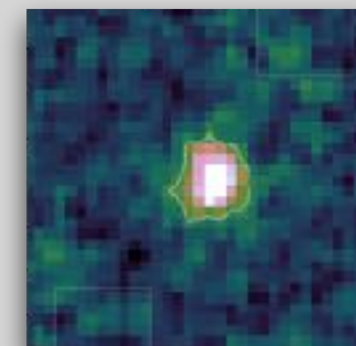
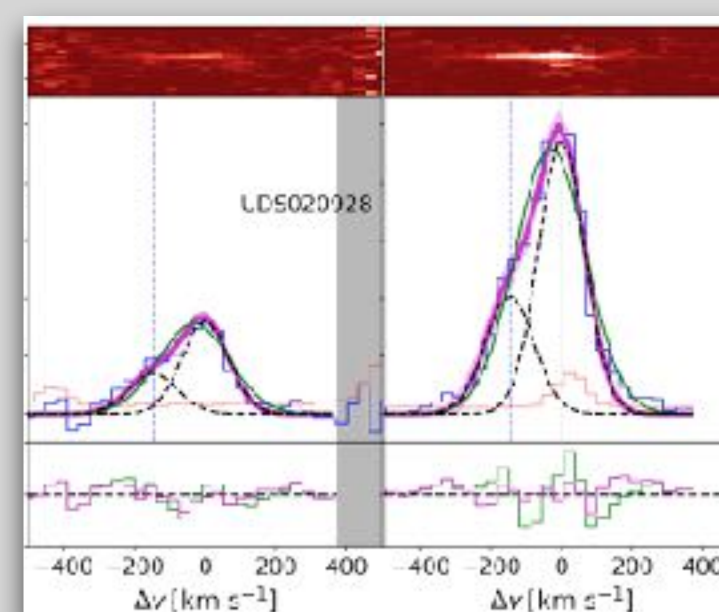
Ionized gas kinematics in UV emission-line galaxies at z~3



Mario Llerena
PhD Student at Universidad de La Serena, Chile

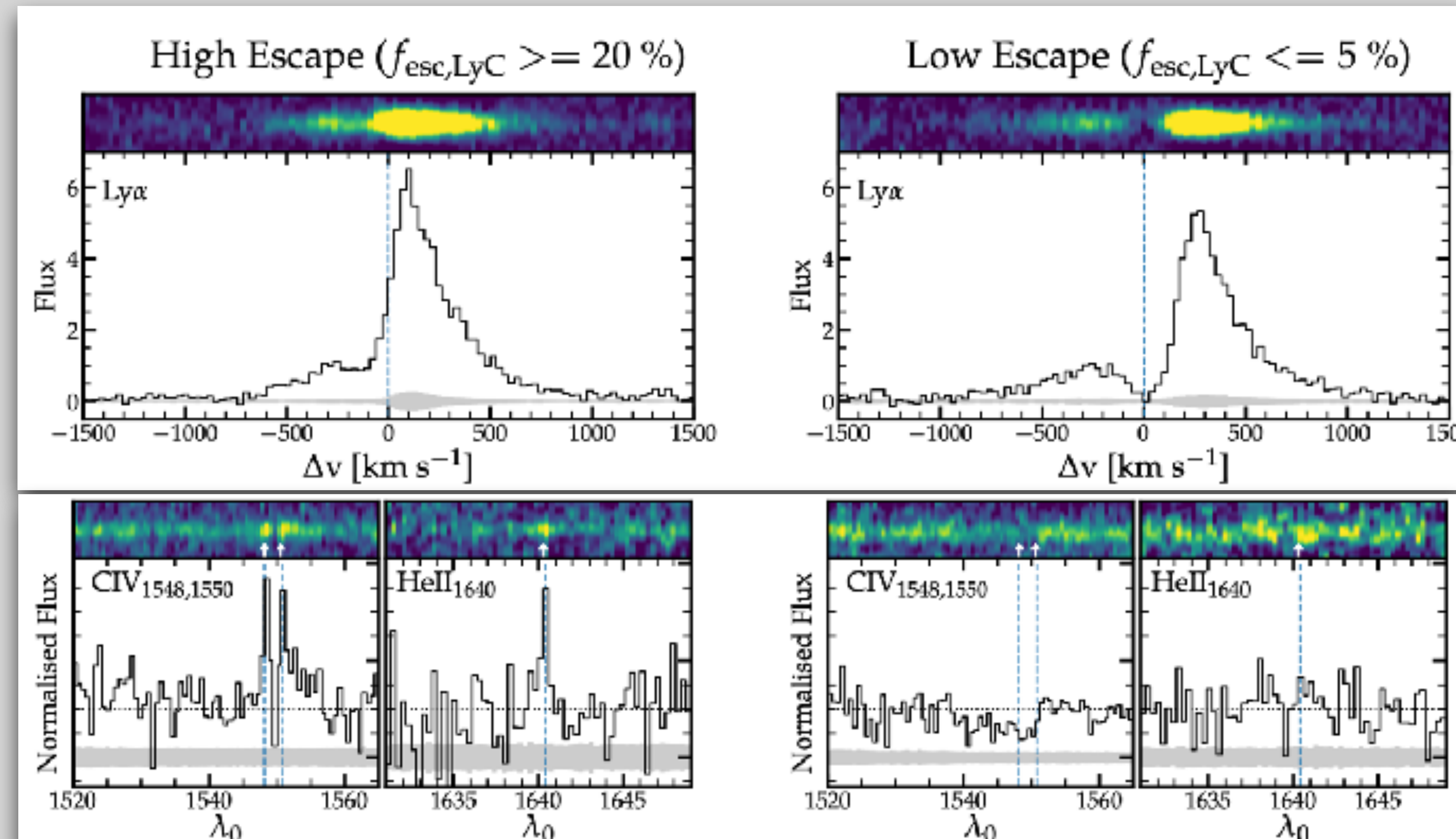
In collaboration with Ricardo Amorín (PhD advisor), Laura Pentericci, Antonelo Calabrò, Fergus Cullen, Alice Shapley + the NIRVANDELS team



From galaxies to cosmology with deep spectroscopic surveys. A tribute to Olivier Le Fèvre.
7 July 2022

Why to study UV emission lines galaxies?

