LOFAR observations of Abell 1682

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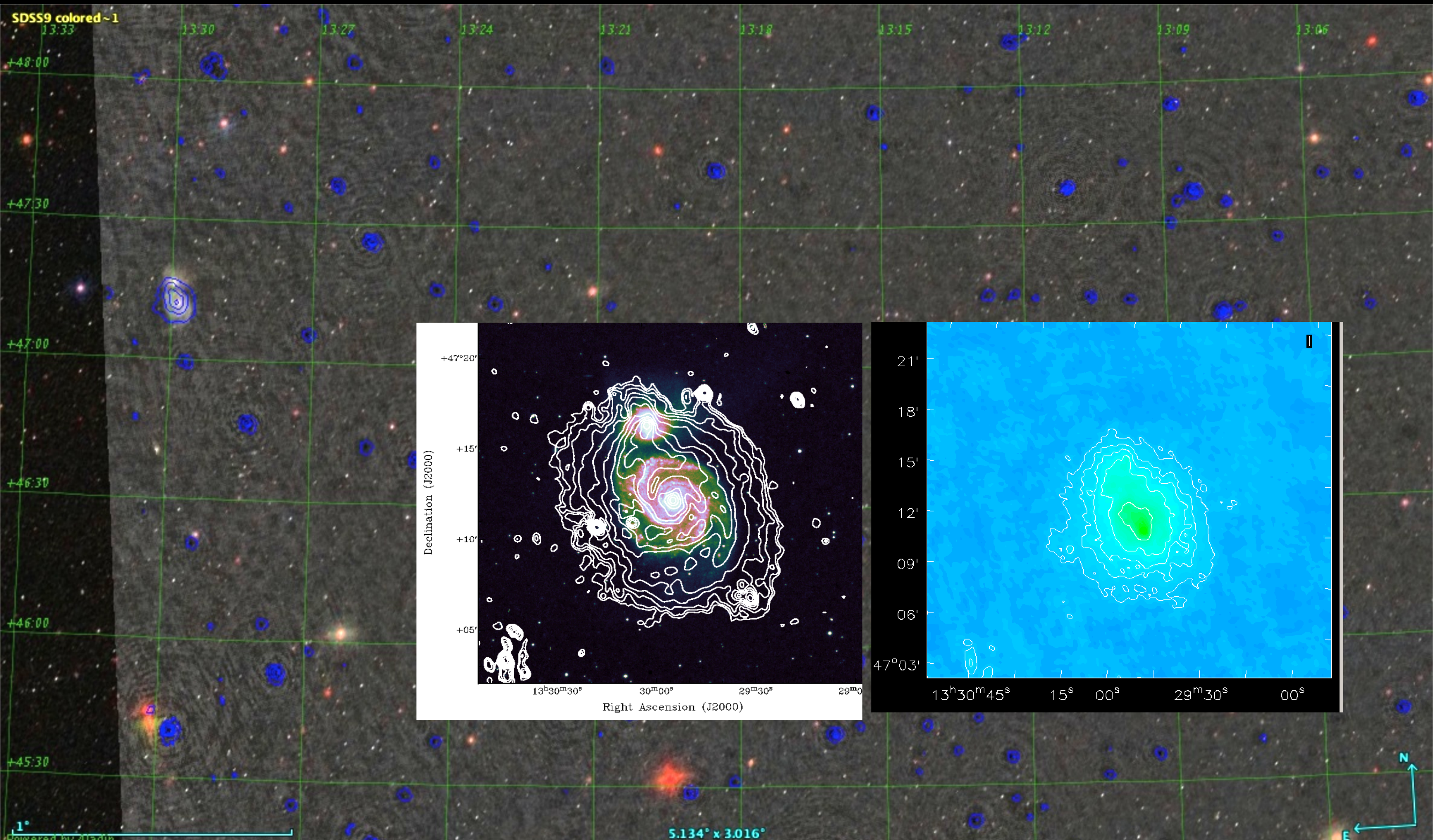
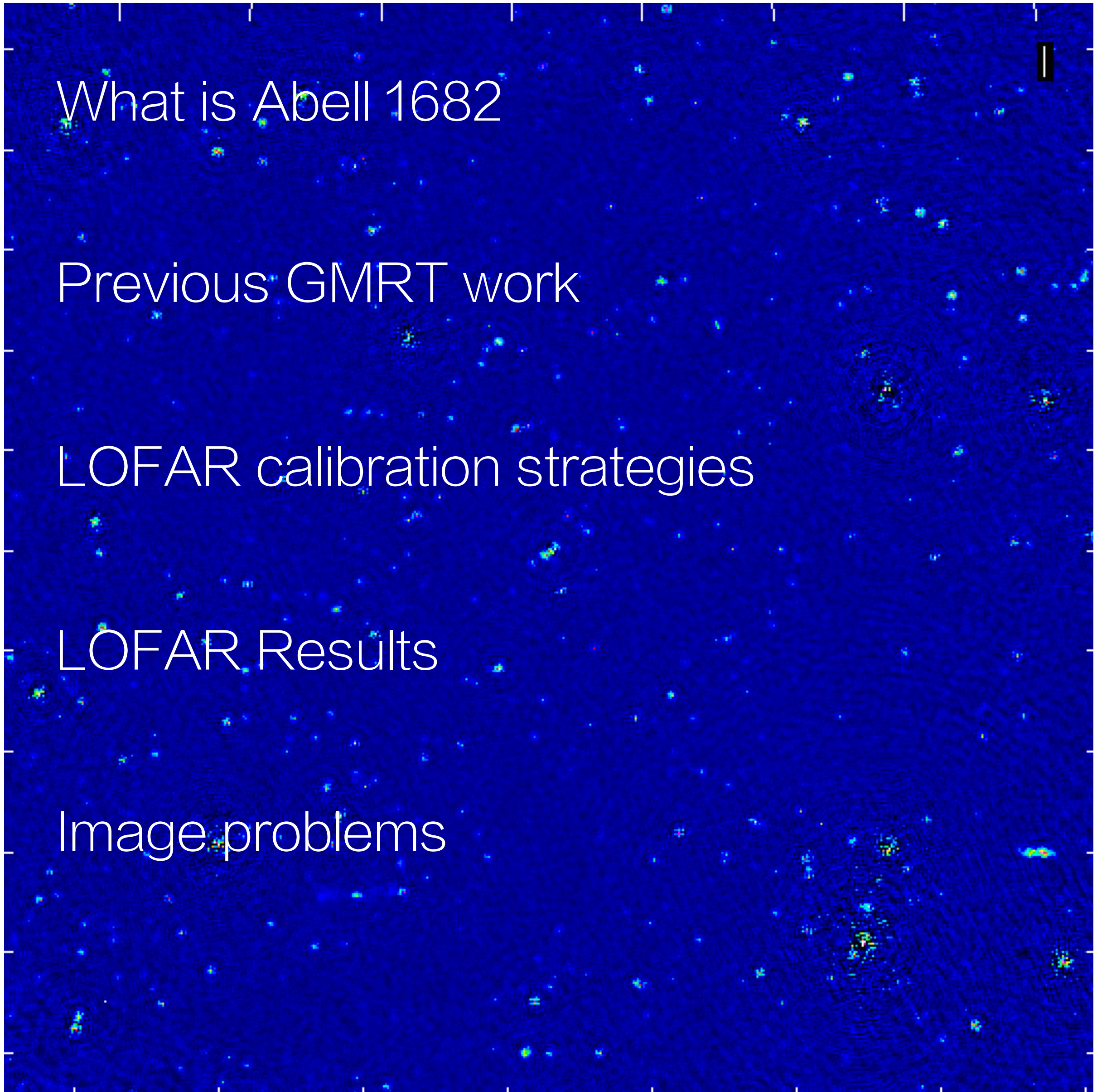


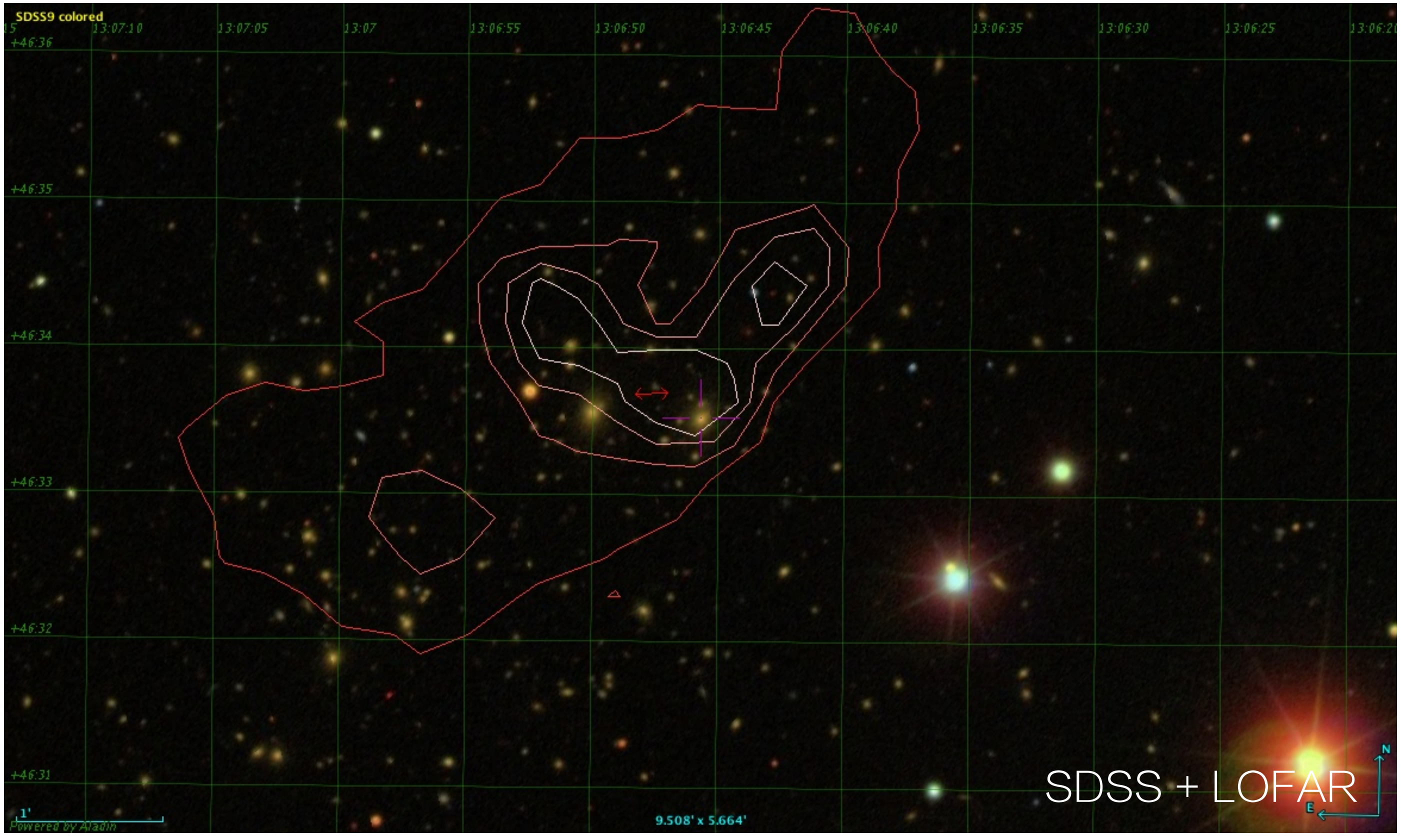
Outline



- What is Abell 1682
- Previous GMRT work
- LOFAR calibration strategies
- LOFAR Results
- Image problems

What is Abell 1682?

- A massive merging galaxy cluster
  (z=0.226)
- Radio emission is dominated by a strong central radio galaxy



What is Abell 1682?

