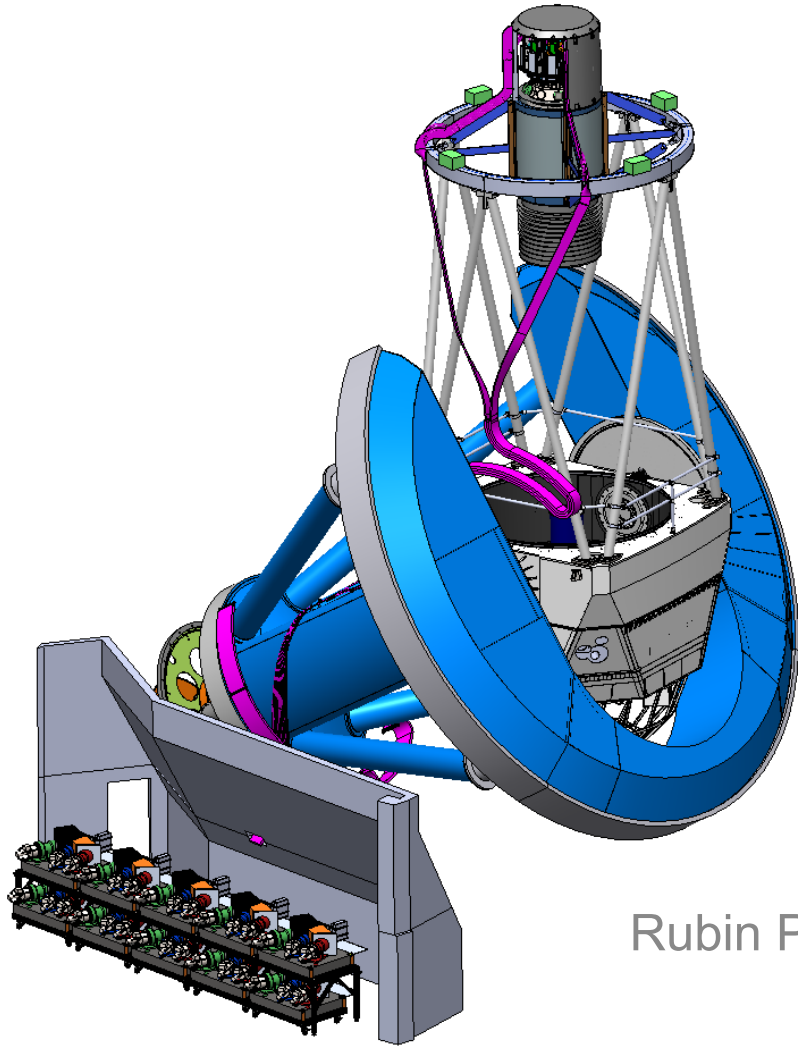# The DESI-II LBG survey

# (Lyman Break Galaxies)

A. Raichoor (LBL), **on behalf of the DESI collaboration**

Rubin Project & Community Workshop — Tucson, USA

Aug. 11th, 2022

**Dark Energy Spectroscopic Instrument**
U.S. Department of Energy Office of Science
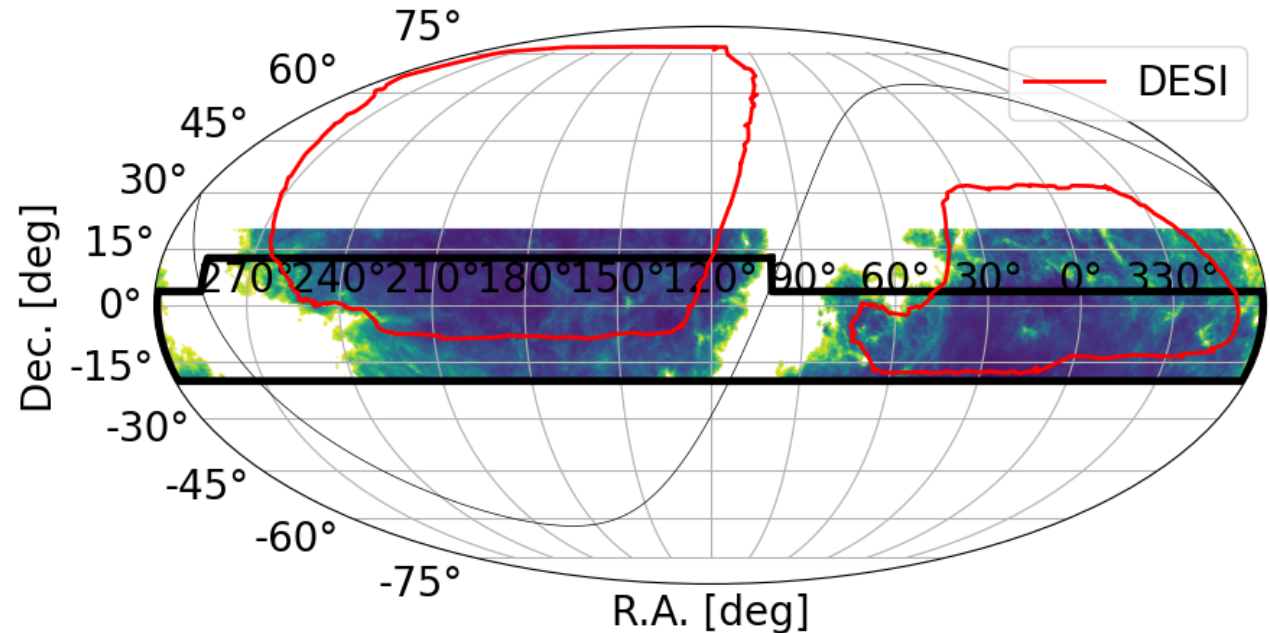Lawrence Berkeley National Laboratory

