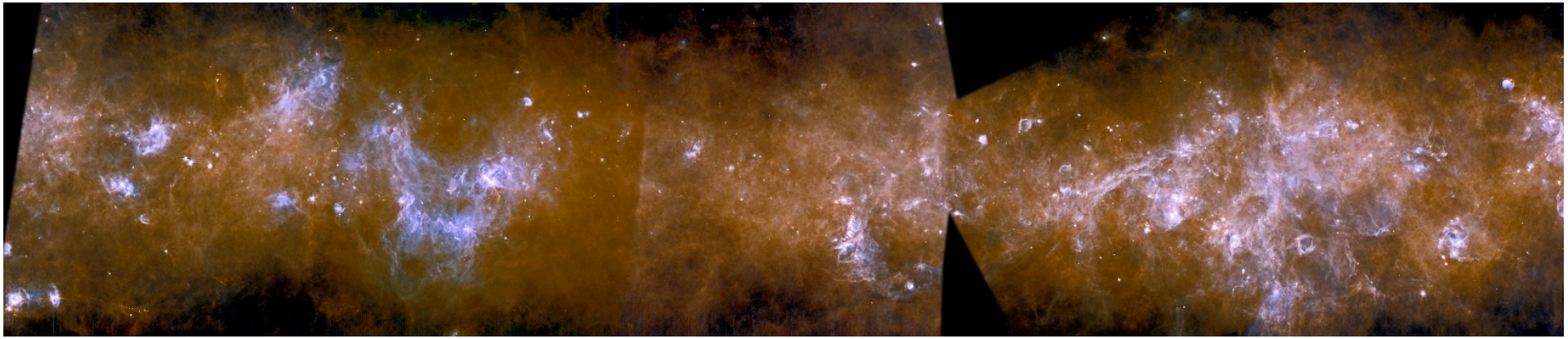
- Investigation of dust heating in M81, M83 and NGC 2403
- Using MIPS 70μm, PACS 70-160μm, SPIRE 250-500μm data, 1.6μm 2MASS and Hα CCD images.
- 70/160μm ratios strongly influenced by SFRs.
- Emission > 250μm from cold component that is rather unaffected by SF but more by the total stellar population.
- Impact on radiative modeling.
- Bendo et al. 2012, MNRAS 419, 1833



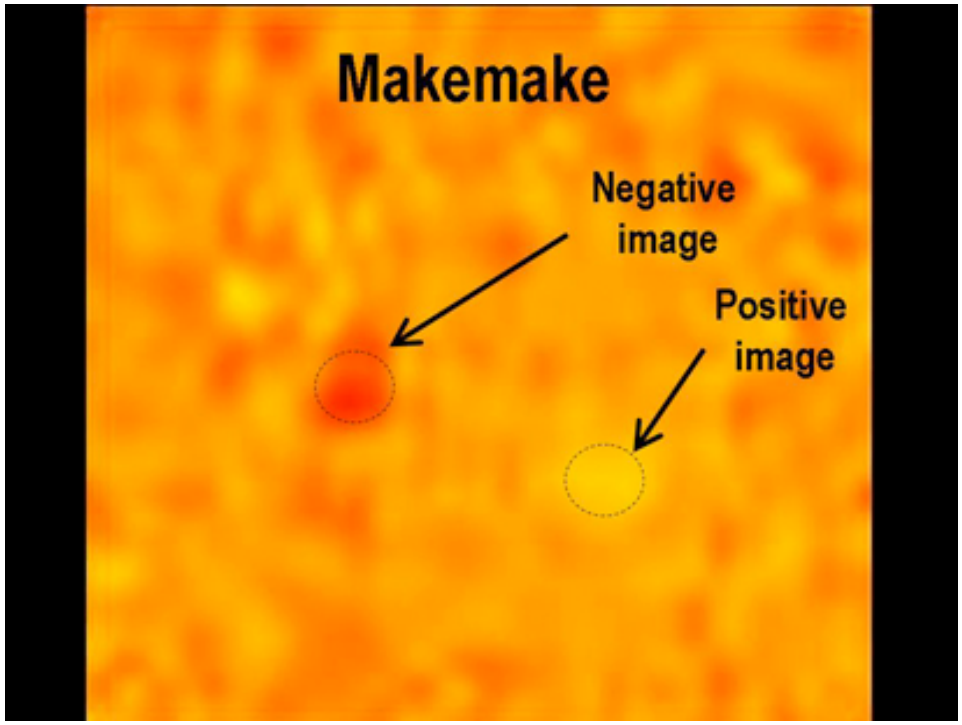
HiGal Survey

- |b|<1deg covered by square tiles, scanned in two directions.
- Covering entire Galactic plane.





