Status LC0_012:
Using LOFAR for detailed studies of AGN and AGN physics

Proposal part of the survey group

➡ targeted nearby known radio sources: study of the energetics and life-cycle

- *3CR radio galaxies +Virgo A*
- *double-double/giants*
- *relics*
- *radio in X-ray cavities*
- *compact radio sources (longbaselines group)*

➡ spectral index

➡ study of relics and restarted (targeted and serendipitous) and double-double radio galaxies

Targets

Who is working on the data:
Judith Croston, Volker Heesen, Jeremy Harwood
Aleksandar Shulevski, Emanuela Orru`, RM
De Gasperin, Rafferty/Birzan
Hardcastle + longbaseline group

Targets for LC0_012 Cycle0 LOFAR

Using LOFAR for detailed studies of AGN, and AGN physics

	HBA obs	HBA comp	LBA obs	LBA comp	Pre-processing	Leading
3C31	10	30	10	15	Southampton?	Nearby 3CR - Croston, Volker Heesen
3C223	10	30	10	15		Croston+Jeremy Harwood+Orru`
3C452	10	30	10	15		Croston+Jeremy Harwood
B1834	10	30	10	15	Nijmegen?	DDRG - Orru`+
3C35	10	30	10	15		Orru' (polariz.)+Shulevski
4C33.33	10	30	10	15		**Giant RG Jamrozy+**
3C247	10	30				LongBaselines group, Hardcastle et al.
3C41	10	30				LongBaselines group, Hardcastle et al.
M87	8	24	8	12		De Gasperin+
3C48			10	15	Amsterdam?	RRL group - Oonk+
Hydra A	6	18	6	9		Cavities - Rafferty, Wise+
Hercules A	6	18				Cavities: Birzan+
VLSS J1431.8+1331	8	24	8	30		Relics - Morganti, Shulevski, Kunert-Bajraszewska
Cygnus A	10	30				McKean+
Total	118	354	92	156		

Total observing	**210**	**Alloc**	**210**
Total computing	**510**		**373**

2013

Observing strategy

ASTRON

- HBA observations interleaved calibrator-sources (2-11min). Quite a lot of time spent on calibrator → important to know stability of the system and accurate flux scale: ongoing tests

- LBA: part of the band on a calibrator (3C196, 3C295...) - Problem with many of the LBA observations (demixing): reobserved a few weeks ago => work on LBA data is lagging behind.

- We did not request night time → investigating the effect of this, so far it seems to be not too bad for HBA but we need to check LBA!

- Pre-processing done initially by pipeline → but the "manual" calibration seems to work better.

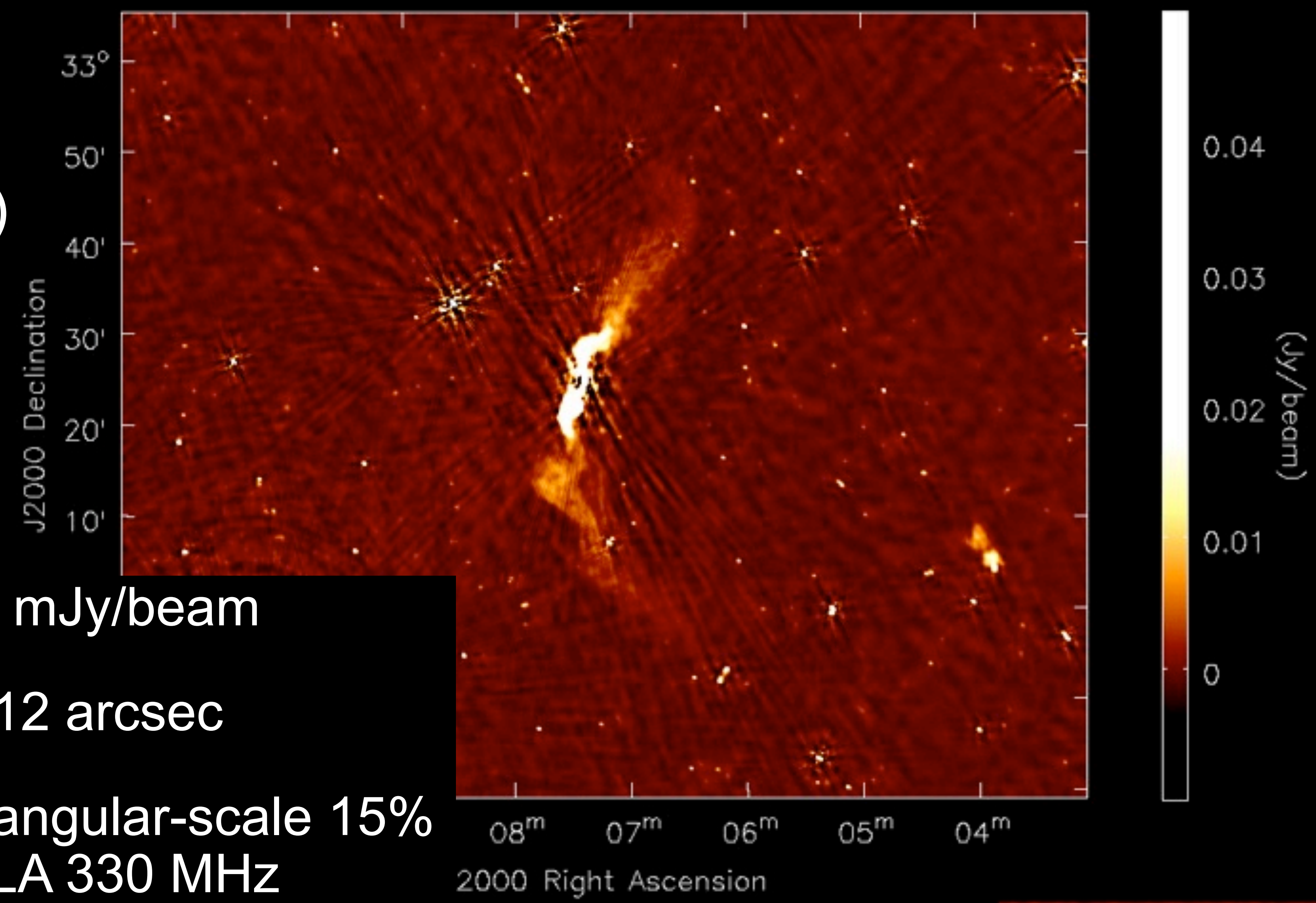
- Raw data kept only for Judith's sources and moved to Southampton
- Other datasets: kept the pre-processed, averaged data => we are moving most of the datasets to the cluster @ASTRON *FLITS* (10 nodes, 200 Tb).

3C31 LOFAR observations

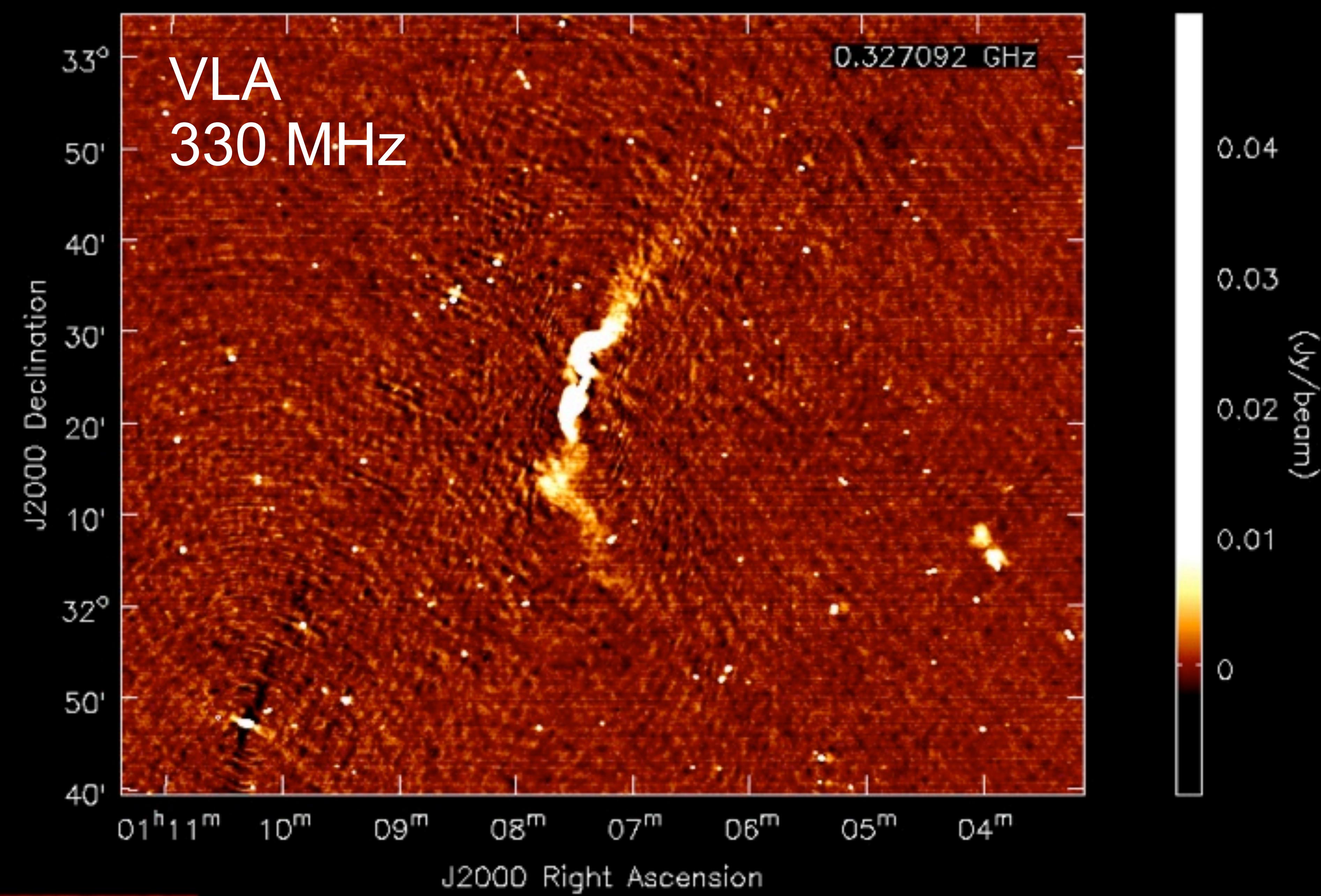
Provided by Judith Croston and Volker Heesen

- 10 hrs observing time in HBA
- 3C48 and 3C196 as primary calibrators
- HBA data pre-processed by ASTRON
- Initial NDPPP
- Calibrate calibrator and transfer solutions
- Combine sub-bands
- Phase-only calibration on each band *(starting model VLSS)* =>
  pipeline work in Southampton by Adam Stewart
- Image with CASA or awimager

