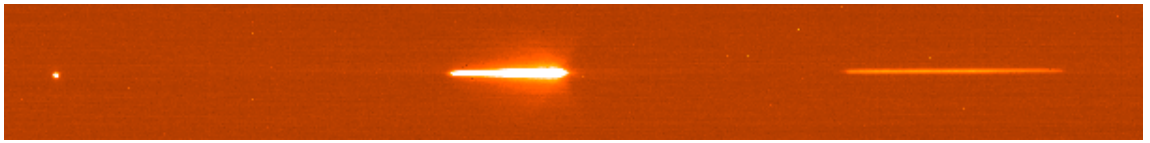
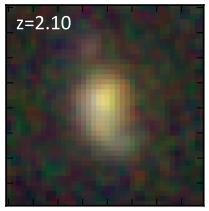
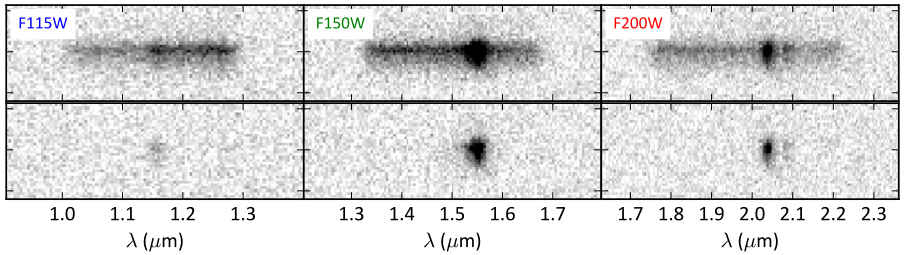
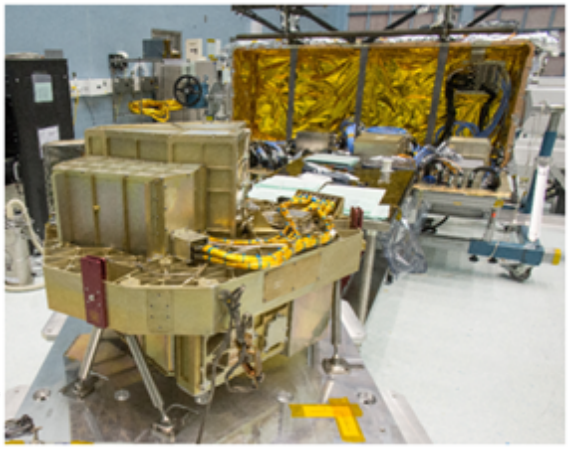
HIGHLY MULTIPLEXED INFORMATION ON EMISSION LINE GALAXIES VIA JWST SLITLESS SPECTROSCOPY