Dwarf Planet 136472 Makemake



Lim et al. 2010, A&A 518, L148

Difference of two observations of dwarf planet Makemake that were made 44 h apart on 01-Dec-2009.

Thanks to the proper motion of the object it appeared as a pair of negative and positive images with fluxes:
F(250μm) = 9.5+/-3.1mJy
F(350μm) = 7.1+/-1.8mJy

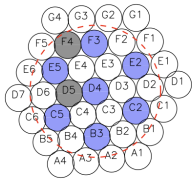
This technique beats very efficiently confusion noise (~6mJy).

Instrument Details

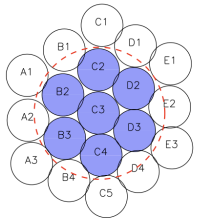
Bolometer Arrays Projected on the Sky

Feedhorn arrays

SSW

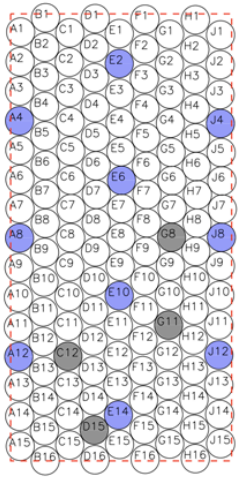


SLW

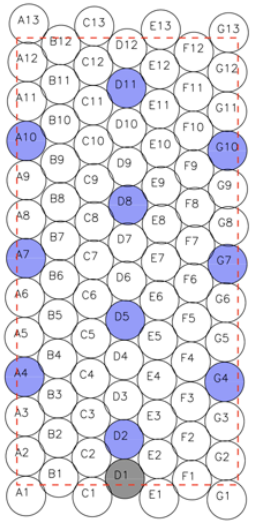


Beams: 16.8"..21.1" 37.3"..42.0"

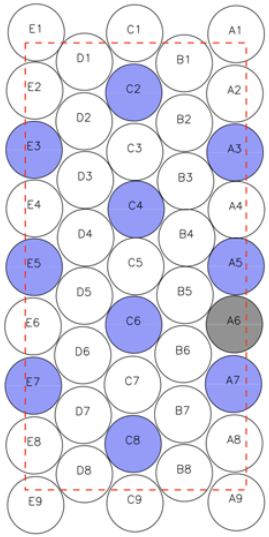
PSW



PMW



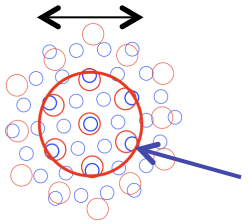
PLW



Beams: 18.3" x 17.0" 24.7" x 23.2" 33.4" x 35.1"

Spectrometer

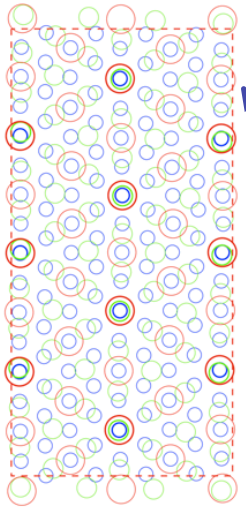
2'



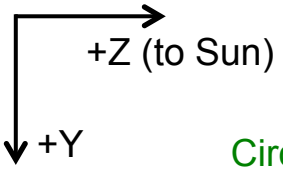
Overlapping beam profiles as projected on the Sky.

