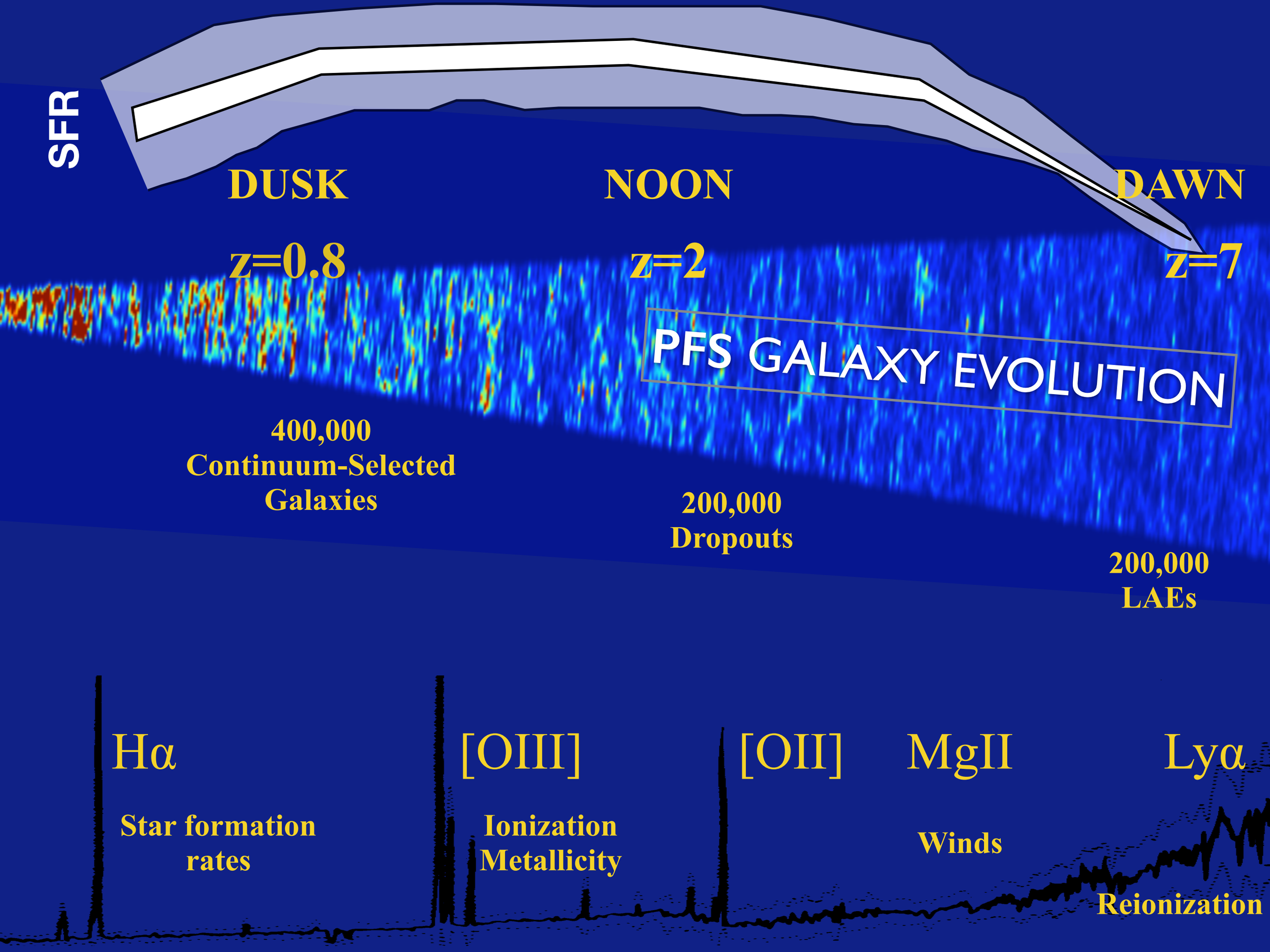
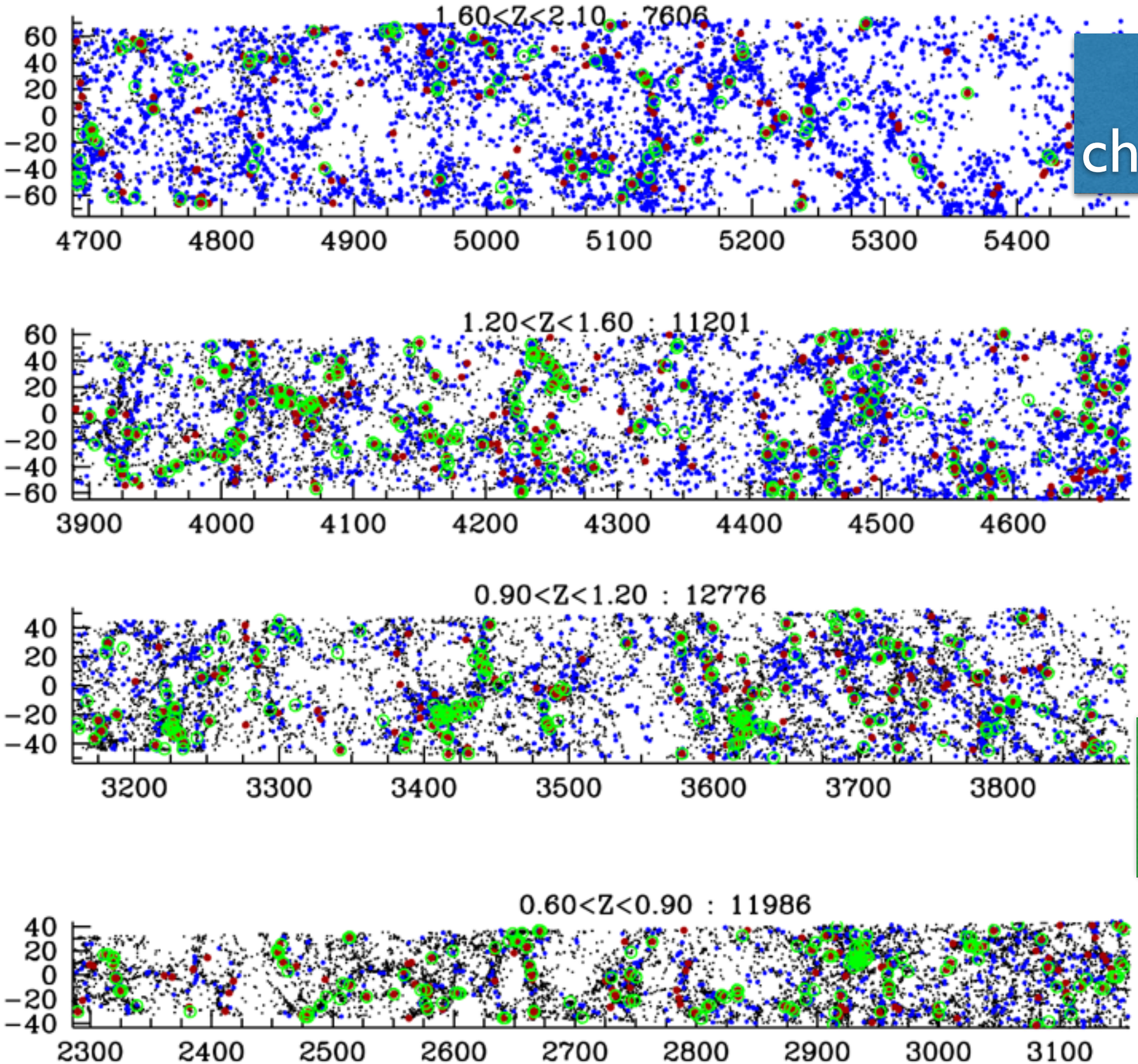

SFR
DUSK
NOON
DAWN
z=0.8
z=2
z=7
PFS GALAXY EVOLUTION
400,000
Continuum-Selected
Galaxies
200,000
Dropouts
200,000
LAEs
Hα
Star formation
rates
[OIII]
Ionization
Metallicity
[OII]
MgII
Winds
Lyα
Reionization

PFS-Galaxy Evolution will chart the formation and evolution of typical galaxies from early building blocks at reionization through the peak epoch of star formation and black hole growth.

Exploit the multiplexing capability of PFS to establish the physical drivers of star formation within the evolving cosmic web

Utilize the wide wavelength coverage of PFS to determine the cosmic history of galaxy mass, chemical abundance, black hole mass and assess the impact of gas accretion, merging, and feedback

Uncovering the evolution of the IGM from reionization to the present

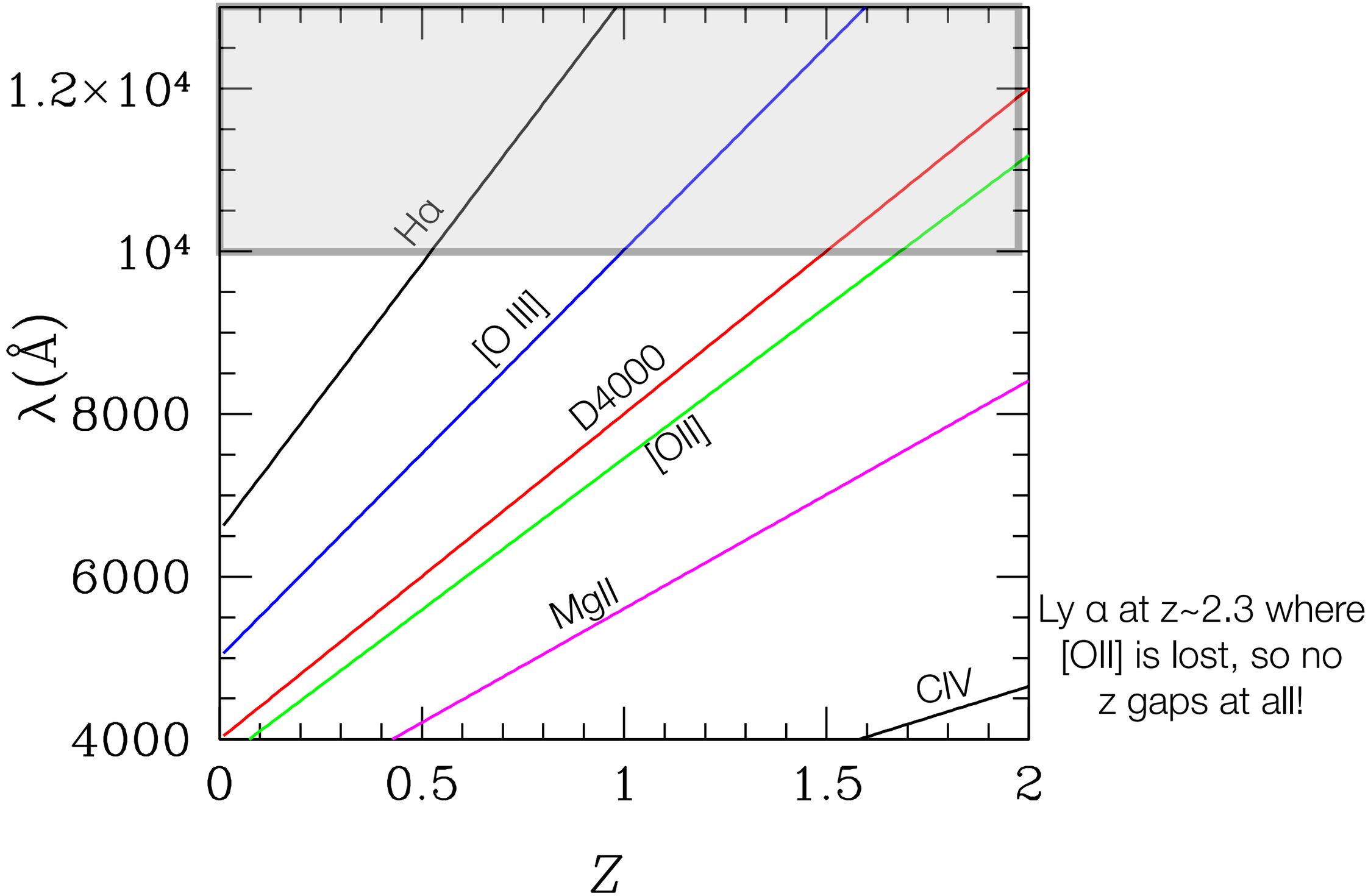


Star formation/ chemical enrichment

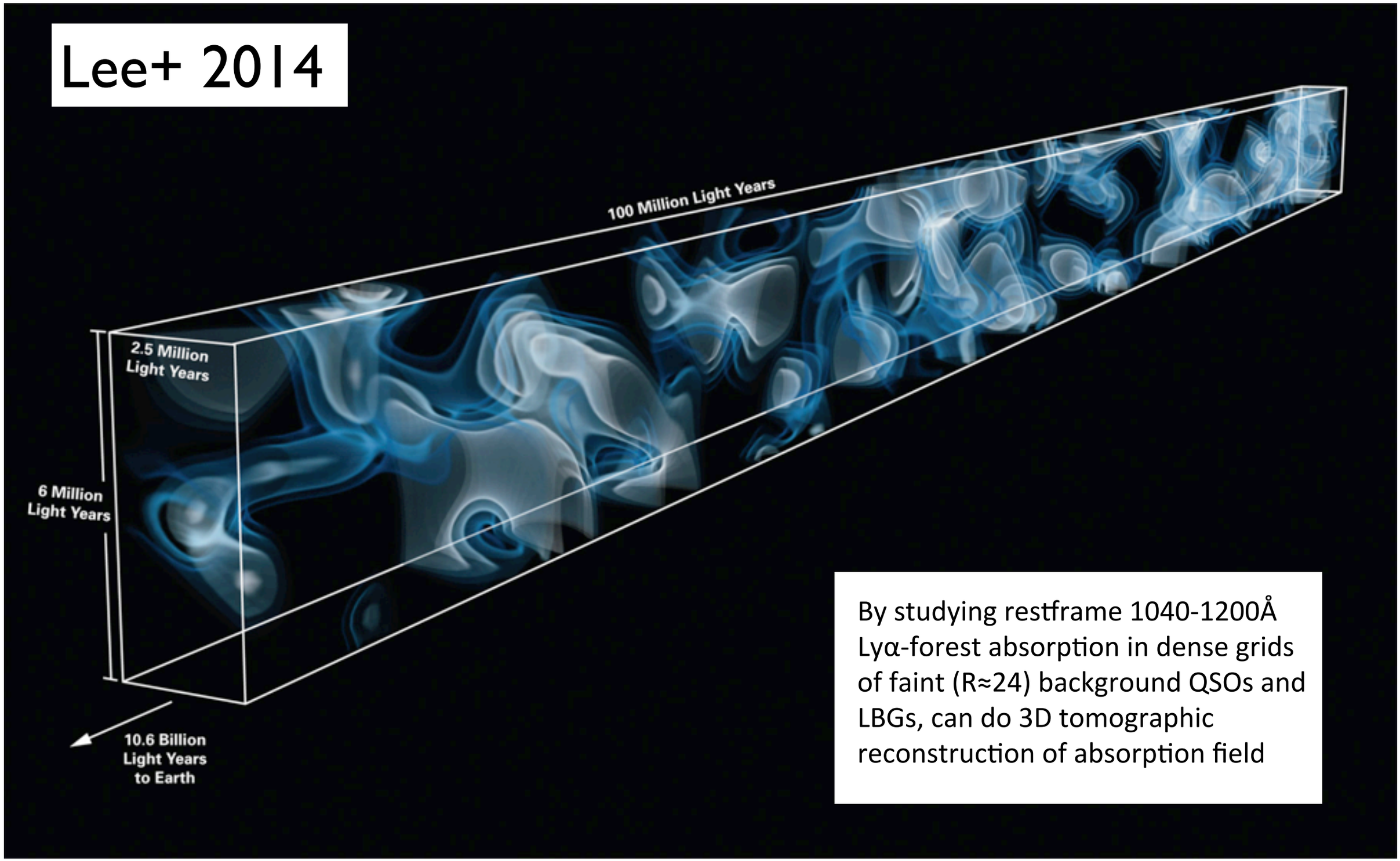
Build-up of stellar mass

Build-up of black hole mass density

Exploit the multiplexing capability of PFS to establish the physical drivers of star formation within the evolving cosmic web



Utilize the wide wavelength coverage of PFS to determine the cosmic history of galaxy mass, chemical abundance, black hole mass and assess the impact of gas accretion, merging, and feedback



Uncover the evolution of the CGM/IGM from reionization to the present

Main Point:
The PFS-Galaxy Evolution Survey
Design is not set in stone

Baseline Survey Design

25 deg^2	~10 deg^2
~200k color- selected galaxies with $0.5 < z < 1.5$ (2hr exp)	~170k color- selected galaxies with $1 < z < 2$ (3 hr exp)
~82k drop-out selected galaxies with $2 < z < 6$ (3 hr exp)	
~20k LAEs with z=2, 6 (5hr exp)	

