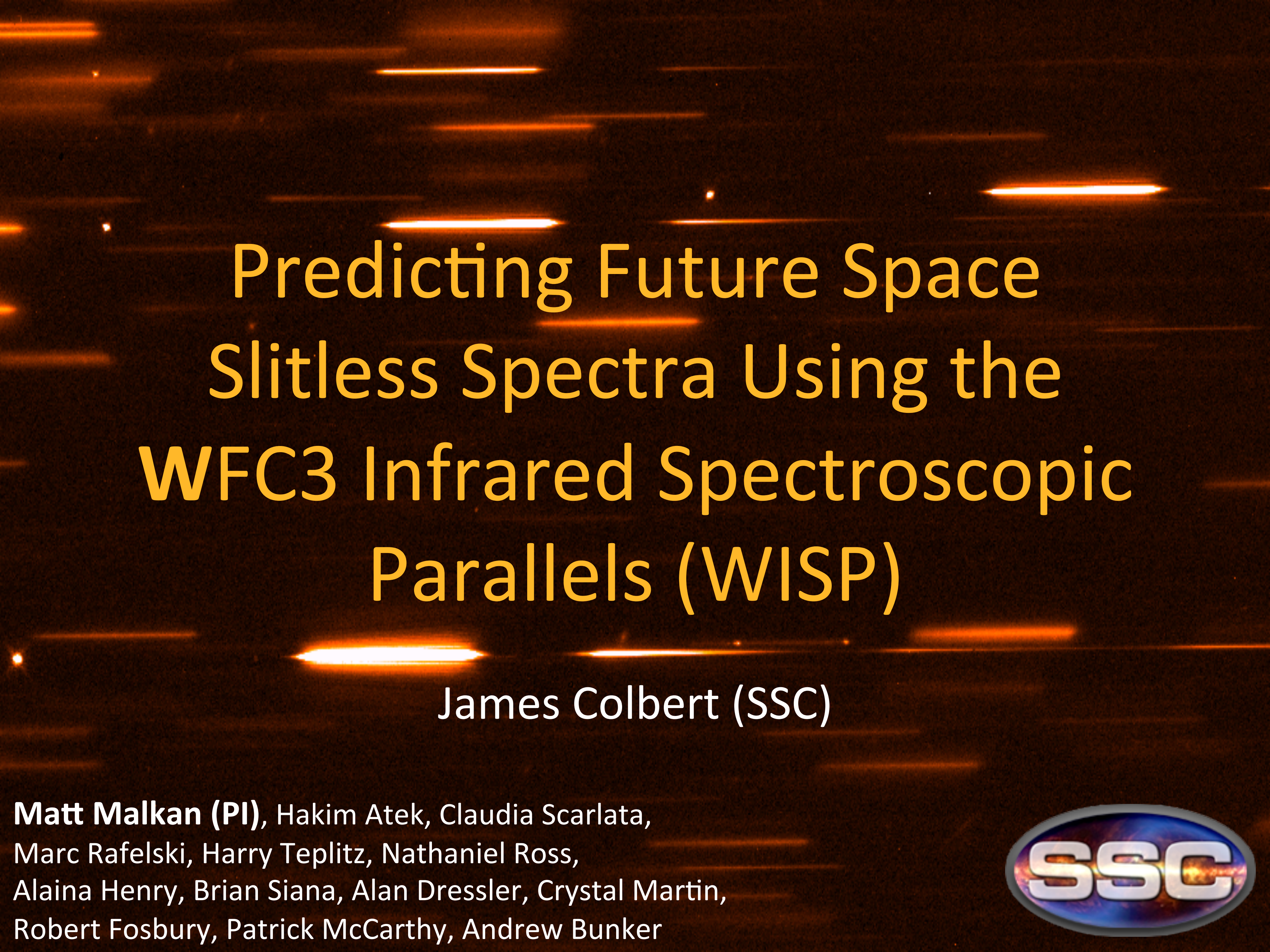


Predicting Future Space Slitless Spectra Using the **W**FC3 Infrared Spectroscopic Parallels (WISP)

James Colbert (SSC)

Matt Malkan (PI), Hakim Atek, Claudia Scarlata,
Marc Rafelski, Harry Teplitz, Nathaniel Ross,
Alaina Henry, Brian Siana, Alan Dressler, Crystal Martin,
Robert Fosbury, Patrick McCarthy, Andrew Bunker

Motivations

Proposed future space missions – Euclid & WFIRST – require millions of redshifts in order to probe dark energy using Baryonic Acoustic Oscillation (BAO).

BAO analysis requires accurate redshifts [$\delta z/(1+z) \leq 0.1\%$] and that means spectroscopic redshifts over a very large area are required. The solution is *near-infrared slitless spectroscopy*, which can measure Hα and OIII emission from $0.7<z<2$, depending on the final chosen wavelength range.

