James Webb Space Telescope – An Introduction

Who was James Webb?

James Edwin Webb was the second NASA Administrator, Feb 1961 – Oct 1968, and initiated the science program at NASA

JWST: History

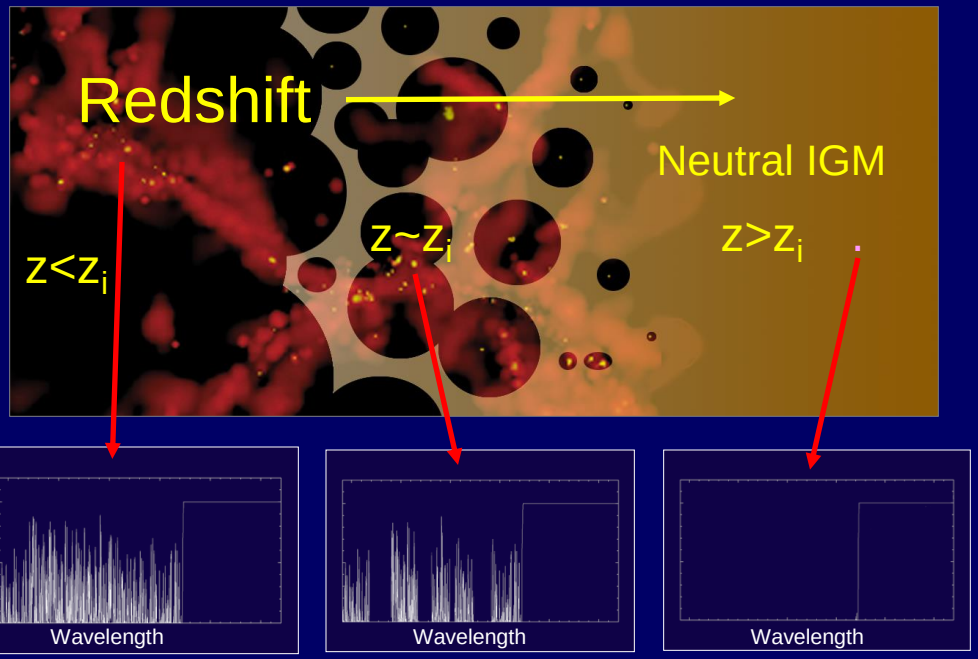
2001 NAS Decadal Survey:

The Next Generation Space Telescope (NGST), the committee's top-priority recommendation, is designed to detect light from the first stars and to trace the evolution of galaxies from their formation to the present. It will revolutionize understanding of how stars and planets form in our galaxy today.

