
# A Near-IR spectrograph to unlock the Universe beyond Habitable Worlds

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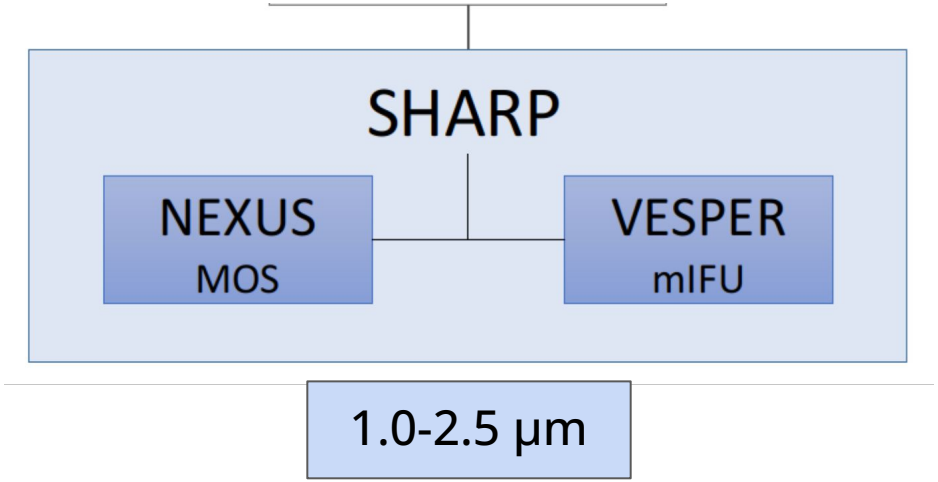
# What is SHARP

**SHARP** is a multi-object multi-mode NIR spectrograph designed to **exploit** the **high angular resolution** of new-generation telescopes.

NEXUS slitlets MOS
Configurable Slits




VESPER multi IFU
Modular system

**SHARP** exploits the capabilities of HWO probing the Universe **also** beyond Habitable Worlds

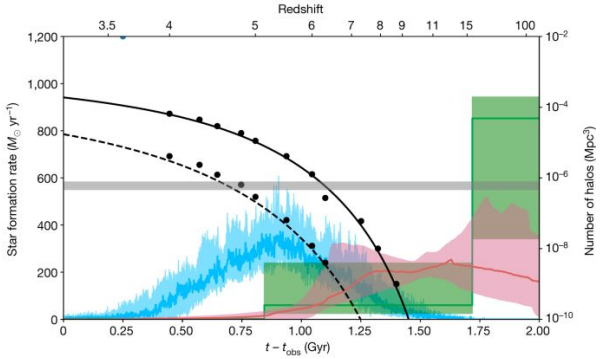
# SHARP Main Properties

| SHARP | NEXUS | VESPER |
|---|---|---|
| Spectral range | 1.0-2.5 μm | 1.2-2.4 μm |
| Multiplexing | up to 48 slits (1”.5 length) | 6 probes (1”.7x1”.5 each) |
| Field of View/Area probed | 1’.2 x 1’.2 | 12” x 70” (single module) |
| Pixel scale | ~35 mas | ~31 mas |
| Resolution $\lambda/\Delta\lambda$ | ~ 200, 2000, 6000 (0”.2 ref) | ~3000 |

