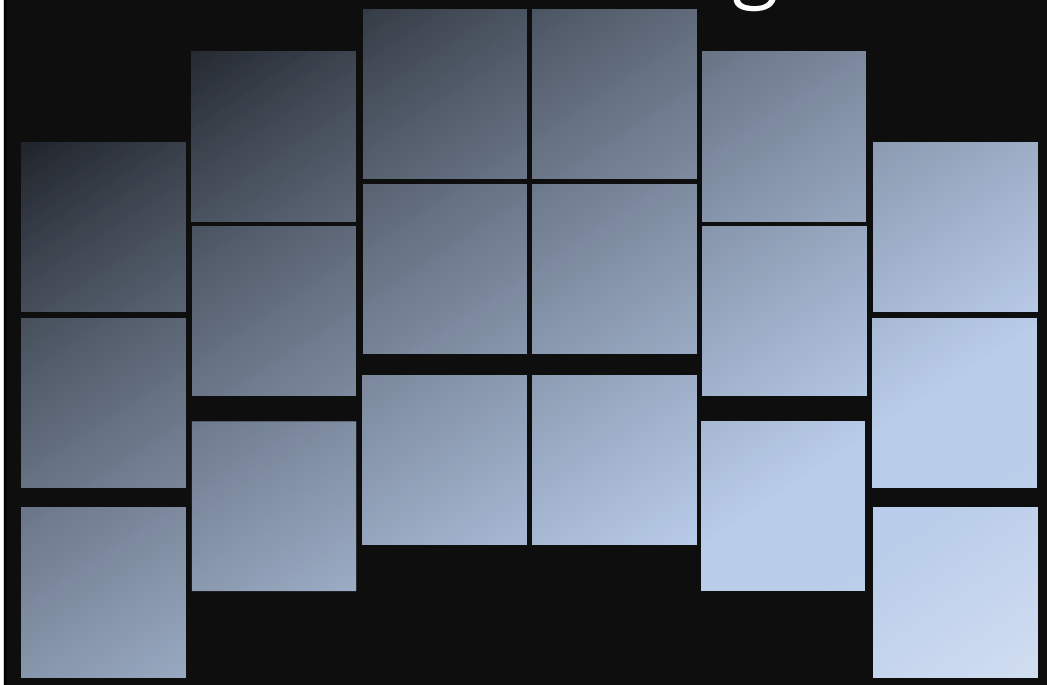
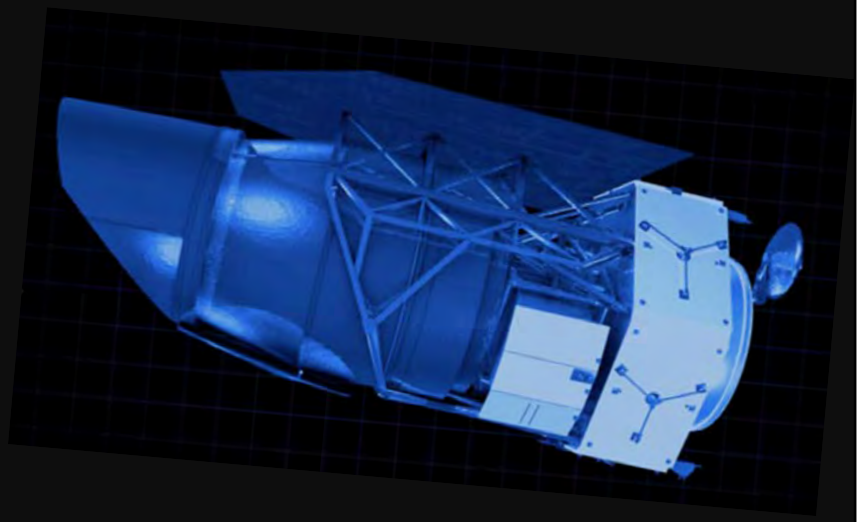
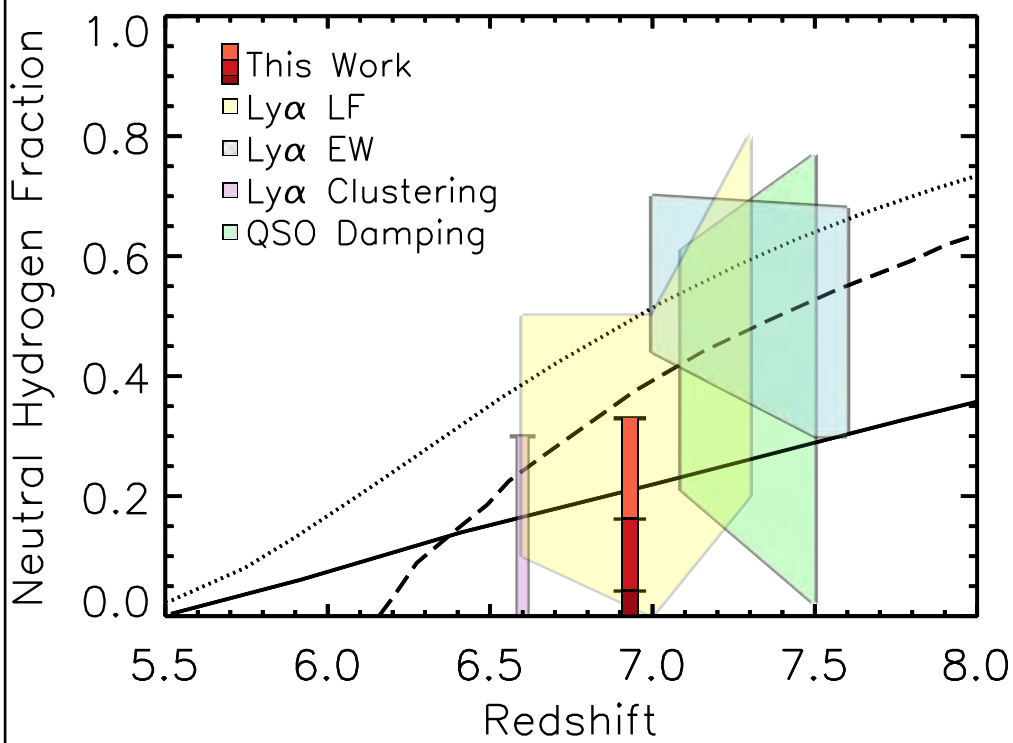
Recovering Lyα emitters from deep *Roman* grism data





