The Potential of SCUBA-2

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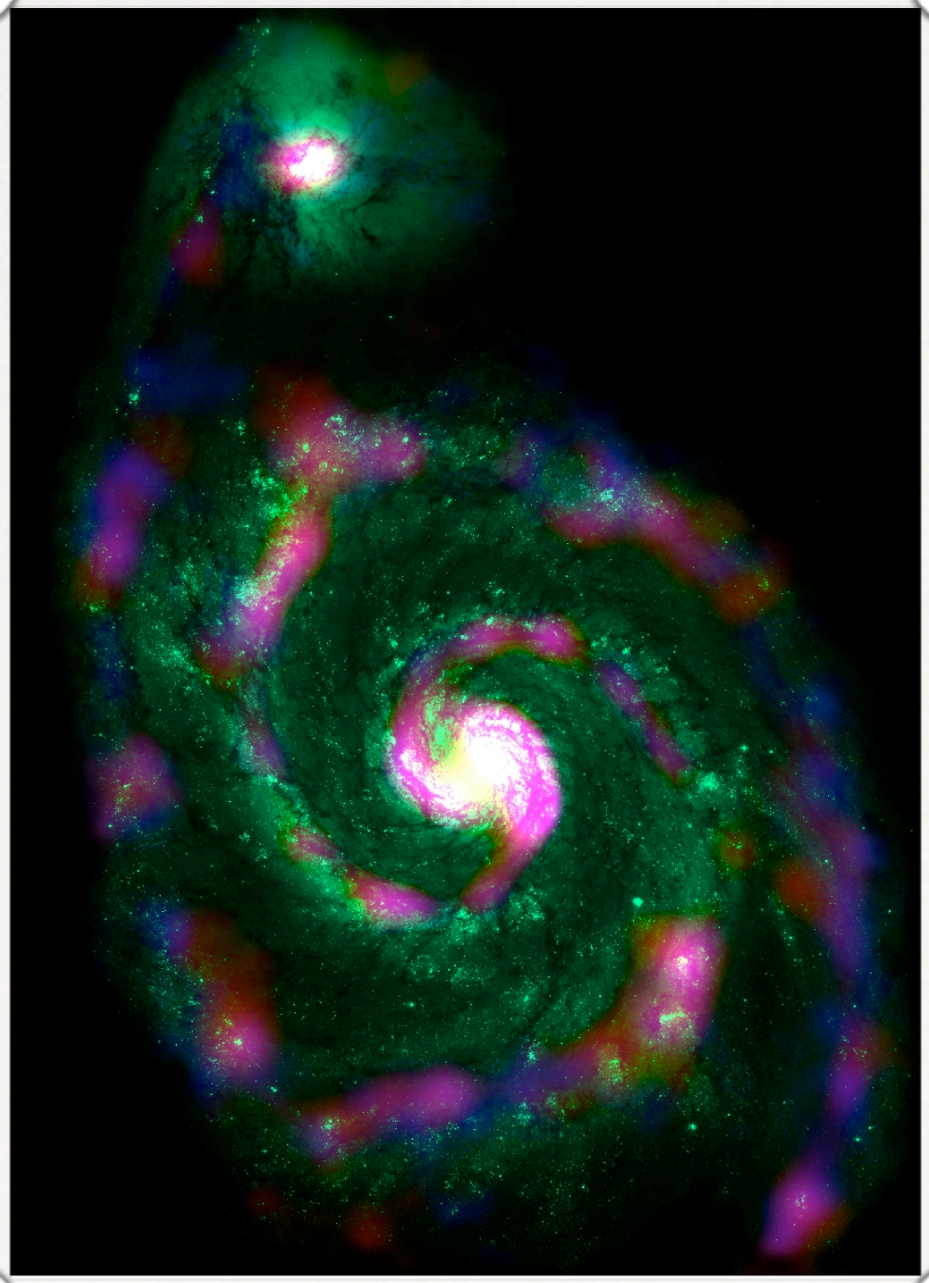


A colour composite image of M51. The underlying green image is from the HST, with the blue and red regions showing the SCUBA-2 450μm and 850μm emission, respectively.

Credit: JAC/UBC/NASA

Outline

Introduction

Some early results from commissioning
and JLS Science Verification

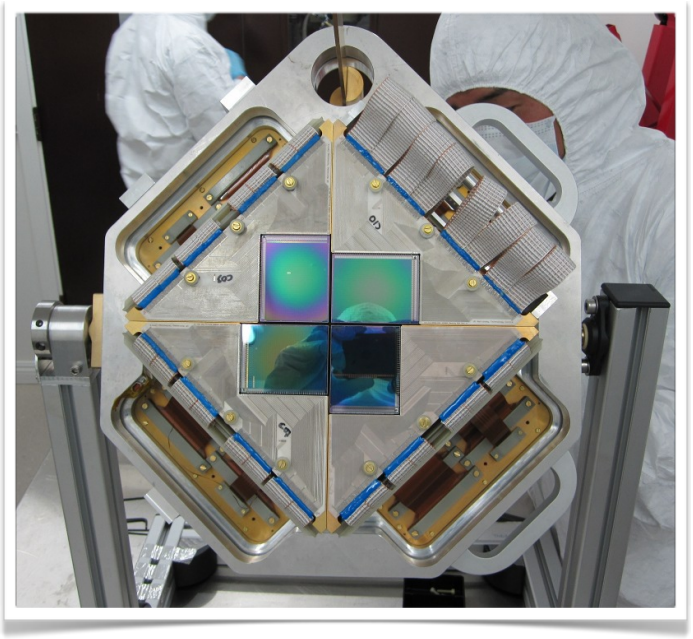
Competitiveness of SCUBA-2

Introduction

Two focal planes for observing the 450μm and 850 μm wavebands simultaneously

5120 pixels in each focal plane unit

- made up of 4 arrays of 32x40 bolometers
- transition-edge superconductors (TES)



450 μm focal plane unit prior to installation

Instantaneous field of view of 43 square-arcmin

- maximises the JCMT f-o-v available at the Nasmyth focus
- 850 μm focal plane fully sampled, 450 μm focal plane under-sampled

Cryostat cooled to sub-Kelvin temperatures

- cooled to ~ 0.07 K and controlled at ~ 0.1 K
- 4K LHe cold trap has helped maintain extended operation of dilution refrigerator

Introduction

POL-2 and FTS-2 are ancillary instruments provided for by grant from Canadian Fund for Innovation

- will be made available to whole community as common-user instruments

These two instruments on SCUBA-2 make JCMT a unique facility

- there is no other competition for these

Both are due to be commissioned during 12A

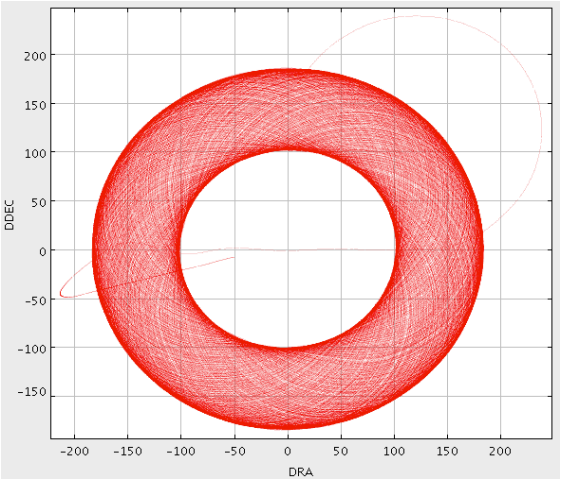
Introduction

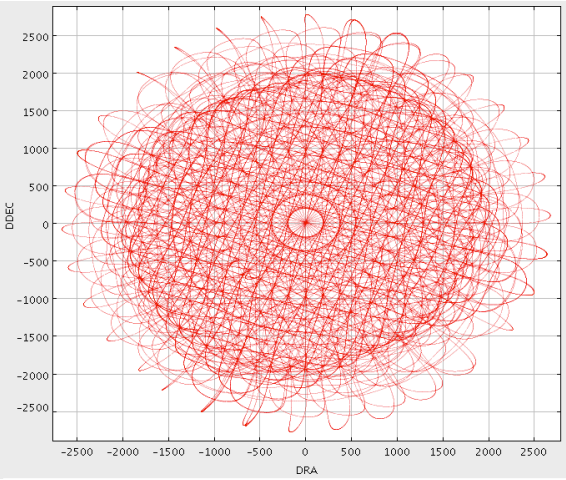
Instrument acceptance was at end of September 2011