# Why SHARP - Science in the 2040s...difficult to predict!

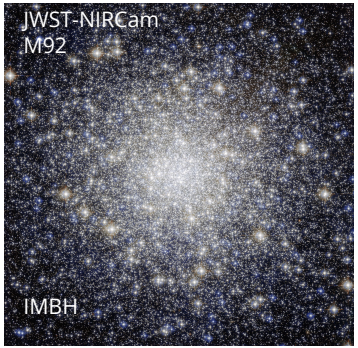
## JWST Heritage

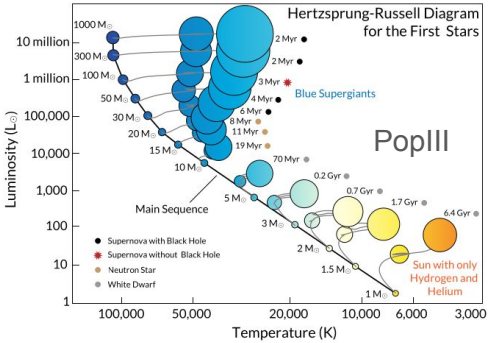
- **Inexplicably high star formation (SF) and fast quenching** in massive galaxies at z~2-5 and in galaxies at z~12-14 ? **Mapping SF regions.**
- **What is the DM fraction in high-z gal.?** Are they too many and too early for the DM haloes of the standard model ? **Measuring $\sigma_v$ and $\sigma_{rot}$ gal.**
- **"Where is"** the elusive **PopIII** of primordial stars ? **Searching for HeII.**
- **Do** Intermediate Massive (~$10^{3\text{-}4}$ $M_{sun}$) Black Holes (**IMBH**) **exist ? Mapping GCs.**




