Properties of Lyα & non-Lyα emitters in the epoch of reionization

Kumari et al. arXiv:2406.11997

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JADES JWST ADVANCED DEEP EXTRAGALACTIC SURVEY

esa

COSPAR, Christ Deemed to be University, Oct 27, 2025

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Cosmic History

When & How Cosmic Reionization occurred?

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Observational Probes of Cosmic Reionization

- Gunn Peterson Absorption Trough (Gunn & Peterson 1965)
- CMB Polarization & temperature Anisotropy (Kogut+2003)
- HI 21cm signal (Furlanetto+2004)
- Gamma-ray bursts (Totanni+2006)

- Potential sources of reionizing photons:

Quasars
Active Galactic Nuclei
Early Star-forming galaxies
Lyman Break galaxies

Lyman alpha emitters

Reviews by
Fan+2006, 2023, Stark+2016

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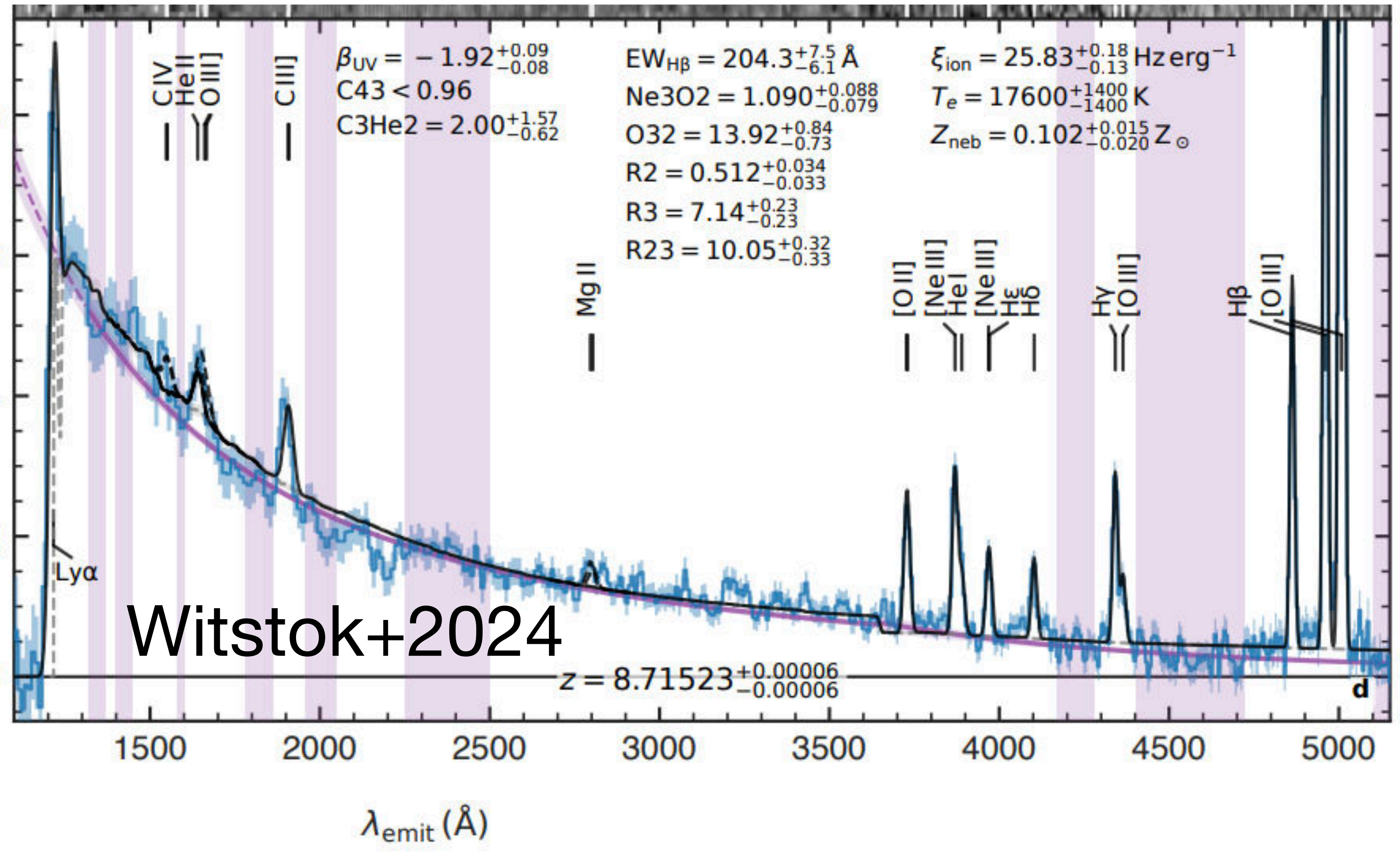
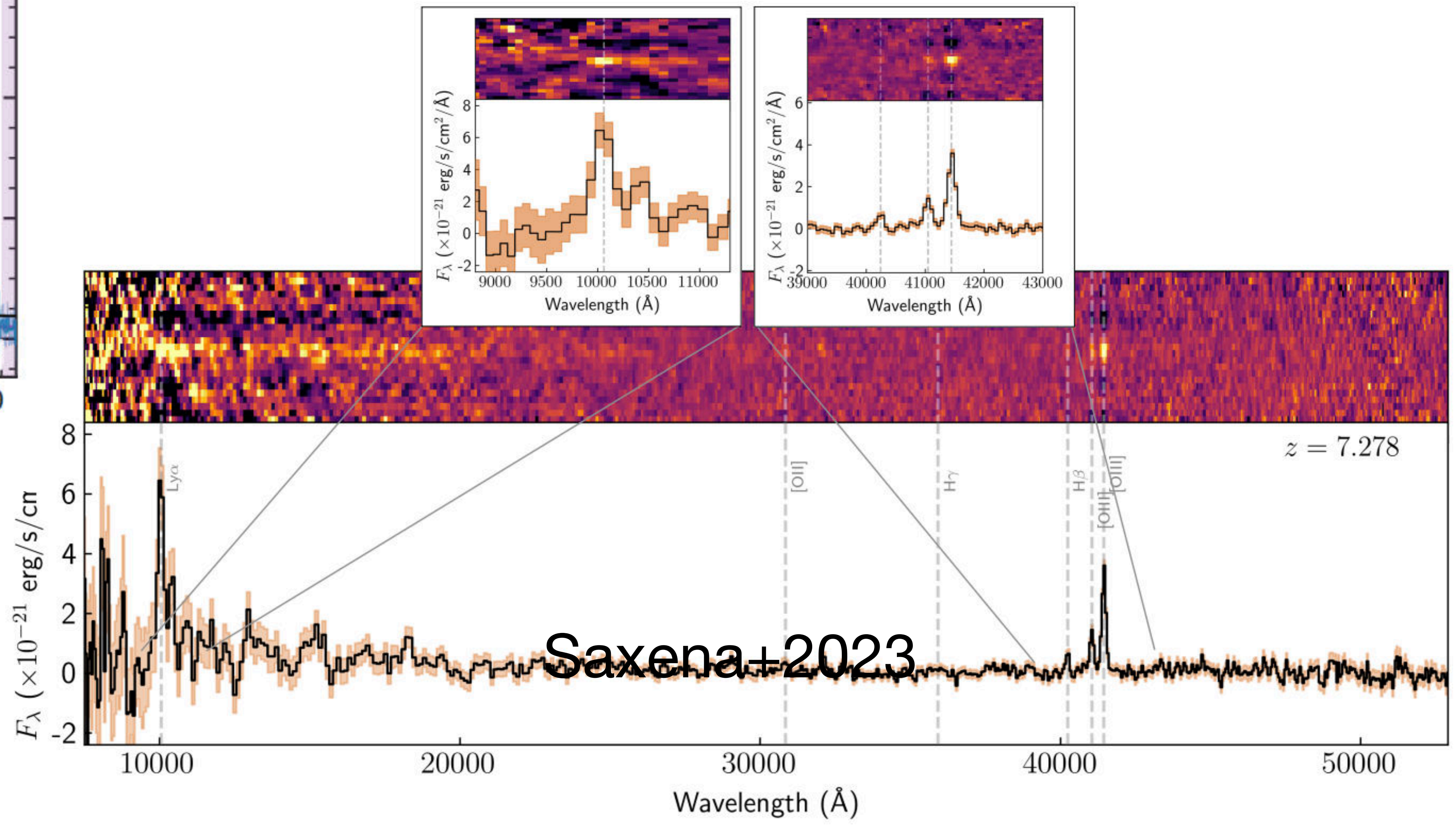
Lyman alpha emitters in JWST era

Since Partridge & Peebles 1967….





