WISP Observational Constraints on the Spectroscopic Universe

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TAKE - HOME MESSAGE

HST grism surveys are useful pathfinders for Euclid.

We measure emission line galaxies in 1 Euclid field-worth of HST grism data (~0.5 deg^2) and find the following:

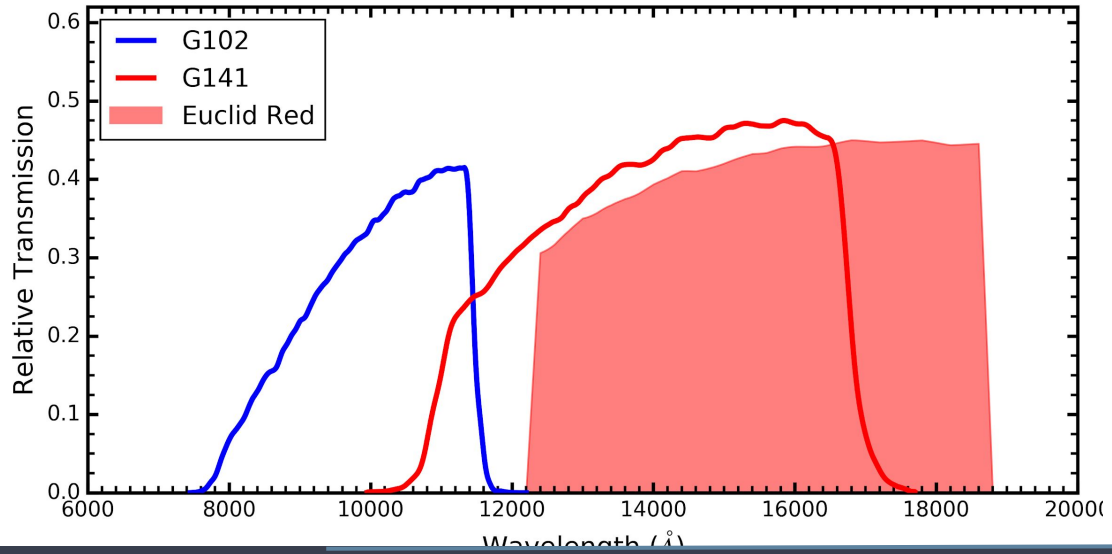
- Emission line detection poses a significant challenge.
- The area number density of line-emitters:

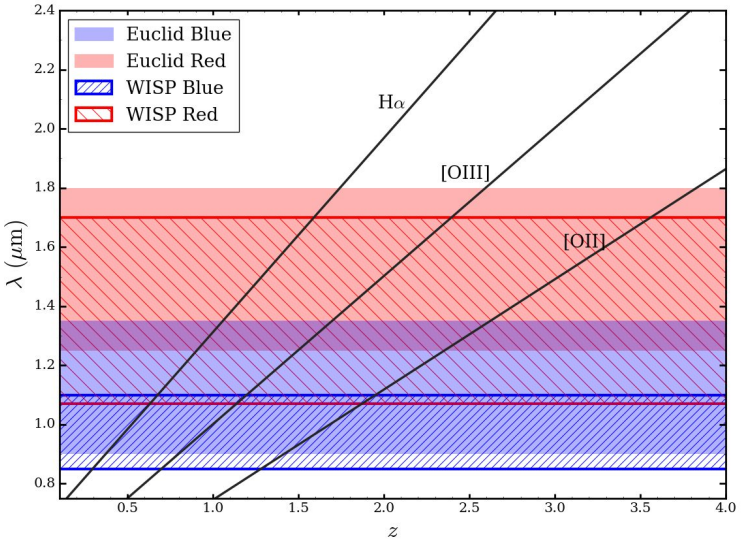
	Observed	Completeness-corrected
Hα+[NII]	**1915 deg^{-2}**	**3239 deg^{-2}**
[OIII]λ5007	**293 deg^{-2}**	**455 deg^{-2}**

- The continuum and emission line sizes are correlated but with large scatter.
- Preliminary work on the comparison between data and simulations points to some directions where simulations can be improved and the need for additional output (e.g., EW, half-light radii)

HST vs. Euclid

	HST / WFC3	Euclid / NISP
Slitless Spectroscopy:	G102: 0.8 - 1.1 µm (R~210) G141: 1.07 - 1.7 µm (R~130)	Blue: 0.92 - 1.25 µm Red: 1.25 - 1.85 µm
Hα coverage:	**0.22 ≤ z ≤ 1.6**	**0.9 ≤ z ≤ 1.8** (Wide Survey)
[OIII] coverage:	**0.6 ≤ z ≤ 2.3**	**1.5 ≤ z ≤ 2.7** (Wide Survey)





HST SPECTROSCOPIC SURVEYS

The WFC3 Infrared Spectroscopic Parallel Survey

A large Hubble Space Telescope (~2000 orbits) pure parallel program surveying the sky in both slitless spectroscopy and direct imaging.

Slitless grism spectroscopy:

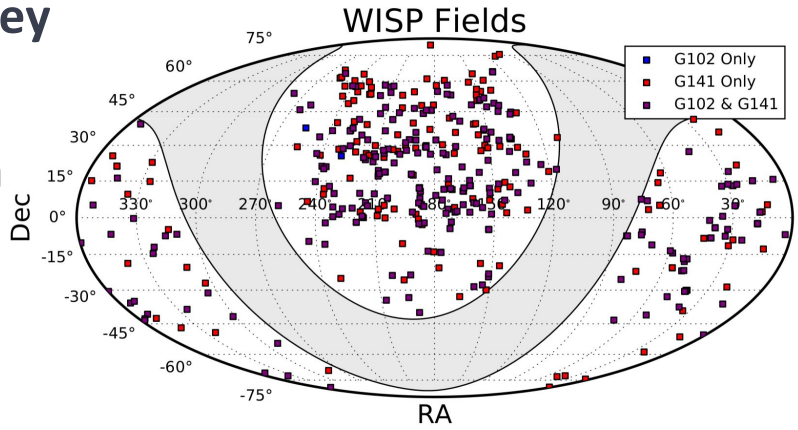
G102: 0.8 - 1.1 μm (R~210)

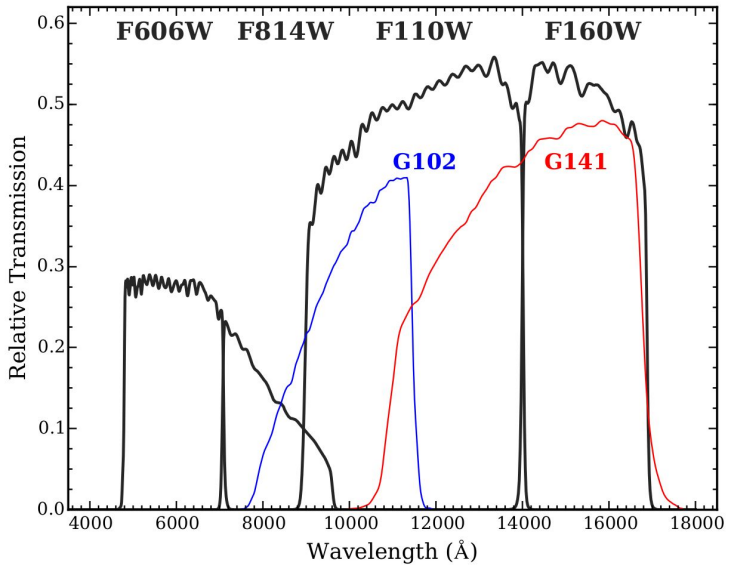
G141: 1.07 - 1.7 μm (R~130)