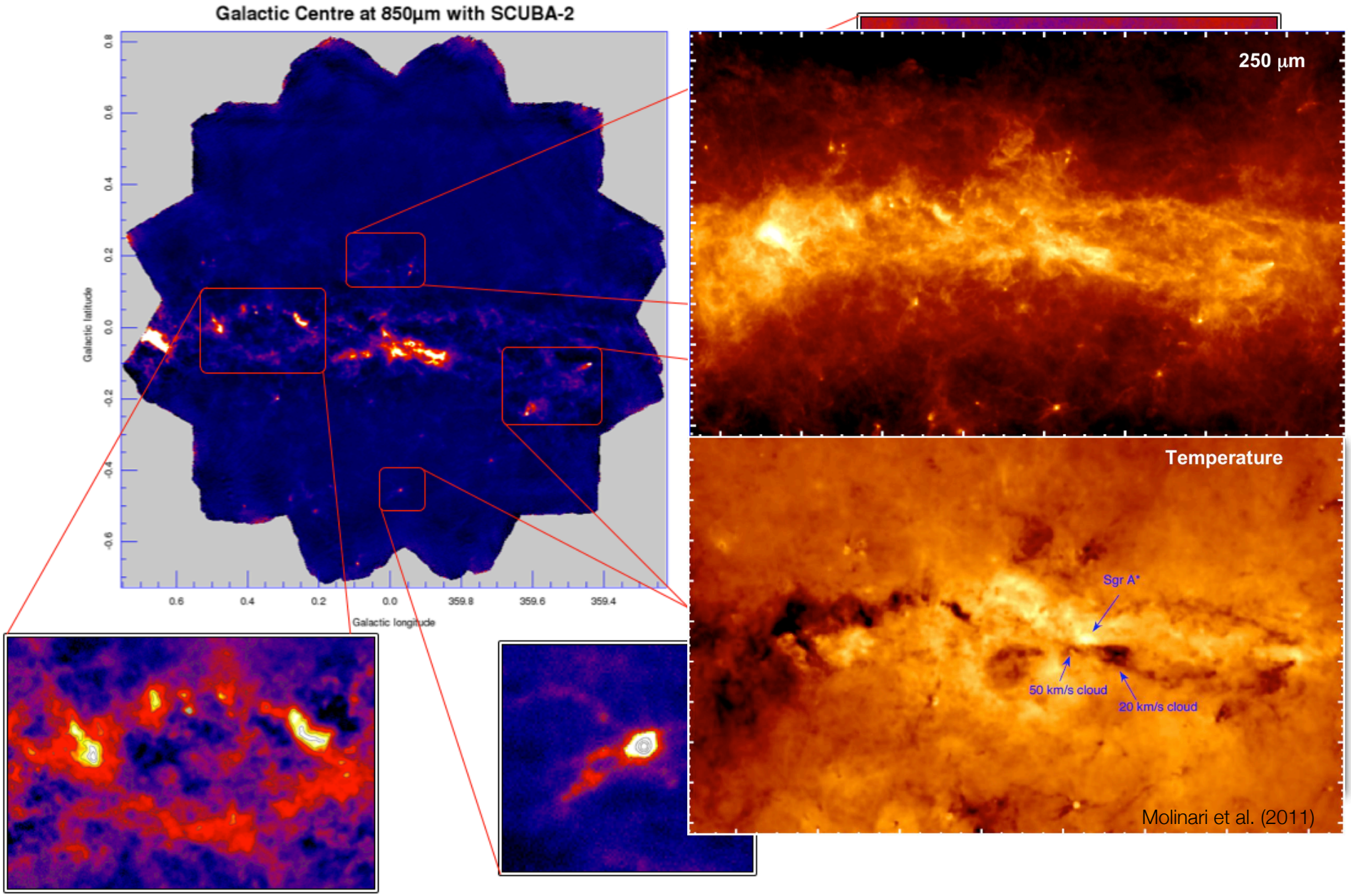
- followed by call for 12A proposals

Mapping modes commissioned

- Daisy ⇒ compact sources
- rotating Pong ⇒ wide field maps (circular field)







http://scuba2.wordpress.com/2011/05/13/postcards-from-the-centre-of-our-galaxy/

Introduction

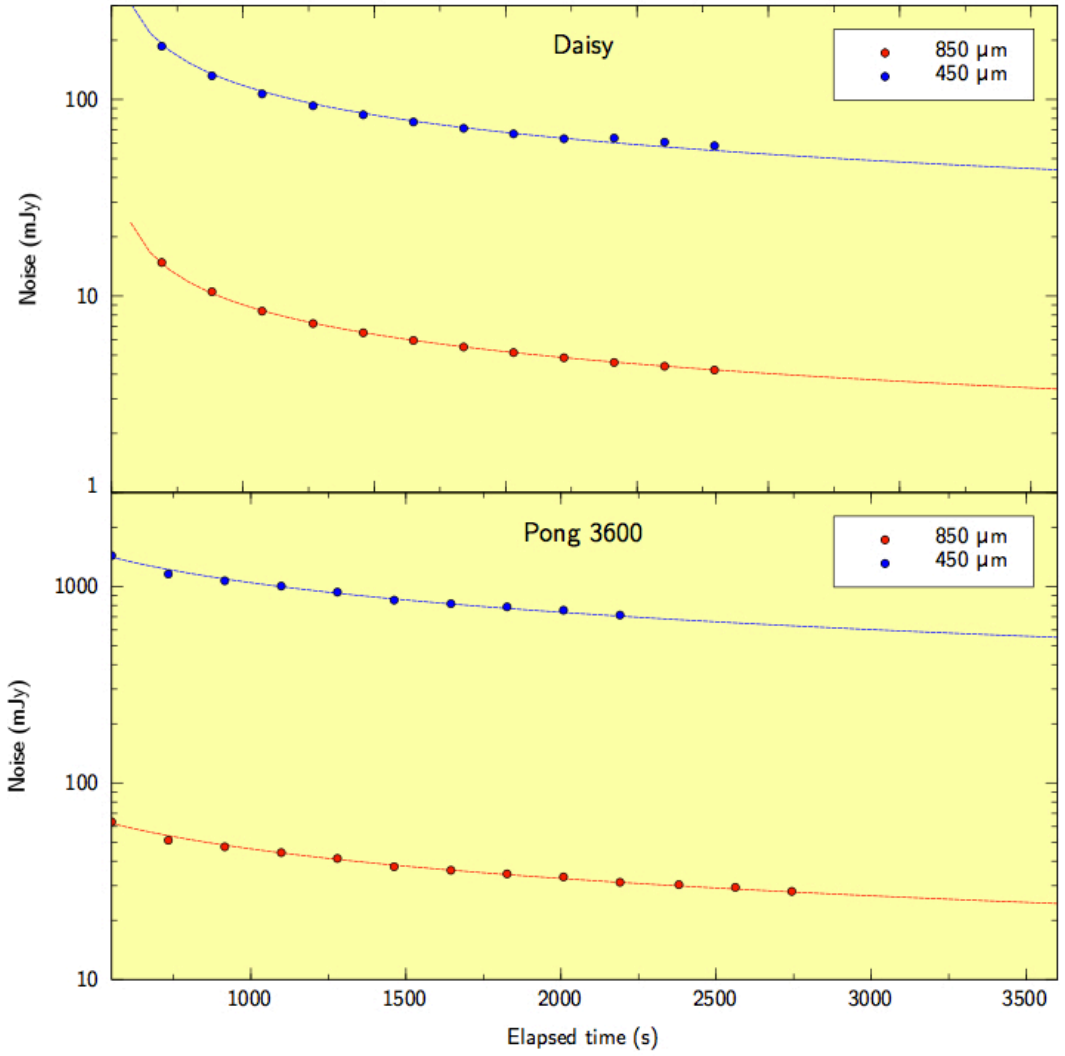
Sensitivities (1σ1hr)

Daisy:

- 850 μm ~ 3 mJy in 4″ pixels
- 450 μm ~ 42 mJy in 2″ pixels

Pong (1-degree):

- 850 μm ~ 25 mJy in 4″ pixels
- 450 μm ~ 560 mJy in 2″ pixels



The first ‘real’ SCUBA-2 observers

Mark Swinbank (U. Durham), Isaac Roseboom (U. Edinburgh),
Jeff Cox (JAC), David Eden (Liverpool John Moores)

JLS Science Verification

JLS science verification with SCUBA-2 started on Oct 4th (UT)

There were two themes that the teams concentrated on in this first phase

- mapping strategy
- map sensitivity and depth

Teams satisfied that they could still achieve scientifically useful sensitivities with the instrument

- the NGLS team had no data during SV but were given commissioning data of NGC7331 to work with
- SUNSS had no data

Results obtained during SV were fed into the rescoping proposals

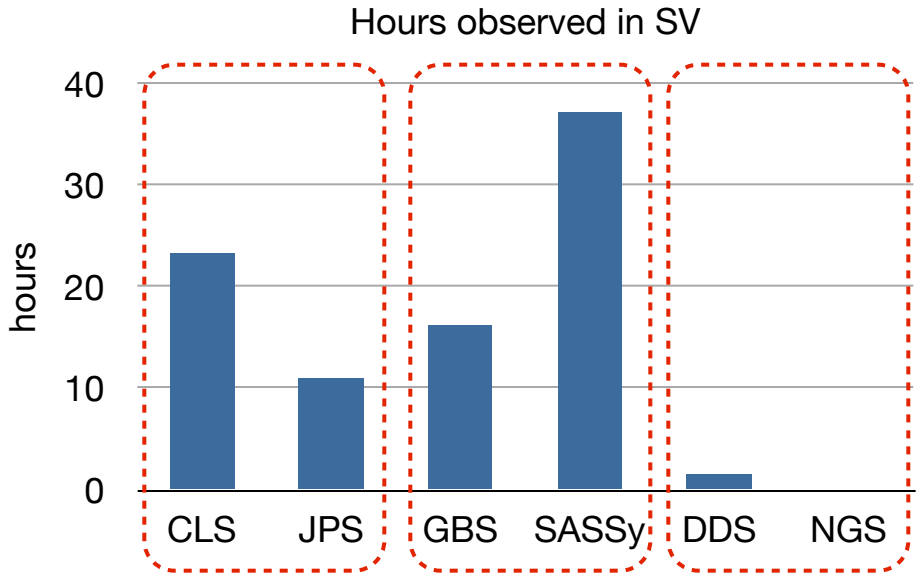
There is still work left to do

- second phase of SV has started this past weekend

JLS Science Verification

Hours observed

Survey	Hrs
S2CLS	23.3
JPS	11
GBS	16.2
SASSy	37.2
SUNSS	1.5
NGLS	0
	89.2



- there were 72 hours available from each 6-night run
- in total, just under 90 hours were observed