With Blue-Selected AGN

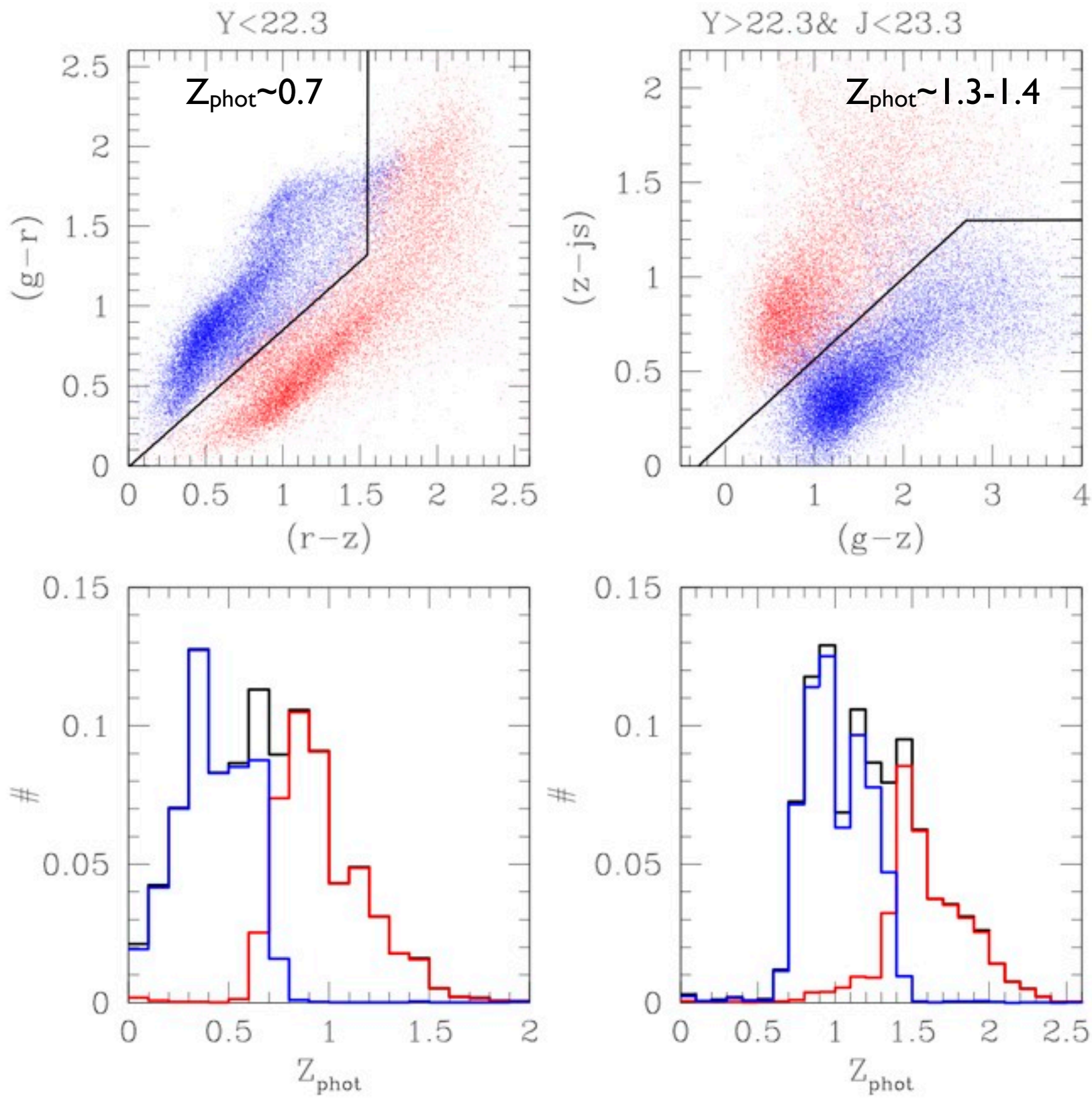
25 deg^2	~10 deg^2
~200k color- selected galaxies with $0.5 < z < 1.5$ (2hr exp)	~170k color- selected galaxies with $1 < z < 2$ (3 hr exp)
~82k drop-out selected galaxies with $2 < z < 6$ (3 hr exp)	
~20k LAEs with z=2, 6 (5hr exp)	
~100 per sq deg **$3 < z < 7$ to J~25 mag** **1 hr integration times**	

selection	sampling	Exp Time	N/PFS pointing	Area in deg^2	N samp	N field /1.33deg^2	Nb of hours
1/ Y<21	75%	1hr ?	~2500	25	1	19	1x1x19=19hr
2/ 21<Y<21.9	75%	1hr	~5500	25	3	19	1x3x19=57hr
3/ 21.9<Y<22.3	75%	2hr	~4500	25	2	19	2x2x19=76hr
4/ Y>22.3 & J<23.3	75%	3hr	~27300	10	14	8	3x14x8=336hr
5/ Y>22.3 & J<23.3 + gzJ selection	75%	3hr	~10000	25	5	19	3x5x19=285hr

<u>Total Time</u> :
1+2+3+4 = 488hr
1+2+3+5 = 437hr

PFS Deep Selection based on COSMOS + UltraVista(Ilbert v2.1 catalog)

* Color selections

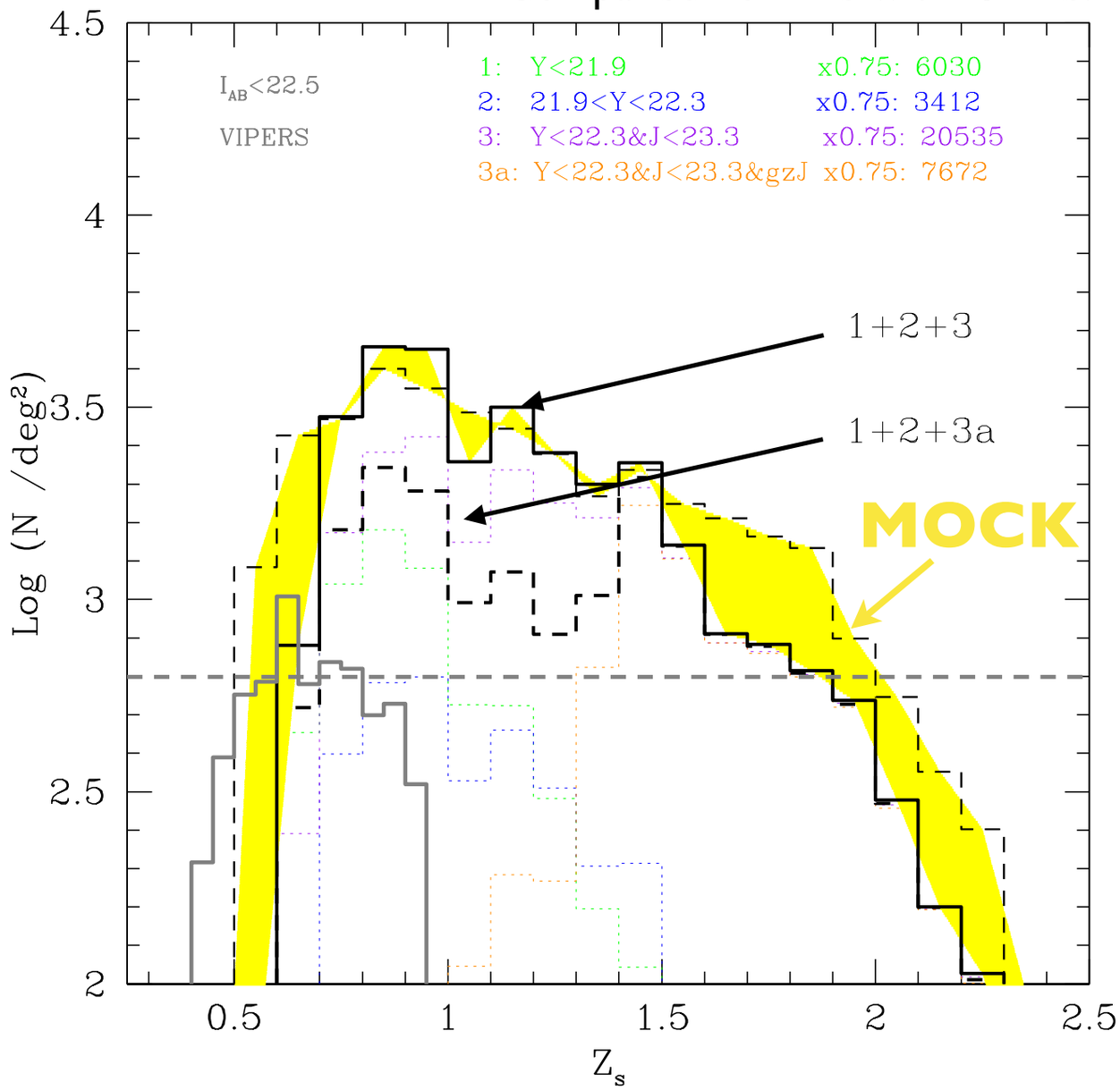


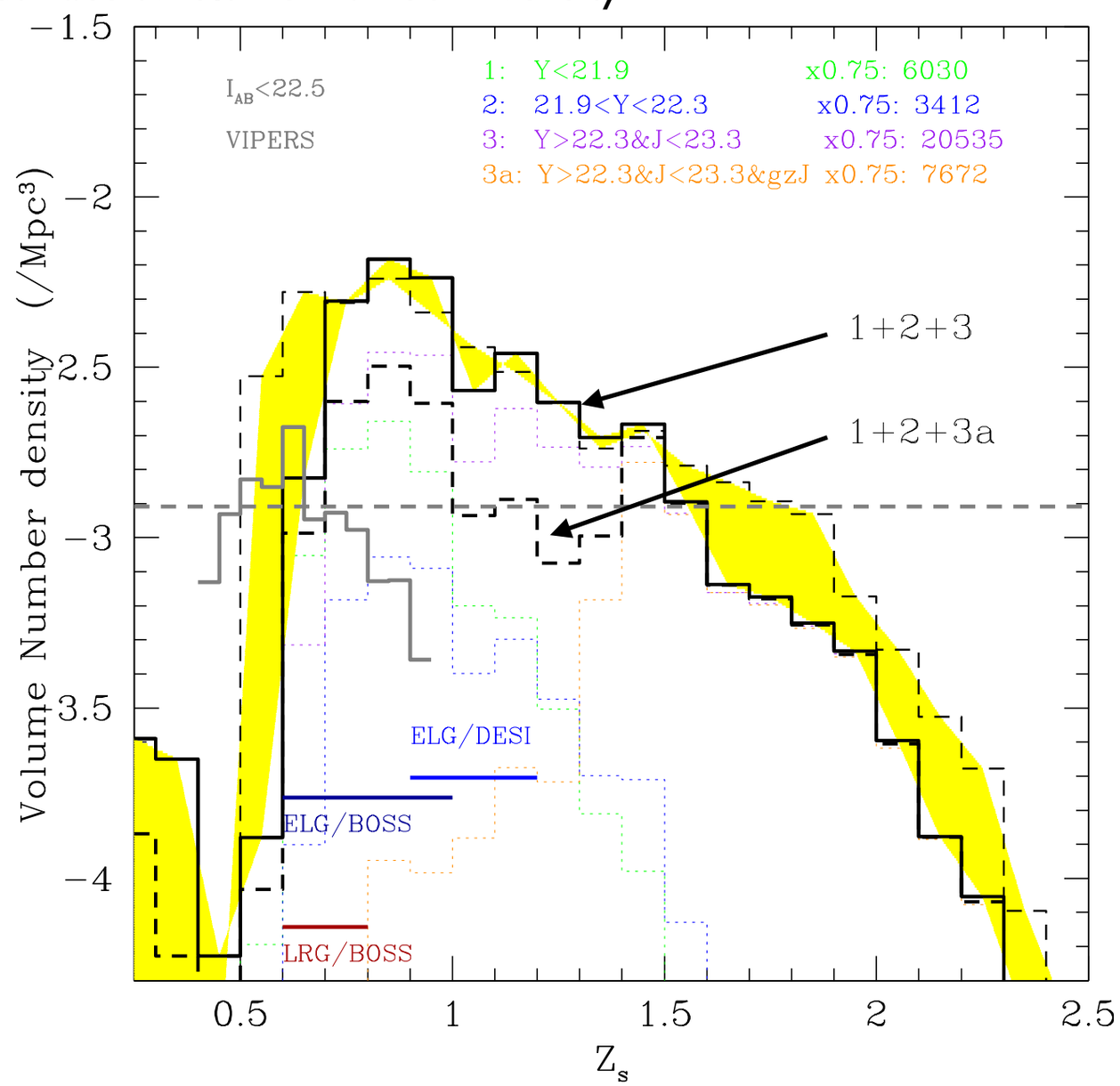
$Zs > 0.7$: $(g-r) < -0.35 + 0.857 * (r-z+0.4)$ OR $(r-z) > 1.55$

$Zs > 1.4$: $(g-z) < -0.30 + 2.310 * (z-j)$ OR $(z-j) > 1.3$

COMPARISON Mock [Roderik] and COSMOS field [ultraVista v2.1]

* Comparison of PFS with VIPERS: Surface & Volume Number Density





* selections : N targets / PFS pointing (1.33deg²)

-1-	Y<21.9	~	**8000**
-2-	21.9<Y<22.3	~	**4500**
-3-	Y>23.3 & J<23.3	~	**27300**
-3a-	Y>22.3 & J<23.3 & gzJ	~	**10200 targets**

* Larger density than VIPERS up to z~1.6

* z<1 : x 2 VIPERS density

* 1<z<1.6: 1+2+3a same density as VIPERS

[can be done over 25deg²]

* comparison with eBOSS / DESI

Next Steps:

— Evaluate photo-z selection efficiency with HSC bands

— Continue to work on our redshift testing

— Think about a Ly alpha absorption program and how it would fit in

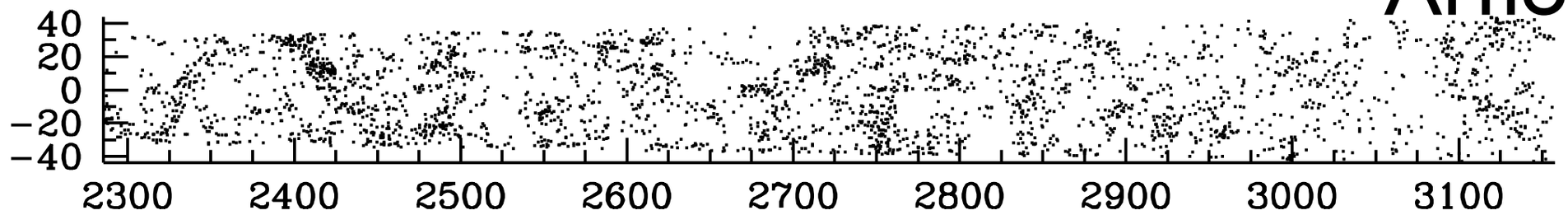
Main Point:
The PFS-Galaxy Evolution Survey
Design is not set in stone

We want your input!!

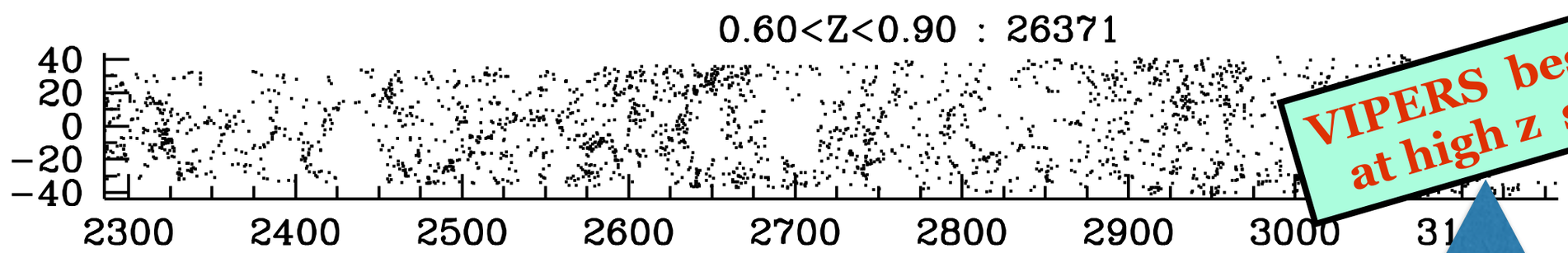
comparison with the VIPERS survey

Thanks to Arnouts!

