Exploring the population of Radio-Loud AGNs at high redshift with the RACS survey

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+

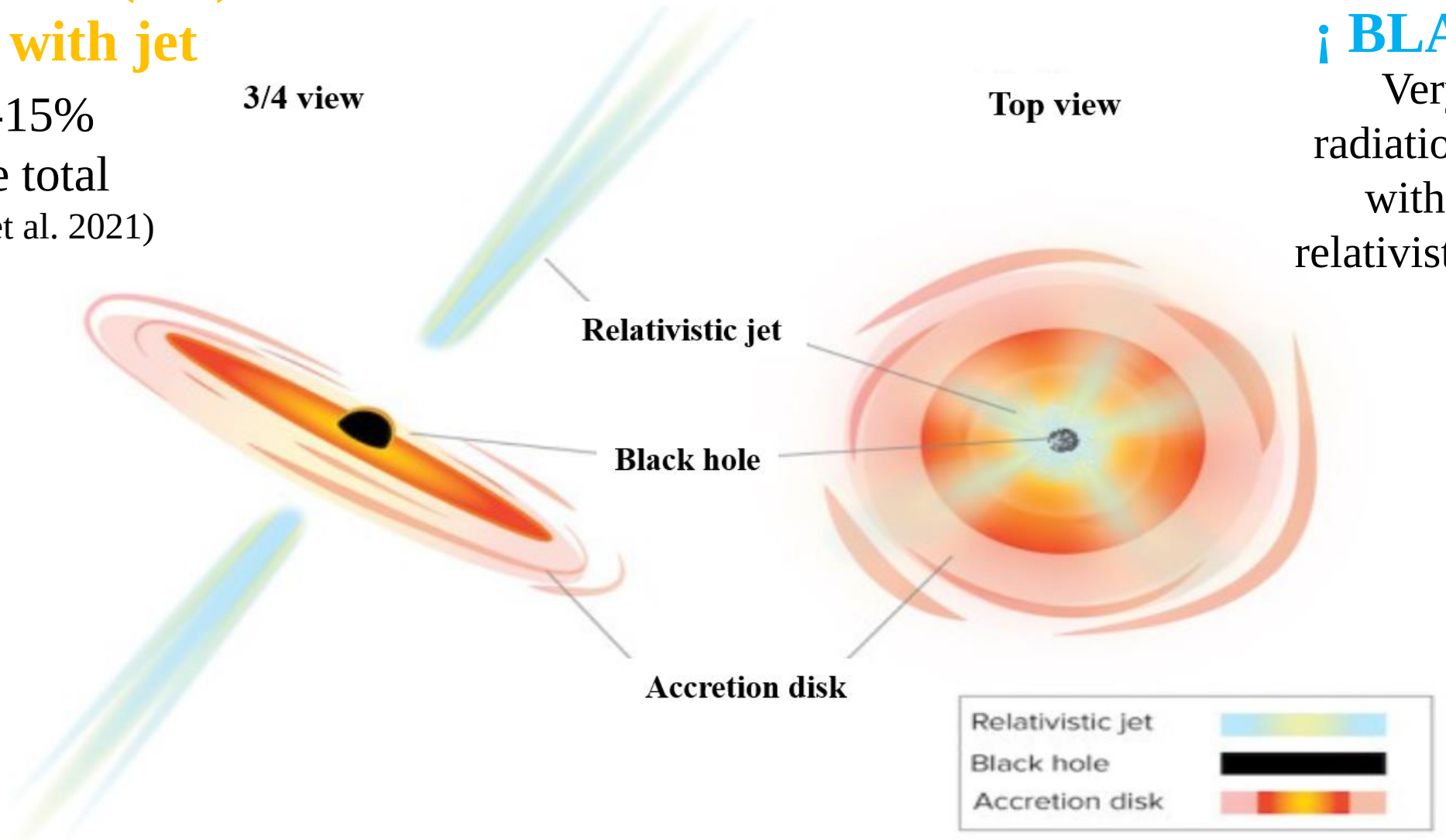
RACS/VAST Team

Active Galactic Nuclei:

AGNs are galaxies extremely bright in the centre due to an accretion process onto a SMBH ($M = 10^6$-$10^{10}\ M_\odot$)

Radio Loud (RL) AGNs with jet

~10-15%
of the total
(e.g. Liu et al. 2021)



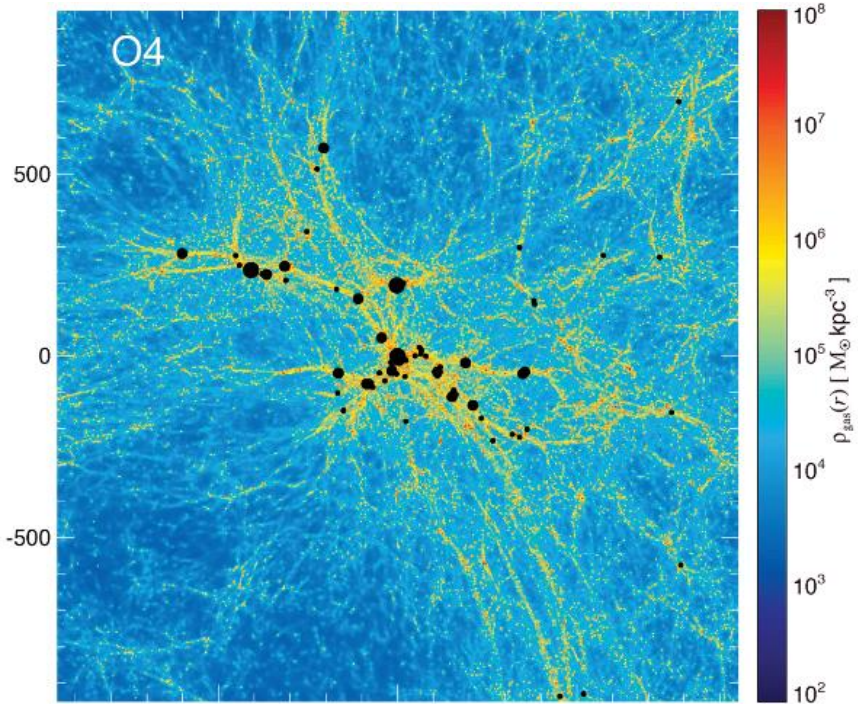
¡ BLAZAR !

