# Search and statistic of remnant radio galaxies in the Lockman Hole

Marisa Brienza - LOFAR status meeting - 2March2016
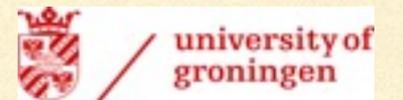
# **WHY** STUDYING REMNANT RADIO GALAXIES?

- Duty cycle of radio galaxies
- Radio source dynamics
- AGN radio feedback
- Fate of seed particles for cluster halos and relics

The fraction of remnant radio galaxies in flux limited samples is small compared to model predictions

Approximately 1 - 3 % of B2 and 3C radio galaxies are in "dying" phase (Giovannini+1988)

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BETTER SELECTION?

**?**

BETTER LUMINOSITY EVOLUTION MODELS?

# SELECTING REMNANT RADIO GALAXIES

LOW FREQUENCY RADIO SURVEY CAN ENHANCE THE DETECTION
NUMBER OF THESE OBJECTS
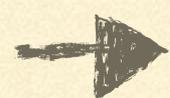
➤ SELECTION
- **STEEP SPECTRAL INDEX**
  (e.g. Parma+2007, Dwarakanath+2009,
  Sirothia+2009, VanWeeren+2009)

- **SPECTRAL CURVATURE**
  (Murgia+2011)

- **MORPHOLOGY**
  (e.g. Saripalli+2009)
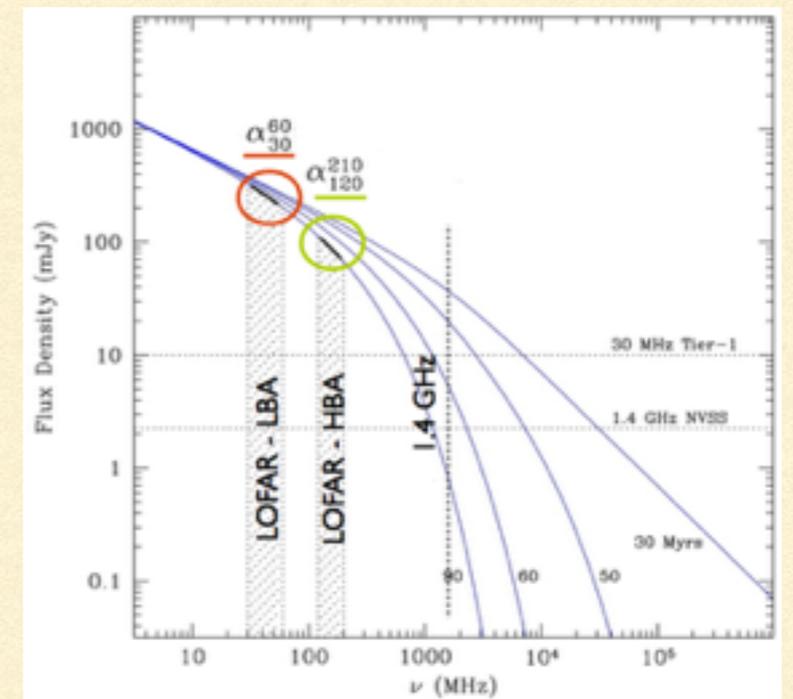


- not all AGN remnants have steep spectrum at low frequencies (e.g. Brienza +2016A&A585,29)
- not all diffuse, low surface brightness emission is signature of AGN remnants

# Selection of sources in the Lockman Hole HBA



WSRT 1400 MHz

Mahony+in prep
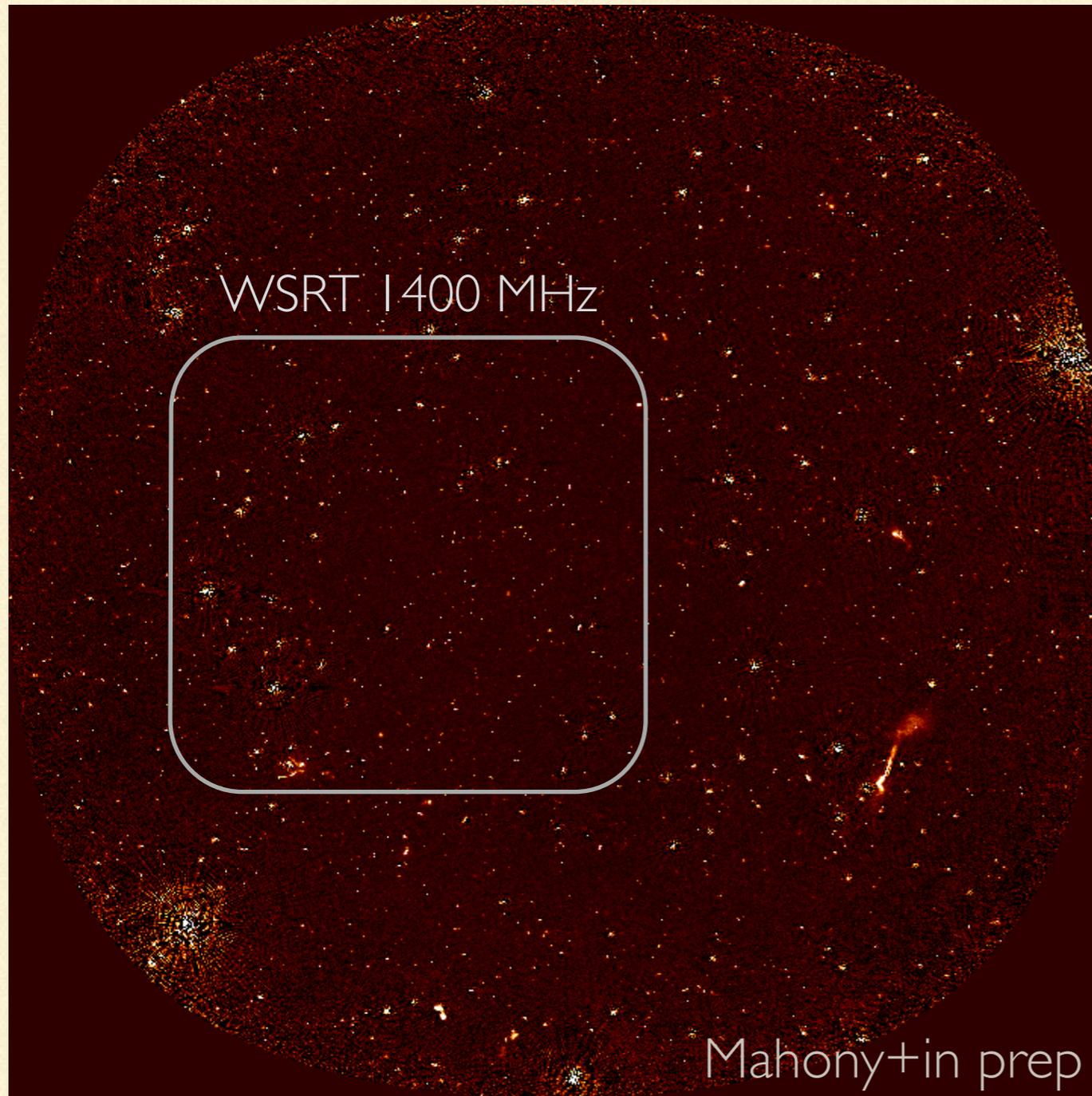
- HBA observation (110-180 MHz)

