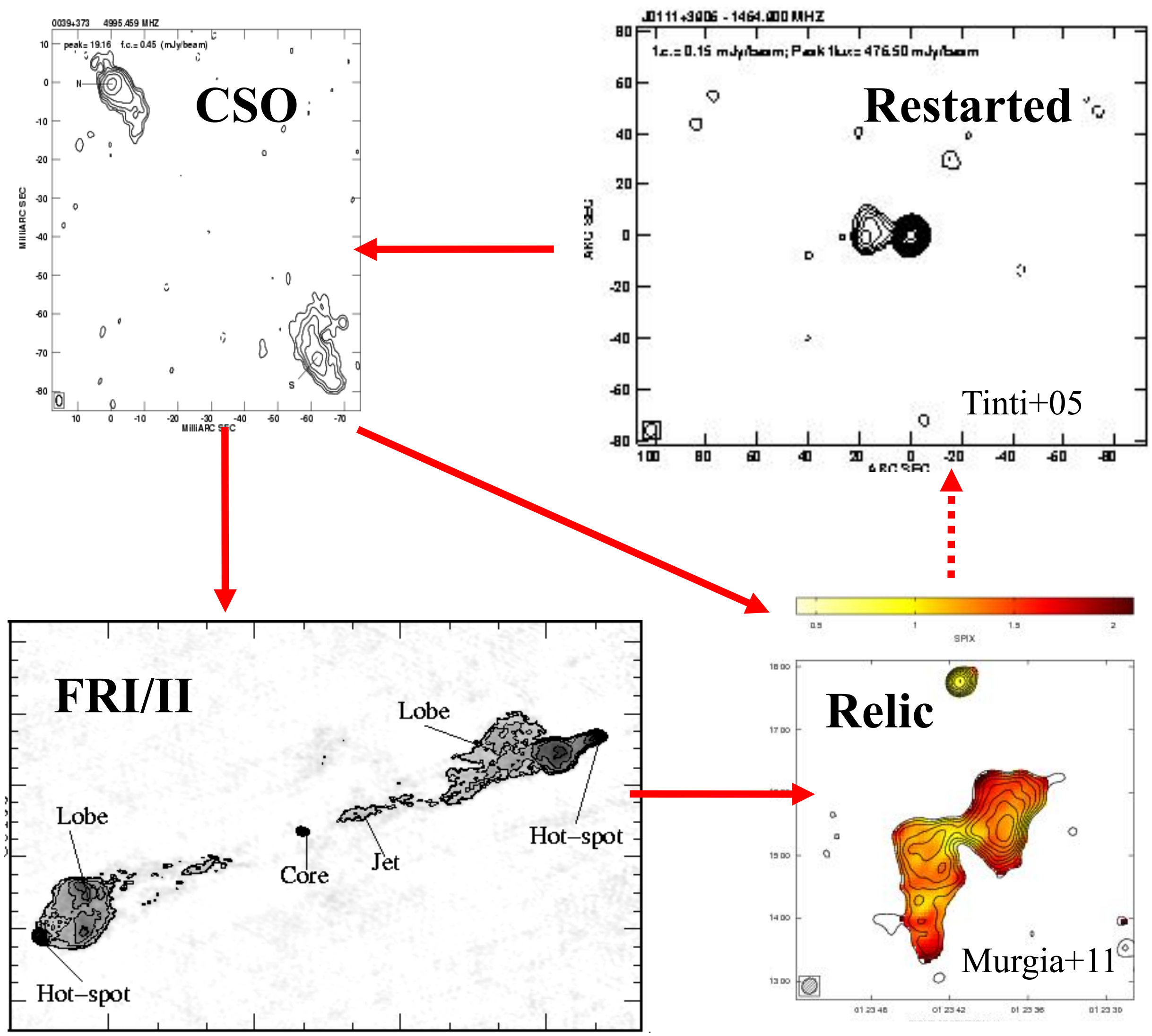
Young radio sources: from newly born to short-lived objects

Monica Orienti
(INAF-IRA)

Co-I: D. Dallacasa, F. D'Ammando, G.Migliori

The life-cycle of the radio emission

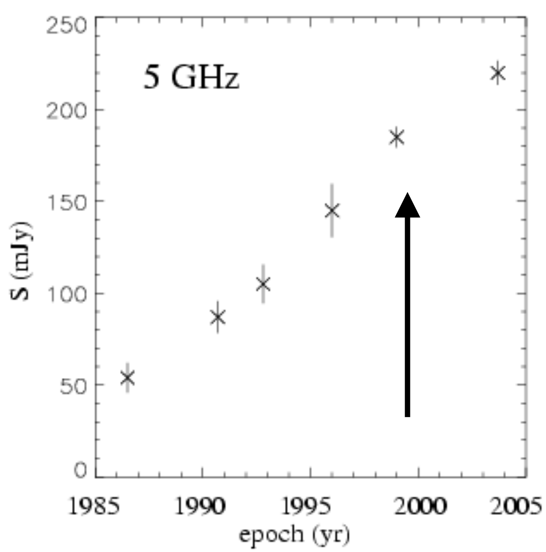


Newly born radio sources

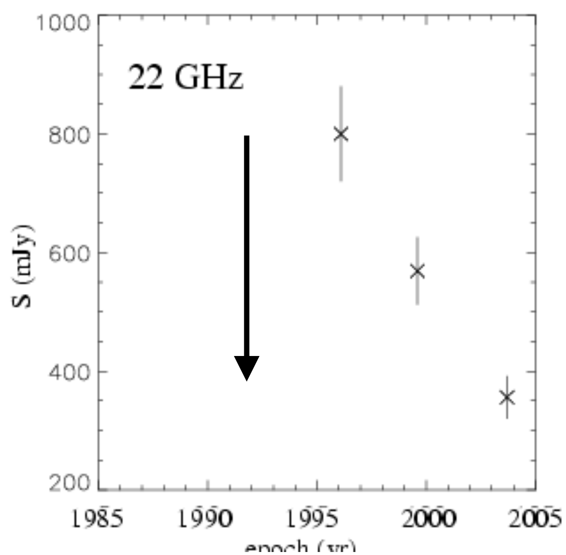
- Only a handful of objects with LS ~ a few pc is known. This number must increase for improving our knowledge of individual radio source evolution and its different paths.

- In newly born radio sources, changes in the radio spectrum produced by adiabatic expansion can be appreciable after a short time.

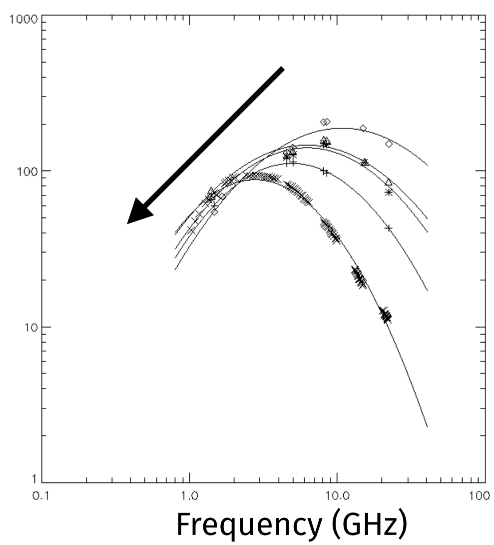
Optically-thick



Optically-thin



Peak frequency



Searching for newly born radio sources

- Multi-epoch multifrequency observations to study the long-term light curve and spectral variability.

3-5 epochs of VLA observations from 1 to ~30 GHz of **35 sources** from the faint HFP samples.