# DESI-II LBG survey: cosmology at z > 2

**Science motivation**

- Large-scale structures at 2 < z < 4: large volume
- BAO and RSD before dark energy dominated (also see e.g., https://arxiv.org/abs/2203.07506)

**DESI-II LBG survey**

- LBG target density : 1k / deg2
- Footprint: 11k deg$^2$ at -20 < Dec. < 20 (EBV<0.2) ; duration: ~5 years



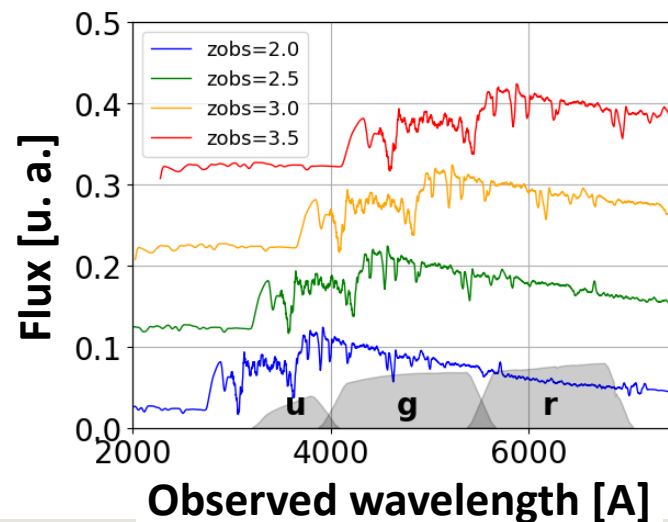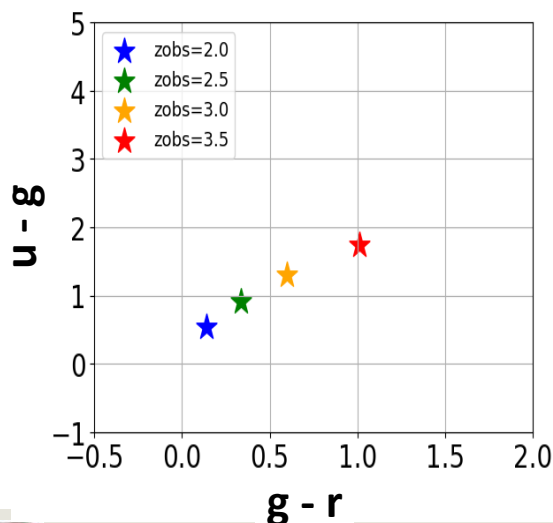Also exploring LAEs (Lyman-α Emitters) at 2 < z < 4 for DESI-II

# LBG: target selection principle

**Lyman Break Galaxy (LBG) Principle**

- Massive, actively star-forming galaxies at z > 2
- Known for decades (e.g., Steidel+96, Adelberger+04, Hildebrandt+09, etc)
- Flux bluewards of 912 A absorbed by the neutral hydrogen ("Lyman break")

