

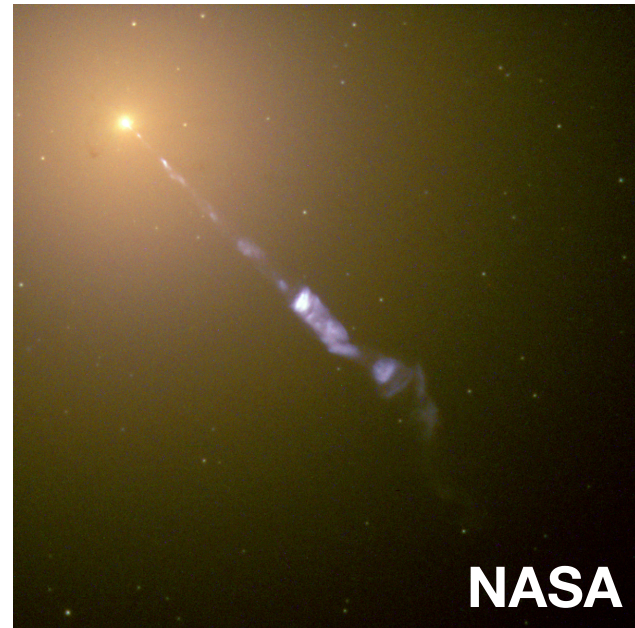
The Nature of the Ionising Spectrum in a Large Sample of $z \sim 3$ LAEs

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Background - What Caused Reionisation?



AGN?



First Galaxies?

Background - Reionisation