- 70 MHz bandwidth (300 subbands)

- 10 hrs int. time

- 14''x18'' resolution

- rms~0.75 mJy

- about 6000 sources

# MORPHOLOGY SELECTION

LOFAR CONTOURS + SDSS



- ⭐ EXTENDED
- ⭐ RELAXED MORPHOLOGIES
- ⭐ LOW SURFACE BRIGHTNESS
- ⭐ WITHOUT COMPACT COMPONENTS
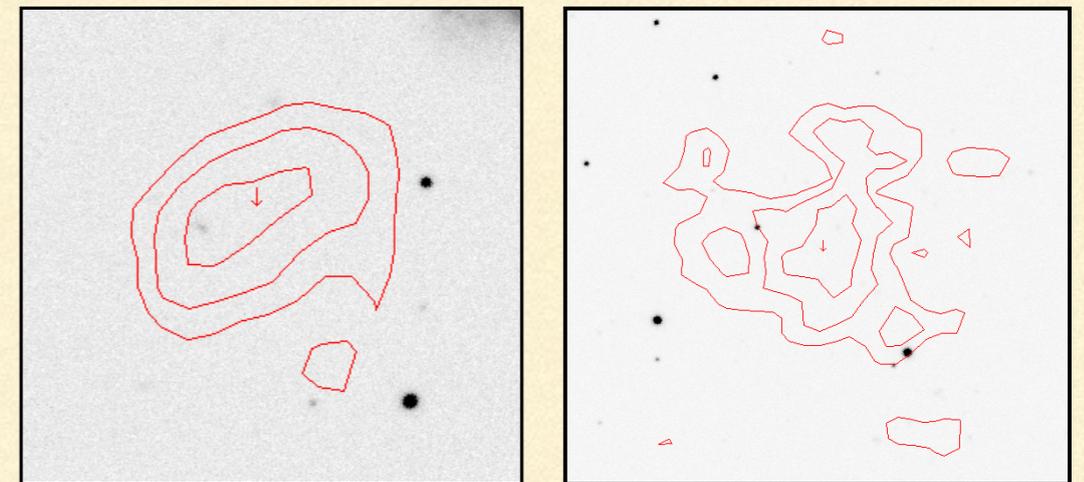
optical ID important to confirm
the nature of the sources!

~ 10 CANDIDATES



CORE PROMINENCE
< 1e-3

# SPECTRAL INDEX >1.2



**WSRT 1400 MHz**
rms **0.01** mJy/beam
beam 11x9''
**LOFAR 150 MHz**
rms 0.75 mJy/beam
beam 18x14''

mean=0.80

WSRT mosaic

**NVSS 1400 MHz**
rms **0.45** mJy/beam
beam 45x45''
**LOFAR 150 MHz**
rms 1.2 mJy/beam
beam 45x45''

mean=0.77

entire LOFAR field

alpha(LOFAR-WSRT)