**BXU (2 < z < 3.5)**

- Lyman break bluewards of the u-band at z < 3.5
- Still ugr-bands based cuts efficient to select 2 < z < 3.5 galaxies (using Lyman series abs.)
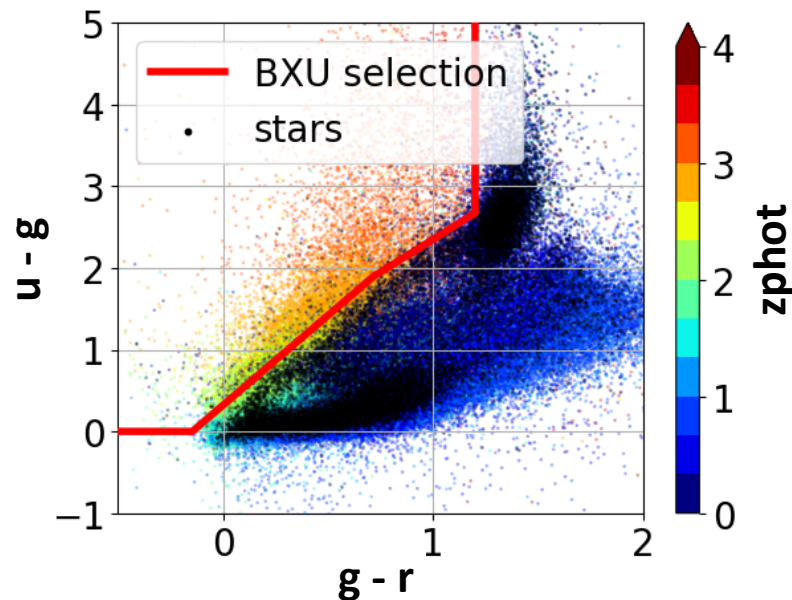
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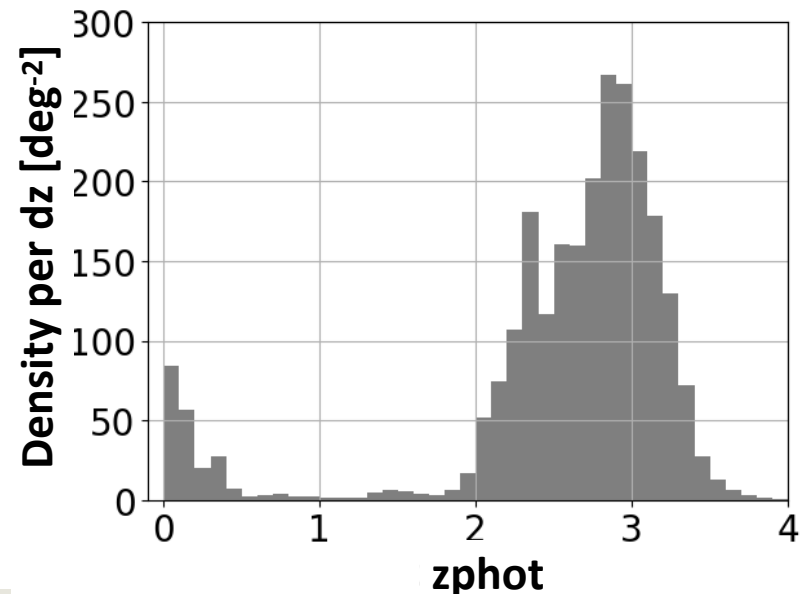
3

# LBG Pilot program: goal and target selection

**Goal**

- Test DESI ability to measure z~2-4 LBG redshifts
- Provide data to develop all the tools: spectro. truth, pipeline development, target selection

**Target selection**

- BXU from ugr-bands very-deep photometry (CLAUDS) over ~5 deg2 in COSMOS



CLAUDS
r < 24.5

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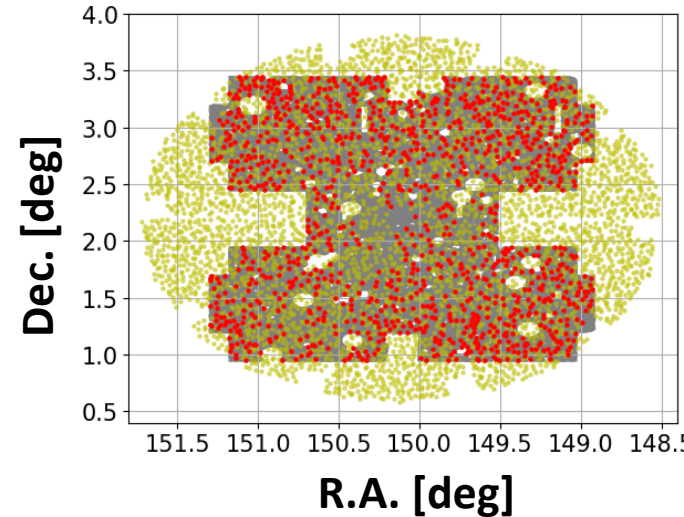Rubin Project & Community Workshop — Aug. 11th, 2022