* VIPERS observations [I<22.5] part of W1 field [1.6x1deg^2]



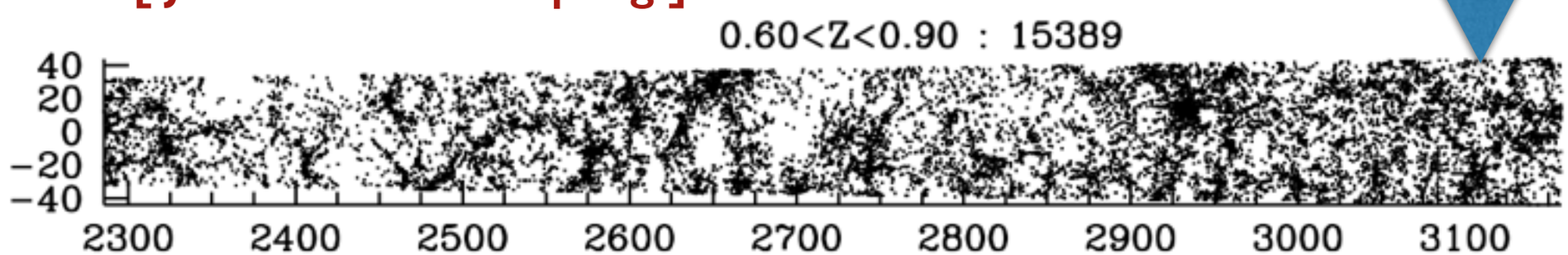
* MOCK VIPERS like [I<22.5 & ~40% sampling] *but no redshift error included yet !*



VIPERS best LSS at high z so far

with its higher resolution ~2000 vs 230 for VIPERS, PFS will improve the contrast of the structures

* MOCK PFS like [J<23.3 & 75% sampling]



In the same redshift range, PFS will increase sampling by 6 wrt VIPERS much improve picture of the cosmic web and density fluctuations

Competitive Landscape/Timing - Upcoming

Telescope / Instrument	Total time(y), DES / 75% complete	Total time(y), LSST / 75% complete	Total time(y), DES / 90% complete	Total time(y), LSST / 90% complete
Keck / DEIMOS	0.51	10.22	3.19	63.89
VLT / MOONS	0.20	4.00	1.25	25.03
Subaru / PFS	0.05	1.10	0.34	6.87
Mayall 4m / DESI	0.26	5.11	1.60	31.95
WHT / WEAVE	0.45	8.96	2.80	56.03
GMT/MANIFEST+GMACS	0.02 - 0.04	0.42 - 0.75	0.13 - 0.24	2.60 - 4.71
TMT / WFOS	0.09	1.78	0.56	11.12
E-ELT / OPTIMOS	0.02 - 0.04	0.50 - 0.74	0.16 – 0.23	3.10 - 4.65

.

Using PFS galaxy samples for photo-z training
Newman+ 2014 (Snowmass)

Competitive Landscape/Timing - Upcoming

Start with a magnitude-limited ‘pilot’ survey over 2 PFS pointings, to evaluate our success rates and target selection.

Cosmology needs this as well, to understand selection function

With the current schedule, we hope this component can occur *before* the SSP

How can we achieve these primary goals?

Sample selection (photo z or color selection?)

Simulations

Survey design

Thanks to Olivier Ilbert!

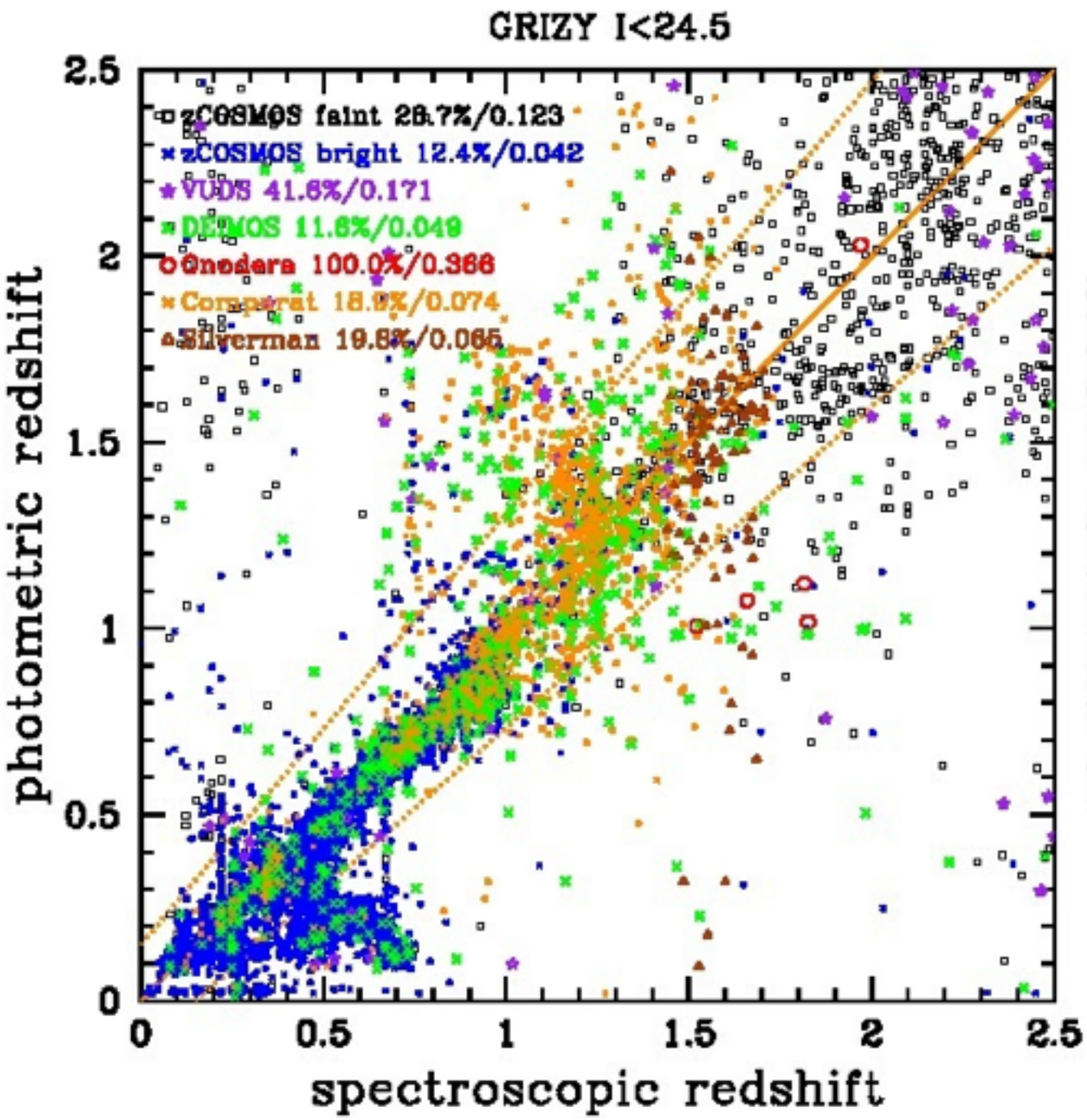
TEST PHOTO-Z FOR PFS TARGET SELECTION

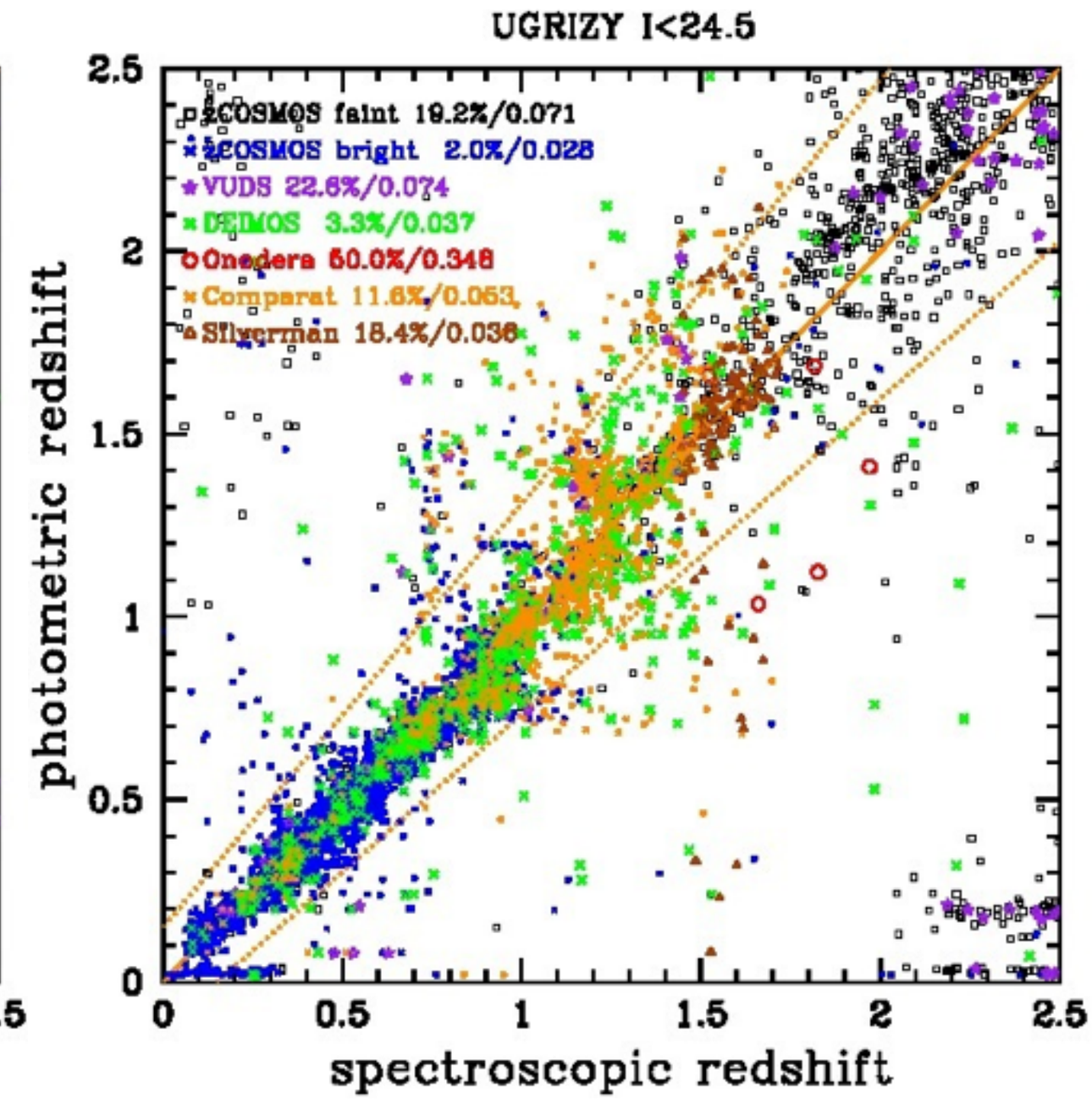
We start from a new COSMOS-SPLASH photometric catalogue created Clotilde Laigle, Henry McCracken (in optical/NIR) and Paul Hsieh for IRAC. Include also the Y HSC (prepared by John and Gunther Hasinger).

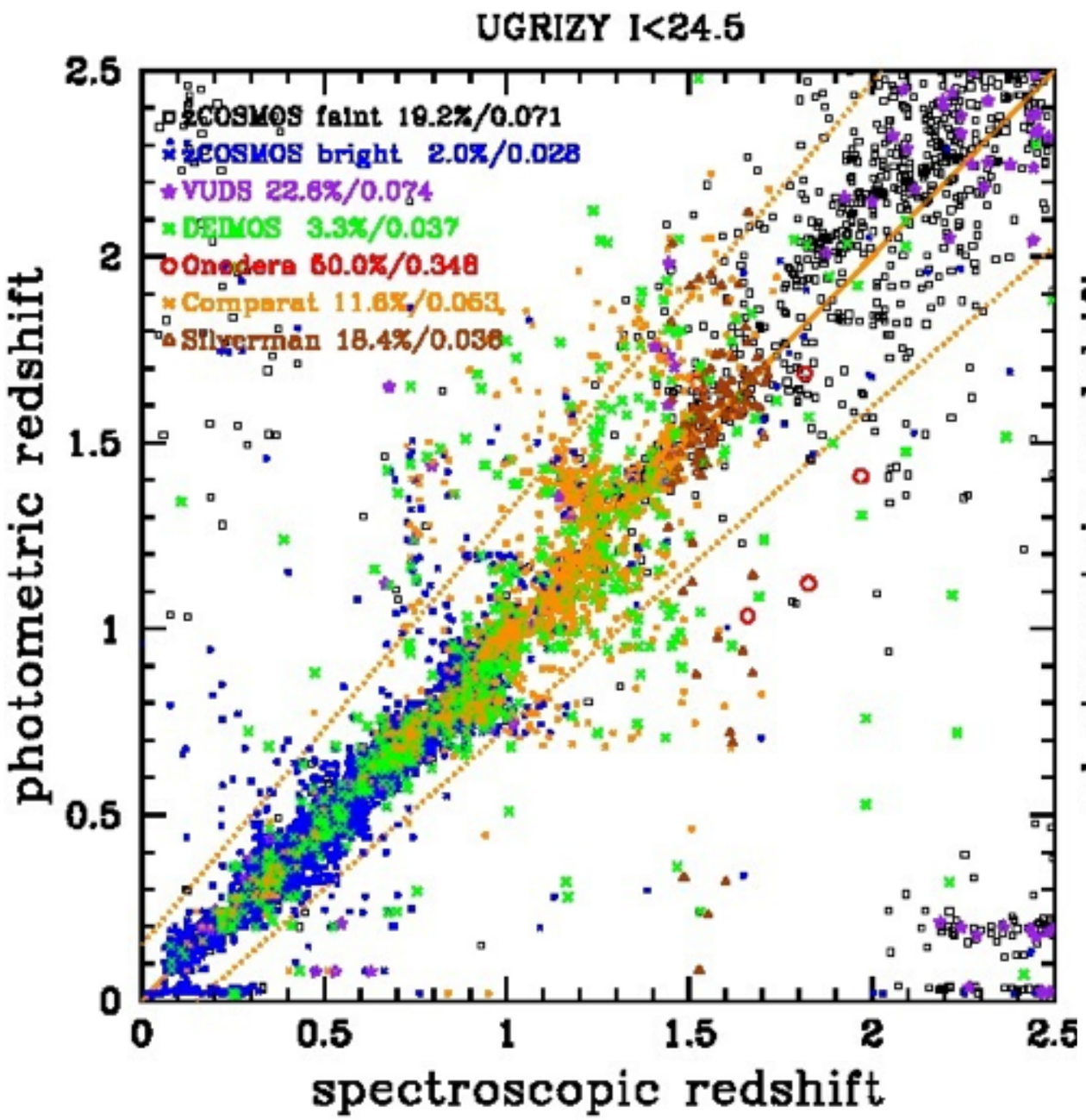
Keep only the U (megacam) GRIZ (suprime-cam) Y (HSC) and J from VISTA. Degrade the error in J to have 23.5 at 10σ

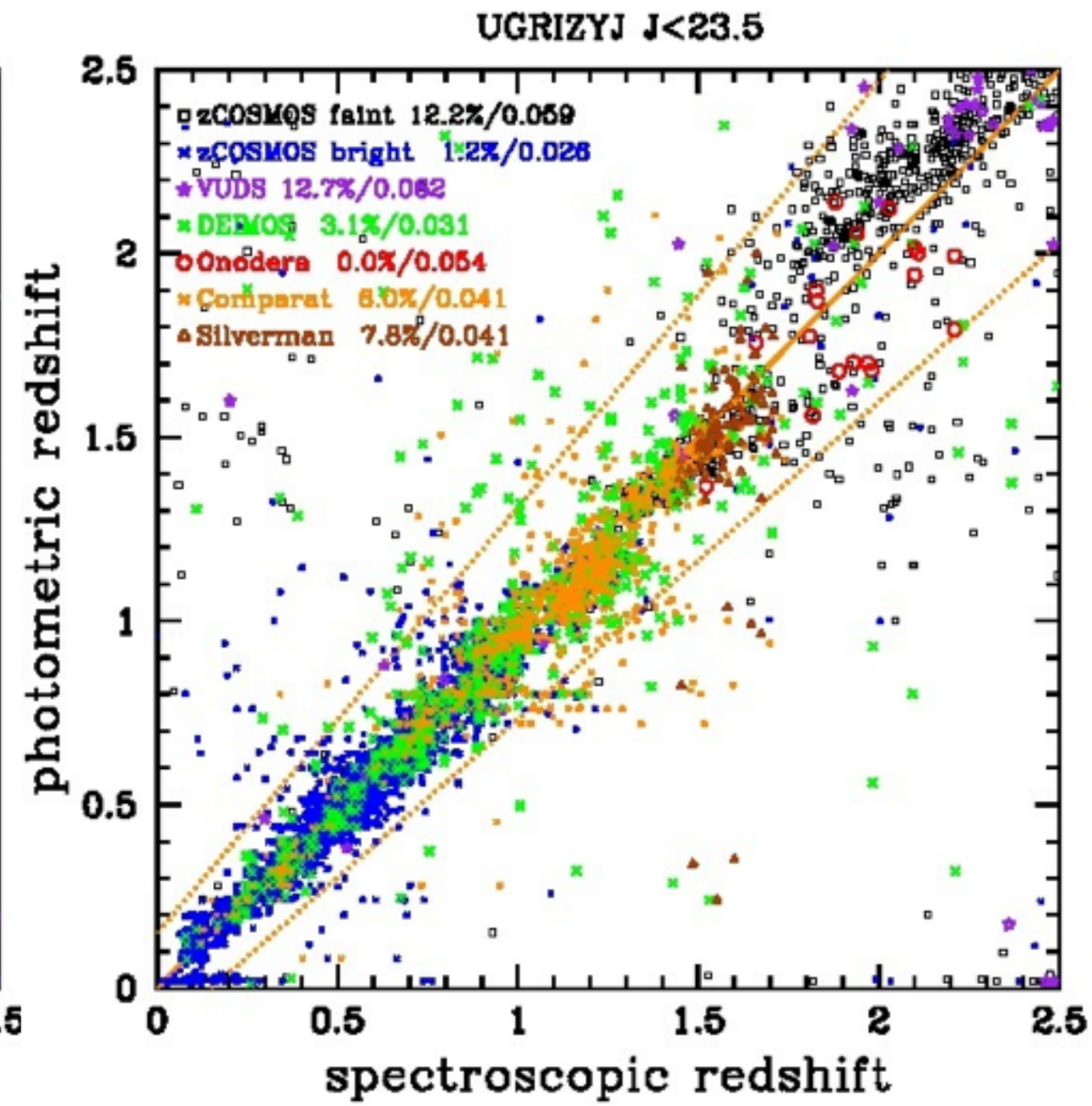
Photo-z computed with the template fitting code Le Phare with the same method as Ilbert 09 and 13.

