HST Grism Spectroscopy of the HFF with GLASS: Lyα Emitters at z>6

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The GLASS Team

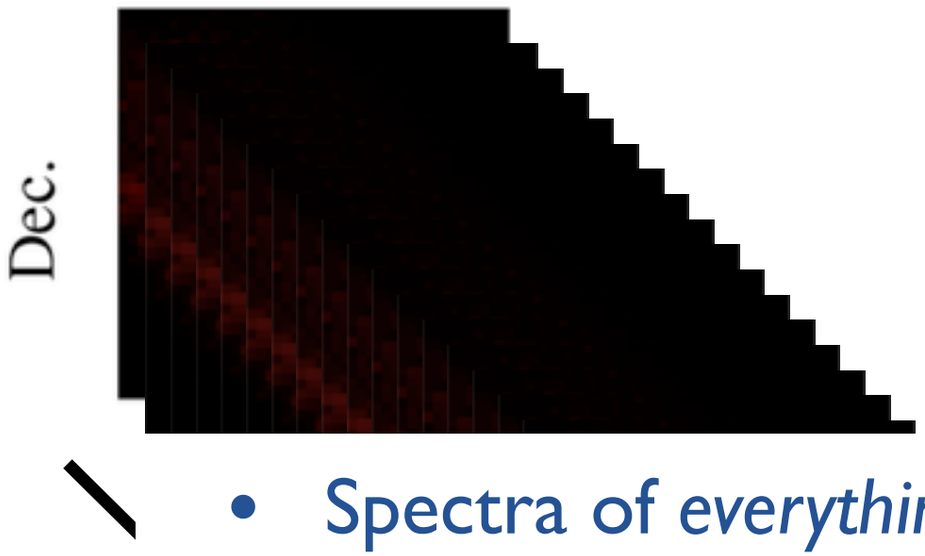
GLASS

The Grism Lens-Amplified Survey from Space

- P.I. Tommaso Treu (UCLA) **glass.physics.ucsb.edu**
- HST Grism Spectroscopy of 10 massive clusters (Cycle 21)

- Investigate the gas and galaxies at the EoR
  - 2nd part of this talk
- Describe how metals cycle in and out of galaxies
  - see Jones' talk in 12+3 minutes
- Support SN searches in the HFF
  - see Rodney's talk tomorrow
- Assess the environmental dependence on galaxy evolution

Grism (slitless/3D) Spectroscopy



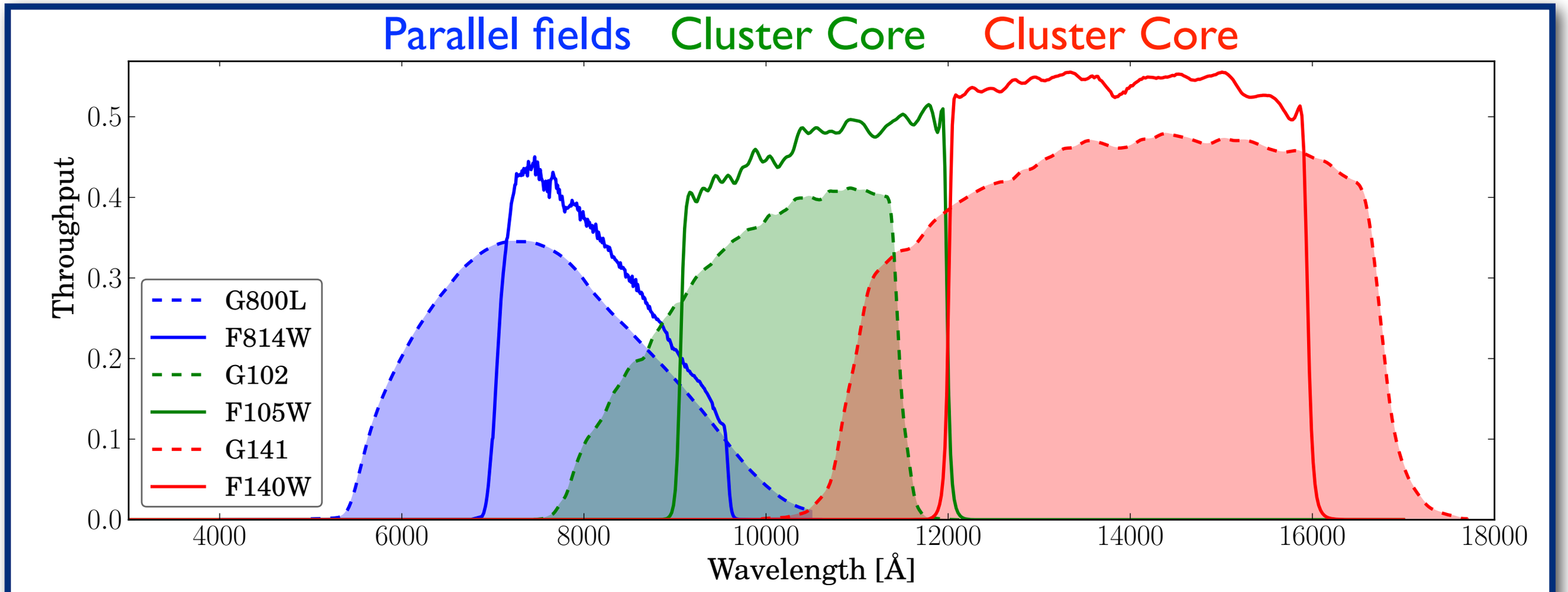
- Spectra of *everything* in the field-of-view

