Studying the Luminosity Function of Lyman Alpha emitters selected behind 17 lensing clusters from MUSE/VLT observations

Tran Thi Thai [1,2], Pham Tuan-Anh[2], Roser Pello[1], Johan Richard[3], Adelaide Claeyessen[4], Ilias Goovaerts[1] & the MUSE Team

1-Laboratoire d'Astrophysique de Marseille (LAM), France, 2-Department of Astrophysics, Vietnam, 3-University de Lyon 1, France, 4-Stockholm University, Sweden.

Abstract: We present the results of our study of the Lya Luminosity Function based on sample of ~600 sources with Lya luminosities down to 10^{39} erg s^{-1} and redshifts in the range z=[2.9, 6.7]. These Lya emitters (LAE) have been selected behind 17 lensing clusters observed with MUSE at the ESO/ VLT. Taking advantage of the magnification effect, this unique data allows us to set strong constraints on the contribution of the LAE population to cosmic reionization. We discuss the shape of the Luminosity Function (LF) up to the faintest limits and its evolution with redshift. The faint end of the Luminosity Function displays a steep slope up to log(L(Lya))~40.5, roughly in agreement with previous results obtained by de la Vieuville et al. (2019) using only four clusters. There is also some evidence for a flattening towards the faintest edge that still needs further investigation.