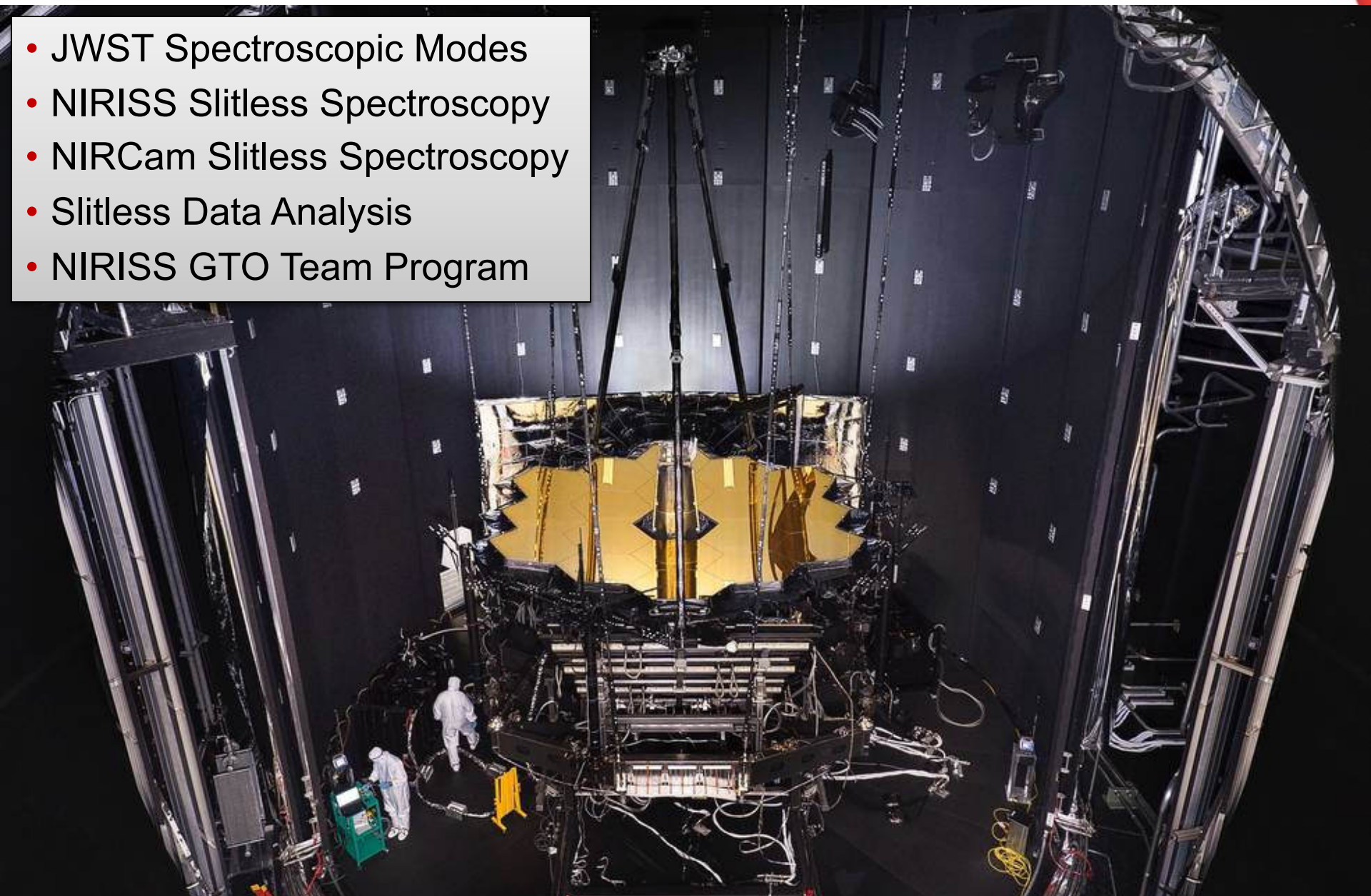


Chris Willott, National Research Council Canada, Victoria

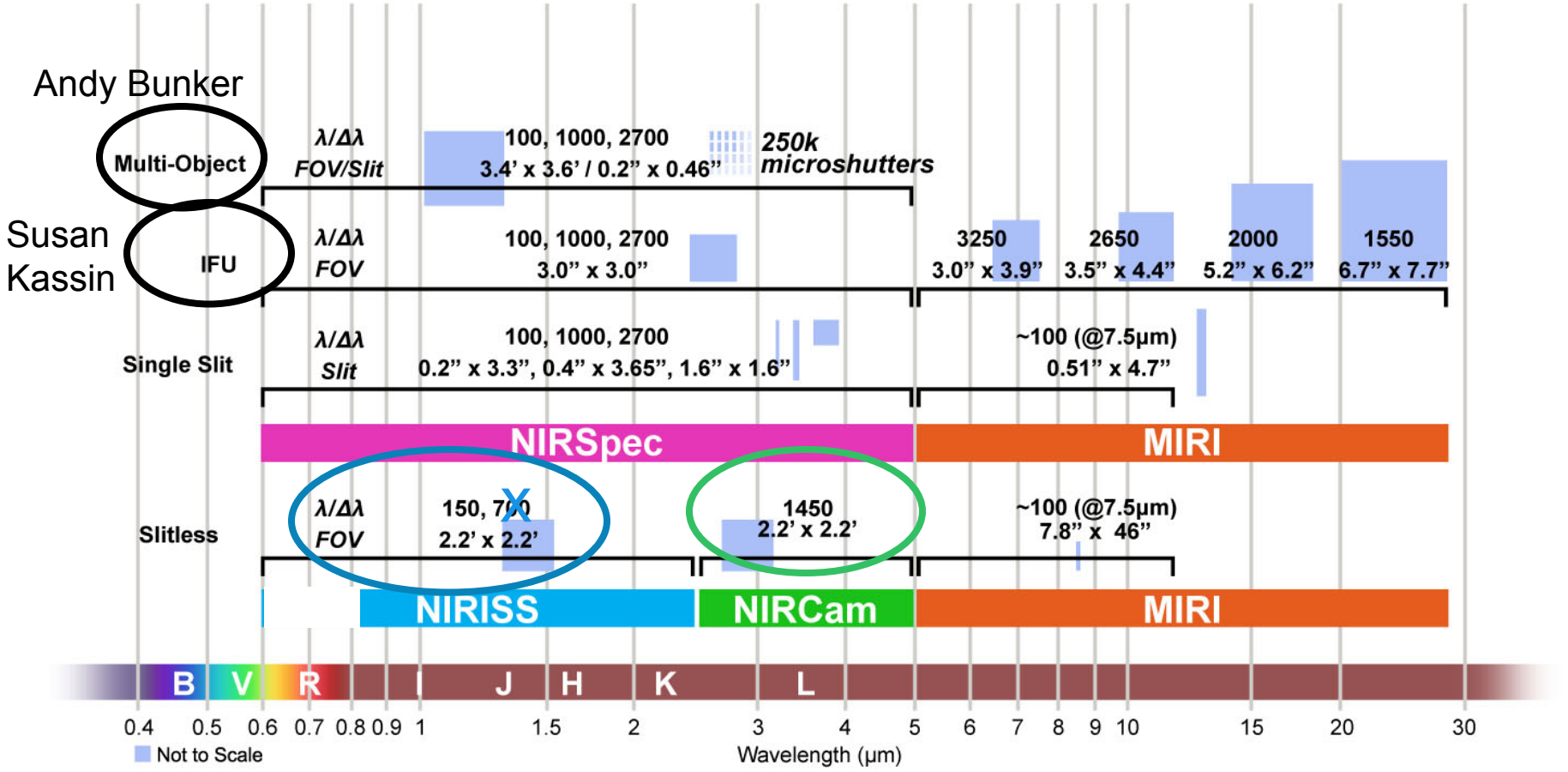
Emission Line Galaxies with MOS
Cambridge, 22 Sept 2017

Outline

- JWST Spectroscopic Modes
- NIRISS Slitless Spectroscopy
- NIRCam Slitless Spectroscopy
- Slitless Data Analysis
- NIRISS GTO Team Program



JWST Spectroscopic Modes



NIRISS overview

At a glance:	
Detector	Teledyne HAWAII-2RG; HgCdTe with 5.2μm cutoff; 2048 × 2048 pixels
Field of View	2.2′ × 2.2′
Plate scale	0.065 arcsec / pixel
Pupil Wheel	“Blue” filters; Grism GR700XD; Aperture Mask NRM
Filter Wheel	“Red” filters; Grisms GR150C,R

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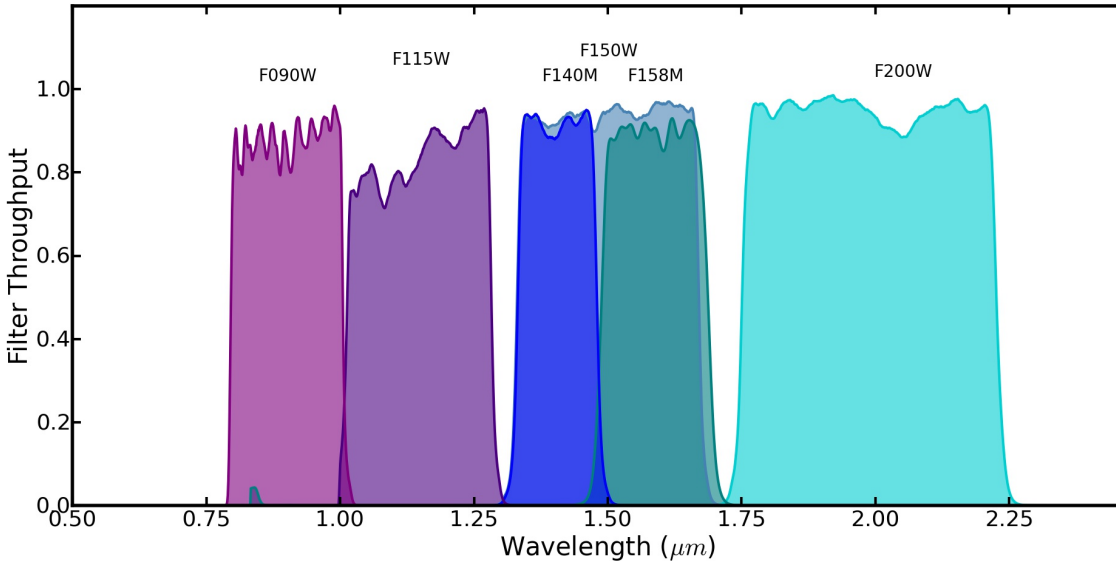
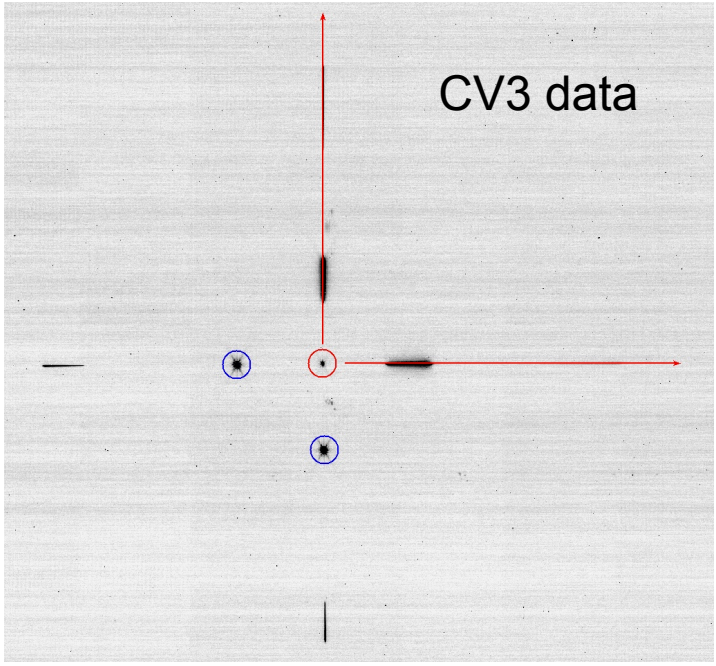