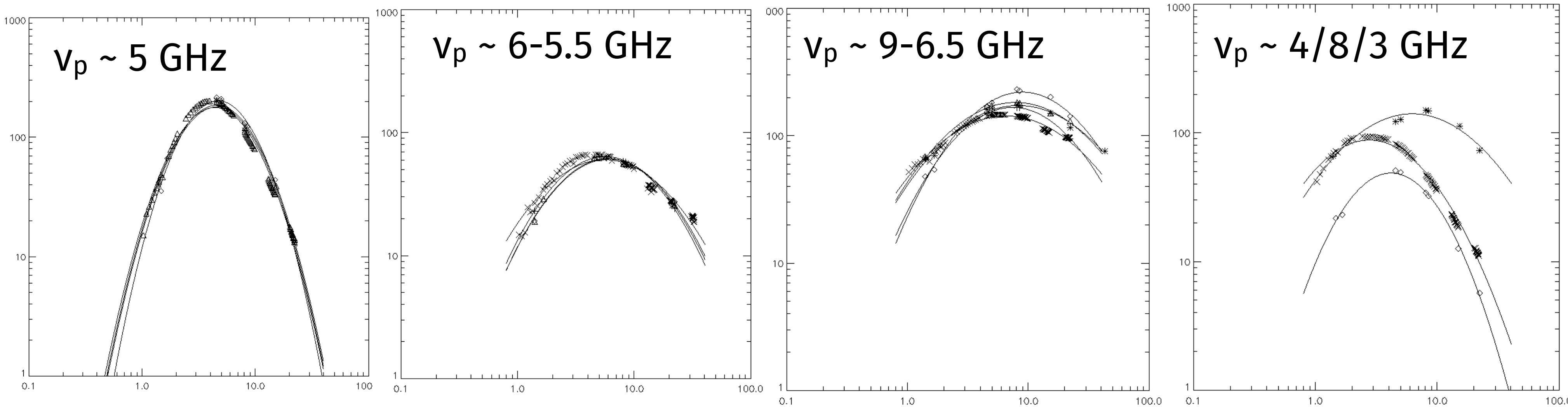
- High frequency (> 5 GHz) pc-scale VLBI observations to determine the structure.

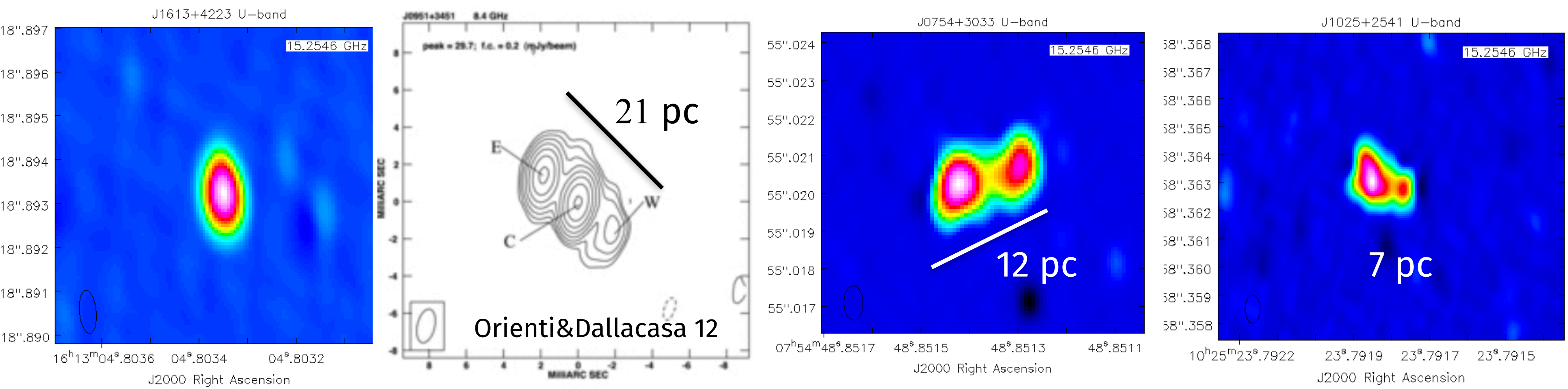
VLBI observations from 8/15 to 15/22 GHz of **26** faint HFP sources.

JVLA and VLBA results

Different types of variability.

Orienti&Dallacasa 20

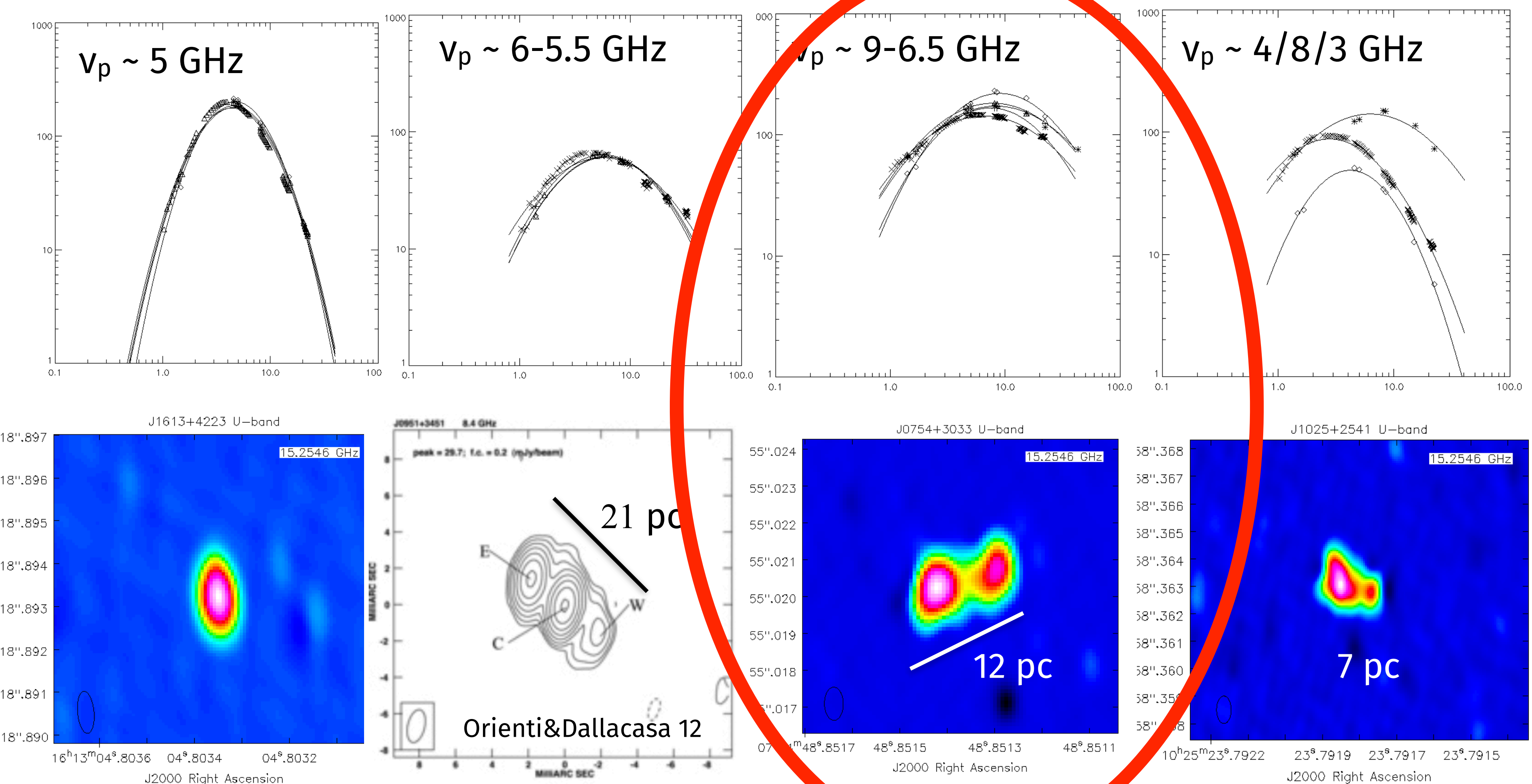




30% with double/triple structure, 30% resolved, 40% unresolved.

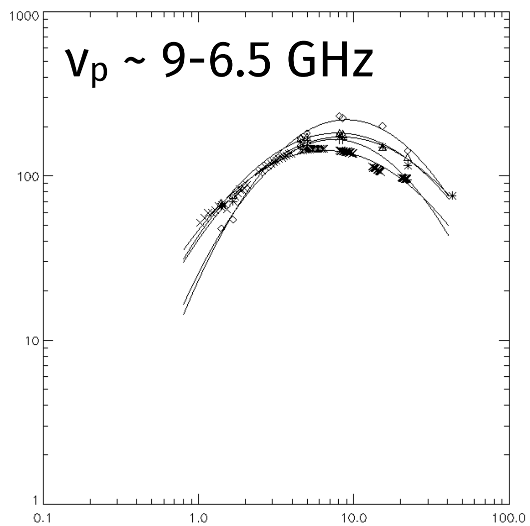
JVLA and VLBA results

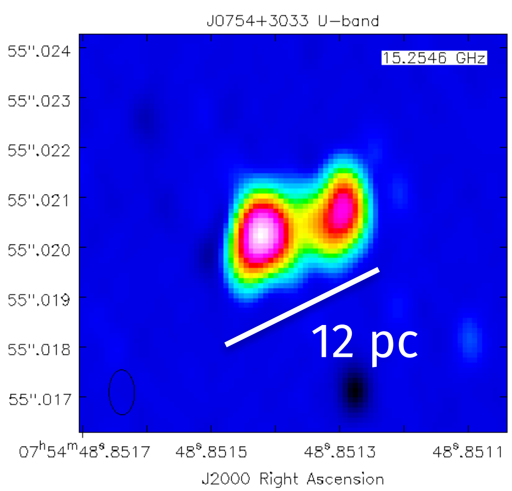
Different types of variability.