*Glazebrook+24*

Massive galaxies
Early galaxies



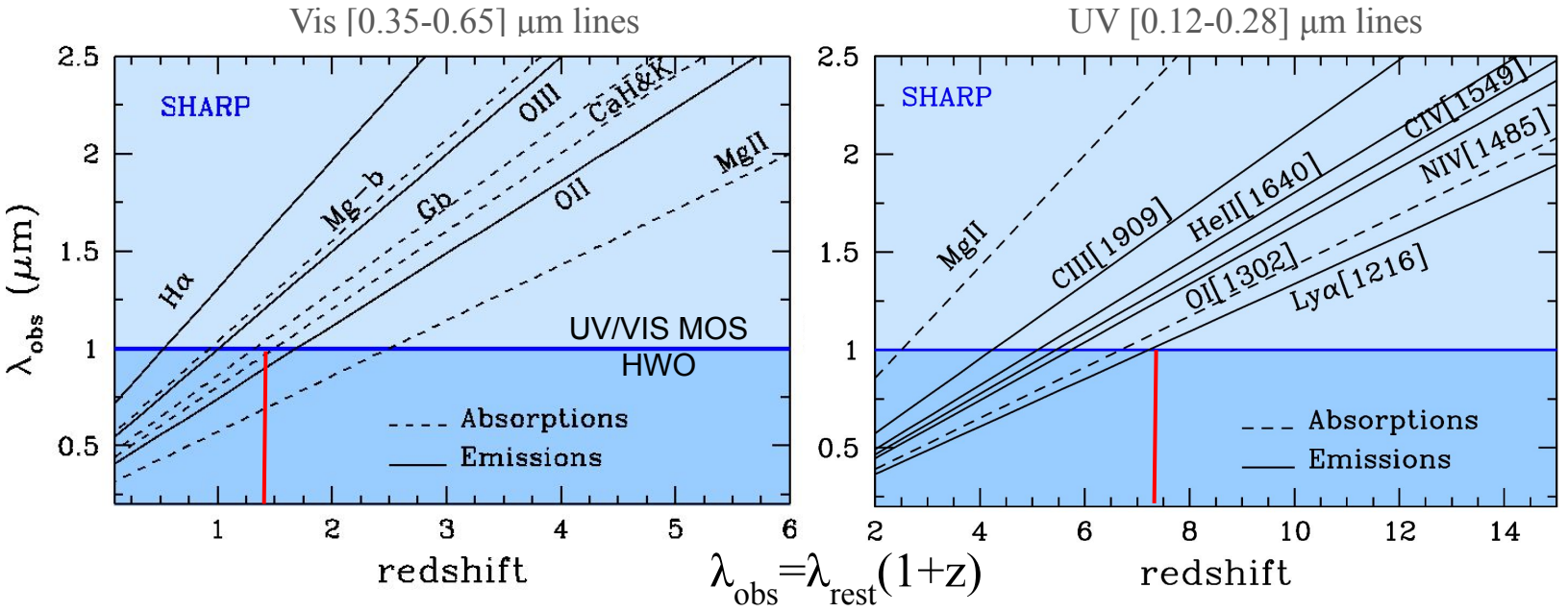




**Most of the fundamental information is stored in the spectra**

# Why NIR?

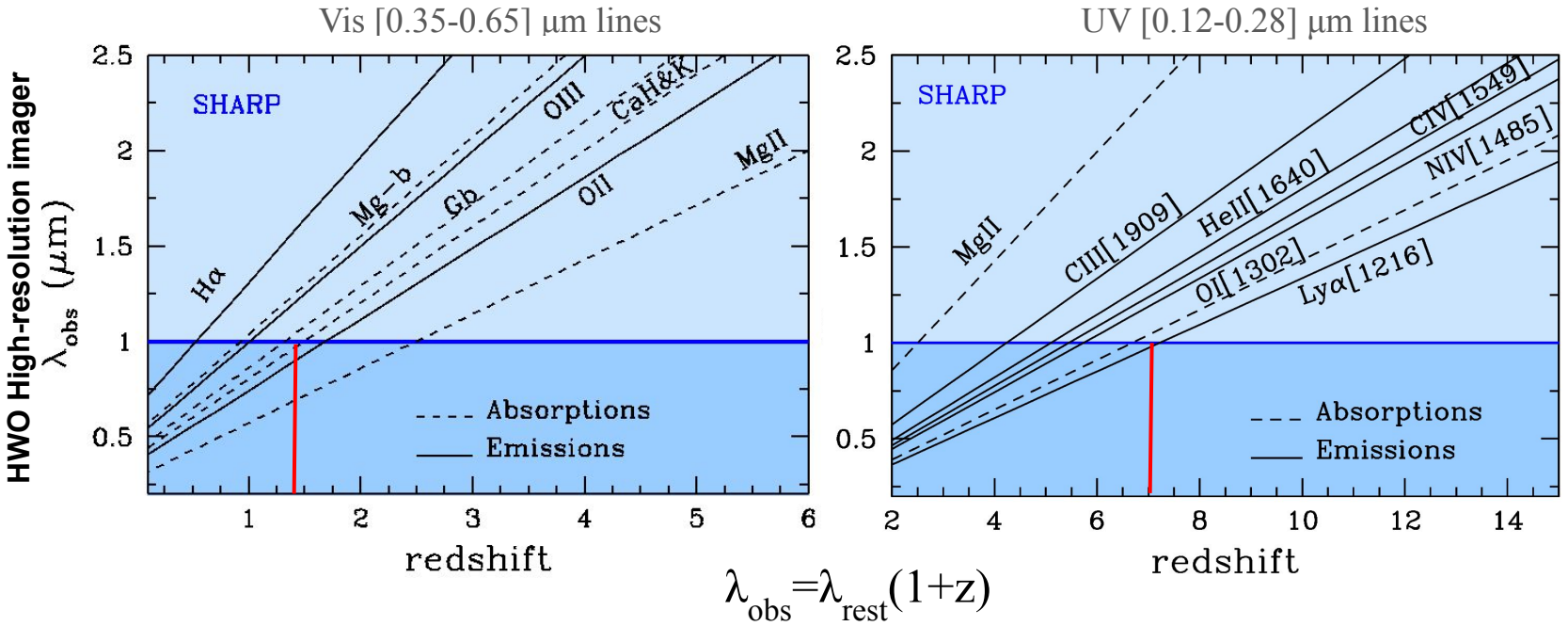
- Critical for detecting **water**, **organic** compounds**, icy** signatures small bodies/moons
- Essential for seeing **through the dust,** nearby star forming regions
- Necessary **to study galaxy properties** beyond z~1 **up to z~5**
- Necessary **to probe the Universe** beyond z~7 **up to z~20**

