Spectroscopy with the James Webb Space Telescope

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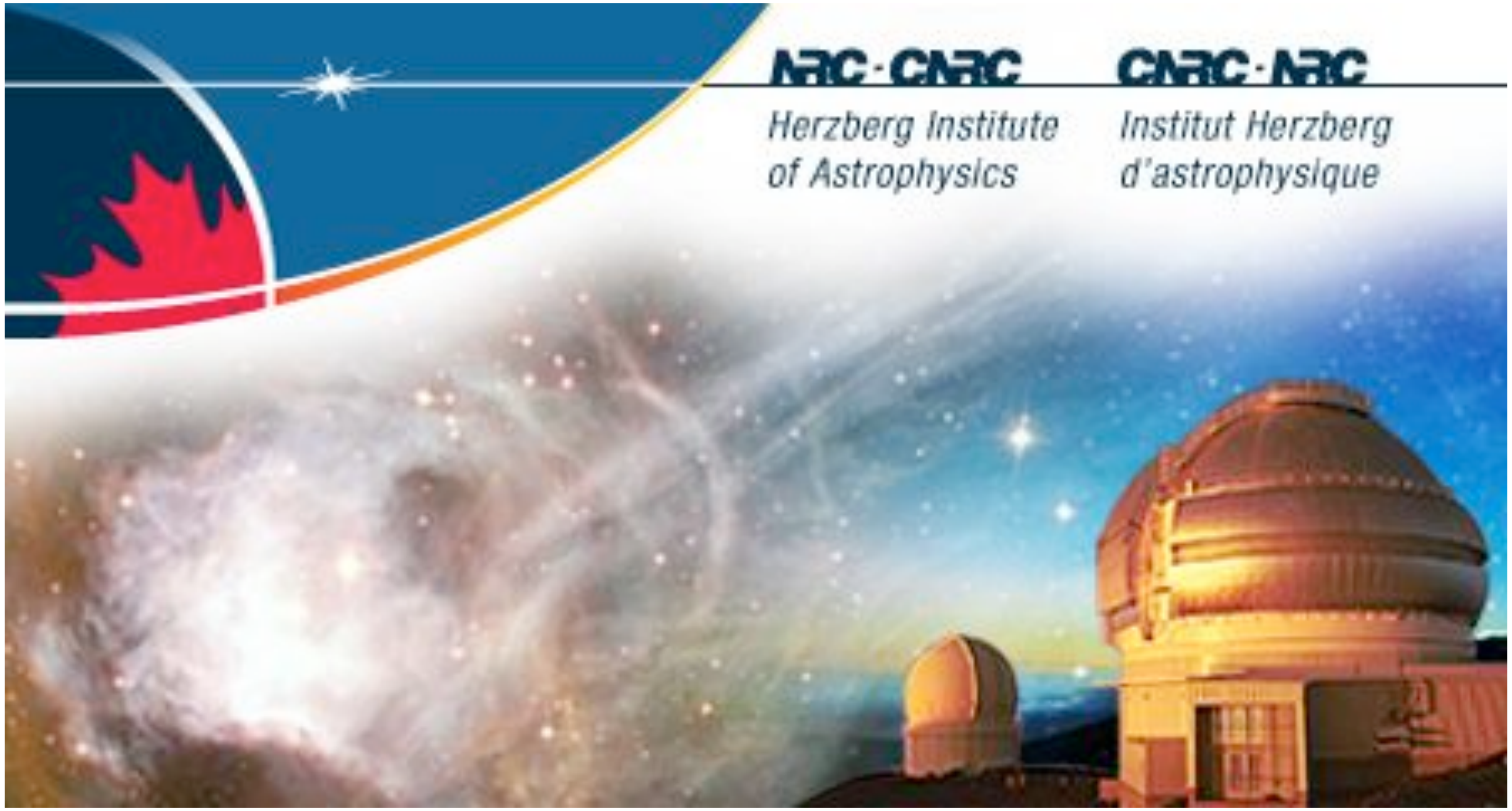
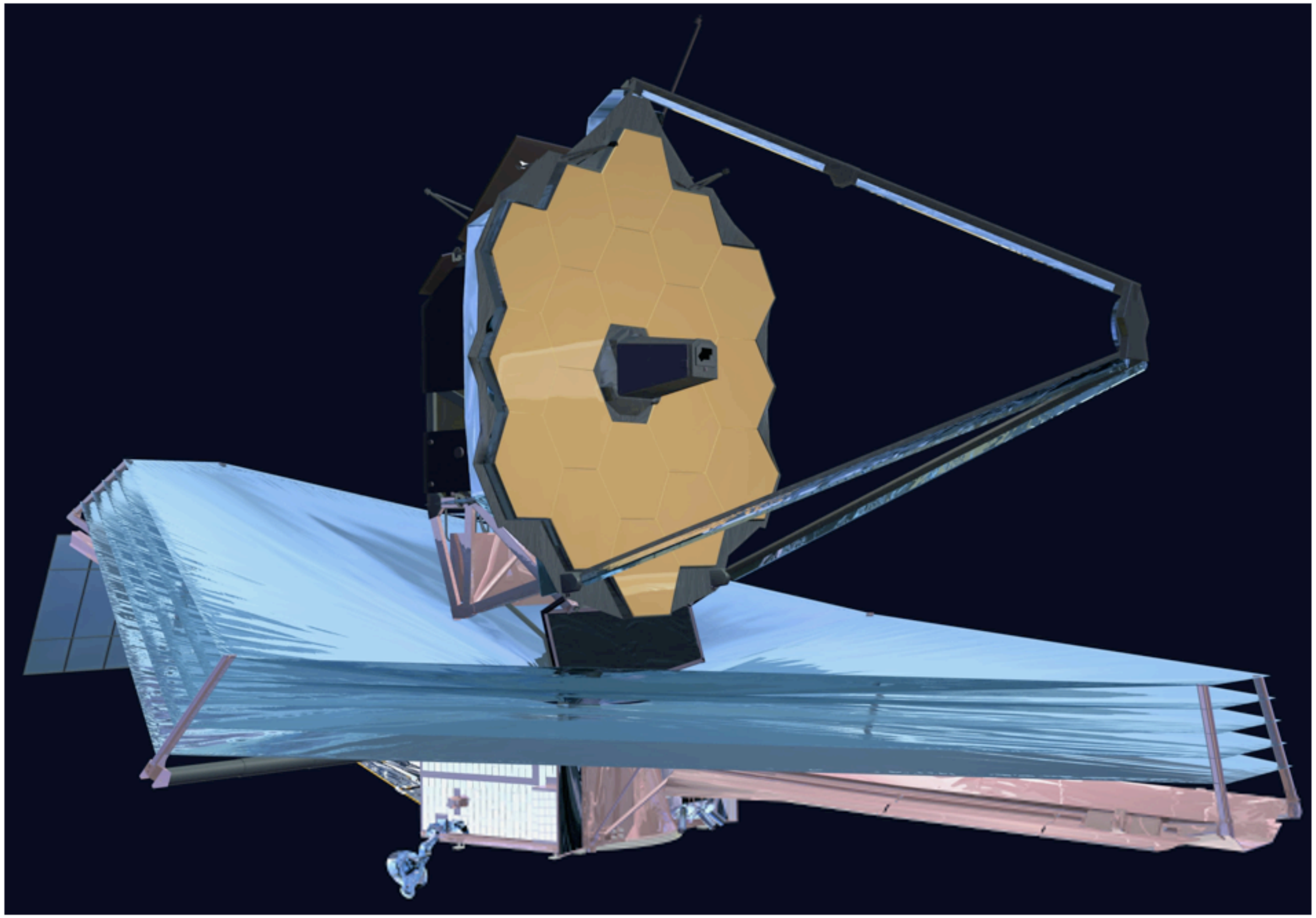


