

## LOFAR MSSS

*Multifrequency Snapshot Sky Survey*

## Update

George Heald (MSSS Project Leader)  
(on behalf of the MSSS Team)  
MKSP Meeting, 13/5/2013



Goals: obtain broadband sky model, shakedown LOFAR operations

## MSSS-LBA



Frequency: 30-75 MHz  
(8 x 2 MHz bands)

**Resolution:**  $\leq 100$  arcsec

**Sensitivity:**  $\leq 15$  mJy/beam

Area: 20,000 square degrees

**Number of Fields: 660**

Simultaneous beams: 5

## MSSS-HBA



Frequency: 115-160 MHz  
(8 x 2 MHz bands)

**Resolution:**  $\leq 120$  arcsec

**Sensitivity:**  $\leq 5$  mJy/beam

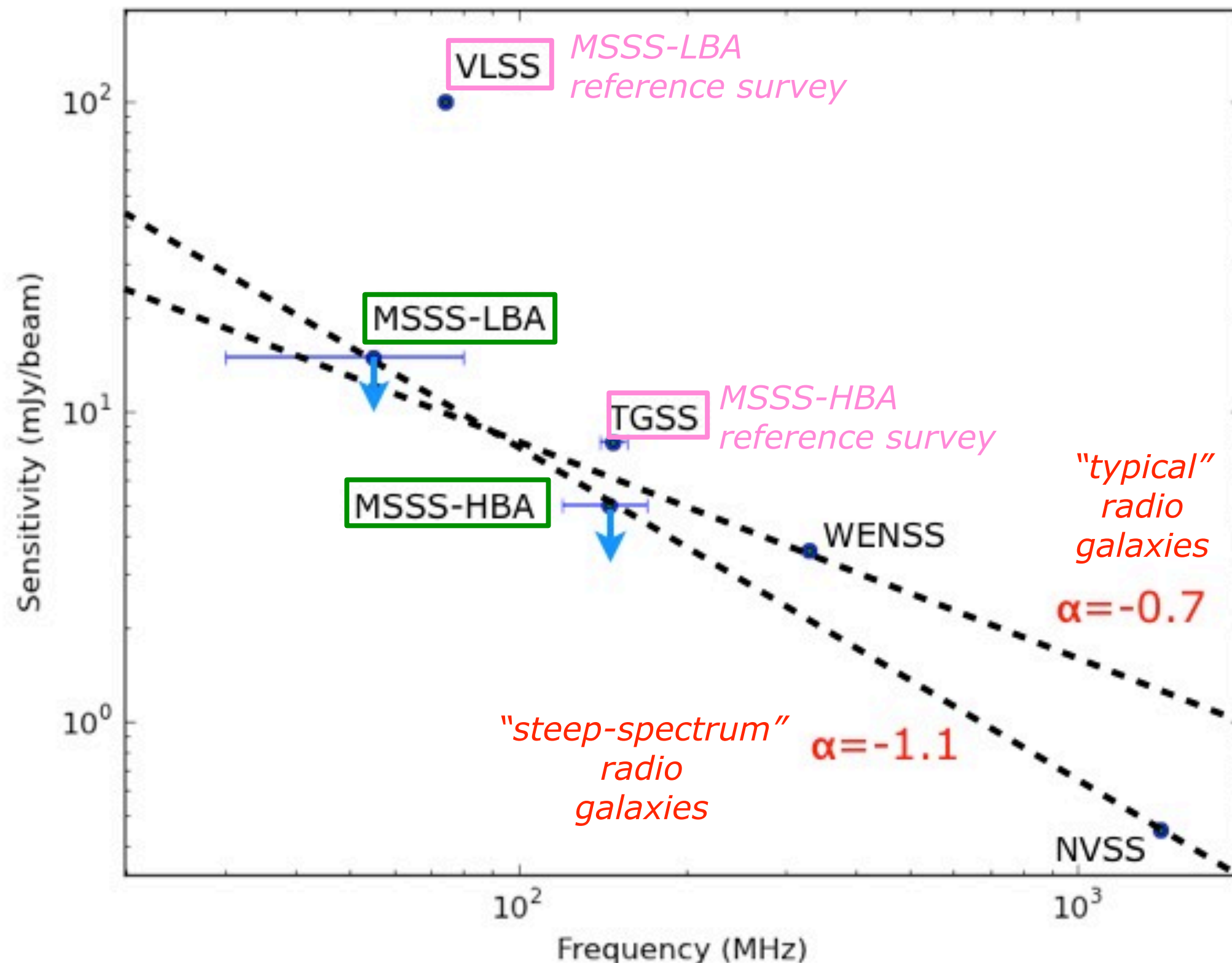
Area: 20,000 square degrees

**Number of Fields: 3616**

Simultaneous beams: 6

MSSS surveys the entire northern sky - **TWICE** - in 45 days

- MSSS covers a huge frequency span by itself, and matches well with existing radio surveys like WENSS and NVSS





- Roberto Pizzo
- Adebahr, Björn
- Bell, Michael
- Birzan, Laura
- Bonafede, Annalisa
- Brentjens, Michiel
- Breton, Rene
- Broderick, Jess
- Carbone, Dario
- Carroll, Patricia
- Cendes, Yvette
- Croston, Judith
- Daiboo, Soobash
- De Gasperin, Francesco
- Fallows, Richard
- Ferrari, Chiara
- Gregson, Jon
- Hardcastle, Martin
- Harwood, Jeremy
- Hassall, Tom
- Horneffer, Andreas
- Iacobelli, Marco
- Jelic, Vibor
- Jones, Dave
- Jurusik, Wojciech
- Macario, Giulia
- Martinez, Oscar
- McKean, John
- Mulcahy, David
- Nikiel-Wroczyński, Blazej
- Offringa, Andre
- Orru, Emanuela
- Pandey, V.N.
- Pietka, Gosia
- Prasad, Peeyush
- Rowlinson, Antonia
- Sabater Montes, José
- Scaife, Anna
- Scheers, Bart
- Shulevski, Alexandar
- Sobey, Charlotte
- Sotomayor-Beltran, Carlos
- Stewart, Adam
- Stroe, Andra
- Swinbank, John
- Tasse, Cyril
- ter Veen, Sander
- van der Horst, Alexander
- van der Tol, Bas
- van Velzen, Sjoert
- van Weeren, Reinout
- Williams, Wendy



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- , Sjoert
- n, Reinout

- Williams, Wendy



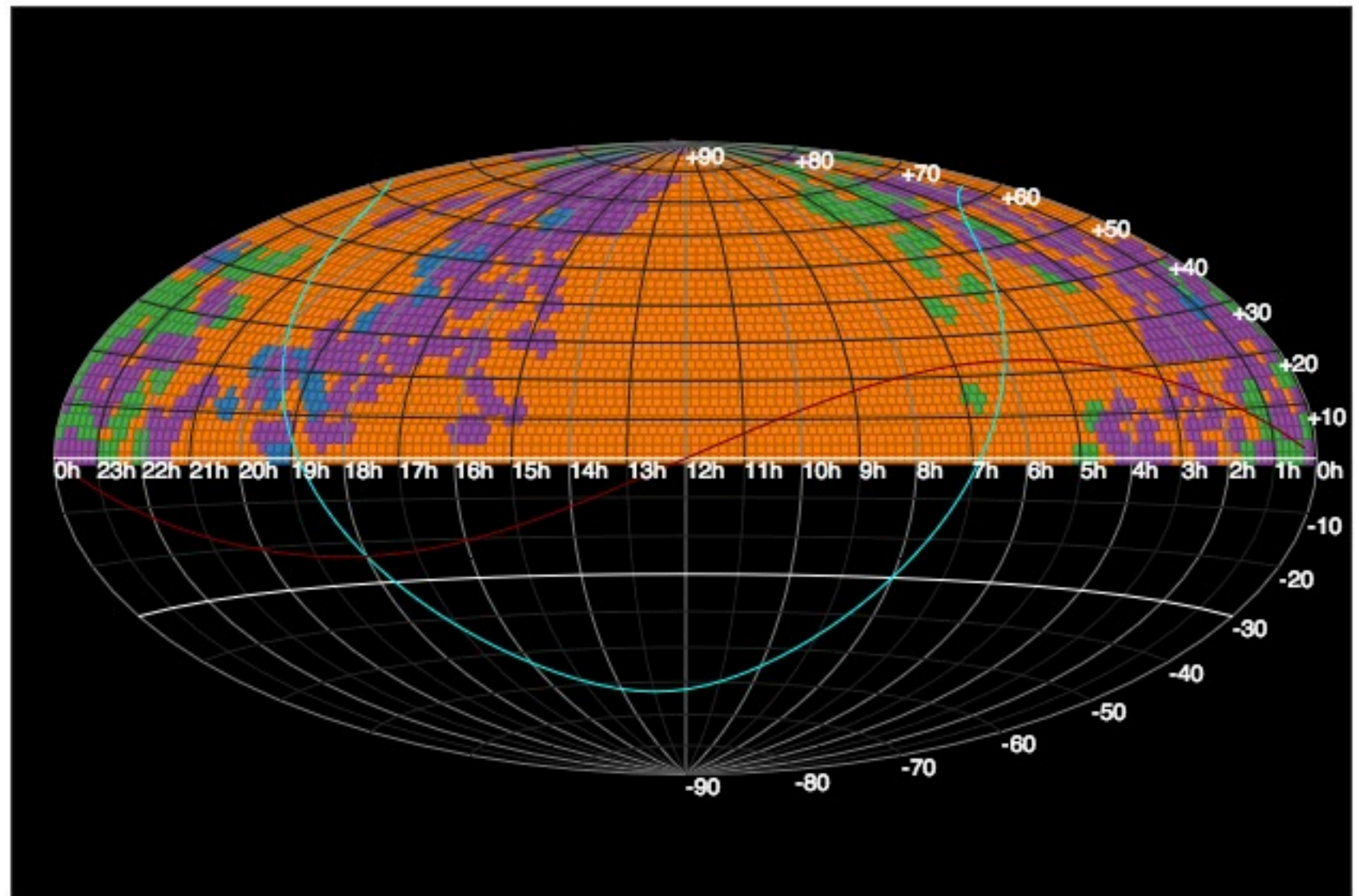
- MSSS-HBA started recently, and is  $\sim 30+\%$  complete!

## LOFAR Observation Database

### MSSS HBA

|                       |              |
|-----------------------|--------------|
| Number of Targets     | 3616         |
| Number of Calibrators | 8            |
| Start Date            | 8 Feb. 2013  |
| Stop Date             | 4 May 2013   |
| Completed Fields      | 1128 (31.2%) |
| Information collected | 6 May 2013   |

Show me the data »



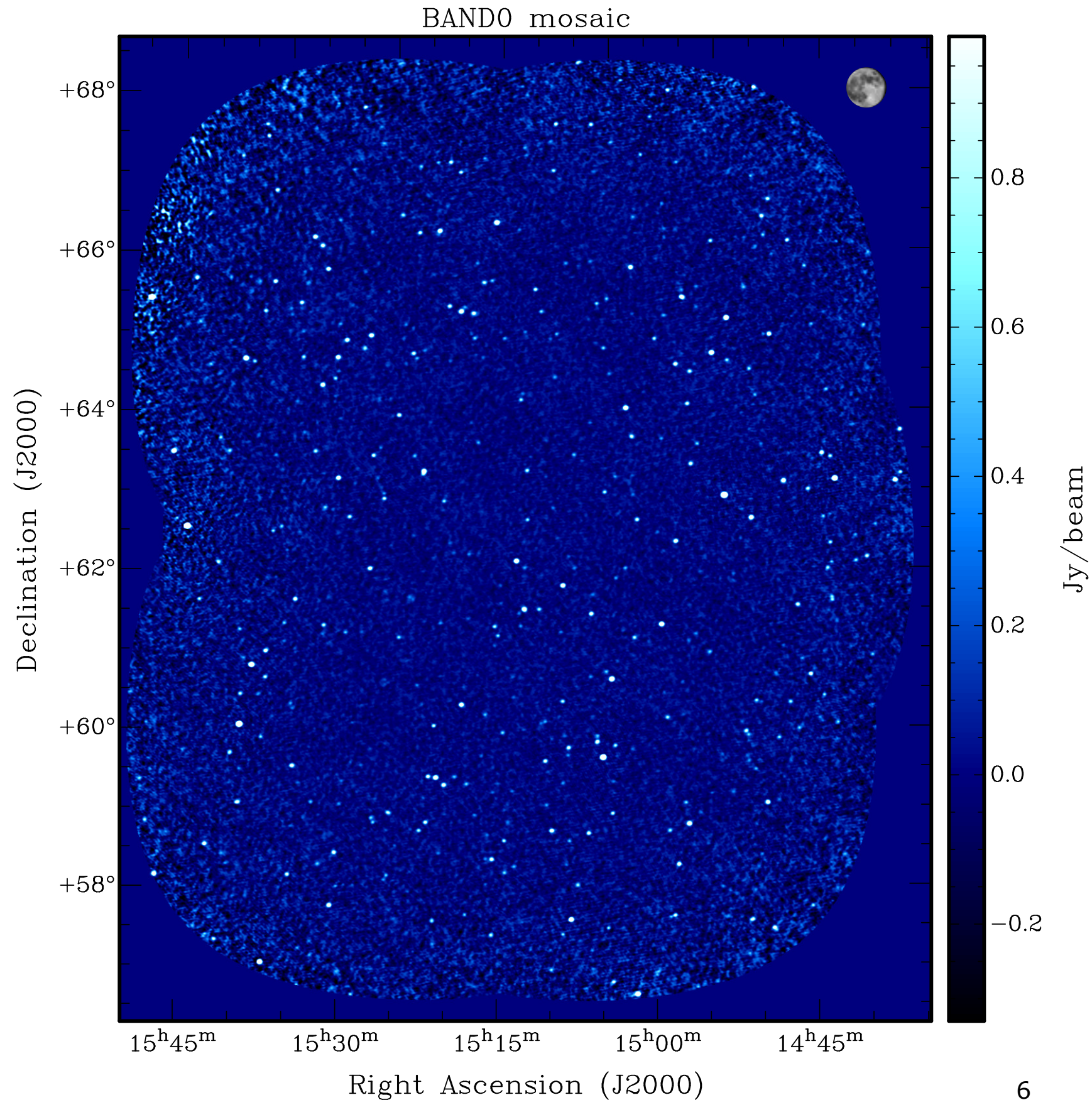
Hammer Projection

Map based on code from [this project](#).

Data available on CEP (8.0%)  
Data archived (23.2%)  
Partial data available (2.4%)  
Data missing (0%)  
Not yet observed (66.5%)

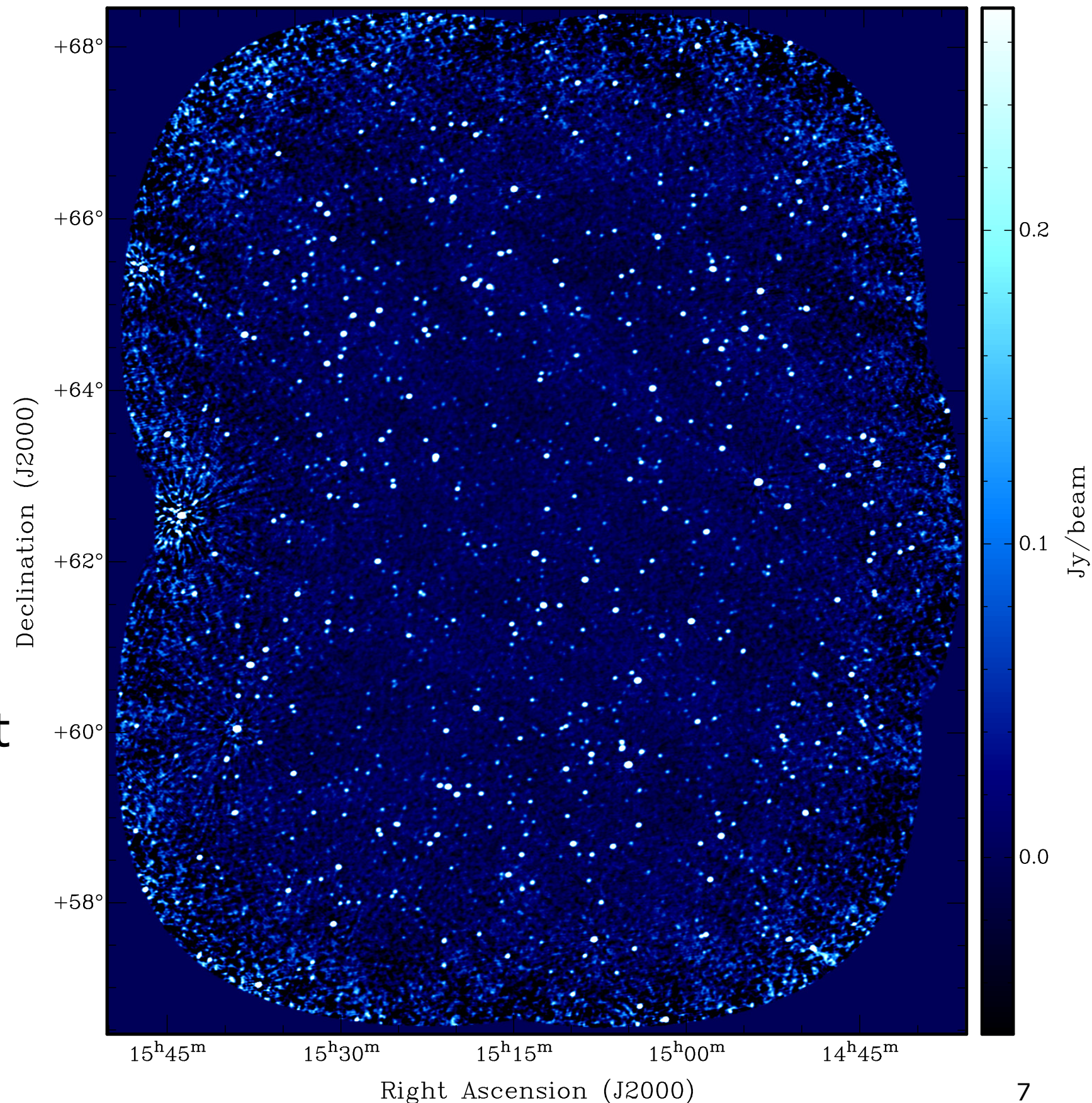


- Standard processing results in this mosaic

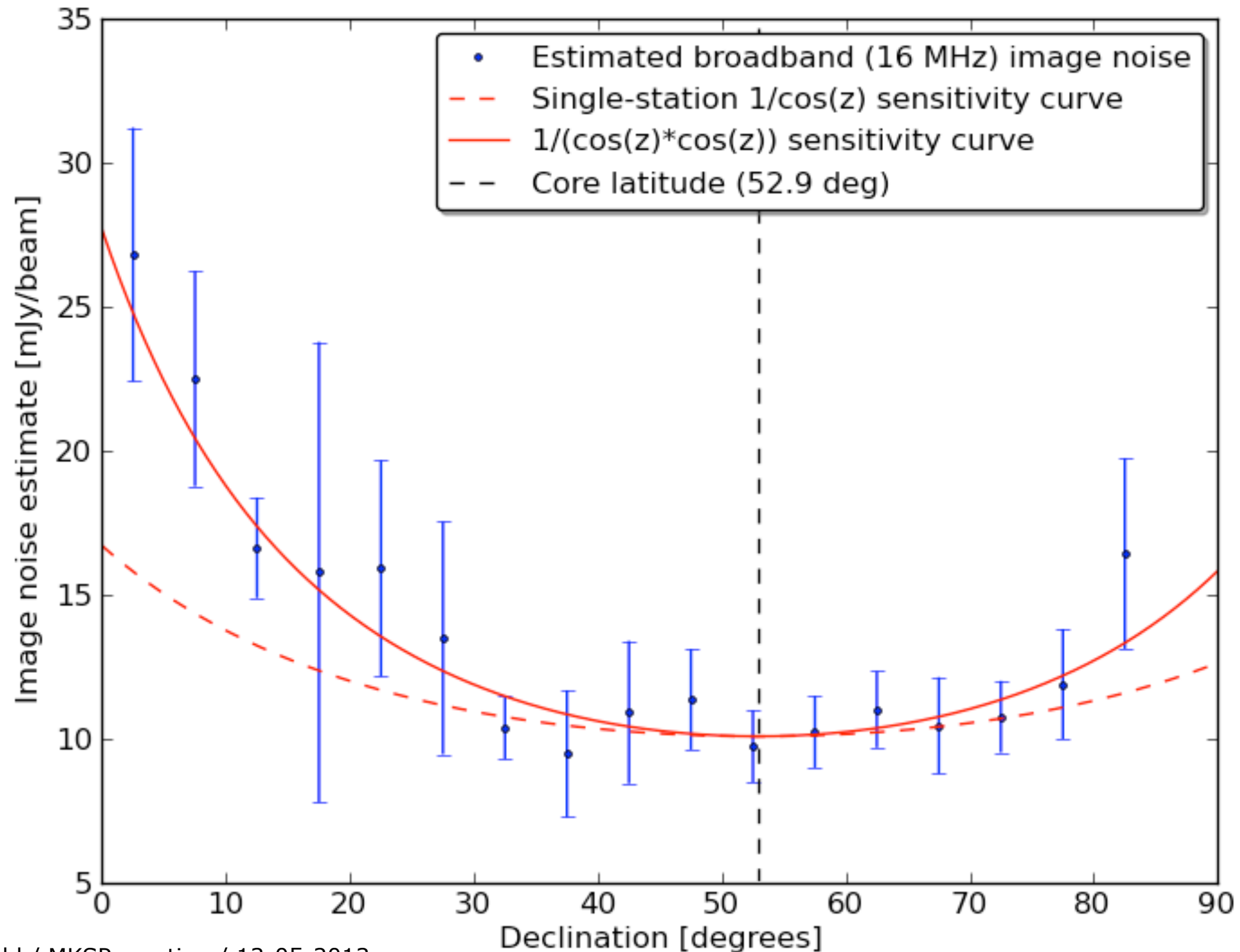




- Standard processing results in this mosaic
- Combining all bands leads to final image ( $\sigma=10$  mJy/beam at resolution  $\sim 2'$ )
  - (16 MHz, 14 min)
- NB: MSSS now in 8-bit mode, so 6 HBA fields simultaneously!