Photometer

4'

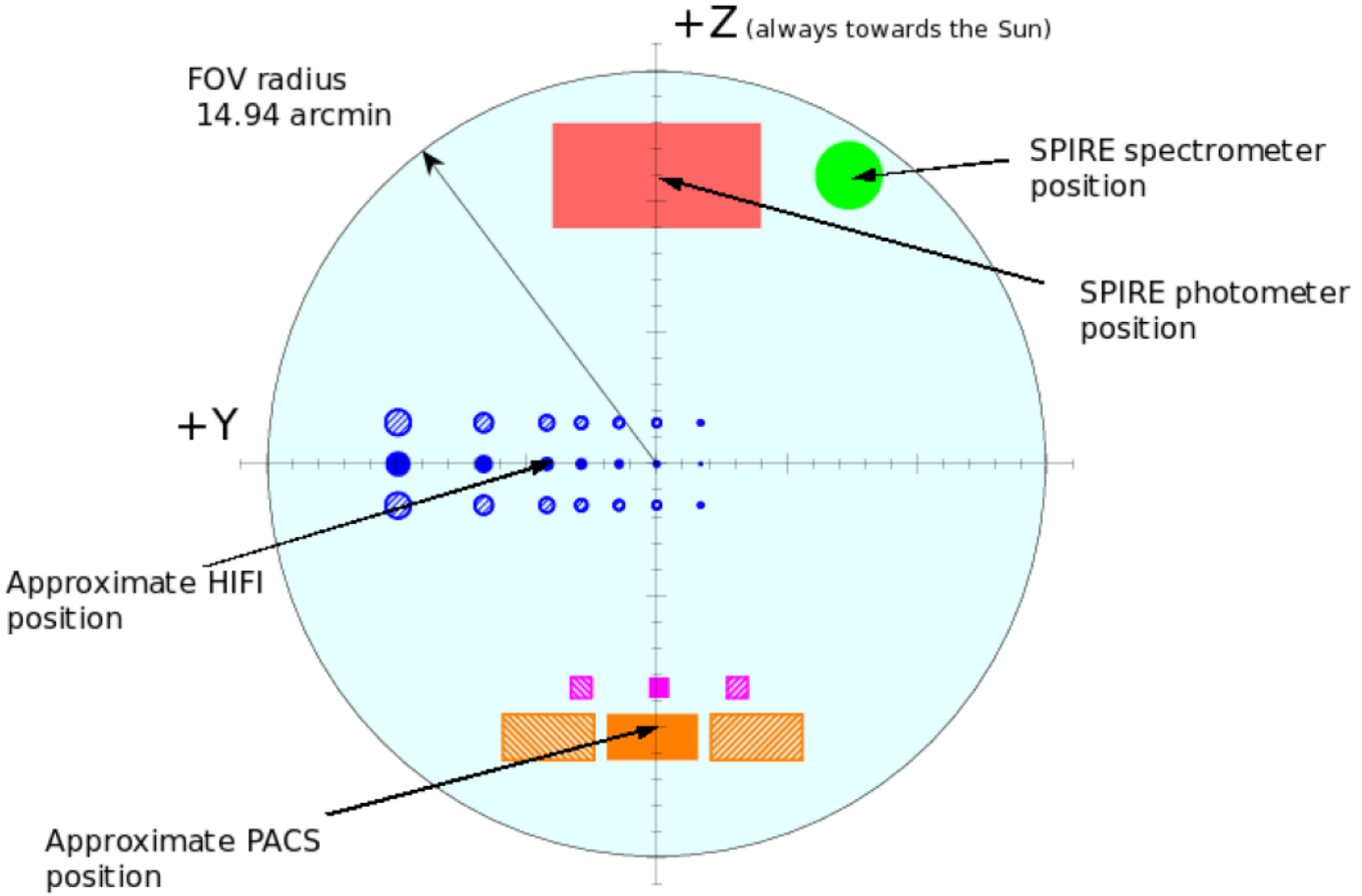


8'