The James Webb Space Telescope (JWST)

Joint project of NASA, ESA and CSA

- 6.5m primary mirror
- Orbit at Sun-Earth Lagrange point L2
- Cold (T<50 K), infrared-optimised
- Wavelengths of operation 0.6-29 microns
- Launch scheduled for 2013 (Ariane 5)

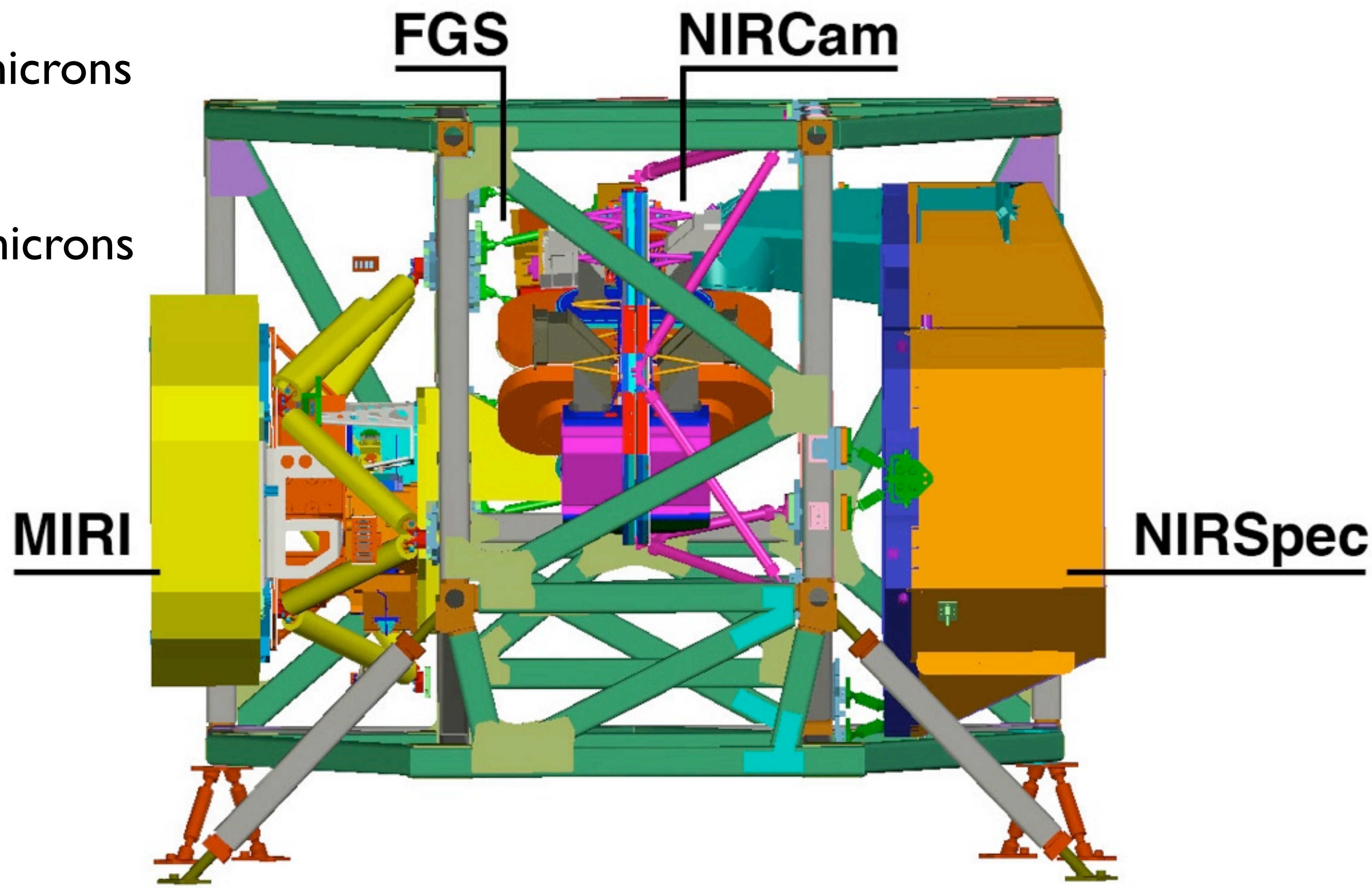


The James Webb Space Telescope (JWST)

