Slitless Spectroscopy at Cosmic Dawn with Roman

Sangeeta Malhotra

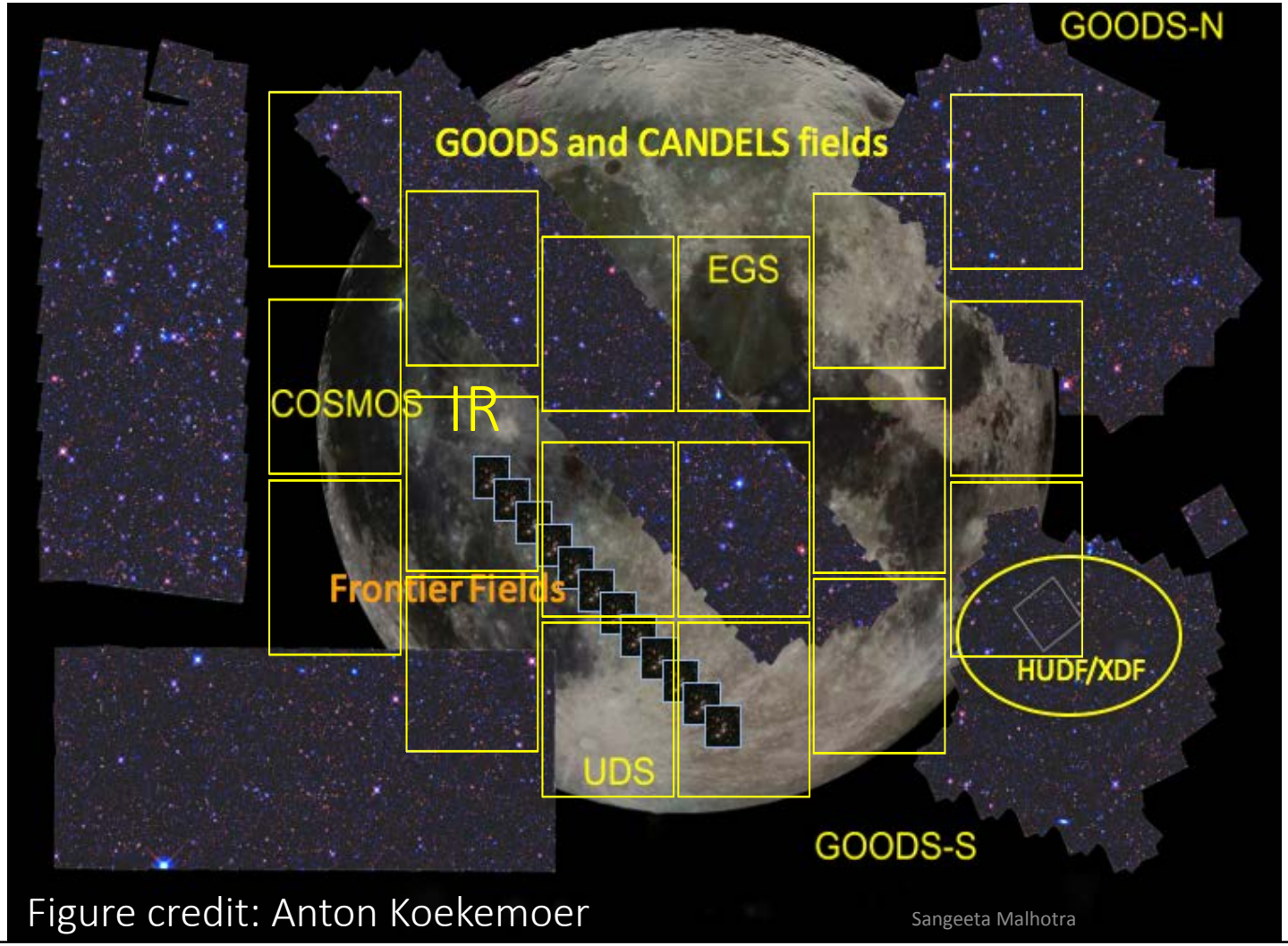


Figure credit: Anton Koekemoer

Deep Slitless Spectroscopy from Space

Slitless spectroscopy from space for EoR science: Above the OH airglow; spatial resolution boosts S/N ratio.