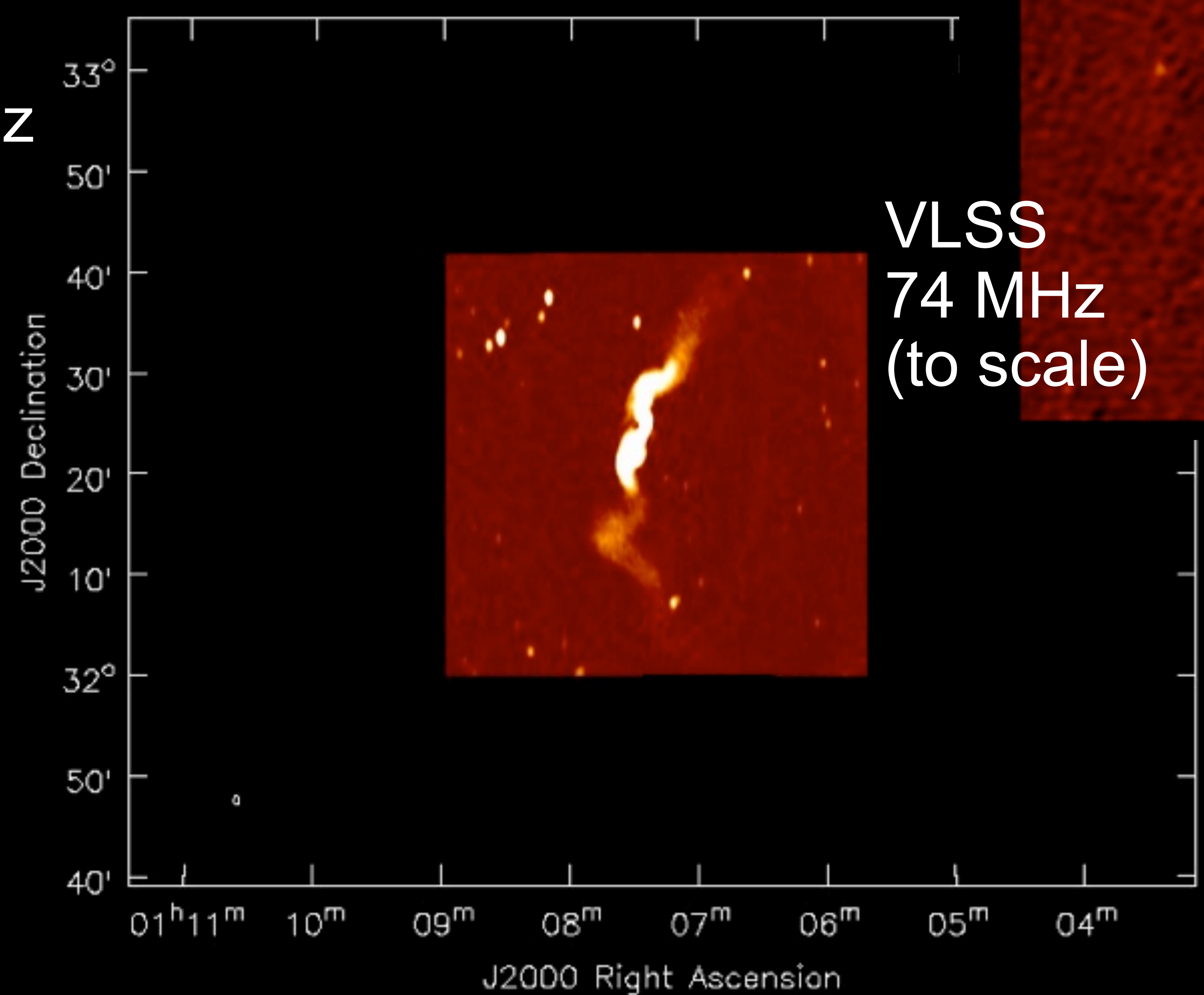
LOFAR
144 MHz
(244 SBs)



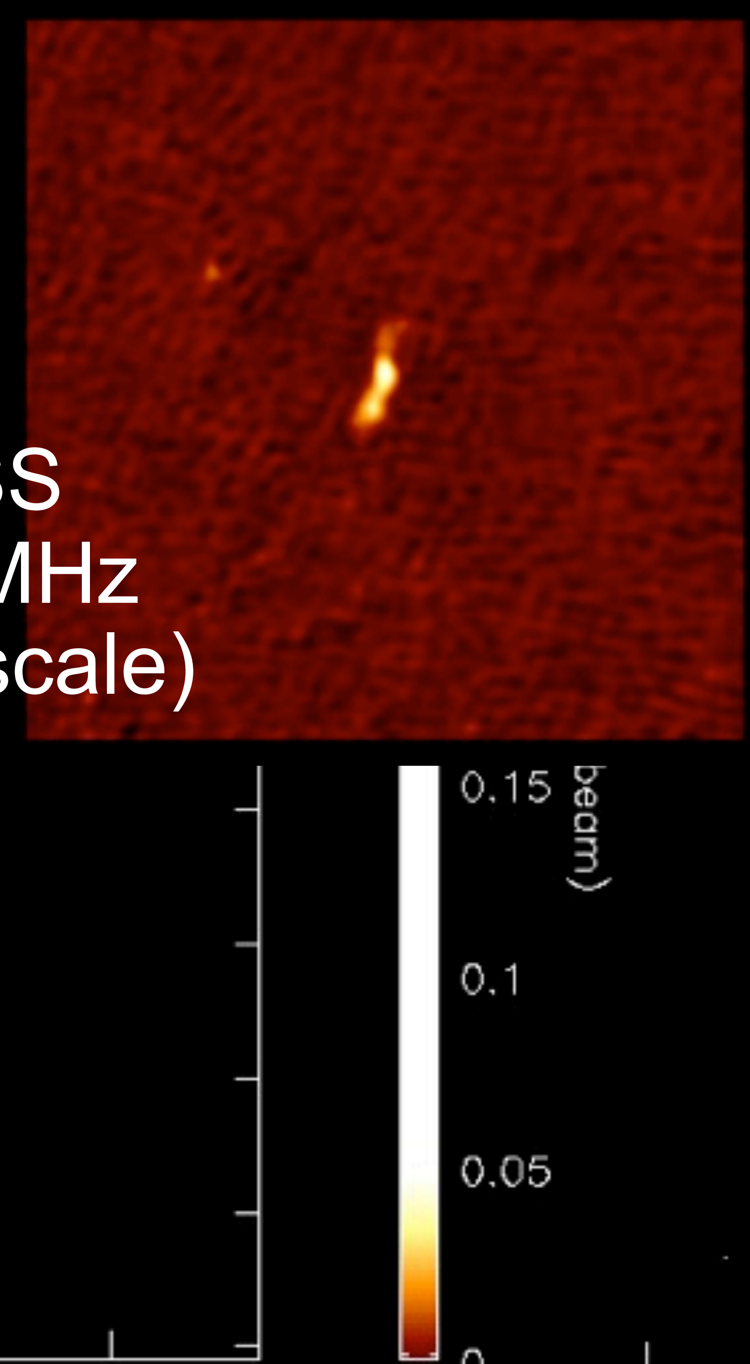
- Noise rms = 0.7 mJy/beam
- Resolution: 17x12 arcsec
- LOFAR largest-angular-scale 15% larger than at VLA 330 MHz

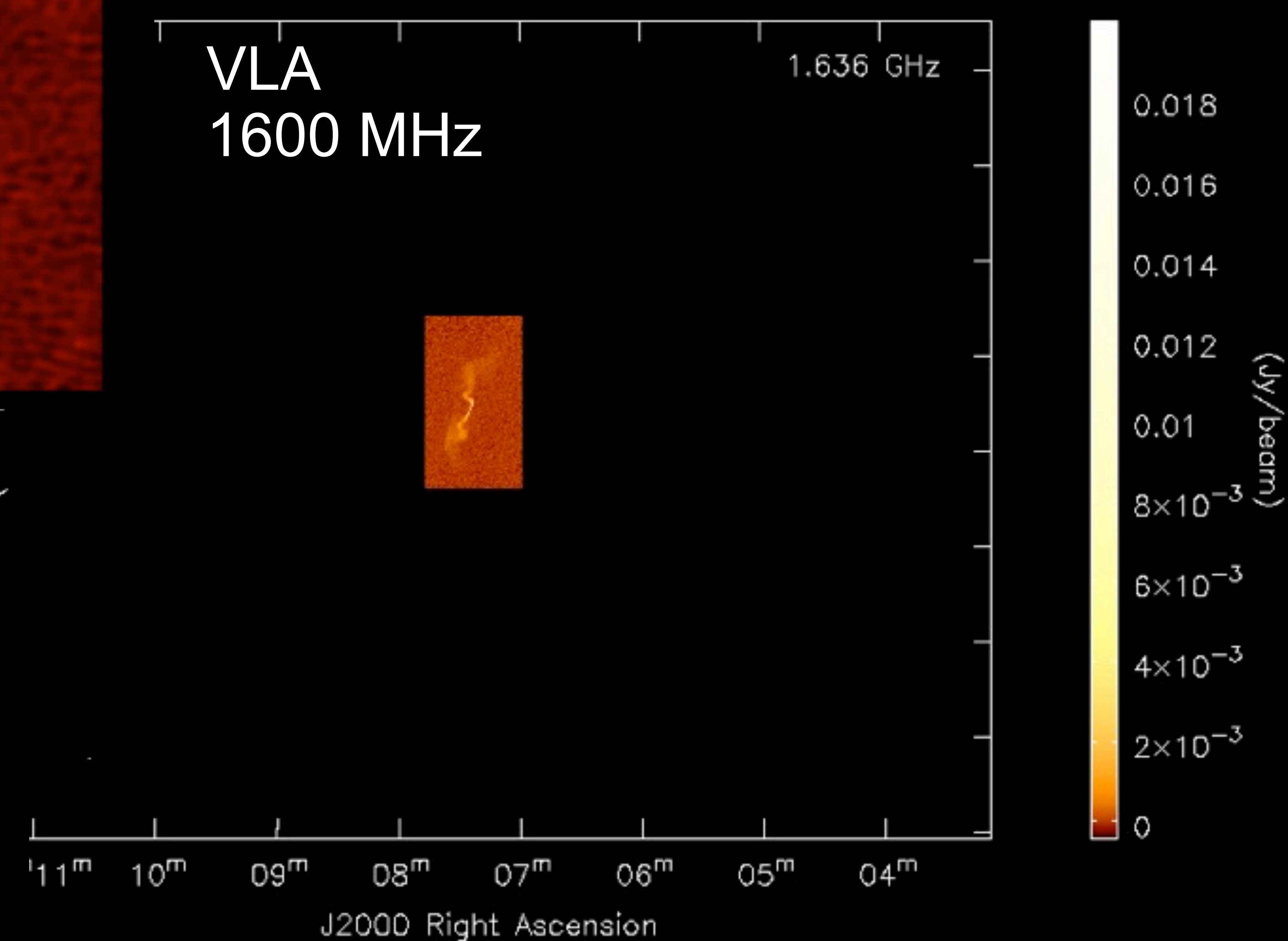


WSRT
608 MHz



VLSS
74 MHz
(to scale)

