The VTL at Paranal observatory (credit : eso.org)

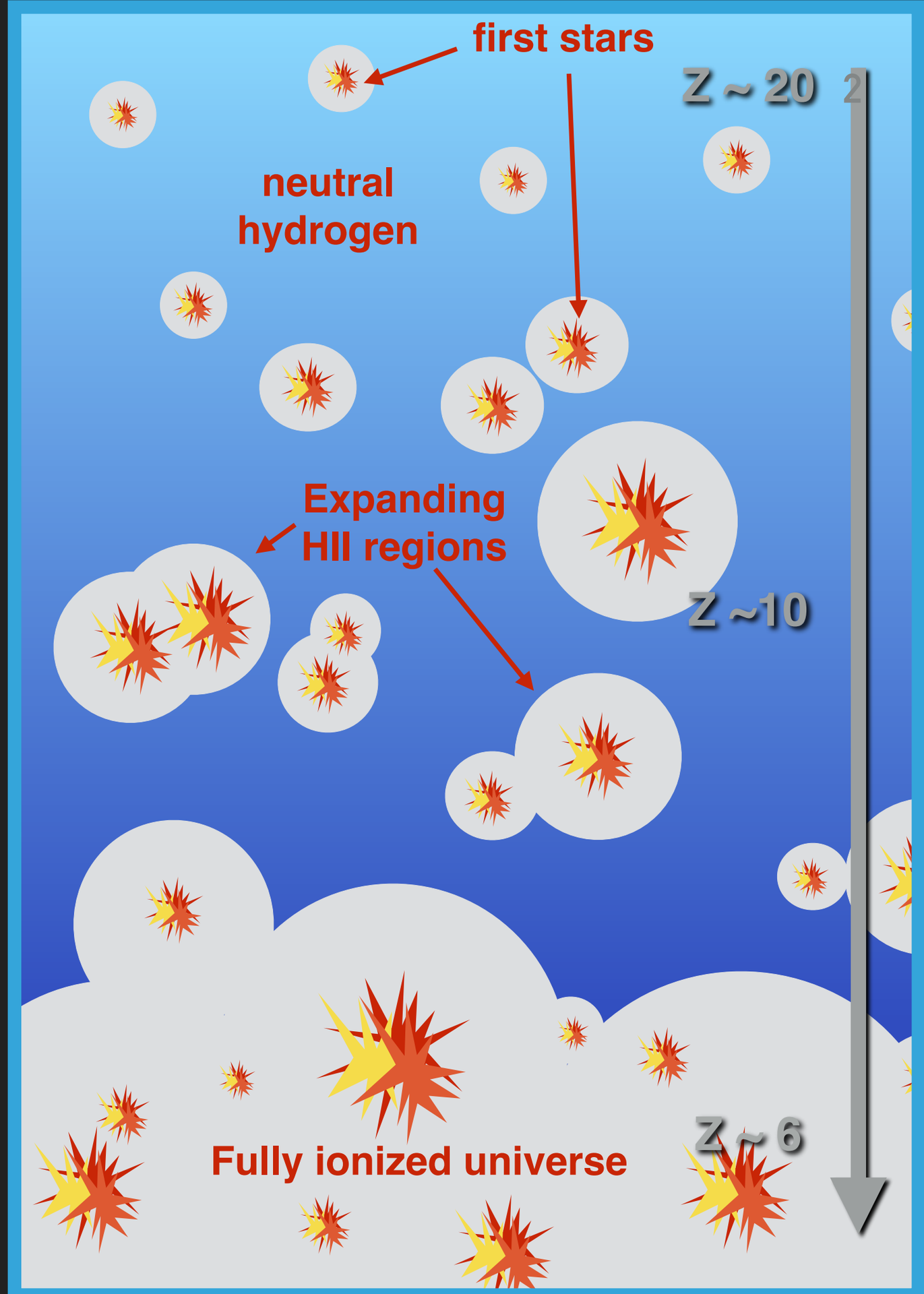
CHARACTERISTICS OF THE SOURCES OF COSMIC REIONIZATION : THE COMBINED VIEW OF MUSE AND EMIR

GEOFFROY DE LA VIEUVILLE (1ST YEAR PHD STUDENT)