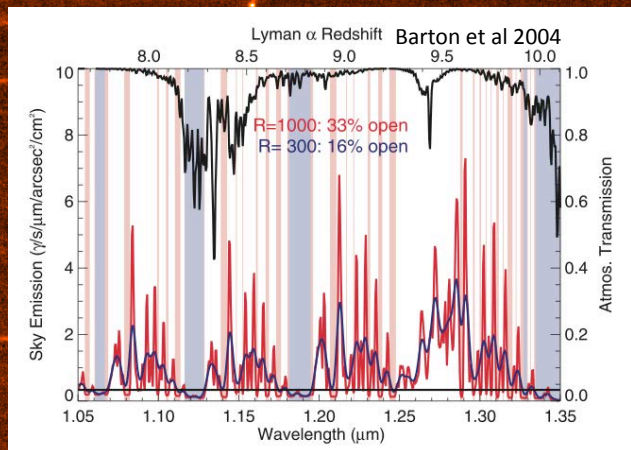
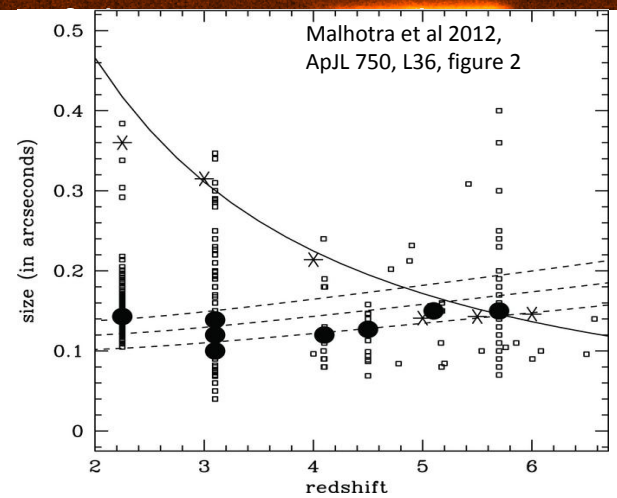


FIG. 1.—"Windows" in the *J*-band night-sky spectrum. The black line indicates the transmission of the night sky (*scale on right*). We plot the night-sky spectrum at two resolutions ($R = 1000$, *red line*; $R = 300$, *blue line*) to indicate regions below $\frac{1}{3}$ of the mean background (blue shading for moderate resolution, red shading for high resolution). At moderate resolution, only a small number of windows are available.



Lyman alpha galaxies are small at all redshifts.

Results from deep HST grism

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GRAPES: HUDF, G800 10 orbits x 4 PAs