Relation with LyC leakers



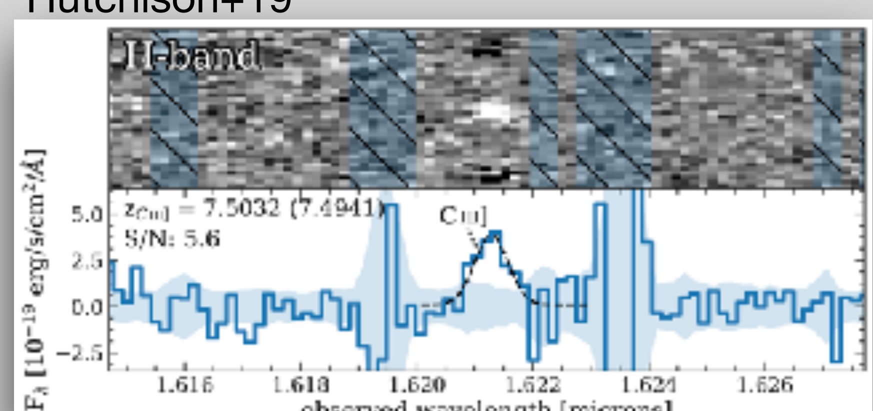
Naidu+2022

Indirect indicators of ionizing photons leakage

Feedback from young stars
Gas disperses and holes are created

Outflows to open channels of escaping

Hutchison+19

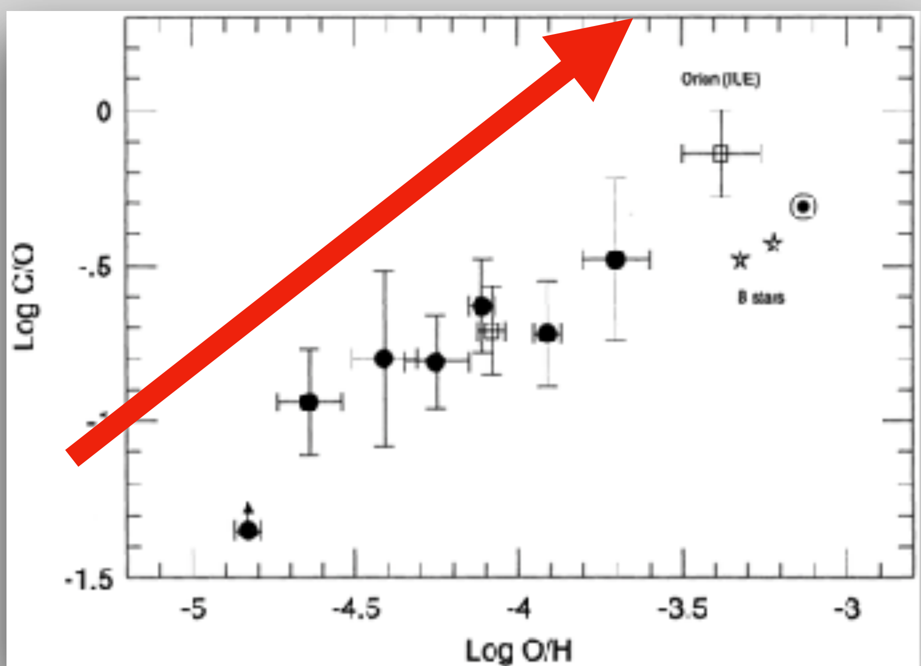


In particular, CIII]1909 emitters

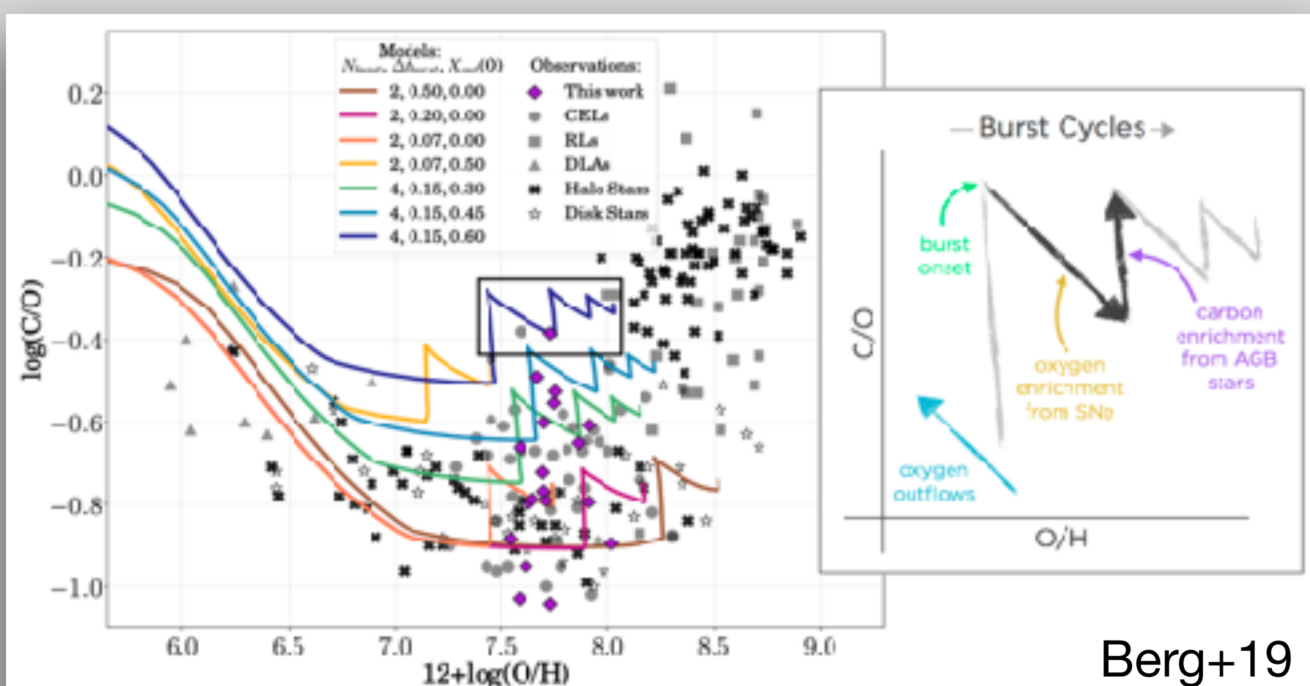
Lya is strongly attenuated in the Epoch of Reionization, which makes CIII] one of the most intense UV lines

C/O abundance as chemical clock

Relative ages



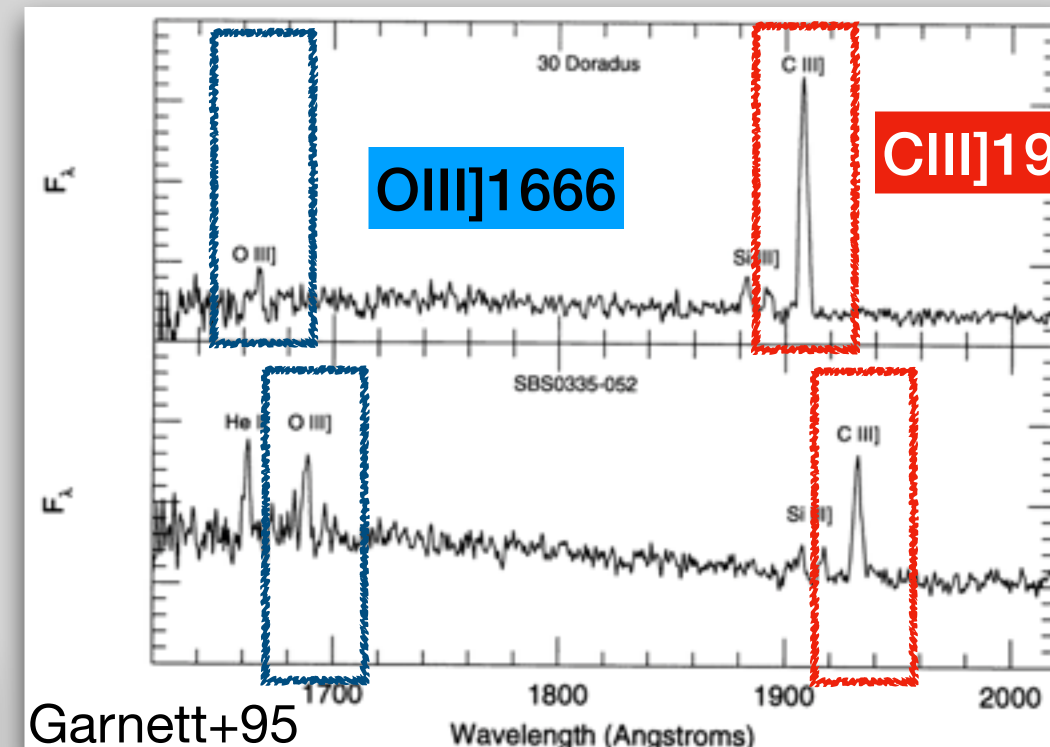
Delayed C released from IMSs or metallicity driven winds of MSs



Berg+19

No intense carbon emission lines in the rest-optical

CII4267 (very faint) has been detected in local HII regions (e.g. Esteban+02)



