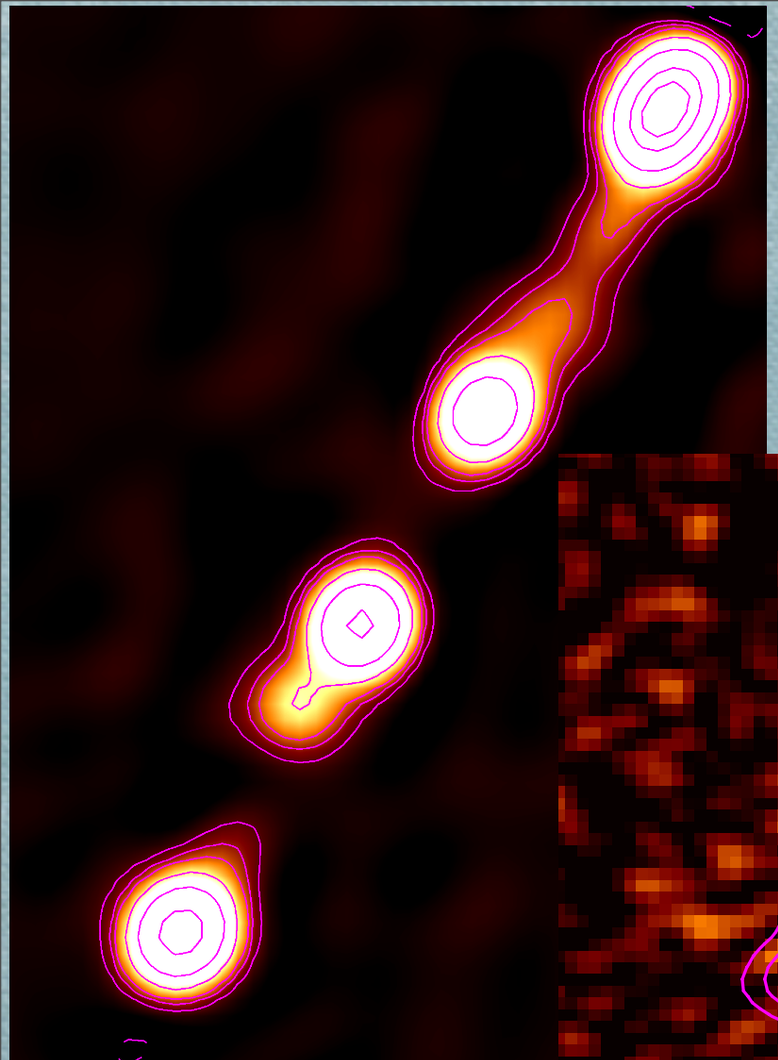
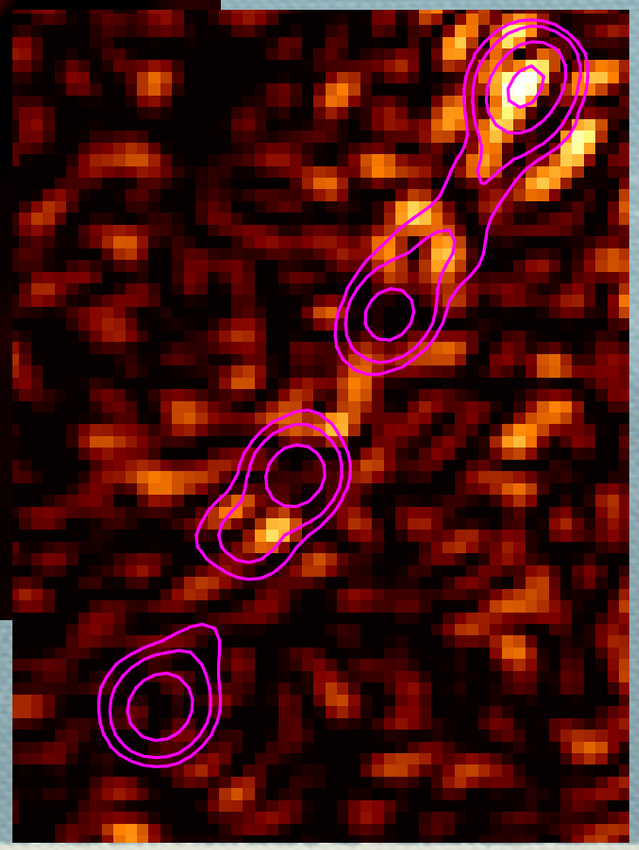
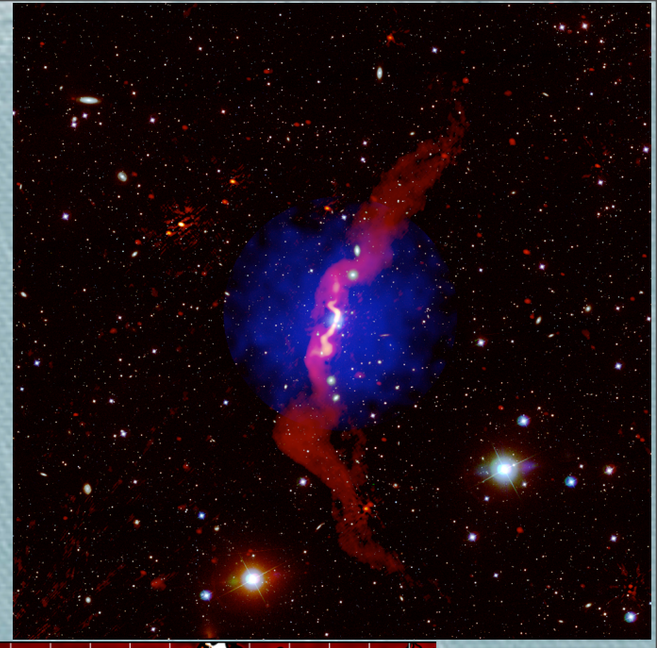
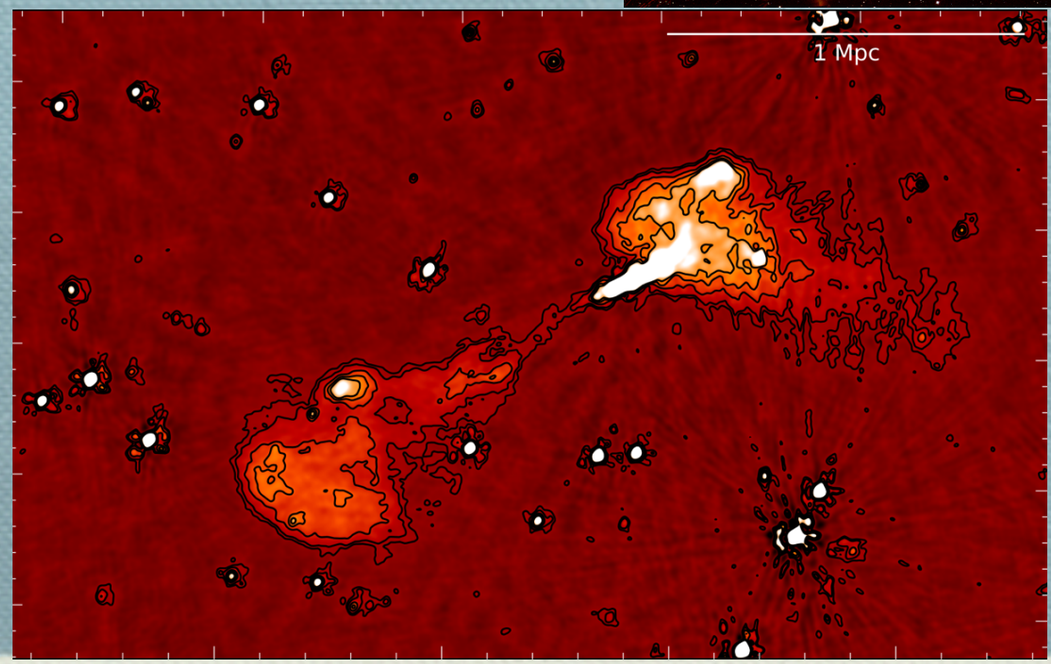








Giant radio galaxies with LOFAR

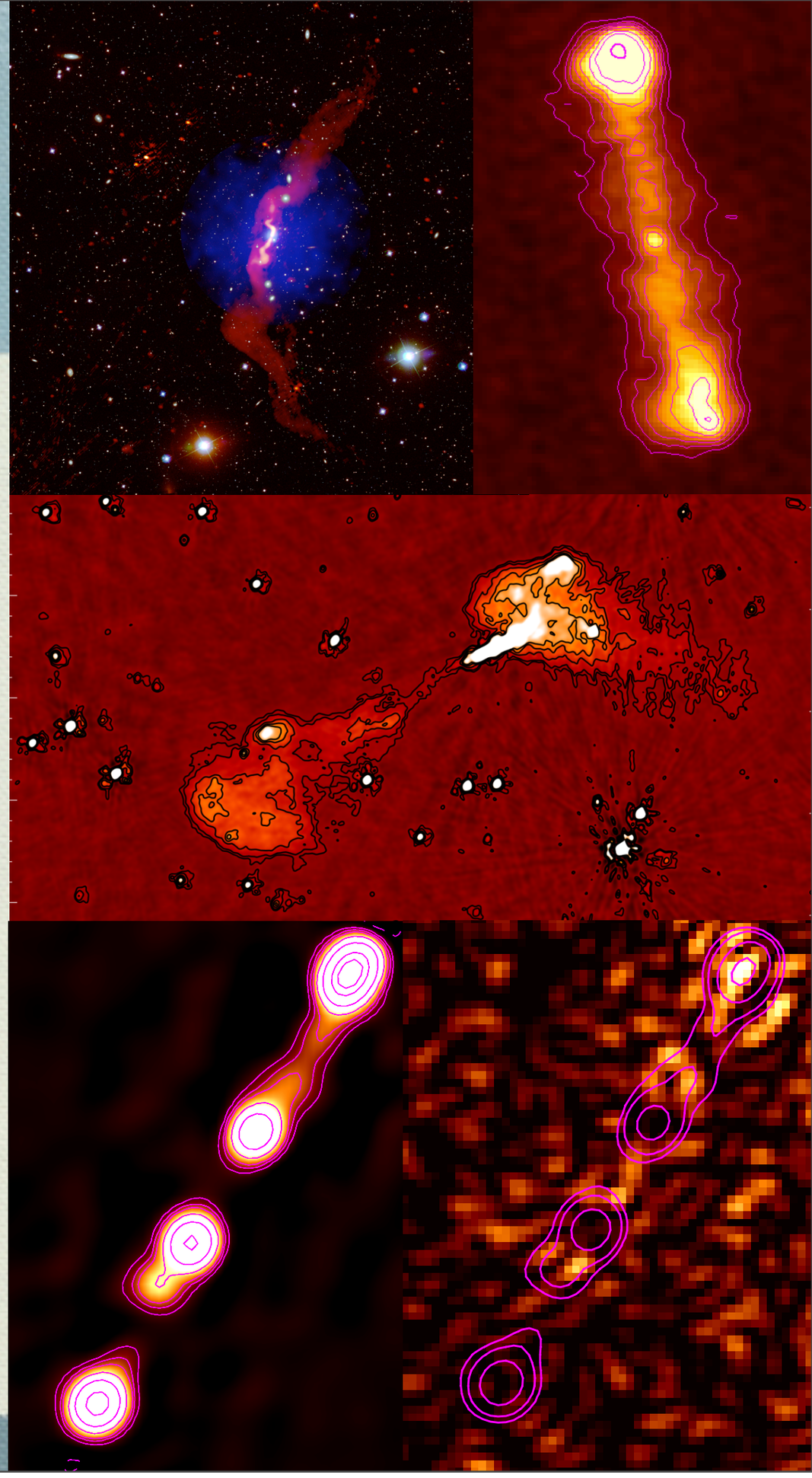
Emanuela Orru'

Outline

- Giant Radio Galaxies
- GRG working group
- LOFAR resuls
- GRG in Tier 1 fields

Giant radio galaxies

- *projected linear size > 1 Mpc*
- *old radio galaxies evolved in a low density medium: low energy electrons*
- *information over large portions of IGM - B in low density environment*
- *energy transport at Mpc scales*
- *200 known GRG potentially biased*
- *highly polarized at high frequencies*
- *good calibrators in polarization - RM grid*

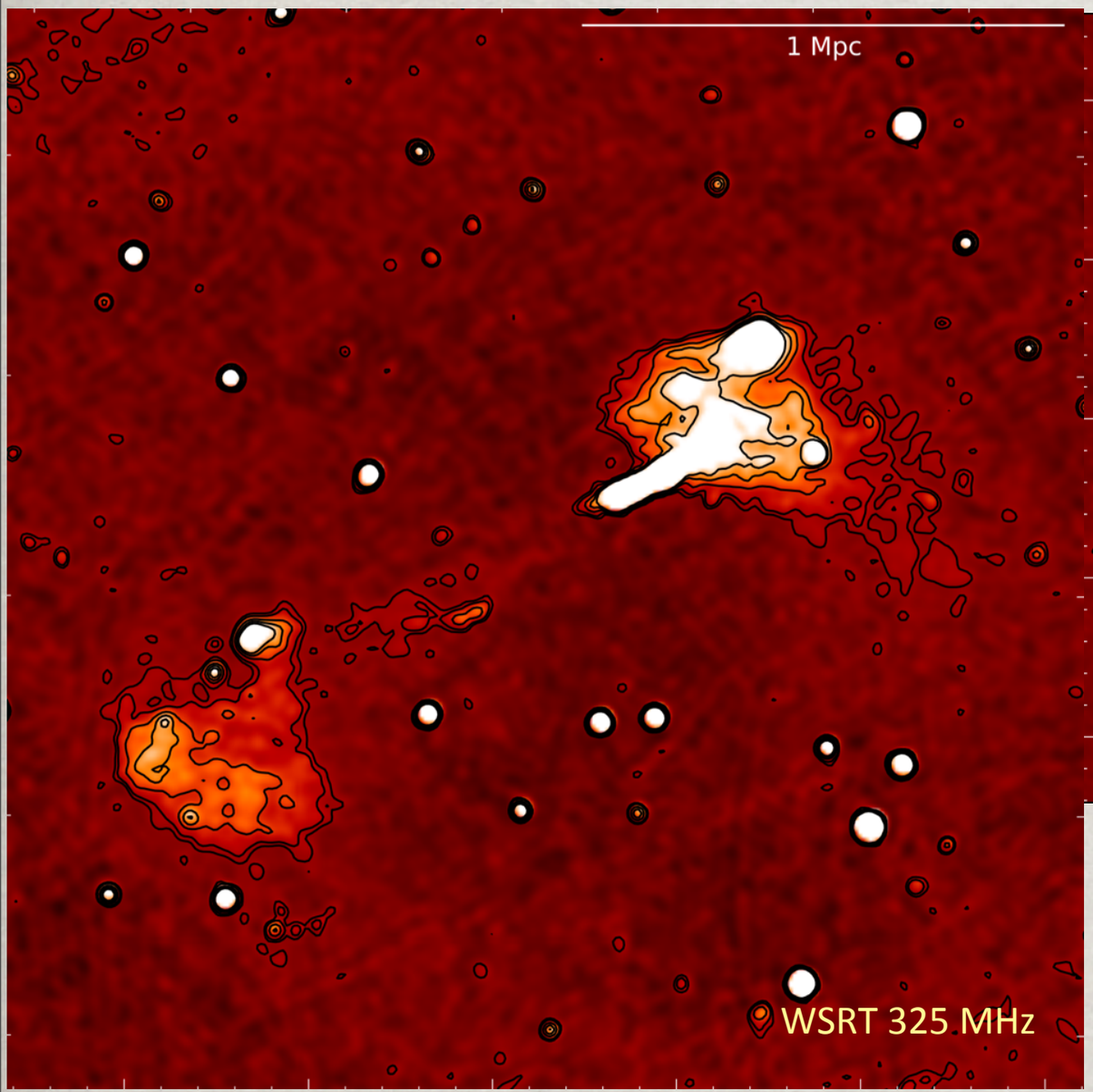


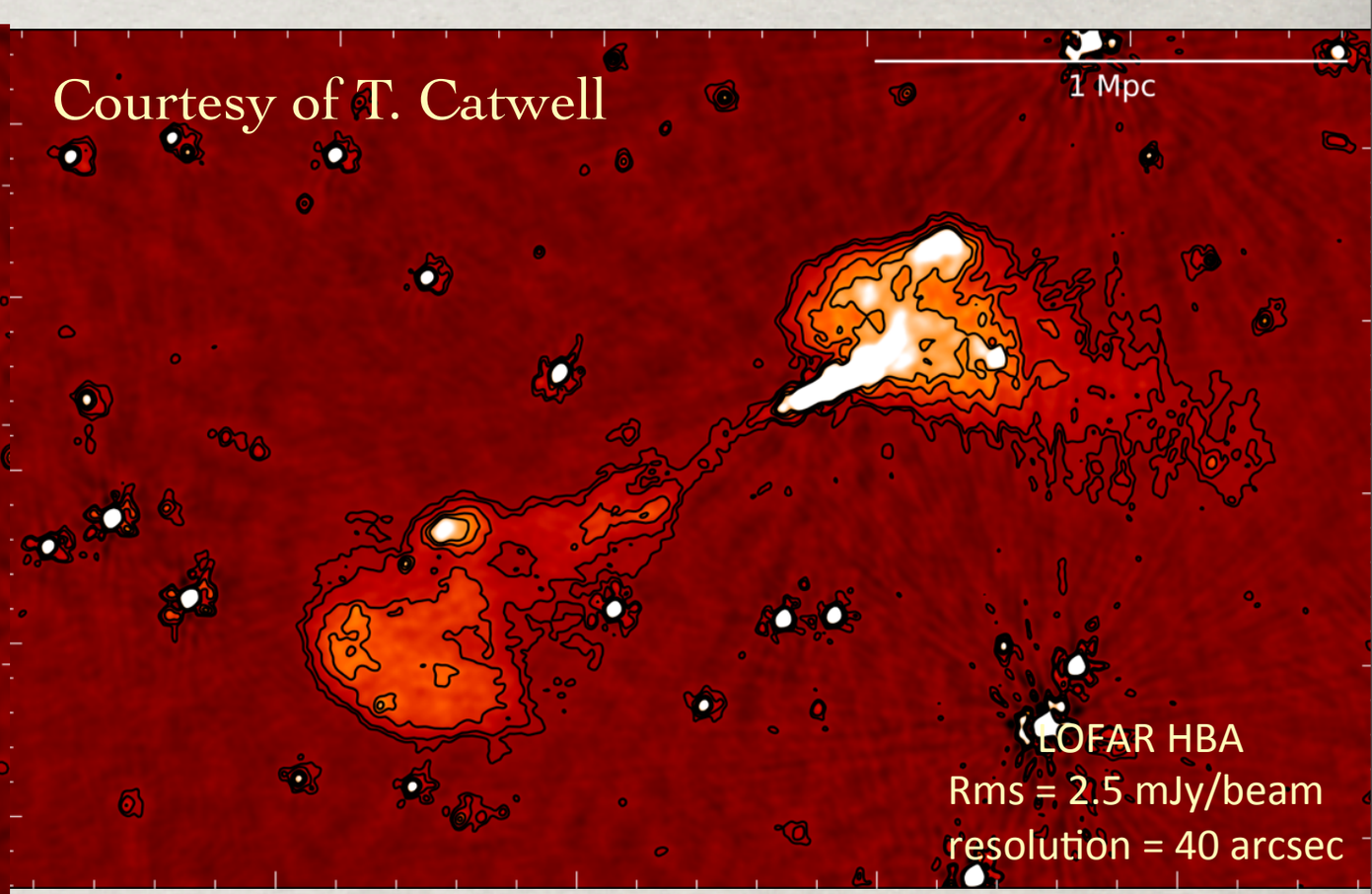
GRG Working Group

Chair . **E. Orru'-** P. Alexander - **M. Jamrozy - V. Heesen** - E. Middelberg - R. Pizzo - J. Riley - G. de Bruyn - M. Birkinshaw - L. Saripalli - **T. Cantwell - D. Mulcahy** - A. Bonafede - A. Scaife - R. Morganti -J. Croston -**A.Shulevsky - T. Shimwell, C. Roskowinski,** P. Bartel. New: **Pratik Dabhade**

- Joined effort of MKSP & Nearby AGN (Chair R. Morganti)
- Study of interesting targets multi-frequency data available
- Long term plan: synergy with SKSP search GRGs in survey fields.
- One telecon once per month
- Common goal obtain good total intensity image and run RM synthesis on each field.
- Overlap with Nearby galaxies and Galactic foregrounds WGs

