Hunting for the Dark Phases of Galaxy Formation with MUSE: The Hammerhead Field

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and the MUSE collaboration

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Dark Galaxies

- Theoretical models suggest that the early phases of galaxies formation should involve an epoch when galaxies are gas rich and inefficient at forming stars: a dark galaxy phase (e.g., Krumholz & Dekel 2012).

- We take advantage of the quasar-induced, fluorescent Lyman α emission to study and detect in emission these otherwise almost invisible objects.

- Early works selected dark galaxies as emitters with $EW_0 > 240$ Å around quasars and found that they are compact and gas-rich but the current sample is very limited (12).

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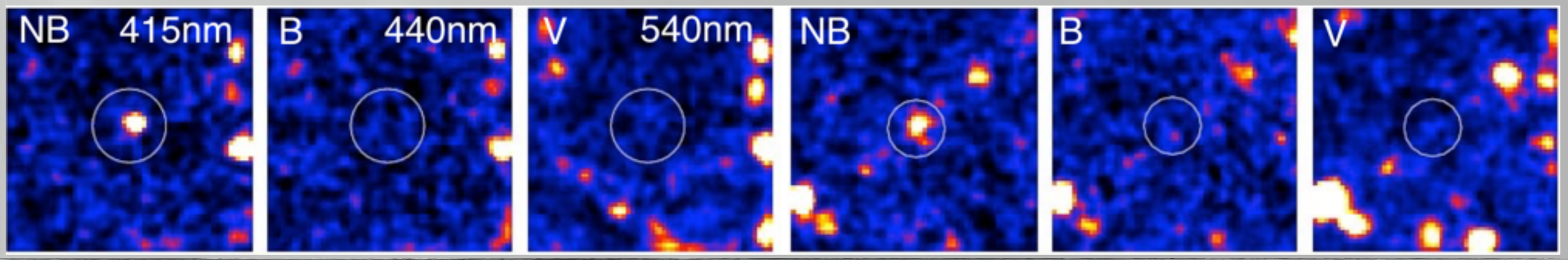

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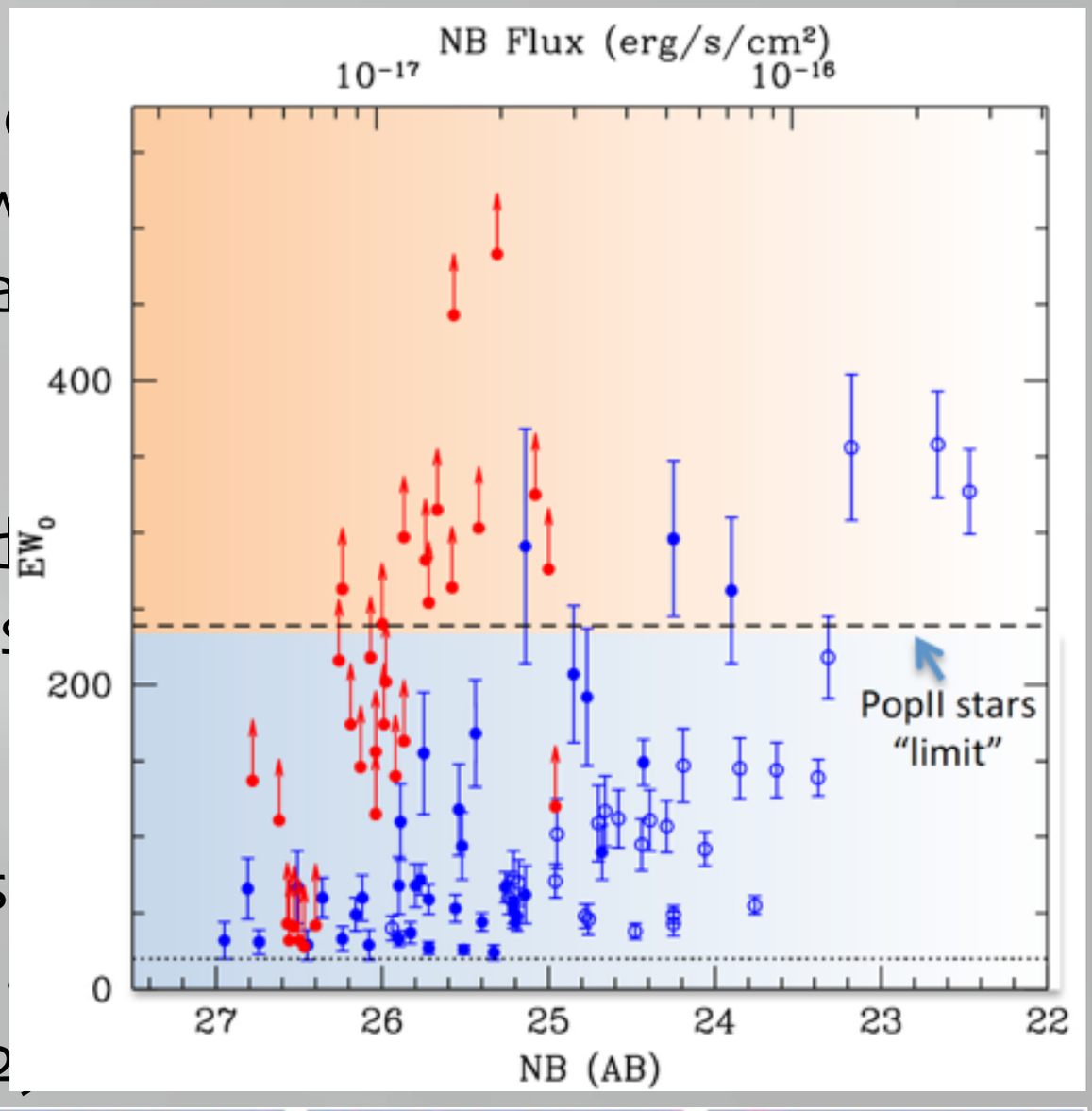