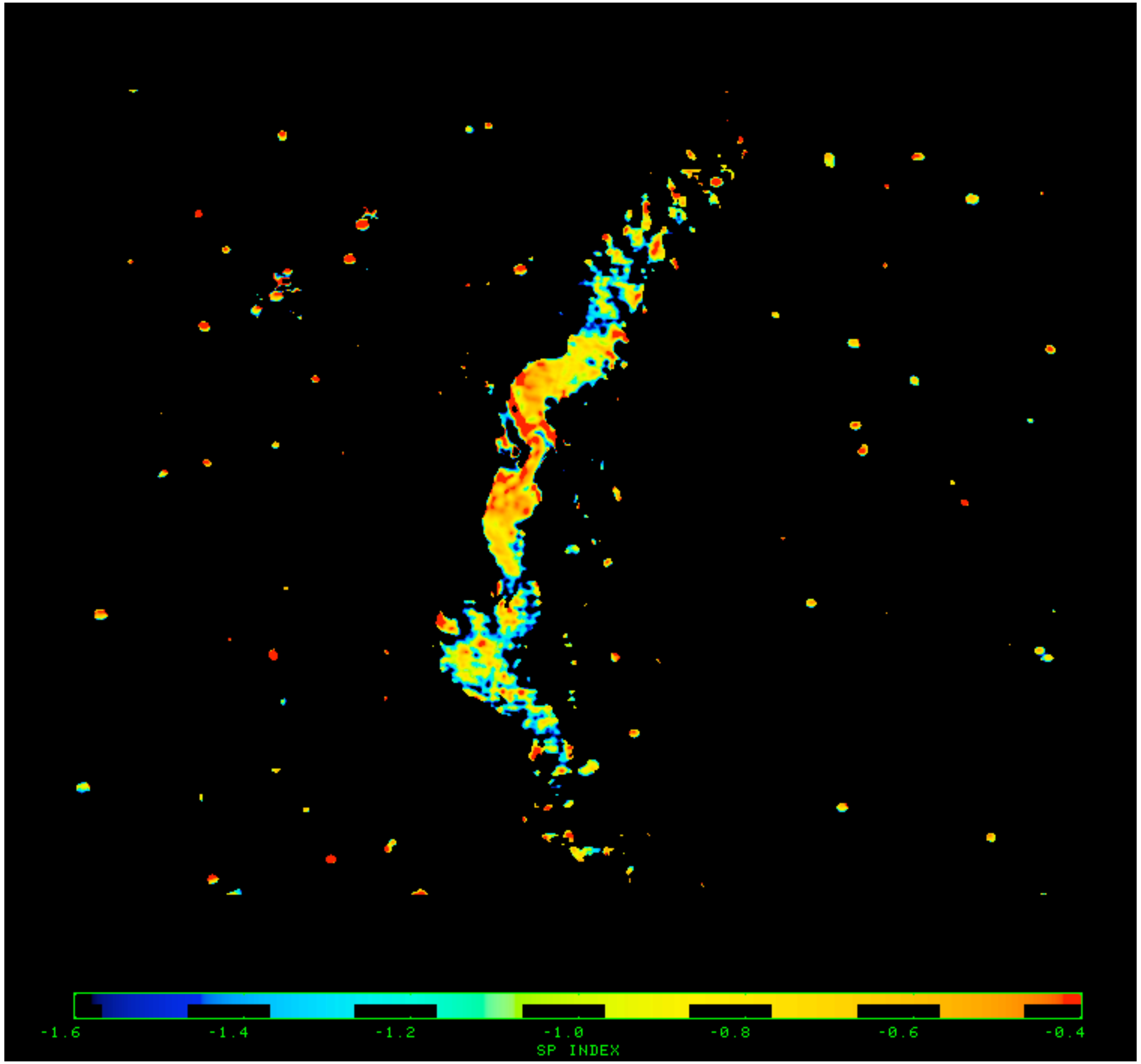




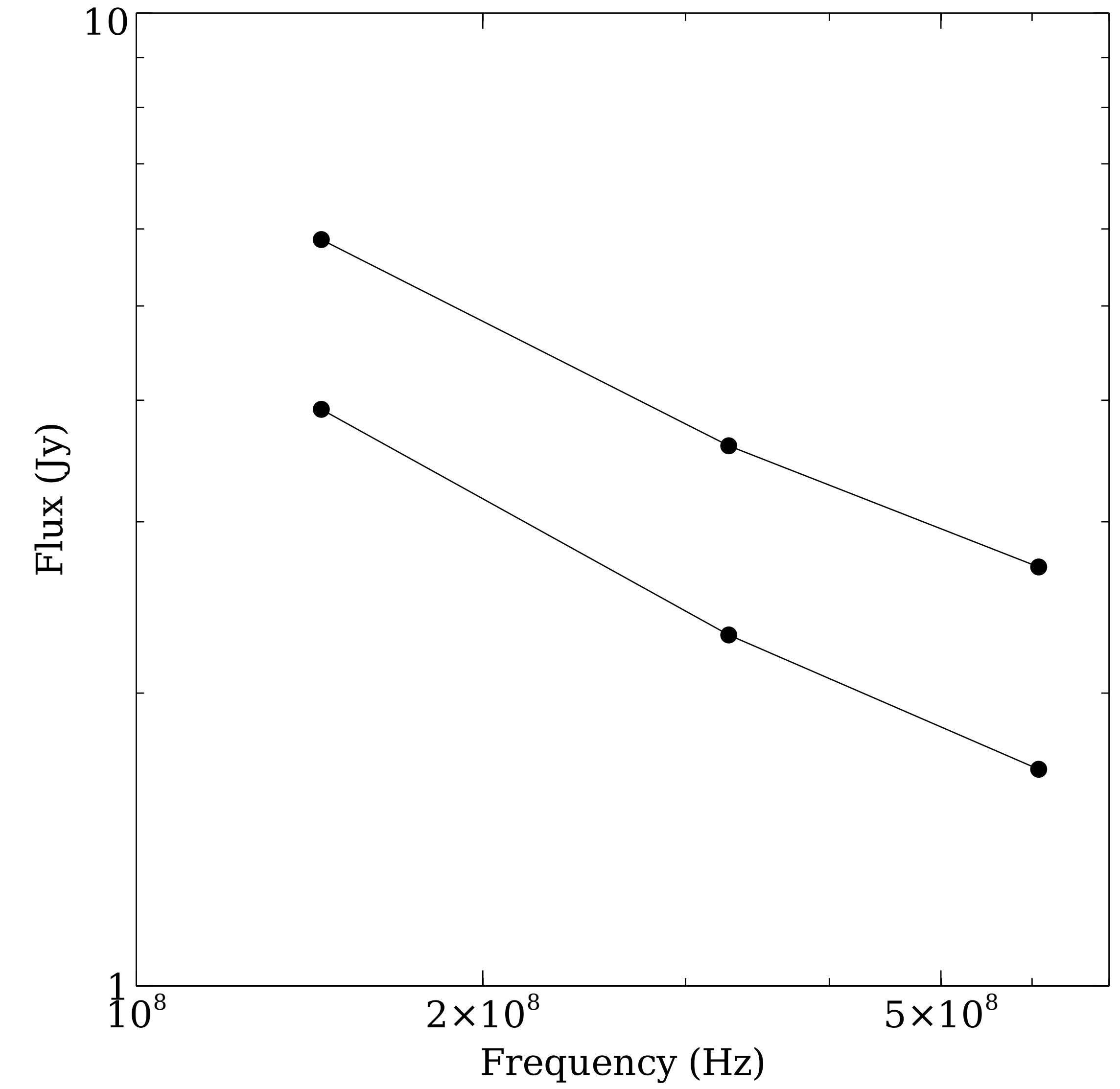
- Imaged with CASA clean
- Peak flux density: 5.2 Jy
- Noise rms = 0.7 mJy/beam
- Resolution: 17x12 arcsec
- S/N = 7400
- LOFAR largest-angular-scale 15% larger than at VLA 330 MHz