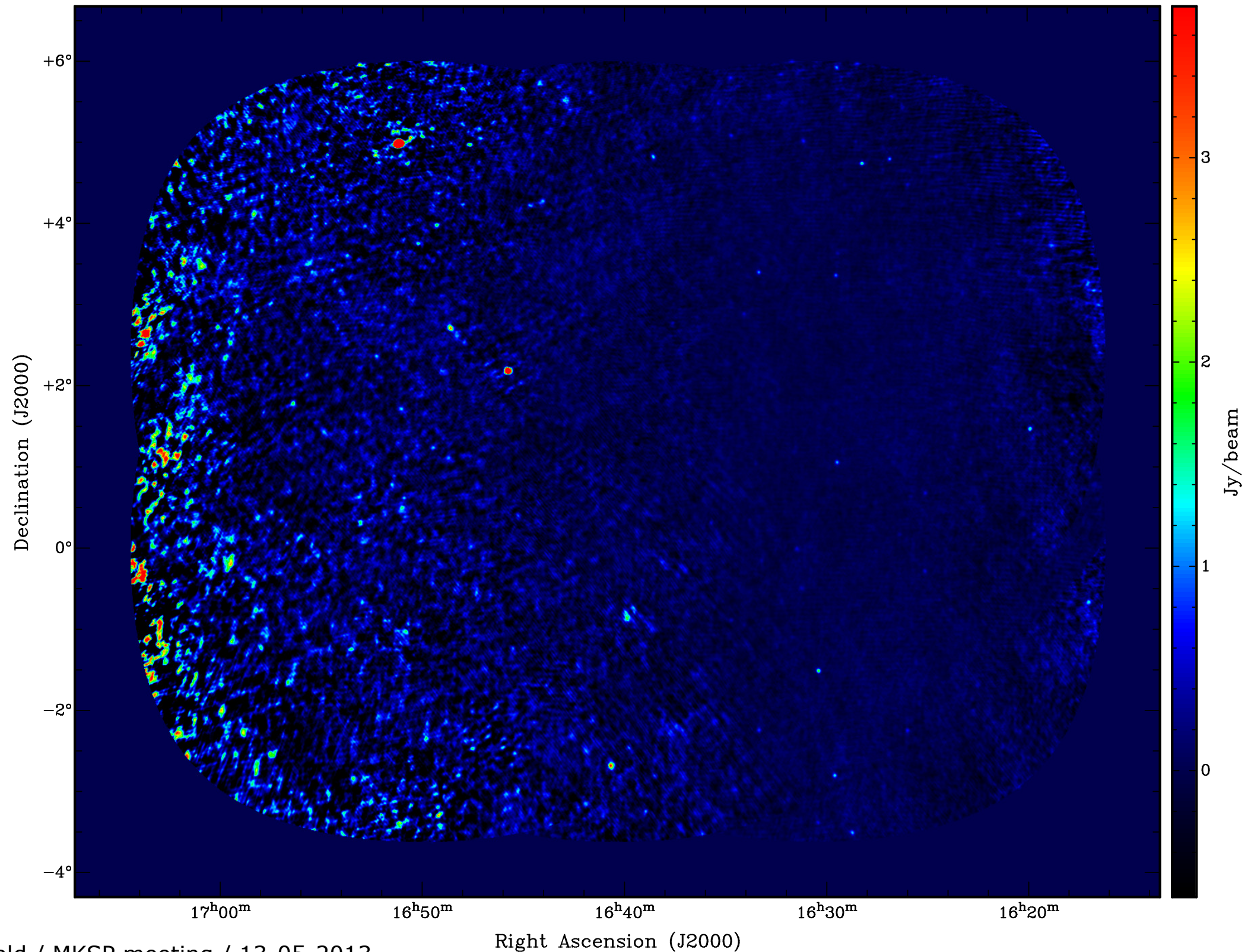


- Measured rms noise in 2510 cleaned images

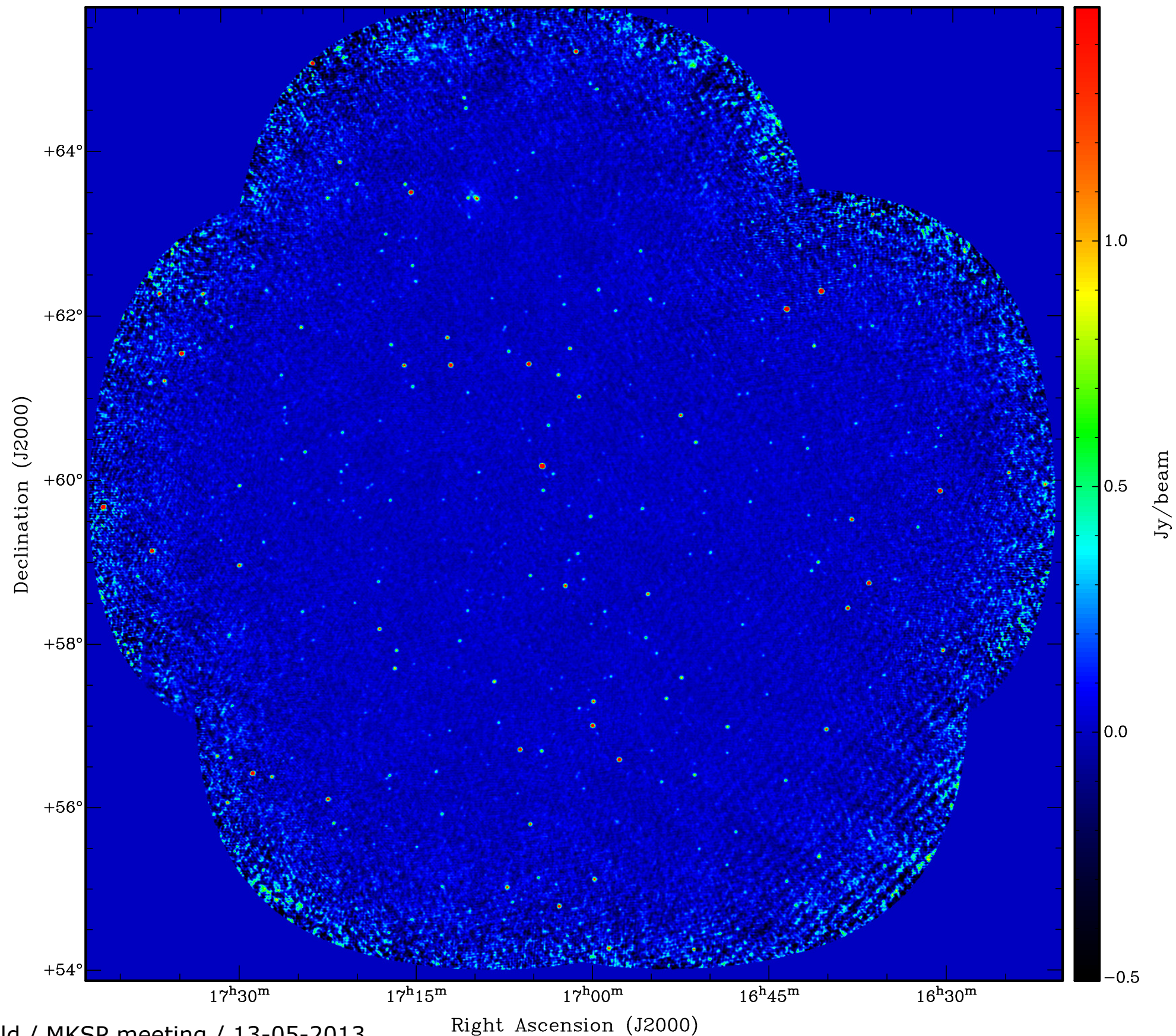




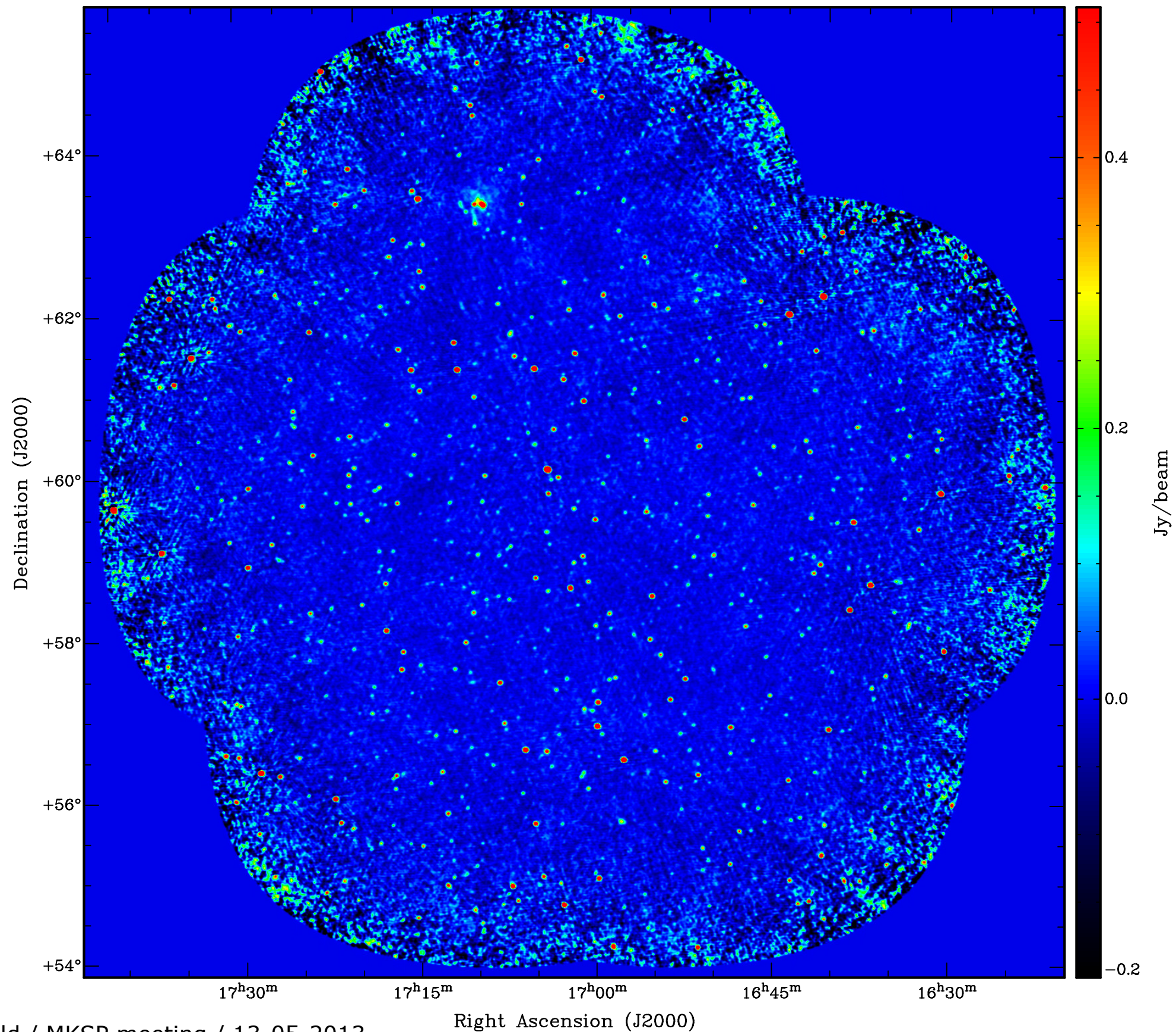
- In this case HerA causing problems



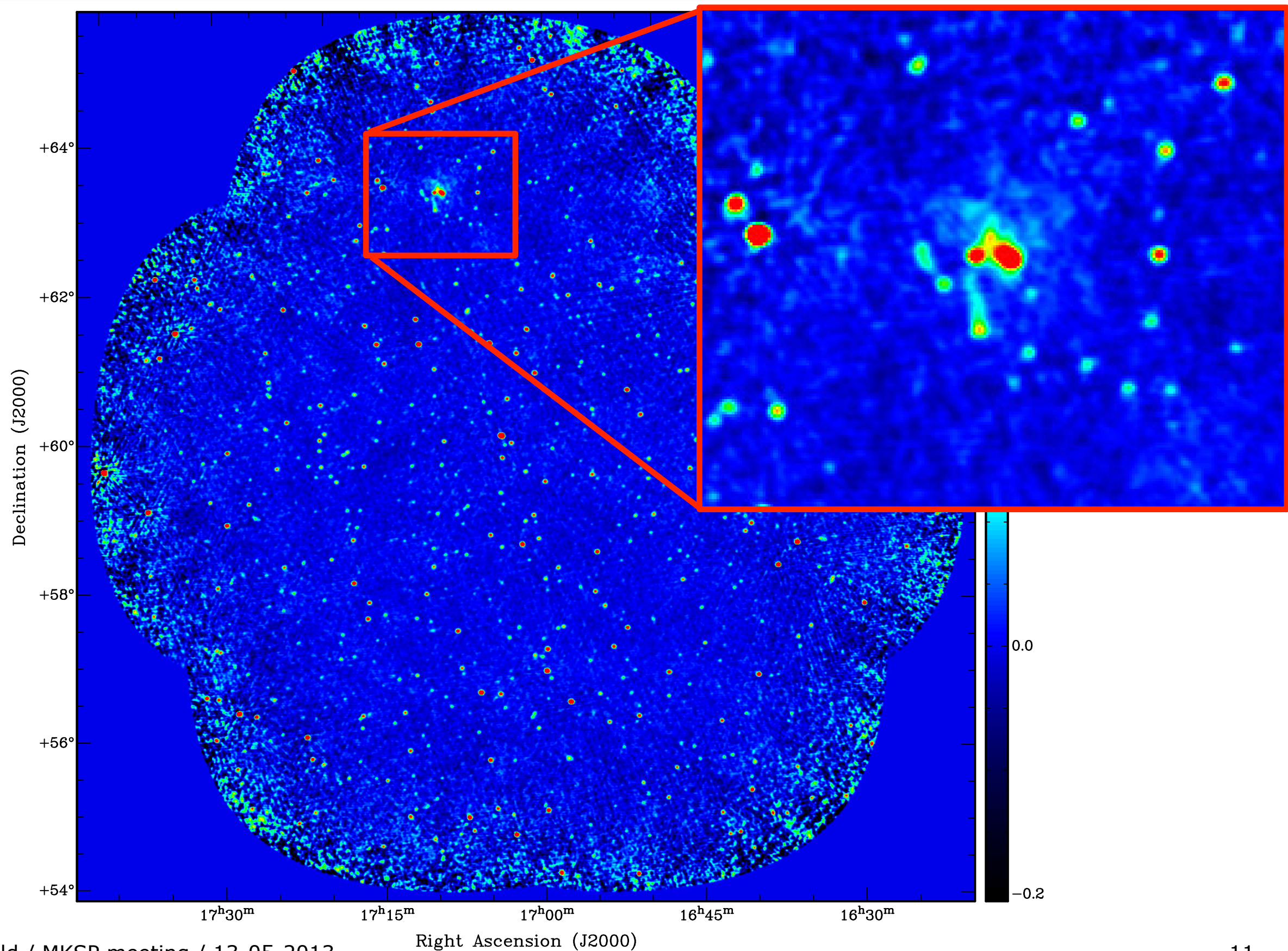




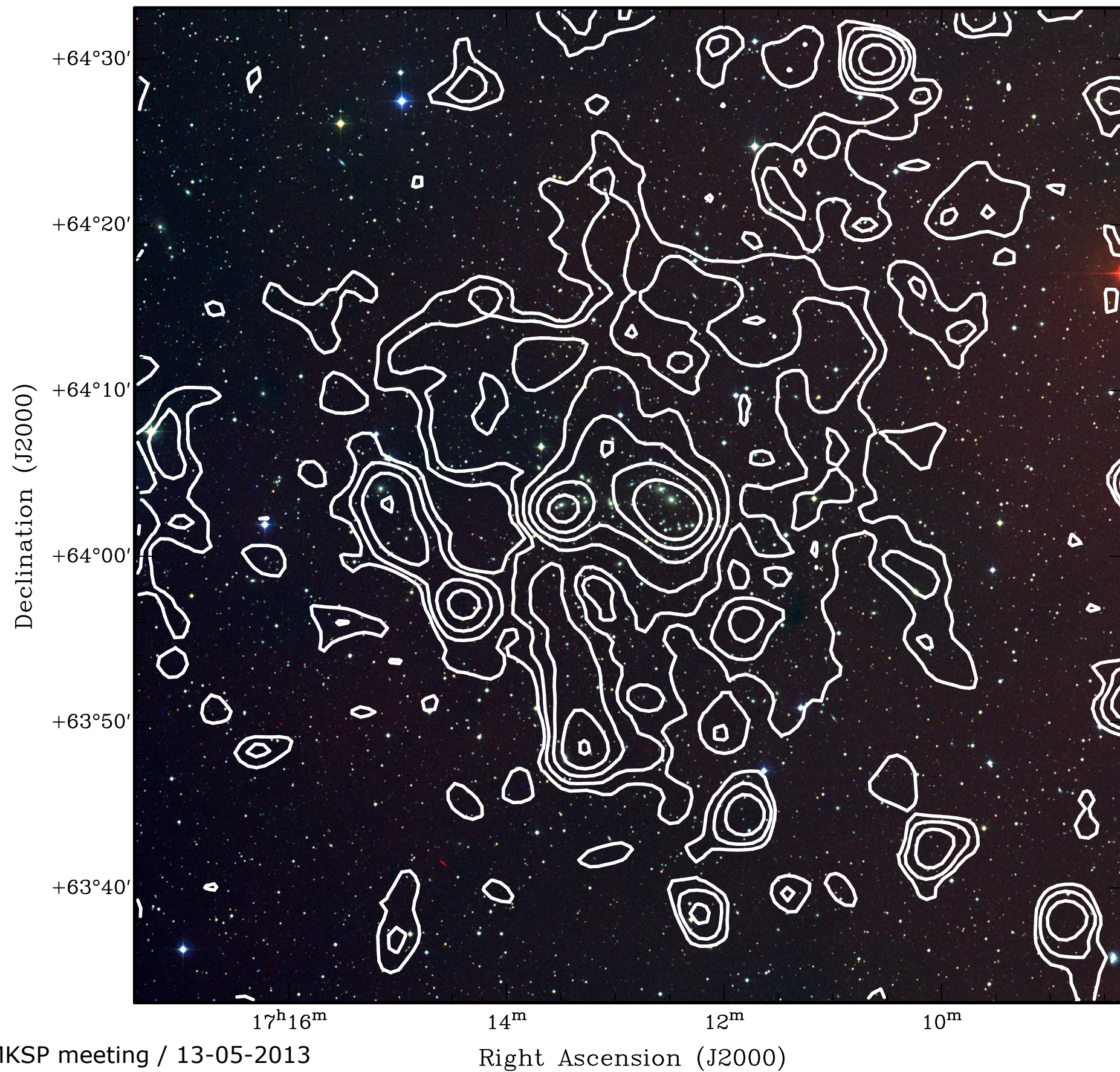






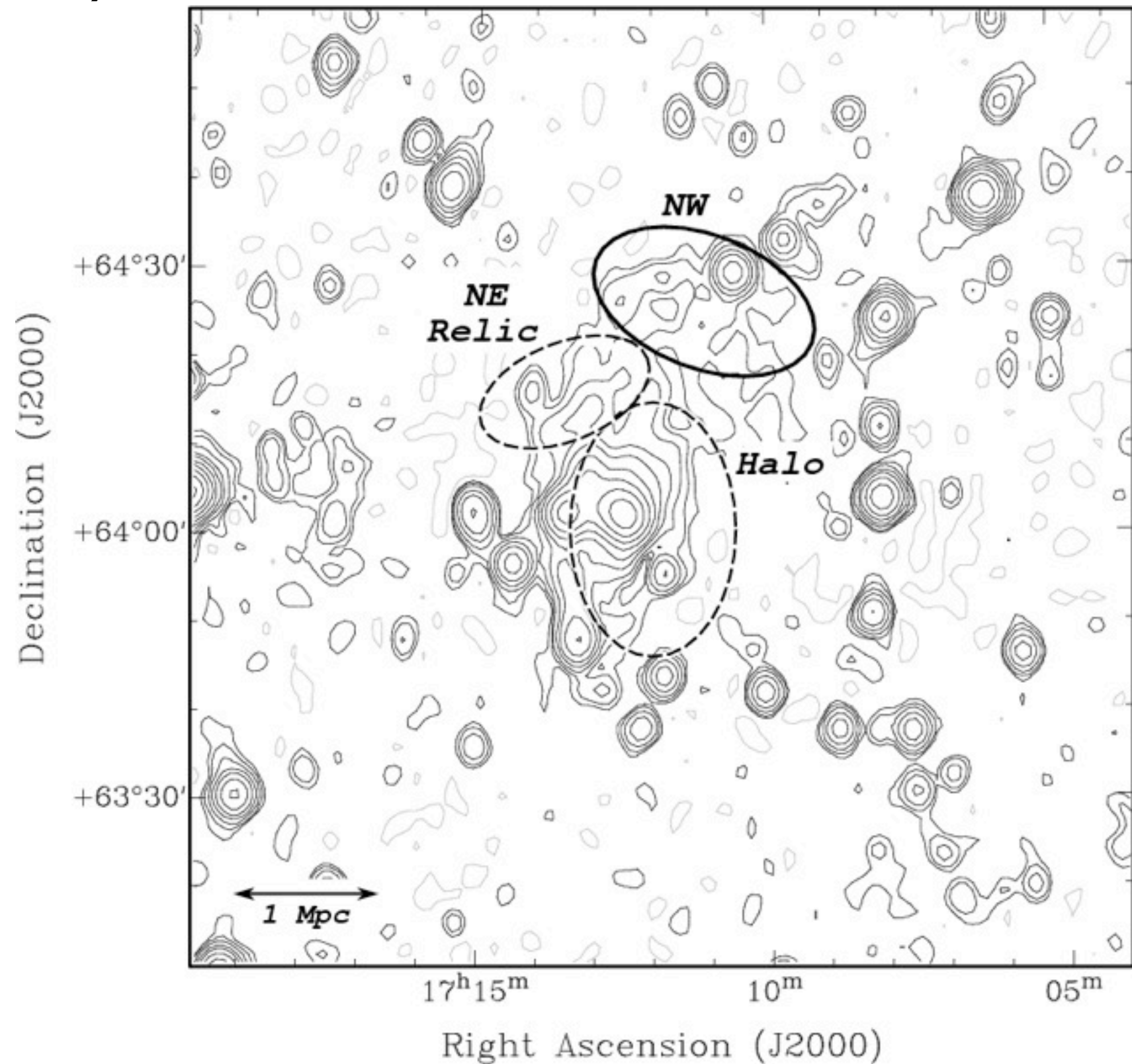
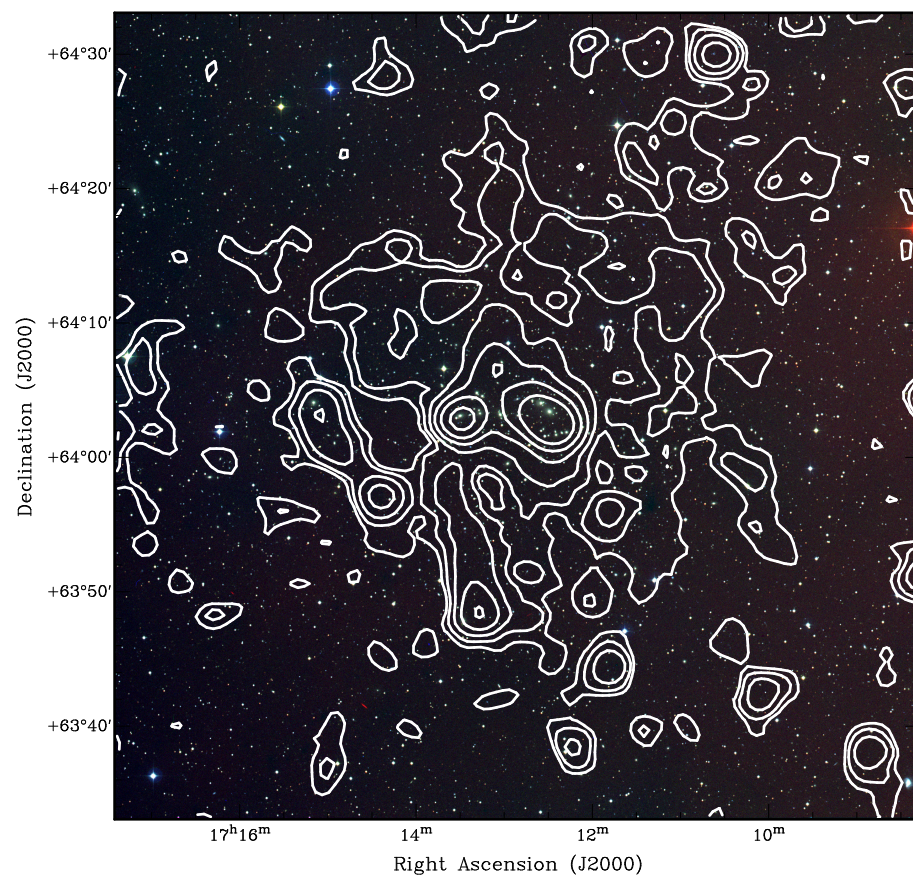