30% with double/triple structure, 30% resolved, 40% unresolved.

Blazars or young objects?





$$\nu_{p,1} = \nu_{p,0}\left(\frac{t_0}{t_0 + \Delta t}\right)^4$$

$$t_0 \sim 150^{+100}_{-50}\text{yr}$$

$$S_1 = S_0\left(\frac{t_0 + \Delta t}{t_0}\right)^3$$

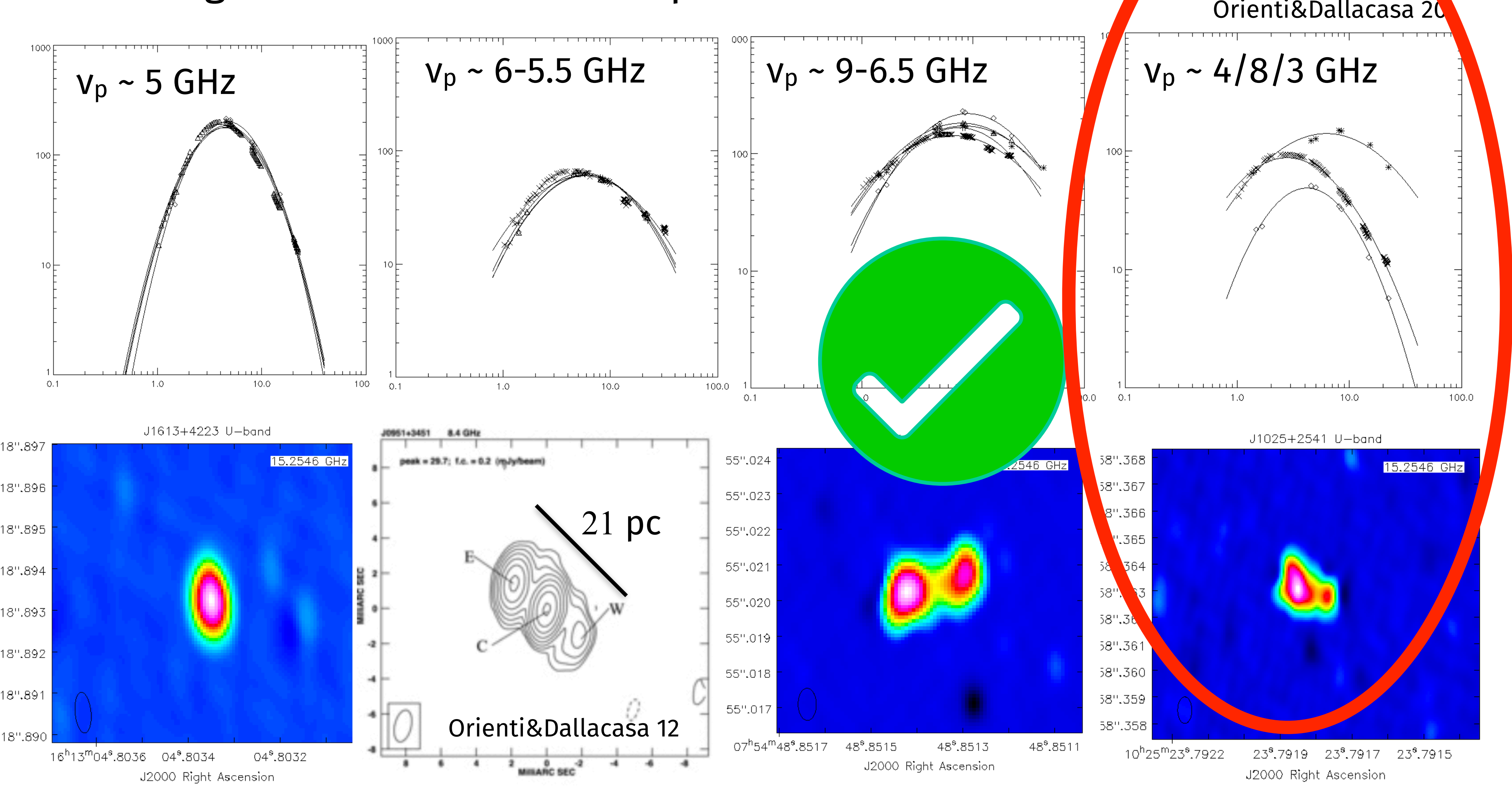
$$t_0 \sim 110^{+50}_{-30}\text{yr}$$

$$v_{\text{exp}} \sim 0.2^{+0.2}_{-0.05}\text{c}$$

Consistent with a young radio source in adiabatic expansion

Blazars or young objects?

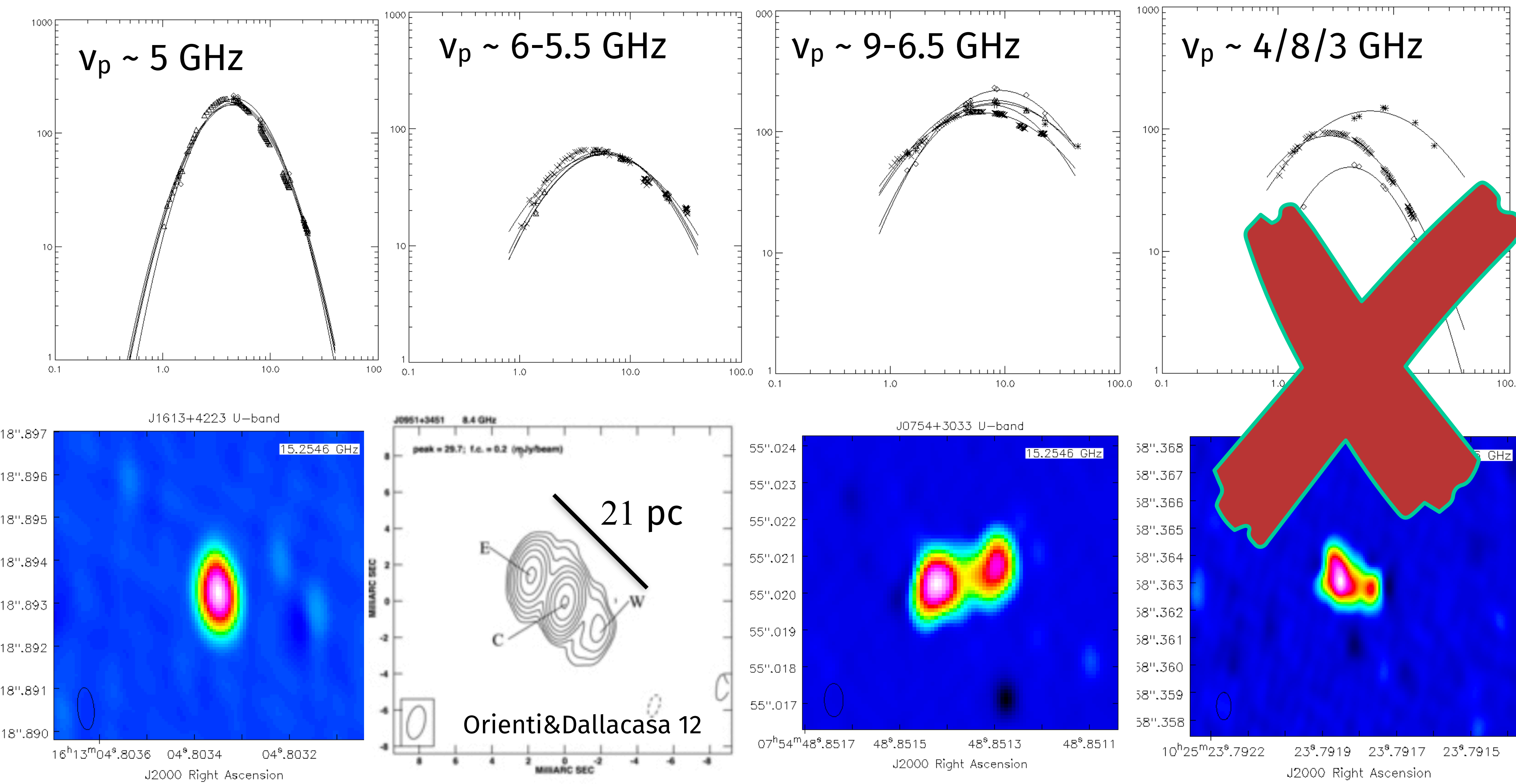
Young sources in adiabatic expansion.