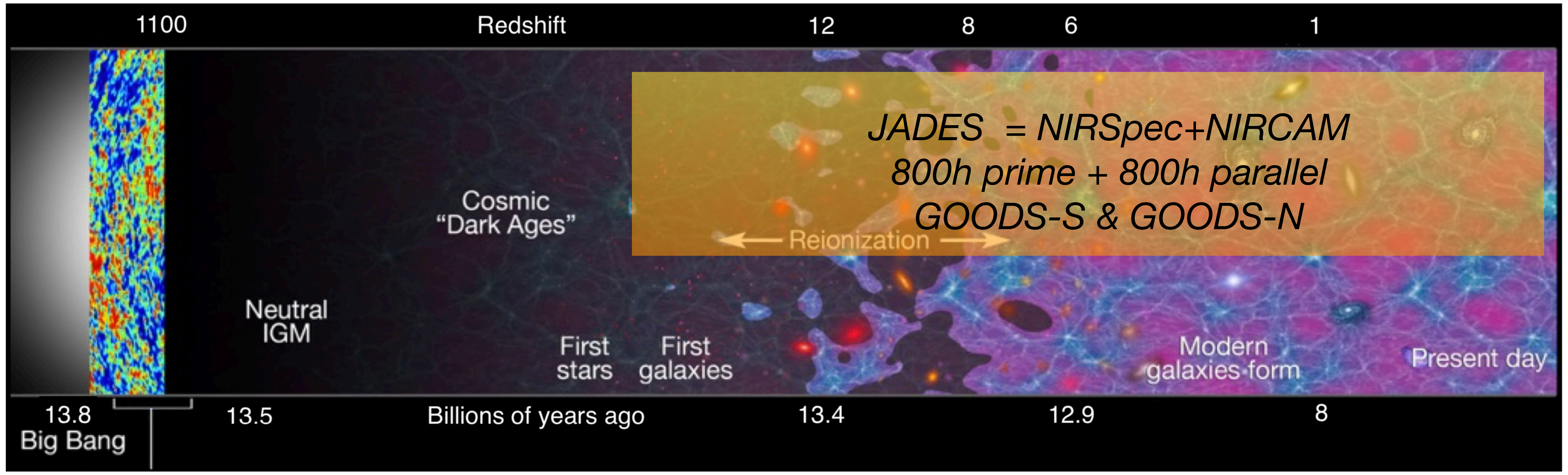
Thanks to JWST/NIRSpec:
Several spectroscopic detection & analysis

(e.g.,Bunker+2023, Jones+2023, Maseda+2023, Tang+2024, Saxena+2023a, 2023b, Witstok+2024a,2024b, see also, Heintze+2024, Roberts-Borsani+2024)

Various ground-breaking studies though difficult to draw broad conclusions on LAE and non-LAE populations.

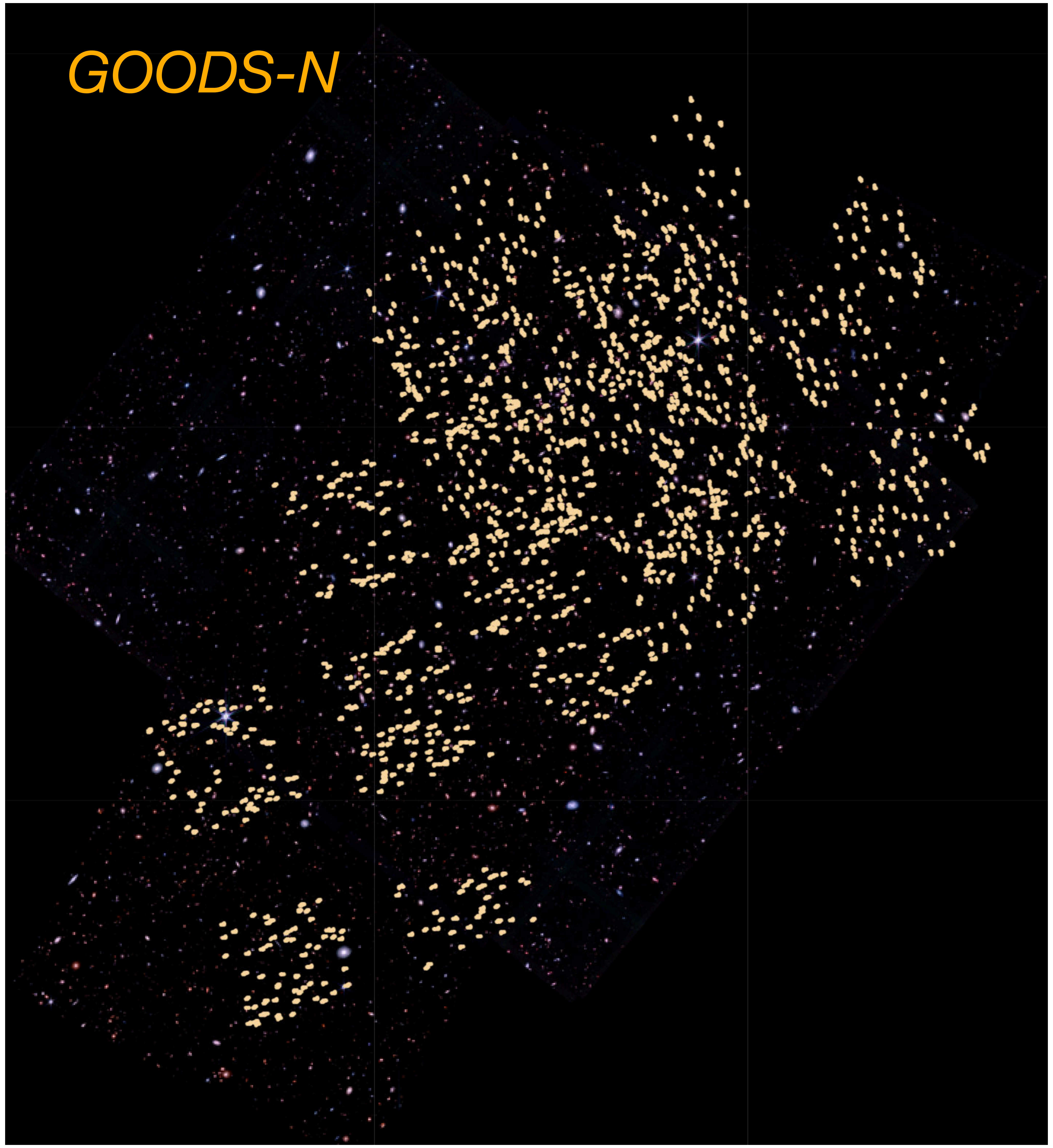
JADES: Galaxies population

JADES: JWST Advanced Deep Extragalactic Survey



Low (R~100), Medium (R~1000) &
High resolution (R~2700)
Multi-object spectroscopy (MOS) via NIRSpec
&
NIRCam imaging in 9 filters.

See e.g., Bunker+2020, Rieke+2020, Eisenstein+2023, Bunker+2023



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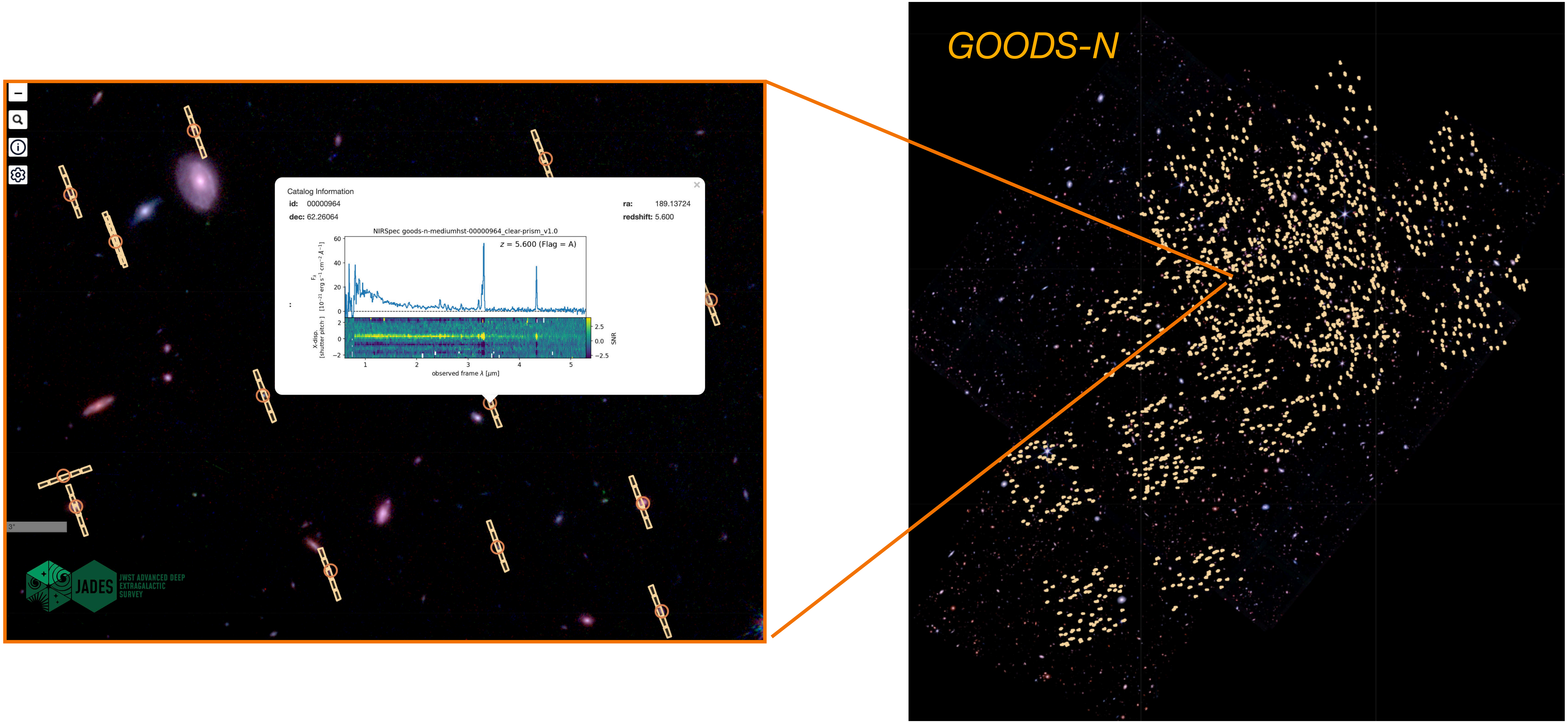
JADES: Galaxies populations via MSA