- Reionisation is governed by the rate at which ionising photons are produced


$$\dot{n}_{ion} = f_{esc} \cdot \xi_{ion} \cdot \rho_{SFR}$$

Fraction of
escaping LyC
photons

Number of
ionising photons
produced per
unit of star
formation rate

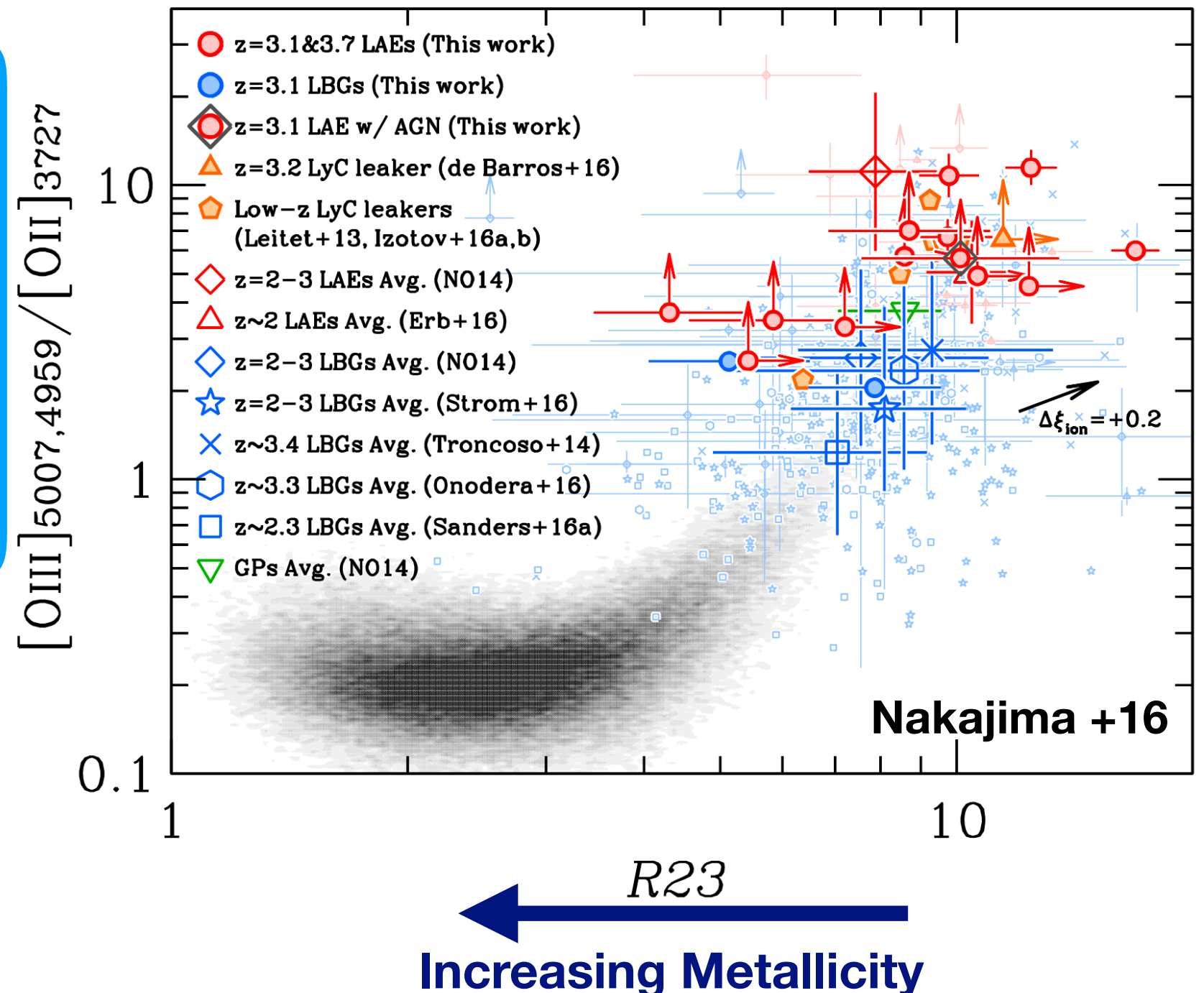
Integrated
volume density
of star forming
galaxies