- Spatial information to create resolved EL and metallicity maps
  - e.g. Schmidt et al. 2013, Nelson et al. 2012, 2013, Jones et al. 2014

- Emission Line redshift precision $\Delta z \sim 0.005$
  - e.g. Brammer et al. 2012

GLASS : Bands and Wavelength

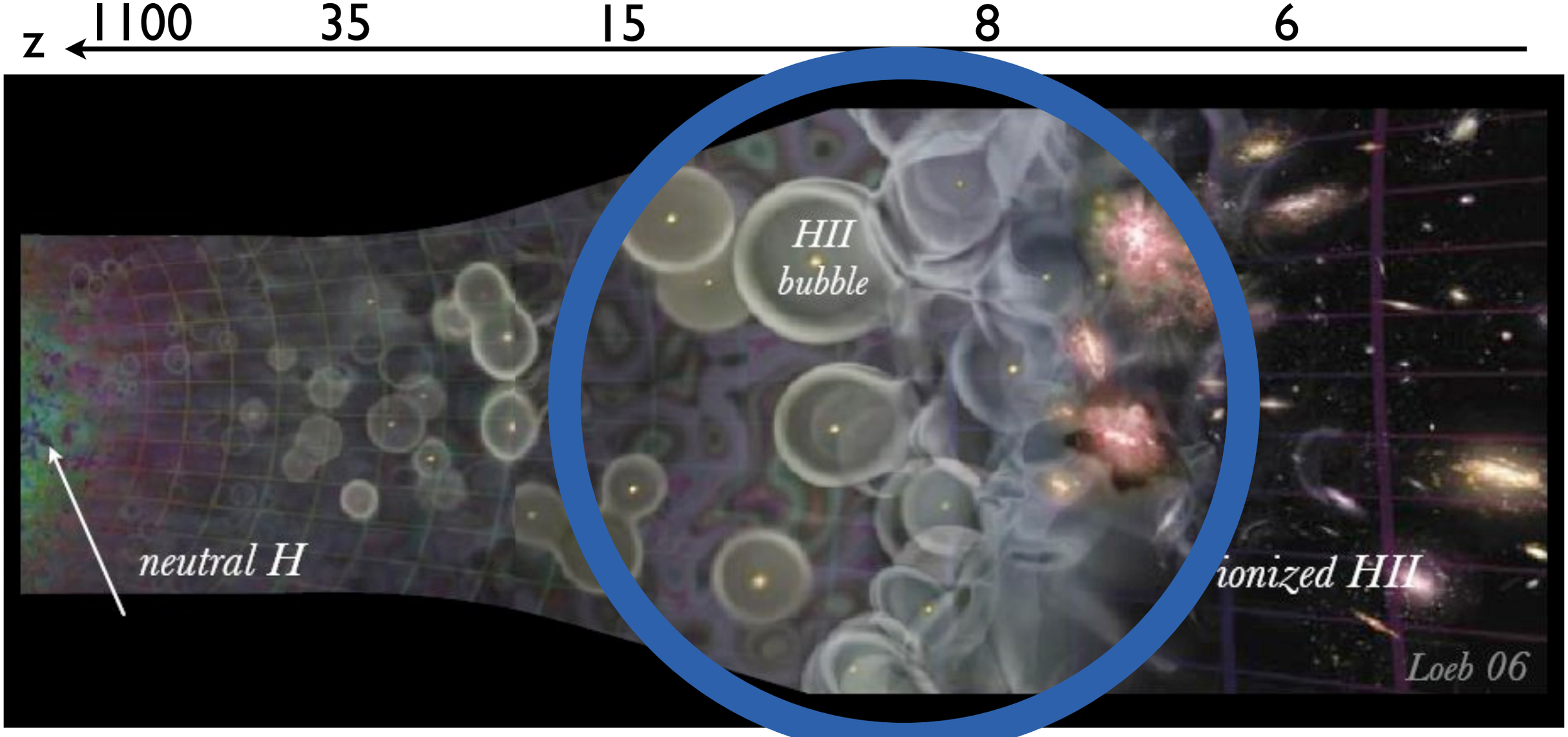
5.6 — Lyα redshift — 13.0