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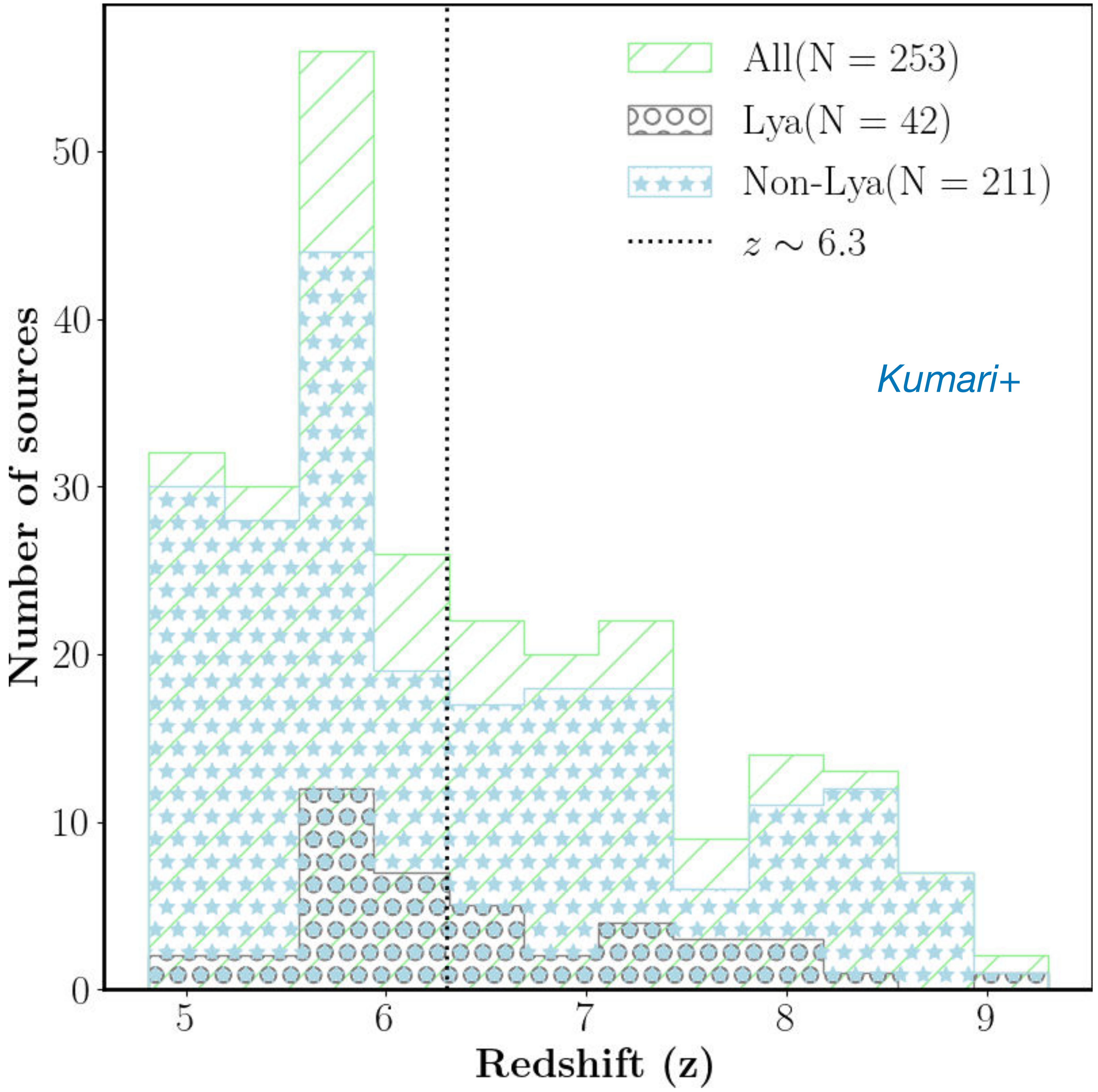
JADES: LAE versus non-LAE population

- Sample Selection:
  - Redshift range: 4.8-9.6
  - Rest-wavelength range: Lya to [OIII]5007
- Sub-samples:
  - LAEs vs non-LAEs
  - Based on redshifts
- Stacking spectra within 6 sub-samples



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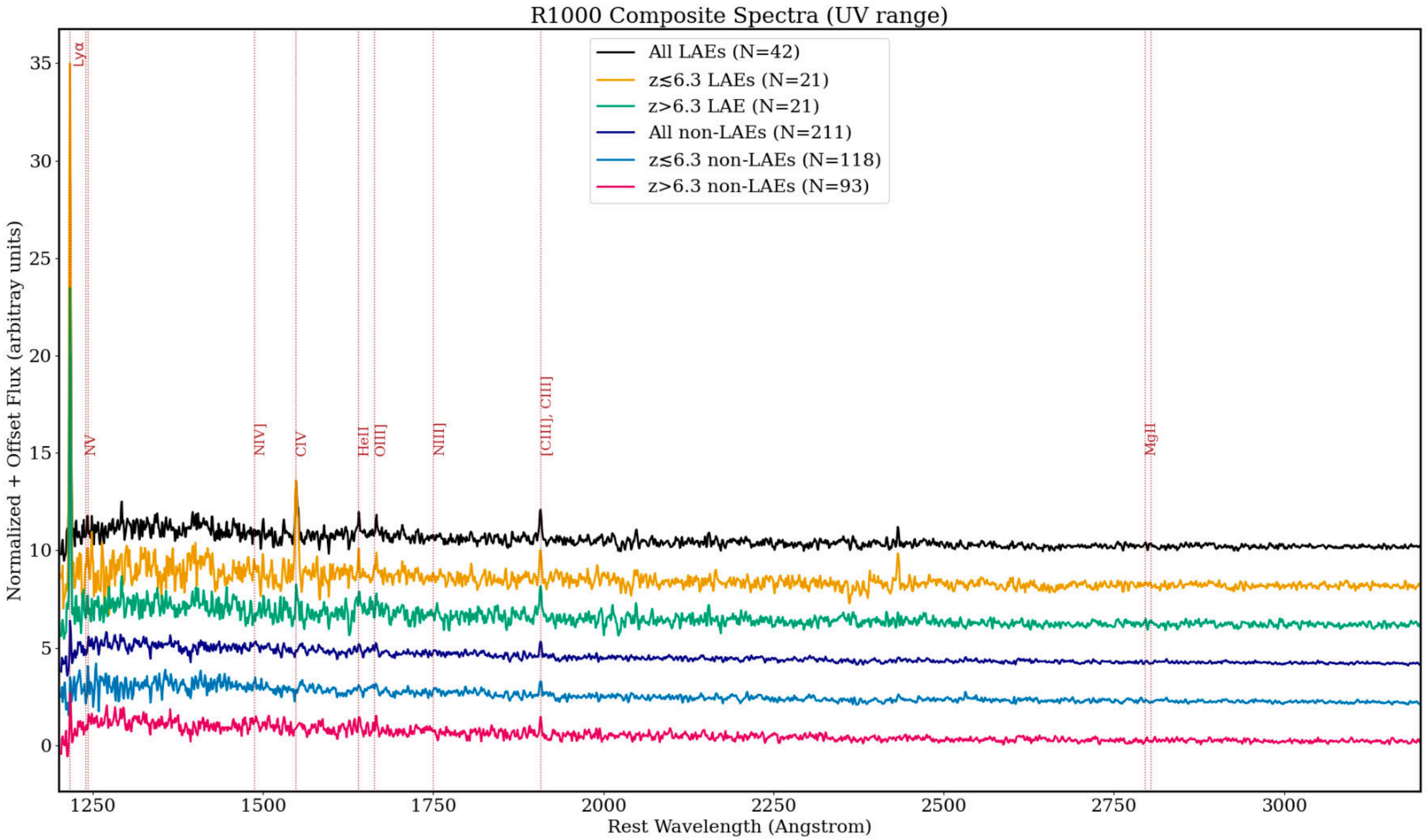
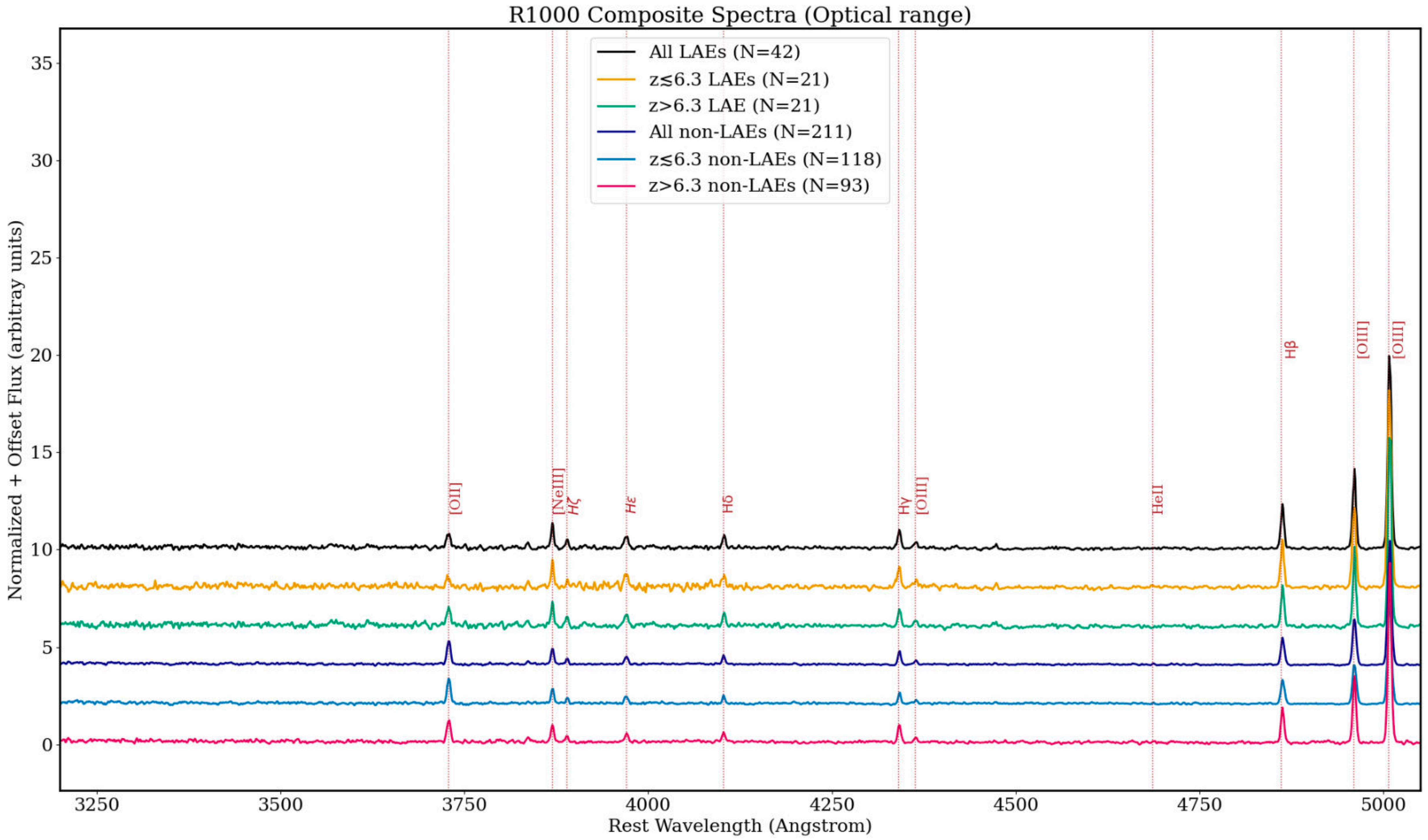
R1000 Composites: LAEs versus non-LAEs