Background - LAEs as Low-z Analogues

- The spectral hardness (ξ_{ion}) of galaxies during the reionisation era is one of the biggest unknowns

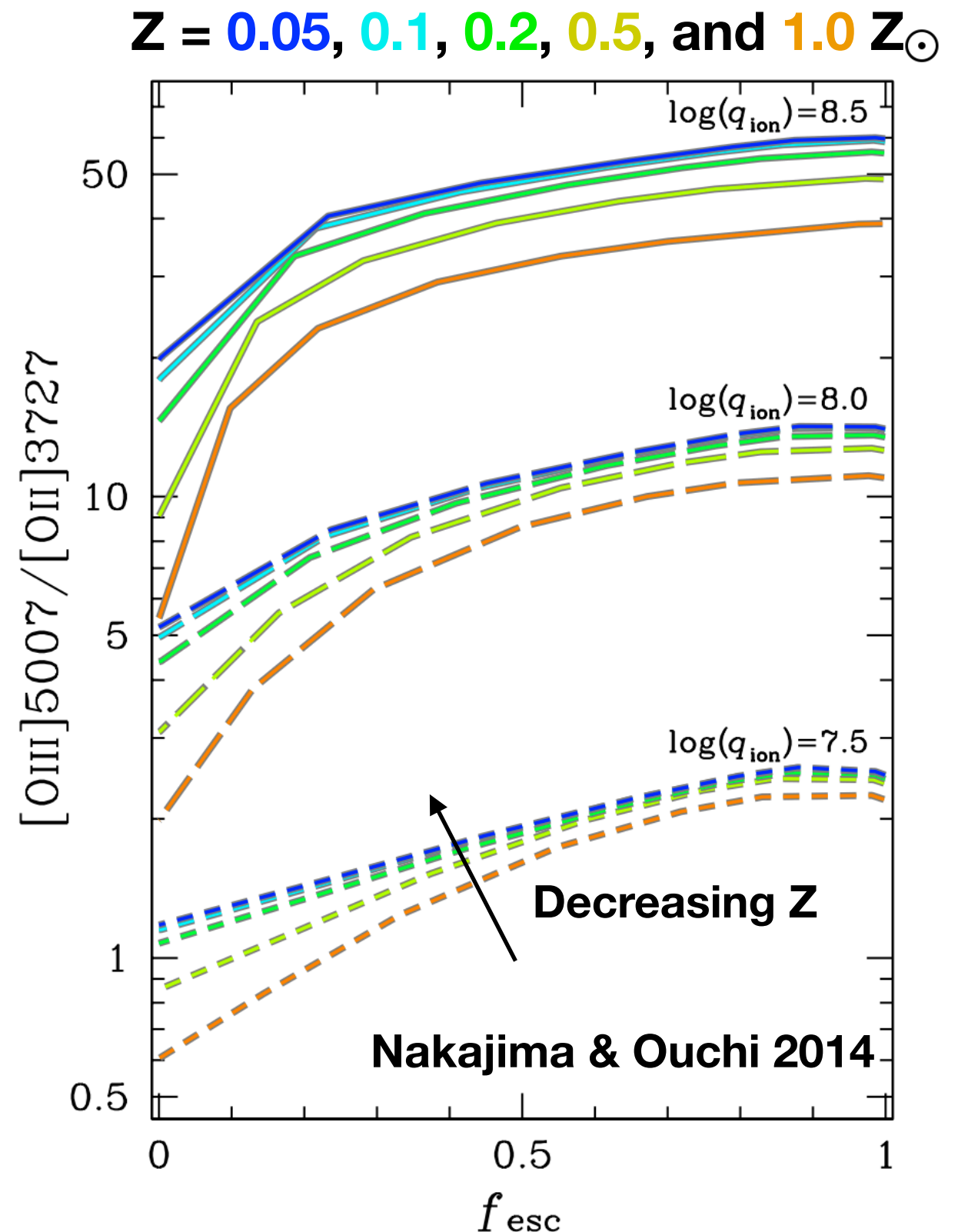
**$z=3.1$ Lyman Alpha
Emitting Galaxies
(LAEs) as
reionisation era
analogues**