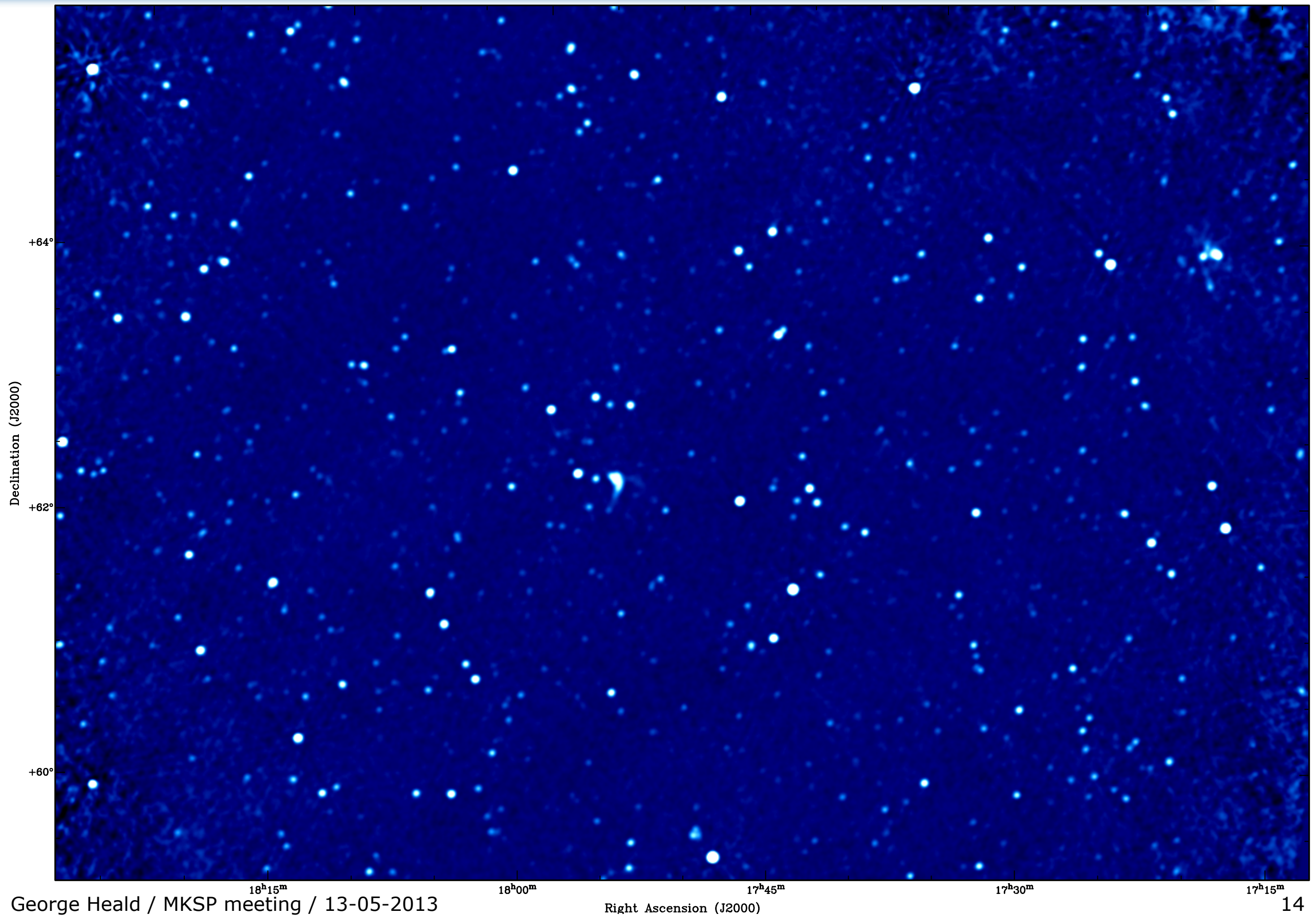




- cf Pizzo & de Bruyn (2009)  
WSRT, 150 MHz

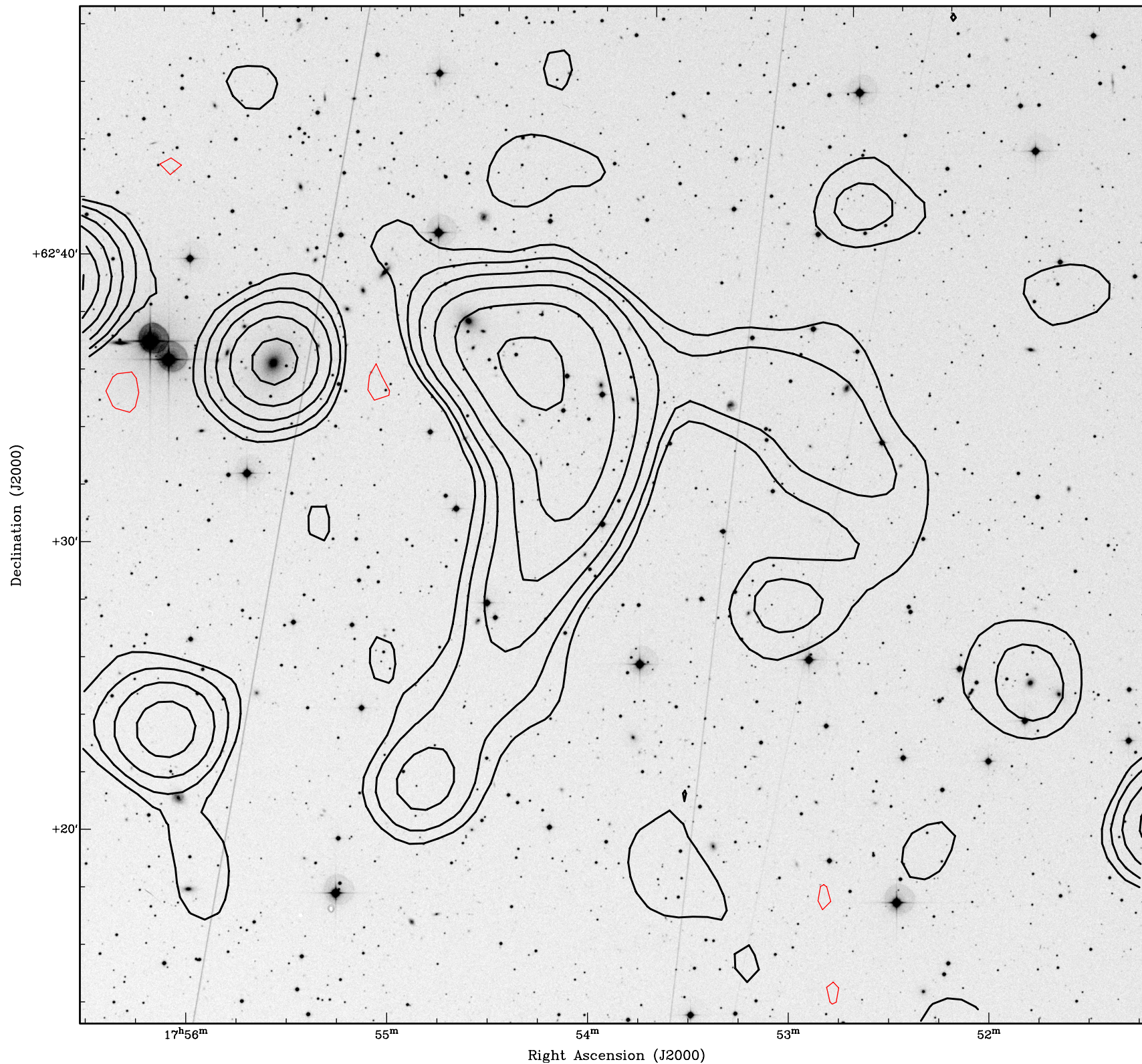






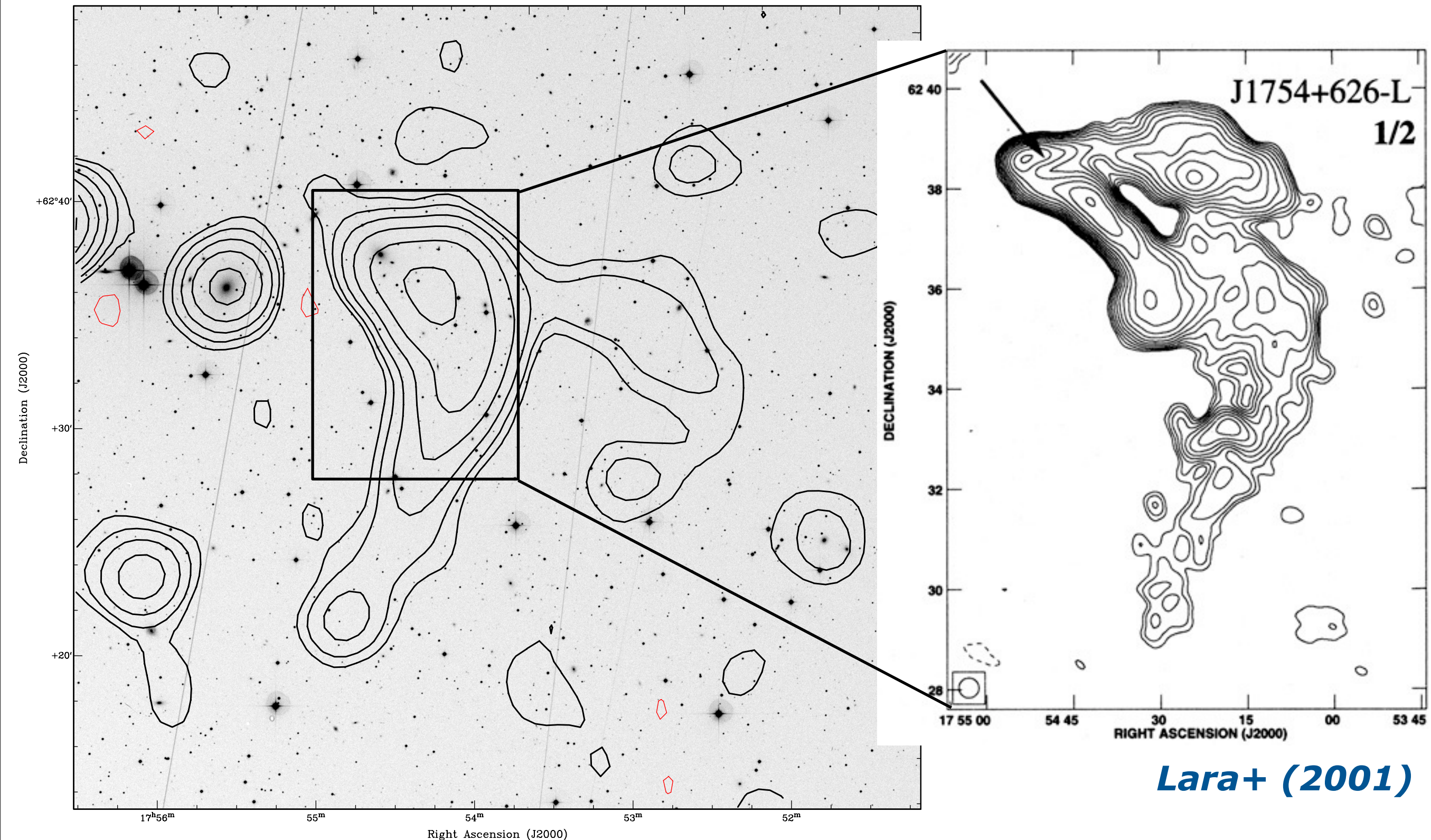


- Extended beyond 1400 MHz emission





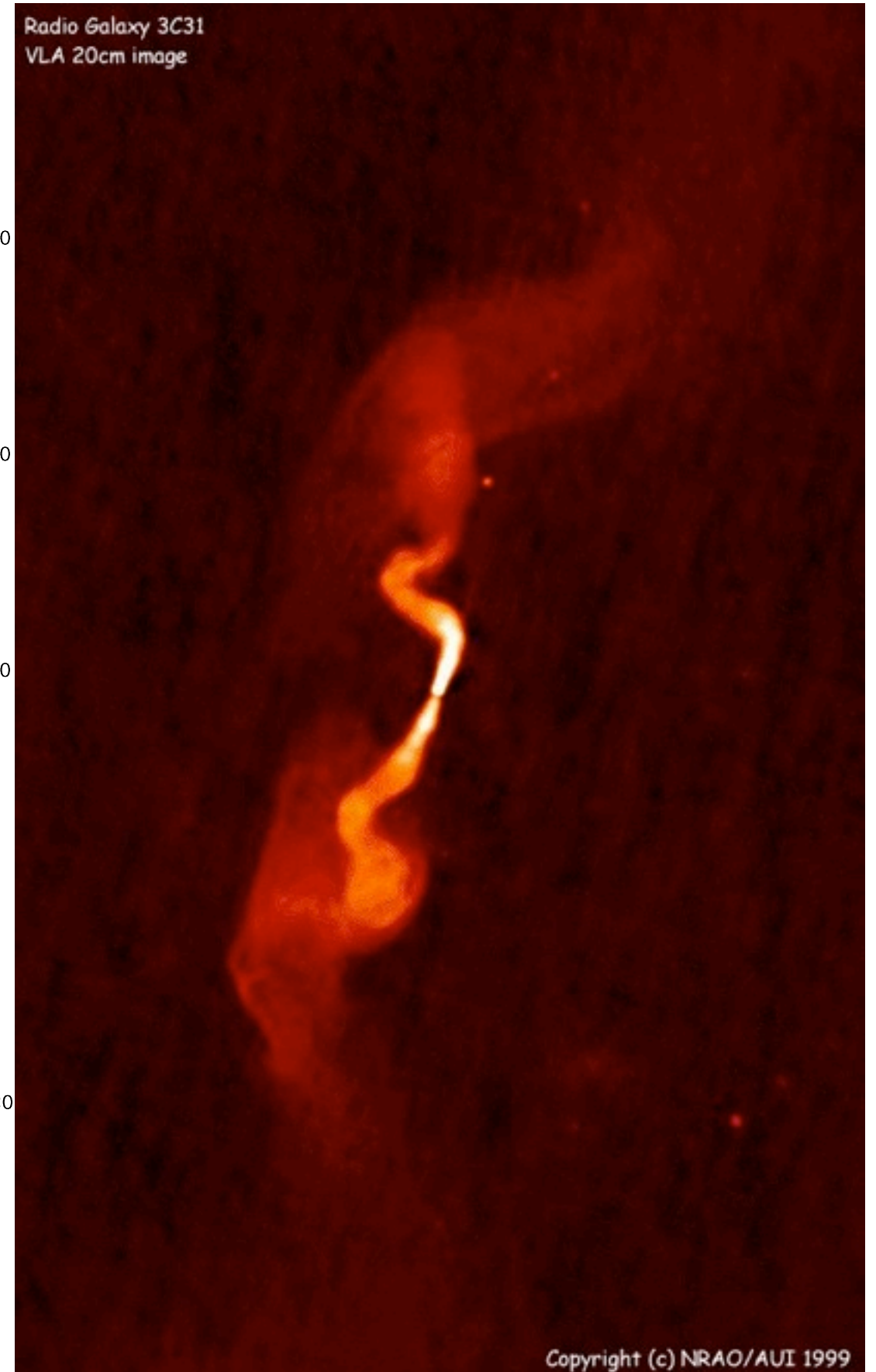
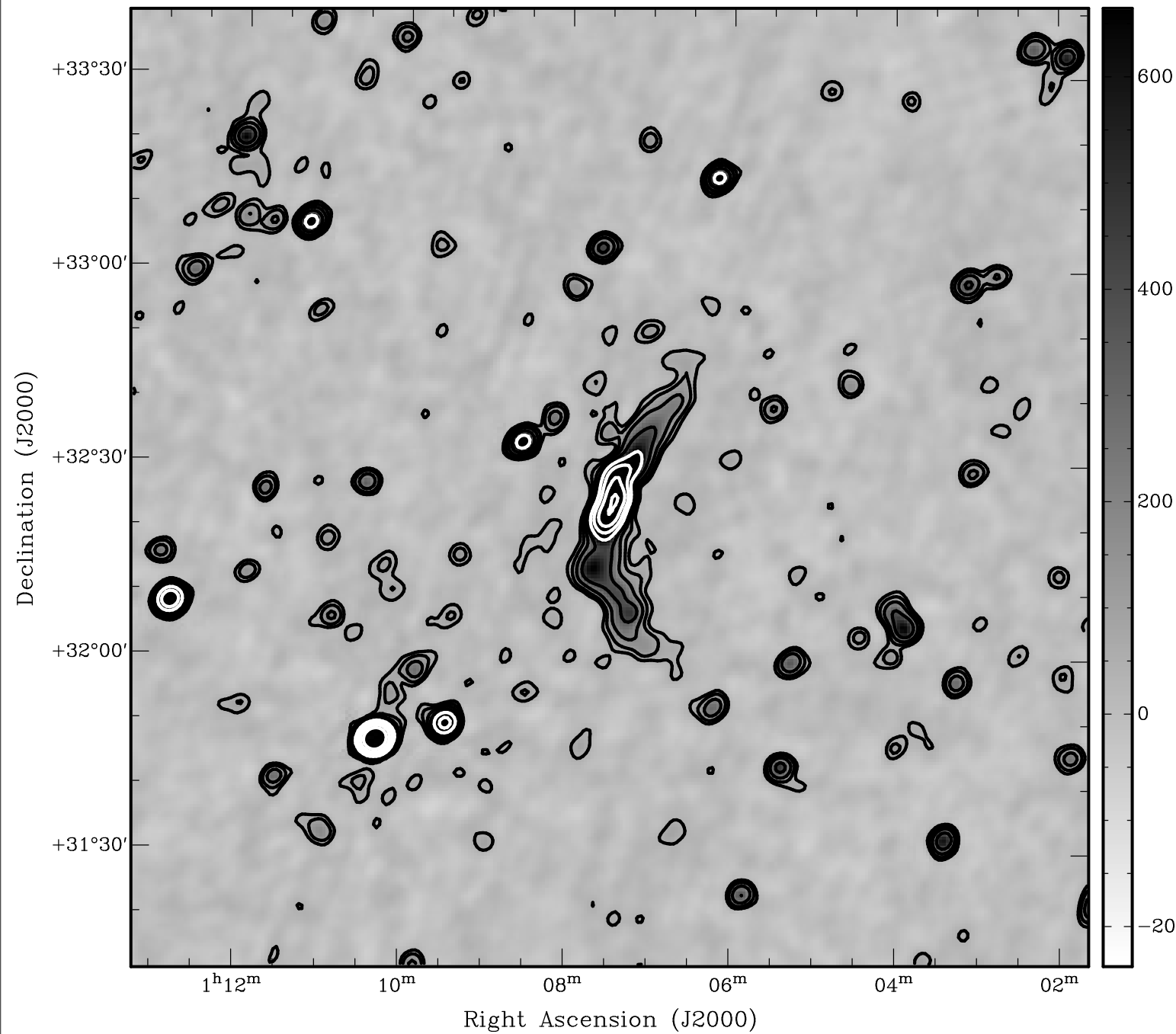
- Extended beyond 1400 MHz emission