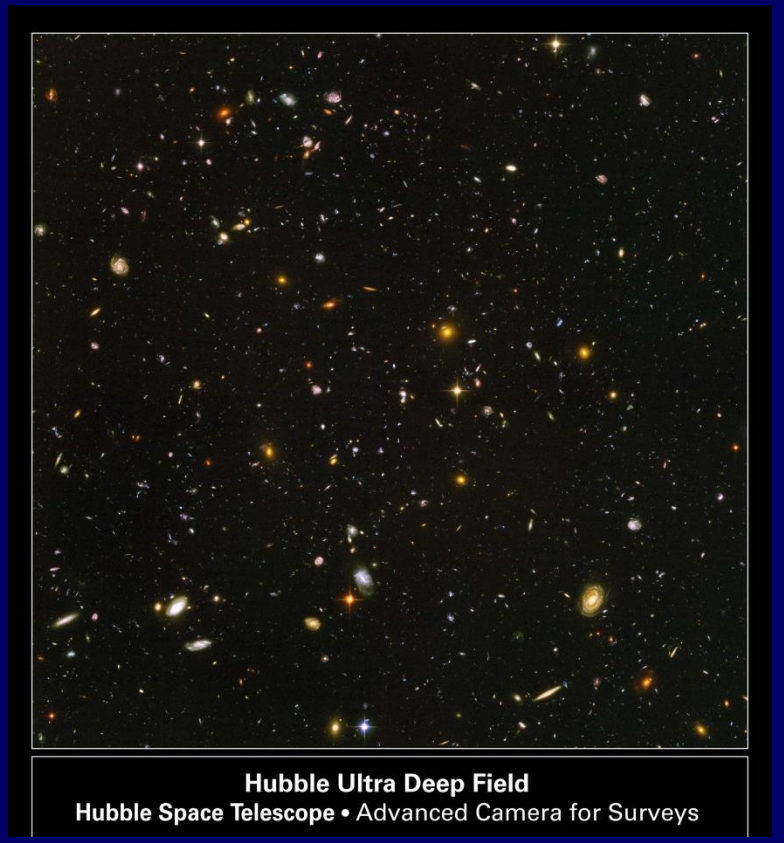
JWST: Science Goals

End of the dark ages: first light and reionization

- What are the first galaxies?
- When did reionization occur?
  - Once or twice?
- What sources caused reionization?



Lyman Forest Absorption | **Patchy Absorption** | **Black Gunn-Peterson trough**

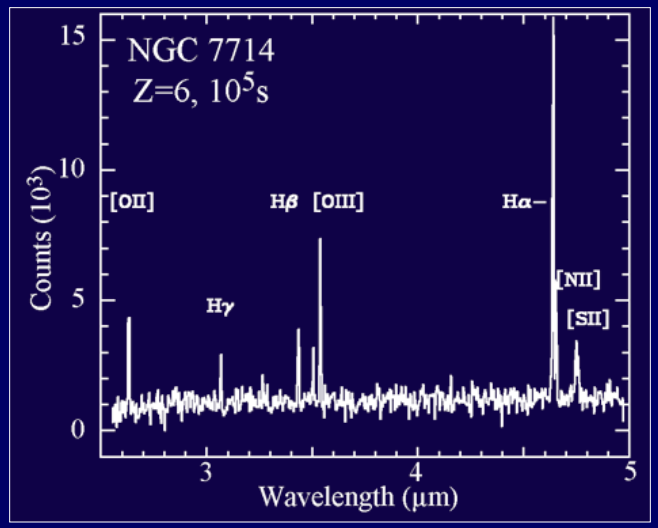


- Ultra-Deep NIR survey (1.4 nJy), spectroscopic & Mid-IR confirmation.
- QSO spectra: Ly-α forest
- Galaxy spectra: Balmer lines (2×10^{-19} ergs/cm^2/sec)

The assembly of galaxies

- Where and when did the Hubble Sequence form?
- How did the heavy elements form?
- Can we test hierarchical formation and global scaling relations?
- What about ULIRGs and AGN?