NGC 6251

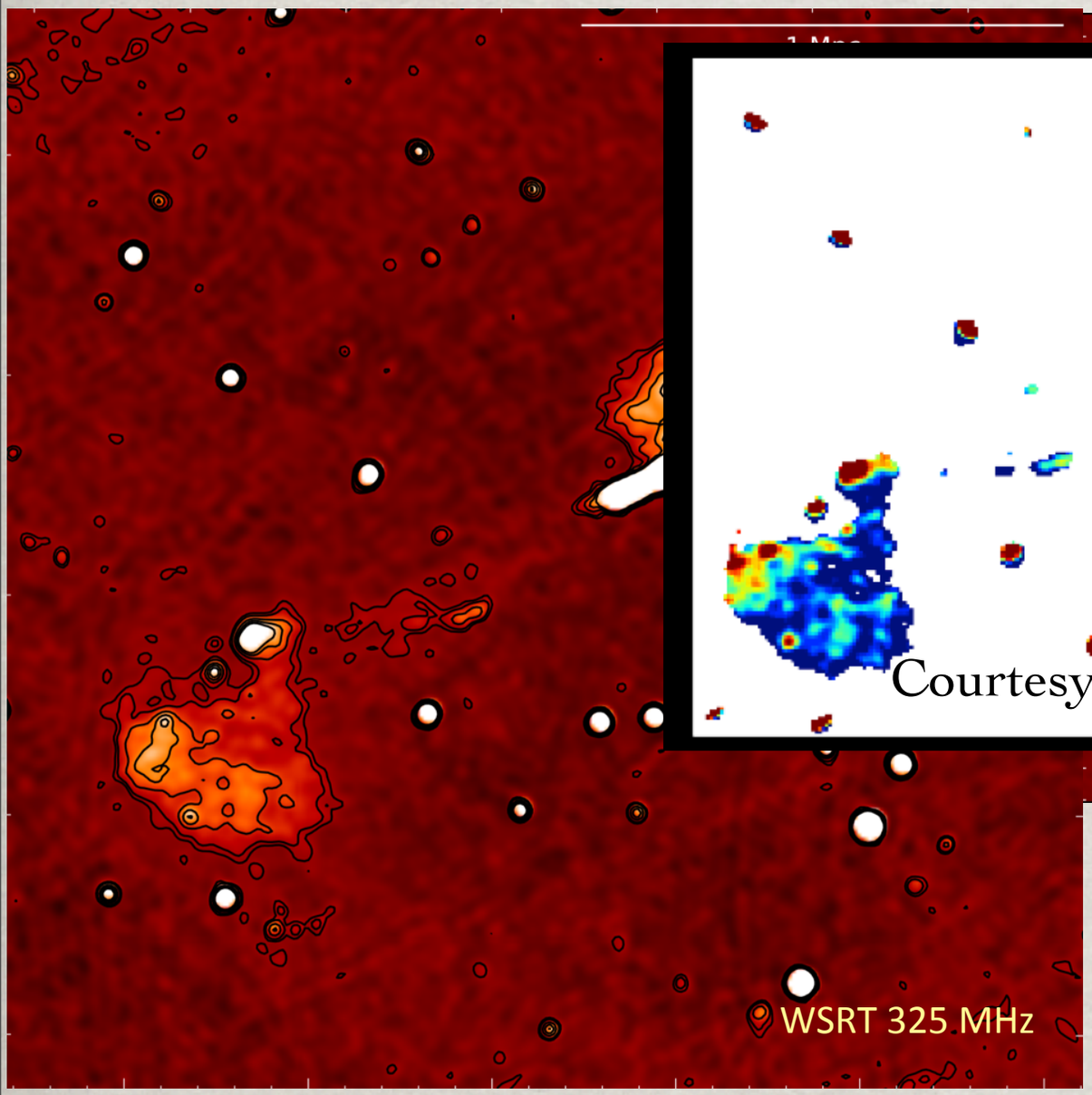


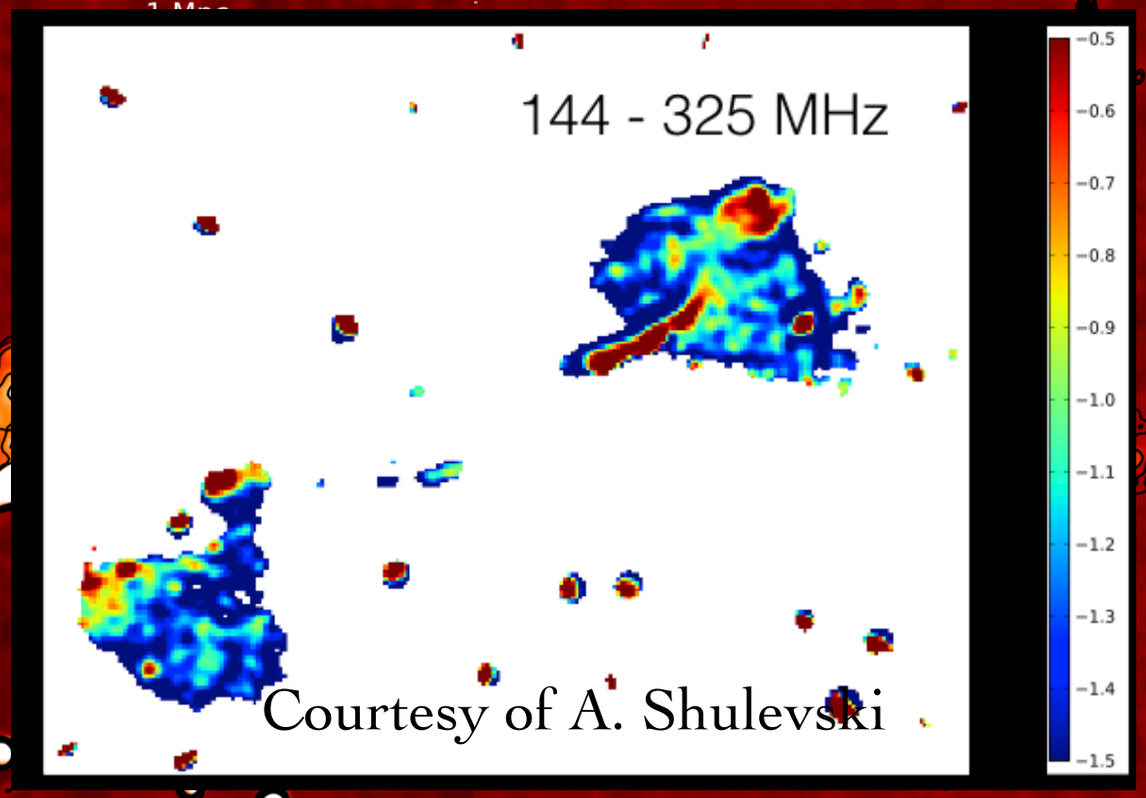


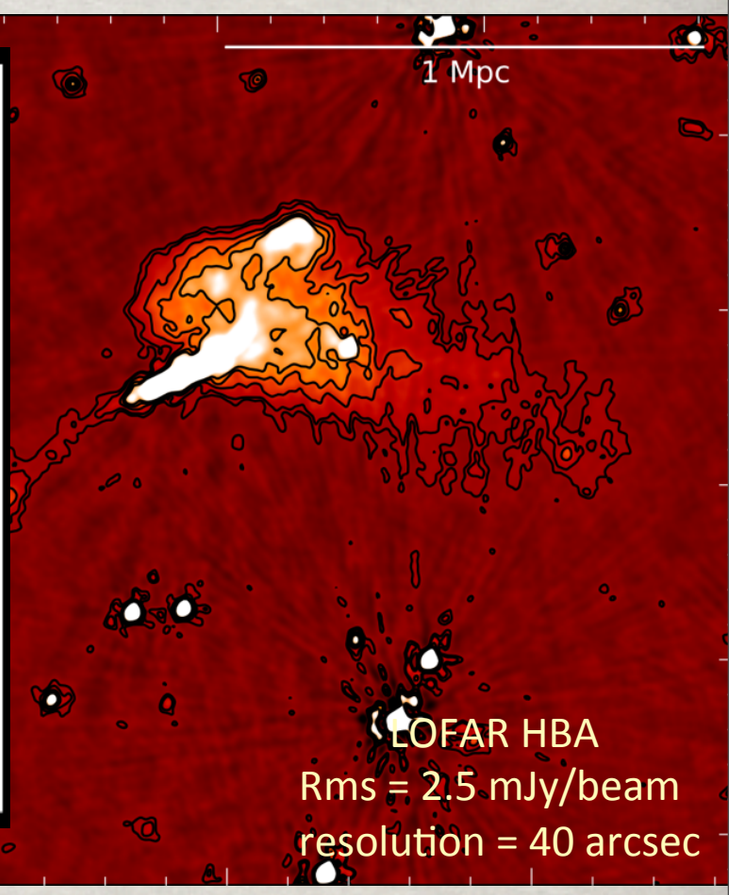
z=0.024710

- Counter-−jet visible at HBA frequencies
- Diffuse extension to northern lobe as visible at these frequencies
- Direction dependent calibration necessary to reduce the noise and artifacts in the image

NGC 6251







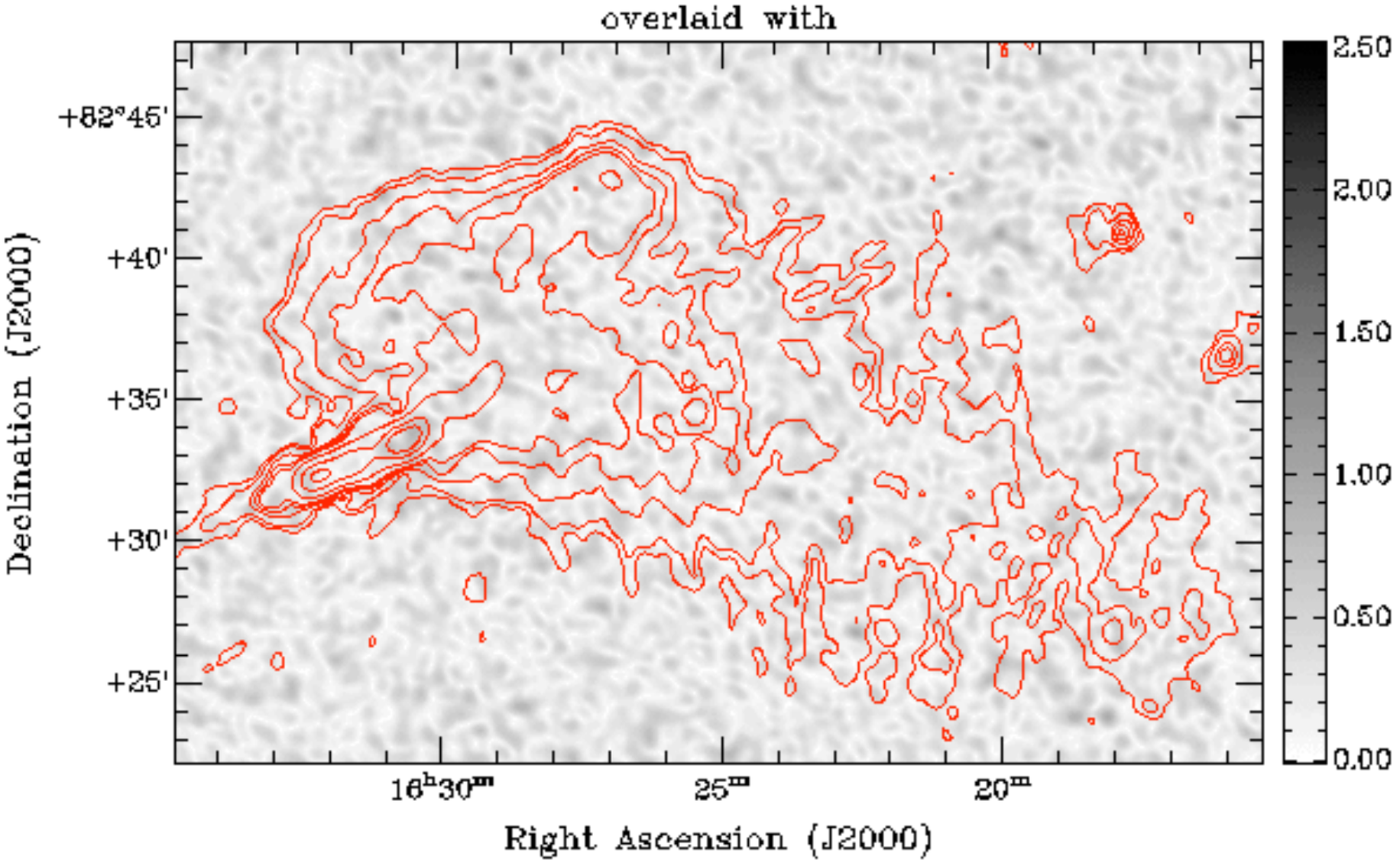
z=0.024710

✳ Counter-−jet visible at HBA frequencies

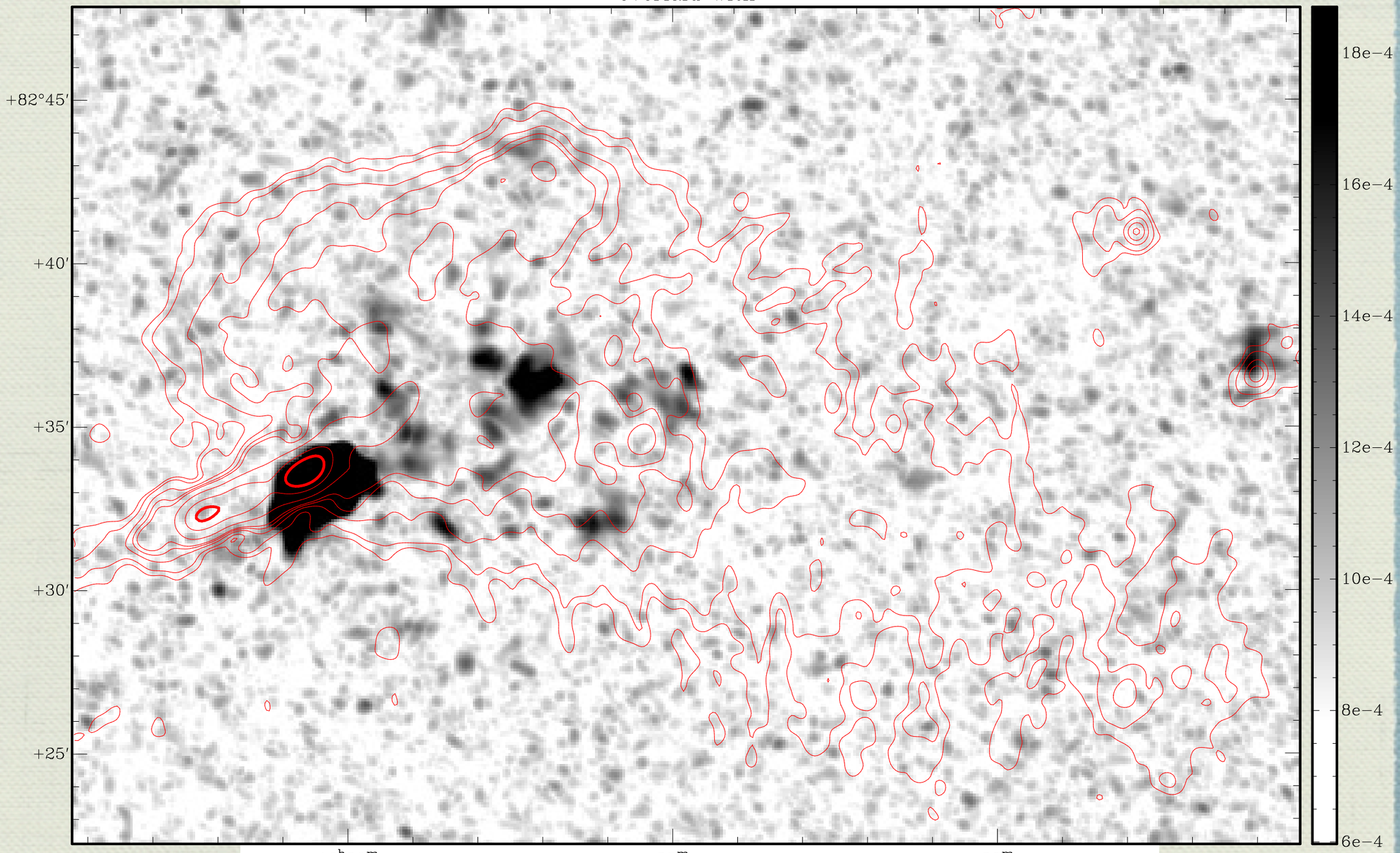
✳ Diffuse extension to northern lobe as visible at these frequencies

✳ Direction dependent calibration necessary to reduce the noise and artifacts in the image

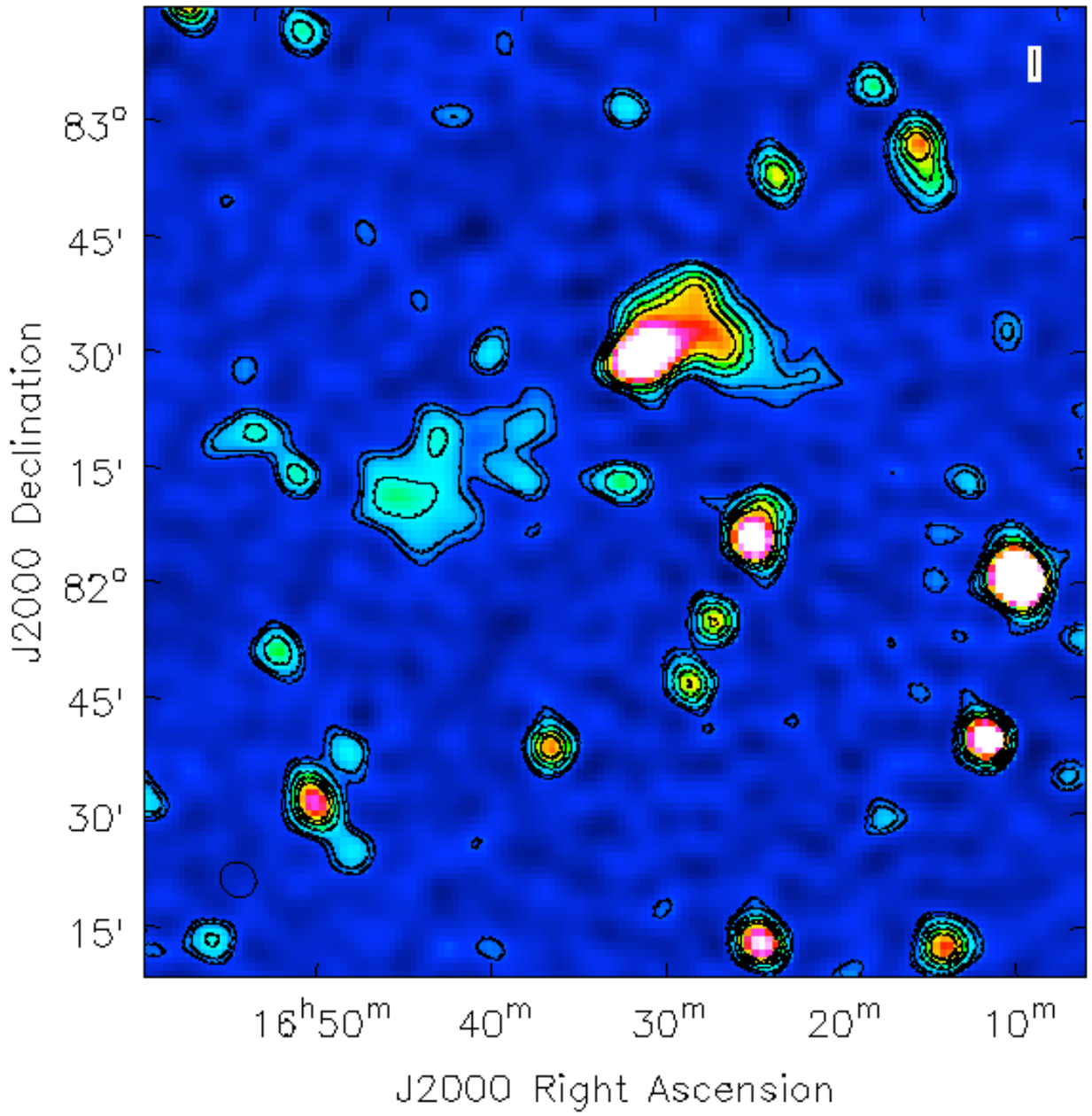
Phi: −6.600000e+01



overlaid with



LBA

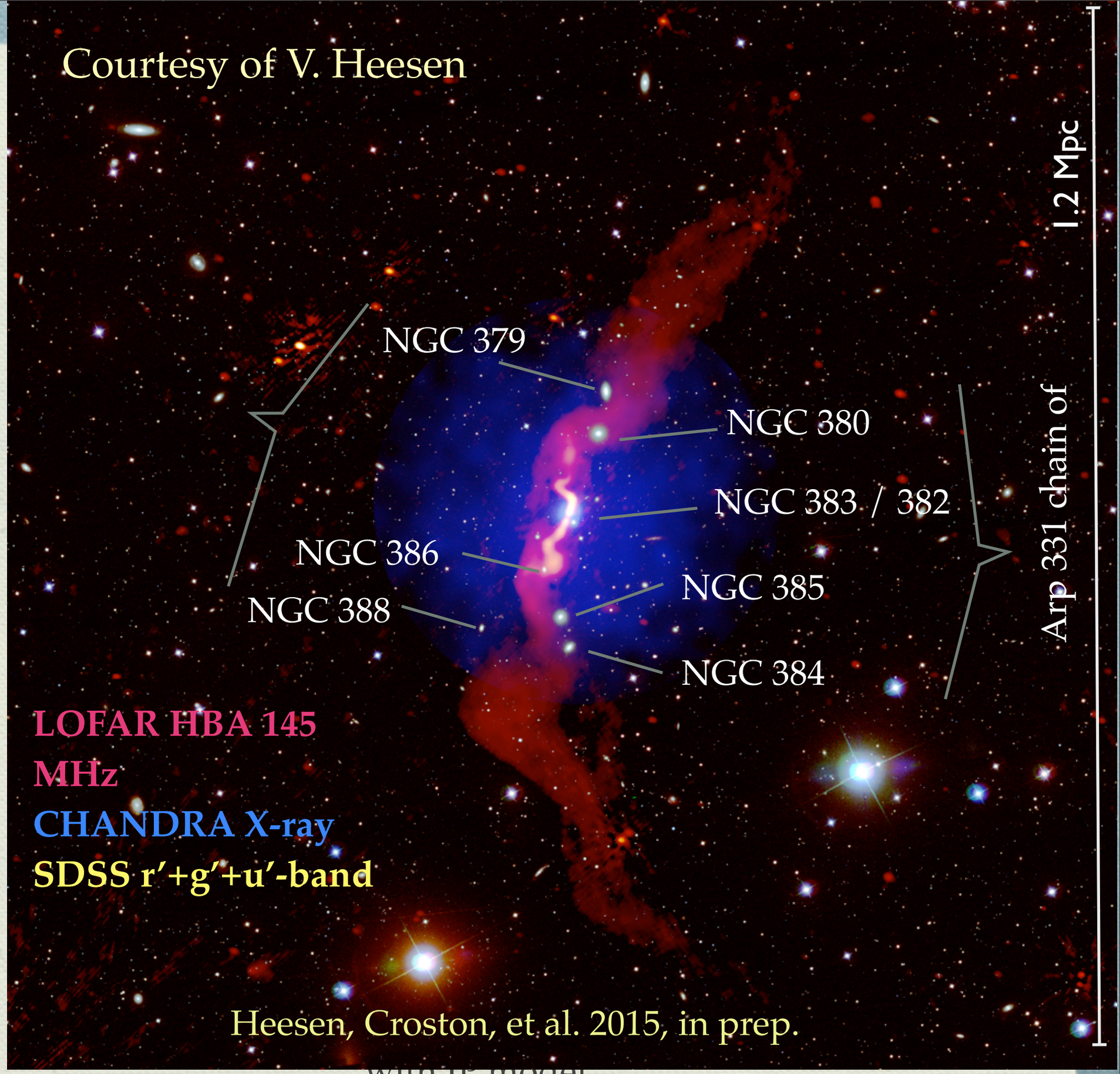

83°
45'
30'
15'
82°
45'
30'
15'
Declination
J2000
16h50m
40m
30m
20m
10m
J2000 Right Ascension

3C 31

✳z=0.0169

✳ 3C31 is a Giant with Lofar L=1.1 Mpc

✳ Bridge emission between the lobes



with JP model.

3C 31

✳z=0.0169

✳ 3C31 is a Giant with Lofar L=1.1 Mpc

✳ Bridge emission between the lobes

✳Spectral index power-law up to 100 kpc (jets/lobes), exponential drop of emission > 200 kpc from nucleus (tails).

✳Spectral steepening modeled with advective cosmic-ray model.

✳Magnetic field strength in radio tails 1–10μG, with ~3μG on average. Agreement with JP model.