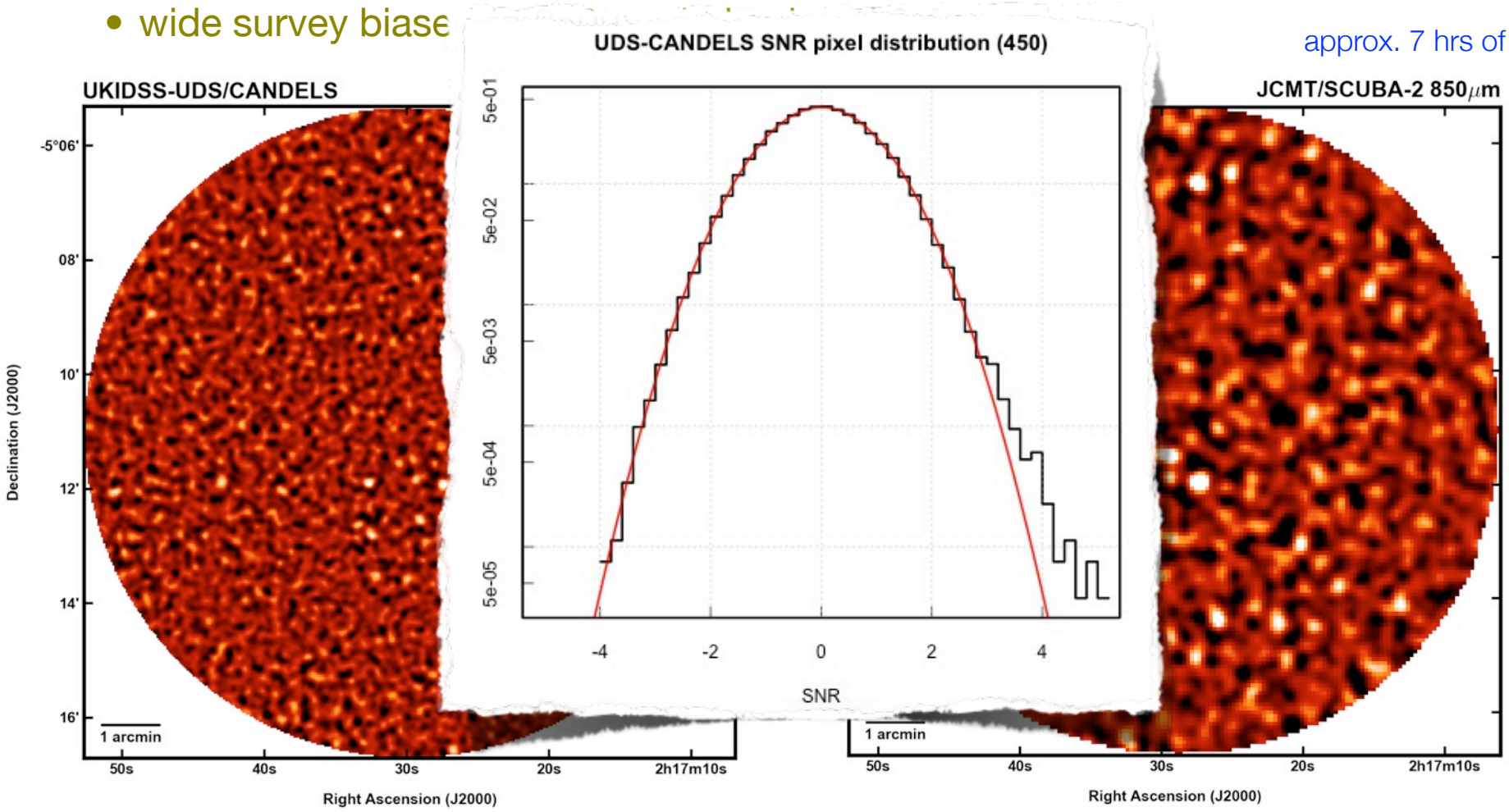
Four of the six teams obtained some data, with the NGLS and SUNSS shift totally weathered out

Results: S2CLS

The cosmology survey planned their SV according to weather

- small and deep, biased to 450μm, during band 1 weather
- wide survey biase

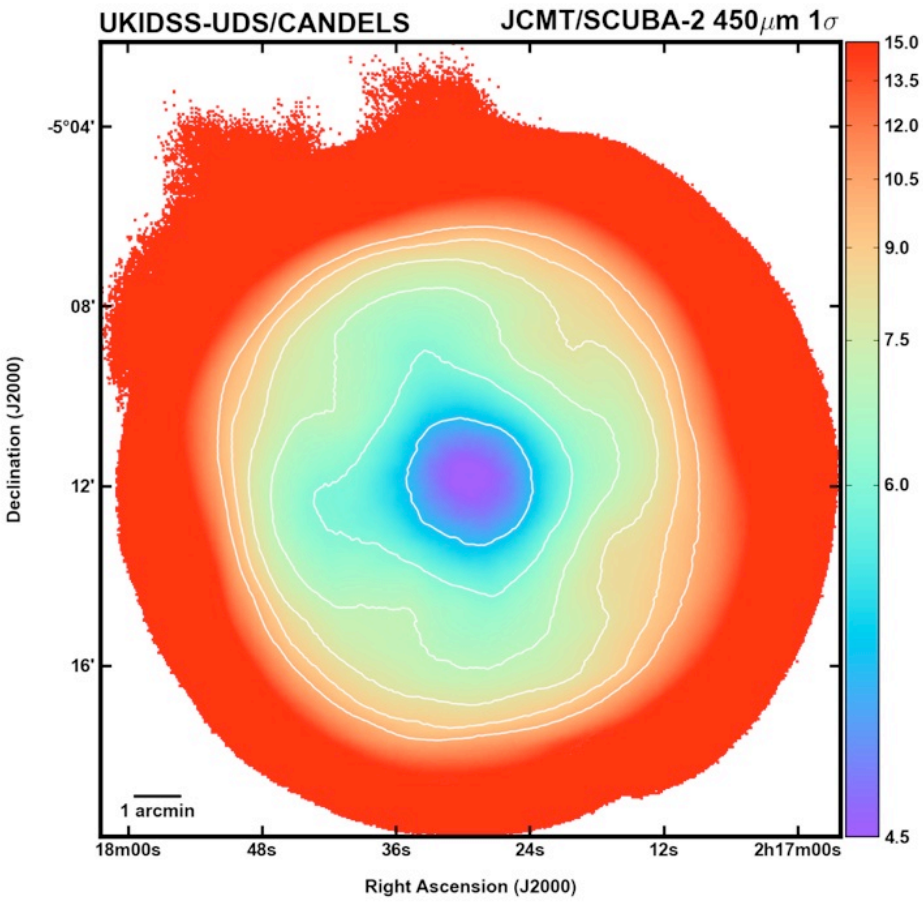
approx. 7 hrs of data

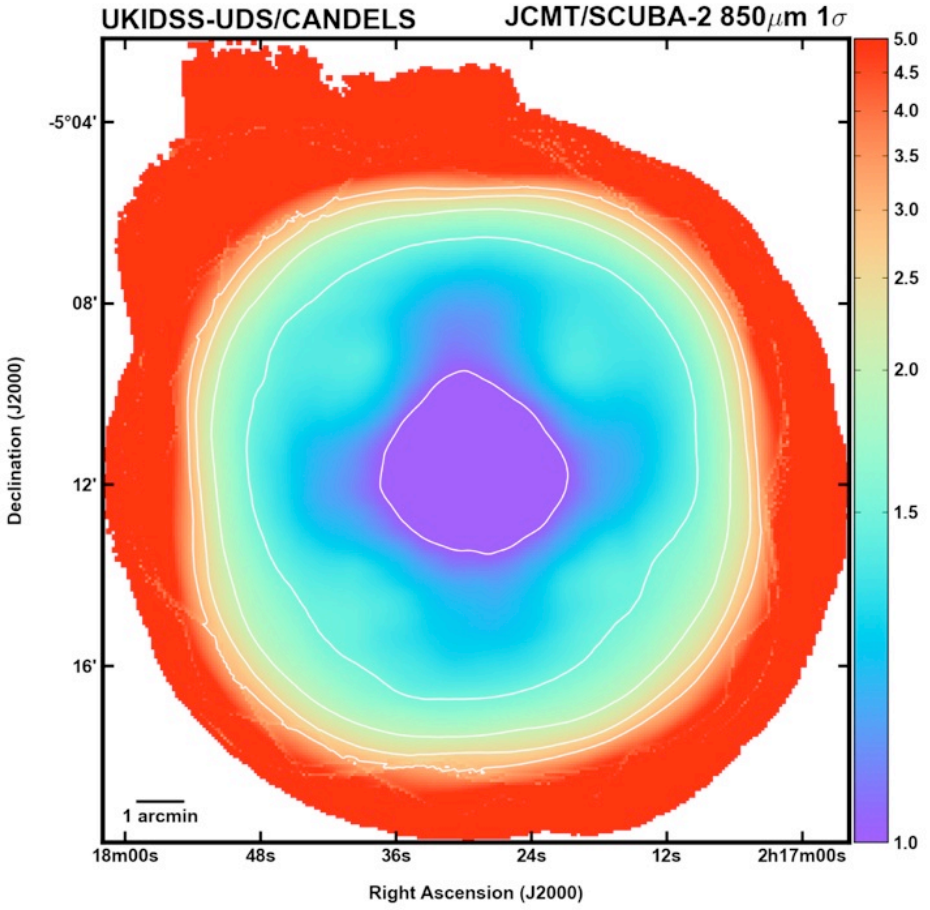


Results: S2CLS

The cosmology survey planned their SV according to weather

- small and deep, biased to 450μm, during band 1 weather
- wide survey biased to 850μm during band 2-3 weather