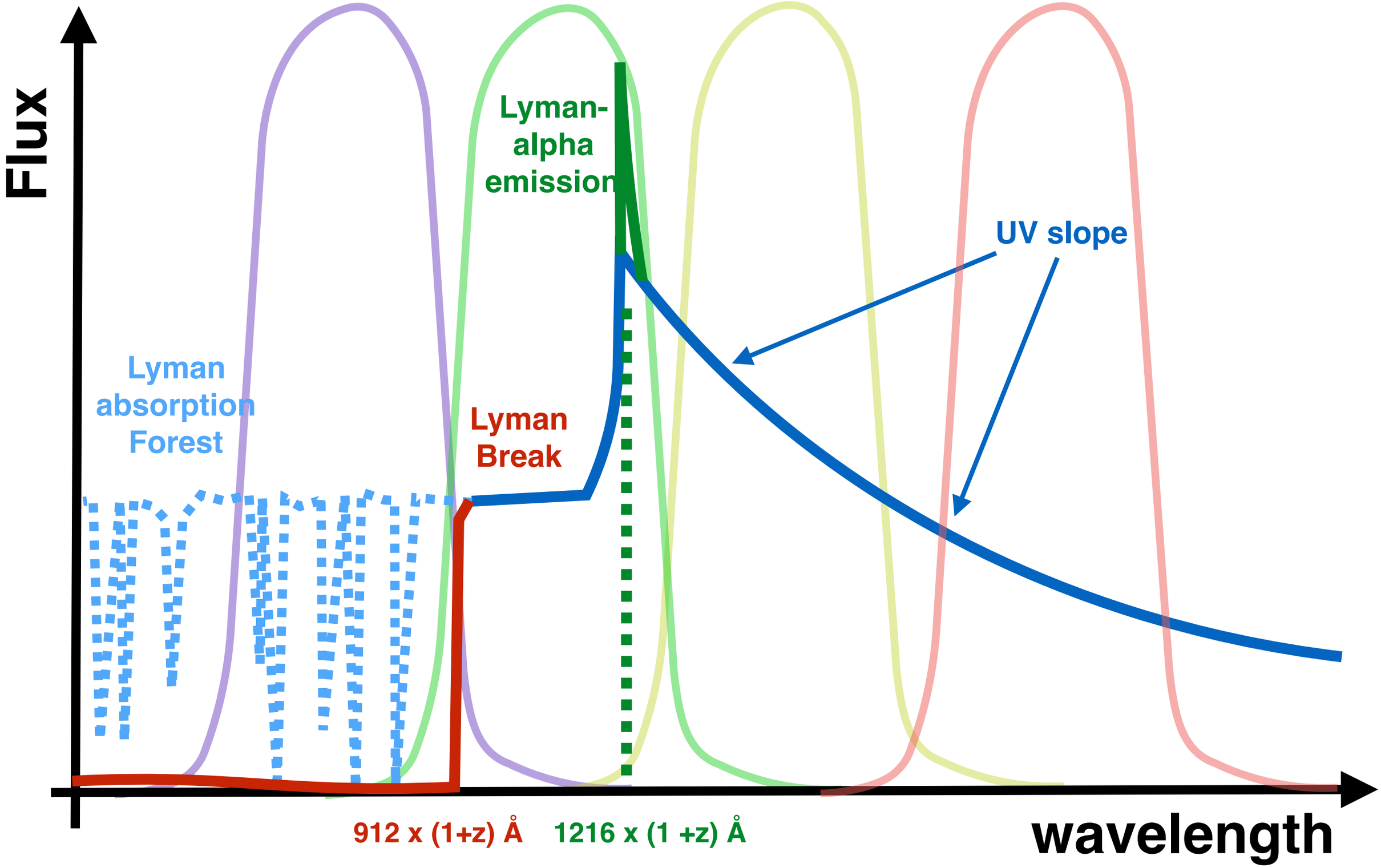
SUPERVISOR : ROSER PELLO

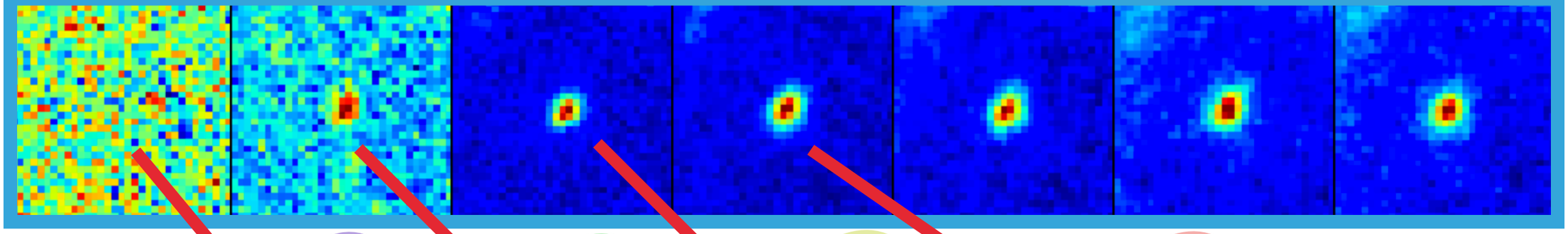
COSMIC REIONIZATION

- 6 < Z < 12 (500 millions to 1 billion year after expansion of the universe)
- Bubbles of ionized hydrogen : **patchy reionization (Becker+2015)**
- Need for enough **UV photons** to maintain the ionized state
- **Low mass, faint star forming galaxies** according to previous studies of **luminosity function** (Bouwens+2015a, D. Bina+2017 in prep., A. Drake+2016)
- **LAEs and LBGs** (selection mean)
- Unknown relative contribution of the two populations to reionization