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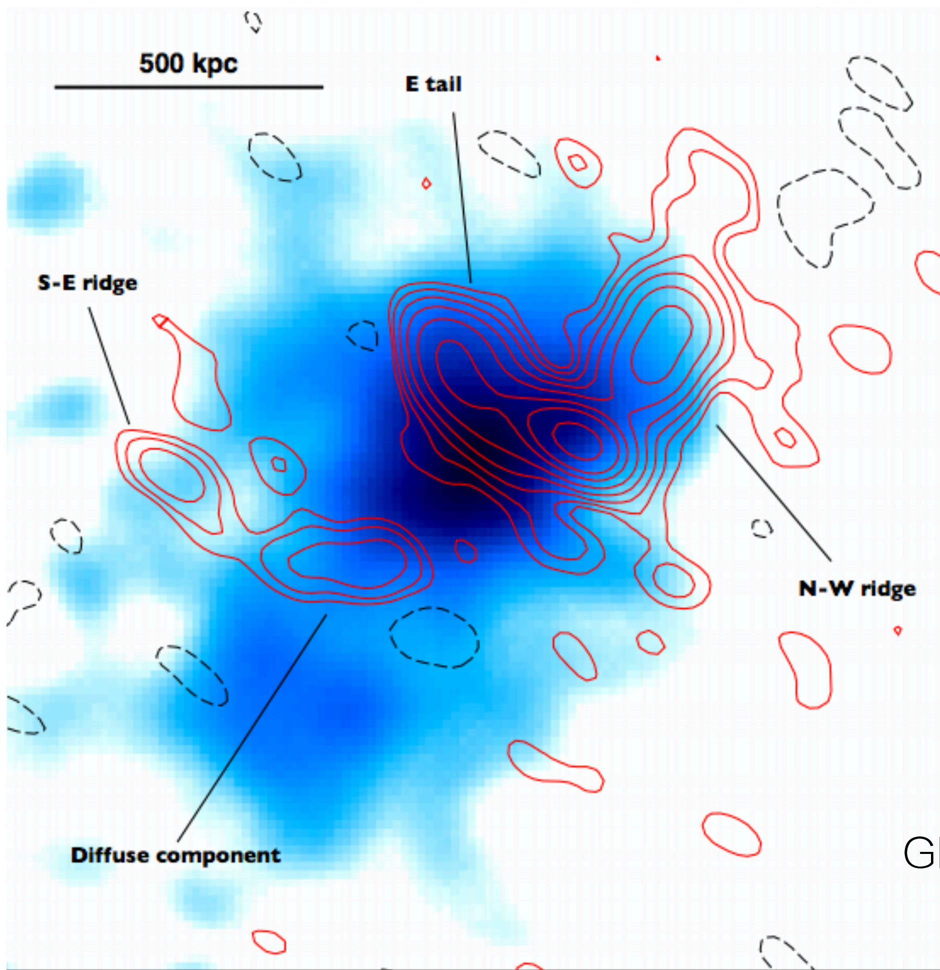
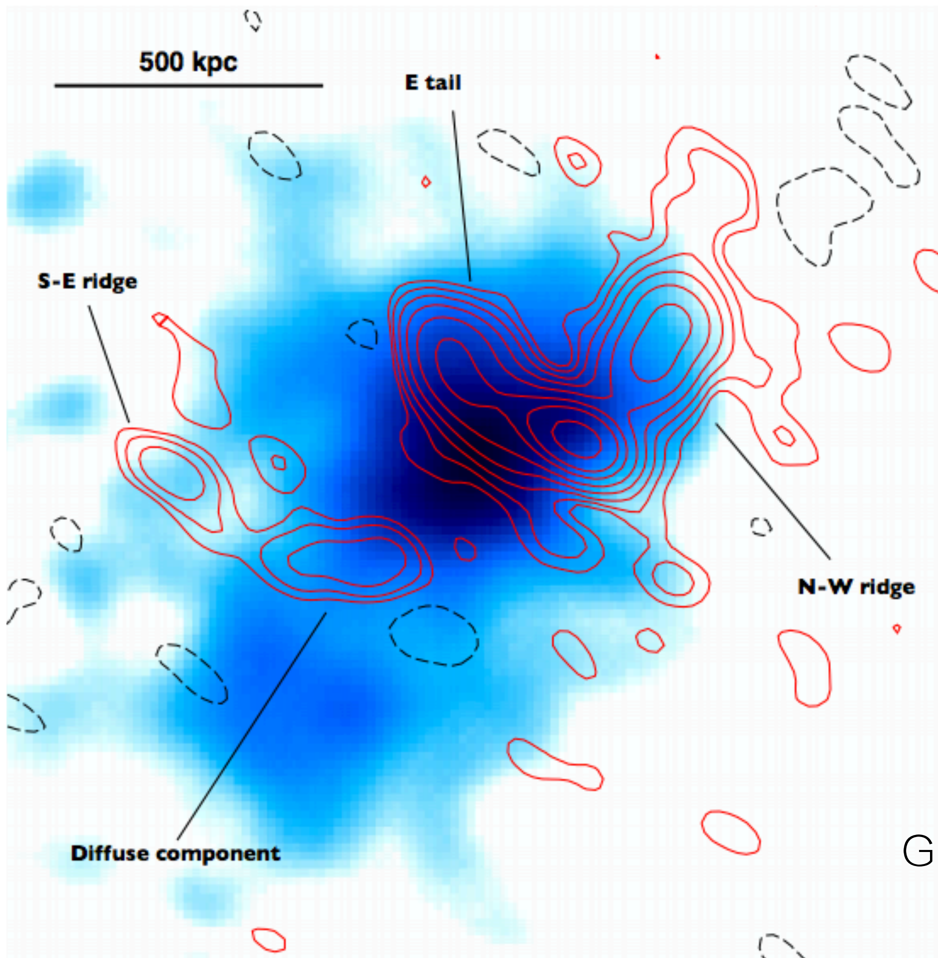


G. Macario et al 2013: GMRT 150 MHz contours overlaid on Chandra

Galaxy Clusters

- Typically discovered by X-ray telescopes
- Detect emission from diffuse gas in the cluster



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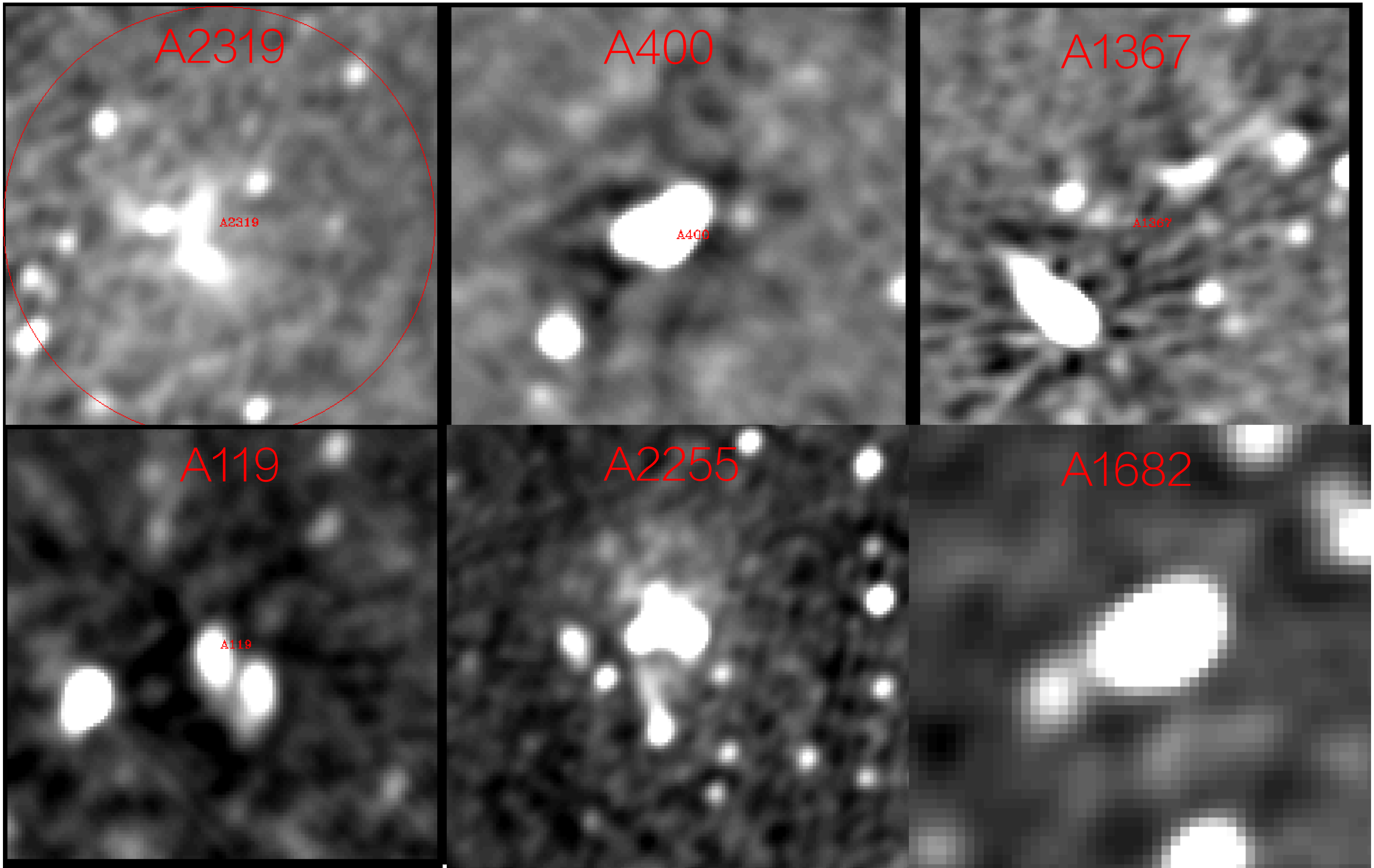
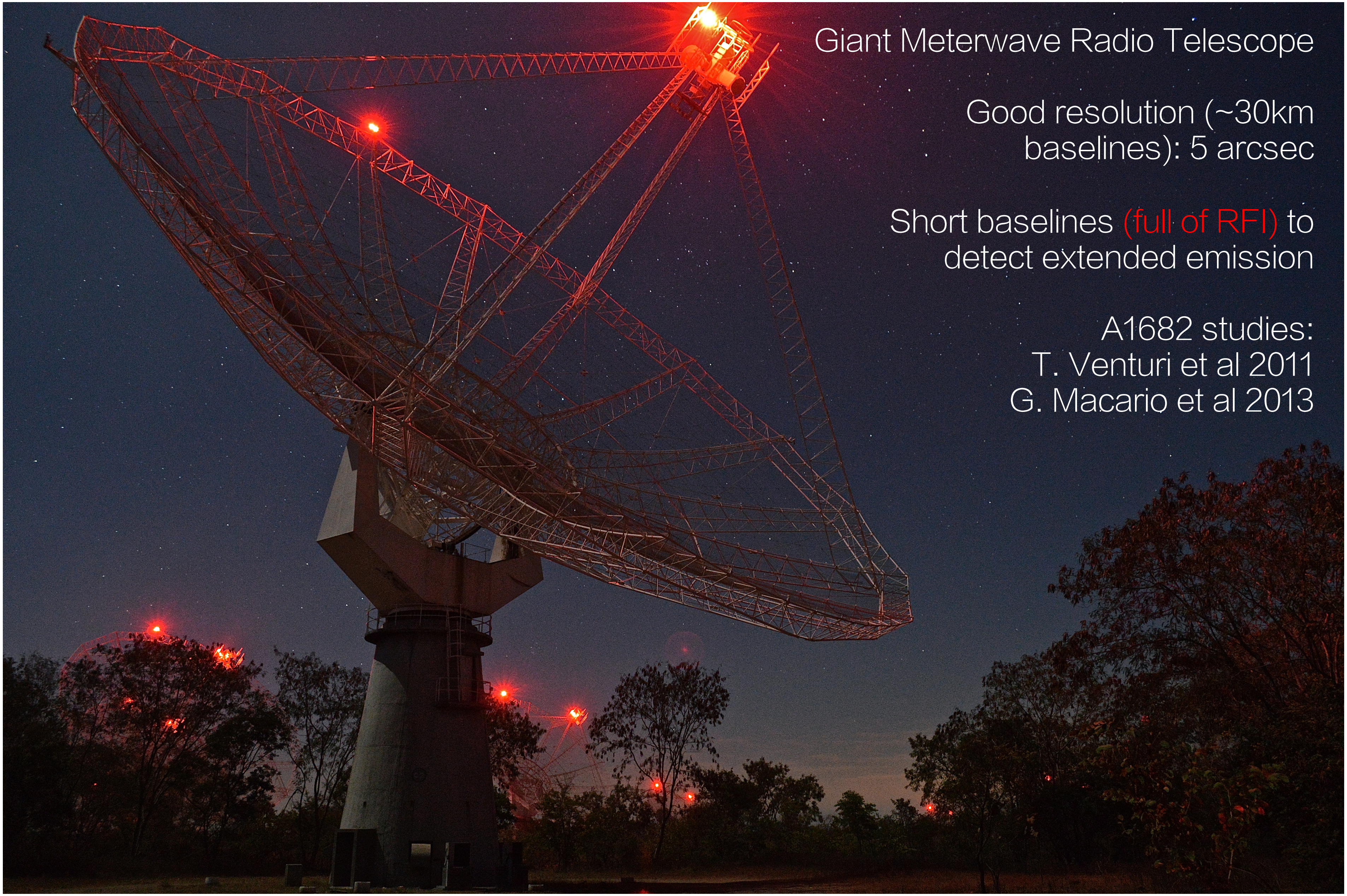
Galaxy Clusters

MSSS detections



Previous GMRT work



Giant Meterwave Radio Telescope

Good resolution (~30km baselines): 5 arcsec

Short baselines (full of RFI) to detect extended emission

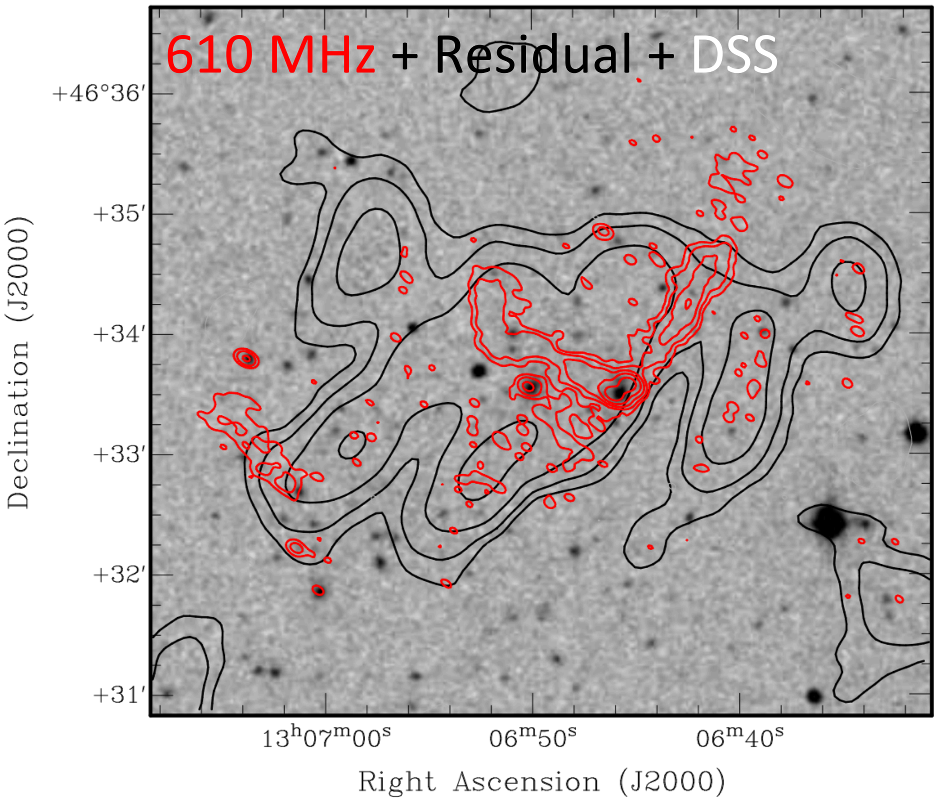
A1682 studies:
T. Venturi et al 2011
G. Macario et al 2013