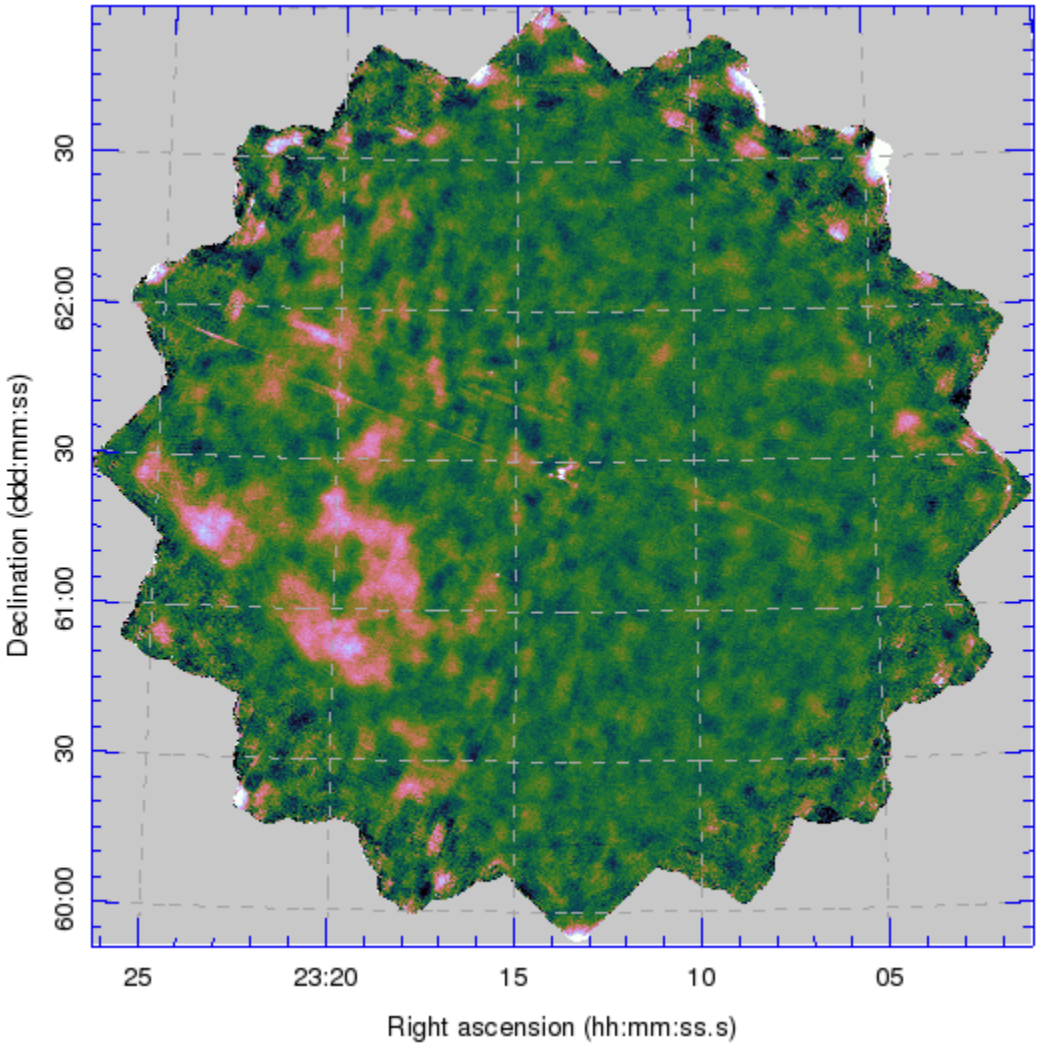




Results: SASSy

SASSy aims to use the available band 4 weather to produce a shallow (30mJy) survey of the submillimetre sky

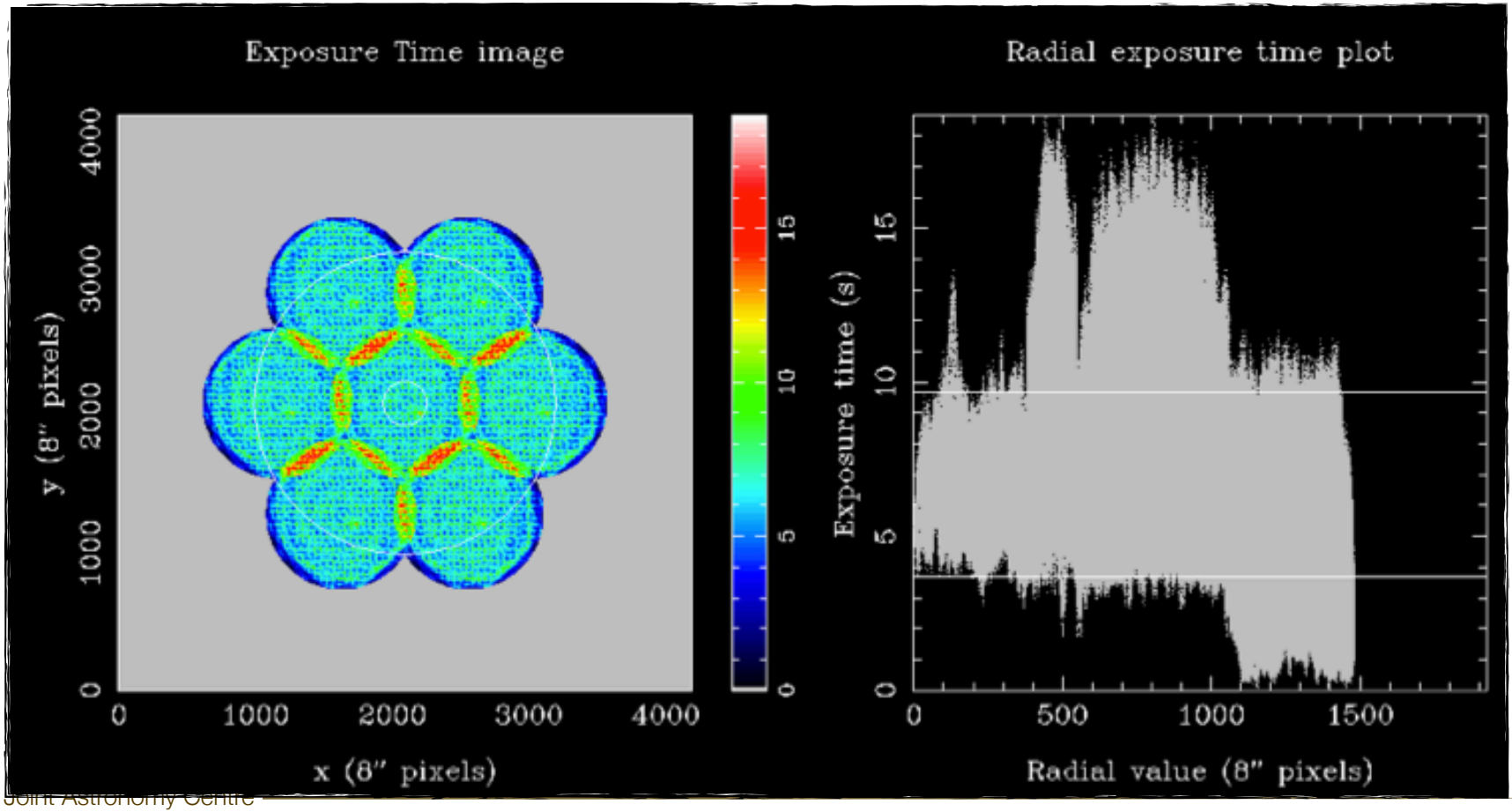
- main concern in SV is to develop a mapping strategy that will enable a wide field survey
- a new 2 deg mapping mode was tested and found to work very well
- tests showed that a coadd of 3 maps (~ 2 hrs) achieved the target sensitivity of ~ 30 mJy



Results: SASSy

SASSy aims to use the available band 4 weather to produce a shallow (30mJy) survey of the submillimetre sky

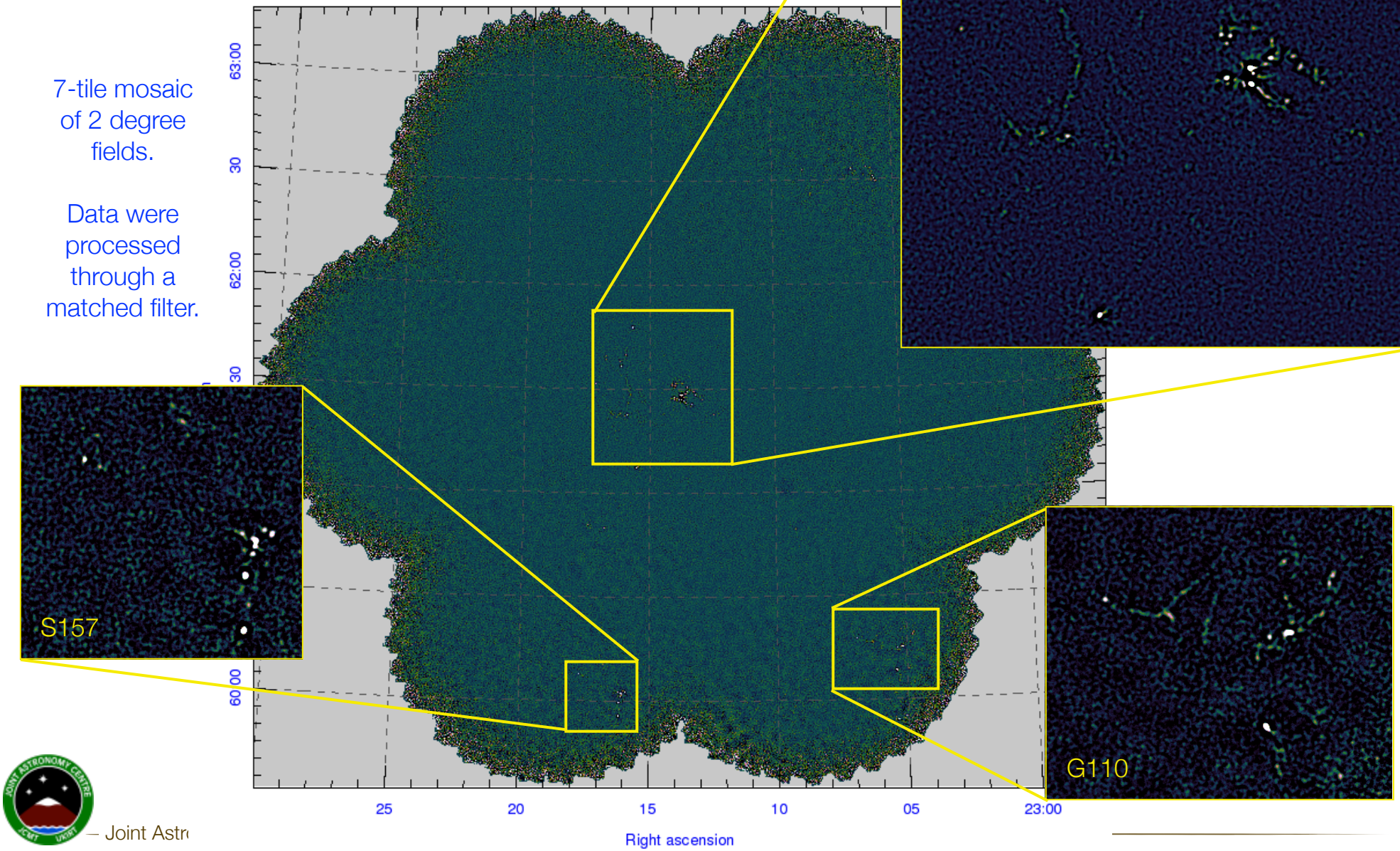
- a ‘closely-packed’ tiling strategy w/ 2 deg scans was simulated and then tested



Results: SASSy

7-tile mosaic of 2 degree fields.

Data were processed through a matched filter.

