MUSE+WFC3 STUDIES OF CIII] EMITTERS

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Leiden Observatory

(A&A accepted; part of forthcoming MUSE UDF Paper Series)

Sterrewacht Leiden

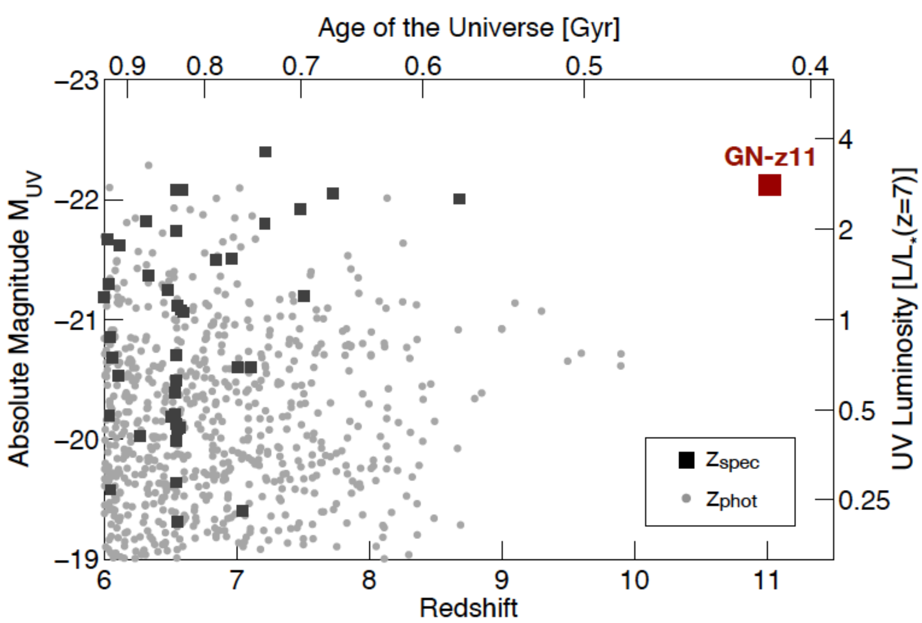
muse

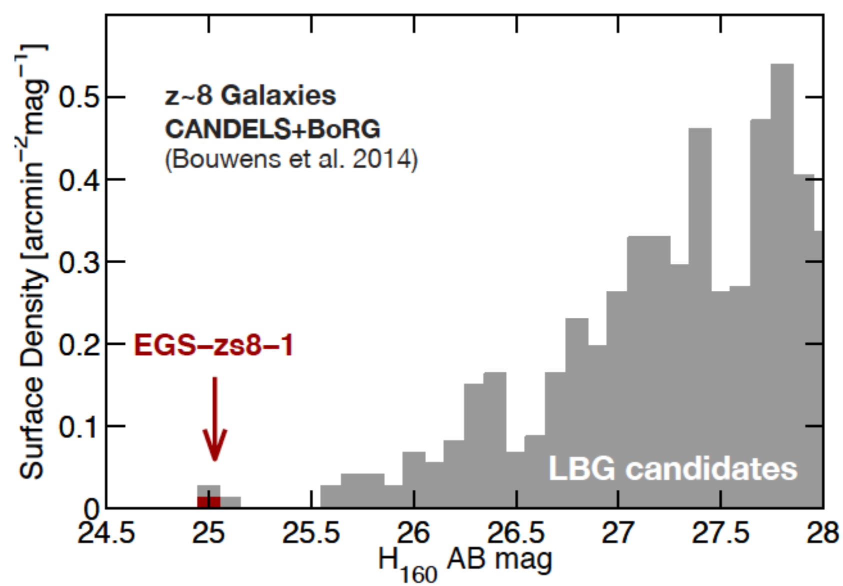
multi unit spectroscopic explorer

AIP CRA Lyon ESO ETH Institut für Astrophysik Göttingen irap NOVA

The current state of high-z spectroscopy

- Hundreds of photometric candidates at z > 5 from CANDELS, HUDF, BoRG, etc.
- But relatively few spectroscopic confirmations from Ly-α or continuum breaks (a few 10s in MUSE)

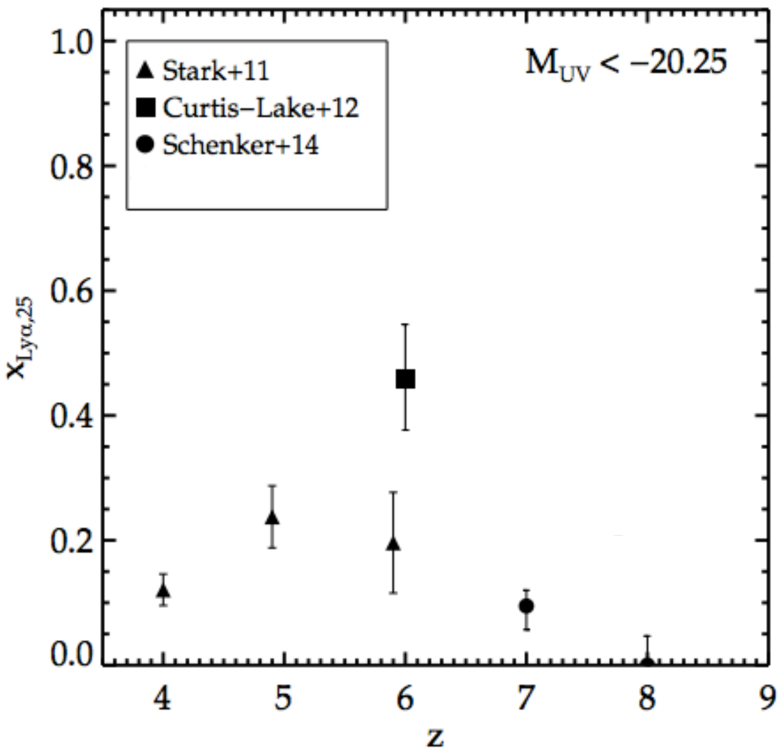




Oesch+15,16

What's going on at high-z?

- Increasingly neutral IGM at z>6 leads to increased scattering of Ly-α photons (Stark+11, Pentericci+11, Treu+13, Dijkstra+14, …)

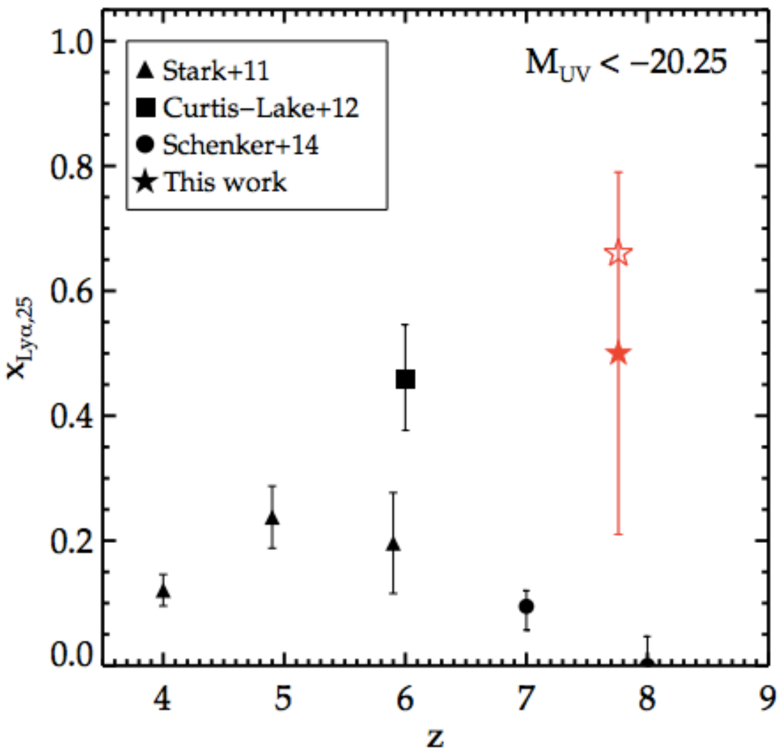


Stark+16

What's going on at high-z?

- Increasingly neutral IGM at z>6 leads to increased scattering of Ly-α photons (Stark+11, Pentericci+11, Treu+13, Dijkstra+14, …)

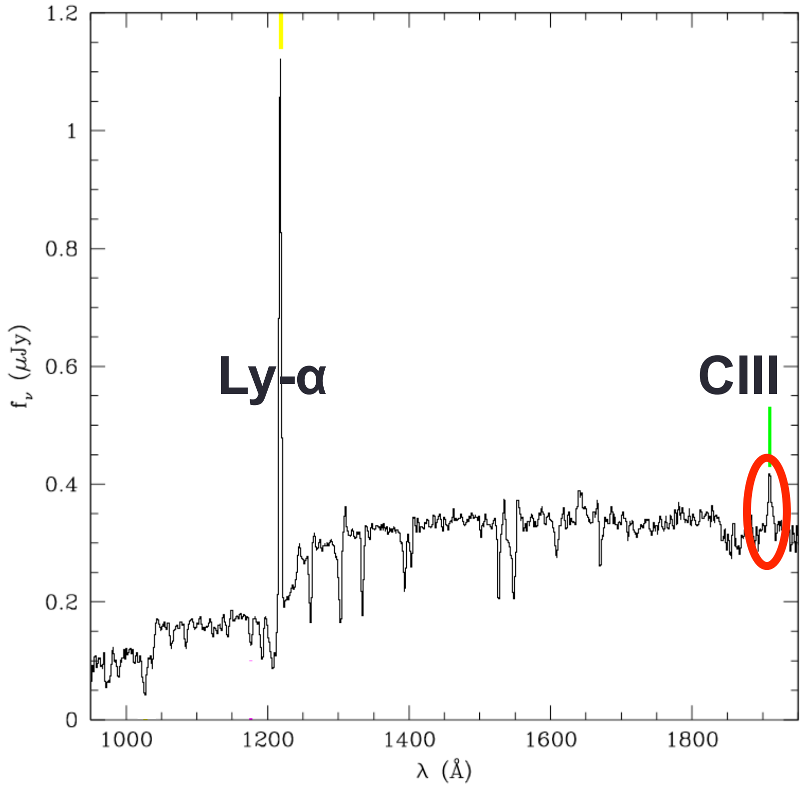
- (New results indicate that this may not be true around the most extreme galaxies)



Stark+16

CIII: the best thing since Ly-α?