4 science instruments:

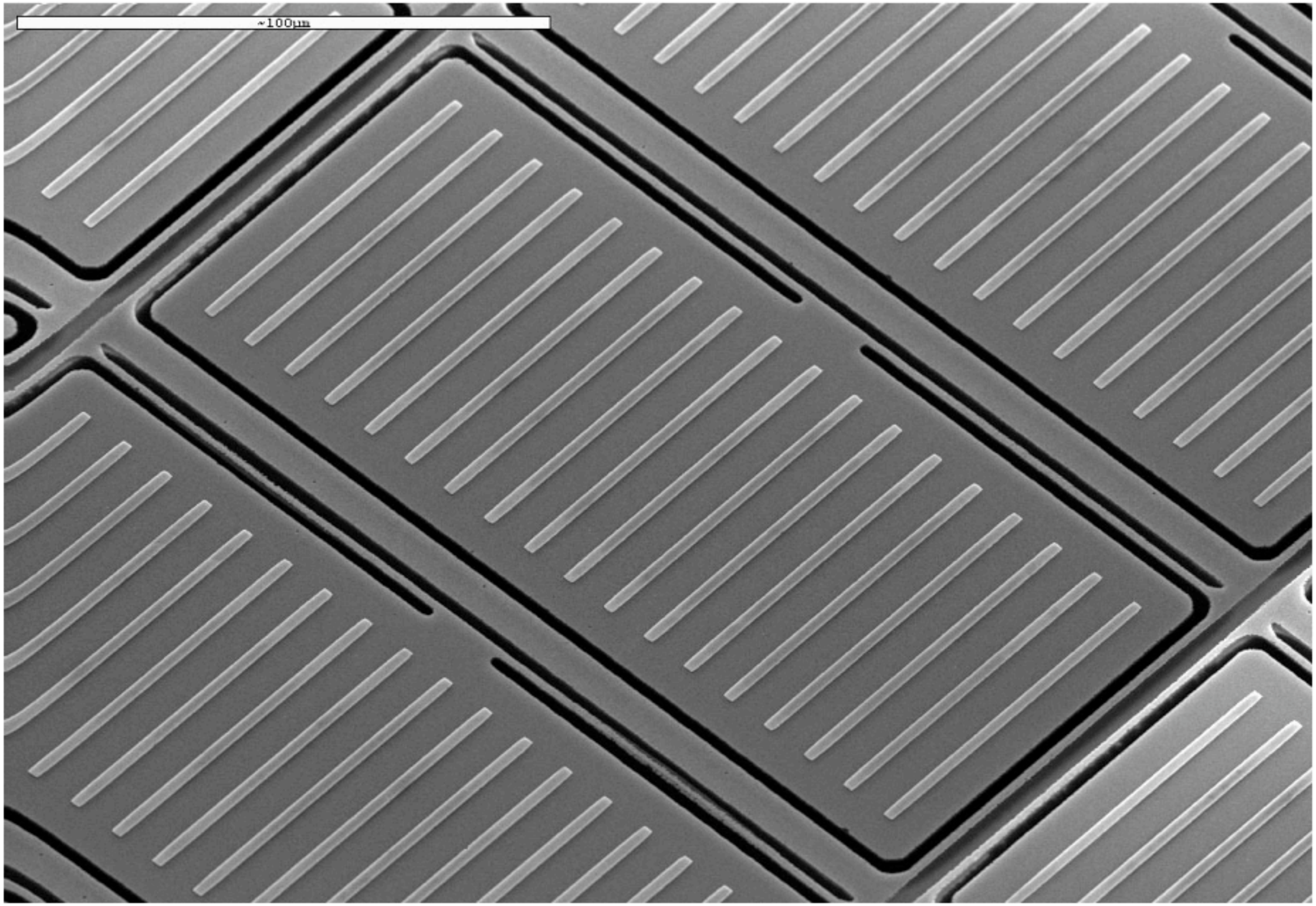
NIRCam
NIRSpec } < 5 microns
TFI / FGS

MIRI > 5 microns



NIRSpec

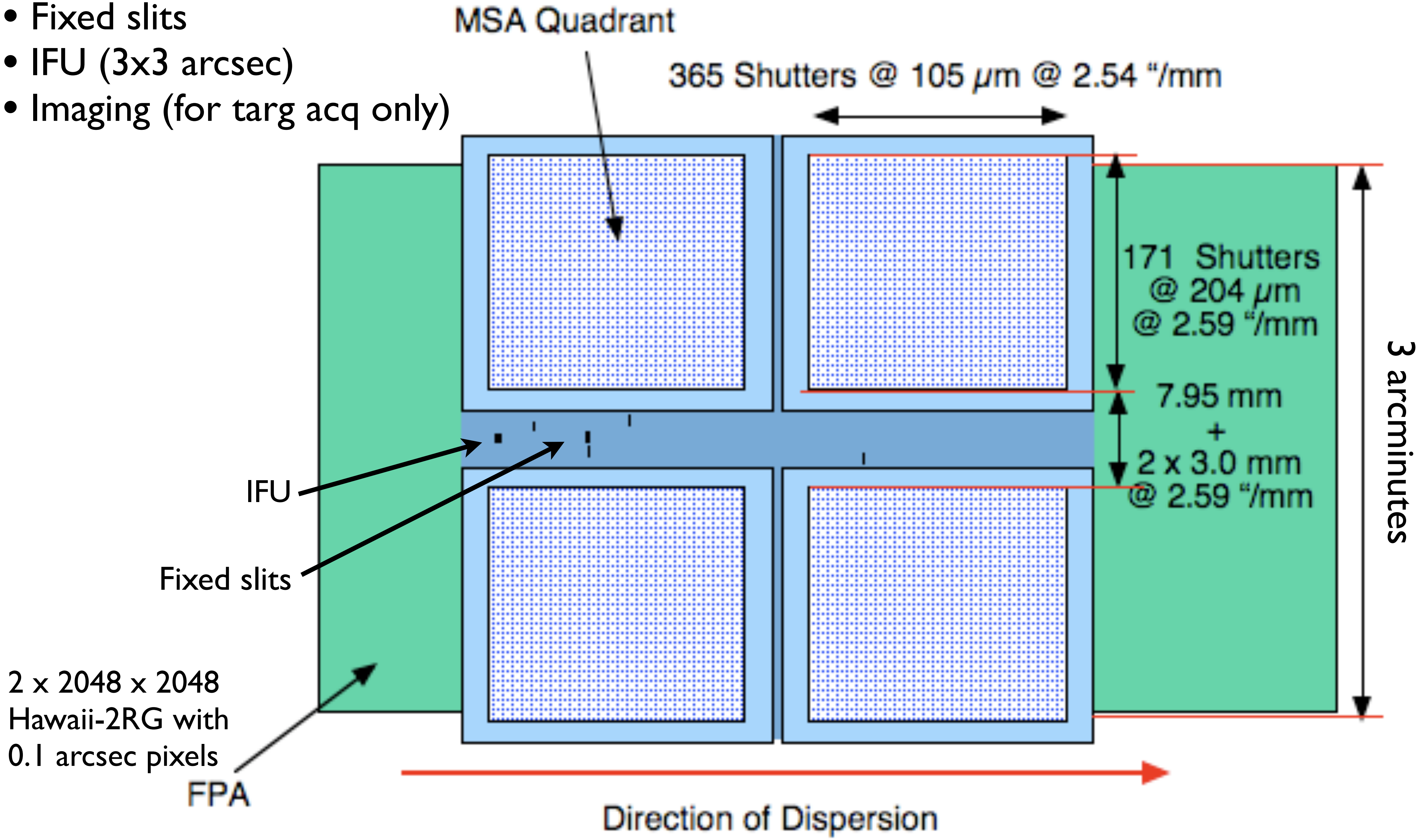
NIRSpec uses microshutter arrays to create spectroscopic masks