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# LBG Pilot program: observations

## Spectroscopic observations

- Mar. - Apr. 2021 + Mar. 2022
- 3 tiles (one tile = 3k-4k science targets over 8 deg2)
- Multiple exposures:
    - allows one to generate shallower coadds (1h, 2h)



## Spectroscopic effective time

- Measure the effective signal to noise delivered by the system, accounting for:
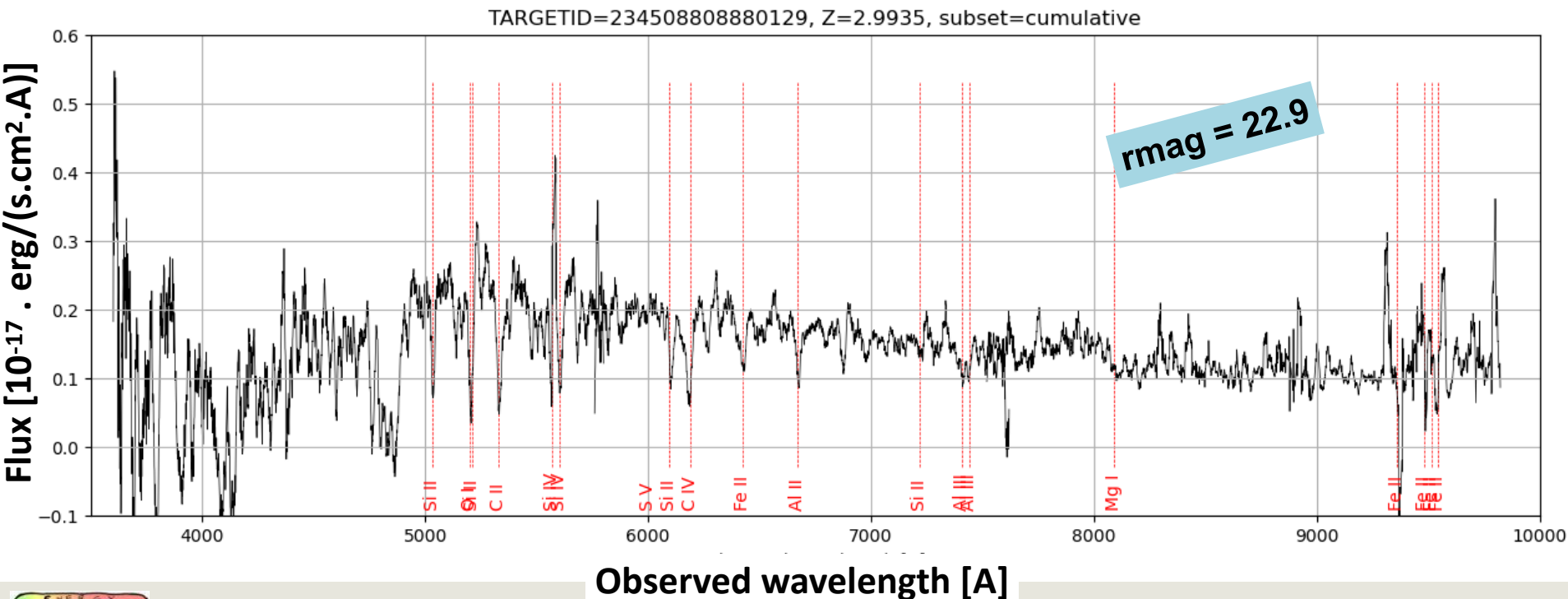    - observing conditions
    - per-fiber properties

| Tile | Spectro. effective time | Targets |
|------|------------------------|---------|
| 80871 | 19 x 1000s = 5.2h | 3.0k (LBGs / g-dropouts) |
| 80872 | 20 x 1000s = 5.6h | 3.5k (LBGs / g-dropouts) |
| 82636 | 8  x 1300s = 2.8h | 3.7k (LAEs / u-dropouts / LBGs) |

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# LBG Pilot program: visual inspection

**Visual inspection**

- 811 spectra visually inspected
- 366 / 811 = 45% true LBGs
- Absorption / emission lines nicely present in the spectra!