NIRISS Wide Field Slitless Spectroscopy

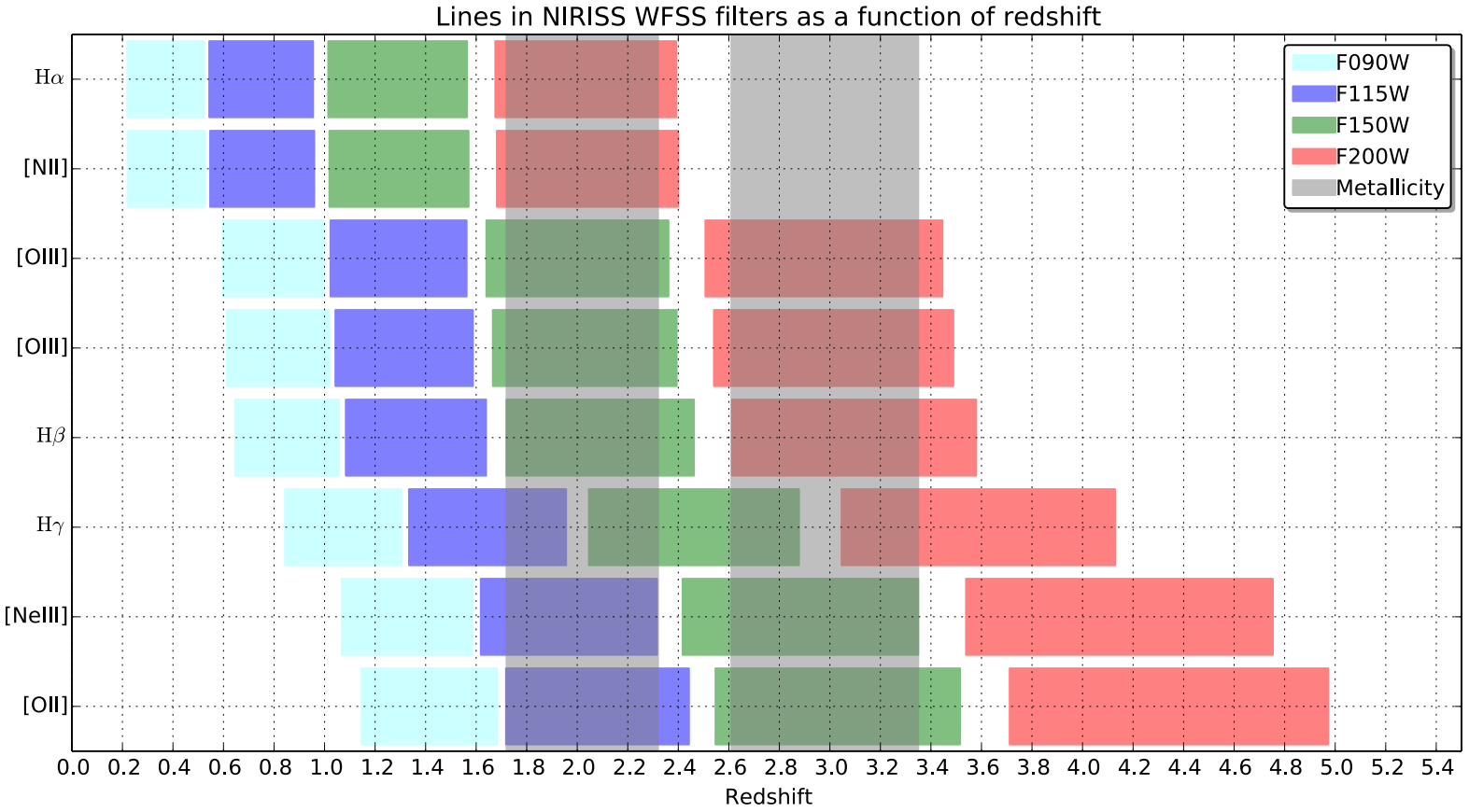
- Spectra of **all** objects in the field.
- In a ‘’blank’’ field there are **~3000** galaxies at mag < 28 ➔ high **multiplex** factor.
- Almost complete **spectral coverage** from 0.9 to 2.2 microns.
- At least one **strong emission line** 0.5<z<4.9. Lyman-α if present at 6<z<17.
- **Resolving power** 100 to 200.
- **Spatial resolution**: 0.06’’ ~ 0.5 kpc.
- **No slit losses.**
- **Map of emission lines.**
- Powerful for **blind emission line** surveys and continuum **breaks**.
- **Cross-dispersed** grisms to mitigate contamination.
- **Point-and-shoot observing** – no target acquisition
- Ideal for **parallels** due to simple operation.



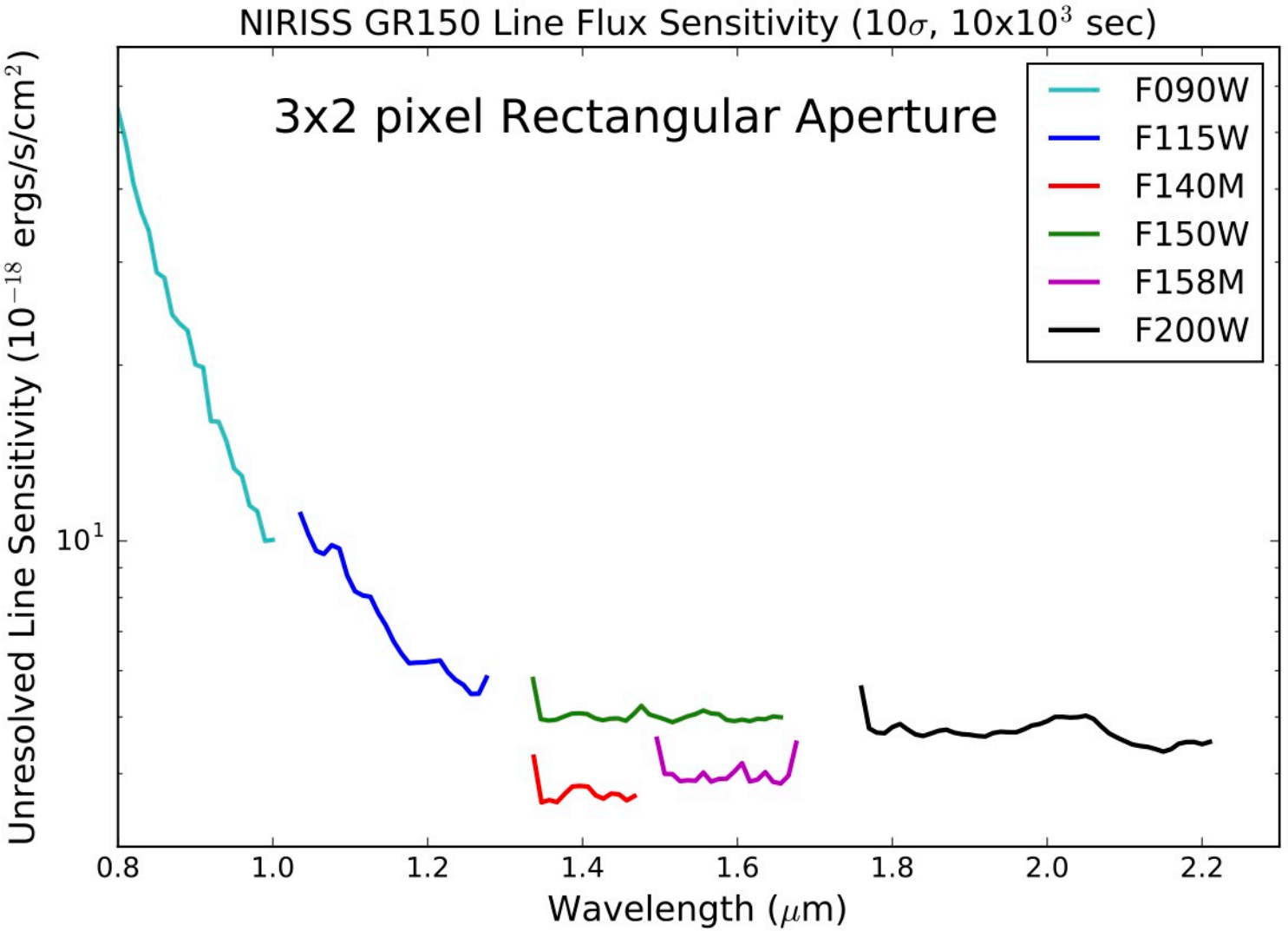
NIRISS Wide Field Slitless Spectroscopy

Oxygen, Neon and H Balmer emission lines at redshifts 1 to 3.3 will be used to determine gas-phase metallicities and study the inflow/outflow histories of galaxies.