Blazars or young objects?

Contamination from blazars.

Orienti&Dallacasa 20

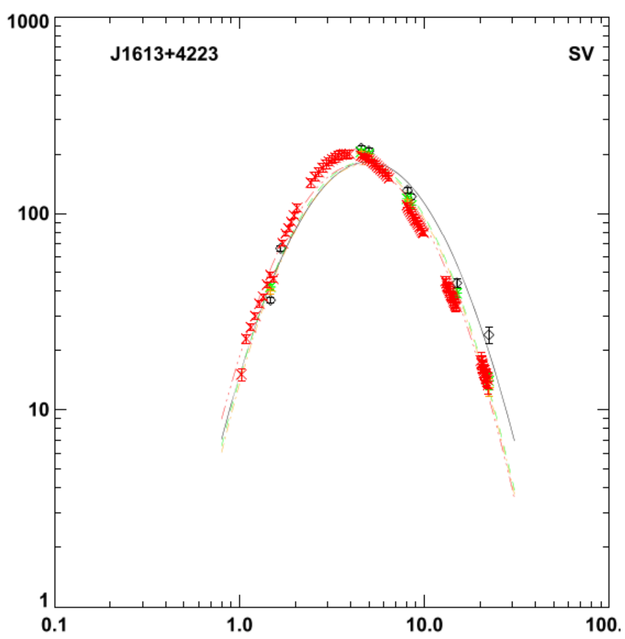


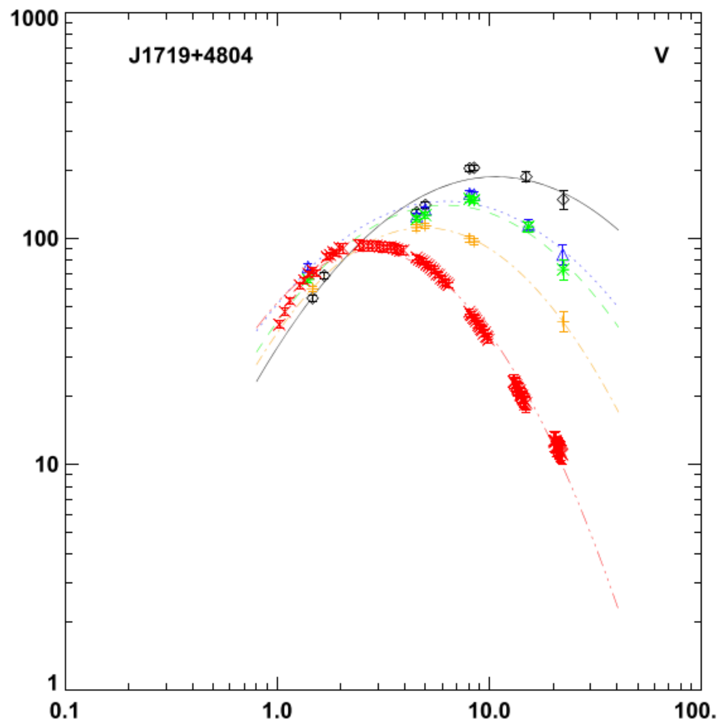
Fast evolving sources

97% show long-term variability;

51% show variability consistent with adiabatic expansion

v_{exp} ~0.1c - 0.7c





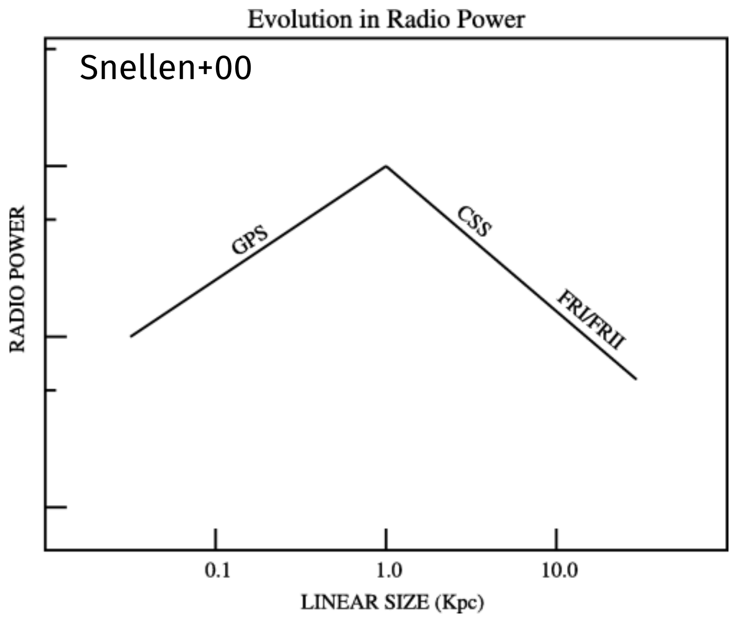
20% with steep (α > 1) spectra

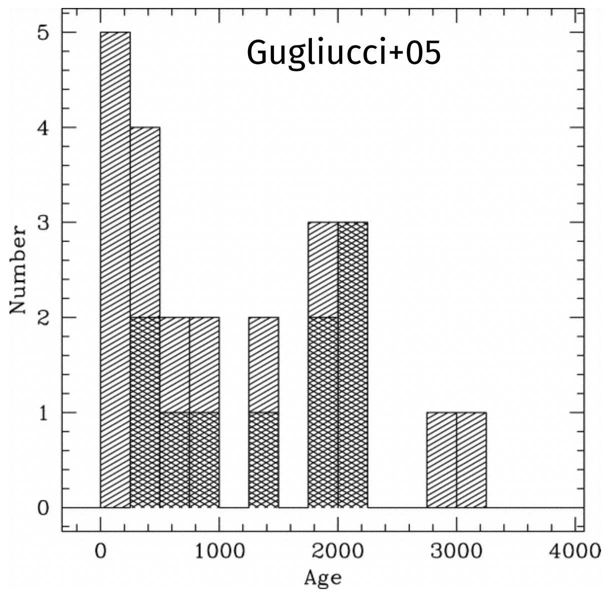
20% fast evolving sources with rapid flux density decrease in the optically-thin part of spectrum

Hardly progenitors of classical FRI/FRII sources

Count excess

Excess of young radio sources in flux-density limited catalogs cannot be explained with luminosity evolution.





The age distribution of a sub-samples of CSO peaks ~500 - 1100 yr.

(Gugliucci+05; An&Baan 12)

Searching for short-lived radio sources

AIM: constraining the incidence of fading objects at different evolutionary stages

MODELS:

1) intermittent radio emission lasts 10^{4-5} yr and recurs 10^{5-6} yr
(Reynolds&Begelman97)

2) intermittent radio emission lasts $<10^{3-4}$ yr and recurs 10^{4-5} yr
(Czerny+03)

EXPECTATIONS:

1) excess of MSO (LS > 1 kpc)

2) excess of CSO (LS < 1 kpc)

Searching for faders

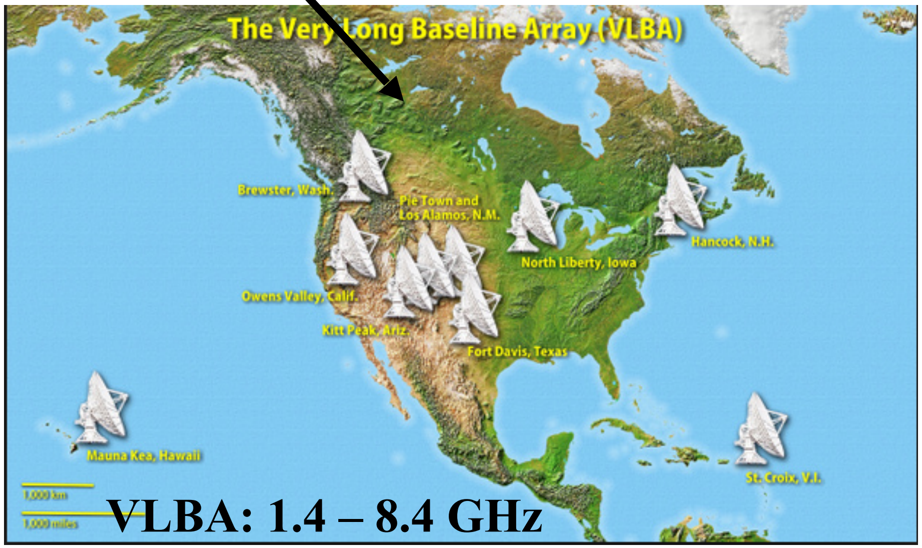
B3-VLA CSS: **87/373** sources from B3-VLA with S_{408} > 0.8 Jy

Looking for candidate faders from the Fanti+01 B3-VLA CSS sample.

