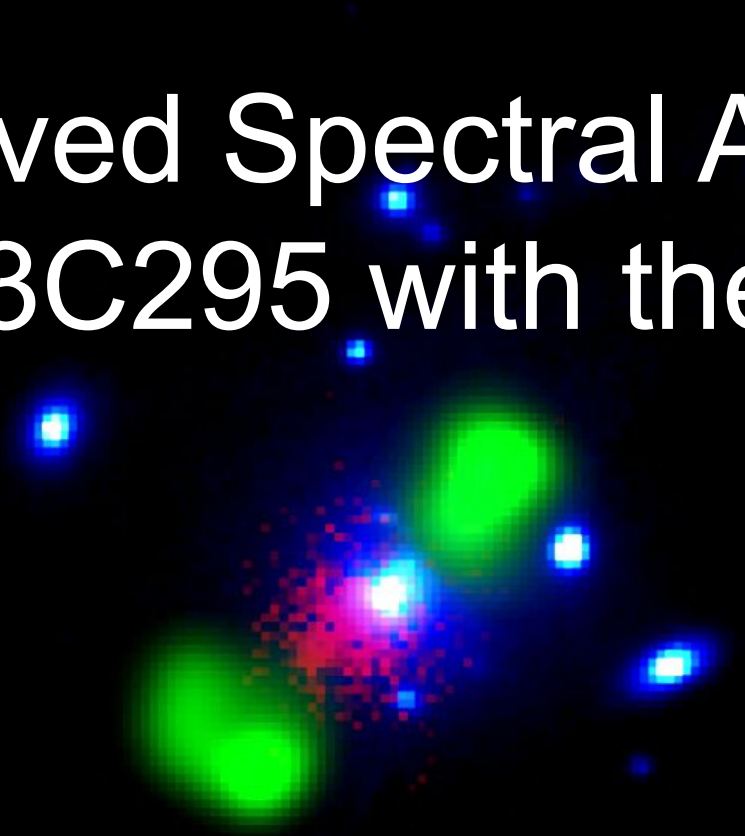
Resolved Spectral Analysis of 3C295 with the ILT



E. Bonnassieux, F. Sweijen, M. Brienza, K. Rajpurohit, C. J. Riseley, A. Bonafede, N. Jackson, L. K. Morabito, G. Brunetti, J. Harwood, A. Kappes, H. J. Rottgering, C. Tasse, R. van Weeren

Outline

- Why 3C295

- The International LOFAR Telescope

- Multi-Wavelength Science at Low Frequencies

Why 3C295?

In practical terms:

One person's foreground / calibrator / sidelobe source

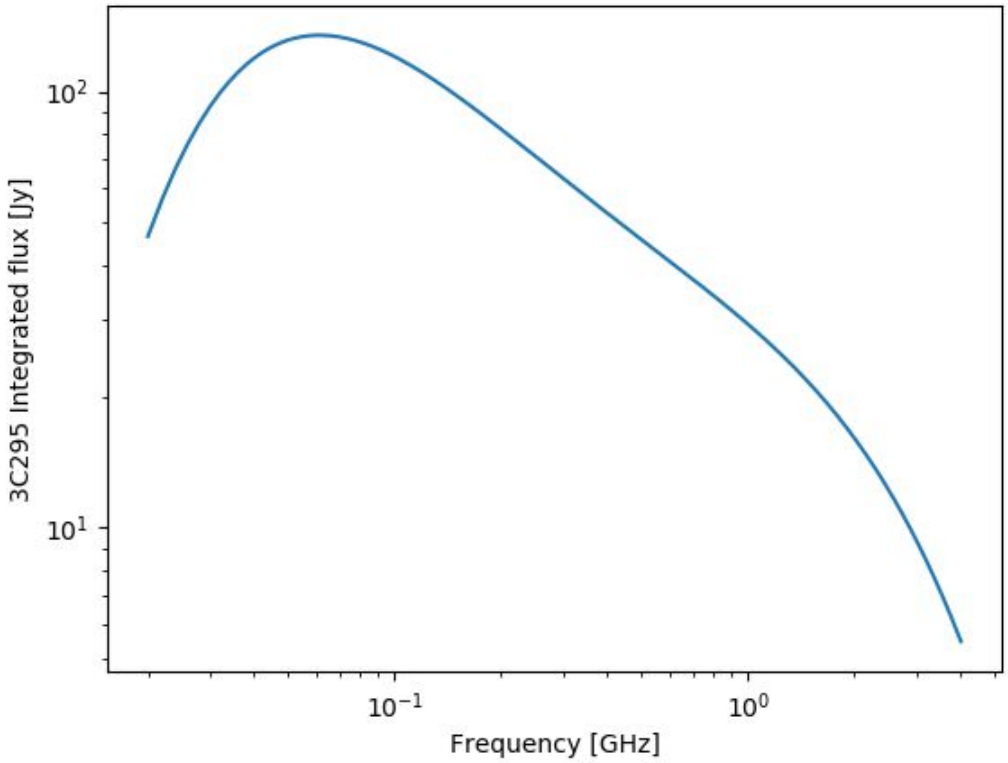
is someone else's science target!

To maximise scientific yield of SKA & pathfinders, we must develop this mindset.

But what, specifically, makes 3C295 a science target?

Why 3C295?