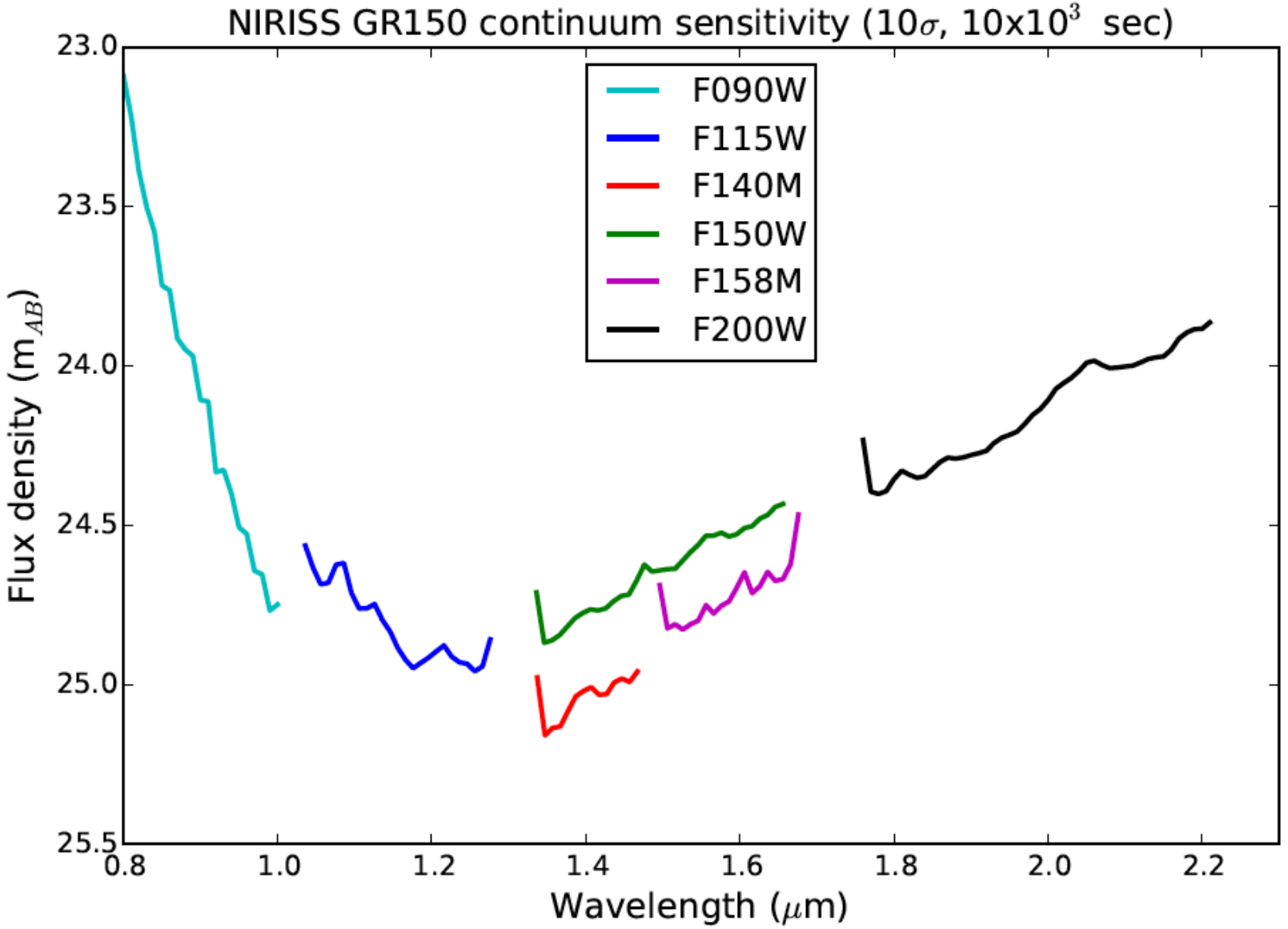
Slitless mode makes these measurements more reliable than those based on slit spectroscopy.



NIRISS Wide Field Slitless Spectroscopy



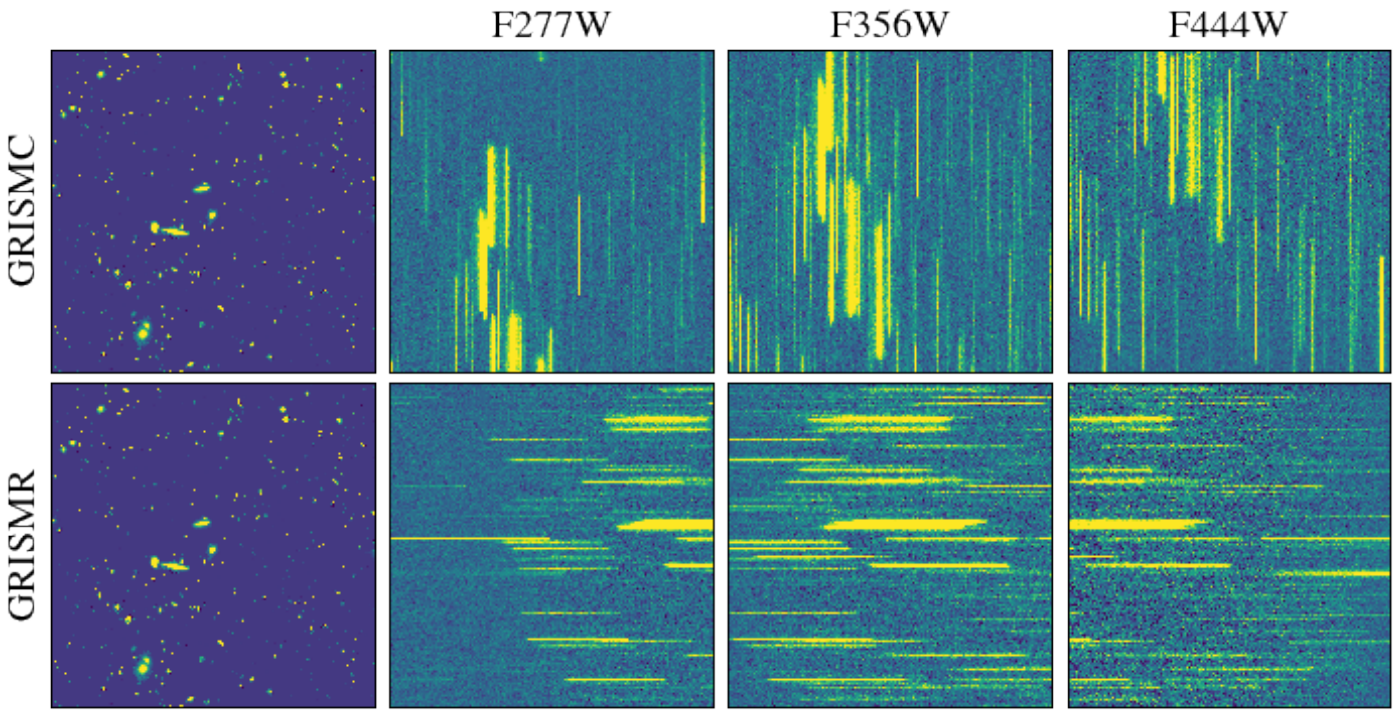
WFSS continuum sensitivity



NIRCam Wide Field Slitless Spectroscopy

NIRCam WFSS differs from **NIRISS** by:

- Wavelength range 2.5 to 5 microns
- Spectral resolution 10x higher at R~1500 ➔ spectra 10x longer
- Two modules gives double the area (10 sq arcmin, but lower away from 4 microns).



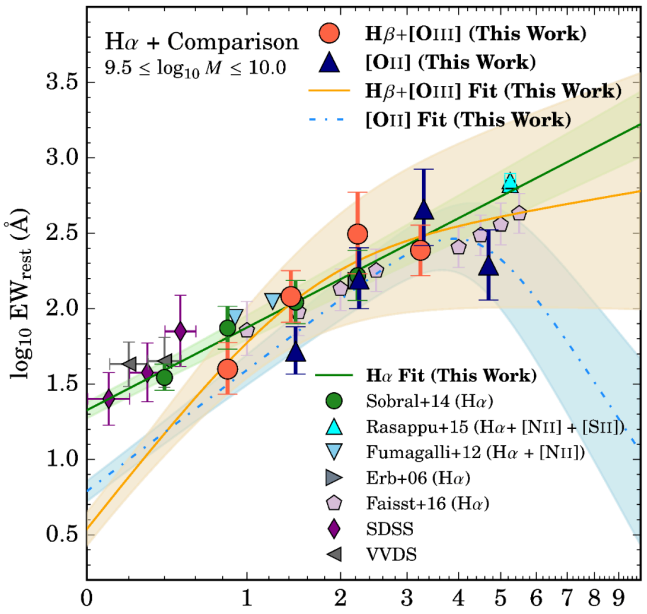
N. Pirzkal

NIRCam Wide Field Slitless Spectroscopy

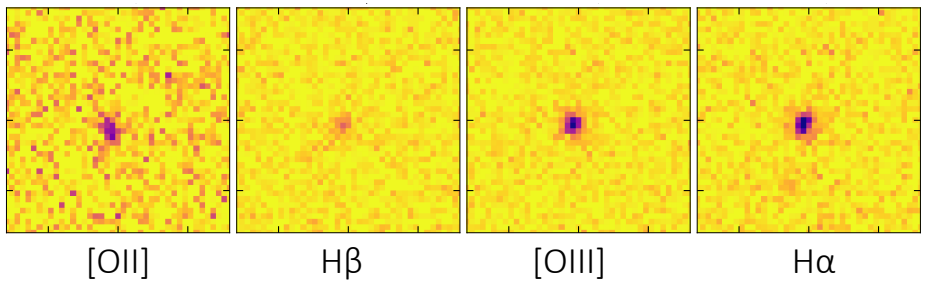
NIRCam WFSS will measure rest-frame optical line ratios of z>4 galaxies

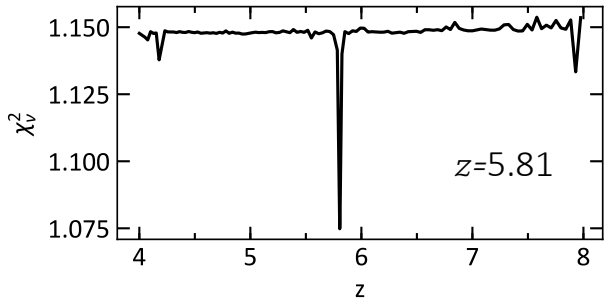
Spitzer IRAC photometry shows galaxies at these redshifts have strong lines.