Emission lines measured for **~1518 arcmin^2**

3D-HST/AGHAST Survey

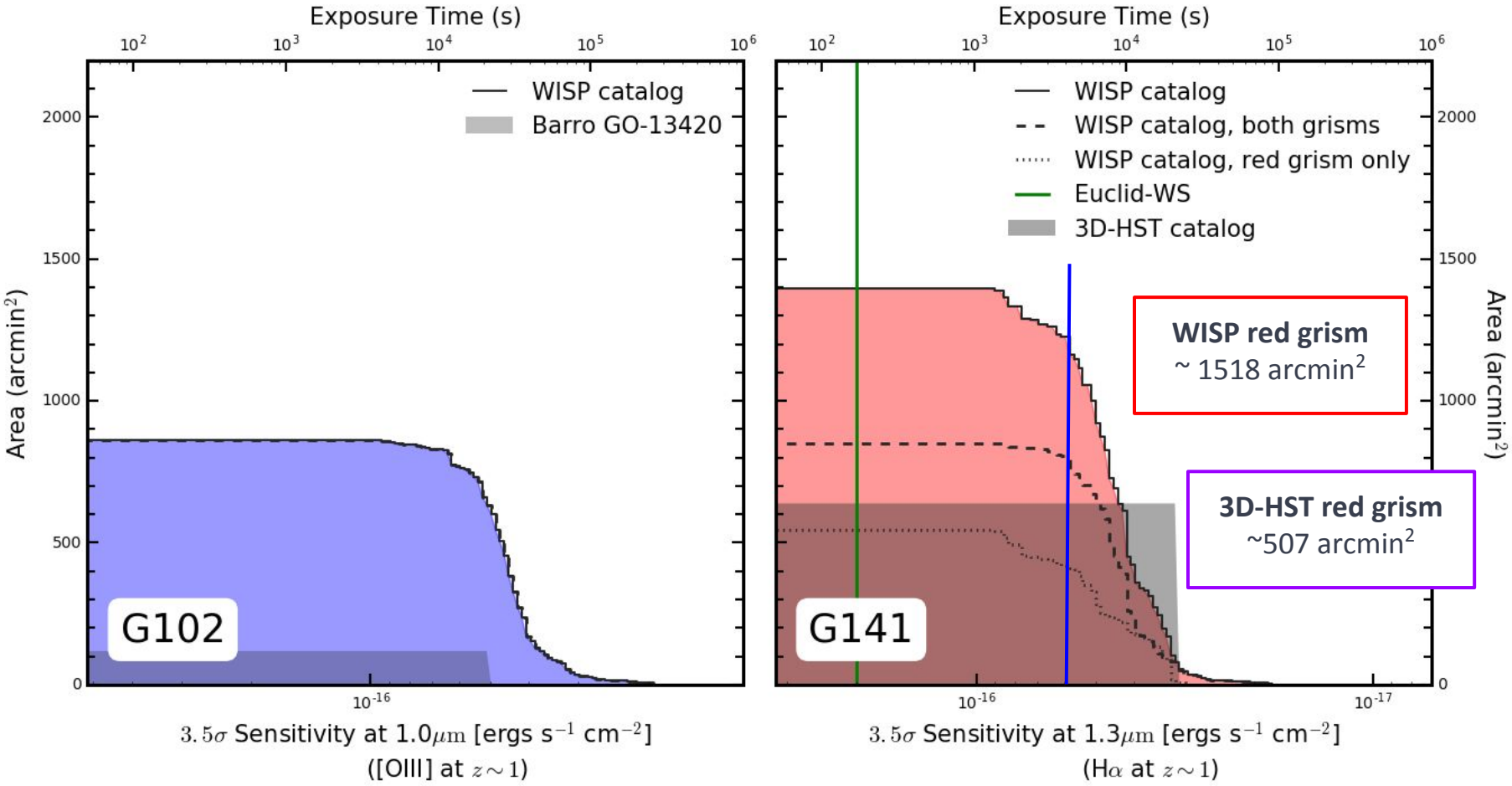
Coverage in just G141: **507 arcmin^2**





THE WISP SURVEY

Total area A_{eff} ~0.56 deg^2



WISP red grism
~ 1518 arcmin^2

3D-HST red grism
~507 arcmin^2

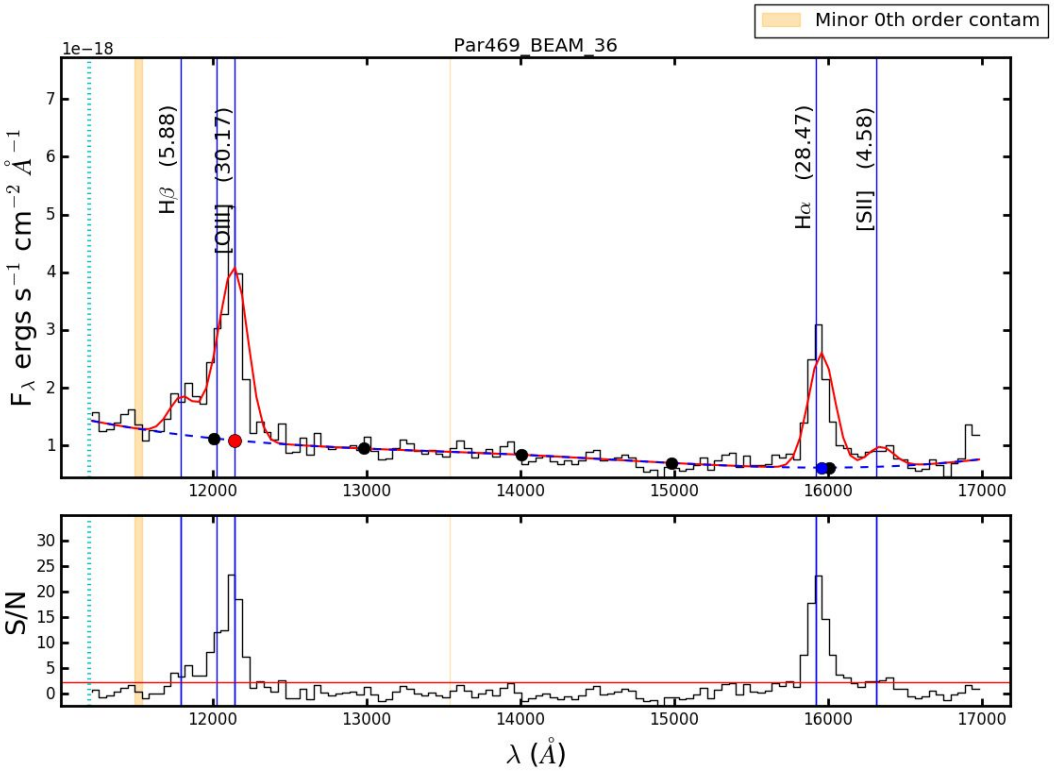
EMISSION LINE DETECTION

Building the emission line catalog is a 2-step process:

1. Emission line detection using an algorithm to detect peaks above a 3σ threshold in the 1-D spectra

2. Screening the emission line candidates, identifying the lines and fitting fluxes and redshifts

→ **65% failure rate**



EMISSION LINE DETECTION - COMPLETENESS

The exact same analysis is performed on 10,000 simulated galaxies to derive the catalog completeness as a function of galaxy parameters

Divided equally between “shallow” (G141-only) and “deep” (G102+G141) fields

Source redshift

$0.3 \leq z \leq 2.3$

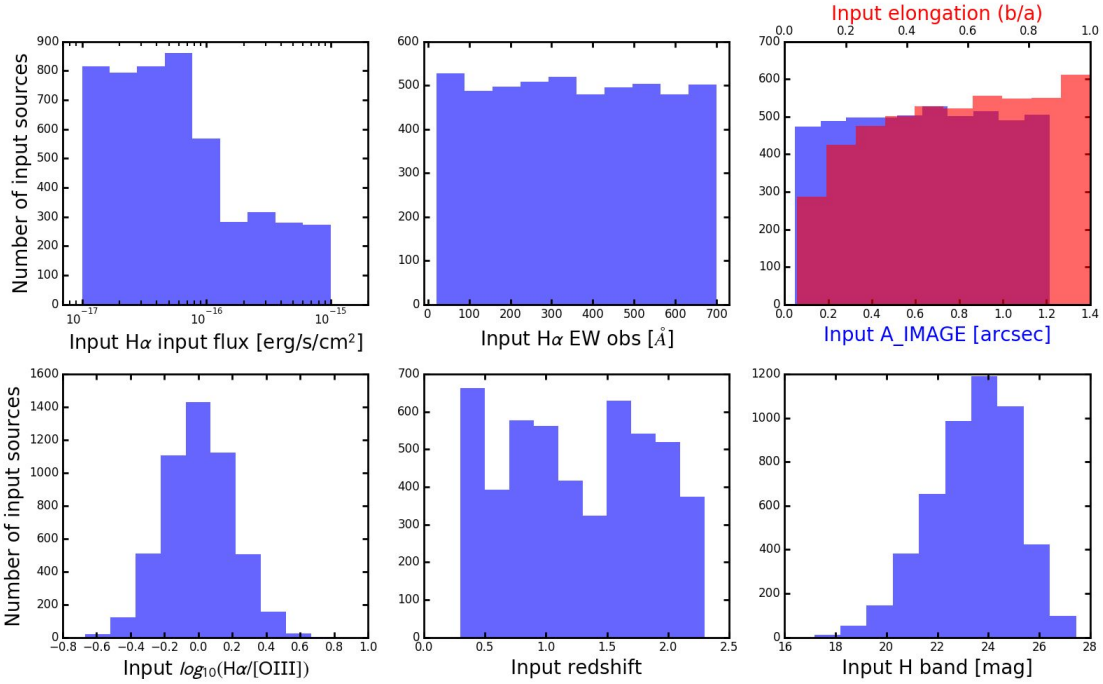
Source semi-major axis

$0.05'' \leq a \leq 1.2''$

Hα flux, EW

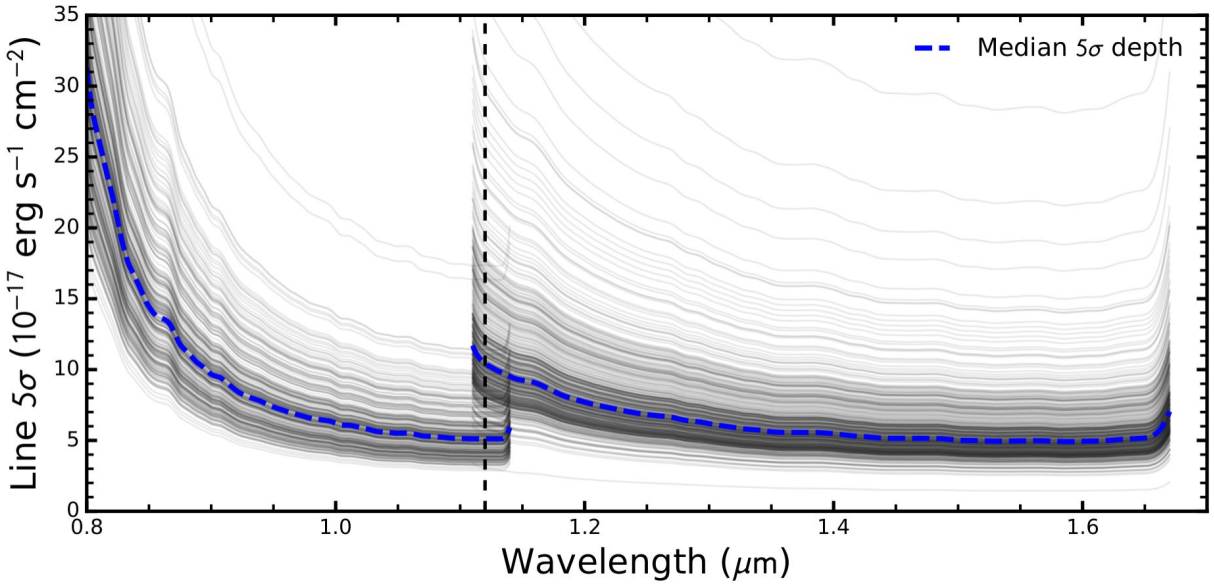
$1 \times 10^{-17} \leq f_{obs,H\alpha} \leq 1 \times 10^{-16}$

$20 \leq EW_{obs,H\alpha} \leq 700$ Å



EMISSION LINE DETECTION - COMPLETENESS

Completeness is calculated as a function of source size, emission line equivalent width, and the emission line flux scaled by the field depth