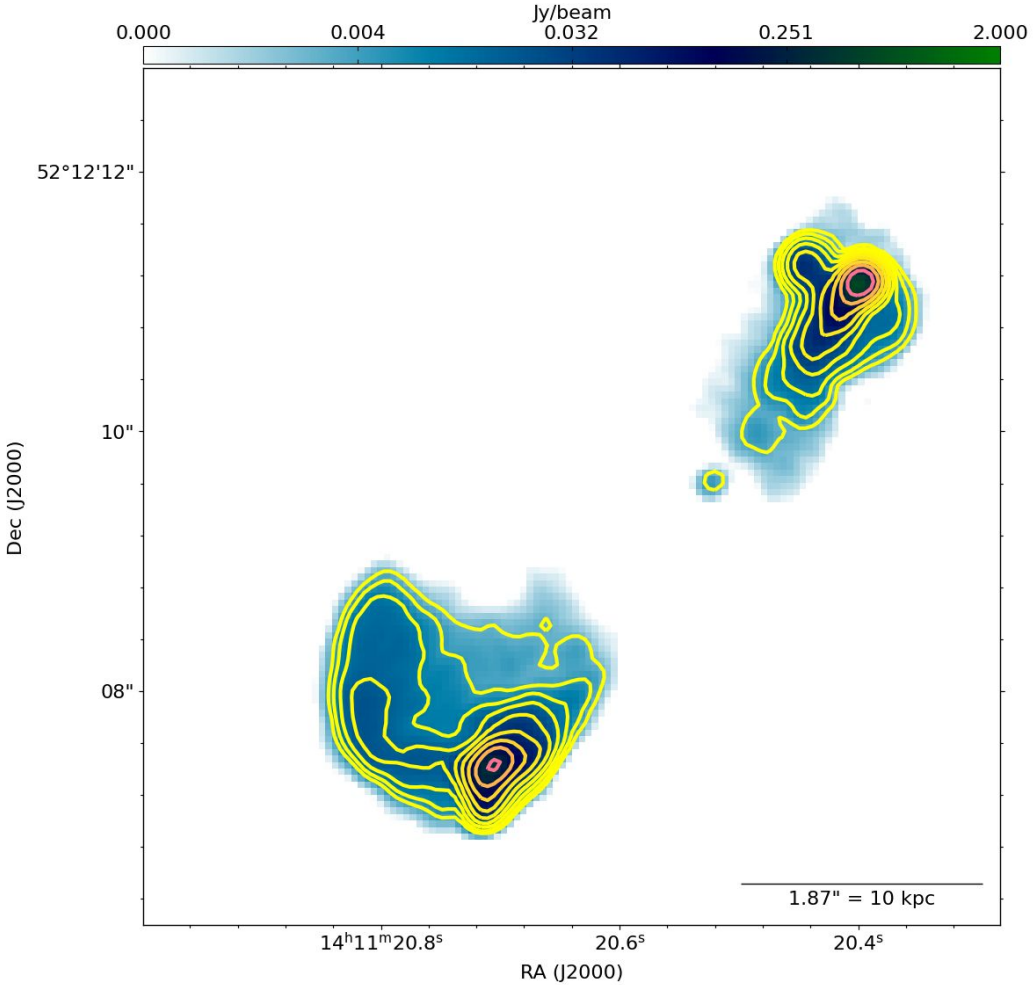
- Bright, compact radio galaxy
- Integrated spectral properties very well-studied at all frequencies



(radio, but also optical and X-ray!)

Why 3C295?

- Bright, compact radio galaxy
- Integrated spectral properties very well-studied at all frequencies
- Resolved spectral properties well-known at higher frequencies (> 1GHz)