TARGETID=234508808880129, Z=2.9935, subset=cumulative

rmag = 22.9

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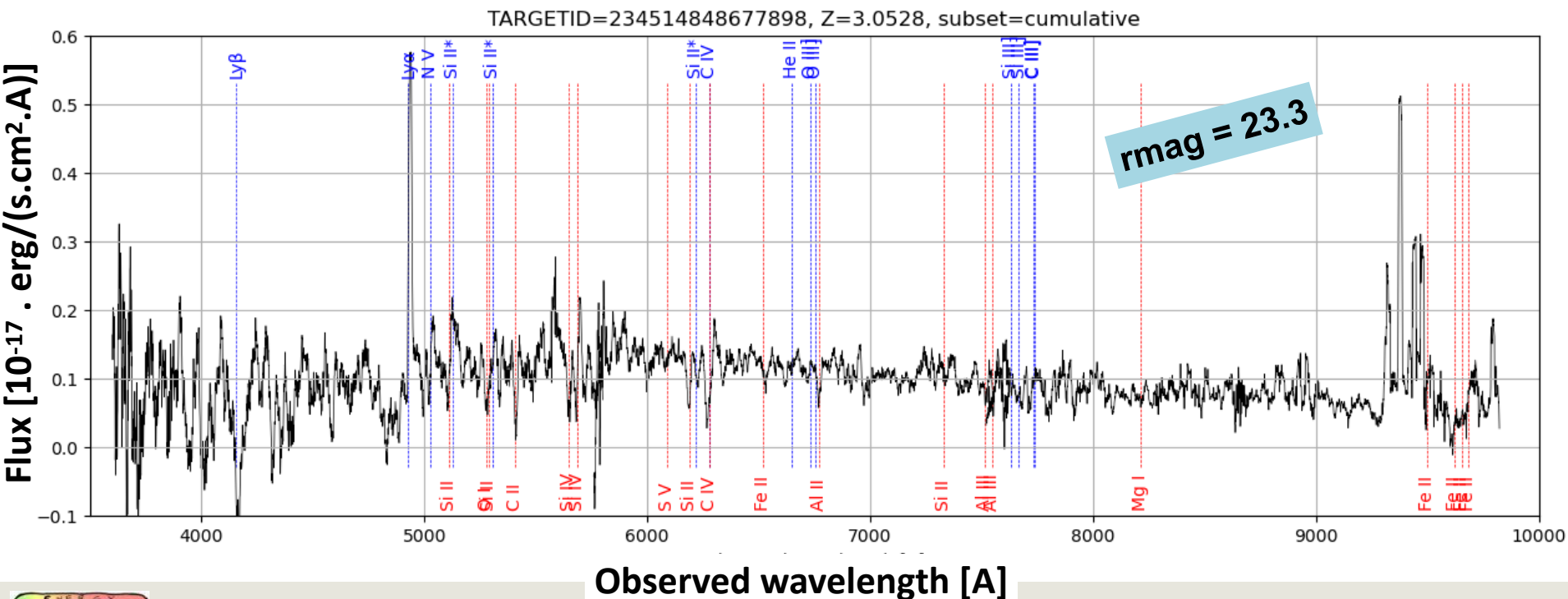Lawrence Berkeley National Laboratory

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# LBG Pilot program: visual inspection

**Visual inspection**

- 811 spectra visually inspected
- 366 / 811 = 45% true LBGs
- Absorption / emission lines nicely present in the spectra!



TARGETID=234514848677898, Z=3.0528, subset=cumulative

rmag = 23.3

Flux [$10^{-17}$ . erg/(s.cm$^2$.A)]

Observed wavelength [A]

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# LBG Pilot program: pipeline

**Spectroscopic reduction**

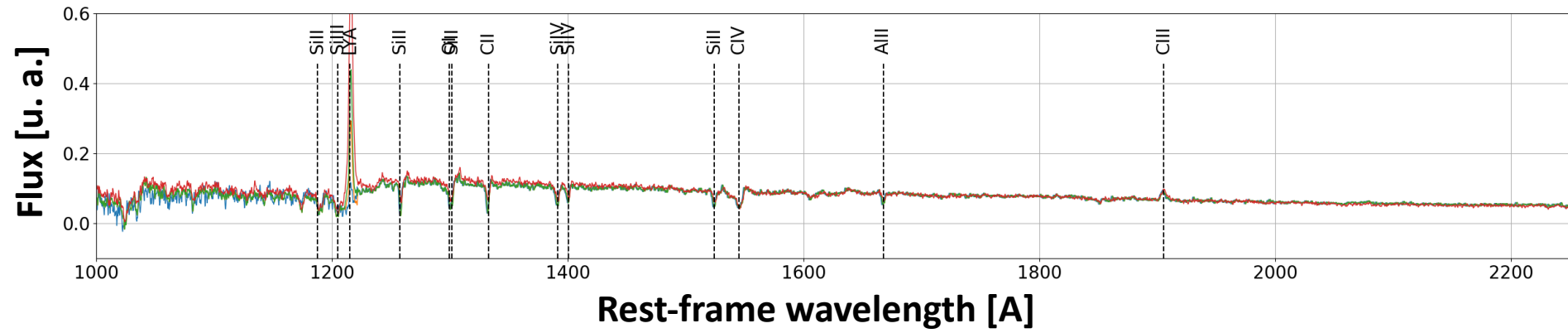- Stacks from visually confirmed LBG spectra, used as templates in pipeline (redrock)