Selection criteria:

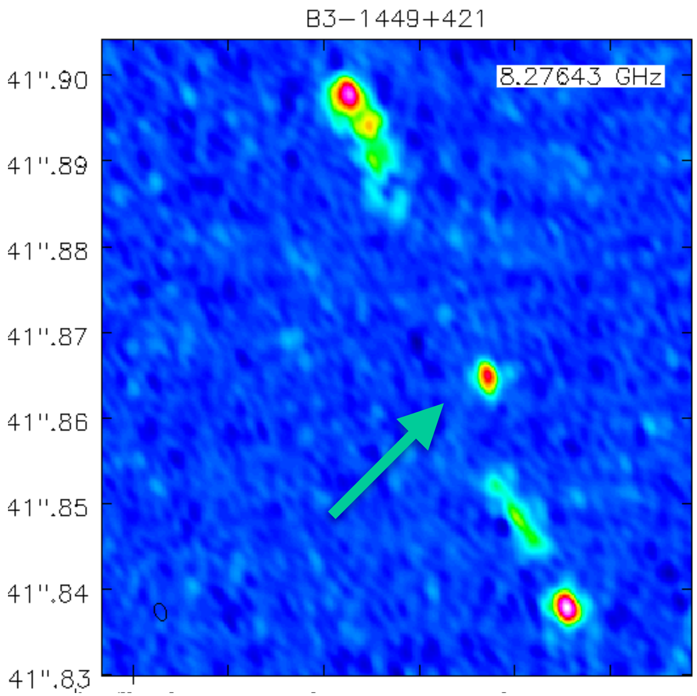
- Steep spectrum with $\alpha > 1.0$
- No evidence of active regions

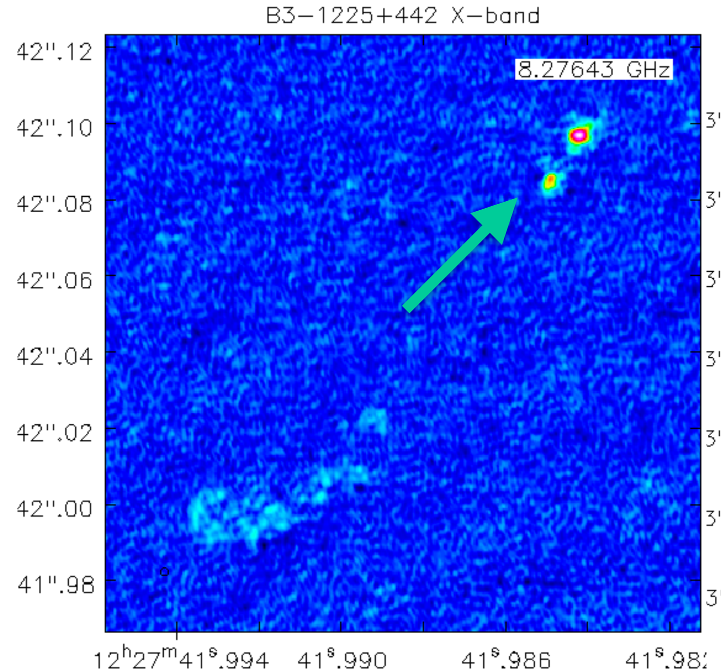
18/87 CSS sources: **12/59** with LLS > 1 kpc, **6/28** with LLS < 1 kpc