*Lara+ (2001)*

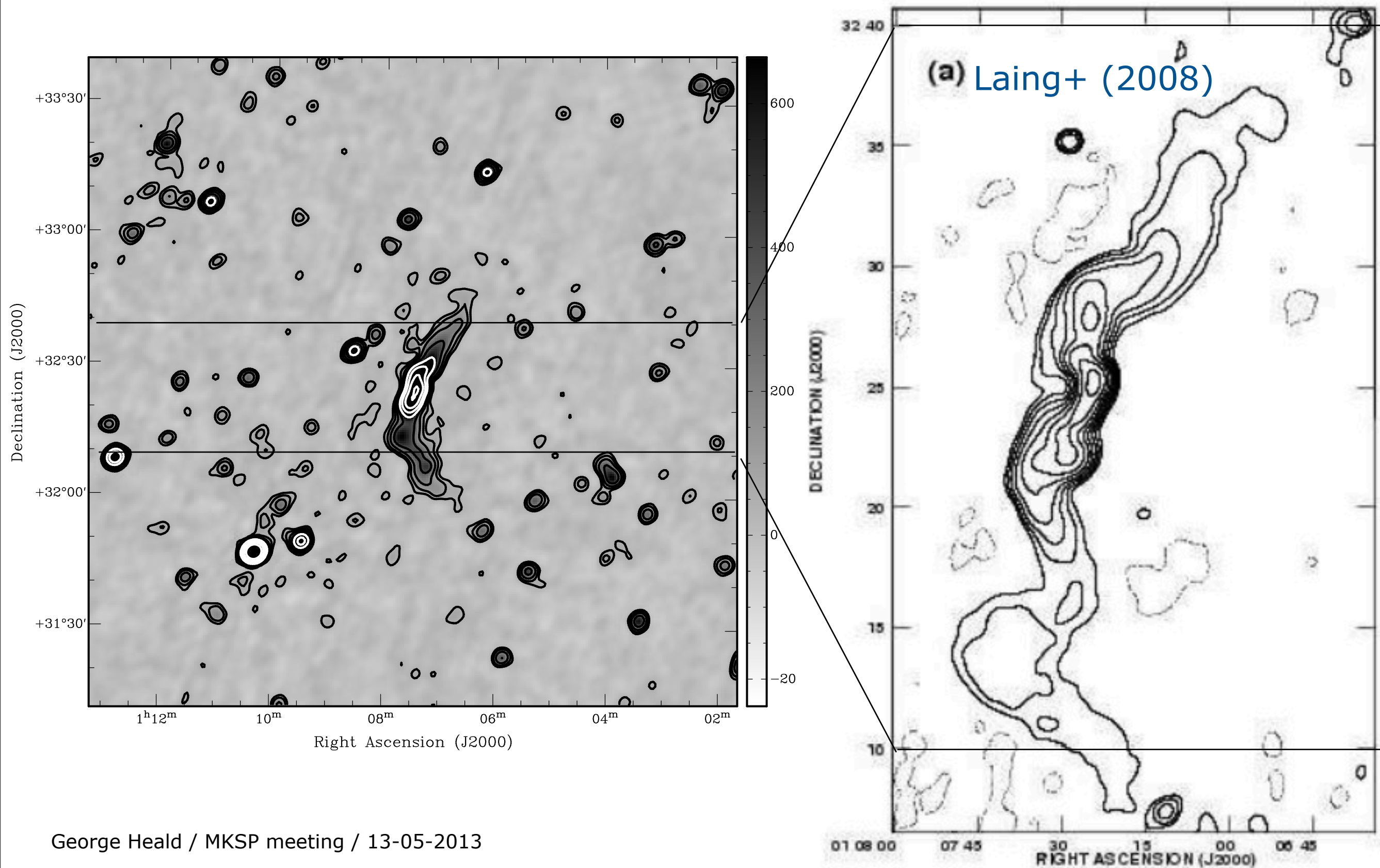


## ■ 3C31





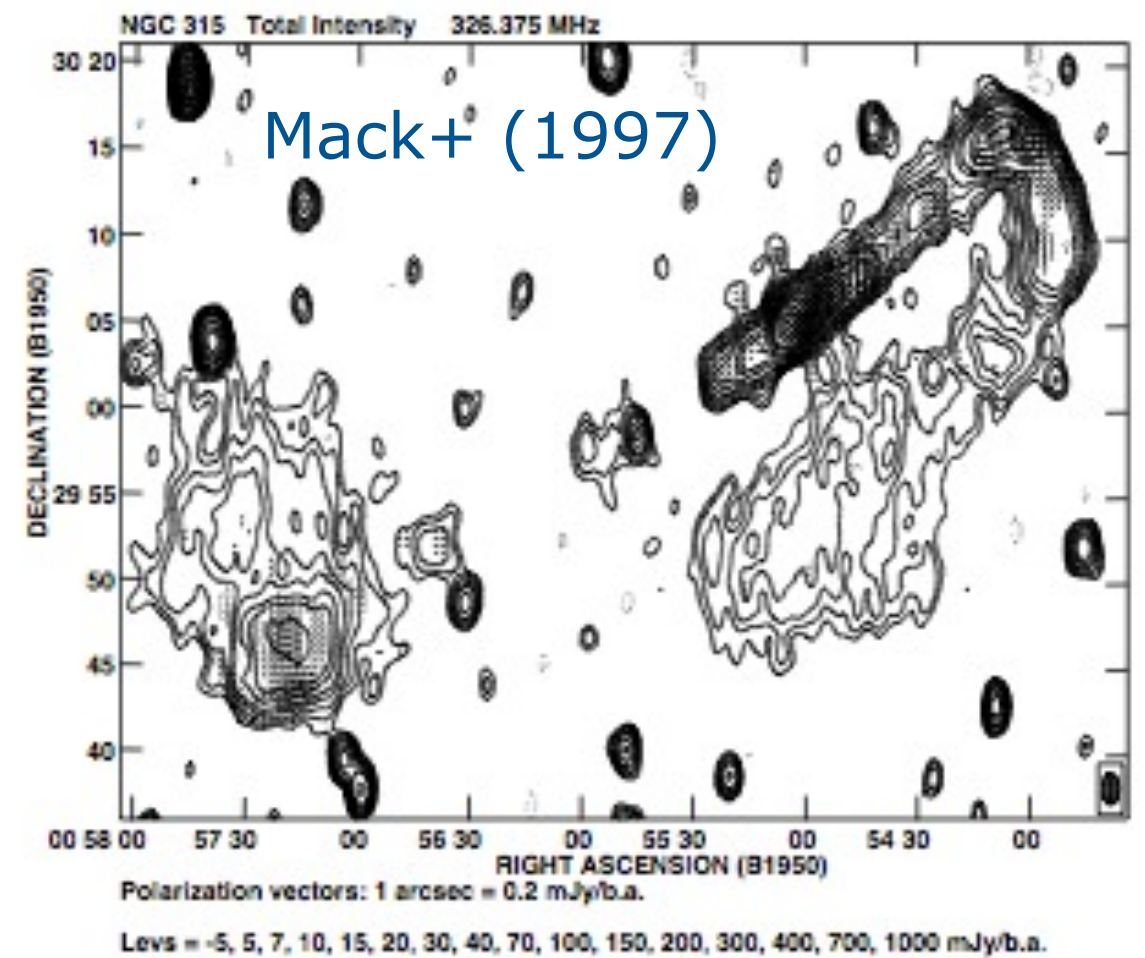
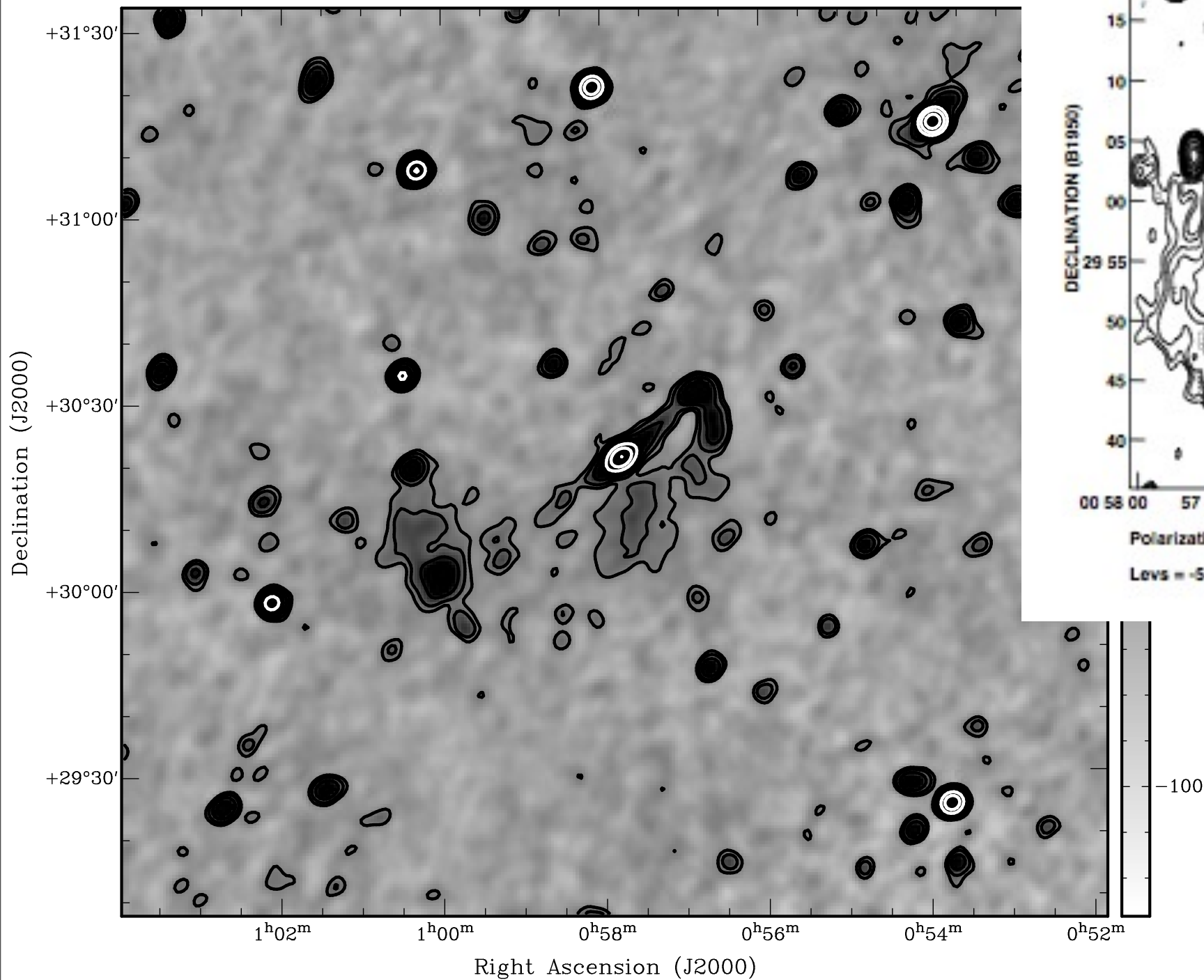
## ■ 3C31



George Heald / MKSP meeting / 13-05-2013

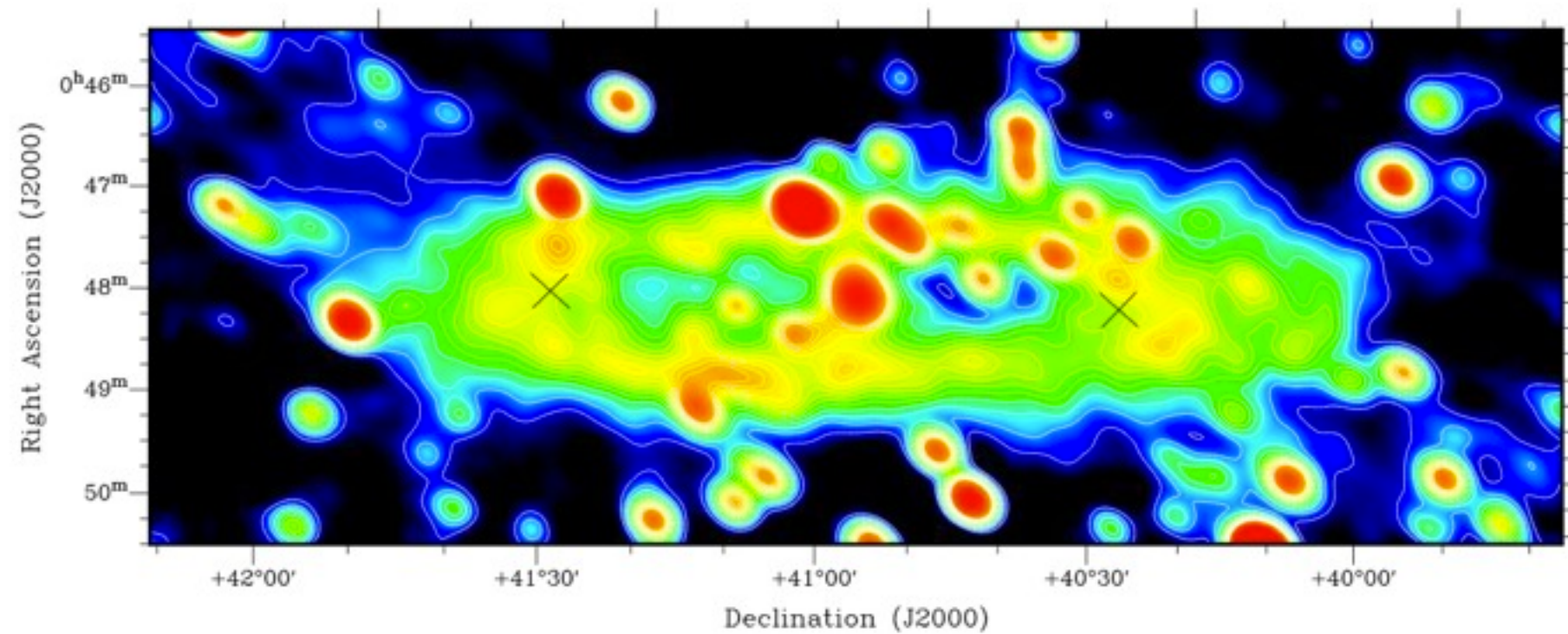
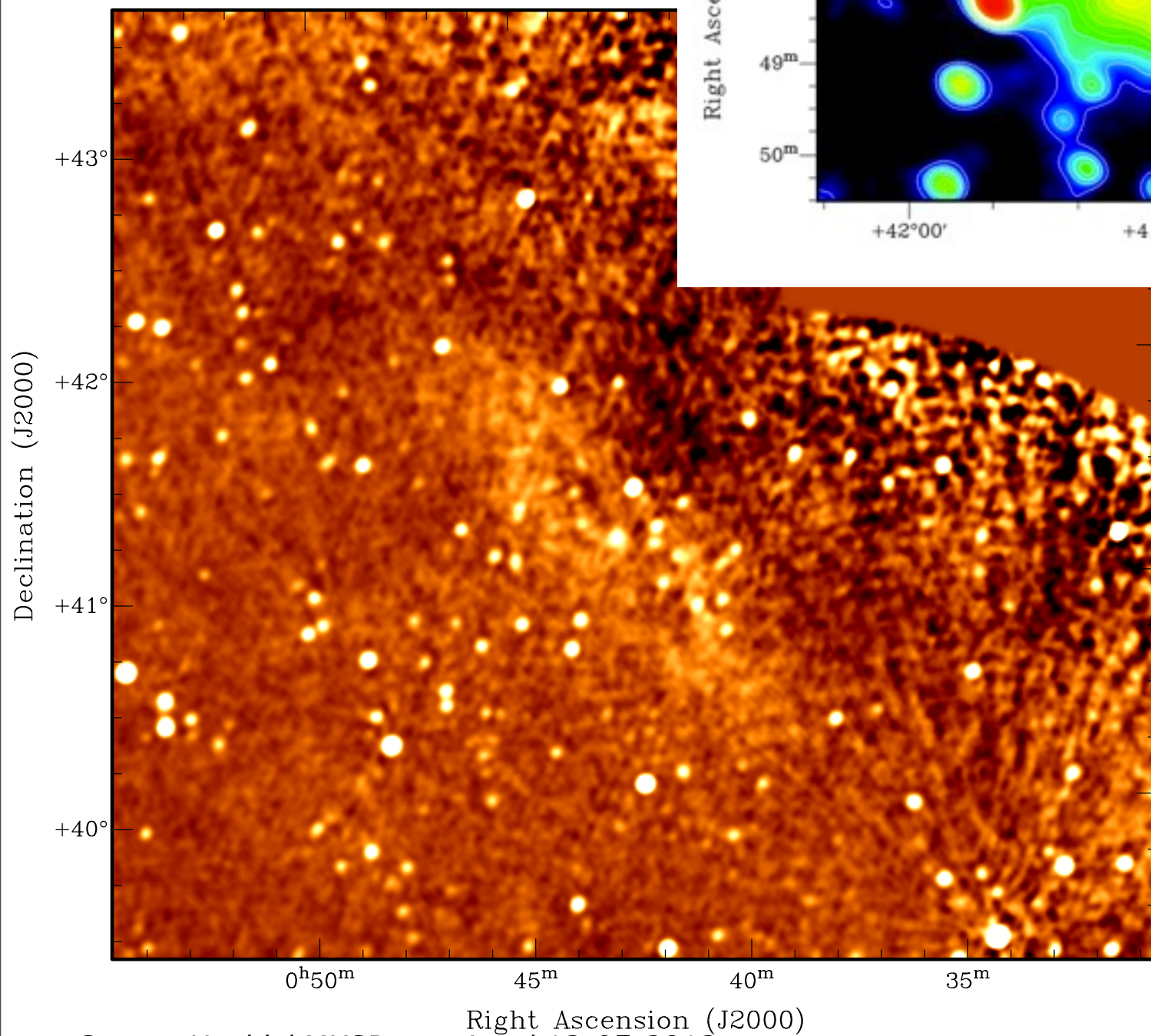


## ■ NGC 315





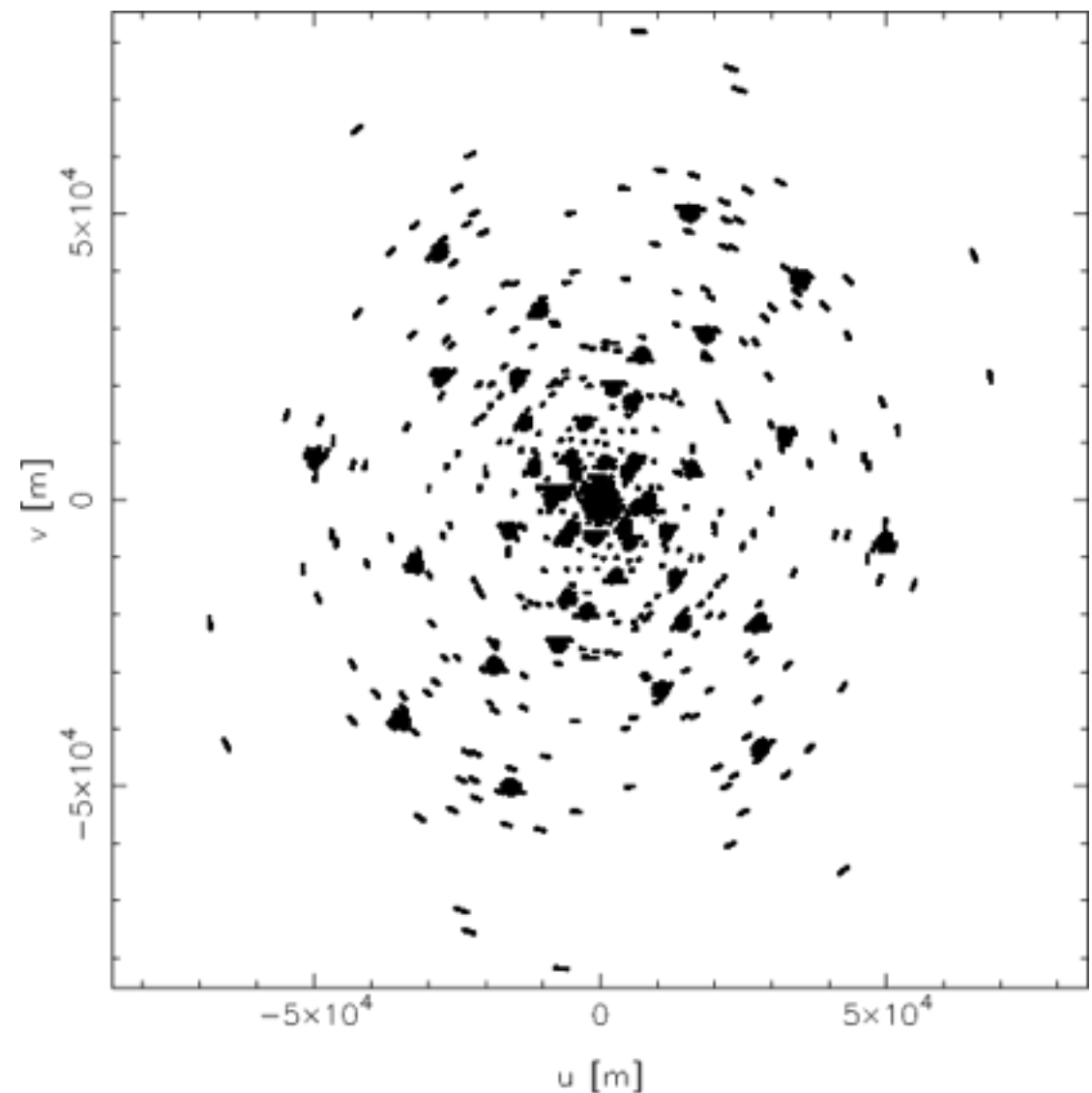
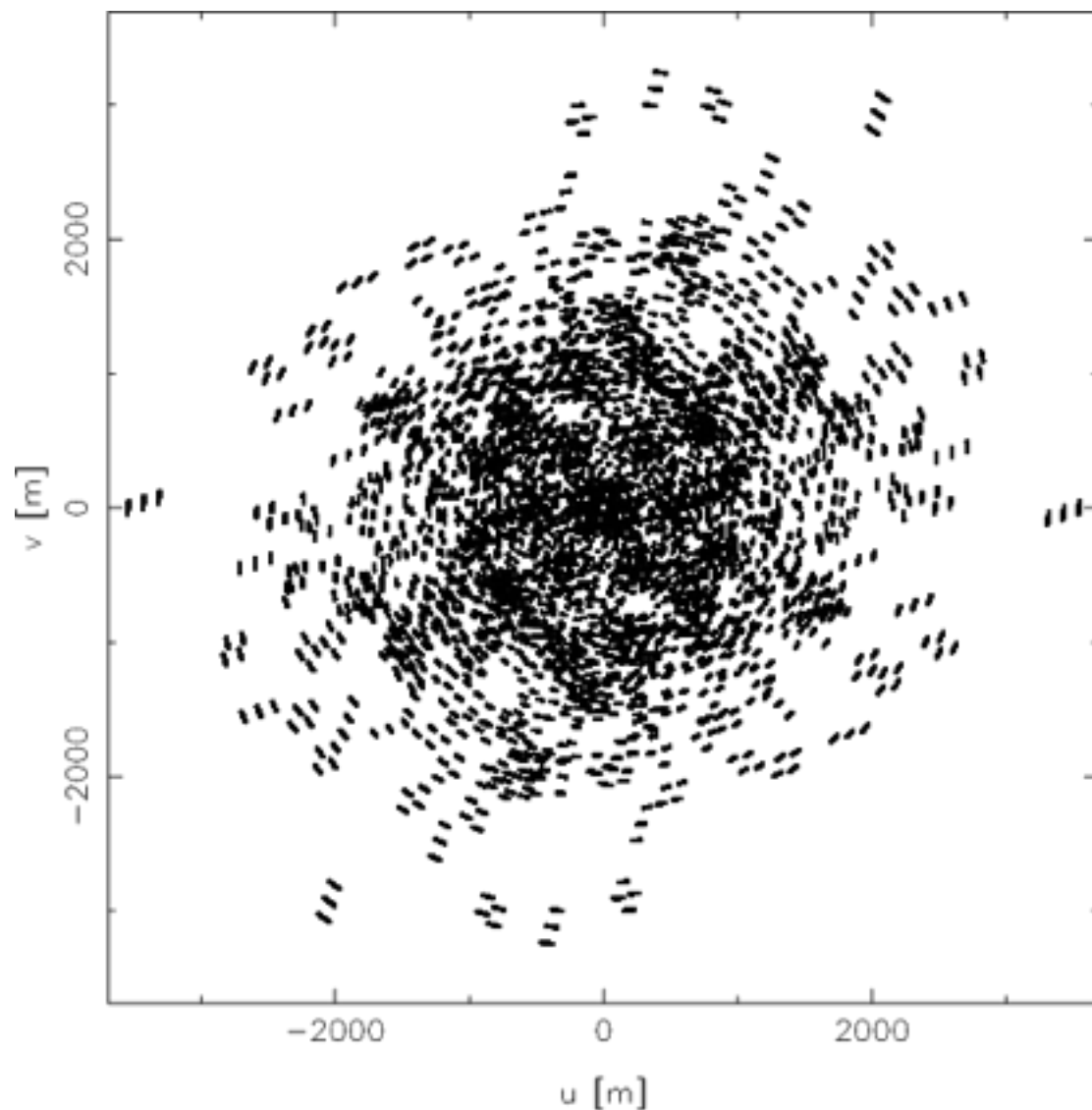
- M31



Gießübel et al (submitted)



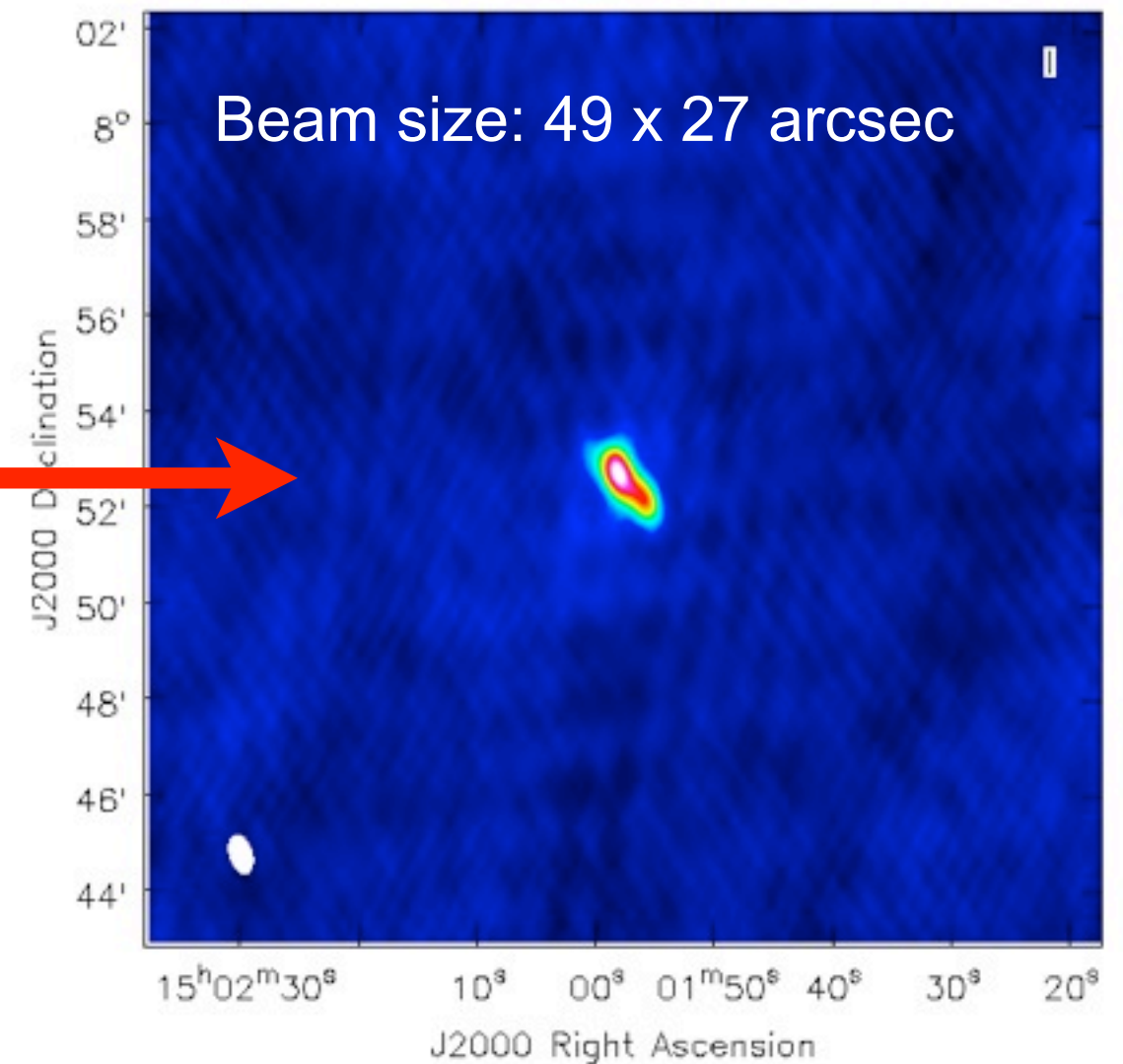
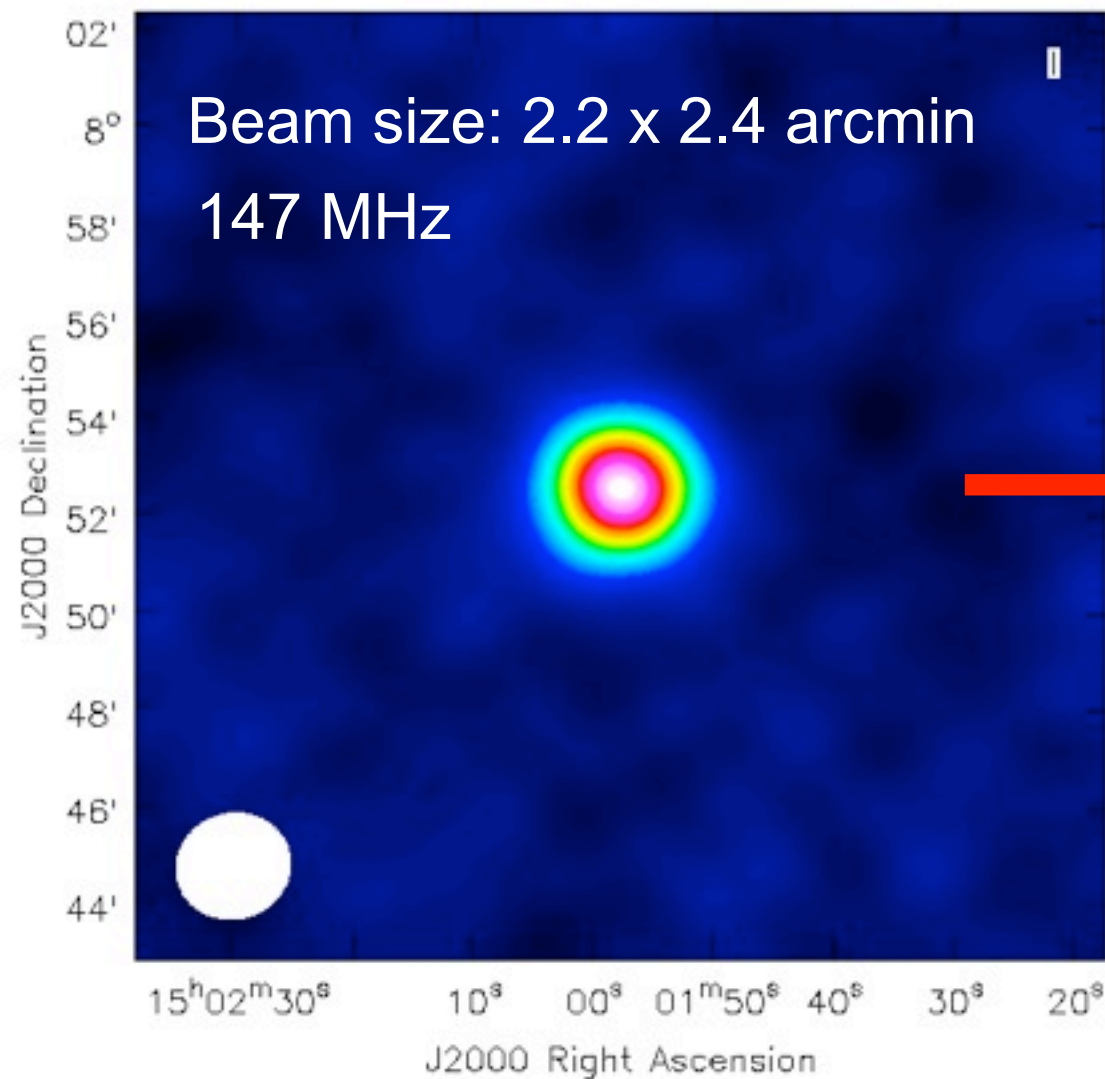
- Longer baselines are present in the data and are calibrated
- Higher resolution images of selected sources/fields can be produced if compute time available for the imaging (and should lead to an updated MSSS after the first data release)