Garnett+95

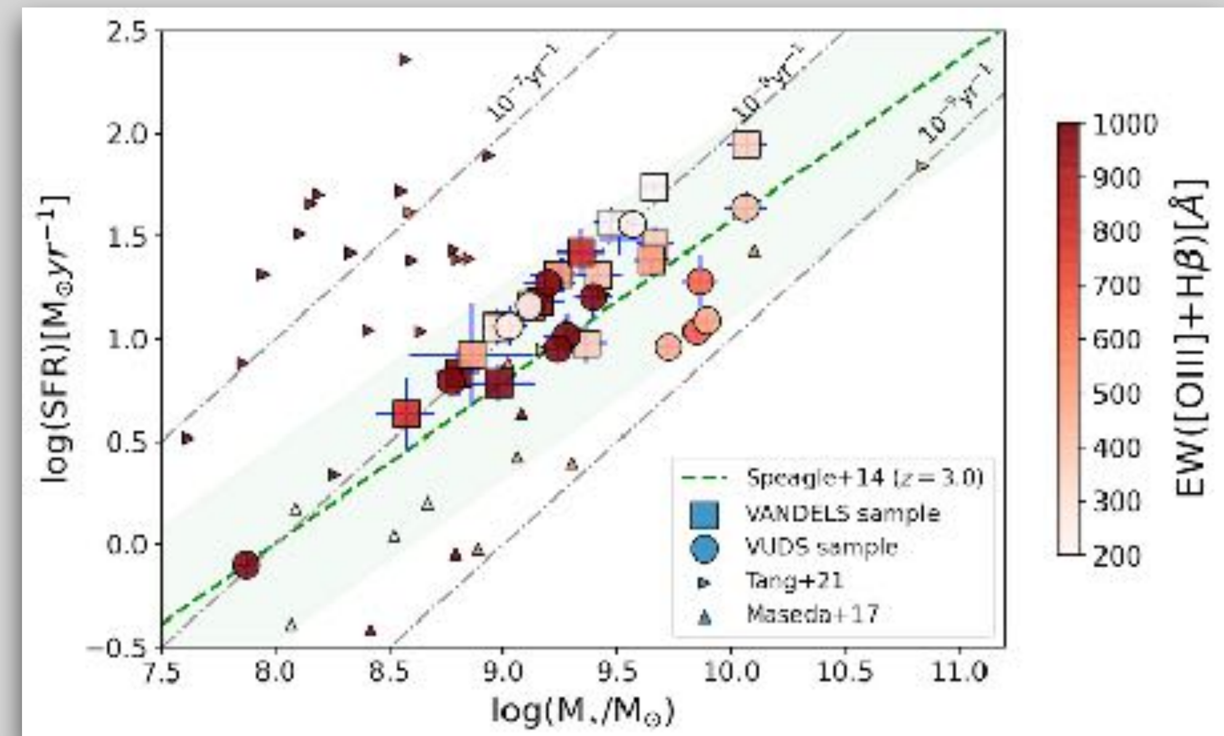
Longer burst duration and lower star formation efficiencies correspond to low C/O ratios.

Local galaxies: CLASSY survey (Berg+21)
Cosmic noon: VUDS, VANDELS

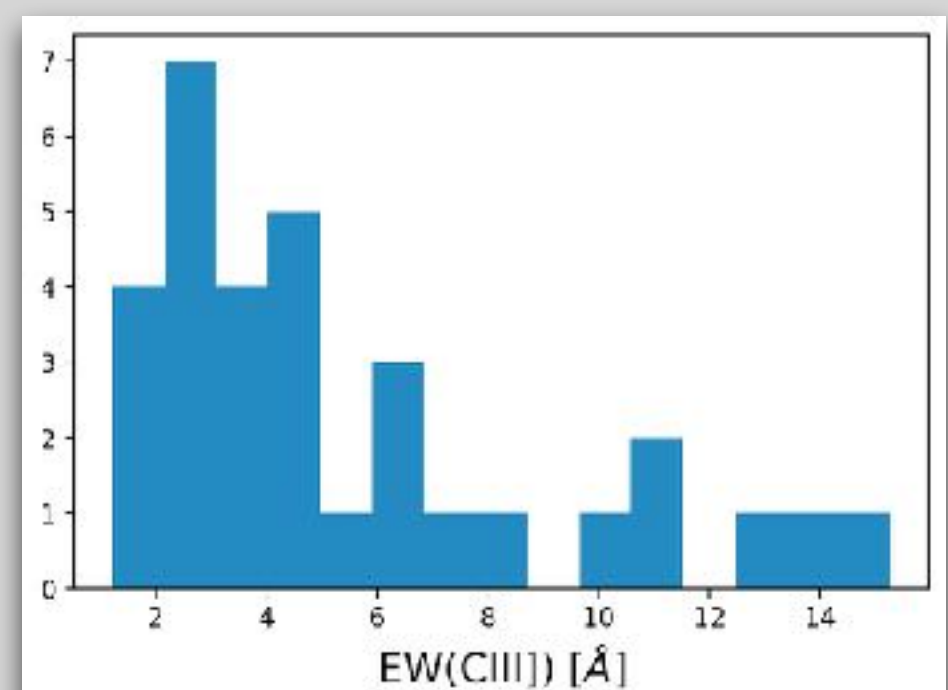
GOAL: Exploring the ionization properties, chemical abundances and ionized gas kinematics of star-forming galaxies at z=2-4 from combined UV-optical diagnostics

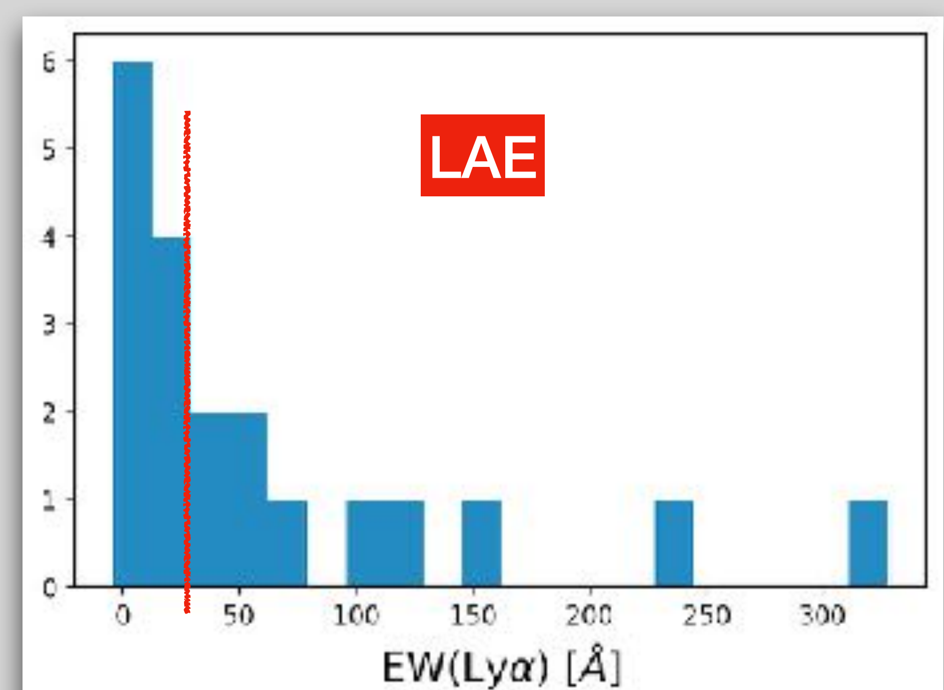
Sample selection

- 17 CIII] emitters at z~3 in the NIRVANDELS survey -MOSFIRE follow-up of VANDELS galaxies (Cullen+21)
- 11 VUDS CIII] emitters at z~3 in the MOSDEF survey (Kriek+15)
- 4 VUDS extreme CIII] emitters (Amorín+17), follow-up with VLT/Xshooter



BAGPIPES SED fitting with nebular component and sub-solar metallicity -> to estimate continuum in rest-optical lines