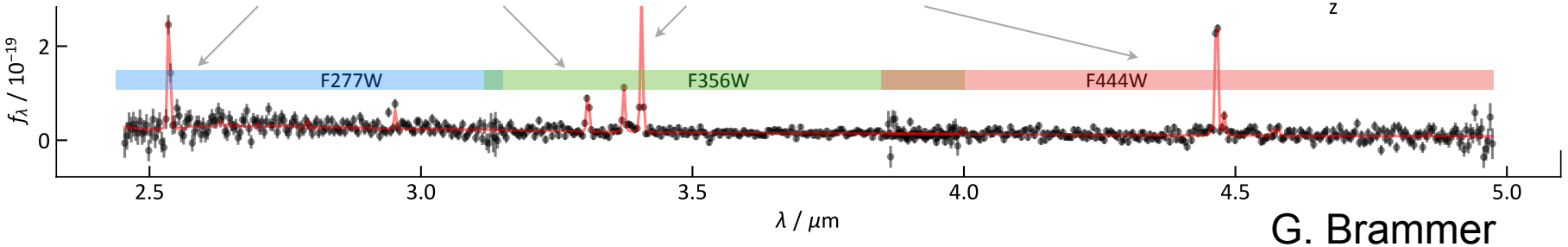
Emission line EWs increase with redshift and decreasing mass/metallicity.