- Spectra of ~10000 (m_{F140W} < 24) with spectroscopic limits ≲ 1e-18 erg/s/cm^2 ; Schmidt et al. 2014a

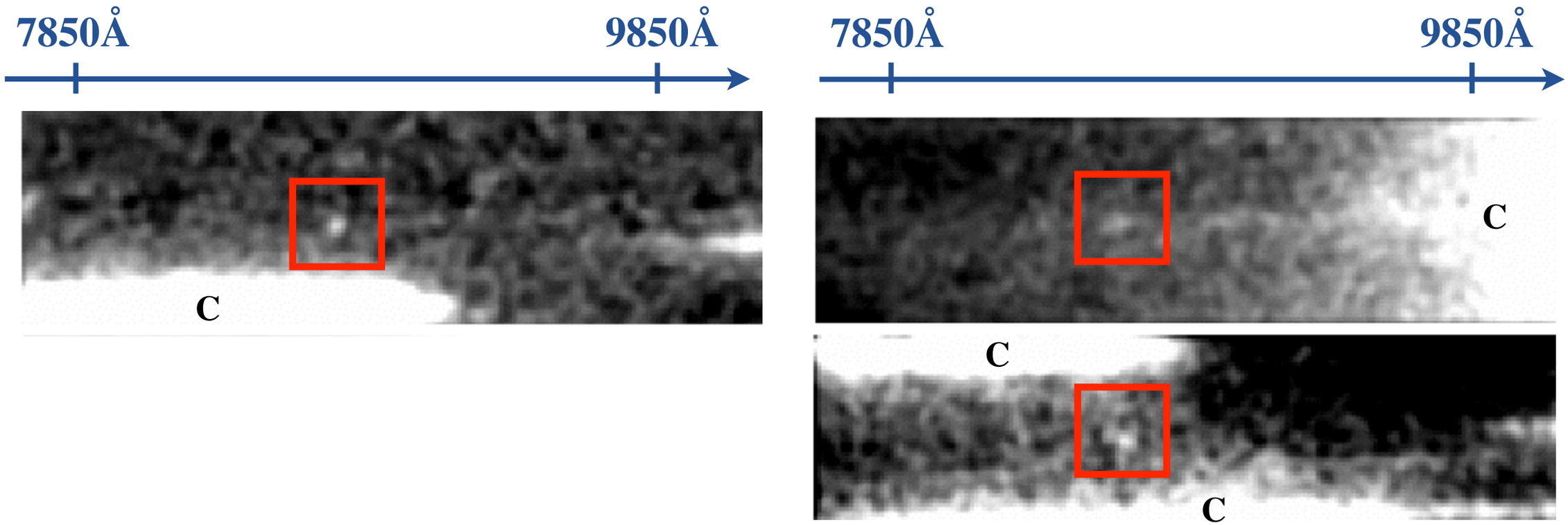
GLASS Galaxies at the EoR

- The epoch of reionization is where neutral hydrogen was (re-)ionized by radiation from the first astronomical sources, cf. talks by Bullock, Oesch, Coe, Atek, Livermore, Huang



