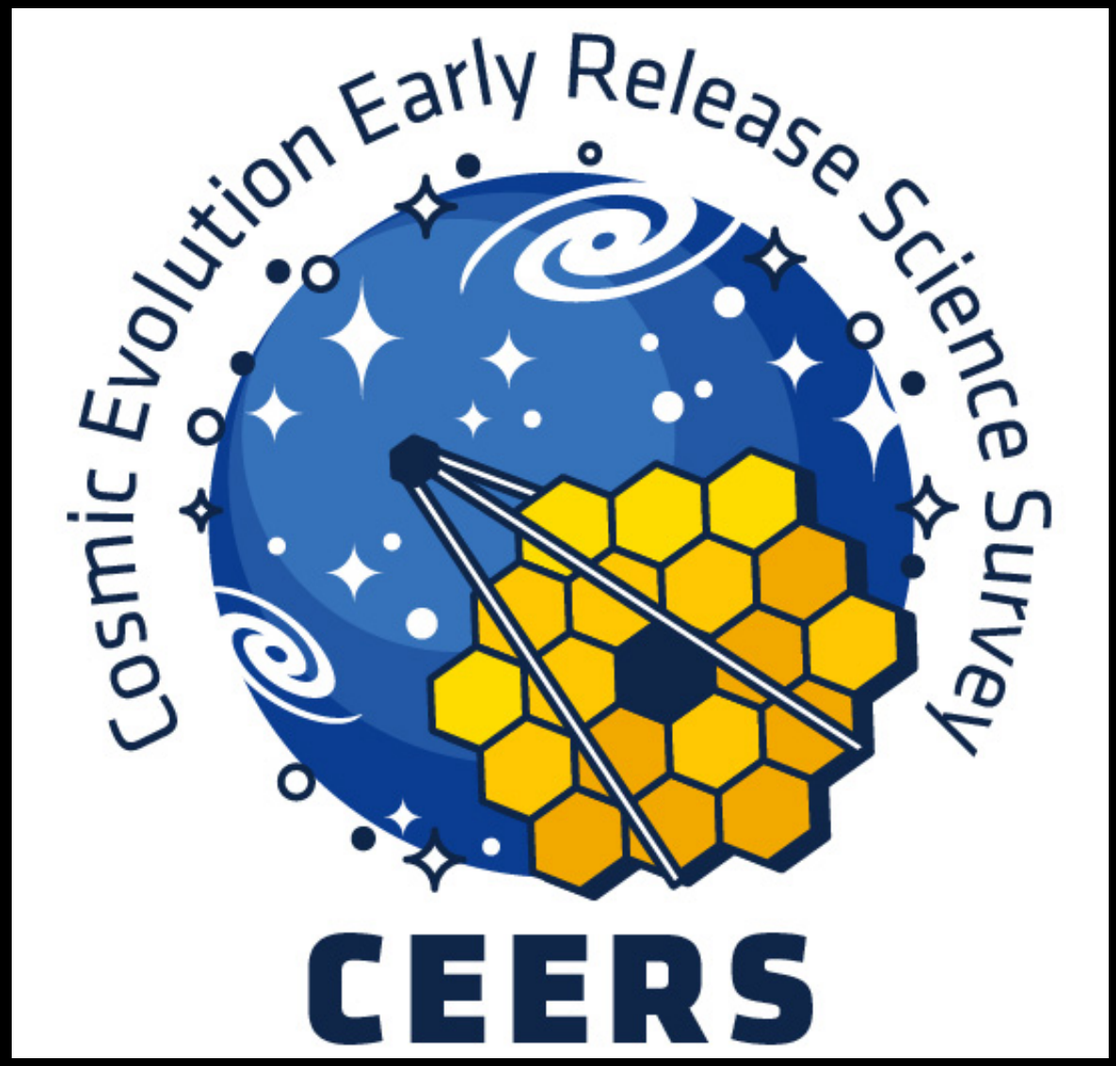
The Cosmic Evolution Early Release Science Survey (CEERS)

PI: Steven Finkelstein (UT Austin)

Co-I's: Mark Dickinson (NOAO), Harry Ferguson (STScI), Andrea Grazian (Rome), Norman Grogin (STScI), Jeyhan Kartaltepe (RIT), Lisa Kewley (ANU), Dale Kocevski (Colby), Anton Koekemoer (STScI), Jennifer Lotz (STScI), Casey Papovich (Texas A&M), Laura Pentericci (Rome), Pablo Perez-Gonzalez (Madrid), Nor Pirzkal (STScI), Swara Ravindranath (STScI), Rachel Somerville (Rutgers), Jon Trump (UConn) & Steve Wilkins (Sussex)