High redshift galaxies spectra





Flux

Lyman-alpha emission

UV slope

Lyman absorption Forest

Lyman Break

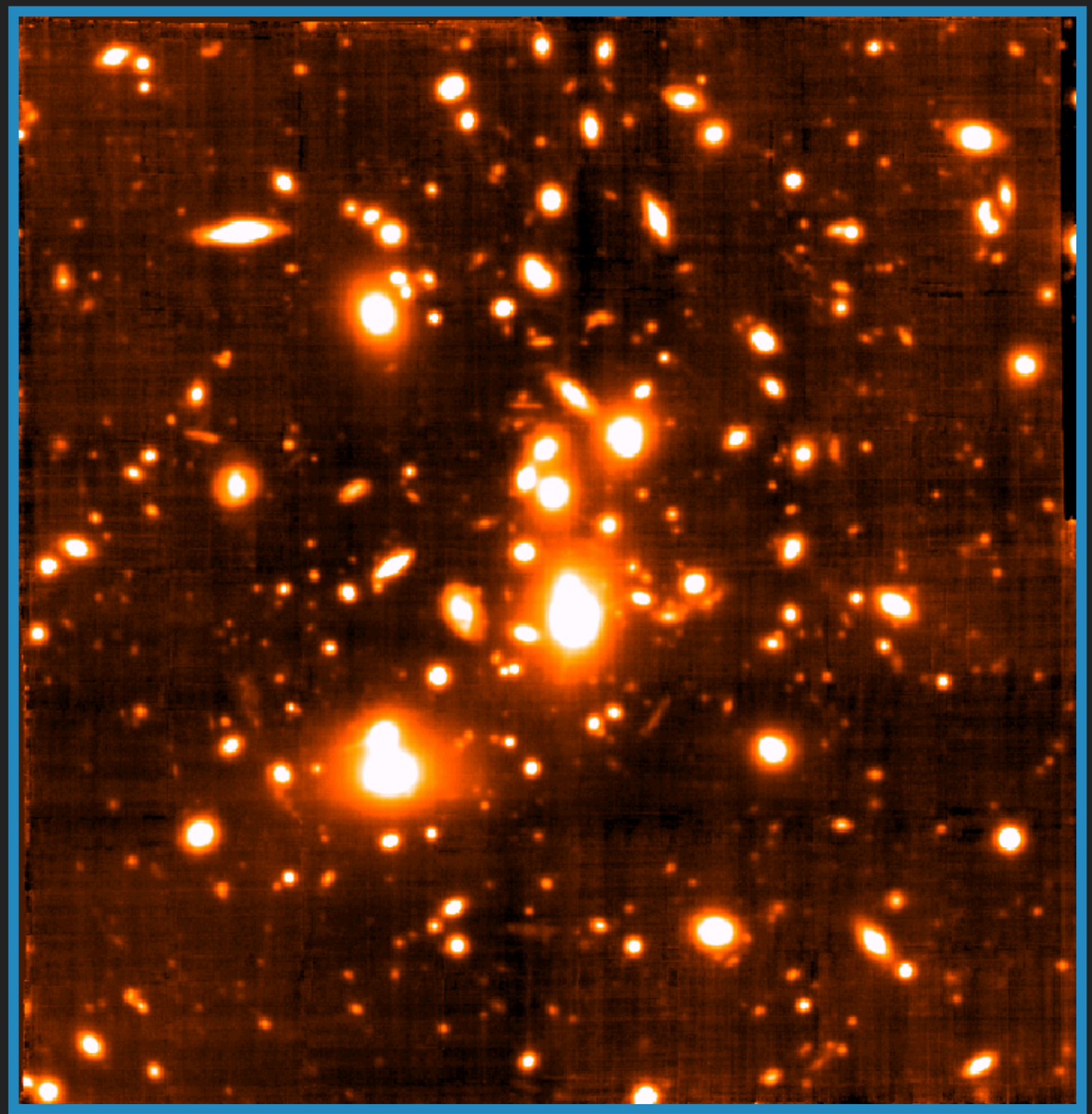
912 x (1+z) Å

1216 x (1 +z) Å

wavelength

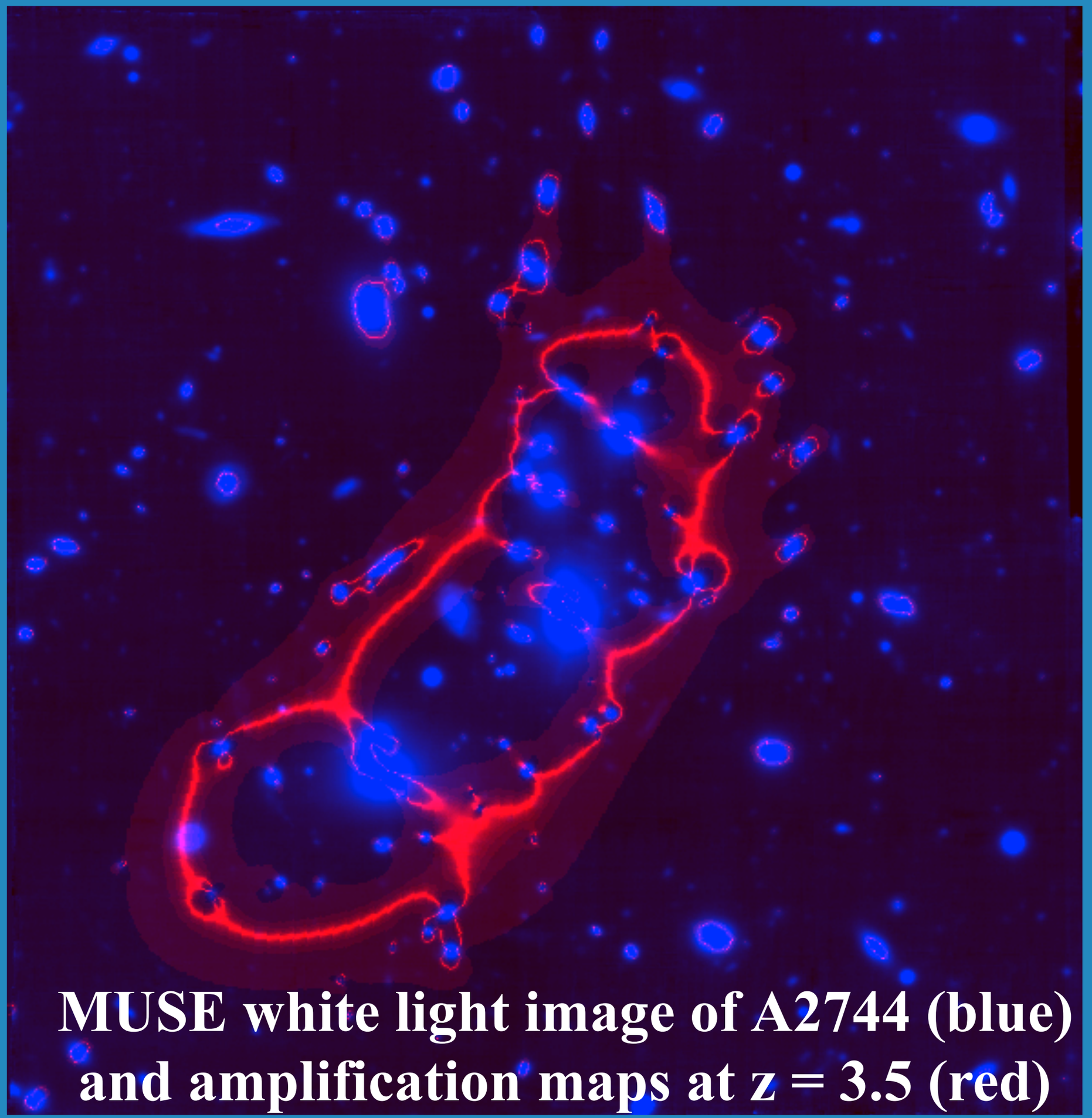
Observations strategies

- Observation of **lensing cluster** : go fainter (10 to 100 than in empty fields)
- The explored volume of universe decreases
- Use of a **mass model**
- **MUSE : integral field spectrograph on the VLT (chili)**
- Blindly detect emission line galaxies