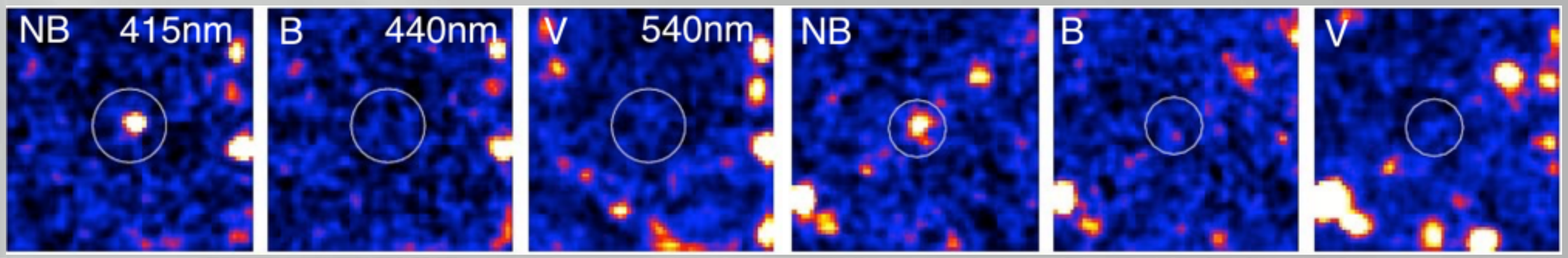

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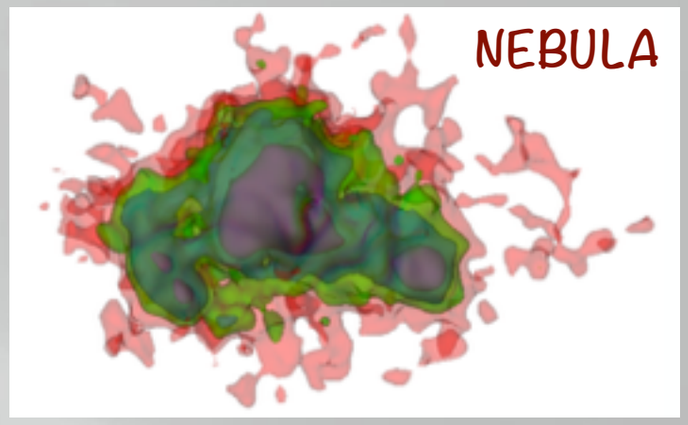
MUSE deep cubes are the best place to search for/analyse these dark galaxies with both spatial and spectral information.