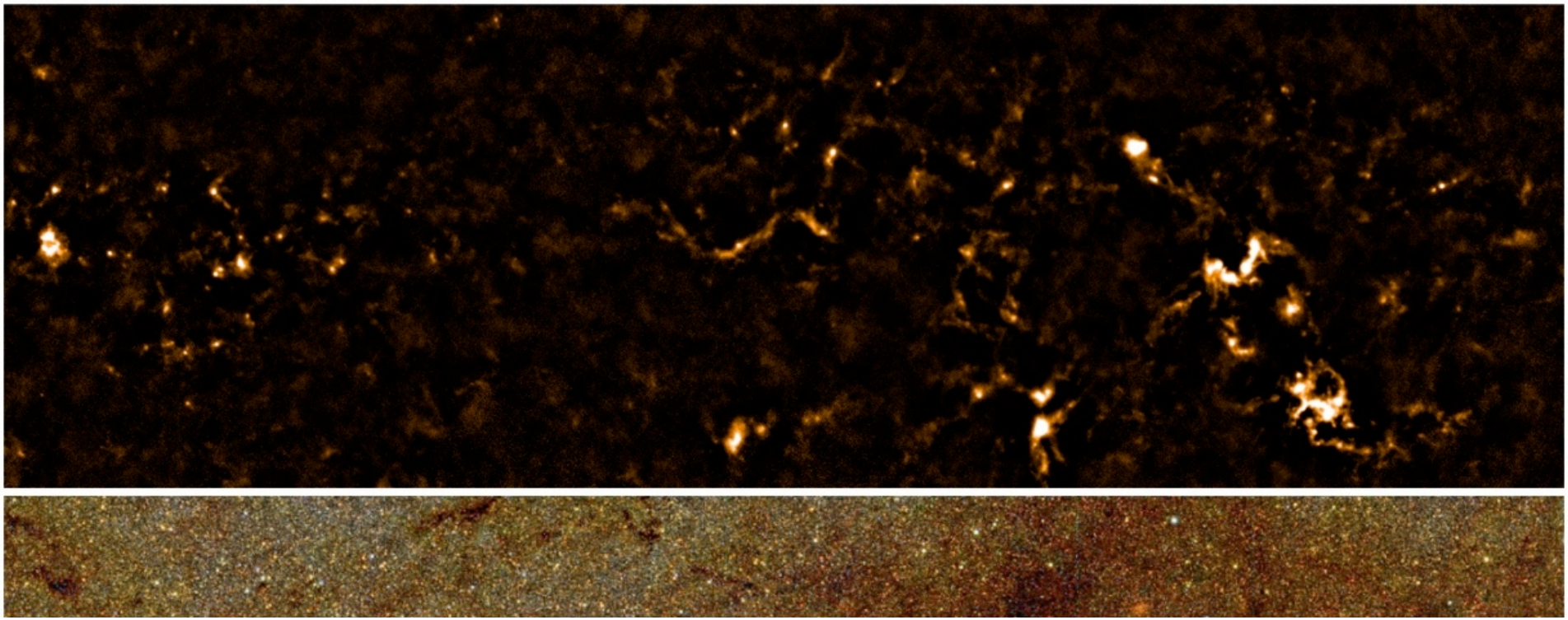


Results: JPS

The aims are to map the inner Galactic plane at 450μm and 850μm

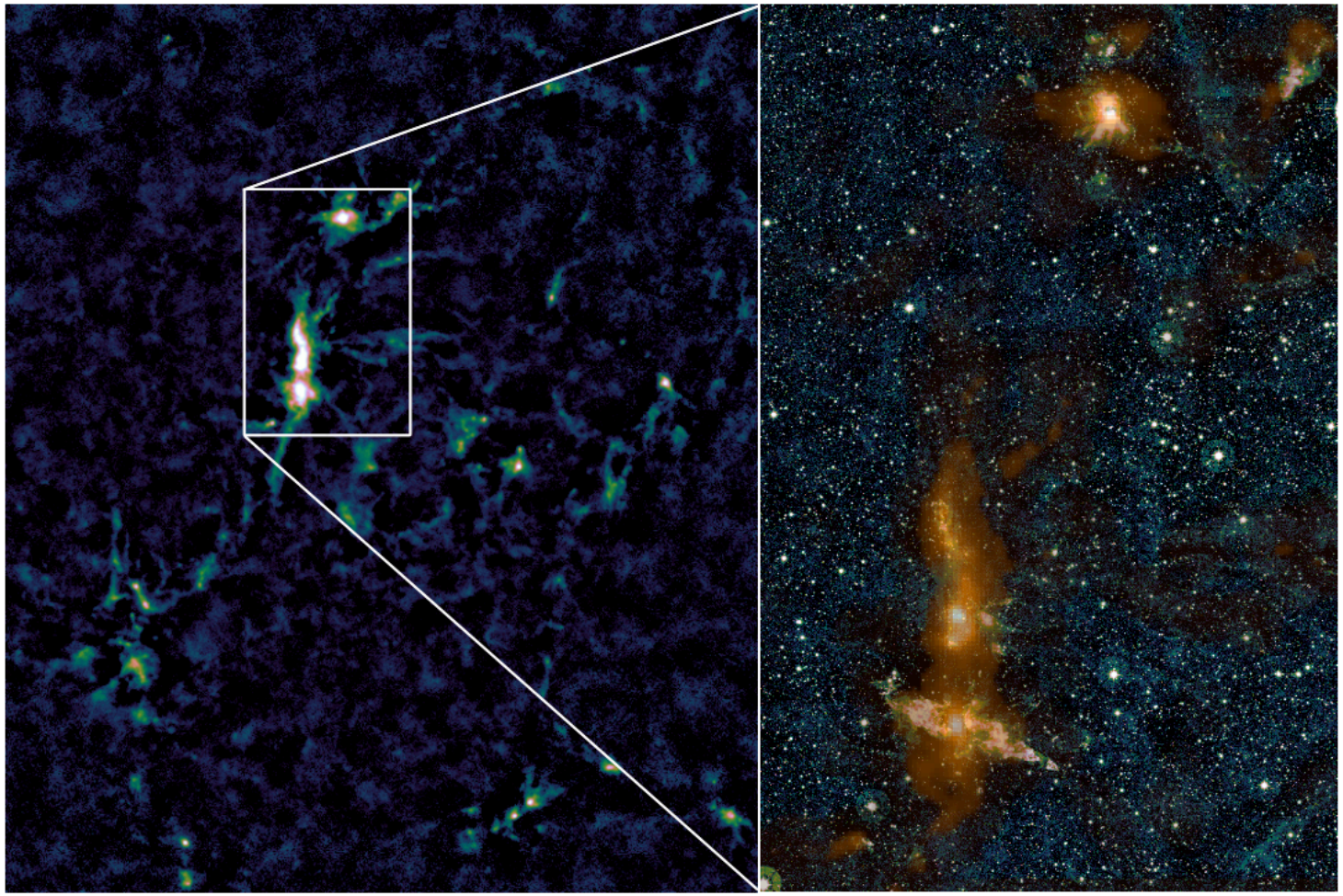
- main concerns where with achieving a scientifically useful sensitivity and tiling strategy

Data taken during commissioning along the Galactic plane centred on *l* = 11°



Results: JPS

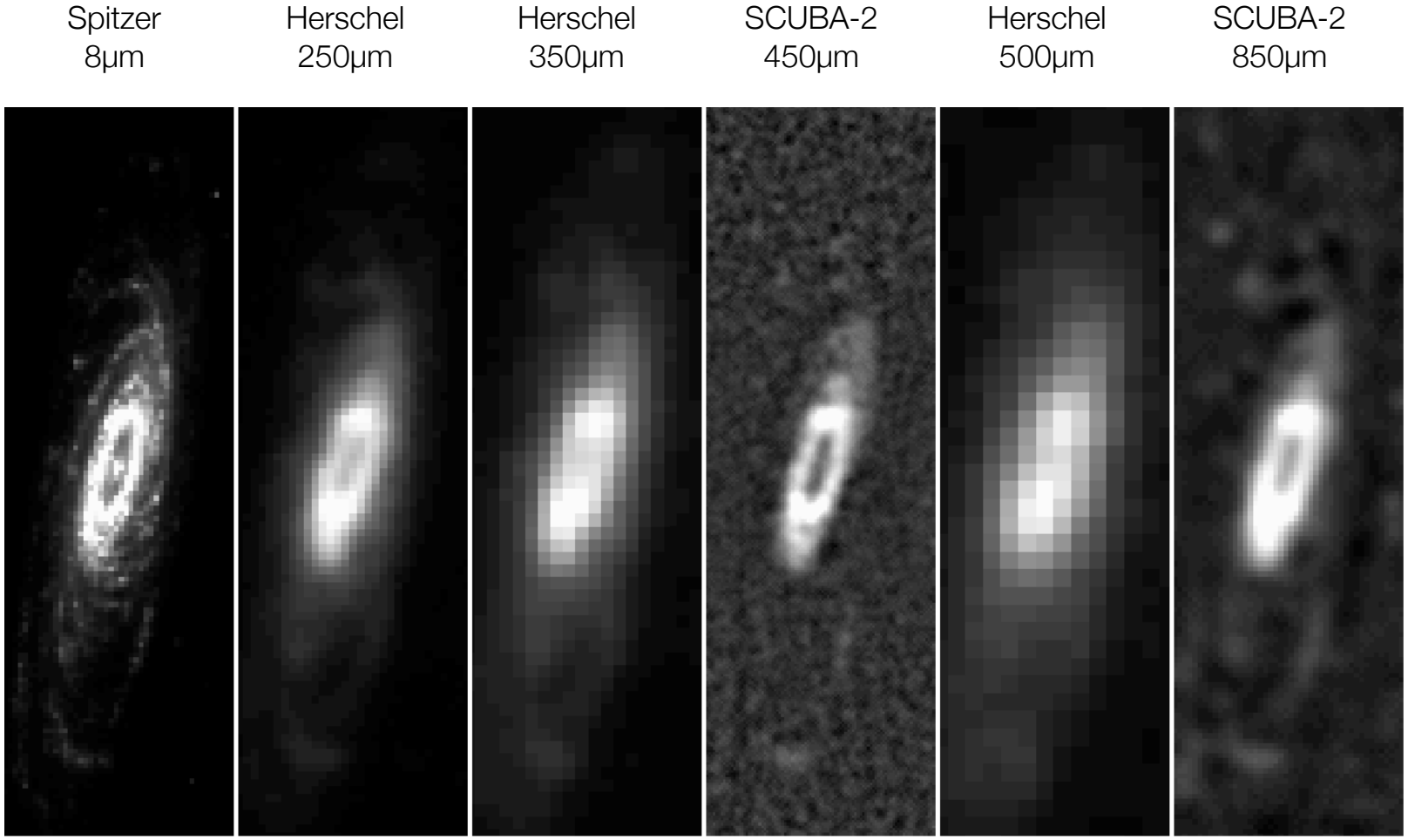
The aims are to map the Galactic plane at 450μm and 850μm



SCUBA-2 850μm emission with UKIRT/WFCAM image.