Isak Wold, Sangeeta Malhotra, James Rhoads, Vithal Tilvi, Austen Gabrielpillai and The Cosmic Dawn SIT

Results from Wide-Field Lyα Surveys Today



Wold et al. 2021 (submitted: arXiv:2105.12191)

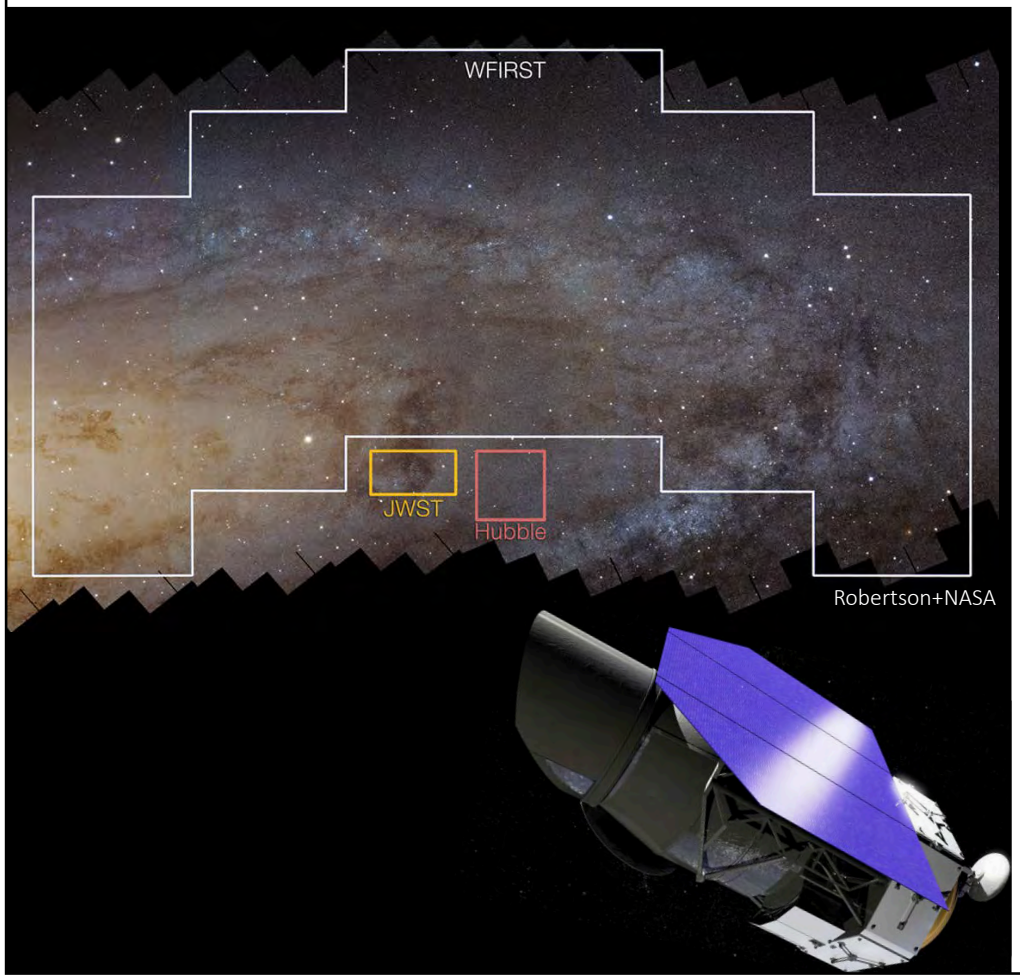
•We are conducting a definitive 24 deg^2 Lyα survey at z=6.9 -- The Lyman-Alpha Galaxies in the Epoch of Reionization (LAGER) project. This survey uses DECam's uniquely large FOV and detector sensitivity in the near-infrared, as well as a custom-made NB filter probing a Δz of 0.09.