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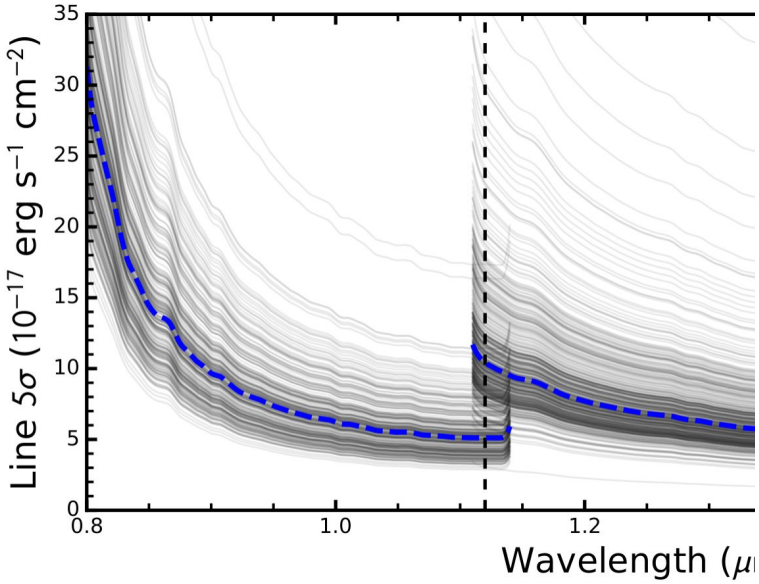
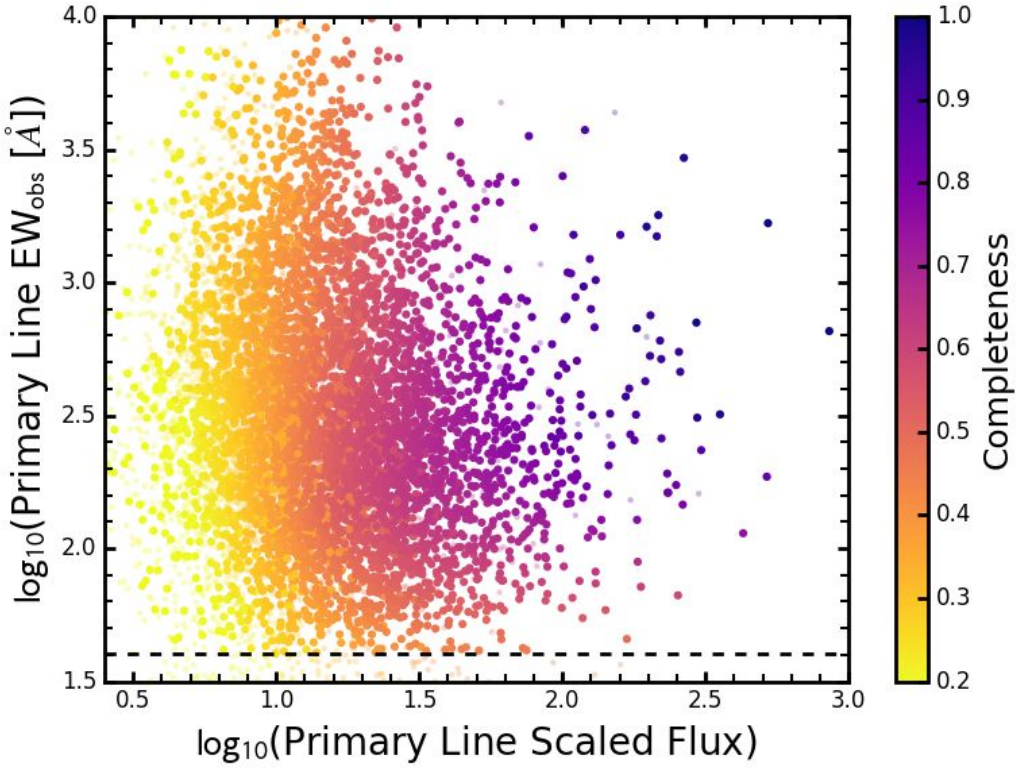




CONSTRUCTING THE EUCLID WIDE SAMPLE

From the WISP+3D-HST catalog, we select sources in Euclid's flux and z ranges:

Emission line flux	$f \geq 2 \times 10^{-16}$ erg s^{-1} cm^{-2}
Observed wavelength	$\lambda_{obs} \geq 1.25$ μm
Emission line signal-to-noise	S/N > 5
Observed equivalent width	$EW_{obs} \geq 40$Å

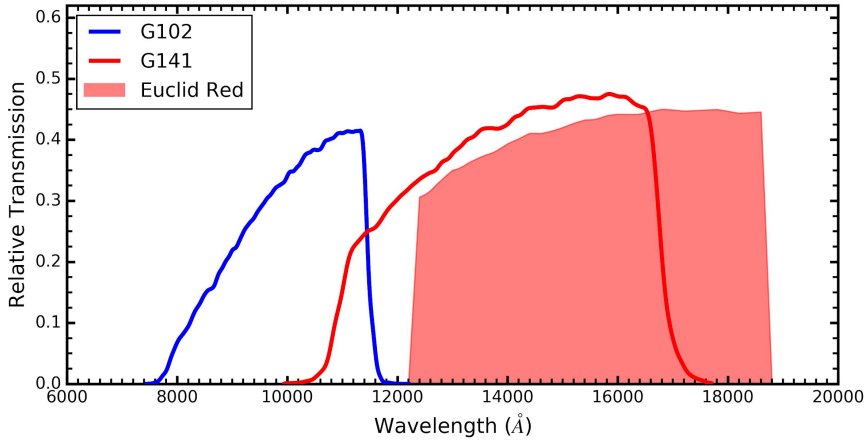
Emission lines are therefore in the following redshift ranges:

Hα+[NII] coverage: 0.9 ≤ z ≤ 1.6

[OIII]λ5007 coverage: 1.5 ≤ z ≤ 2.4

Total numbers:

Hα+[NII]-emitters:	1914 deg^{-2}
[OIII]λ5007-emitters:	293 deg^{-2}



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Observed equ

Emission lines are

Hα+[NII] c

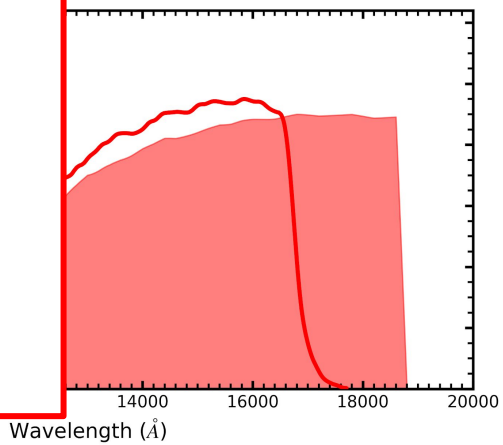
[OIII]λ5007 c

Total numbers:

Hα+[NII]-emi

[OIII]λ5007-e

	Observed	Corrected
Hα+[NII]		
S/N > 5	1914/deg^2	3239/deg^2
S/N > 3.5	2131/deg^2	3641 deg^2
[OIII]λ5007		
S/N > 5	293/deg^2	455/deg^2
S/N > 3.5	302/deg^2	471/deg^2



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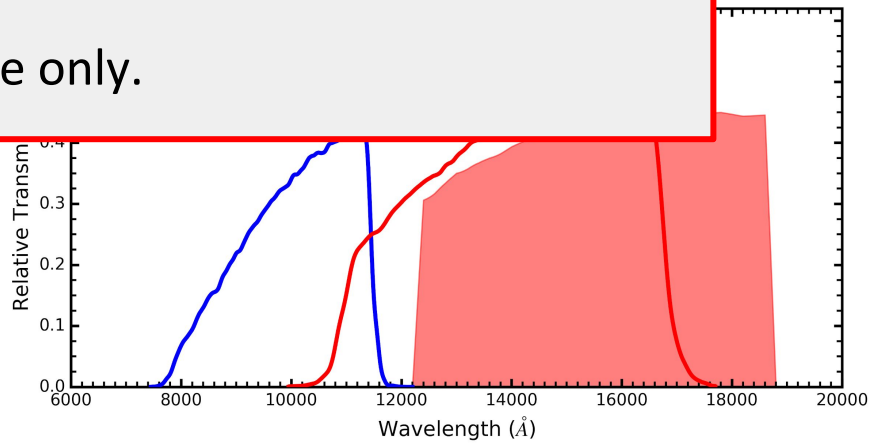
Emis

PLEASE NOTE:

- All Hα fluxes include [NII].
- [OIII] fluxes include the λ5007 line only.



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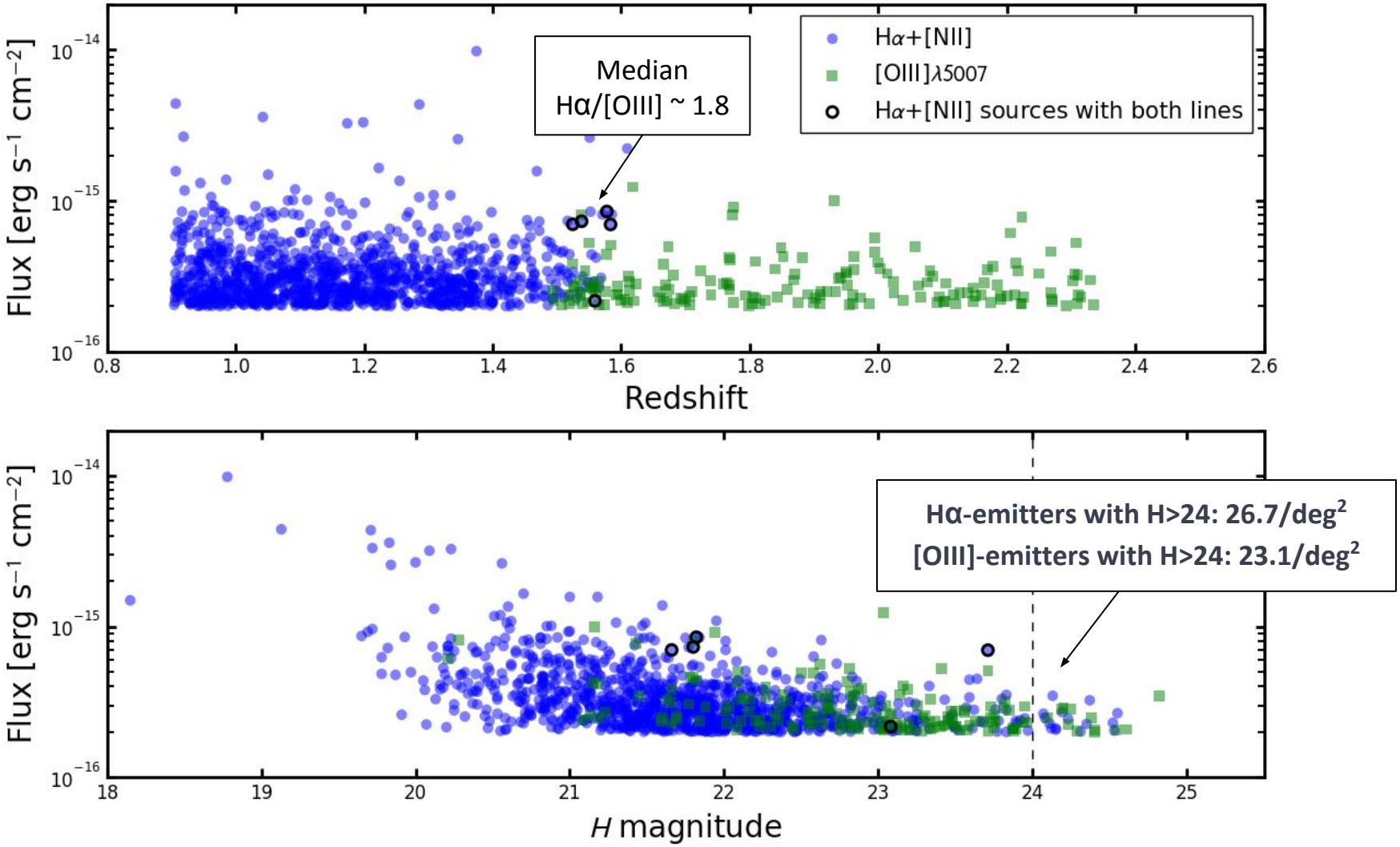
WISP + 3D-HST SAMPLE