Full CEERS team: 105 scientists over 10 countries, including 28 institutions

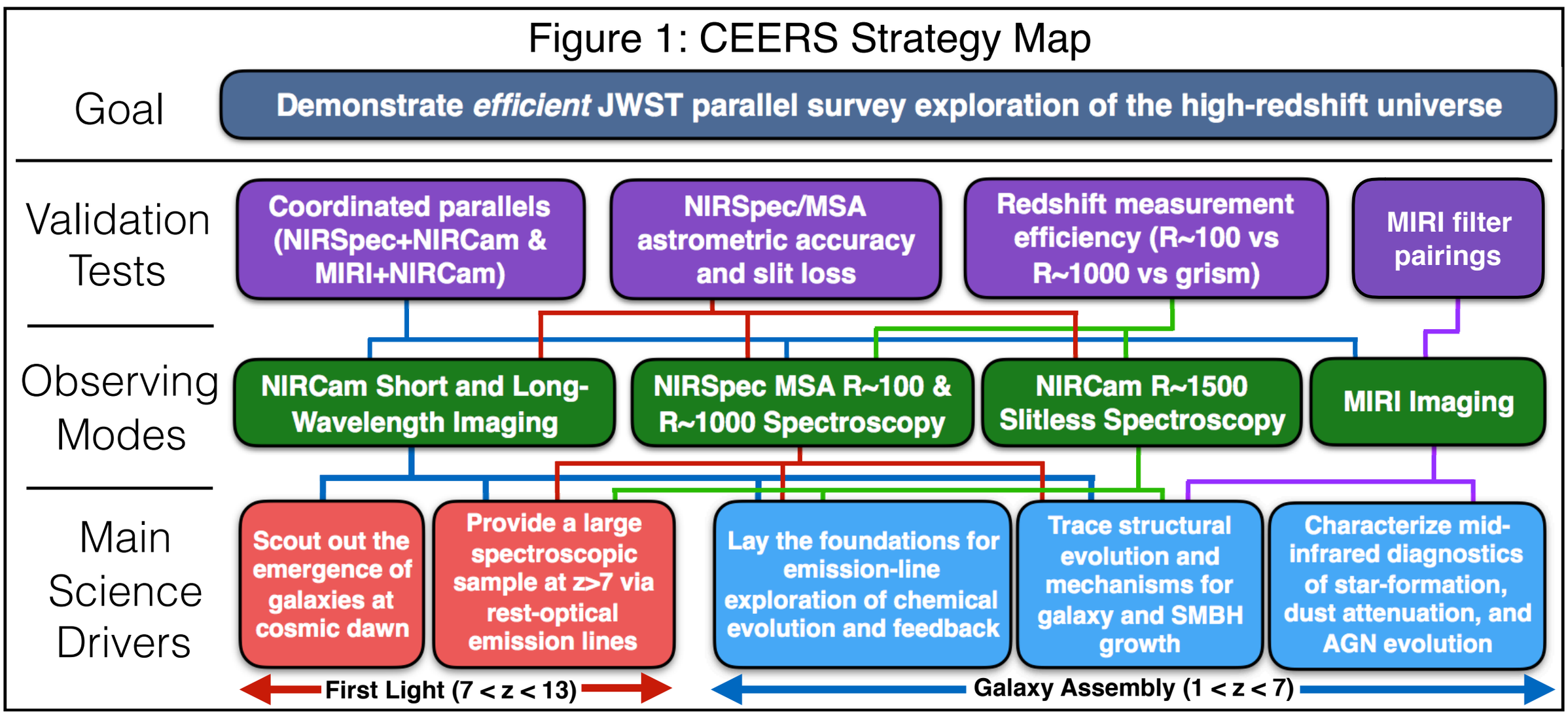


https://ceers.github.io

@ceers_jwst

CEERS Strategy

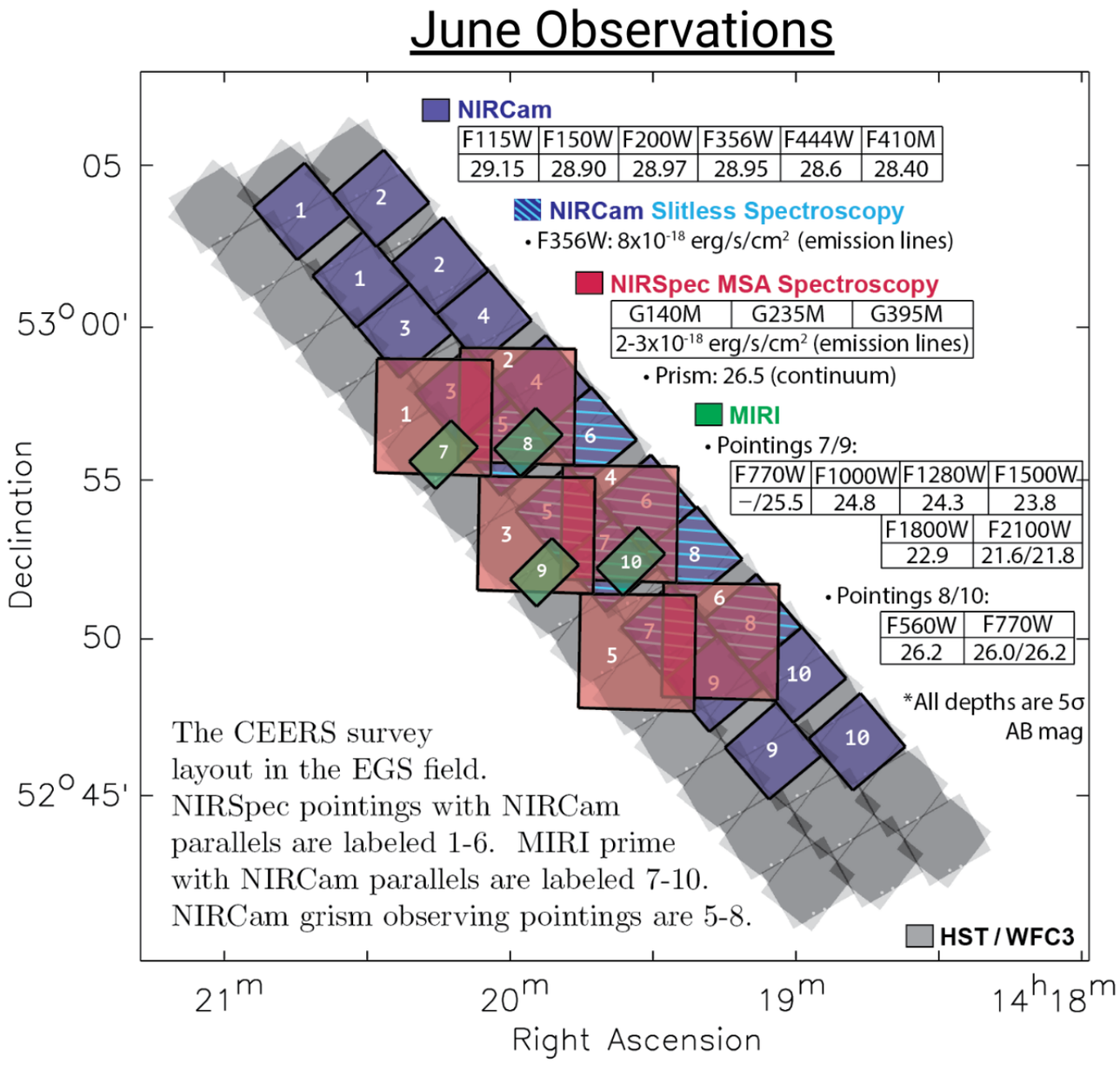
Figure 1: CEERS Strategy Map



- Coordinated parallels involving three instruments and four observing modes, to perform numerous validation tests, and targets several science drivers across $1 < z < 13$.