3C31 spectral index

Radio spectral index
144 – 330 MHz

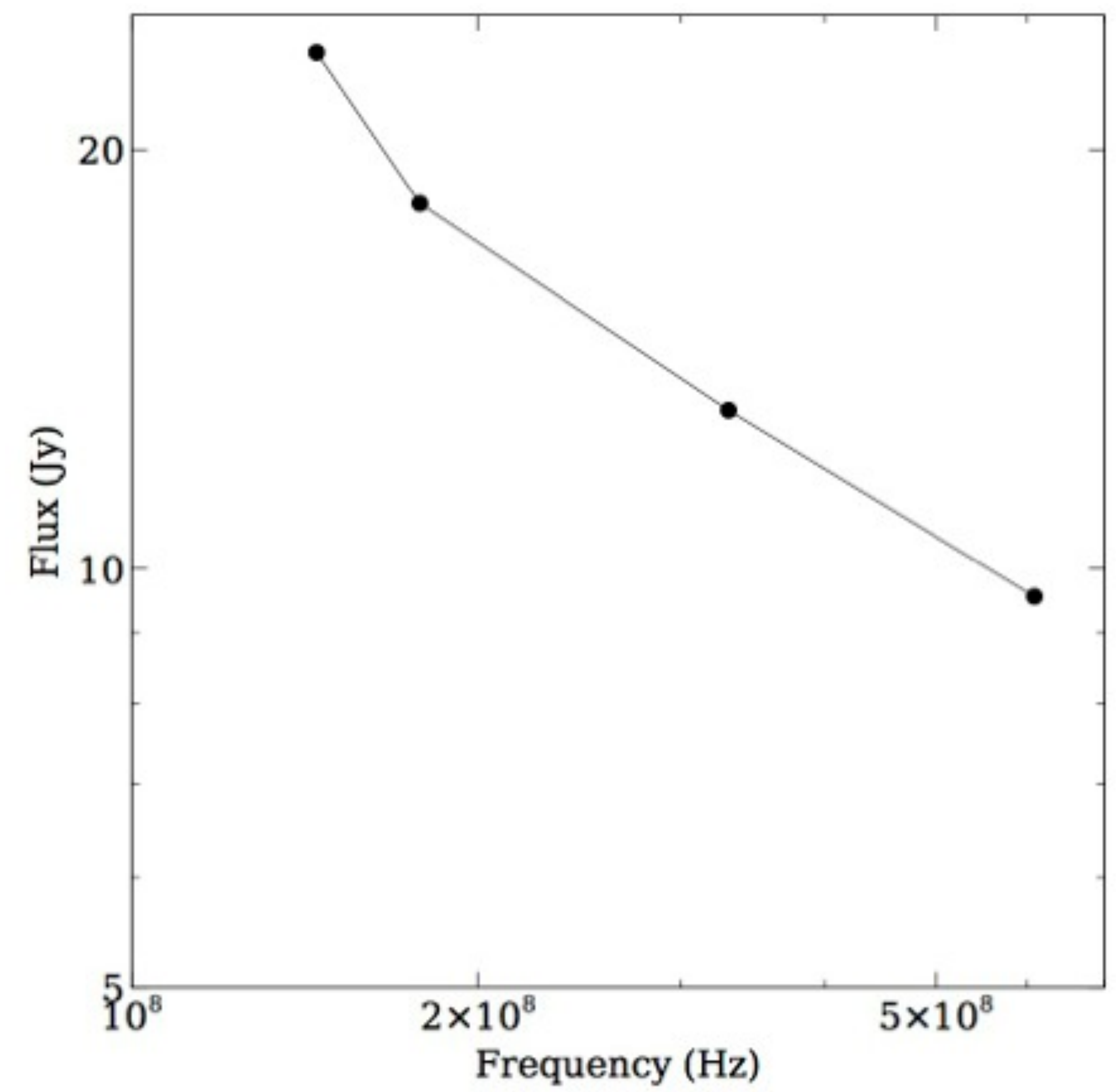


145 MHz HBA, 330 MHz VLA and 608 MHz Westerbork



Two large regions of the inner lobes, SI~0.55

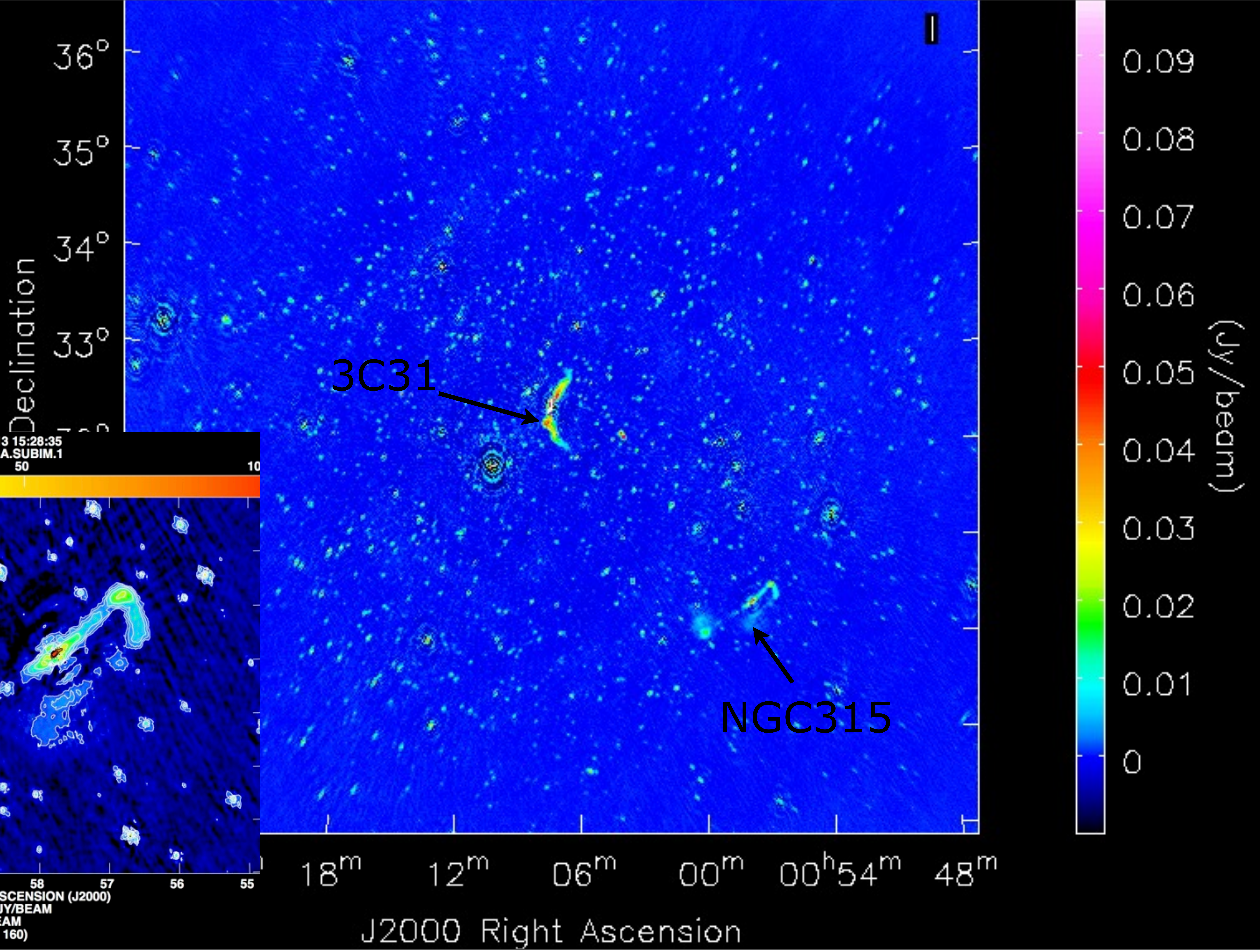
flux scale looks reliable to within at least ~15%

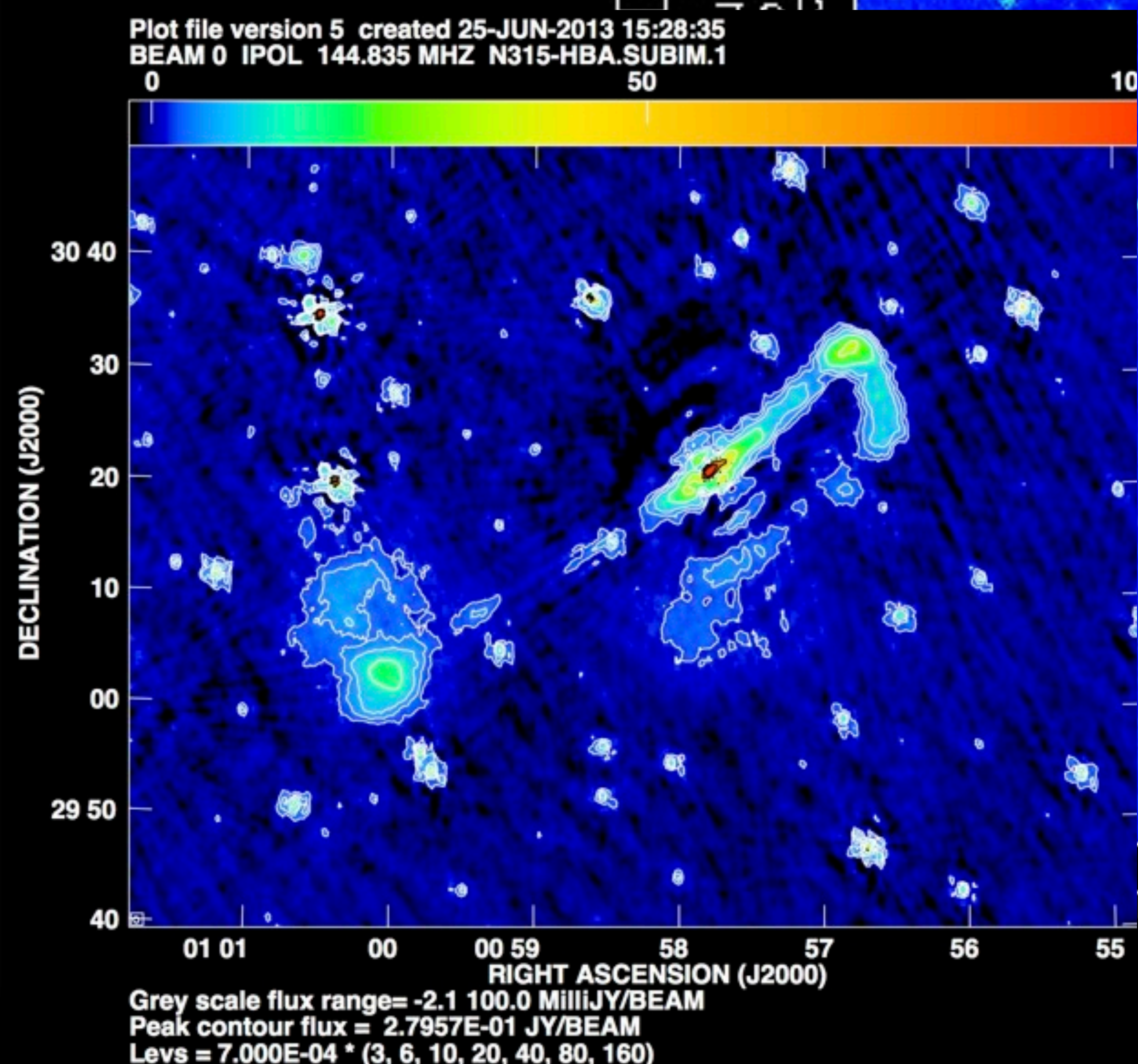


Integrated

Large field!