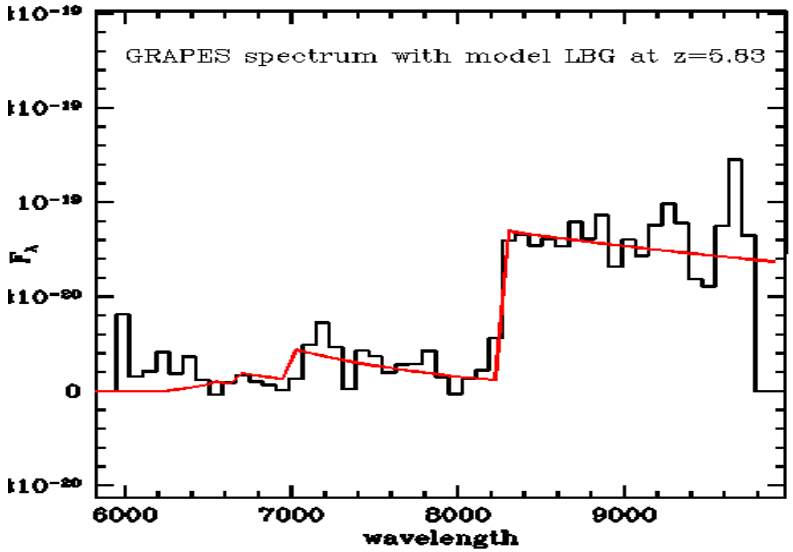
PEARS: G800, 8 fields to 5 x 4 PAs

FIGS: G102, 4 fields 8x5PAs

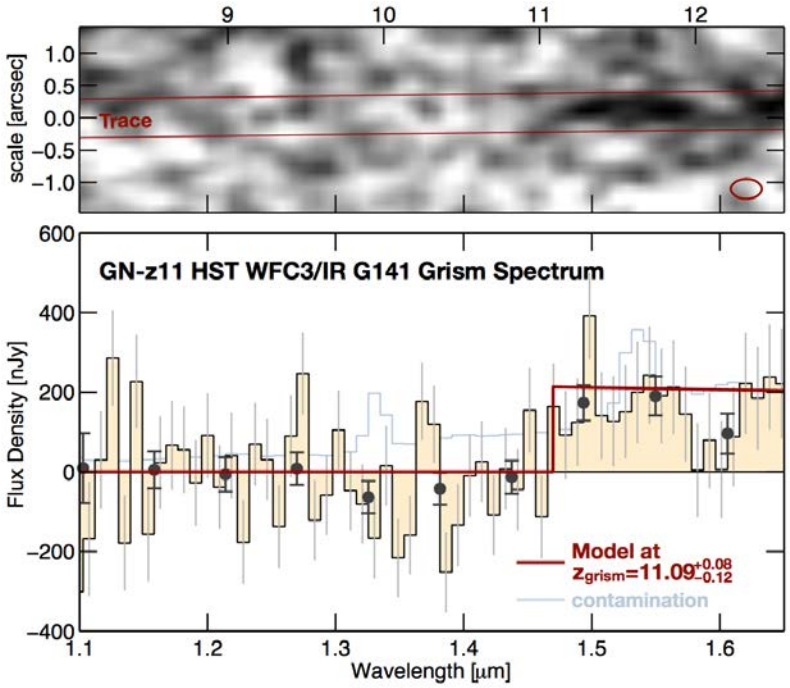
(Deep Imaging data from HST)

Deep HST slitless grism data

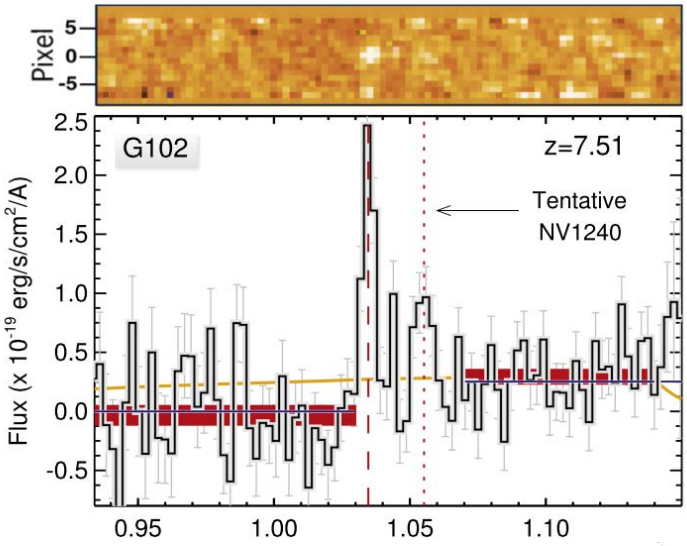
Malhotra et al. 2005



Z=11 galaxy (Oesch et al. 2016)



Z > 7 Ly-α lines in FIGS.