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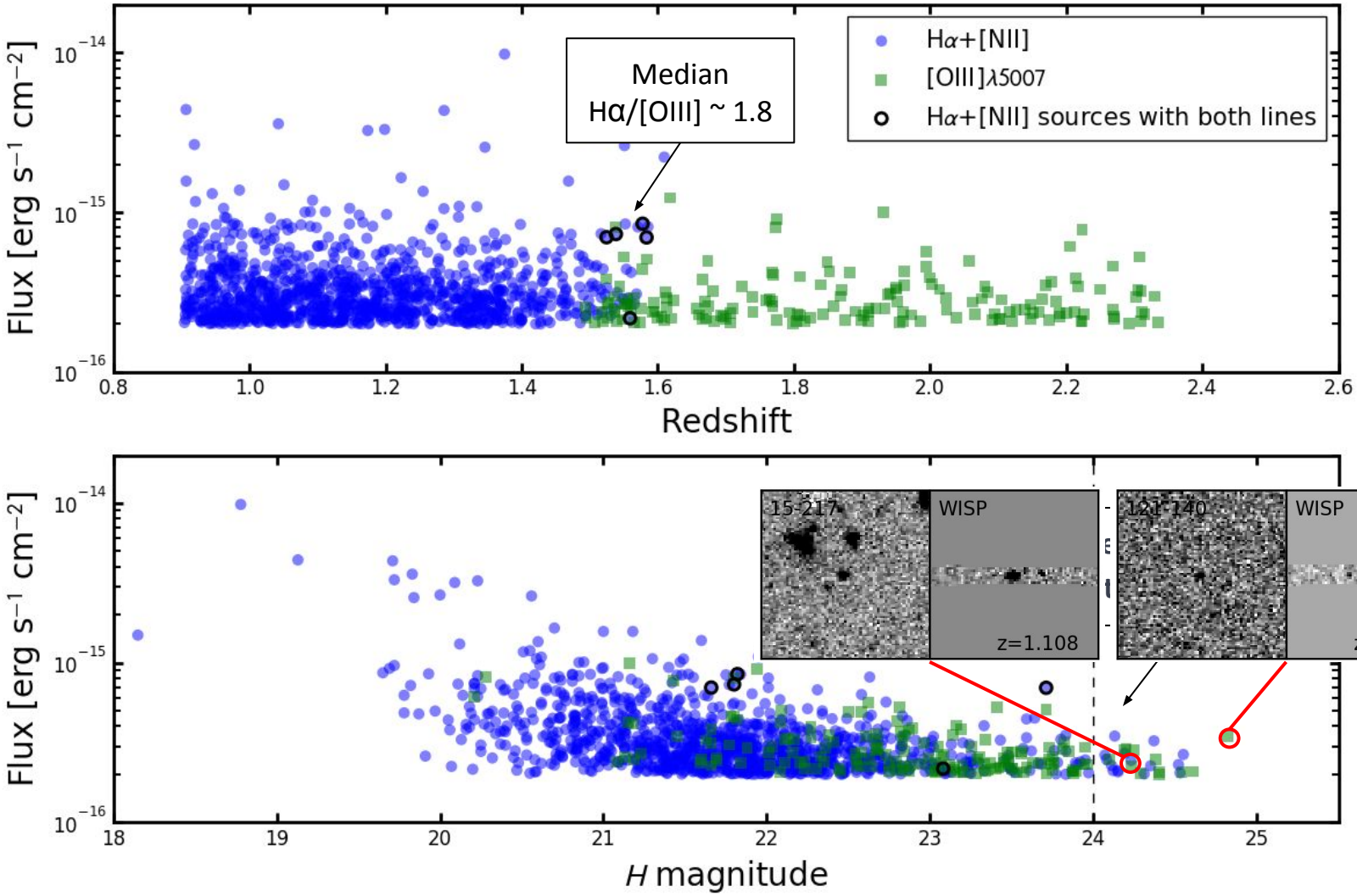
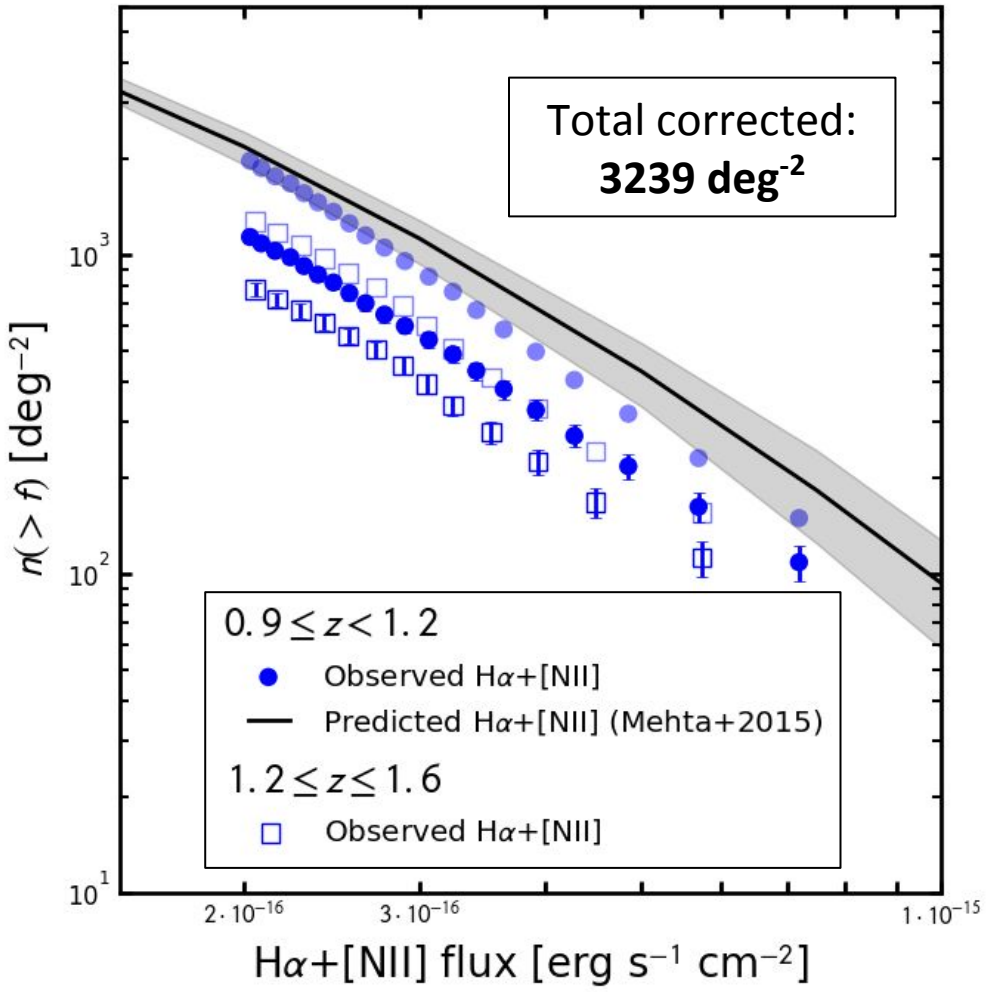
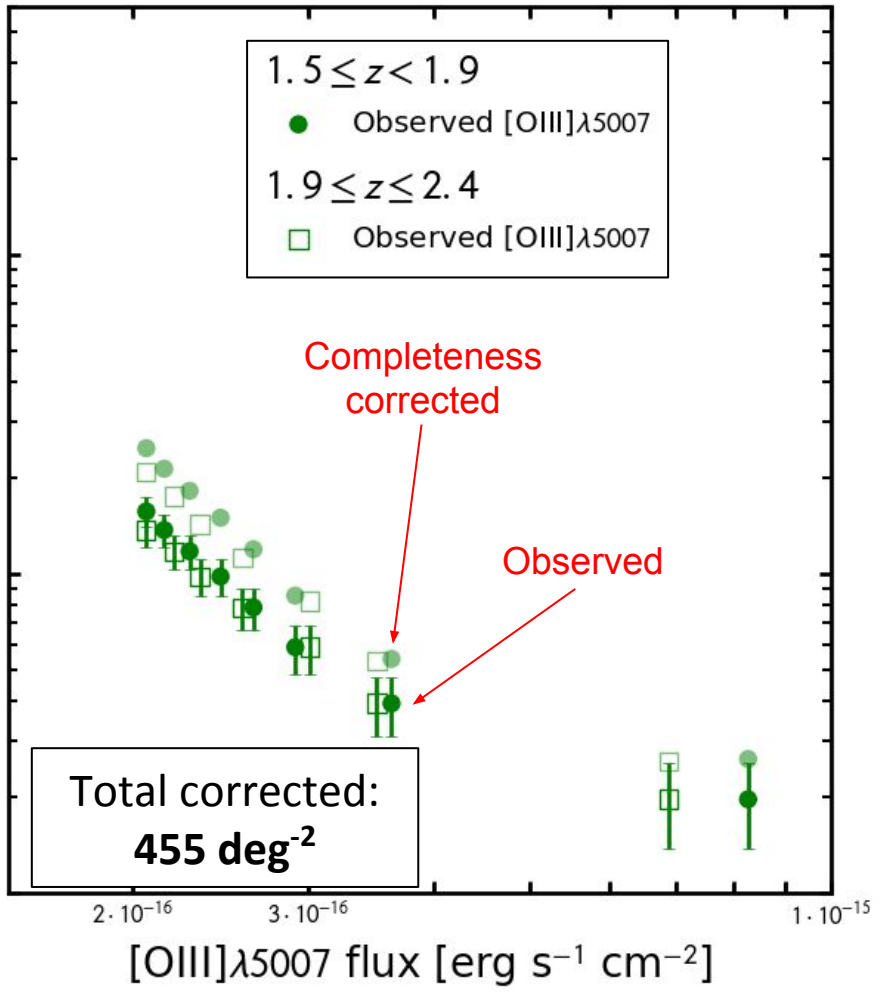