Image baselines 20km - 244 SB
V. Heesen

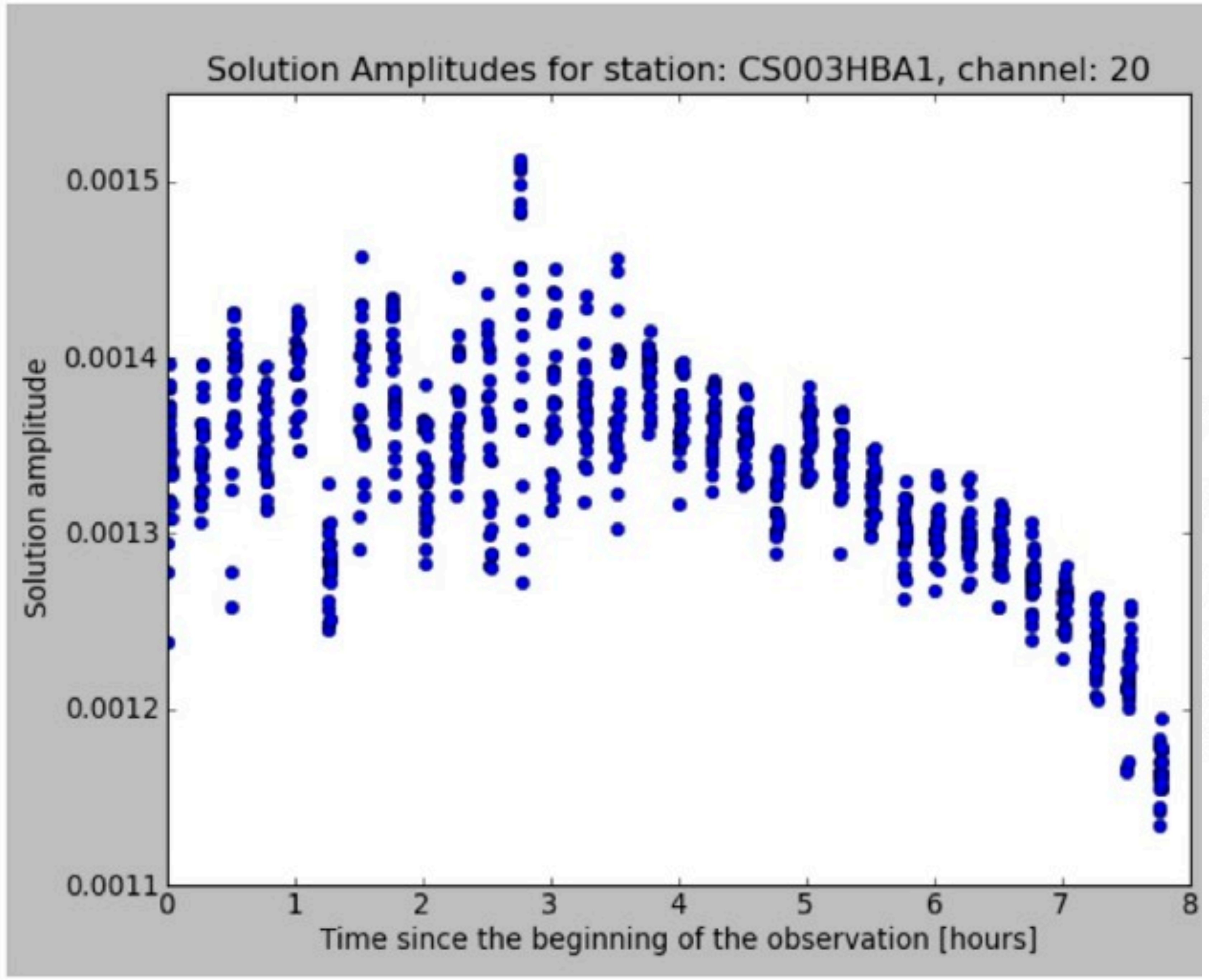


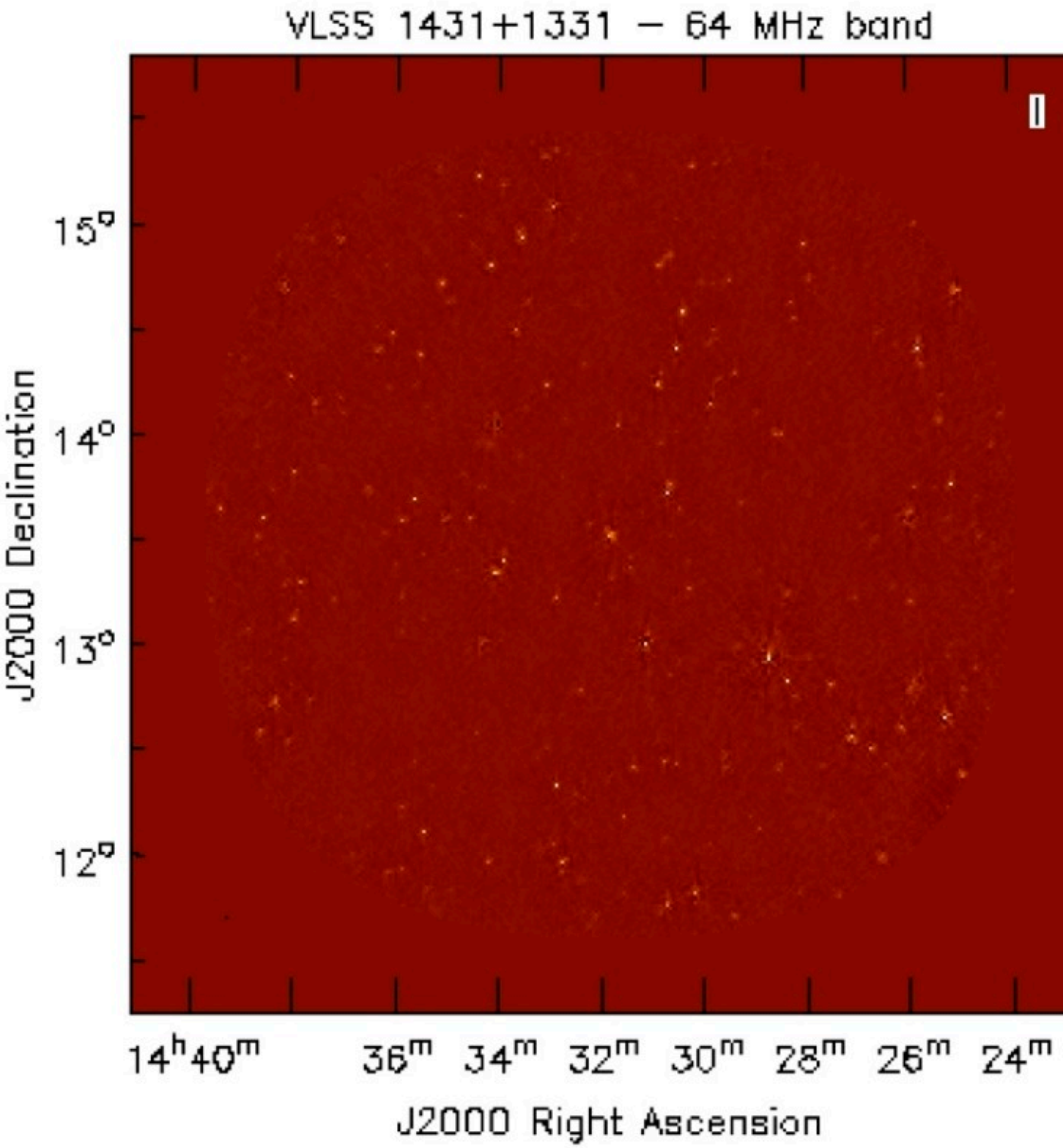


Relic VLSS 1431+1331 HBA - Aleksandar Shulevski (selected from van Weeren et al. sample)

Calibrator amplitude solutions

over the observing run.





Processing strategy:

LOFAR Pipeline:

- calibrator scan A&P calibration
- Solution transfer to target

Our pipeline:

- Concatenate data in freq. and time, remove A-team, flag RFI / outliers.
- Phase calibration on target, VLSS initial model (Sagecal, selfcal)
- AW imaging

11" resolution, noise: 1.89 mJy / beam

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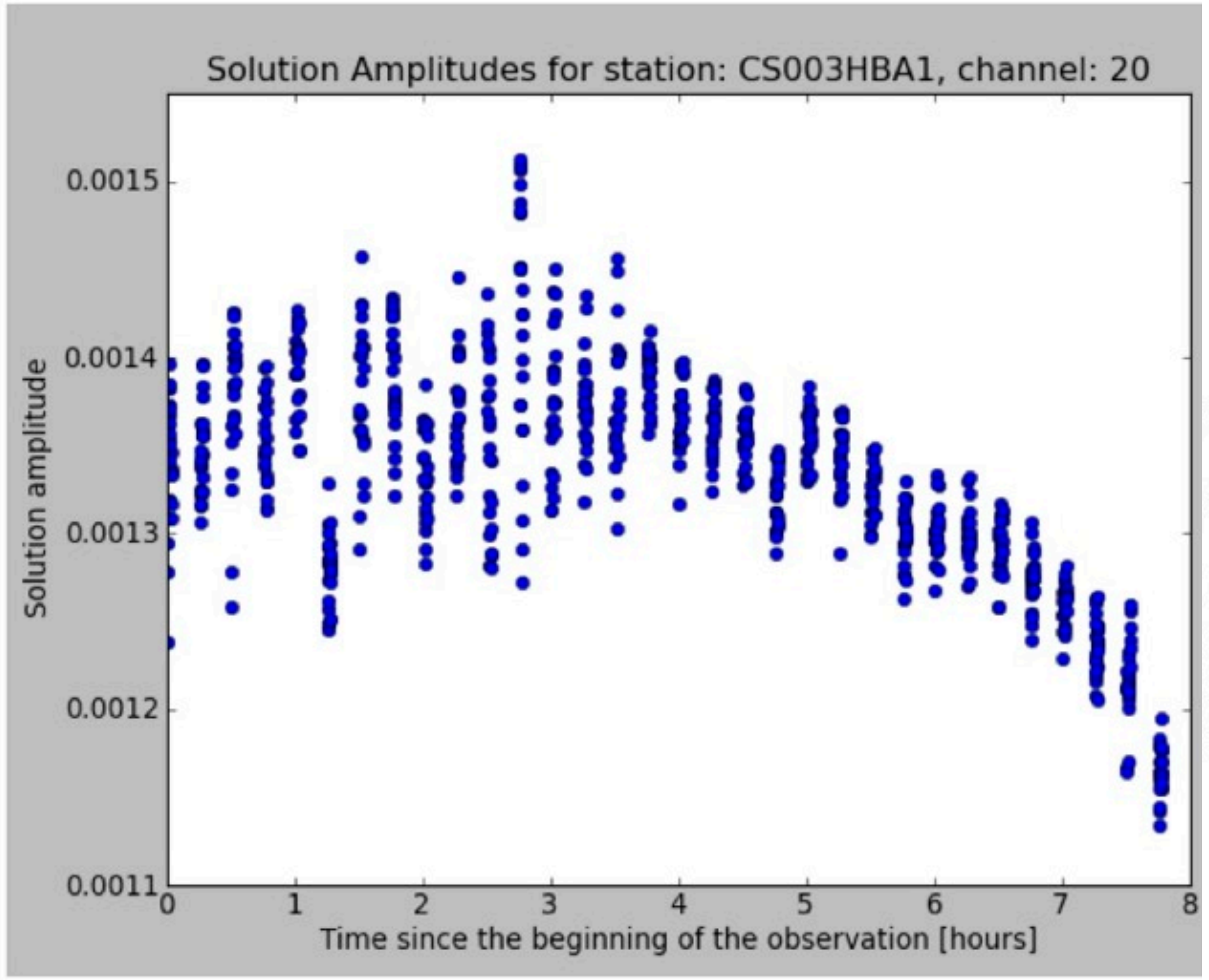