- Up to 10% of Ly-α but is not energetic enough to ionize Hydrogen

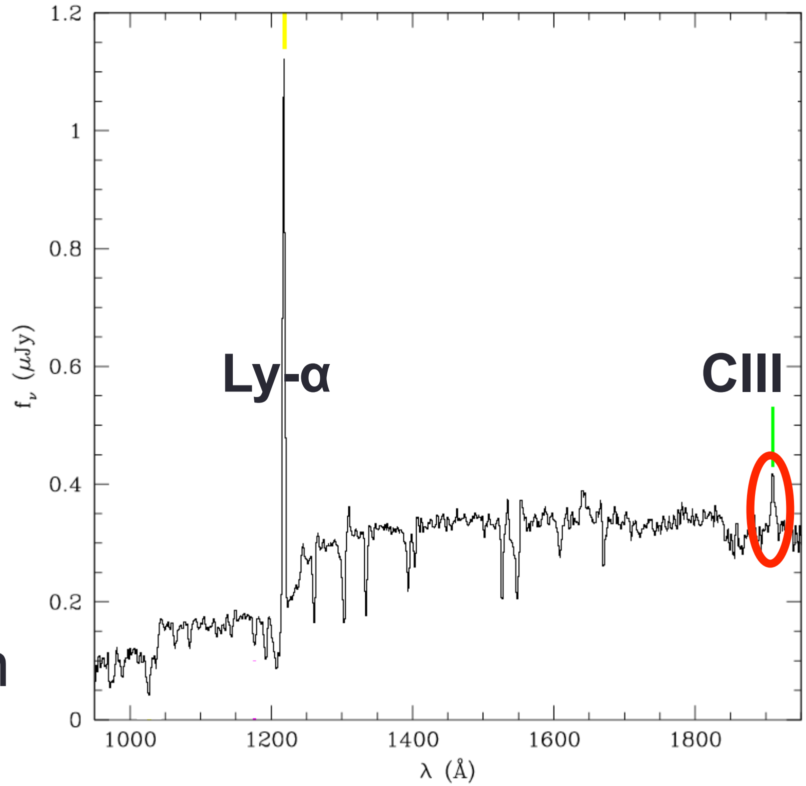


Shapley+03
(z~3 LBG stack;
~1000 galaxies)

CIII: the best thing since Ly-α?

- Up to 10% of Ly-α but is not energetic enough to ionize Hydrogen
- Photoionization models ➔ "Easier" to interpret than Ly-α
- Doublet (1907/1909 Å) ➔ unambiguous redshift determination at high-resolution

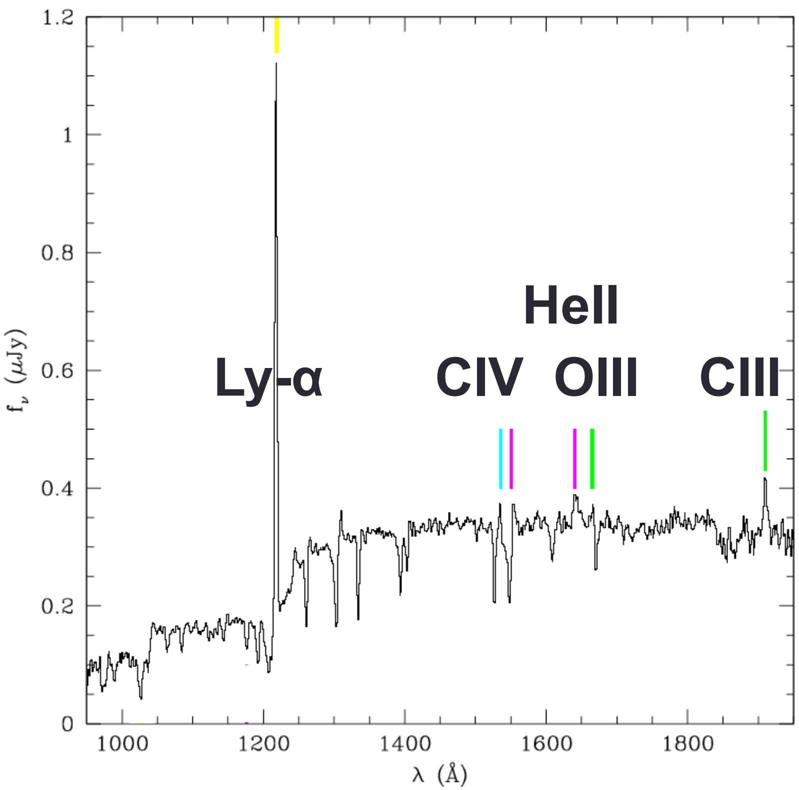
BUT current samples are small and biased



Shapley+03 (z~3 LBG stack; ~1000 galaxies)

Physics with CIII and the rest-UV in general

- CIII doublet sensitive to electron density
- CIII and OIII 1665 (or 5007) can constrain C/O abundance
- These and other lines, like HeII 1640 and CIV 1549 can constrain:
    - Ionization parameter
    - AGN diagnostics
    - Metallicity



Shapley+03 (z~3 LBG stack; ~1000 galaxies)

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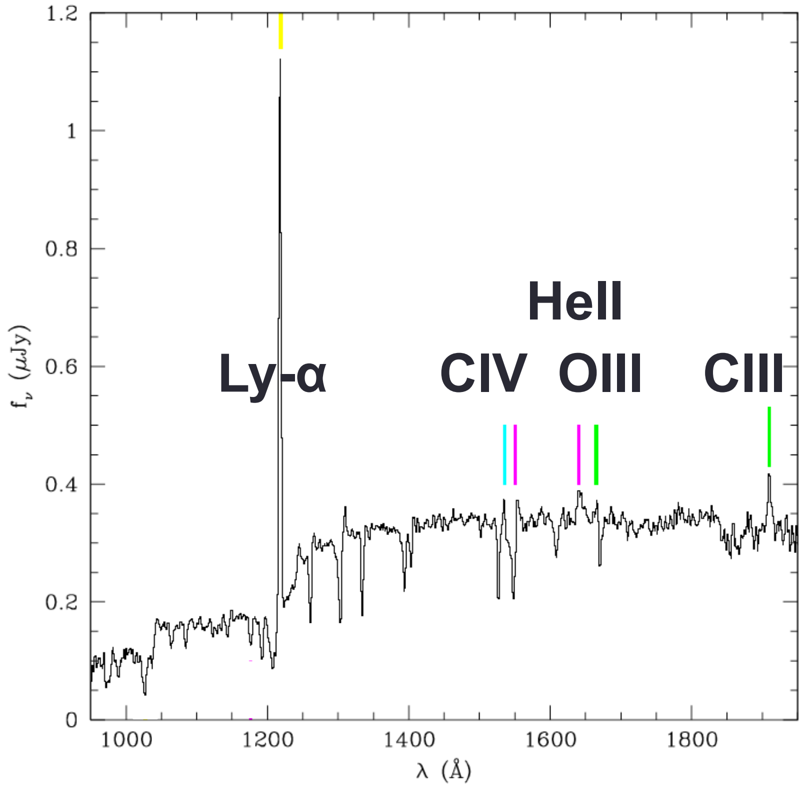


MUSE probes these lines at 1.5 < z < 4

Shapley+03 (z~3 LBG stack; ~1000 galaxies)

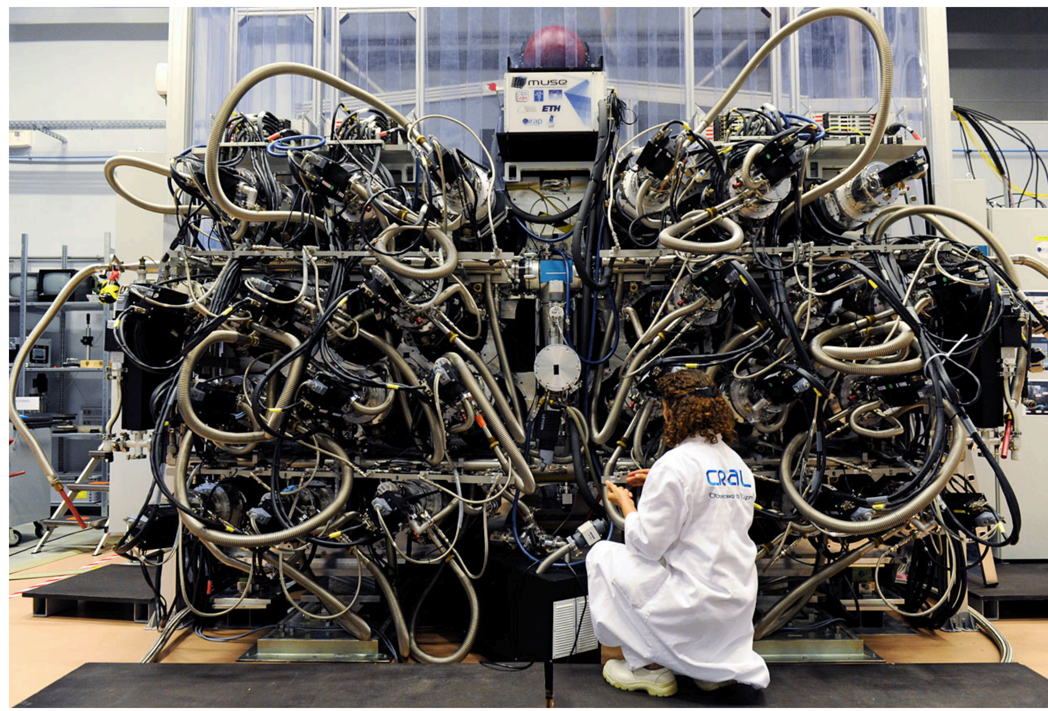
MUSE spectroscopy

- MUSE at the VLT
- R~3000
- 4650-9300 Å
- 1’x1’ Integral Field Unit

- AO system should be online from end of 2017

muse

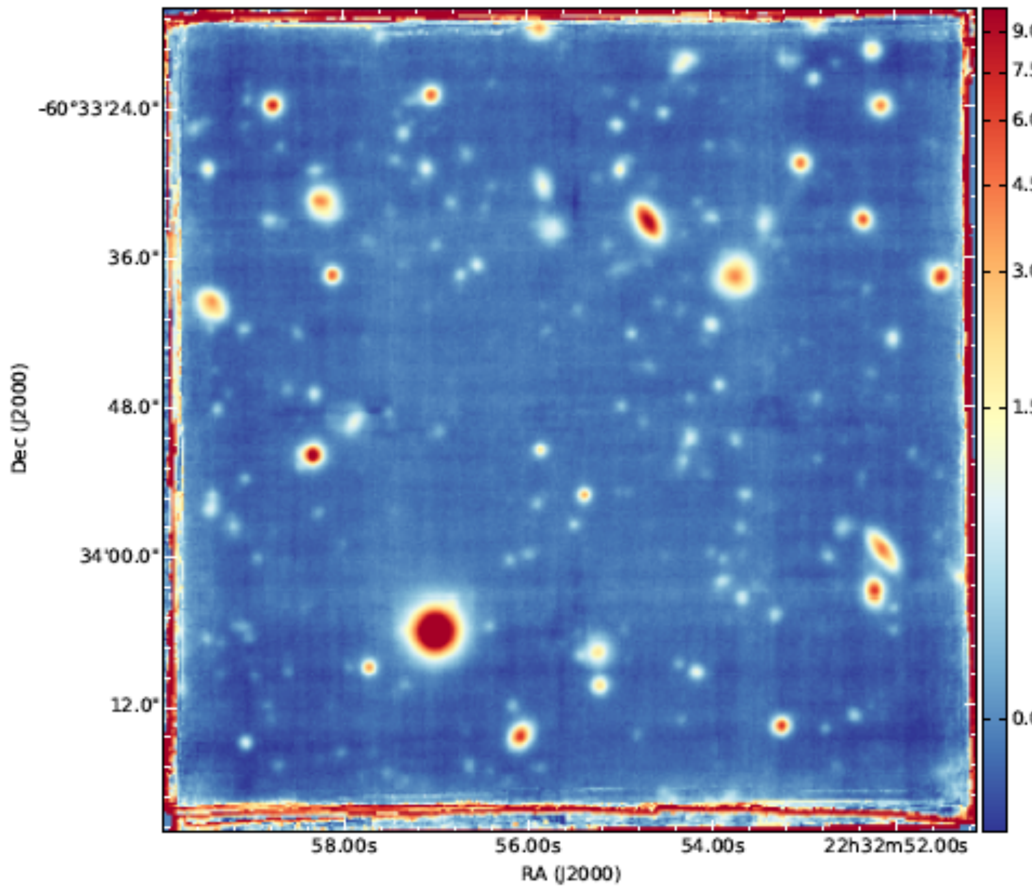
multi unit spectroscopic explorer



ESO

MUSE spectroscopy

- MUSE at the VLT
- R~3000
- 4650-9300 Å
- 1'x1' Integral Field Unit
- ~20 hours in the HDFS (Bacon+15)
- Flux limit ~3x10^{-19} erg/s/cm^2