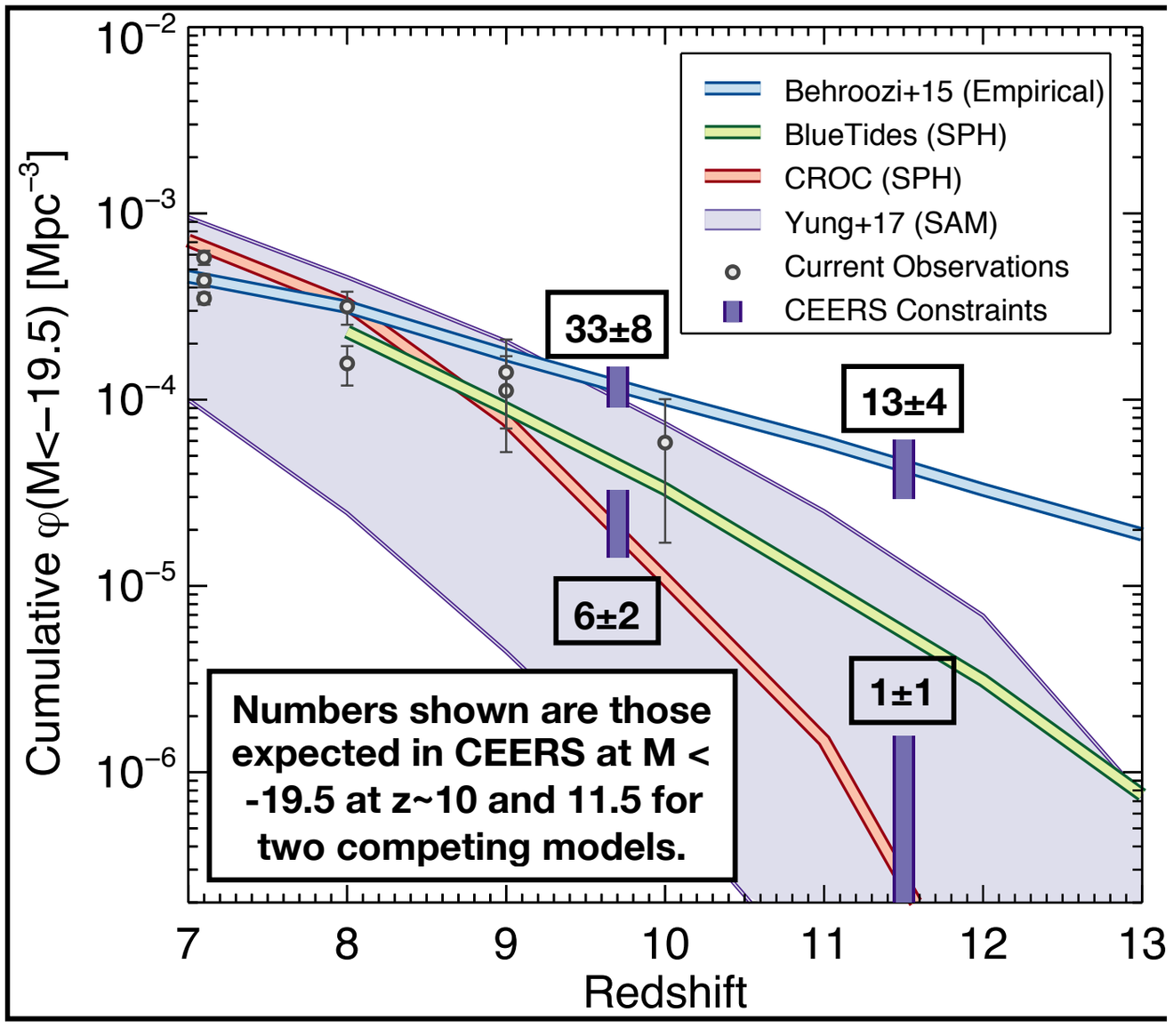
CEERS Observing Plan

- Primary Field: EGS
- 4 pointings: MIRI prime w/ NIRCam in parallel
  - MIRI: 2 pointings deep F560W & F770W, 2 pointings shallower obs out to 21 μm.
- 6 pointings: NIRSpec prime with NIRCam parallel
  - Imaging in 5-6 filters (1.2-4.5 μm).
  - R~1000 spectroscopy in all six pointings, R~100 in four pointings.
- 4 pointings: NIRCam grism prime (F356W)



Science Goal #1

- CEERS should detect ~5-50 galaxies at z > 10, which can distinguish between models which assume different star-forming efficiencies.



Science Goal #2

- CEERS will detect numerous diagnostic emission lines out to z~10, allowing spectroscopic confirmation and measurement of key physical properties, including ionization parameter and metallicity.