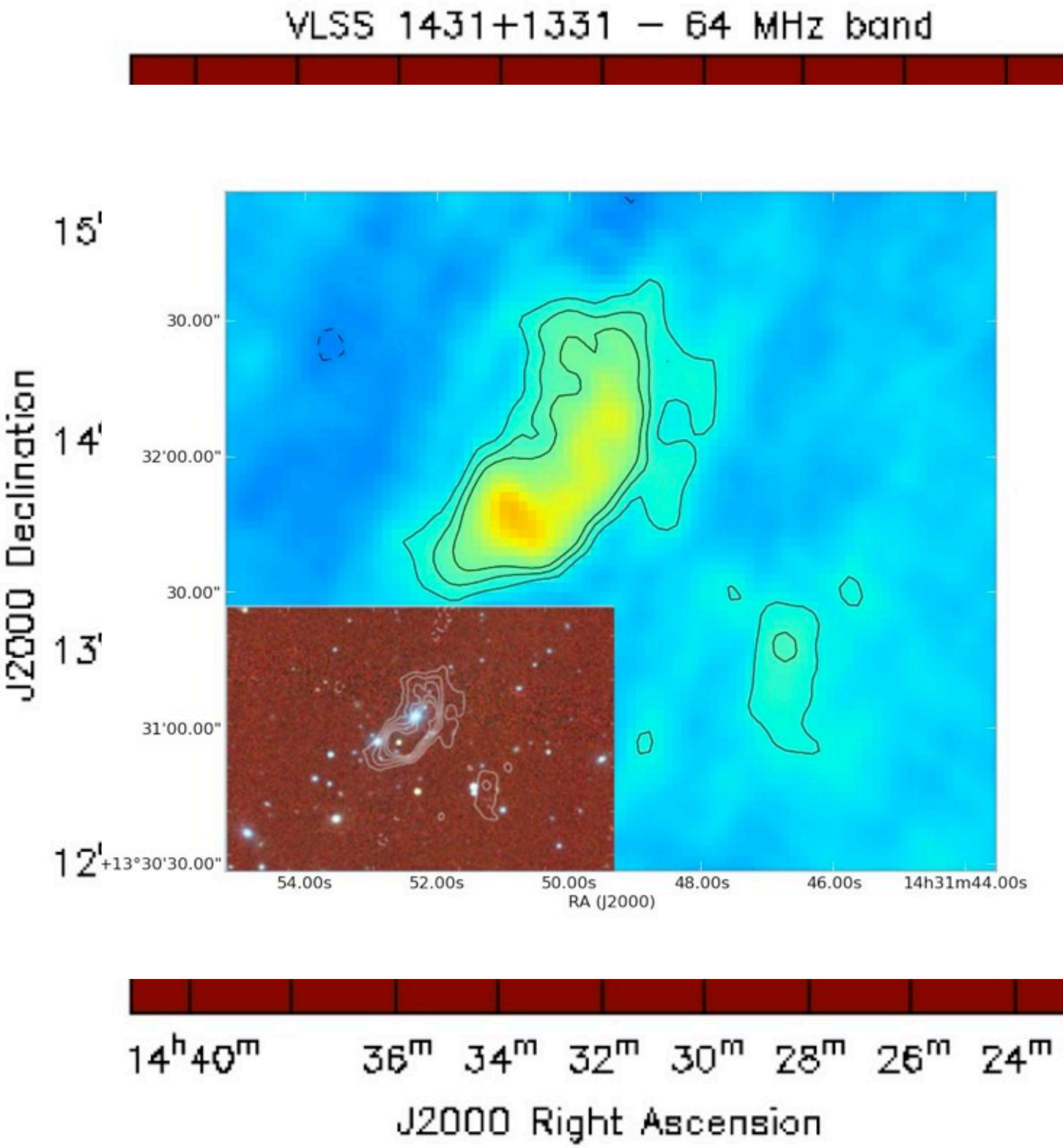

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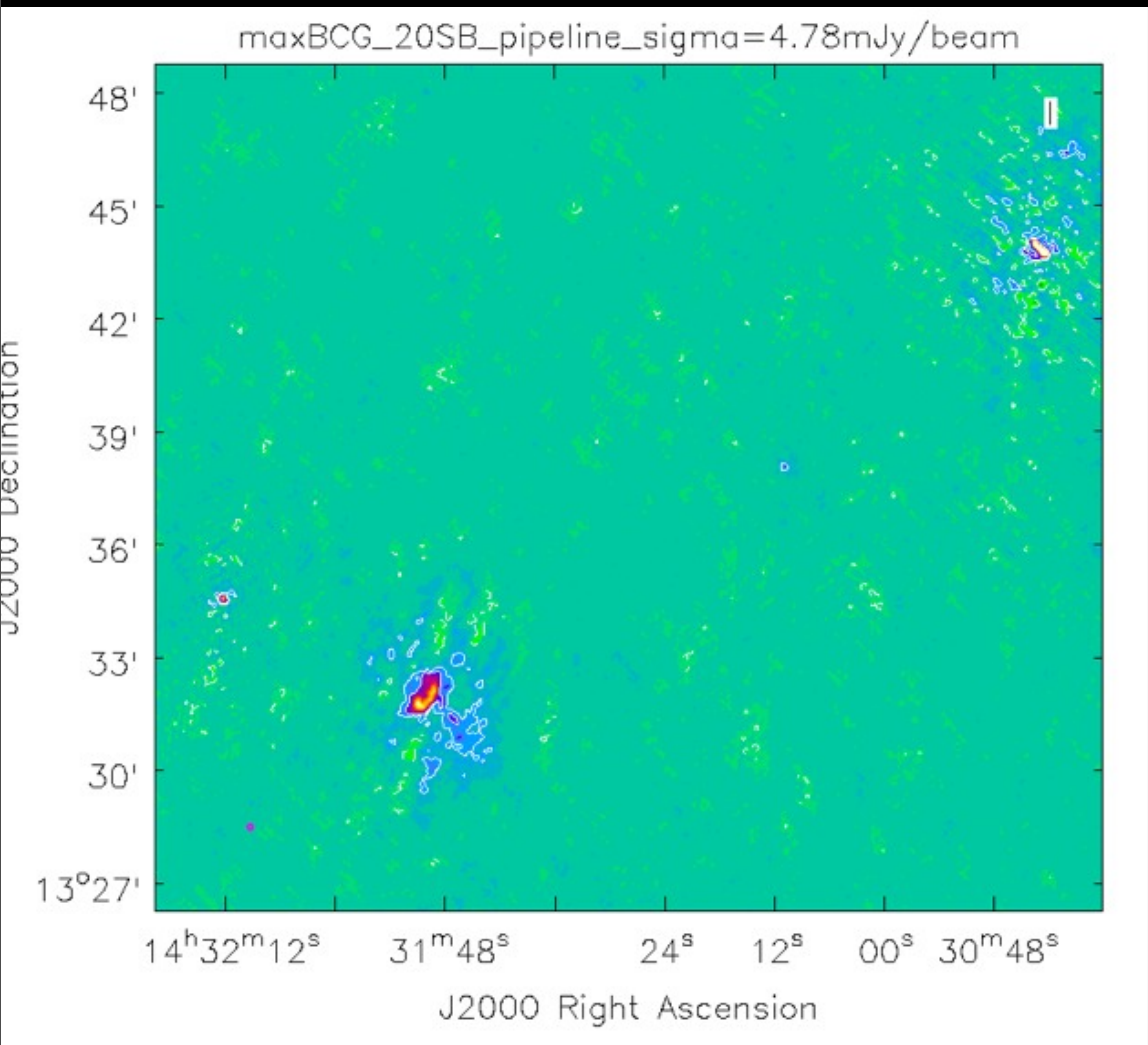
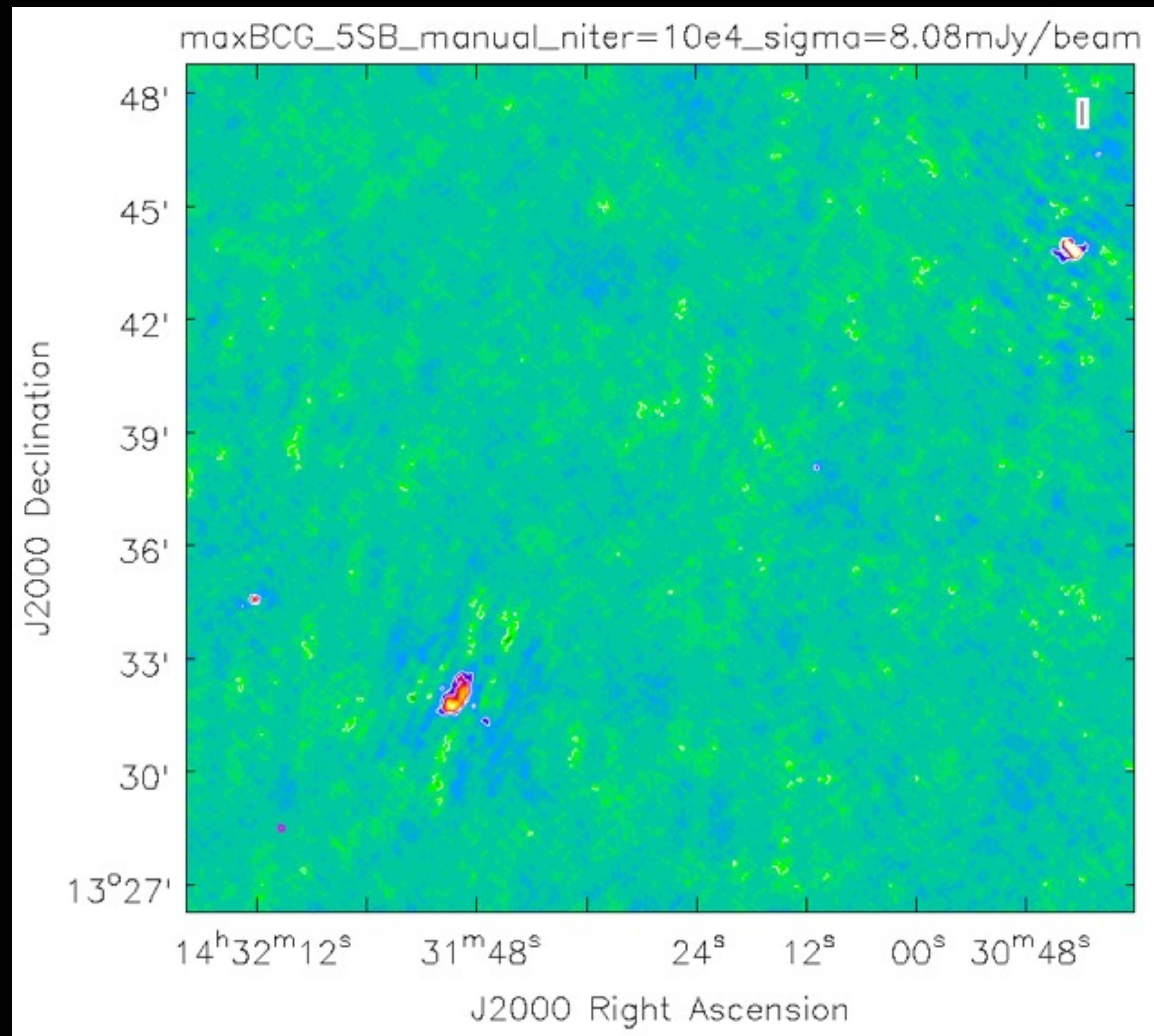
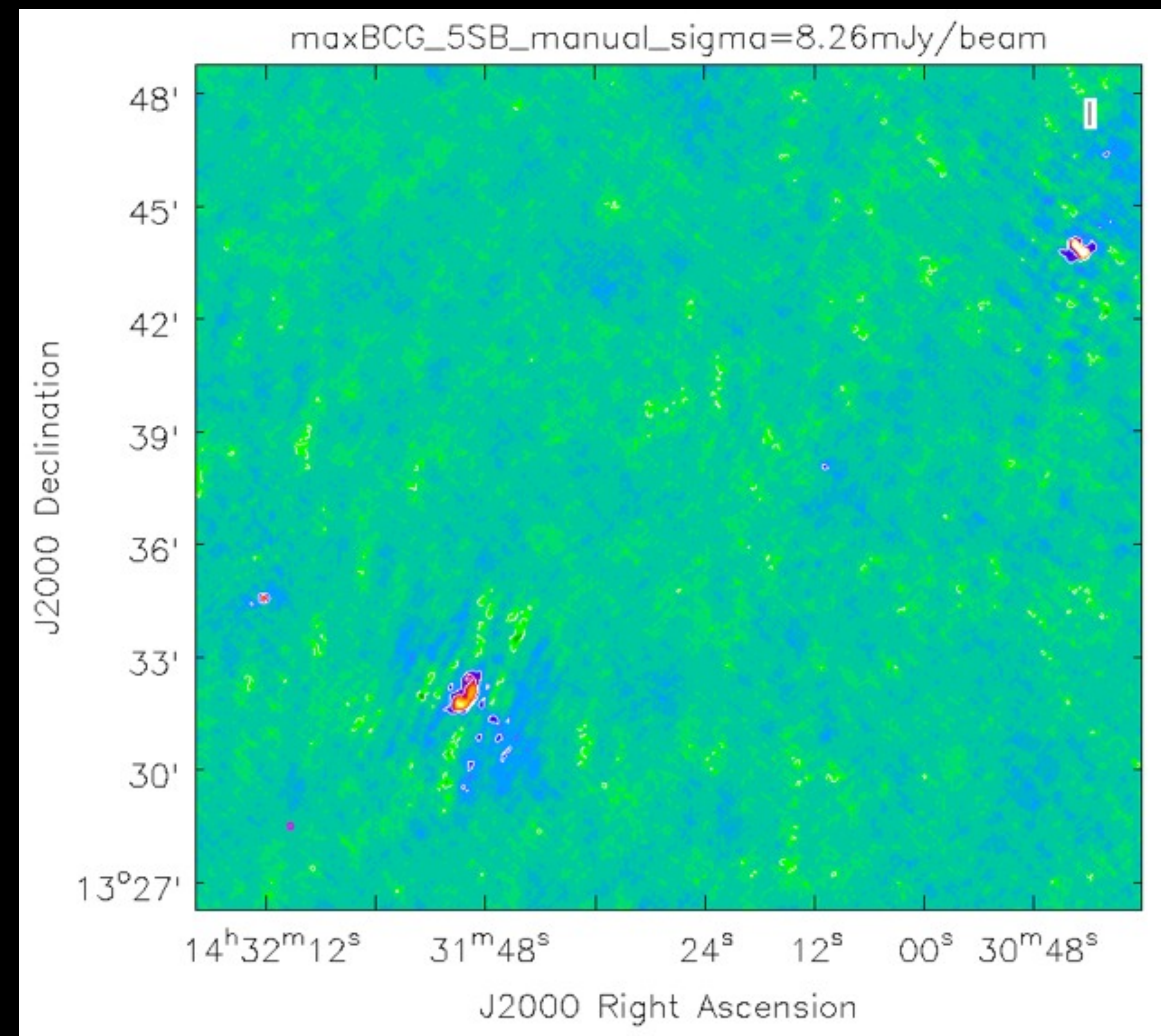
Check of the “automatic” vs “manual” calibration