HDF-S

MUSE spectroscopy

- MUSE at the VLT
- R~3000
- 4650-9300 Å
- 1’x1’ Integral Field Unit

(a wide-area IFU acts like a MOS)

- ~20 hours in the HDFS (Bacon+15)
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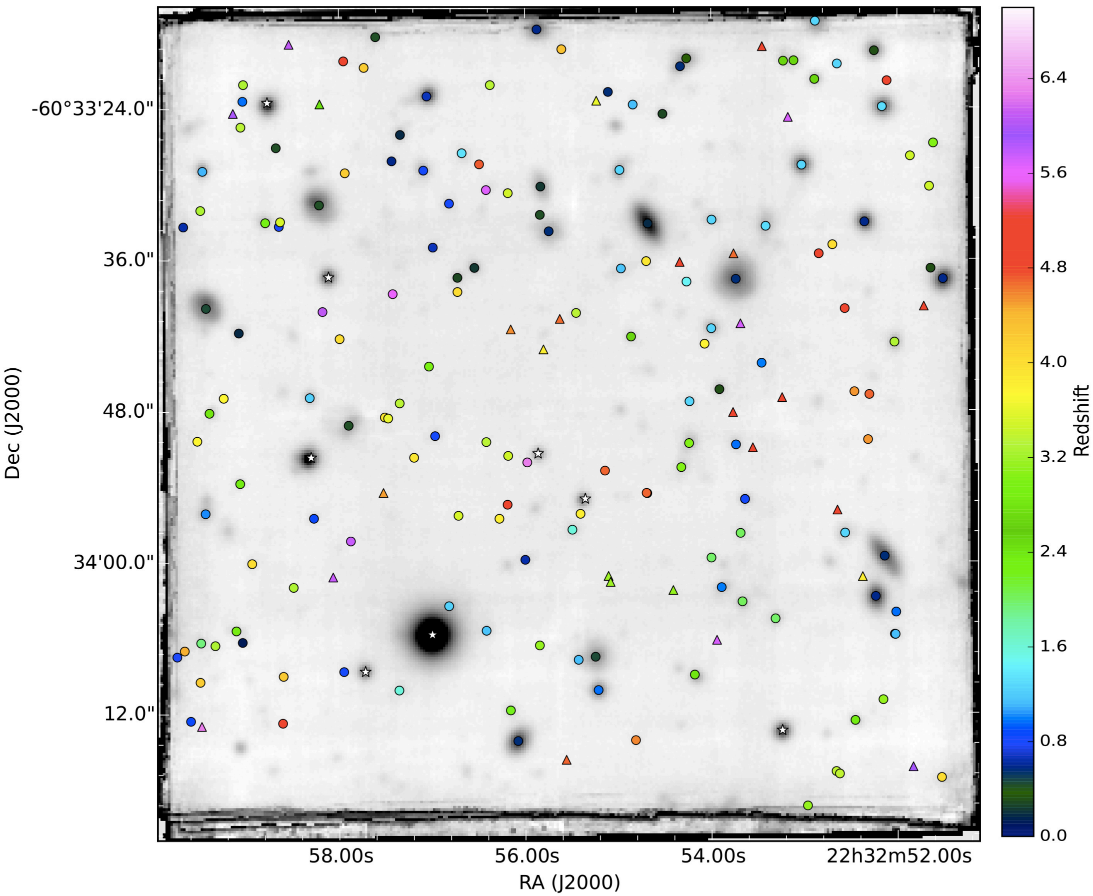


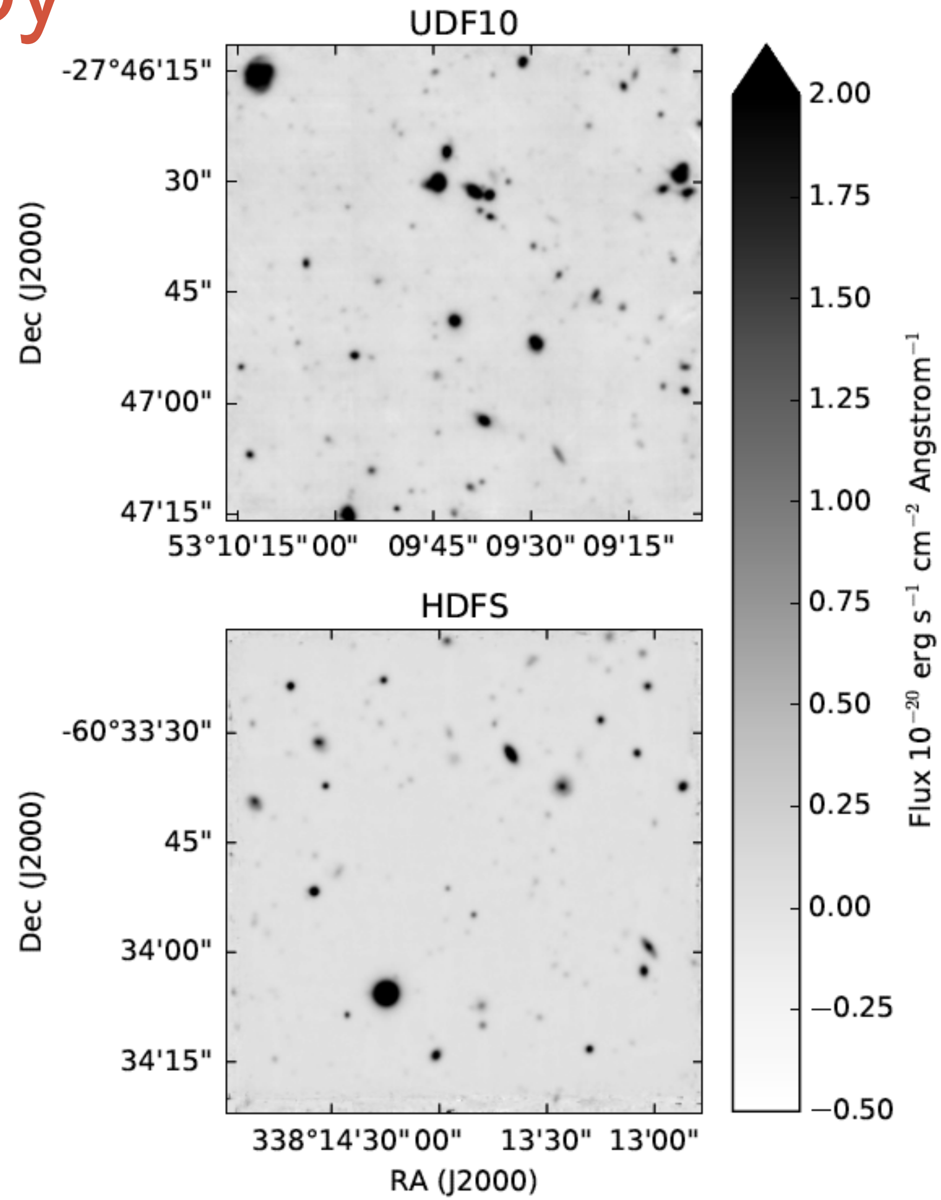
HDF-S

MUSE spectroscopy

- MUSE at the VLT
- R~3000
- 4650-9300 Å
- 1'x1' Integral Field Unit

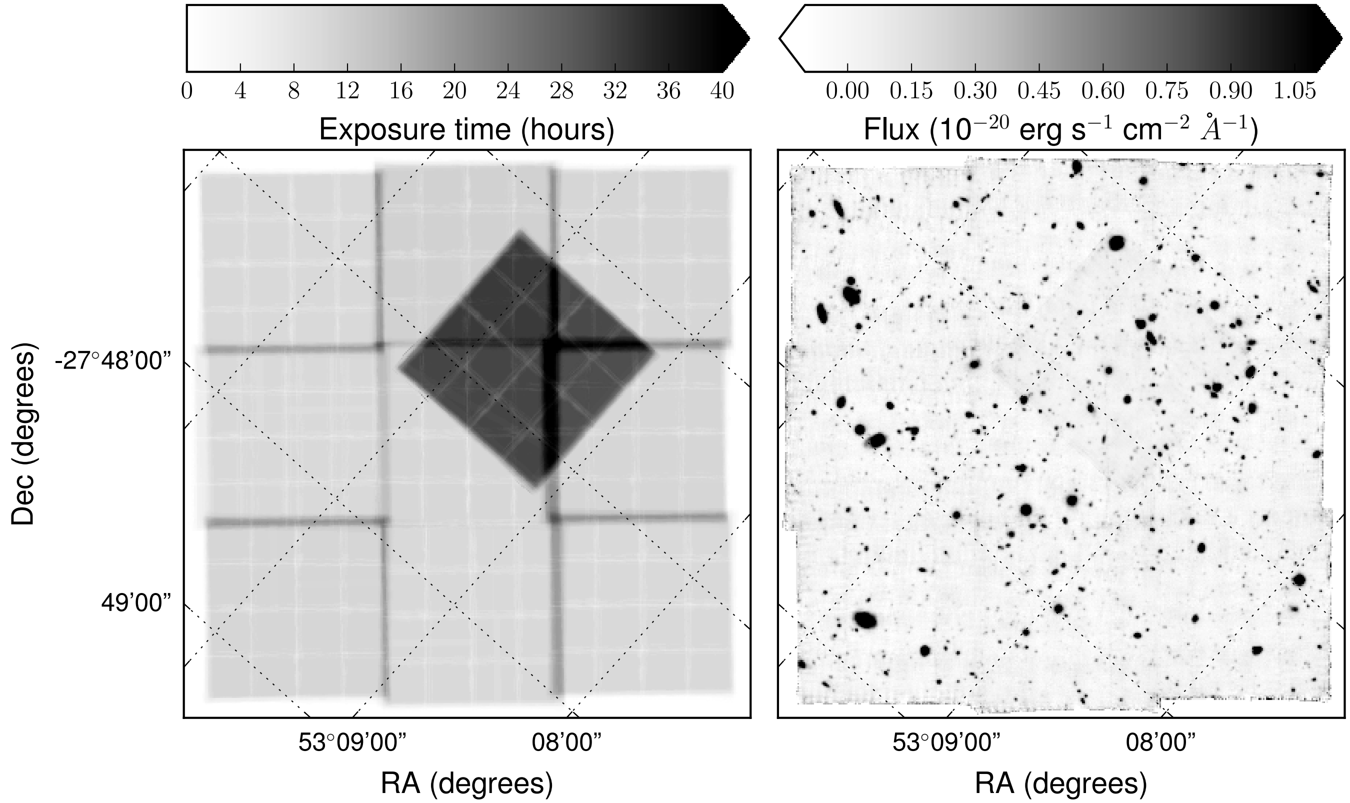
- 30+ hours in the UDF (GTO; Bacon+17)
- ~20 hours in the HDFS (Bacon+15)