- LAEs are low mass,
low metallicity
(dust-free)



Background - LAEs as Low-z Analogues

- [OIII] excesses and presumably ξ_{ion} and f_{esc} increase with redshift (ionised bubbles)
- [OIII] excess seen in LAEs is similar to emission measured in IRAC narrow band excesses at $z > 6$
- Hypothesis: Correlation between large [OIII]/[OII] and spectral hardness and LyC leakage (Nakajima & Ouchi 2014)



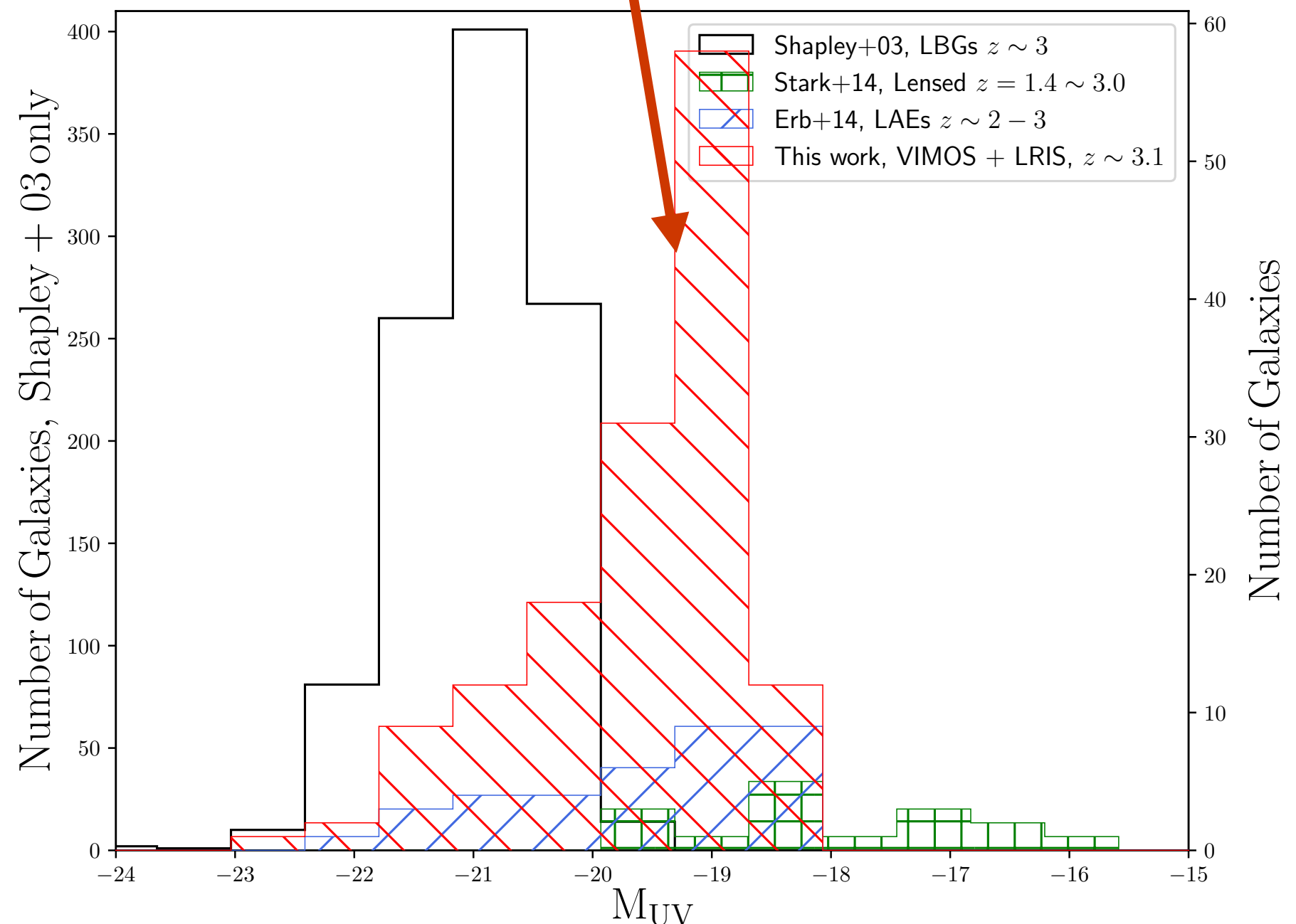
This work - Sample

Very faint sample,
comparable to
Stark+14 but a
much larger
sample

VIMOS: Ly α
detected in 68
LAEs at $z \sim 3$

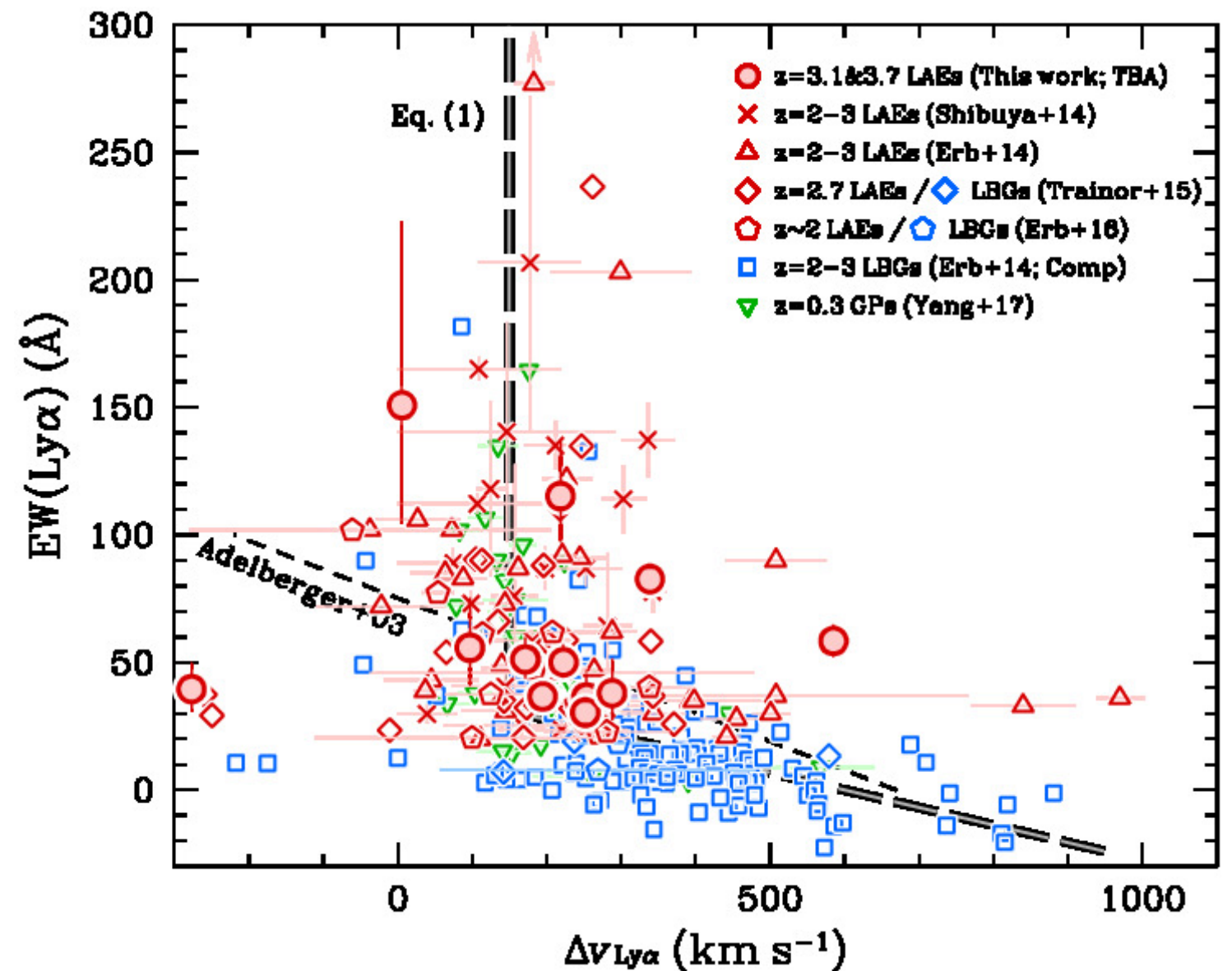
LRIS: Ly α
detected in 40
LAEs at $z \sim 3$