Fraction of failures in %: abs(zp-zs)/(1+zs)>0.15
Sigma of (zp-zs)/(1+zs) from the NMAD


GRIZY I<24.5
zCOSMOS faint 28.7%/0.123
zCOSMOS bright 12.4%/0.042
VUDS 41.6%/0.171
DEIMOS 11.6%/0.049
Onodera 100.0%/0.366
Comparat 18.9%/0.074
Silverman 19.6%/0.065
photometric redshift
spectroscopic redshift
0
0.5
1
1.5
2
2.5


UGRIZY I<24.5
zCOSMOS faint 19.2%/0.071
zCOSMOS bright 2.0%/0.028
VUDS 22.6%/0.074
DEIMOS 3.3%/0.037
Onodera 50.0%/0.348
Comparat 11.6%/0.053
Silverman 18.4%/0.036
photometric redshift
spectroscopic redshift
0
0.5
1
1.5
2
2.5


UGRIZY I<24.5
zCOSMOS faint 19.2%/0.071
zCOSMOS bright 2.0%/0.028
VUDS 22.6%/0.074
DEIMOS 3.3%/0.037
Onodera 50.0%/0.348
Comparat 11.6%/0.053
Silverman 18.4%/0.036
photometric redshift
spectroscopic redshift
0
0.5
1
1.5
2
2.5

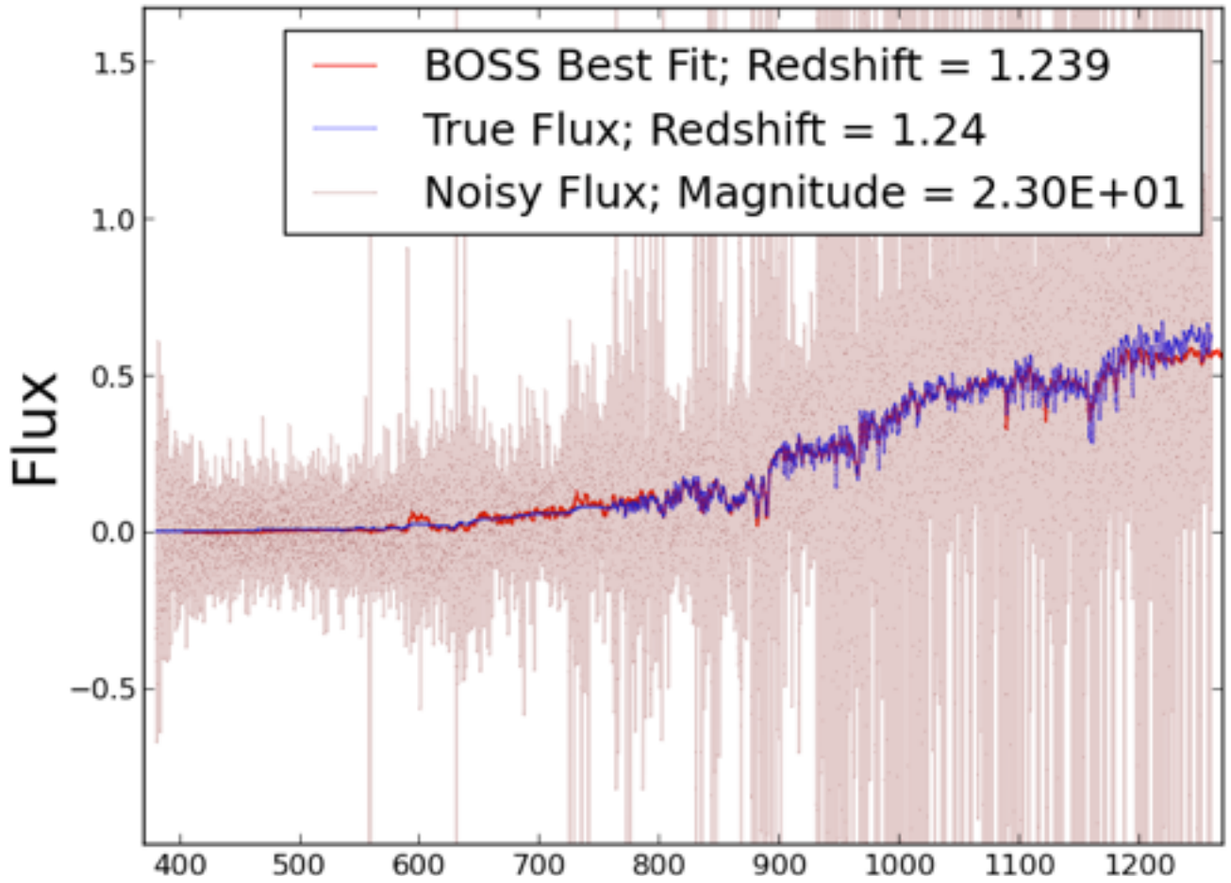

UGRIZYJ J<23.5
zCOSMOS faint 12.2%/0.059
zCOSMOS bright 1.2%/0.026
VUDS 12.7%/0.062
DEIMOS 3.1%/0.031
Onodera 0.0%/0.054
Comparat 6.0%/0.041
Silverman 7.8%/0.041
photometric redshift
spectroscopic redshift
0
0.5
1
1.5
2
2.5

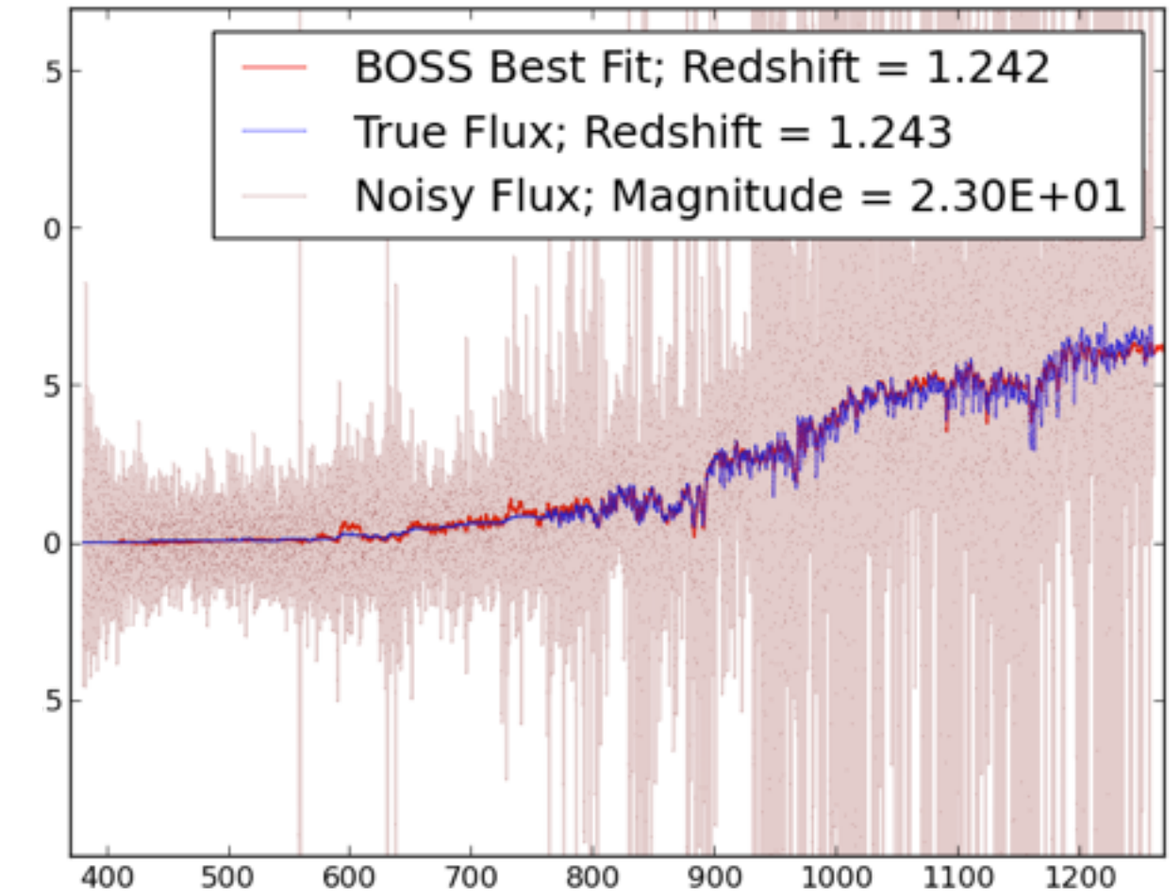
Feasibility Studies: Hirata simulations

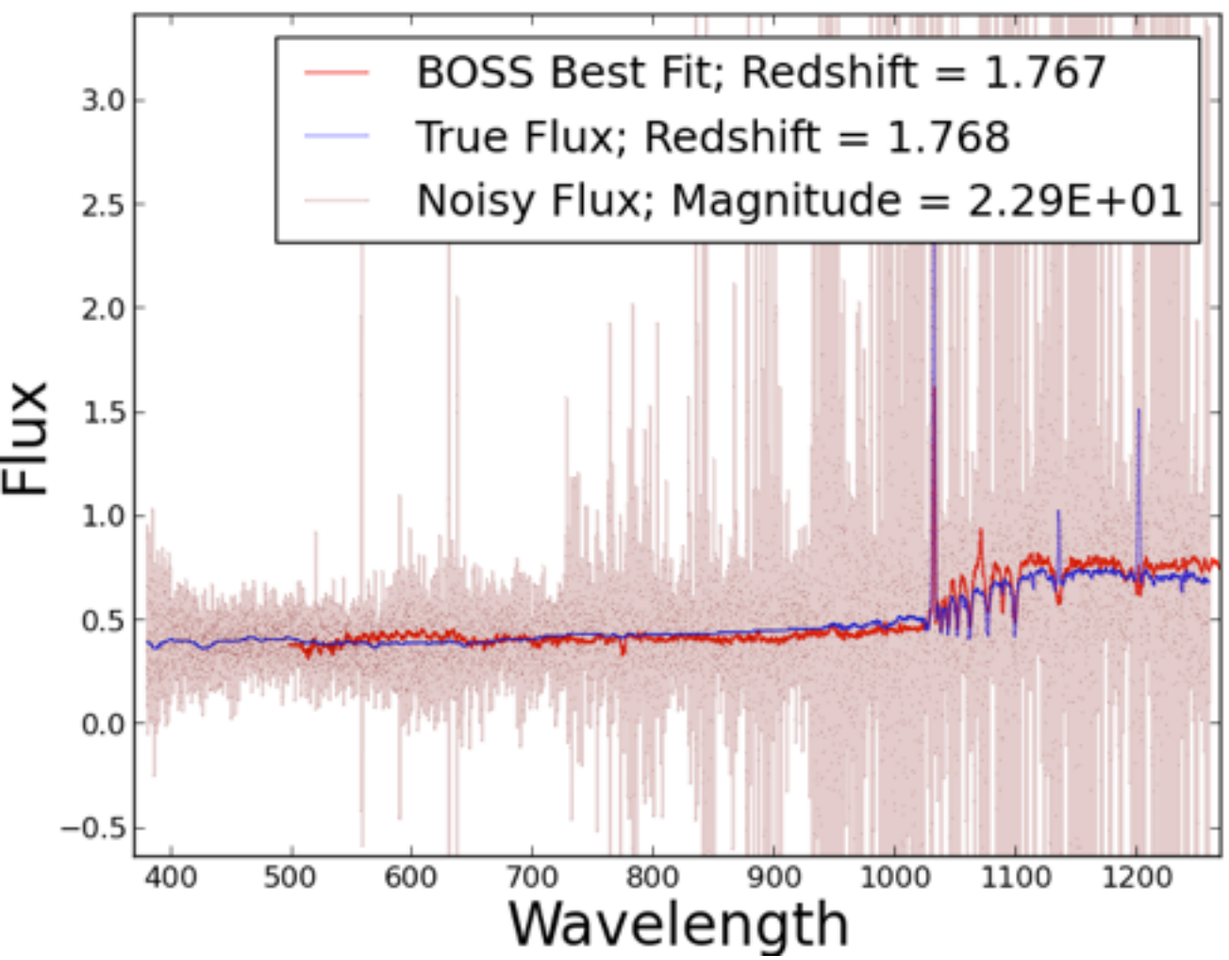
- *Systematic sky subtraction residuals* – These are modeled by adding a "noise" term corresponding to some percentage of the sky counts in each spectral pixel. We currently set this to 2% of the brightest of the pixel and its neighbor on either side (equivalent to 1% sky subtraction accuracy on a 4-pixel resolution element).

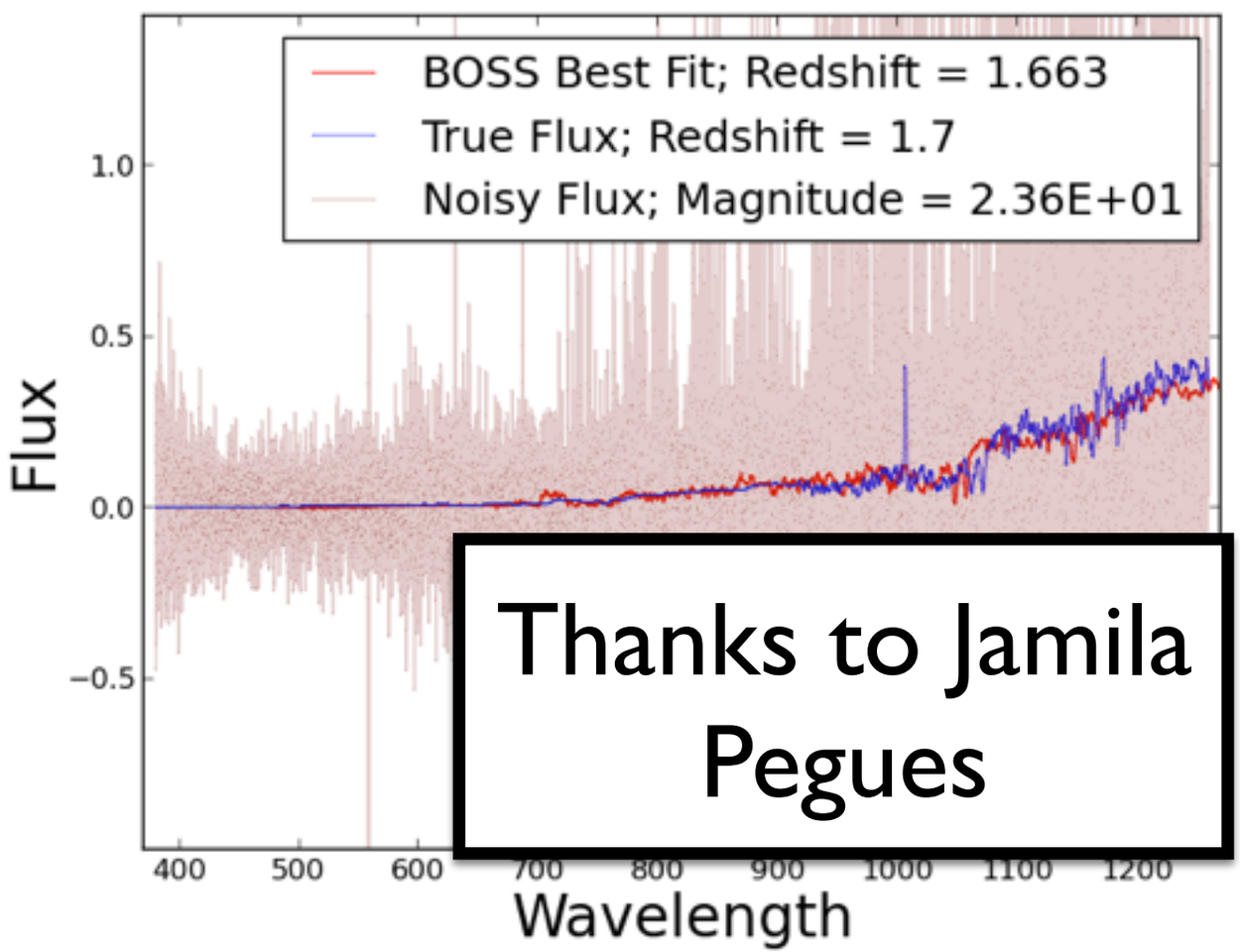
- *Small-angle stray light* – We assign to the grating an effective number of lines that is 1/3 of the actual number.