Results: NGLS

The NGS were weathered out during SV but were given access to data of NGC 7331 that were taken during commissioning



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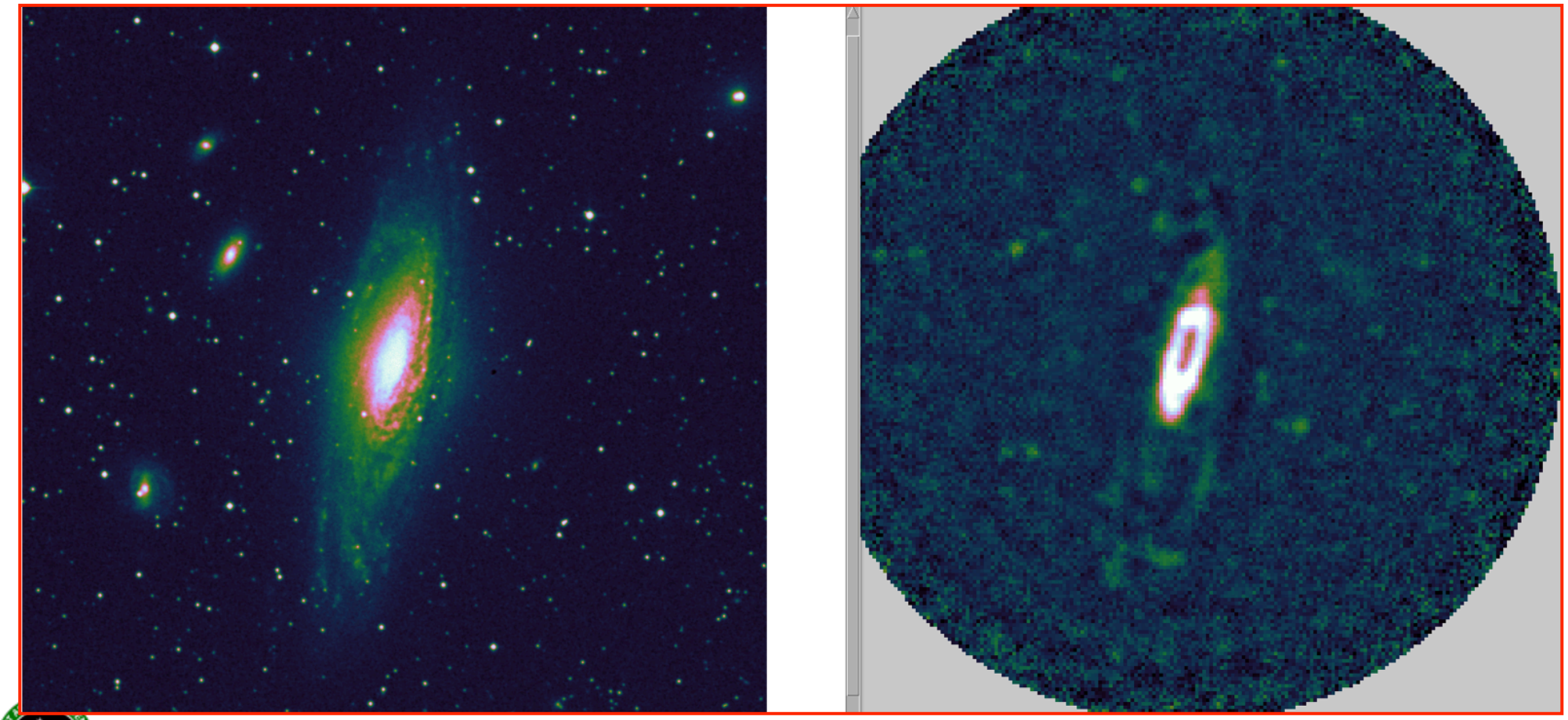
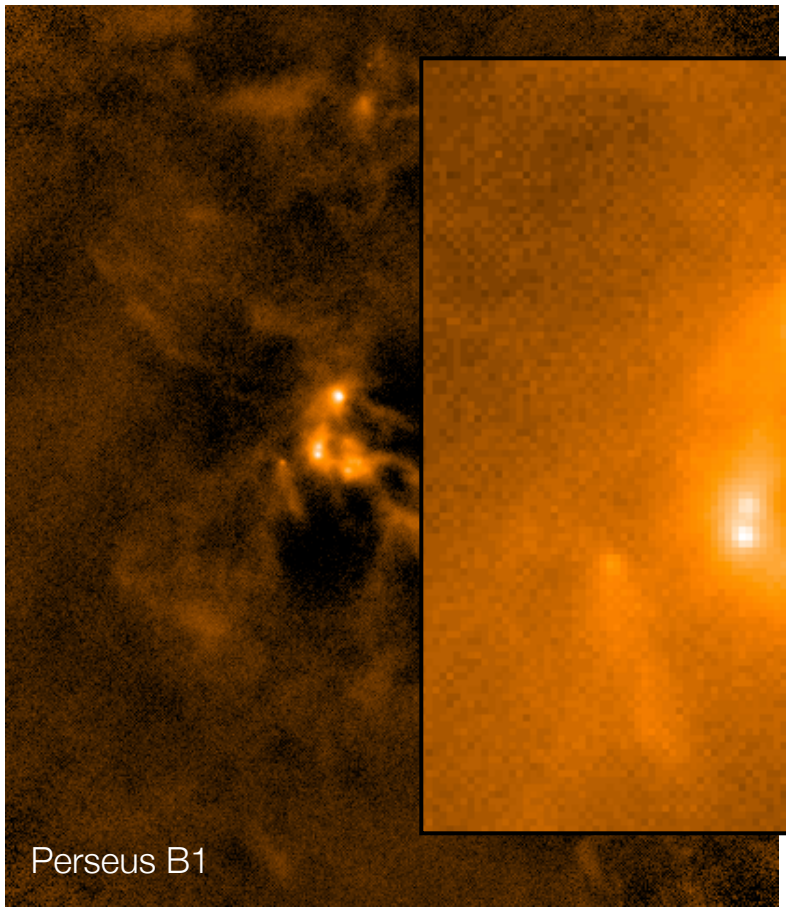


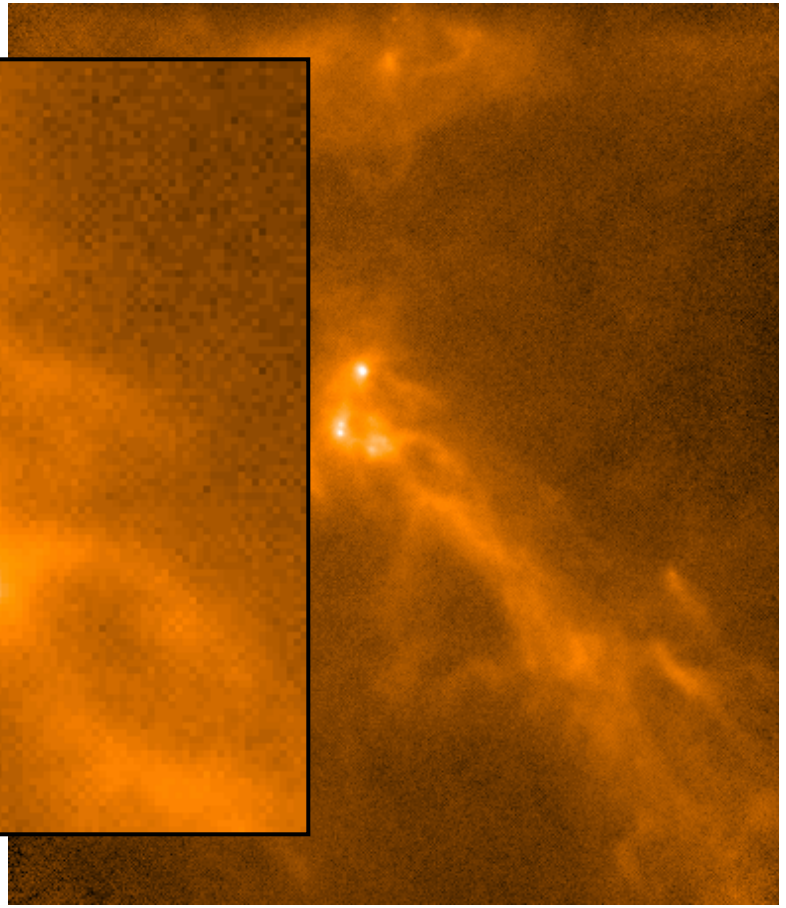
A number of background galaxies detected, some of which do not have optical counterparts

Results: GBS

The GBS team had a productive SV with useful data in band 1 weather



SCUBA-2 450μm image. Negative bowls around bright structure an issue.



SCUBA-2 450μm image with large scale structure from Herschel 500μm folded in.