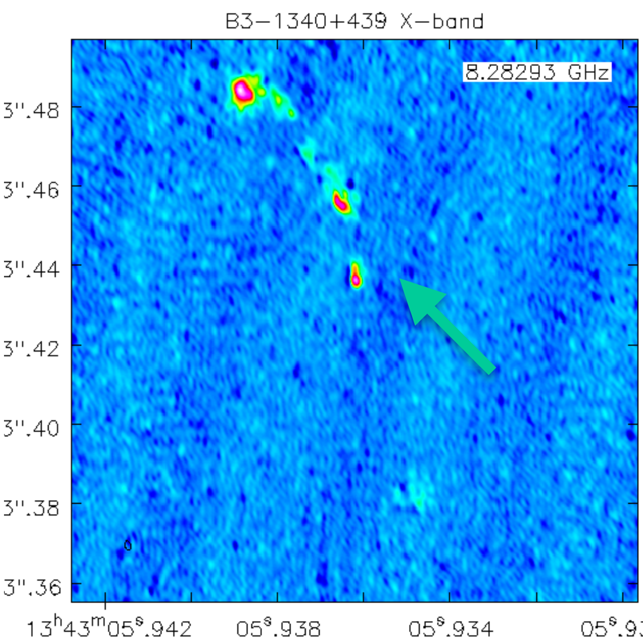


LS < 1 kpc: preliminary results

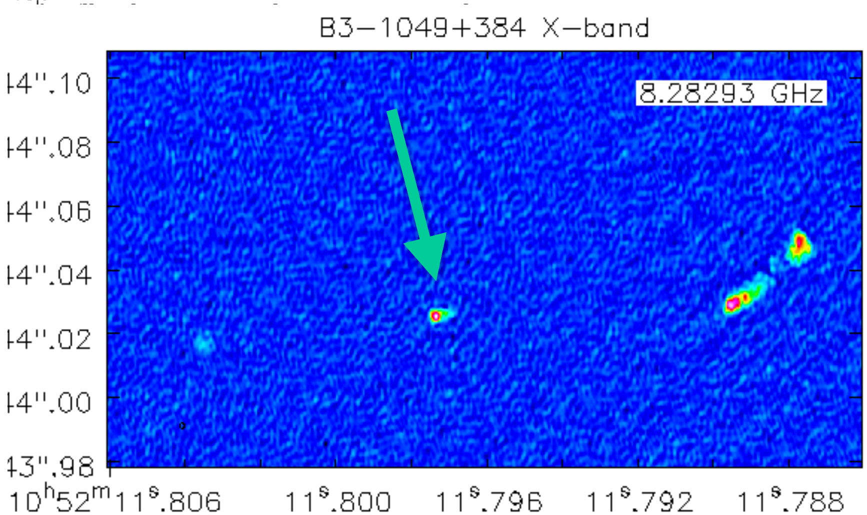
VLBA observations at 1.4, 5, 8.4 GHz







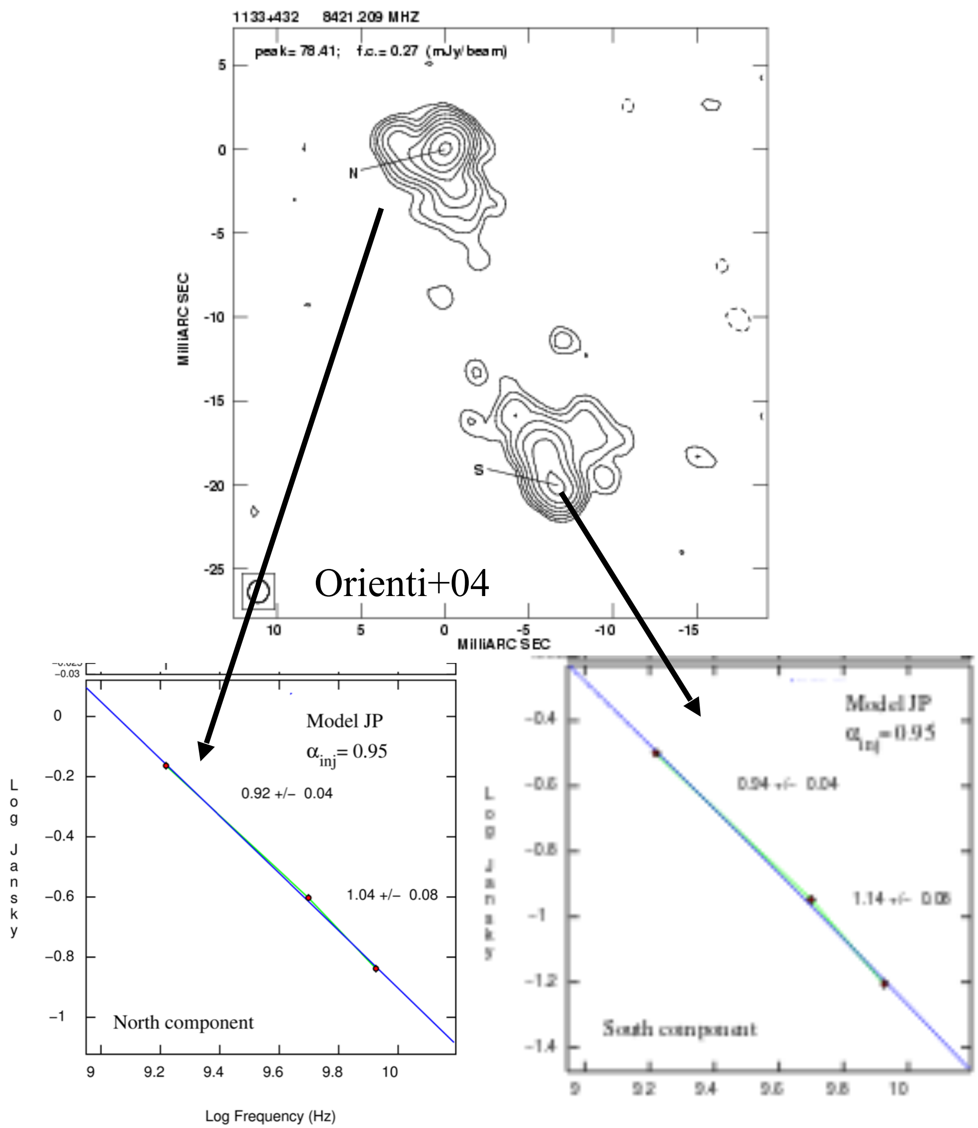
Orienti et al. in prep

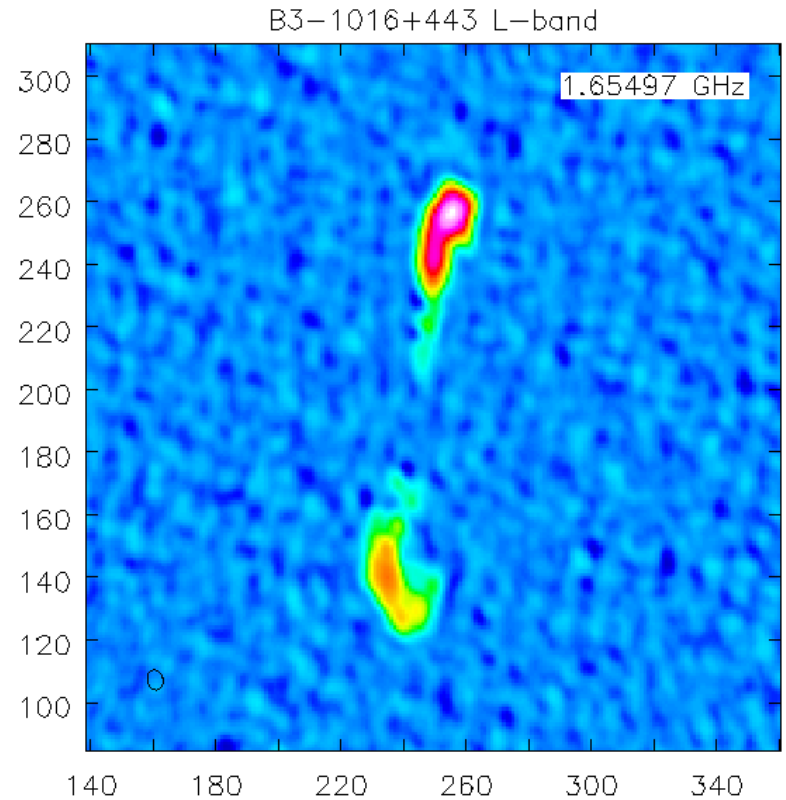


4/6 sources (~66%) with clear detection of the core

LS < 1 kpc: preliminary results

VLBA observations at 1.4, 5, 8.4 GHz





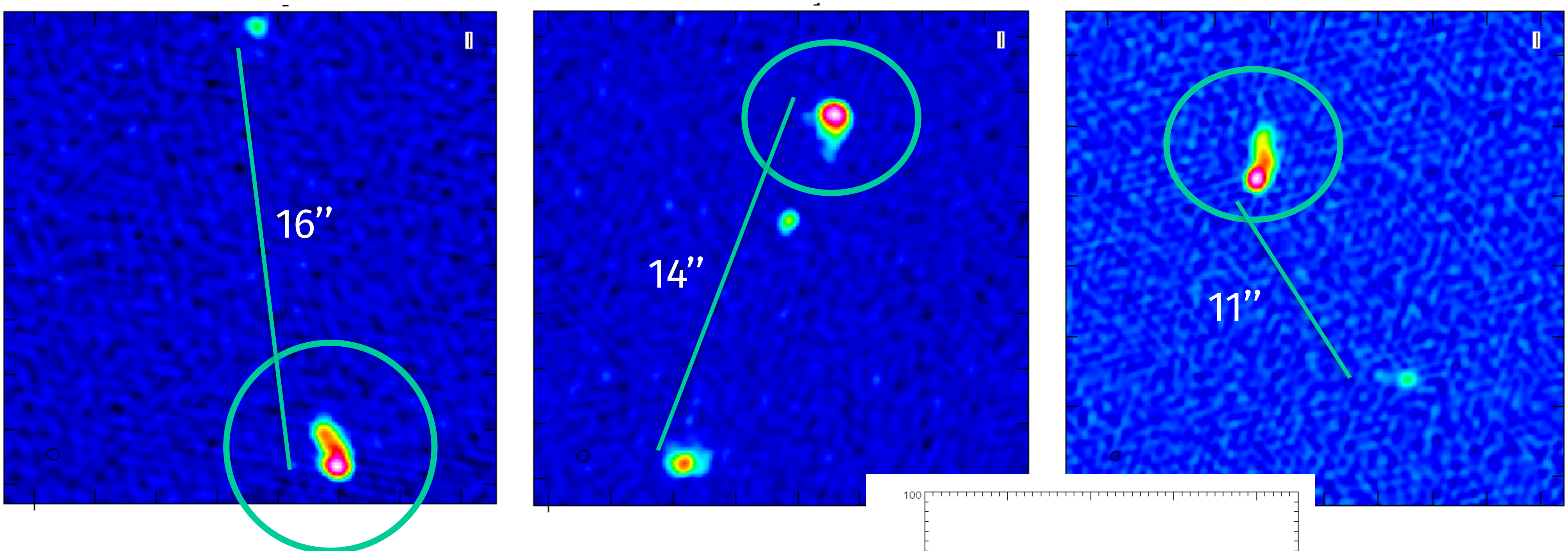
2 out of 28 CSO sources (~7%) with LS < 1 kpc do not show active regions

Orienti et al. in prep

LS > 1 kpc: preliminary results

VLA observations from 1 to 14 GHz

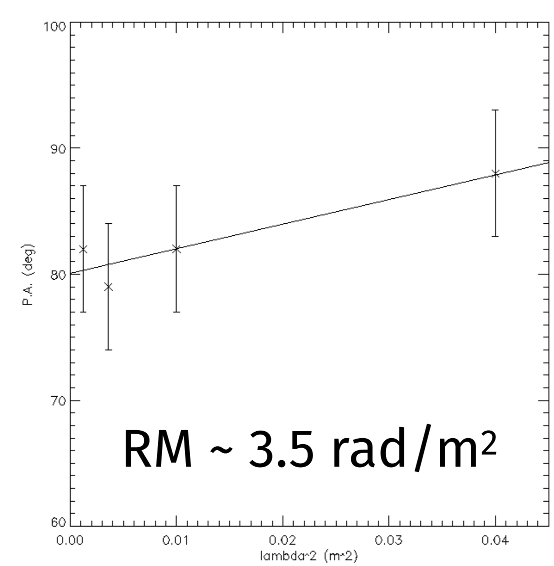
Orienti et al. in prep



3 sources turned up to be LSO.