Potential Lyα in GLASS Spectra

- Multiple imaged source behind RXJ2248 at z = 6.11
  - Boone et al. (2013) and Balestra et al. (2013)
- GLASS observes each Cluster at 2 PAs ~90° apart
  - Minimizes contamination and strengthens line recognition

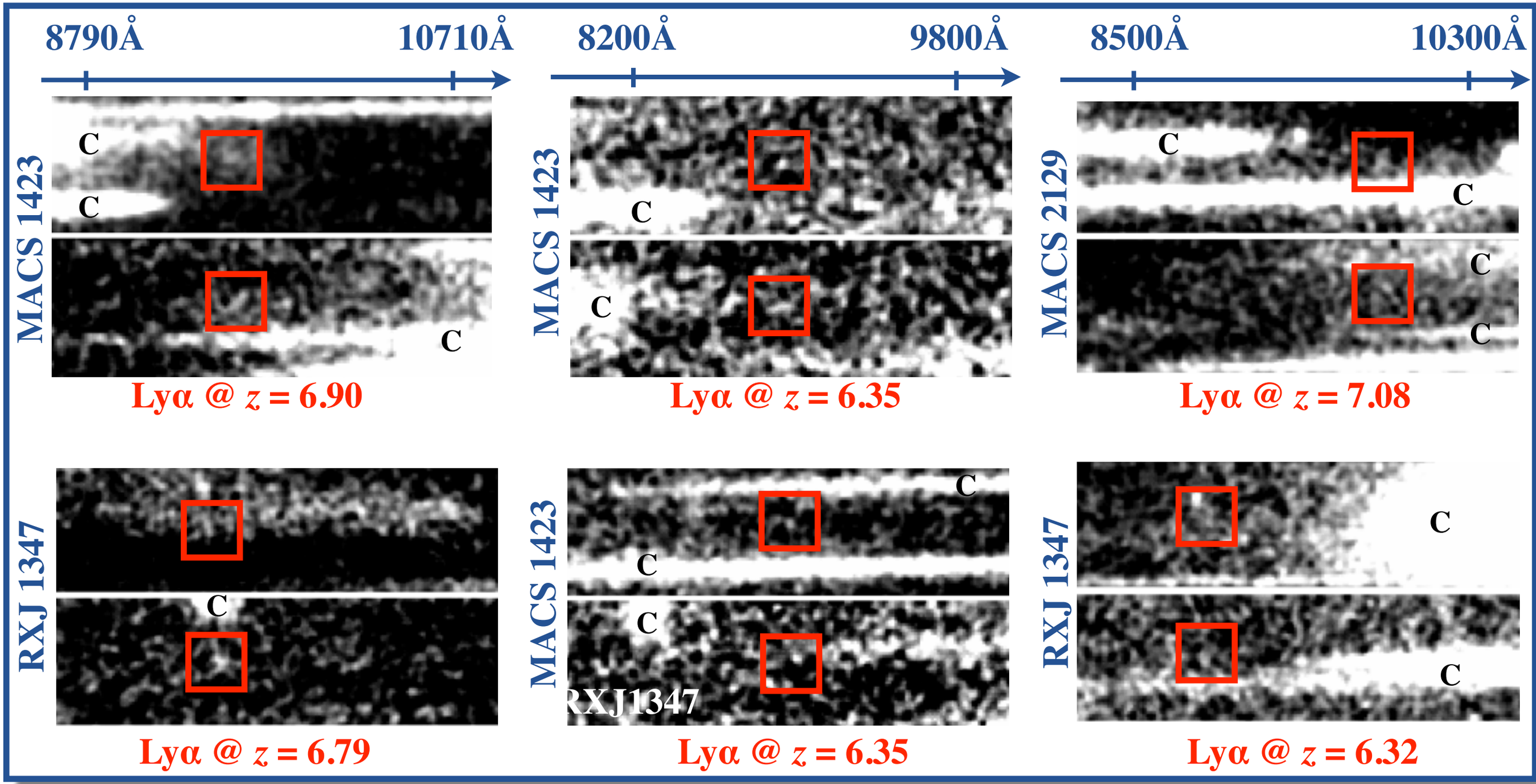


Lyα @ z = 6.11 C = Contamination Lyα @ z = 6.11

Potential Lyα in GLASS Spectra

- 6/10 Clusters have complete GLASS data
  - A2744, MACS0717, MACS1423, MACS2129, RXJ1347, RXJ2248
- ~20 LBGs per cluster selected via:
  - Color selections: i, z, Y, J, JH dropouts
  - Photo-z: BPZ (Benitez 2000) and EAZY (Brammer et al. 2008)
  - Literature samples from e.g. Atek et al. (2013), Zheng et al. (2014), Ishigaki et al. (2014), Bradley et al. (2014), Karman et al. (2014)
- 20-30% of LBGs show 'line-features' in the GLASS spectra