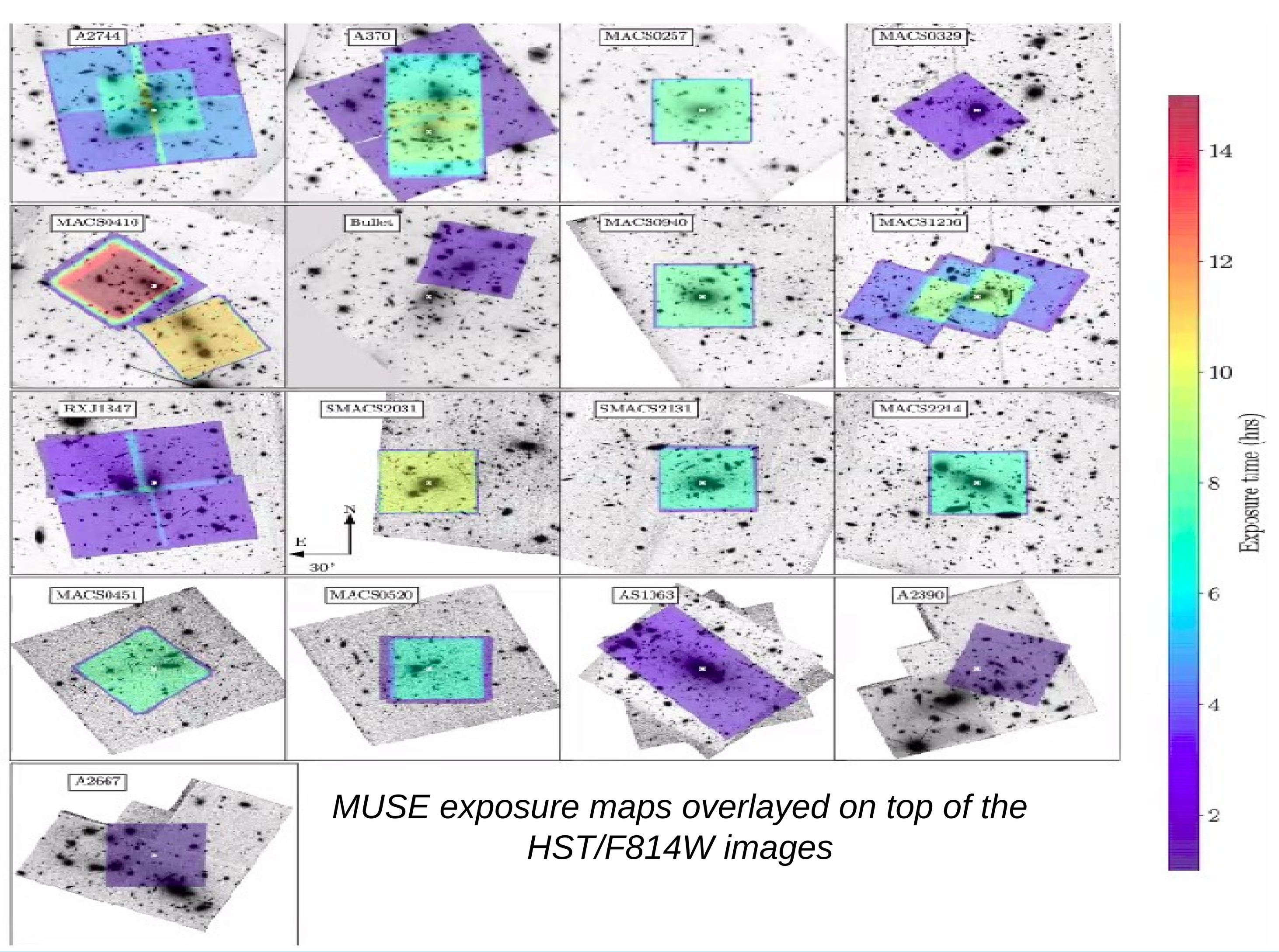
Introduction

MUSE stands for Multi-Unit Spectroscopic Explorer, an integral field spectrograph installed at the Very Large Telescope of the European Southern Observatory (Bacon et al. 2010), covering a region of 1 arcmin^2 field of view. MUSE has opened a new era in the study of strong lensing clusters, in particular thanks to its ability to detect distant and faint background galaxies without any preselection.

MUSE data cubes have three dimensions, two in the spatial direction and one in wavelength, with 3681 channels ranging from 4750A° to 9370A°, effectively detecting Lyman Alpha Emission at redshift 2.9 < z < 6.7