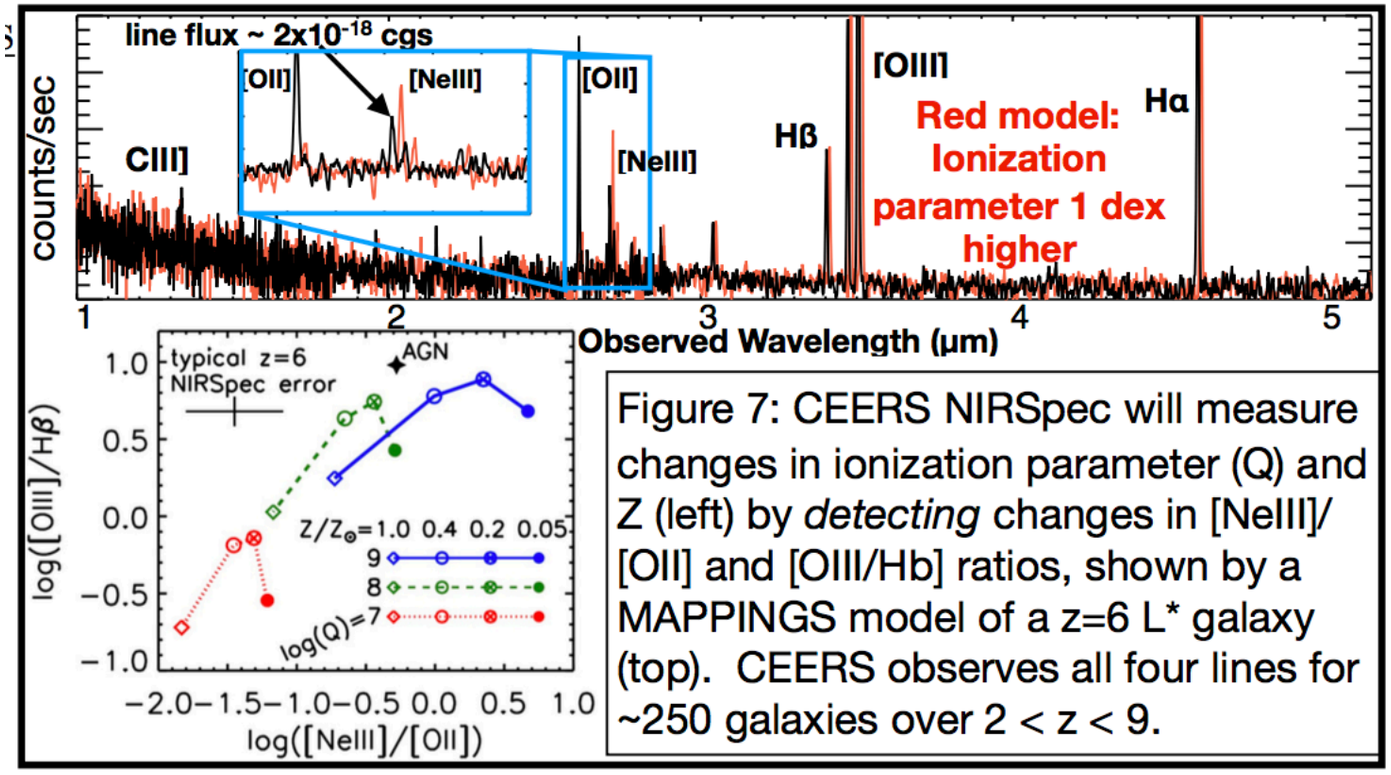


Figure 7: CEERS NIRSpec will measure changes in ionization parameter (Q) and Z (left) by *detecting* changes in [NeIII]/[OII] and [OIII/Hb] ratios, shown by a MAPPINGS model of a z=6 L* galaxy (top). CEERS observes all four lines for ~250 galaxies over 2 < z < 9.

Table 1: #Galaxies Observed by CEERS NIRSpec

	All z	6 < z < 9	3 < z < 6	1 < z < 3
R~1000 (6 pointings)	330	32	97	161
R~100 (4 pointings)	299 (150)	27 (21)	82 (57)	150 (55)

*** Numbers in parentheses are those covered at both R~100 and ~1000**

Science Goal #3

- CEERS will unveil high-resolution rest-optical morphologies for modestly-high redshift galaxies, and high-resolution imaging in the PAH/hot-dust continuum for galaxies at moderate redshifts.

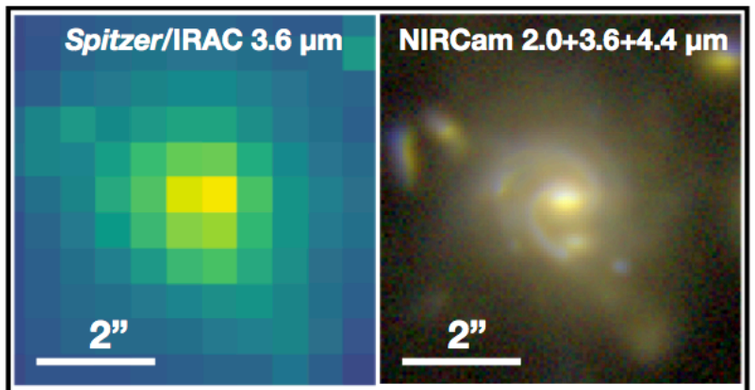


Figure 5: Simulated IRAC (left) and NIRCam (right) images of a z~2 galaxy, highlighting CEERS' ability to probe rest-optical sub-structure.