- Large LAE population selected (~ 160 on several fields)
- **Is the density of ionizing photon from LAE enough to reionize the universe ?**

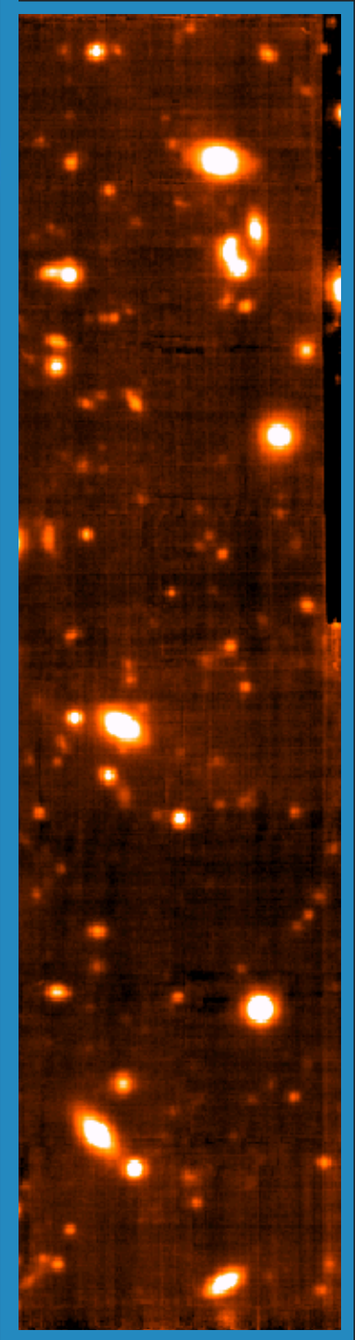


MUSE white light image of the A2744 field

- Observa
  fainter (
- The exp
  decreas
- Use of a
- **MUSE :**
  the VLT
- Blindly
- Large L
  on seve
- **Is the d**
  LAE enc
  univers



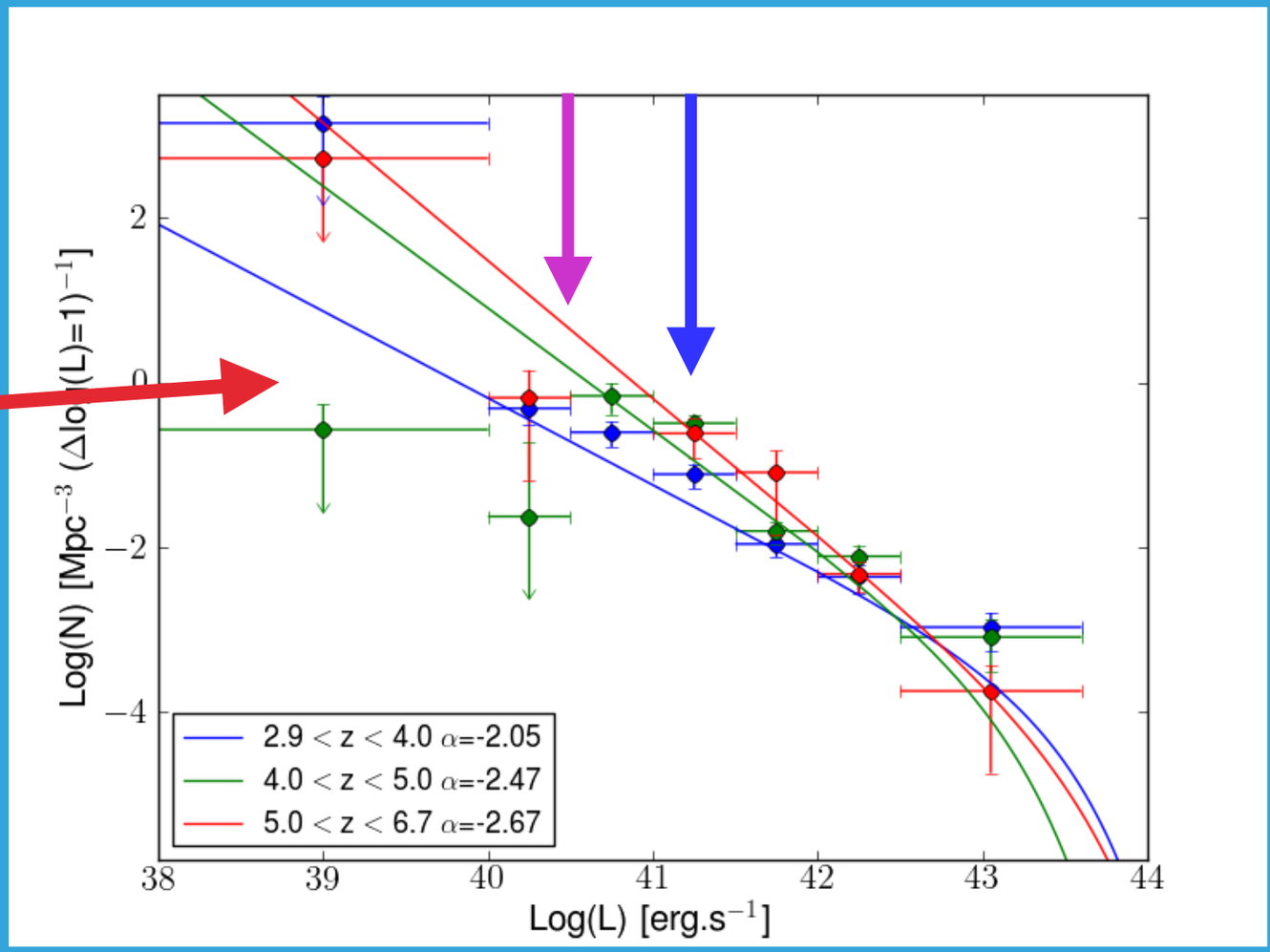
MUSE white light image of A2744 (blue) and amplification maps at z = 3.5 (red)