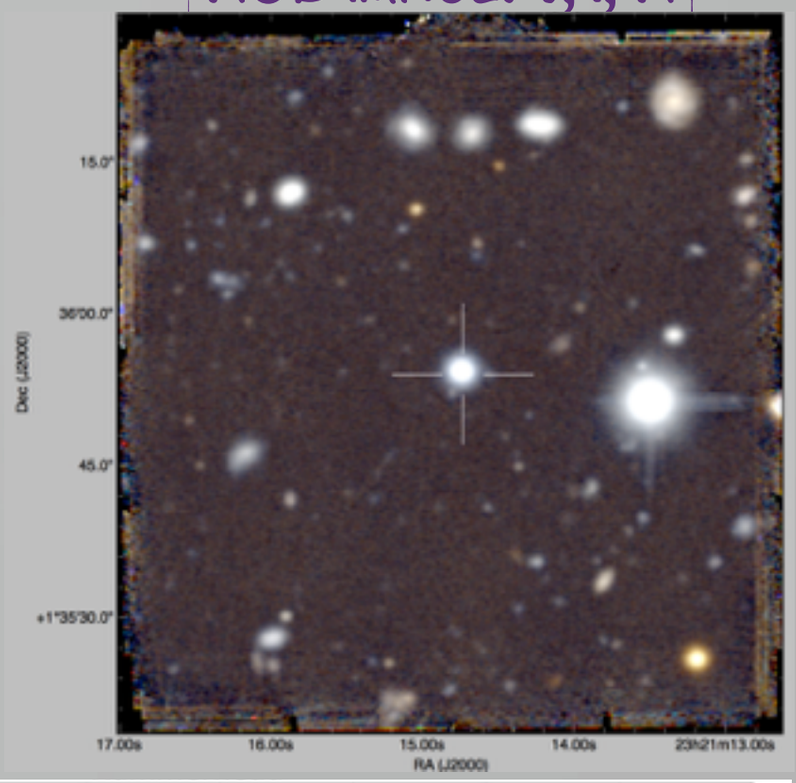
The Hammerhead

DATA

Name	J2321+0135 QSO
Redshift	3.199
Observations	9h - 36 exps.

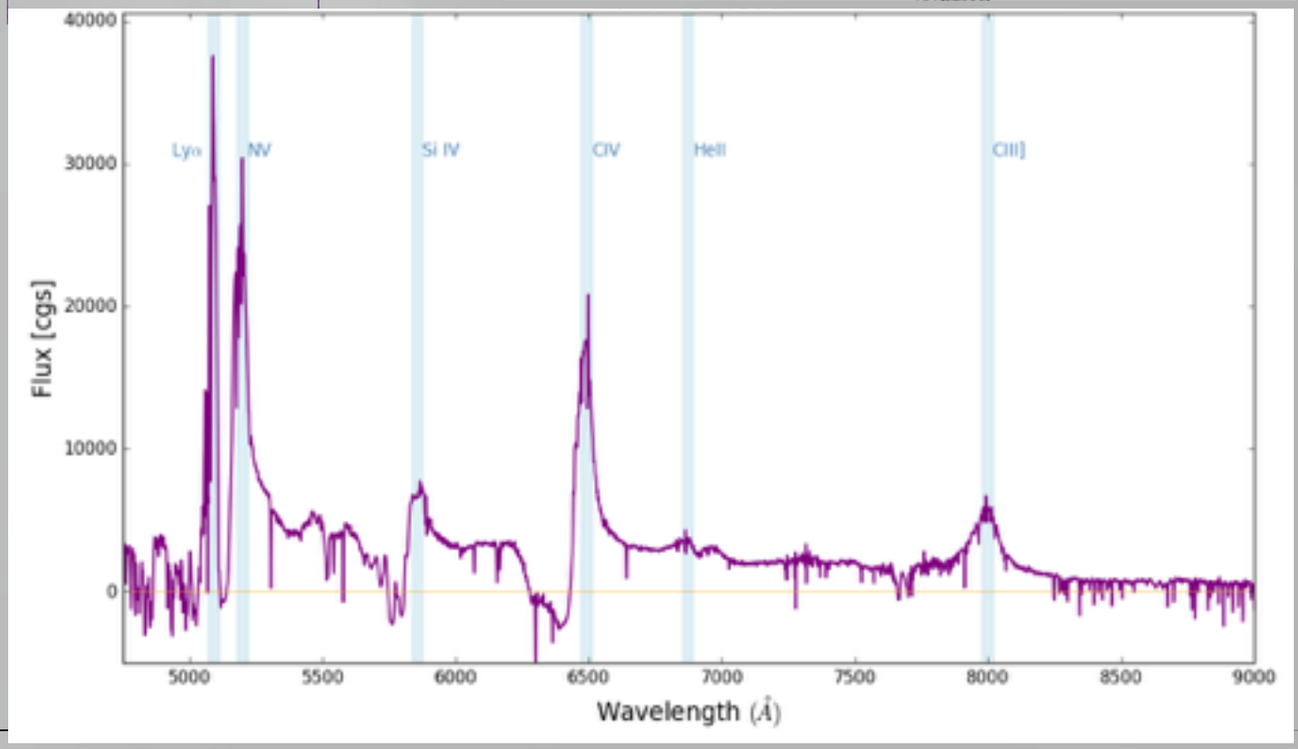


RGB image: V, I, R



Reduction	MUSE Pipeline v1.2 muse_scibasic & muse_scipost
Post Processing	CubEx v1.6 tools (Cantalupo in prep.) Astrometric offsets CubeFix (Flat-field correction) CubeSharp (Sky subtraction) CubeCombine