Cluster sample

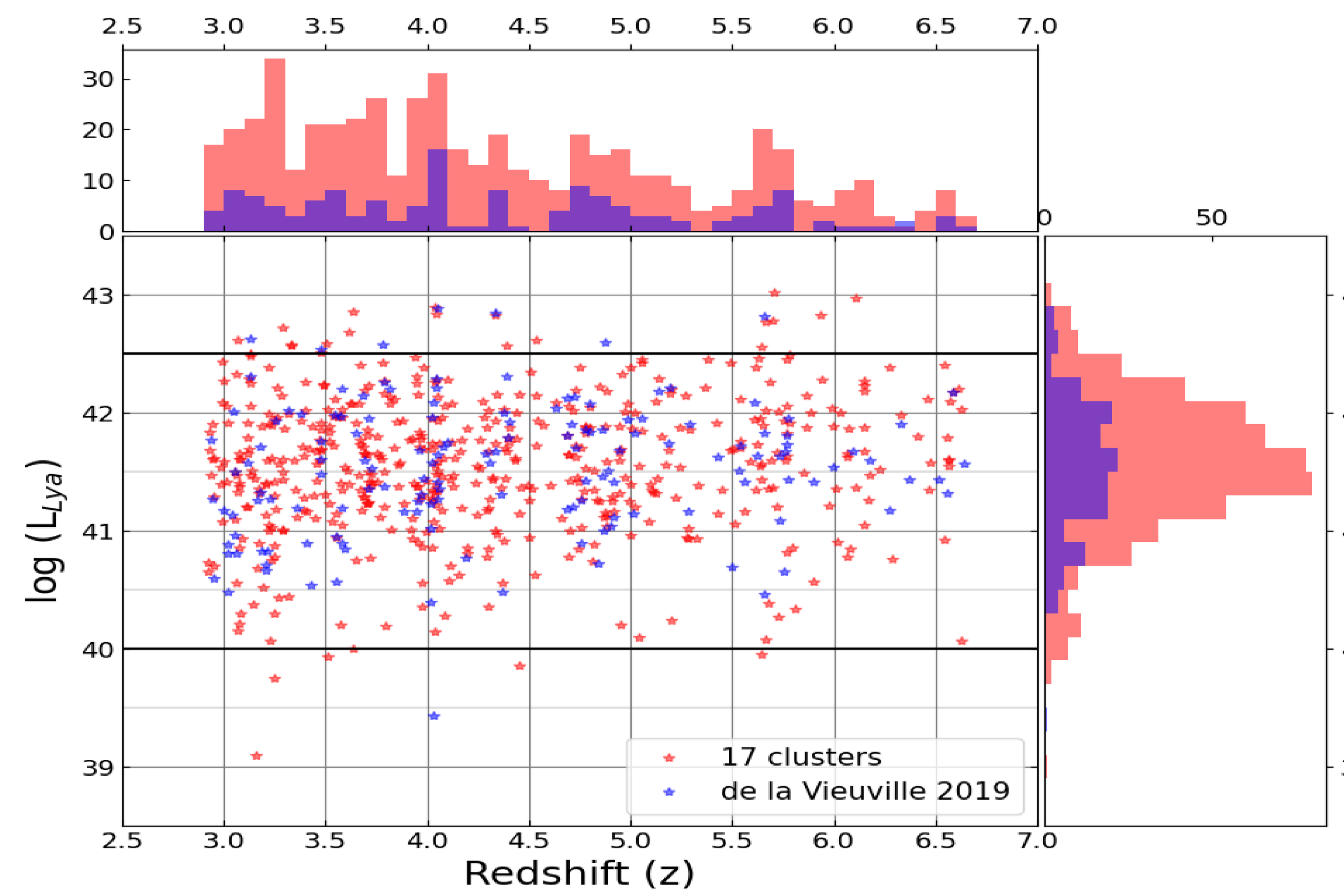
This study includes 18 data cubes on 17 lensing clusters. The seeing value, defined as the FWHM of the point spread function at 7000 A°, varies from 0.52" to 1.02" among the fields. Cluster redshifts range between z=0.2 and 0.6. The field of view is pointed to the core regions in order to maximize the number of strongly lensed LAEs. The observing time for each cluster varies between 2 and 14 hours (see figure), with a total integration time of about 120h. Details can be found found in Richard et al (2021).