Results: GBS

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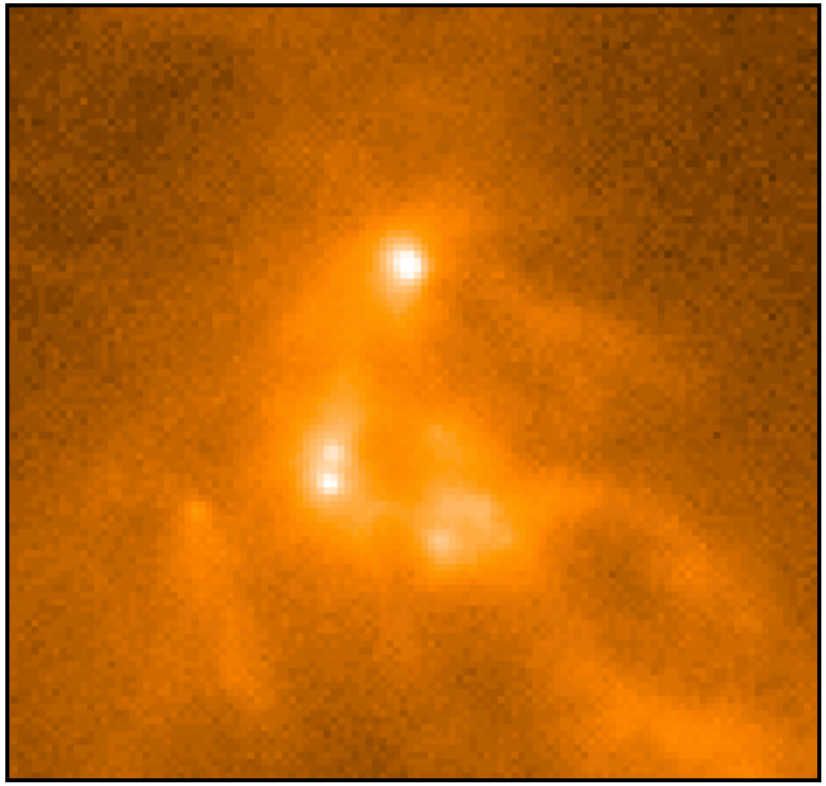

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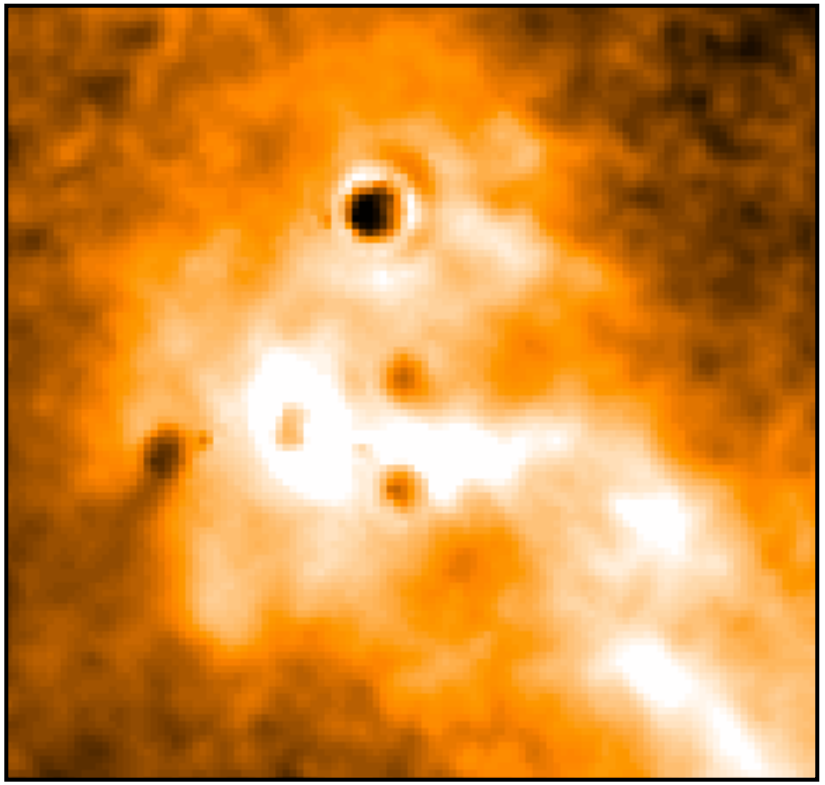
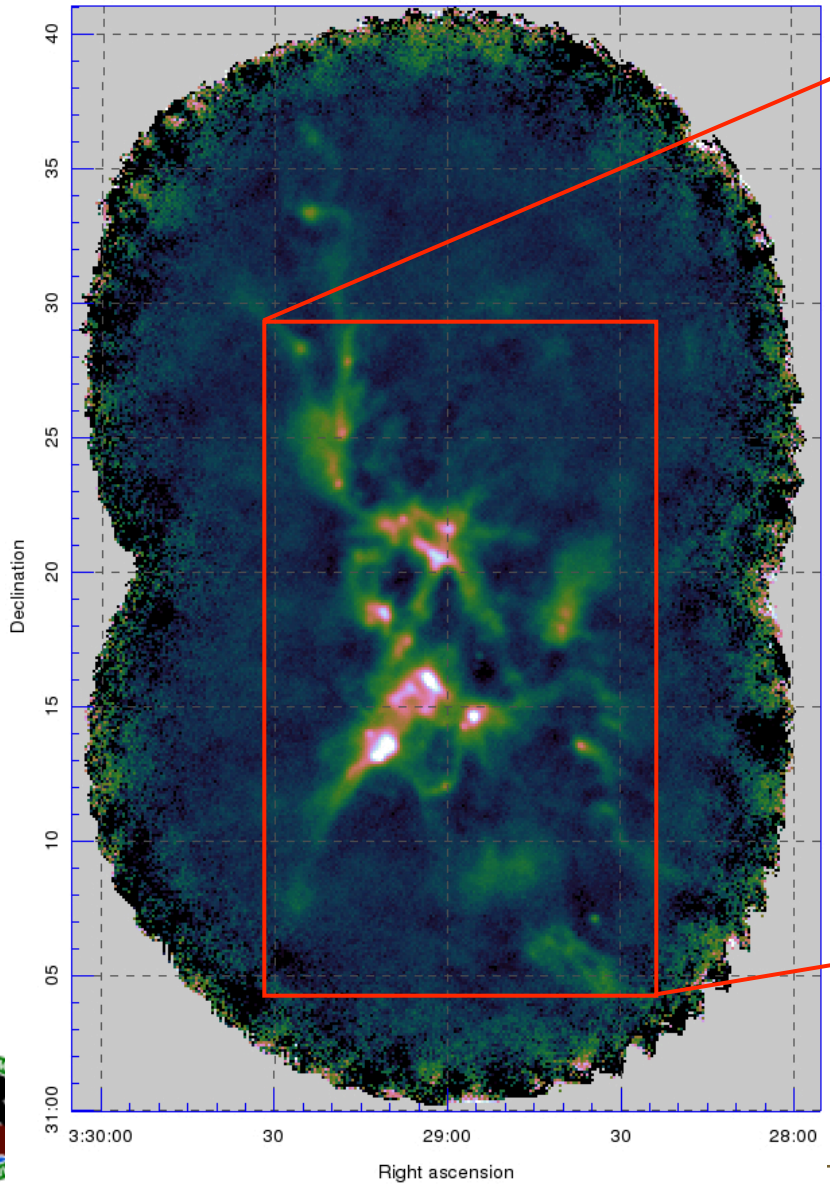
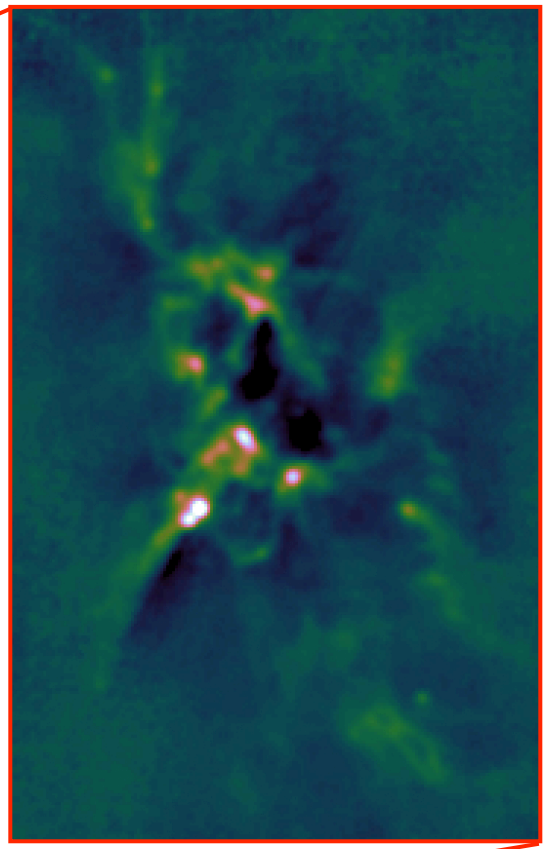


Spectral index image from ratio of SCUBA-2 450μm image (convolved to 15" beam) with Herschel at 250μm. The bright emission should be where the cold material is.

Results: GBS





NGC 1333 from the SCUBA Legacy Catalogue (Di Francesco et al. 2008).

NGC 1333 in Perseus with SCUBA-2 from data taken during S2SRO.

Competitiveness review

Wayne Holland recently compiled a competitiveness review for the JCMT Board

- to determine the competitiveness of SCUBA-2/JCMT over the next few years (up to ~ 2016)

There were three metrics used in this comparison...

- per-detector sensitivity
- mapping speed
- angular resolution

... and they were presented as

- the sensitivity to a given mass of dust
- large area mapping speed relative to SCUBA at 850 μm
- time to map 1 square degree to a given depth

Space-based instruments are not included in the following comparison and only instruments with wavelengths comparable to 450μm and 850μm