Previous GMRT work

High resolution GMRT maps enabled them to subtract the radio galaxy and relics

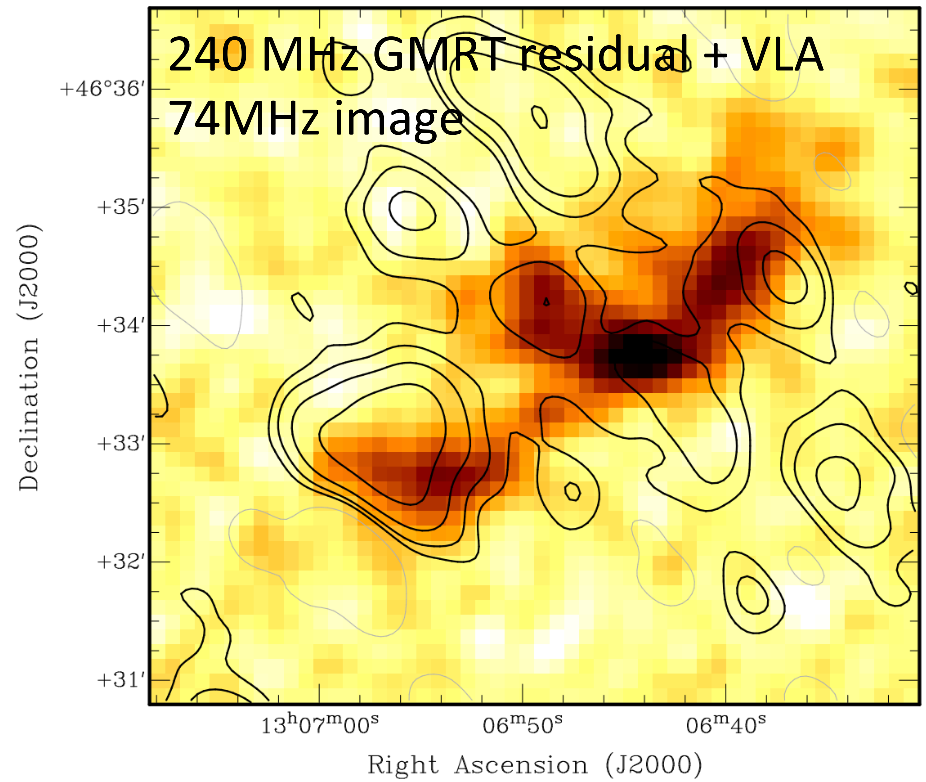
Leaves behind a radio halo?

T. Venturi et al 2011



610 MHz: Red contours ±0.15,0.6,2.4 mJy/b

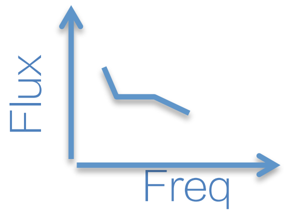
Black: residual image: ±0.3, 0.6, 1.2, 2.4 mJy/b, (1σ ~ 0.1)



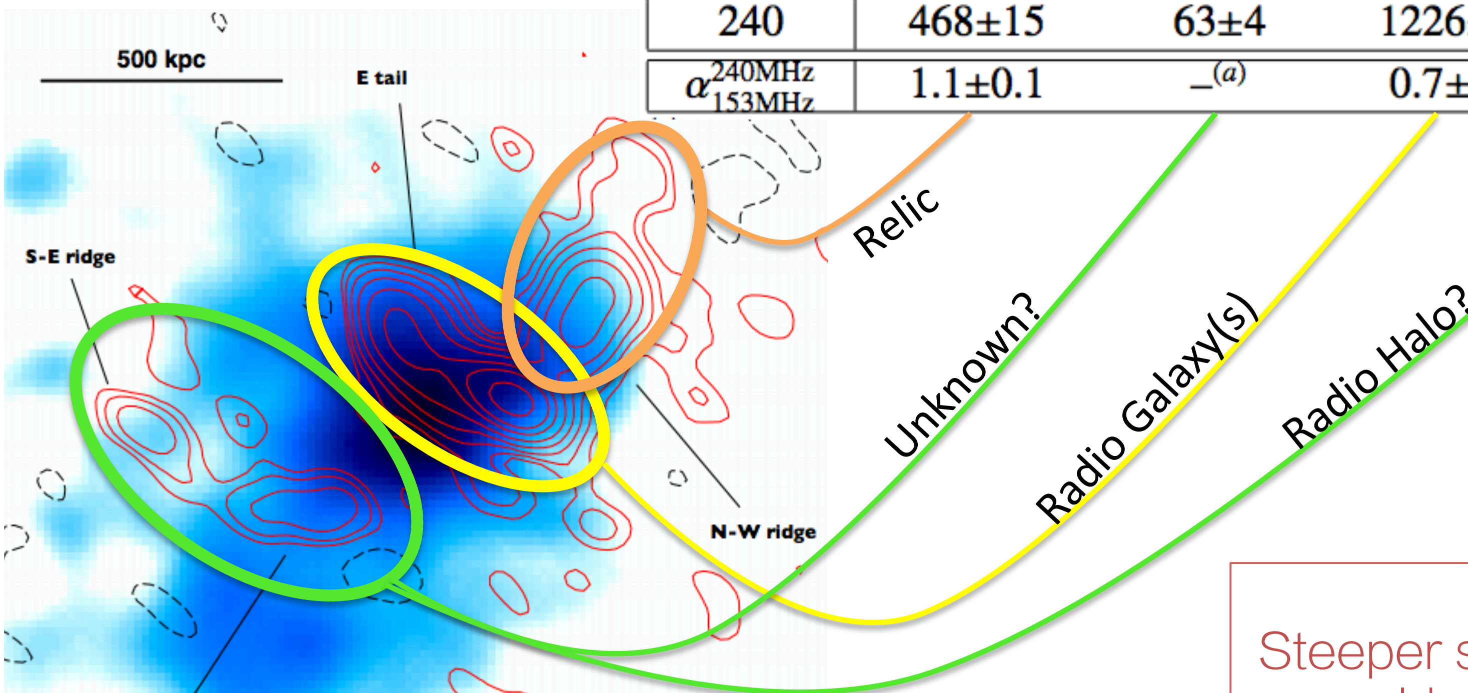
240 MHz: Black contours ±0.6,1.2,2.4,4.8 mJy/b, (1σ ~ 0.3 mJy/b)

Previous GMRT work

- Spectral index maps tell us about the nature of the radio emission



ν [MHz]	$S(\nu)$ [mJy]			
	N-W ridge	S-E Ridge	E Tail	Diff. Comp.
153	746 ±149	62±12	1710±342	98±20
240	468±15	63±4	1226±40	46±4
α_{153MHz}^{240MHz}	1.1±0.1	–[a]	0.7±0.1	1.7±0.1



G. Macario et al 2013:
GMRT 150 MHz contours
overlaid on Chandra

Steeper spectral index =
older electrons

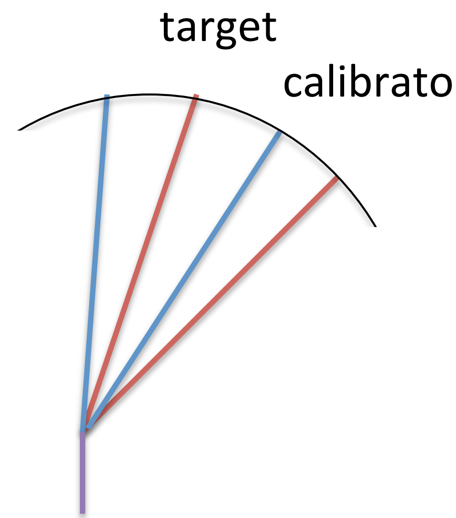
LOFAR Observational Setup

- 2013 dual beam HBA observation
  (set up by someone else)

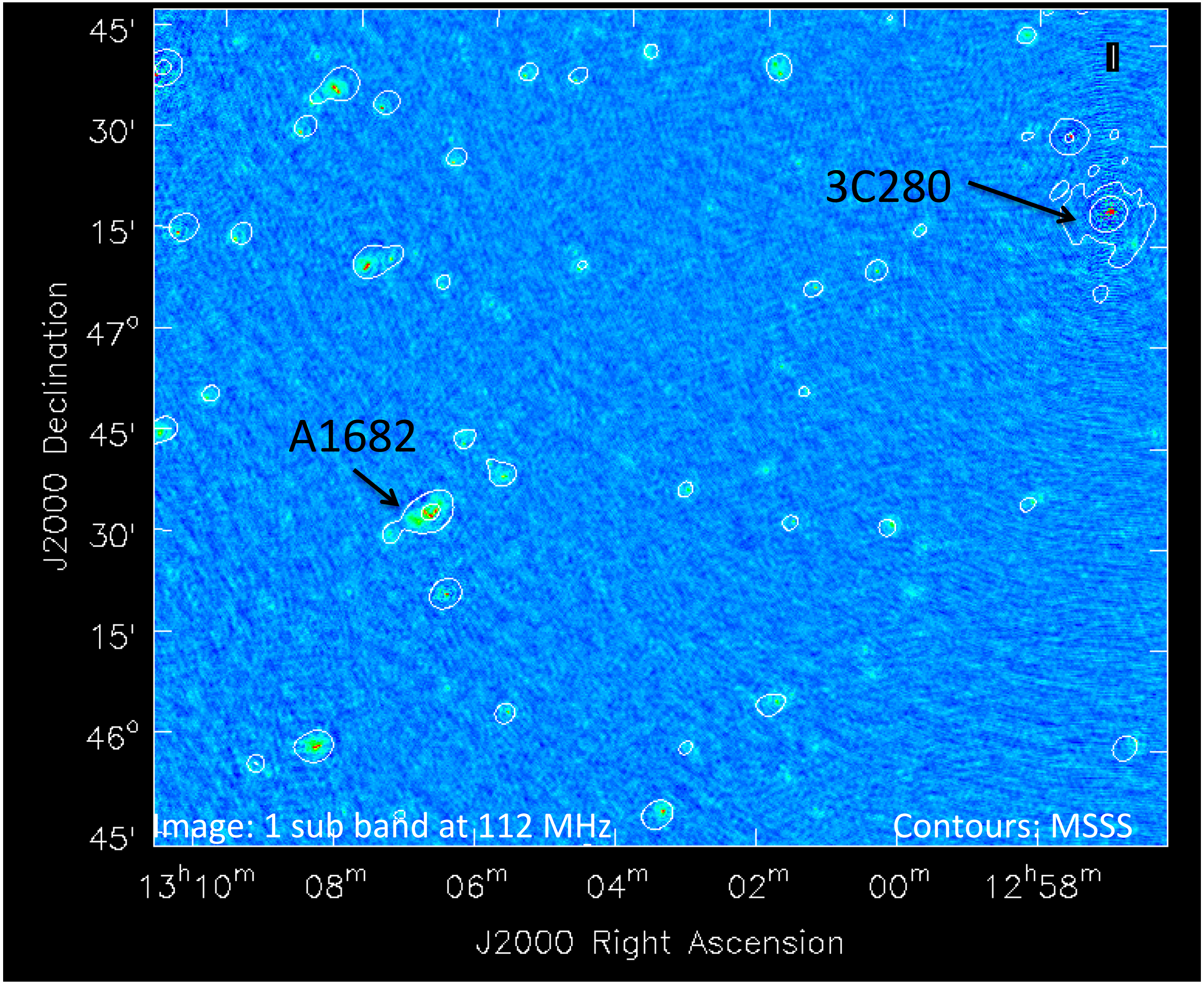
- Calibrator: 3C 280
  (have to create my own model from VLA)

- Calibrator–Target separation: 1.86°
  (useful for self-calibration and potentially mosaicking)

- 366 sub bands on target, 122 on calibrator
  (To transfer solutions do we need interpolation in frequency?)