HWO High-resolution imager



# Why NIR?

## Necessary to follow up >2000 sources in an image of HWO-HRI



# Why ~30 mas angular resolution?

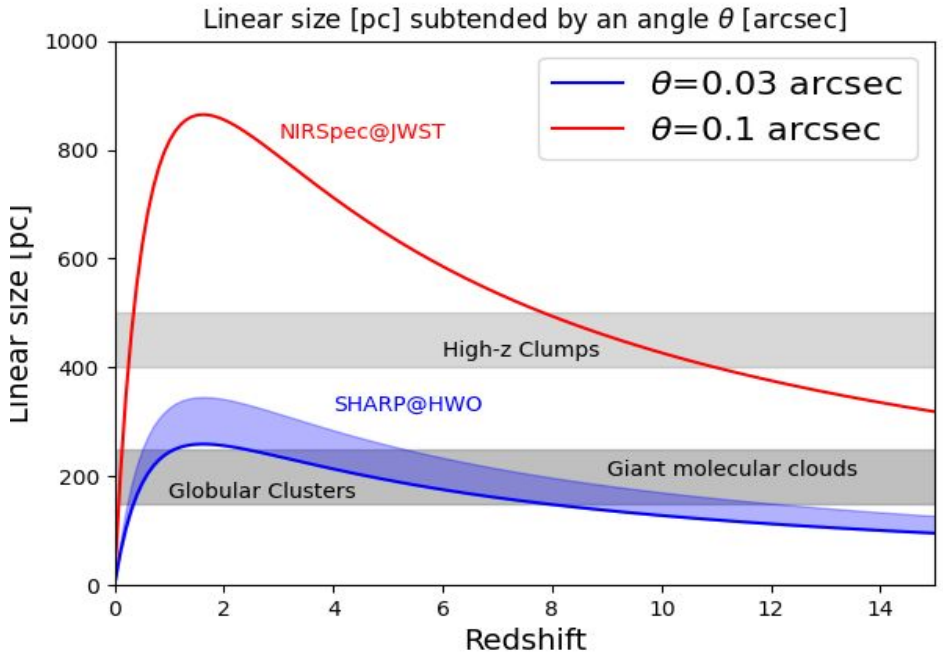
**~30 mas** sample sizes comparable to **Giant molecular gas clouds over the cosmic time**.

**Giant molecular gas clouds**
**~150-250 pc, up to $10^{6\text{-}7}$ $M_{sun}$**

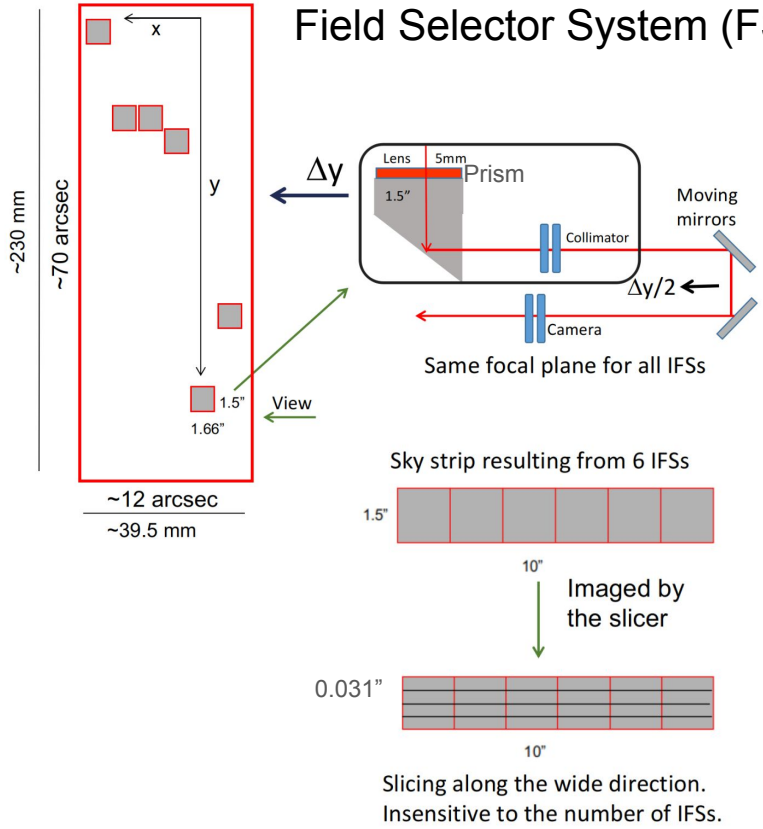
- Main star-forming units
- Main metal production units
- Galaxy rotation tracers ⇒ DM