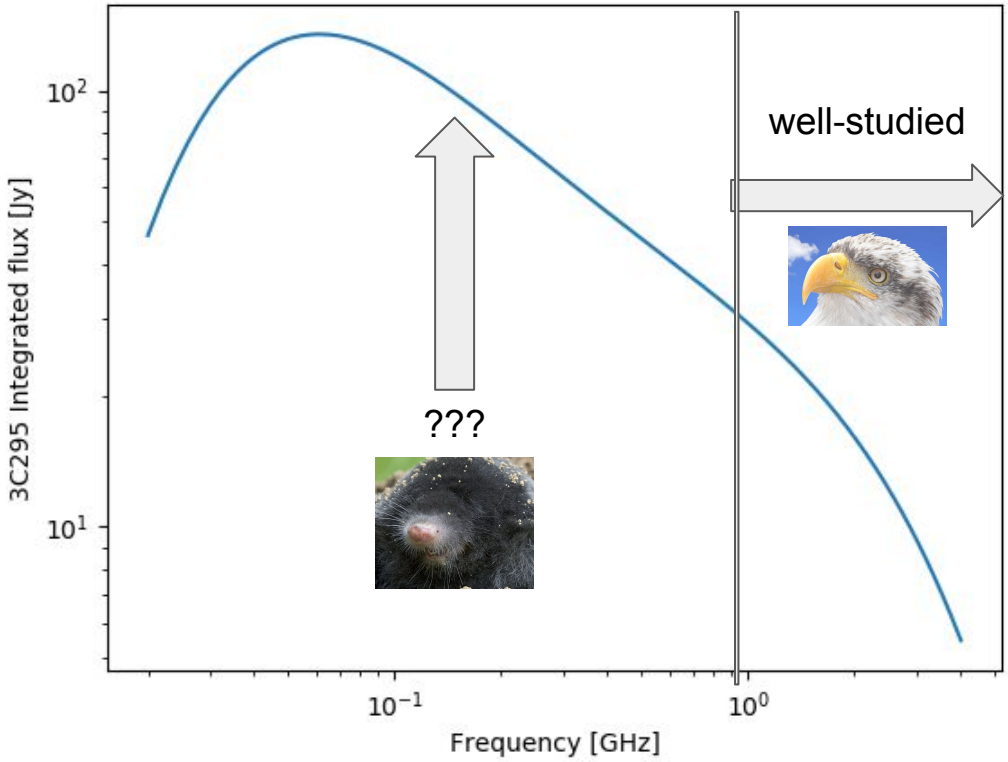


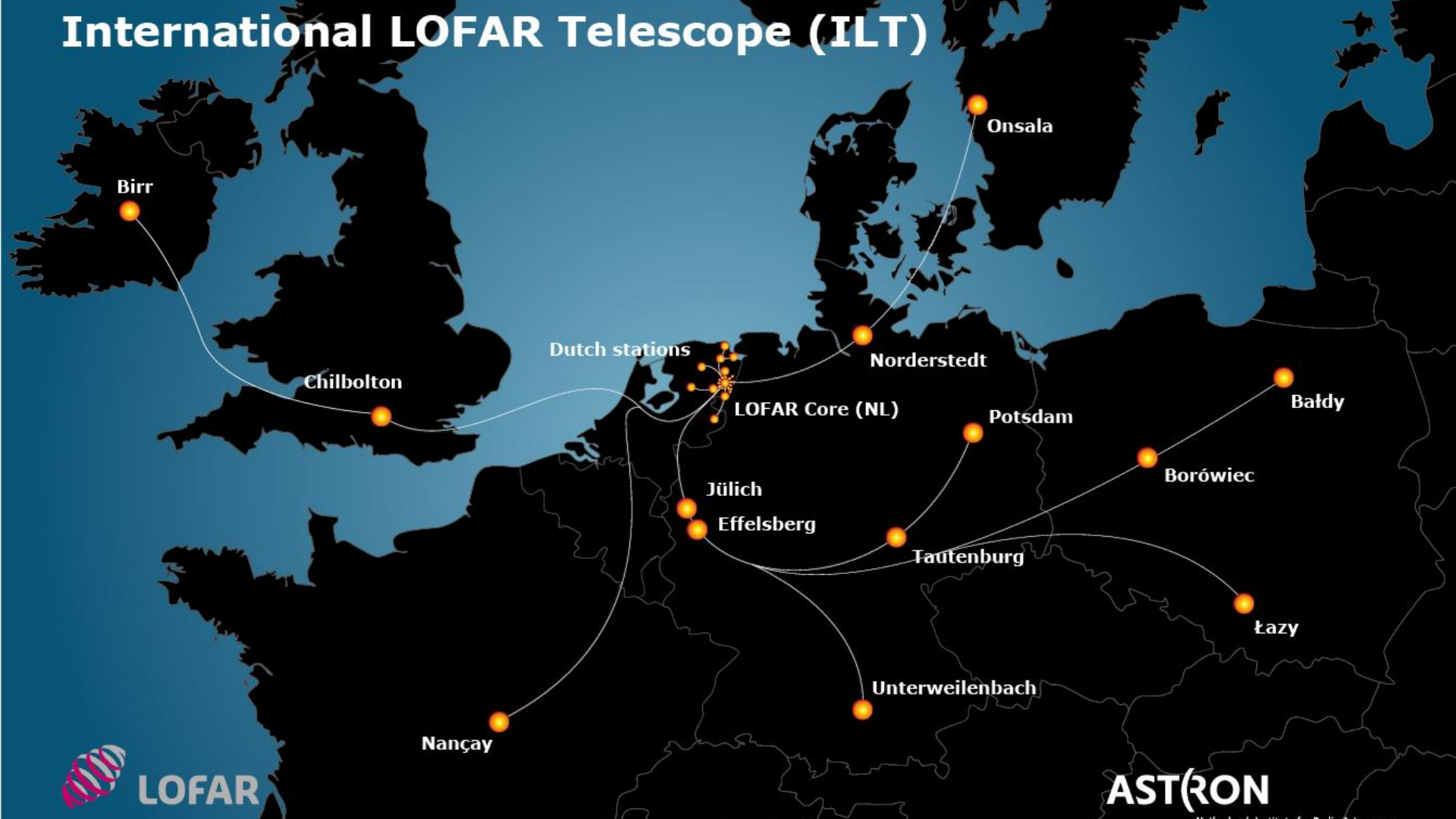
Why 3C295?

- Bright, compact radio galaxy
- Integrated spectral properties very well-studied at all frequencies
- Resolved spectral properties well-known at higher frequencies

  …

- but not LOFAR frequencies (144 MHz)




International LOFAR Telescope (ILT)
Onsala
Birr
Dutch stations
Norderstedt
Chilbolton
LOFAR Core (NL)
Potsdam
Bałdy
Borówiec
Jülich
Effelsberg
Tautenburg
Łazy
Unterweilenbach
Nançay
LOFAR
ASTRON

The International LOFAR Telescope

- Low-Frequency ARray: European SKA precursor instrument
- Dipoles on the ground: interferometer of phased arrays
- Nominal sensitivity: 0.16 mJy
- Resolution: 0.4” at 144 MHz
- Low-v coverage of Northern sky, valuable even once SKA online.