Various physical properties such as dust-extinction, electron temperatures, ionization parameter and escape fraction of Lya and LyC…

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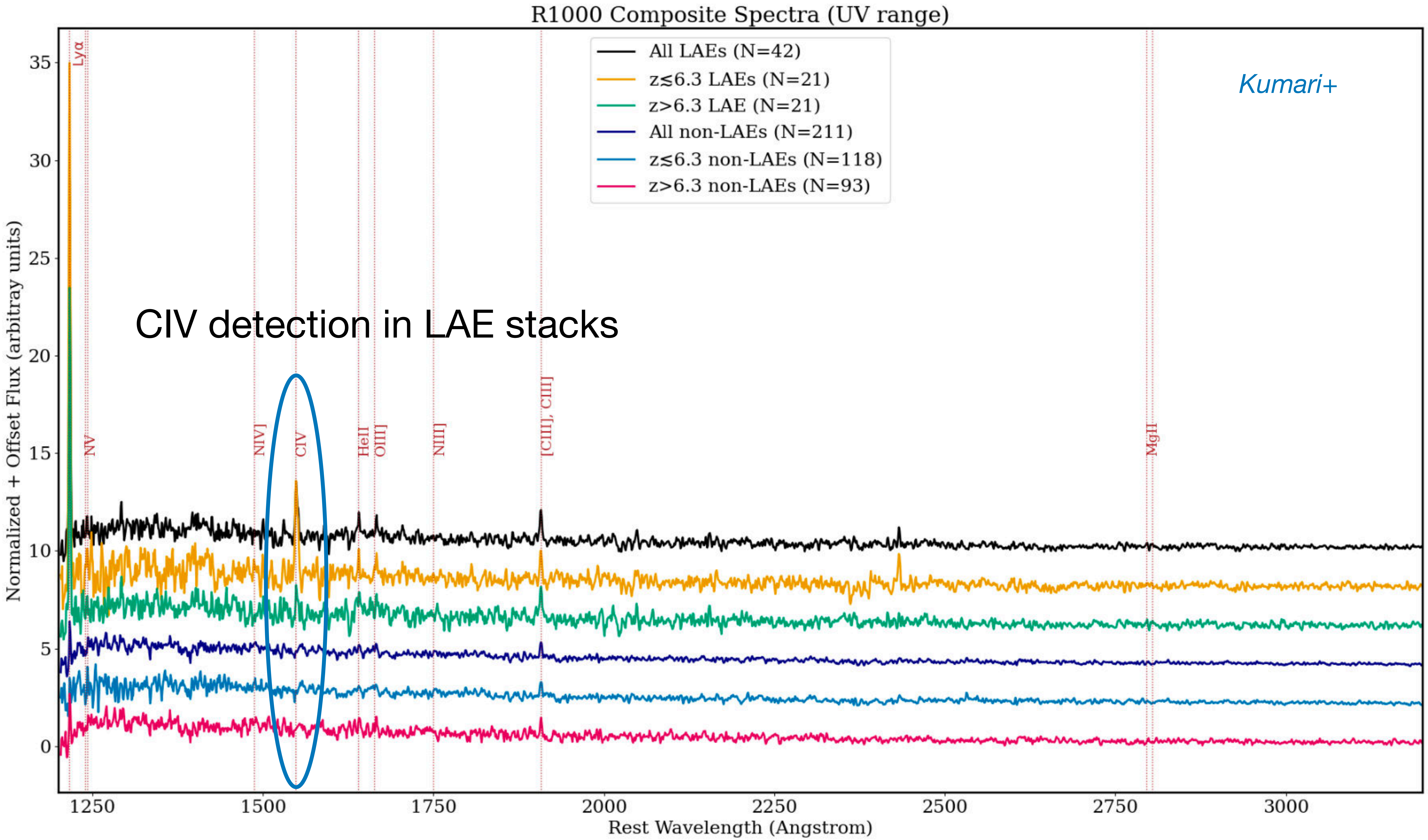
R1000 Composites: LAEs versus non-LAEs



High energy photons ->

Hard radiation field

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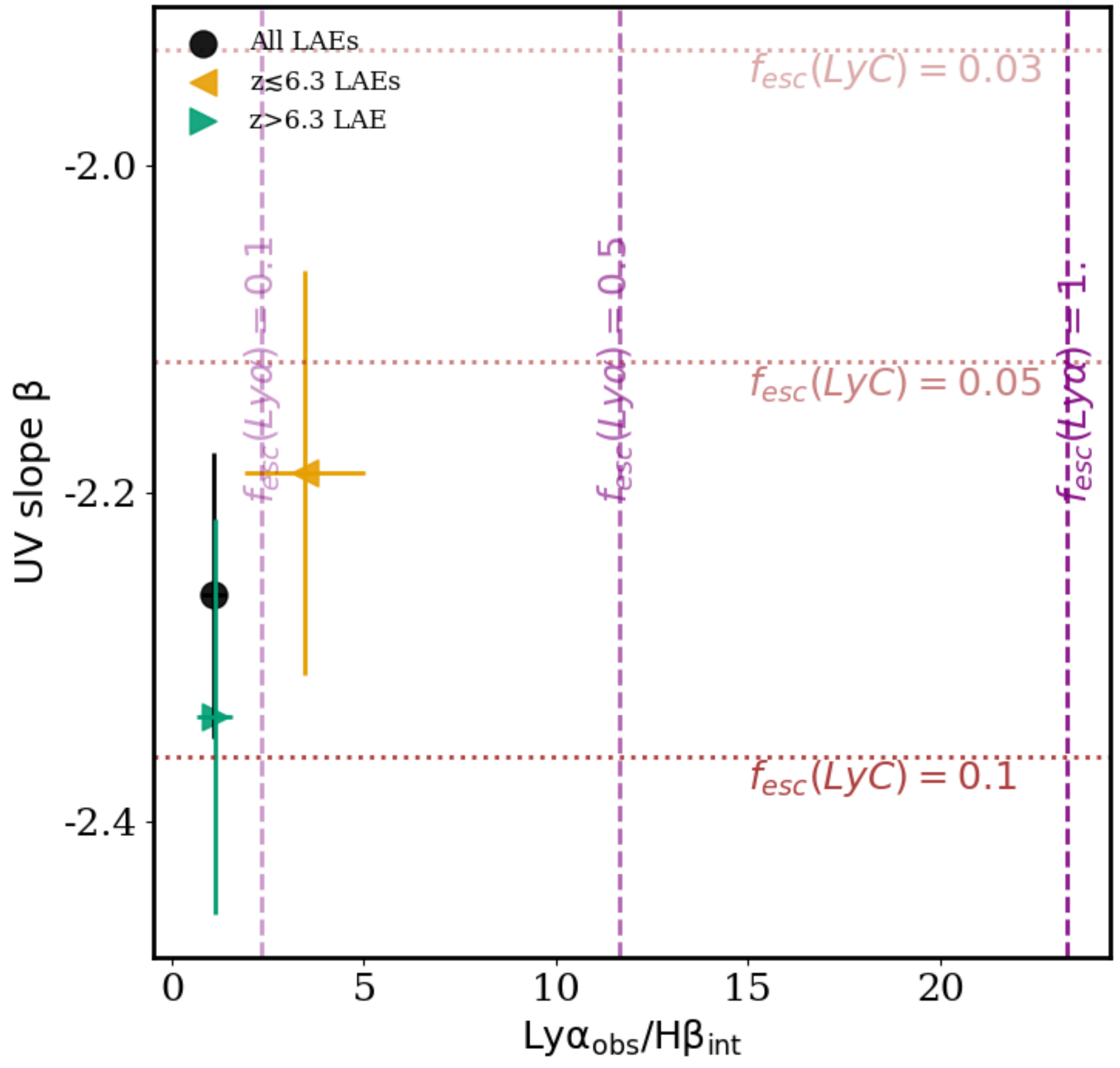
LAEs: Escape fractions of Lya & LyC