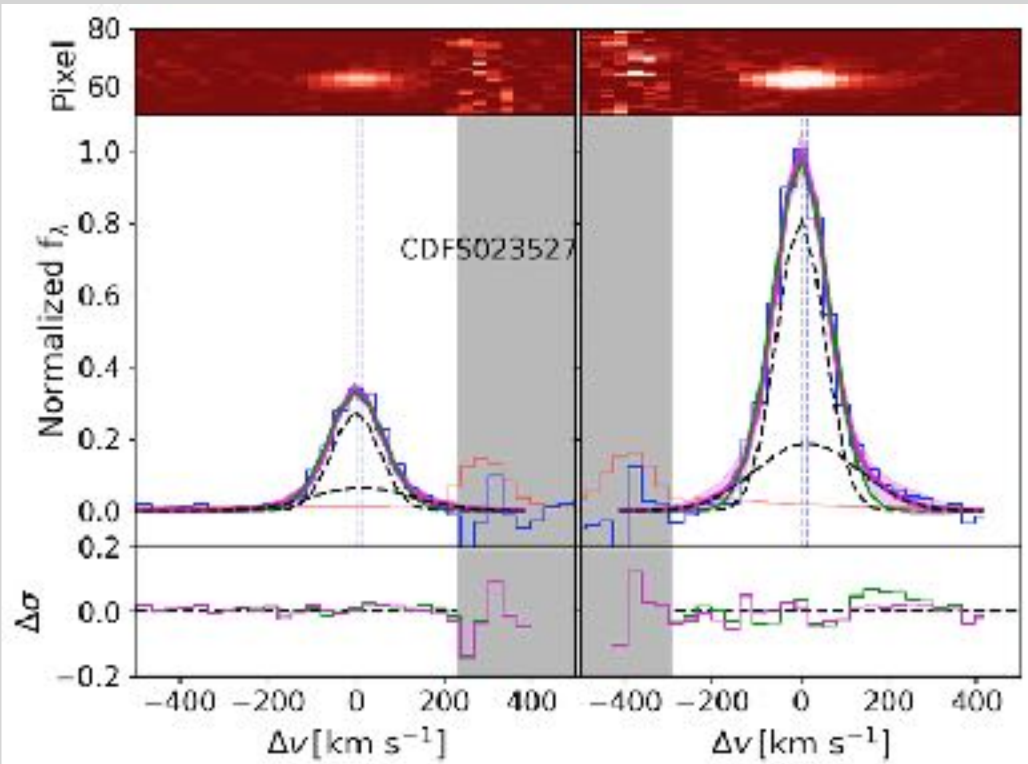




[OIII] kinematics

We use LMFIT with two gaussian with fixed 3:1 ratio and fixed component kinematics

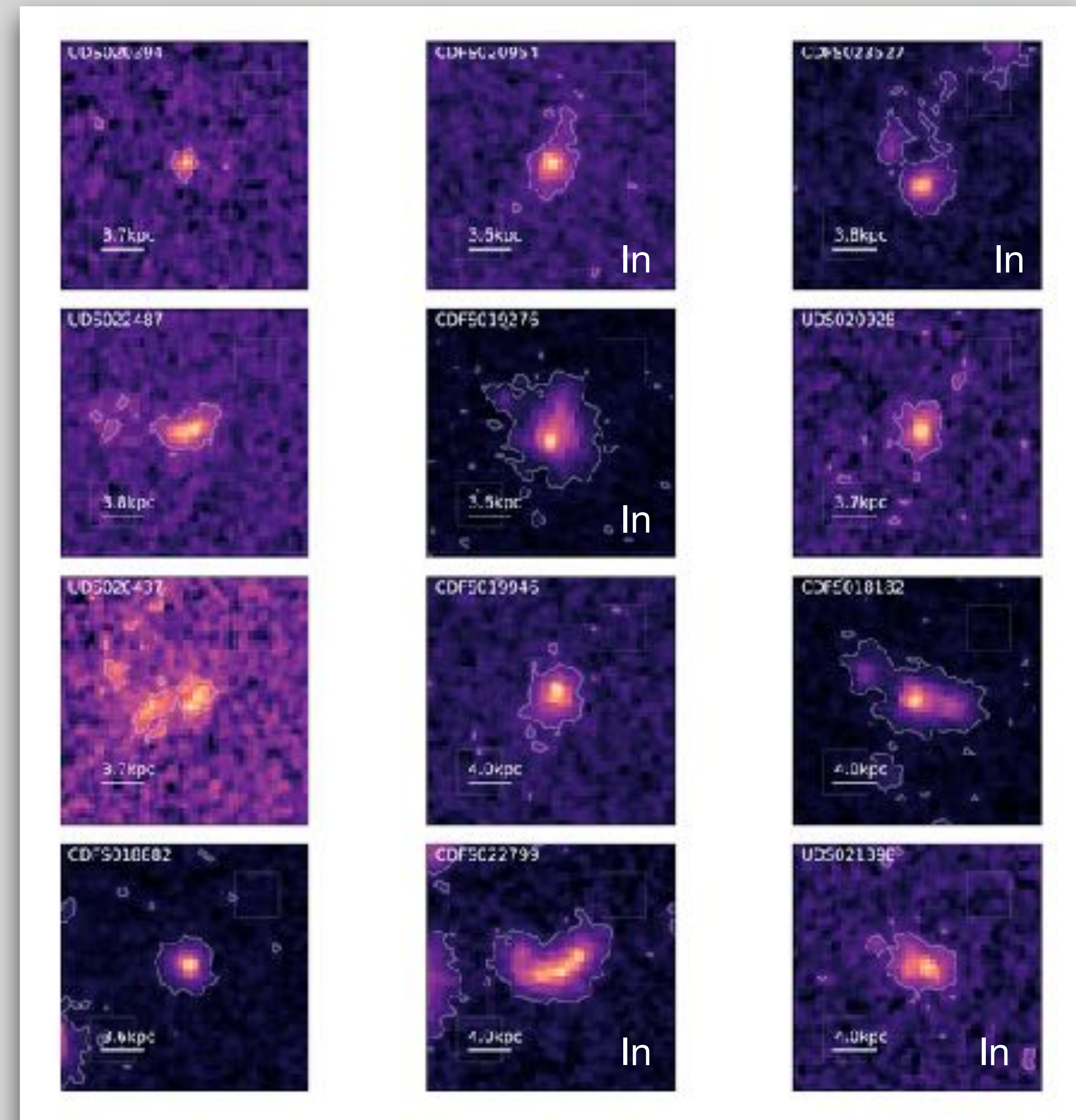
We evaluate the statistical improvement of the model based on variation of Bayesian Information Criterion (Fabozzi+14)