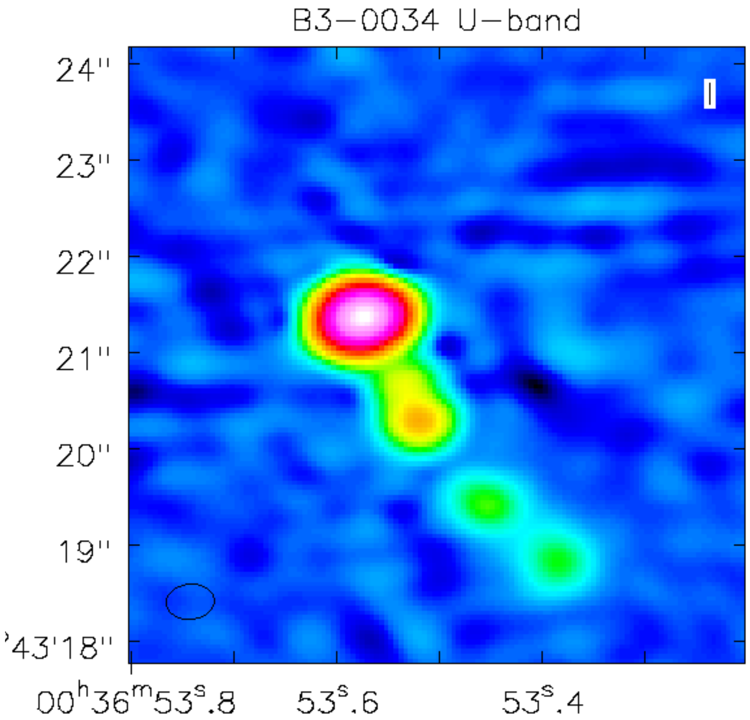
RM of the “CSS” component consistent with the Galactic value.

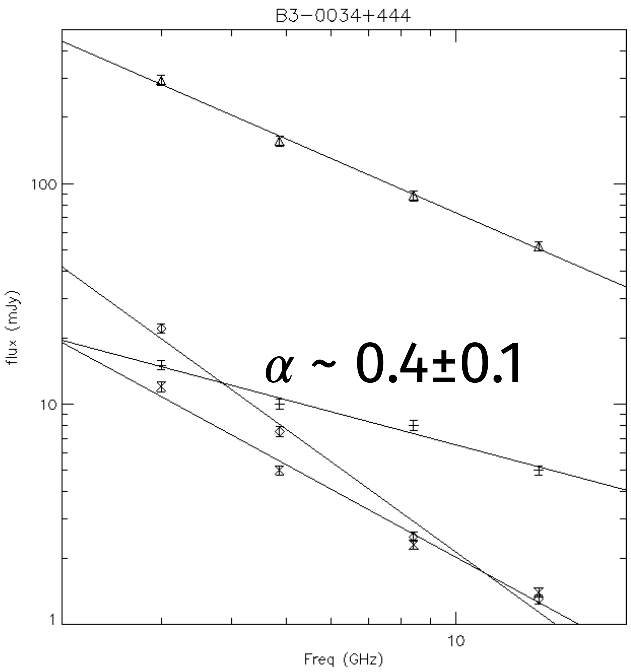
Removed from the sample (now of 56 sources).



LS > 1 kpc: preliminary results

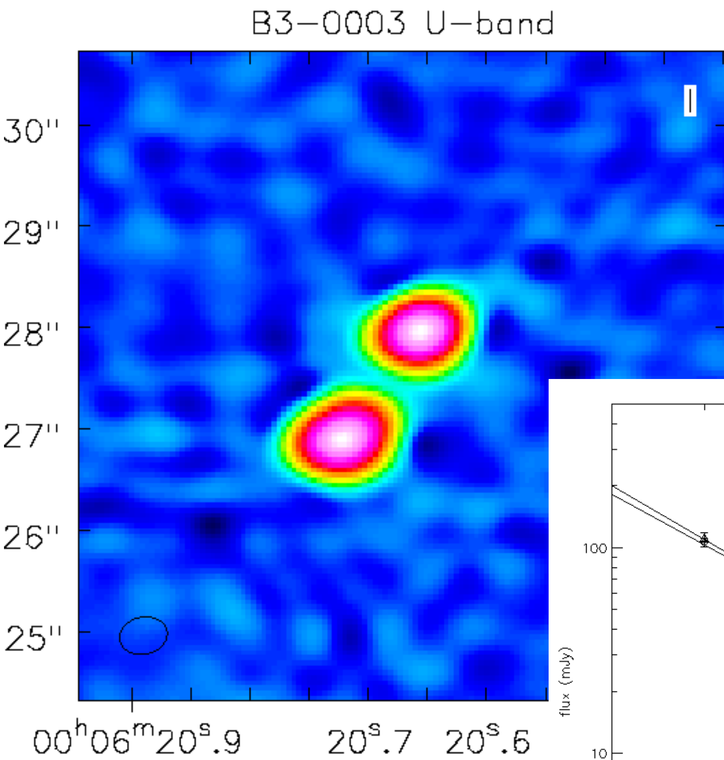
3 MSO sources with active regions

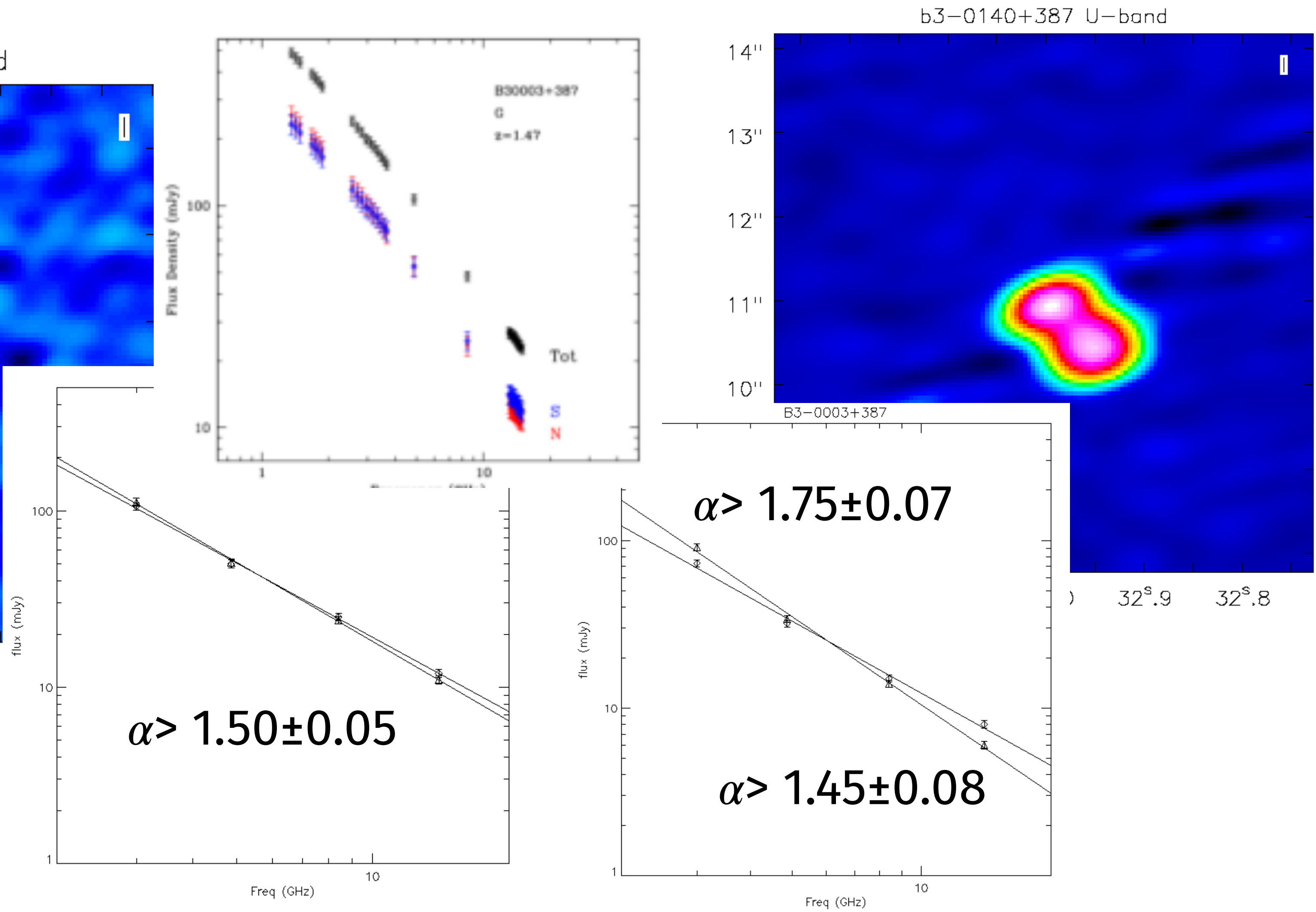




LS > 1 kpc: preliminary results

6/56 (~10%) MSO sources with no obvious active regions (> 1.2).