alpha(LOFAR-NVSS)
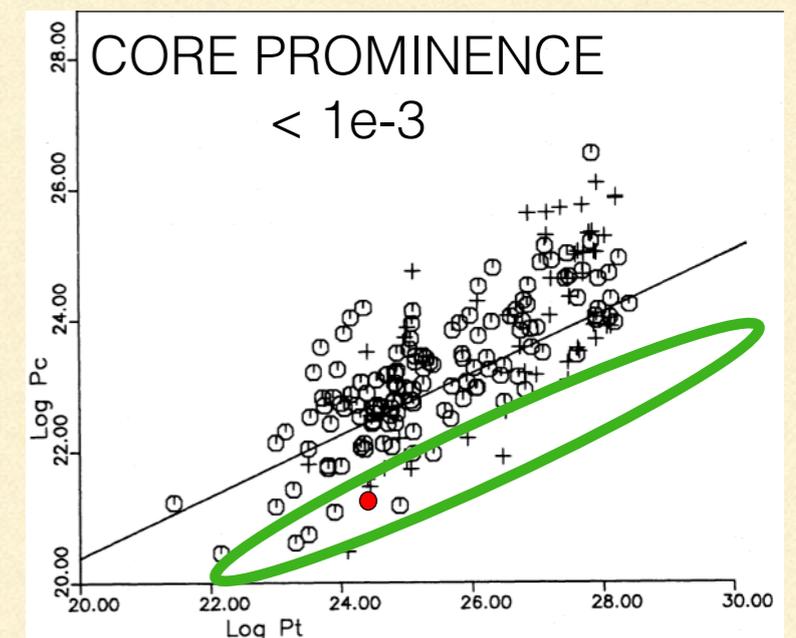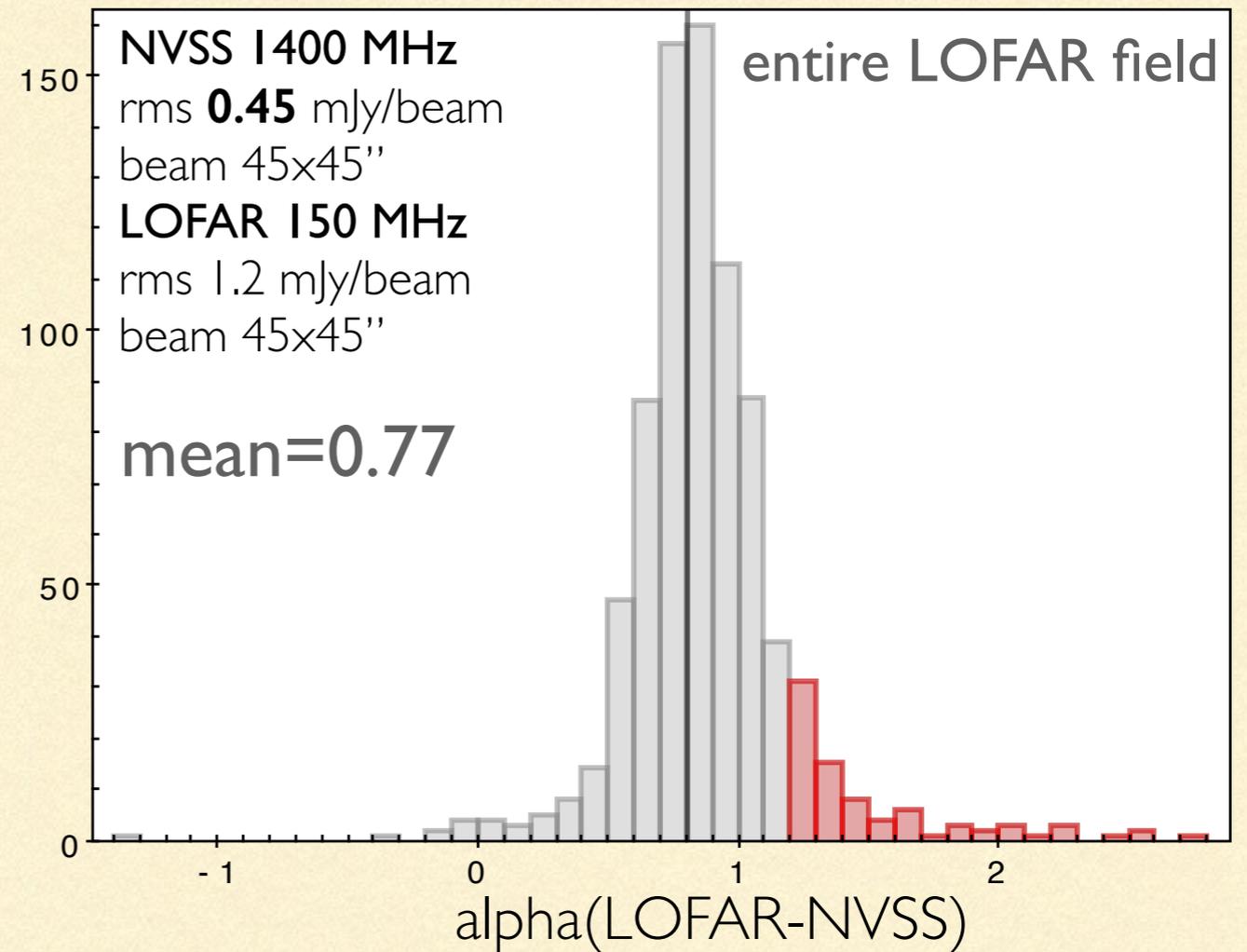