•Lyα photons are resonantly scattered by neutral hydrogen and are sensitive to the ionization state of the intergalactic medium.

•Our latest results based on 150 Lyα galaxies found within 4 of the 8 planned LAGER fields find a neutral hydrogen fraction consistent with zero (red upper limit).

•. Probing higher redshifts from the ground is inefficient. We need a space-based instrument capable of probing a large volume (wide Δz + area).

The advantages of the *Roman Space Telescope*

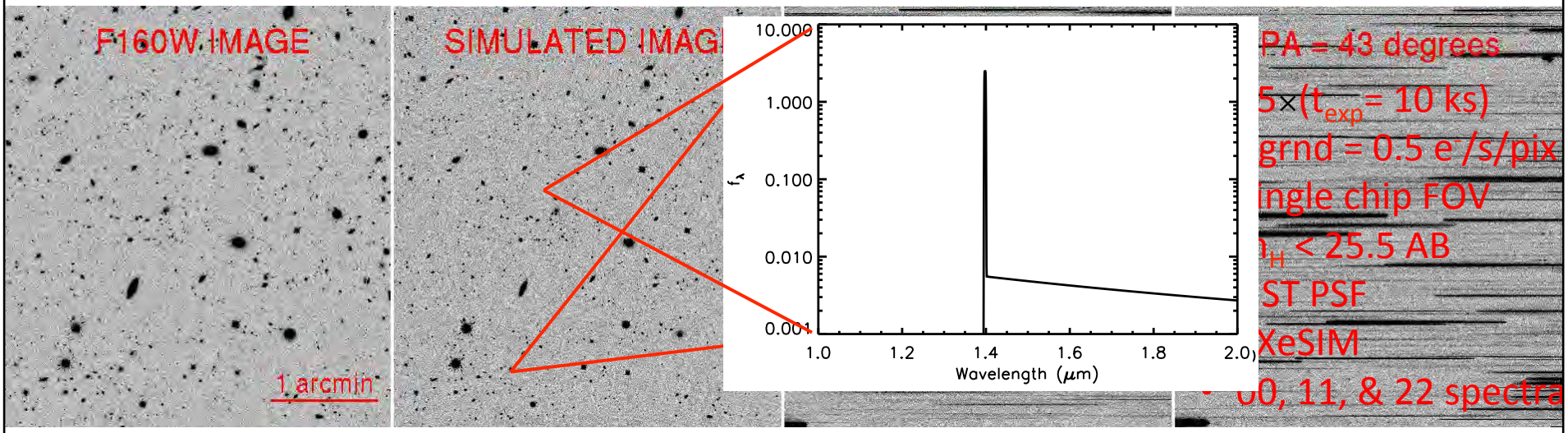


- A wide-field (0.281 deg^2) NIR grism that can efficiently survey z≳7 Lyα emitters (λ=1.00-1.93μm).