- *Diffuse stray light* – We take 2% of the OH line flux incident on the detector and uniformly spread it over all pixels. (This may be appropriate for a detector that reflects 10% of the incident radiation, and then there are many surfaces that could potentially reflect this radiation back. Refining this parameter will be a priority since the S/N forecasts degrade rapidly if it gets worse.)



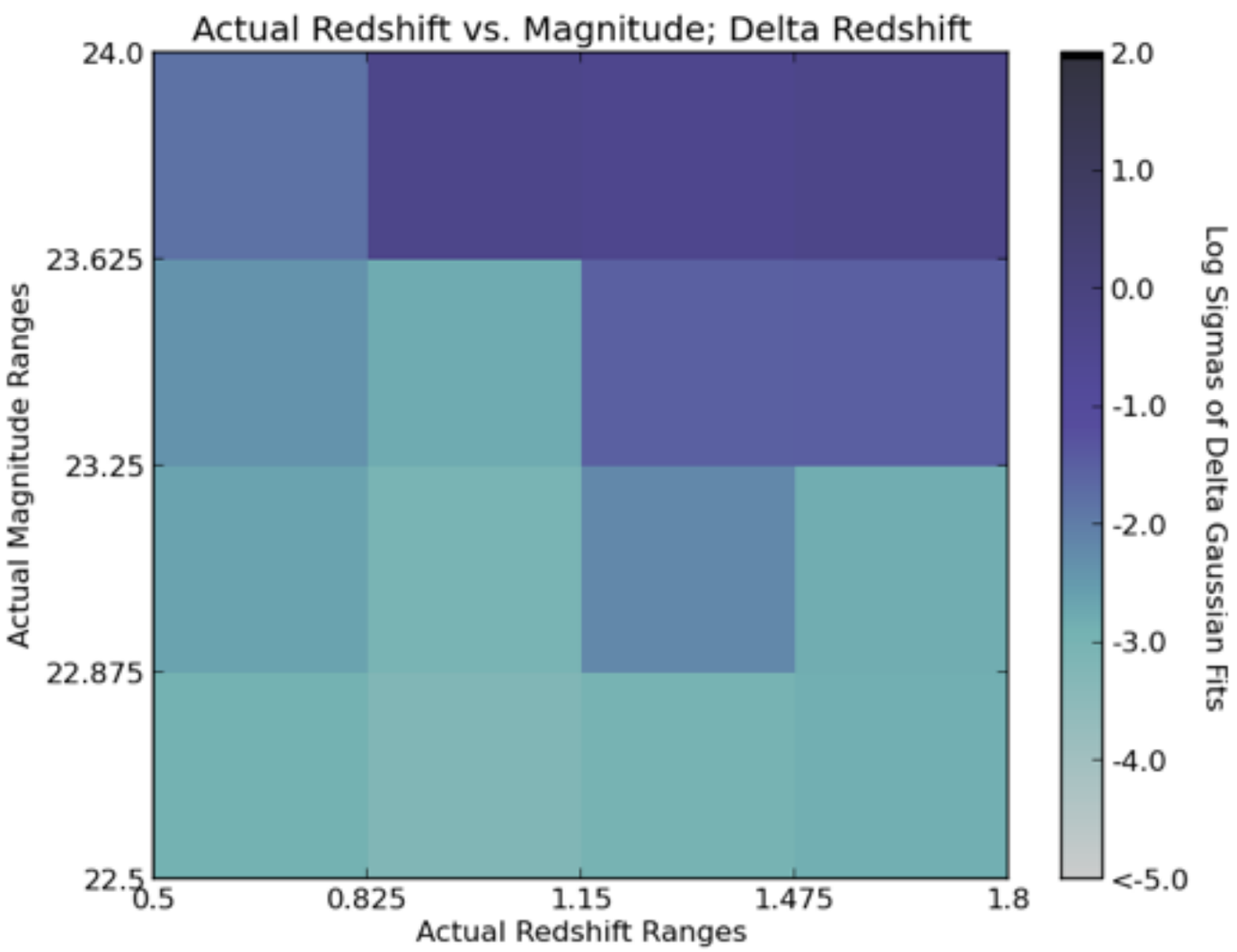




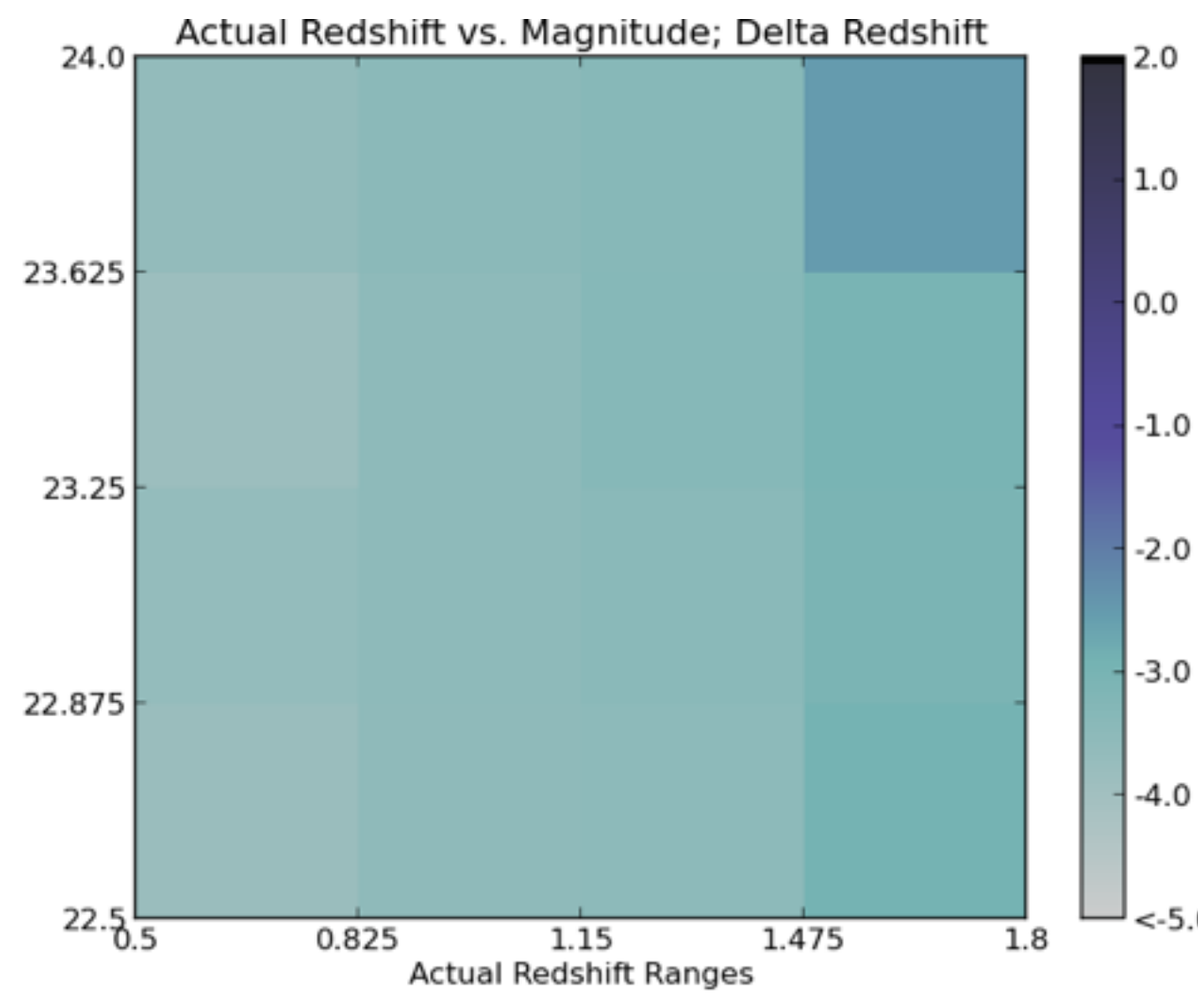


Thanks to Jamila Pegues

PASSIVE