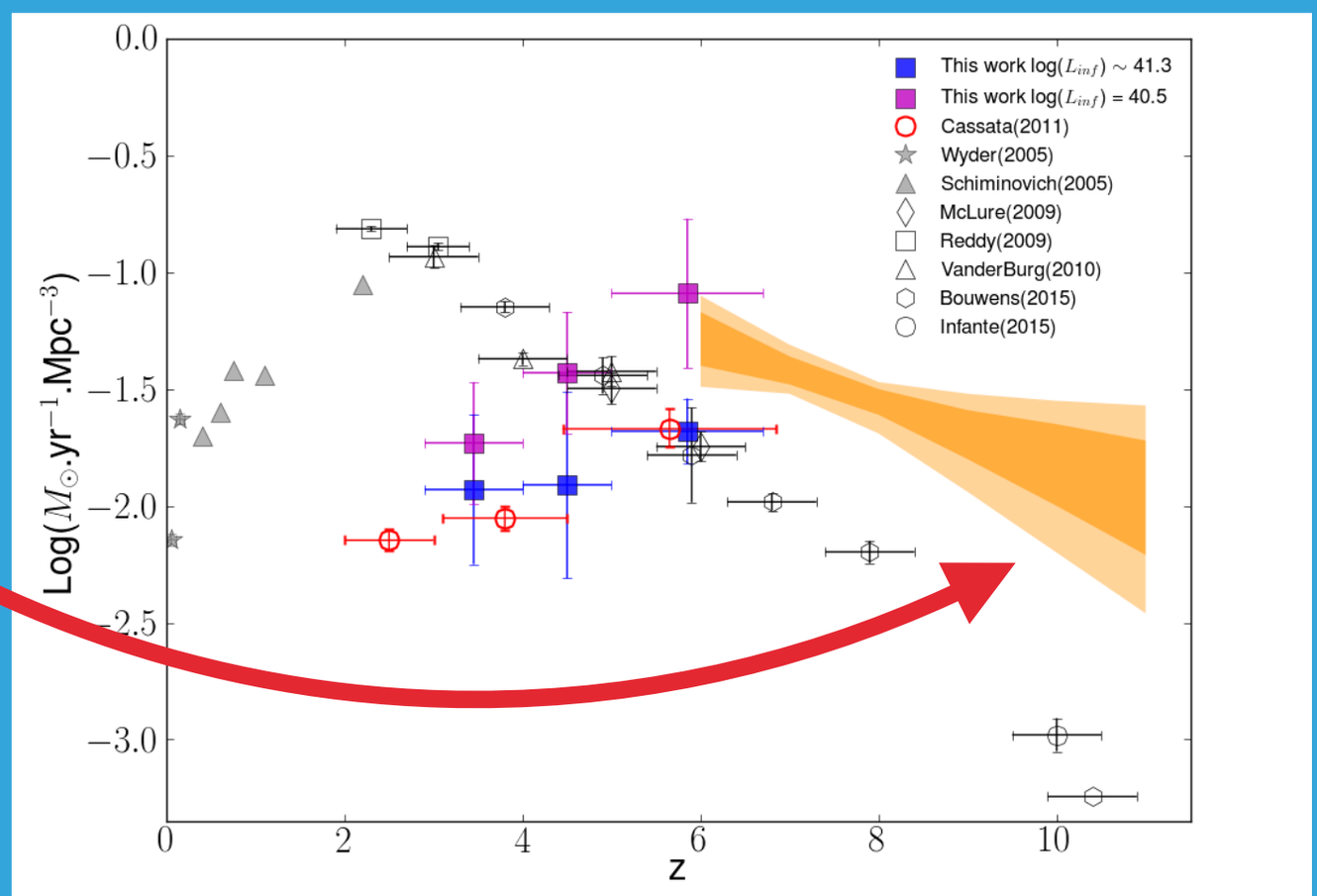


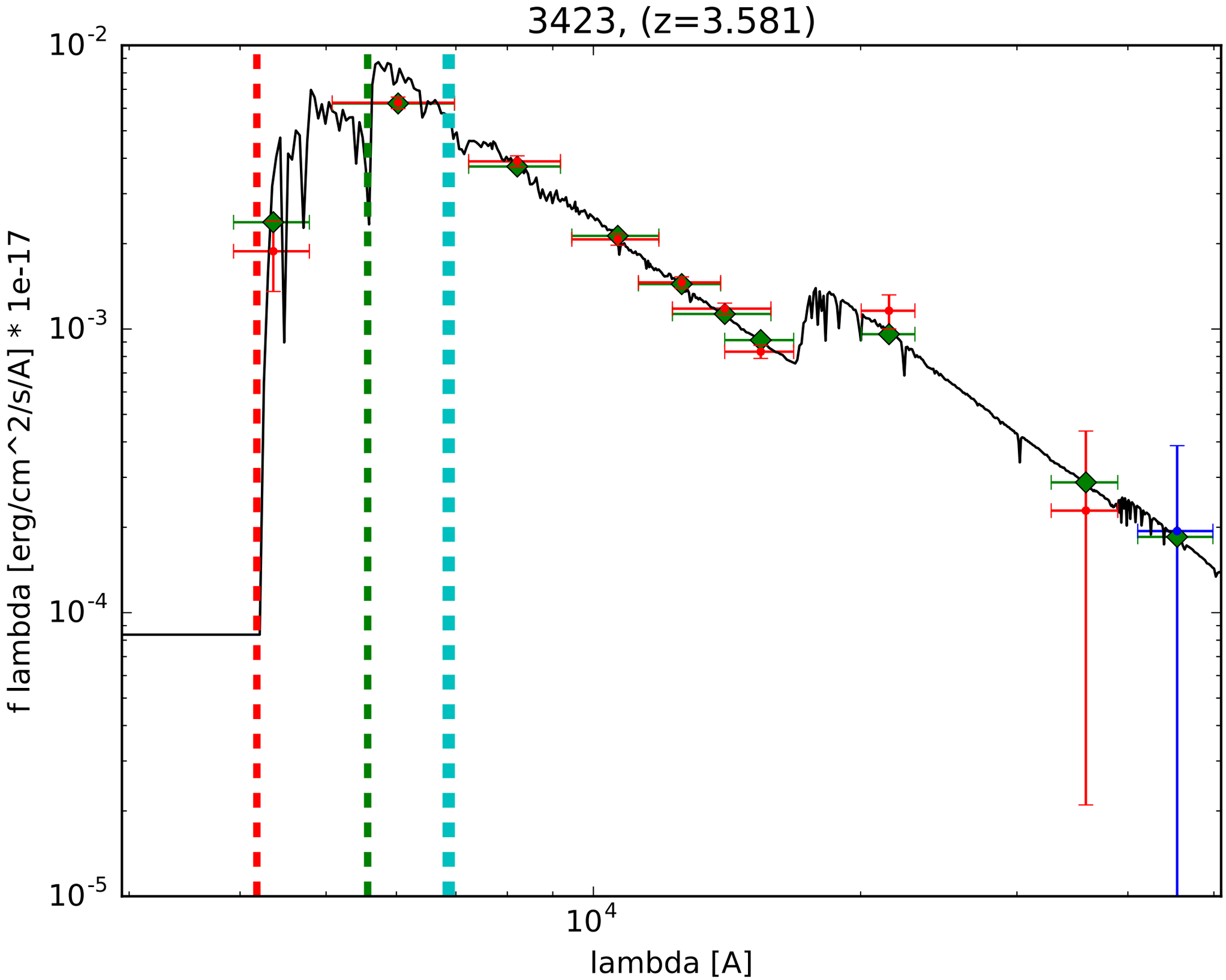
4 field

STAR FORMATION RATE DENSITY

- LAE luminosity function (D. Bina) at different redshifts
- SFRd derived from the integration of the LAE LF –> **ionizing flux density**
- **160 spectroscopically confirmed LAEs** in 4 different clusters
- **39.5 < Log10(Lya) < 42.5**
- Results are **integration dependent**
- SFRd needed to reionize the universe (Bouwens+2015a)
- **LAEs population produces enough ionizing flux to reionize the universe at z~6**