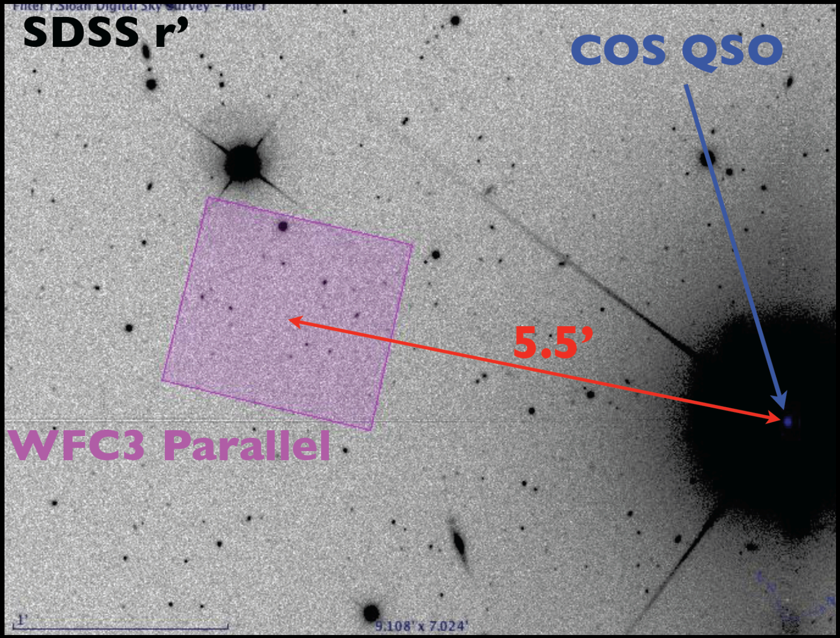
The Hubble Space Telescope presently has near-infrared slitless spectroscopy capabiility using its WFC3 camera. Using a combination of its G102 (0.8-1.15μm; R~210) and G141 (1.15-1.7μm; R~130), it probes much of the proposed wavelength and redshift range at comparable wavelength resolution.

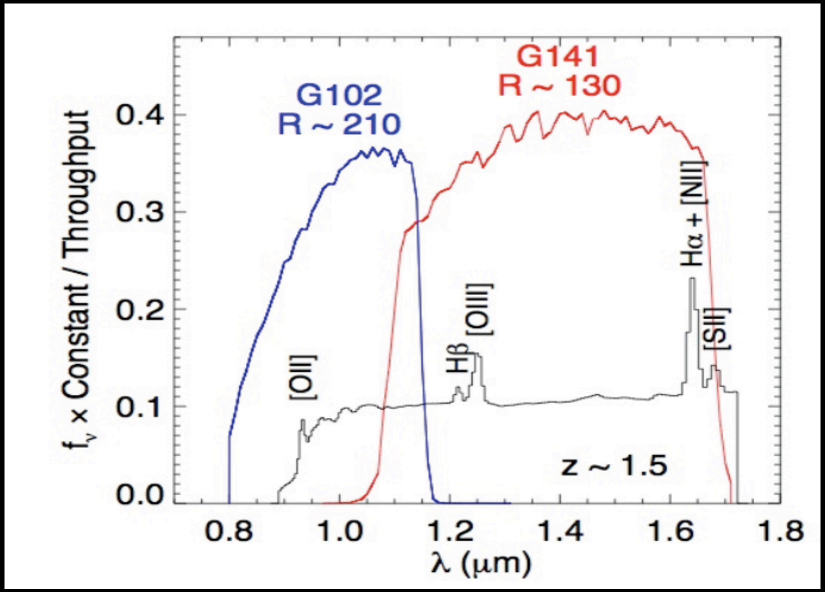
No better laboratory presently exists for testing what these future space missions will see and what difficulties they may face.