3C 31

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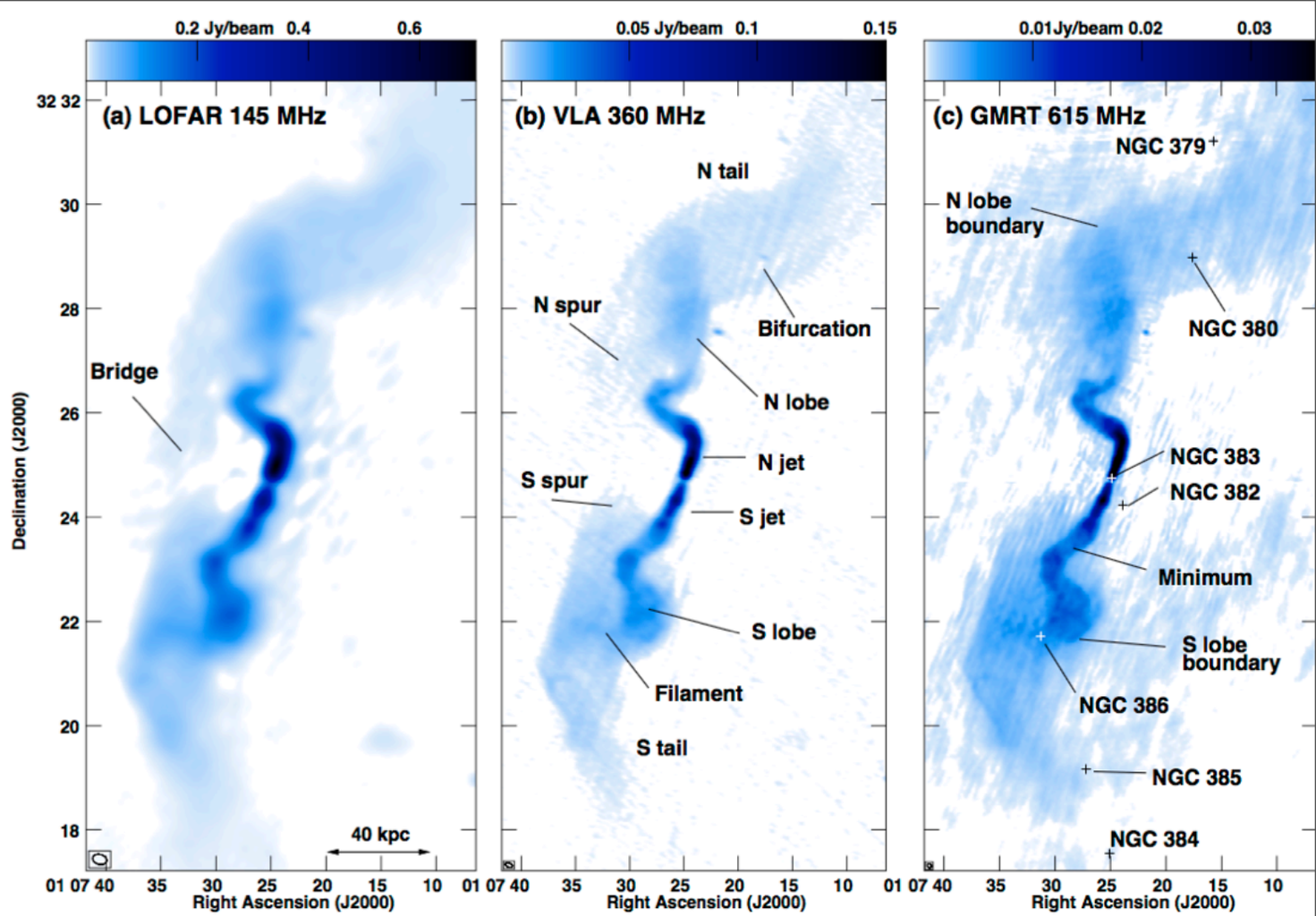

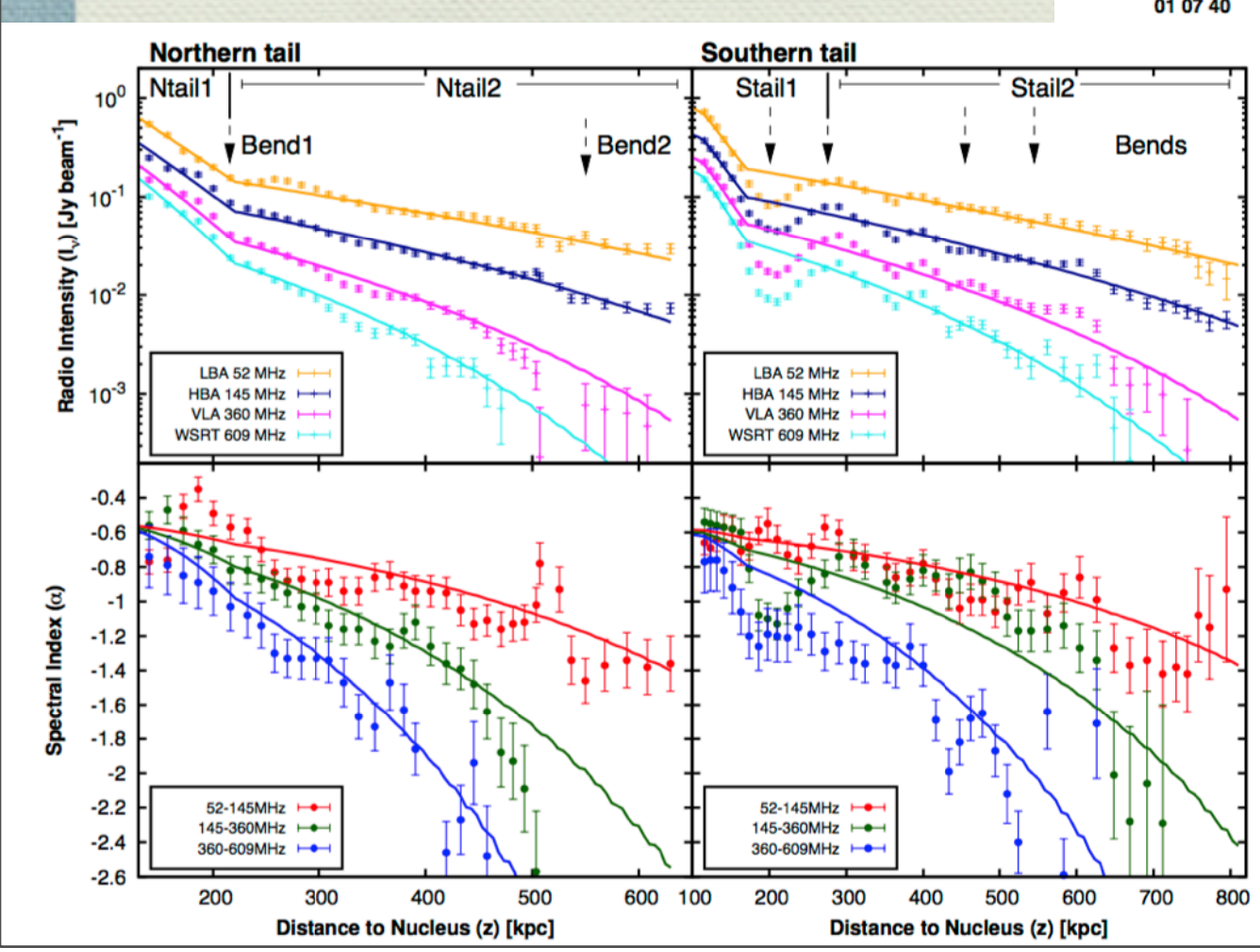

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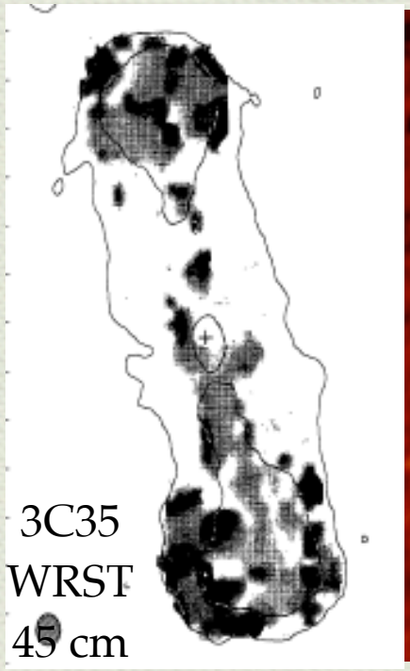
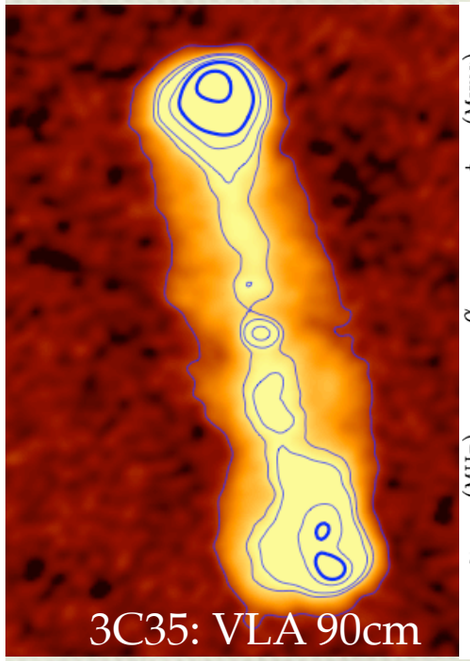
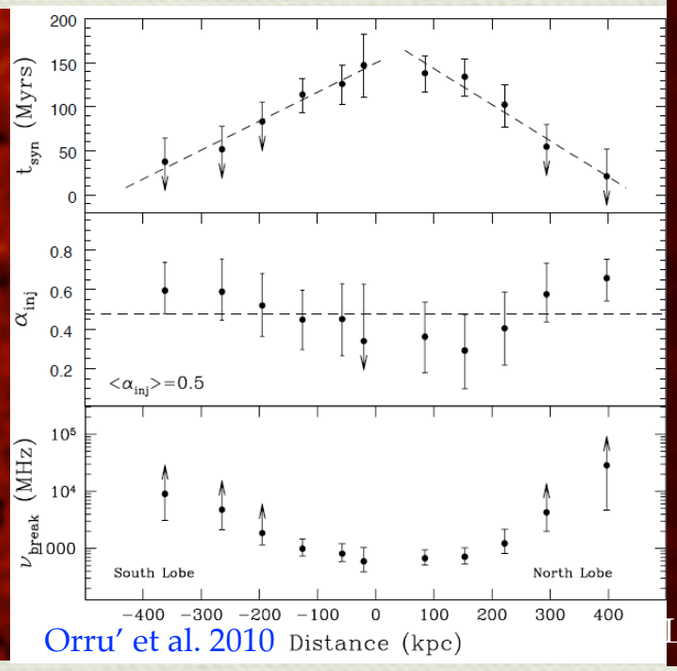
3C 35

z=0.0673

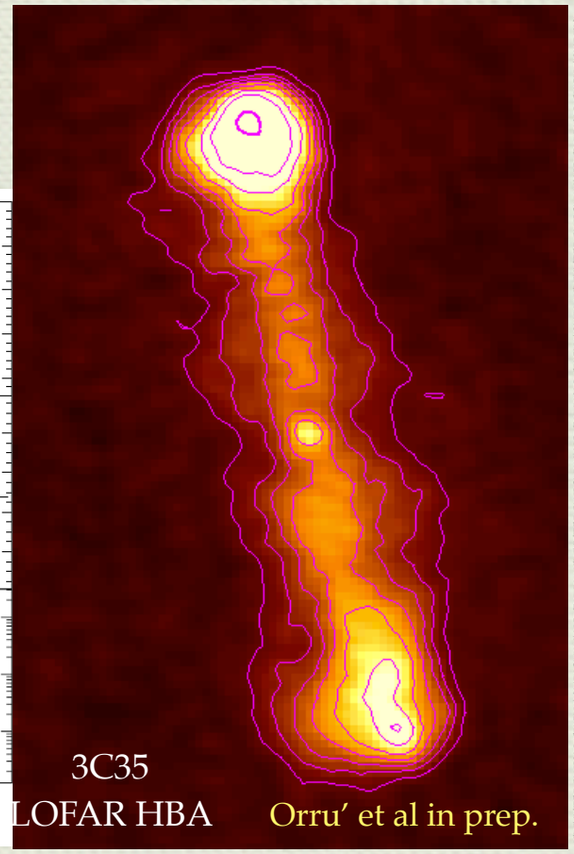
LLS = 0.95 Mpc







Orru' et al. 2010



Orru' et al in prep.

3C35
LOFAR HBA

POLARIZATION?