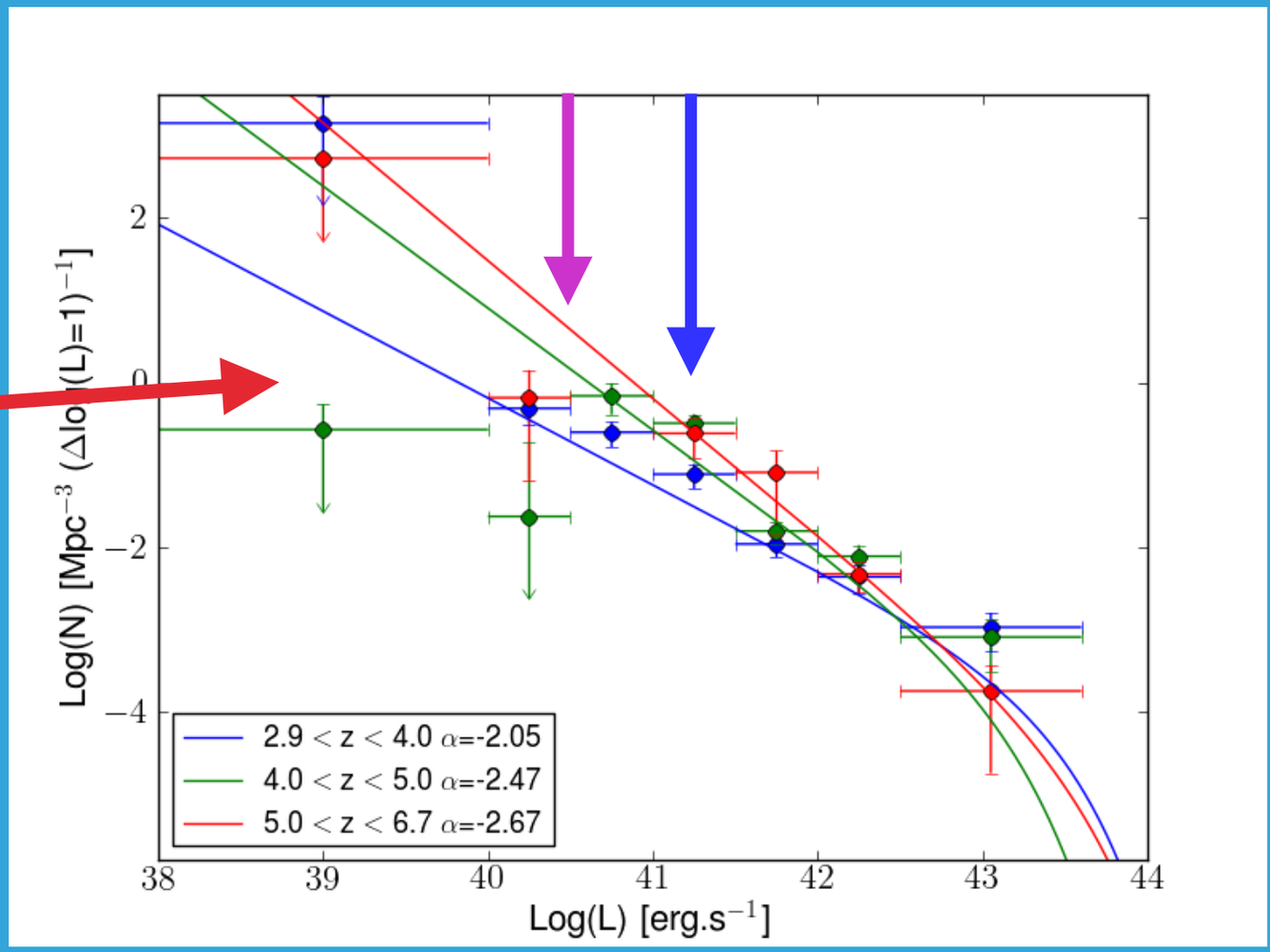


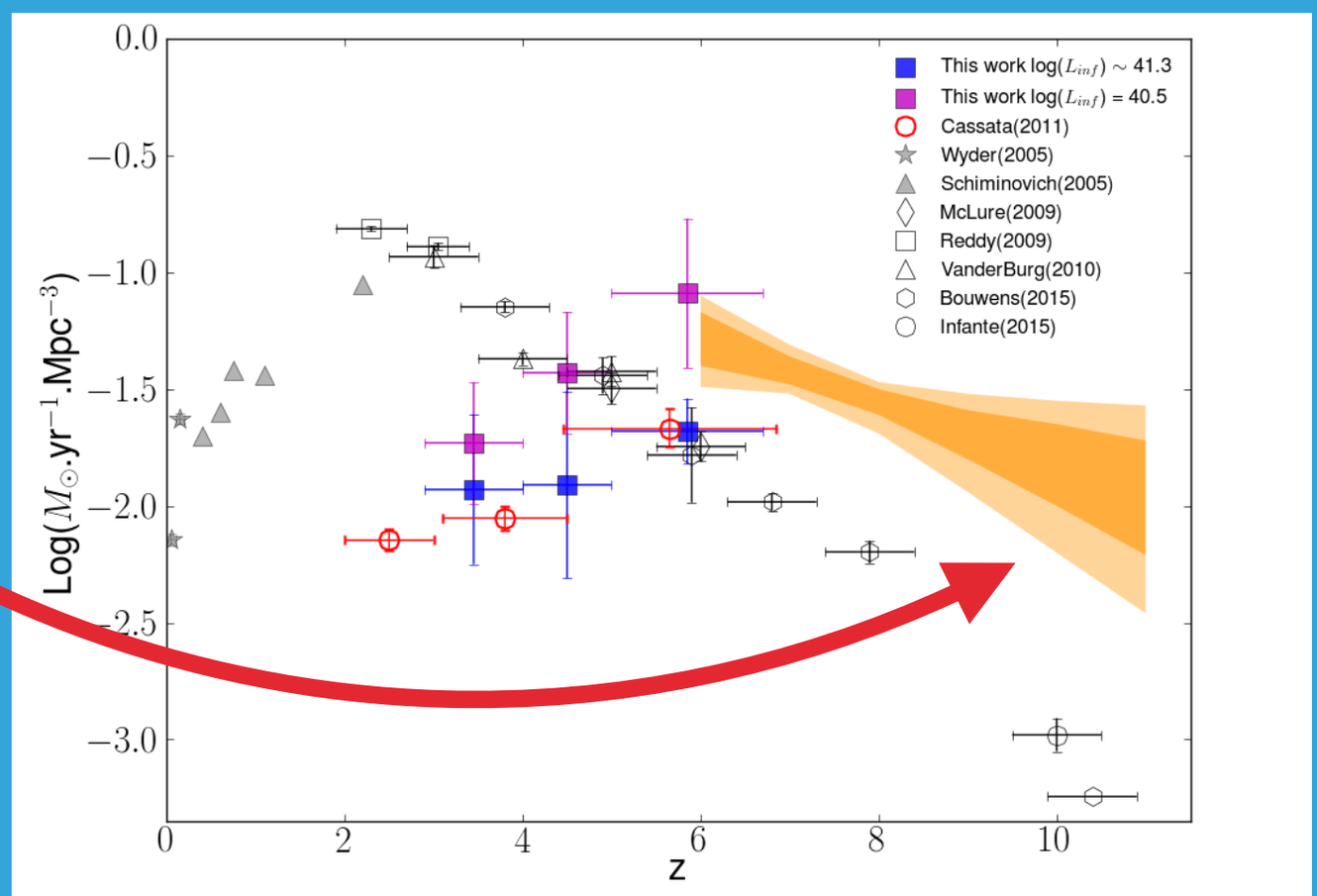

3423, (z=3.581)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
f lambda [erg/cm^2/s/A] * 1e-17
10^{4}
lambda [A]


0
2
4
6
8
10
z

STAR FORMATION RATE DENSITY

- LAE luminosity function (D. Bina) at different redshifts
- SFRd derived from the integration of the LAE LF –> **ionizing flux density**
- **160 spectroscopically confirmed LAEs** in 4 different clusters
- **39.5 < Log10(Lya) < 42.5**
- Results are **integration dependent**
- SFRd needed to reionize the universe (Bouwens+2015a)
- **LAEs population produces enough ionizing flux to reionize the universe at z~6**