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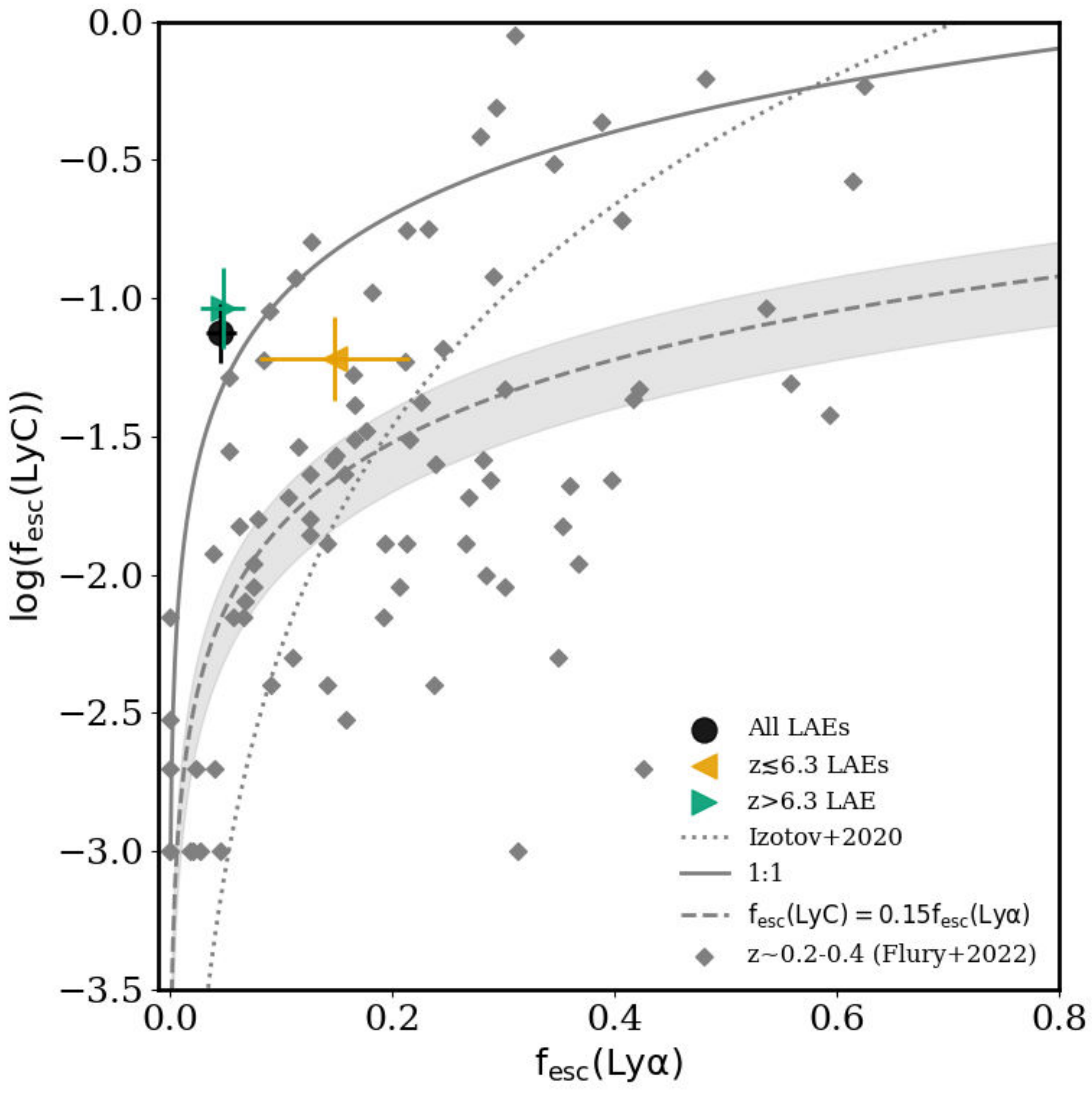
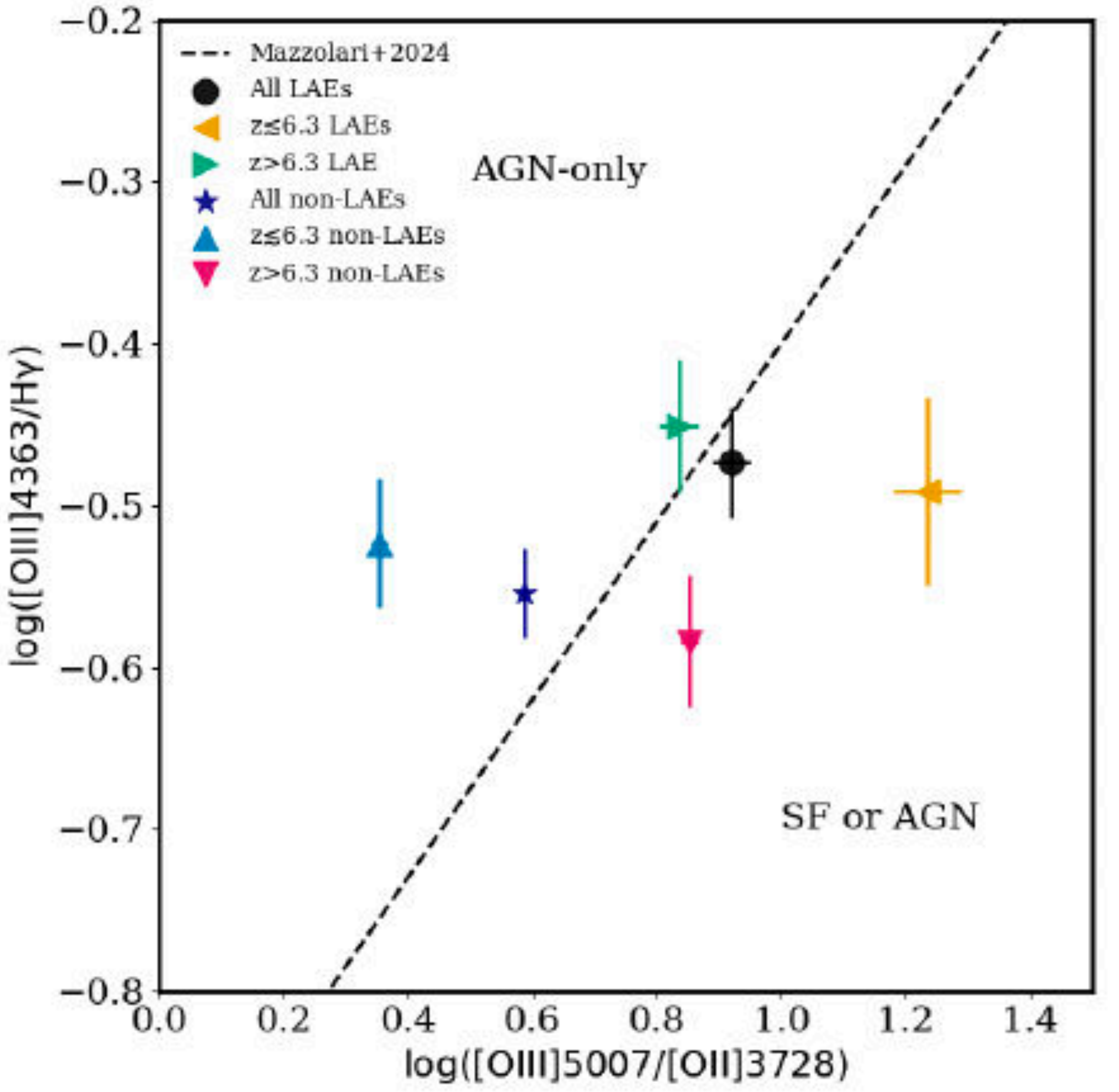
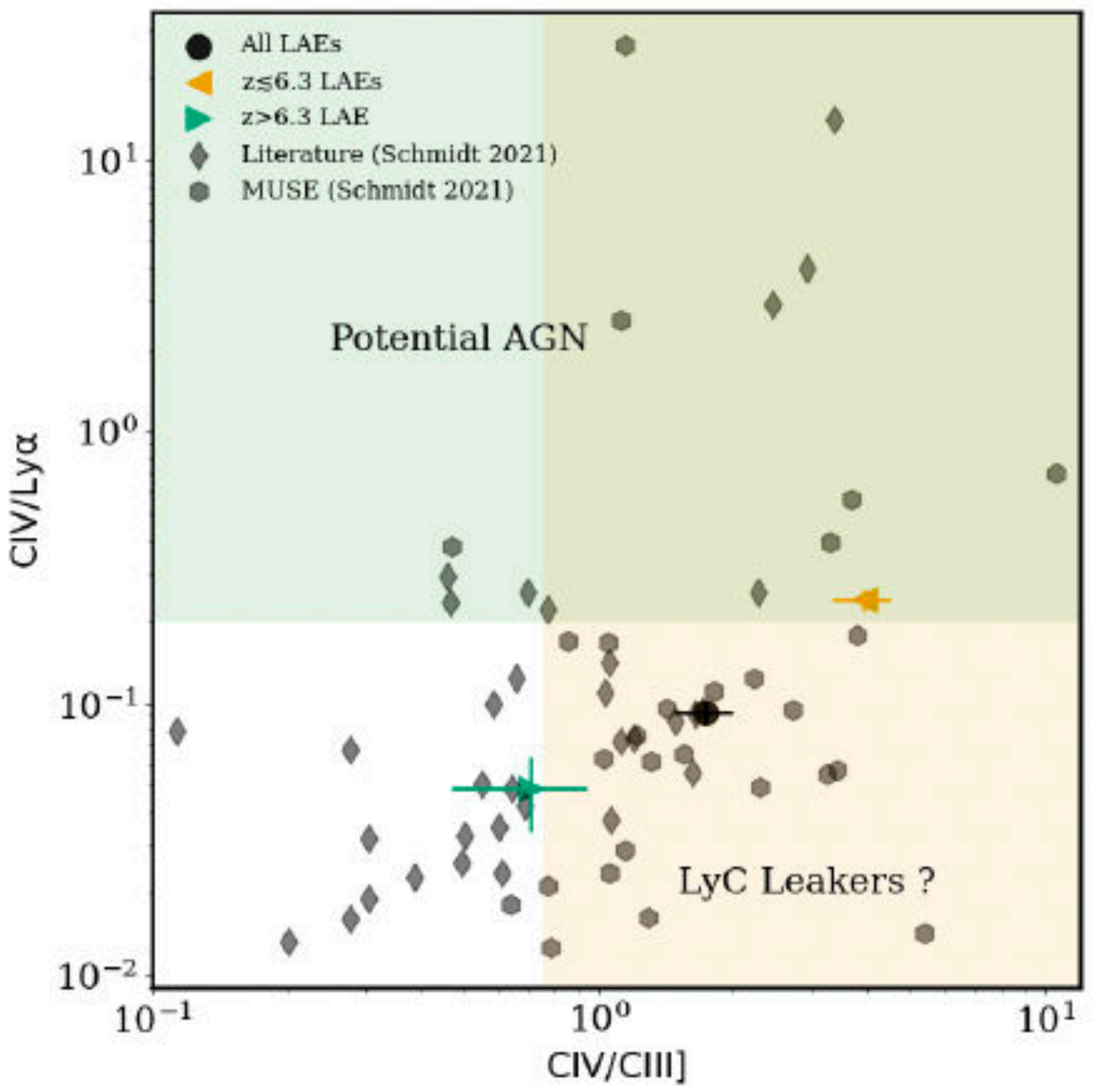