WISP

WFC3 Infrared Spectroscopic Parallels

WFC3 Infrared Spectroscopic Parallels





1. Both G102+G141 grisms in long visits (4-5 orbits) ➔ 50 fields
   G141 only in shorter opportunities ➔ 100 fields

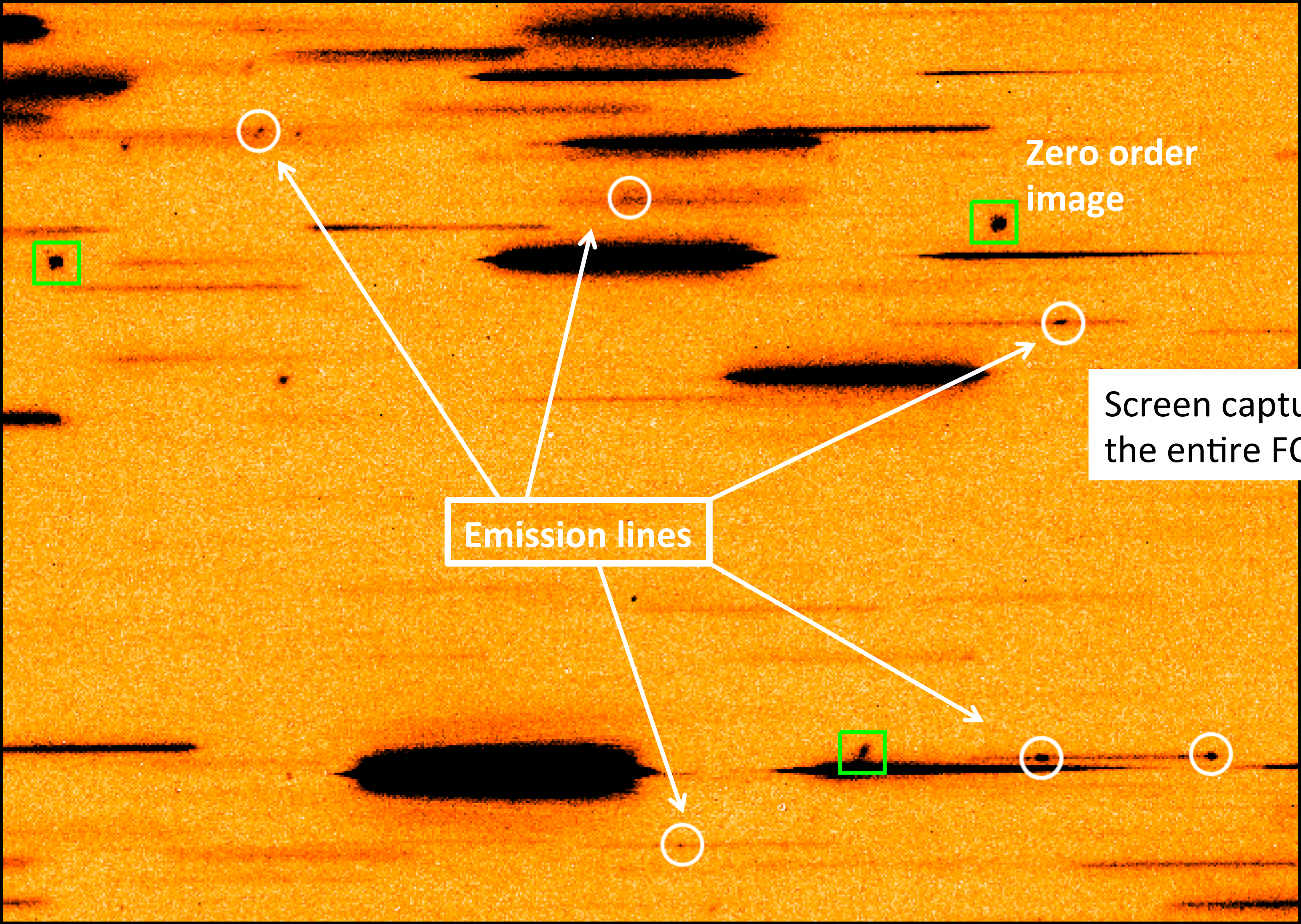
2. Continuous spectral coverage samples large 3D volume in multiple lines (~1Mpc^3 @ z=1-2)