- No interference from bright sky lines which enables continuous redshift coverage.

- Our initial simulations show that a 70hr grism survey can reach line depths comparable to the deepest ground-based surveys.

Roman multi-position-angle grism simulations



Simulated sources are populated based on observational constraints of actual objects within the COSMOS field (Skelton et al. 2014) plus simulated LAEs that span a range in redshift and flux.

Goal: Characterize *Roman*'s ability to detect LAEs at Cosmic Dawn

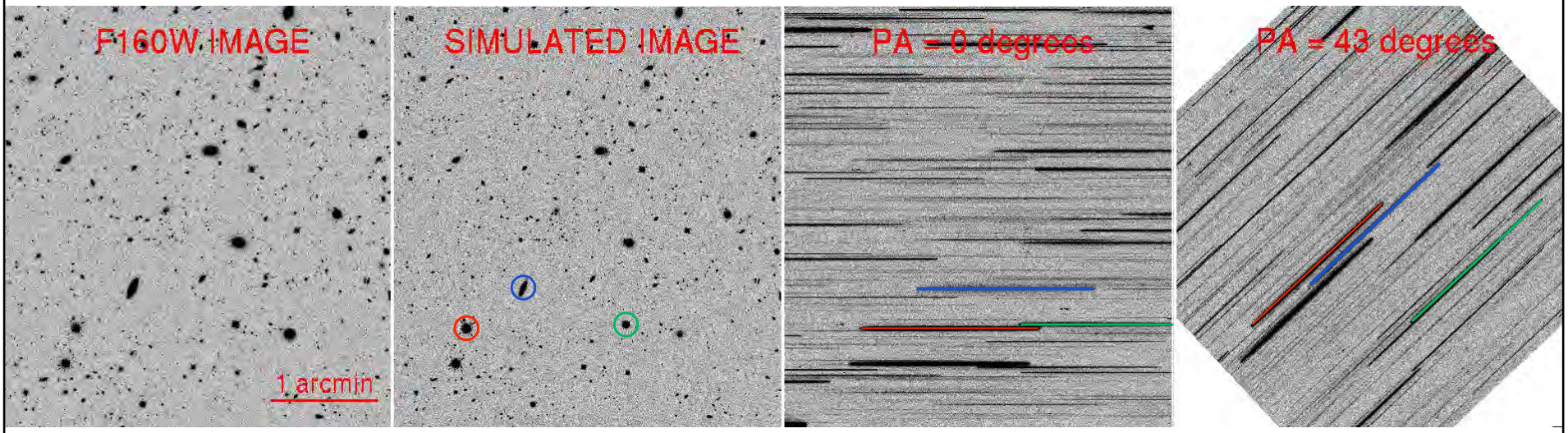
aXeSIM setup

foreground density	mag limit	field center	fov	pixel scale	wavelength range	dispersion 11	dispersion 00	dispersion 22	backgrnd	PSF
55 obj/ $arcmin^2$	<25.5	150.128 2.3023	13.8 $arcmin^2$	0.11'' /pix	9500-19000A	10.764 A/pix	265.7A/pix	5.62 A/pix	0.5 e^-/s/ pix	HST F160W

Simulated LAEs setup

Number of simulated LAEs	magnitude range	half-light radius range	redshift range	line flux range
288	25.5-28.5	$0.17 \pm 0.02''$	7.5 – 10.5	4.5 to 70E-18 cgs