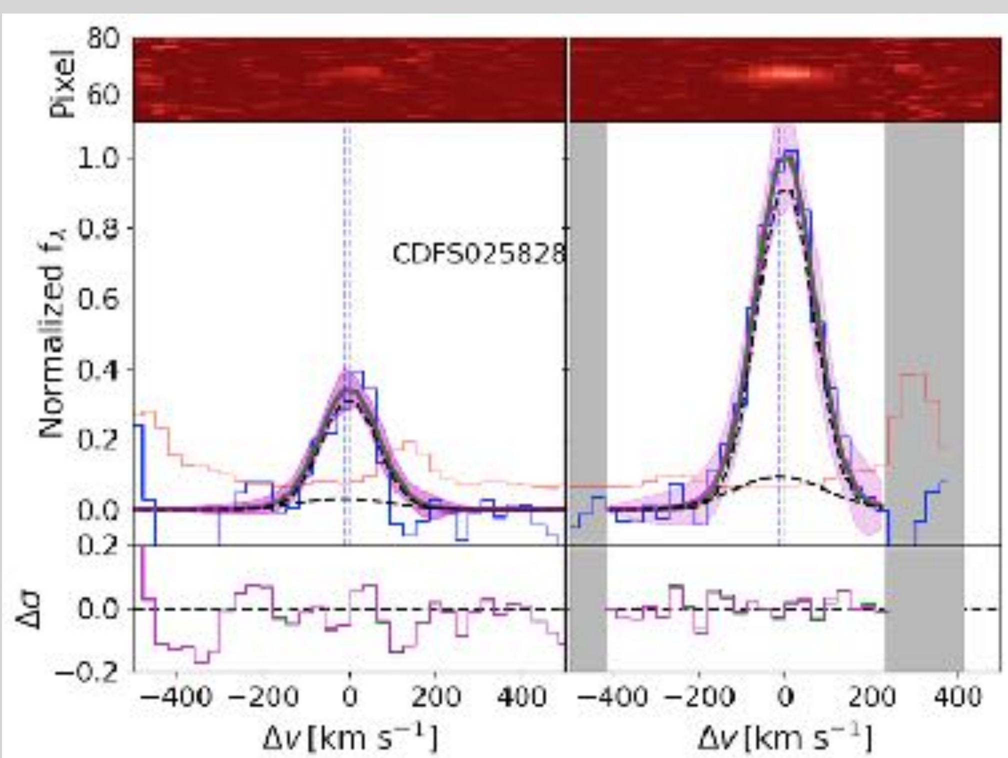


ΔBIC>2 in 24 galaxies. Improved with 2 gaussians

Typical FWHM narrow: ~110km/s

Typical FWHM broad: ~ 250km/s



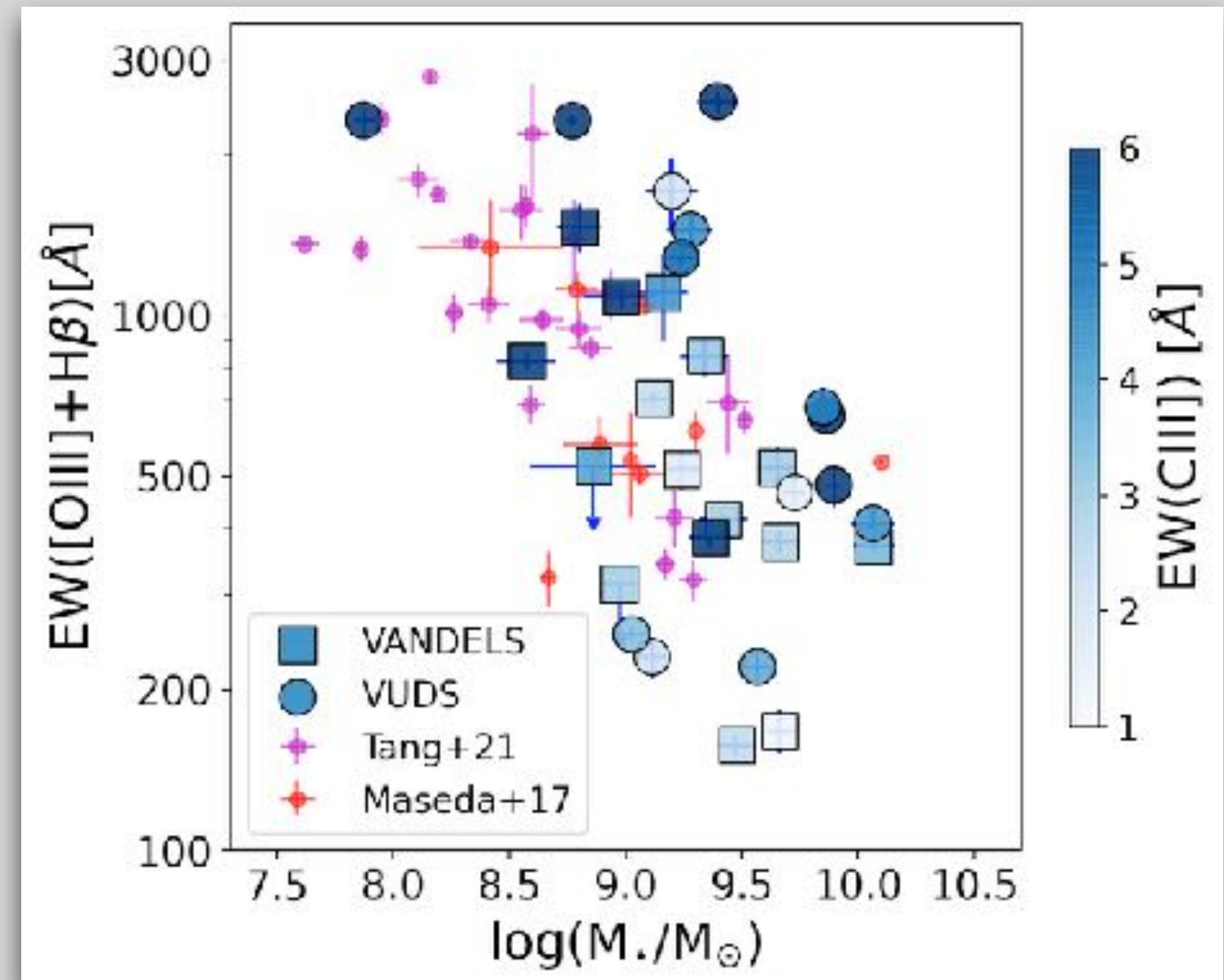


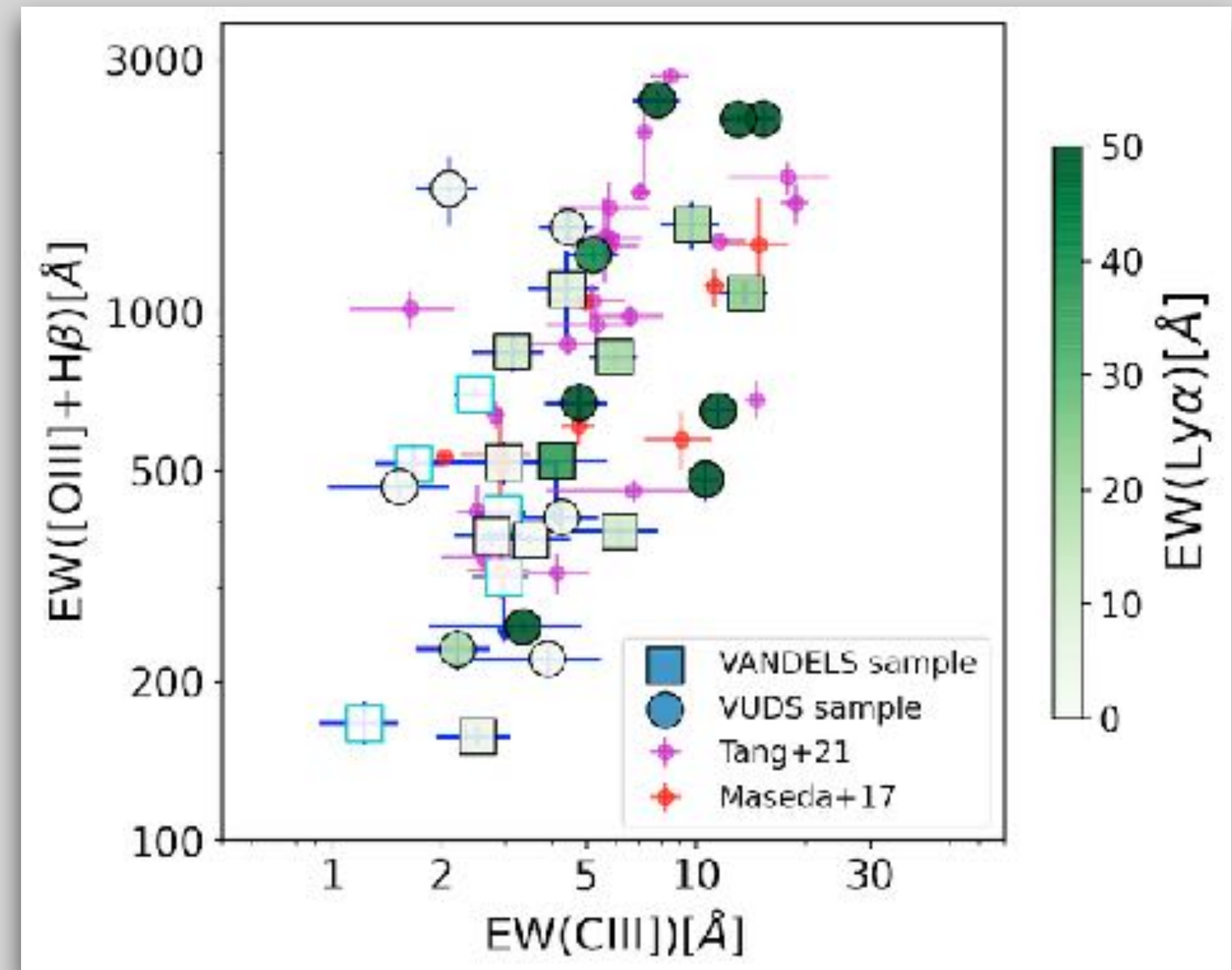
ΔBIC<2 in 8 galaxies. Only one gaussian

HST H-band

Consistent (mostly) with Calabrò+22 (submitted) with kinematics with absorption lines