- Flux limit ~3×10^{-19} erg/s/cm^2

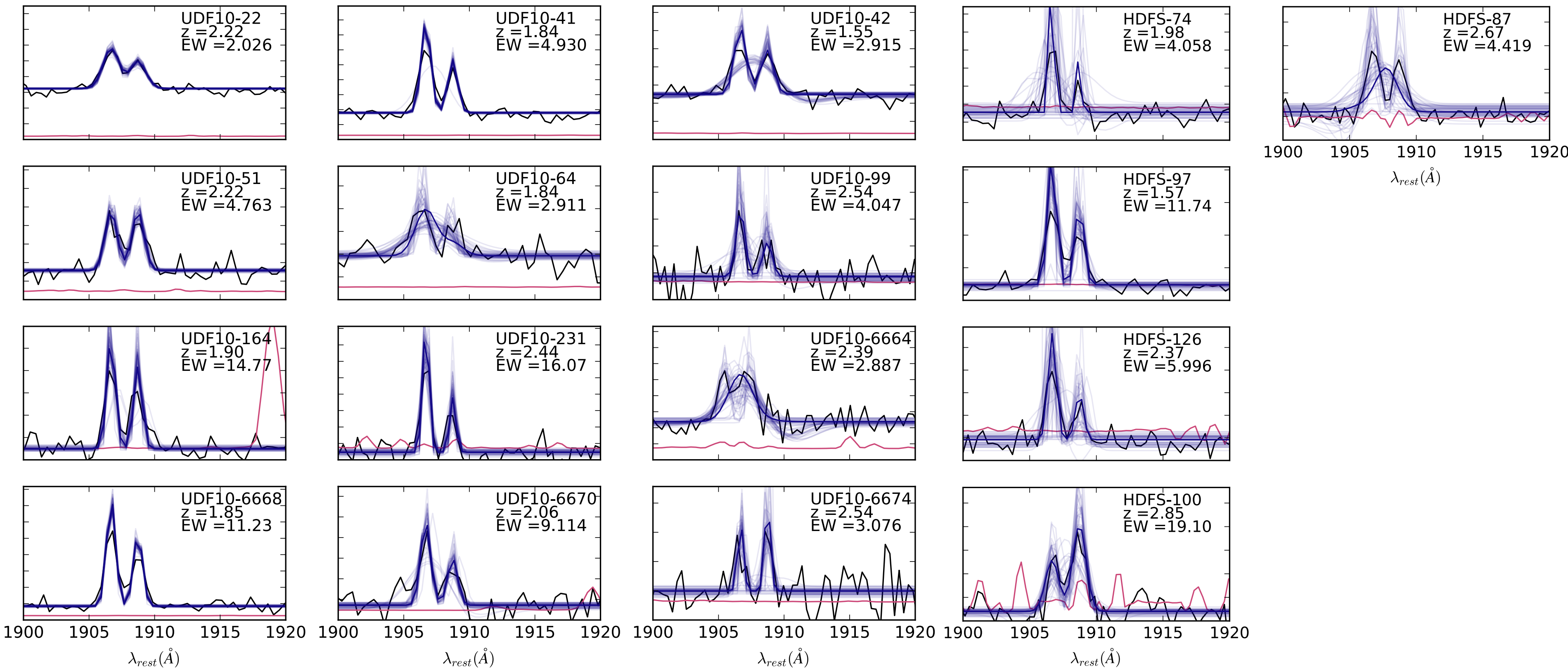


(The full MUSE UDF Program)

- MUSE UDF program has two components:
  - “Deep” (1x30 h) and “Mosaic” (9x10 h)
  - Matches footprint of deepest HST imaging



17 CIII Emitters (> 3-σ, > 1 Å EW)



Are the CIII emitters intrinsically different?

- Compare e.g. SED-derived quantities (MAGPHYS – da Cunha+08)

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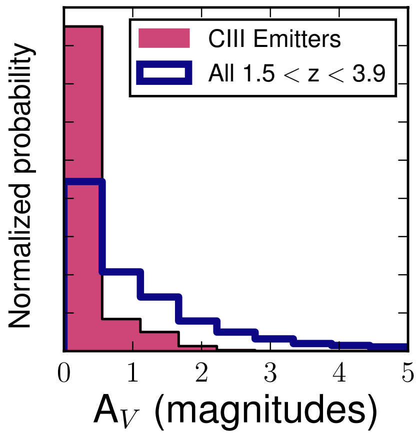

Are the CIII emitters intrinsically different?

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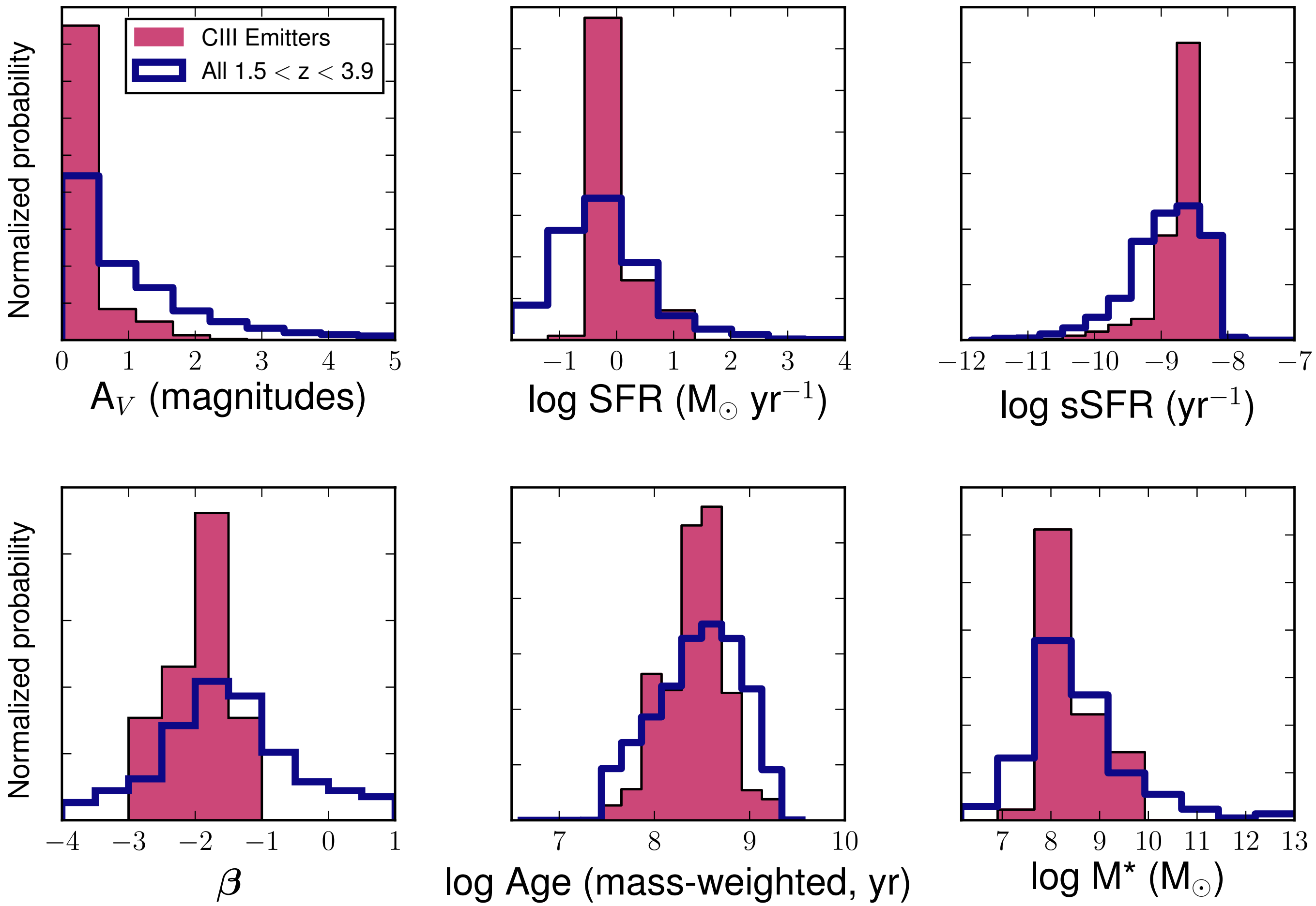
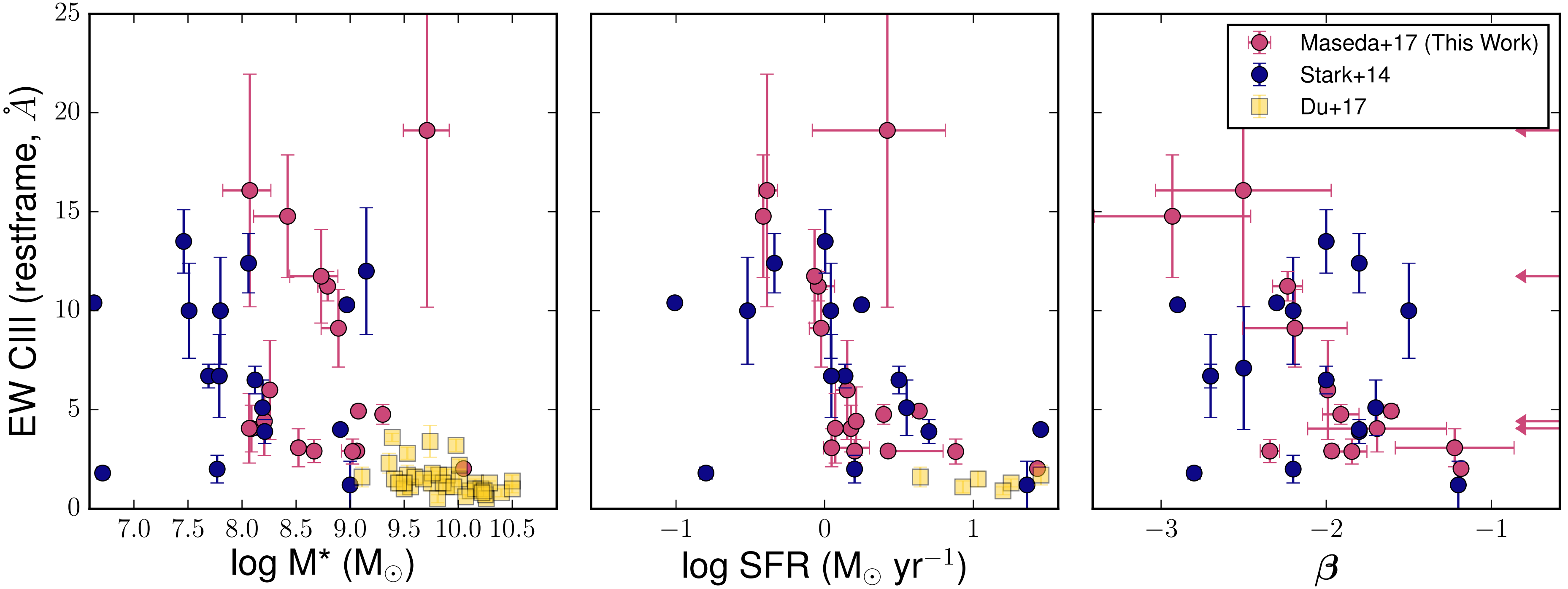
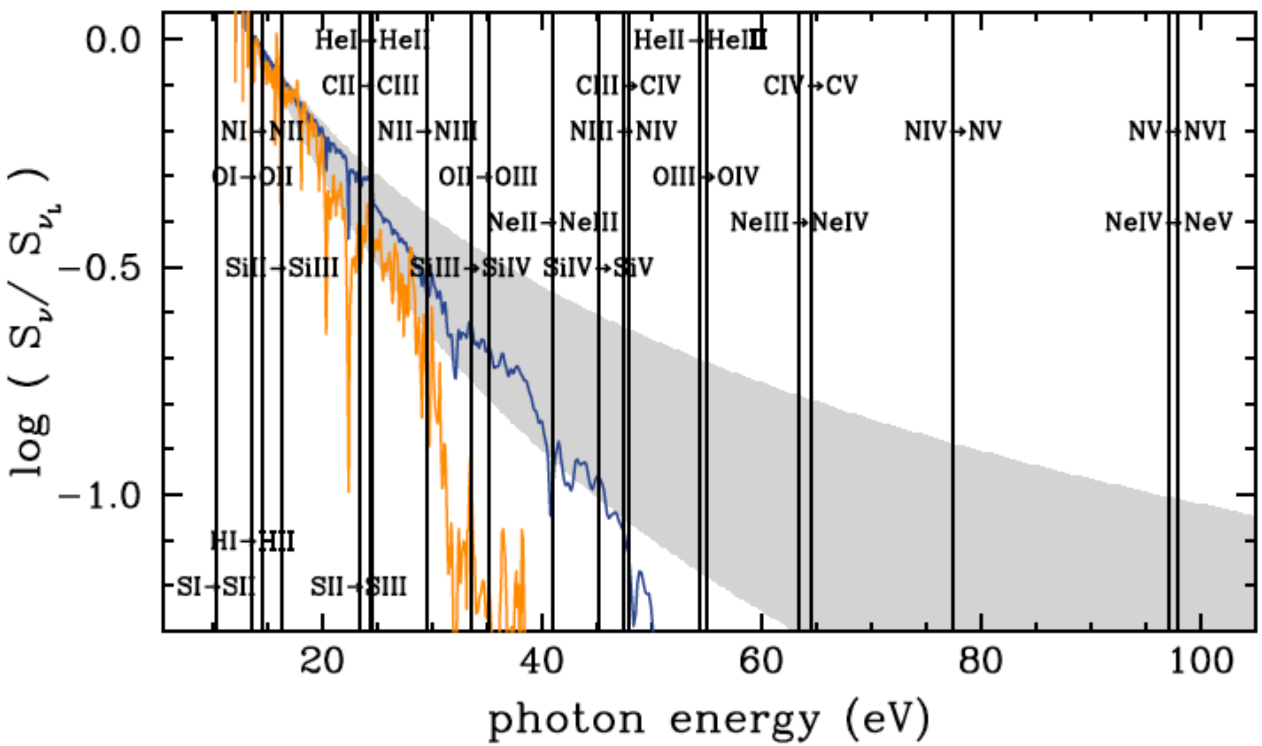