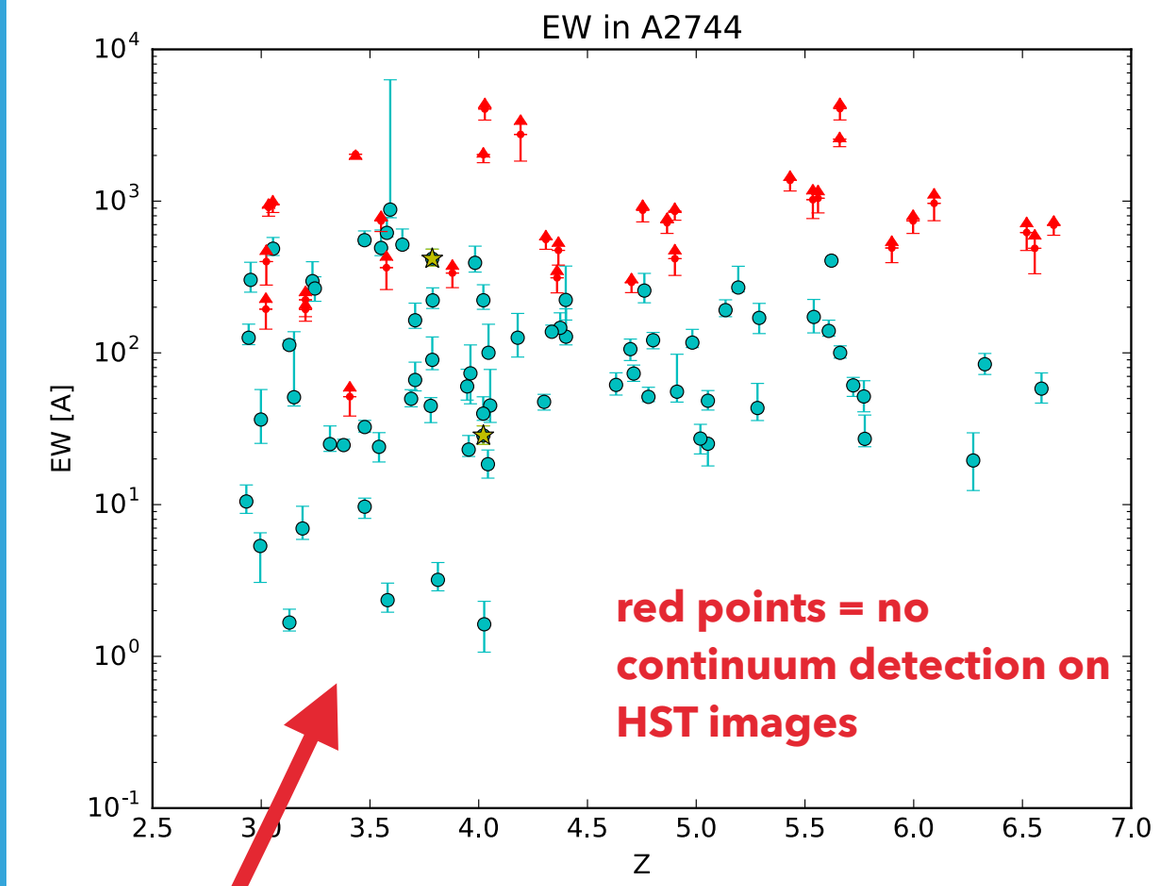
GOALS OF THE PROJECT

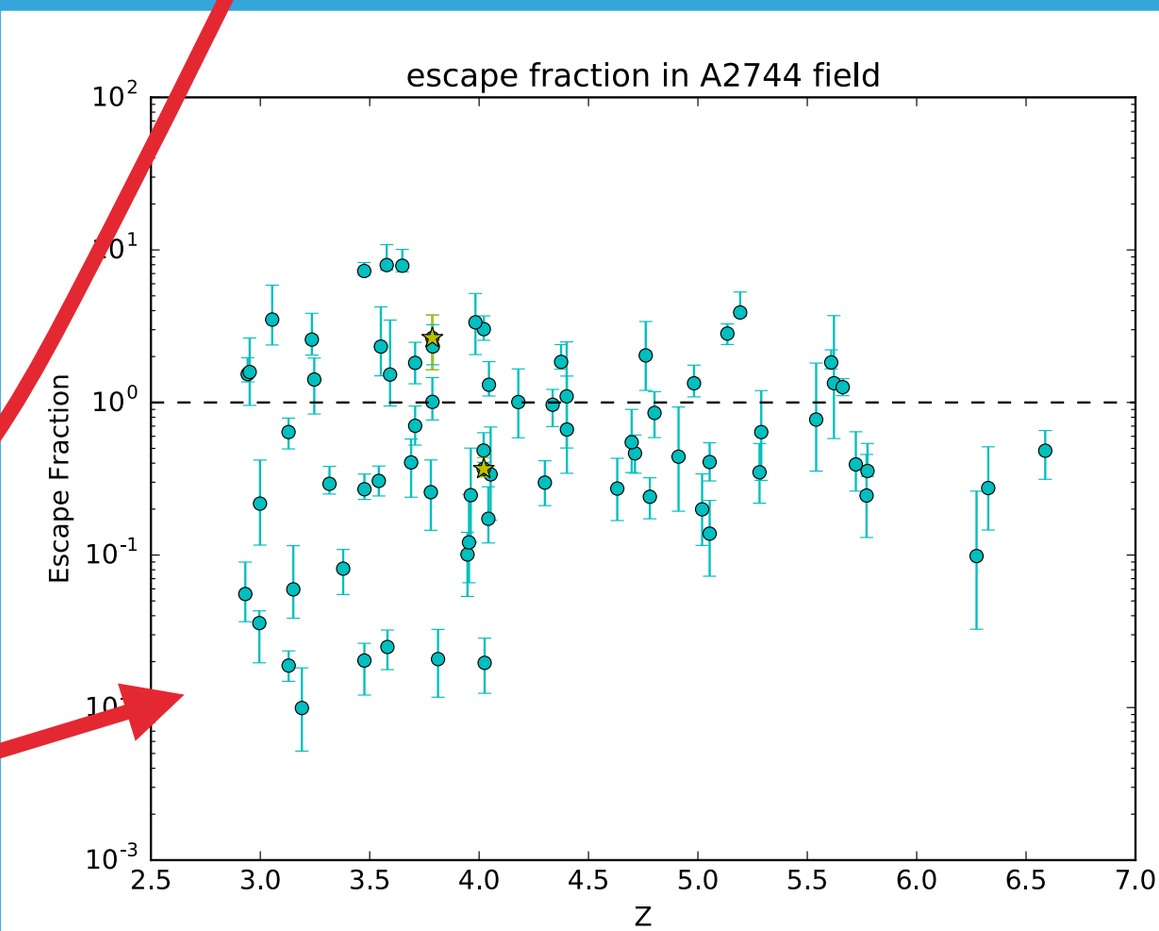
- **What is the impact of the selection process in the results derived from the luminosity function ?**
    - Already have results on the LAE LF (Bina+2017 in prep.)
- **Relative contribution** of the LAE and LBG population
    - LAE **spectroscopic** selection done by G. Mahler ($2.9 < z < 6.7$)
    - LBG **photometric** selection is currently on-going ($3.4 < z < 8.3$)
    - Comparison in the **same volume of universe**
- Study the intersection of those two populations
    - Characterize the two populations

LAE CHARACTERIZATION

- **Lensing characterization** of the sources (Lenstool, J.-P. Kneib+1996)
- **Monte Carlo iterations** on photometry
- **SED fitting** with HyperZ (Bolzonella+2000)
- Resulting **UV (1500 A) and Lya continuum flux population**
- **Dust correction** for the escape fraction (Blanc+2011)

- **EW(Lya) population and Fescp population**
- **median value for EW : 72.8 A**
- **median value for escape fraction : 0.48**





LBG SELECTION

- From photometric data (HST, Hawk-I Kband, Irac1 and 2) (Astrodeep catalog,Merlin+2016)
- **Zlim = 3.4**
- **SED fitting**
- 5 categories from 1 to 5 based on the value of :