GSFC

NIRSpec

- 4 Microshutter arrays (MSA) - total of ~ 250 000 shutters
- Fixed slits
- IFU (3x3 arcsec)
- Imaging (for targ acq only)



NIRSpec

NIRSpec optimized for low- and medium-spectral resolution due to very low background:

- R=100 prism covers 0.8-5 microns in one shot
- R=1000 grating - 3 settings: 0.8-1.8, 1.7-3, 2.9-5 microns
- R=2700 grating - 3 settings: 0.8-1.8, 1.7-3, 2.9-5 microns

MSAs give NIRSpec a unique multi-object spectroscopy capability

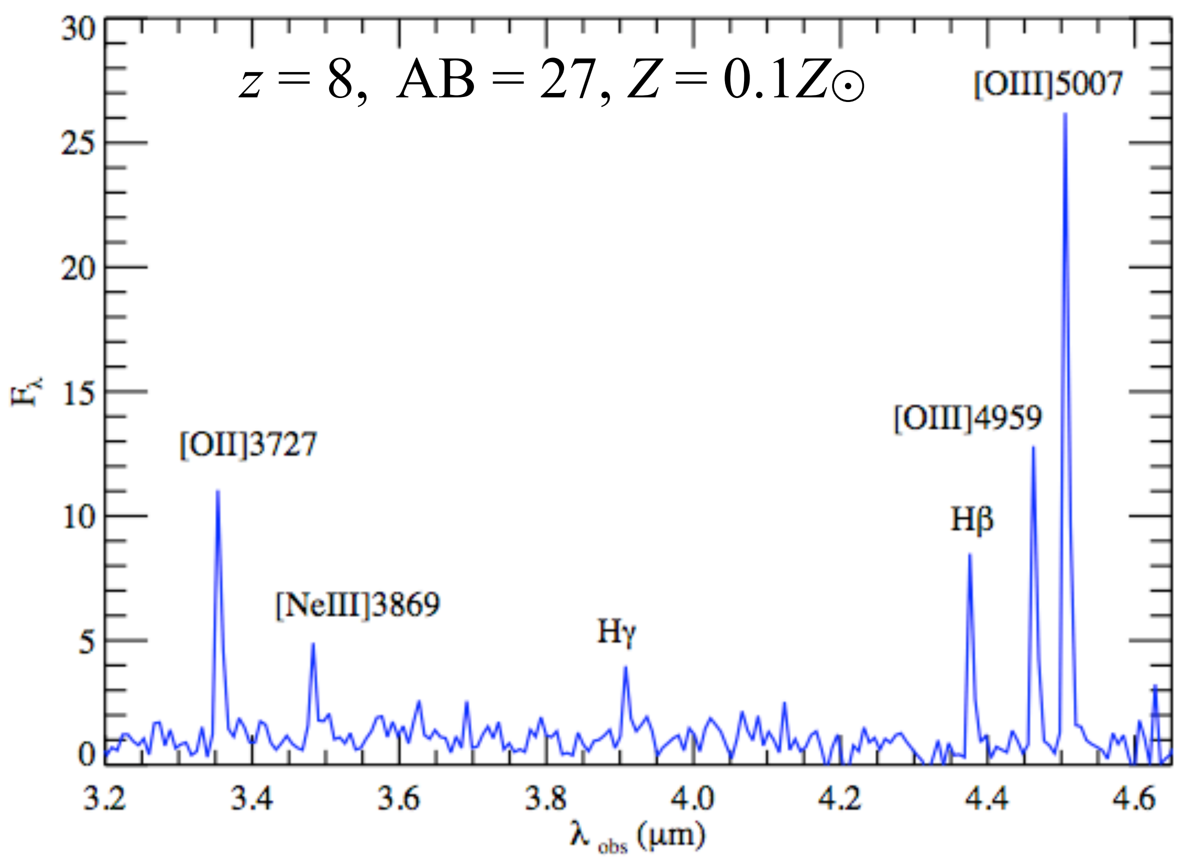
Can get simultaneous spectra for over 100 objects over 3 x 3 arcmin field.