Apparent UV Magnitude: 24.7-28.9



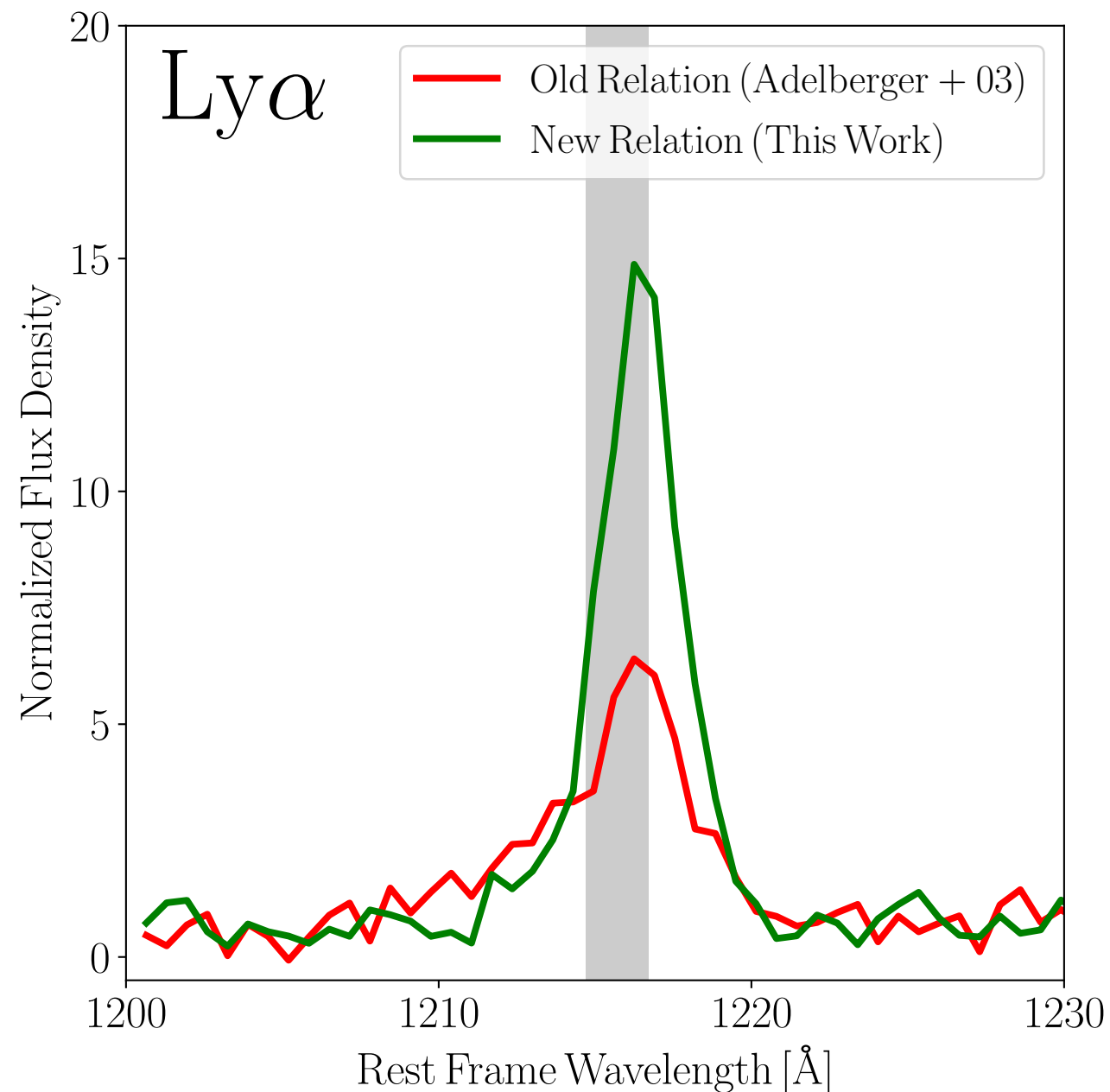
Method - Stacking

- We stack the spectra to measure the mean ξ_{ion} for $z \sim 3$ LAEs
- We need the velocity offset of Lyman alpha emission compared to nebular lines (which we can't see as the UV metal lines are not visible)
- We use $z_{systemic}$ if it is available or estimate $\Delta v_{Ly\alpha}$ using an empirically derived relation between $\Delta v_{Ly\alpha}$ and $EW_{Ly\alpha}$