NO EMISSION

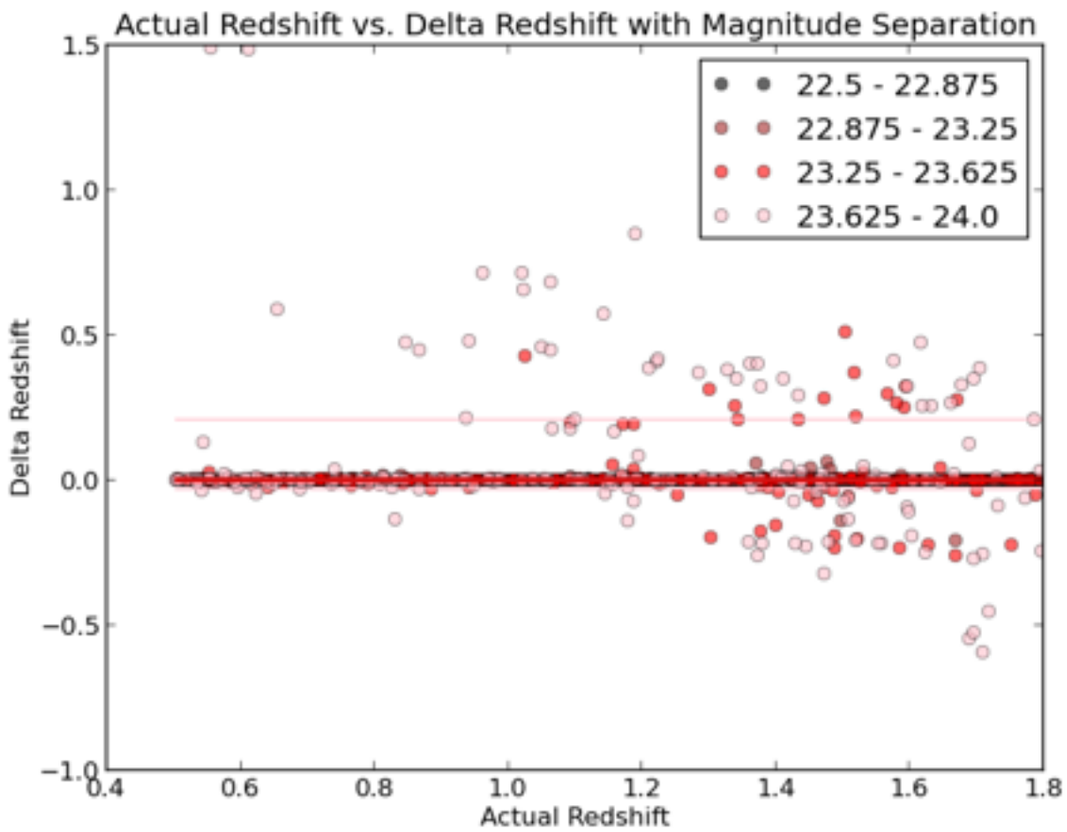


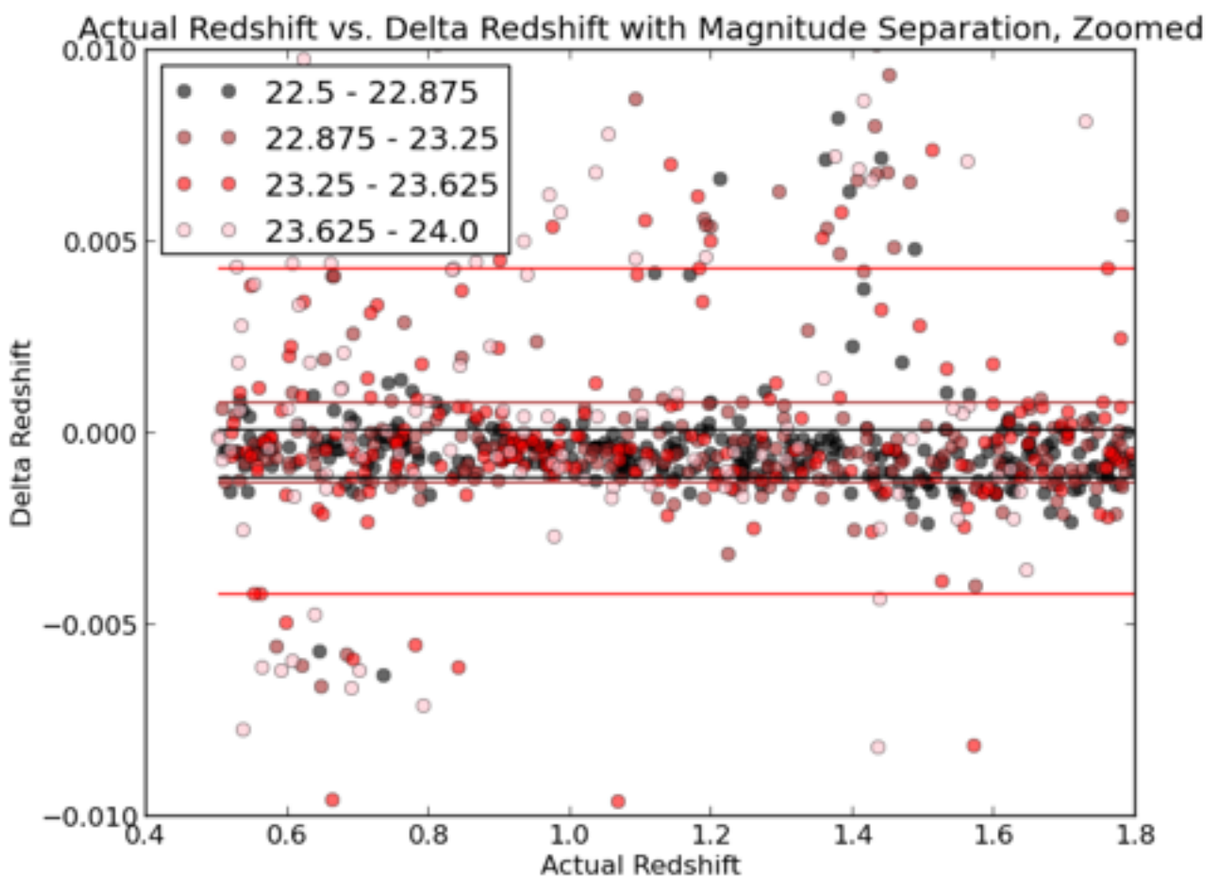
YOUNG
SOME EMISSION



Old, no emission

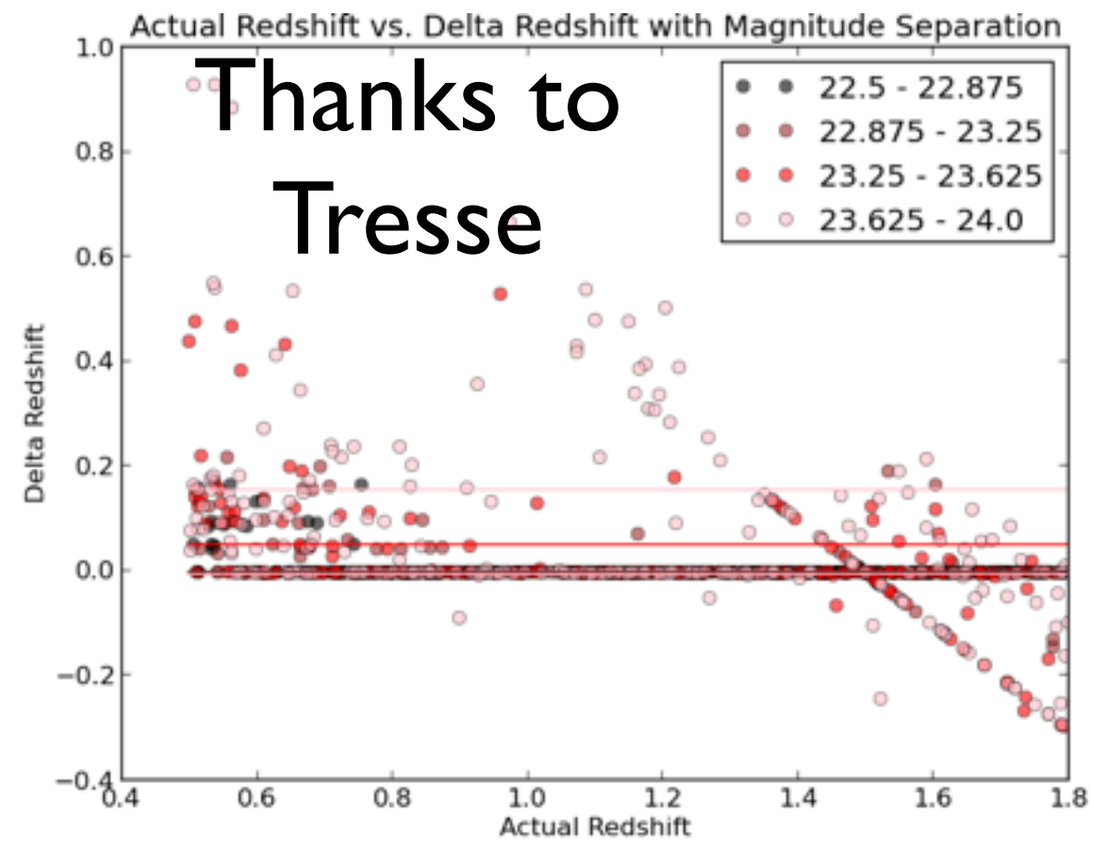
BOSS

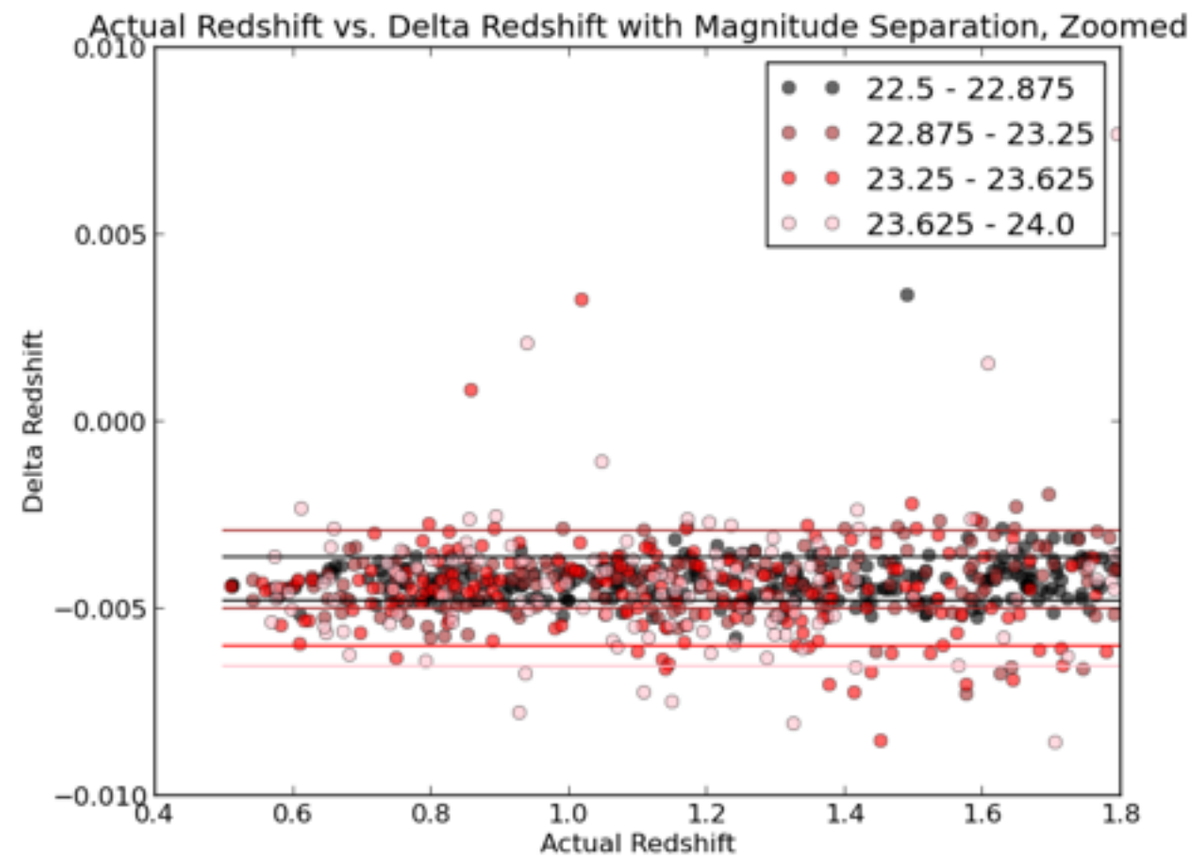




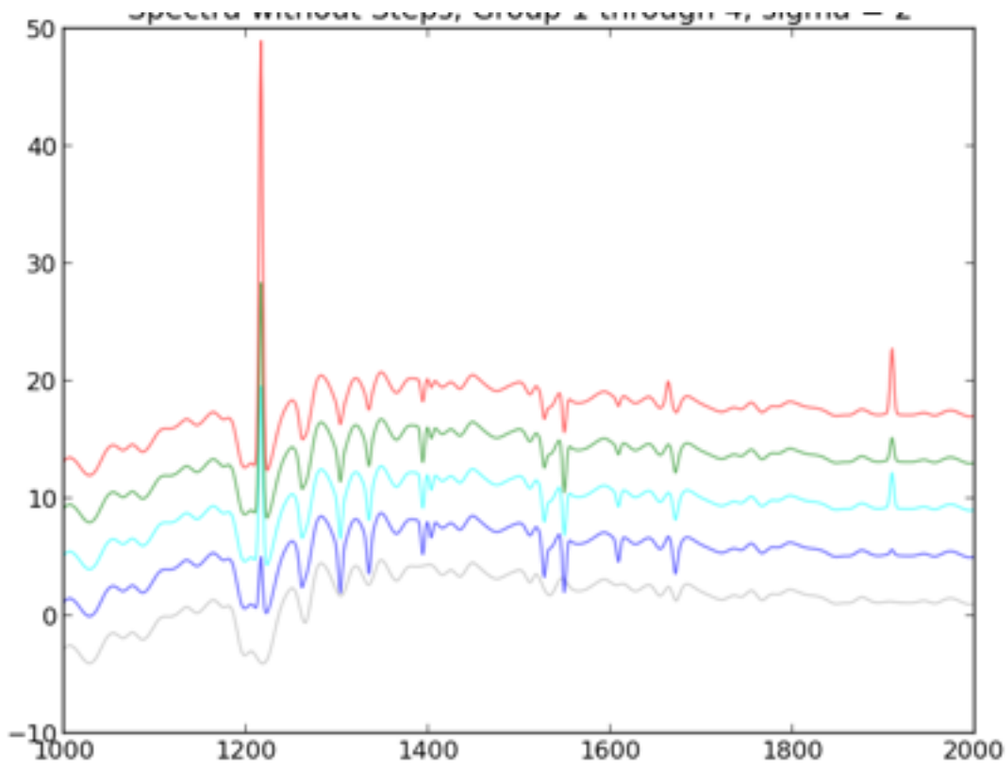
EZ

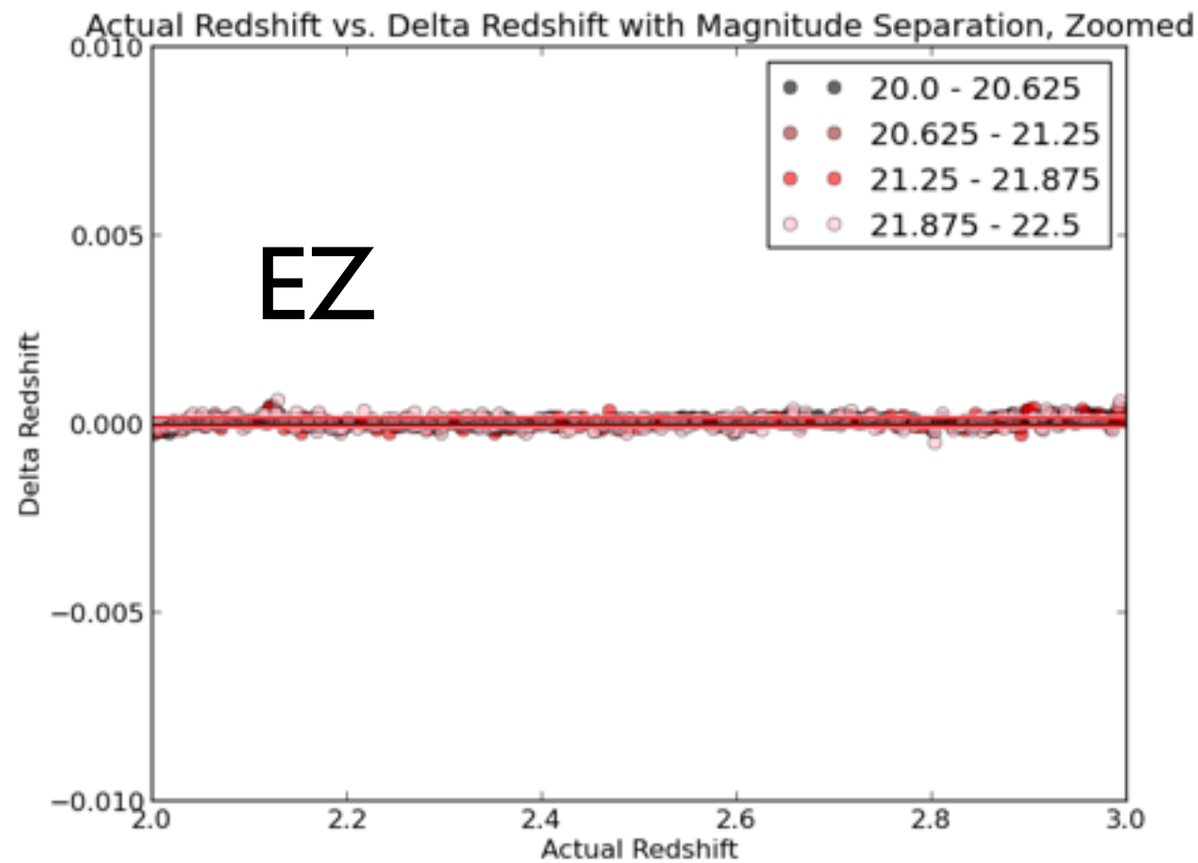
Thanks to Tresse

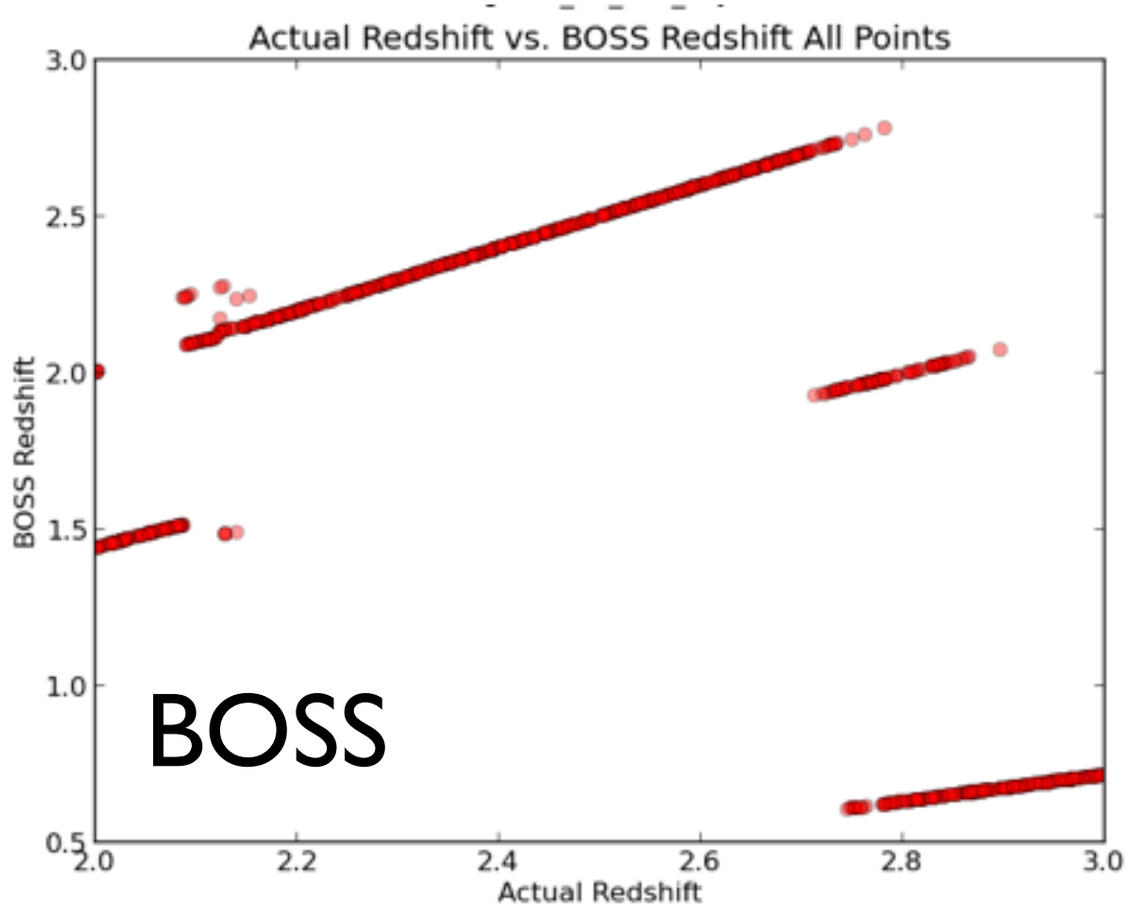




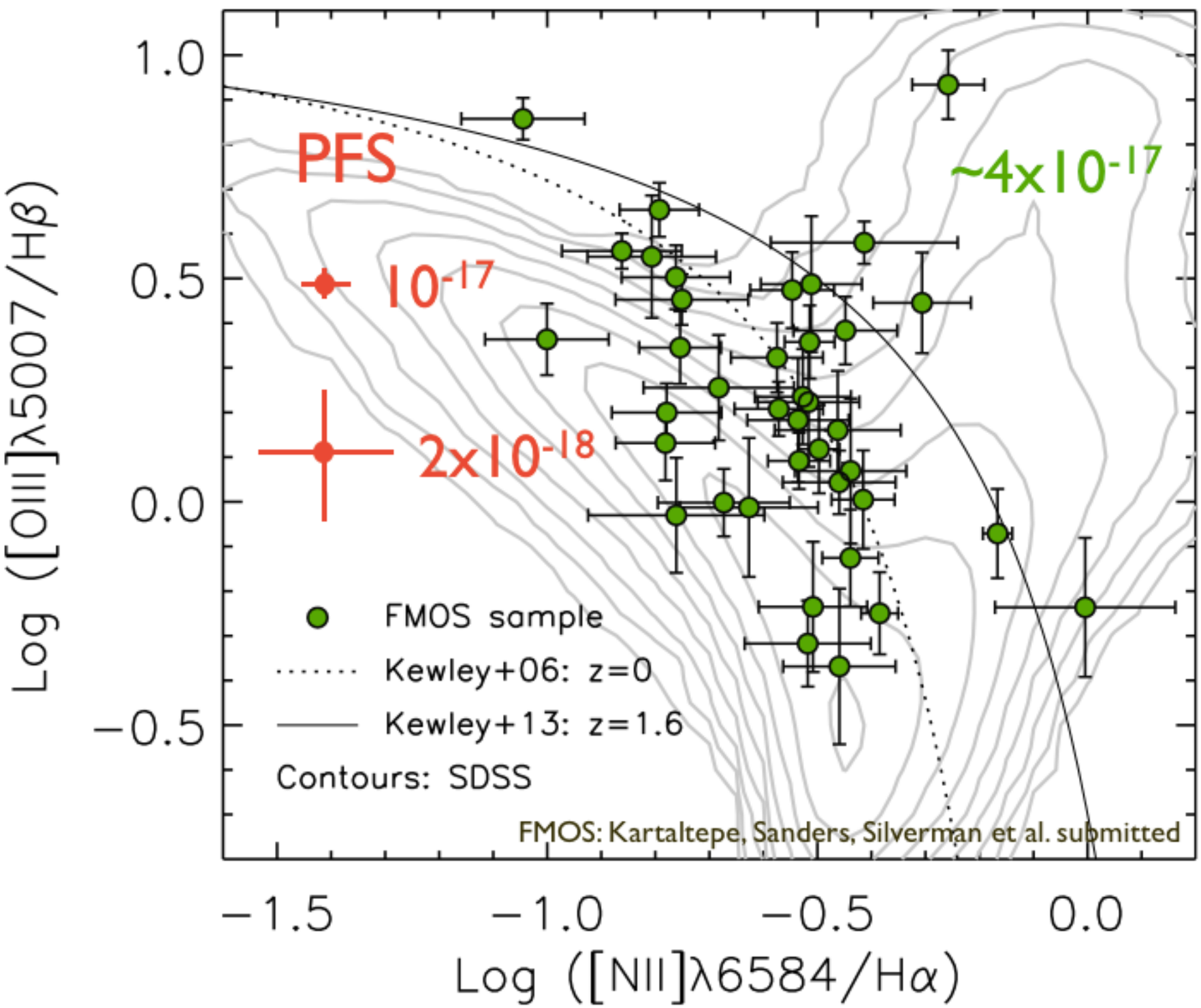
Drop-out Templates (EZ)







Starting to quantify what we can measure…



Thanks to Silverman!