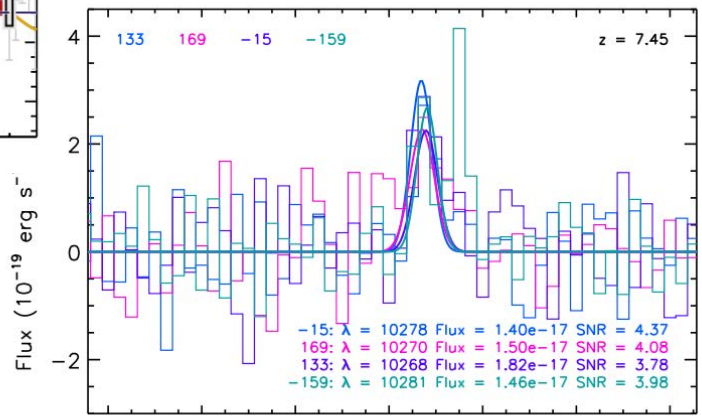
Tilvi et al. 2016

z=7.51; simultaneous line & break

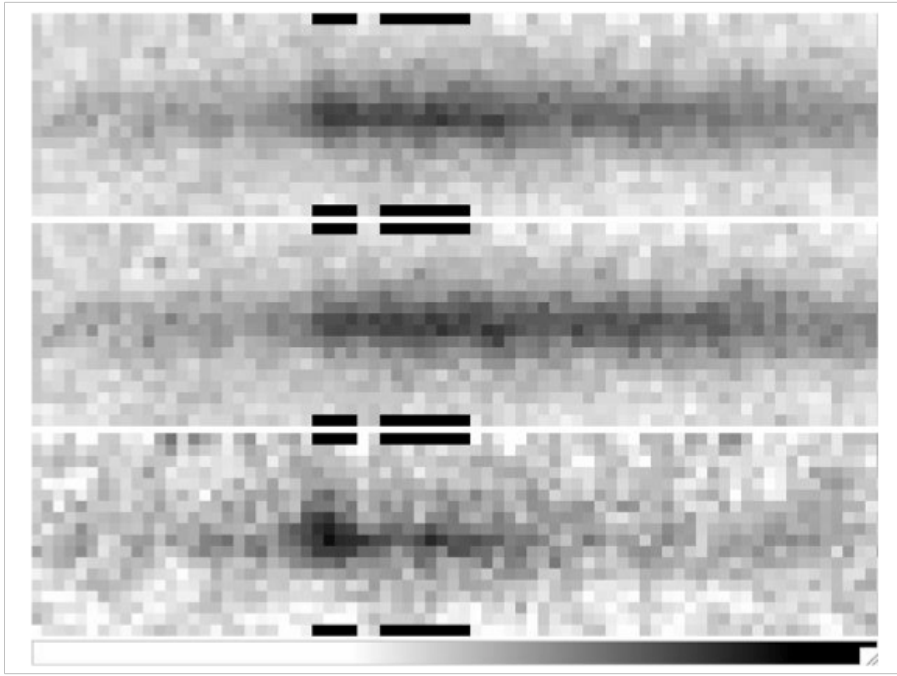
FIGS: The Faint Infrared Grism Survey with HST. PI Sangeeta Malhotra; Survey paper Pirzkal et al 2018.

Larson et al. 2018

z = 7.45, high equiv. width



Spectroscopy unbiased to Lyman α:

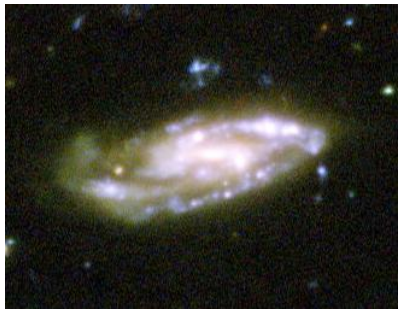


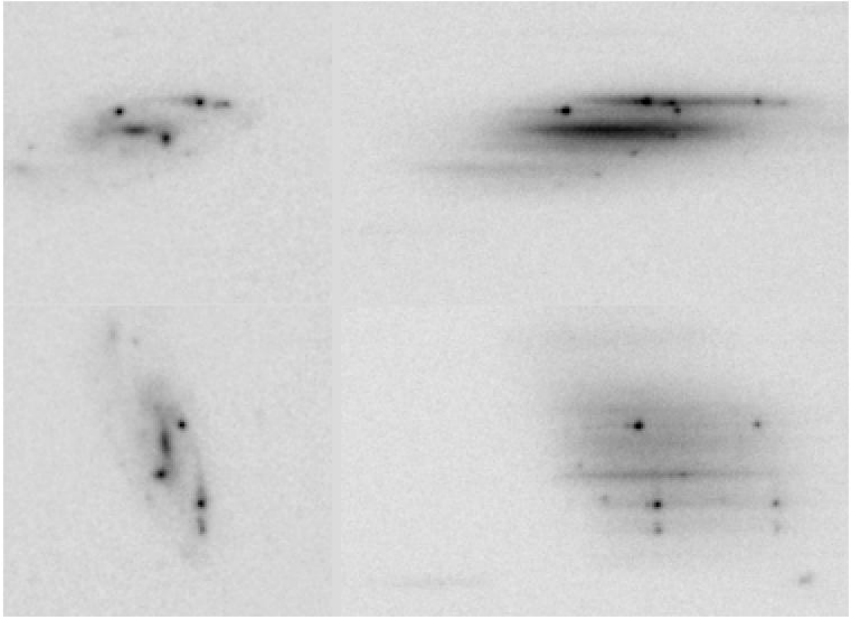
Real HST grism spectra from the GRAPES and PEARS projects. Composite z ~ 5 LBG spectra for the full GRAPES sample (top), and those without LyA (middle) and with LyA (Bottom).

[Rhoads et al 2009].