Potential Lyα in GLASS Spectra



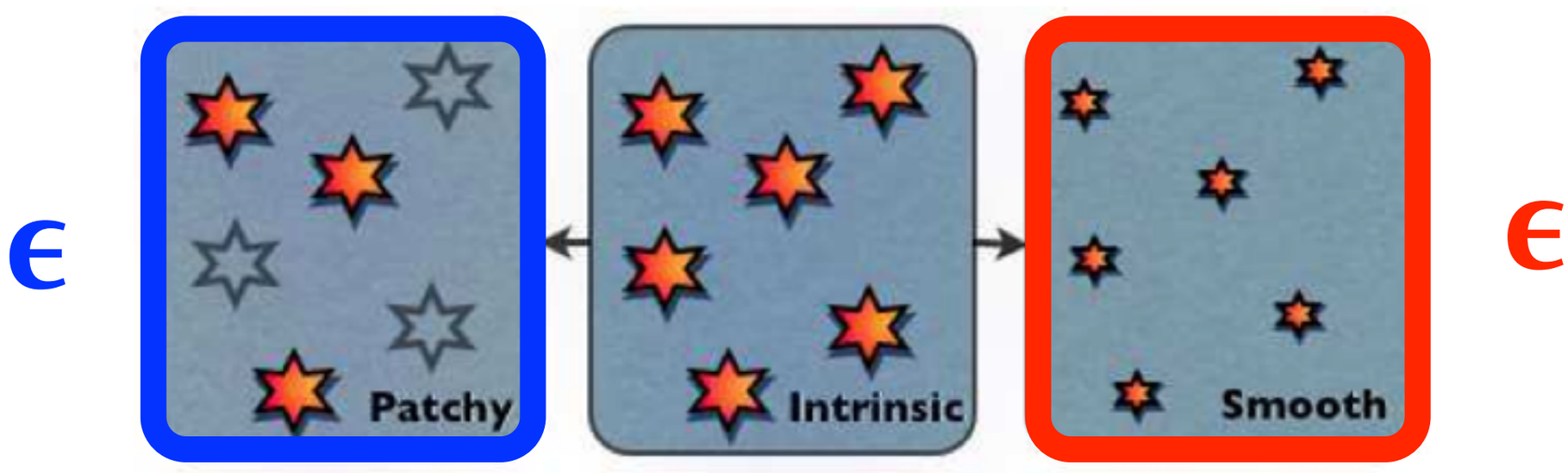
Lyα @ $z = 6.90$ | Lyα @ $z = 6.35$ | Lyα @ $z = 7.08$

Lyα @ $z = 6.79$ | Lyα @ $z = 6.35$ | Lyα @ $z = 6.32$

GLASS EoR Inference at z > 7

- Collected all z > 7 galaxies in completed GLASS clusters
- Selected spectra for objects with low contamination level
- Estimated Lyα EW limits based on grism spectra
  - Conservatively ignoring the potential Lyα detections for now