3. Many independent fields (>150 so far), overcoming Cosmic Variance

WISP

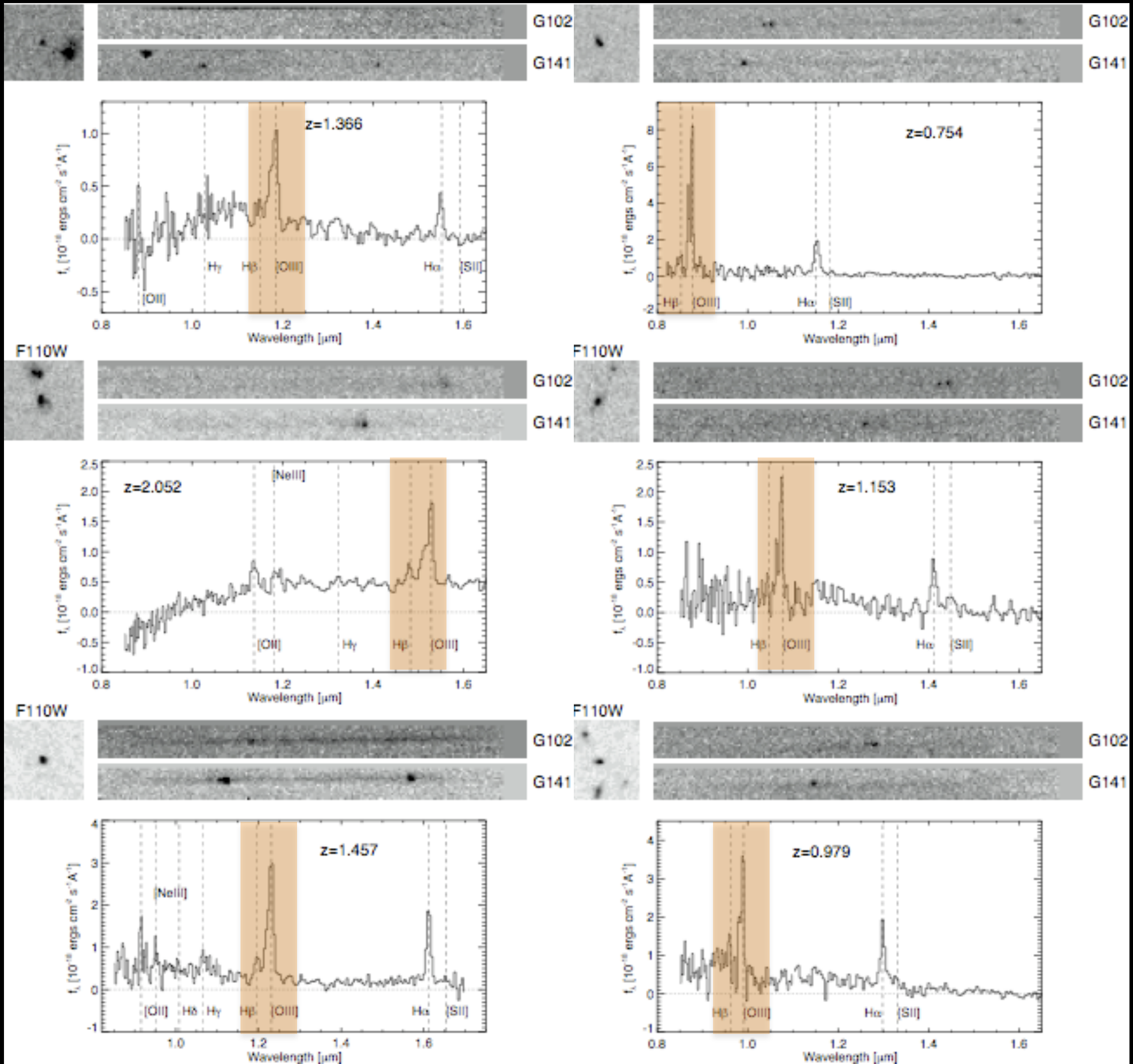
WFC3 Infrared Spectroscopic Parallels

The Data



Screen capture of ¼ of the entire FOV

The Data



Combination of two (overlapping) grisms gives wide spectral coverage (0.8--1.7μm)

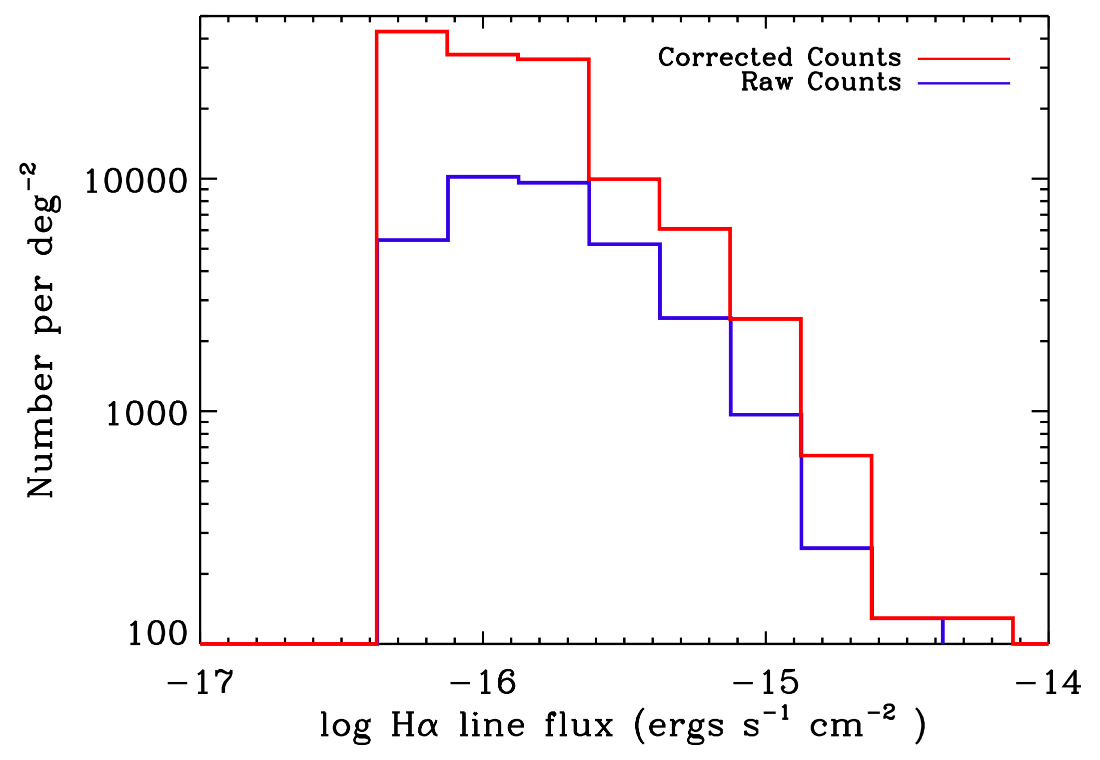
Excellent resolution (~2 pixels) means that we resolve [OIII]5007/4959 lines in compact galaxies

Atek et al. (2010)

WISP

WFC3 Infrared Spectroscopic Parallels

Line Extractions



All lines are identified automatically, following a continuum fit to each source.