Resulting Survey Design

25 deg^2

~200k color- selected galaxies with $0.5 < z < 1.5$ (2hr exp)

~82k drop-out selected galaxies with $2 < z < 6$ (3 hr exp)

~20k LAEs with z=2, 6 (5hr exp)

~9 deg^2

~170k color- selected galaxies with $1 < z < 2$ (3 hr exp)

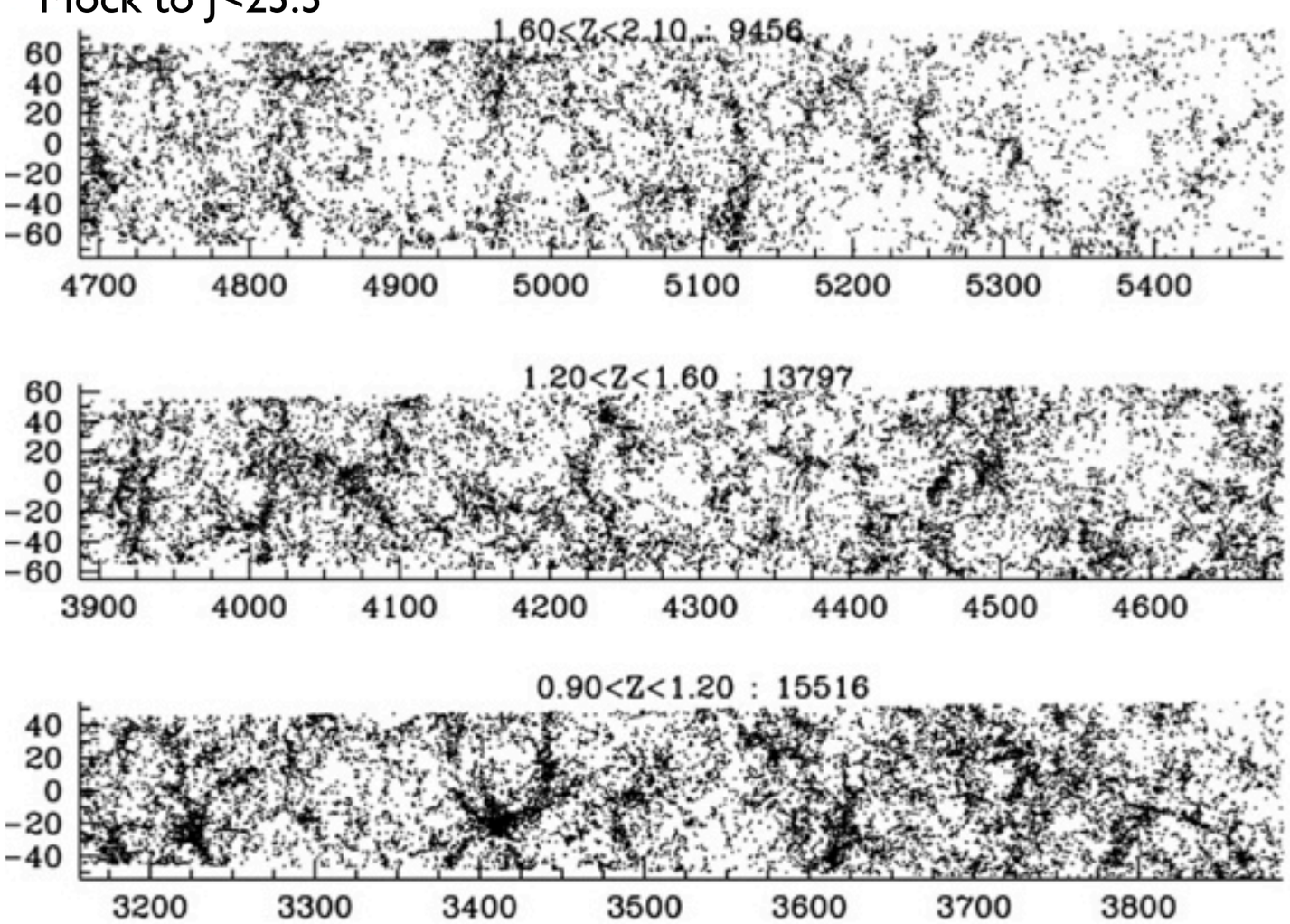
Justify Volumes/Predict our ability to measure the cosmic web

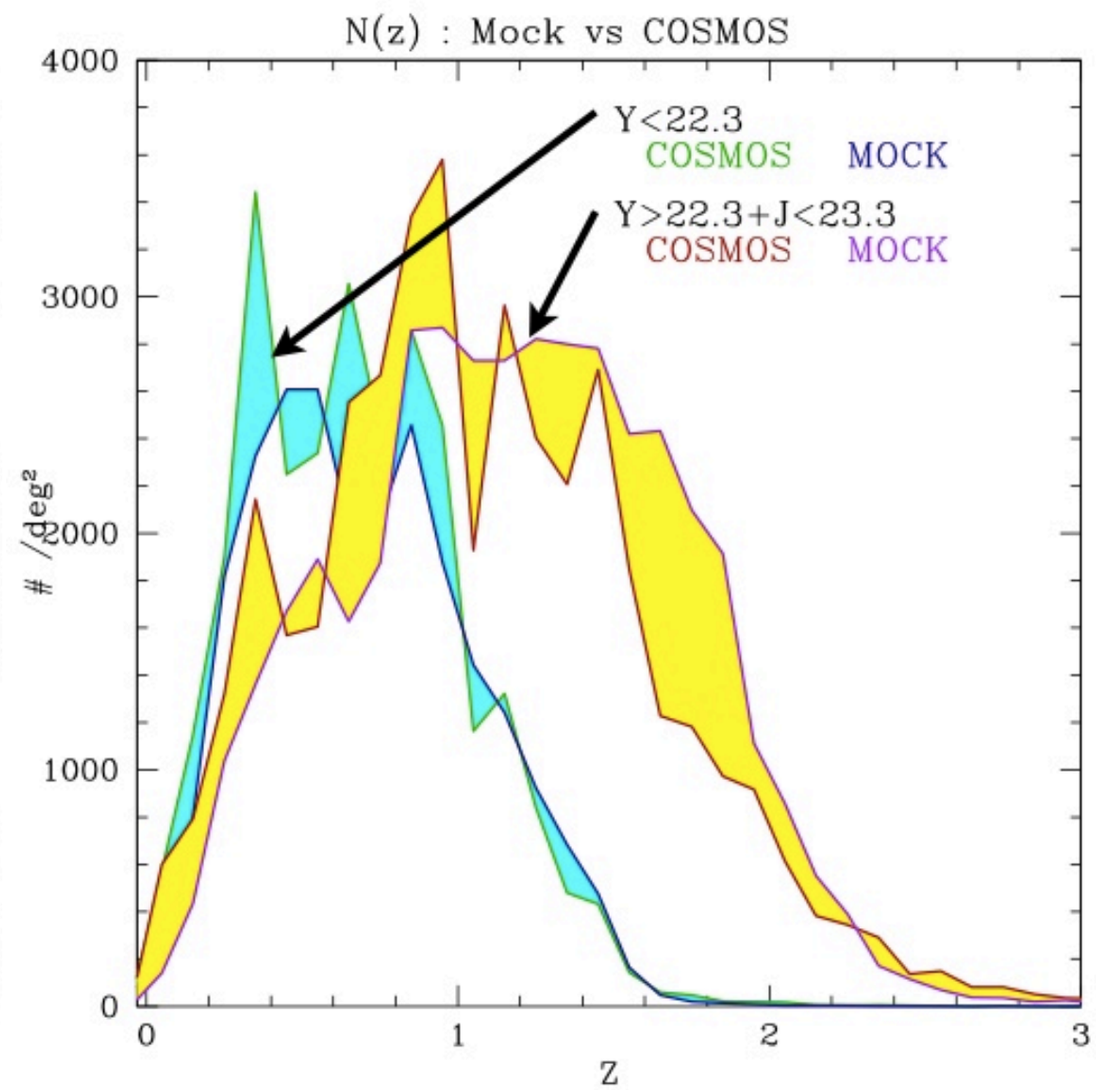
Galaxy Simulations and Mock PFS survey

The simulation: Overzier+ in prep

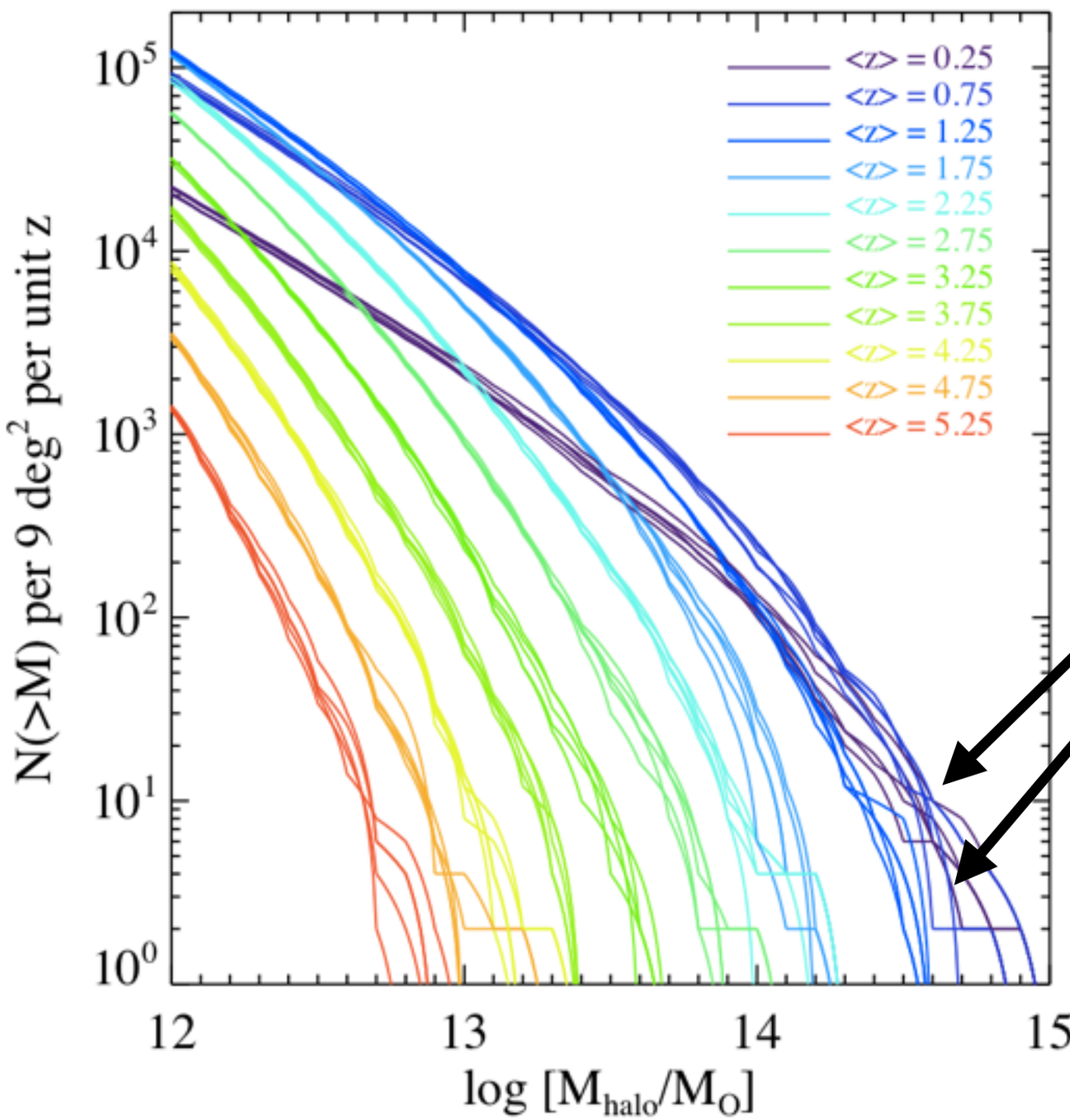
- Millennium Run dark matter simulation updated to the Planck1 cosmology
- Latest semi-analytic model from Henriques et al. (2014, arXiv:1410.0365)
- Mock lightcones in 24 sightlines each measuring ~3 deg^2 (~75 deg^2)
- Star formation histories for each galaxy. Many photometric bands (+ spectra coming)
- Excellent match to the COSMOS number counts versus redshift data