Roman multi-position-angle grism simulations



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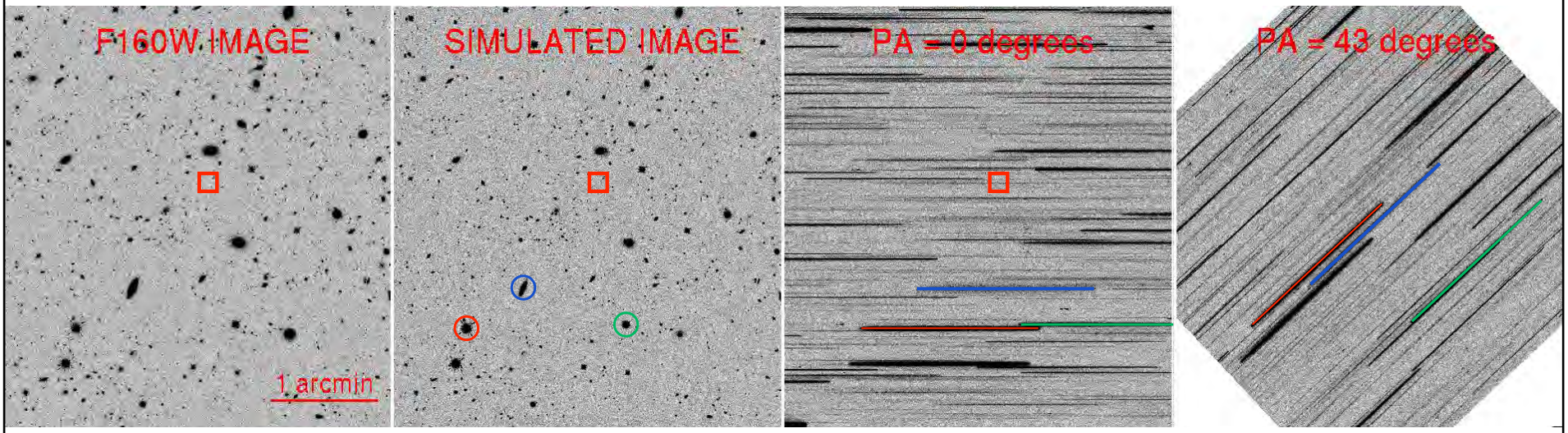

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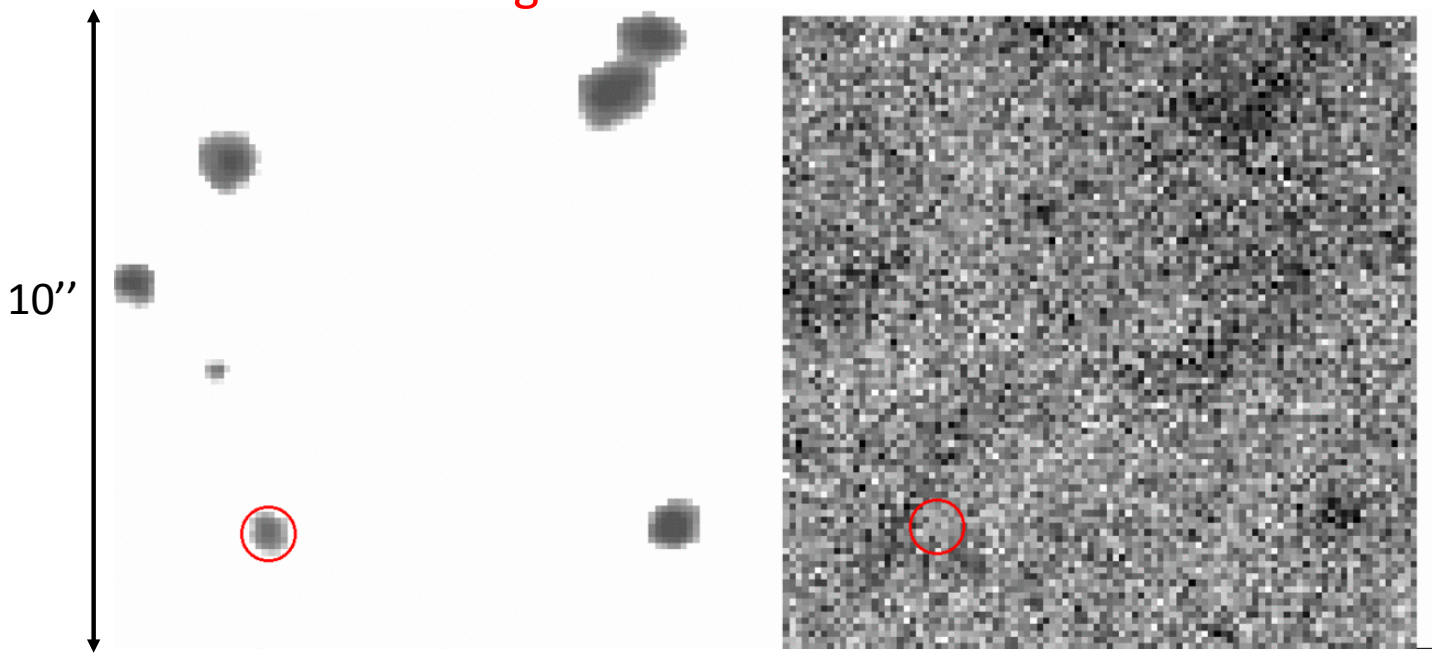
Roman Data Cube Construction

A blind search for emission line sources (for *GALEX* application, Barger+12, Wold+14,17)

Noiseless
Direct Image

t_{exp}=70hrs; 25PAs
Data Cube



Cycling through a wavelength range of 1.27 to 1.28 μm.