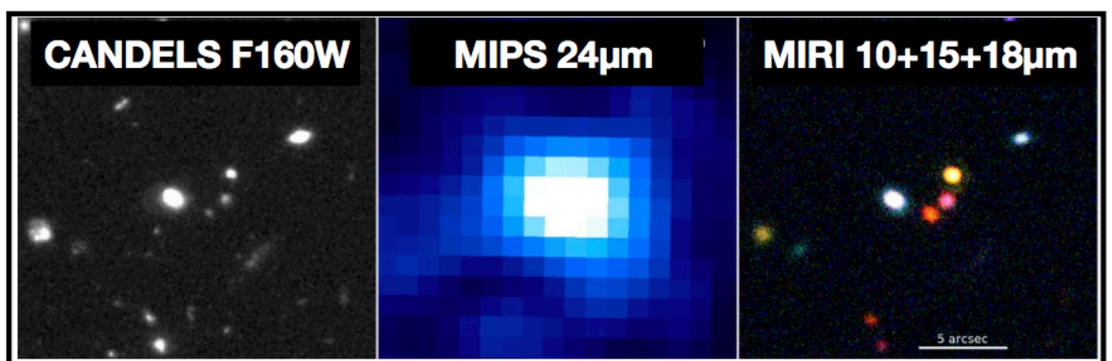
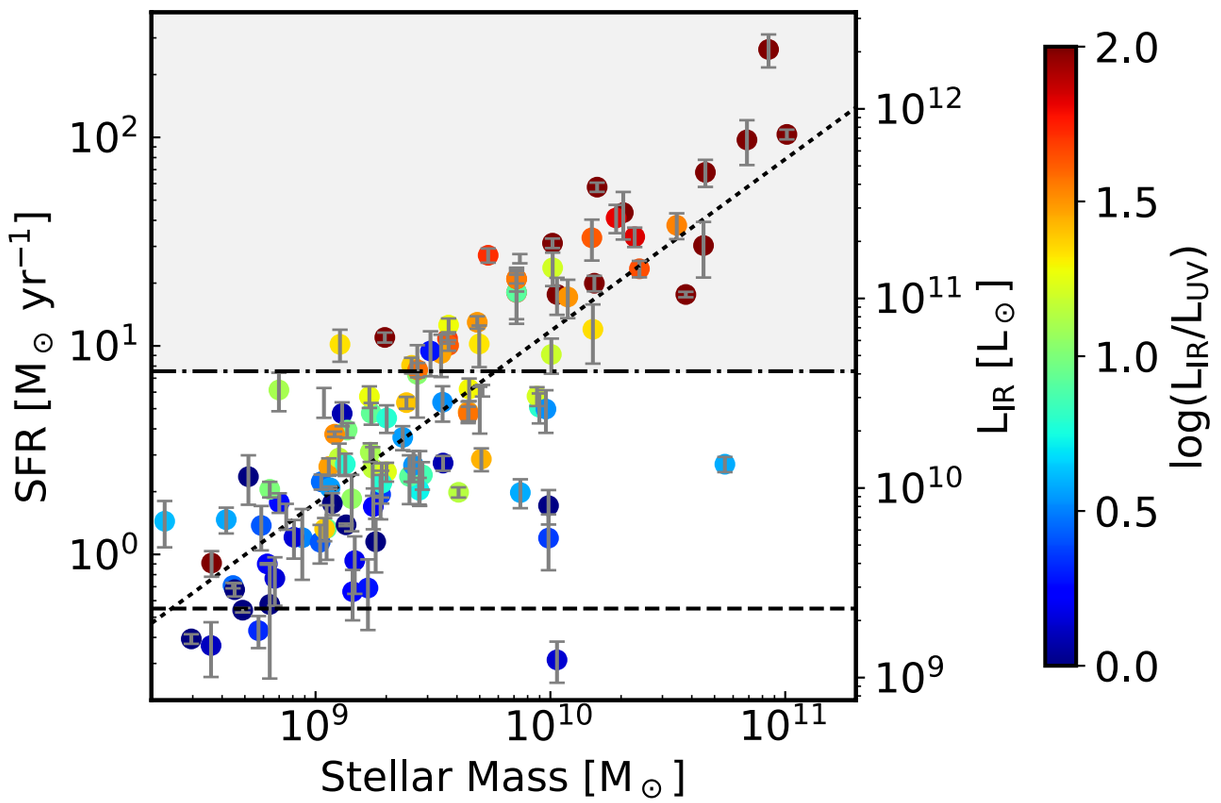
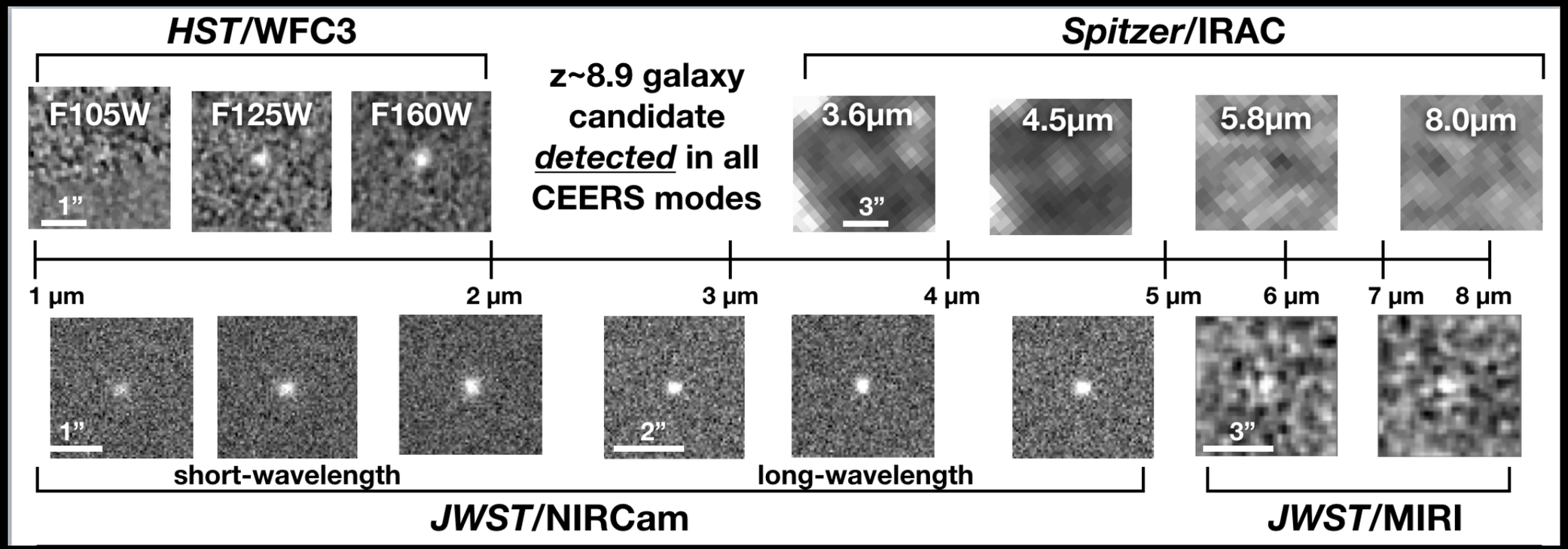


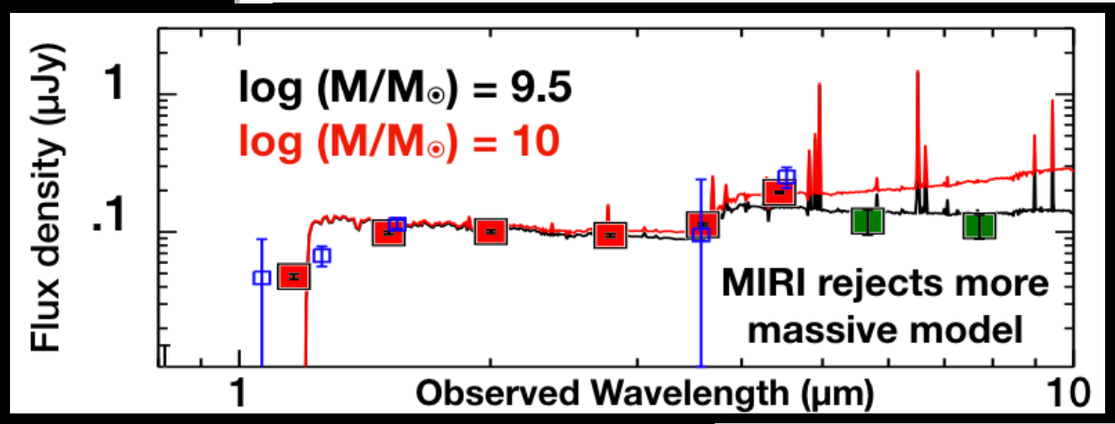
Figure 6: *HST*/WFC3, *Spitzer*/MIPS, and mock CEERS MIRI images of part of the EGS. CEERS goes 1 dex deeper than previous MIPS data.