Parallel data do not allow rotation to remove confusion and no dithering to decrease effects of artifacts and cosmic rays. Requires intensive by eye examination of each line.

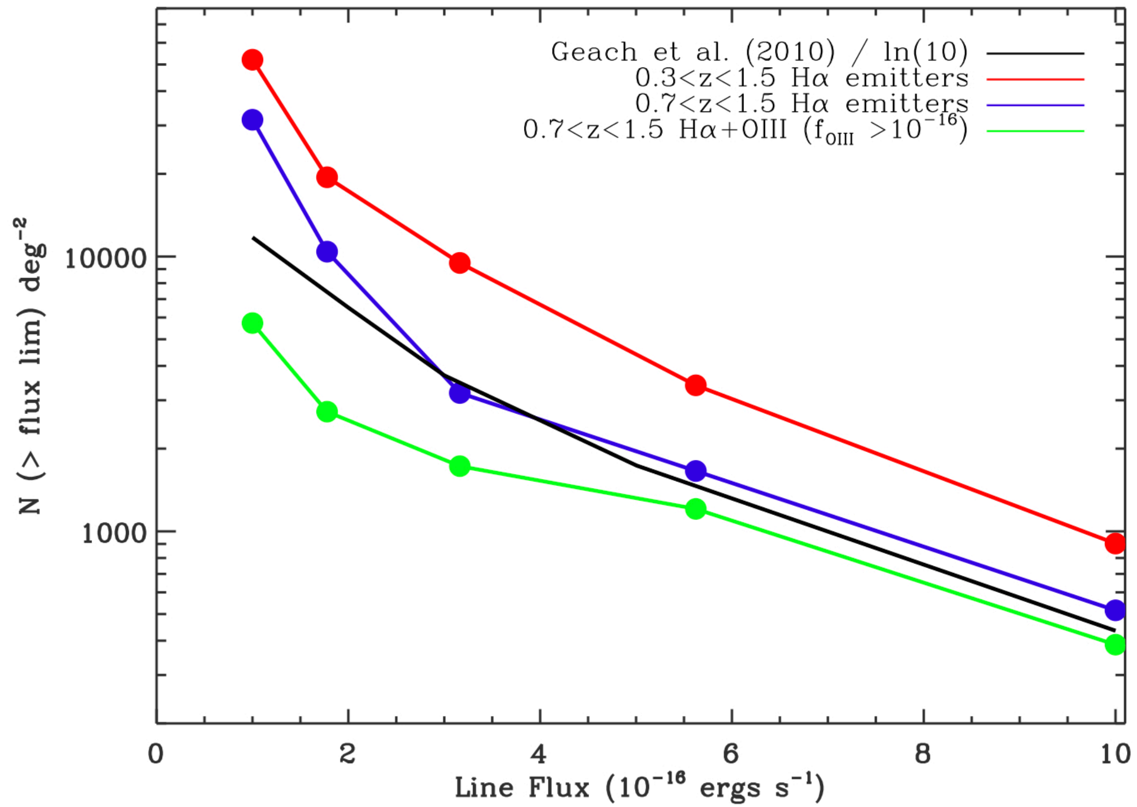
We generated artificial spectra covering full parameter space of magnitudes, fluxes, EW, sizes, and Hα/OIII line ratios in order to measure completeness. Inserted into real frames and recovered.

Present sample: 18 G102+G141 fields over ~60 arcmin^2.
H<25, EW>50Å cut: 500 Hα-emitters

WISP

WFC3 Infrared Spectroscopic Parallels

Cumulative Number Counts



Our cumulative number counts are in agreement with modified Geach et al. (2010) predictions based on NICMOS Hα searches:

3500 deg^{-2} for >3x10^{-16} ergs s^{-1} cm^{-2}

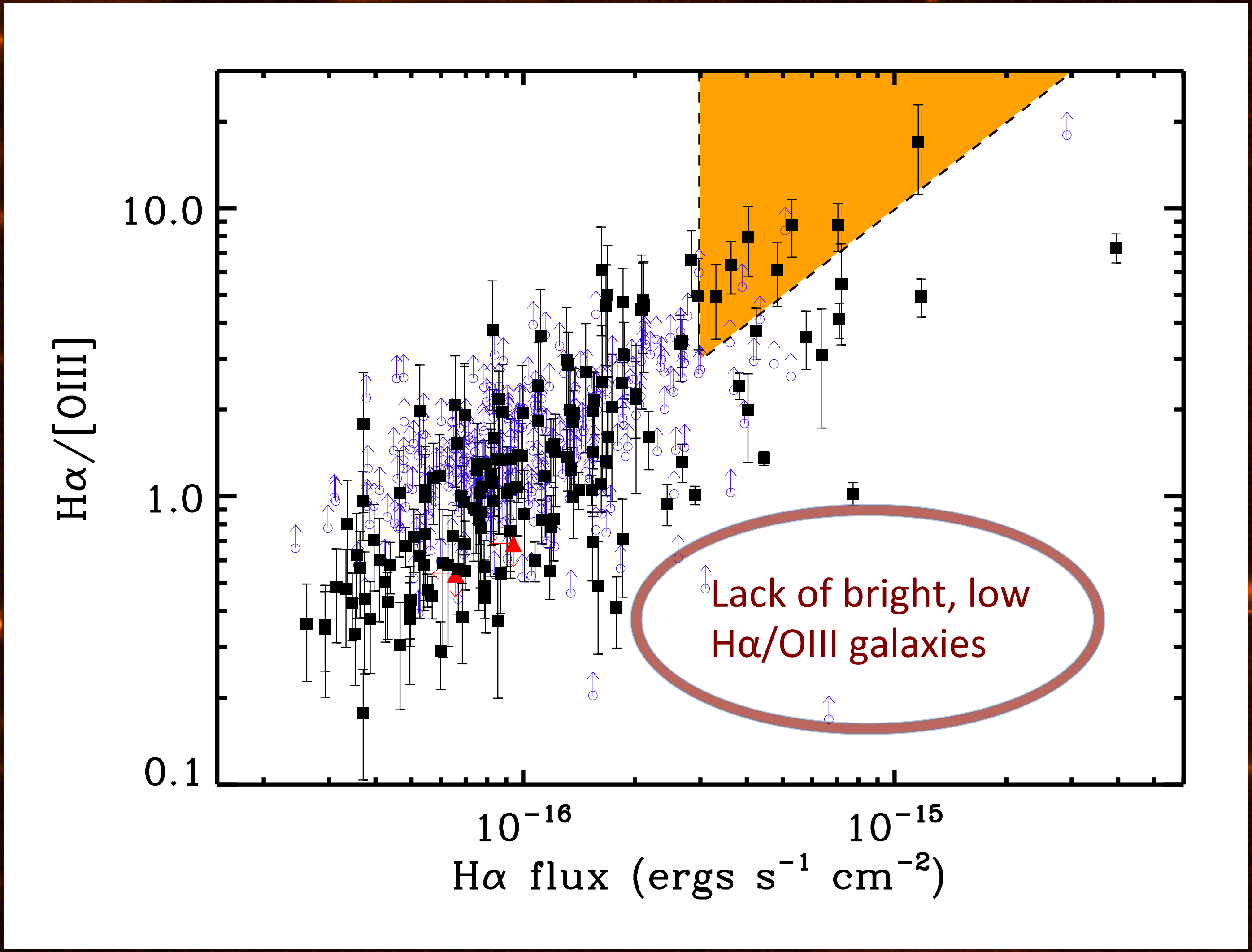
Prediction for OIII +Hα line sources are dependent on assumed limiting flux for OIII:

2000 deg^{-2} for OIII >1x10^{-16} ergs s^{-1} cm^{-2}

WISP

WFC3 Infrared Spectroscopic Parallels

Hα/[OIII] Flux Ratios



Orange region: Predicted single emission line sources, assuming:
Hα > 3x10^{-16} ergs s^{-1} cm^{-2}
& OIII > 1x10^{-16}.

Roughly a *third* of emitters will be single line.