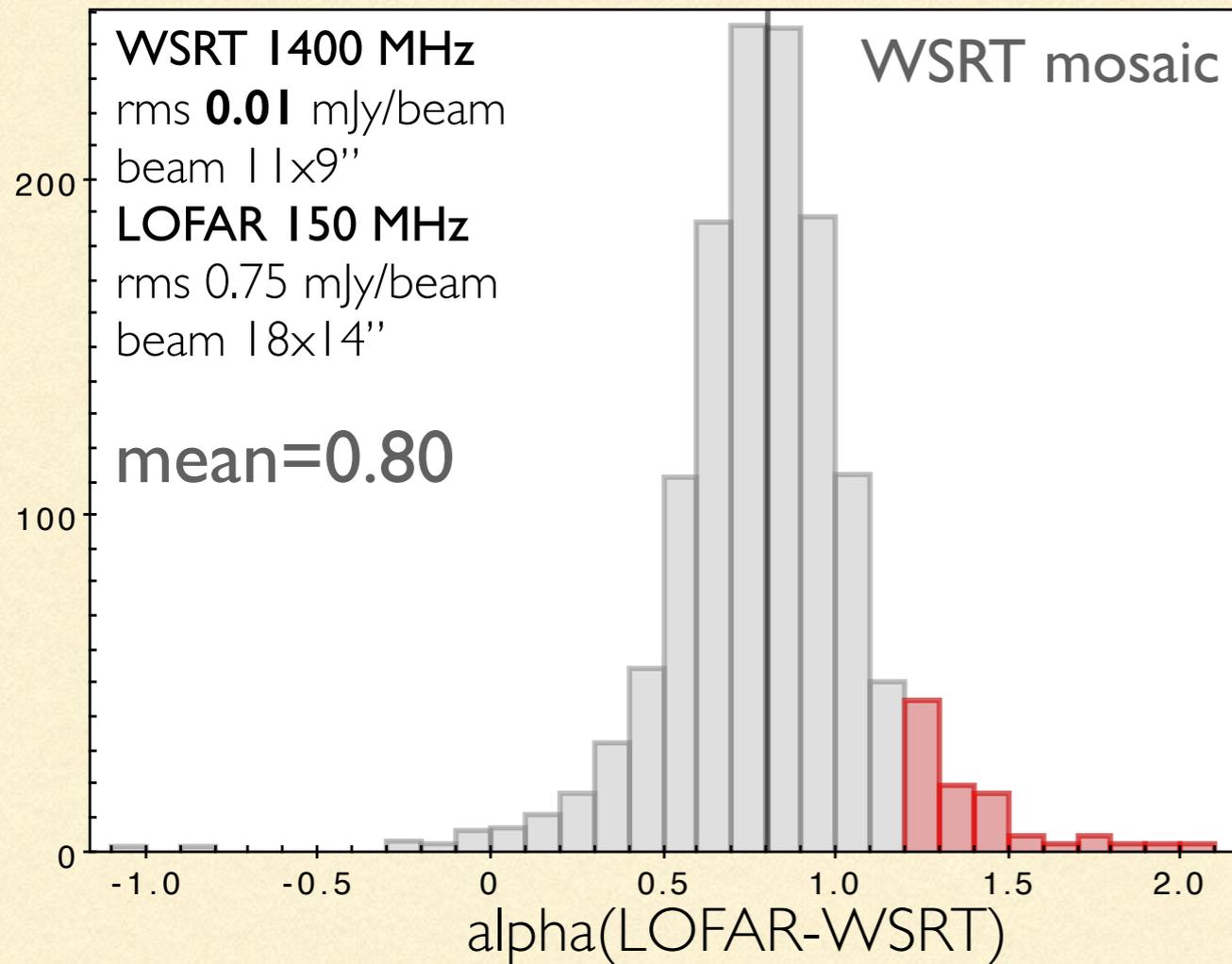
**different sensitivity probing different populations of radio galaxies**