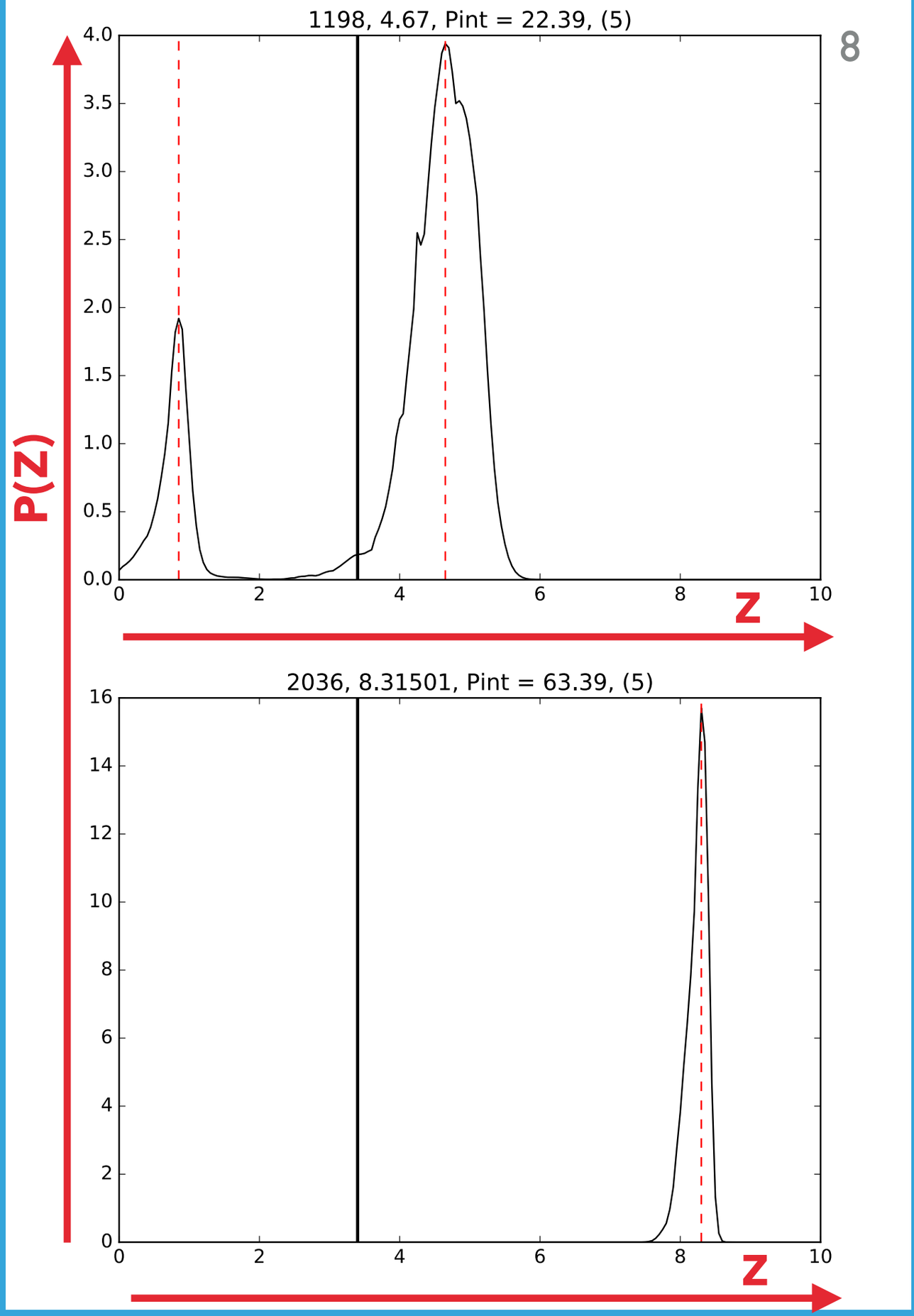
$$\int_{z_{lim}}^{+\infty} P(z)dz$$

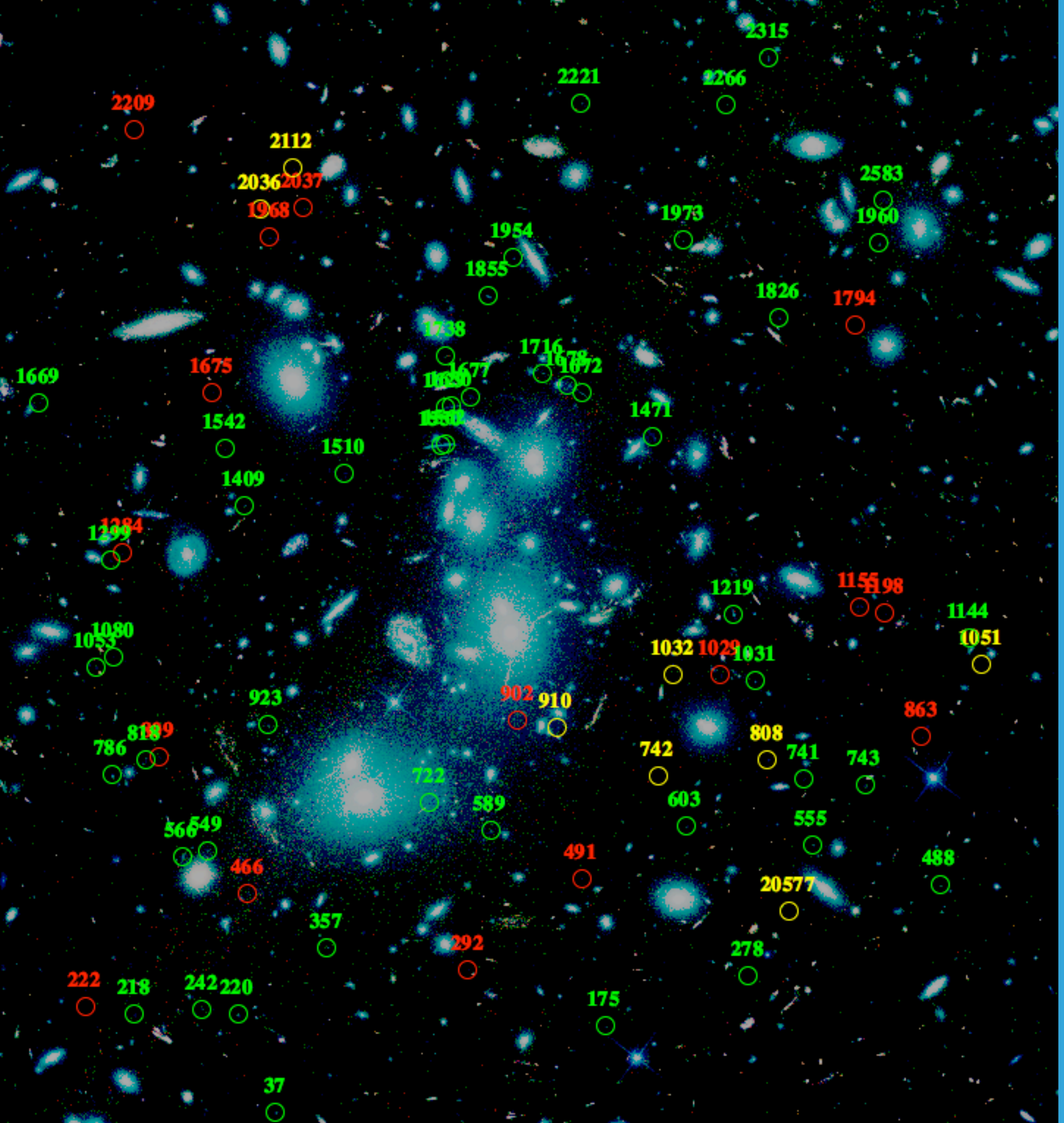
- **80 - 100% : categorie 5**

  60 - 80 % : categorie 4

  etc ...

- How certain we are that the galaxy is a high redshift one





- **green :**
  3.4< Z <4.5
- **red :**
  4.5< Z <5.5
- **yellow :**
  5.5< Z <8.3

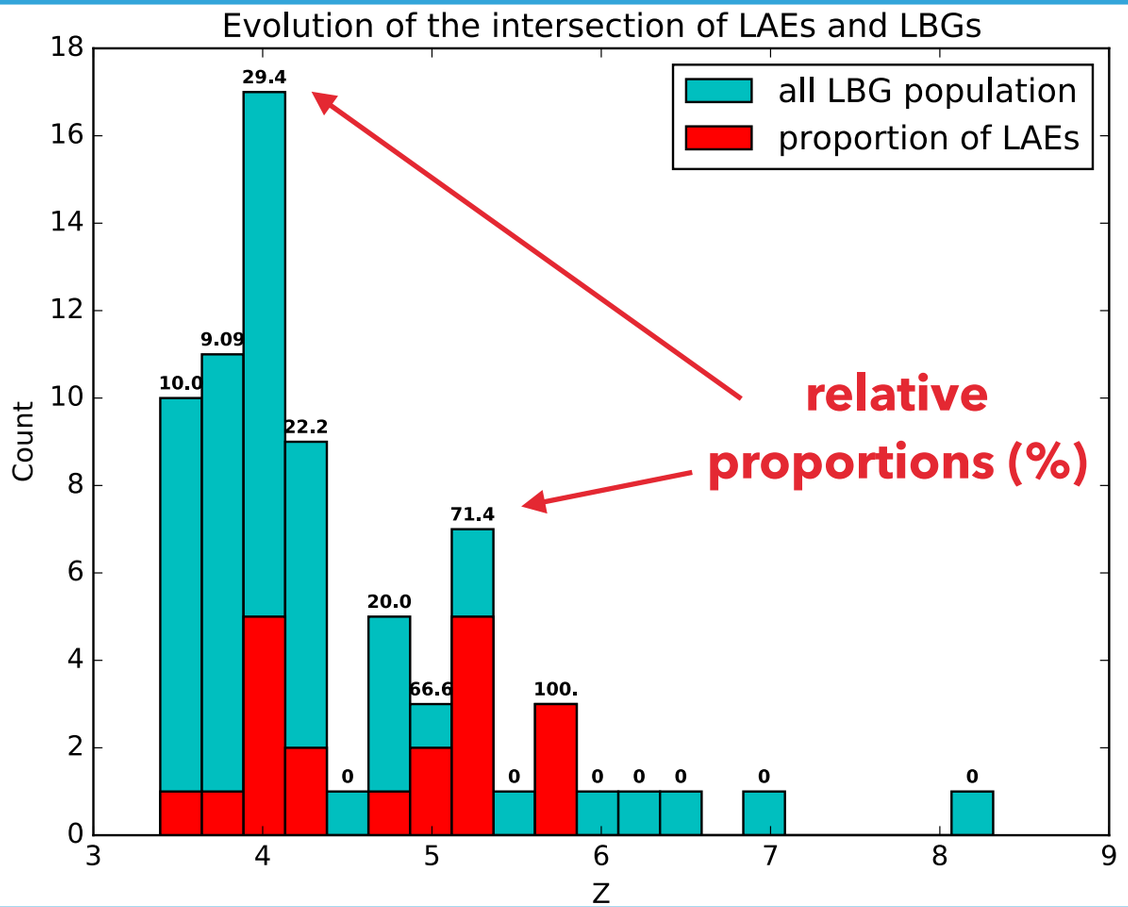
LBG SELECTION

- **72 relatively secure LBGs**
- Among 98 sources, **22 can be matched to the LAE detection catalog**
- Our method to select high redshift galaxies works well
- **No correction for multiple sources yet**

flag	LBGs	LAEs spec confirmed
1	13	0
2	5	0
3	8	2
4	20	5
5	52	15
secure LBGs	72	20

PRELIMINARY CONCLUSION

- **72 LBGs selected** (3.4 < z < 8.3). **20** (28%) of them are also **spectroscopically confirmed LAEs**
- In the intersection of the photometry and detection catalog (76 sources), **20 of them are selected as LBGs as well (26%)**
- **LAEs are likely to play a predominant role in the reionization process**



WHAT'S NEXT

- **Lensing characterization** for the LBG selection
- Compute the **luminosity function for the LBG population**
- Investigate the relative contribution to the total ionizing flux of the two populations