3C 280: Non standard calibrator

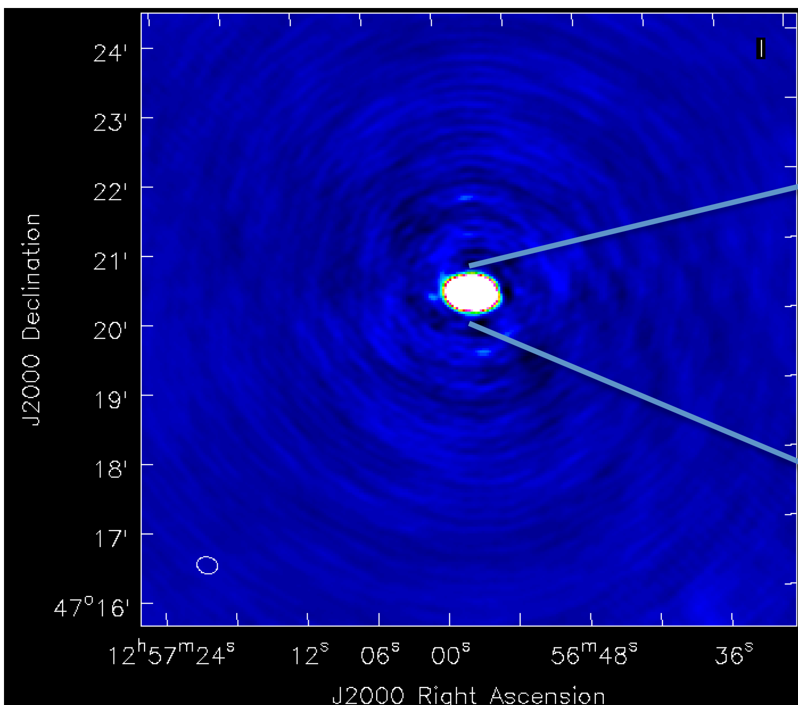


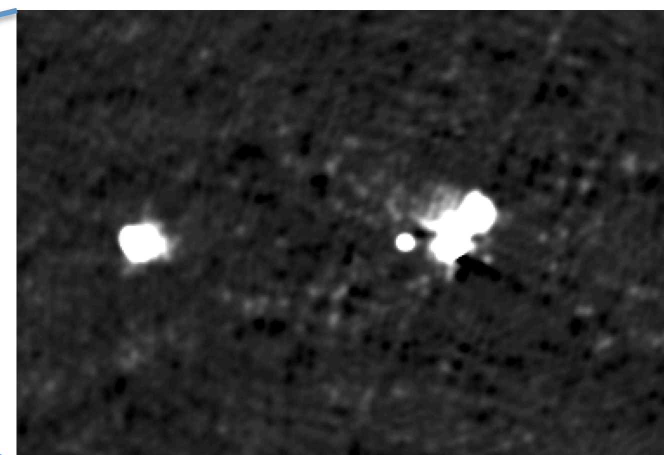
3C 280: Non standard calibrator

- Model created using 5GHz VLA snapshots
- Spectral model built up using the 3C catalogue

K. I. Kellerman and I. I. K Pauliny-Toth (1968)

Source	S_{38}	S_{178}	S_{750}	S_{1400}	S_{2695}	S_{5000}	Notes
3C 280	62 b	23.7 a	7.7 a	4.9 a	2.83 a	1.53 a	





15 arc seconds

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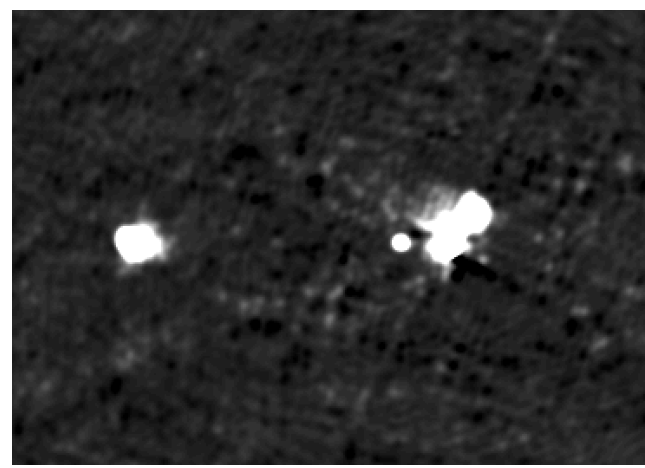
- Assume constant spectral index
- Fit a model (Scaife & Heald 2012):

$$\log S = \log A_0 + A_1 \log \nu + A_2 \log^2 \nu + \cdots$$

$$S[\mathrm{Jy}] = A_0 \prod_{i=1}^{N} 10^{A_i \log^i [\nu/150\,\mathrm{MHz}]}$$



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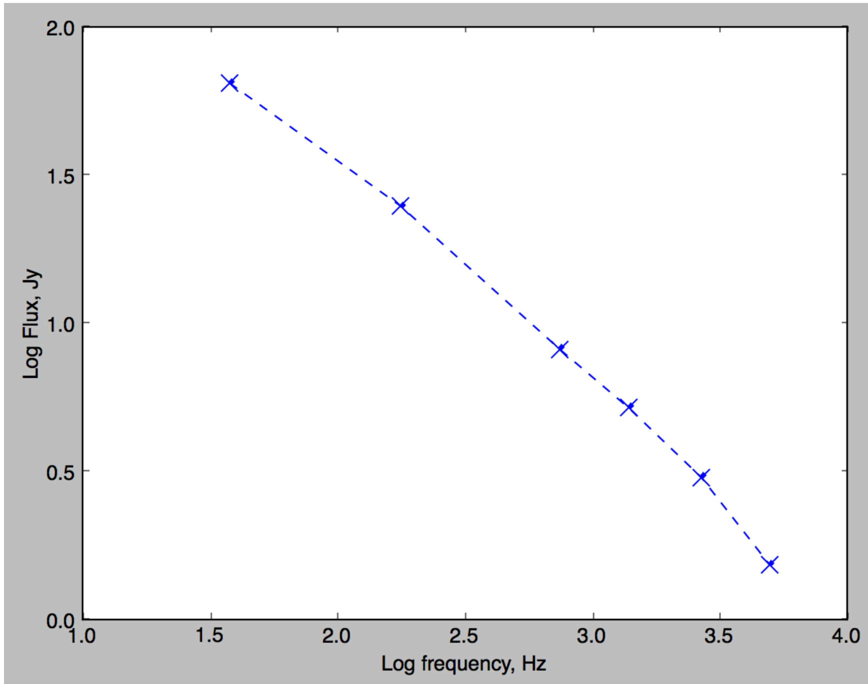
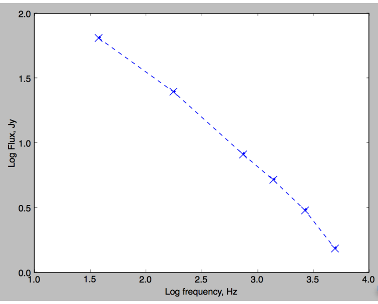
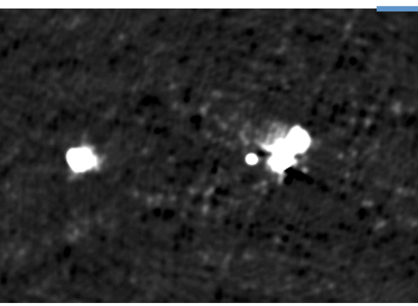


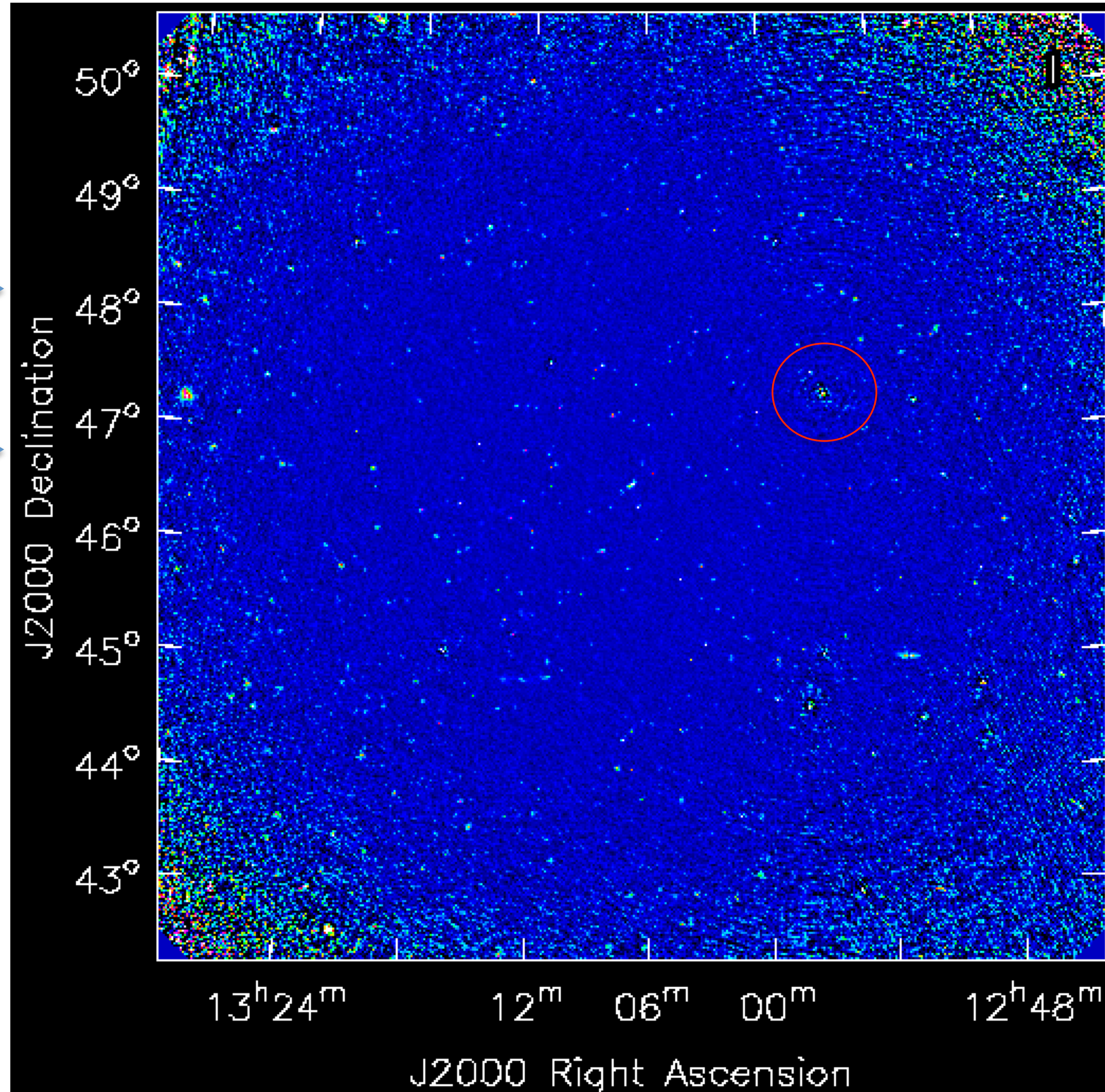
LOFAR Results

Calibrate target beam using 3C280 model



Amp + phase calibration



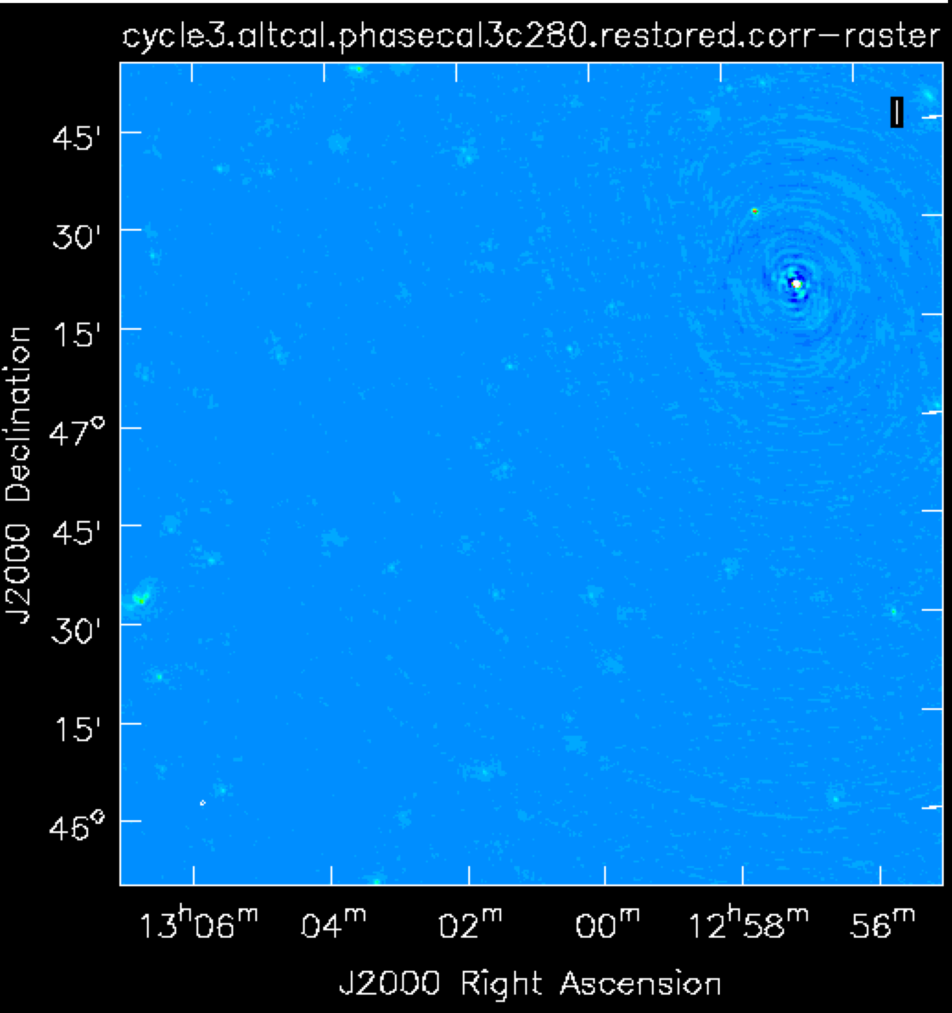


Initial tests show 5% fluctuation in fluxes, as compared to transferring amplitude gain solutions from calibrator beam