Global scale relations

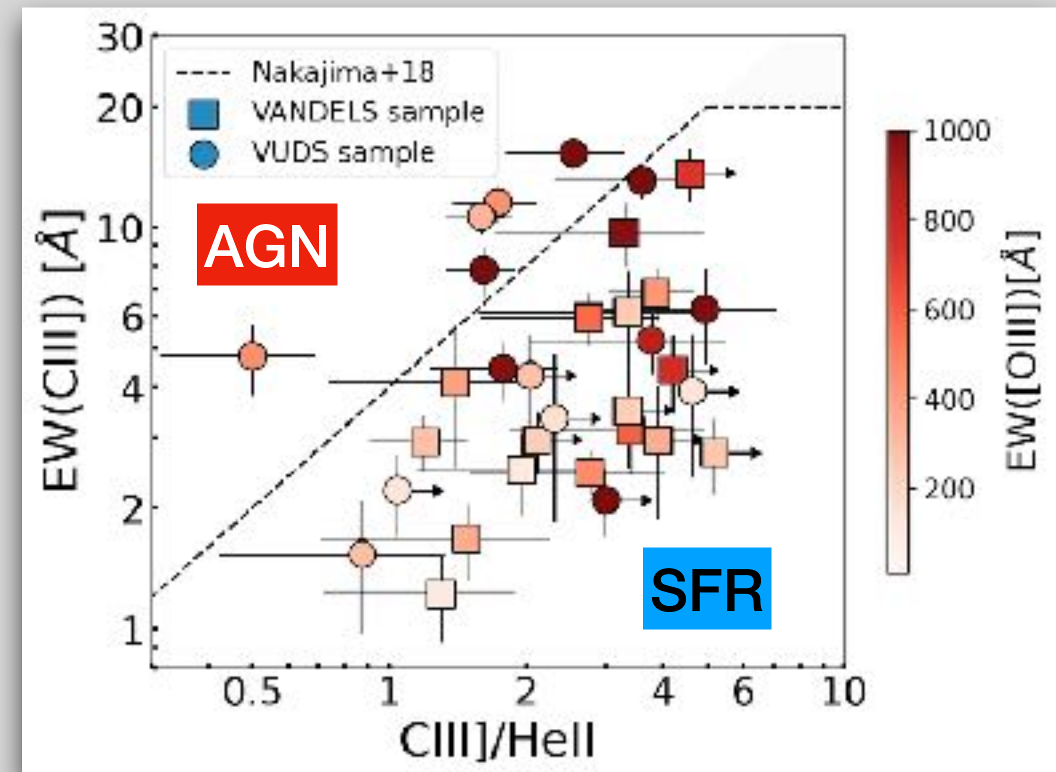




Low-mass galaxies tend to have higher EW(OIII+Hb) and EW(CIII])