4C +08.43

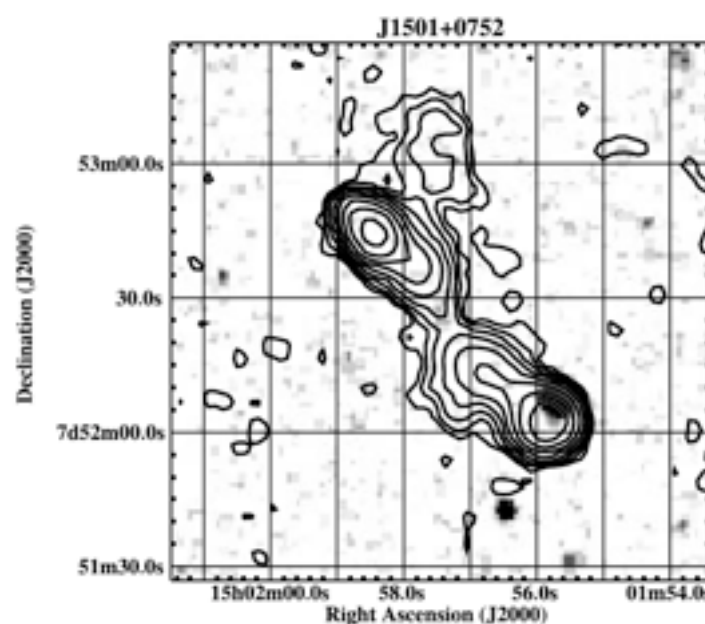
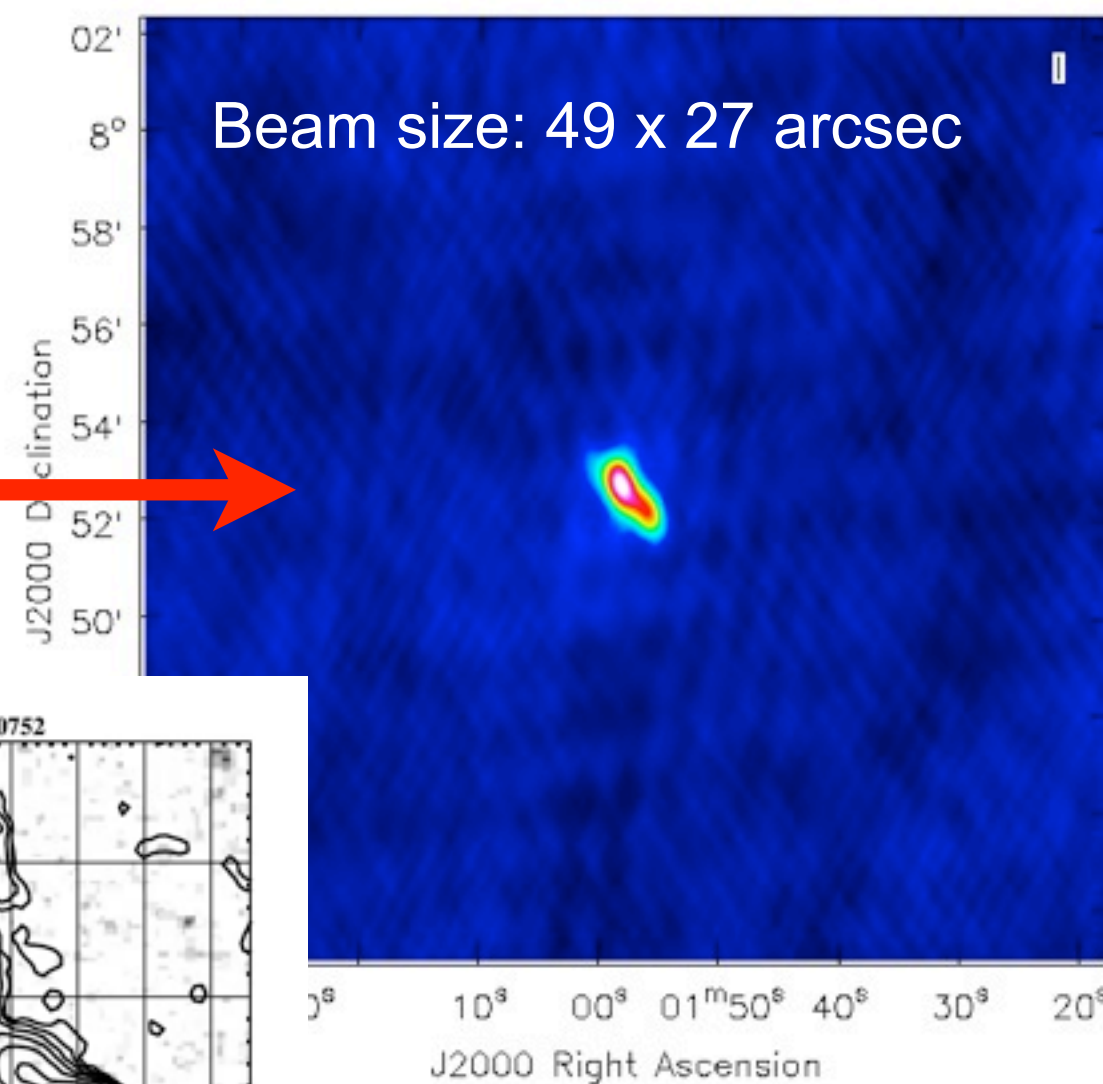
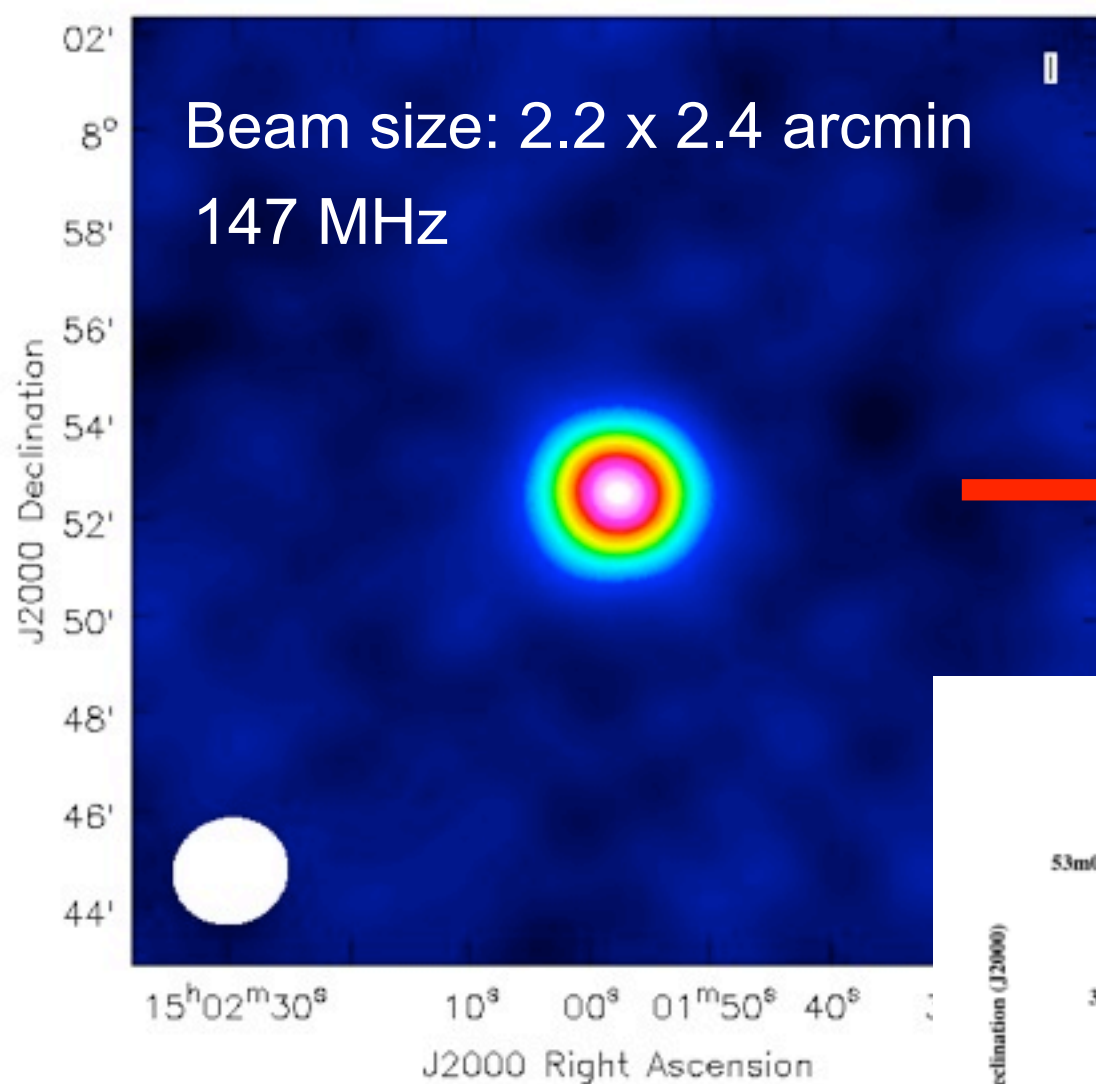


**McKean**



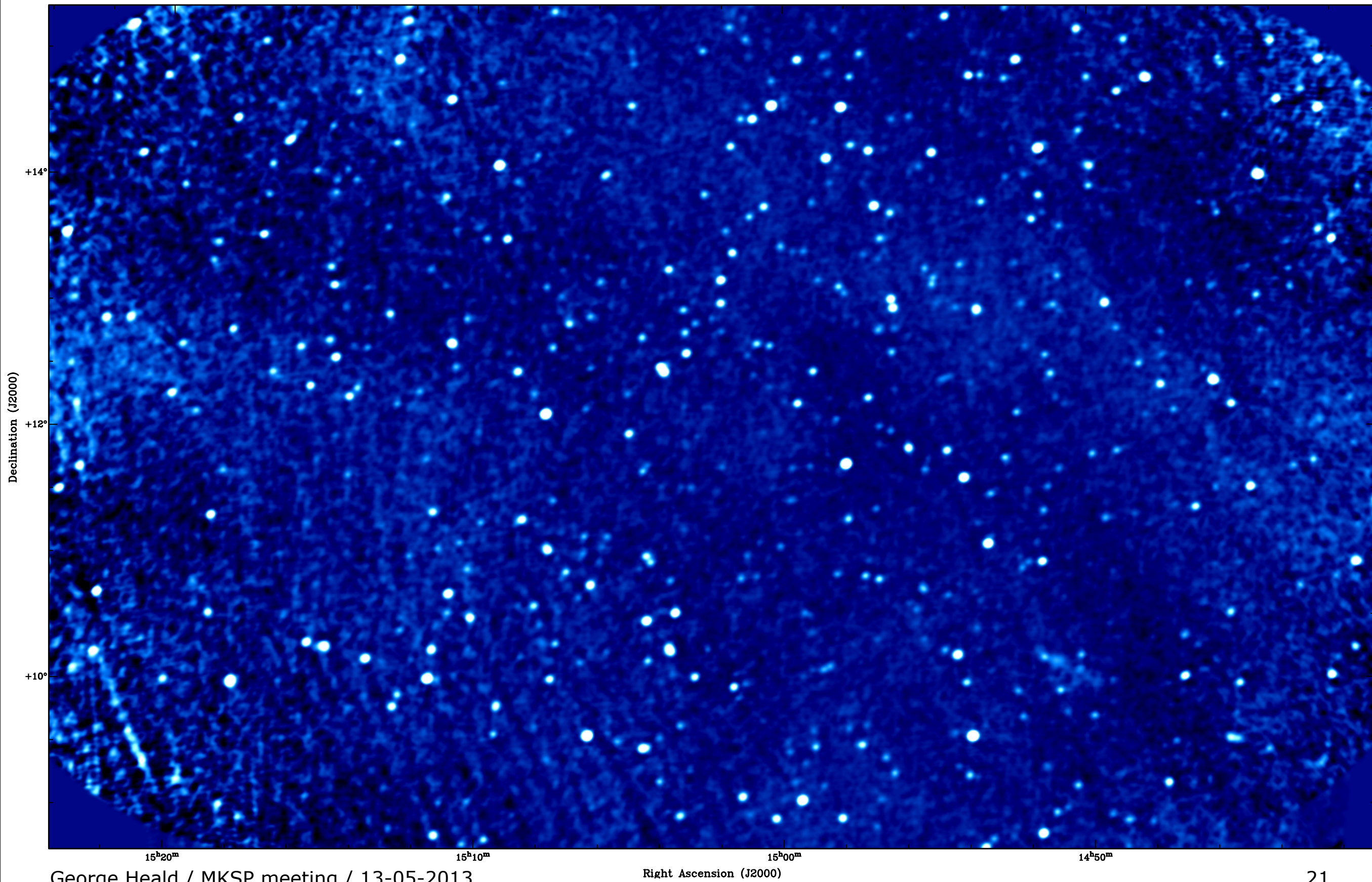


4C +08.43



**McKean**





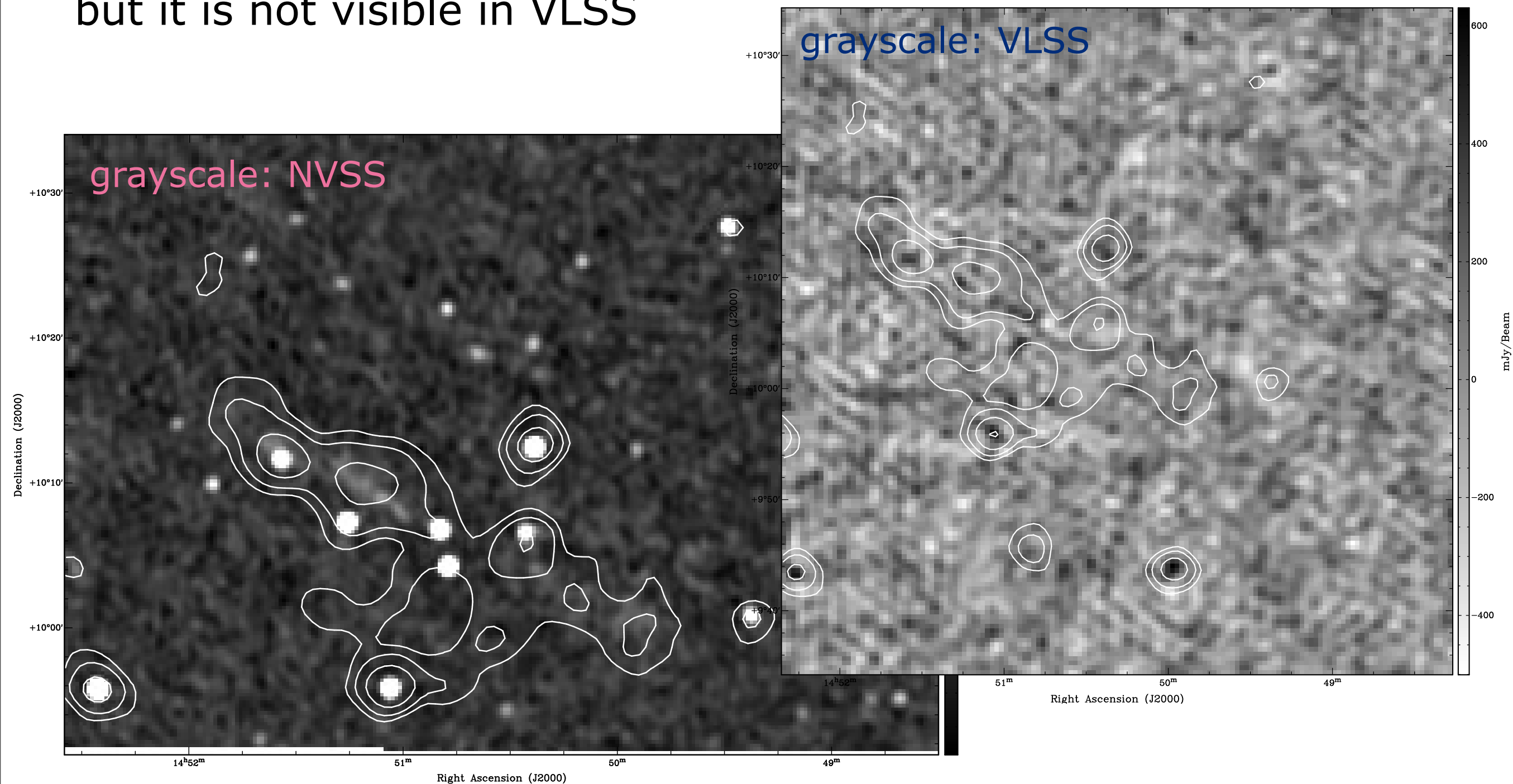


- Extended ( $\sim 36'$ ) source centered on flat-spectrum radio source coincident with one member ( $z=0.054536$ ) of a galaxy triplet



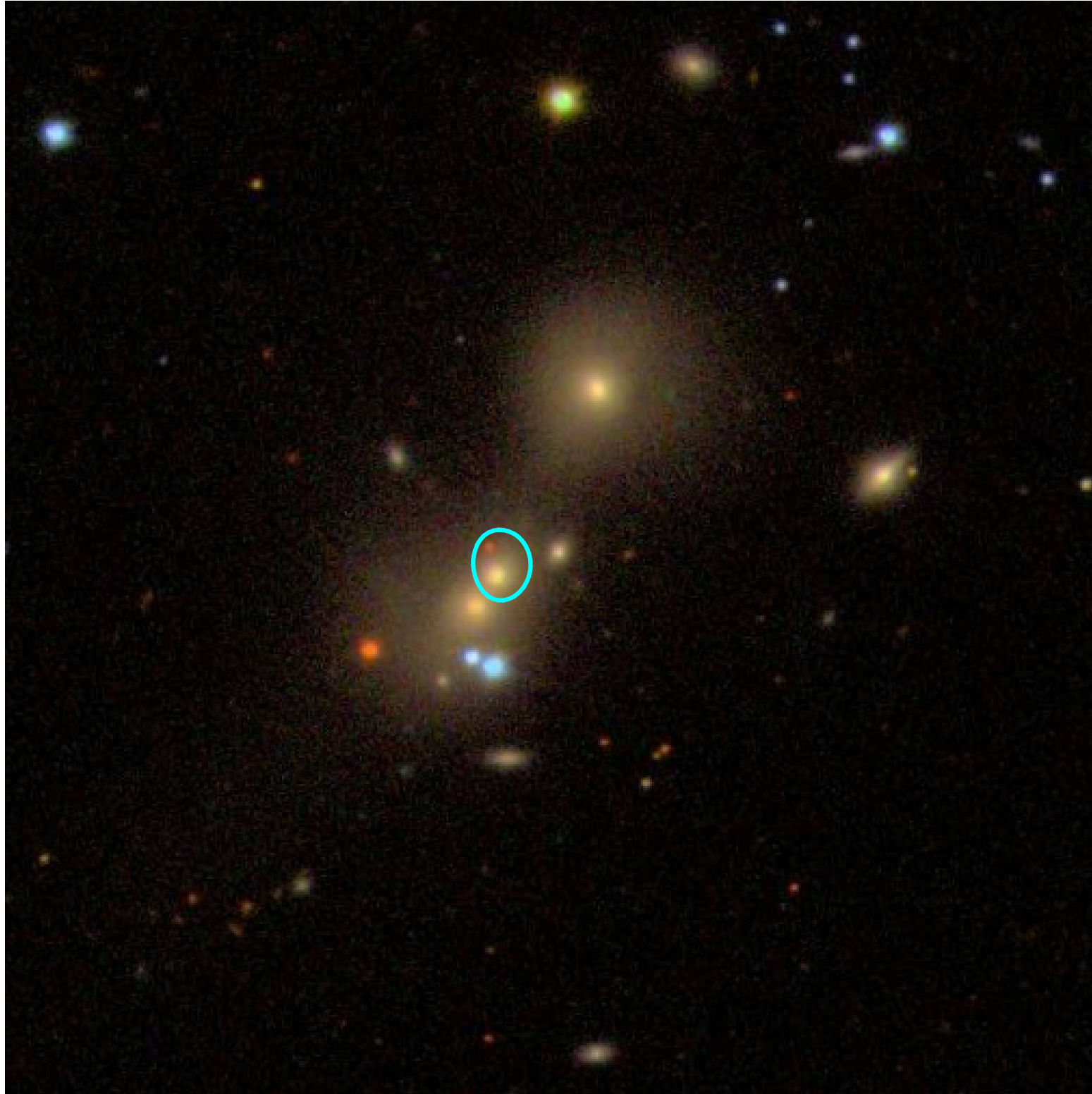


- Faint flux visible in NVSS postage stamp - brightest emission has a steep spectral index between 140 and 1400 MHz ( $\alpha \sim -1.2$ ) but it is not visible in VLSS