**Are they the cradle of GCs ?**
**Are they the first PopIII systems ?**

Not resolved at any redshift by JWST

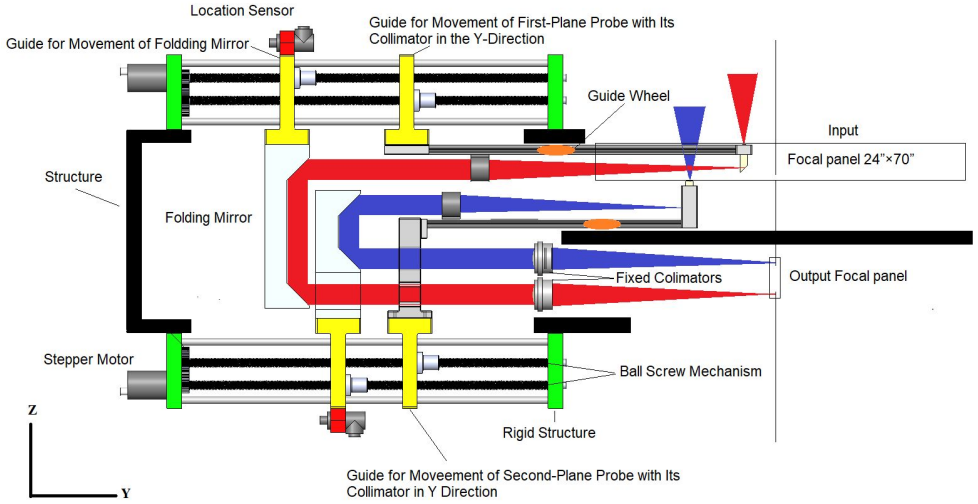


# VESPER the multi-IFU




**One module of VESPER** comprises

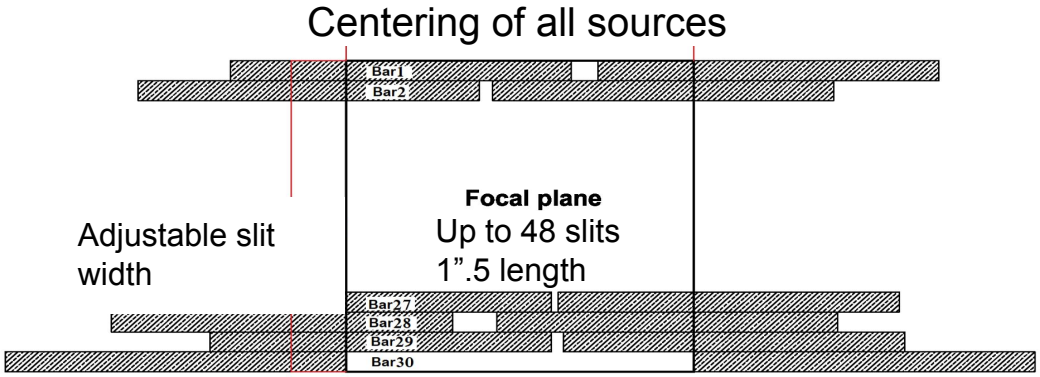
- 6 probes called Field Selector
- 1".7x1".5 each
- deployable over ~12"x70"