MUSE exposure maps overlayed on top of the HST/F814W images

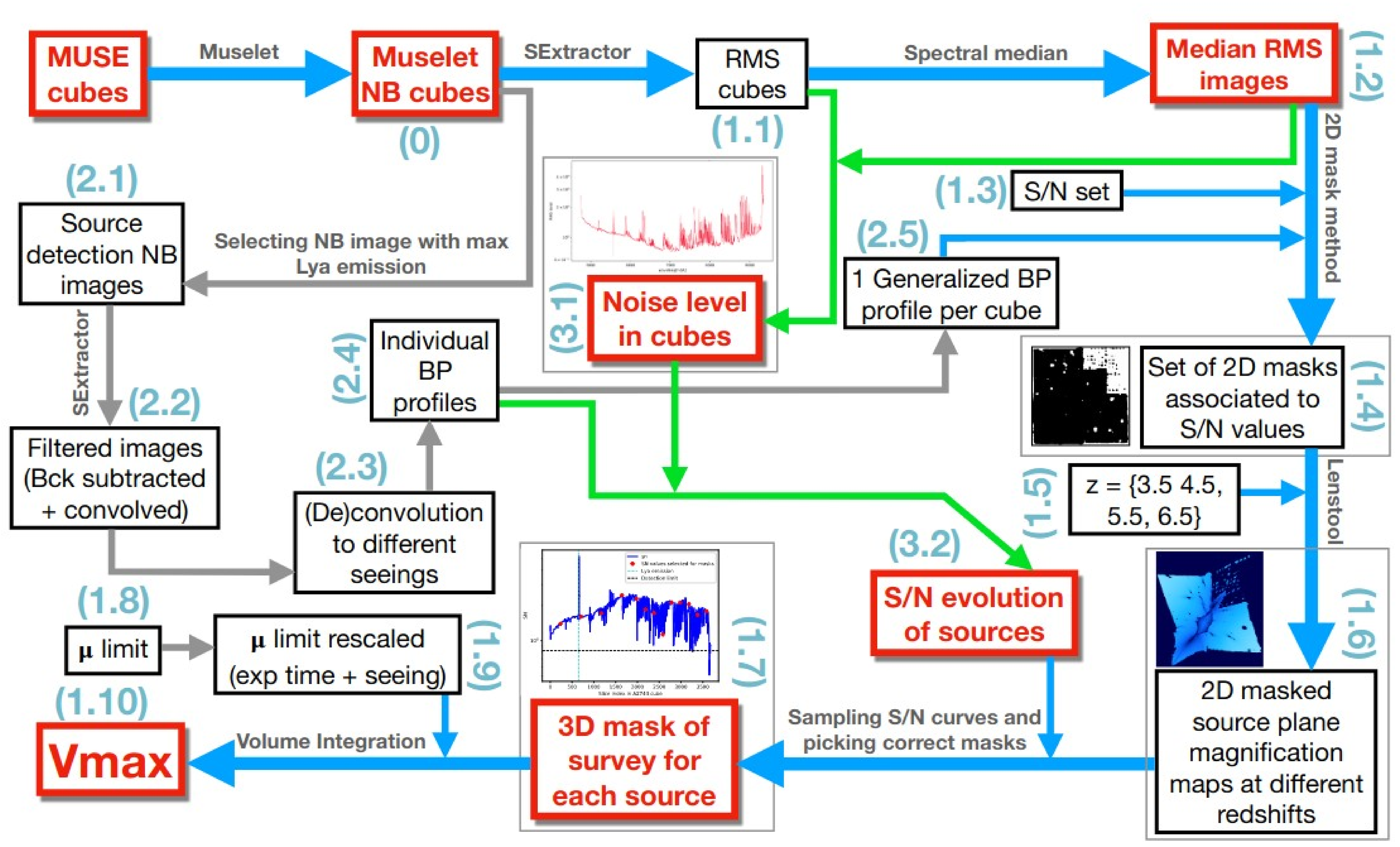
LAEs sample

The methods used to build the catalogs are presented in Richard et al (2021). There are 609 LAEs in our sample (single images), with secure redshifts (confidence levels 2 & 3). For multiple-image systems, the image chosen to represent the parent source is selected based on the quality of the detection, and the reliability of the magnification.



Method

The V_{max} method is adopted to determine the LF values (see expression below). An improved version of the pipeline developed by de la Vieuville et al (2019) is used to compute these values, following this procedure:



LF values at a given of redshift and luminosity bin (i) are obtained by the sum of contributions of LAEs in this bin :

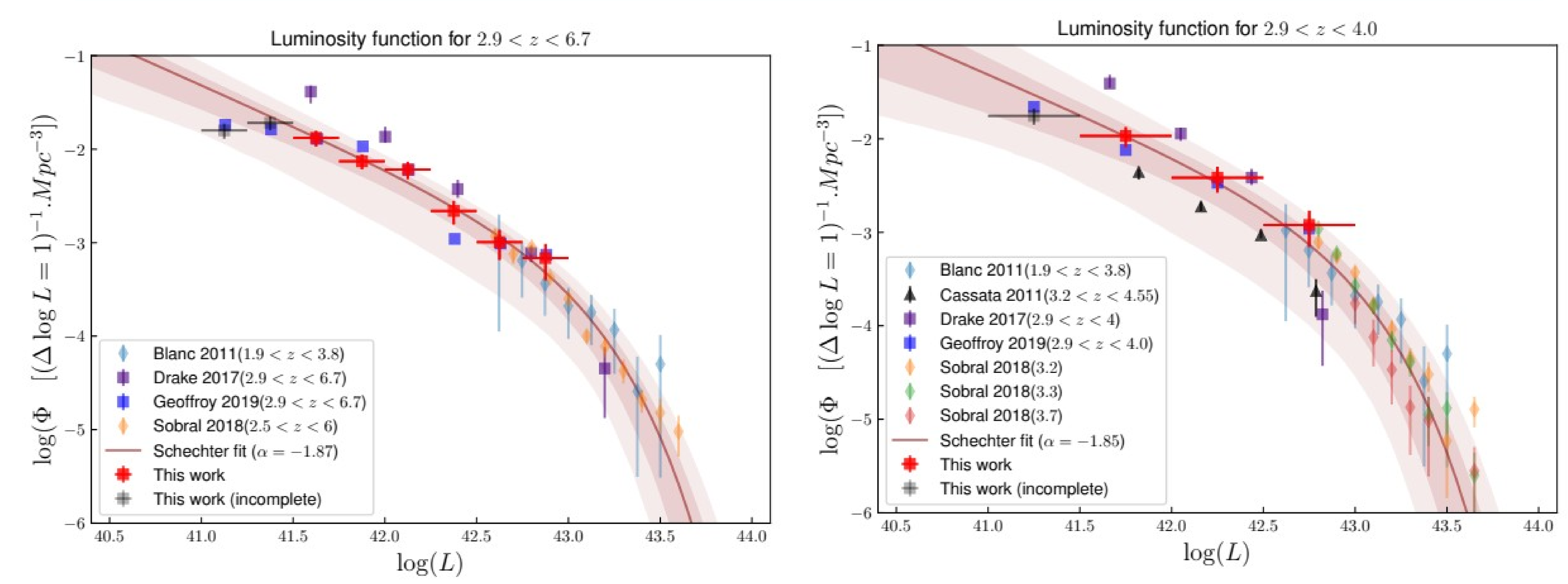
$$\Phi(L_i) = \frac{1}{\Delta \log L_i} \sum_j \frac{1}{C_j V_{max,j}},$$