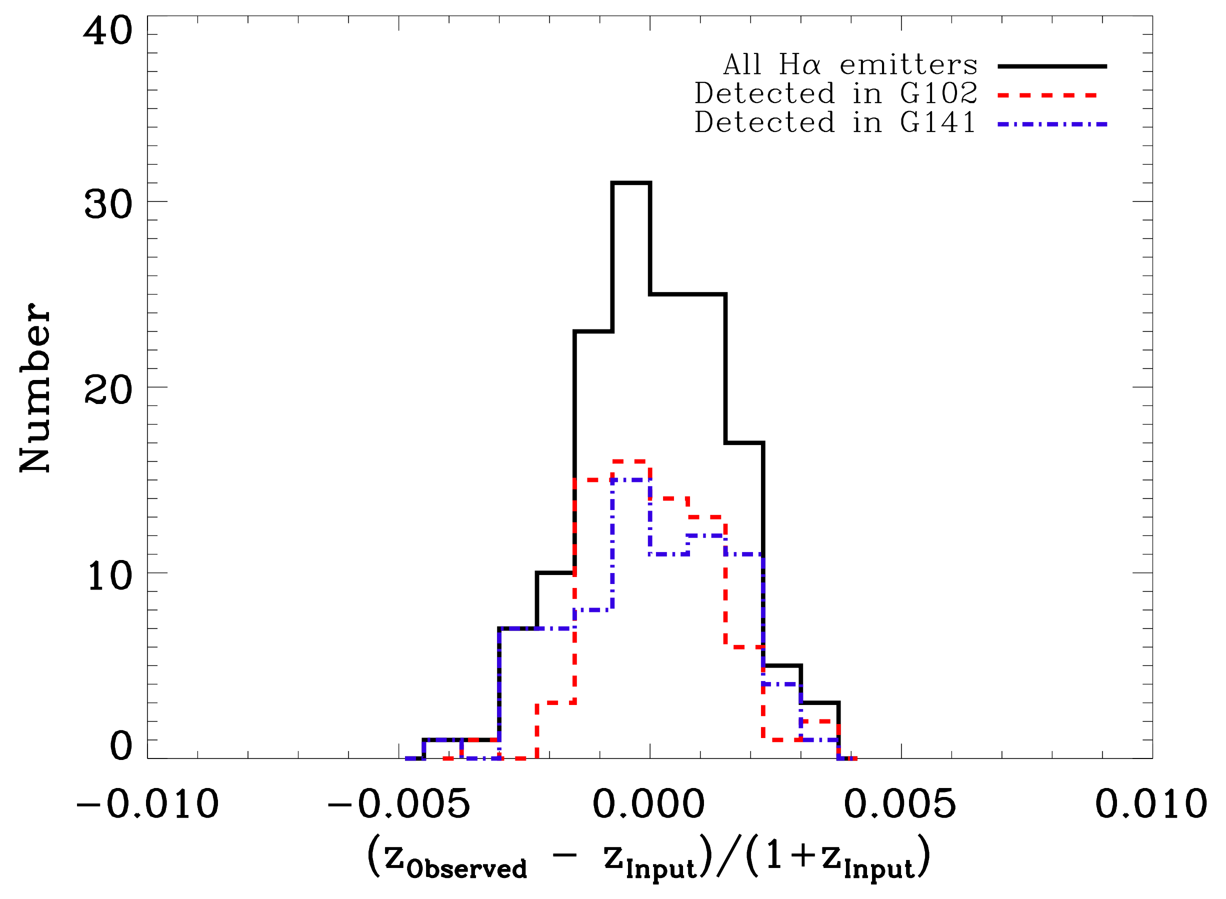
There are NO OIII-emitters where the reverse would be true (over 60 $arcmin^2$).

At >3x10^{-16} ergs s^{-1} cm^{-2} contamination from OIII for single line emitters will be low (0/37 sources), but more area needed.

WISP

WFC3 Infrared Spectroscopic Parallels

Redshift Accuracy



Compared input and observed redshifts from our simulated spectra.

No significant redshift offset seen (~10^{-5} in z).

$\delta z/(1+z)=0.0015$

Higher λ resolution in G102 (R=210 vs. 130): $\delta z/(1+z)=0.0013$

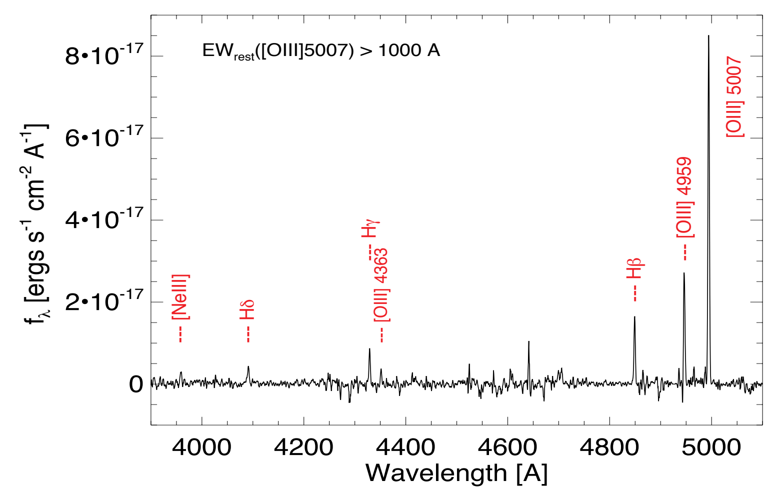
Compact sources (radius < 0.4”) in G102: $\delta z/(1+z)=0.0010$

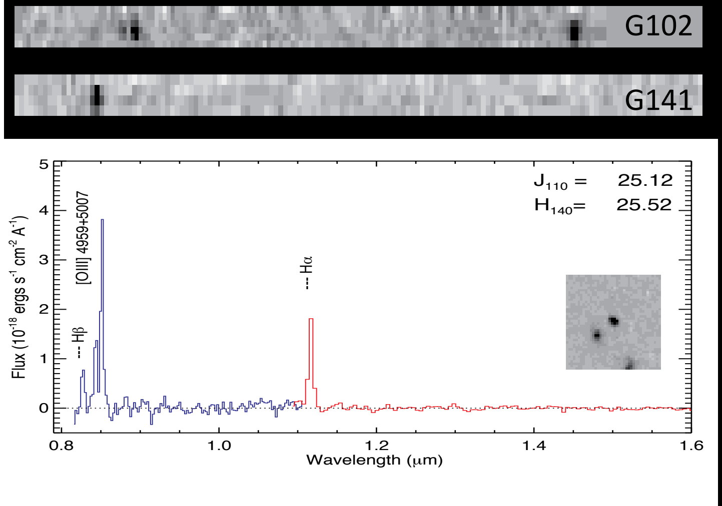
Extreme EW galaxies

WISP is remarkably efficient in discovering z>1 star-forming galaxies,
almost independently of their stellar continuum