The International LOFAR Telescope

Pros:

- VLBI resolutions + short baselines.
- Large FoV for VLBI
- Good sensitivity

Cons:

- Detect large-scale emission with high resolution
- Ionospheric effects make calibration difficult

The International LOFAR Telescope

Data reduction:

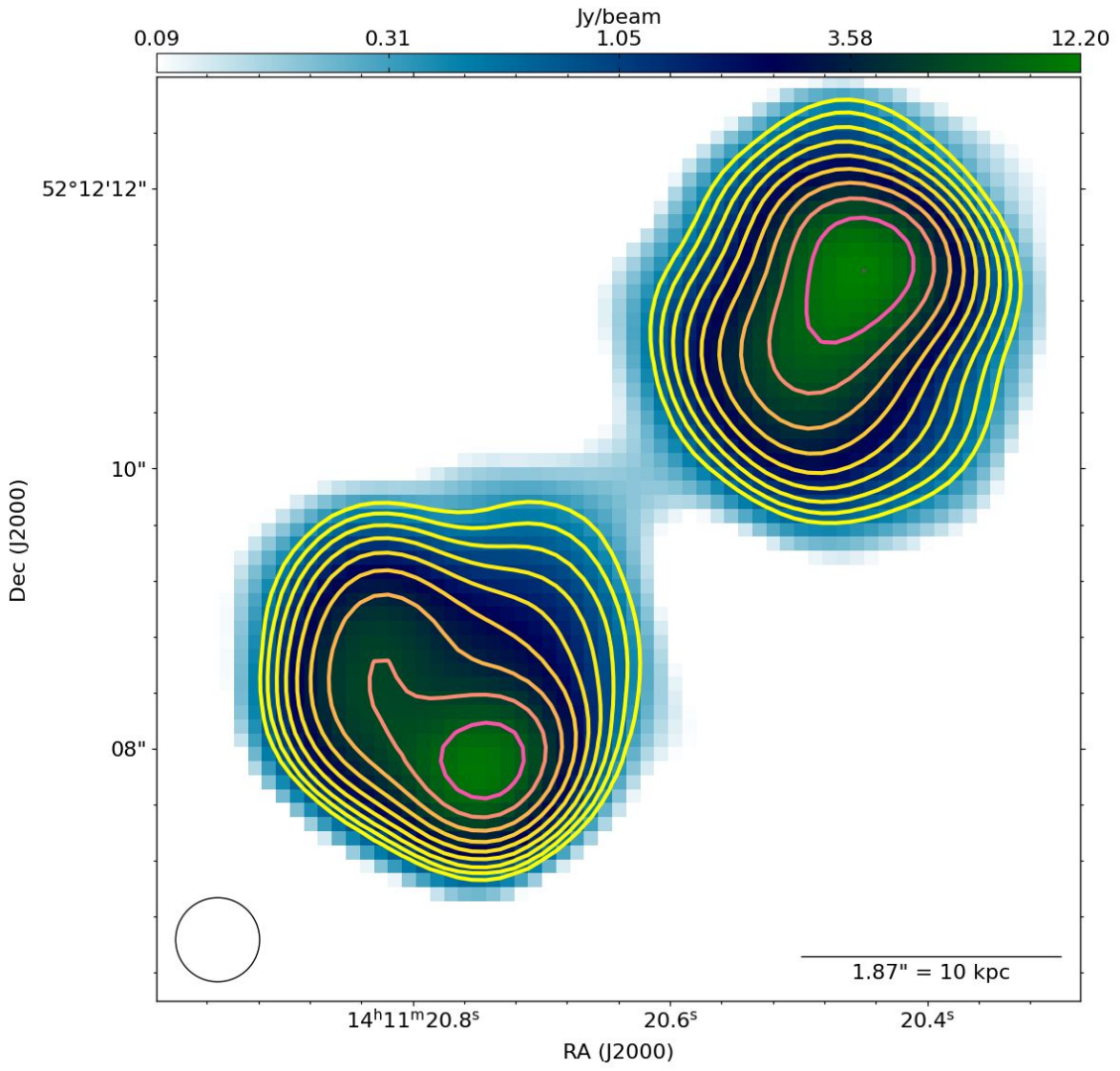
- killMS + quality-based weighting scheme to mitigate ionospheric effects
- Signal-to-noise very high: no fringe-fitting required in this case

Imaging:

- DDFacet used during self-calibration to model out smearing
- Multiple passes of self-calibration to attain high dynamic range (~20k)

Spectral Analysis

- 3C295 @ 132 MHz
- Dynamic range: ~20k
- 0.6” resolution
- No host galaxy detection…
- Map starts at 3sigma, overlays at 5sigma