NEED FOR MULTIPLE POSITION ANGLES

A Spiral galaxy at z=0.3

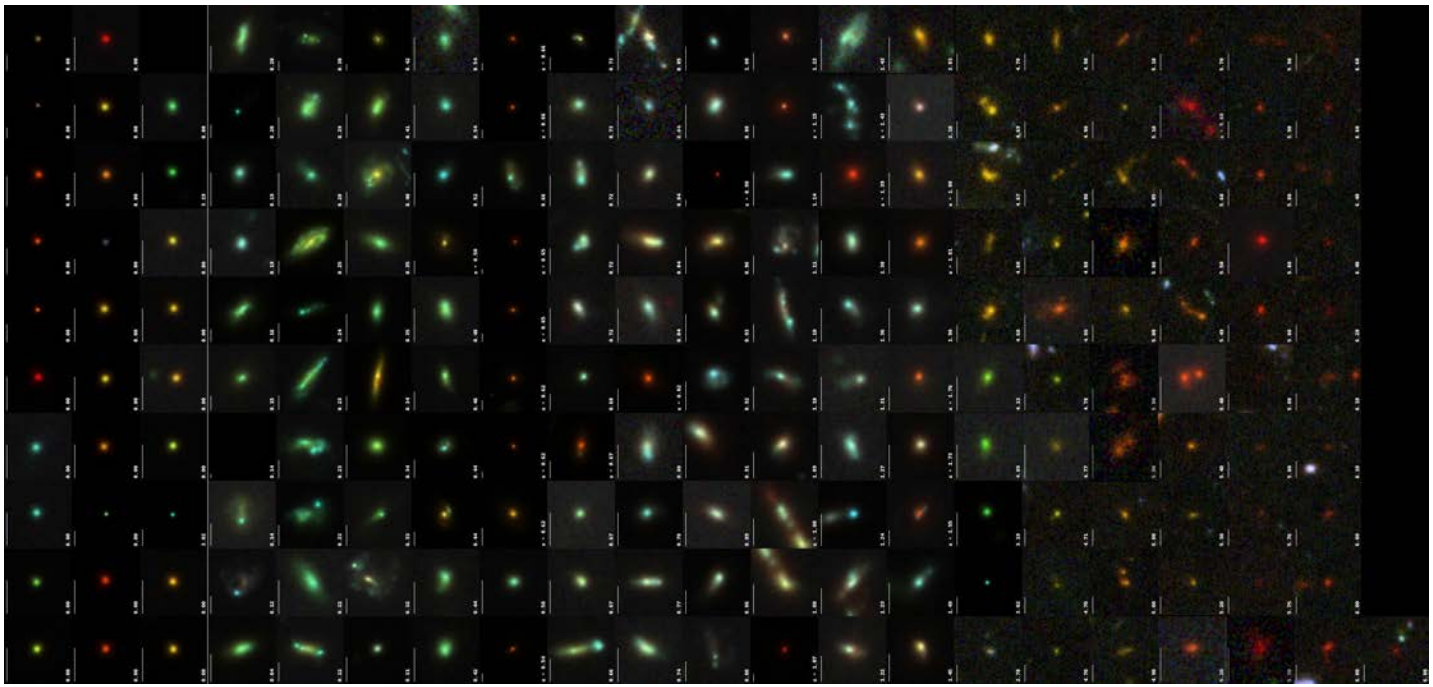




Direct image | Dispersed image

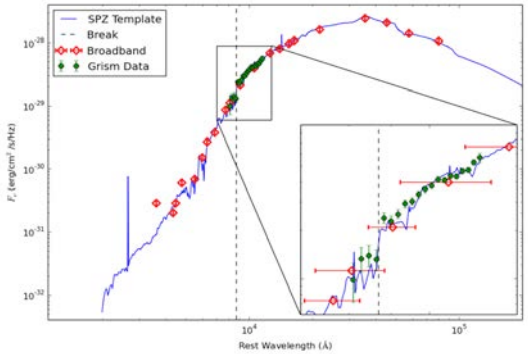
Spectroscopically identified objects:

from 600 to 6.7×10^{10} pc

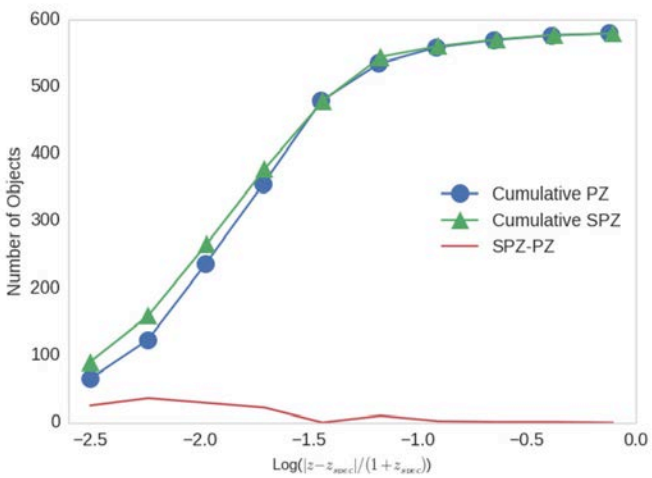


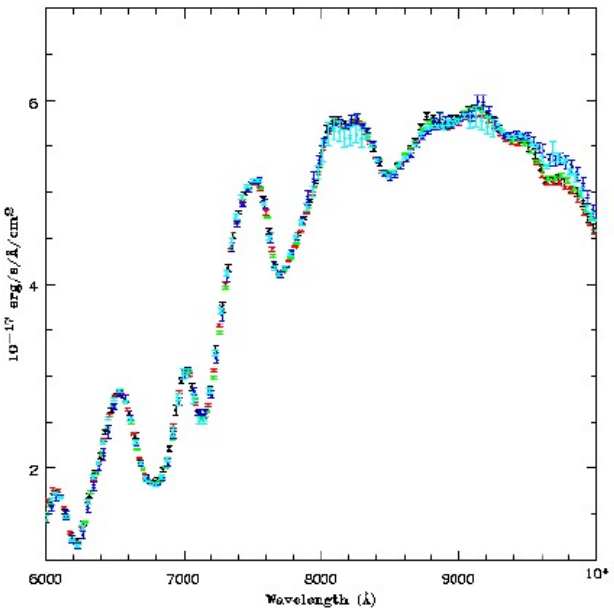
Improving Photo-z's

Pharo et al. 2018, (Ryan et al. 2007)



Improve photo-z's from 3% to 2% scatter





Four orients: 0, 8, 90, 98 degrees orient to disentangle overlapping spectra.

Good agreement demonstrates good wavelength and flux calibration

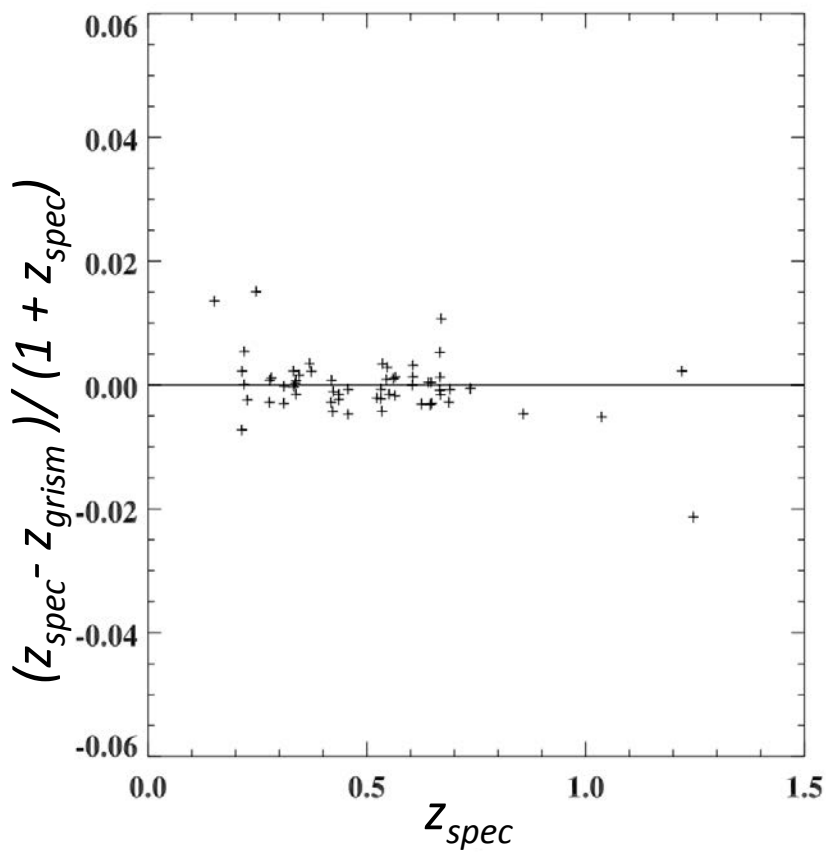


Figure 3. Redshift differences between the spectroscopic and the grism redshifts as a function of the spectroscopic redshifts. The accuracy of the grism redshift is measured to be $\sigma_z = 0.006$. *(From Xia et al, 2011)*

- σ_z = 0.006 for ACS grism, with R = 100 (Xia et al 2011).
- This improves for R ~ 200 WFC3 G102.
- Expect further improvement with R ~ 500 WFIRST grism.

Worry about errors

- Random (known) errors ---- from testing
- Systematics (known) ----- from simulations (?)
- Systematics (unknown at present) – open mind.

"It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so." – Mark Twain.