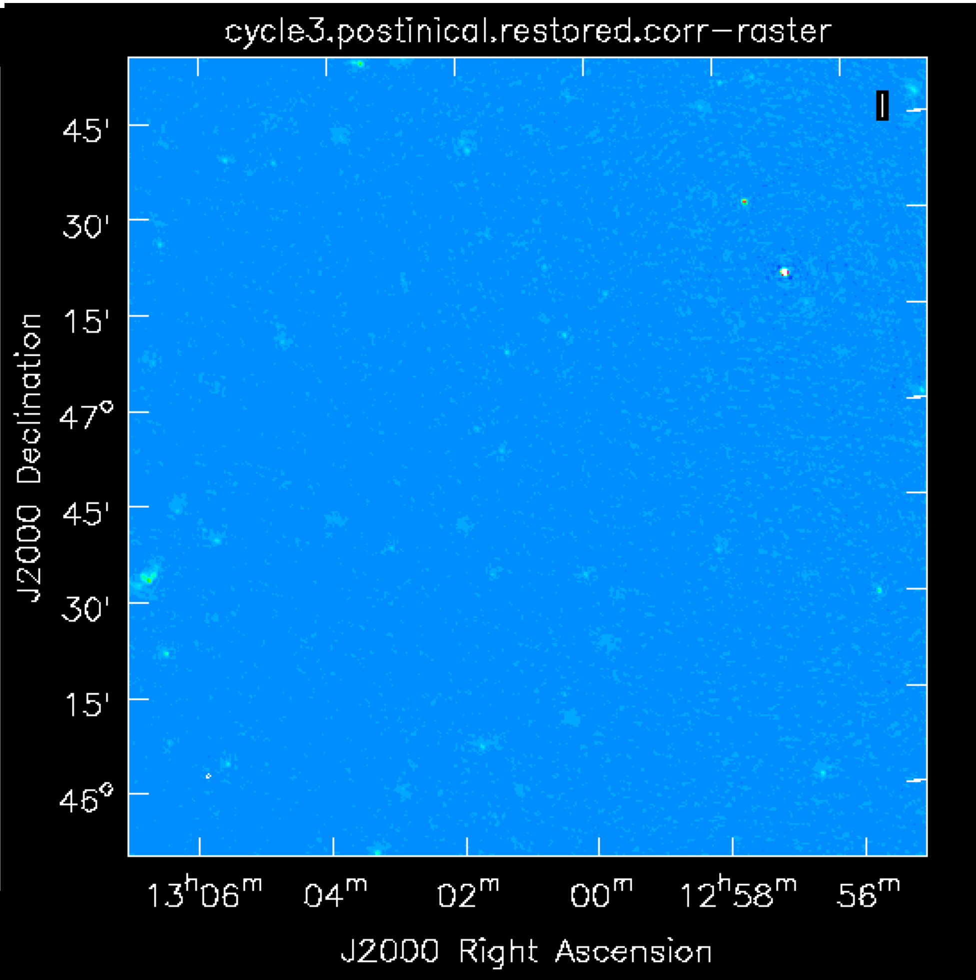
LOFAR Results

Calibrate target beam using 3C280 model

- Gain amp transfer from cal beam
- Phase cal on 3C280

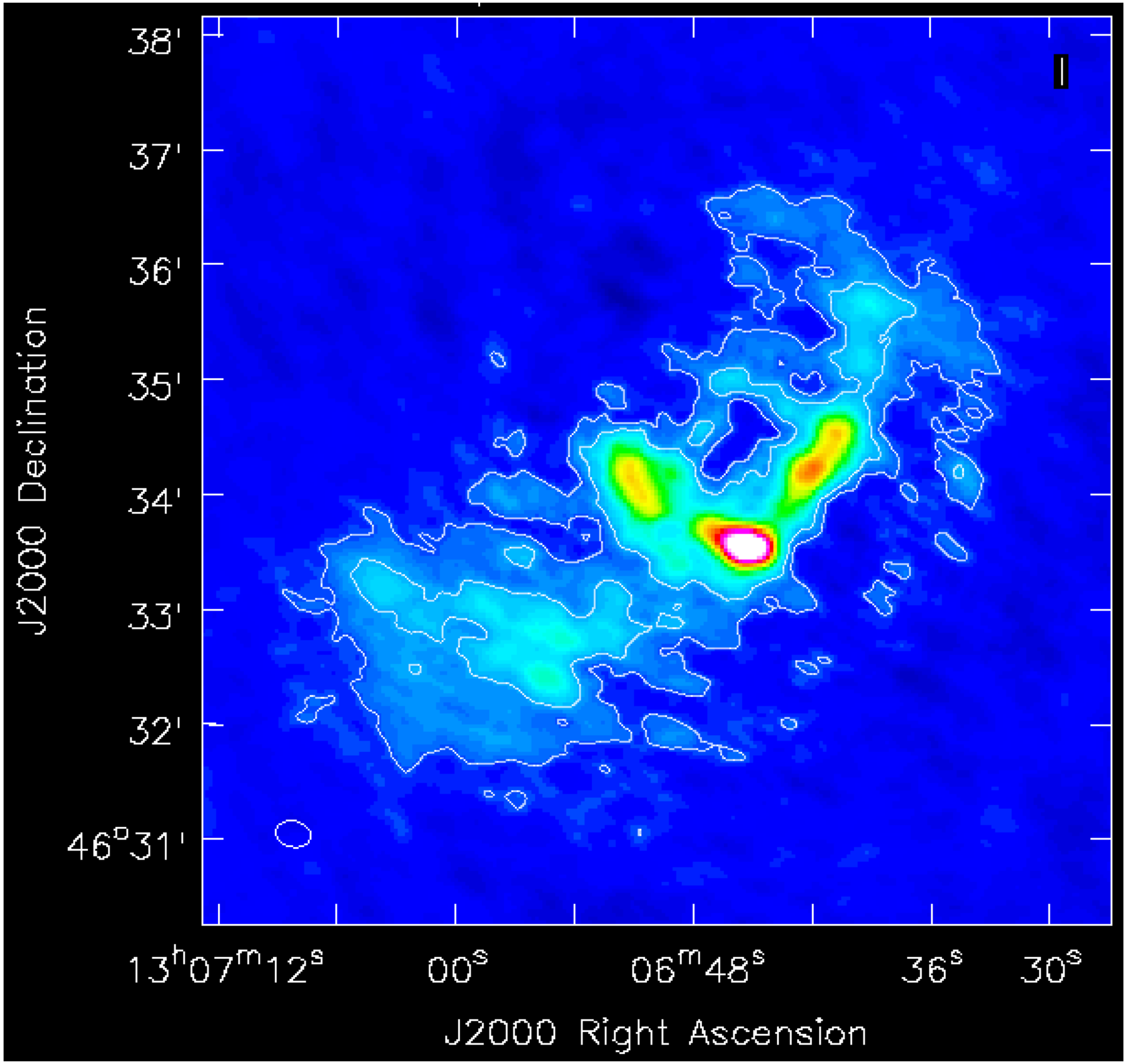


- Direct Amp+Phase solve for target beam



LOFAR Results

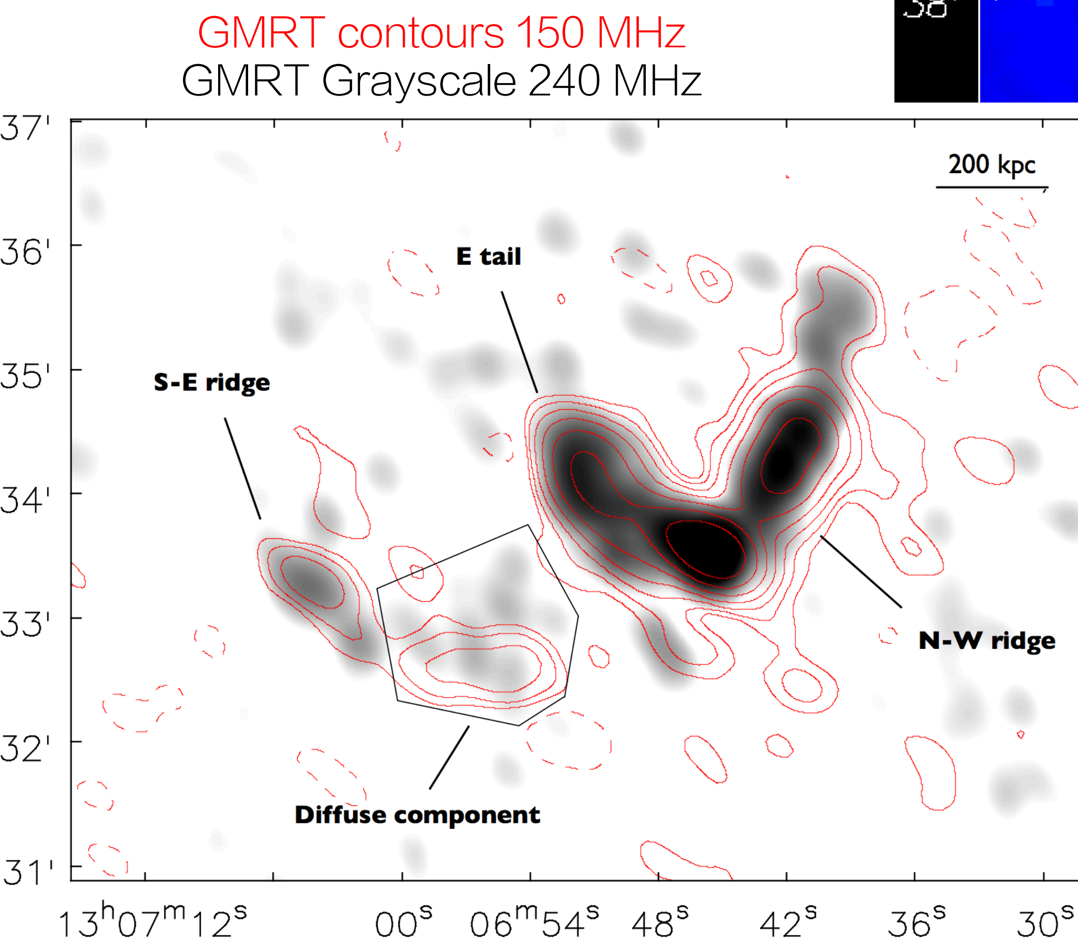
1 sub band, 116 MHz, robust 0, contours at 5/10 σ , 15″ beam