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alpha(LOFAR-NVSS)
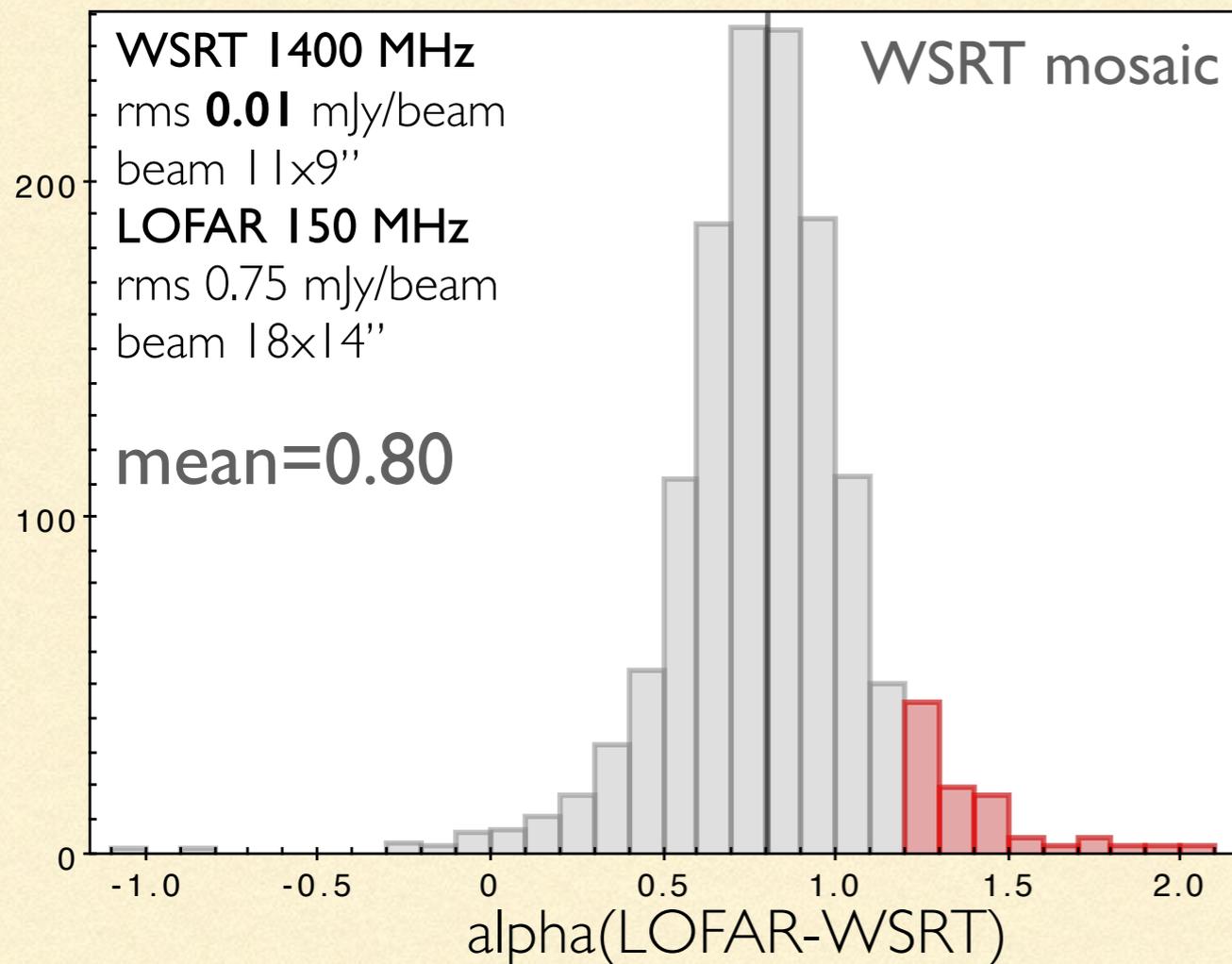
1379 sources