Khostovan+16

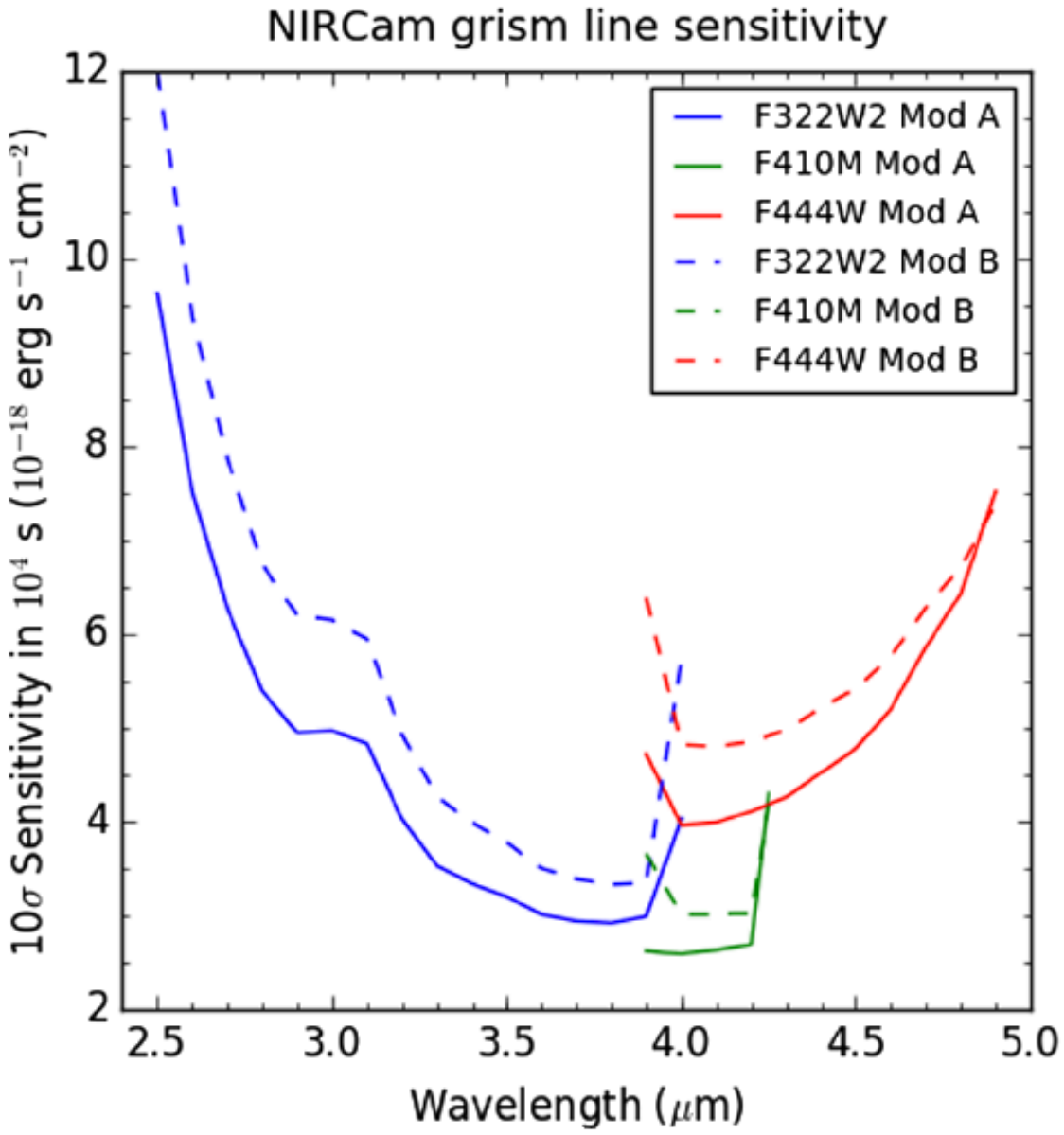






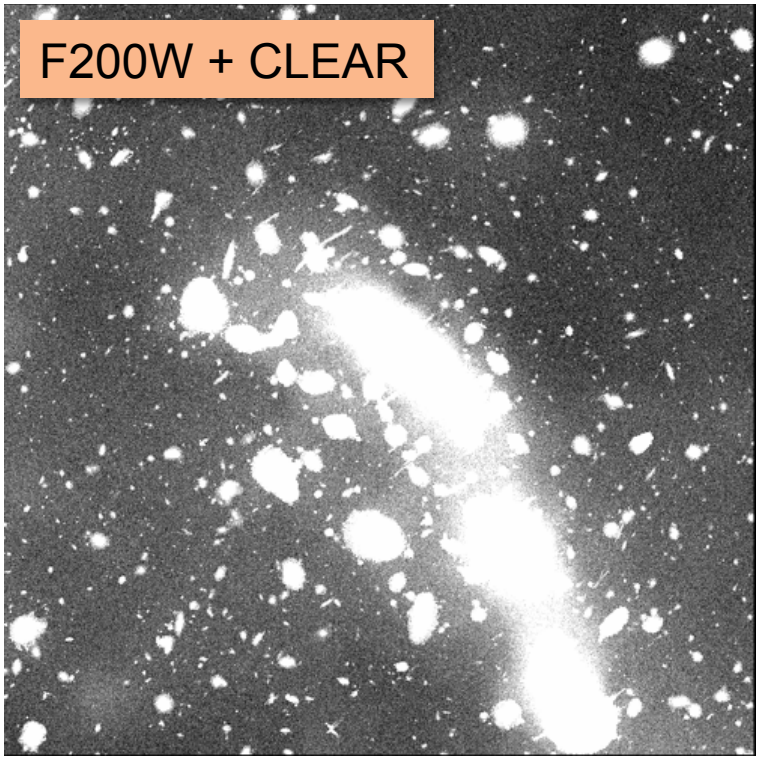
G. Brammer

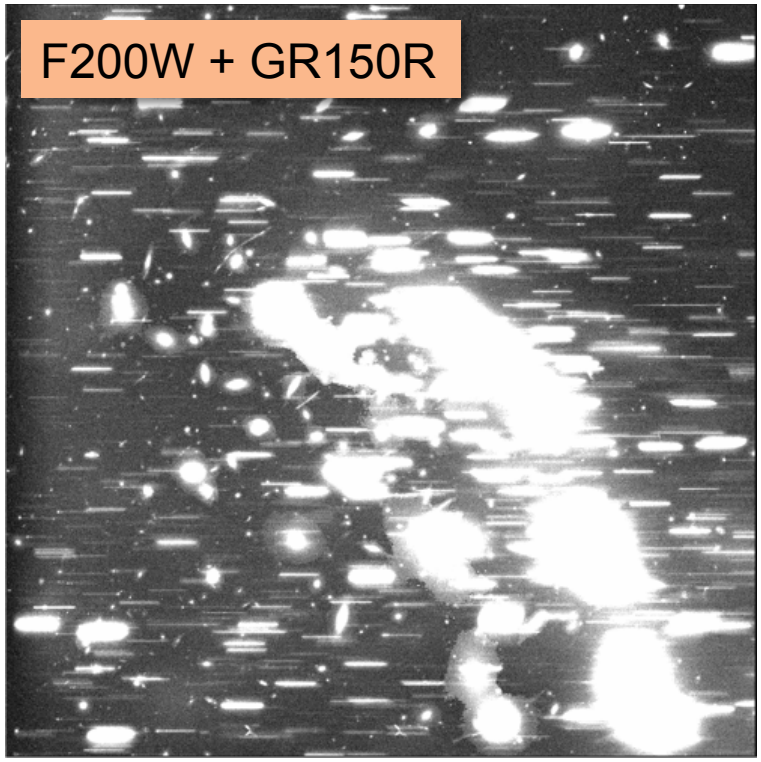
NIRCam Wide Field Slitless Spectroscopy



Slitless Data Analysis

- JWST pipeline will do basic processing steps and some advanced processing for quick look or ‘easy’ cases.
- Expert users will reprocess offline using combination of pipeline and other tools.
- Full contamination modeling required for most situations. Tools exist to help you!!

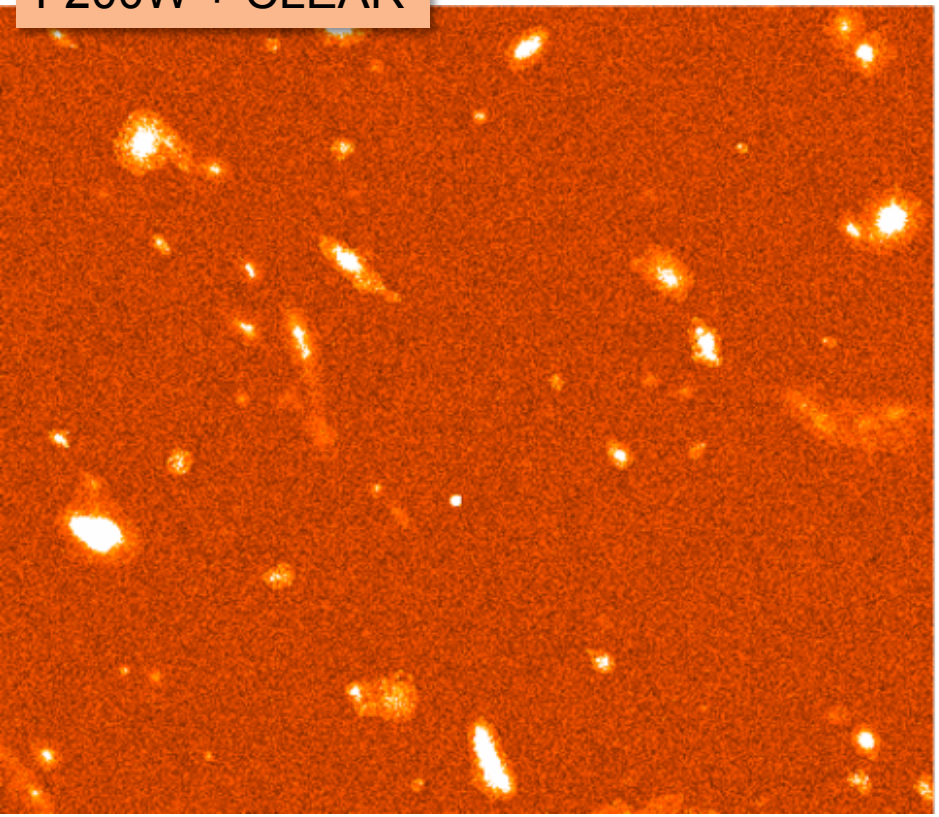




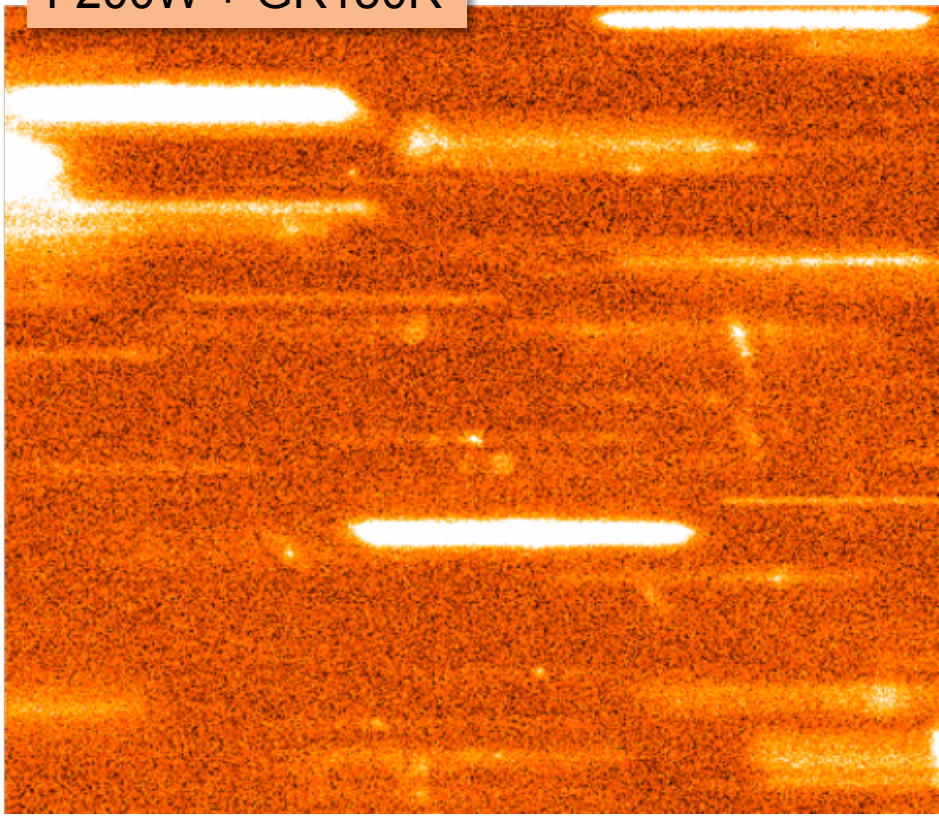
Slitless Data Analysis

Zoom-in to 1% of the simulated field shows many faint galaxies with emission lines – due to high EW in high-z and low mass galaxies.

F200W + CLEAR



F200W + GR150R



The CAnadian NIRISS Unbiased Cluster Survey (CANUCS)

NIRISS High-z Working Group

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Loic Albert
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Rene Doyon
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Paul Goodfrooij
John Hutchings
Andre Martel
Swara Ravindranath
Marcin Sawicki
Chris Willott

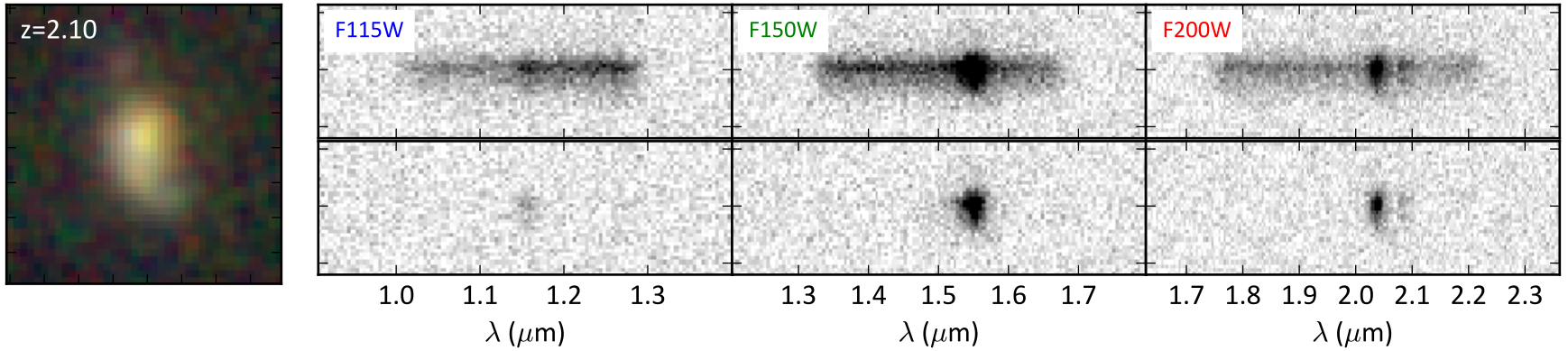
Studying the Universe in and behind massive lensing clusters

CANUCS Survey Design

- We will observe 4 or 5 strong-lensing galaxy cluster fields at 0.35<z<0.7 with **NIRISS, NIRCam** and **NIRSpec**.