Galaxies in GOODS Field

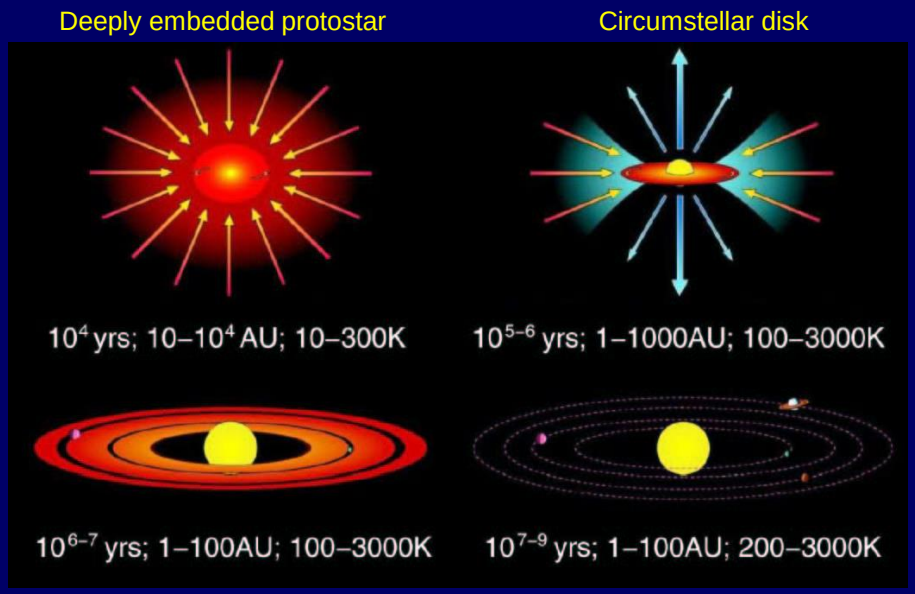


- Wide-area imaging survey
- R=1000 spectra of 1000s of galaxies at $1 < z < 6$
- Targeted observations of ULIRGs and AGN

Birth of stars and protoplanetary systems

- How do clouds collapse?
- How does environment affect star-formation?
  - Vice-versa?
- What is the low-mass IMF?

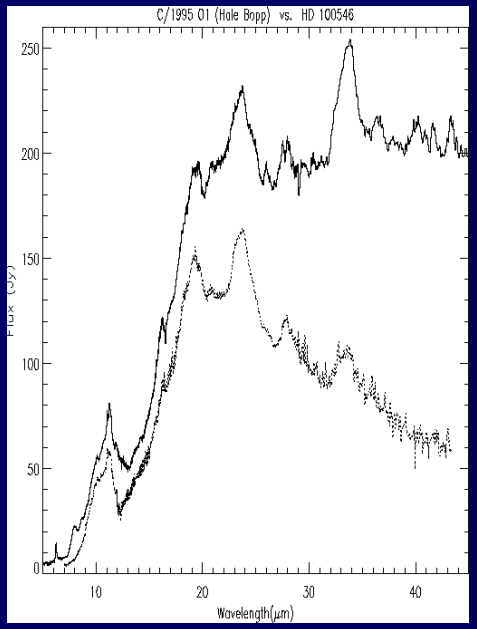
The Eagle Nebula
as seen in the infrared



- Imaging of molecular clouds
- Survey “elephant trunks”
- Survey star-forming clusters

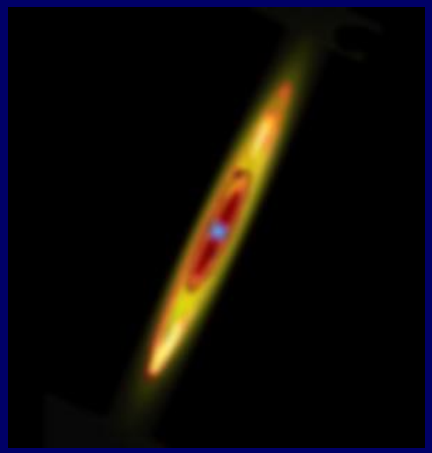
Planetary systems and the origins of life

- How do planets form?
- How are circumstellar disks like our Solar System?
- How are habitable zones established?