7% steep
25% of resolved sources (>26'') are steep
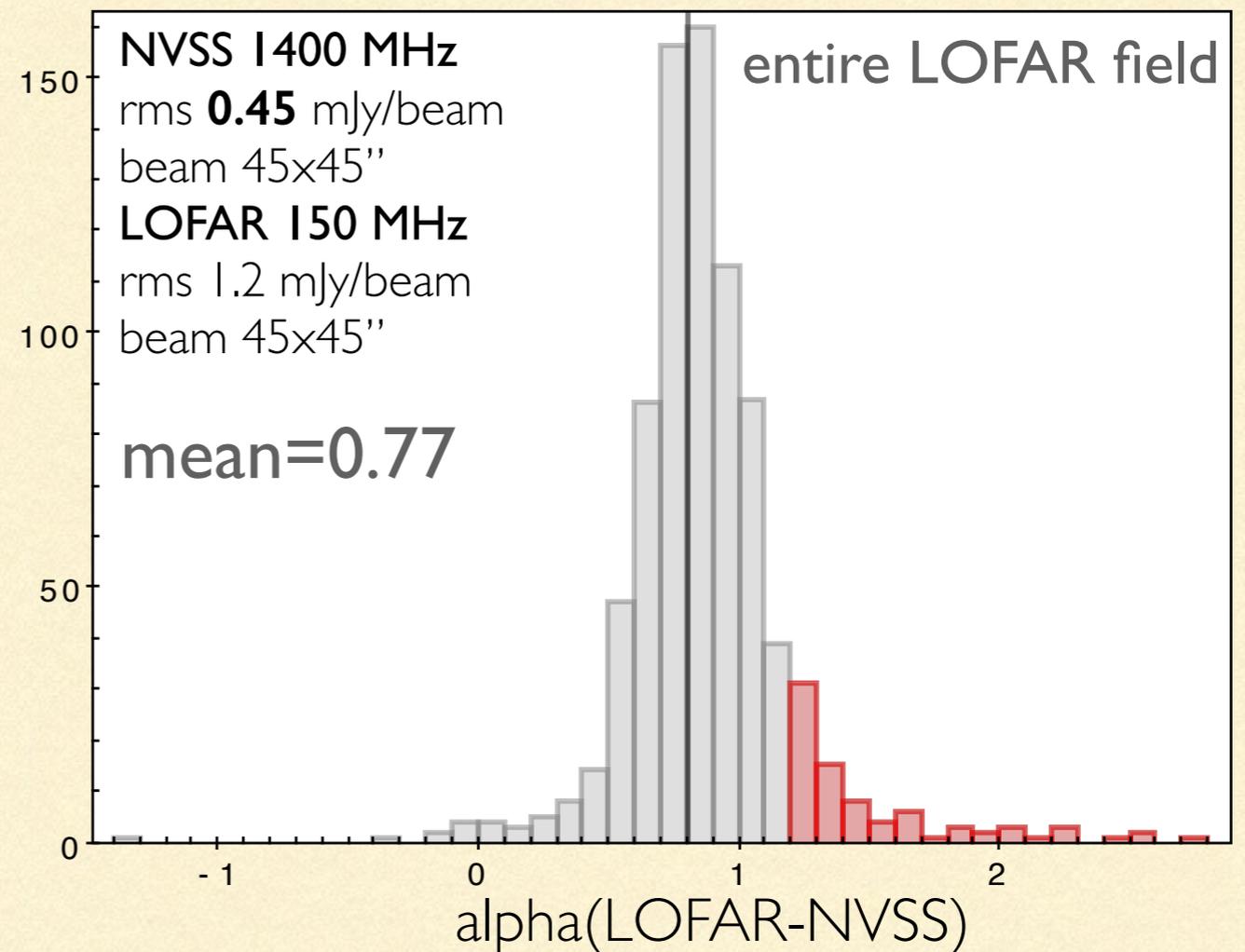
743 sources
with spectral index cut applied (36.5mJy)
5.8% steep
35% of resolved sources (>64'') are steep