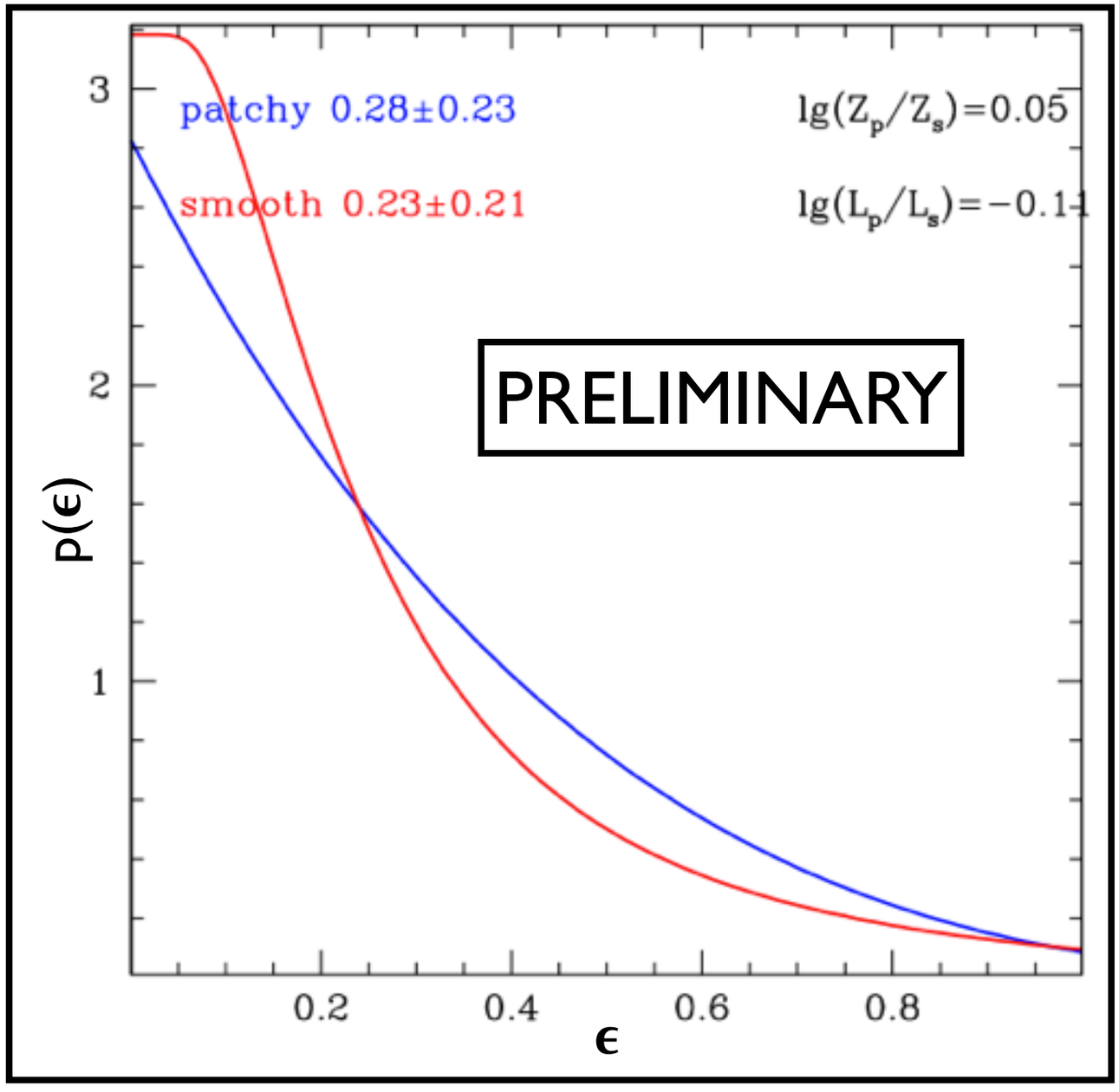
- Apply Bayesian EoR inference from Treu et al. (2012)



Tilvi et al. 2014

EoR State at z > 7: Upper Limits

(If none of the Lyα detections are confirmed)



See also Treu et al (2013; z~8), Pentericci et al. (2014; z~7) and Tilvi et al. (2014; z~8)

BOTTOM LINE

GLASS

- Well underway (6/10 completed clusters)
- Spectra of *everything* in the WFC3/ACS FoV

Lyα at z > 6

- 100s of spectra of LBGs resulting in EW limits
- 10s of confirmed/candidate Lyα emission lines

THE GLASS TEAM

glass.physics.ucsb.edu

Attending HHF @ Yale

- **Tommaso Treu**, PI (UCLA)
- Marusa Bradač (UCD)
- Gabriel Brammer (STScI)
- Mark Dijkstra (UoO)
- Alan Dressler (Carnegie Obs.)
- Adriano Fontana (INAF Rome)
- Raphael Gavazzi (IAP)
- Alaina Henry (NASA Goddard)
- Austin Hoag (UCD)
- Kuang-Han Huang (UCD)
- Tucker Jones (UCSB)
- Patrick Kelly (UCB)
- Matt Malkan (UCLA)
- Charlotte Mason (UCSB)
- Laura Pentericci (INAF Rome)
- Bianca Poggianti (INAF Padova)
- Kasper Schmidt (UCSB)
- Massimo Stiavelli (STScI)
- Michele Trenti (Cambridge)
- Anja vd Linden (DARK/Stanford)
- Benedetta Vulcani (KIPMU Tokyo)
- Xin Wang (UCSB)

SPACE

GLASS

HST spectroscopy of clusters.