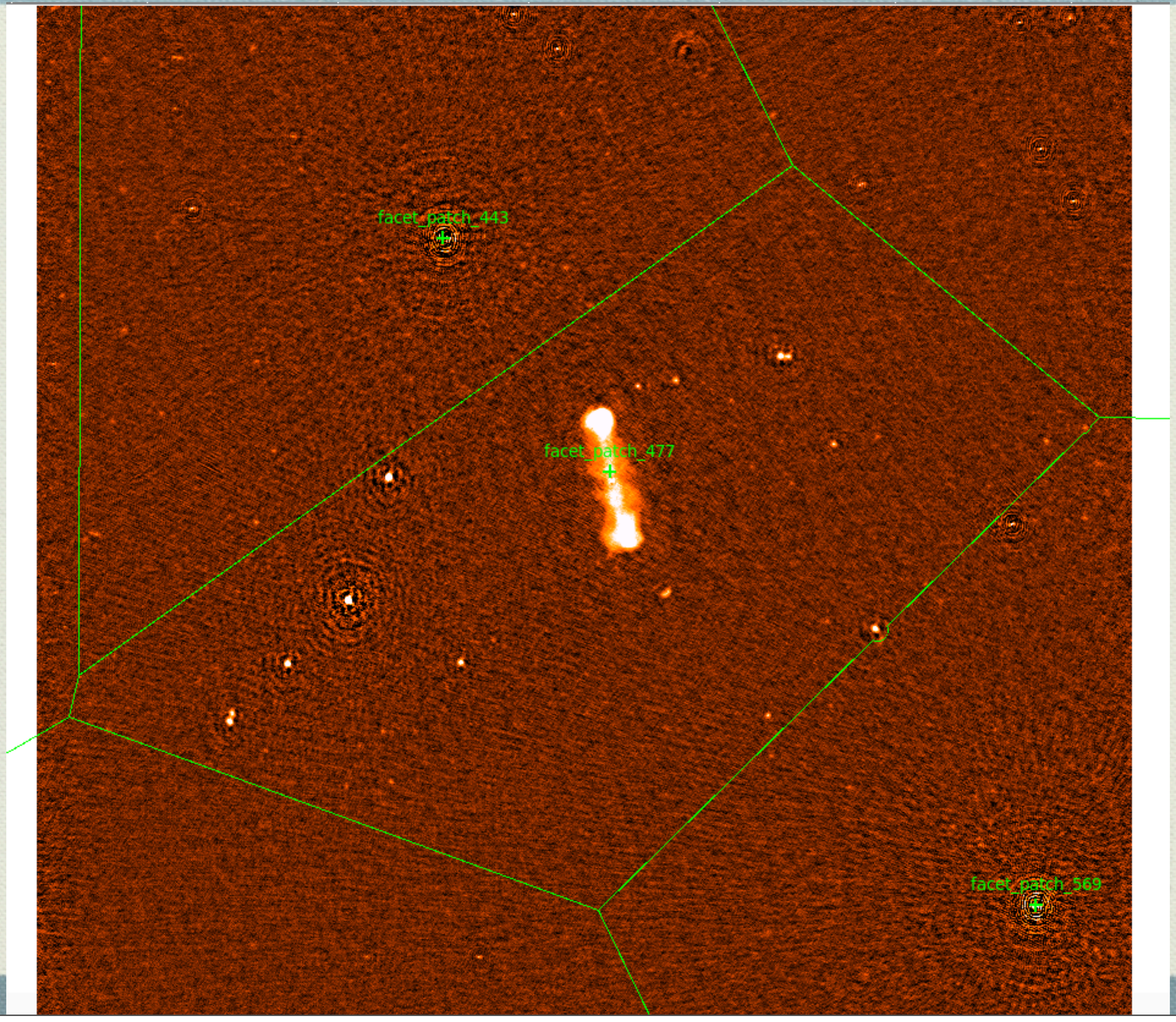
stay tuned

3C 35

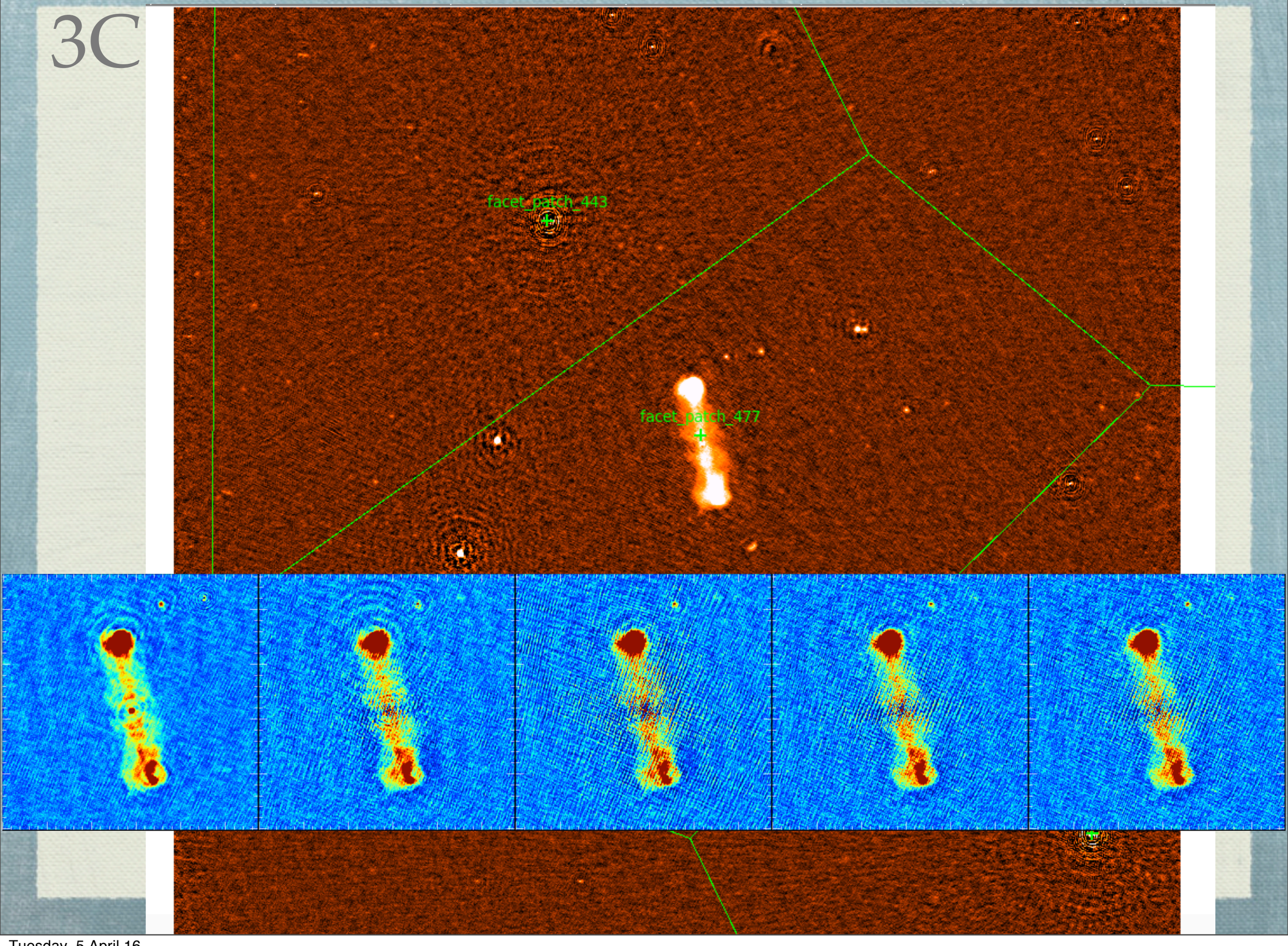
z=0.0673

LLS = 0.95 Mpc

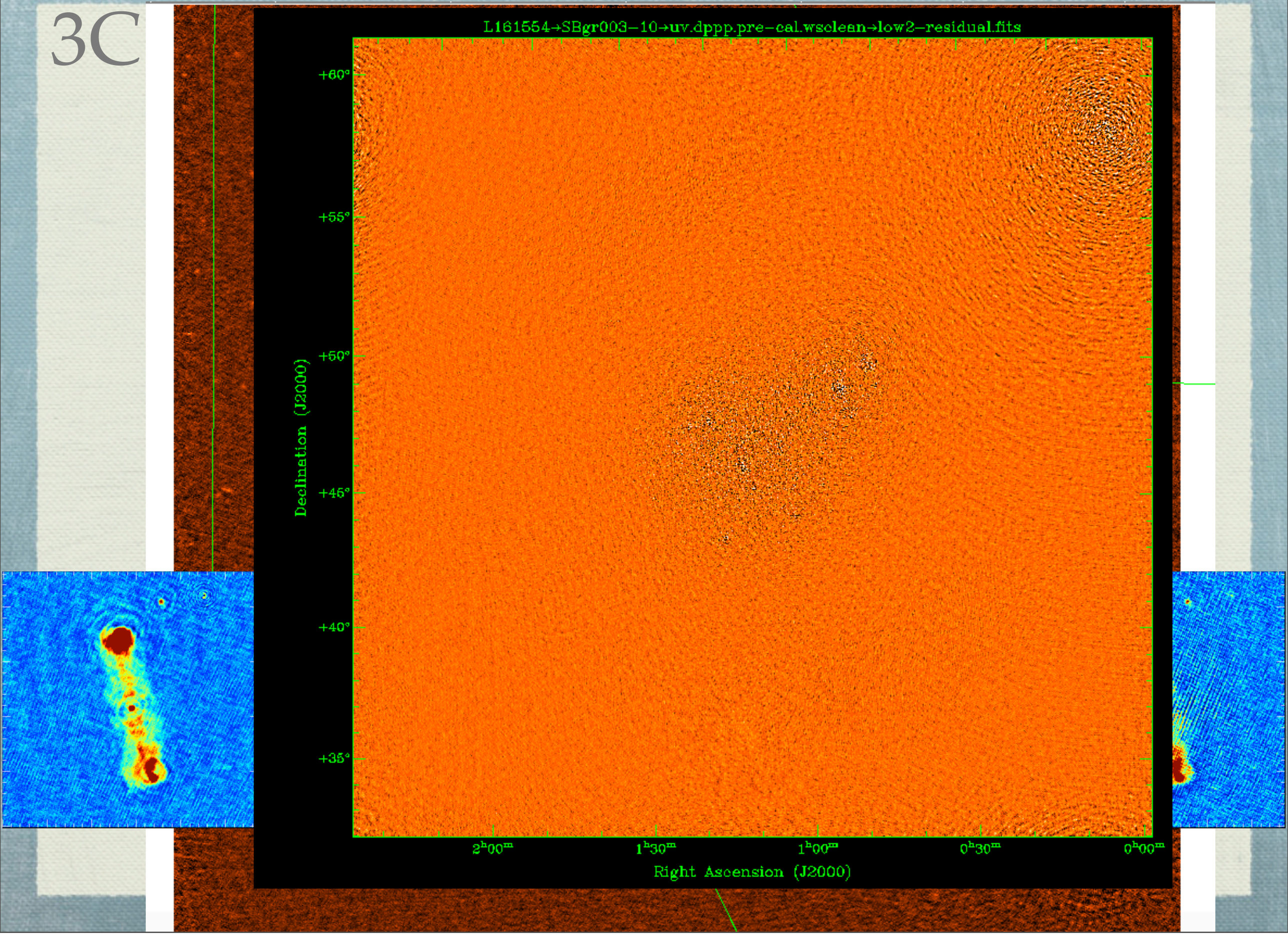
3C



3C

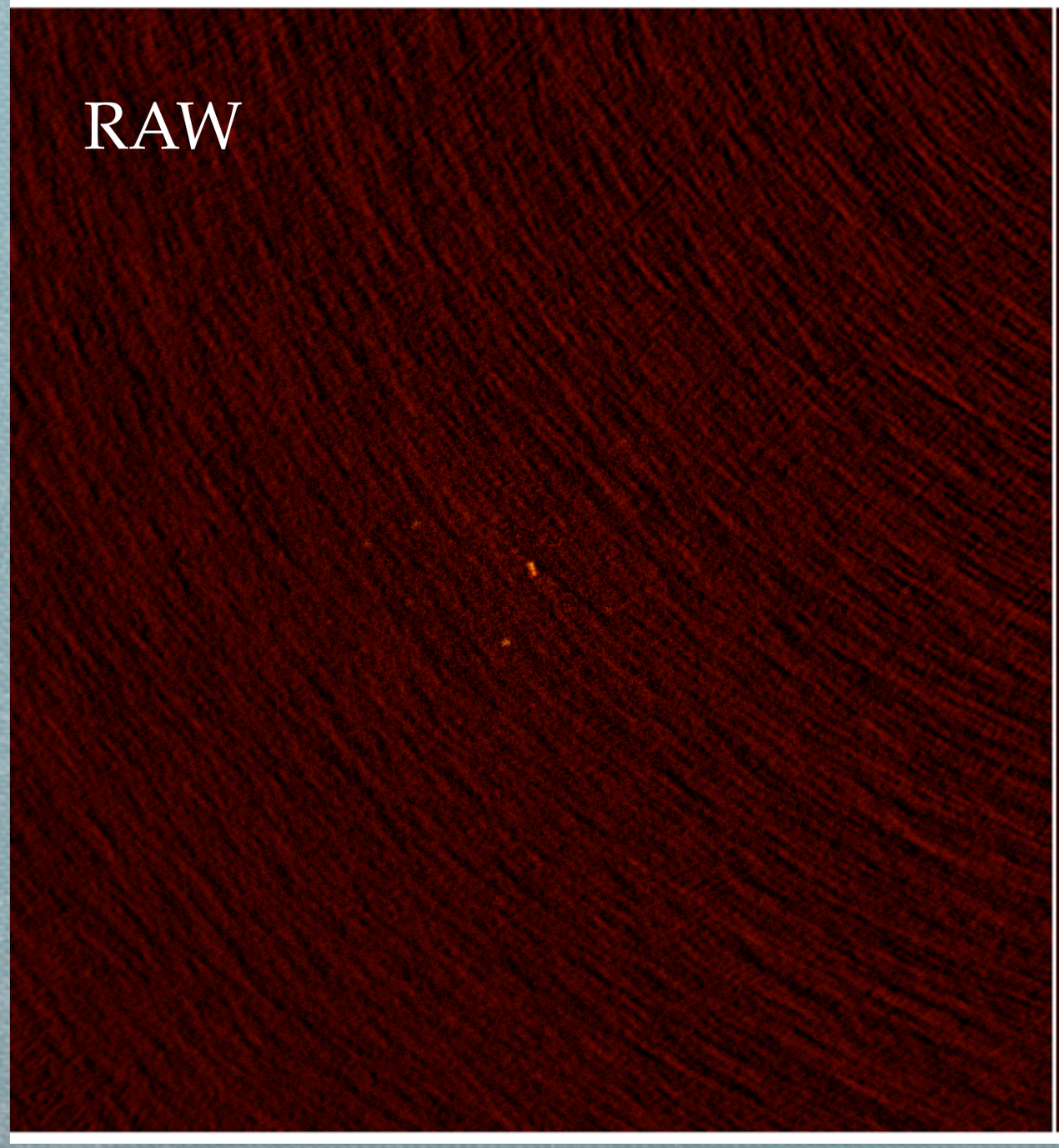


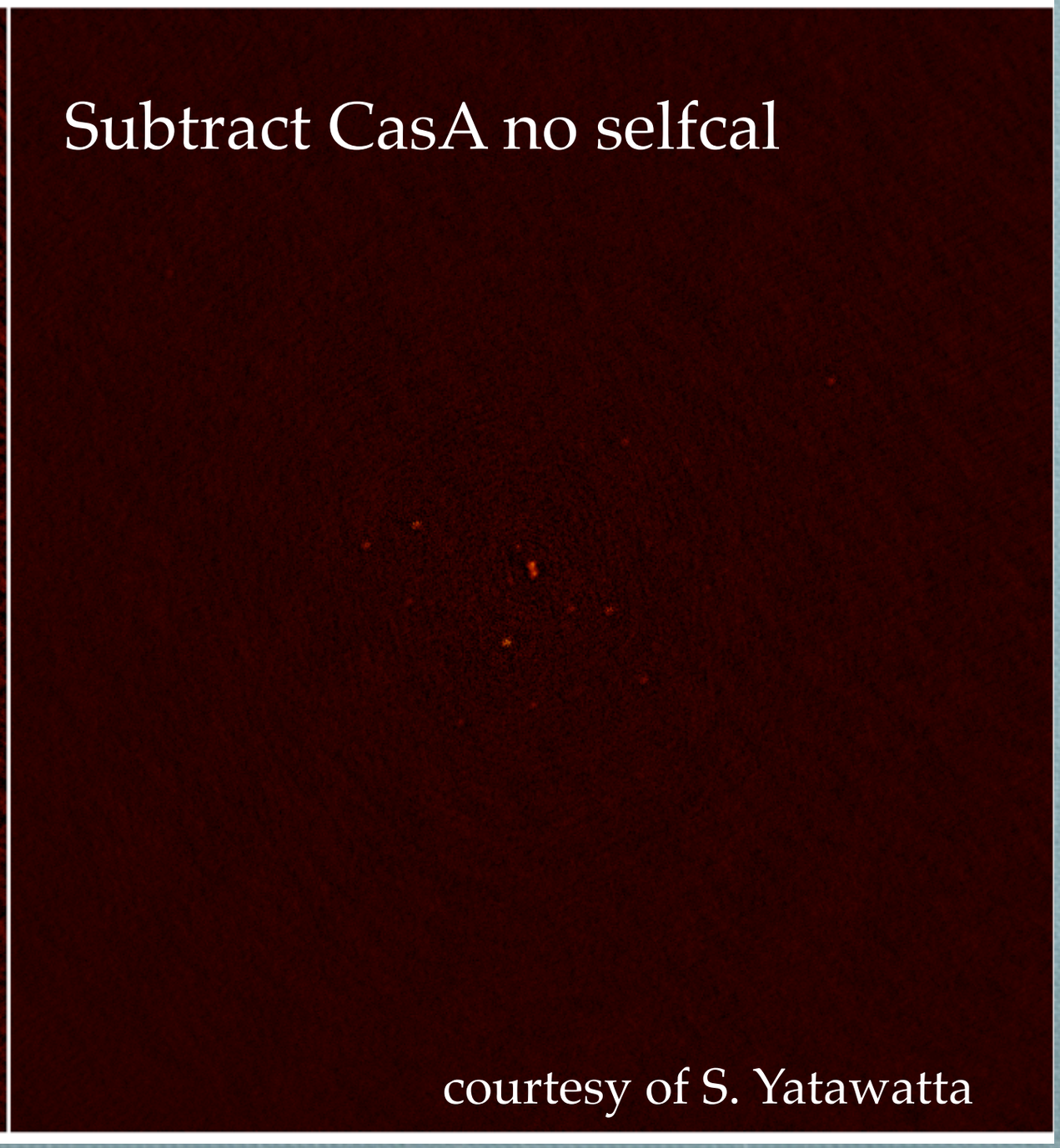
3C


L161554→SBgr003-10→uv.dppp.pre-cal.wsclean→low2-residual.fits
+60°
+55°
+50°
+46°
+40°
+35°
Declination (J2000)
2h00m
1h30m
1h00m
0h30m
0h00m
Right Ascension (J2000)

LBA

- One SB. After removing CasA using Sagecal.
- Needs more SBs for selfcal with Consensus Optimization





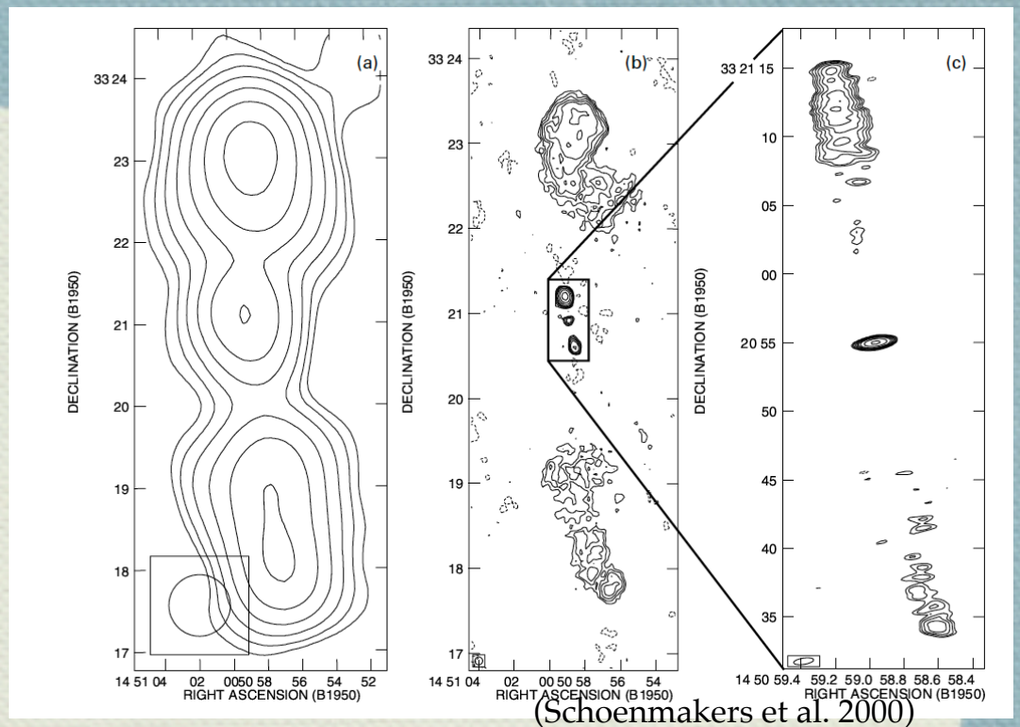
Subclass of GRG are Double-double RG

DEF: DDRG consists of a pair of double radio sources with a common centre

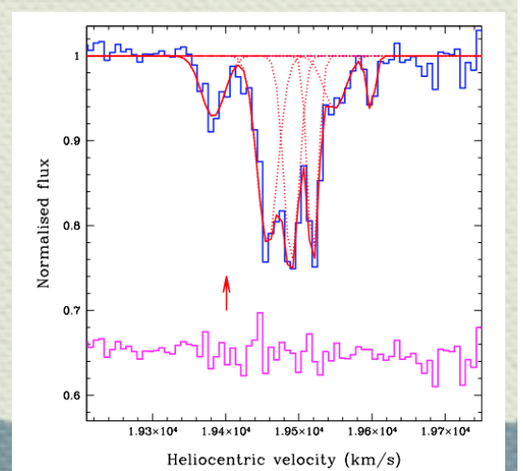
(Schoenmakers et al. 2000)

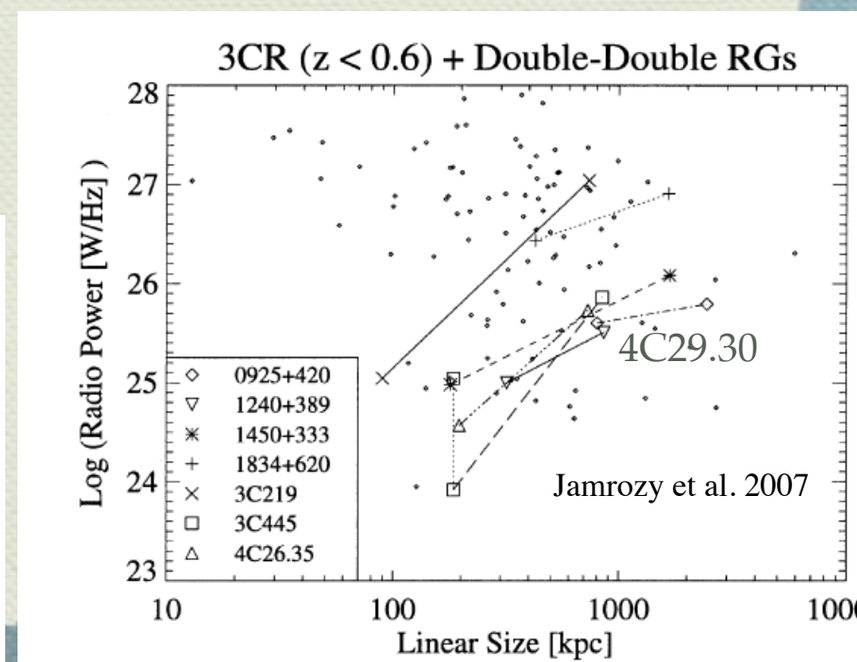
Are the evidence of recurrent jet activity in AGN

- well aligned within 10 deg or X-shaped, inner edge-brightened
- outer no hotspot but one case
- moderate redshift (selection effect?)
- linear size ~ Mpc, no frequent in small RG samples
- inner doubles in DDRGs has an FRII structure although its luminosity belongs to the FRI category or lie in the borderline of the FRI/FRII classification
- HI absorption observed in few DDRG
- small RM



(Schoenmakers et al. 2000)

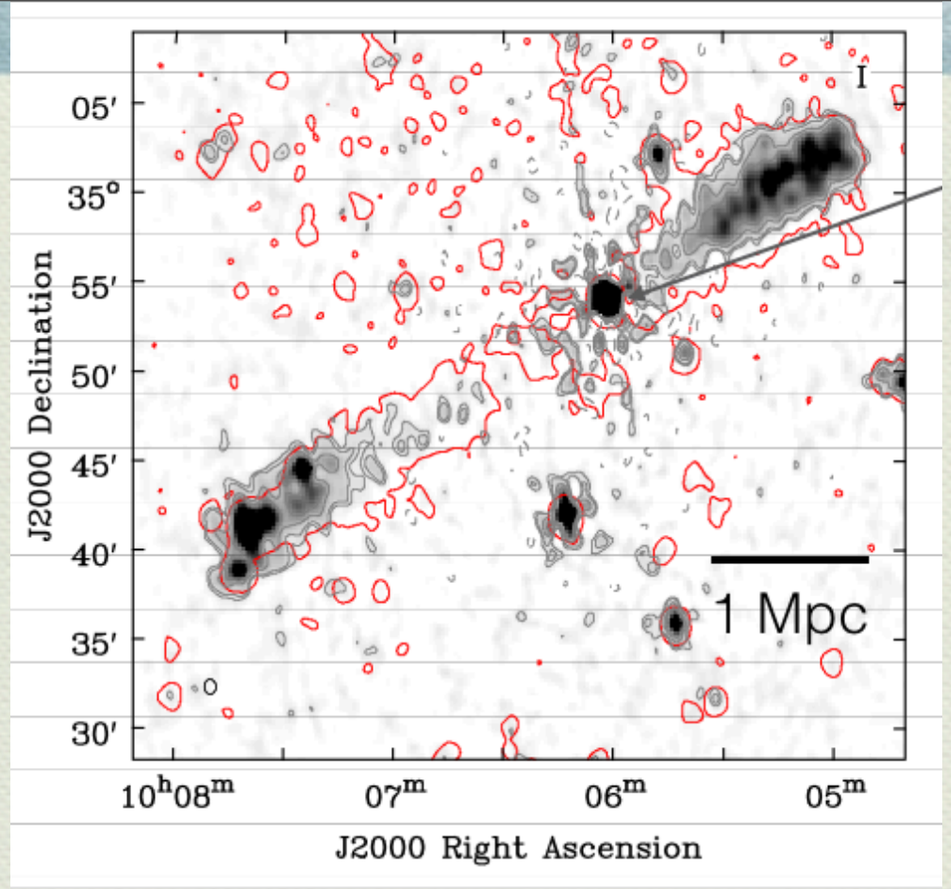


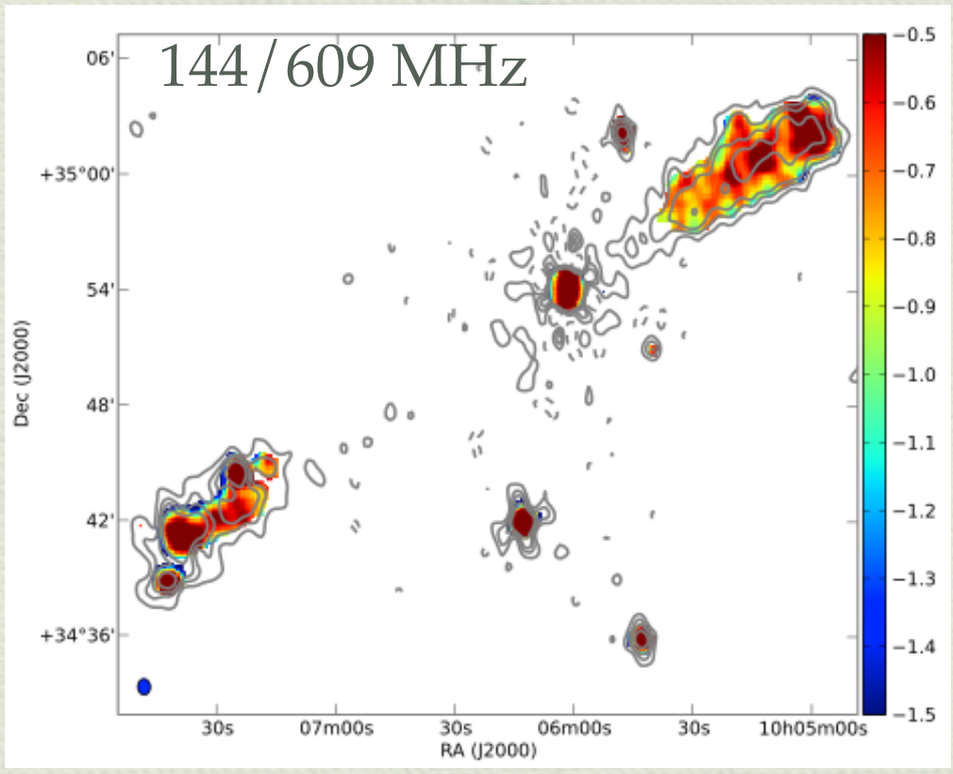


3C 236

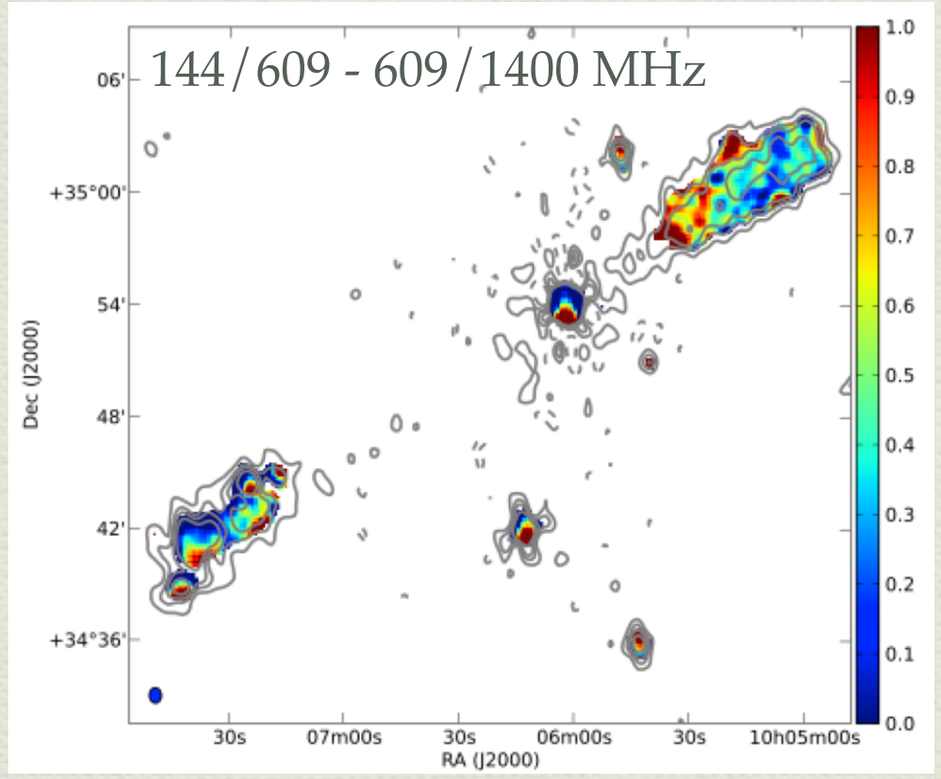
Courtesy of A. Shulevski

CSS source in the center
DDRG
LOFAR HBA frequency = 144 MHz
Bandwidth = 12 MHz
noise = 7 mJy/beam
resolution = 50 X39 arcsec





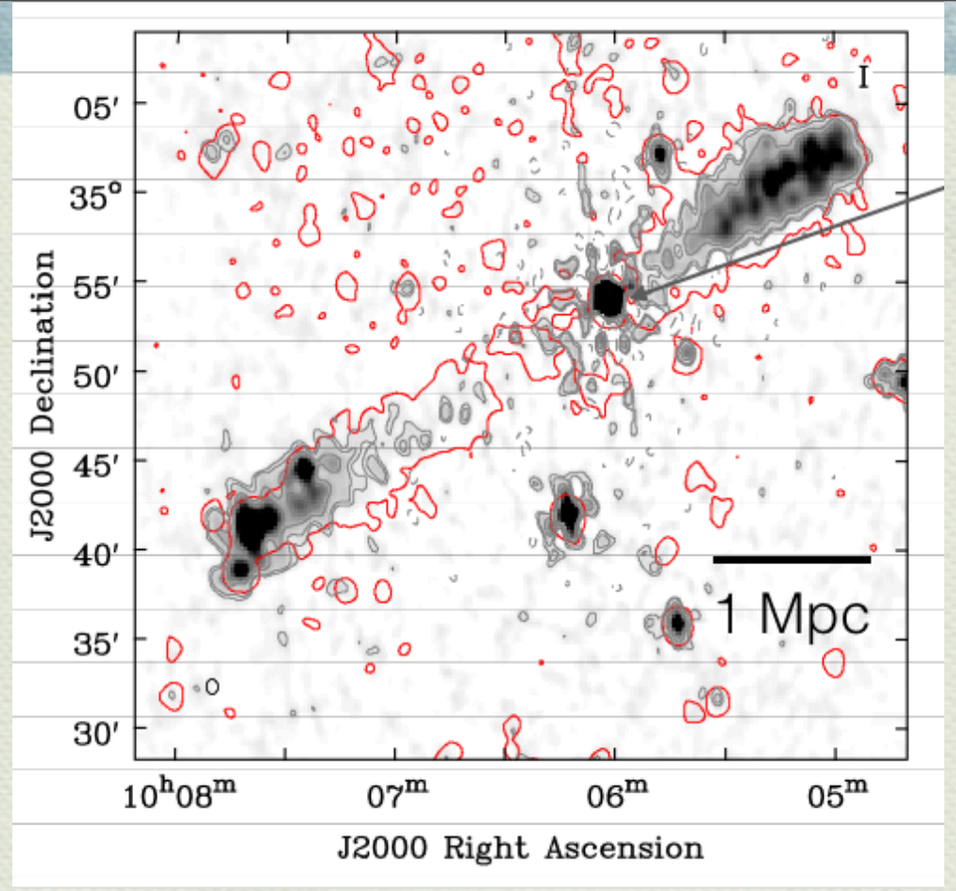
LOFAR/WRST spectral index map
Injection index values in lobes