What controls the strength of CIII?



SF or AGN?

- CIII alone cannot constrain the type of ionizing radiation



Feltre+15

SF or AGN?

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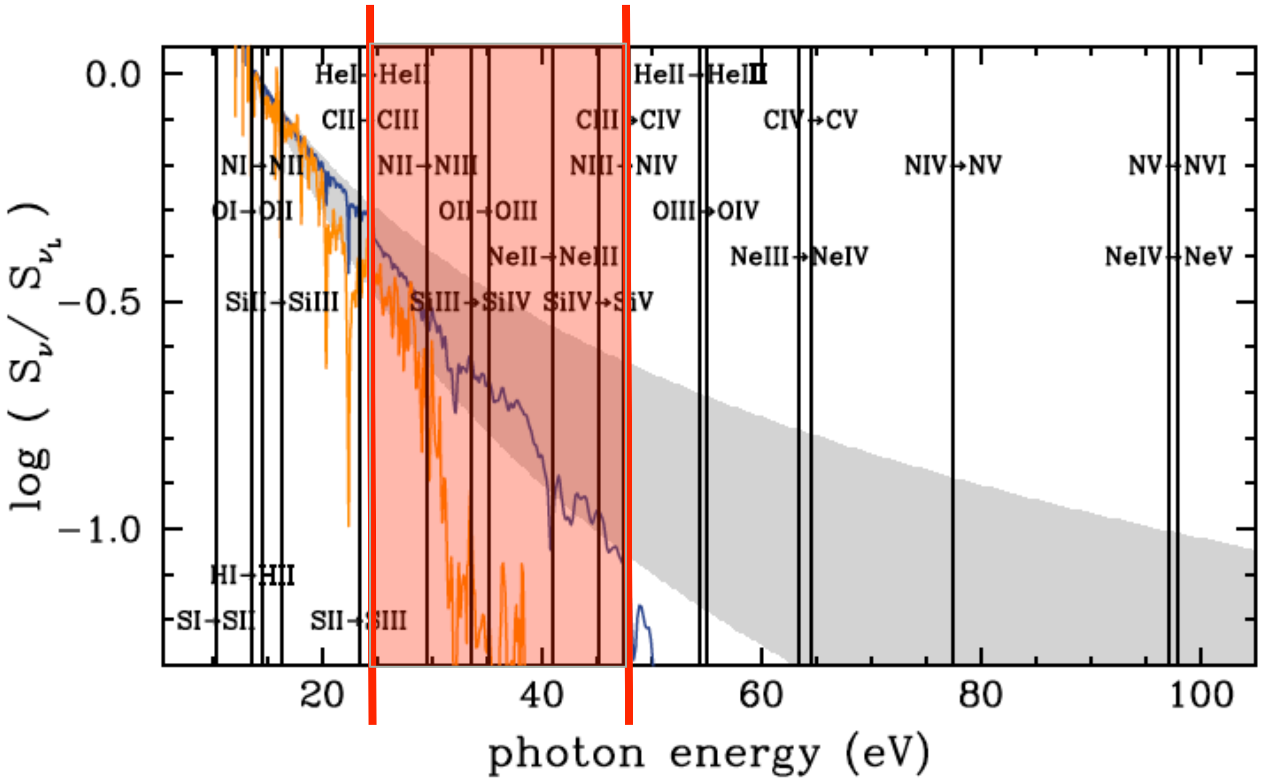
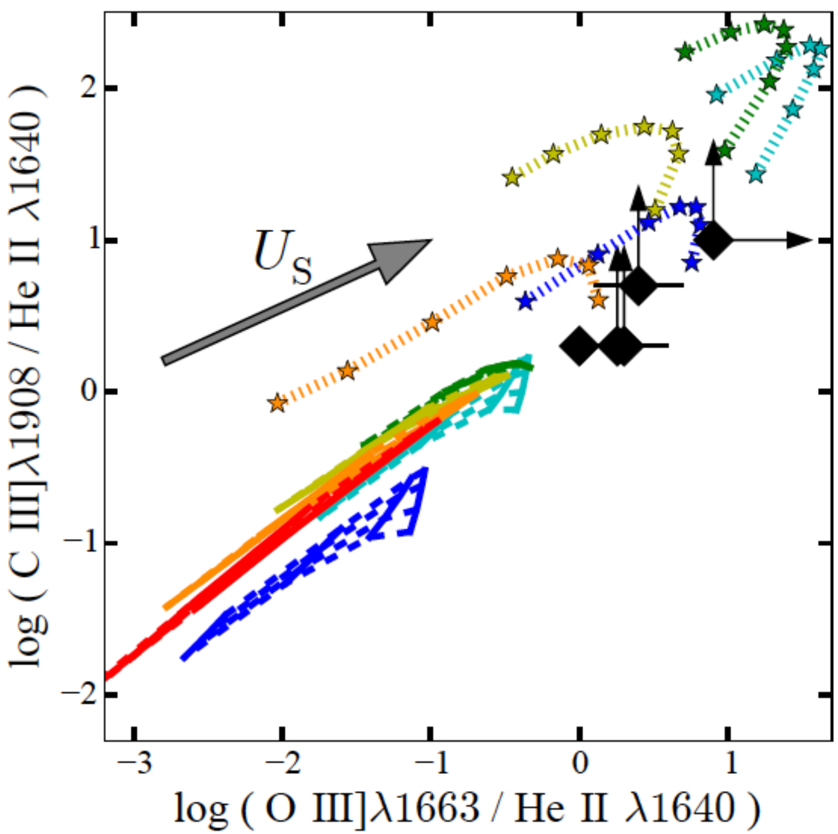


Feltre+15

SF or AGN?

- CIII alone cannot constrain the type of ionizing radiation
- MUSE has coverage of HeII, OIII, SiIII…



Feltre+15, Gutkin+16

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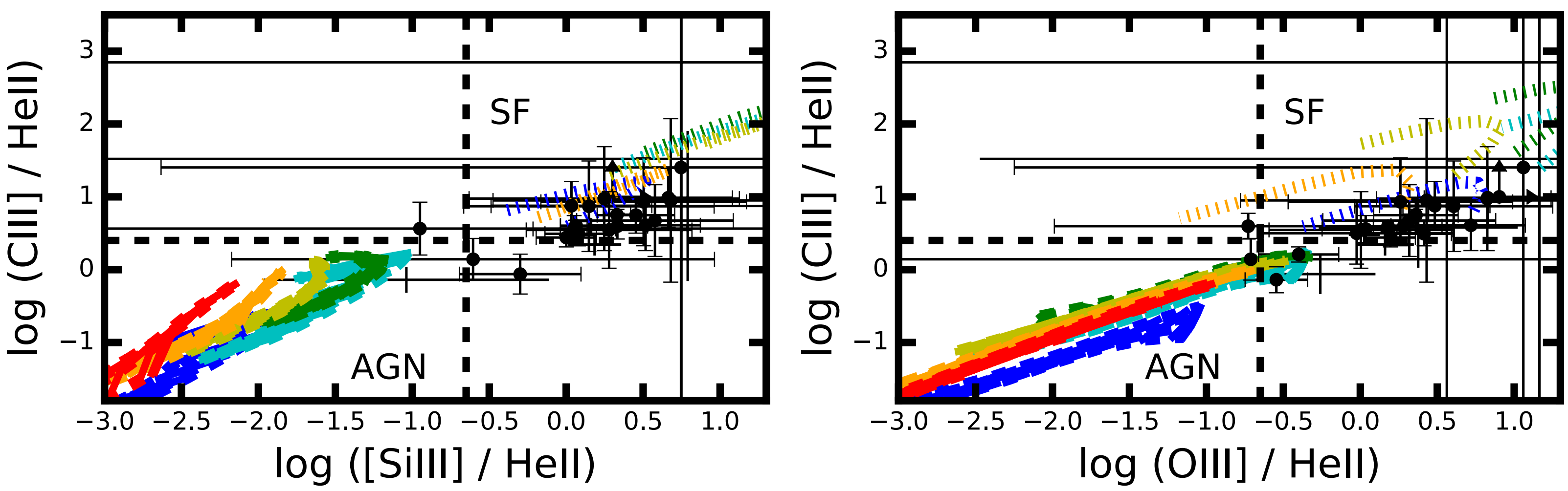
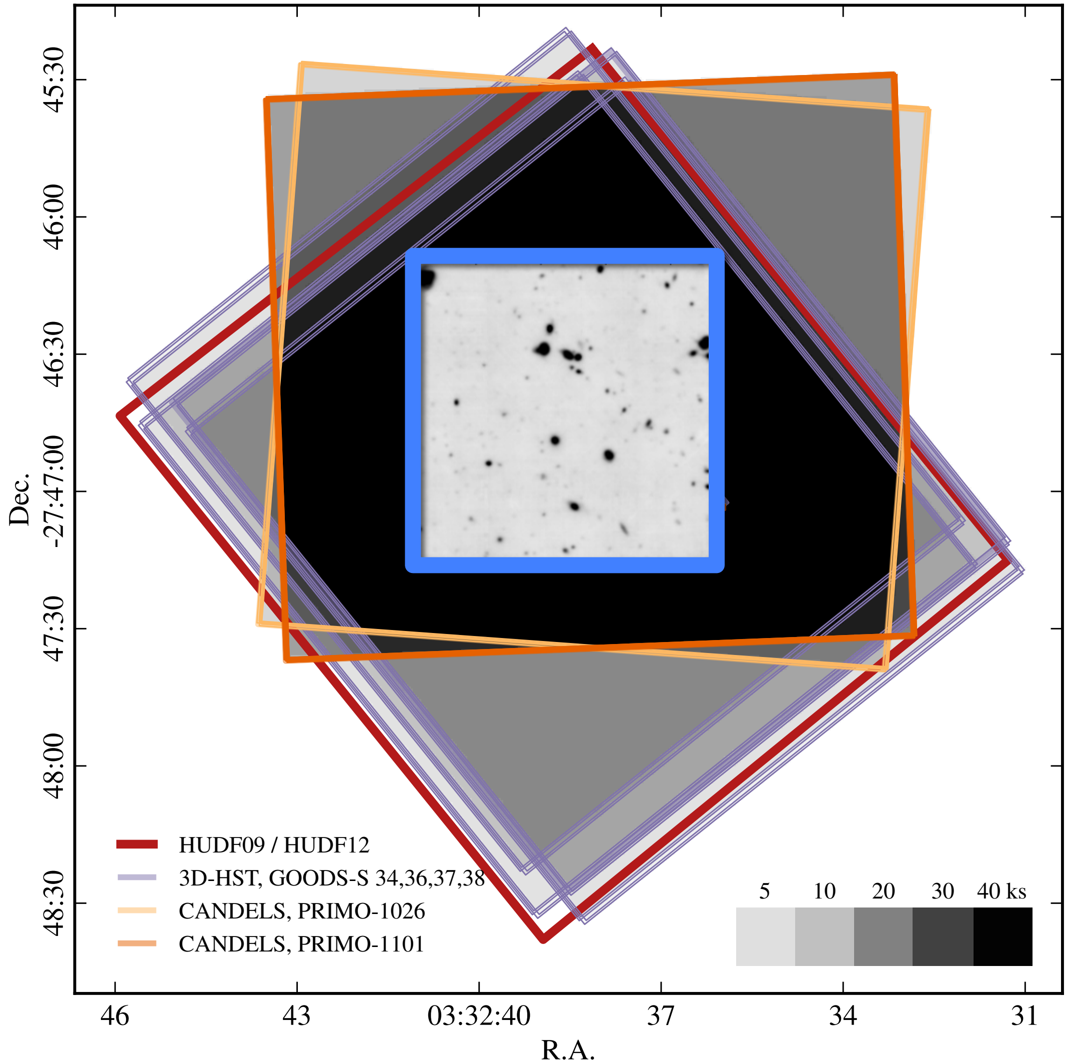