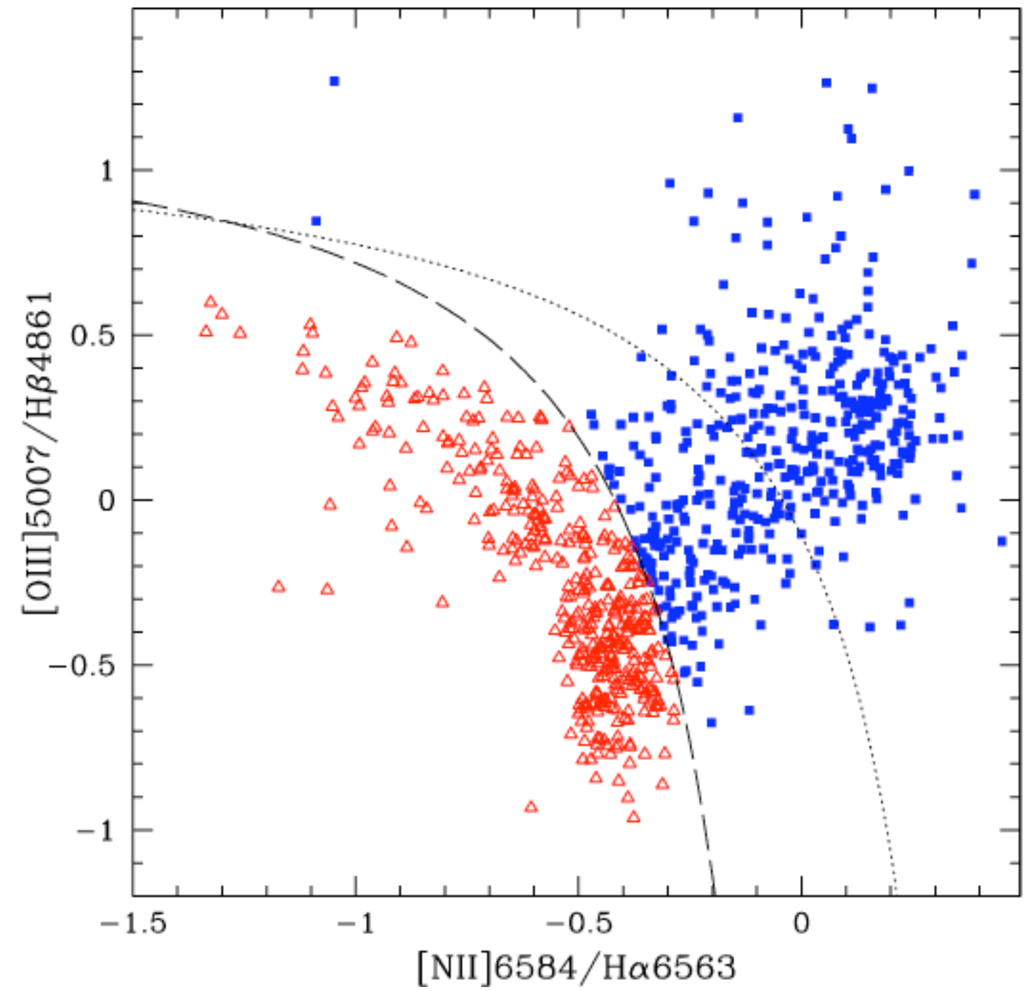
Long exposures (100ks) will enable spectra of ultra-faint (AB~29) objects.

Star formation and assembly of z>2 galaxies

High quality spectra can be fit by population synthesis galaxy models to yield the star formation history, dust reddening, stellar mass and dynamical mass.

R. Maiolino et al.: *JWST*





By measuring the ratios of emission lines for starbursts, NIRSpec can determine the metallicity evolution of distant galaxies.

Can also use line ratios to separate AGN from star formation.

Deep Radio Surveys

Trace AGN and star formation activity back to early epochs.

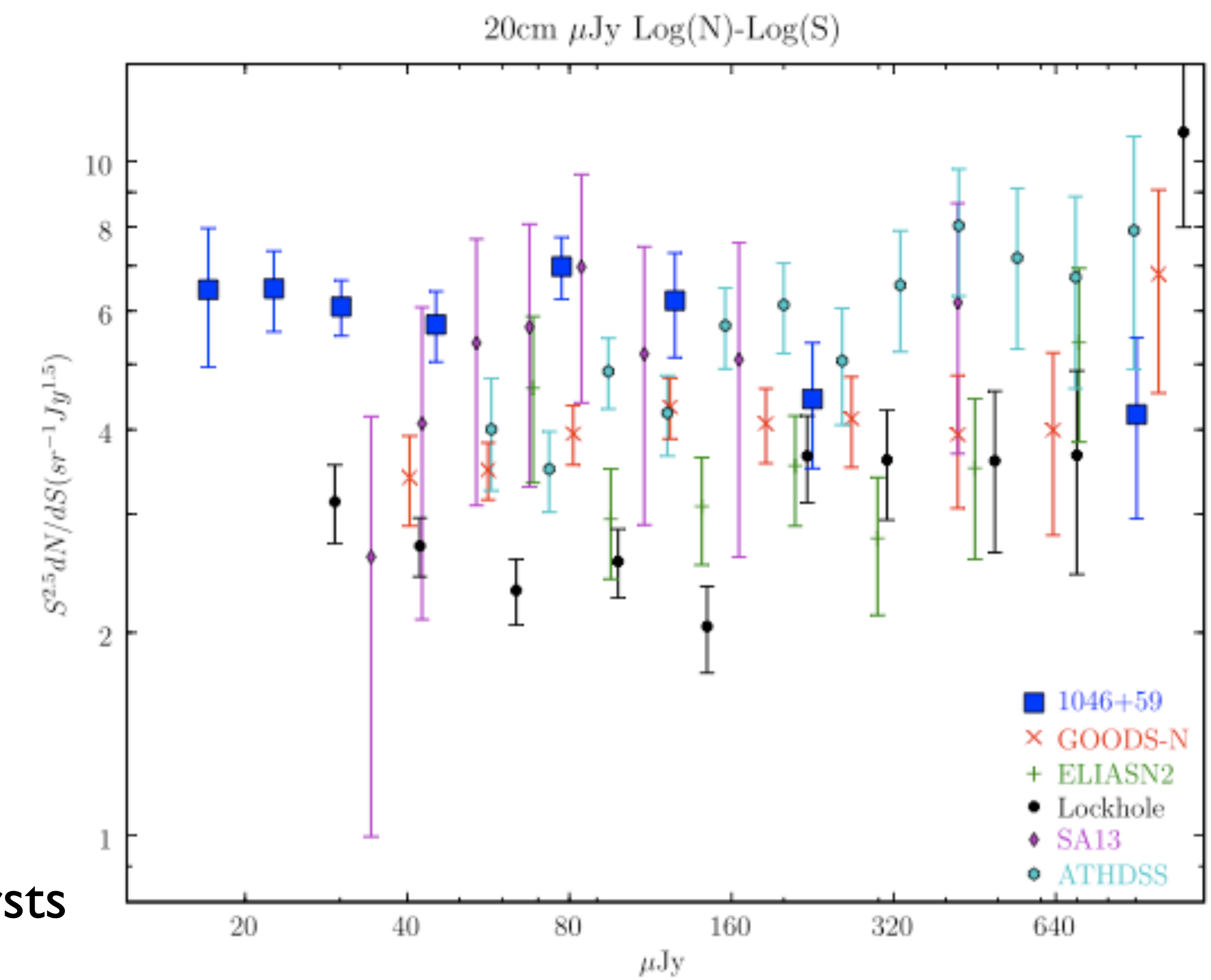
At a flux limit of 15 μJy (1.4 GHz), source counts show ~50 radio sources per NIRSpec FOV.