Spectrum



@z=3.199 QSO Ly α emission is at λ=5089Å

DATA

The Hammerhead

- PSF & Continuum subtraction of the brightest sources with CubEx tools

- Extraction of 3 sub-cubes (λ_{width}=200 Å) around QSO Ly α:

  OFF-Blue cube 4800-5000 [Å]

  ON-SOURCE cube 5000-5200 [Å]

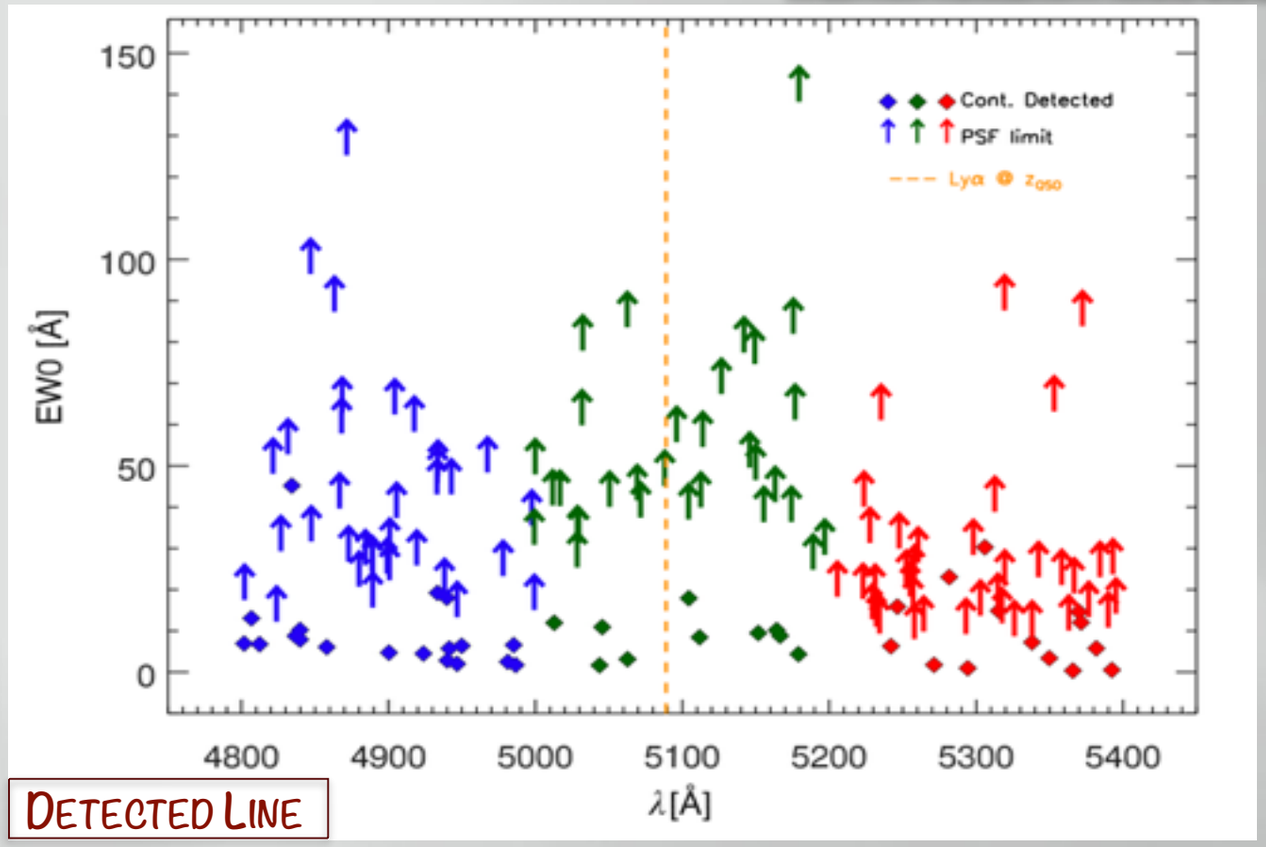
  OFF-Red cube 5200-5400 [Å]