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# LBG Pilot program: pipeline

**Spectroscopic reduction**

- Stacks from visually confirmed LBG spectra, used as templates in pipeline (redrock)

**Selecting reliable redshifts**

- **\*Very simple / preliminary\*** criterion here:
  - efficiency: selects 45-55% of the true LBGs for 1h-2h spectroscopic coadds
  - purity: ~75% of the selection are true LBGs, irrespective of the effective time

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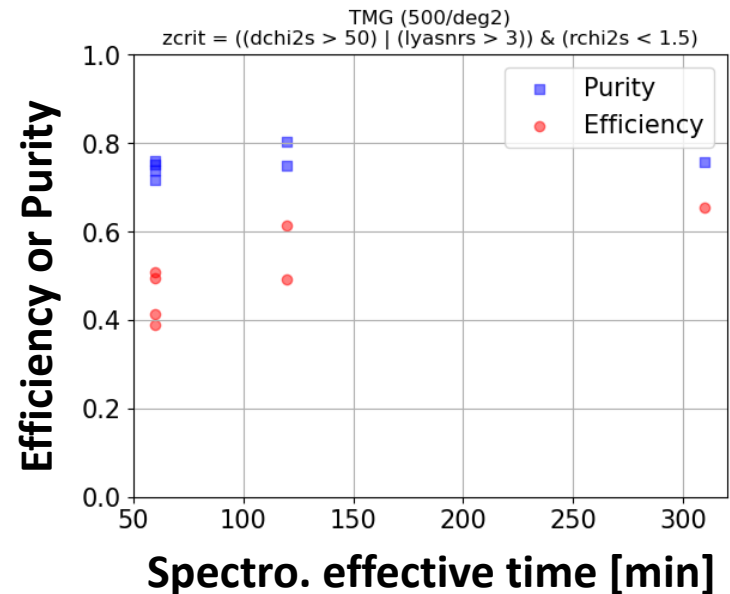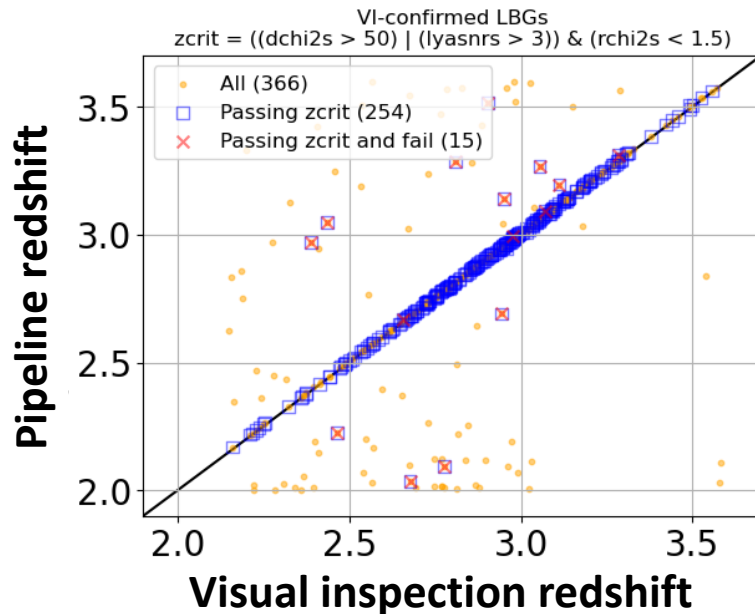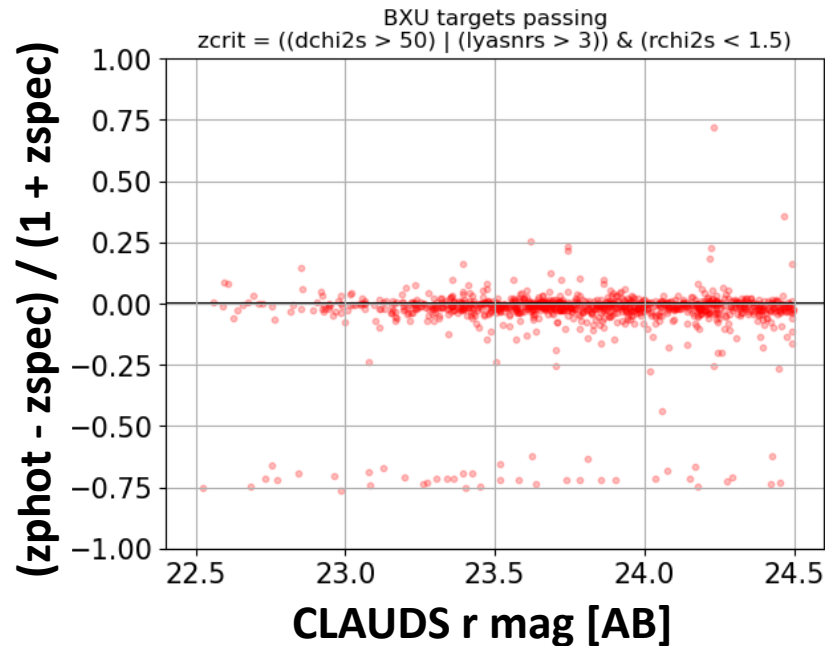
# LBG Pilot program: DESI performance