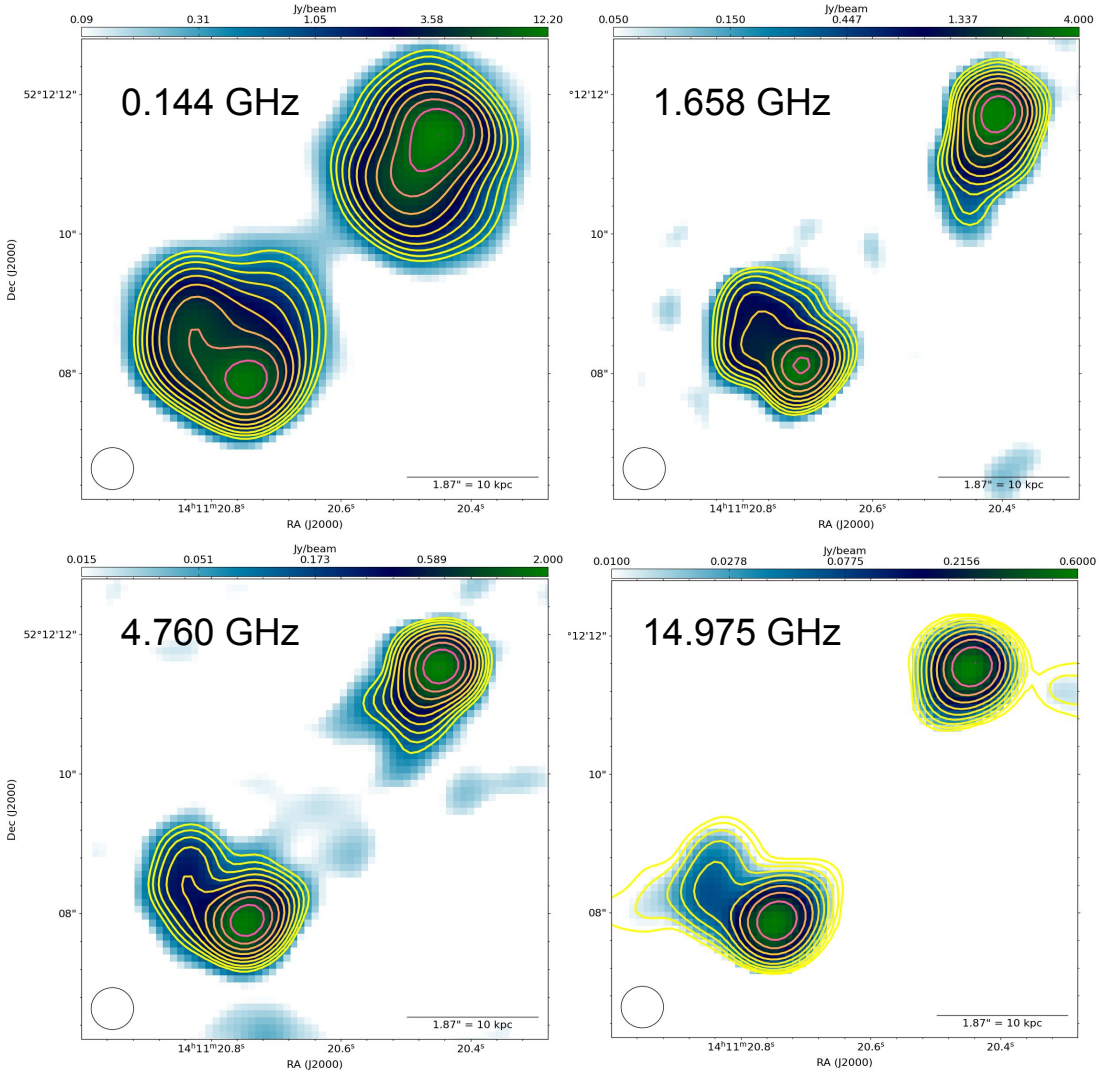
Spectral Analysis

- Colour-colour analysis:

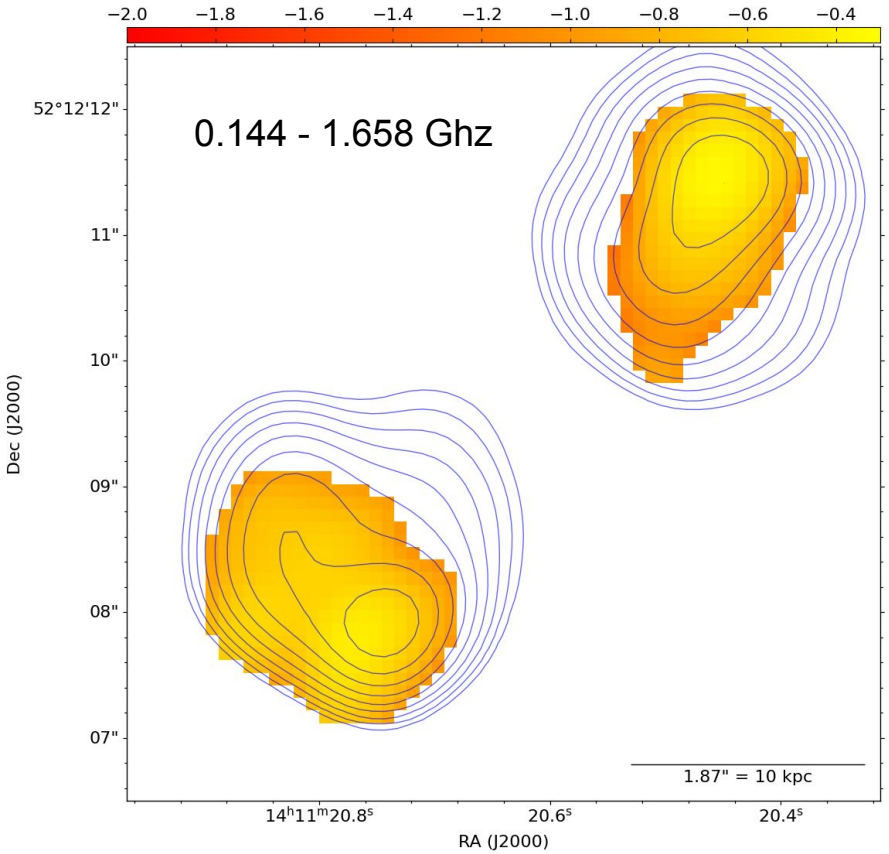
  4 frequencies required

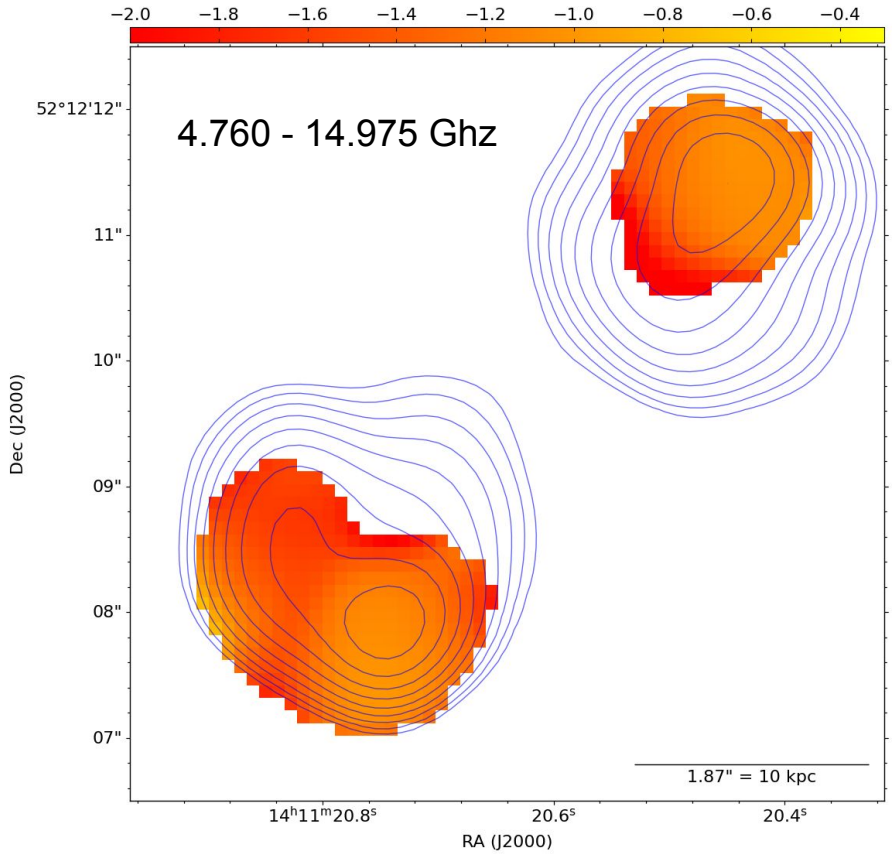
- MERLIN + VLA at higher freq
- Imaging done to maximise