Diagnostics of escape fraction of LyC?

Ionization source: LAEs versus non-LAEs





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AGN dominating all samples?

CIV/Lya & CIV/CIII] for LAEs at z<6.3 ~ 5x for LAEs at z>6.3

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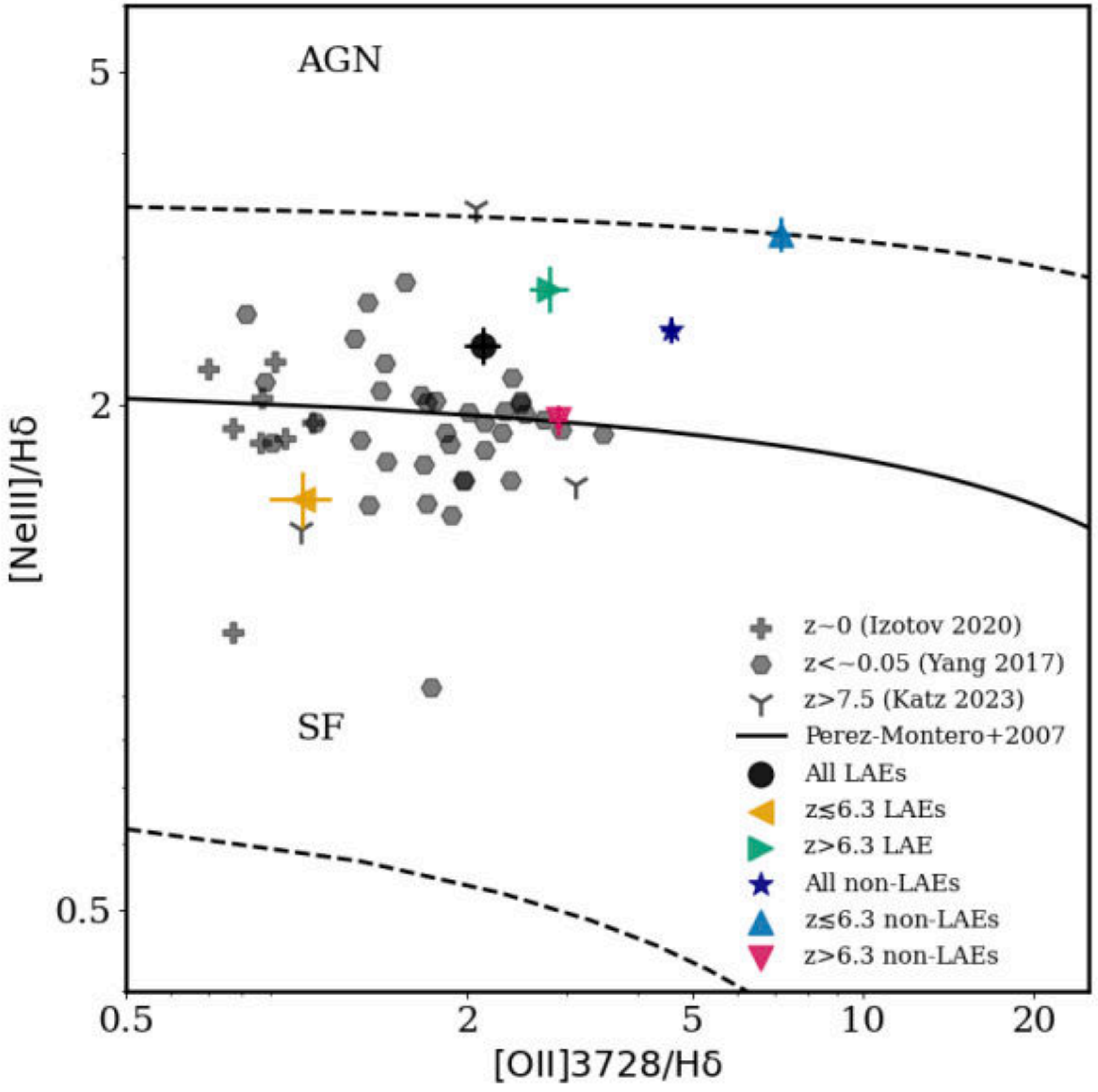
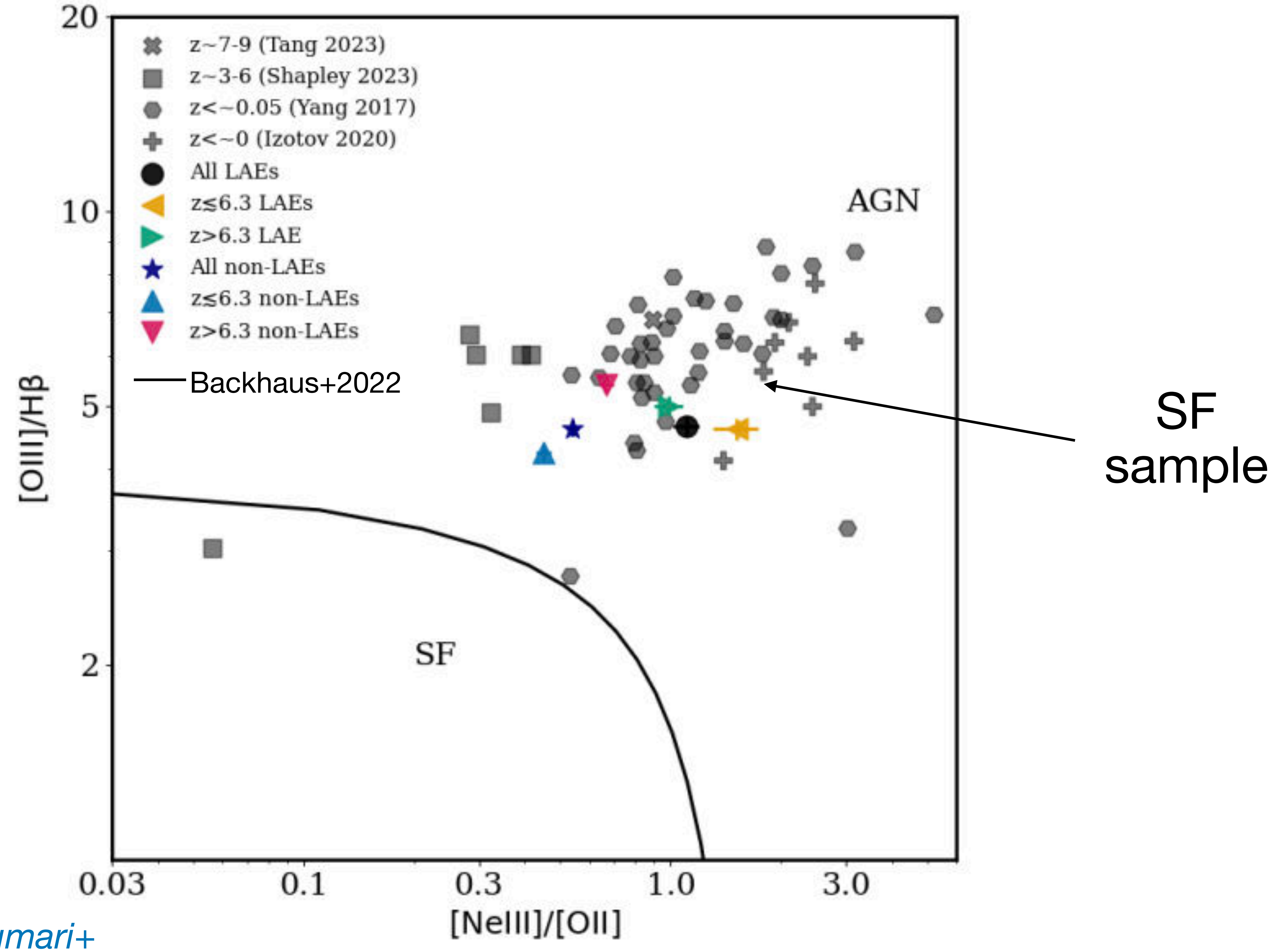
Ionization source: LAEs versus non-LAEs