**DESI performs well!**

- Fraction passing zcrit is flat up to r ~ 24.5 mag
- $z_{spec}$ measurements of spectra passing zcrit are in good agreement for 1h, 2h, and ~5h coadds
- 1h-2h is sufficient to get reliable redshifts
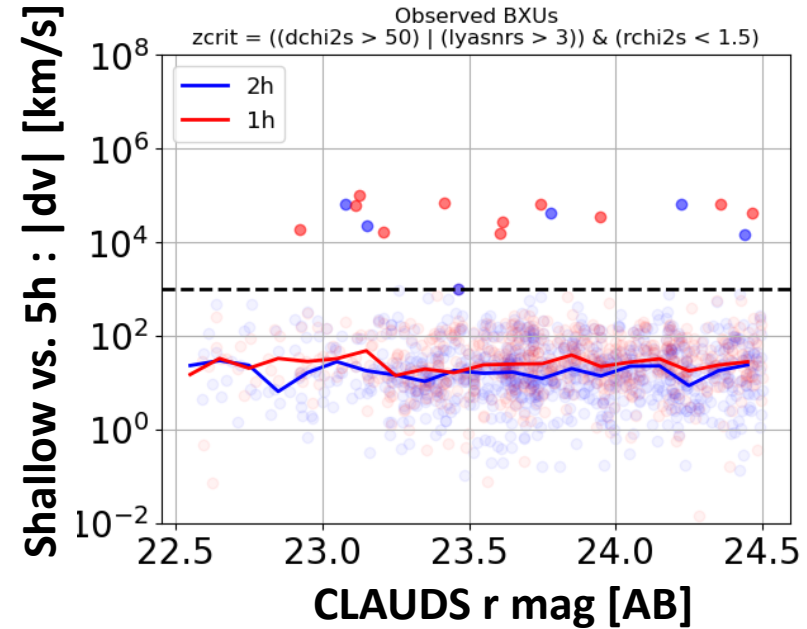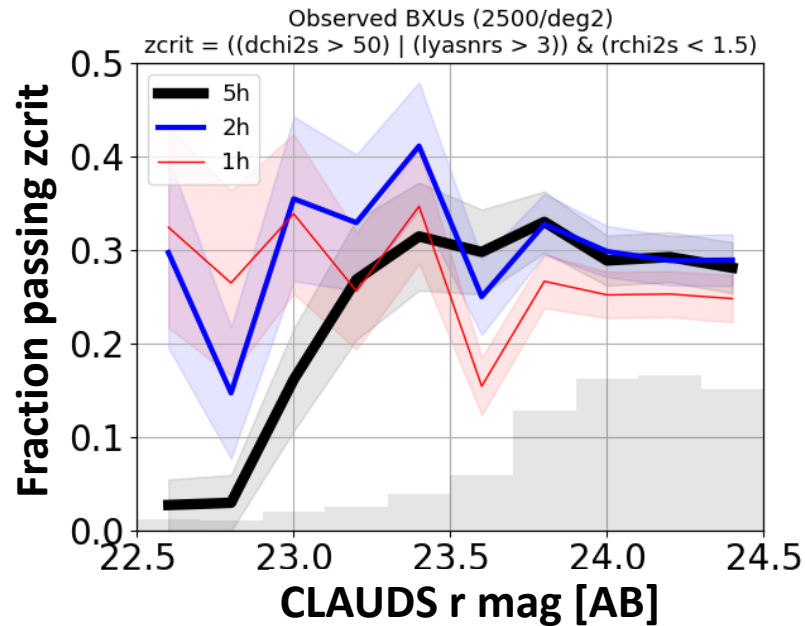
# LBG Pilot program: LBG $z_{phot}$ validation