  uv-coverage similarity etc

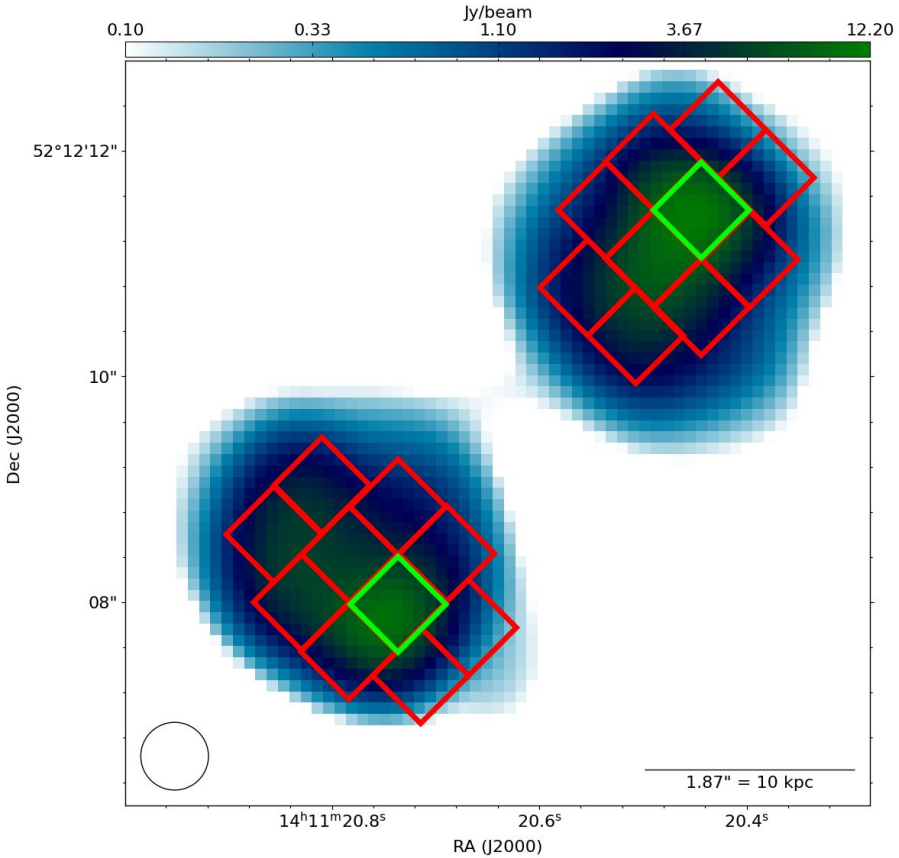


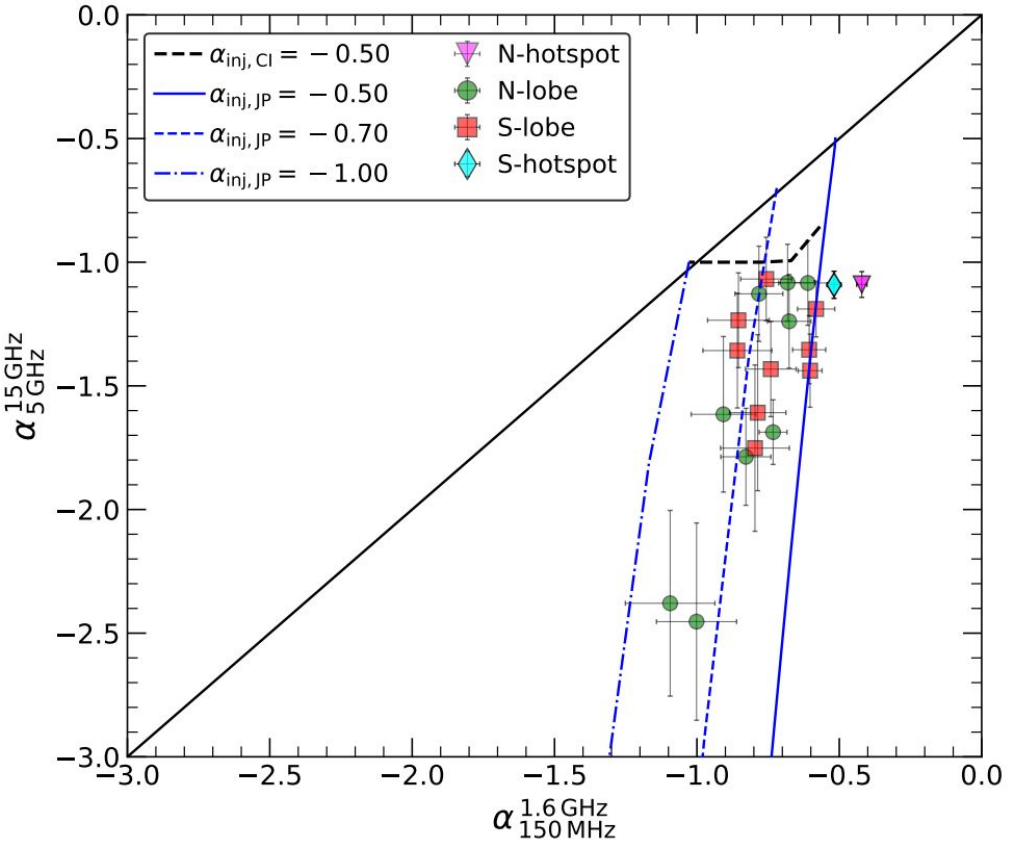
Spectral Analysis - spectral index maps



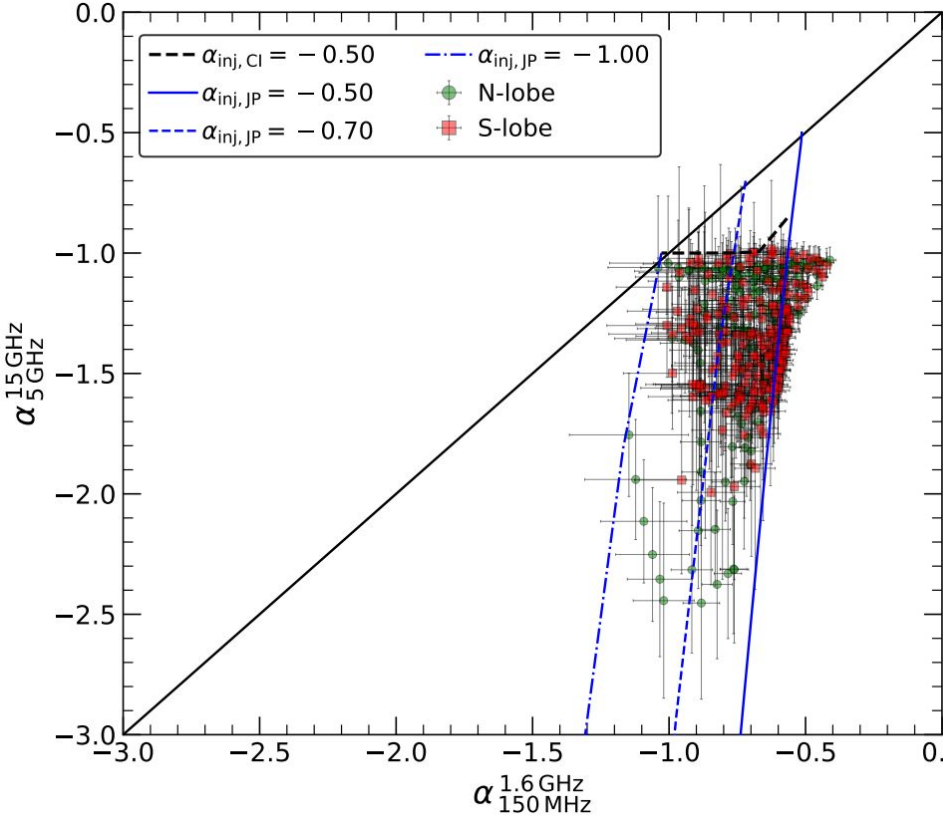


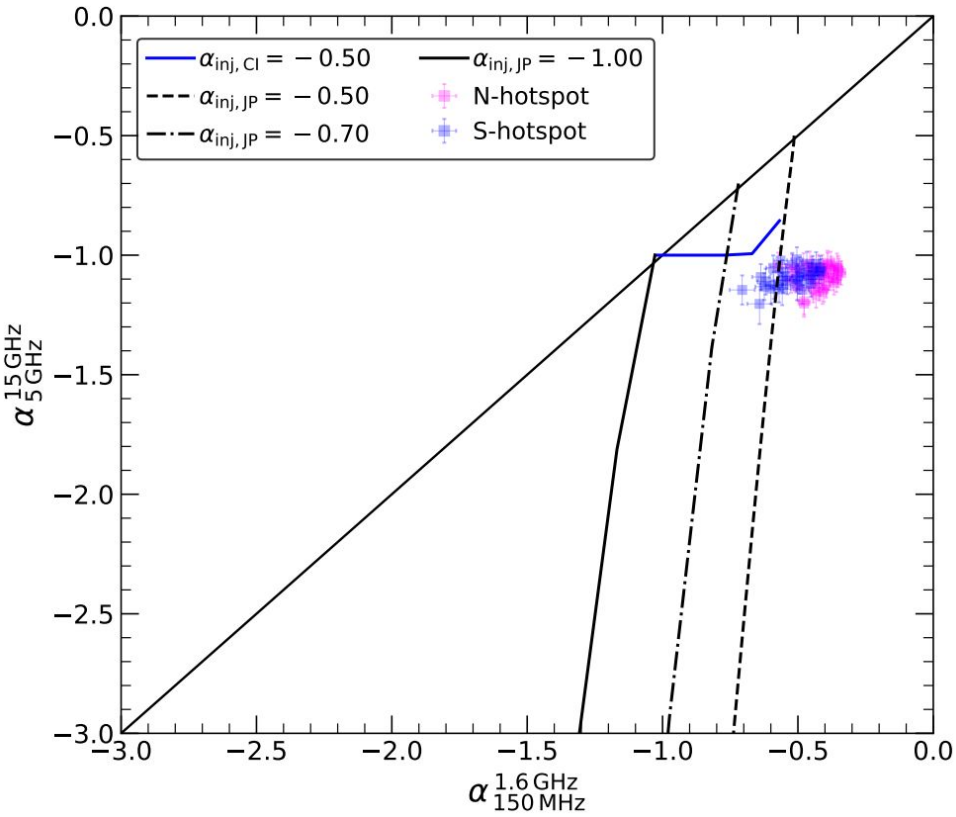
Spectral Analysis - regional radio colour-colour plots