NUMBER COUNTS

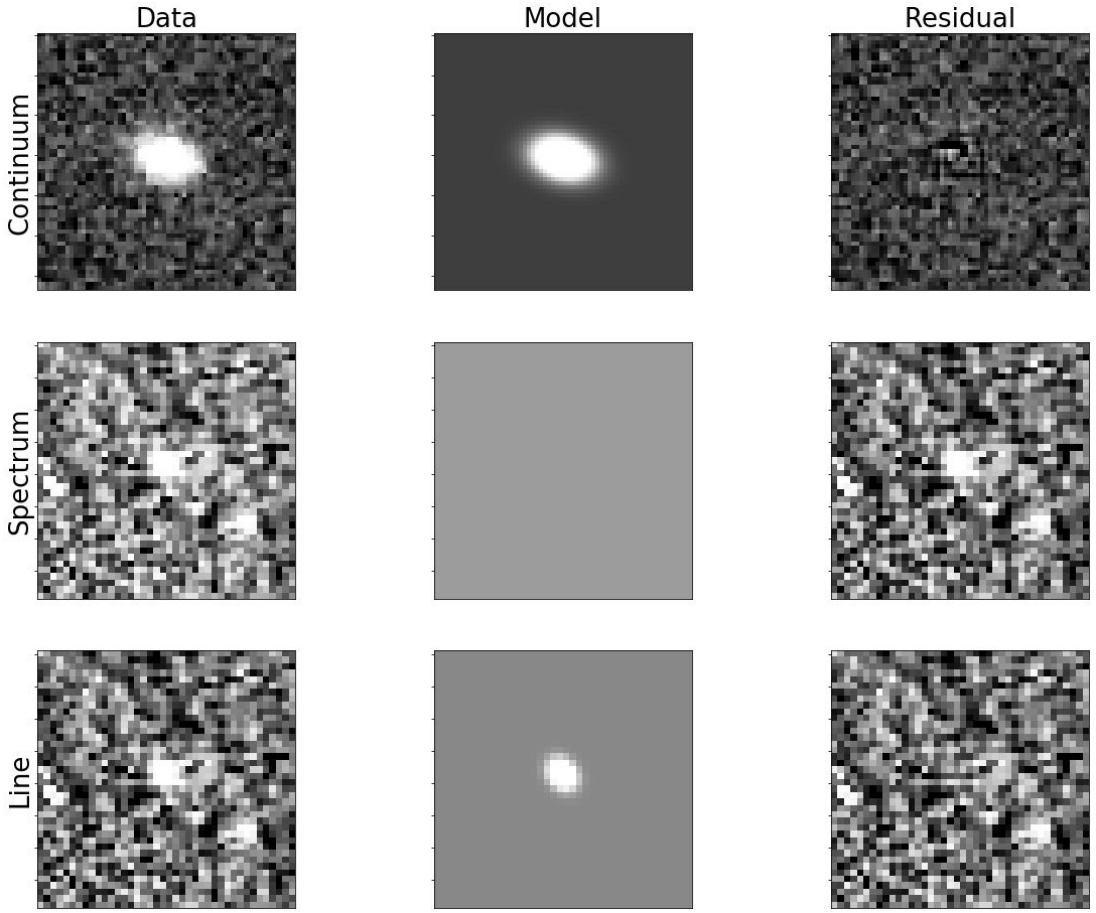




Hα EMISSION HALF-LIGHT RADII

PSF-corrected half-light radii

Measured both in the continuum and in the line images, by fitting a 2D model



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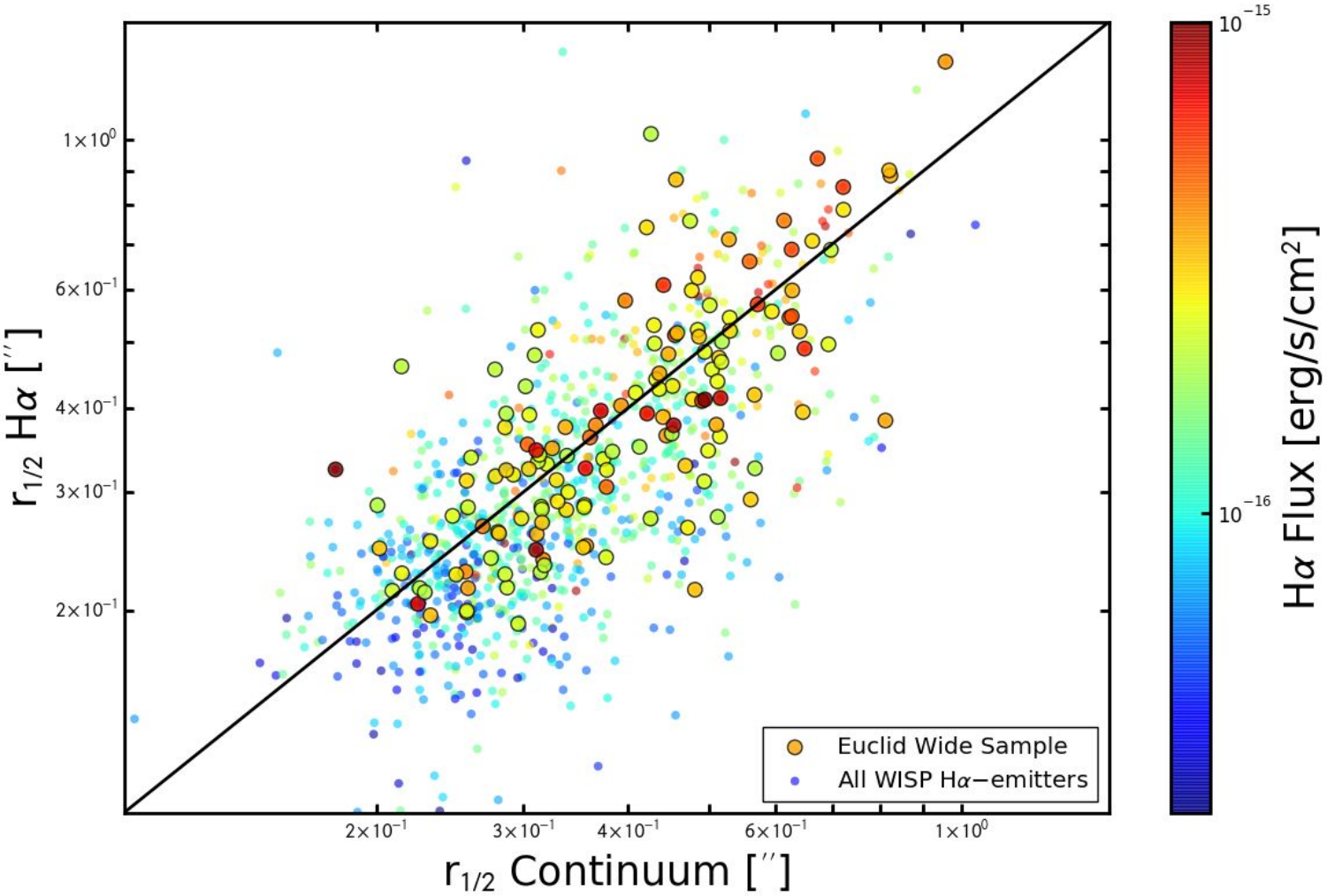
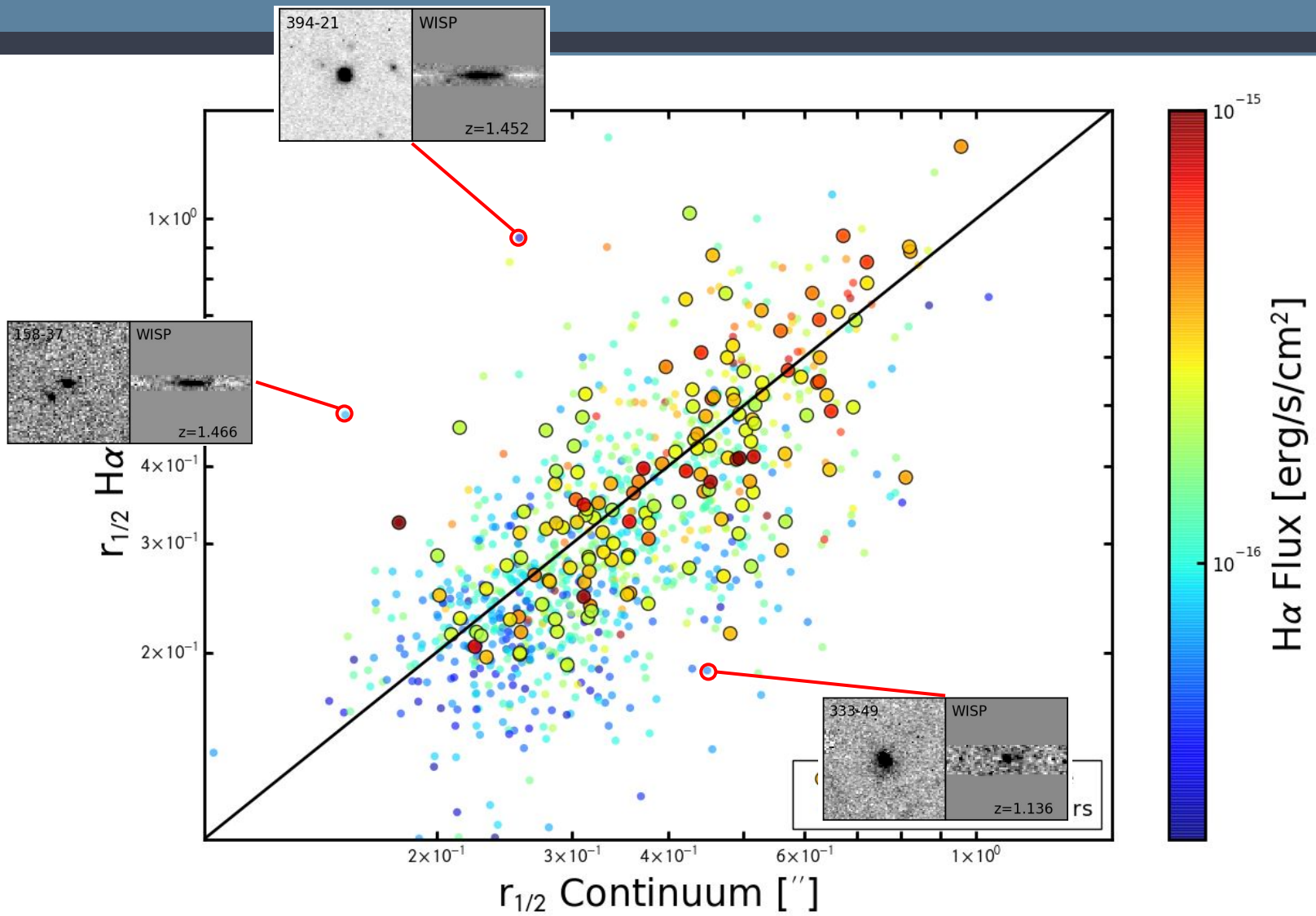