[OIII] is enhanced by two “conspiring” correlations:

1- SSFR increases as the stellar luminosity of the galaxy decreases
2- The metallicity drops as the continuum gets fainter

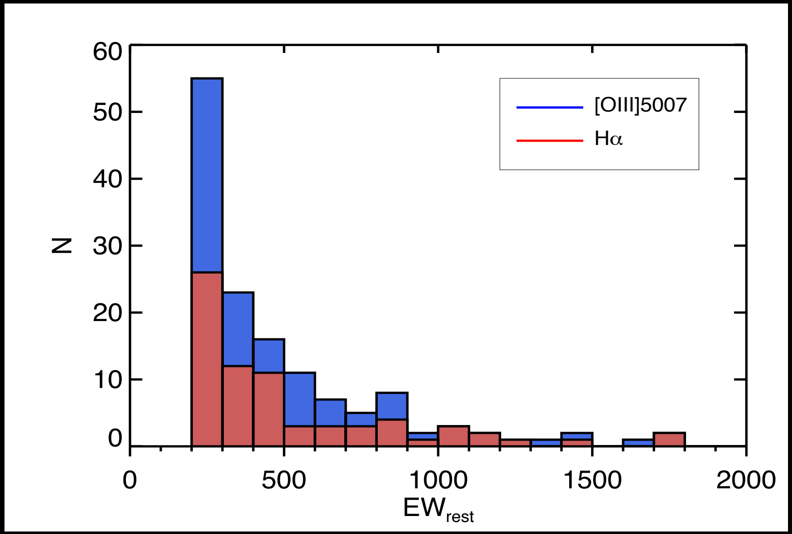


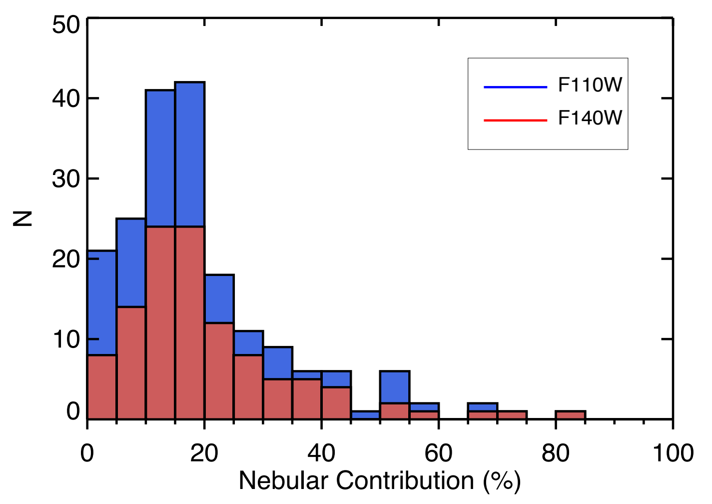


In 58 fields analyzed so far, we identified more than 170 high EW emission line galaxies, spanning the 0.5<z<2.5 redshift range (Atek et al. 2011).

Extreme EW galaxies

Atek et al. 2011





Rest frame EW distribution of WISP high EW galaxies

These objects have important implication for the stellar population properties we infer for high-z galaxies, and can also affect the high-z dropout selection

Conclusions

As of today WISP has covered ~50 independent fields with continuous spectral coverage between 0.8 and 1.7 μm and another 100 fields between 1.1 and 1.7 μm.

- For Hα > 3x10^{-16} ergs s^{-1} cm^{-2}: 3500 deg^{-2}
  In agreement with modified Geach et al. (2010) predictions based on NICMOS Hα searches:
- For Hα > 3x10^{-16} ergs s^{-1} cm^{-2}, [OIII] >1x10^{-16} ergs s^{-1} cm^{-2}: 2000 deg^{-2}

- Roughly a third of > 3x10^{-16} ergs s^{-1} cm^{-2} emitters may be seen as single (no OIII) Hα lines in surveys to that depth.
  - We find NO OIII-emitters at these flux limits without Hα, but small sample.

- HST WFC3 redshift accuracy: $\delta z/(1+z)=0.0015$
  For G102 only, compact sources: $\delta z/(1+z)=0.0010$

- WISP finds numerous (~1 arcmin^{-2}) high EW, low metallicity emission line sources
  - Implication for inferred stellar population properties and high-z dropout selection