# SPECTRAL CURVATURE = alpha_high-alpha_low
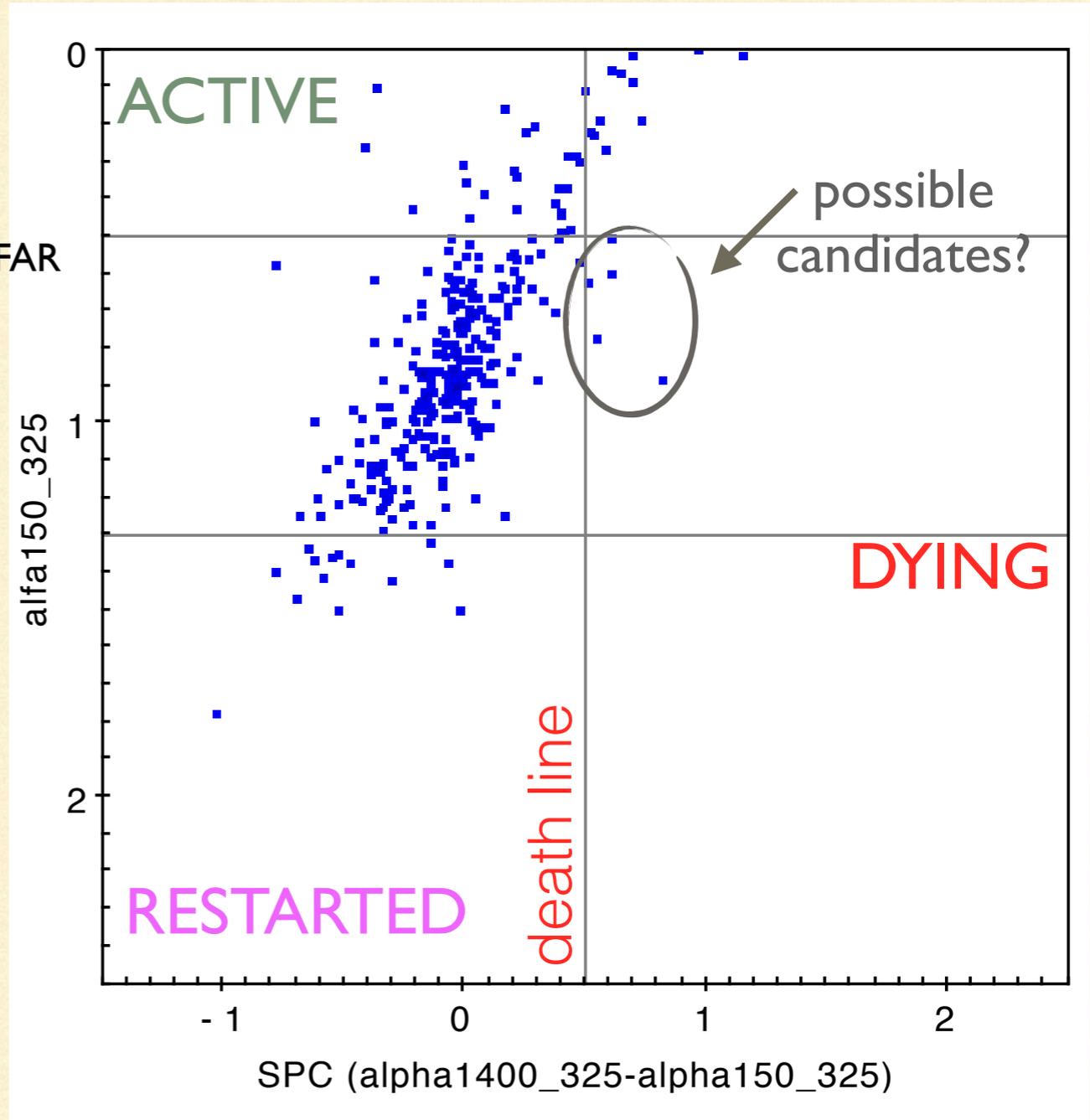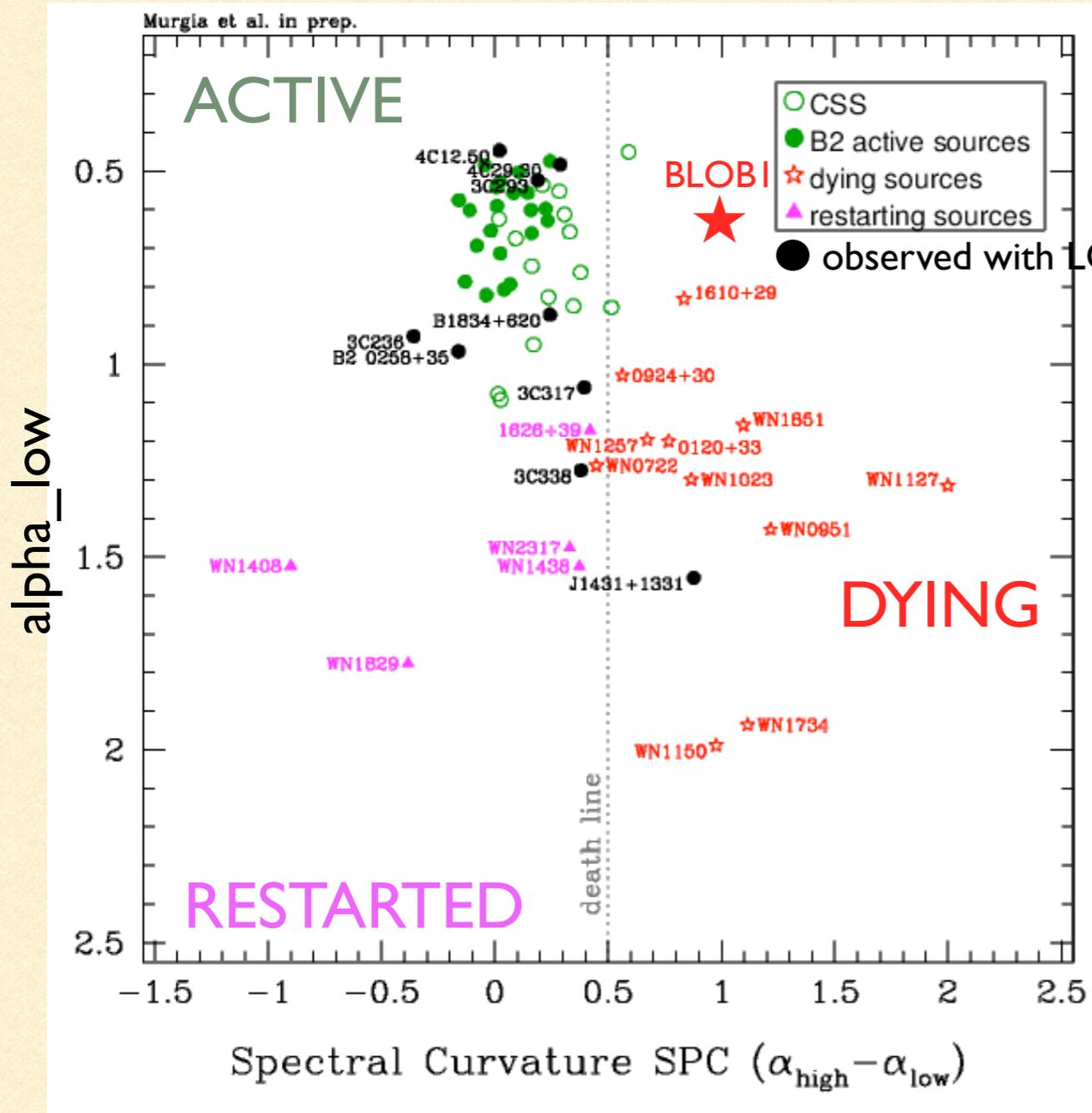