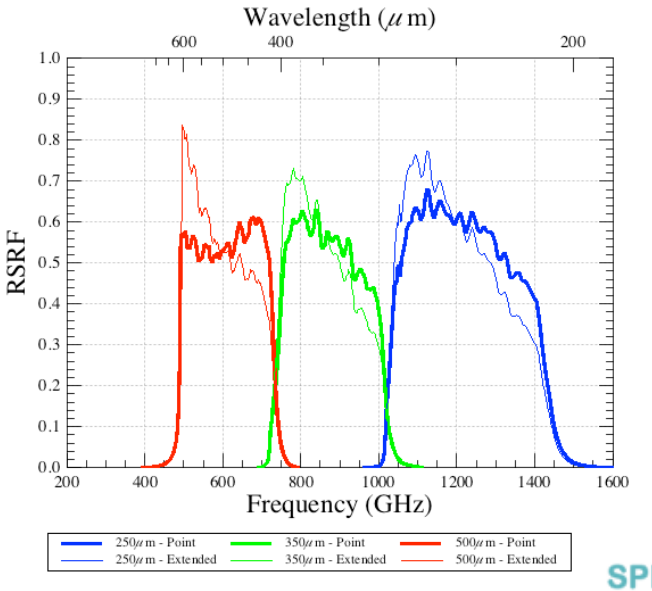


Circles in diagrams to the right show FWHM of detector beam profiles

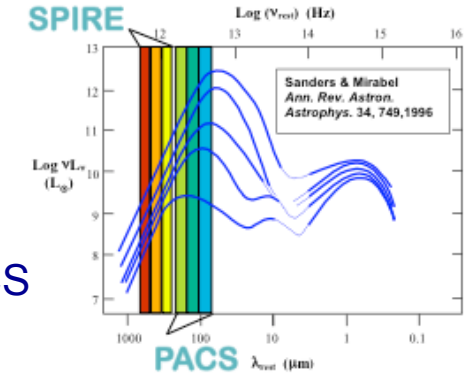
SPIRE in the Herschel Focal Plane



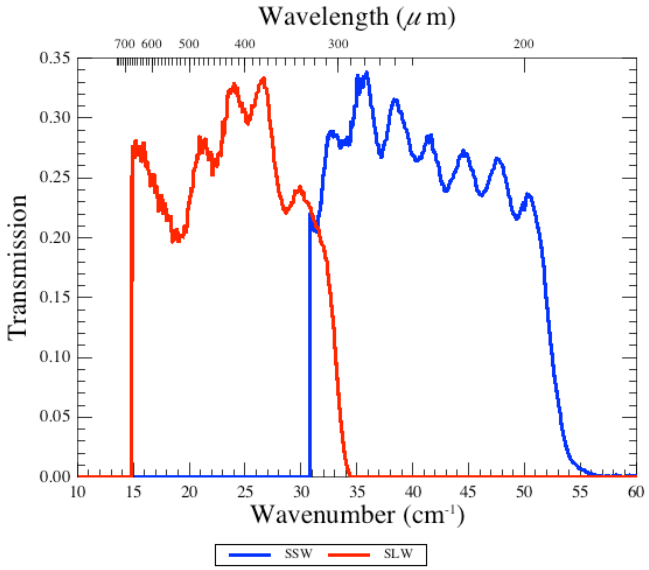
SPIRE Wavelength Coverage



Photometer



Complementary to PACS

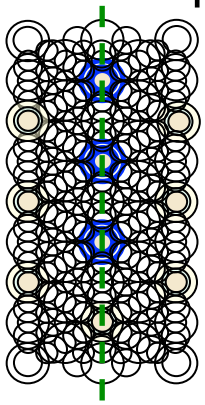


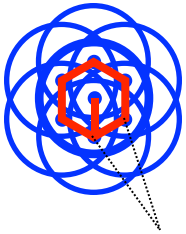
Spectrometer

Photometer AOT

7 point jiggle (point source)

126" chop + nod



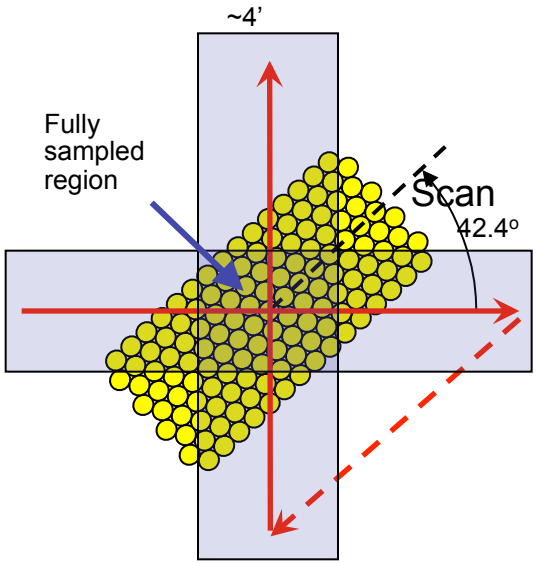


single step ~ 6"

7-point jiggle for point source photometry, to compensate pointing error and under-sampling. Chopping and nodding at each jiggle position.