Spectral Analysis - per-pixel radio colour-colour plots





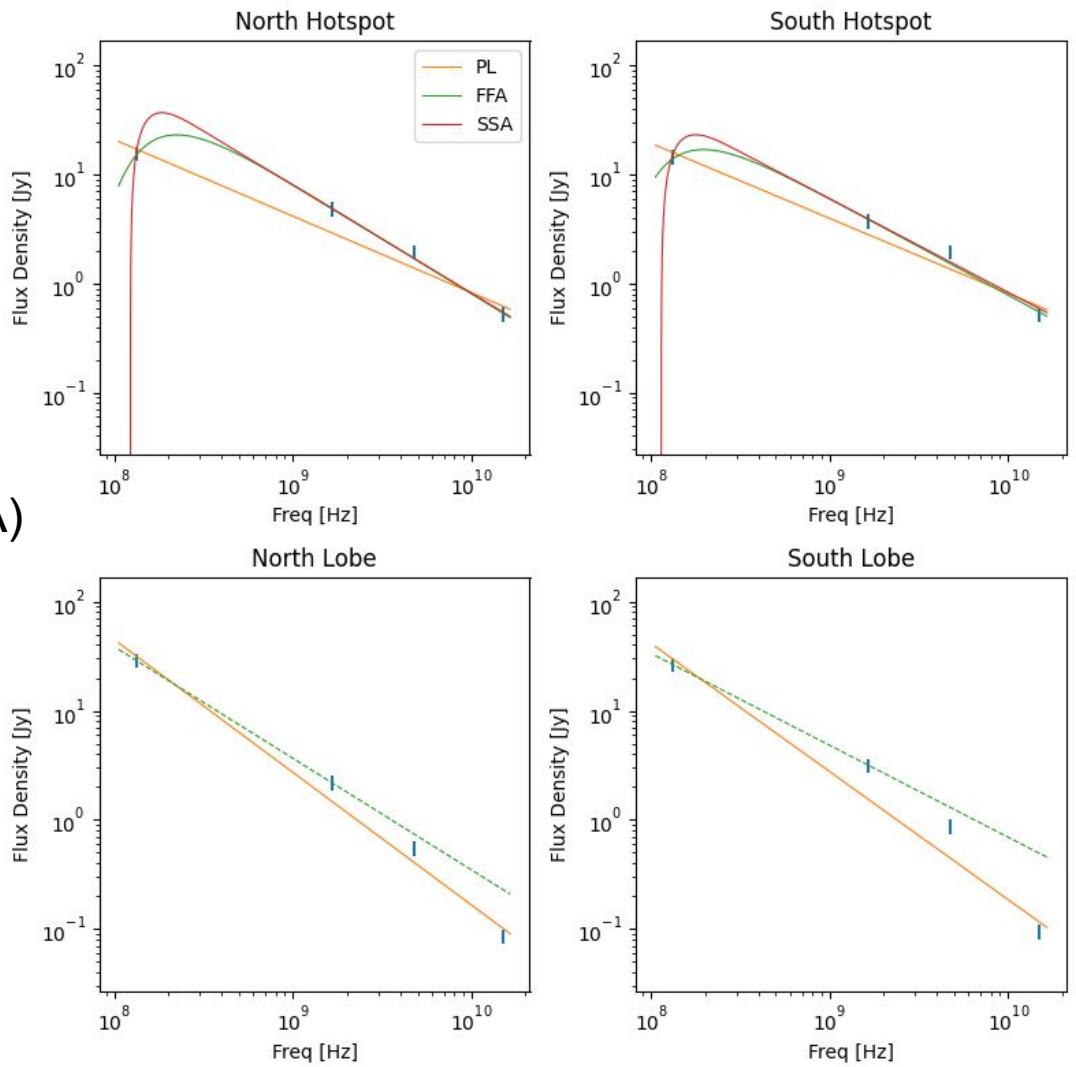
Spectral Analysis - per-component fitting

- 3 models fitted to hotspots:
  Power Law (PL)
  Free-Free Absorption (FFA)
  Synchrotron Self-Absorption (SSA)

- Only PL fitted to lobes

- FFA/SSA significantly degenerate
  -> need LBA obs to constrain!

- High-freq cutoff in lobes



Conclusion

- 3C295 conclusively features self-absorption in hotspots, which can be distinguished from general emission using current tools.

- ILT observations with HBA antennas opening up new parameter space for studying radio galaxies

- LBA observations needed to truly constrain 3C295 spectral properties

- Further technical work needed to match LBA and HBA resolutions - but once done, will provide very interesting SED constraints on mass scale!