EVLA will go deeper.

What are these sources?

30 μJy sources have:

(i) flat(ter) spectral indices
(ii) optical/near-IR SEDs of starbursts
(iii) low X-ray flux for starbursts



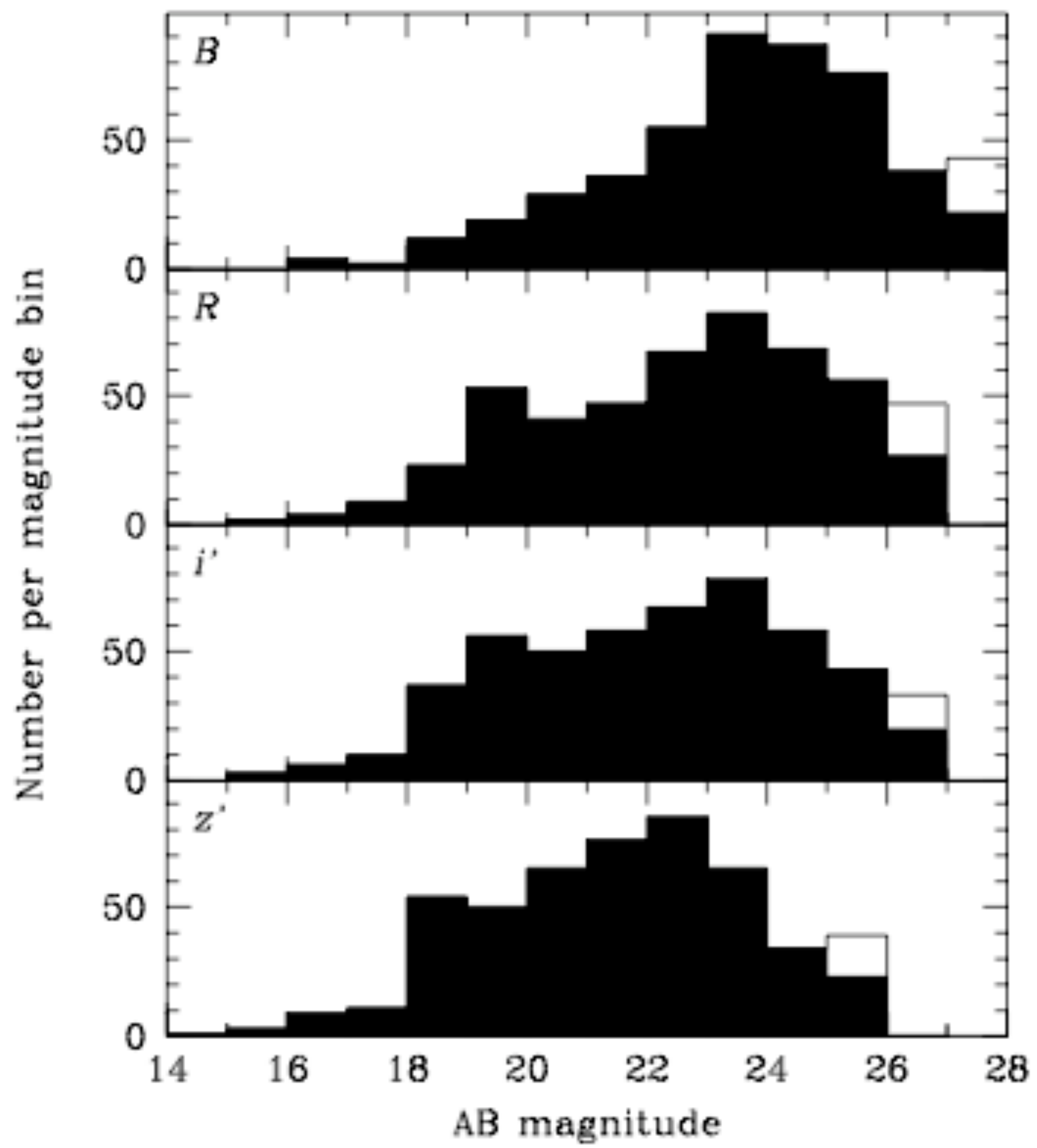
Owen & Morrison (2008)

Deep Radio Surveys

NIRSpec spectroscopy can provide:

- redshifts (lines/continuum)
- AGN activity
- star formation rate (lines/continuum)
- dust reddening
- stellar mass
- metallicity