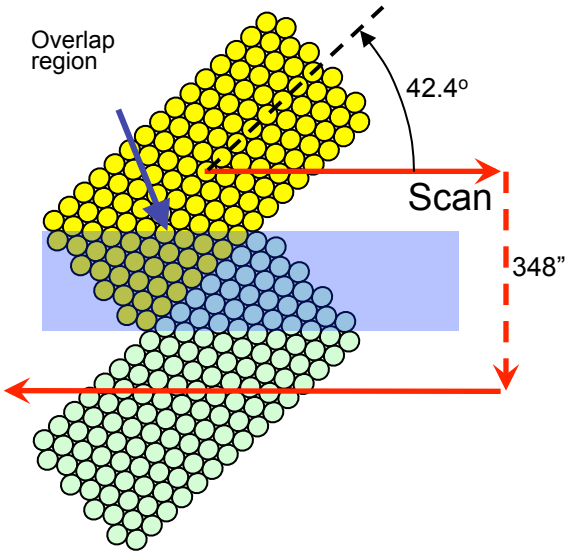
Some observations exist in the archive but were never used for standard observation programs.

small map



Single cross scan at 84.8° replaces Jiggle map. Scan map at speeds of 30 and 60 "/sec. Full spatial sampling in center of scans.

scan (large) map

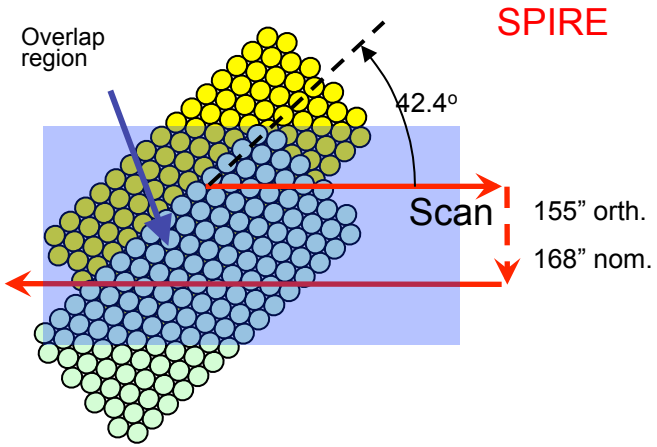


Scan map at speeds of 30 and 60 "/sec is most efficient mode **for large-area surveys**. Parameters are optimized for full spatial sampling and uniform distribution of integration time. Cross scan capability (84.8°)

Parallel Mode SPIRE and PACS

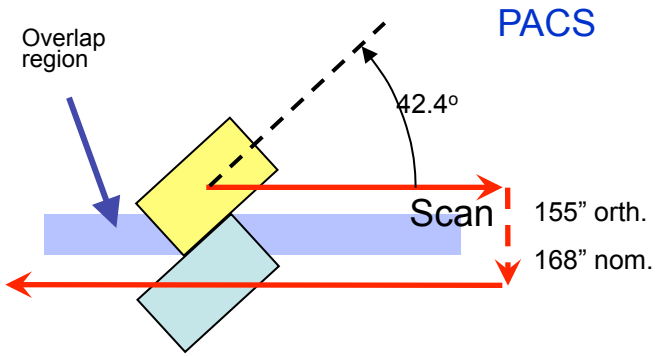
- Scan maps at speeds of 20 and 60"/sec with PACS and SPIRE active in parallel are useful for large-area surveys.
- The distance between PACS and SPIRE apertures is 21 arcmin.
- Two almost orthogonal (84.8°) directions for cross scanning are available.

SPIRE Geometry



Considerable redundancy for SPIRE due to smaller scan distance needed by PACS arrays. **Sample rate lowered from 18 to 10Hz.**

PACS Geometry



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.

Examples for Photometer End Products