$\Delta \log L_i$: width of a given luminosity bin in logarithmic scale

C_j: Completeness value for the LAE (j)

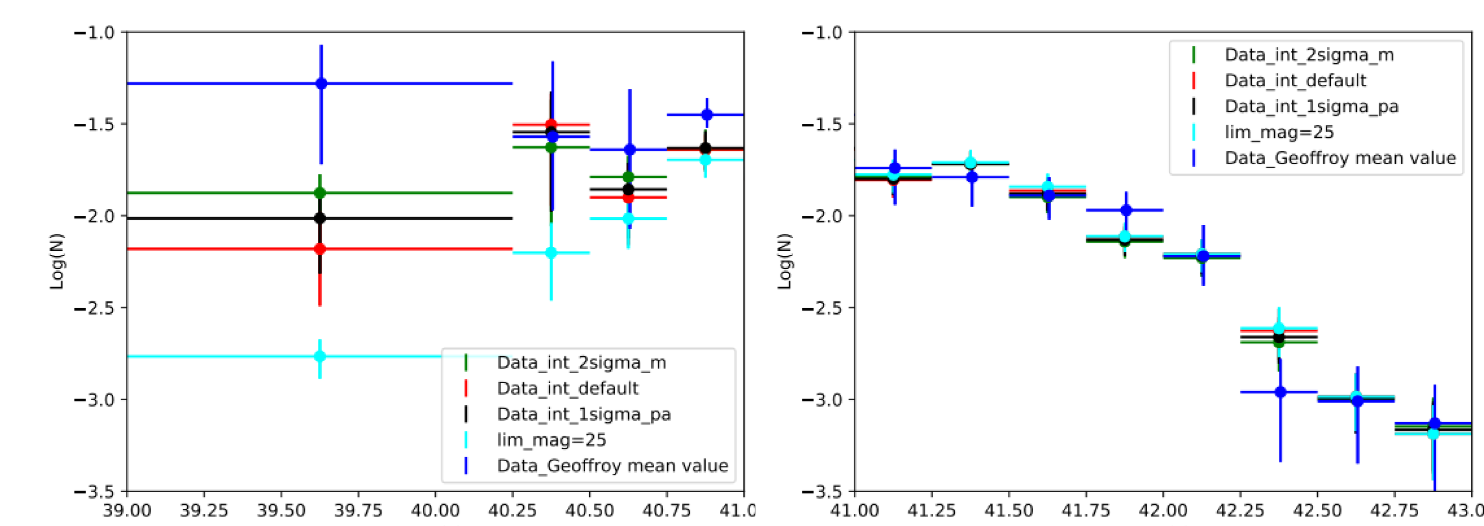
$V_{max,j}$: Effective volume of the survey where the individual LAE (j) could have been detected

Results



The maximum co-volume probed between 2.9 <z <6.7 is ~48 000 Mpc^3, that is three times larger than de la Vieuville et al (2019).

The steep slope of the LF is consistent with other results in the literature at least up to log (L_{Lya})~40.5. A turnover is observed for fainter luminosities, that still needs further investigation.



The statistic achieved at log L_{Lya} <40.5 is much better with the current sample. At these faint luminosities, the main contributors are the sources in the highest magnification regime.

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thai.tran@lam.fr