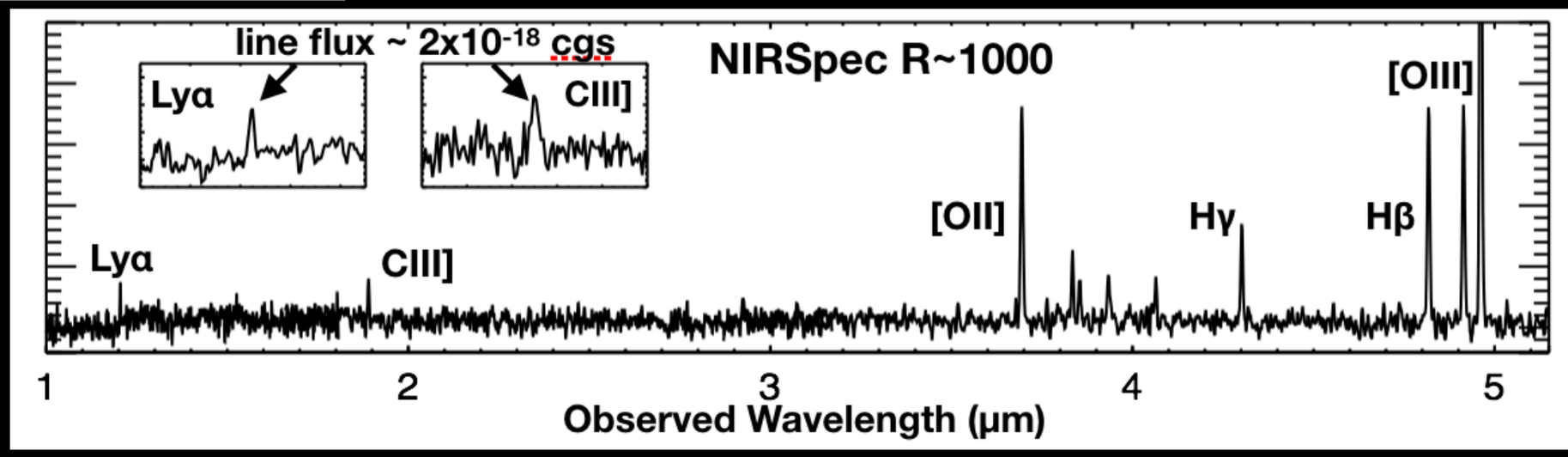
M* vs. SFR from our MIRI simulations. CEERS goes 1 dex deeper than MIPS/FIDEL.