No atmosphere
No skylines

SPACE

CLASH

FRONTIER FIELDS

Extensive HST imaging of clusters

GROUND

Atmospheric absorption and skylines

European Southern Observatory

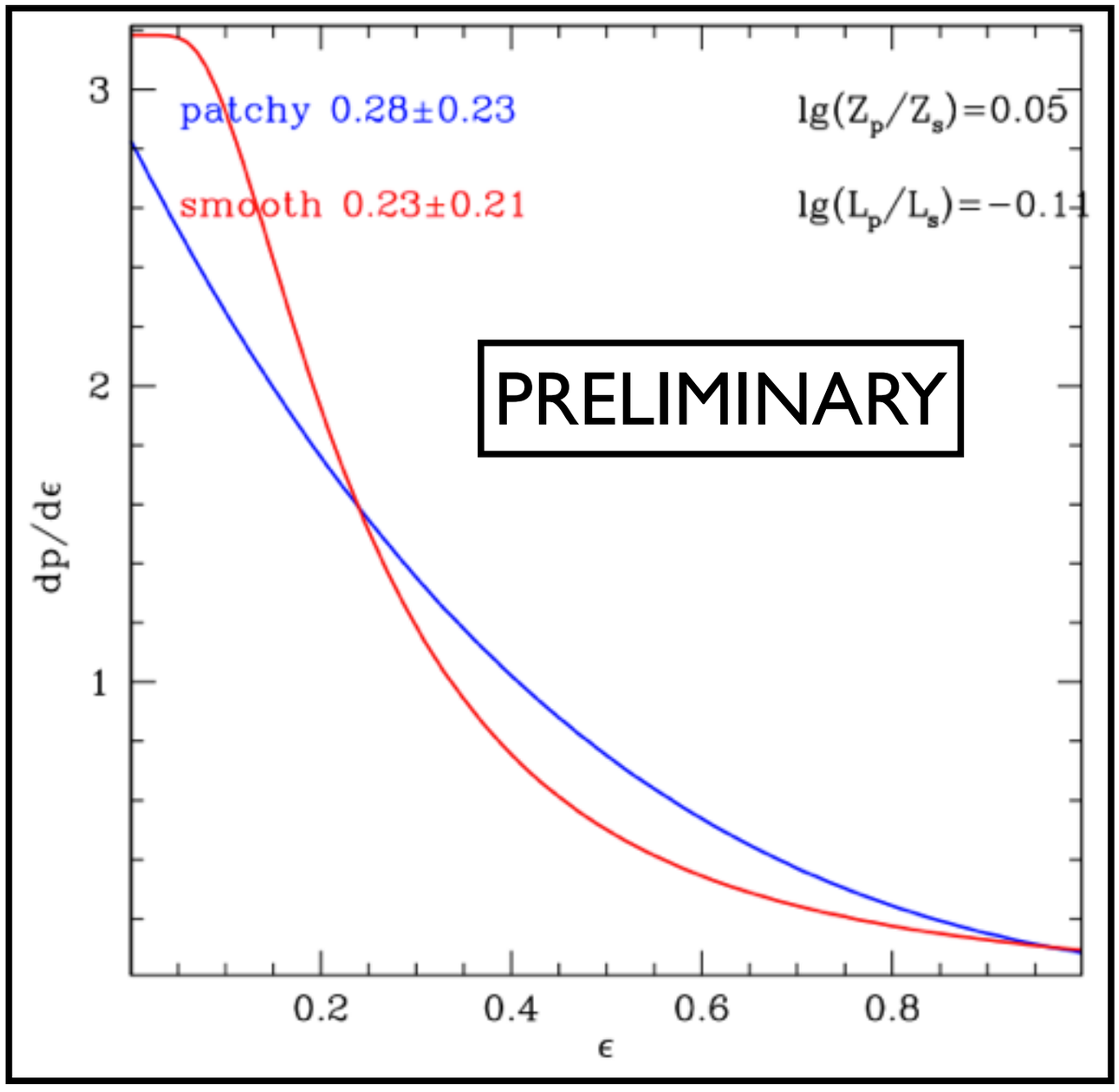
www.eso.org