Spectral curvature map
Older plasm in the inner NW lobe

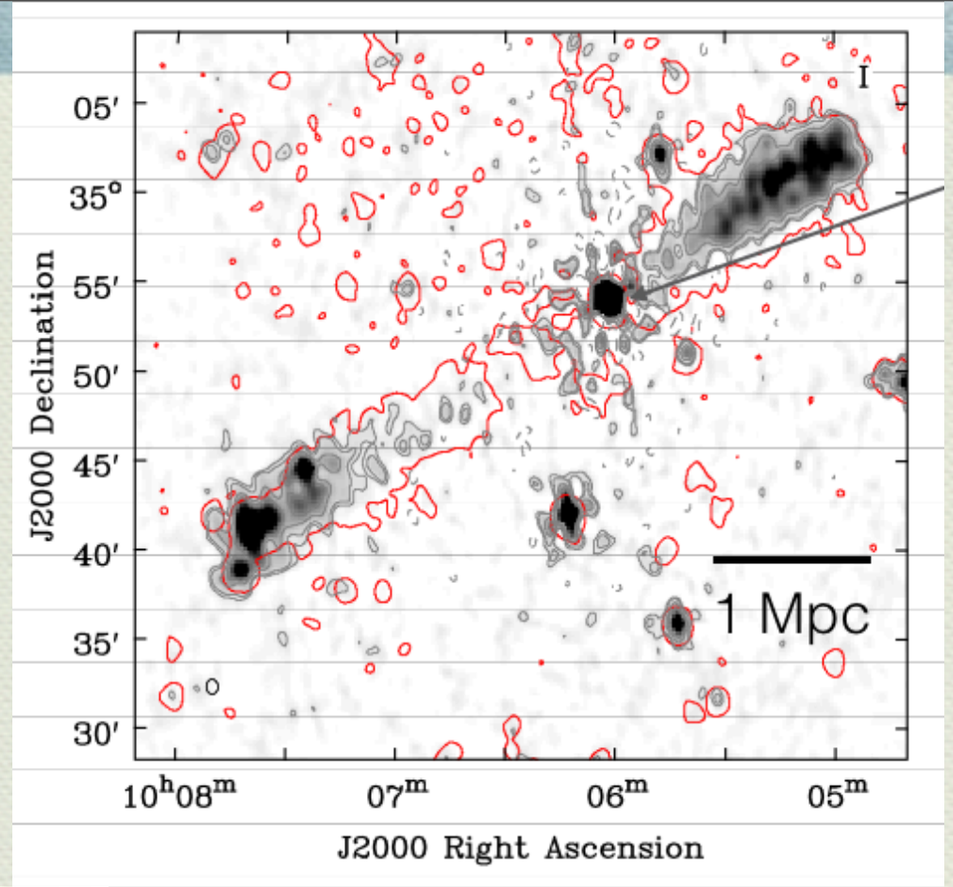
3C 236

Courtesy of A. Shulevski

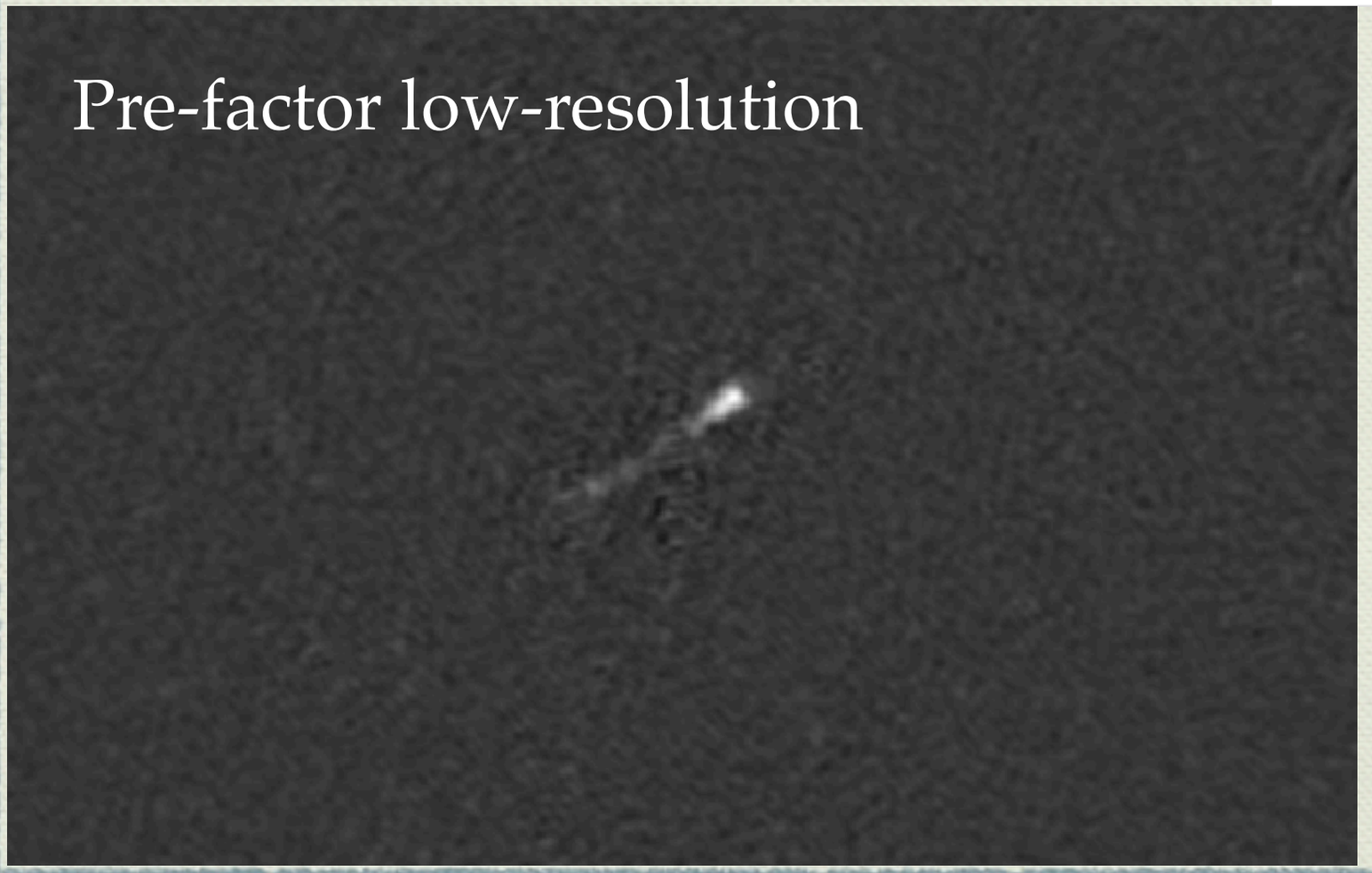


3C 236

Courtesy of A. Shulevski

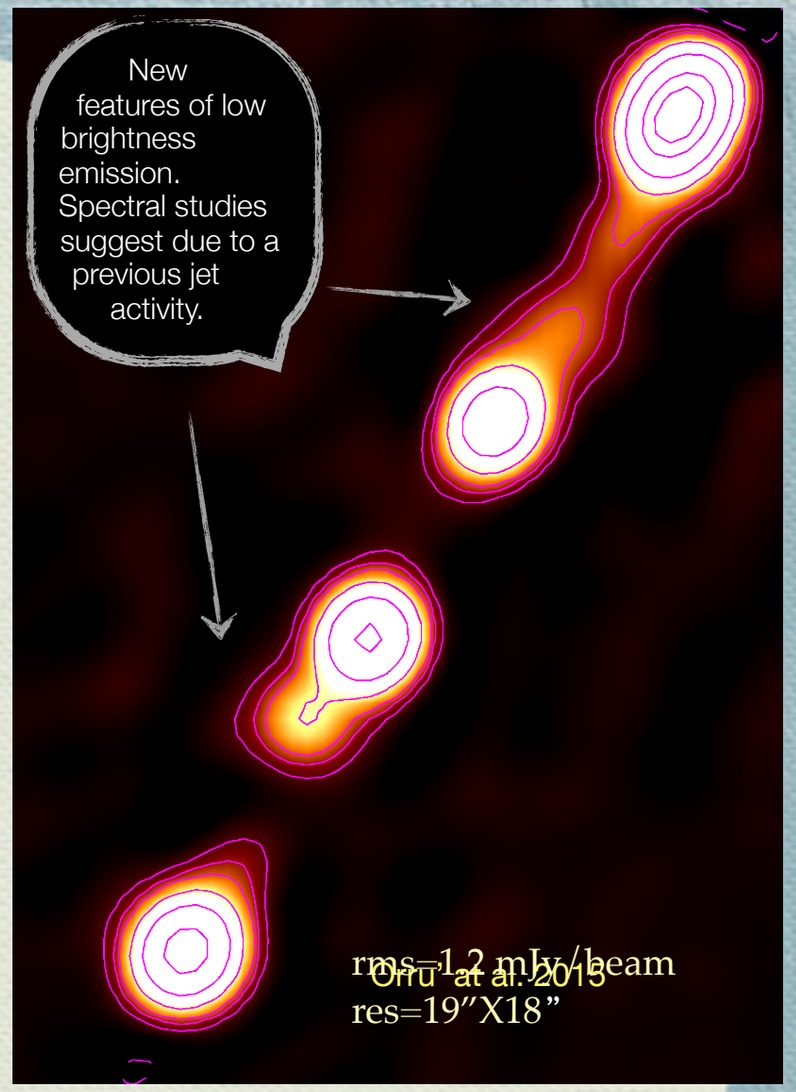


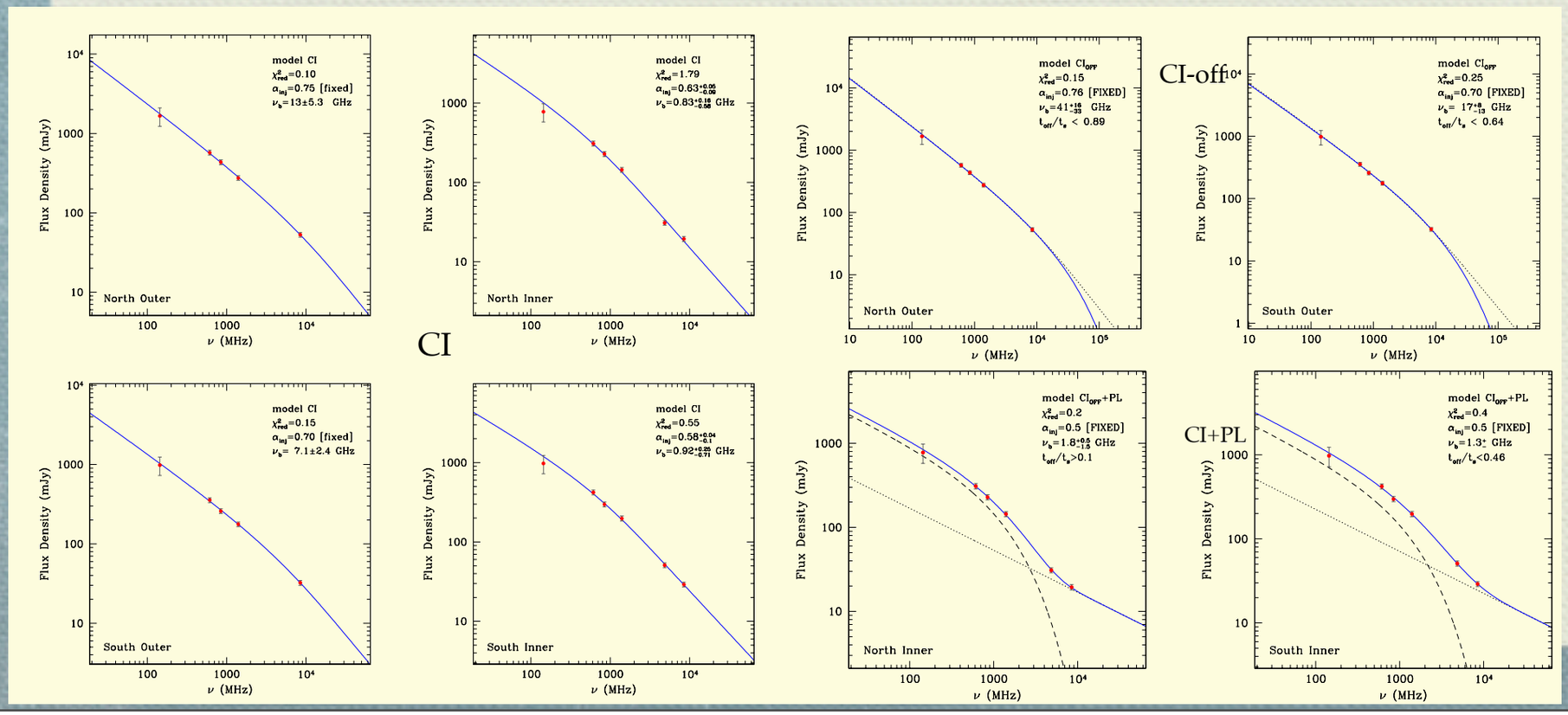
Pre-factor low-resolution



LOFAR HBA

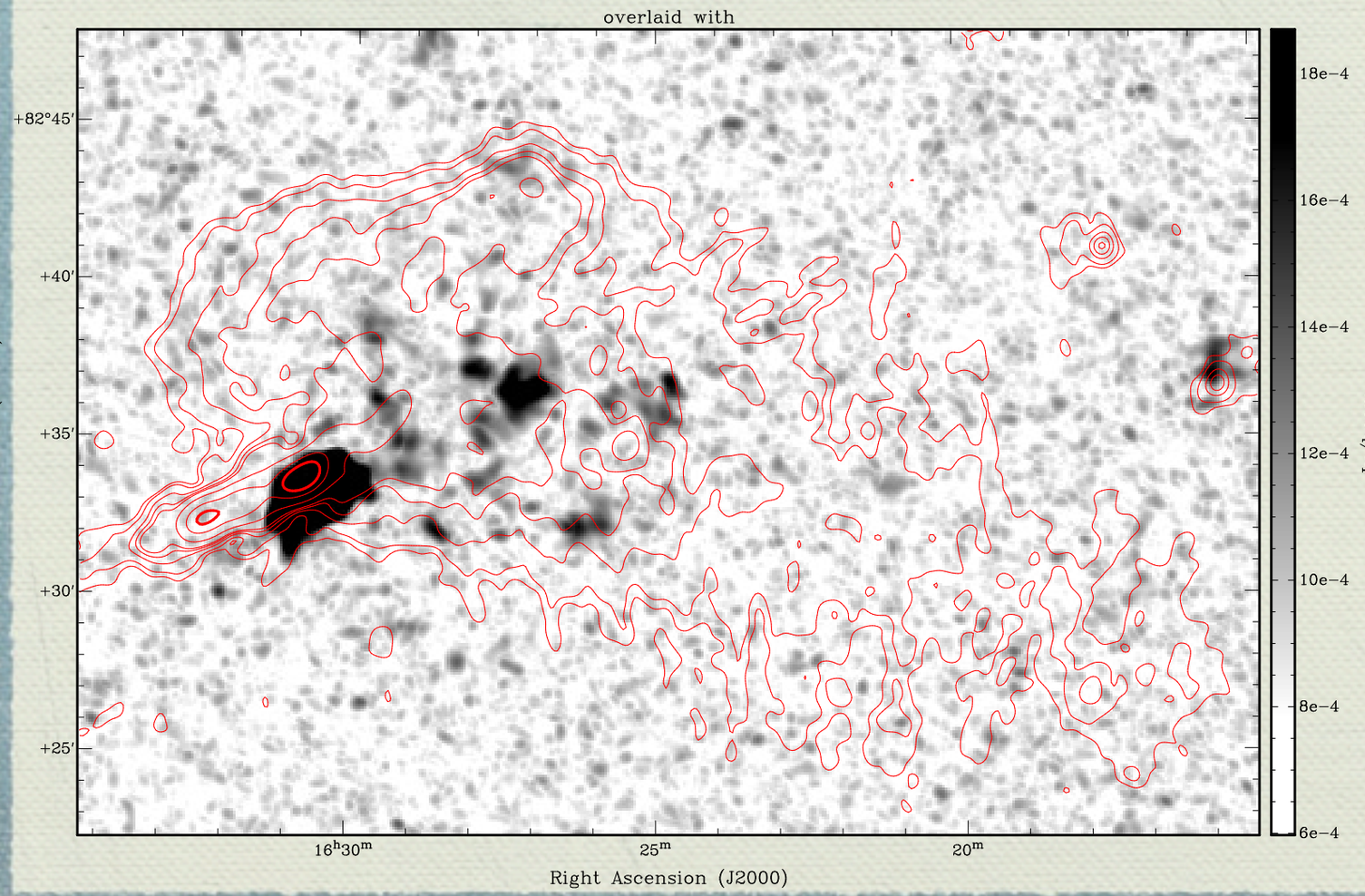
- no detection of the core (GPS)
- 4 components resolved
- new features elongation of inner lobes
- South-inner misalignment of elongation w.r.t the outer lobe
- The fit of the CI was not satisfactory for the inner lobes. We fit a CI + a PL to take into account for the new feature
- The outer since the are expected to be powered off we fitted the CIoff

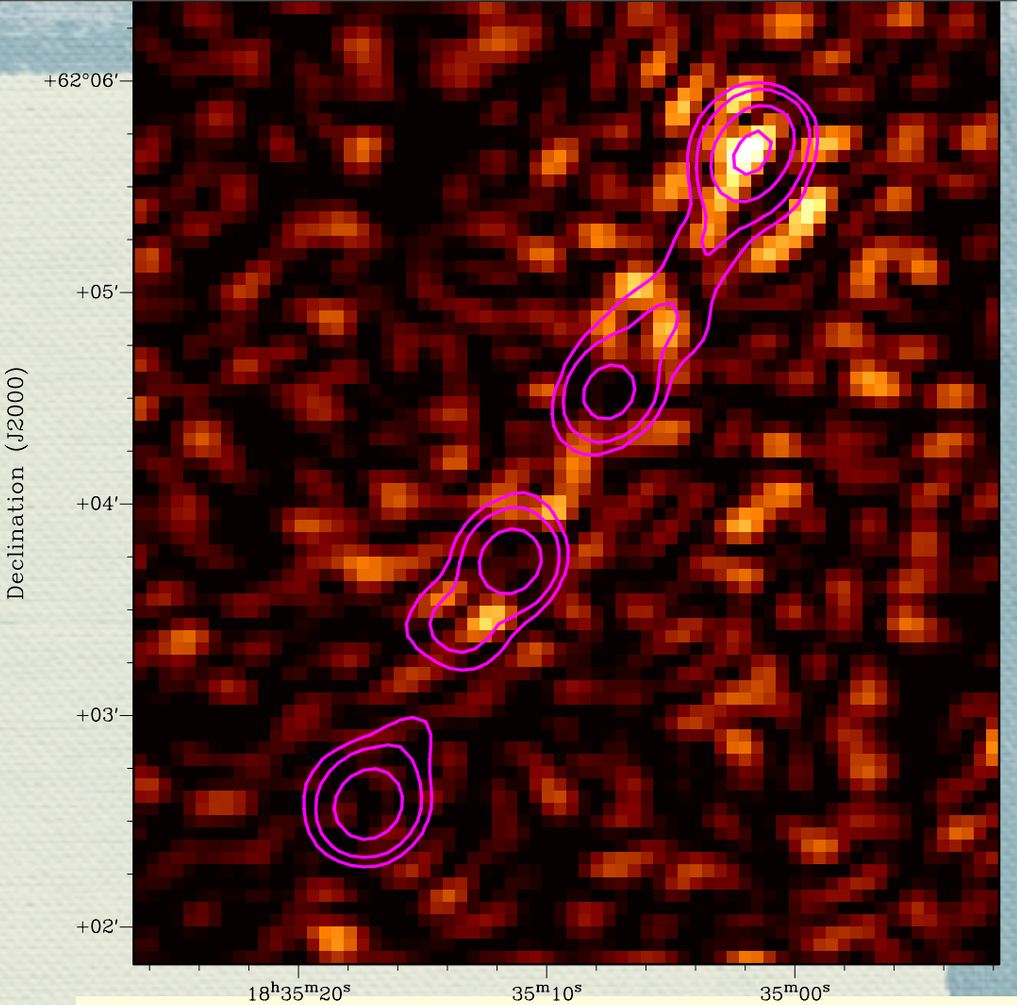


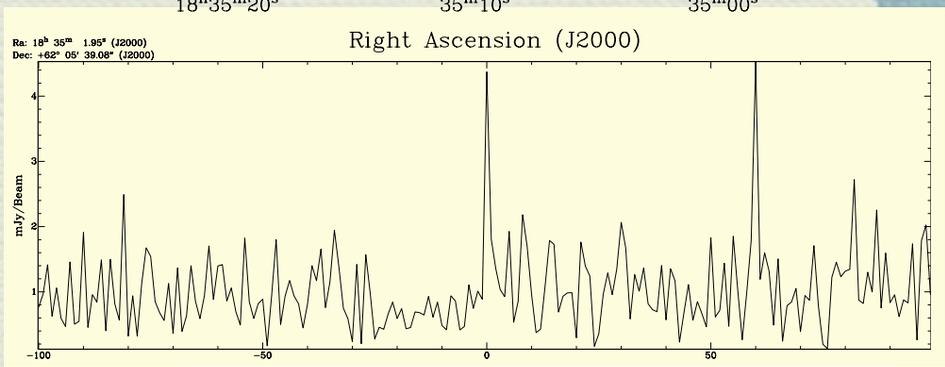


Polarization

- To study the IGM properties.
- Detection lower than expected due to various reasons: ionosphere, calibration ...
- confirmed the RM found at hight frequencies.
- Plan to create RM-grid for each field.







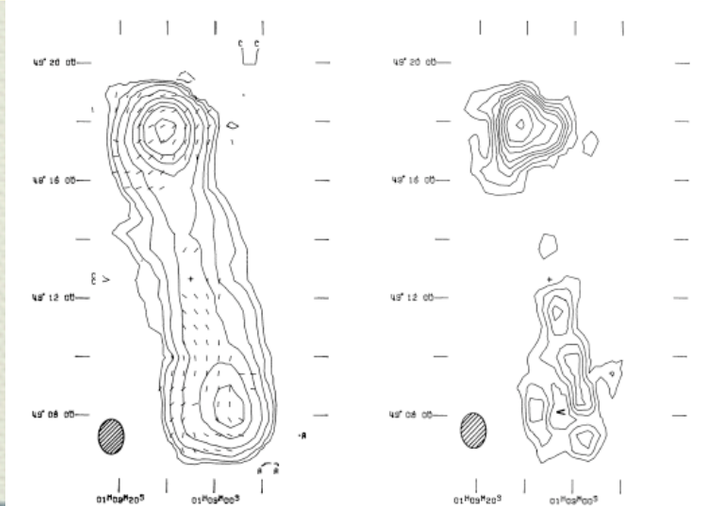


FIGURE 19. — 3C 35, 49 cm I + φ ; — 10, 10, 20, 40, 80, 160, 240, 320, 500 mJy/beam.