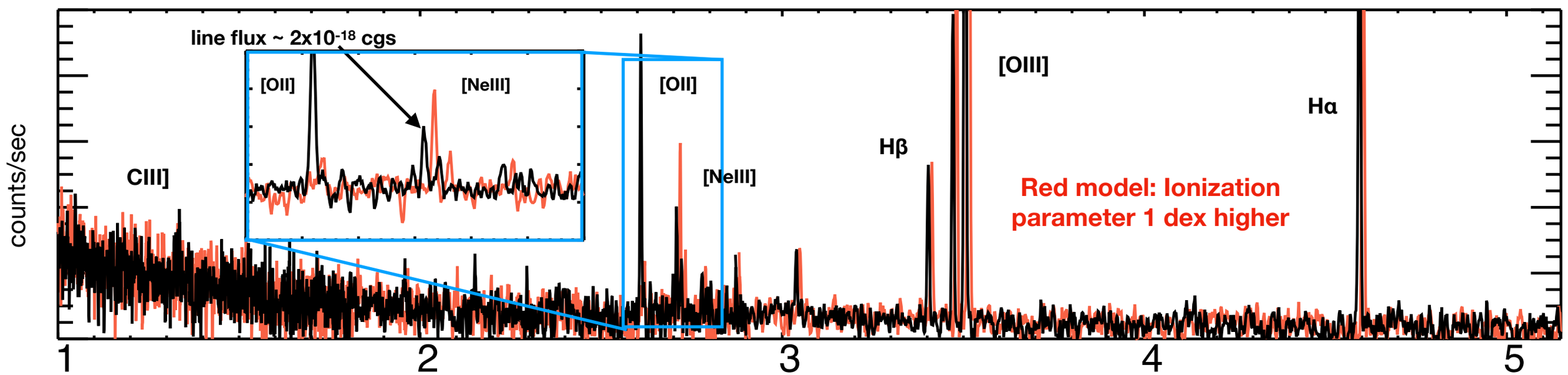
Example z~9 Observation

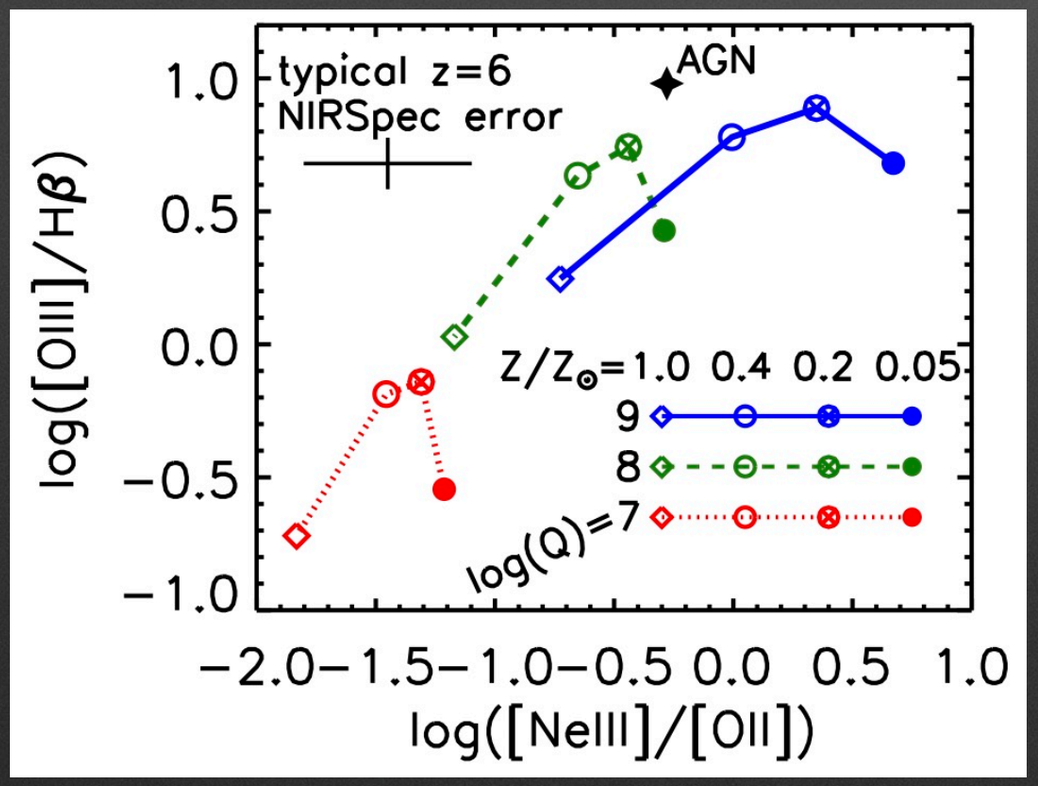






Example z~6 Observation





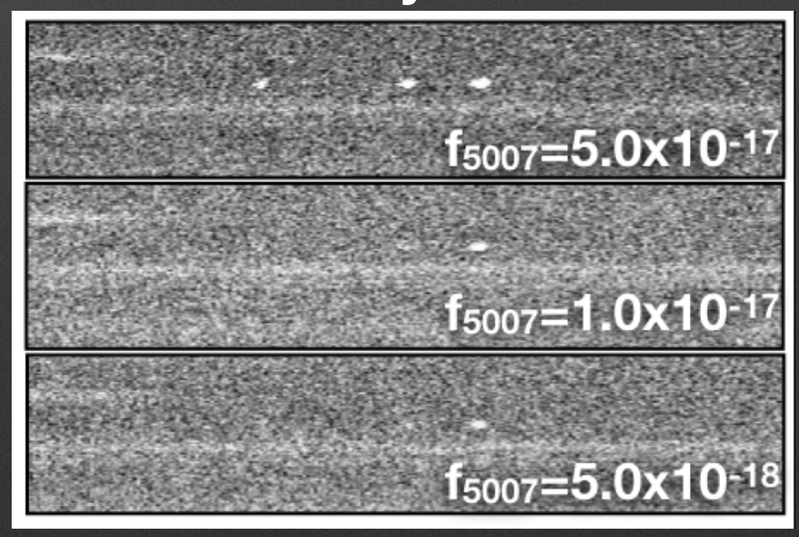
CEERS NIRSpec will measure changes in ionization parameter (Q) and Z (left) by *detecting* changes in [NeIII]/[OII] and [OIII/Hb] ratios, shown by a MAPPINGS model of a z=6 L* galaxy (top). CEERS observes all four lines for ~250 galaxies over $2 < z < 9$.

NIRCam Grism

- We included a NIRCam grism component to:
  - Allow direct measures of slit-losses
  - Demonstrate this is a mode for science, and specifically compare to NIRSpec R~100 and R~1000

- Perform a blind search for emission lines at high-z.
  - We expect ~50 [OIII] lines at 5.3 < z < 7, almost all from galaxies un-detected in CANDELS.
    - Also sensitive to Hα and [OII] at lower and higher redshift.

Simulation by Nor Pirzkal



1245s F356W grism integration @ z=6

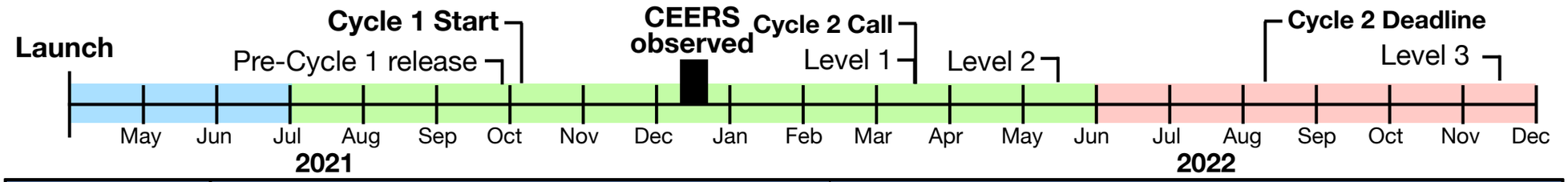
Deliverables

Notables:

- Updated HST mosaics & catalogs pre-launch Also will communicate to community, including blog, and "CEERS briefings"
- v0.5 products 3 months after data acquisition
- v1 products and catalogs 5-6 months after data acquisition
- Final release, including slit-loss analysis, ~11-12 months after acquisition

Table 3: CEERS Analysis Plan and Community Data Release Calendar

Assumes nominal Cycle 1 start of Oct 2021 and CEERS observations in Dec 2021; all data releases will shift commensurate with any observation delay