Roman Data Cube Construction

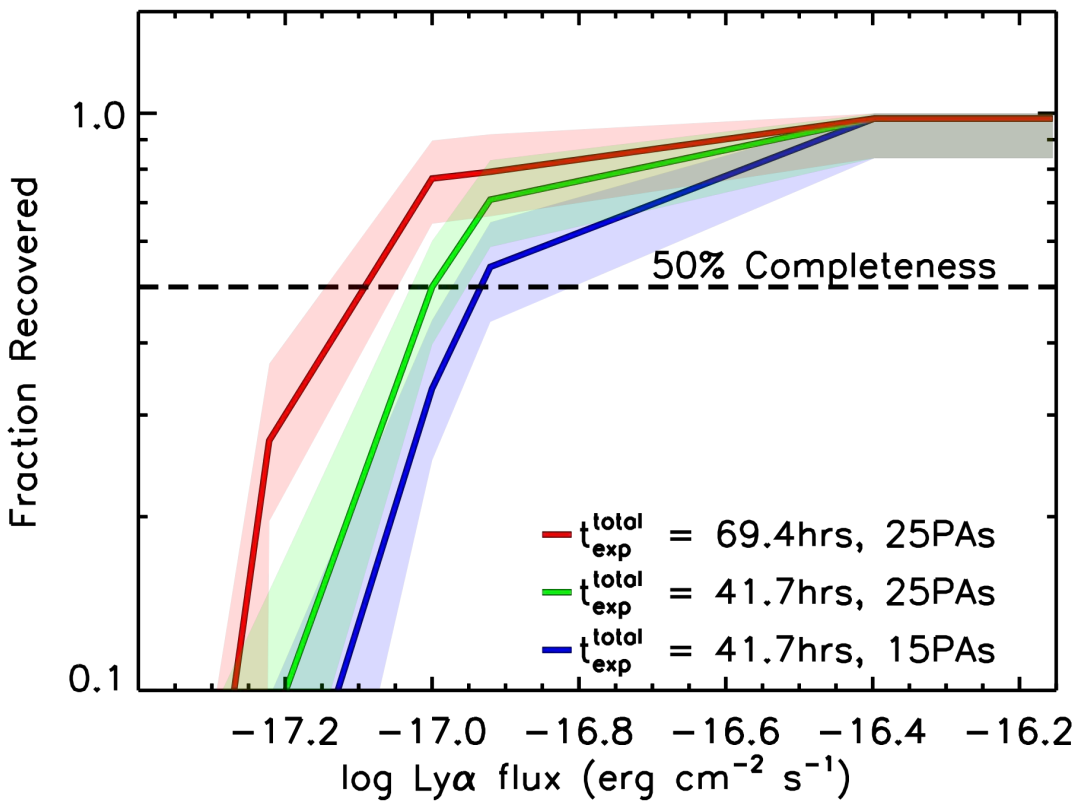
A blind search for emission line sources (for *GALEX* application, Barger+12, Wold+14,17)

Noiseless
Direct Image

t_{exp}=70hrs; 25PAs
Data Cube

Wavelength = 1.277 μm

Lyα Emitter Completeness



- Our simulations show that a 70hr grism survey can reach line depths comparable to the deepest ground-based surveys.
- Keeping the total exposure time constant, we find increased returns with more PAs.
- Assuming no evolution from z=7, we expect a 8<z<9 LAE sample size of N=450 per square degree.
- Any significantly smaller number is an indication of the increasing opacity of the IGM and the onset of the reionization epoch.

Summary

1. *Roman*'s ability to obtain deep near-infrared spectra over a wide field of view will allow us to coherently measure the evolution of the Lyα luminosity function at z>7. This will provide ionization measurements of the IGM at cosmic dawn.

2. Our work demonstrates that a 70hr grism survey – with a realistic foreground scene – can achieve Lyα line depths comparable to the deepest z=7 NB surveys.

My contact information: isak.g.wold@nasa.gov