Need to combine with deep mm, FIR, X-ray to fully understand sources



100 microJy SXDS VLA survey

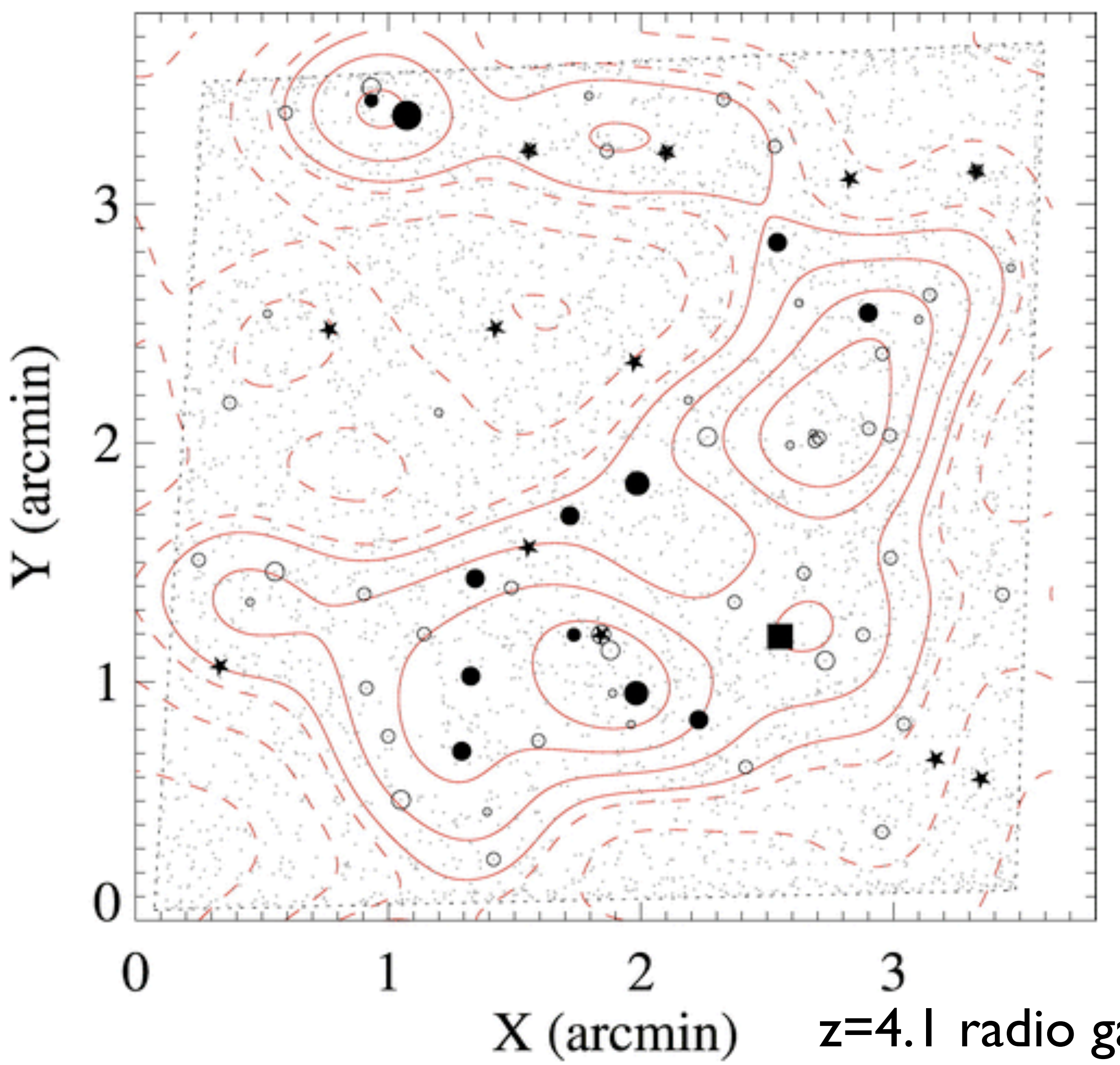
Simpson et al. (2006)