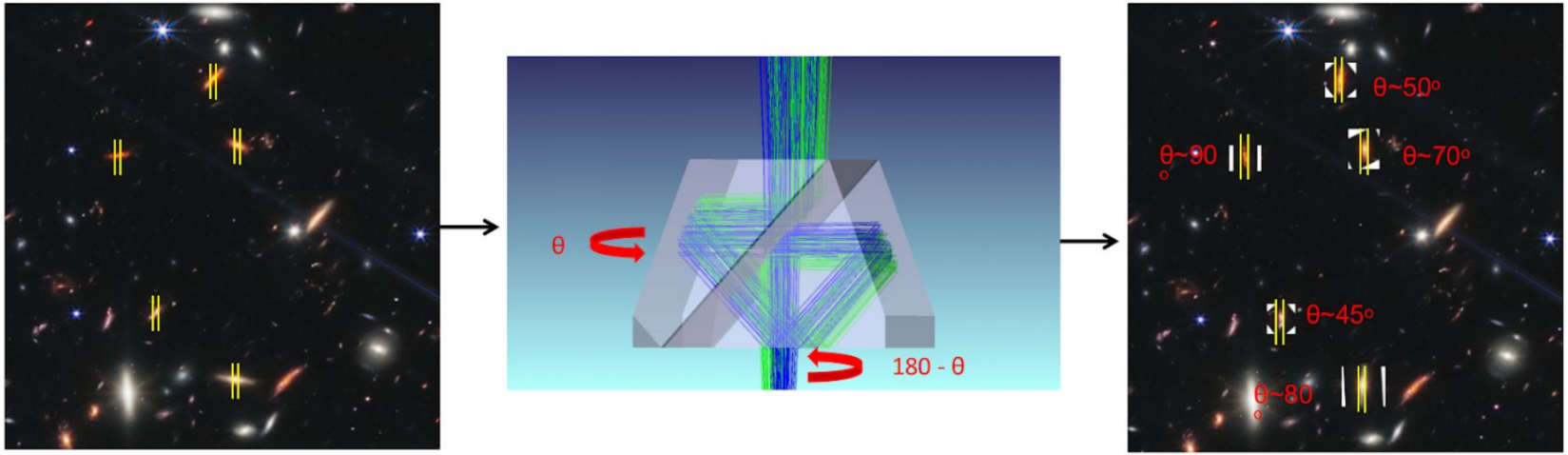


# NEXUS the multi-object

## Configurable Slit System (CSS)

- Slits fed by an **inversion prism** rotating by an arbitrary angle the subtended field