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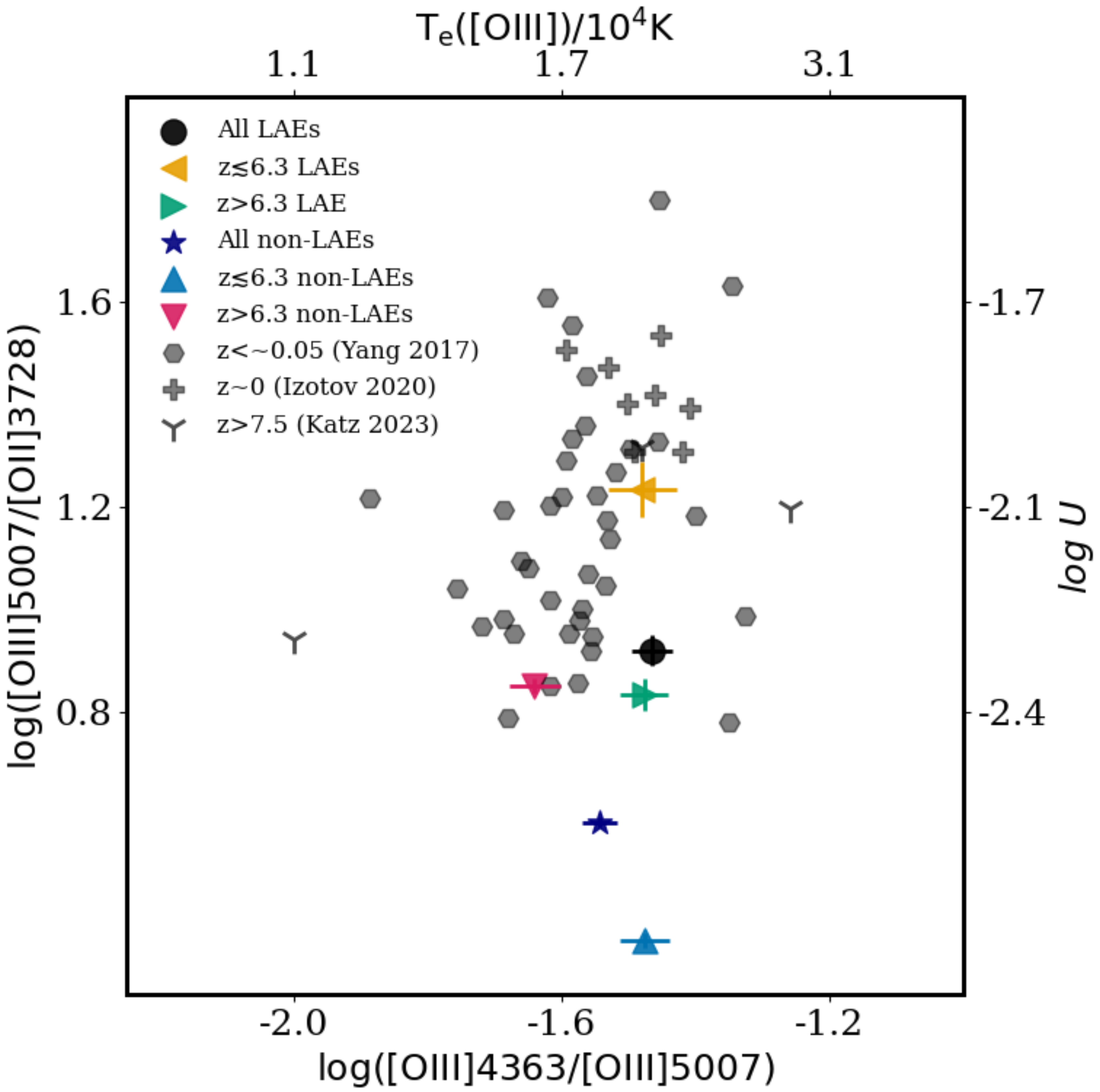
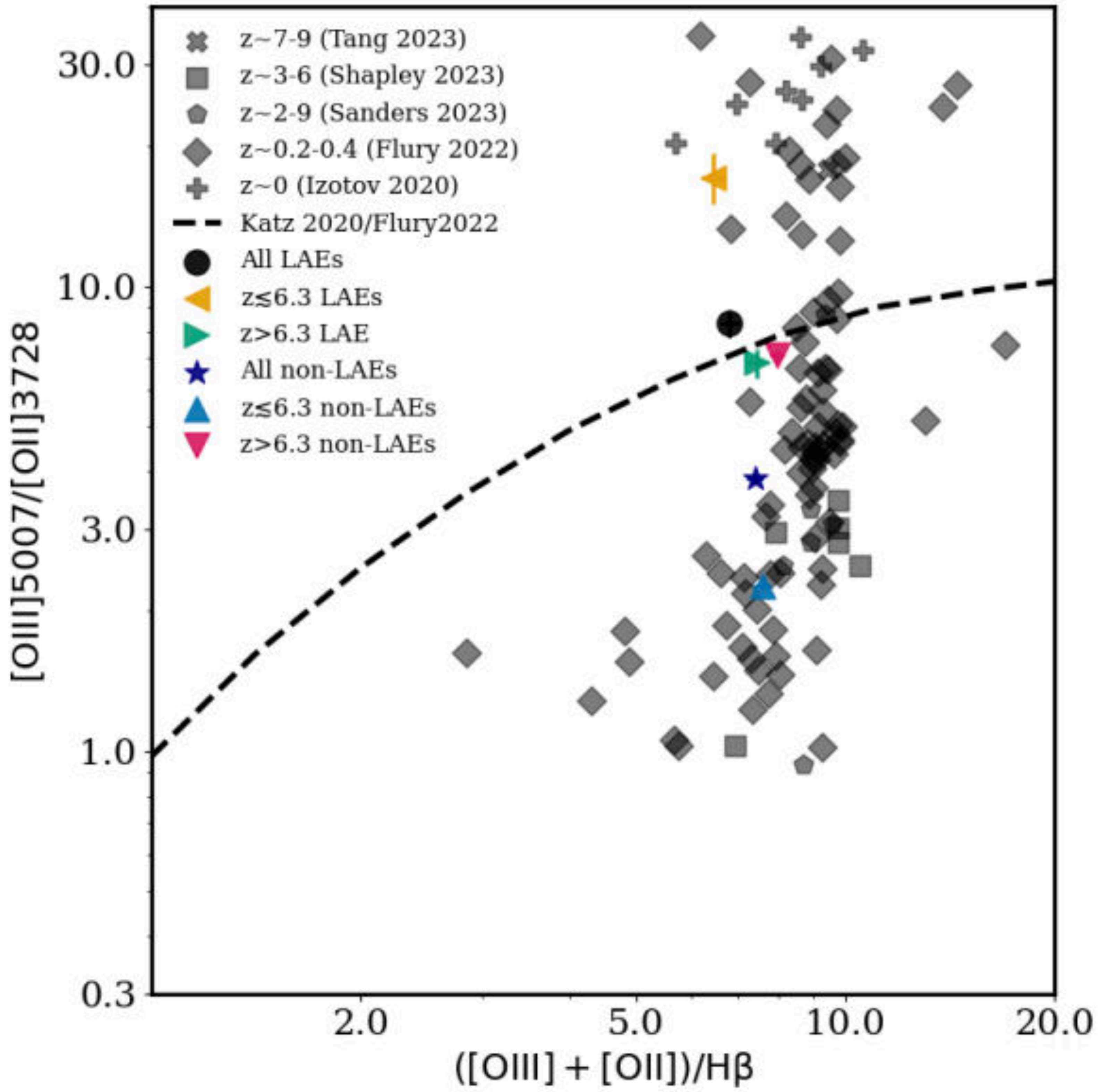
Line ratio diagnostic diagrams not useful!