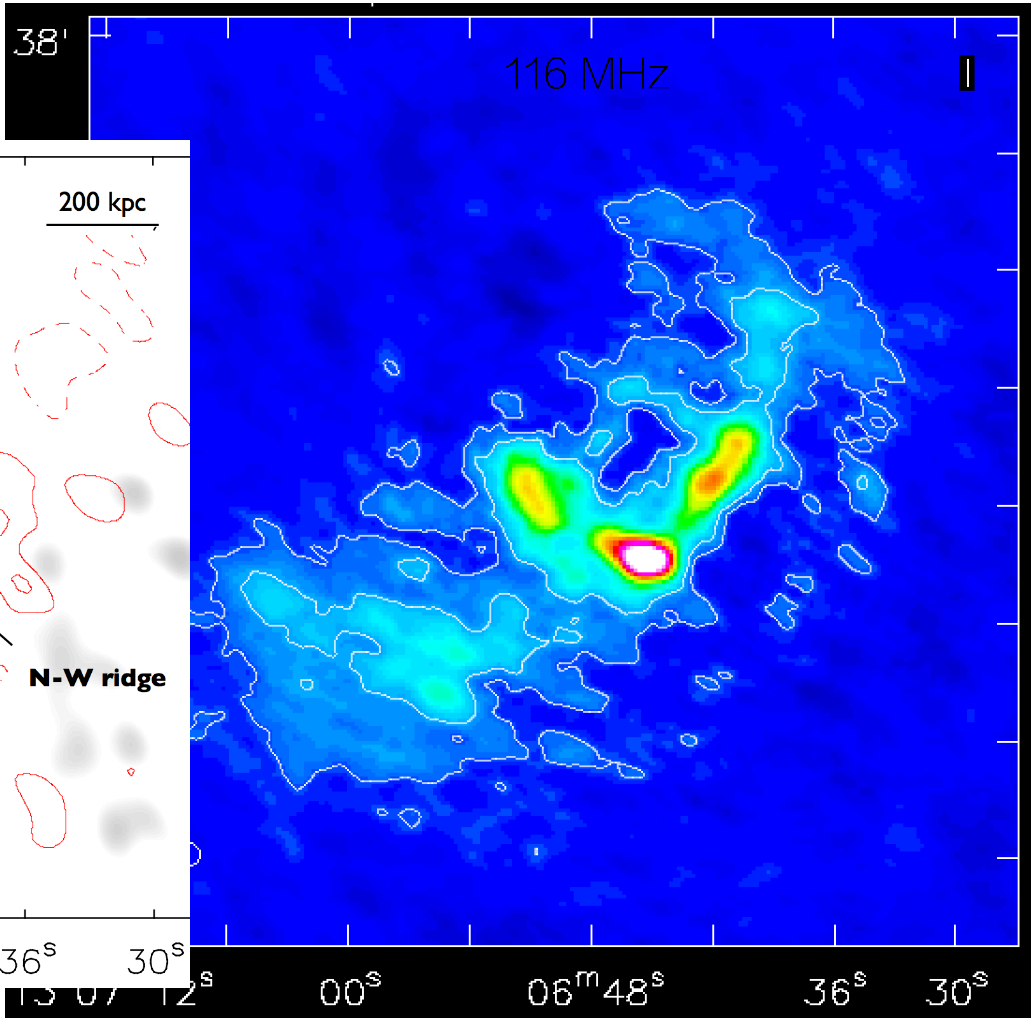


Noise ~6 mJy

LOFAR Results

+ GMRT

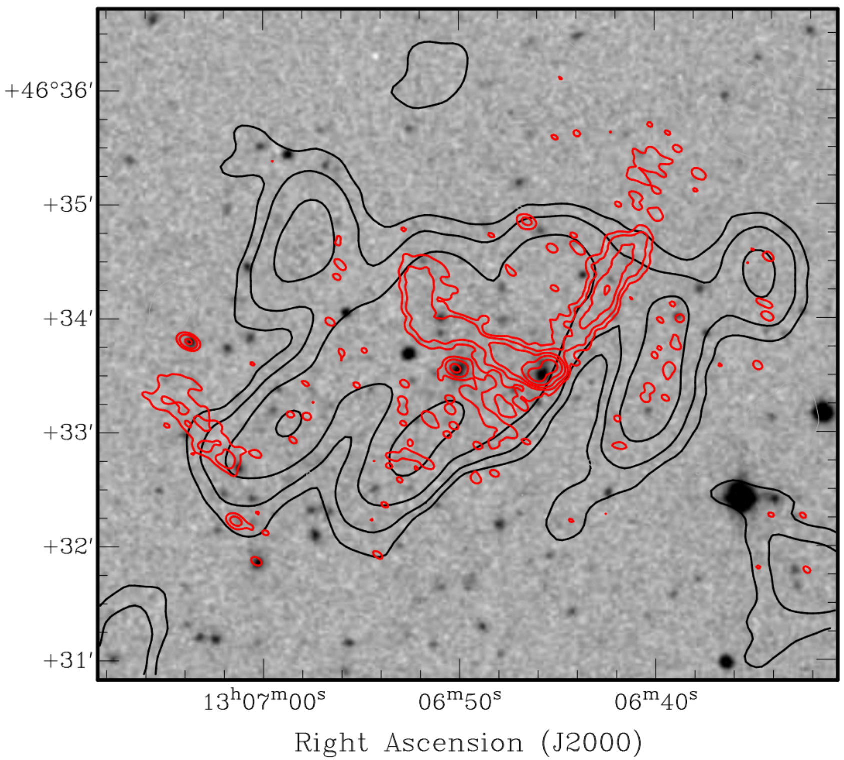


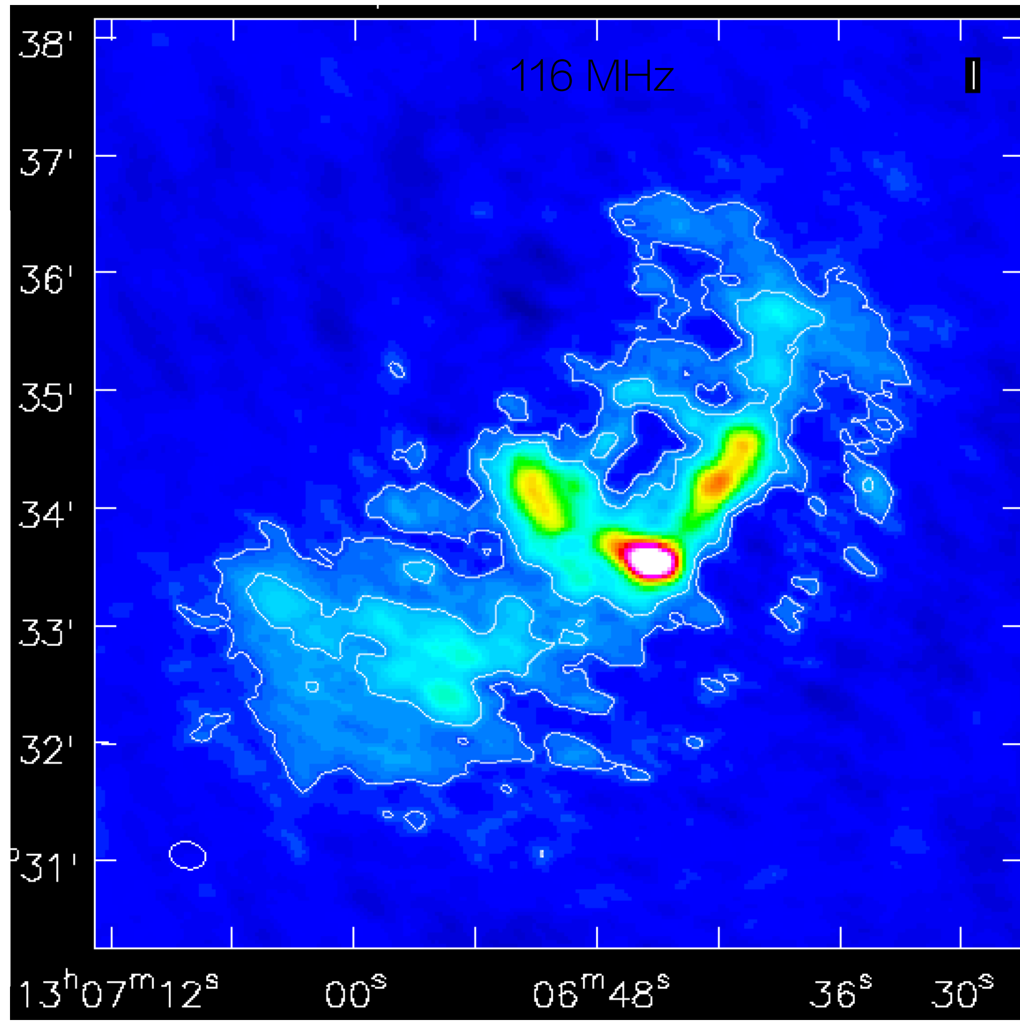


LOFAR Results

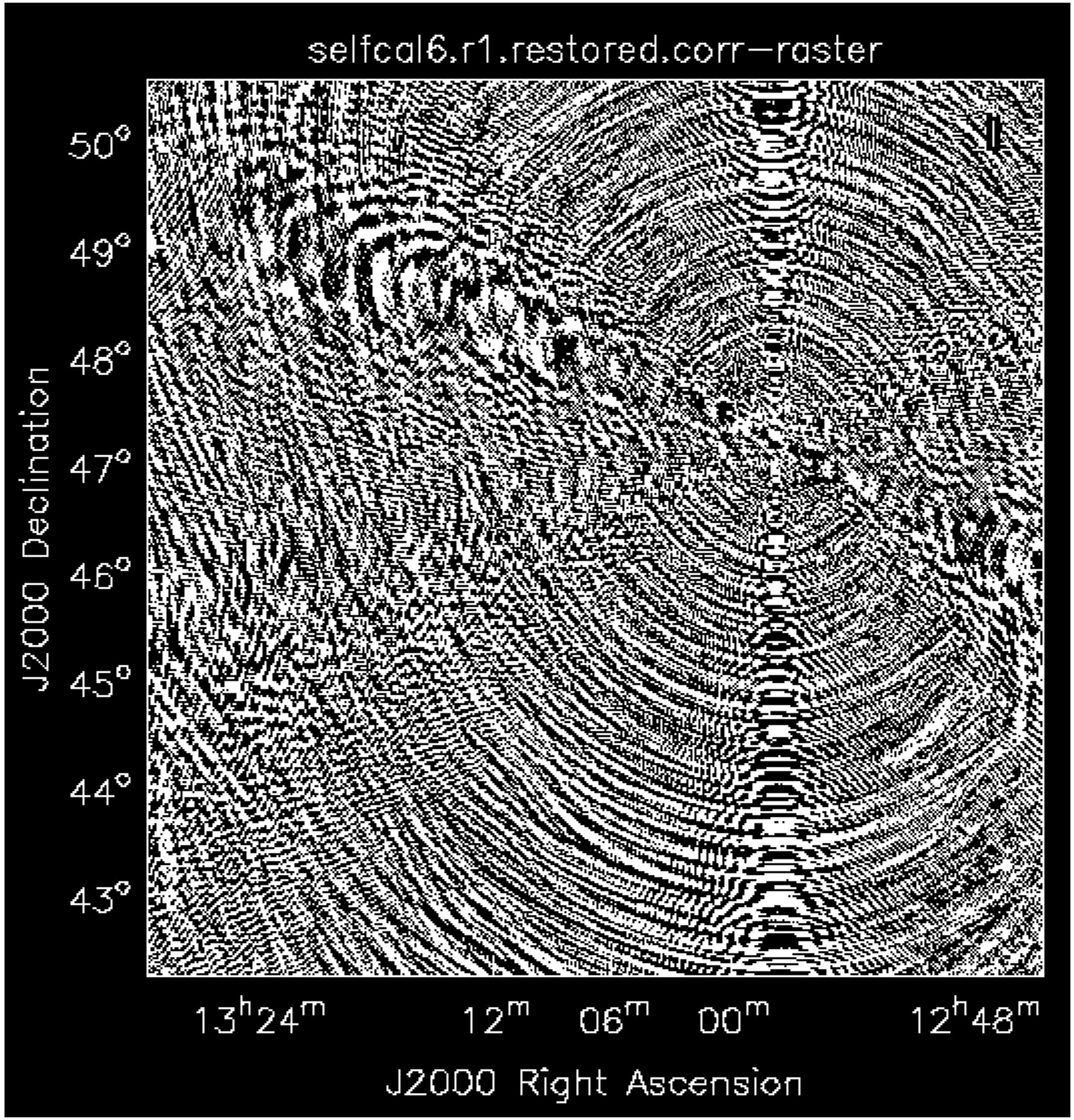
+ GMRT

GMRT contours 610 MHz



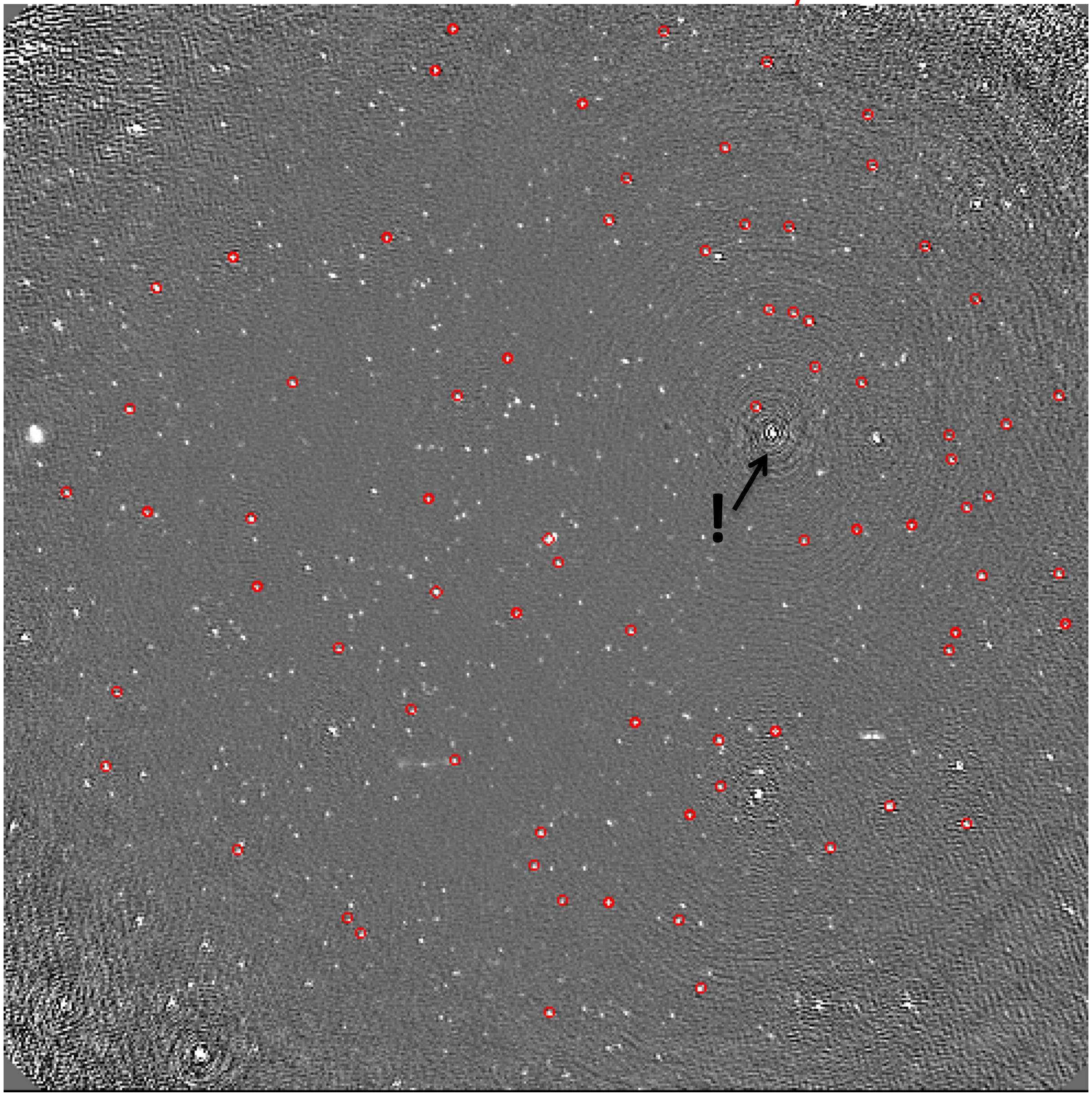


When things don't go to plan...