**Photometric redshifts**

- Key for target selection development
- Validated for LBGs by spectroscopic redshifts (~1000 zspec's here)

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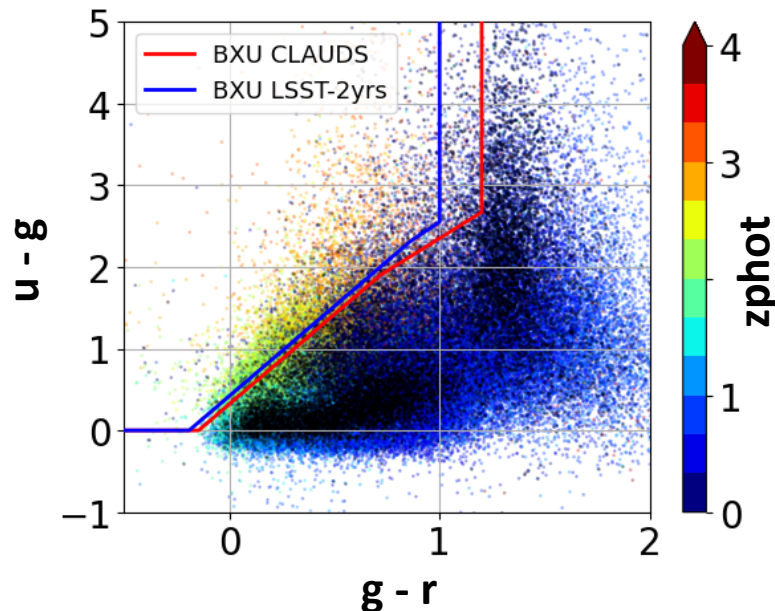
11

# In development

**Target selection**
- refining with feedback from DESI pilot observations
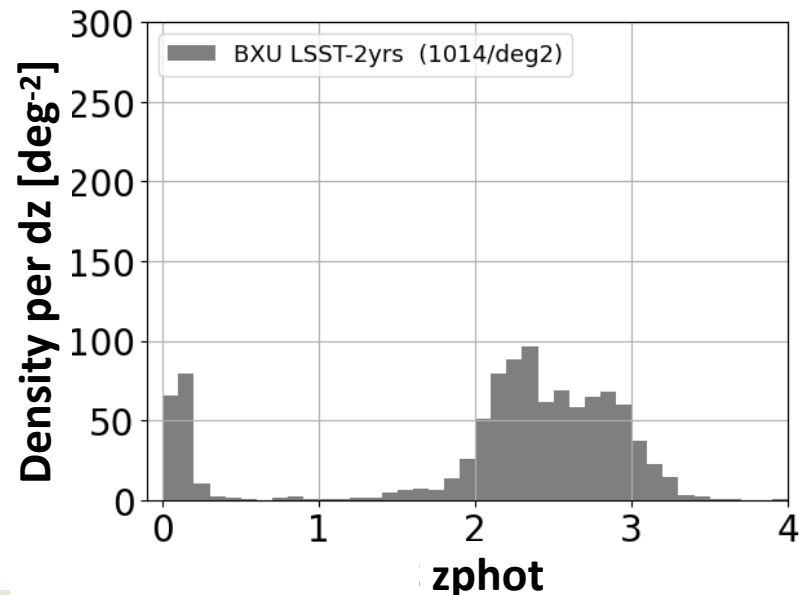- work from LSST 2-years depths

*More visual inspections, more DESI observations!*

**Automatic redshift measurement**
- Improvement on the existing pipeline side (1D-spectra reduction, templates, redrock)
- Exploration of new methods with CNN (to identify LBGs and estimate the redshift)



LSST-2yrs
r < 24.15

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# Conclusions

**Lyman Break Galaxies (LBGs)**

- will be a key tracer to perform at cosmology z~2-4
- are expected to be a driver for the DESI-II experiment

**LBG selection requires deep ugr-bands photometry**

**Pilot DESI observations with LBGs**

- targets selected on deep CLAUDS photometry
- actively on-going efforts to develop LBG-specific approach
- DESI can efficiently measure r < 24-24.5 LBG redshifts in 1h-2h

**Pursuing efforts to improve performance**

- target selection (refining with feedback from pilot observations, using more realistic photometry)
- redshift automatic measurement (pipeline improvements, new methods as CNN)

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