(Including data from UDF Mosaic; Maseda+ in prep)

MUSE+WFC3 in the UDF



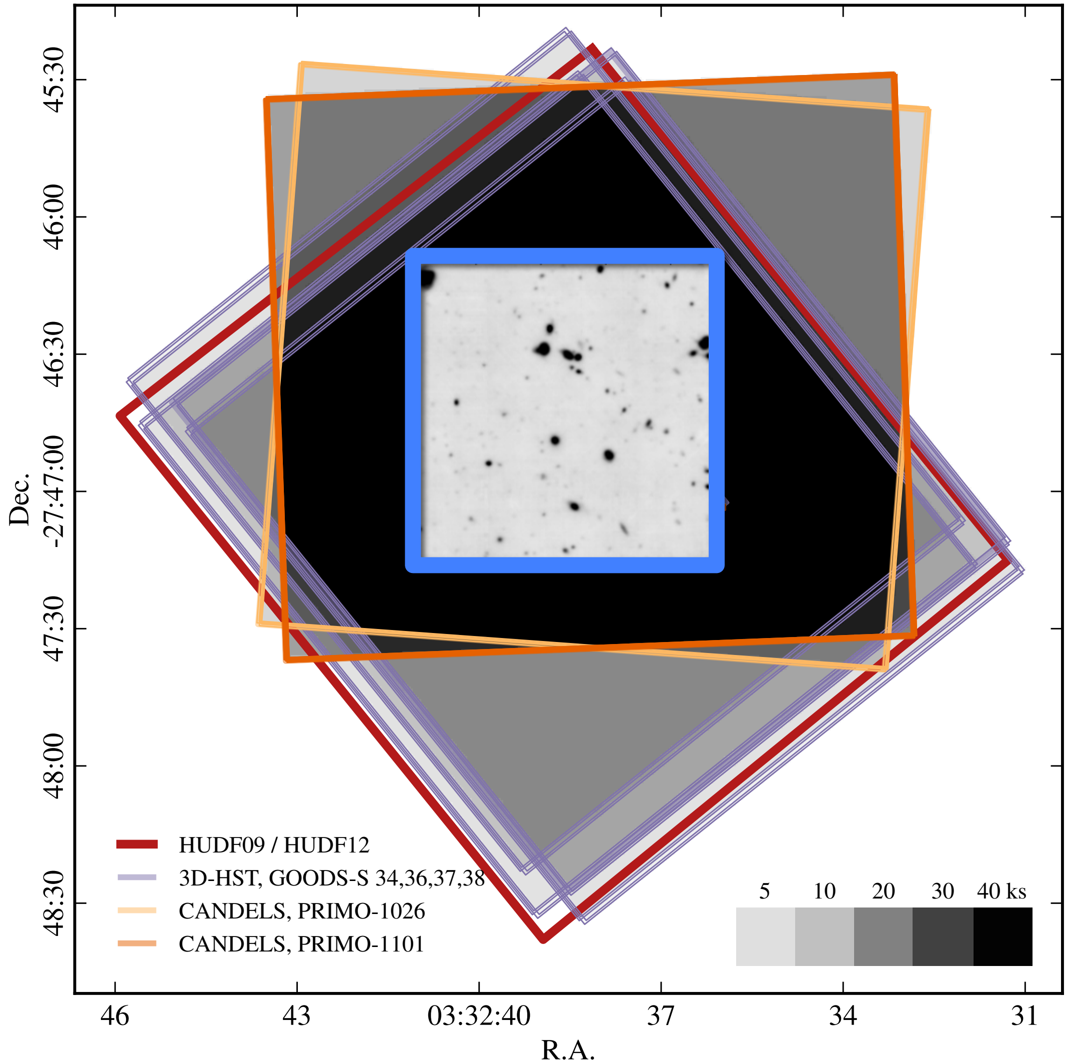
WFC3 G141 slitless spectroscopy from 1.1-1.7 μm

40ks: Line sensitivity of < 10^{-18} erg/s/cm^2

MUSE UDF-10 is well-matched to deep HST imaging and spectroscopy!

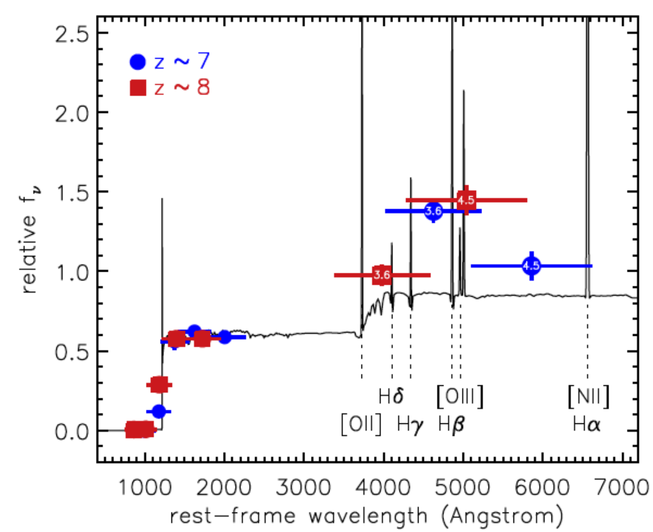
Adapted from Brammer+13

MUSE+WFC3 in the UDF



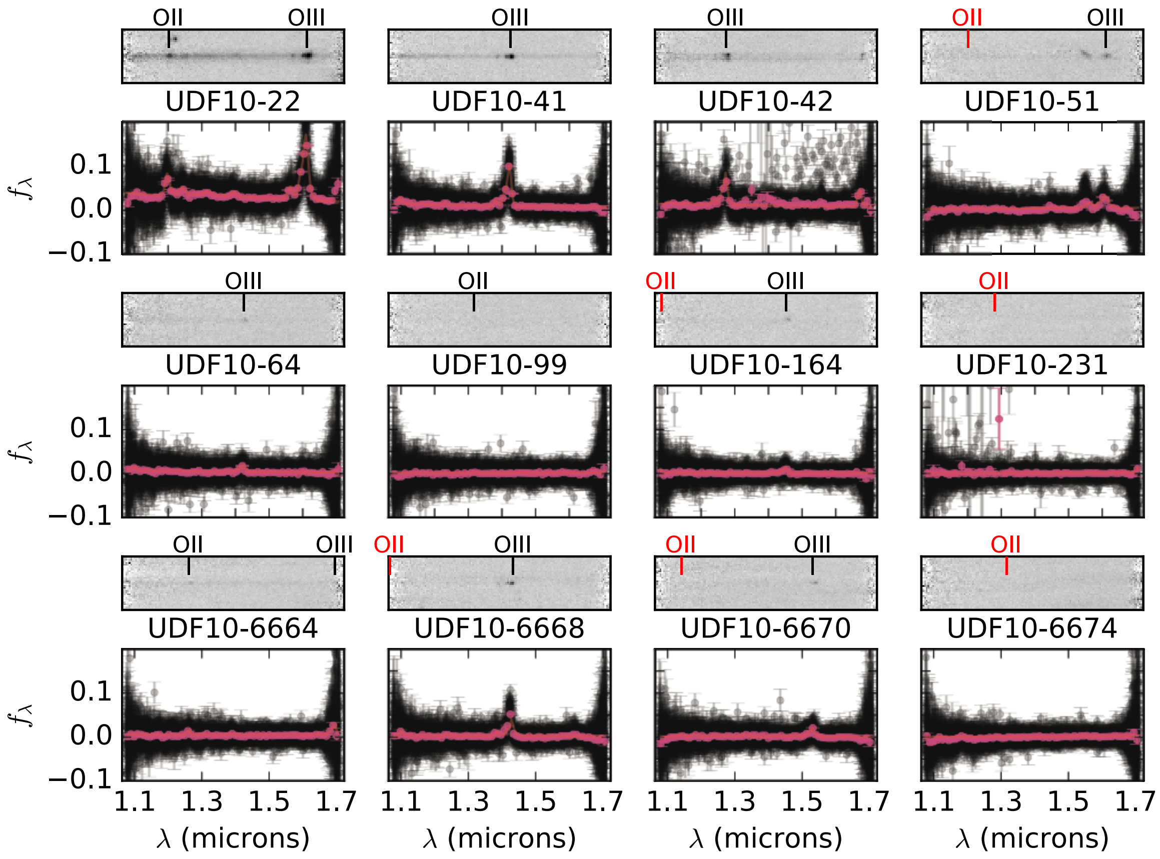
WFC3 G141 slitless spectroscopy from 1.1-1.7 μm

High-EW optical lines expected to be common at high-z (e.g. Labbe+13)