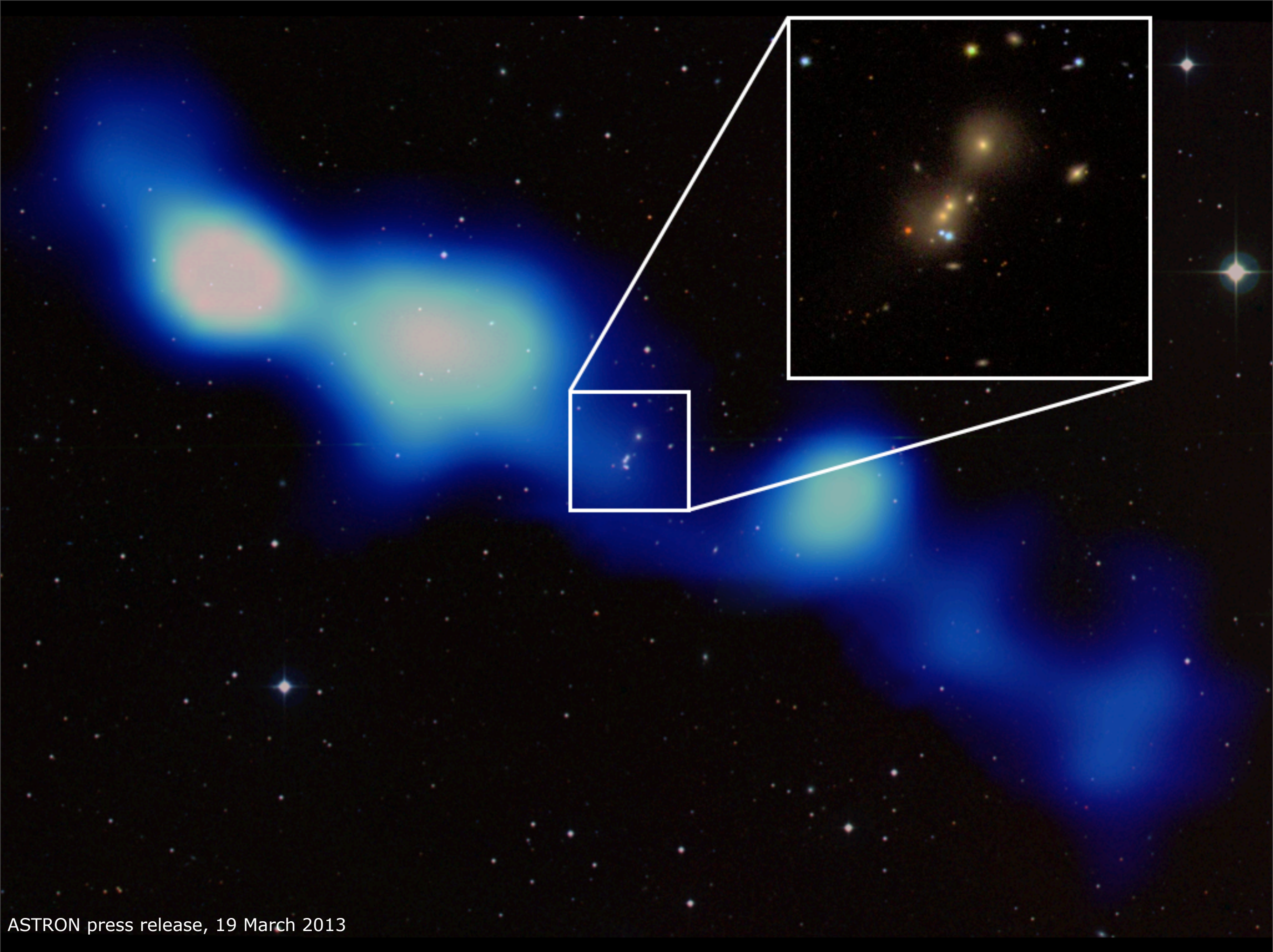




- UGC 9555 (Galaxy triplet);  $z=0.05$  (+NVSS 48 mJy/beam contour)





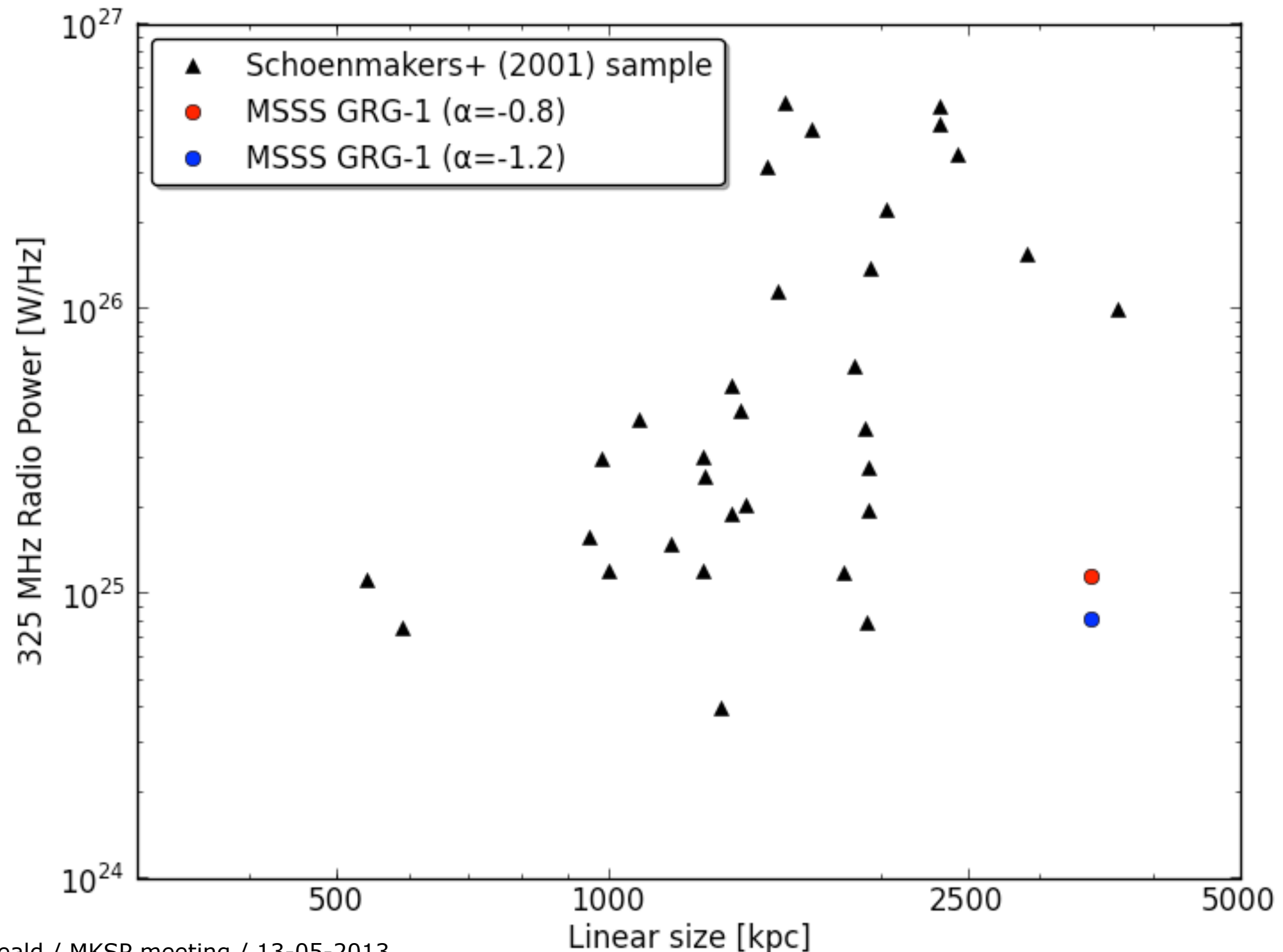


ASTRON press release, 19 March 2013

mercoledì 29 maggio 13

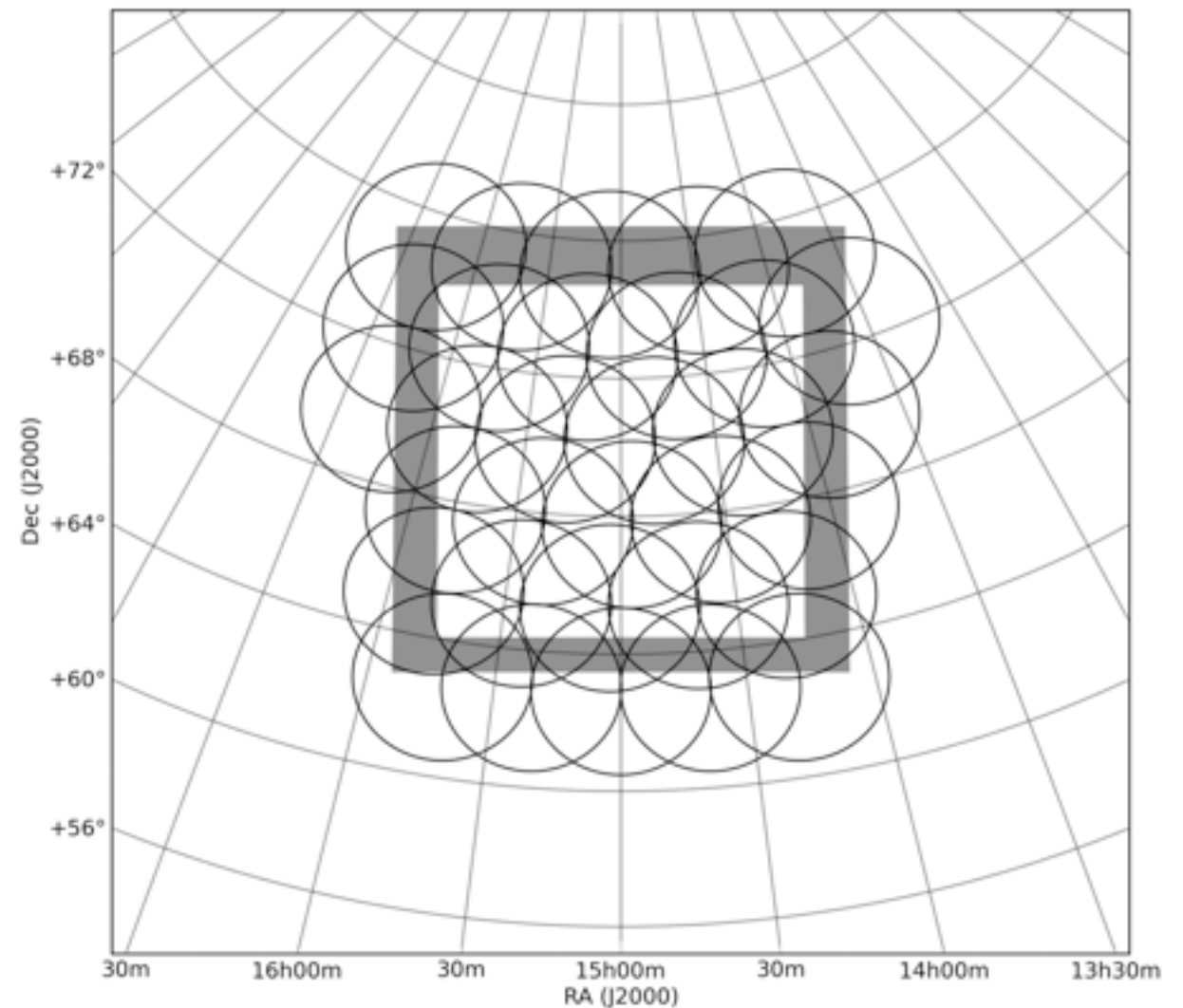
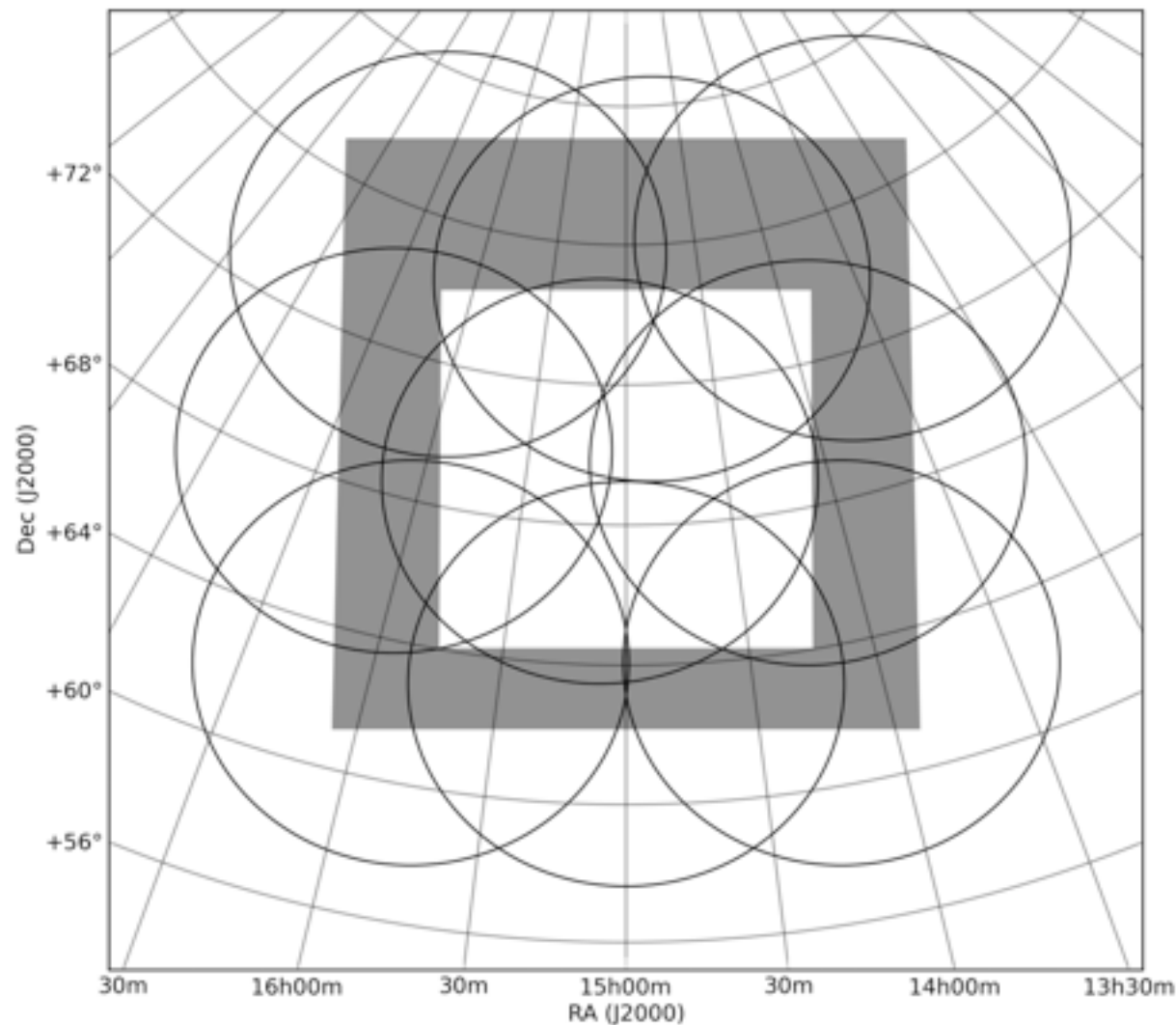


- Identified as a GRG associated with the flat-spectrum NVSS source



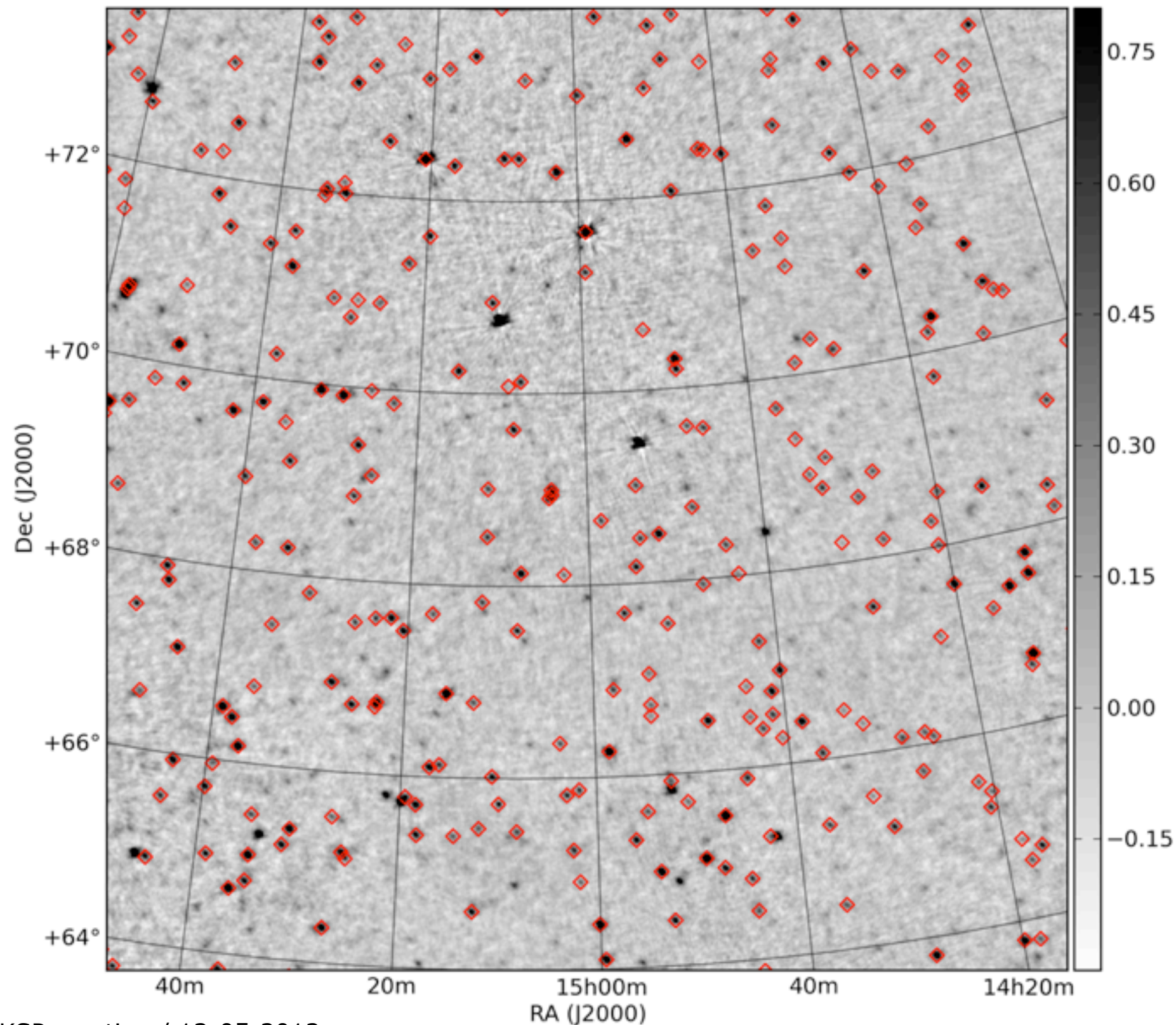


- Mosaics formed from 9 LBA fields and 32 HBA fields



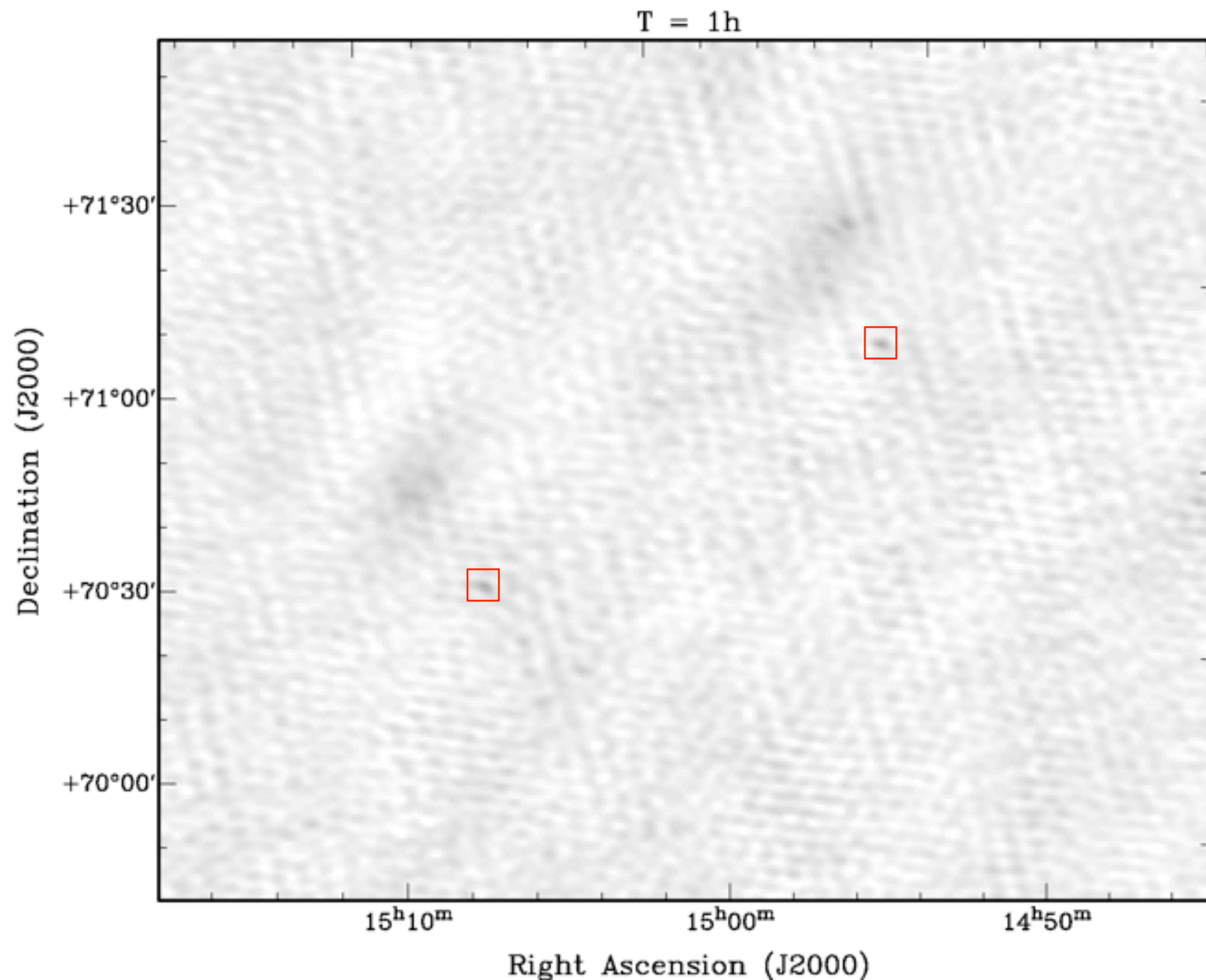


- LBA 46 mJy/beam, 2' resolution



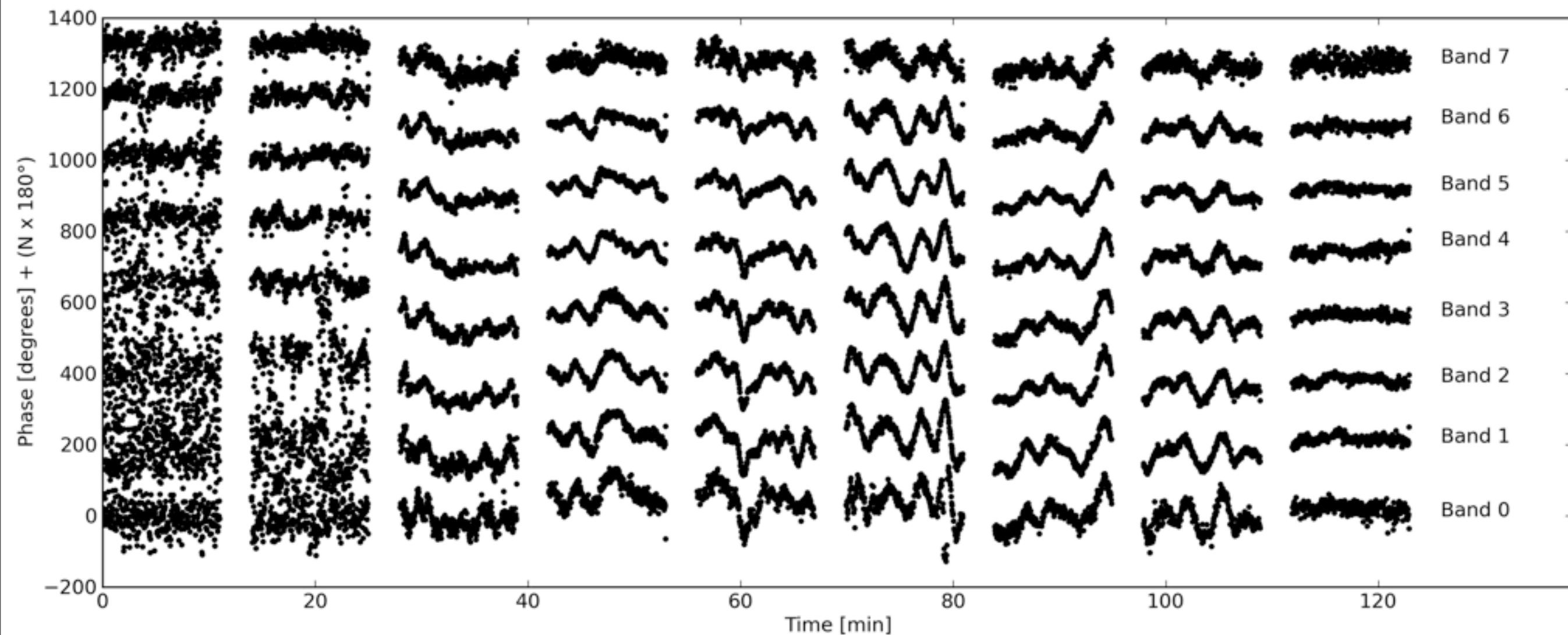


- Sequence of 9 snapshot (11 min each) images @ 31 MHz
- Direction-independent calibration before imaging