Data Release	Spectroscopy (NIRSpec MSA and NIRCam grism)	Imaging (NIRCam and MIRI)
Pre-Cycle 1	Interface with STScI to finalize observing design (*Grogin, Dickinson, Kocevski, Finkelstein*). Build and release simulated data for all CEERS observations; use to master and optimize data reduction pipelines (*all STScI Co-I's, Dickinson, Kartaltepe, Papovich, Somerville, Kewley, Finkelstein*). Produce and release improved *HST* ACS & WFC3 mosaics and catalogs (*Dickinson, Koekemoer, Finkelstein*). Design CEERS website and data interface; begin blog (*Finkelstein*). Participate in STScI briefings (*Finkelstein, Dickinson, Papovich, STScI Co-I's*), and CEERS-led briefings at predominantly underrepresented minority-serving institutions across US (*all Co-I's*).	
Level 1	**v0.5 Reduced 2D and 1D Spectra** *NIRSpec: Dickinson, Kartaltepe, Lotz & Ferguson* NIRCam Grism: *Pirzkal, Finkelstein & Trump*	**v0.5 Image mosaics** *NIRCam: Koekemoer & Finkelstein* MIRI: *Papovich & Perez-Gonzalez*
Level 2	1) v1 Reduced 2D and 1D Spectra 2) v1 Spectroscopy cat (line fluxes and spec-z): *Dickinson, Kartaltepe, Trump, Pentericci, Ravindranath, Pirzkal, Finkelstein*	1) v1 Image mosaics 2) v1 PSF-Matched Photometry cats: *HST*+NIRCam, MIRI: *Finkelstein, Ferguson, Papovich, Grazian, Perez-Gonzalez* 3) Release sample of z>9 candidates: *Finkelstein+team*
Level 3	1) v2 Reduced 2D and 1D Spectra 2) Publish v2 Spectroscopic Catalog *Dickinson, Kartaltepe, Trump, Pentericci* 3) Publication of NIRSpec slit-loss and MSA vs. grism scientific efficiency analysis: *Dickinson, Finkelstein, Pirzkal, Ferguson*	1) v2 Image mosaics 2) v2 EGS multi-wavelength cats (incl, photo-z, M*, SFR): *Finkelstein, Ferguson, Papovich, Grazian, Perez-Gonzalez, Wilkins, Pirzkal* 3) *F200W* Morphology catalogs (e.g., R_e, n_{Sersic}, Gini, M20): *Lotz, Kartaltepe, Kocevski*

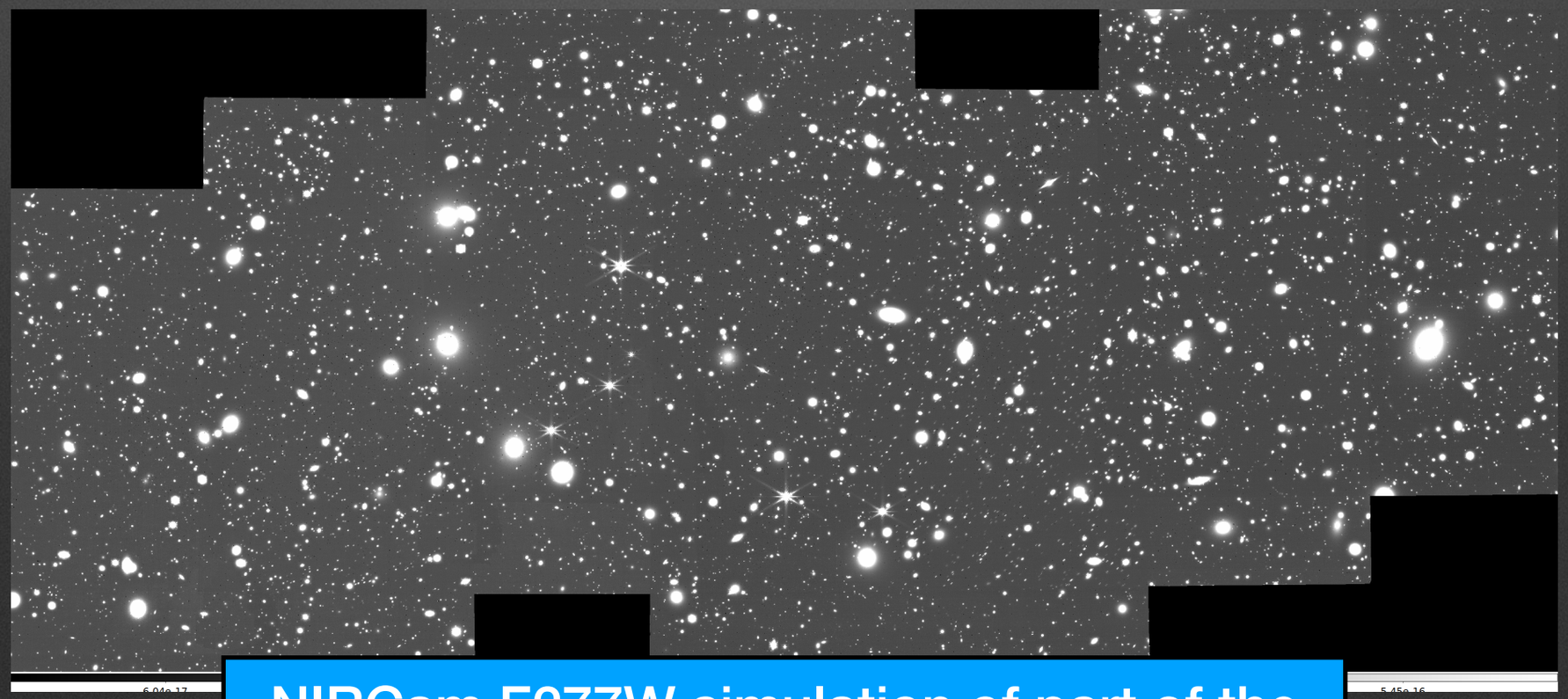
Names given after each task denote the Investigator(s) who will lead each aspect, in collaboration with postdocs, students and/or RIAs under their supervision.

NB: Timeline needs to be updated for new launch date

Simulations

- We are now working to simulate data from all of our observing modes. These will be released to the community.

  - Release will include: raw data, reduced data, and notebooks showing how we ran the data reduction pipeline (as well as any pipeline modifications).



NIRCam F277W simulation of part of the CEERS field, led by Micaela Bagley (UT)

Summary

- CEERS is designed to provide data to nearly all blank-field investigations into the 0.5 < z < 12 universe.
    - It will include data representative of medium-depth *JWST* surveys in nearly all modes.
        - 1-5 μm imaging w/ NIRCam, 5-20 μm imaging w/ MIRI
        - 1-5 μm R~100 and R~1000 spectroscopy with NIRSpec
        - 3-4 μm grism spectroscopy with NIRCam
- The CEERS team is dedicated to a rapid release of high quality reduced data products and catalogs.

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