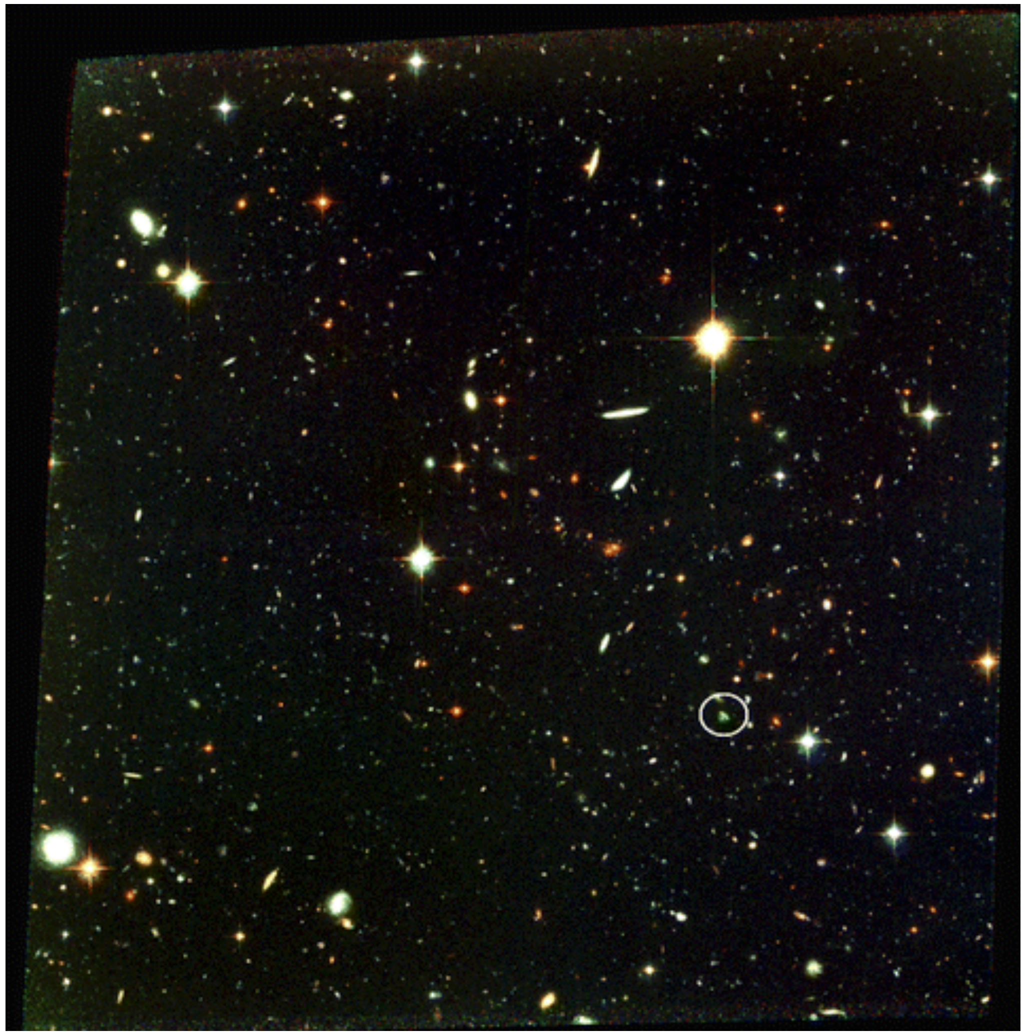
Radio-selected high-z proto-clusters

Powerful radio galaxies reside in high mass galaxies at all redshifts.

Some also have been found in overdensities, possible protoclusters.

NIRSpec could study ~ a hundred galaxy cluster candidates per observation.





z=4.1 radio galaxy TN J1338-1942 Overzier et al. (2008)

Mapping stars and ionized gas in high-z galaxies

High-resolution CO observation of z=6.42 SDSS quasar with the VLA

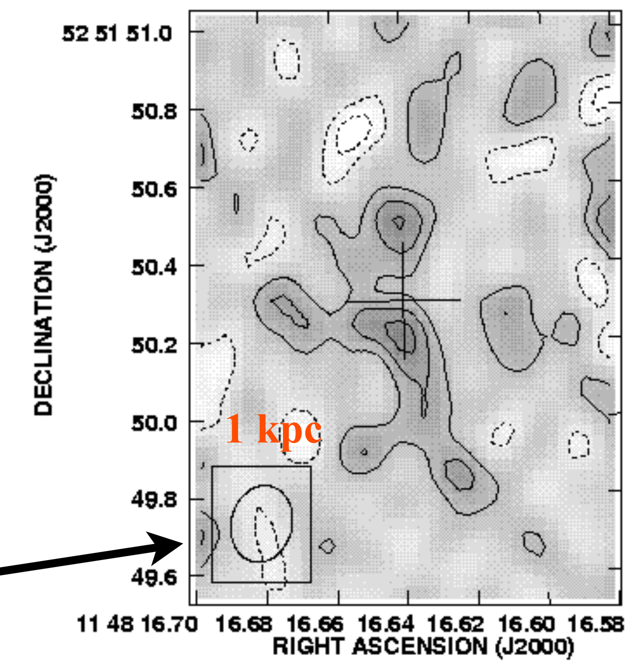
CO line width of 280 km/s

Dynamical mass within central 2 kpc: $\sim 10^{10}\,M_\odot$

Molecular gas mass $\sim 10^{10}\,M_\odot$

similar resolution to JWST

VLA CO 3–2 map

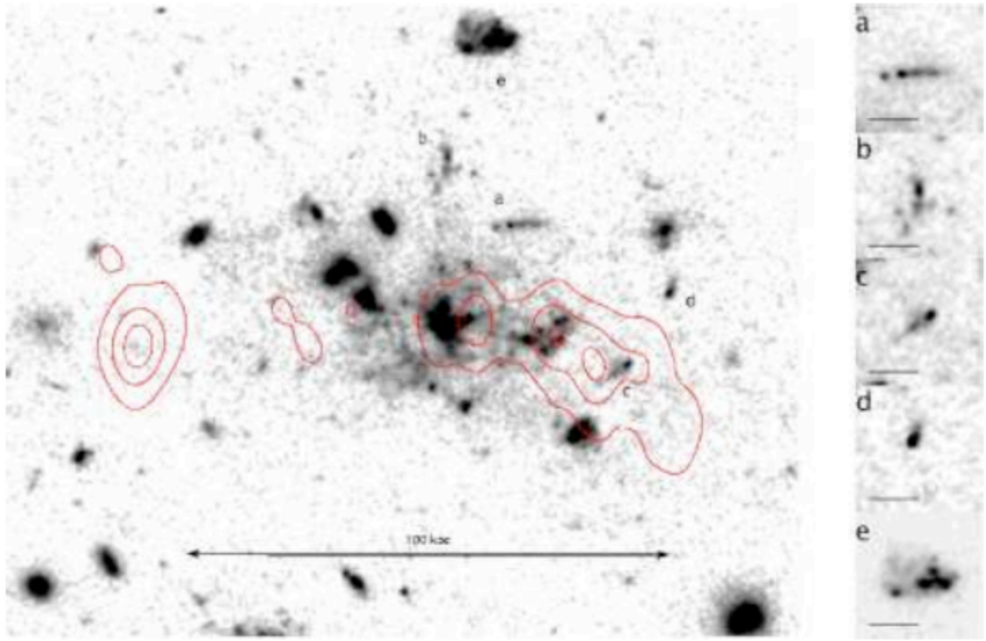


Walter et al. (2004)

Use NIRSpec IFU, EVLA and ALMA to map the host galaxy properties to compare:

- stars
- ionized gas
- dust
- molecular gas (density)

z=2.2 radio galaxy MRC 1138-262



Overzier et al. (2007)

Conclusions

JWST set for launch in 2013 - not long after completion of first large multi-frequency EVLA surveys.

NIRSpec will provide a huge gain in sensitivity for near-IR spectroscopy of small, faint sources.

Versatile instrument with MSA, fixed slits and IFU.

Multiplexing capability will allow for programs with hundreds (thousands) of spectroscopic redshifts of very faint sources.

High quality spectra to give not just redshifts, but information on galaxy star formation and AGN properties.