Mock to J<23.3





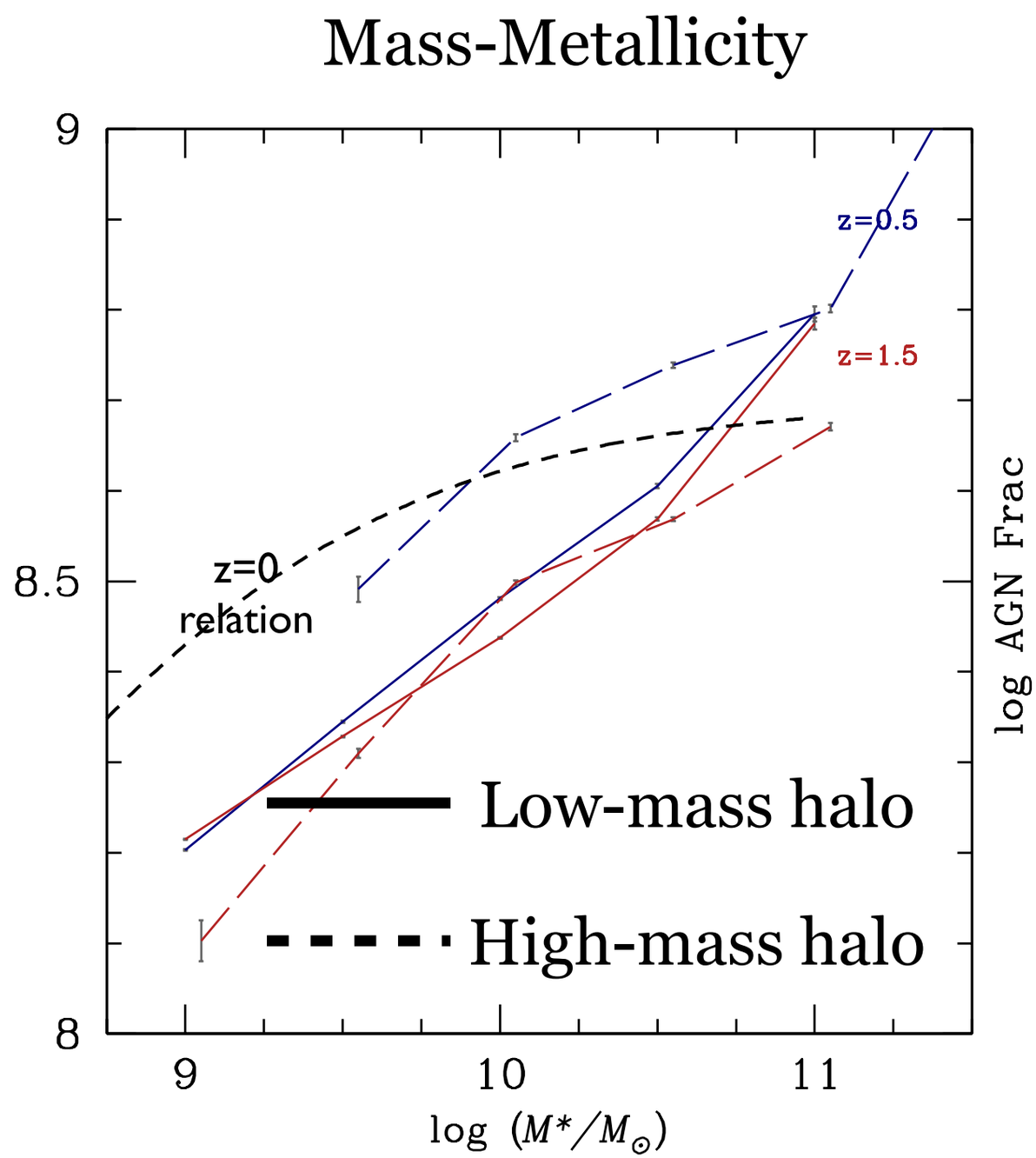
Cumulative Halo Mass Distribution

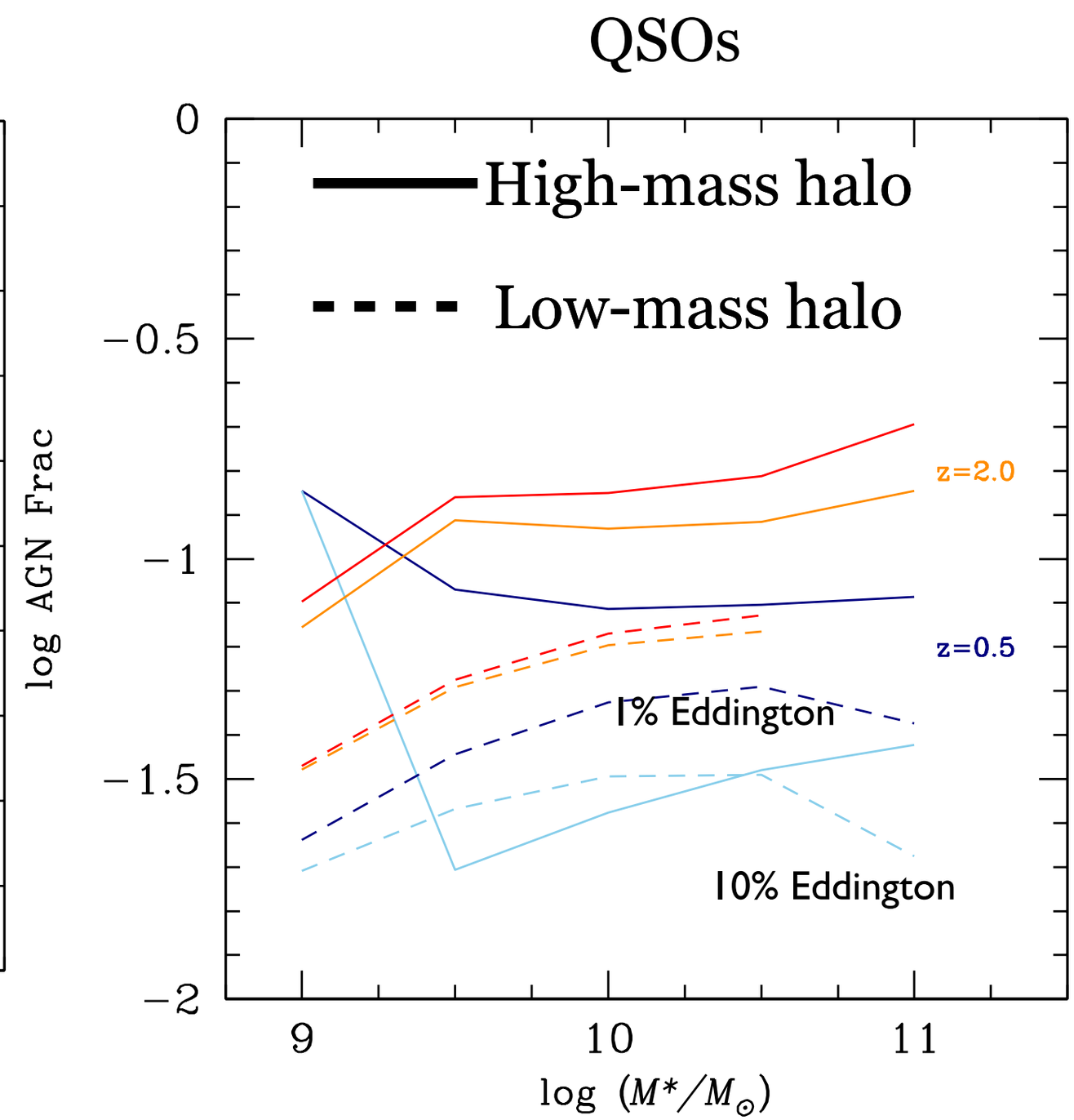


Cosmic Variance

Thanks to Overzier!

Evolution of physical properties in cosmic web

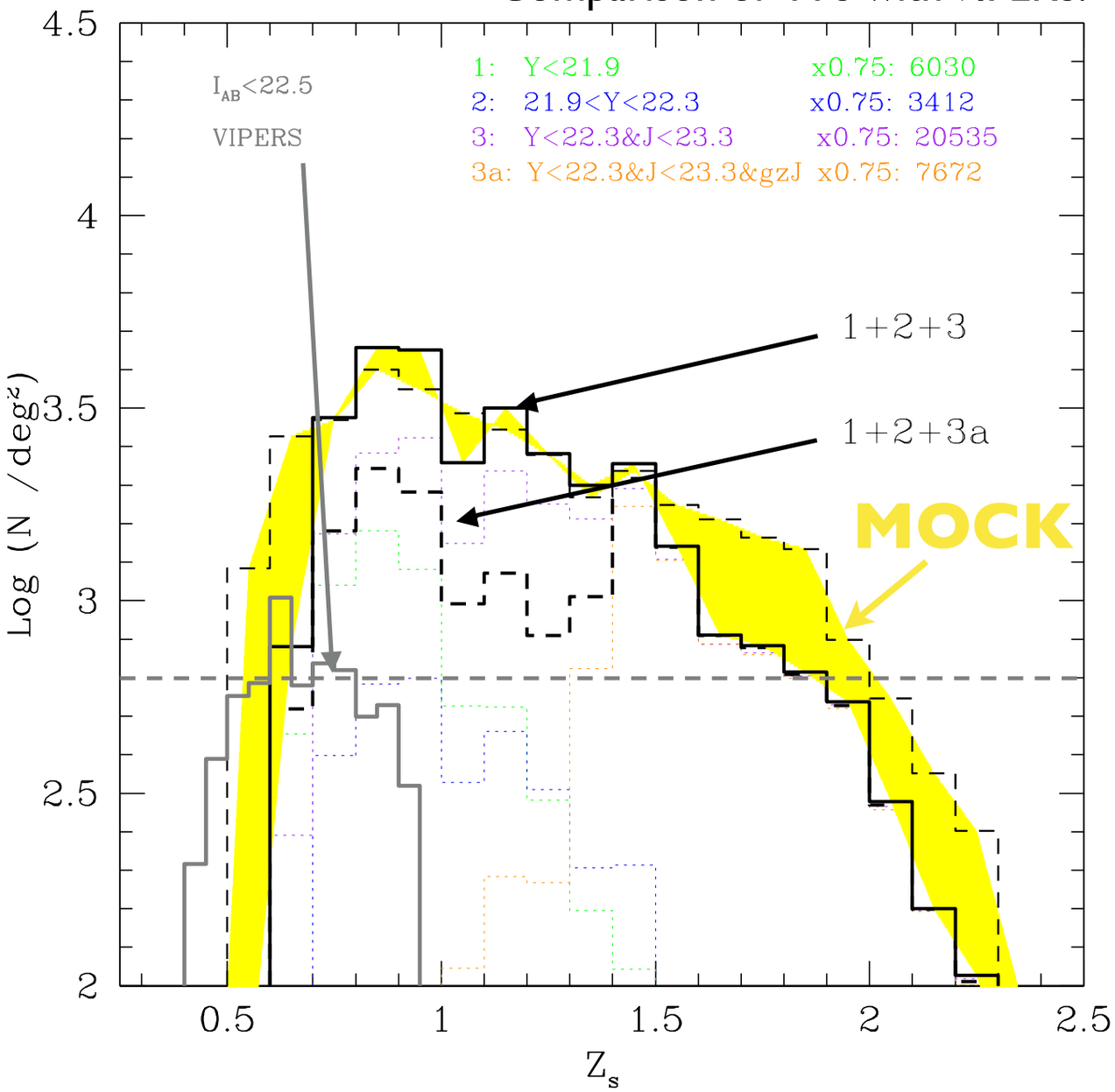


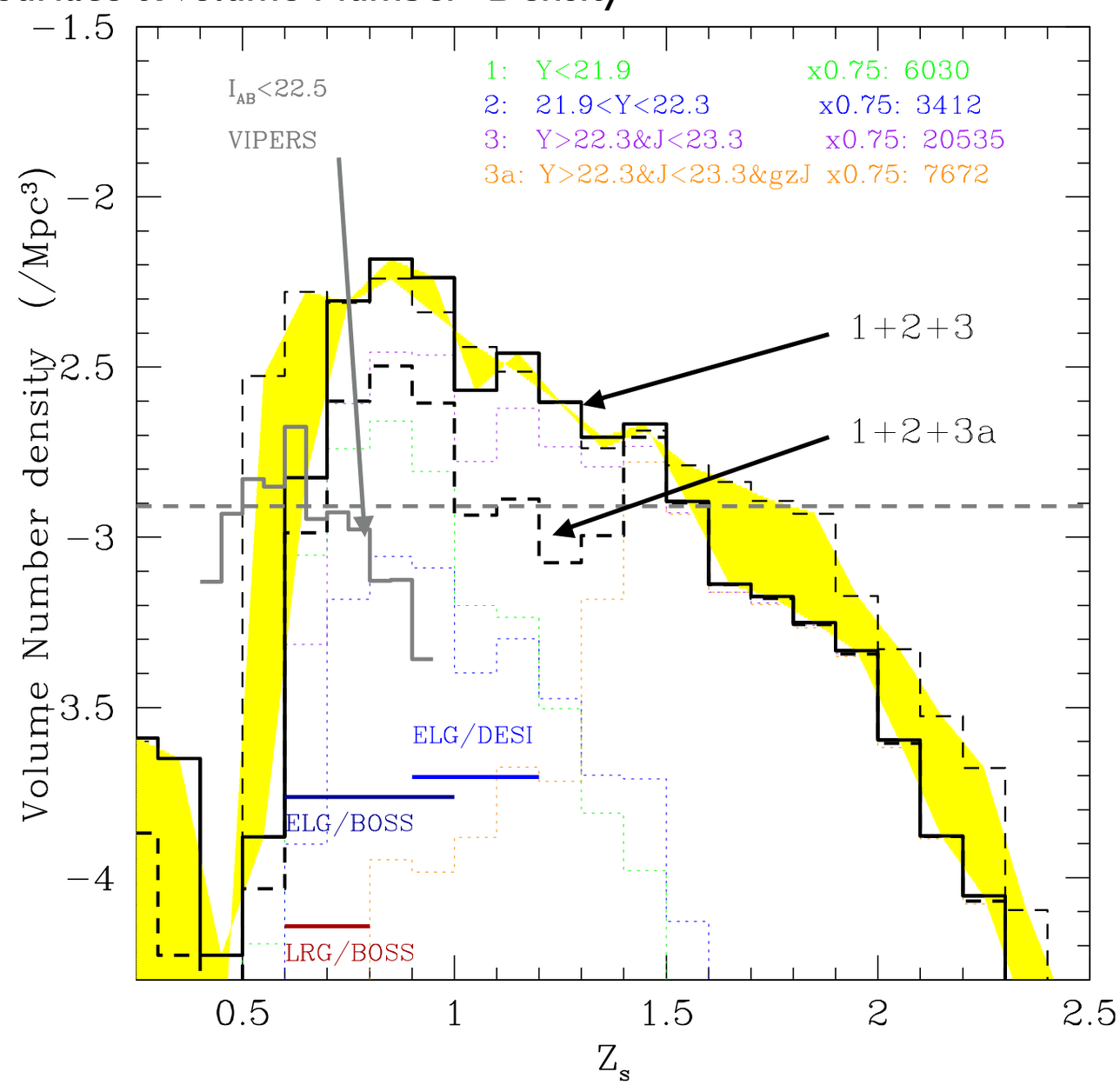


Comparison between SAM Mock (R. Overzier) and COSMOS catalog (Ultra-Vista v2.1, O. Ilbert)

Arnouts

* Comparison of PFS with VIPERS: Surface & Volume Number Density





* selections : N targets / PFS pointing (1.33deg^2)

-1-	Y<21.9	~	**8000**
-2-	21.9<Y<22.3	~	**4500**
-3-	Y>23.3 & J<23.3	~	**27300**
-3a-	Y>22.3 & J<23.3 & gzJ	~	**10200 targets**

* Larger density than VIPERS up to z~1.6

* z<1 : x 2 VIPERS density

* 1<z<1.6: 1+2+3a same density as VIPERS

[can be done over 25deg^2]

* comparison with eBOSS / DESI

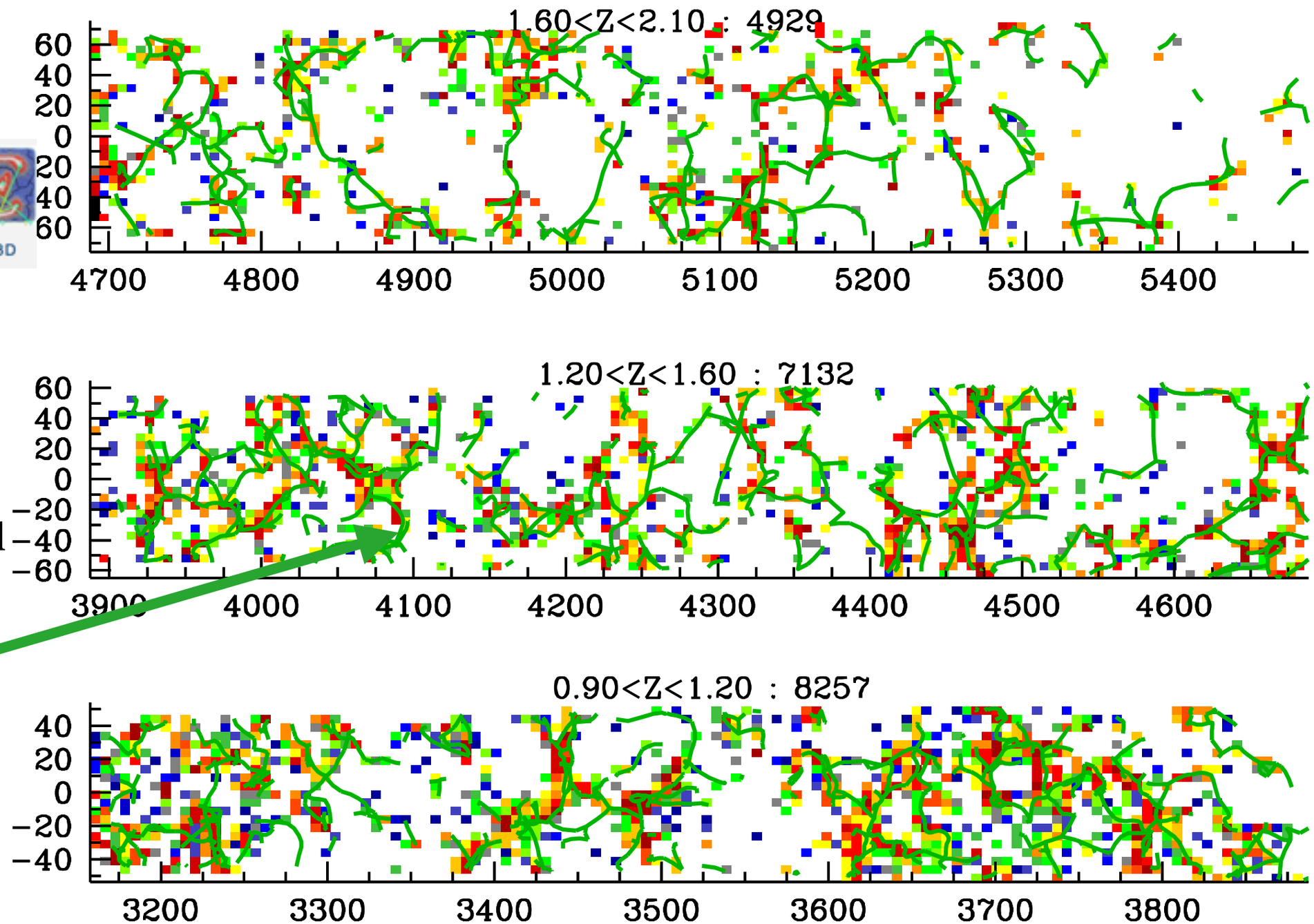
Reconstruction of the Cosmic Web with PFS survey

Analysis of the 3D density field function with

DisPerSE

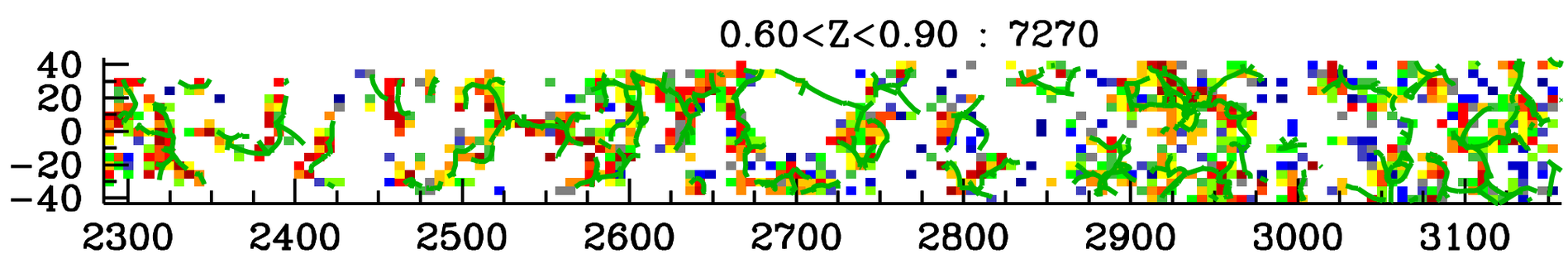
persistent structures identification in 2D and 3D

a 3D Ridge extractor (Sousbie et al., 11)



extract the topological features of the cosmic web : filaments , extrema, voids and walls

Thanks to Arnouts!



NIR Imaging

Progress! Steward collaboration, UKIRT, 240 hrs, 7.5 deg^2

JHK~23.3 AB mag imaging over most of HSC-DEEP

We would like deeper imaging (~600 hrs from VISTA for 14 deg^2)

Ongoing work

NIR Data: Discuss possibility of European collaboration?

With redshift success simulations in hand, move on to measure physical parameters

Work with 2D simulators