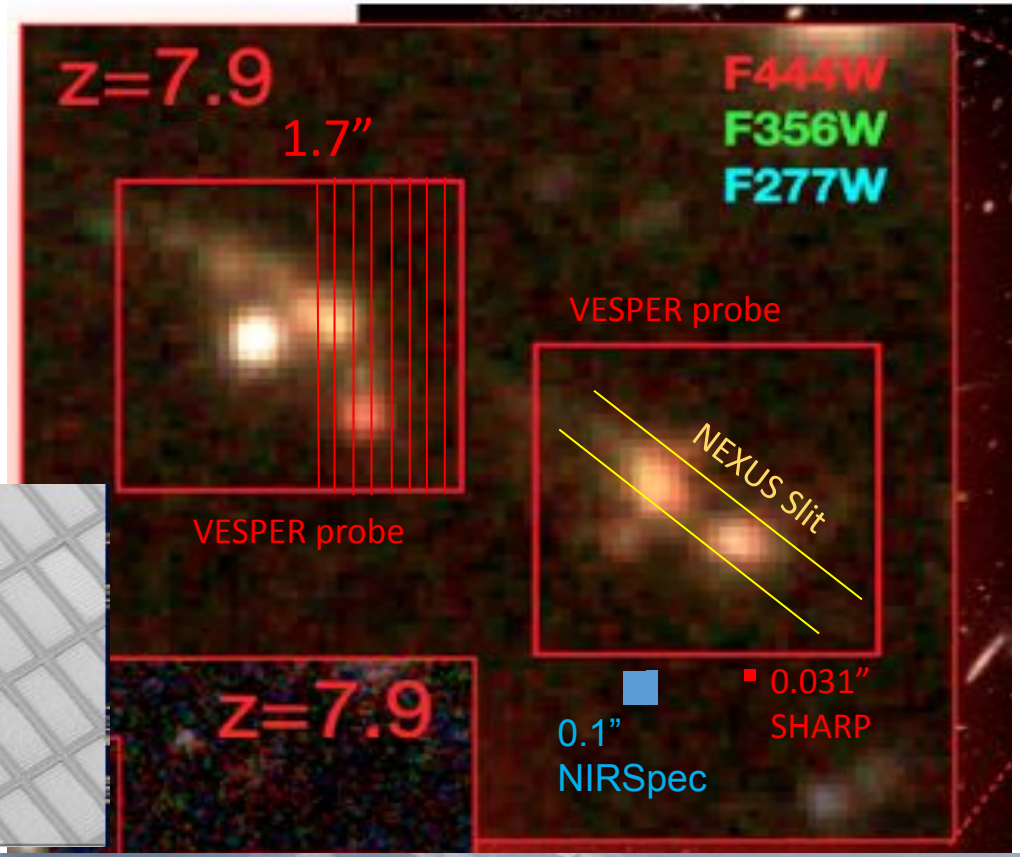


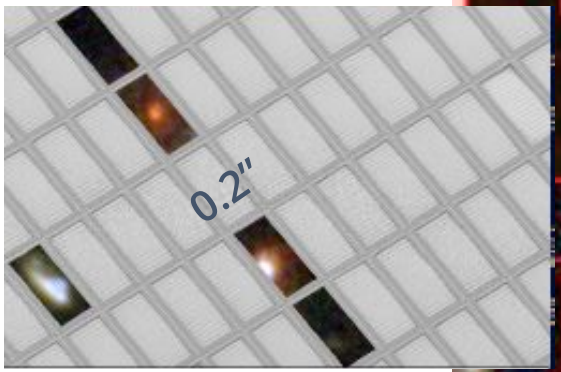
# High-Angular Res Spectroscopy in the 2030s & 40s

| Spectrograph | Multi Plex | Type FoV | Ang res (mas) | λ/Δλ | 2030-34 | 2035-39 | 2040-44 | 2045-49 |
|---|---|---|---|---|---|---|---|---|
| **JWST-NIRSpec** | ~100 | MSA 3'x3' | 100 Pixel size | 100-2700 | | | | |
| **JWST-NIRSpec** | 1 | IFU 3"x3" | 100 Pixel size | 100-2700 | | | | |
| **ELT-MICADO** SCAO SR~0.8 | 1 | Longslit sw<50 mas | 12 diff lim ELT | 20000 | | | | |
| **ELT-HARMONY** MCAO SR<0.5 | 1 | IFU 3"x4" | 12 diff lim ELT | 3000-18000 | | | | |
| **ELT-ANDES** SCAO SR~0.8 | 1 | IFU 1"x1" <1.8 μm | 12 diff lim ELT | 100000 | | | | |
| **GMTIFS** LTAO | 1 | IFU <3"x4" | 50 Pixel size | 5000-10000 | | | | |
| **TMT-IRIS** MCAO | 1 | IFU 1"x1" | 10 Pixel Size | 4000 | | | | |
| **SHARP-NEXUS** | **<48** | **MOS 1".2x1".2** | **35 Pixel size** | **~200-6000** | | | | |
| **SHARP-VESPER** | **6x** | **6 x IFU 1.7"x1.5"** | **31 Pixel Size** | **~3000** | | | | |

# Beyond HWO's mandate and JWST Legacy




MSA NIRSpec@JWST




**VESPER**

6x probes
1.7”x1.5”
31 mas/pix

**NEXUS**

<48 slits
Rotating FoV
35 mas/pix

# SHARP - Addressing Key Questions

**SHARP** will tackle the two overarching questions guiding the next decades:

- How matter assembled to form the first stars, galaxies and the universe we see
- whether we are alone in the Universe, and if habitable worlds exist out there

"Why Everest?" - "Because it's there"

*G. Mallory, 1924*

This is


Thank you!

Paolo Saracco