FIGURE 20. — 3C 35, 49 cm P ; 6, 9, 12, 15, 18, 24, 30, 36, 48 mJy/beam.

Cross match catalogues of known GRG with Tier 1 pointings.

Catalogue courtesy of M. Jamrozy
Images courtesy of T. Shimwell.

(1) 200 GRG unpublished catalogue cross matched with 60 survey fields

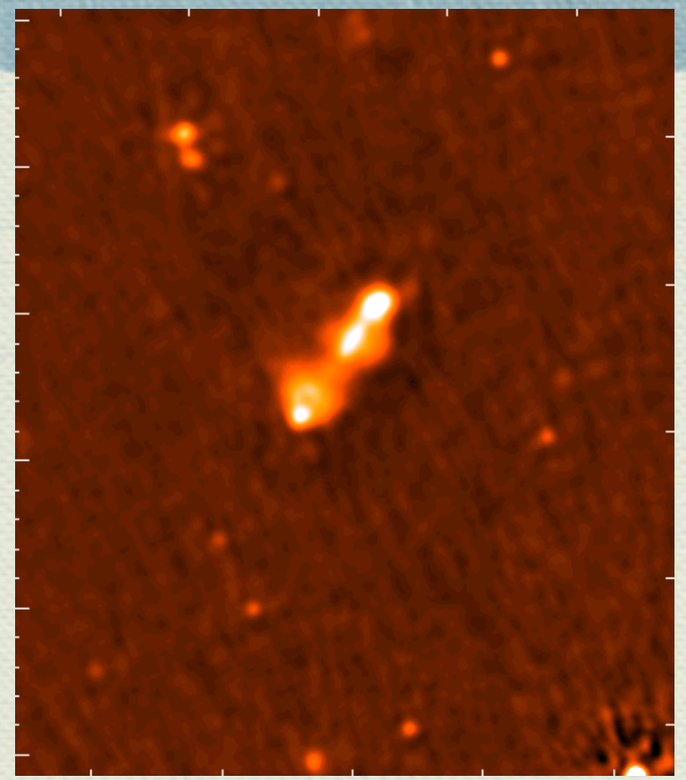
- found 2 GRG
- not same quality due to artifacts - direction independent calibration.

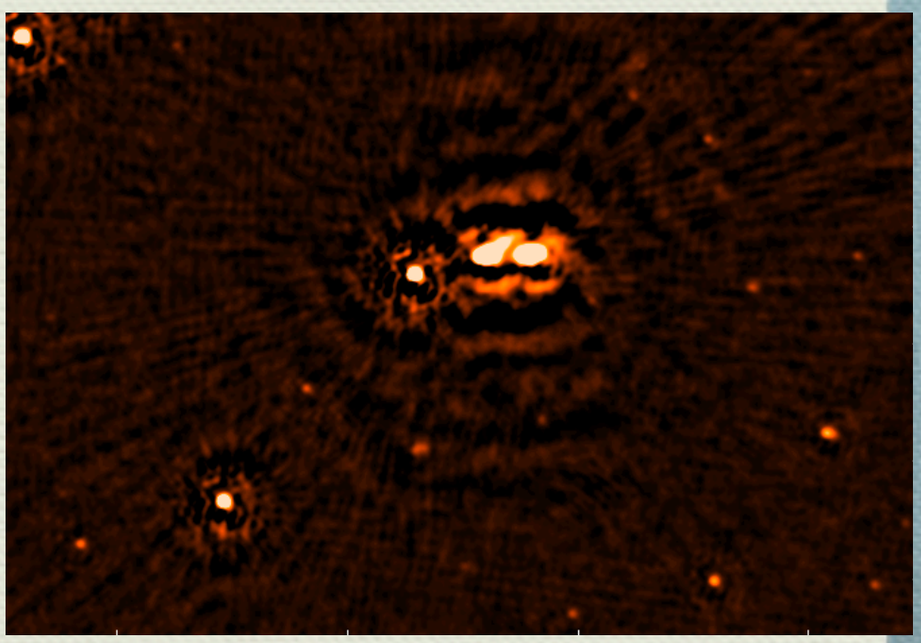
(2) match the catalogue of known GRG to the 200 pointings

- found 28 GRG
- imaged 1 SB
- detection most of the cases, some fields very poor quality - FACTOR will improve them.

(3) If we find interesting sources these will have the priority to be processed with FACTOR.

- availability of radio data at higher frequencies
- environmental study based on X-ray data.





Cross match catalogues of known GRG with Tier 1 pointings

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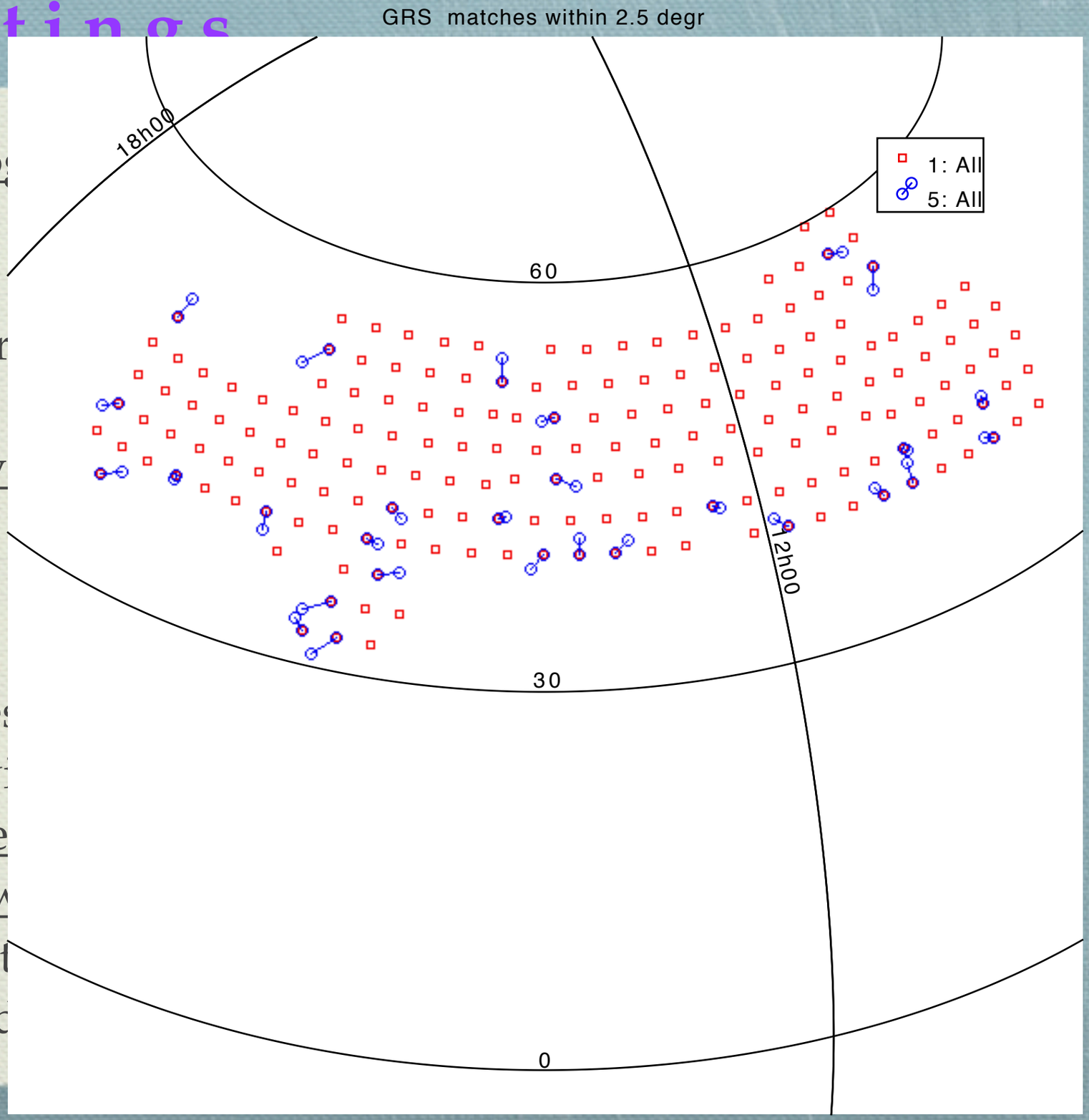
the priority to be processed w

- availability of radio data a
- environmental study base



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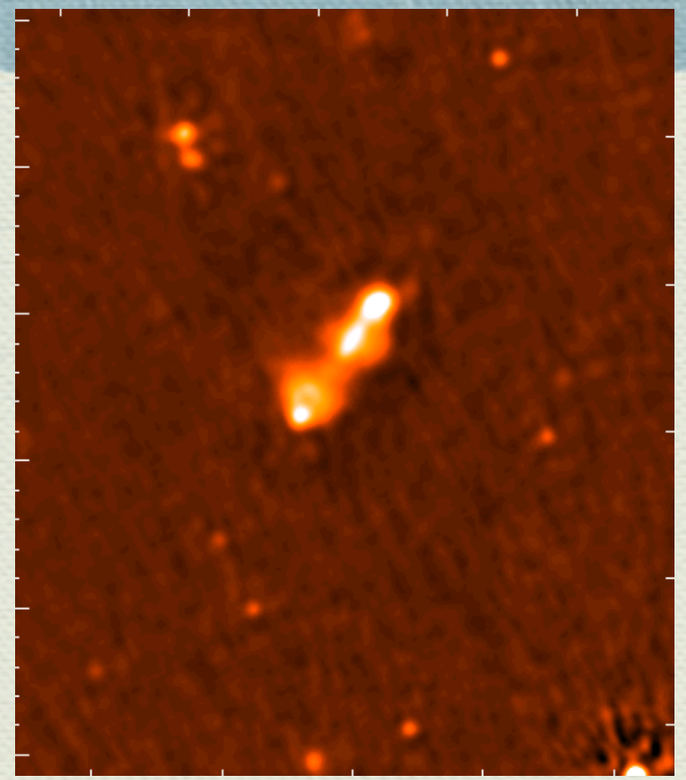
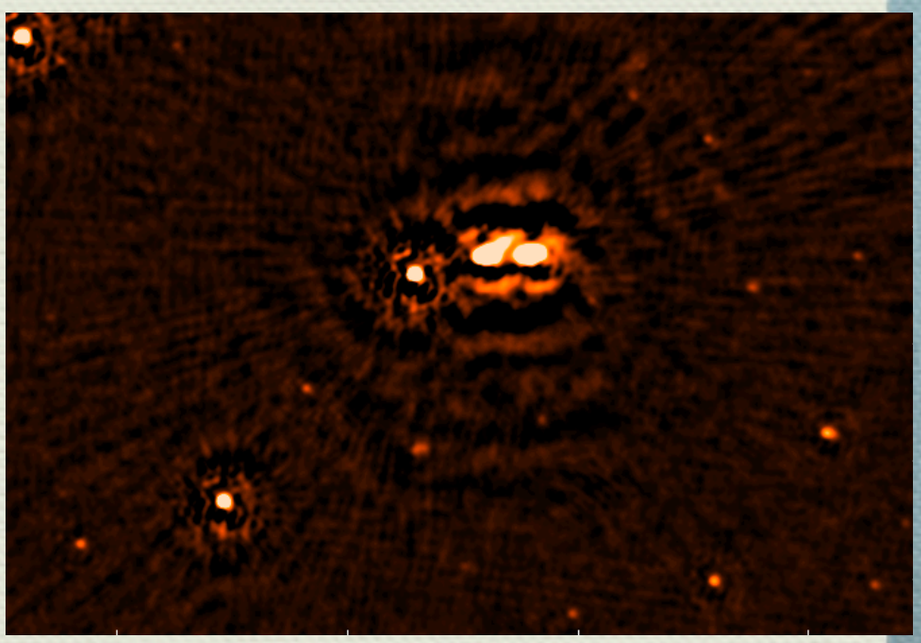
- found 28 GRG
- imaged 1 SB
- detection most of the cases, some fields very poor quality - FACTOR will improve them.

(3) If we find interesting sources these will have the priority to be processed with FACTOR.

- availability of radio data at higher frequencies
- environmental study based on X-ray data.





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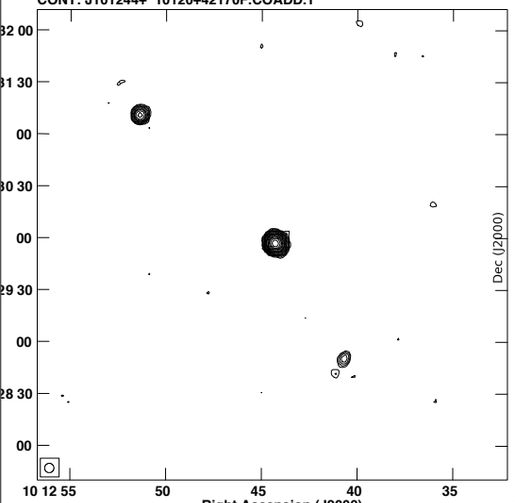
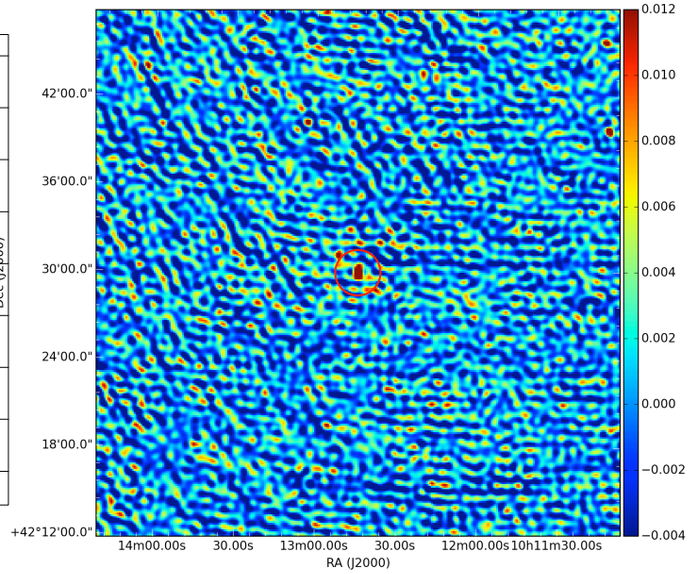


Cont peak flux = 6.5763E-02 JY/BEAM
Levs = 3.900E-04 * (1, 1.410, 2, 2.830, 4, 5.660, 8, 11.31, 16, 22.63, 32, 45.25, 64, 90.51, 128)



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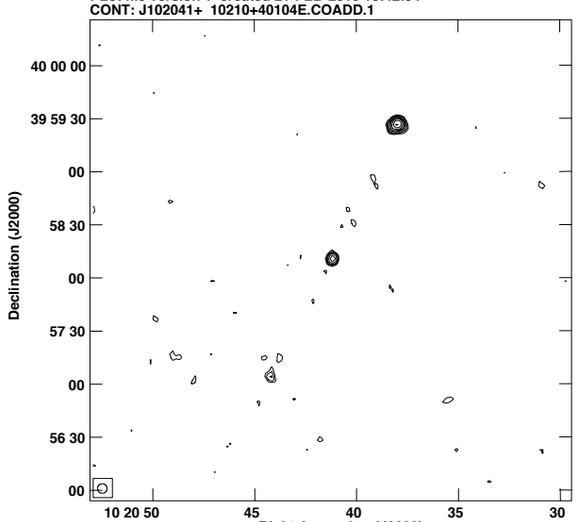
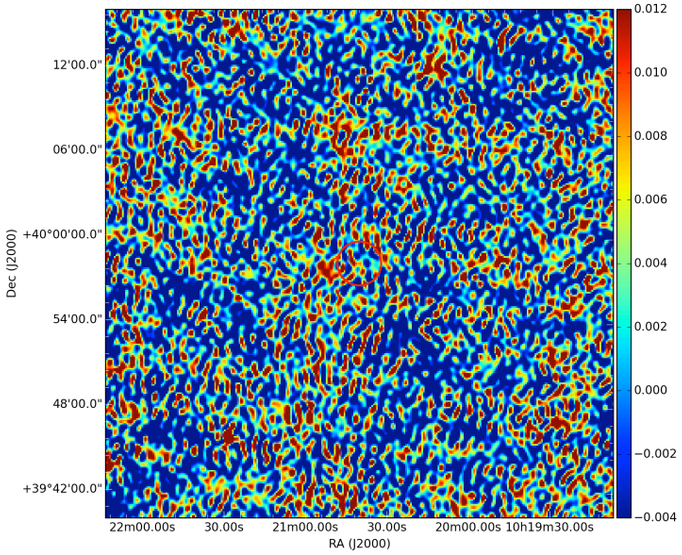
CONT: J102041+ 10210+40104E.COADD.1



Cont peak flux = 5.2616E-03 JY/BEAM
Levs = 4.500E-04 * (1, 1.410, 2, 2.830, 4, 5.660, 8, 11.31, 16, 22.63, 32, 45.25, 64, 90.51, 128)



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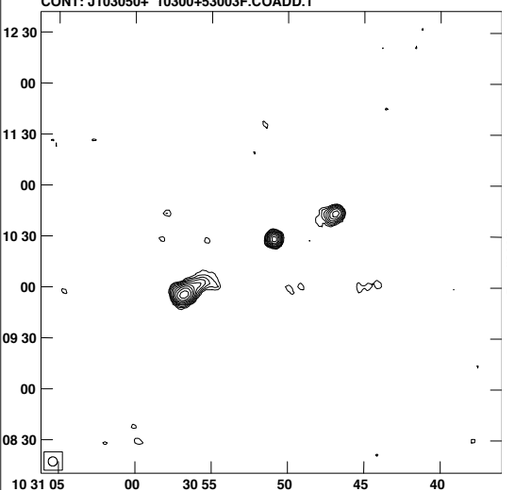
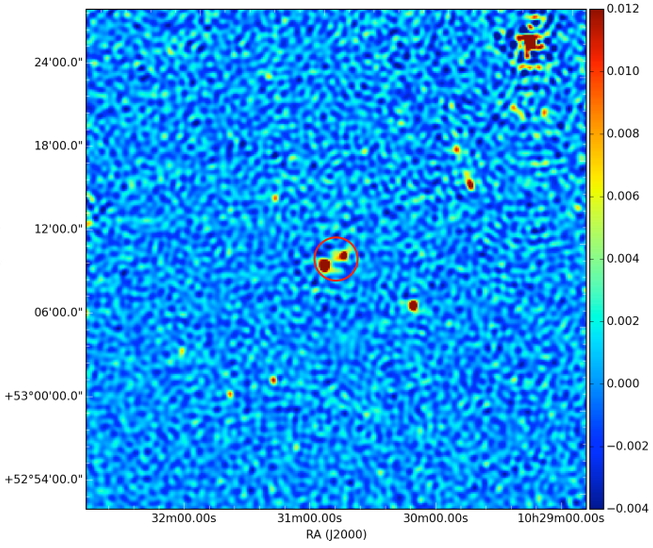
CONT: J103050+ 10300+53003F.COADD.1



Cont peak flux = 1.0252E-02 JY/BEAM
Levs = 5.000E-04 * (1, 1.410, 2, 2.830, 4, 5.660, 8, 11.31, 16, 22.63, 32, 45.25, 64, 90.51, 128)



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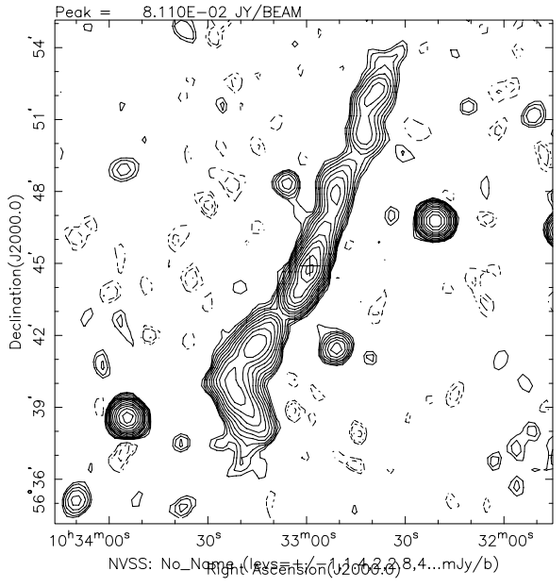
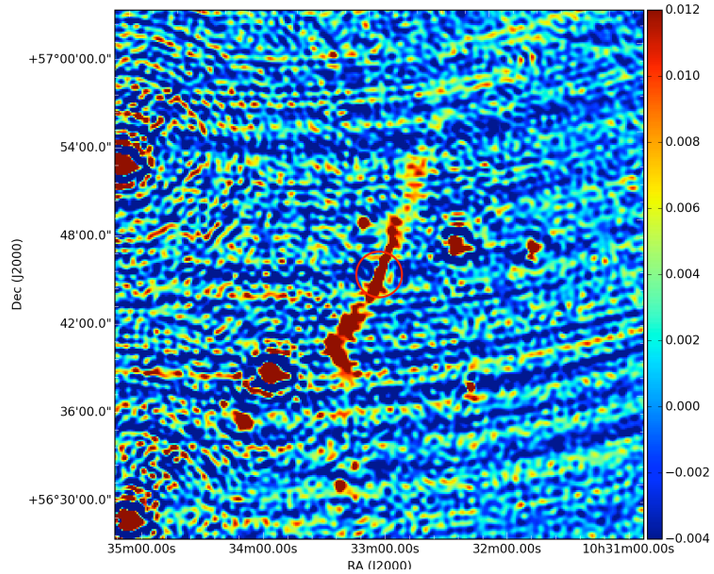
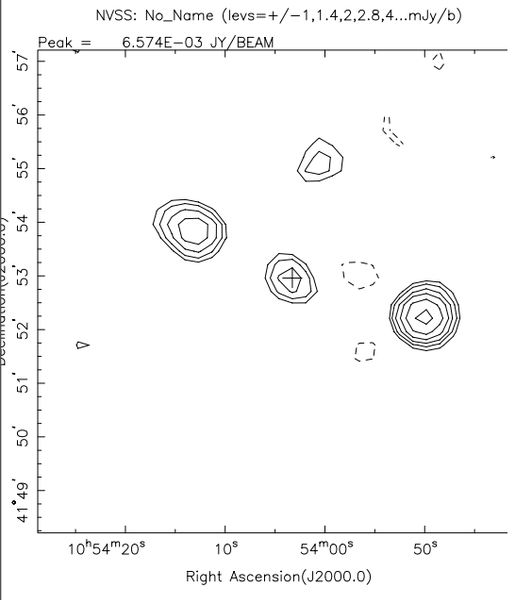
Peak = 8.110E−02 JY/BEAM