Very bright,
radiation produced
within the jet
relativisticly boosted

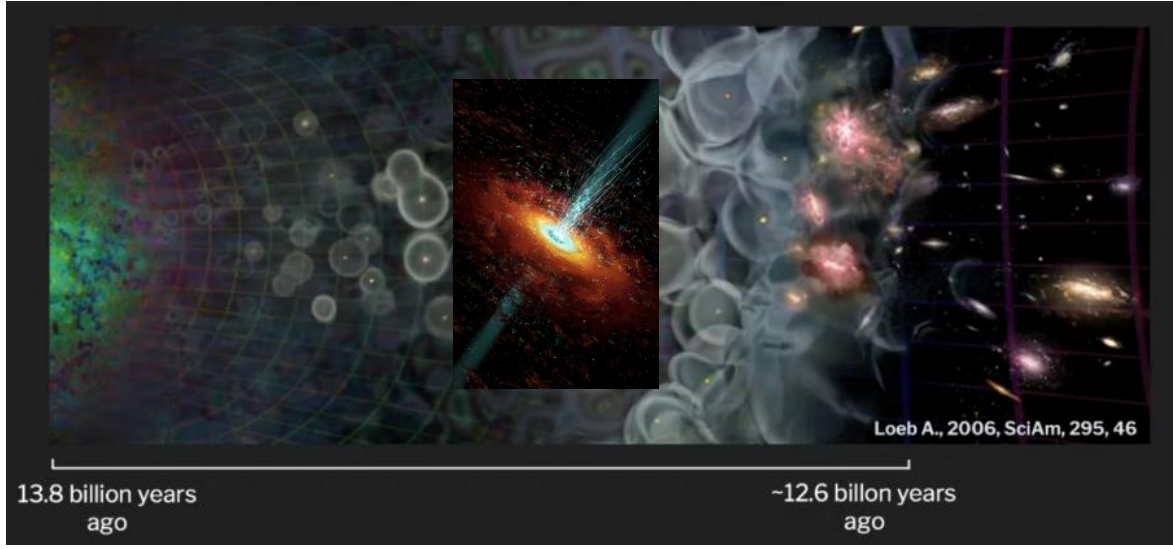
RL AGNs at z>6:

Environment

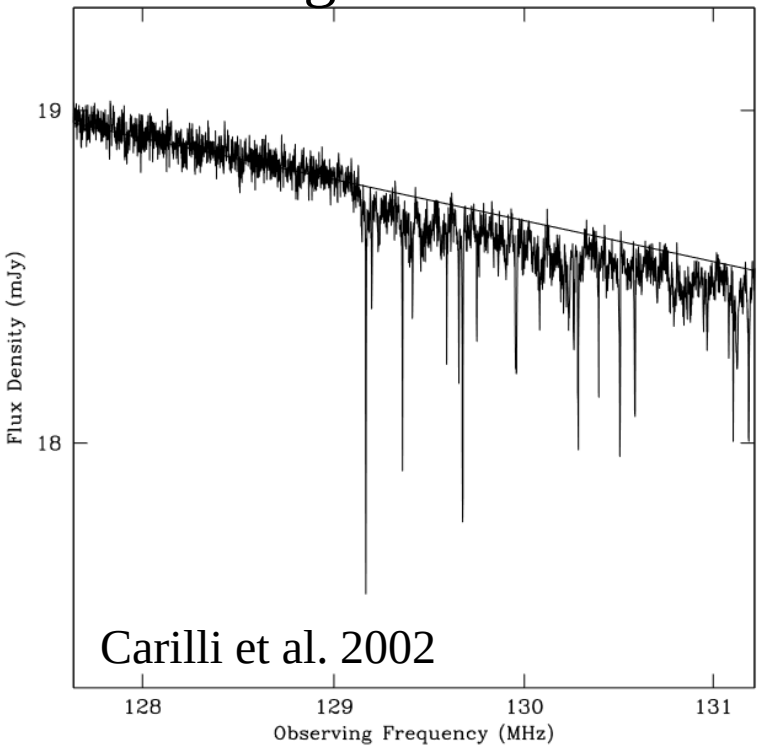
Tracers of the densest environments, the progenitors of the large scale structures observed today



Costa et al. 2014



Backgroung light to study the IGM through the 21cm forest



Carilli et al. 2002

Jets contribution to reionization

e.g. Torres Albà et al. 2020

Evolution and properties of relativistic jets and the jetted SMBHs

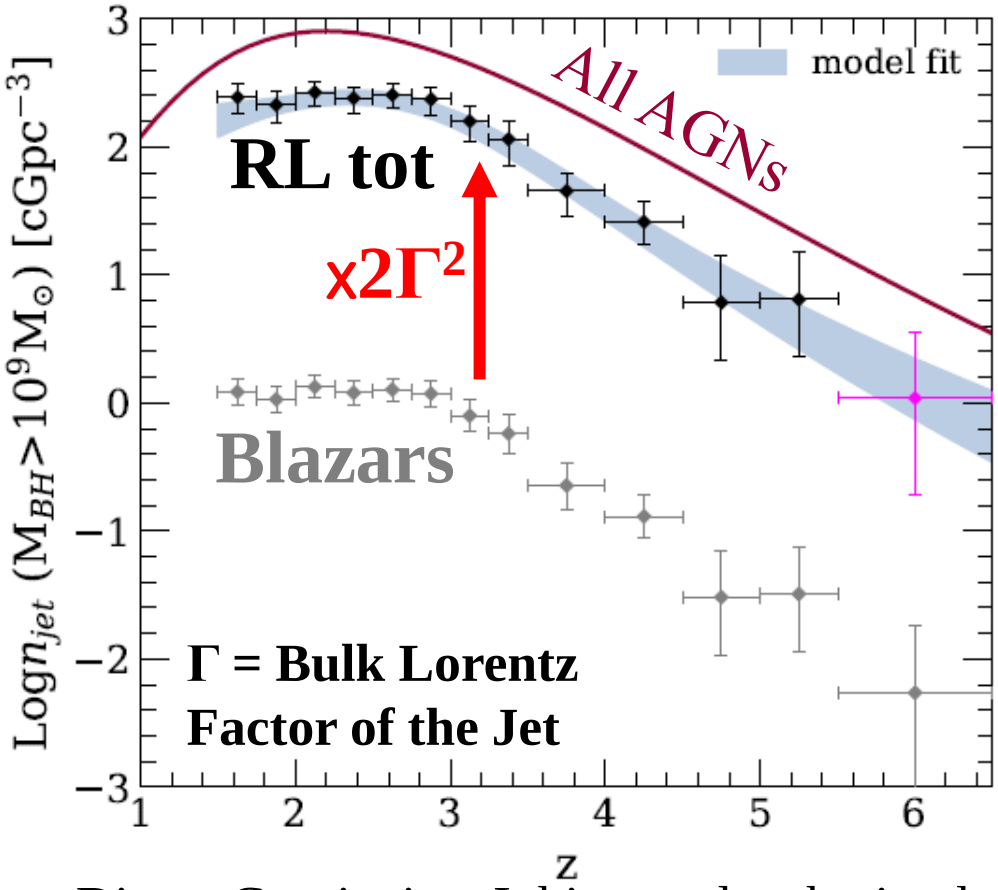
Blazars

Study entire jetted population

Viewing angle: $\theta_v < 1/\Gamma$

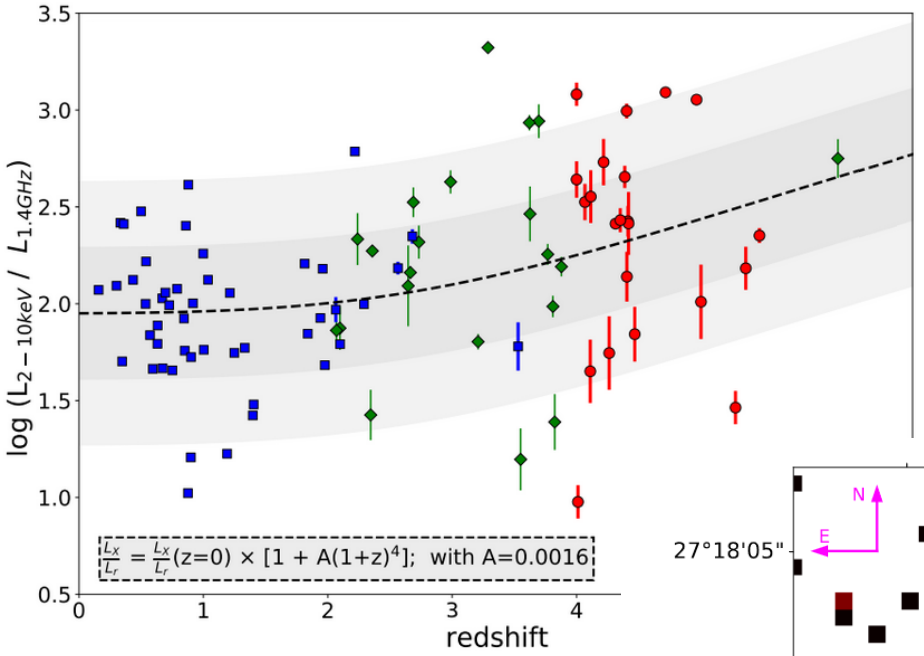
Similar RL AGNs:

$N_{tot} \approx 2\Gamma^2 N_{obs}$ **($\Gamma = 10$, $N_{tot} \approx 200 N_{obs}$)**



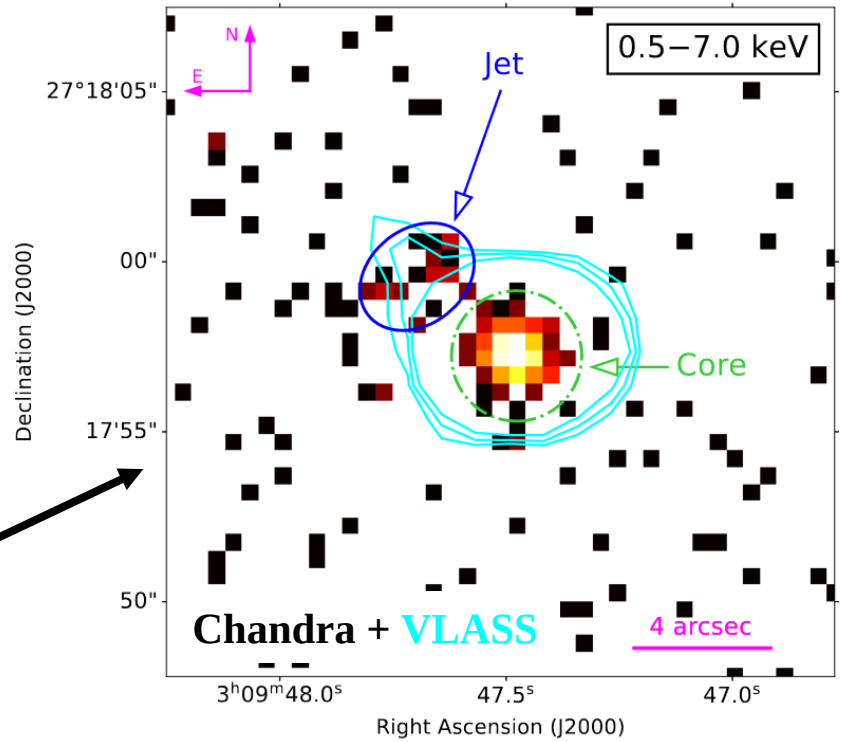
Diana, Caccianiga, Ighina et al. submitted

Evolution of the Jet emission/properties



Ighina et al. 2019, 2021

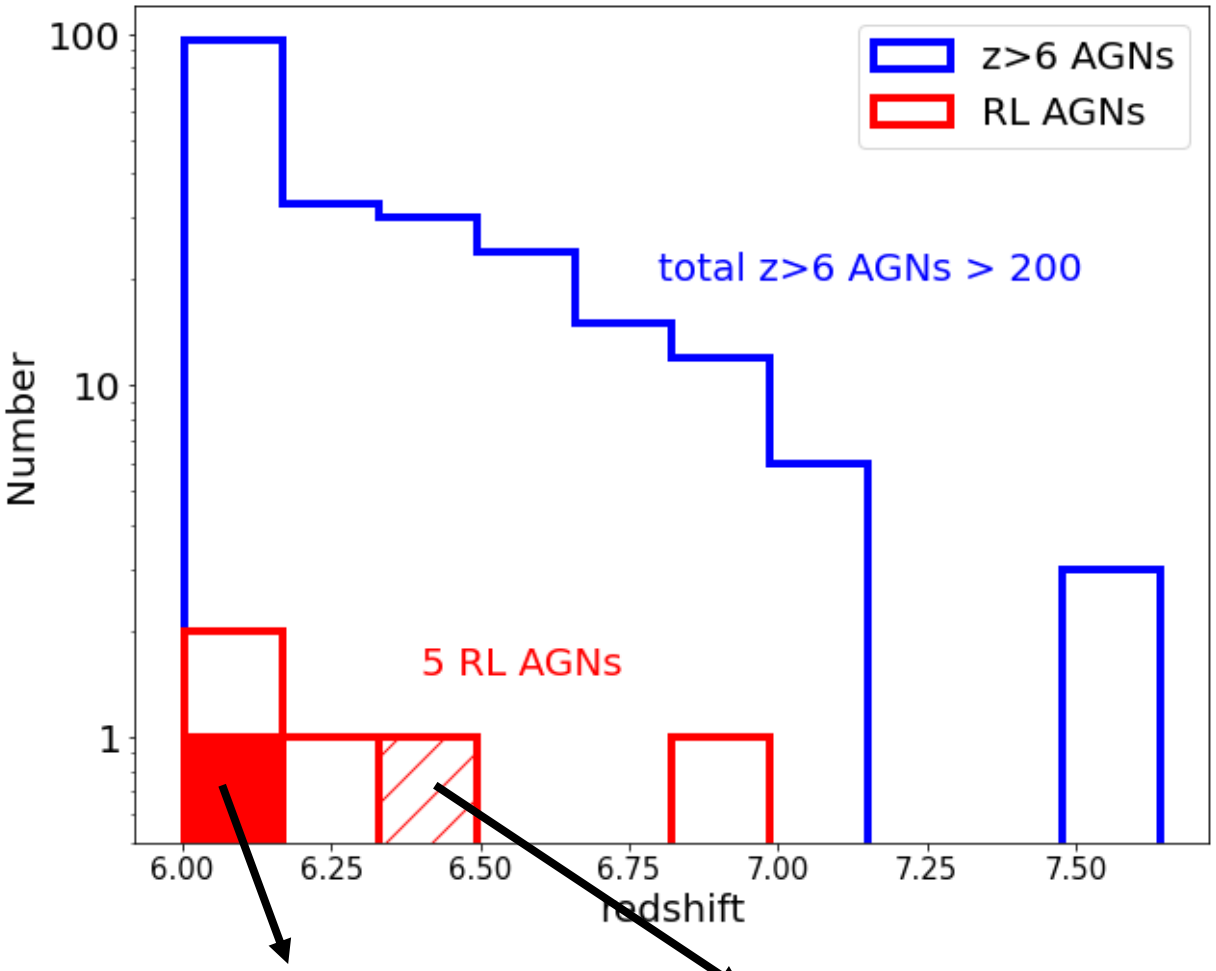
interaction with the CMB photons ?