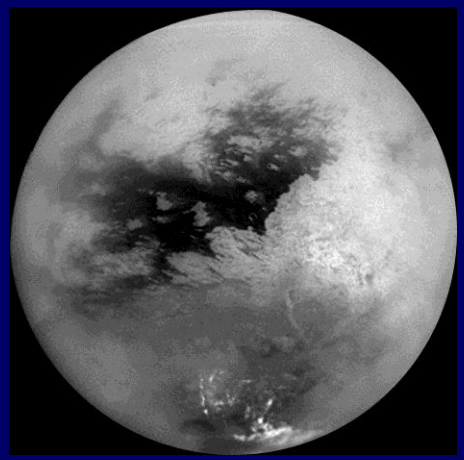


Malfait et al 1998

Spitzer image



Simulated JWST image
Fomalhaut at 24 microns



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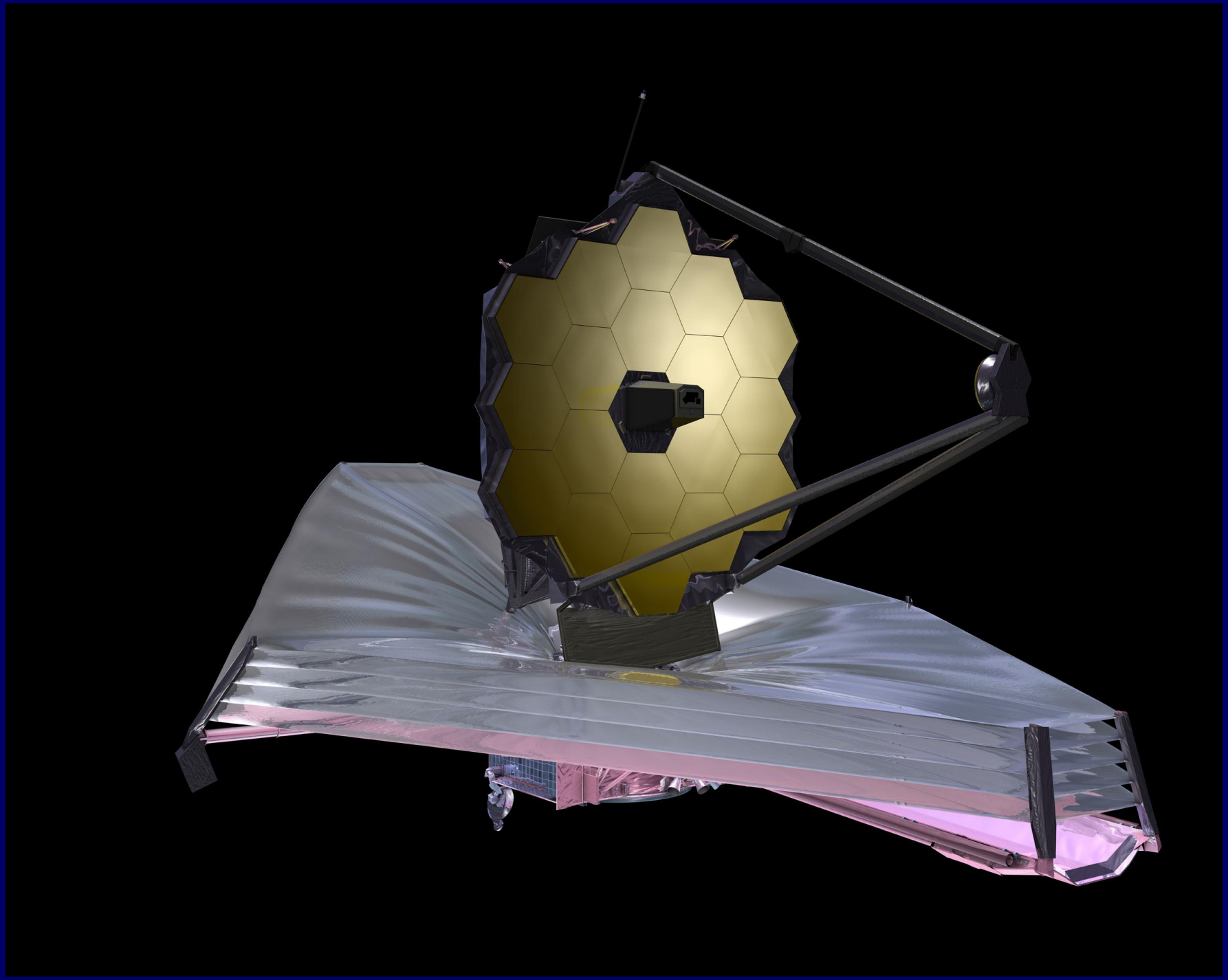
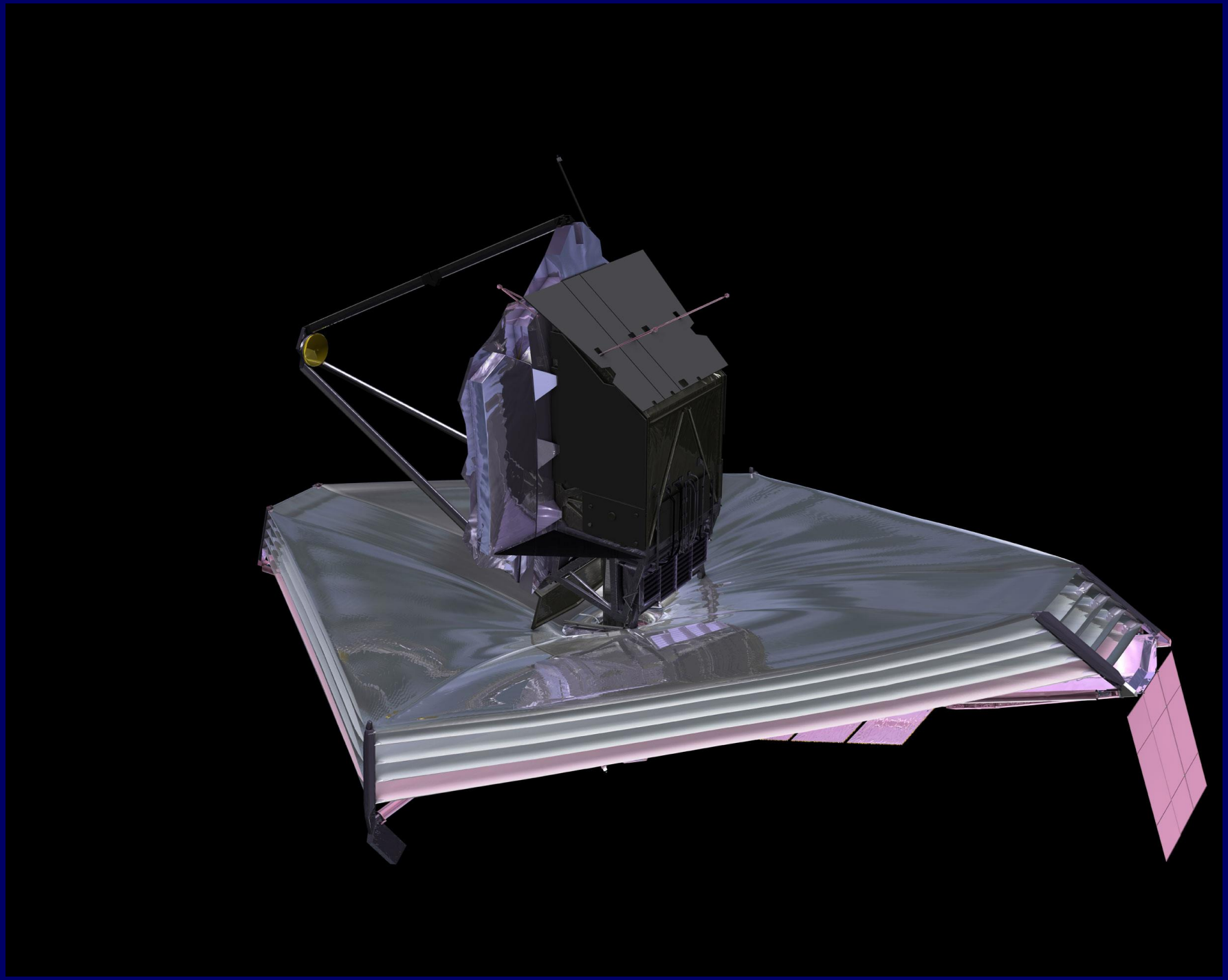
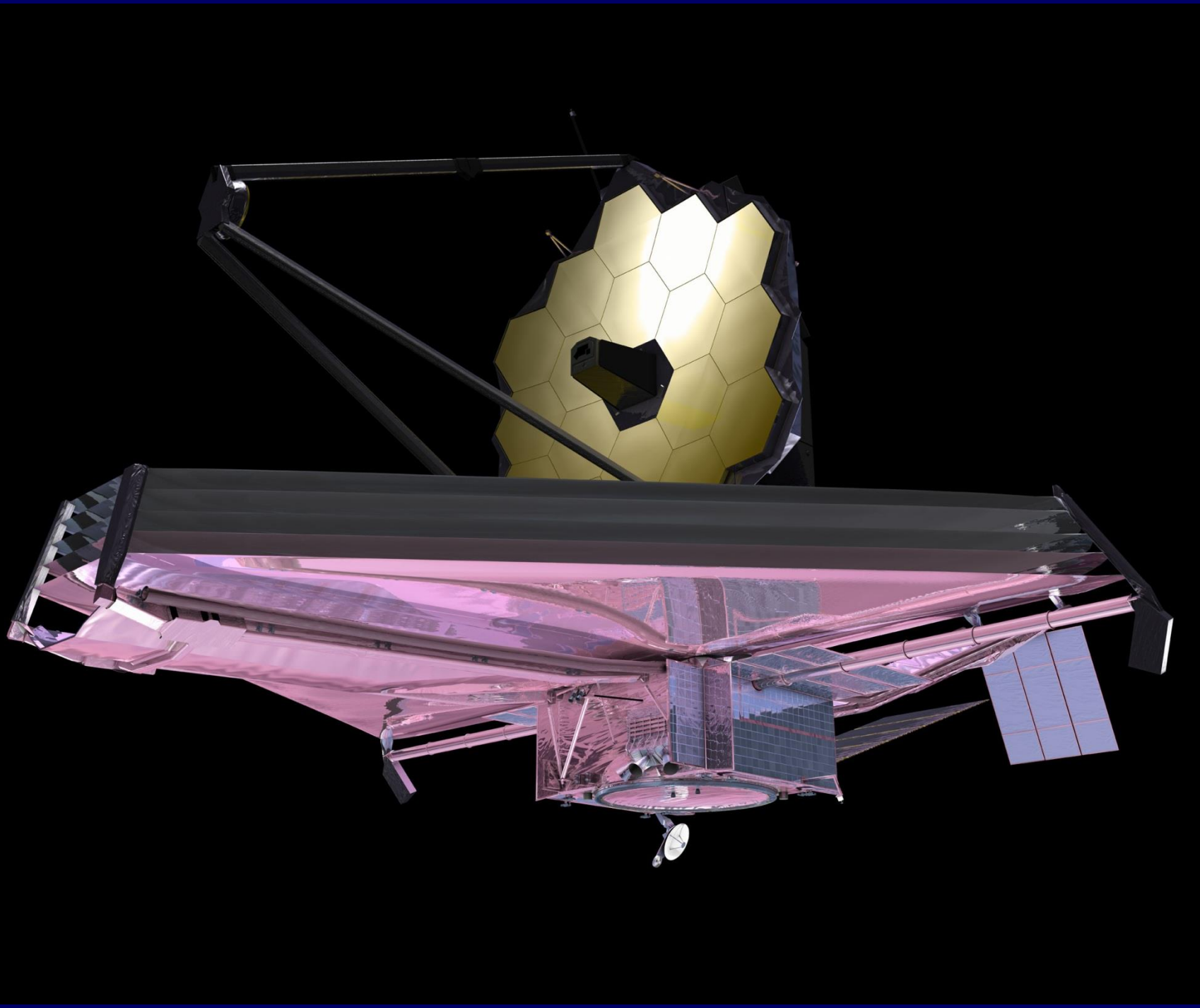
- Extra-solar giant planets
  - Coronagraphy
- Spectra of circumstellar disks, comets and KBOs
- Spectra of icy bodies in outer Solar System