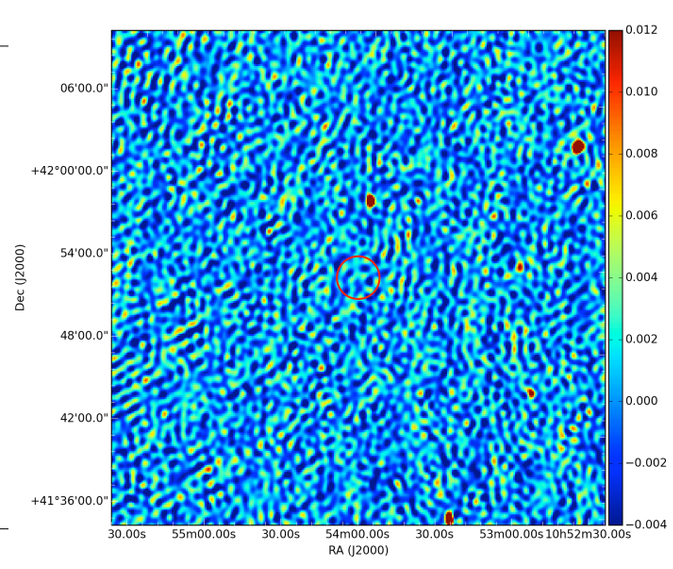


NVSS: No_Name (levs=+/−1,1.4,2,2.8,4...mJy/b)

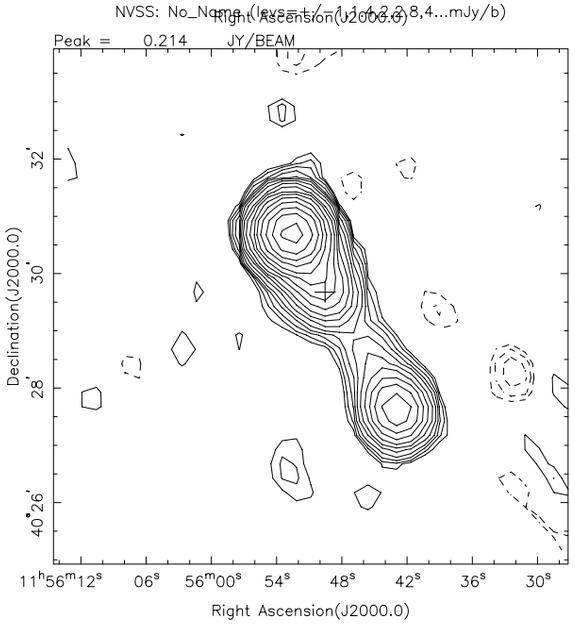


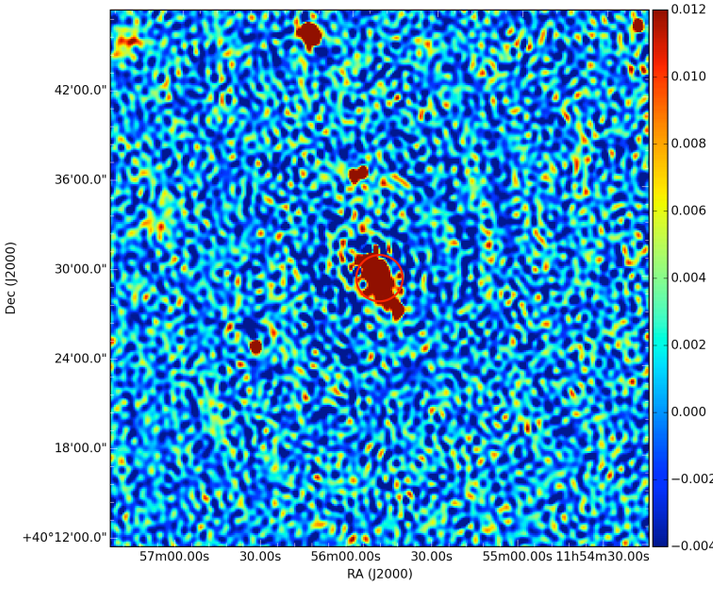
NVSS: No_Name (levs=+/−1,1.4,2,2.8,4...mJy/b)
Peak = 6.574E−03 JY/BEAM

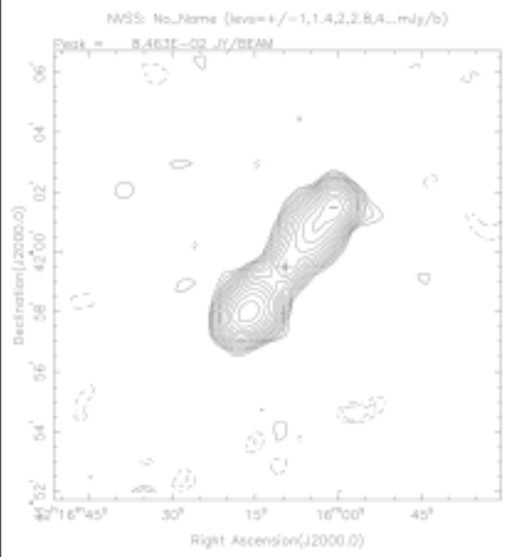


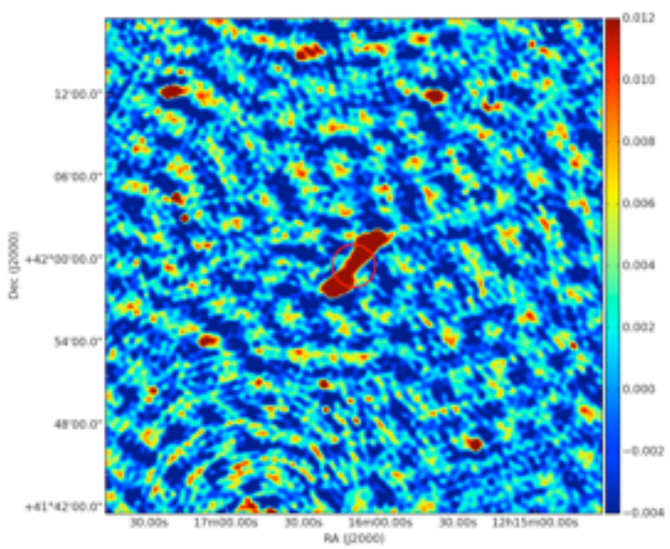


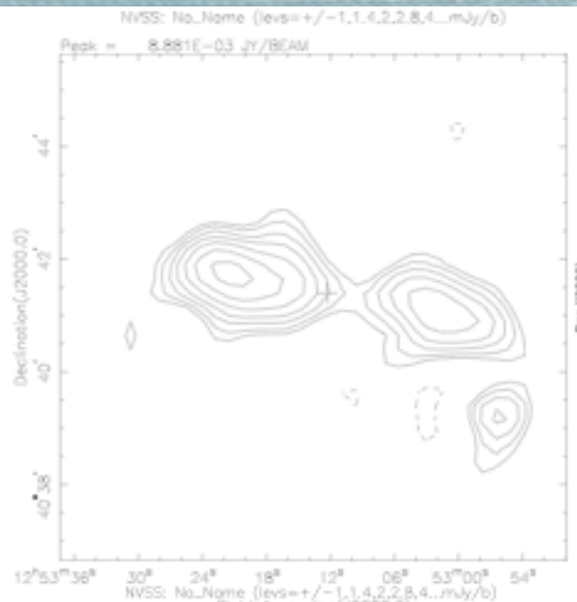
Peak = 0.214 JY/BEAM






NVSS: No_Name (levs=+/-1,1.4,2,2.8,4...mJy/b)
Peak = 8.463E-02 JY/BEAM
Declination(J2000.0)
Right Ascension(J2000.0)


Dec (J2000)
RA (J2000)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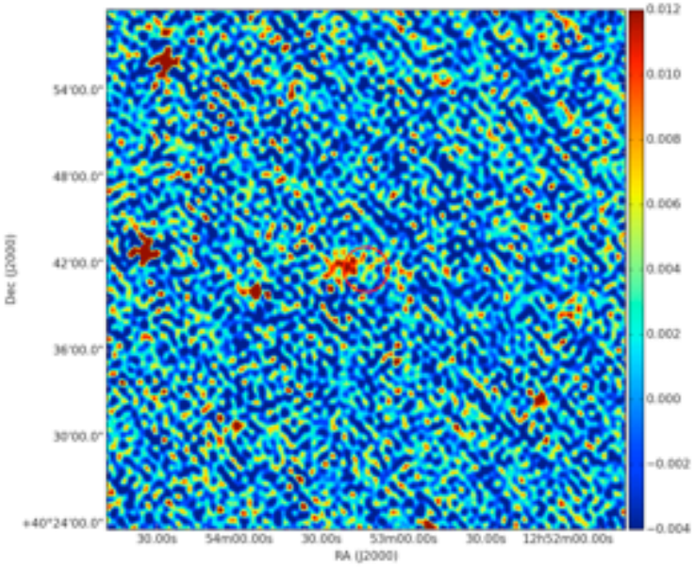
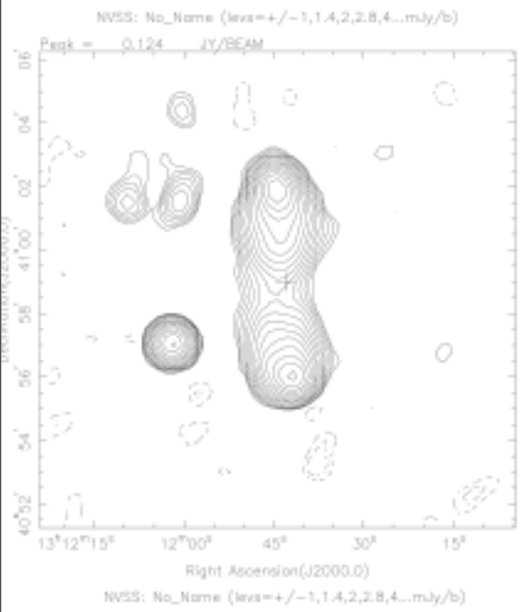
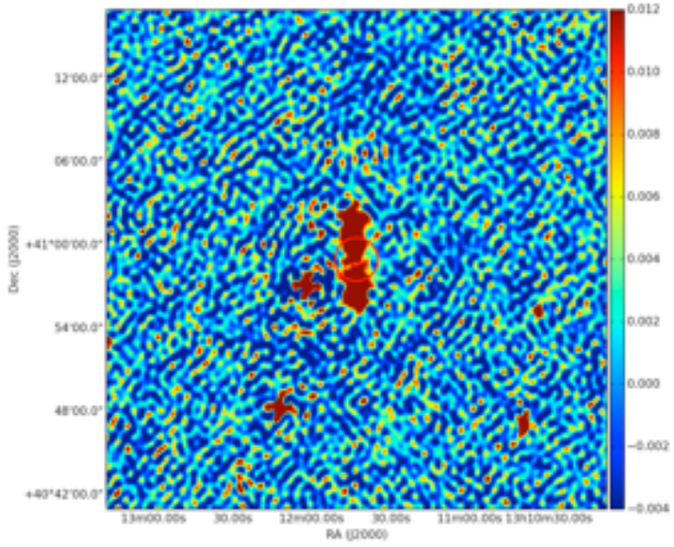
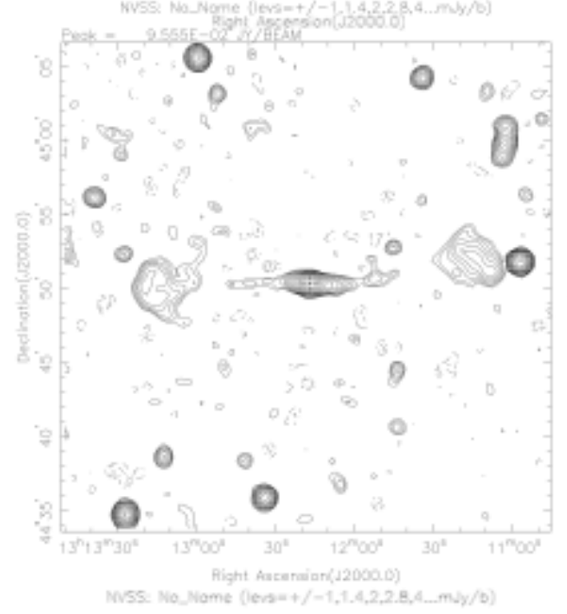
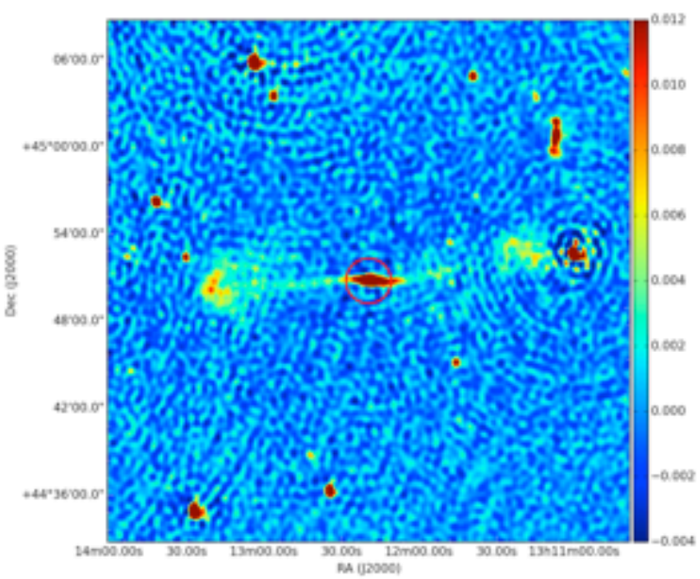
Peak = 8.881E-03 JY/BEAM
Declination(J2000.0)

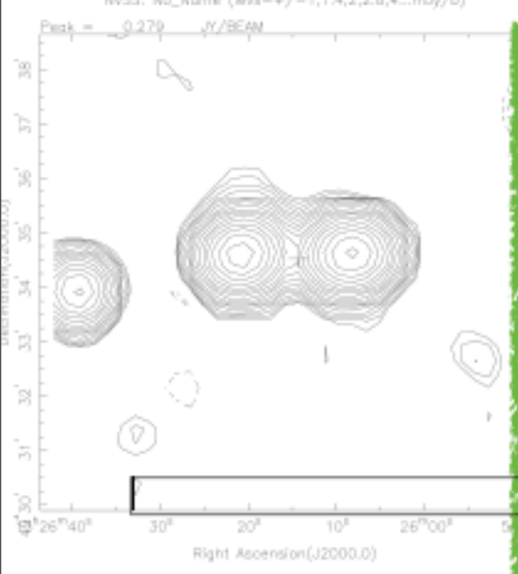

Dec (J2000)
RA (J2000)


NVSS: No_Name (levs=+/-1,1.4,2,2.8,4...mJy/b)
Peak = 0.124 JY/BEAM
Declination(J2000.0)
Right Ascension(J2000.0)


Dec (J2000)
RA (J2000)


NVSS: No_Name (levs=+/-1,1.4,2,2.8,4...mJy/b)
Peak = 9.555E-02 JY/BEAM
Declination(J2000.0)
Right Ascension(J2000.0)


Dec (J2000)
RA (J2000)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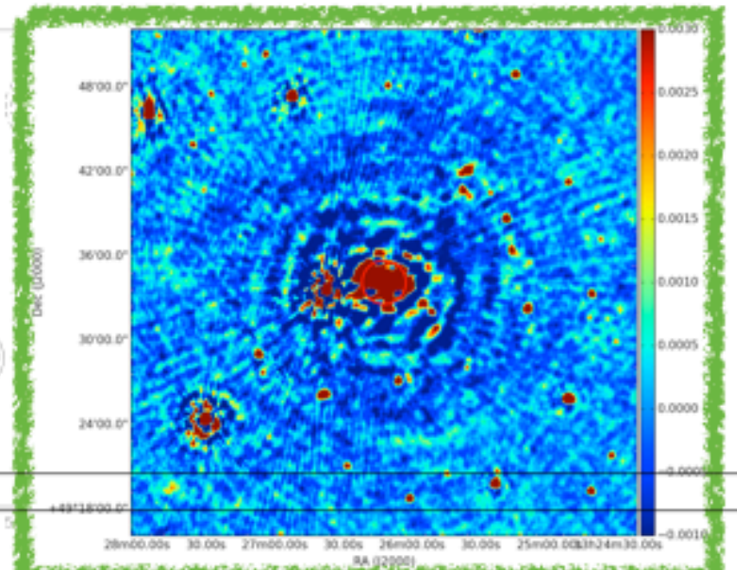
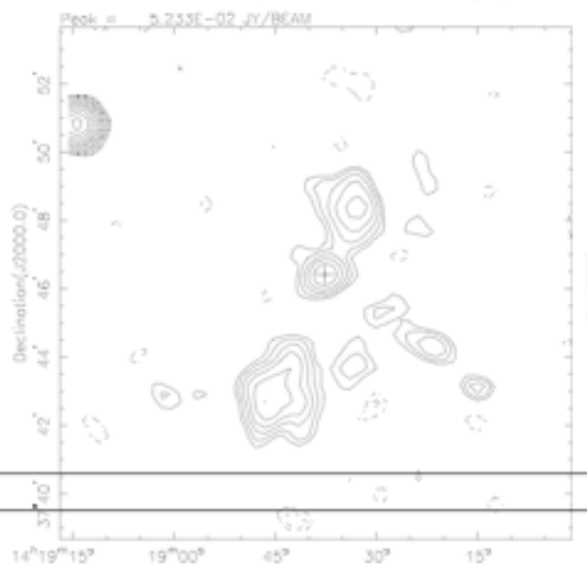
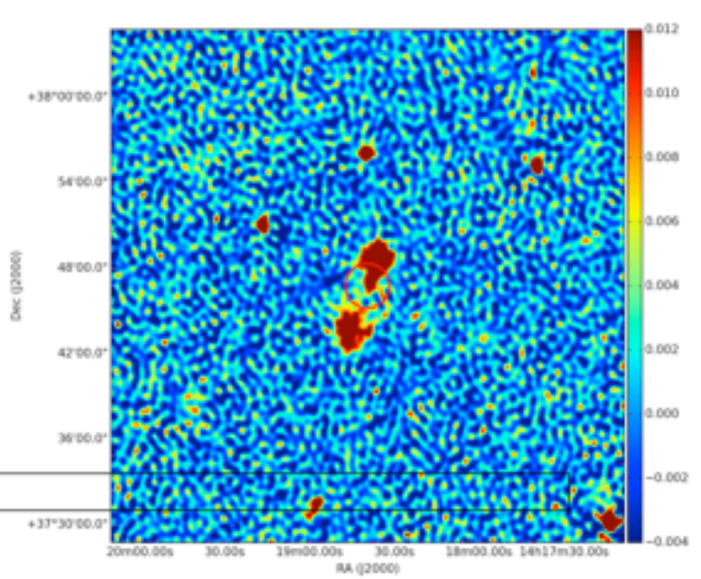
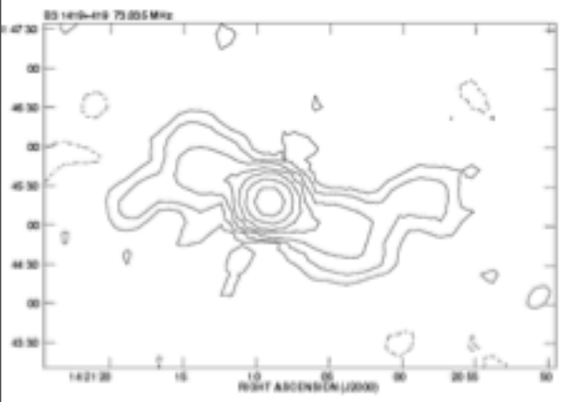
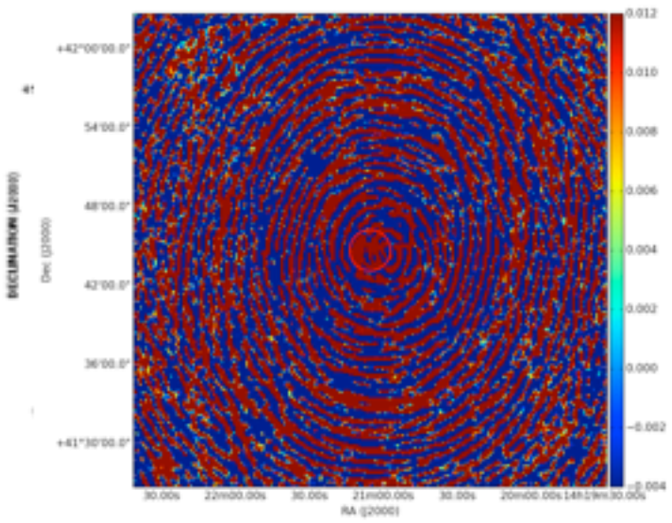
Declination(J2000.0)
Right Ascension(J2000.0)

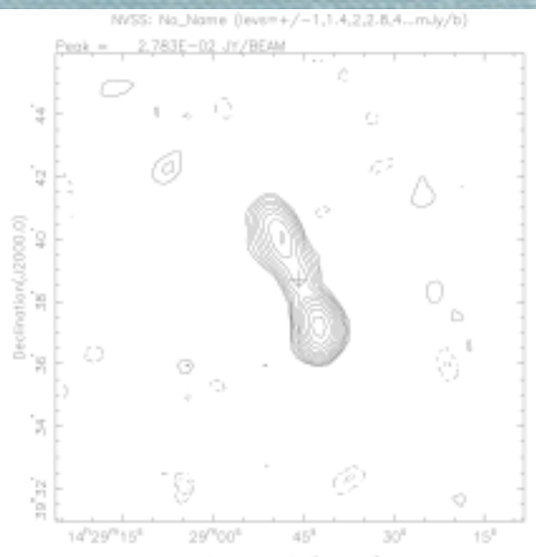

Dec (J2000)
RA (J2000)

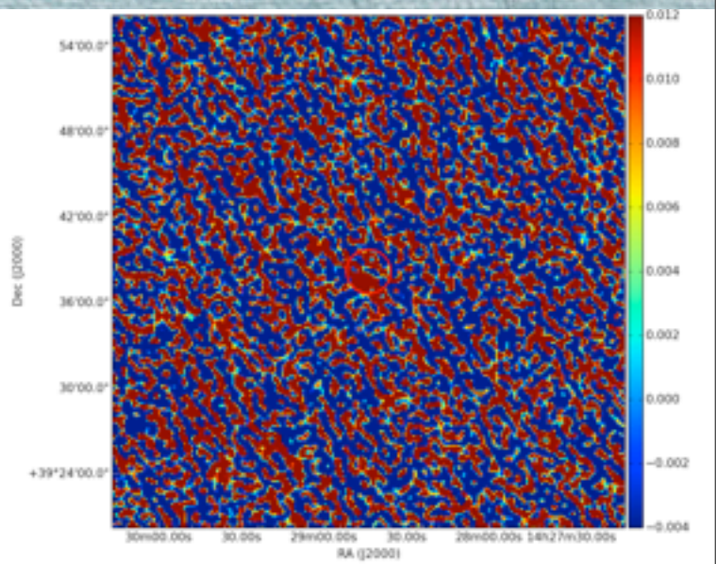

Peak = 5.235E-02 JY/BEAM
Declination(J2000.0)
Right Ascension(J2000.0)


Dec (J2000)
RA (J2000)


RIGHT ASCENSION (J2000)


DECLINATION (J2000)
Dec (J2000)
RA (J2000)


NVSS: No_Name (levs=+/-1,1.4,2,2.8,4...mJy/b)
Peak = 2.783E-02 JY/BEAM
Declination(J2000.0)
Right Ascension(J2000.0)