PSO J0309+27 at z=6.1
(Belladitta, Moretti, Caccianiga et al. 2020)

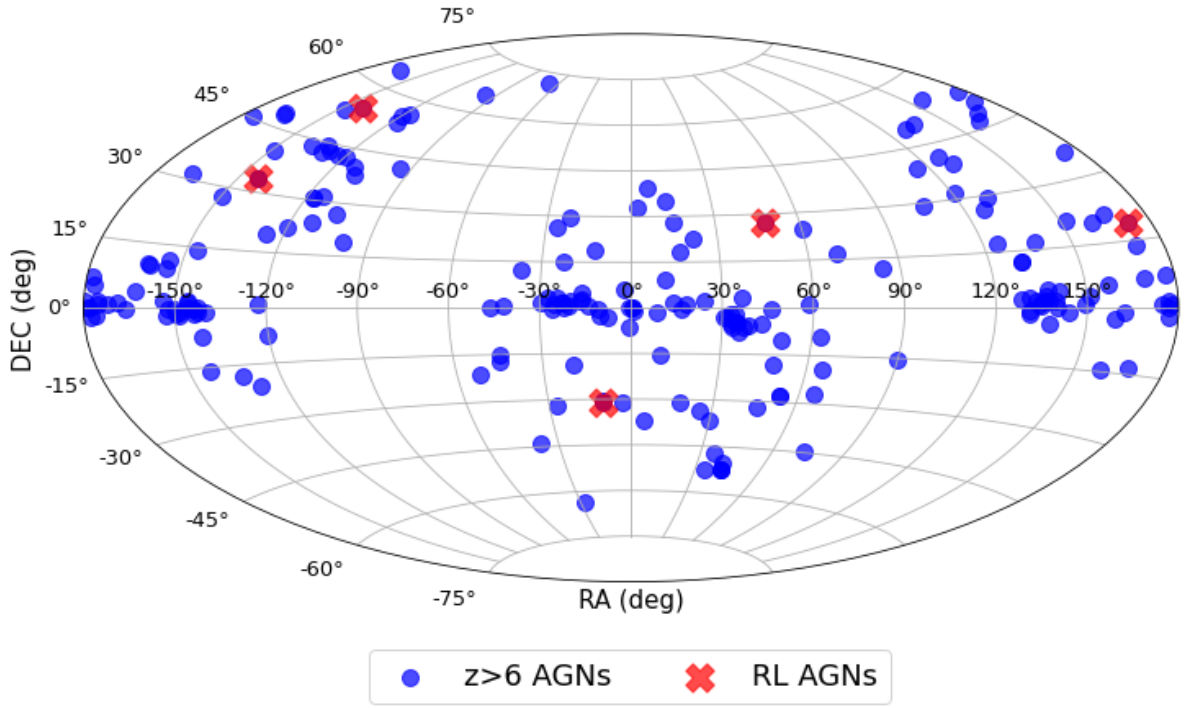
Ighina et al. in prep.

Current high-z AGNs



¡ Blazar !
(z=6.1; Belladitta et al. 2020)

¿ Blazar ?
(z=6.44; Ighina et al. 2021)



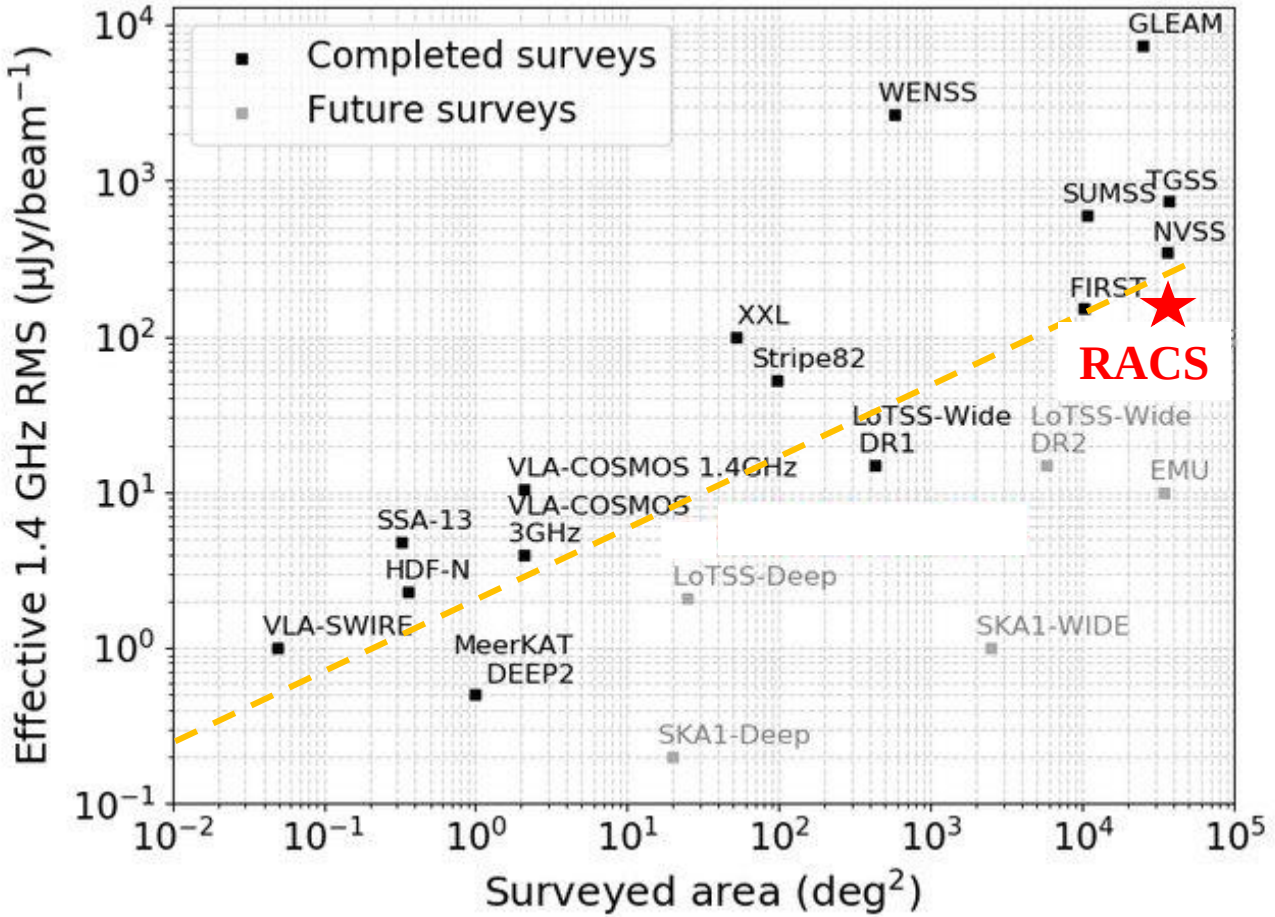
Only 5 RL confirmed at z>6:

McGreer et al. 2006, z=6.12
Willot et al. 2010, z=6.18
Belladitta et al. 2020, z=6.10
Ighina et al. 2021, z=6.44
Bañados et al. 2021, z=6.82

High-z RL AGNs extremely rare sources → best way to find them: **wide-area surveys** Optical/NIR + Radio

Rapid ASKAP Continuum Survey (RACS)