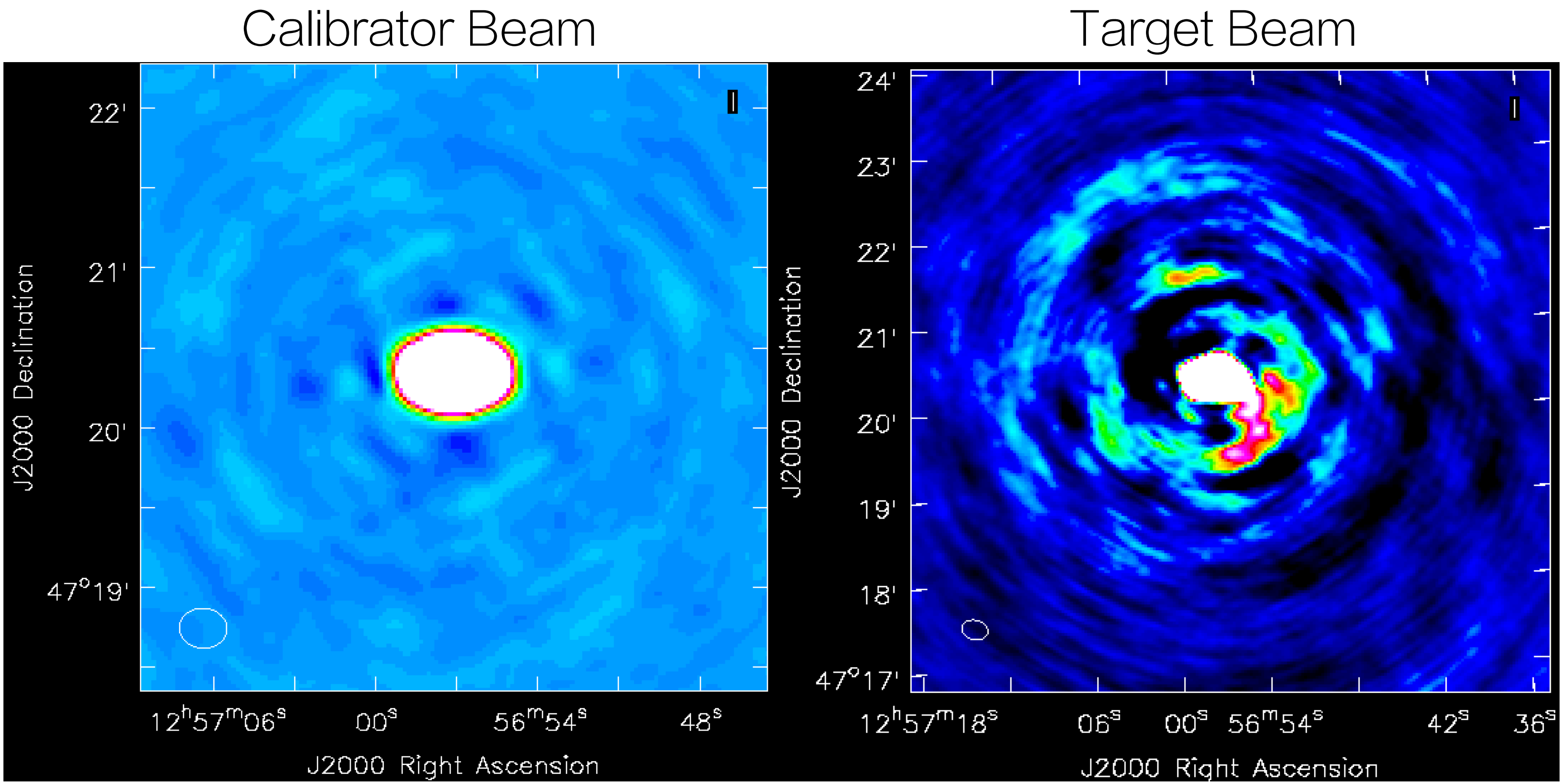
3C280 not in GSM

Circles: All sources above 2Jy



Direction dependent

3C280

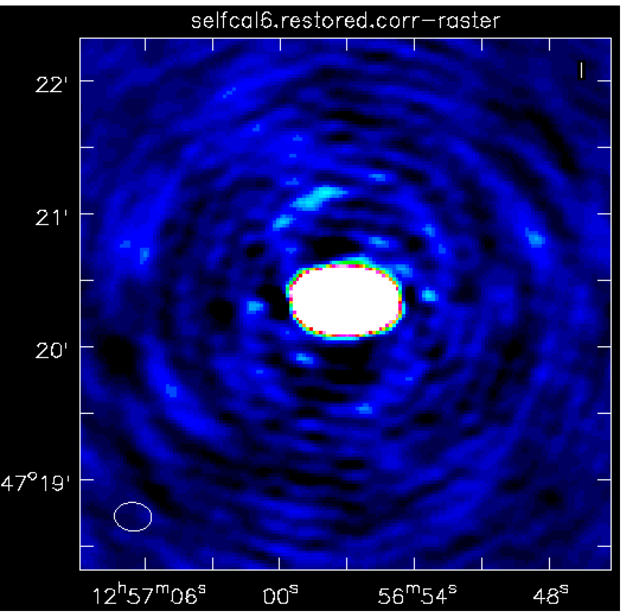


3C280 in target beam not a point source beyond 2 arc minutes

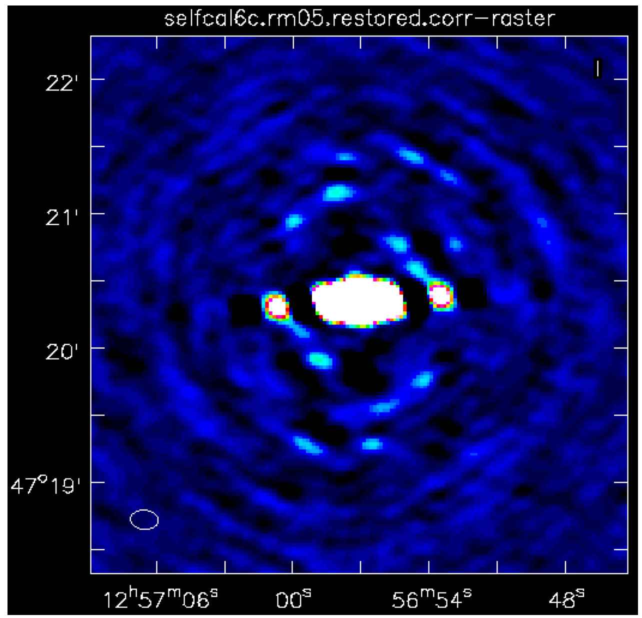
Achieving 7 arc seconds

Calibrator beam
(3C280 at phase centre)

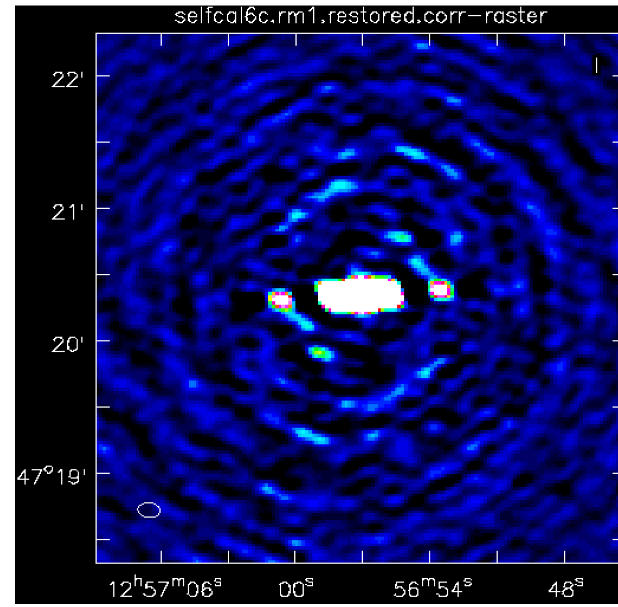
R = 0



R = −0.5

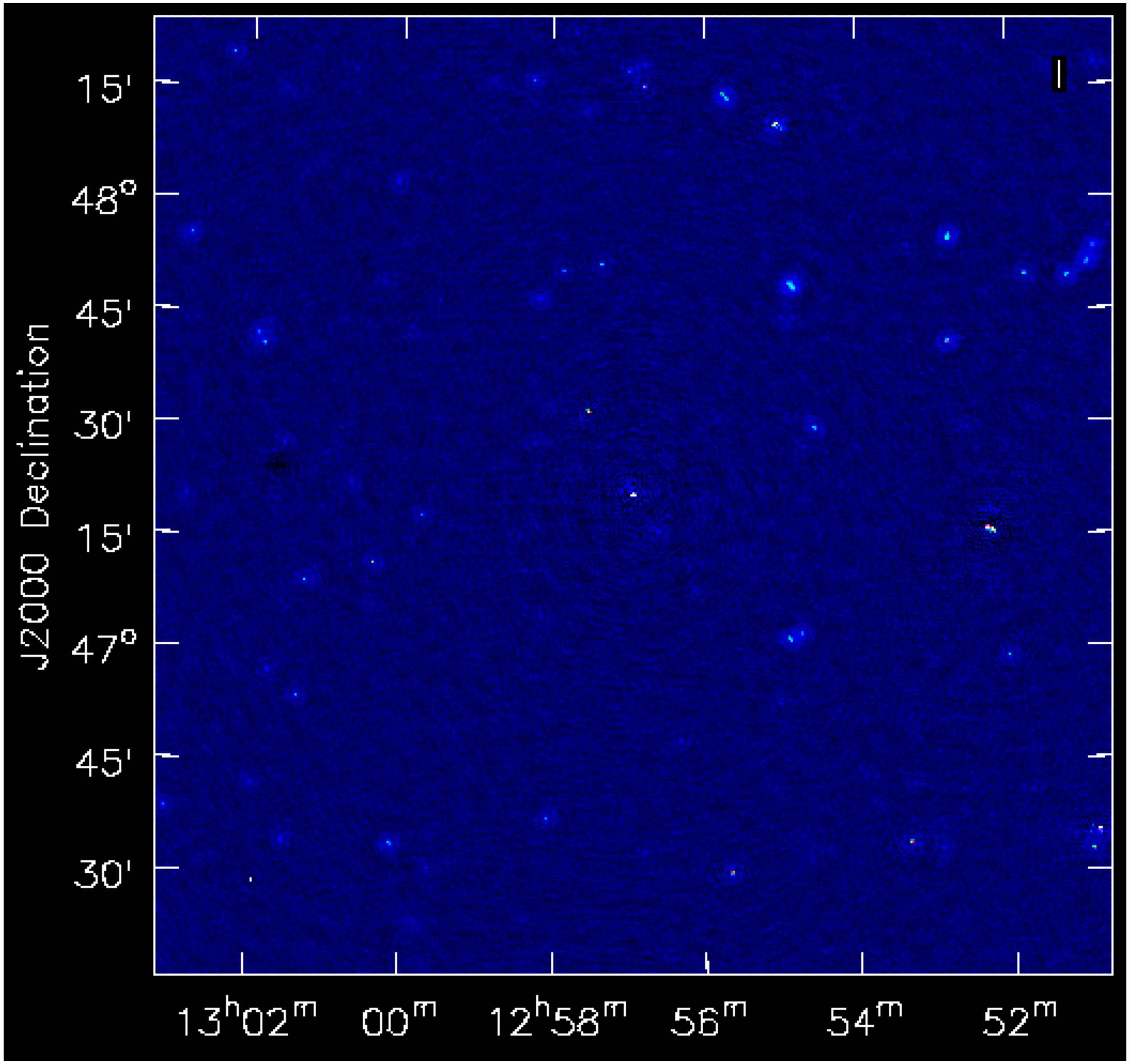


R = −1



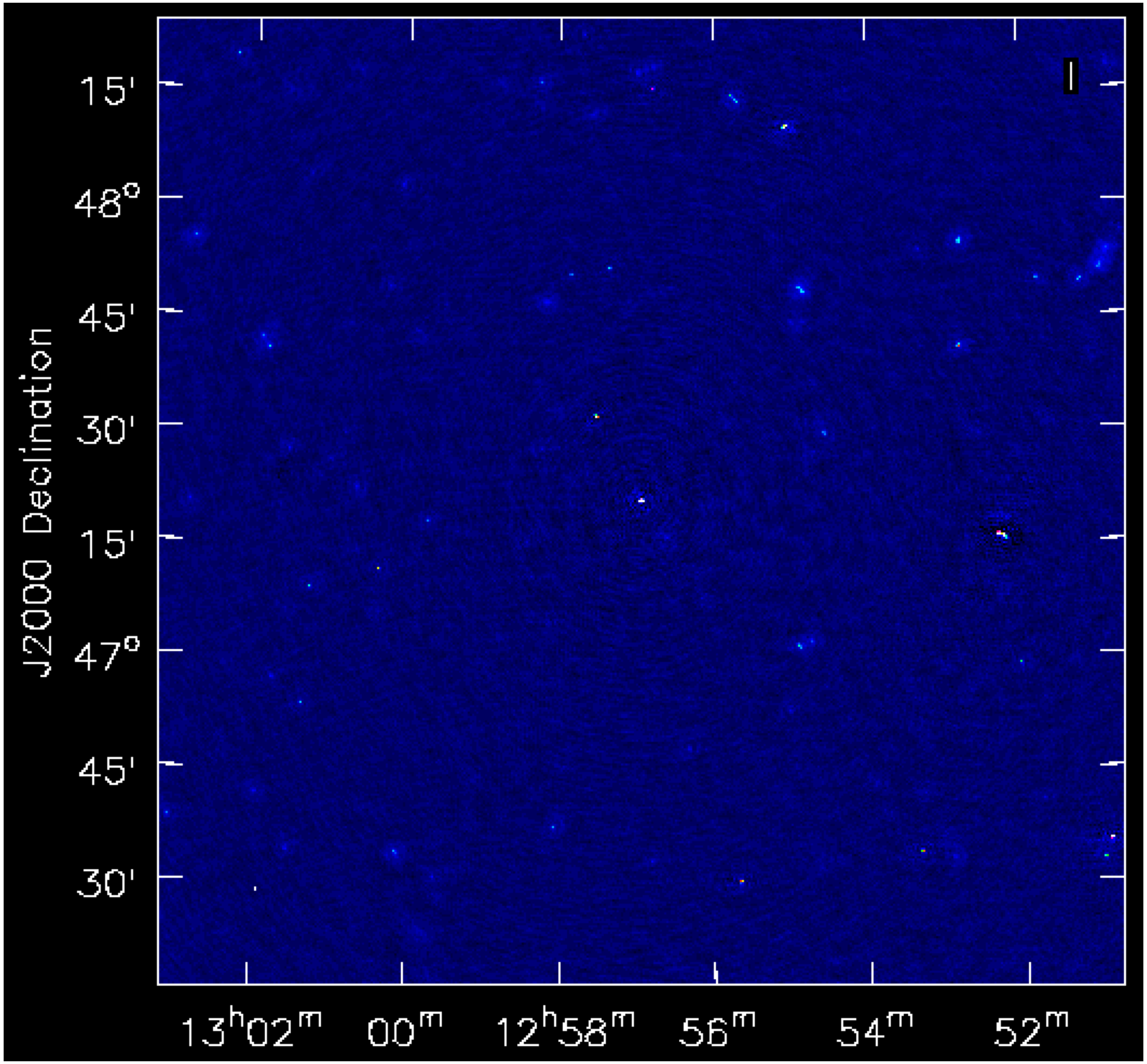
15” → 7”