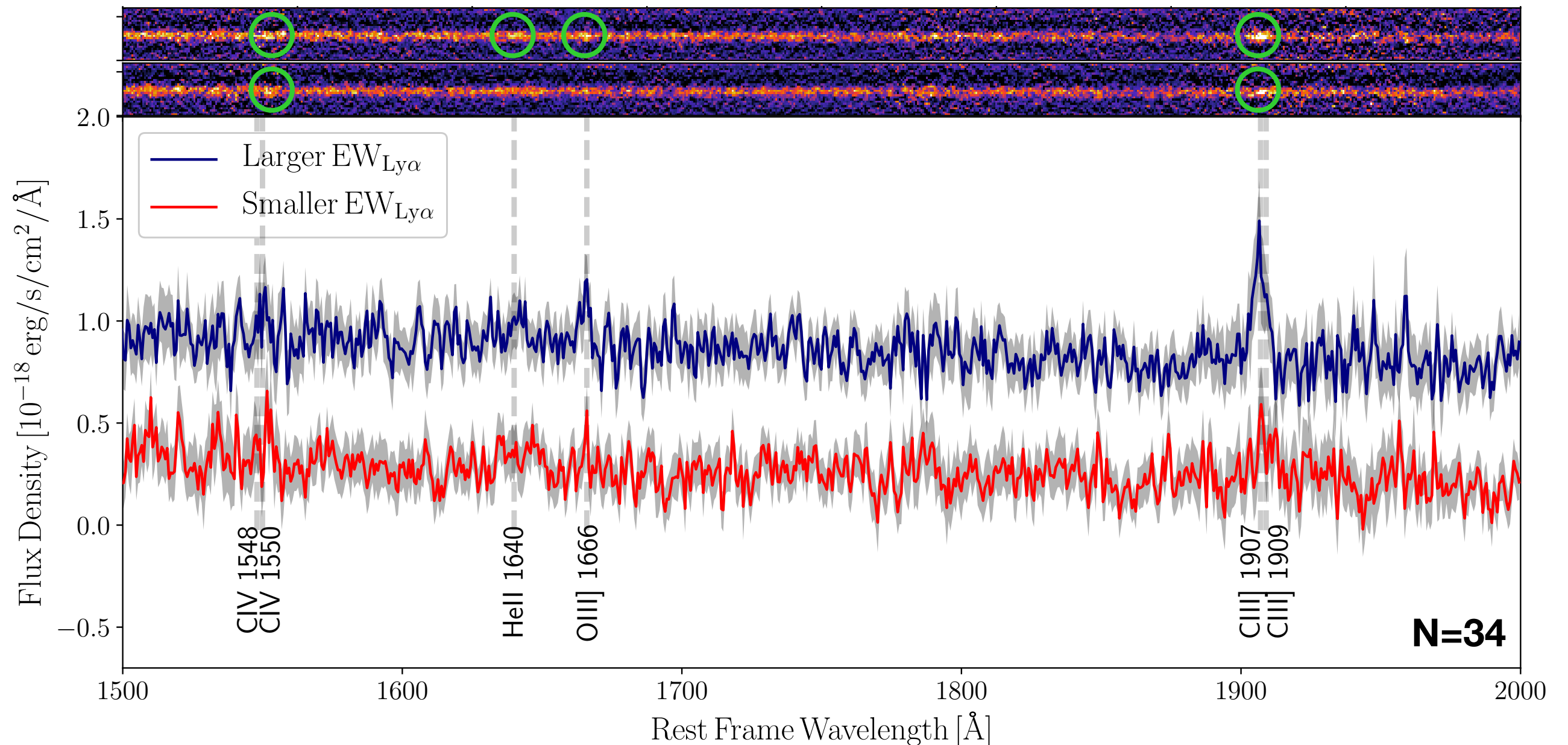
Method - Stacking

- Using this relation improves the sharpness of the peaks compared to previous relations between $\Delta v_{\text{Ly}\alpha}$ and $\text{EW}_{\text{Ly}\alpha}$