Survey	Frequency (MHz)	Bandwidth (MHz)	Resolution (arcsec)	Sky coverage (deg^2)	Sensitivity ($mJy\ beam^{-1}$)	Polarization	$N_{sources}$ ($\times 10^6$)
RACS	887.5	288	15	36 656	~0.25	*I, Q, U, V*	4



Adapted from Tasse et al. 2020

- 1st **all-sky survey** with **ASKAP**
- Covers **all the sky** at **dec < +41deg**
- Rapid poses: 15 mins integration time per FoV 31 deg^2
- Better resolution and **astrometric accuracy** compared to previous surveys
- **3 frequency band with multiple scans**: <u>low-888</u> + mid-1360 + high-1655 MHz

1° data release	Official catalogue
December 2020	September 2021
McConnell et al. 2020	Hale et al. 2020

VIK J2318-3113 (z=6.44)

Projects: GAMA23 (MIDAS + GLASS) + ToO

Data: MWA + uGMRT + ATCA + **ASKAP**

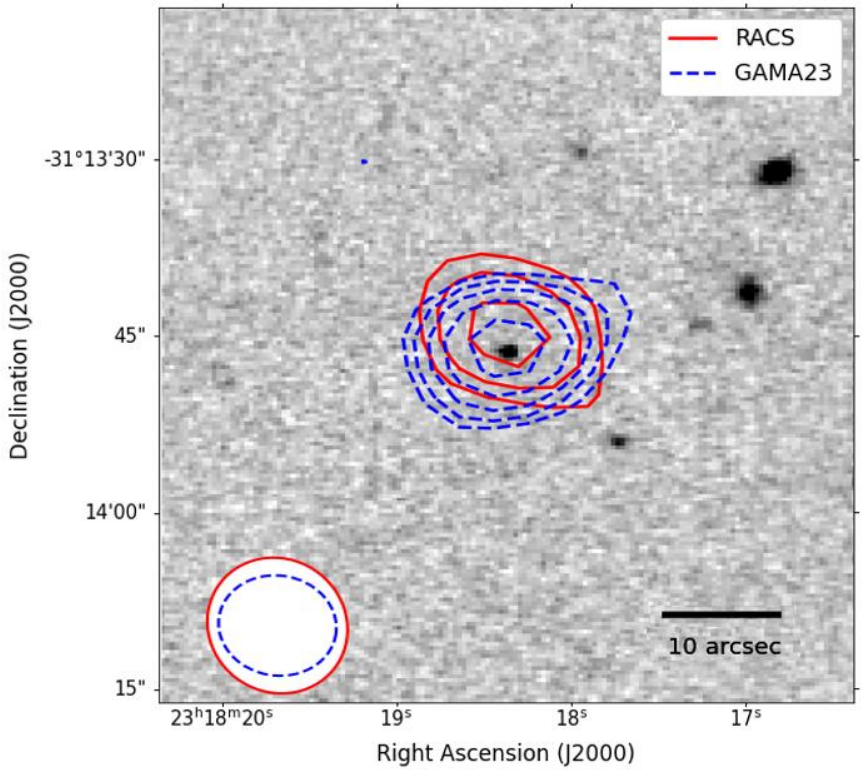
Cross match list ~250 z>6 AGNs

+

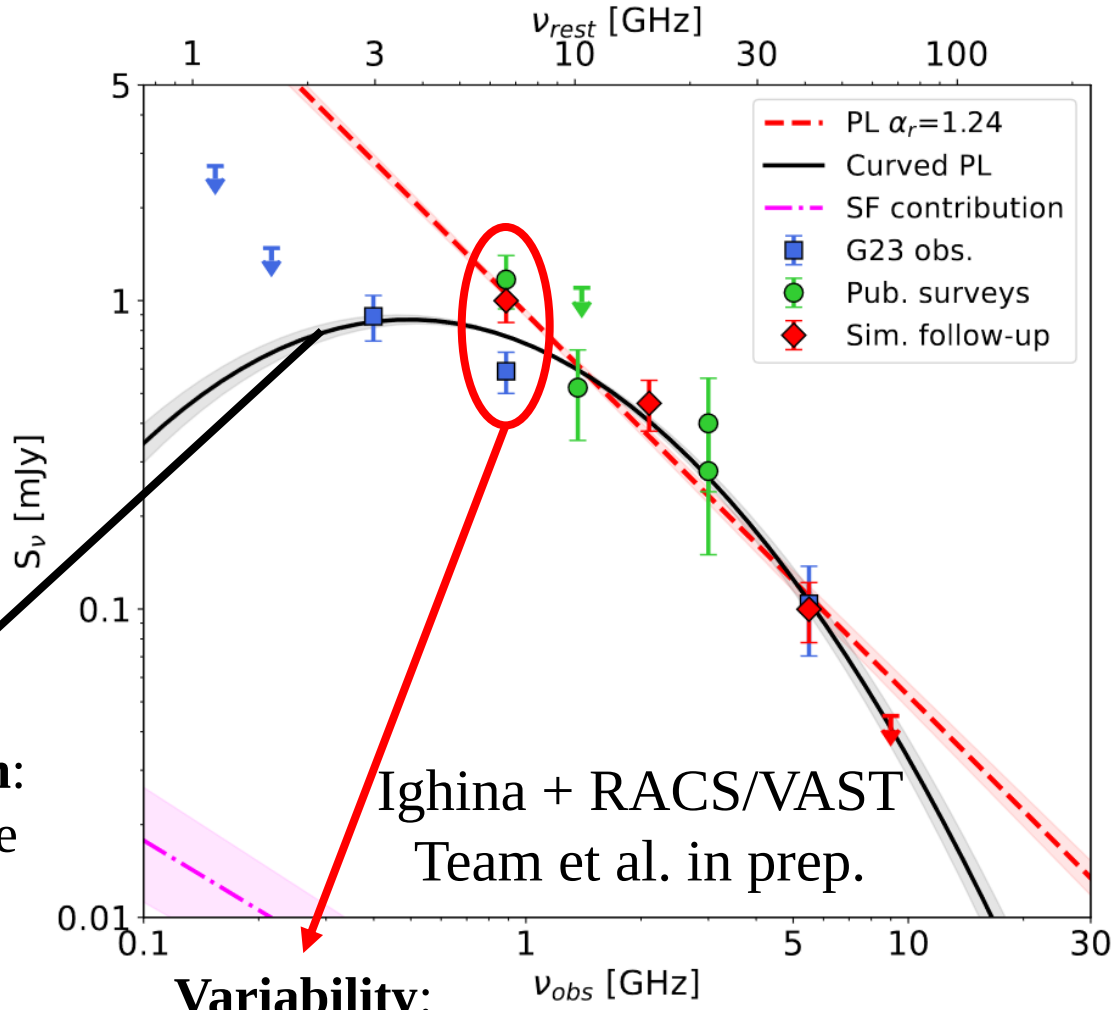
RACS-low 1st data release

New AGN RL: VIK J2318-3113 at z=6.44

the second-most distant RL



Ighina et al. 2021



Peaked Spectrum:

Very young source

~1000 yrs

Variability:

Factor ~2 in 1 year obs. frame (~50 days rest frame)