Hα EMISSION HALF-LIGHT RADII

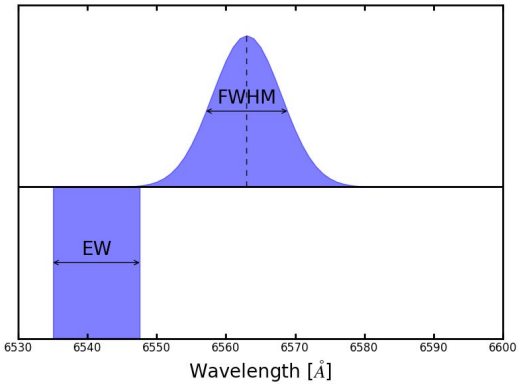


Hα EW DISTRIBUTION

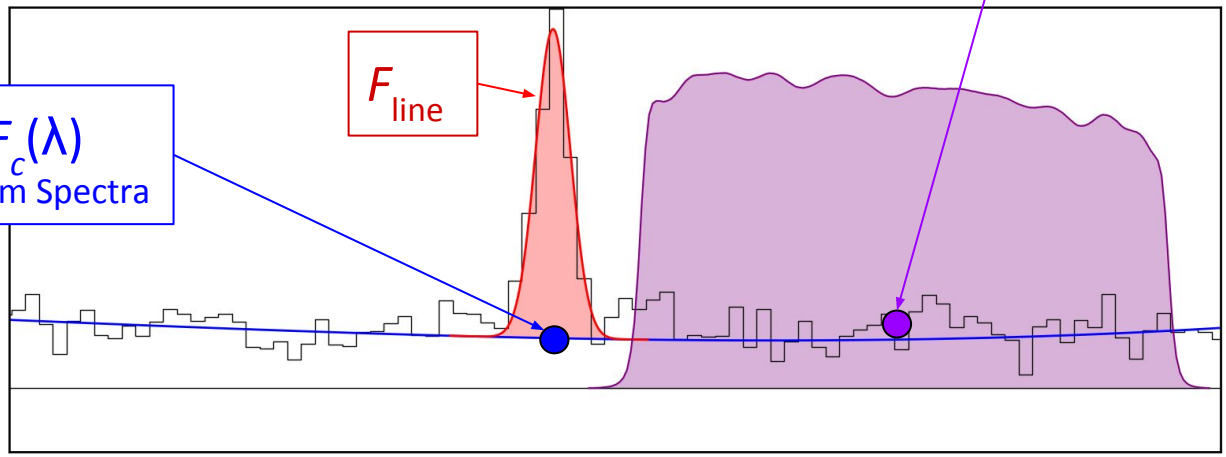
Equivalent Width

$$\mathrm{EW}_\lambda = \int \frac{F_l(\lambda) - F_c(\lambda)}{F_c(\lambda)} \mathrm{d}\lambda$$

$$\mathrm{EW}_\lambda = \frac{F_{\mathrm{line}}}{F_c(\lambda)}$$



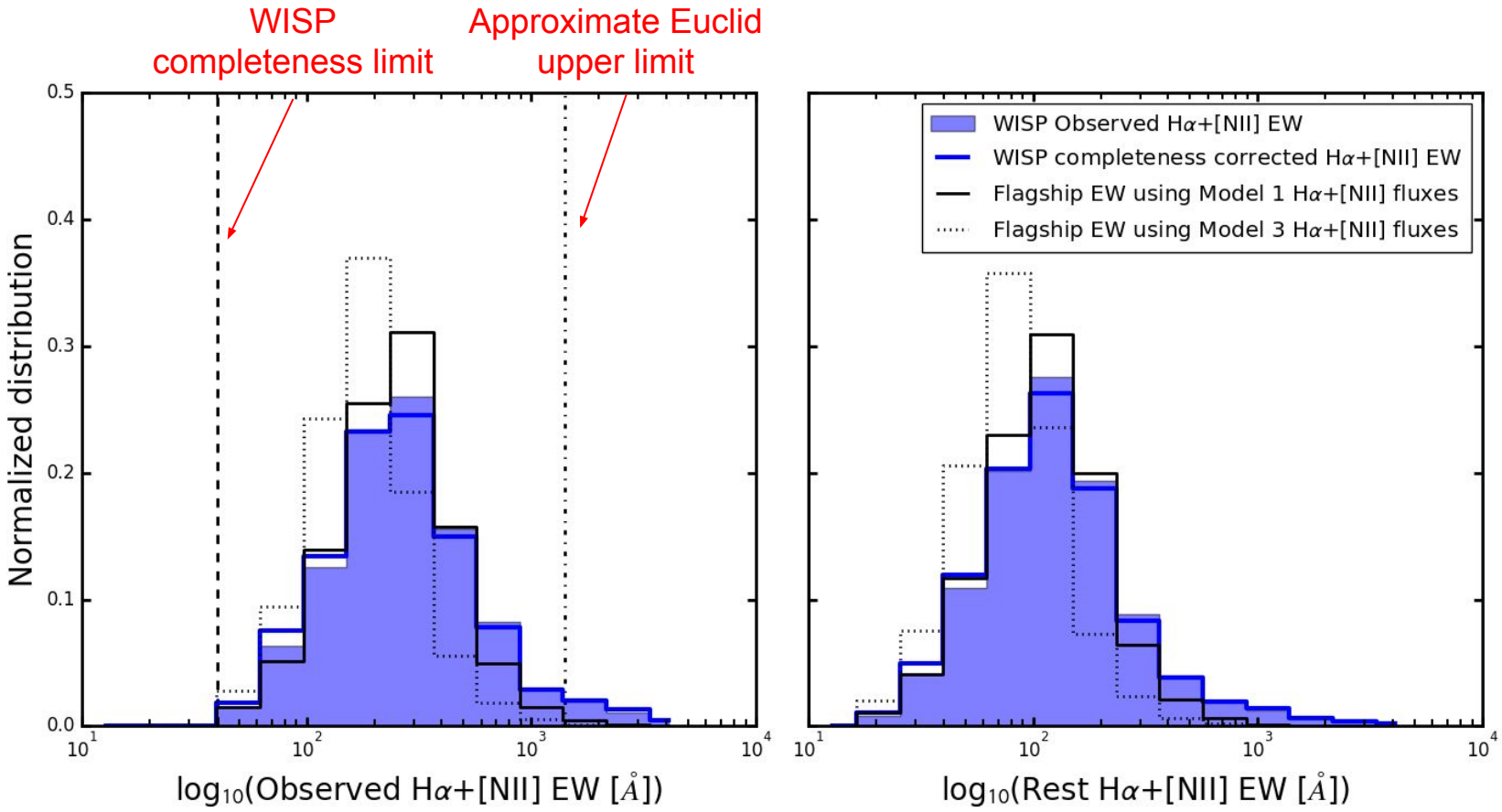
Euclid Flagship $F_c(\lambda)$
measured from broadband magnitude



WISP $F_c(\lambda)$
measured from Spectra

Hα EW DISTRIBUTION

Comparison with Flagship Simulation v1.5.2



~12.5 galaxies/deg^2 with **$EW_{Hα,obs}$ > 1417 Å** and ***H* > 24**

REDSHIFT ACCURACY – SIMULATIONS

All sources:

μ=-0.00020 σ=0.00115

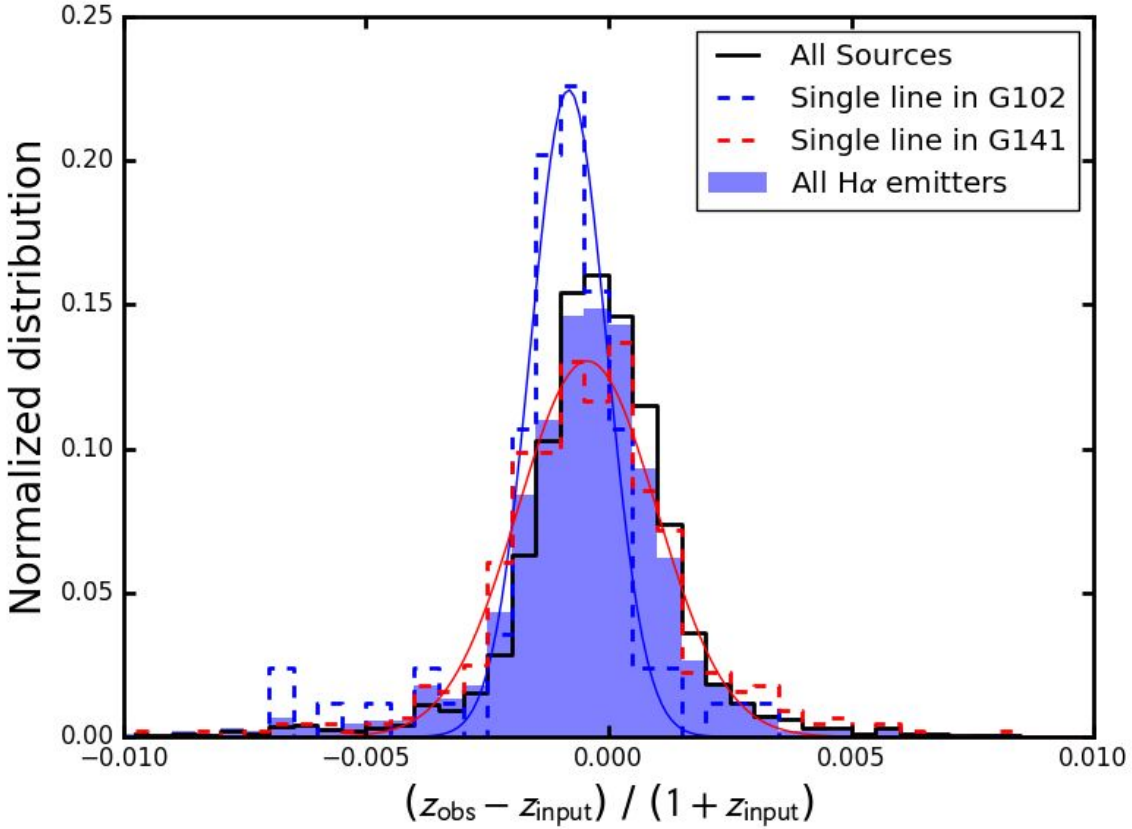
Single line emitters

In G102 (blue grism):

μ=-0.00082 σ=0.00078

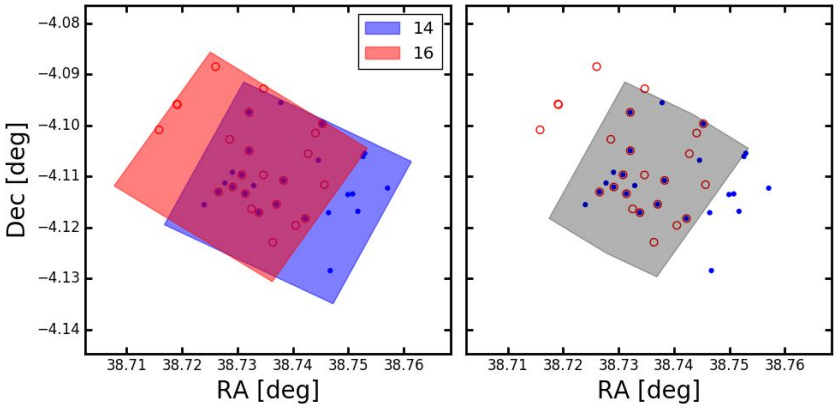
In G141 (red grism):