- Gives a **large sample** of distant galaxies (~3000 at z>1.7) with wide luminosity range due to gravitational lensing.

- The NIRISS grism integration time of ~6 hours per filter will produce unrivalled **deep** slitless spectroscopy more than an order of magnitude **deeper** than previous studies with Hubble at much **higher spatial resolution** and **wider wavelength range**.



CANUCS Science Goals

Observing lensing cluster fields with JWST imaging and spectroscopy leads to a dataset capable of attacking a range of science goals…

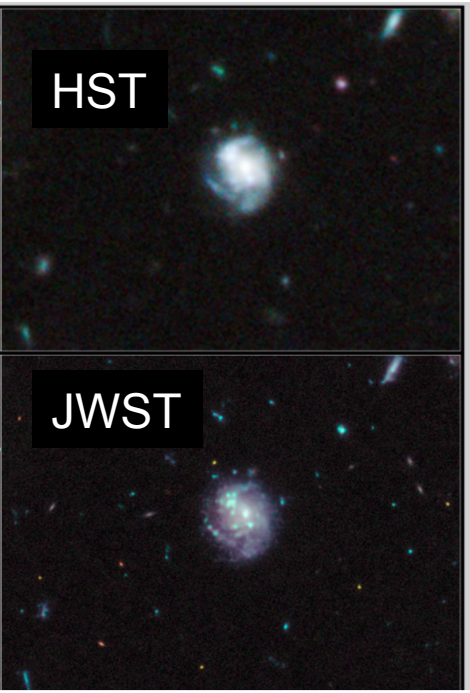
- The Evolution of Dwarf Galaxies
- Galaxies in the Reionization Epoch
- Massive Lensing Clusters
- Quenching
- Mergers and Assembly
- Environmental Dependence
- Transients

The survey emphasizes two unique features of Wide Field Slitless Spectroscopy with NIRISS:

Very high **multiplex** factor

Spatially-resolved emission lines

CANUCS Science Goals

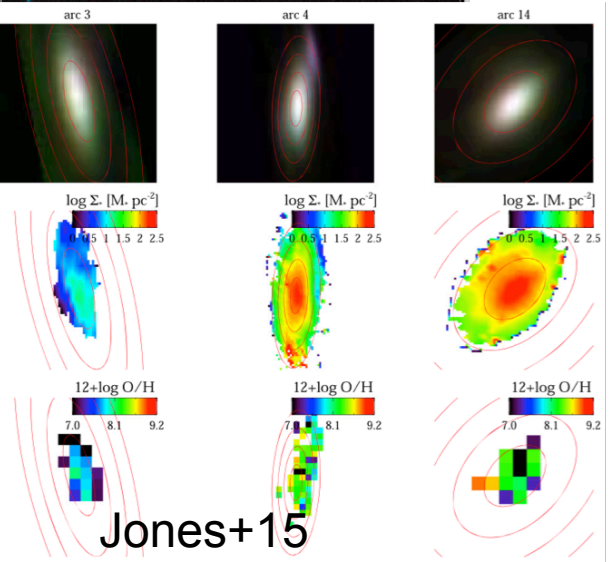


Spatially resolved imaging and spectroscopy

➔

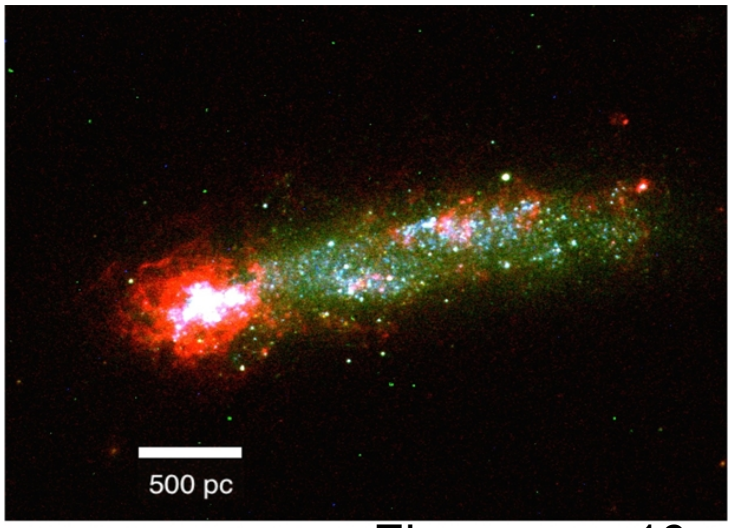
- SF
- Metallicity
- Dust
- Stars, old and young

… clumps, gradients, mergers, accretion, …



Jones+15

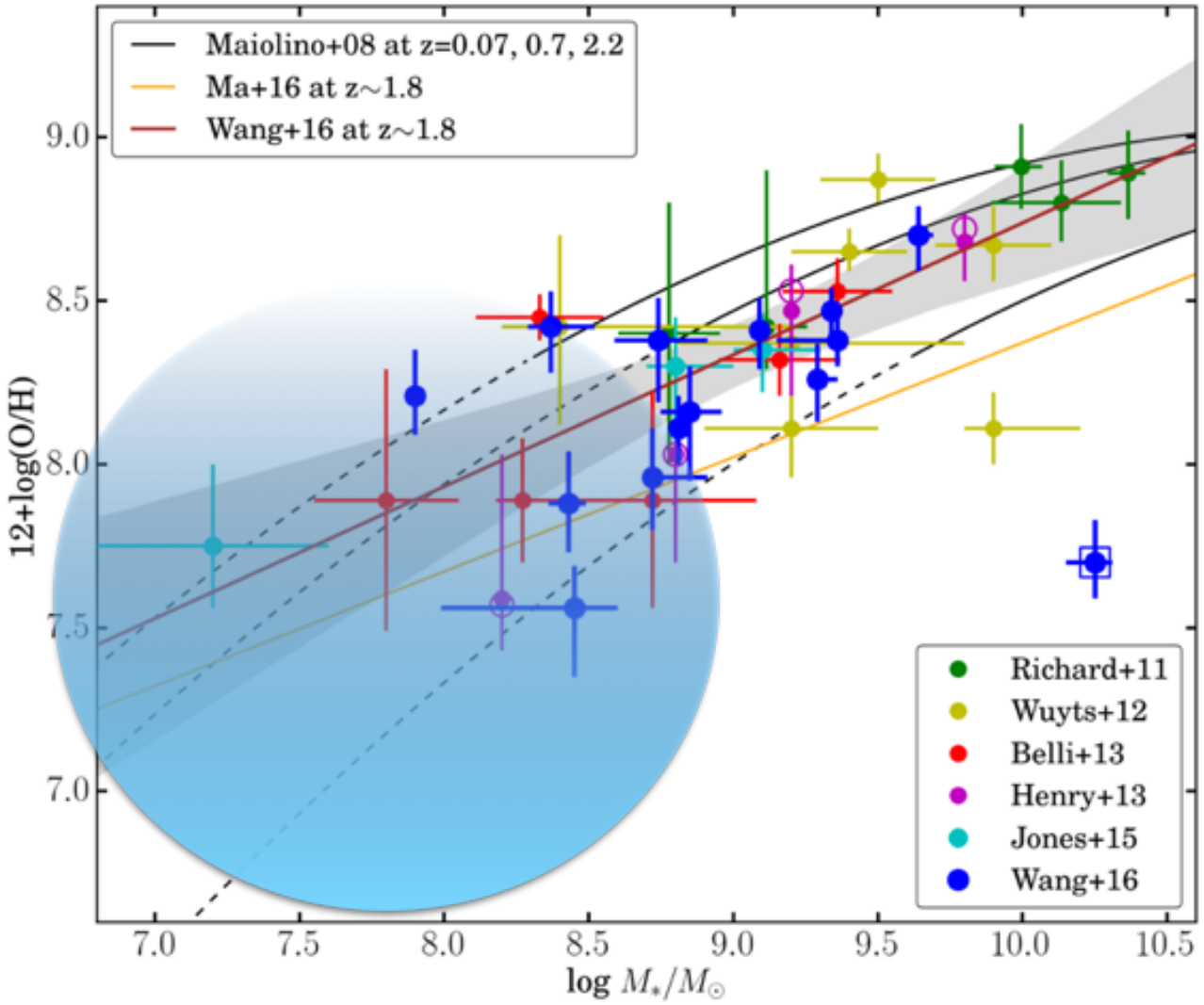
Measure physical conditions and relate to zoom-in simulations to understand how dwarf galaxies evolve.