- Blazar ?
- Refractive Interstellar Scintillation

very compact source

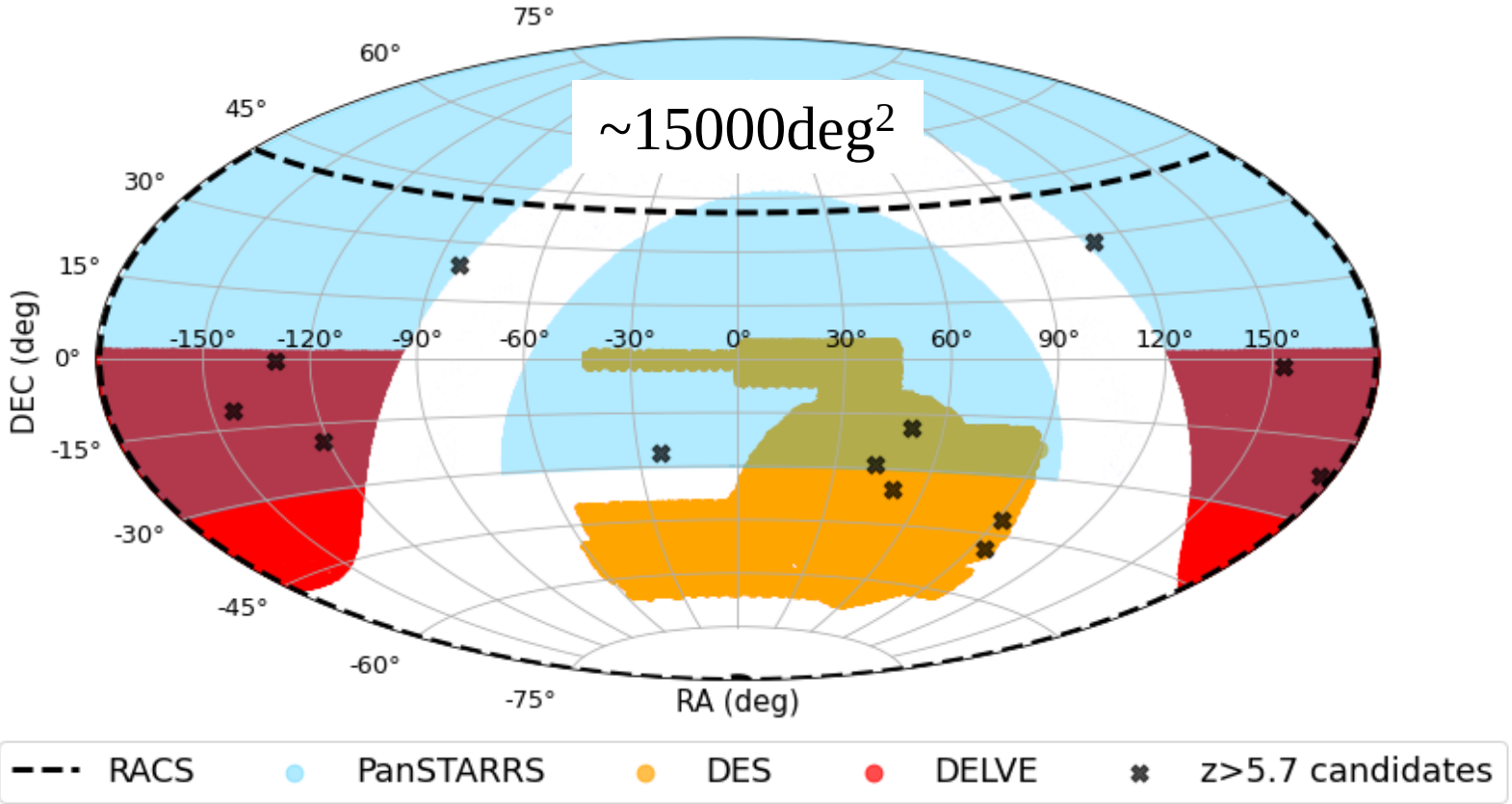
Search for new high-z RL

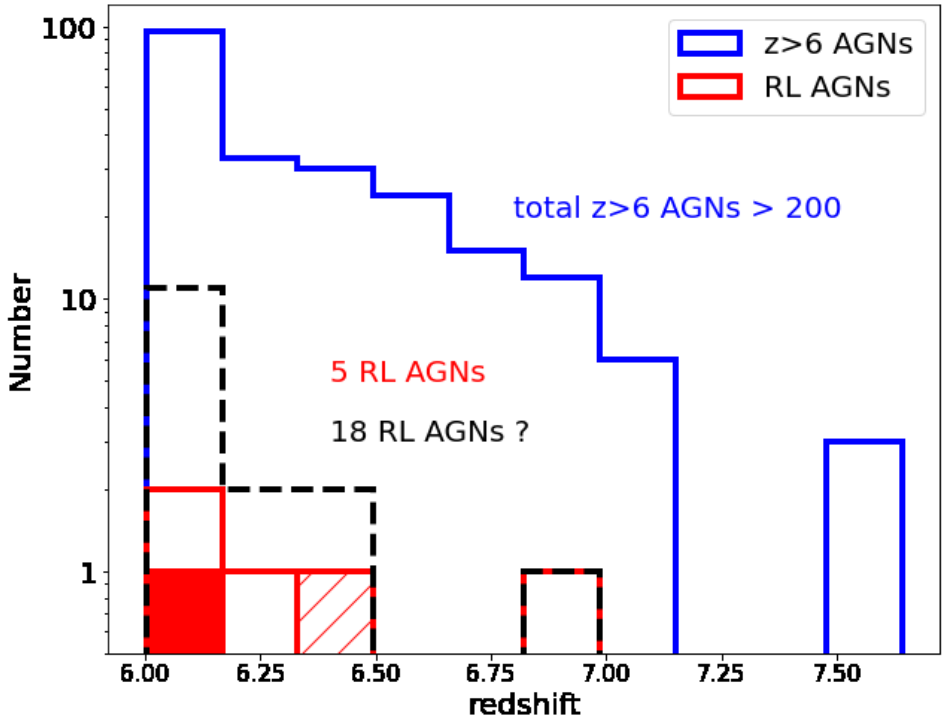
Dropout technique
+
Radio association
→ less strict selection criteria → AGNs missed by previous studies

Optical-NIR surveys:
PanSTARRS – DES – DELVE

Chambers et al. 2016, Abbott et al. 2021,
Drlica Wagner et al. 2021
+
RACS

$S_{888MHz} > 1mJy$
$mag_{1450A} < 21$
~60-70 candidates at z>5
Among which 13 at z>5.7