Ghosts



Noise: 7.3 mJy

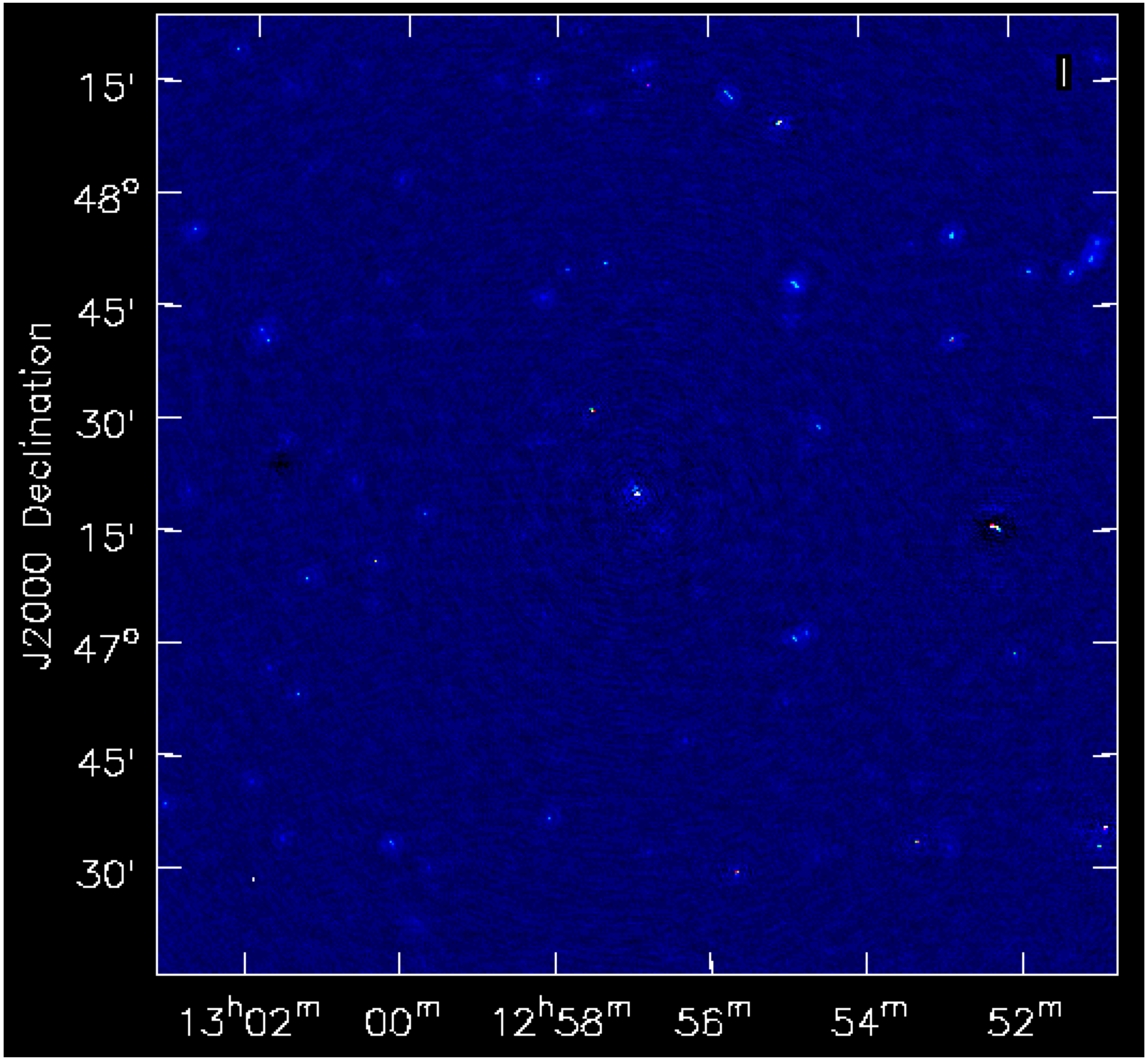
Ghosts



Selfcal on:
1 source

Noise: 7.0 mJy

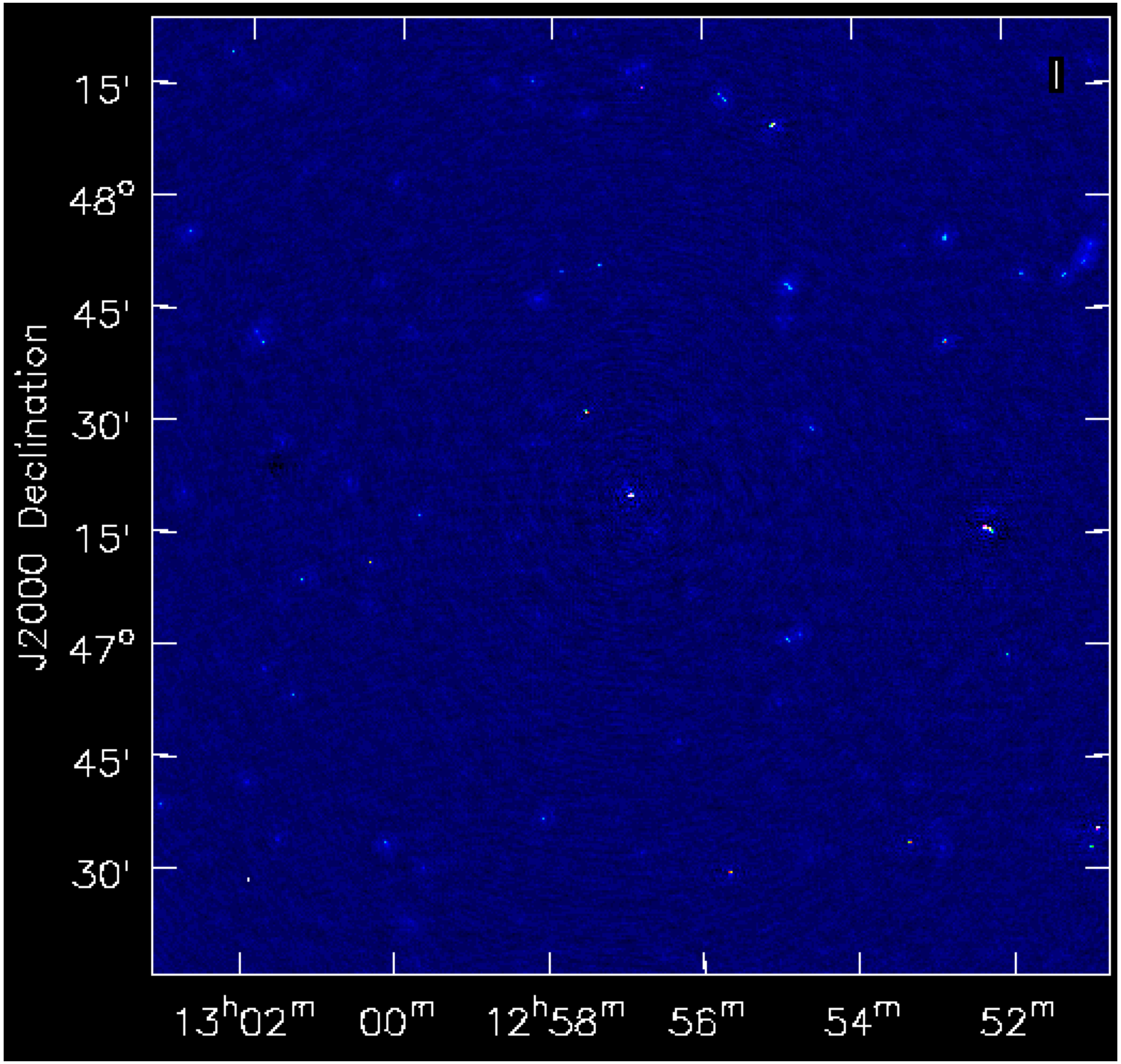
Ghosts



Selfcal on:
13 sources

Noise: 7.0 mJy

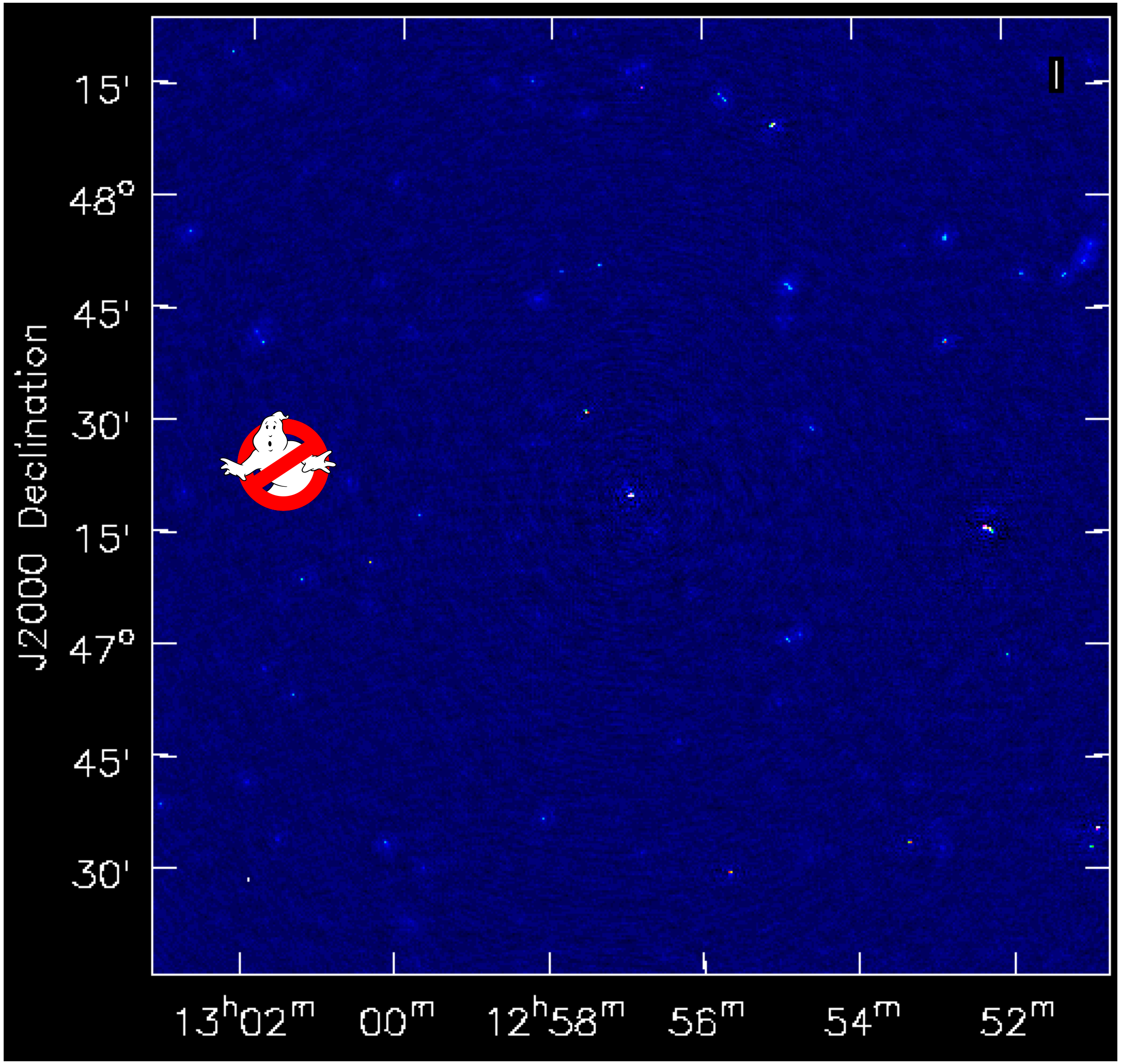
Ghosts



Selfcal on:
100 sources

Noise: 6.6 mJy

Ghosts



Selfcal on:
100 sources

Noise: 6.6 mJy

The Next Steps

- Compare direct amp+phase cal on target beam, with gain solution transfer from calibrator beam

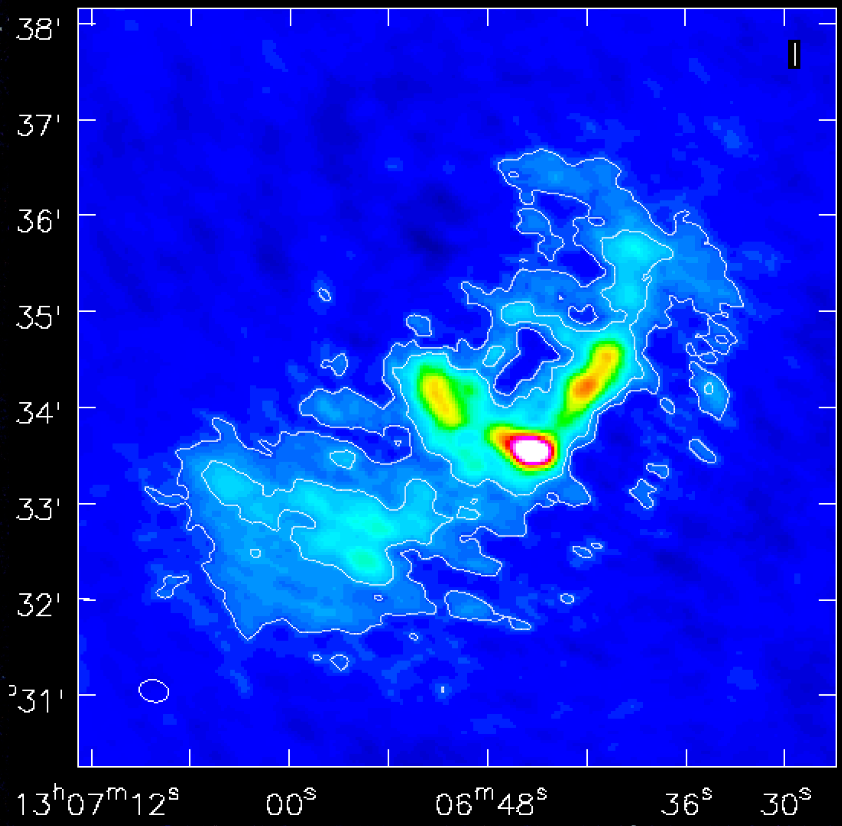
- Finalise simplest calibration strategy

- Combine multiple sub bands from both beams?
  (366 on target and 122 on calibrator)

- Finding the halo: Do I need < 15" resolution for subtraction?
  → direction dependent calibration may be required

- LBA – important to study the steep spectrum diffuse component

Thanks for listening!



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