Ionization conditions: LAEs versus non-LAEs





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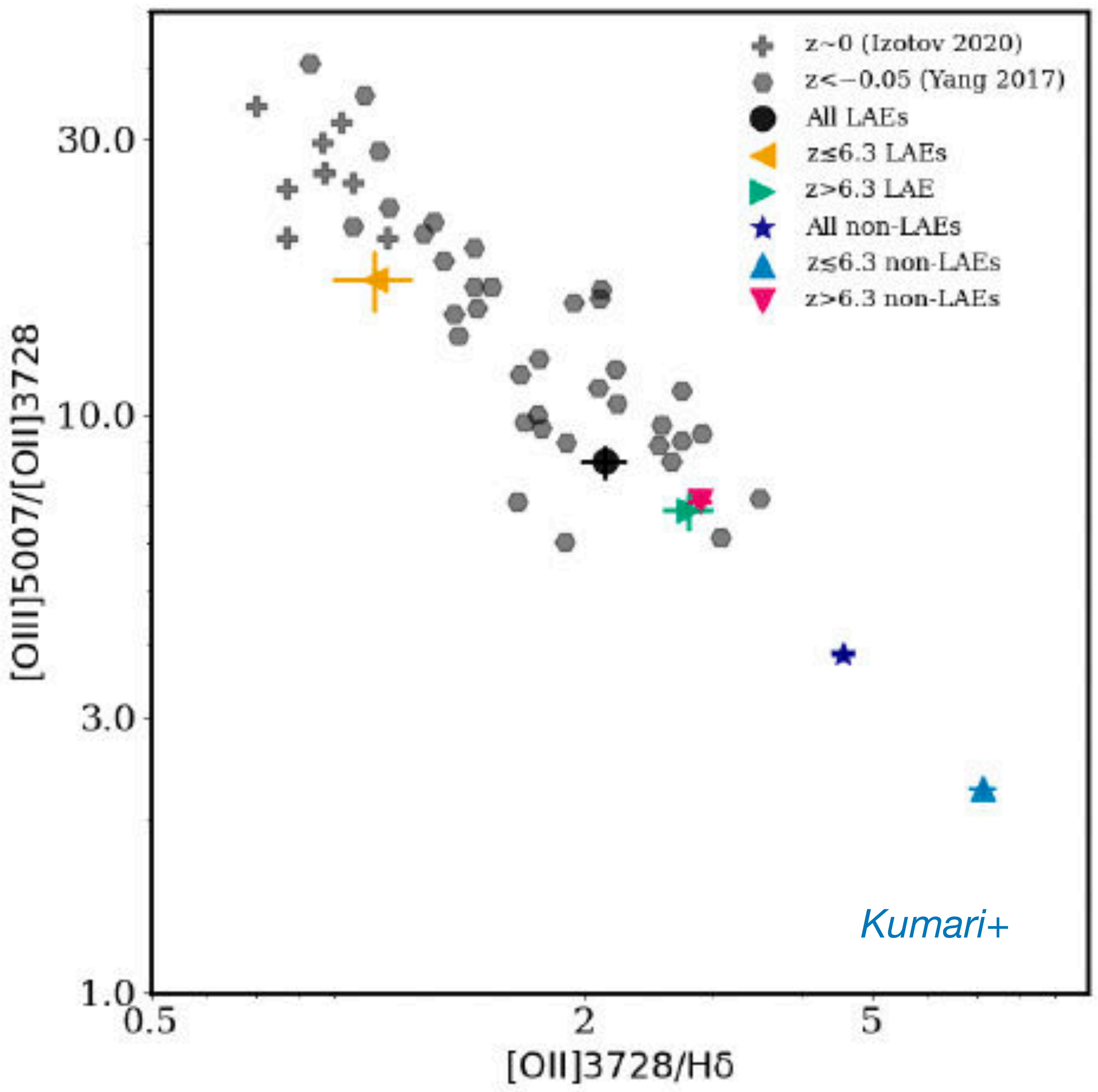
Large variation in log U but comparable Te

Low-metallicity not responsible for high [OIII]/[OII] in LAEs

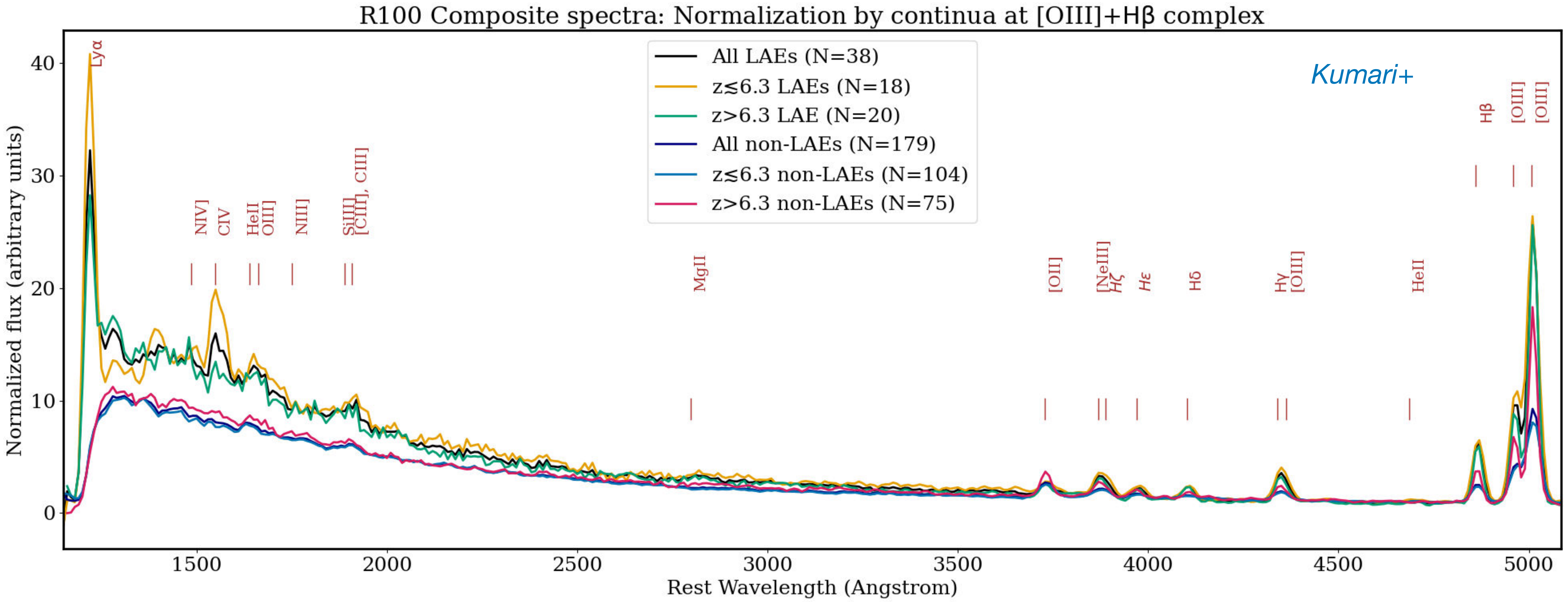
IGM conditions: LAEs versus non-LAEs



LAEs show higher [O III]/[O II] and low [O II]/Hδ at z≲6.3 compared to non-LAEs

But, these line ratios are not sufficient to distinguish the two populations at z>6.3!

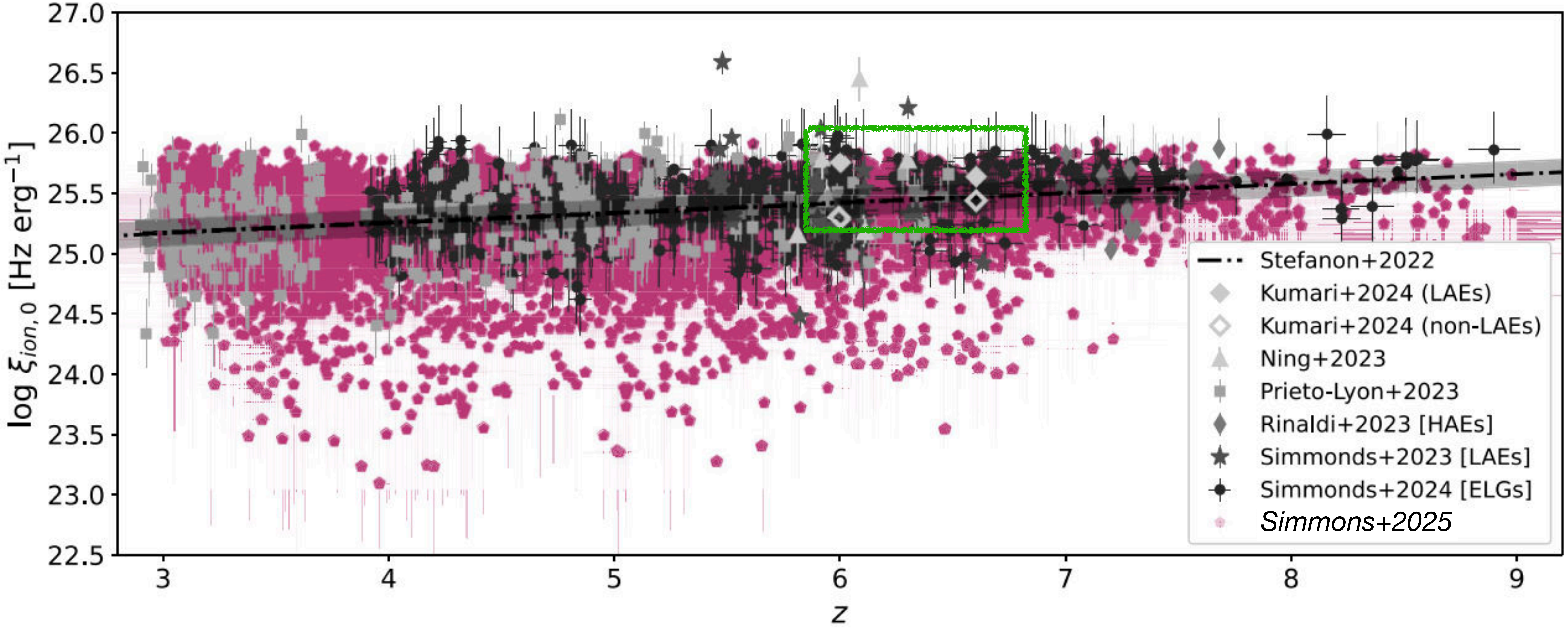
R100 Composites: LAEs versus non-LAEs



Large EW([OIII]4959,5007) for LAEs compared to non-LAEs —> large ionizing photon production efficiency

(Chevallard+2018)

Ionizing photon production efficiency: LAEs versus non-LAEs



log(ξ*ion) for LAE stacks > for non-LAE stacks

log(ξ*ion) LAE samples ~ 25.63-25.75 (Hz erg-1)

Summary

- Stacking analysis on >200 galaxies to study the properties of LAEs & non-LAEs at z~4.8-9.6
- LAEs show much higher [O III]/[O II] and low [O II]/Hδ at z≲6.3 compared to non-LAEs -> possible distinguishing diagnostics for the two populations at z<6.3.
- LAEs samples show large EW([O III]) (>1000˚A) compared to the non-LAEs sample at all redshifts.
- CIV/Lya & CIV/CIII] for LAEs at z<6.3 ~ 5x for LAEs at z>6.3.
- The ionizing radiation for LAEs is hard, as revealed from several diagnostics including CIV detection, high [O III]/[O II](>8), and large values of ξ*ion.

Thanks!