LOFAR-WENSS-NVSS
limited in sensitivity and frequency range

# STATISTICAL MODELS OF THE REMNANT RADIO GALAXY POPLATION

➤ Radiogalaxy.py (Godfrey et al. in prep))

➤ Create mock catalogues of the radio galaxies by assuming appropriate distributions for the model parameters:

- jet power
- redshift
- active time
- observation time
- magnetic field evolution
- volume evolution
- injection index

➤ Comparison with observations

# SOME PRELIMINARY RESULTS!
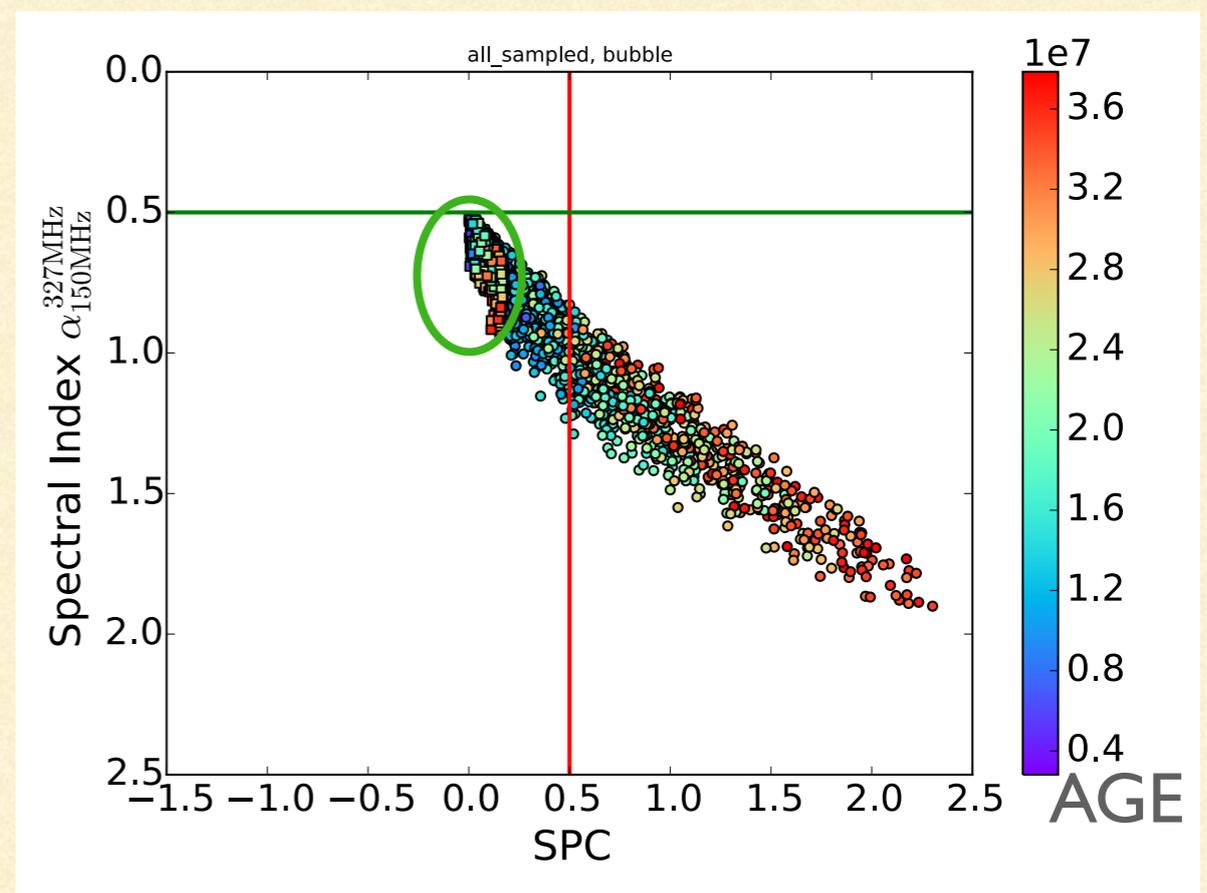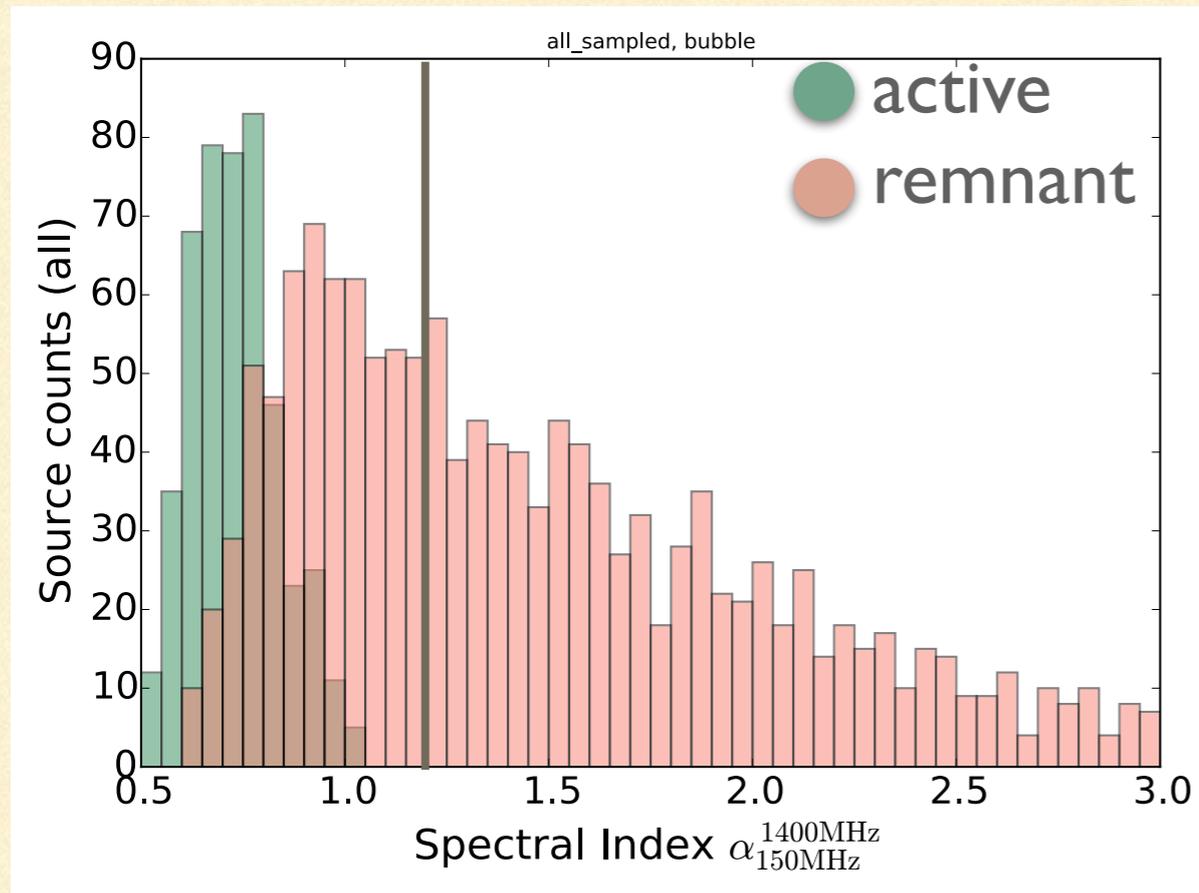


ONLY radiative losses included

⬇

NEED FOR ADIABATIC EXPANSION! (to reproduce observation)
dynamical models are being implemented…

# SUMMARY

Remnant radio galaxies are rare in flux limited samples (2-3%)
This fraction is much lower than what expected if
the luminosity evolution was only driven by radiative cooling

➤ We are combining complementary selection criteria in order not to be biased towards any specific class of dying source

➤ The first observational results on the Lockman Hole show that most of the selected candidates have steep spectra although there are limitations to the use of the other criteria. The fraction of candidates is higher than in previous samples but not enough

➤ Statistical models suggest that radiative cooling is not enough to explain the paucity of remnant radio galaxies observed, i.e. adiabatic expansion is needed

➤ This has implications on the calculation of spectral ages