CIII emitters have strong optical lines

- OIII+Hβ (and OII) for CIII emitters



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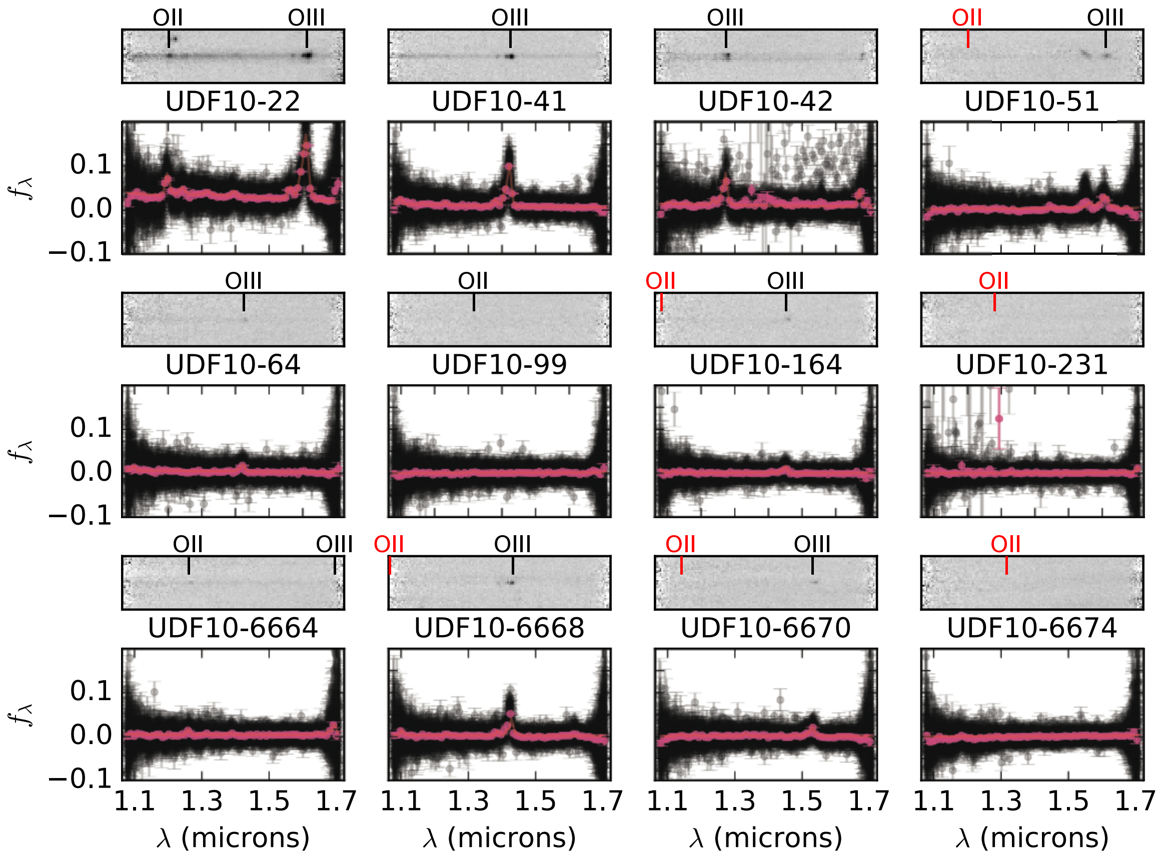
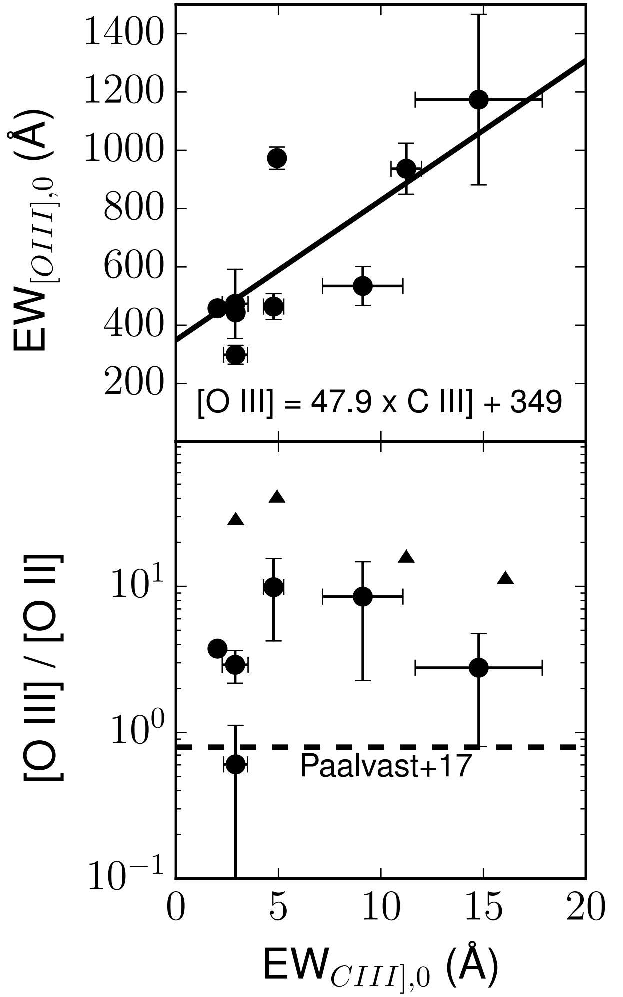
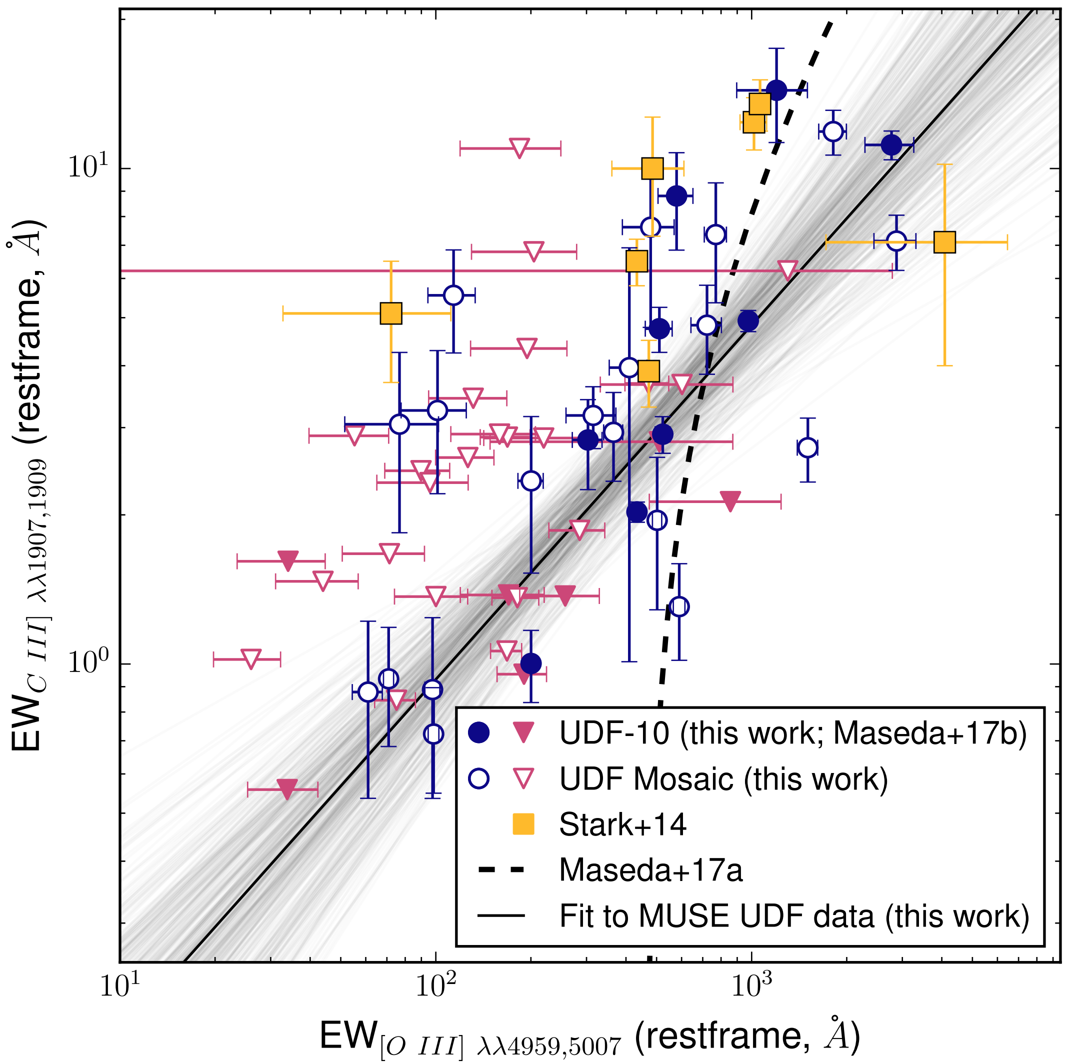




In progress: CIII-OIII from full UDF



Conclusions

- CIII emitters are, on average, younger, more vigorously star-forming, and bluer than non-CIII emitters
- High-EW C III] (> 5 Å) only occurs at masses < $10^{9.5}$ $M_\odot$ and SFRs < 10 $M_\odot$/yr
- Nearly all high-EW OIII emitters (> 250 Å) at these redshifts are CIII emitters