Elmegreen+16

CANUCS Science Goals

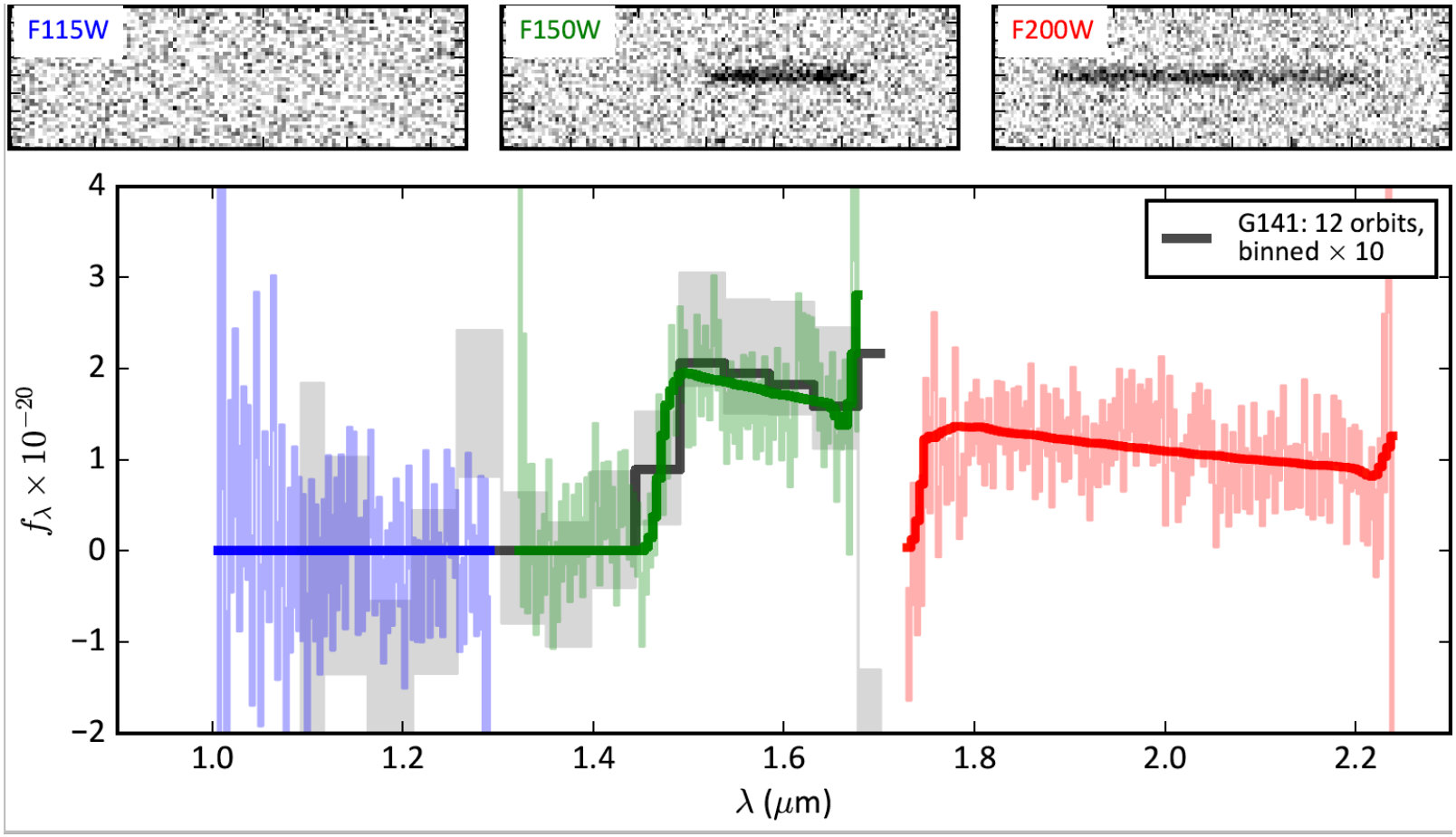
- At z~2 and very low mass few gas-phase metallicities have been measured.
- NIRISS will expand by a large factor the number of z>1 dwarfs with metallicities, many spatially-resolved.
- Will probe the chemical enrichment and outflow/inflow histories of low mass galaxies.



Wang+16

CANUCS Science Goals

- Below is a **NIRISS simulation** of Oesch et al. (2016) **z=11 galaxy**
- Exposure time: ~3 hours per filter
- NIRISS WFSS will get continuum break redshifts even if no Lyman-α

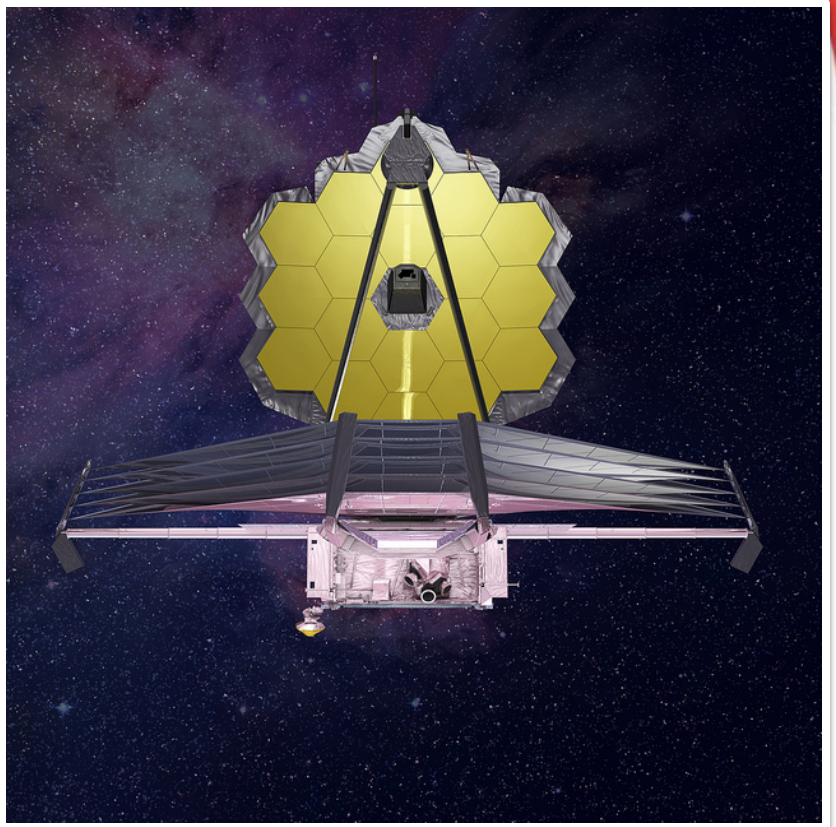


Summary

- JWST Wide-Field Slitless Spectroscopy provides a powerful alternative/ complement to NIRSpec MOS when high redshift completeness or accurate emission line fluxes required.

- Low resolution grism spectroscopy particularly important for emission line maps of low-luminosity galaxies.

- NIRISS GTO team will perform a slitless spectroscopic survey of lensing clusters probing the properties of dwarf galaxies at the peak epoch of cosmic SFR.



JWST is coming soon:

- Cycle 1 GO Call For Proposals just 2 months away…
- See jwst-docs.stsci.edu