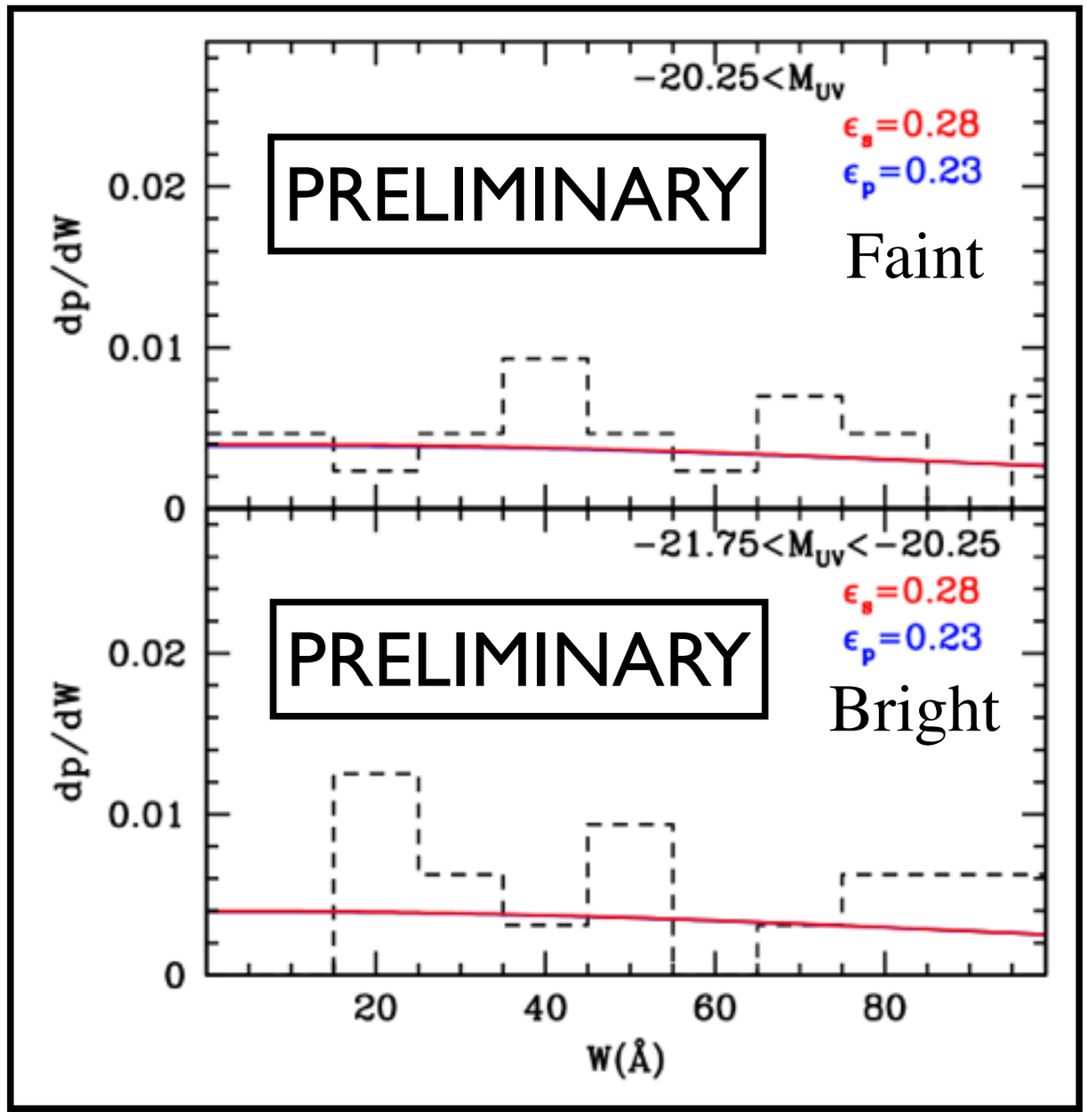
W. M. KECK OBSERVATORY

Similar to synergy between 3D-HST and CANDELS

EoR State at z > 7: Upper Limits

(If none of the Lyα detections are confirmed)





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