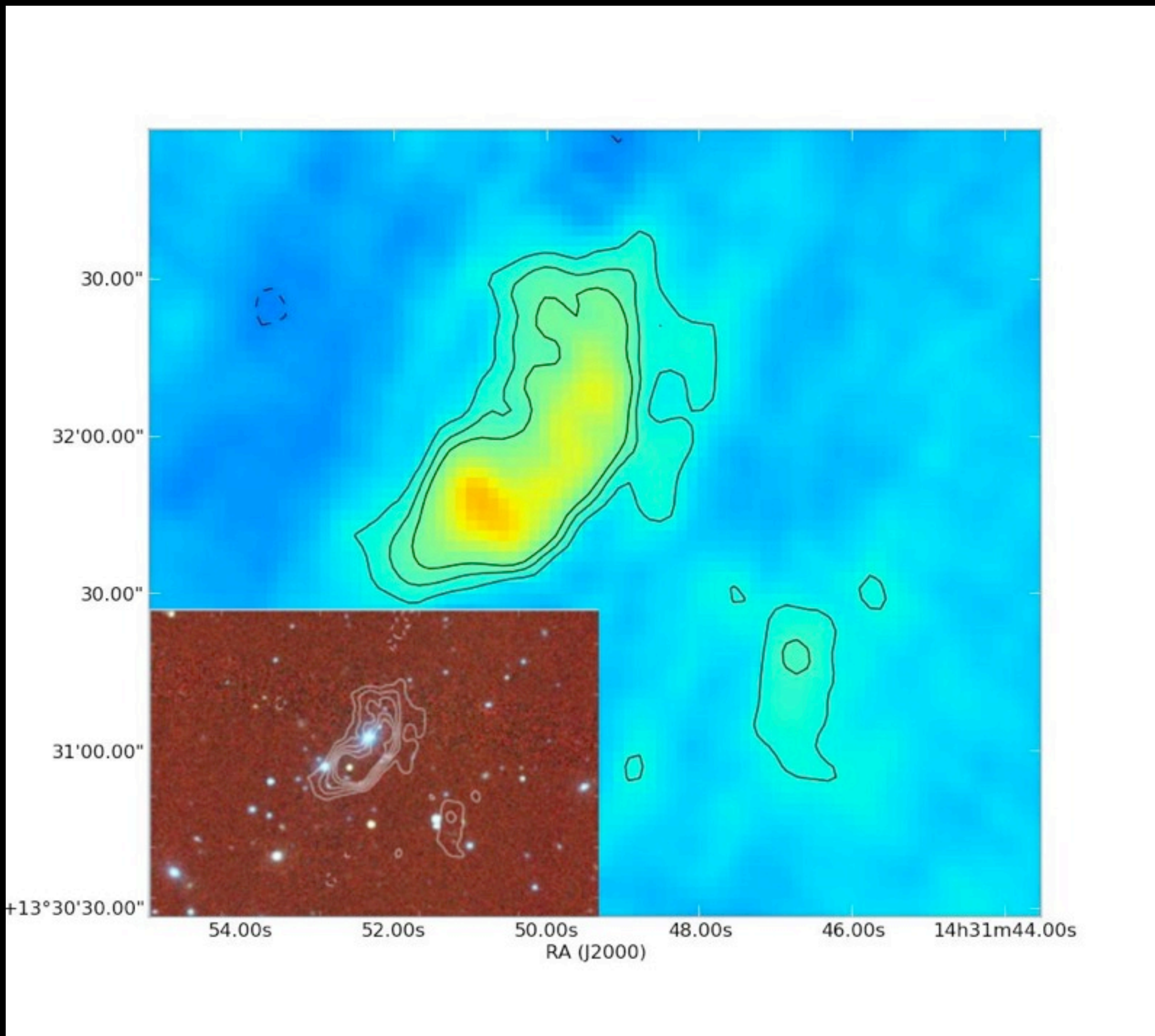


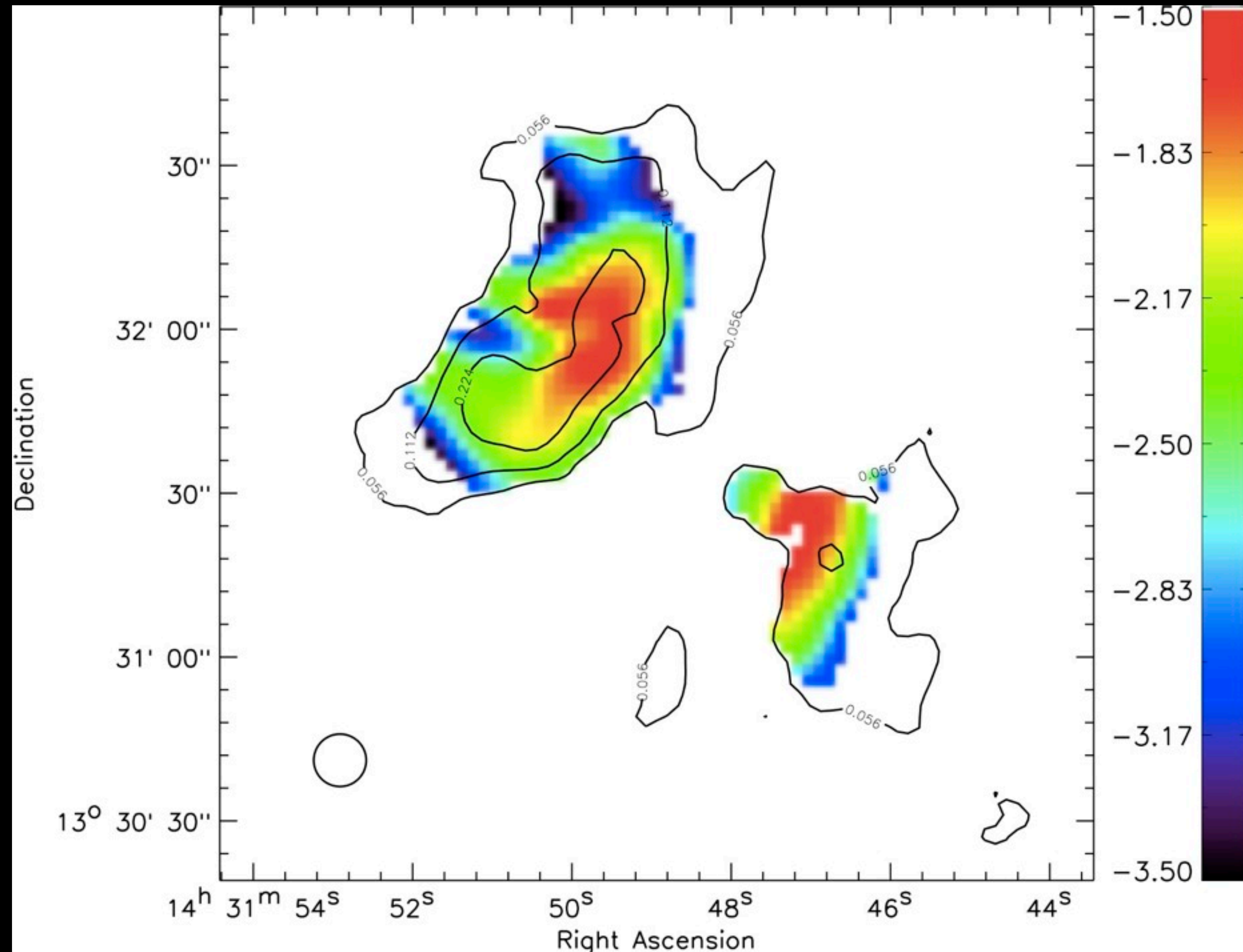


20SB - pipeline

5SB - manual

Derive age of the relic VLSS 1431+1331 via spectral index analysis





Virgo A - Francesco de Gasperin

Broad-band calibration to improve uvcoverage (important for the clean)