Spectroscopy of two candidates

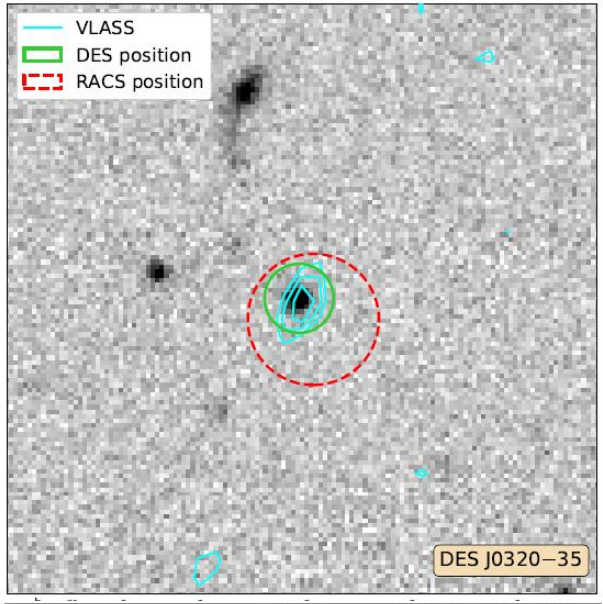
DDT Gemini--South

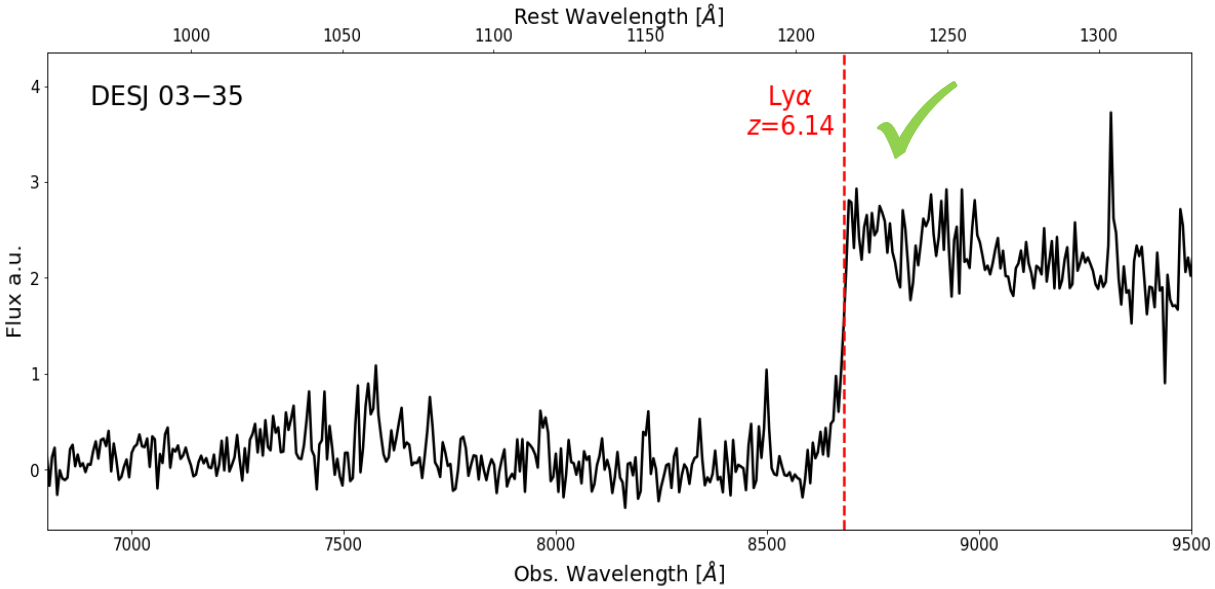
Both strong radio emitters:
radio loudness **R >100**

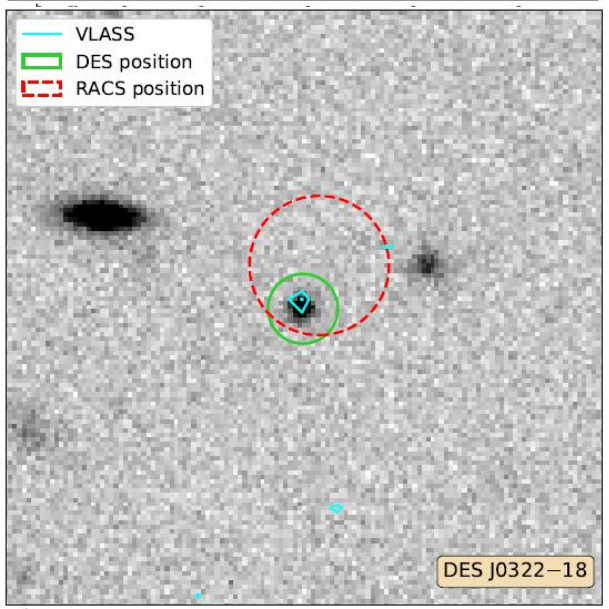
$$R = \frac{S_{5\mathrm{GHz}}}{S_{2500\text{Å}}}$$

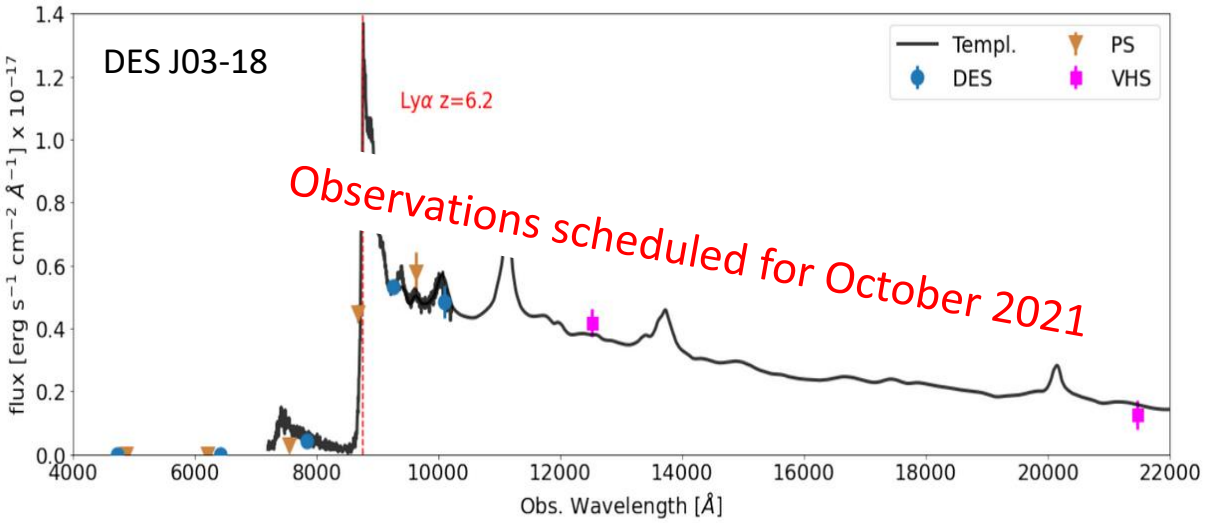
possible Blazars ?

¡ Stay Tuned !