Stacked Spectra - VIMOS

- CIII] Detected, Limits on CIV and HeII



Photoionisation models

Preliminary

**BPASS 1Myr
 $\log n_H = 2$**

Large $EW_{Ly\alpha}$

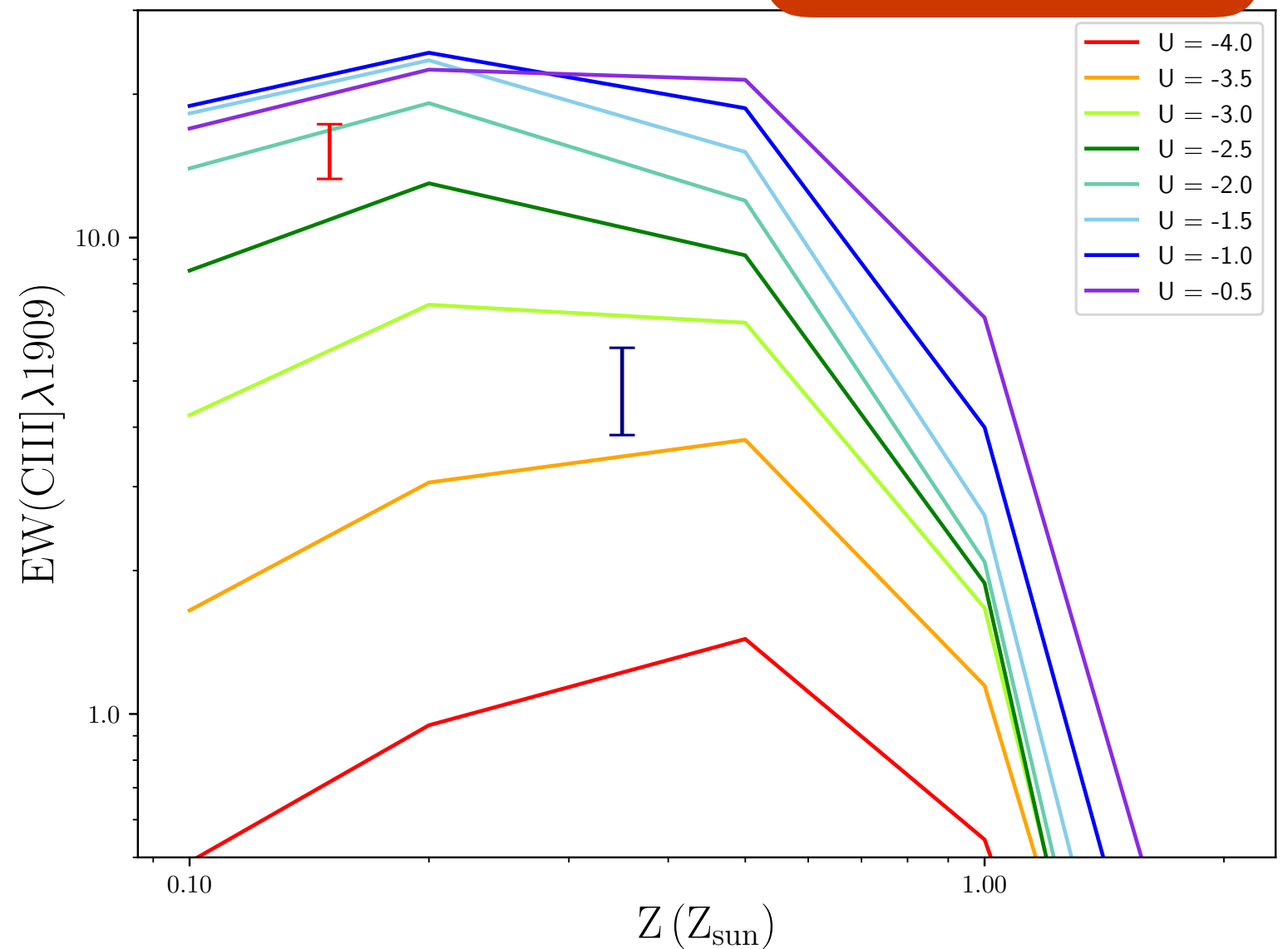
$$\log \xi_{ion} = 25.6 - 25.7 [erg^{-1} Hz]$$

Small $EW_{Ly\alpha}$

$$\log \xi_{ion} = 25.4 - 25.6 [erg^{-1} Hz]$$

Robertson (2013)

$$\log \xi_{ion} = 25.2 [erg^{-1} Hz]$$



**For More, see Nakajima +17
(arXiv:1709.03990)**

Conclusion

- New relation between $EW_{Ly\alpha}$ and $\Delta v_{Ly\alpha}$ improves sharpness of CIII] and Ly α lines
- Spectral hardness increases with $EW_{Ly\alpha}$

Larger $EW_{Ly\alpha}$ $\log \xi_{ion} \sim 25.7$

Smaller $EW_{Ly\alpha}$ $\log \xi_{ion} \sim 25.5$