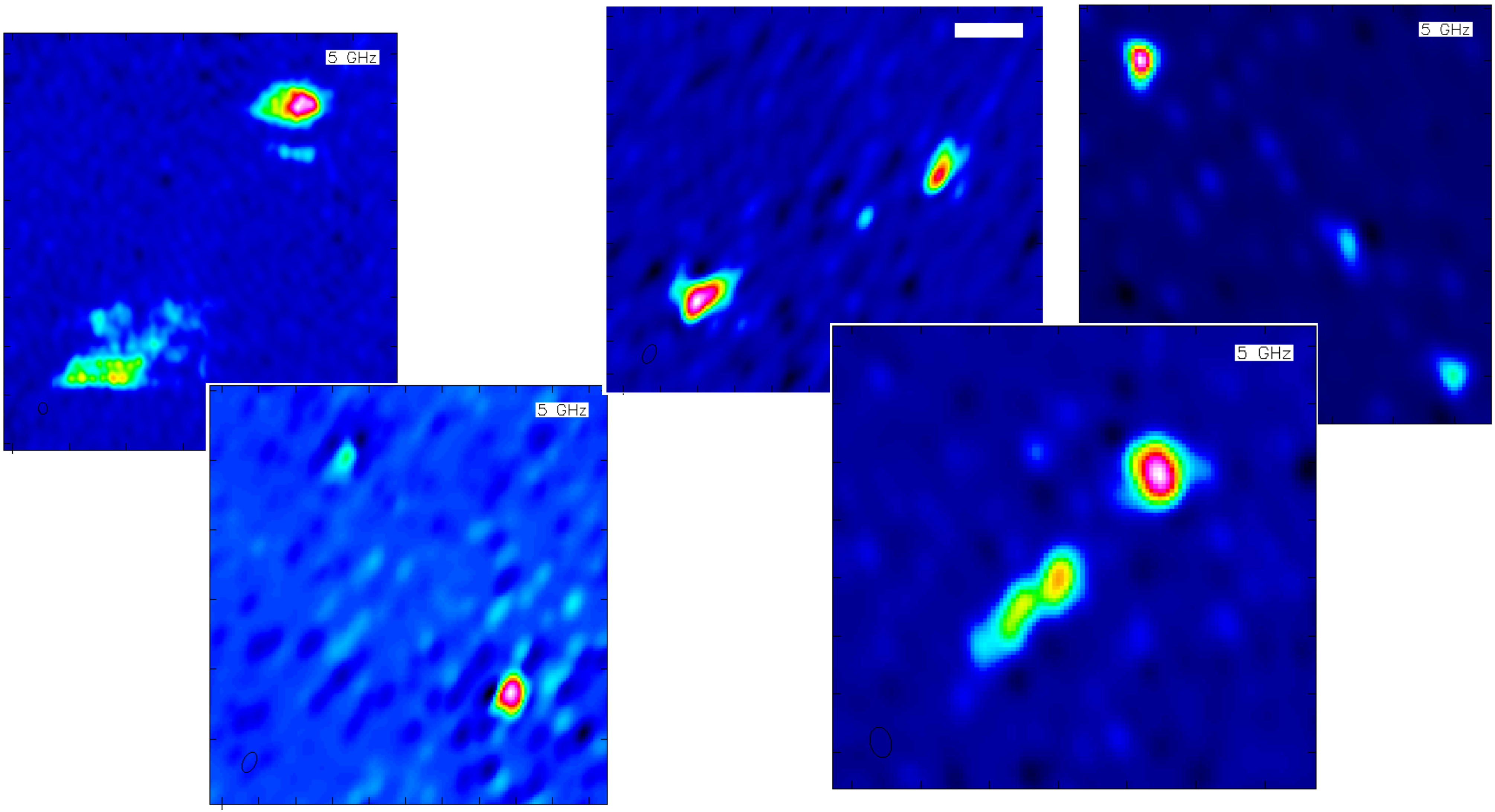




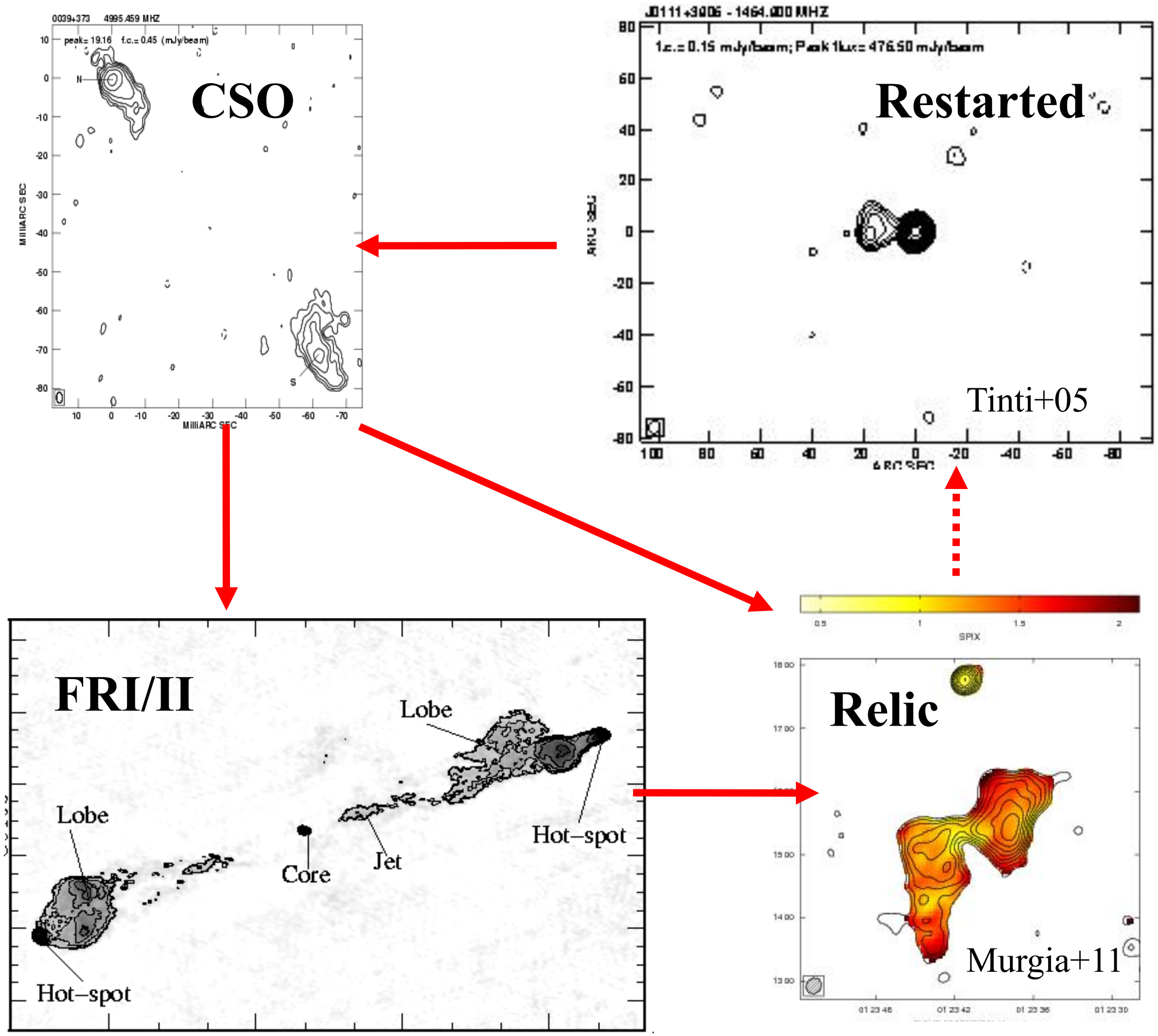
Orienti et al, in prep

eMERLIN observations

- **2/6 with steep components** → **2/56 (~3%) with no active regions**
- 4/6 with core detection



The life-cycle of the radio emission



~3% faders LS > 1 kpc

~7% faders LS < 1 kpc

~20% of HFP have fast evolution

Conclusions

- Young radio sources provide insight into the initial conditions of the evolution of the radio emission

- The time scale of the radio emission is still far to be constrained

- The high sensitivity and resolution of SKA, ngVLA and their precursors are crucial for our knowledge of the life cycle of the radio emission. They will play a pivotal role in finding relic and restarted sources, and will provide for the first time the possibility to investigate the **cosmological evolution** of young radio sources thanks to the study of the MHz-peaked spectrum population.

Thank you