μ=-0.00043 σ=0.00143

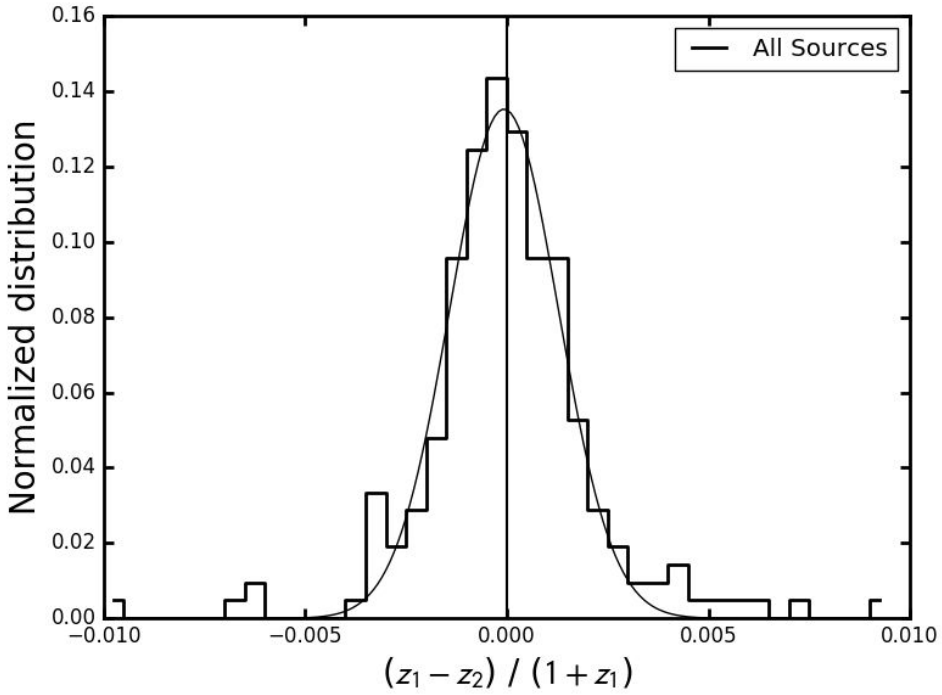


REDSHIFT ACCURACY – MEASURED

We can use redshift measurements of sources observed multiple times (in overlapping WISP fields) to estimate the redshift accuracy



μ=0.00010 σ=0.00136



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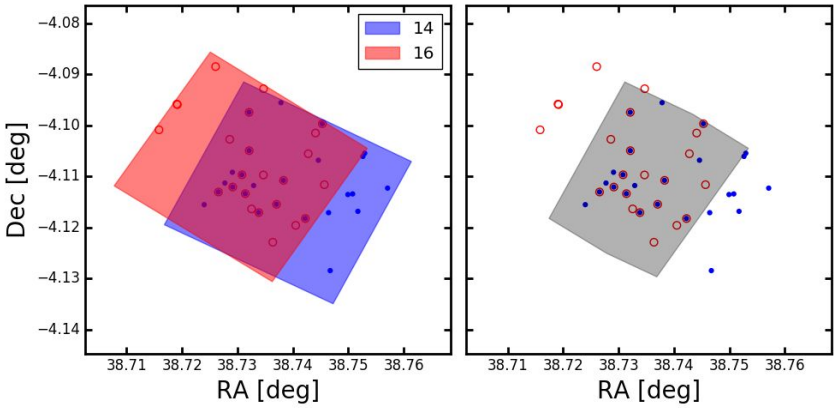
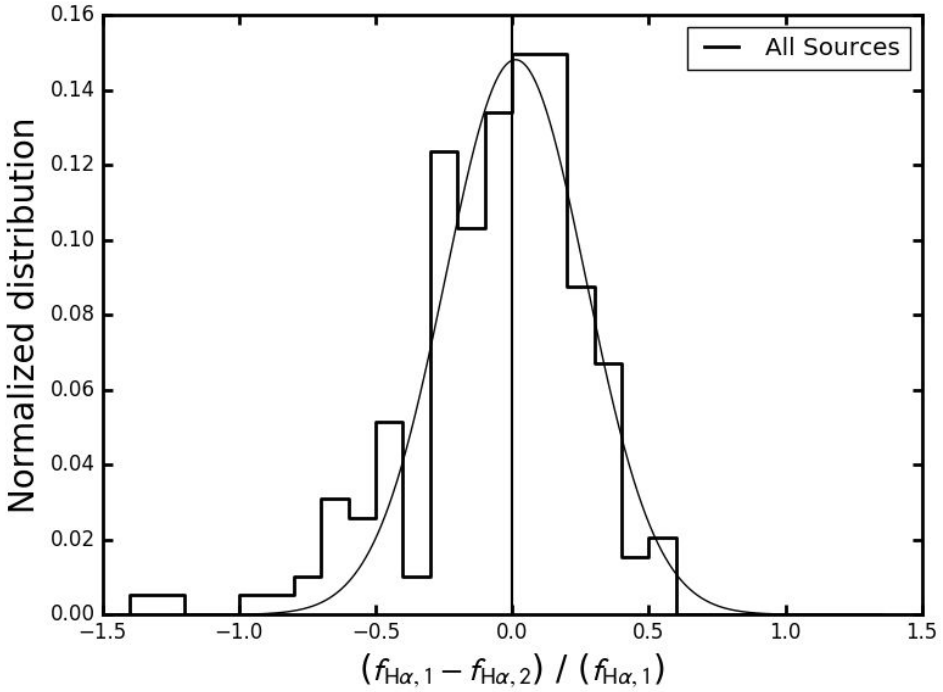


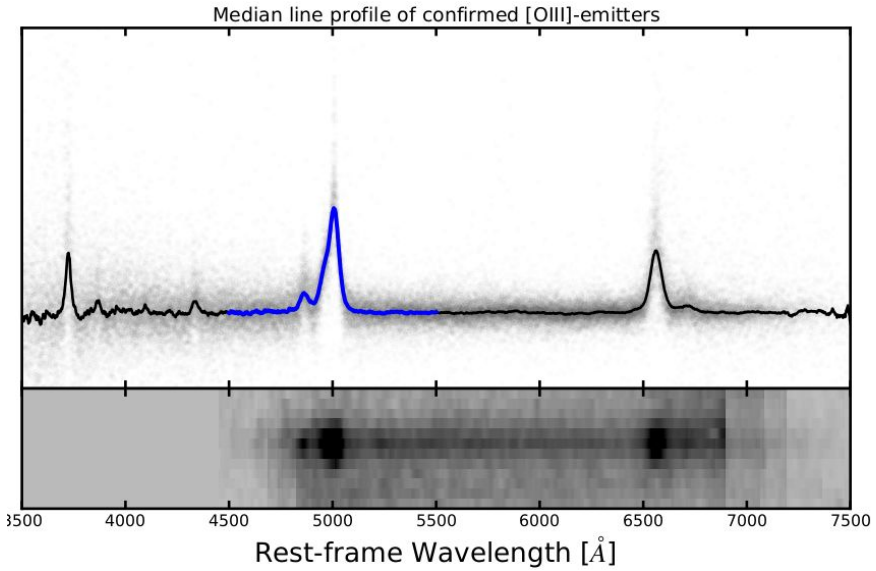
μ=0.012 σ=0.257

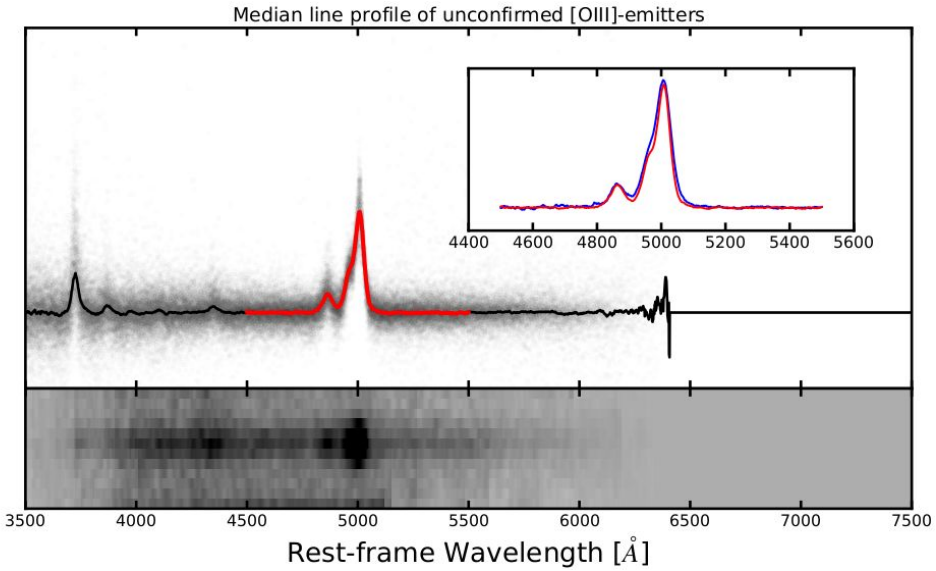


[OIII] EMISSION LINE PROFILE

When only a single line is identified, we assume Hα unless some asymmetry indicative of the [OIII]λ4959+5007 line is present.

Are we therefore biased towards selecting [OIII] with asymmetric profiles?





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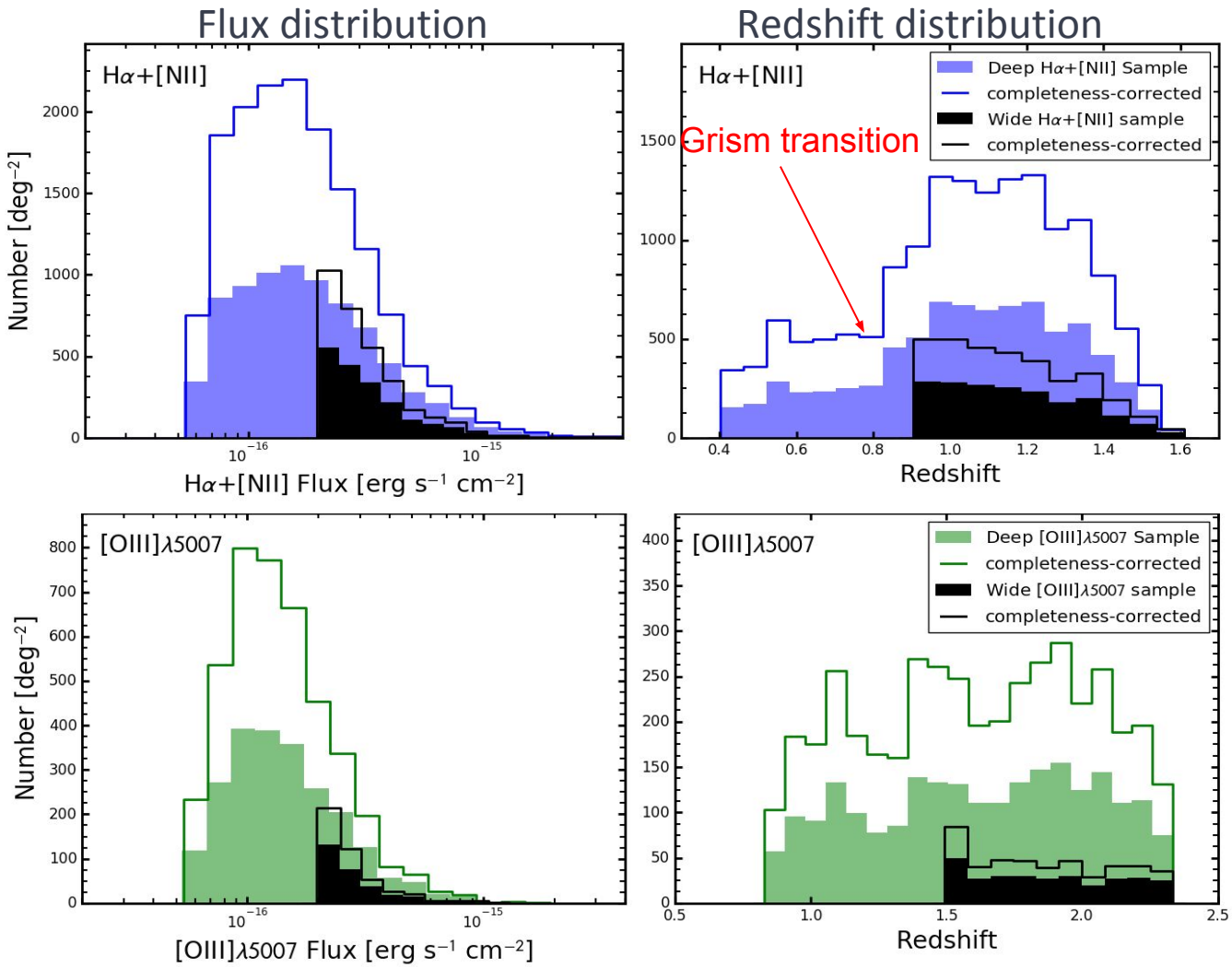
Thank you!