Bonus: why an IFU is important

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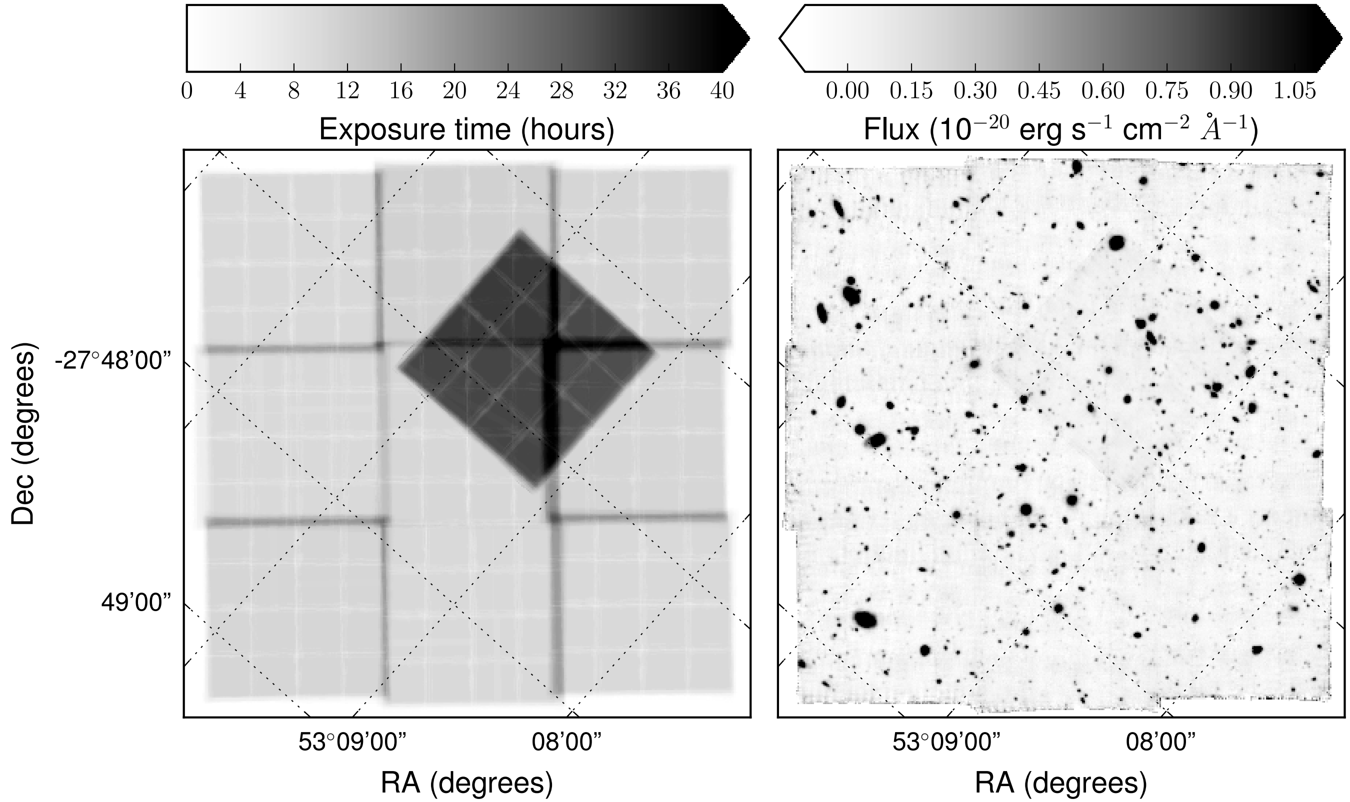
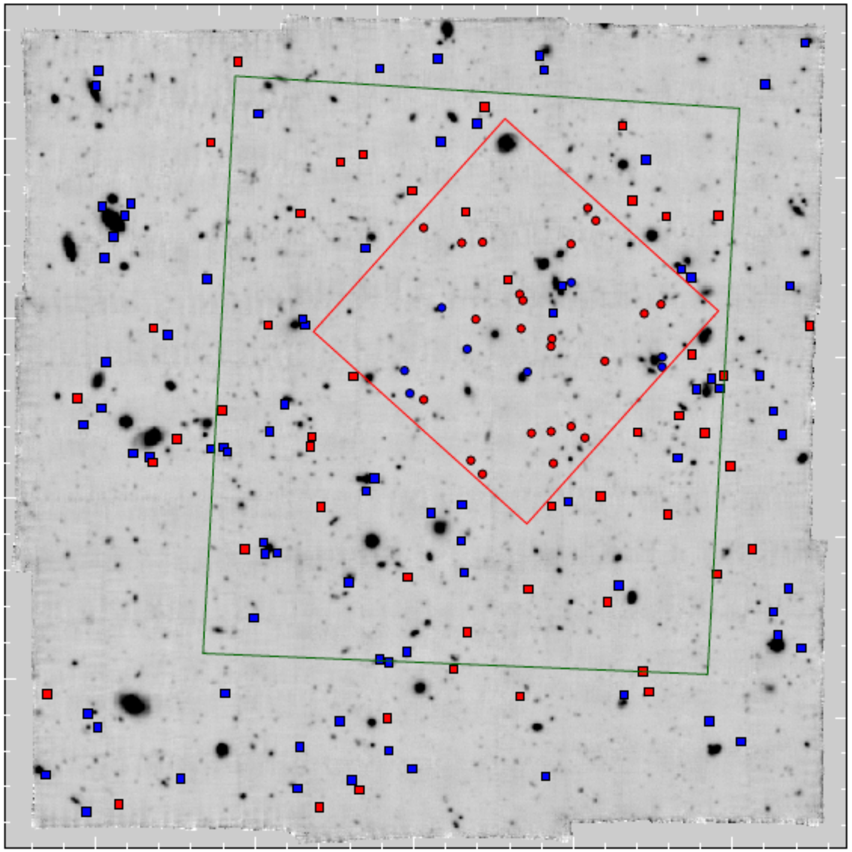
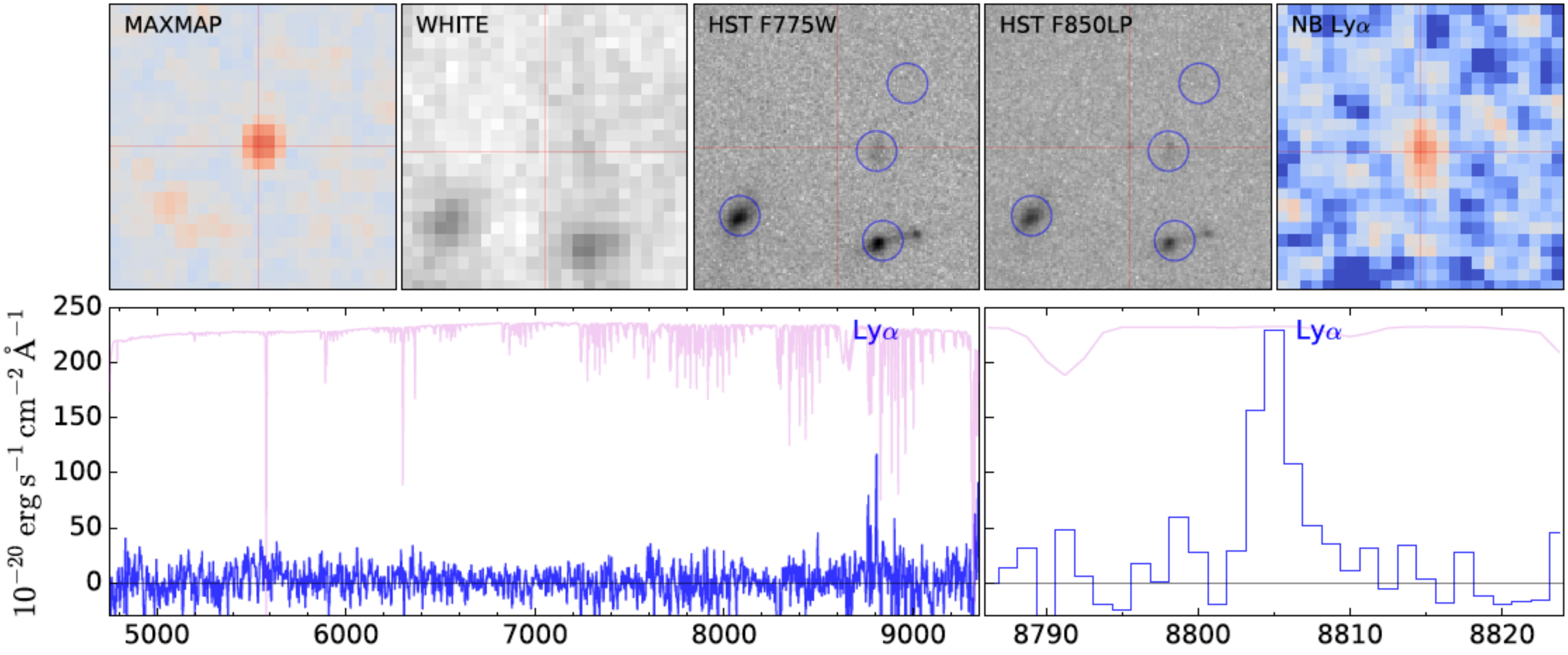


Bonus: why an IFU is important

- No photometric preselection
- Bacon+17: At least 160 sources have MUSE redshifts and no counterpart in the Rafelski+15 catalog
  - Many (> 70) are high-EW LAEs!



HST-undetected LAEs



Bacon+17

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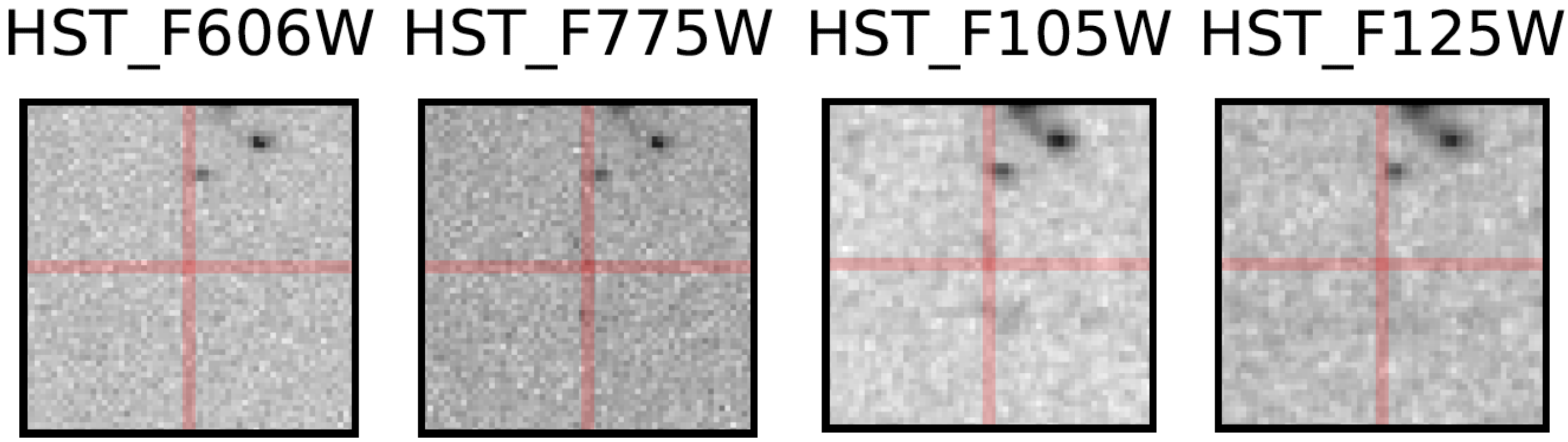

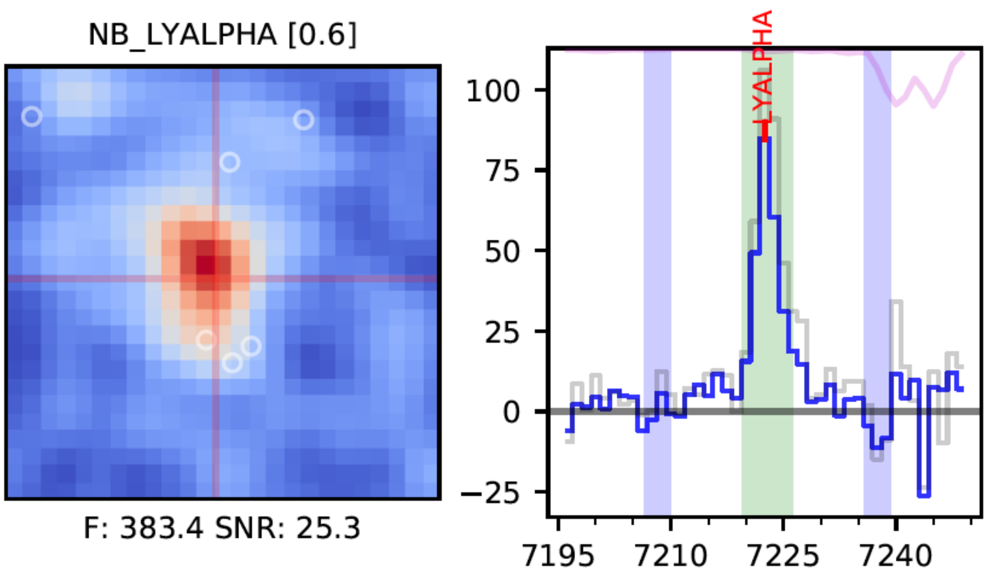

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