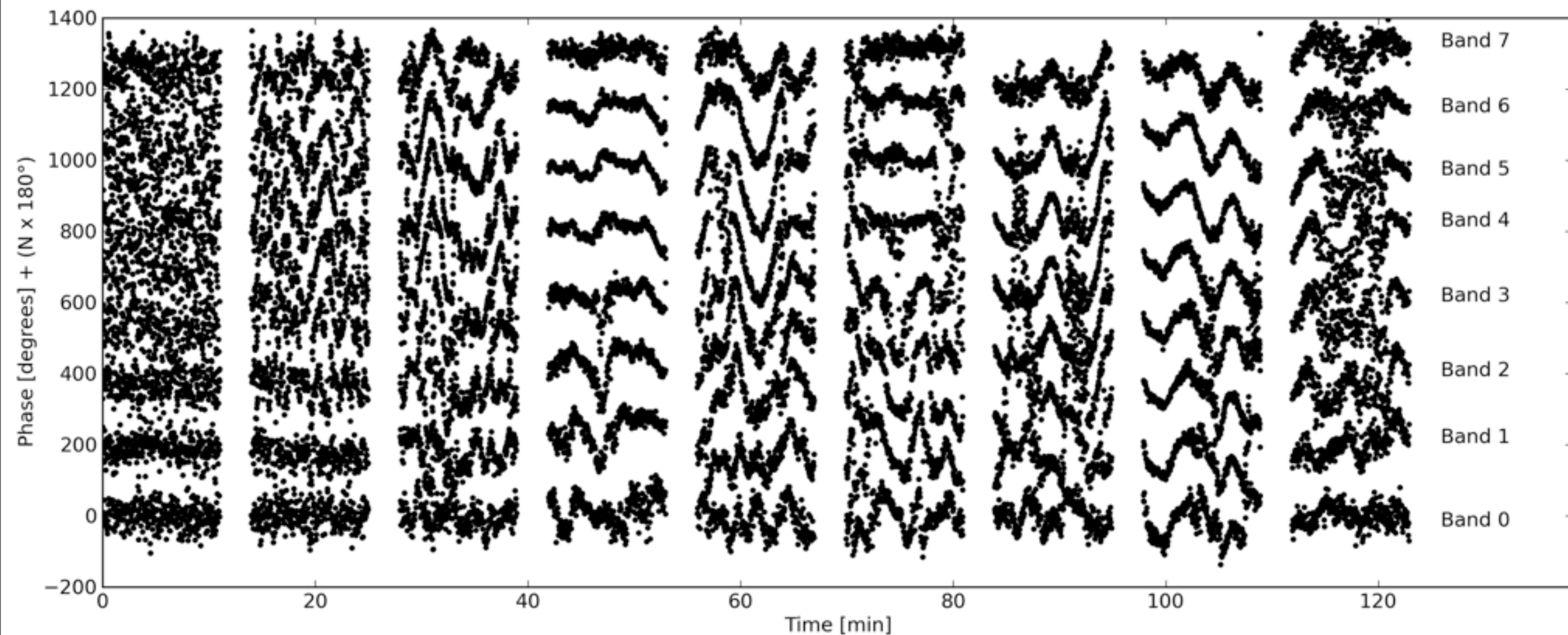


- Clear from phase solutions which snapshots are most strongly affected
- Shown here: CS302LBA (referenced to CS002LBA)



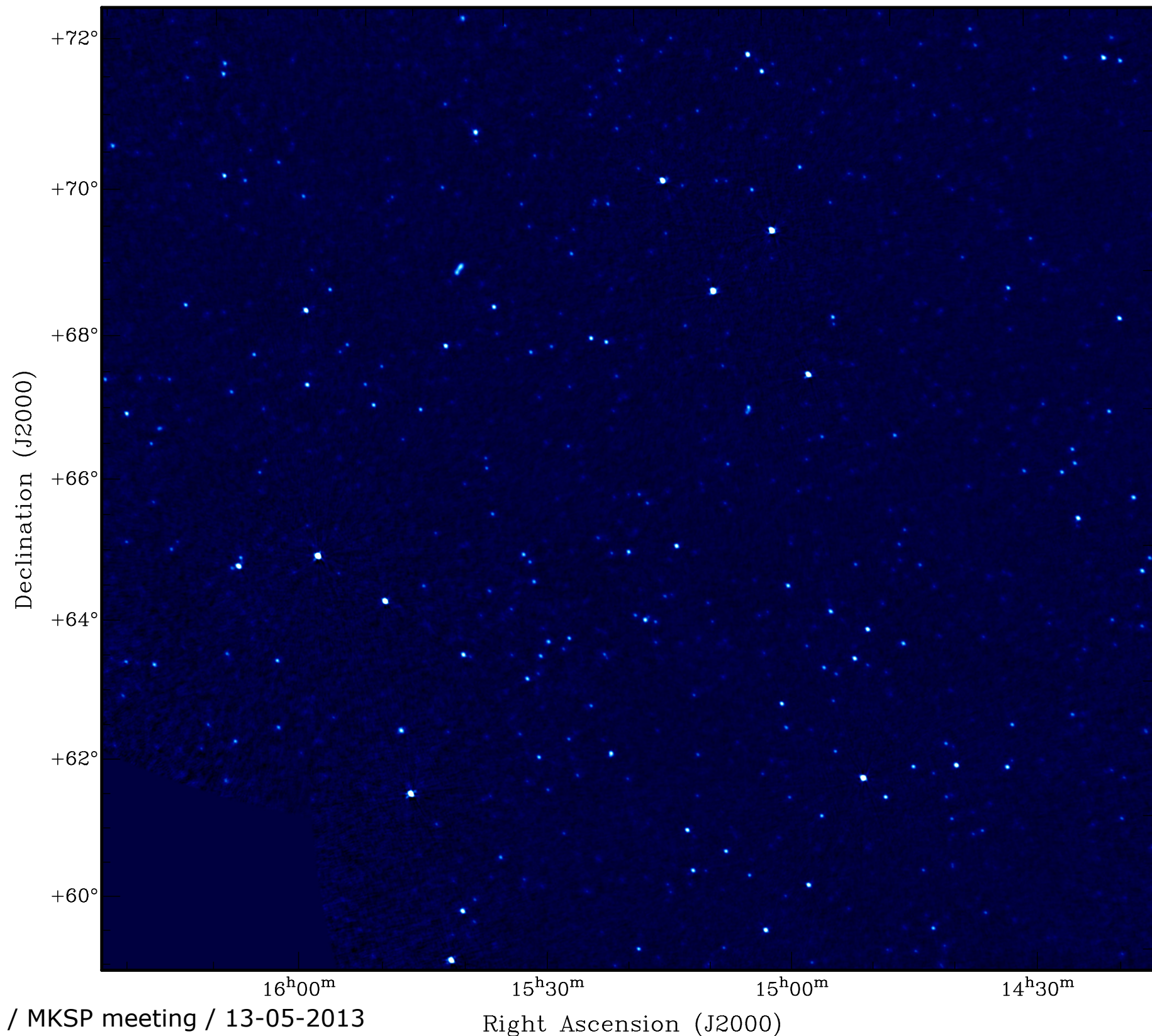


- Clear from phase solutions which snapshots are most strongly affected
- Shown here: RS306LBA (referenced to CS002LBA)



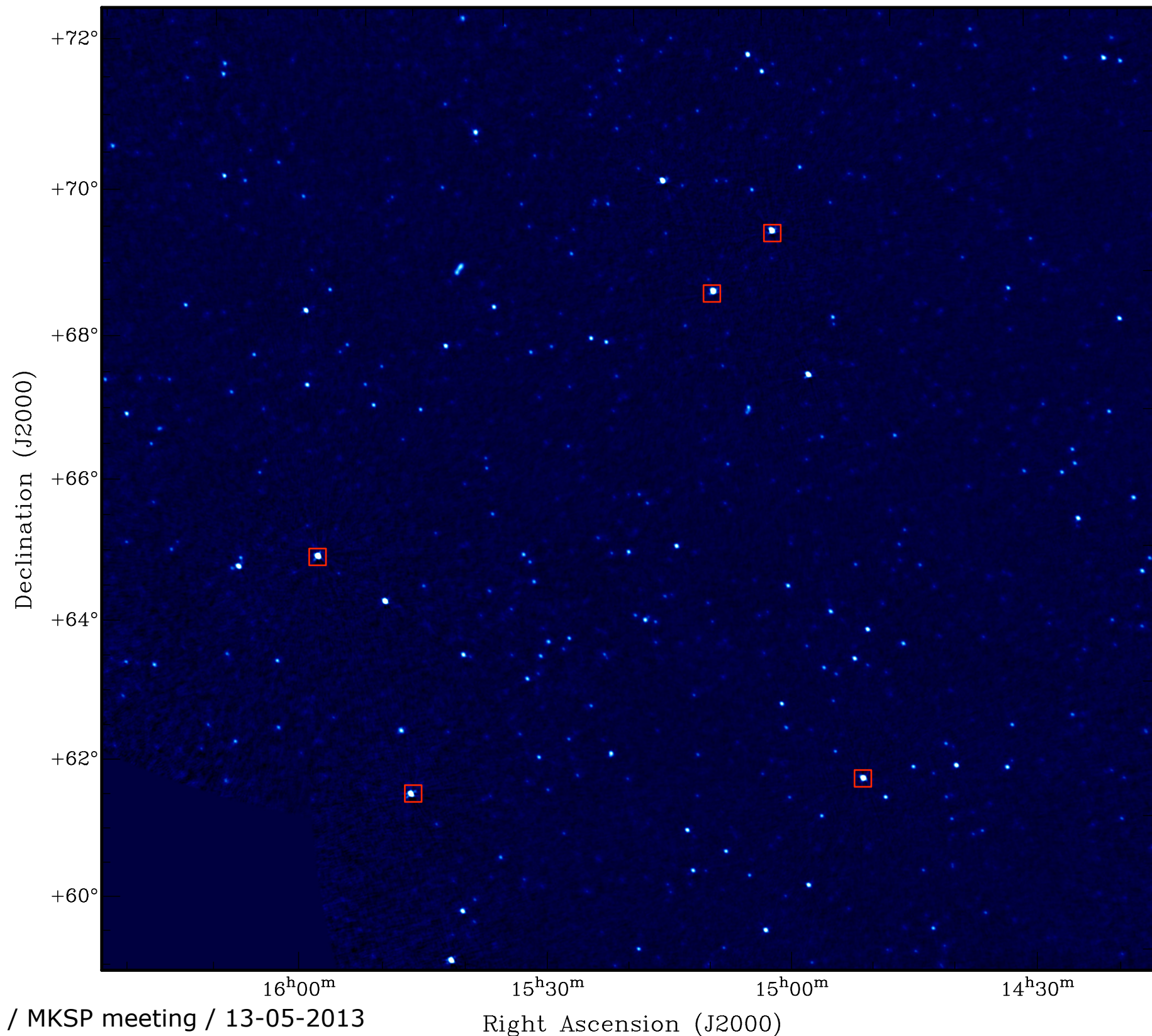


- Using MSSS "peeling" script; 5 sources used for DirectionalGains



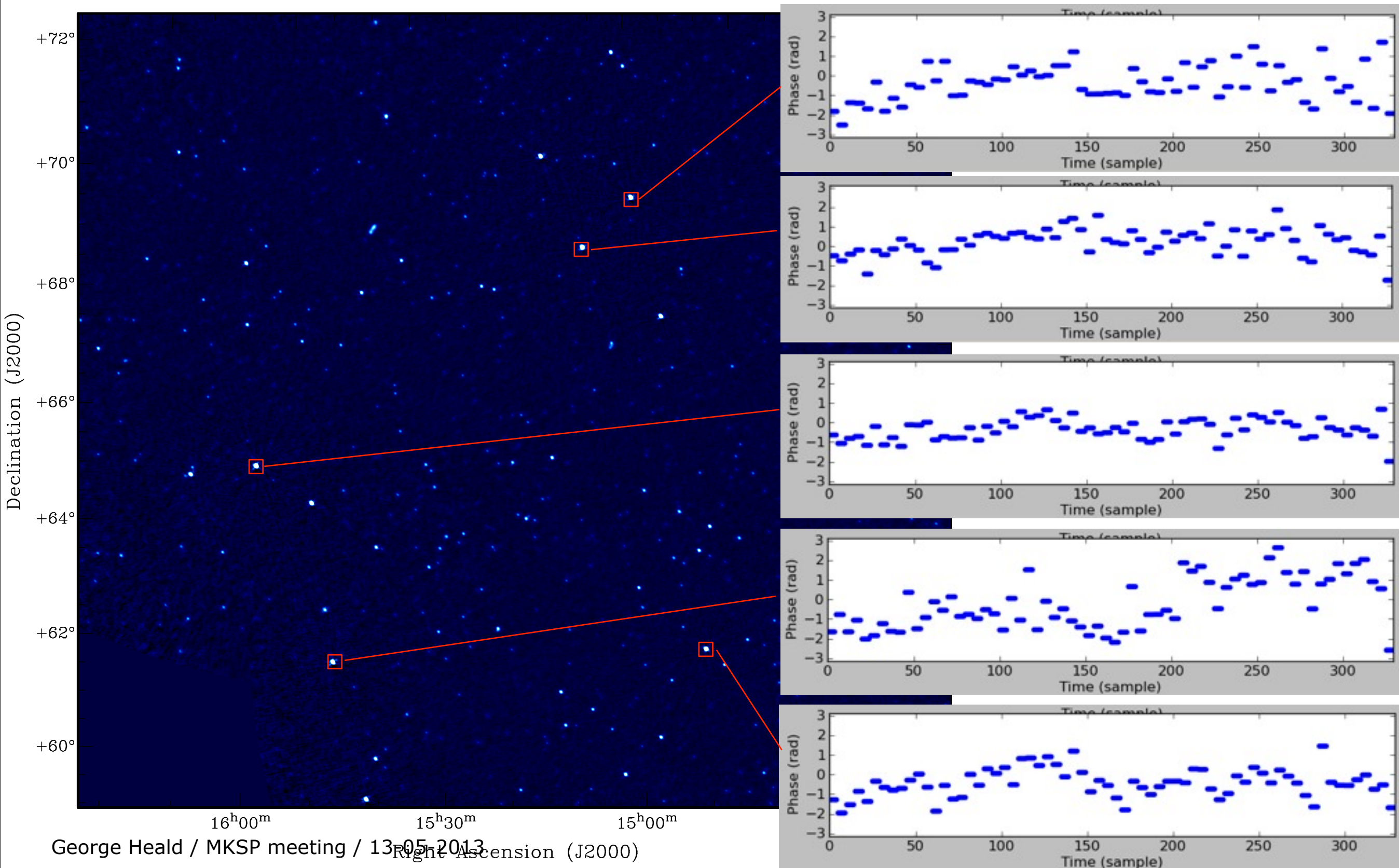


- Using MSSS "peeling" script; 5 sources used for DirectionalGains



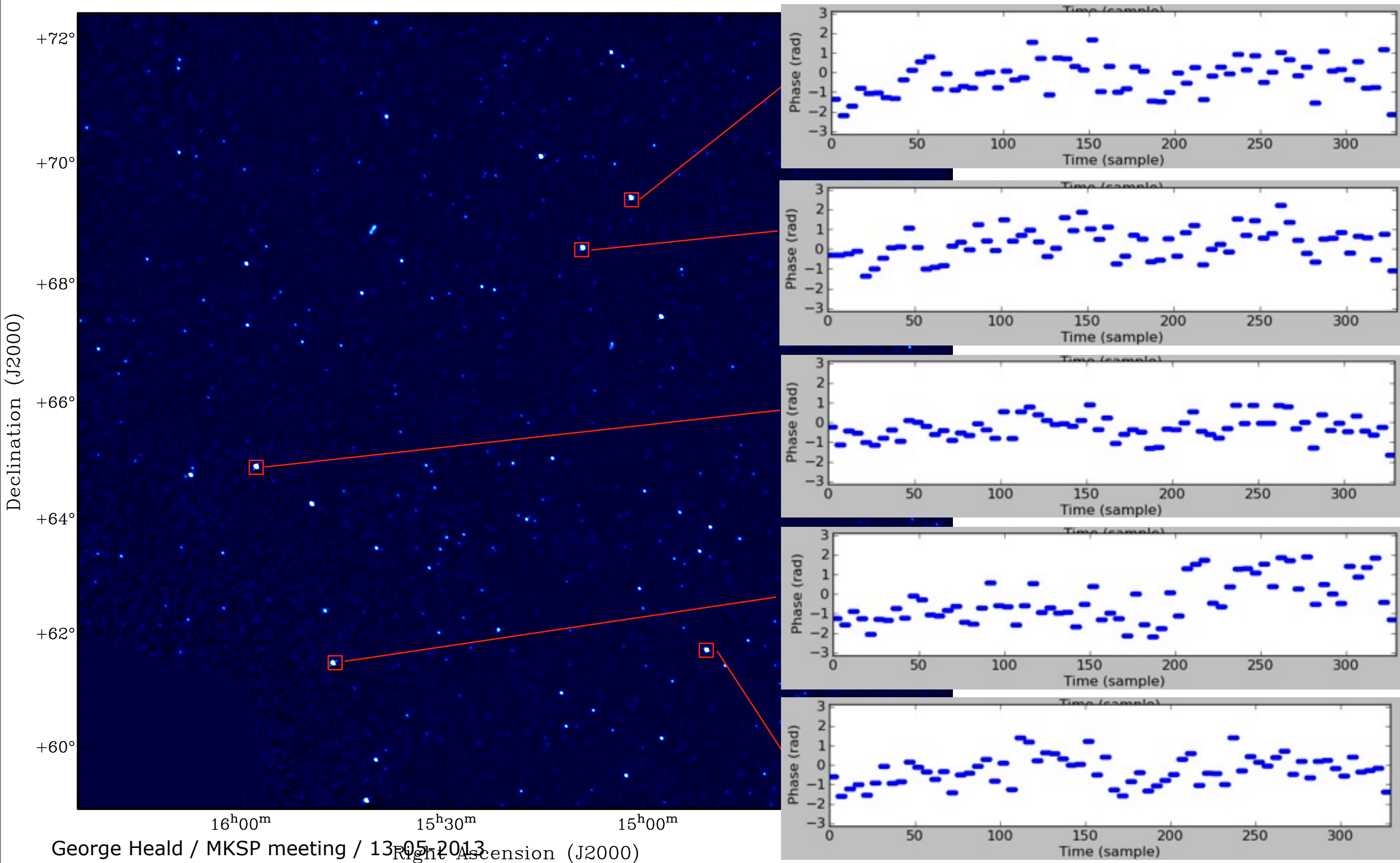


- CS302 DG:0:0 solutions (referenced to CS002)



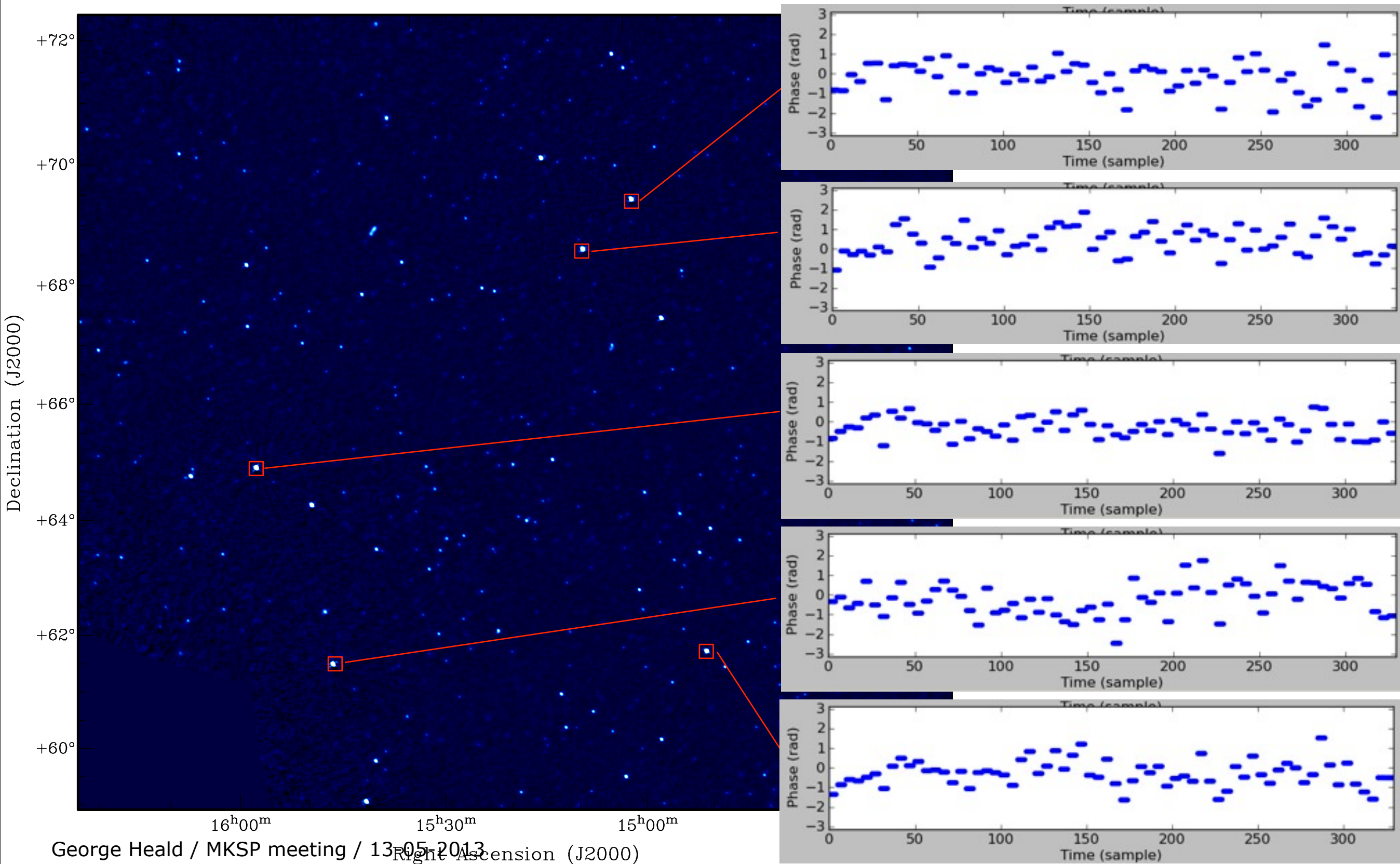


- CS302 DG:1:1 solutions (referenced to CS002)



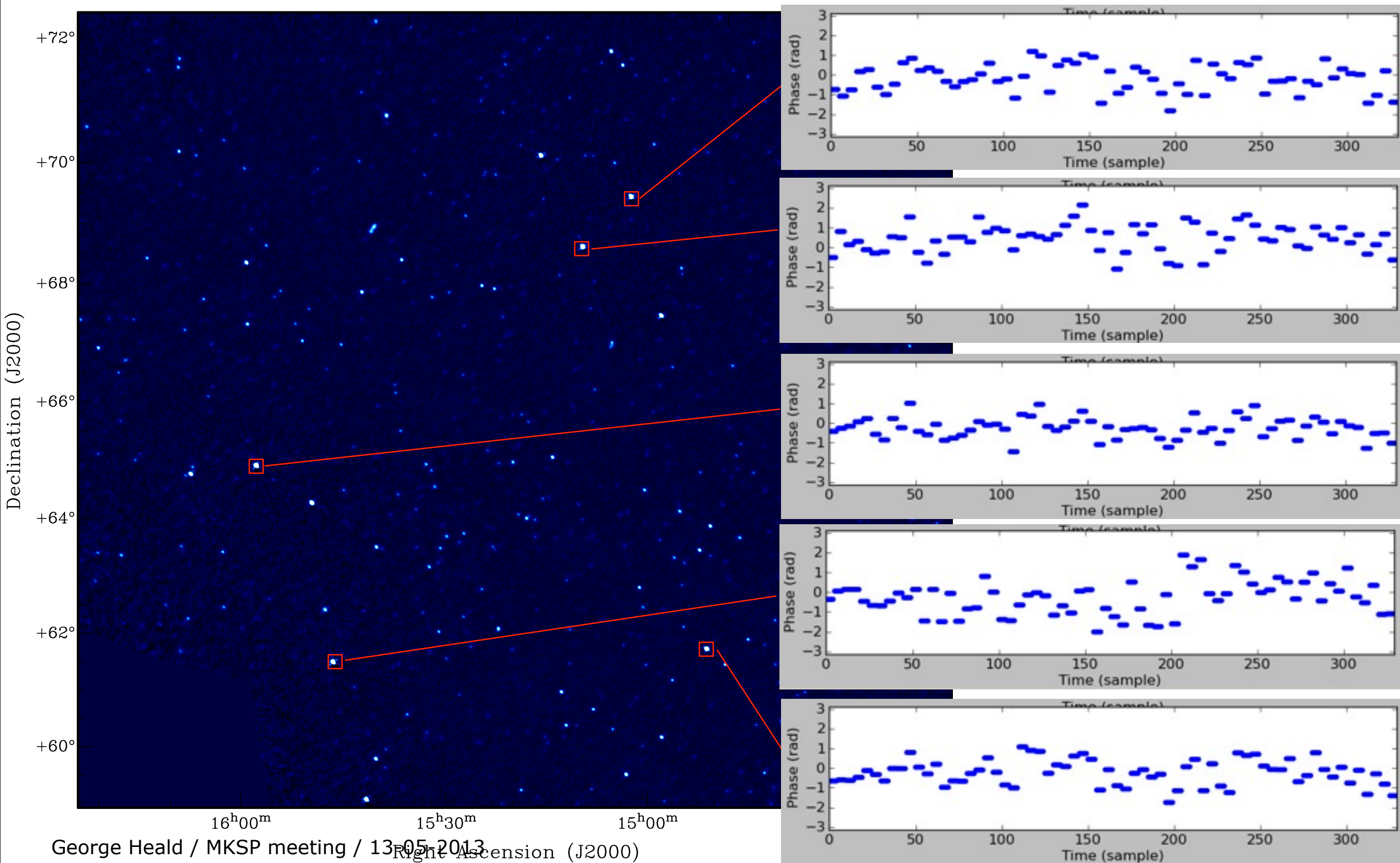


- RS306 DG:0:0 solutions (referenced to CS002)