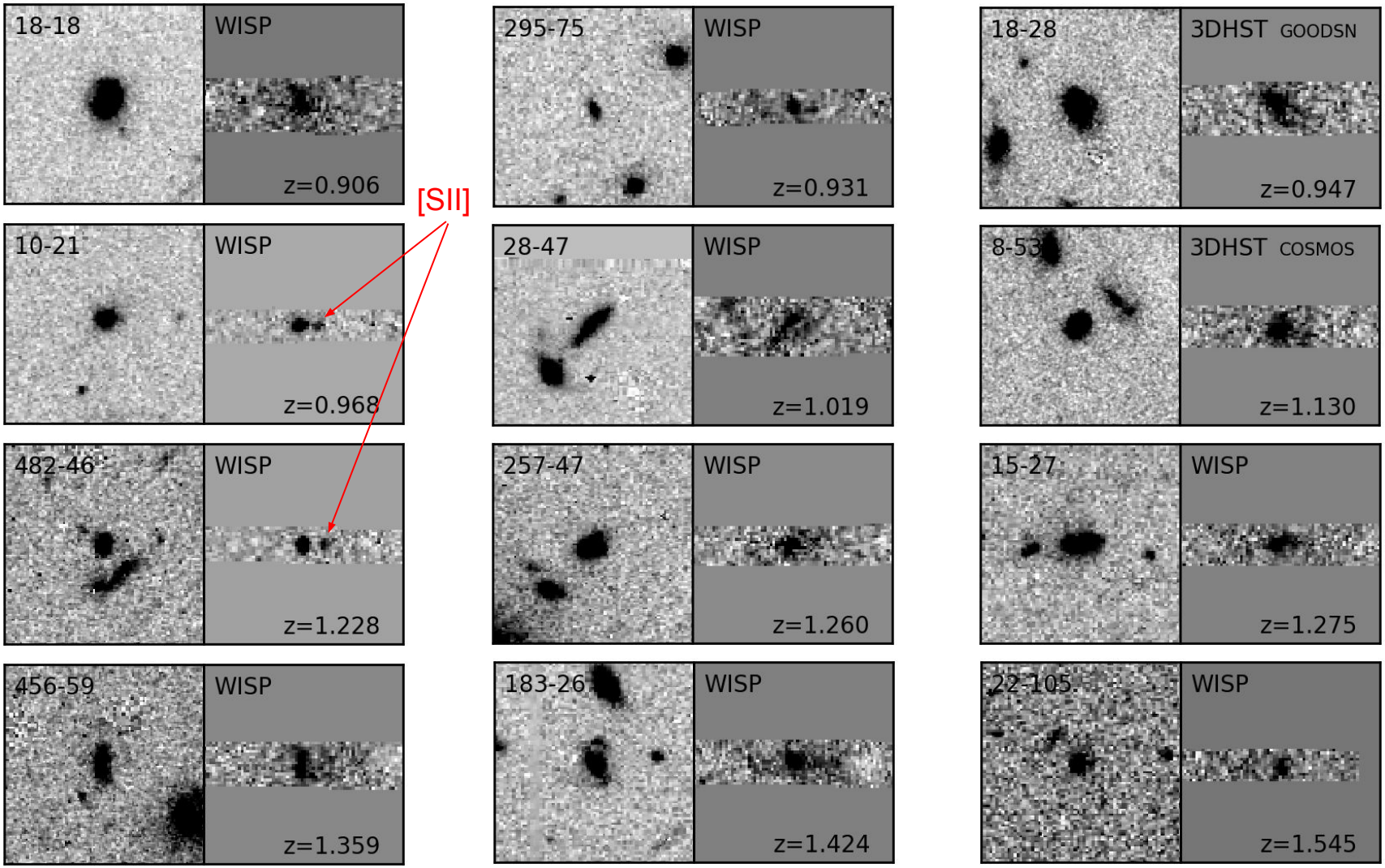
WISP + 3D-HST SAMPLE



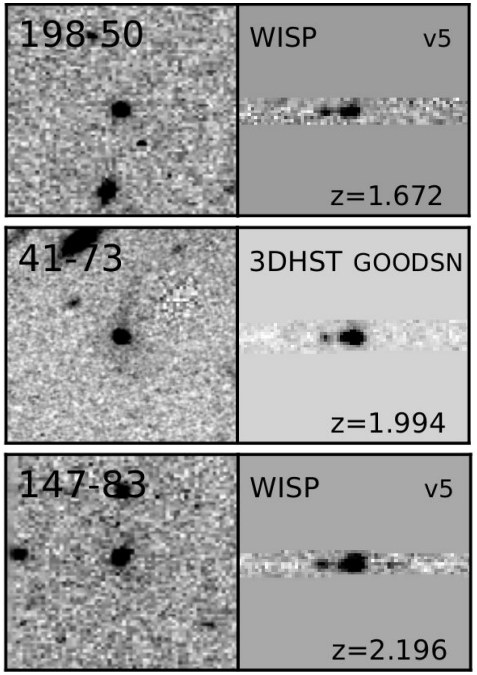
G102
~860 arcmin^2

G141
~2025 arcmin^2

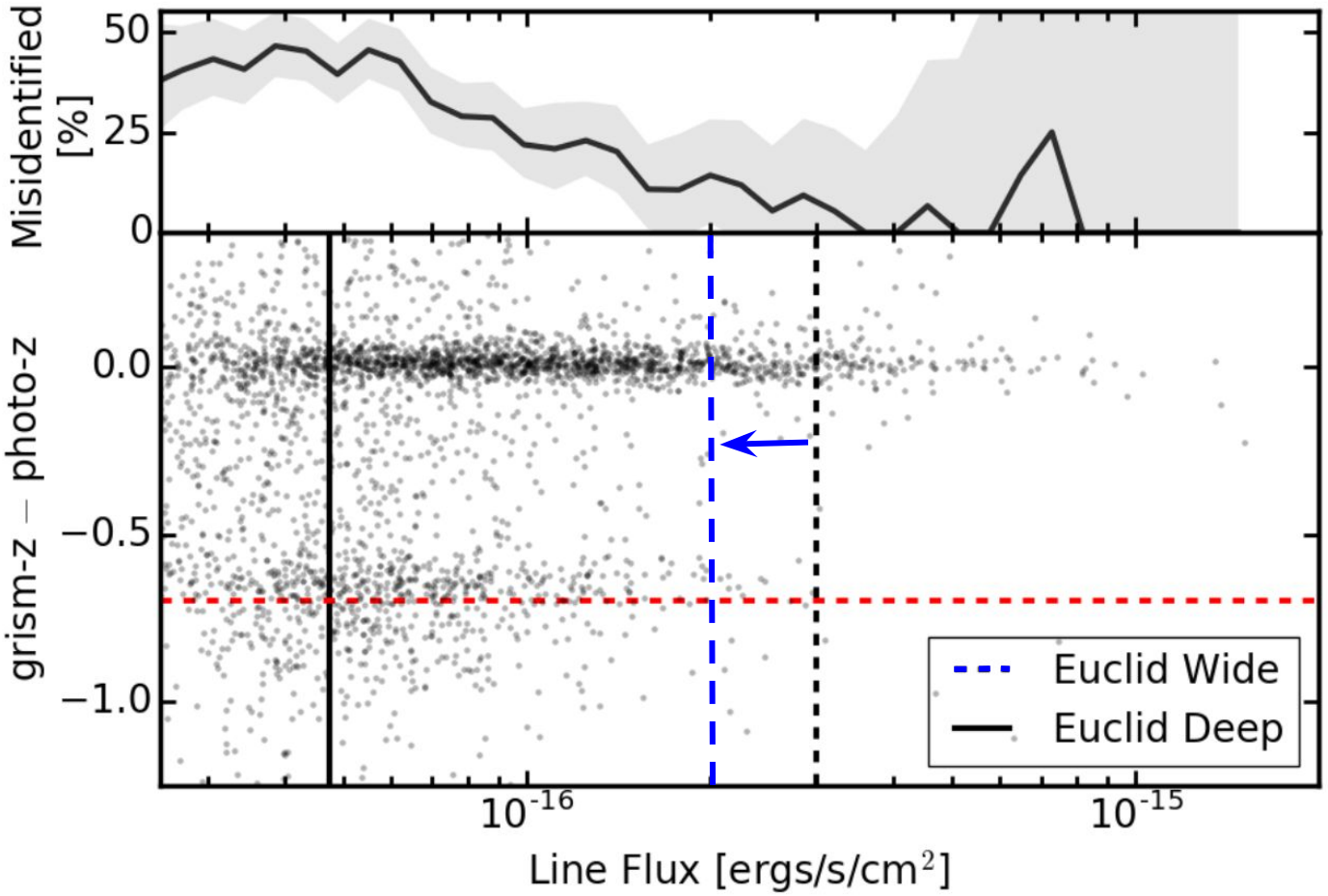
Hα MORPHOLOGIES



[OIII] MORPHOLOGIES



REDSHIFT MIS-IDENTIFICATION



THE 3D-HST SURVEY

For additional statistics, we add emission line galaxies from the 3D-HST Survey

The AEGIS, COSMOS, GOODS-N and GOODS-S fields:

112 pointings covering A_{eff} ~507 arcmin^2

We processed all data using the WISP reduction pipeline and used the same process to detect and measure emission lines from both surveys.