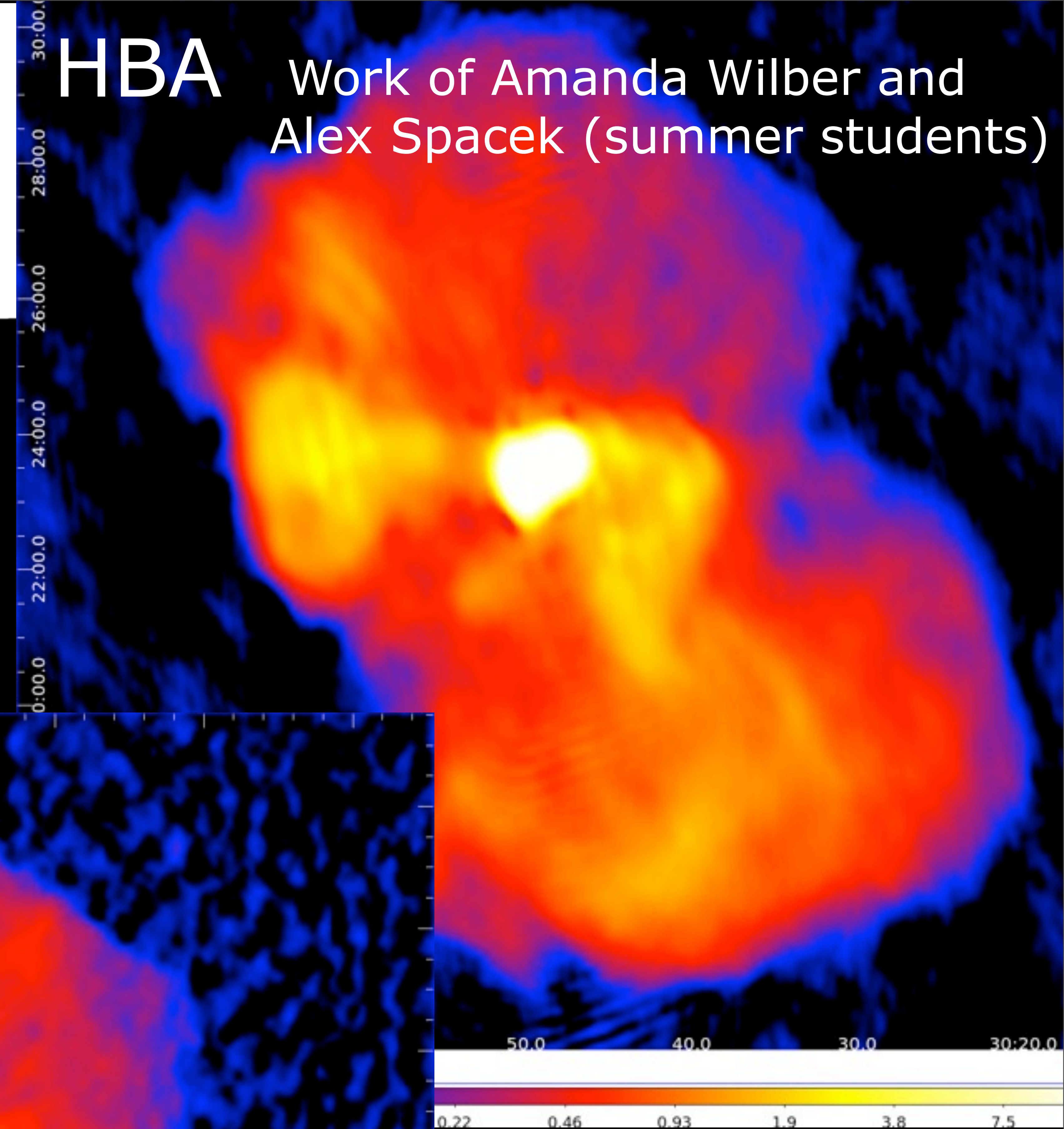
HBA: still working at improving the calibration of the remote stations (added and calibrated in th eselfcal cycles)

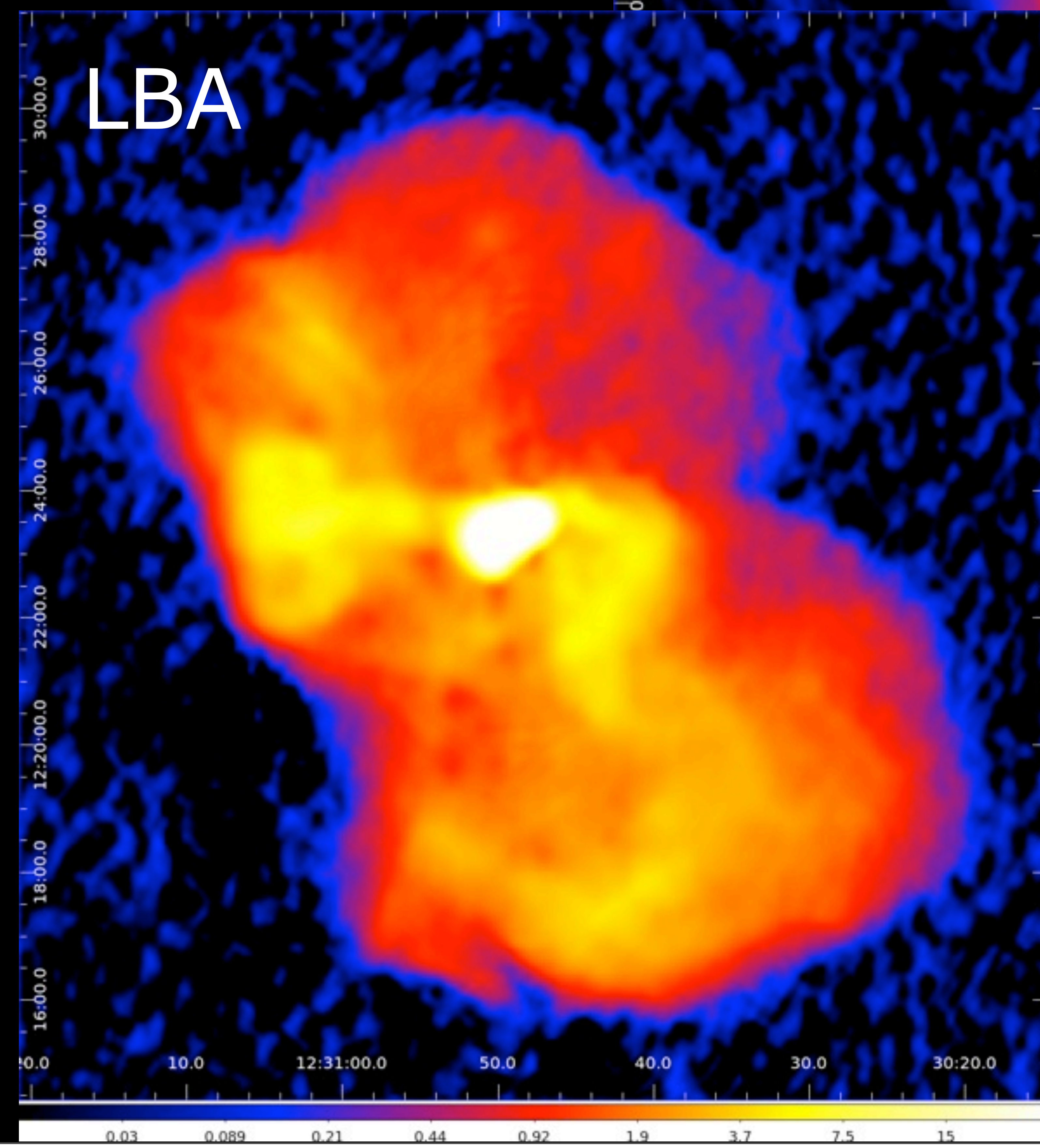
➡ HBA

6 SBs spread all over the bw
4 remotest station excluded (we are working to calibrate them)
robust: 0
RMS: 20 mJy
Dyn Range: 35k
resolution: 24"x12"

➡ LBA

7 SBs spread all over the bw
all station included
robust: -0.5
RMS: 40 mJy
Dyn Range: 60k
resolution: 18"x18" (almost the same resolution of the old HBA map)





Next goal: wide field of the Virgo A area

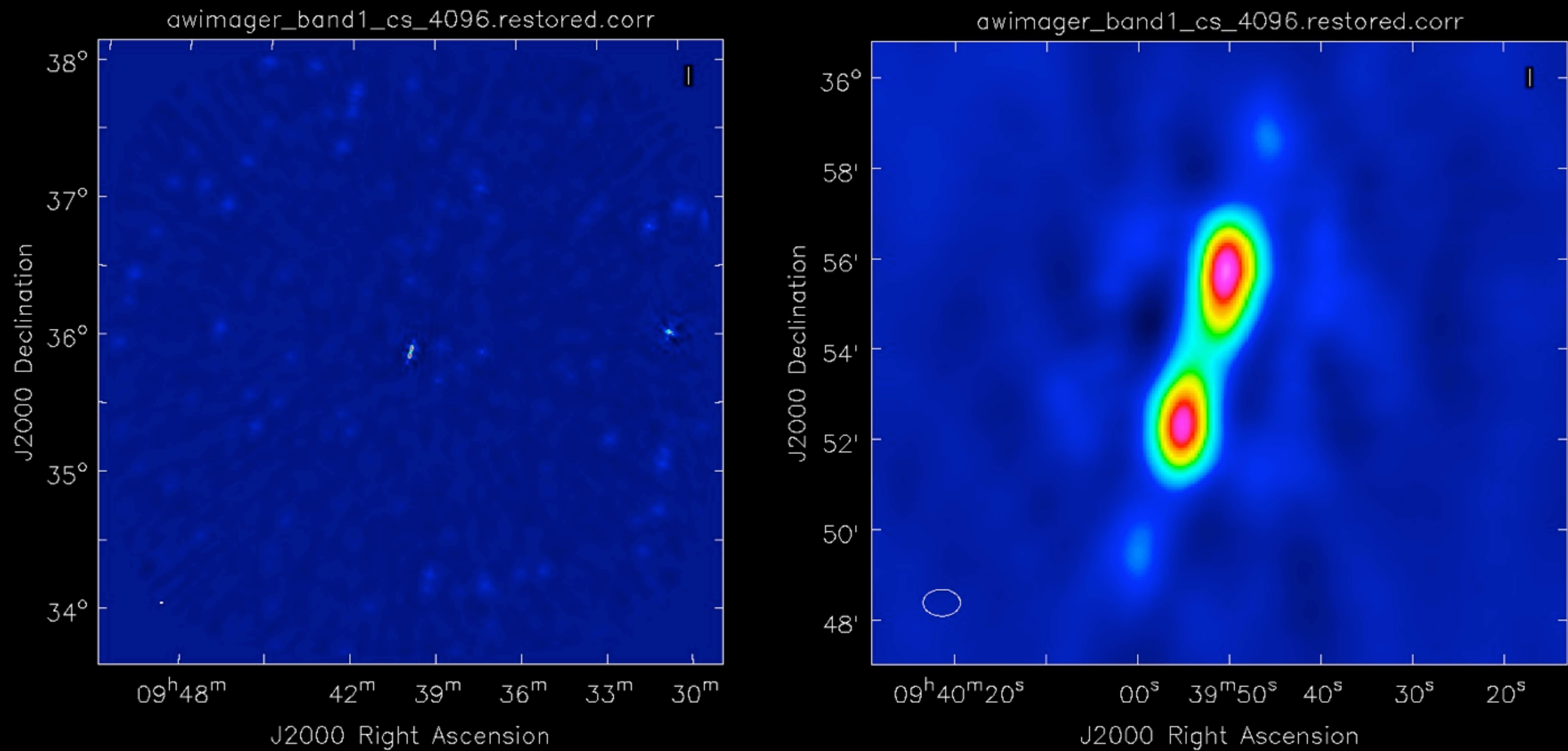
3C223 – Band 1 LBA INITIAL IMAGING - Jeremy Harwood

- RMS: 27 mJy / Beam

- Total flux correct to within ~5% compared to Orru 2010 (extrapolated from 73.8 MHz)

- Total flux density: 35.39 Jy
- Northern lobe: 19.28 Jy
- Southern lobe: 16.10 Jy

- Extrapolation from 178 MHz shows under estimation of flux density – A promising initial sign for our future spectral analysis!



Left: 4 Degree FoV of 3C223 at 51.6Mhz using AWImager

Right: Image zoomed to 3C223

3C223 – Current Issues and Next Steps

- ‘Fuzzy halos’ around background point sources
- Artefacts close to source
- Image out to ~10 degrees to locate any further bright sources
- Imaging with CASA for comparison of image quality and flux
- Reduction of HBA data and further LBA bands

What next?

ASTRON

- Still problems for source sources (Hydra A, Her A)

- A number of test to be done:
are we happy with the approach we have followed for the observations? in particular the interleaving calibrator of HBA, did we spend too much time on calibrator? was it necessary? did we have problems with observations done (partly) during the day?

- Catch up with the LBA datasets....

- First source (3C247) observed for the “longbaseline” group and soon starting the reduction

- More sources to be observed soon (e.g. double-doubles)