Dec (J2000)
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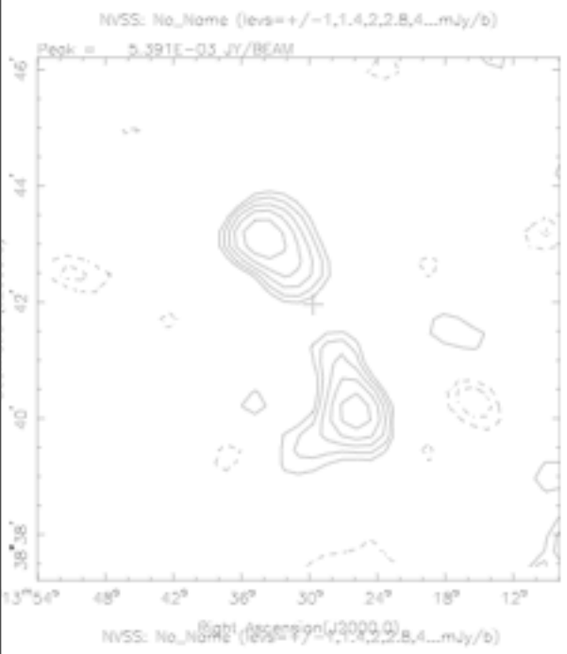
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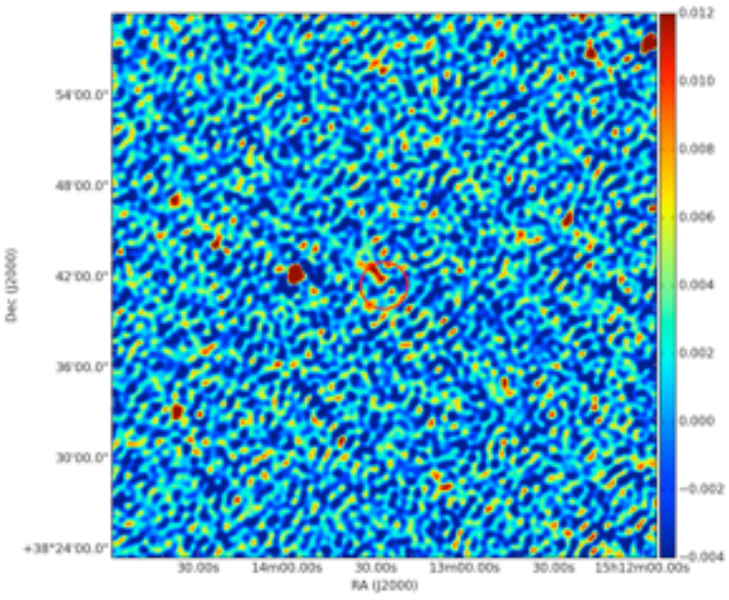
Peak = 5.391E-03 JY/BEAM
Right Ascension(J2000.0)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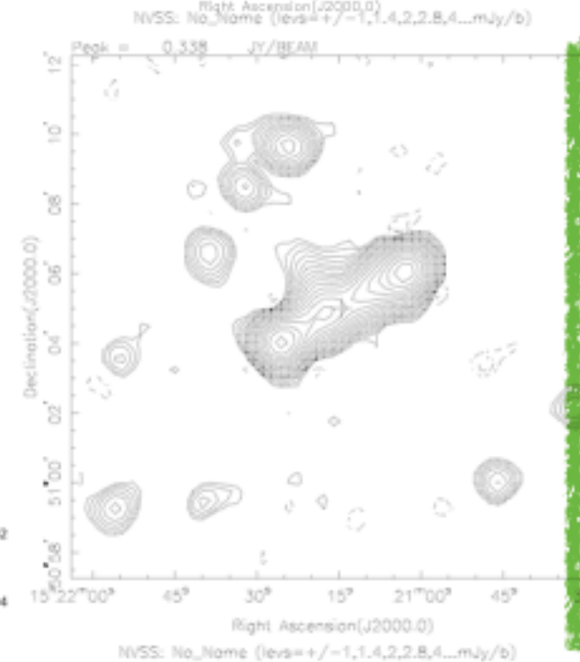
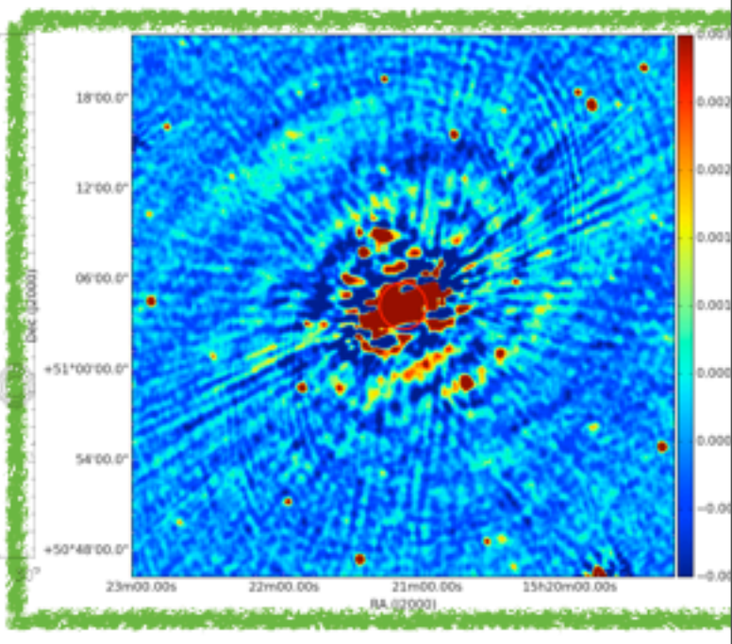
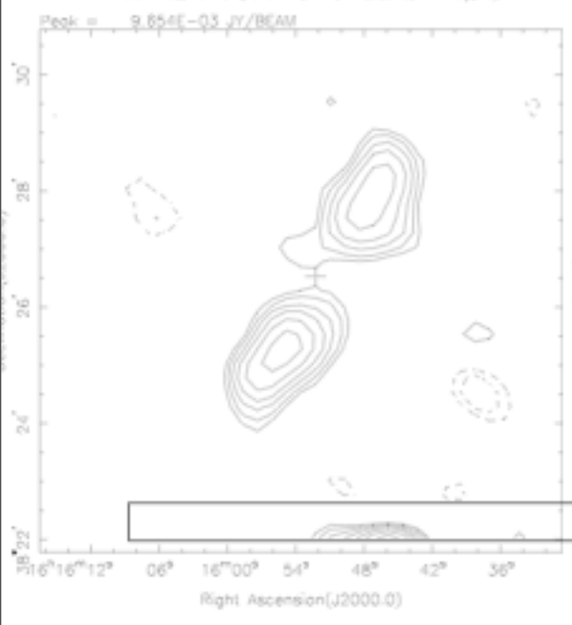
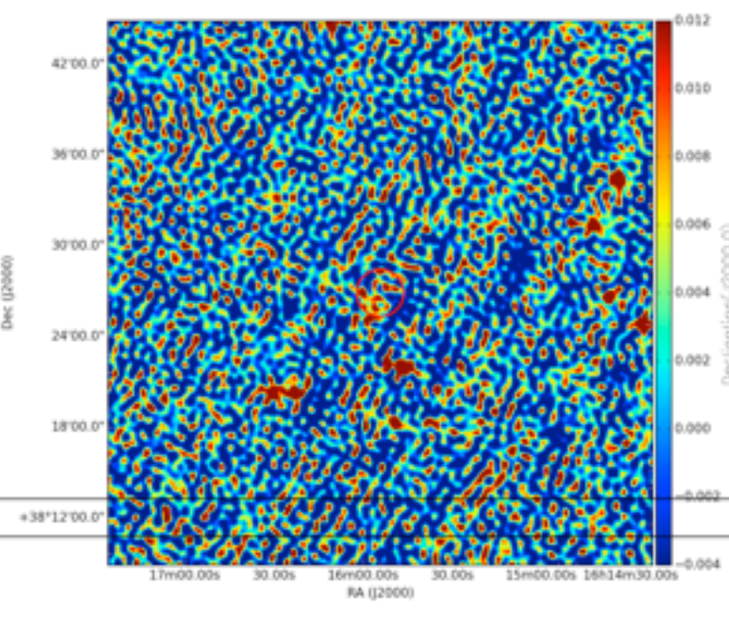
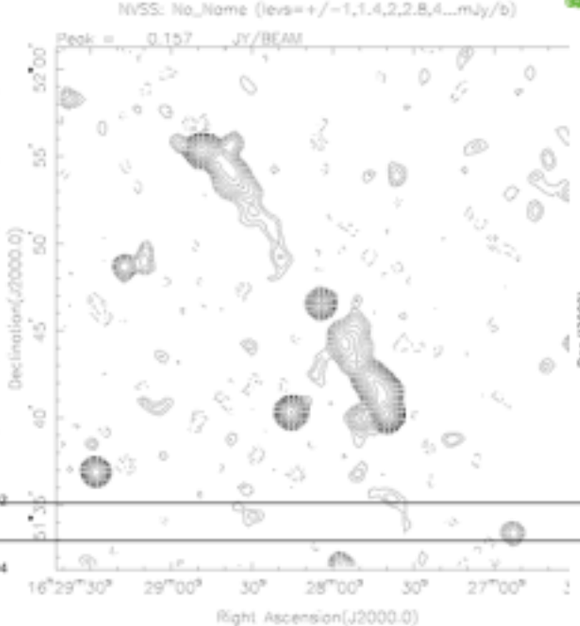
RA (J2000)


NVSS: No_Name (levs=+/-1,1.4,2,2.8,4...mJy/b)
Peak = 0.538 JY/BEAM
Declination(J2000.0)
Right Ascension(J2000.0)


Dec (J2000)
RA (J2000)


Peak = 9.854E-03 JY/BEAM
Right Ascension(J2000.0)


Dec (J2000)
RA (J2000)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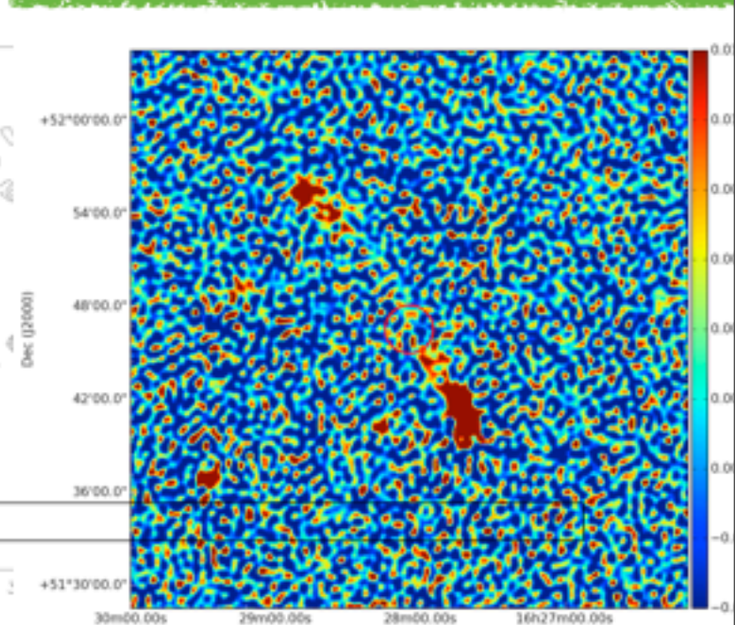
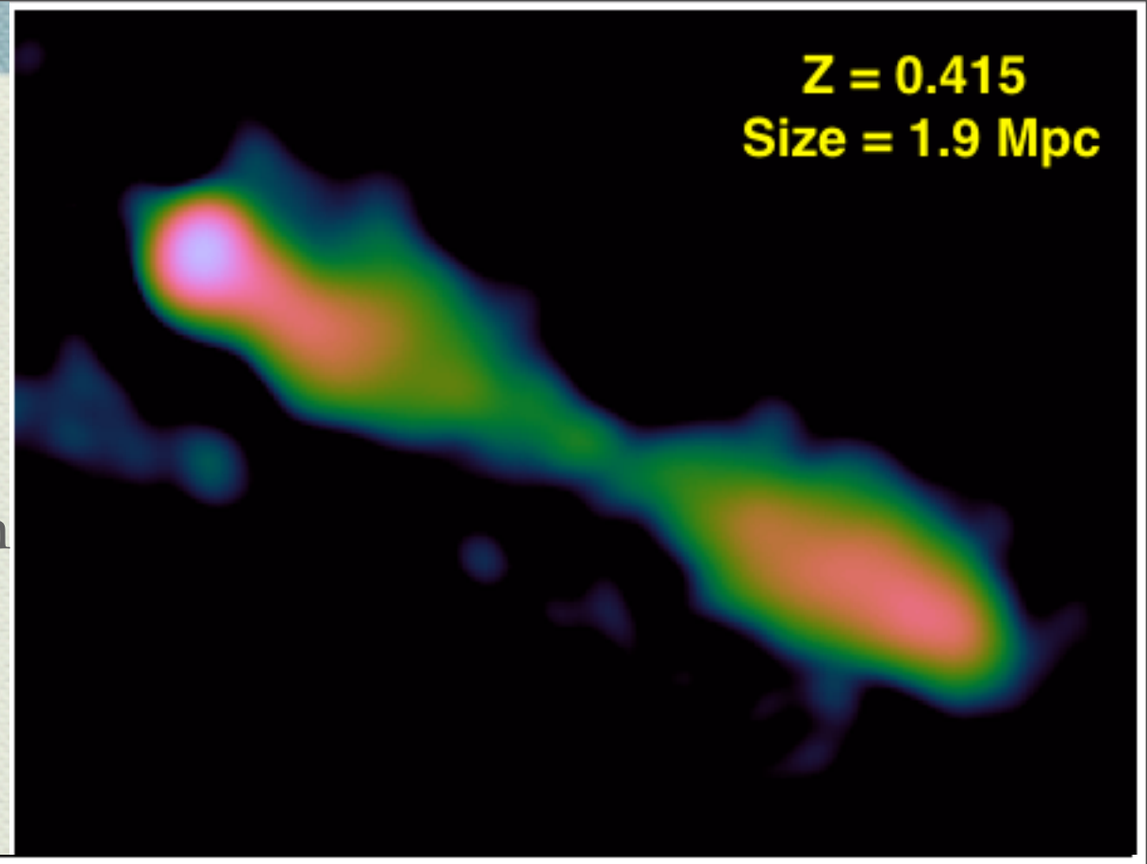
Declination(J2000.0)
Right Ascension(J2000.0)

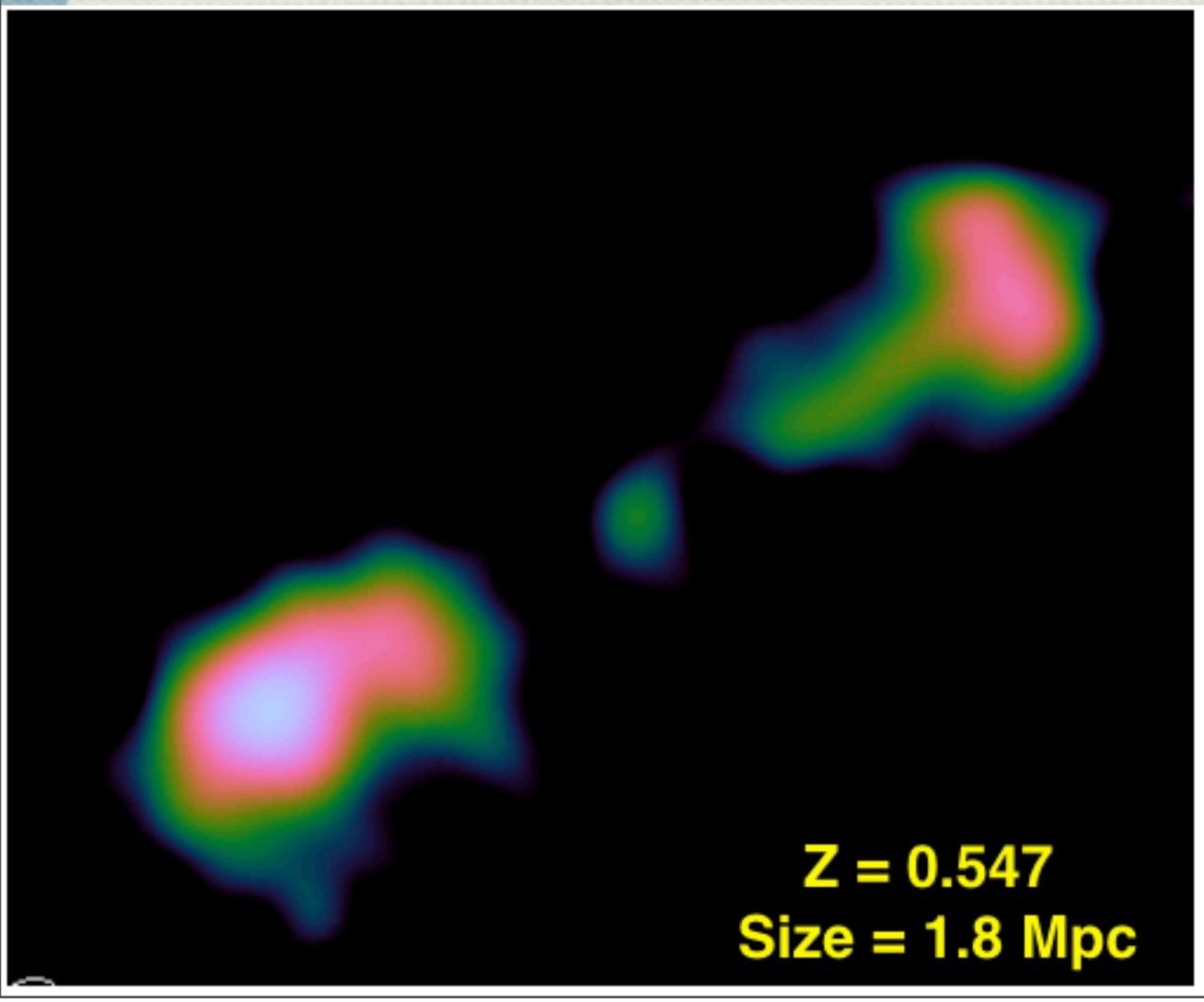

Dec (J2000)
RA (J2000)

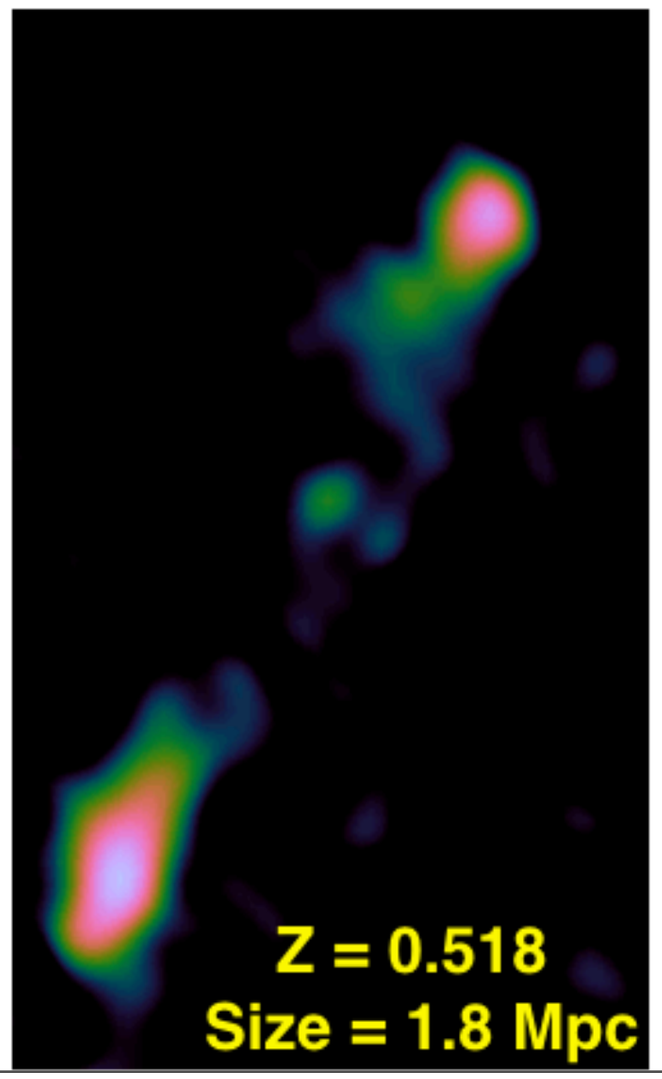
New-GRGs from Tier 1

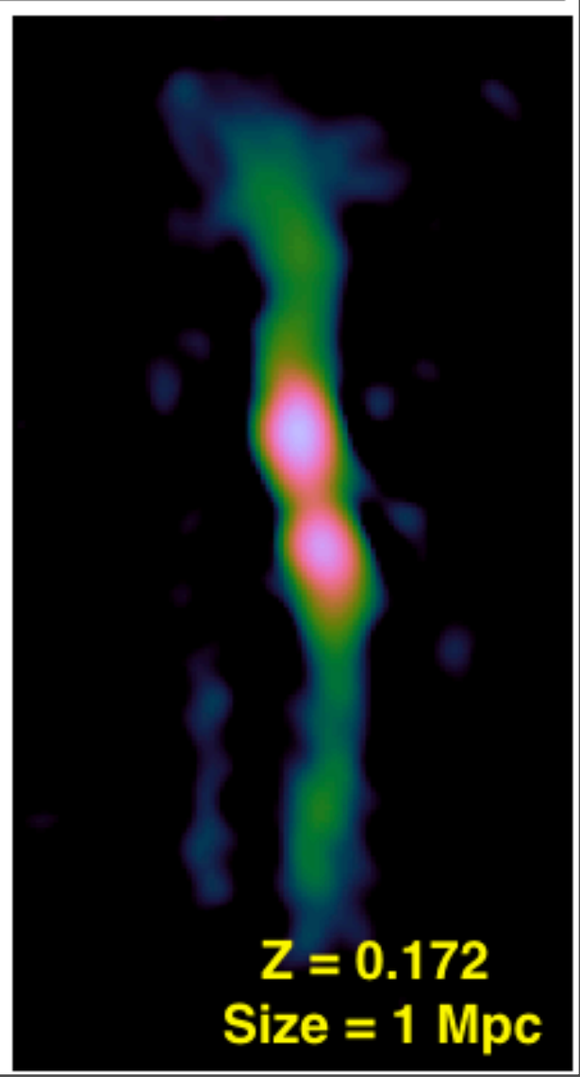
Pratik Dabhade (IUCAA, India)

- few sample of GRGs found via visual inspection of Tier 1 fields.
- resolution 20″, rms ~ 0.3-0.8 mJy/beam









Challenges

- computing facilities
- man power (technical/software people)
- initial catalogue
- artifact free images
- detection of faint and extended features from catalogue by source founding (new method recently published)
- tools for standard assessment of results
- search and identification of the object on other surveys, redshifts, follow ups etc.

Conclusions and future plans

✳The study of GRG at low frequency reveals interesting properties of the AGN low energy particle population and magnetic fields.

✳The study of DDRG provides information about multiple jet activity keeping track of AGNs duty cycle up to very “old particles”

✳The GRG working group:

- ✳ is concentrating its activity on single targeted observations
- ✳in the long term cross match with GRG catalogues
- ✳exploitation of Survey fields to compile new catalogues of GRG and DDRG - more difficult blind search/detection of new GRG and DDRG