- 3D detection and extraction of the line emitters with CubEx using a Signal to Noise=3.5 and a number of minimum connected voxels=40

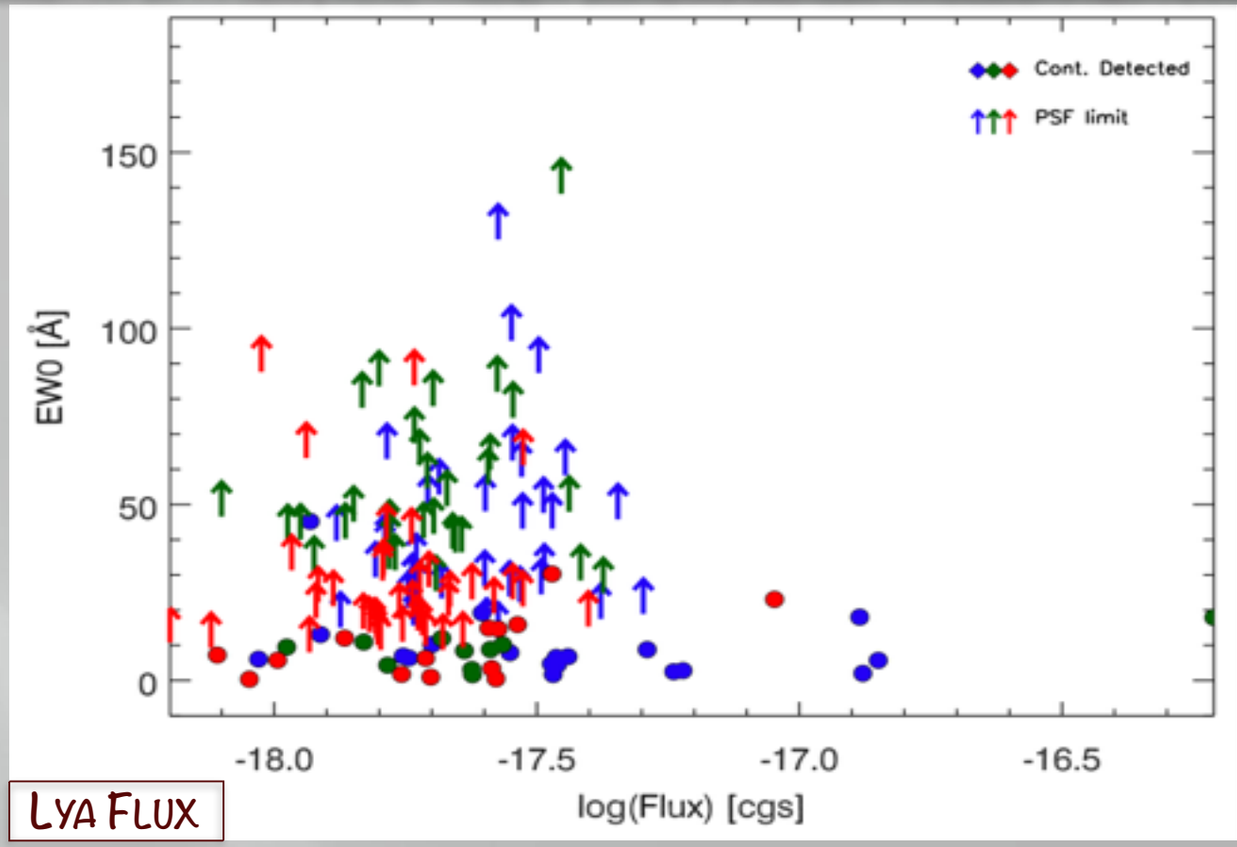
- Two approaches for the Equivalent Width measurements:
  - Matched-aperture for the continuum detected candidates (same aperture for $F_{Ly\alpha}$ and F_{cont})
  - PSF limit for the continuum undetected candidates ($F_{PSF} > 3\sigma$)

EQUIVALENT WIDTHs DISTRIBUTION

(WORK IN PROGRESS)



DETECTED LINE



LYA FLUX

EW APERTURE-MATCHED & PSF LIMIT

- No evidence (yet) at current limits for dark galaxies in the (small) volume probed around the Hammerhead Quasar.
- Working on improving our EW measurements.
- Extending our analysis to other deep (>9h) QSO MUSE fields.