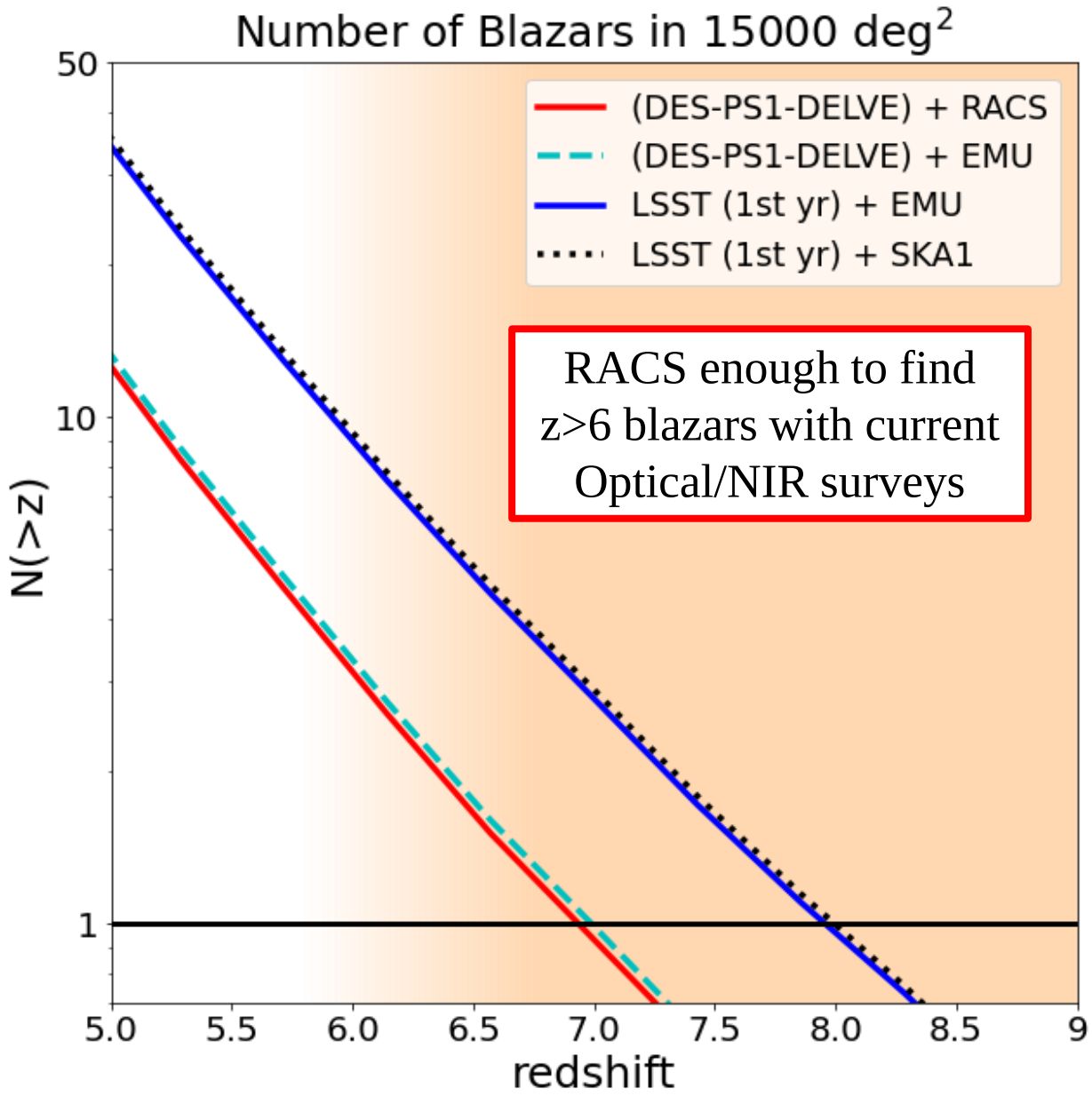


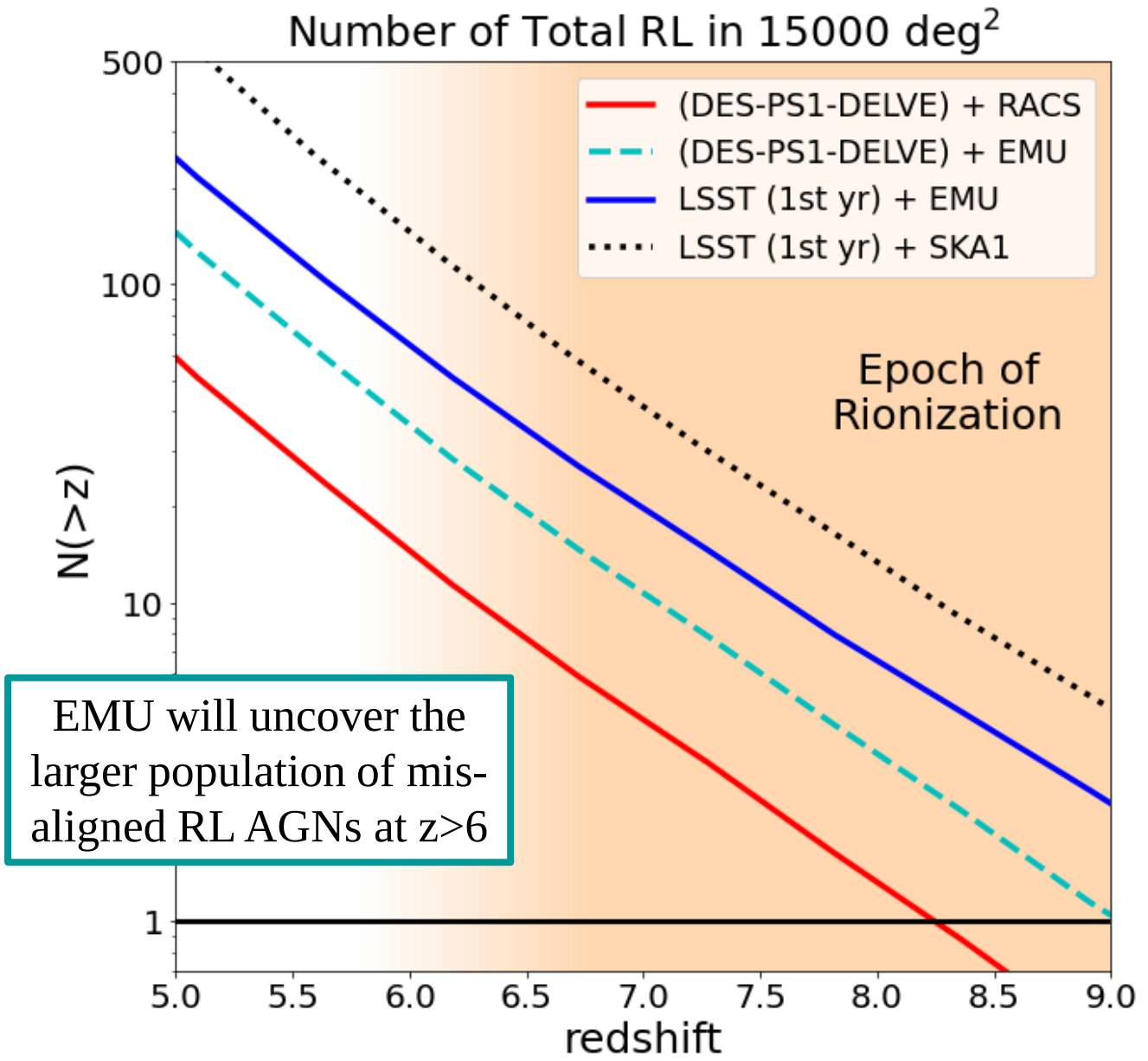




Expected blazars/RL in the future

RACS: S_{lim} ~ 1 mJy
EMU: S_{lim} ~ 0.1 mJy





Summary:

- **RACS** in less than a year it has **increased the number of known z>6 RL AGNs by 50%**, with:
  - the **second-most distant RL AGN (z=6.44)** → follow-up observations indicates it is a young radio source, maybe a blazar ?
  - two new candidates under spectroscopic observations → **one** already **confirmed (z=6.14);**
- 13 new candidates from RACS, **potentially triplicate the current number of z>6 RL AGNs**
- **RACS** uncovers the **blazar** population at z>6;
- **EMU** /SKA1 will be crucial to reveal the entire RL AGNs regardless of the orientation, even at z>8.

¡ Thank you for the attention !

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Contact me !