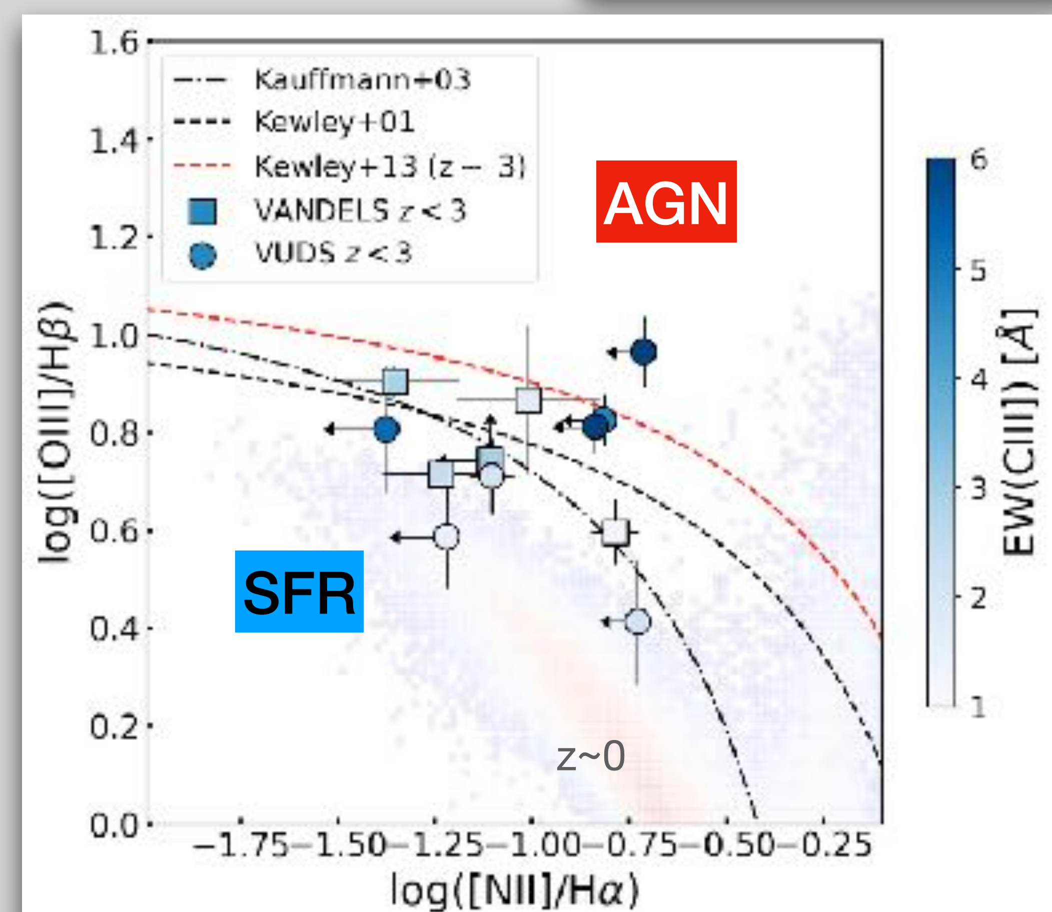
Large scatter and short dynamic range

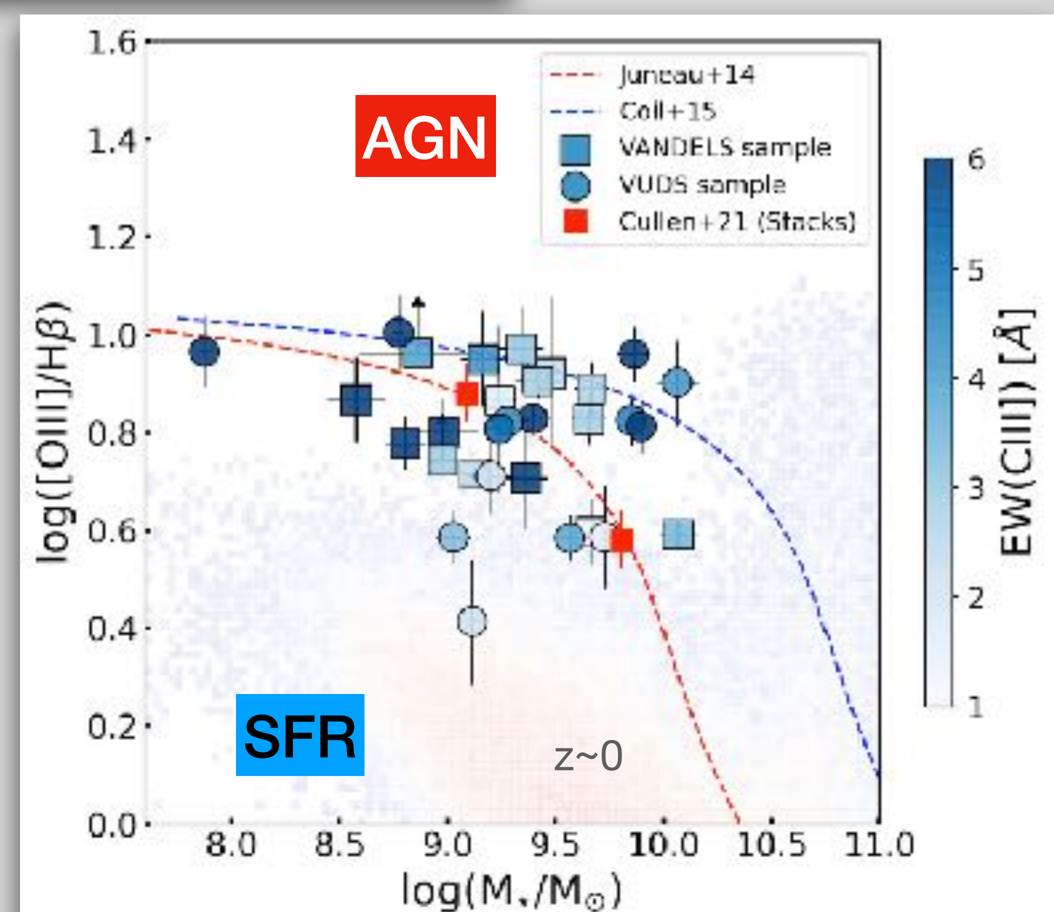
Ionizing source



Global (narrow+broad) fluxes

Consistent with being powered by massive stars

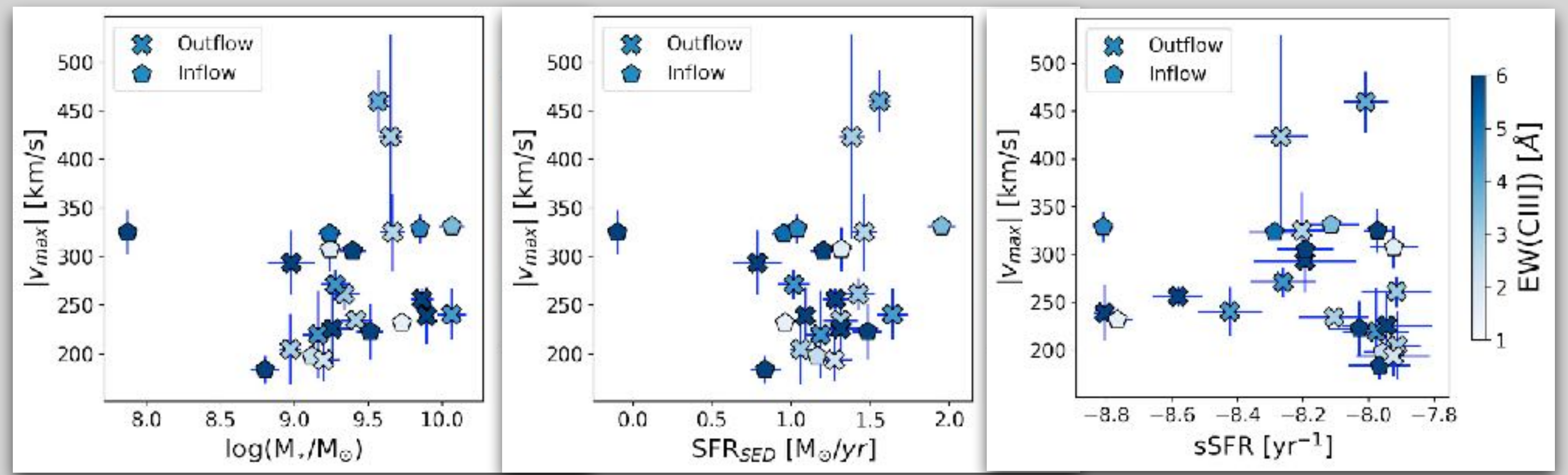




Maximum velocity of the flow

$$v_{out} = \Delta v - 2 \times \sigma_B$$

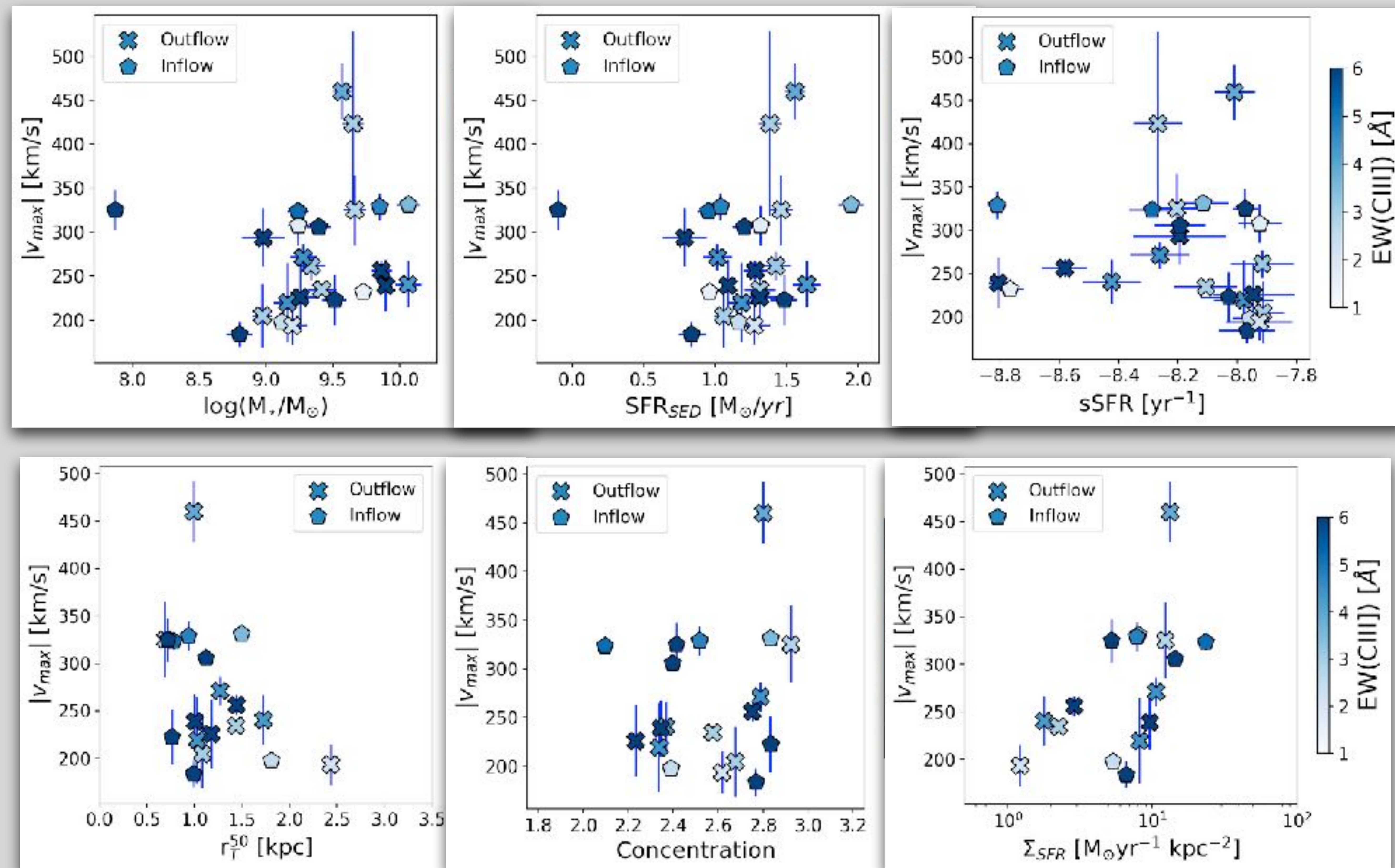
Following Concas+22



Maximum velocity of the flow

$$v_{out} = \Delta v - 2 \times \sigma_B$$

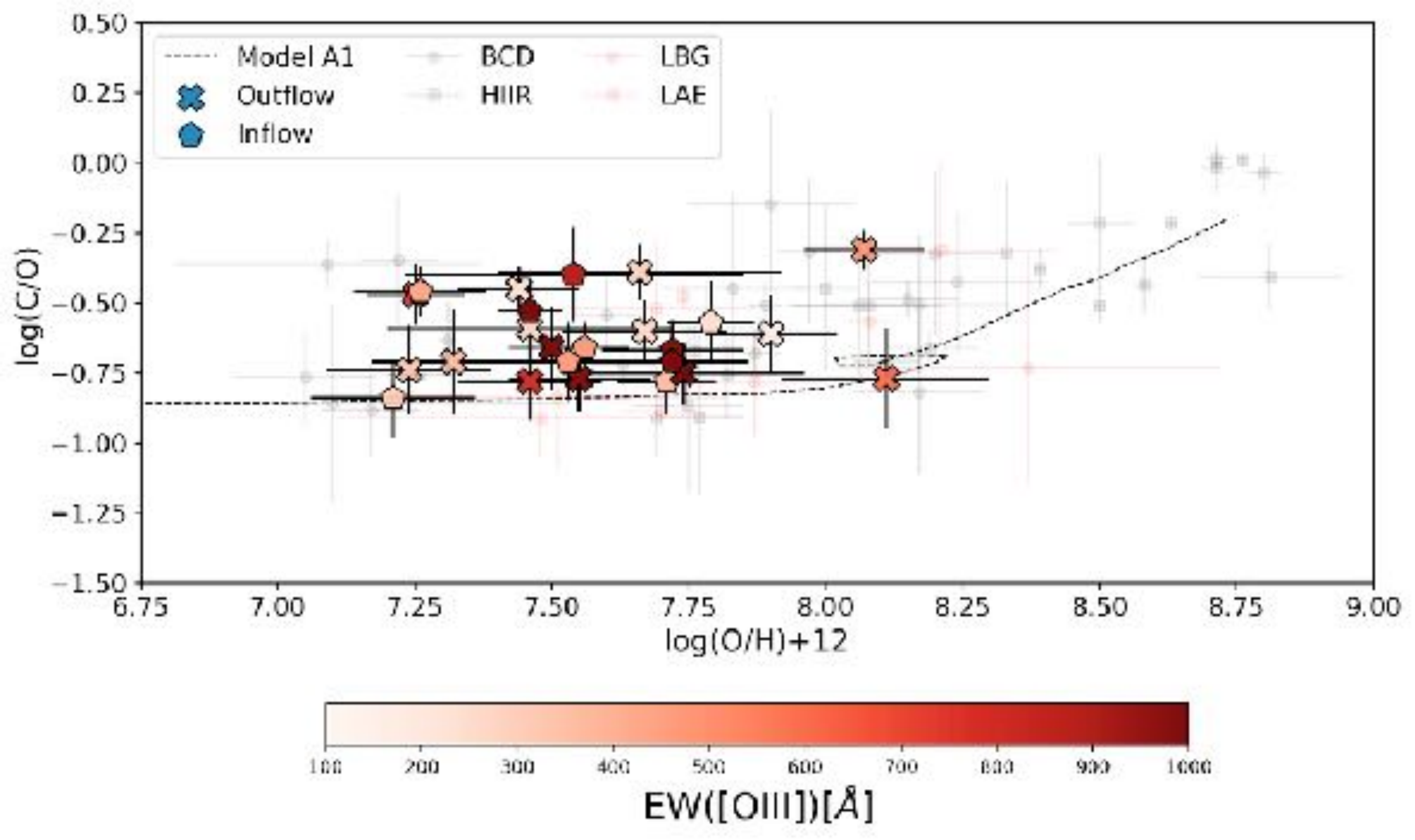
Following Concas+22



Ribeiro+16, Calabrò+22(submitted)

Chemical abundances

HCm-UV (Perez-Montero+17): Including CIII], OIII]1666, [OIII]5007, Hb



O32-calibration (Bian+18): offset up to 0.8 dex

Also observed in CLASSY (z~0) galaxies (Mingozzi+22, submitted)

If compared with pure UV calibrations (Byler+20), Δ~-0.12 dex

Mass loading factor

$$\eta = \dot{M}_{out}/SFR$$

Following Concas+22

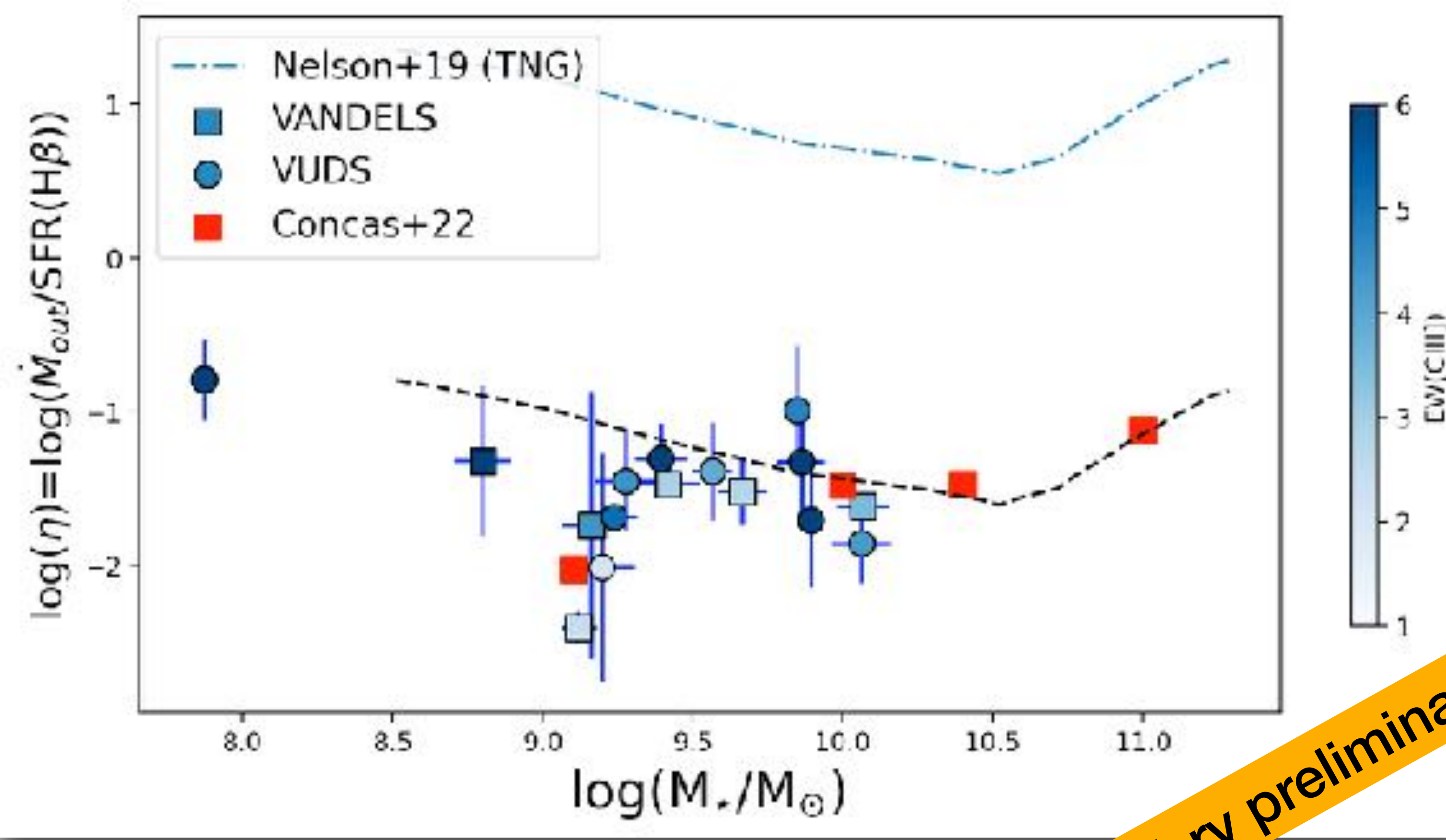
$$\dot{M}_{\rm out} = C\,\frac{\rm M_{out}\,v_{out}}{\rm R_{out}} = \\ = 1.02\times10^{-9}\left(\frac{v_{\rm out}}{\rm km\,s^{-1}}\right)\left(\frac{\rm M_{out}}{\rm M\odot}\right)\left(\frac{\rm kpc}{\rm R_{out}}\right) C\,{\rm M_\odot}\,yr^{-1}$$

Vout: ~250km/s

Sizes ~2.2kpc

$$\rm M_{out}^{[OIII]} = 5.33\times10^{4}\left(\frac{L_{B}^{[OIII]}}{10^{40}\,erg\,s^{-1}}\right)\left(\frac{100\,cm^{-3}}{n_e}\right)\frac{1}{10^{[O/H]}}M_\odot$$

Electron density: 100-1000 cm^-3 (from [OII]3727)



Very preliminar

Outflows may be more important in low mass galaxies with low metallicities and hard radiation fields

Things to be checked and improved

-Dust reddening: No Ha for z>3 targets

-Stacking to increase S/N

Suggestions are welcome!

Summary

-We find evidence of [OIII] broad component in 75% of the sample

-We do not find clear relations of flow velocity with stellar mass, SFR, morphology

-We do find insights of dependence of flow velocity with SFR surface density (and size in I-band tracing UV rest-frame)

-They show low gas-phase metallicities with some cases with slightly high C/O, suggesting flow maybe reducing metallicity.

-Outflows may be more important in low mass galaxies with low metallicities and hard radiation fields

Thanks!