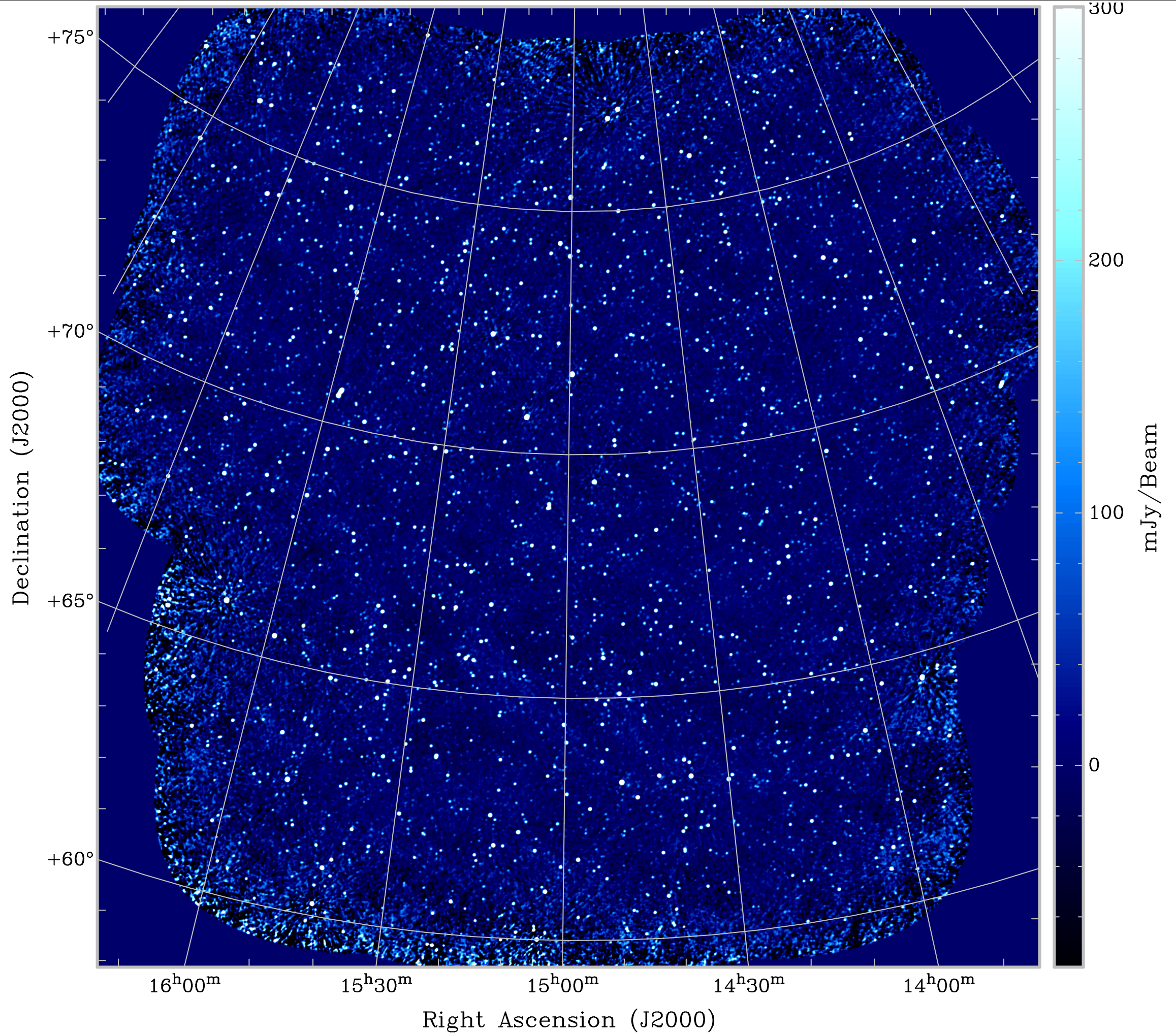




- RS306 DG:1:1 solutions (referenced to CS002)

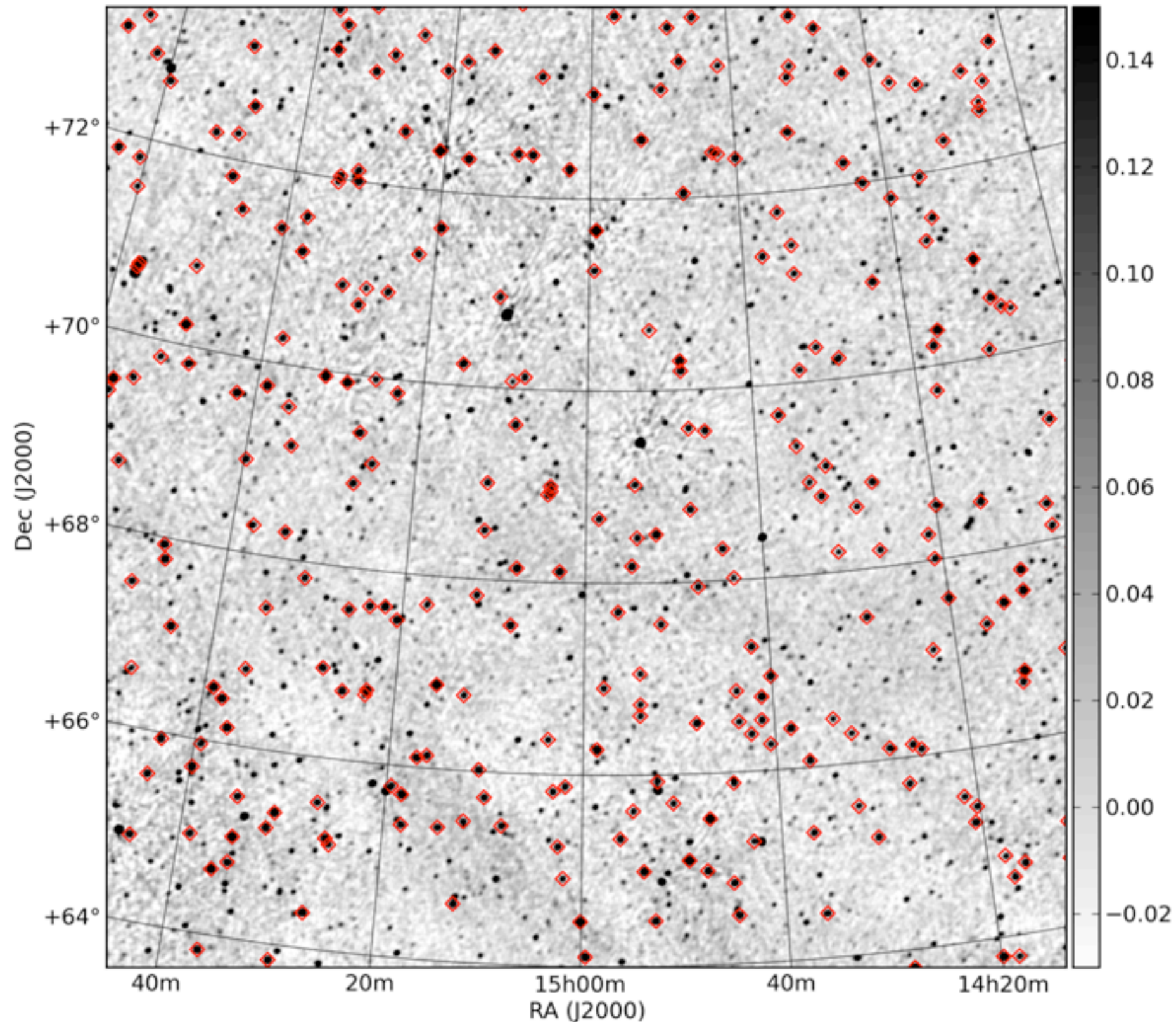






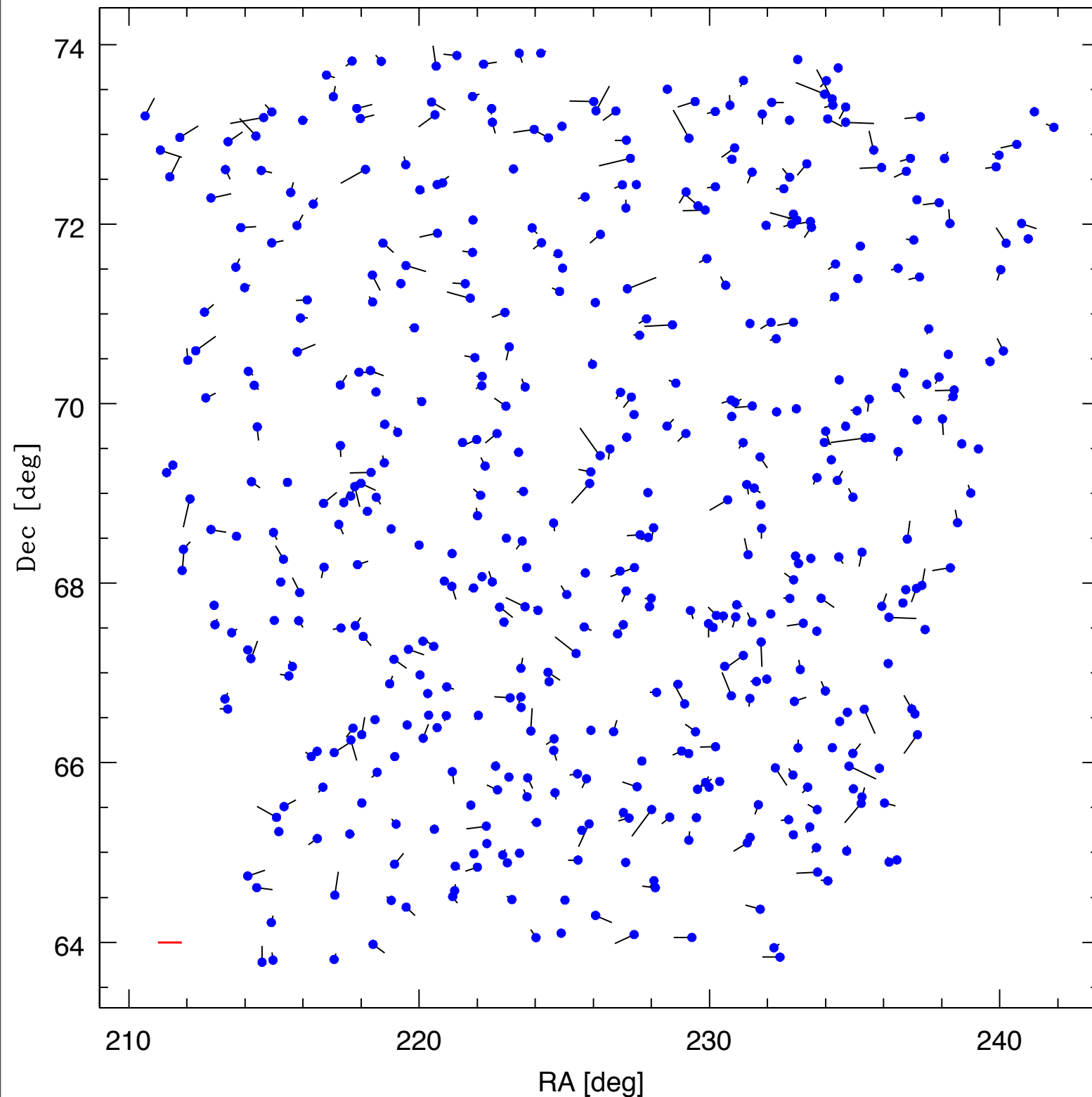


- HBA 11 mJy/beam, 2' resolution





- Currently focused on producing MVF mini-catalog for public release

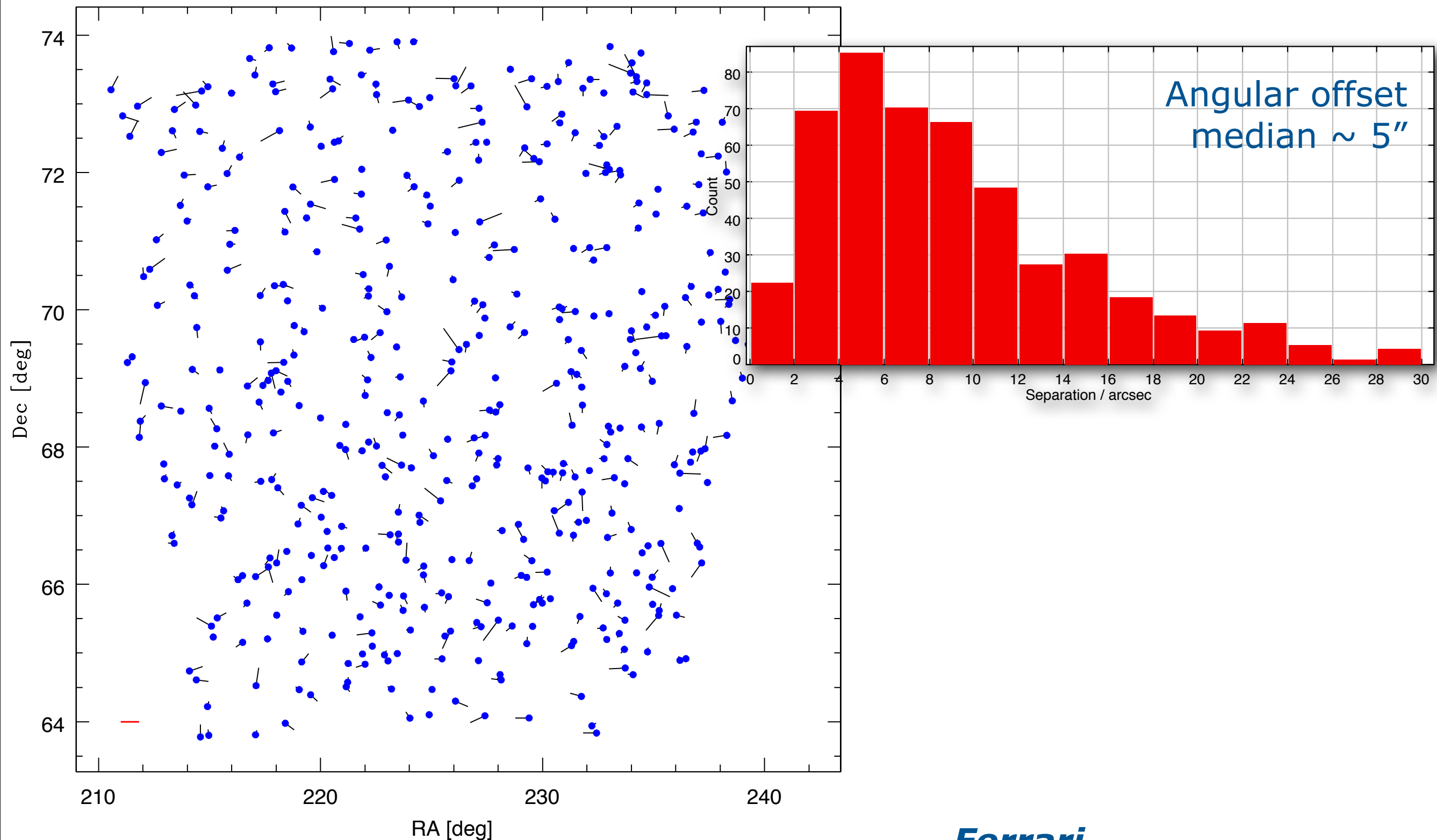


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*Ferrari*

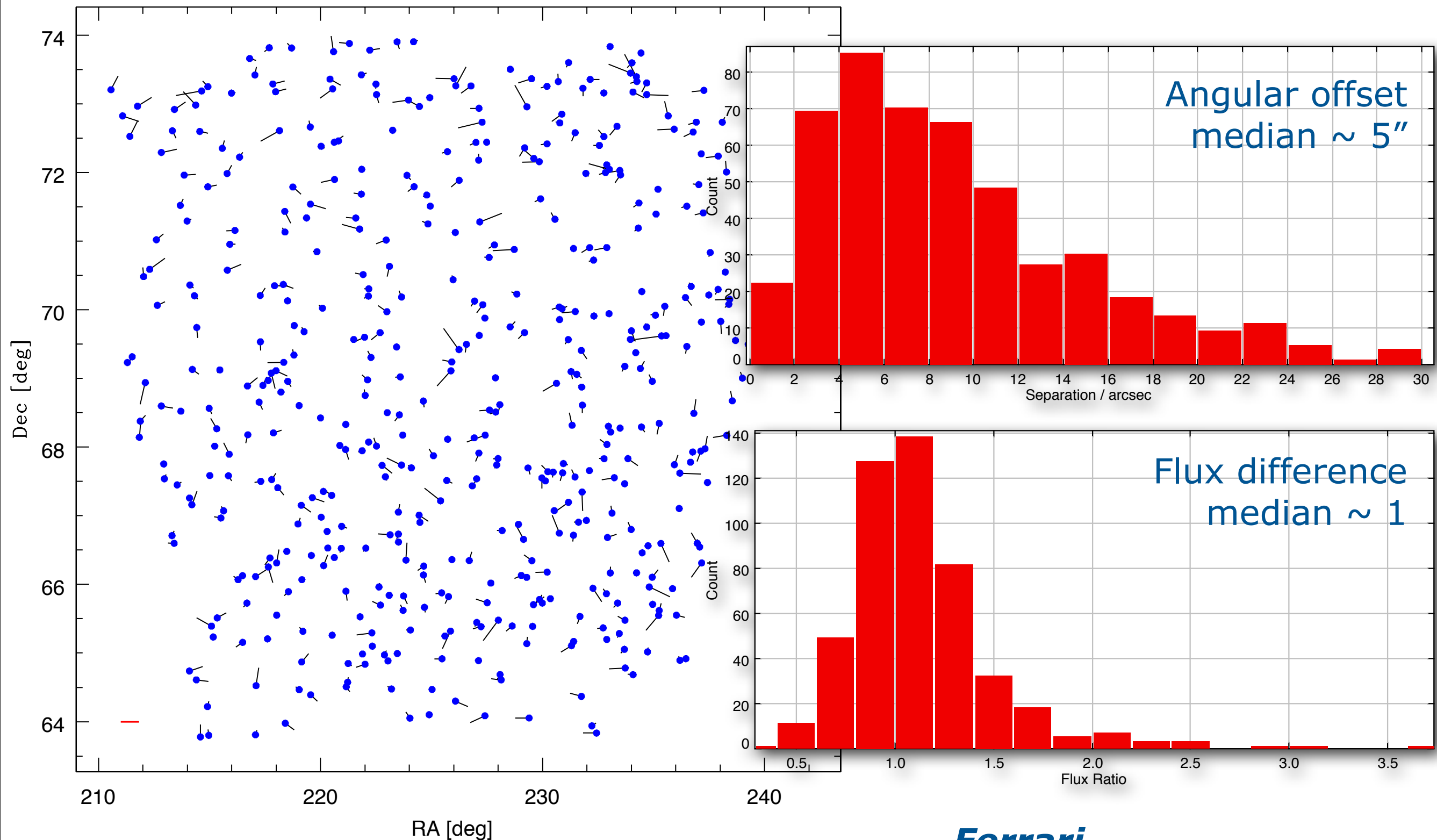


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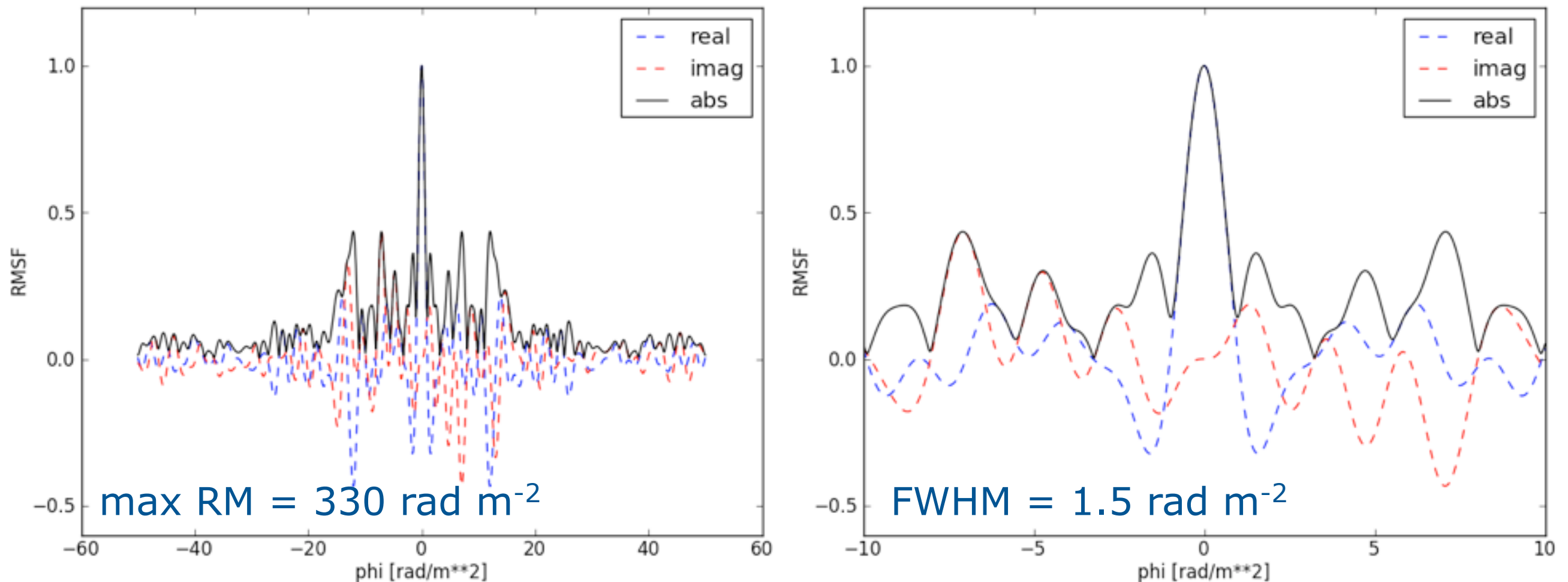
*Ferrari*



- Release MVF mini-catalog mid 2013 (together with publication of MSSS overview journal article)
- Complete MSSS-HBA observations (projected June 2013)
  - Processing & imaging keeps up with observations
  - Production of HBA catalog and QC phase
  - Release of HBA catalog projected late 2013
- Resume MSSS-LBA observations
  - Ionospheric situation needs additional effort
  - Release of LBA catalog likely 2014
- As (computing) time allows, re-processing and imaging to allow higher angular resolution survey products
- RM Synthesis .... ?



- Frequency coverage in HBA allows for shallow polarization search



- Imaging step needs work:
  - awimager “channel” mode does not work (?)
  - casa imager does not apply beams
- Preliminary images made (Fan region) but further testing needed (during busy days?!) - field around PSR B1937+21 is observed!