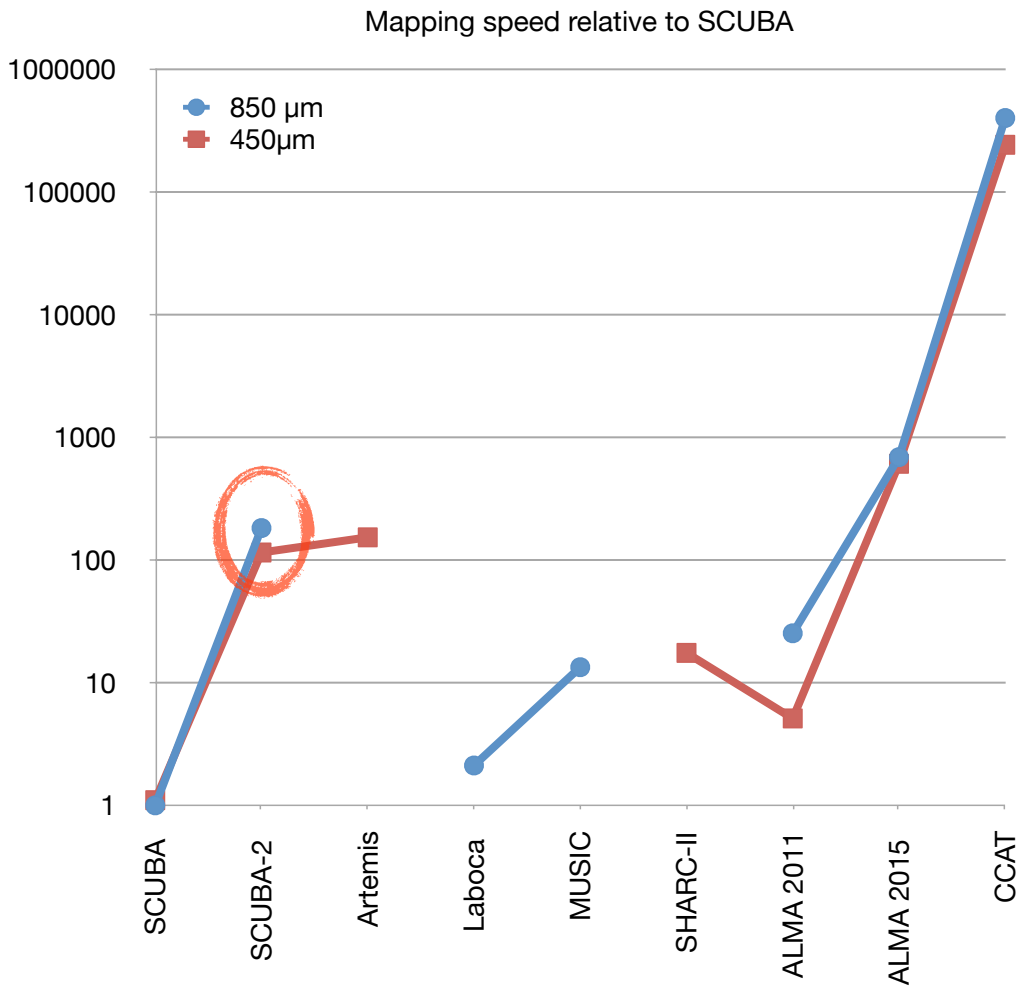
Competitiveness review

Mapping Speed

- SCUBA-2 performs well against any other instrument
- Artemis on APEX only instrument to provide competition at 450μm
- becomes less competitive once ALMA upgraded to full complement of dishes in 2015 and CCAT comes on-line

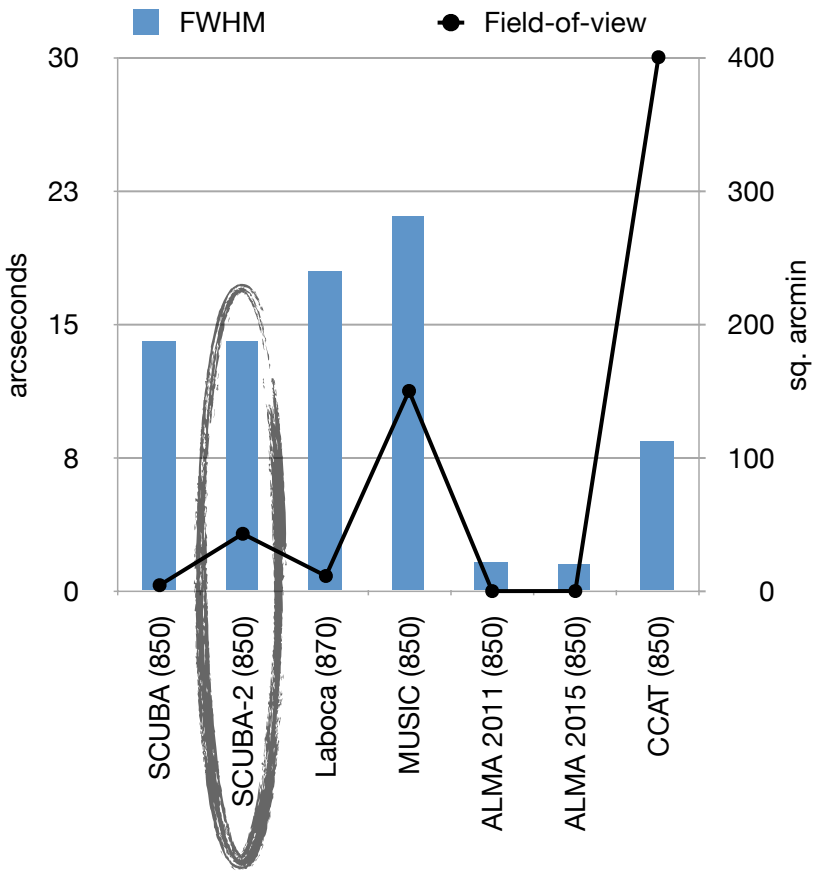
CCAT numbers based on preliminary design studies of probable first-light instruments

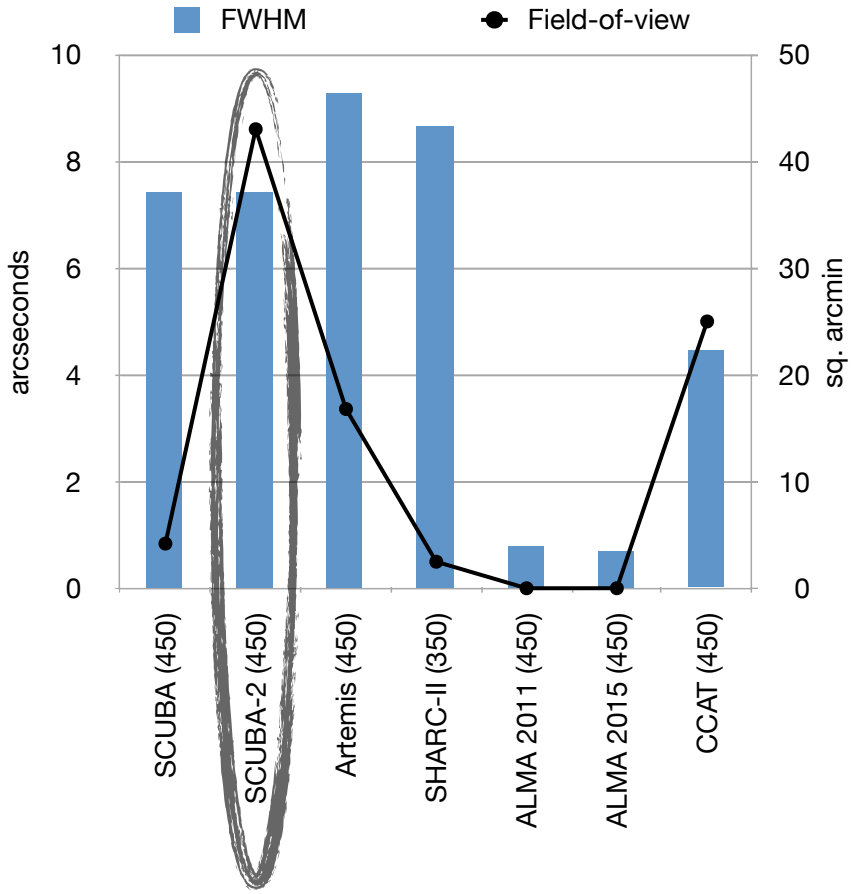
(more later from WSH)



Competitiveness Review

Comparison of the instantaneous field of view and angular resolution





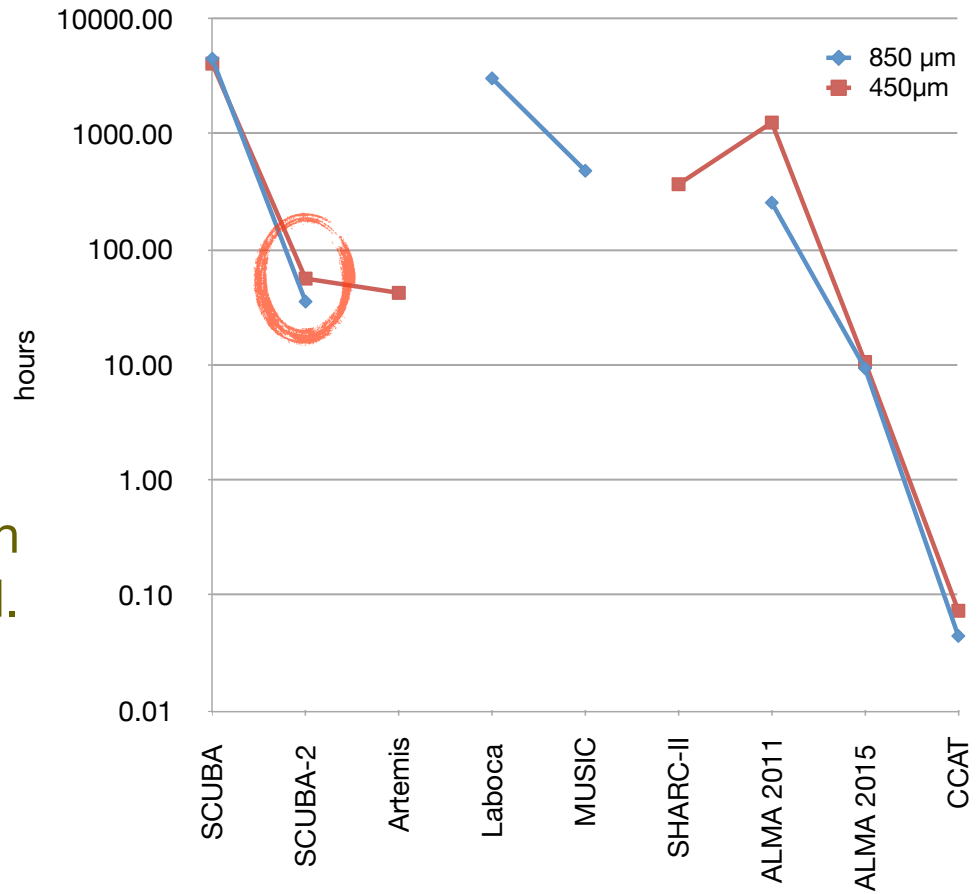
Competitiveness Review

Science goals of any modern submillimetre instrument are to map a large area of sky to good sensitivity

Parameters chosen:

- 1 square degree
- 5 x 850μm confusion limit
  - ~ 2.5 mJy

Comparison shows that SCUBA-2 has a very significant role to play in the next few years and will remain competitive up to 2015 and beyond.



Conclusion

Survey observing with SCUBA-2 has started and initial indications are good

JLS projects have been rescoped and are being considered by JLSRG

Performance against other facilities shows that JCMT/SCUBA-2 will remain competitive for the foreseeable future

- plus, POL-2 & FTS-2 are unique

There is still has a significant role for JCMT/SCUBA-2 to play

- limited competition until much larger facilities such as the fully extended ALMA and CCAT come on line