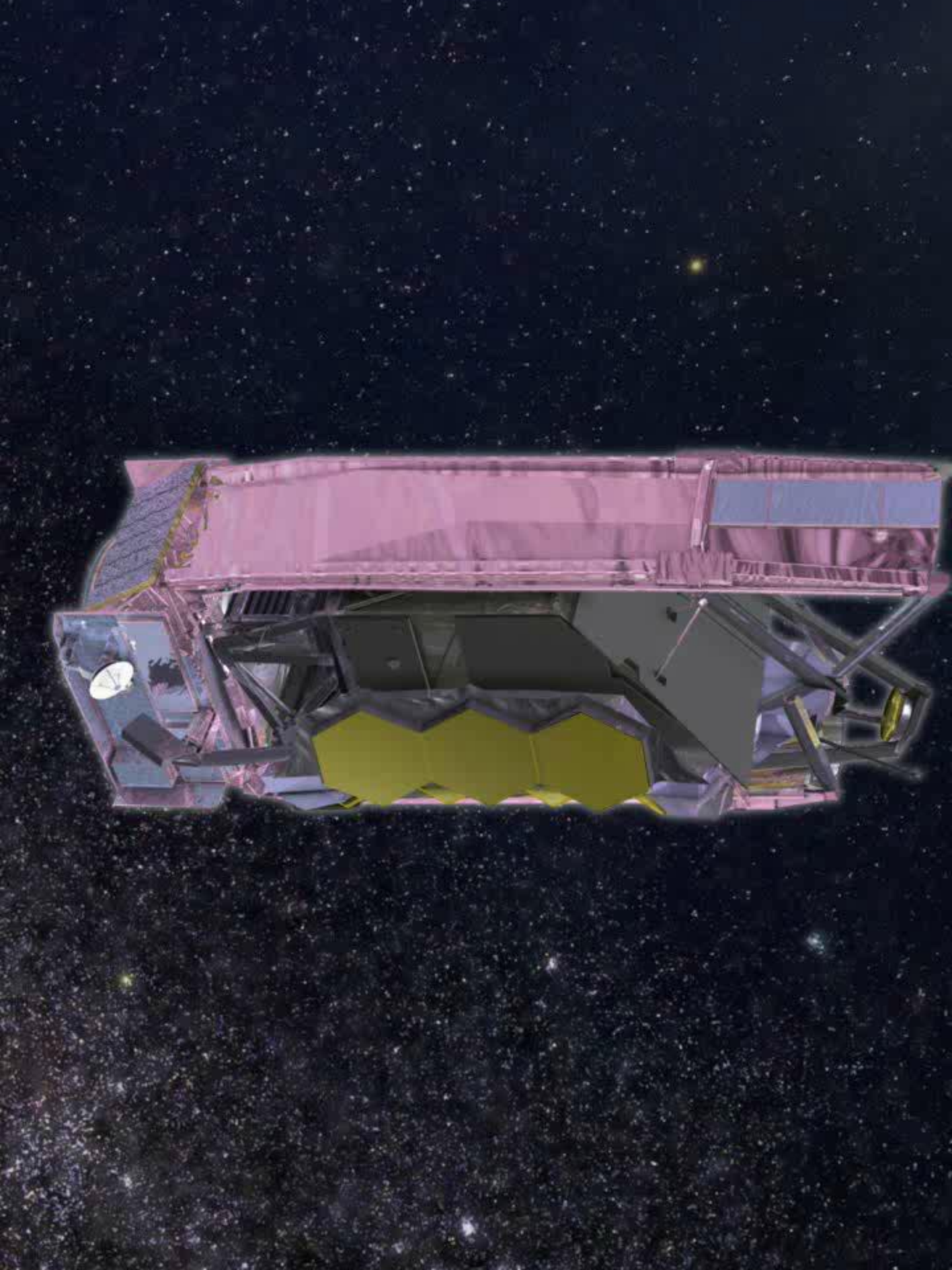
JWST: Observatory Design

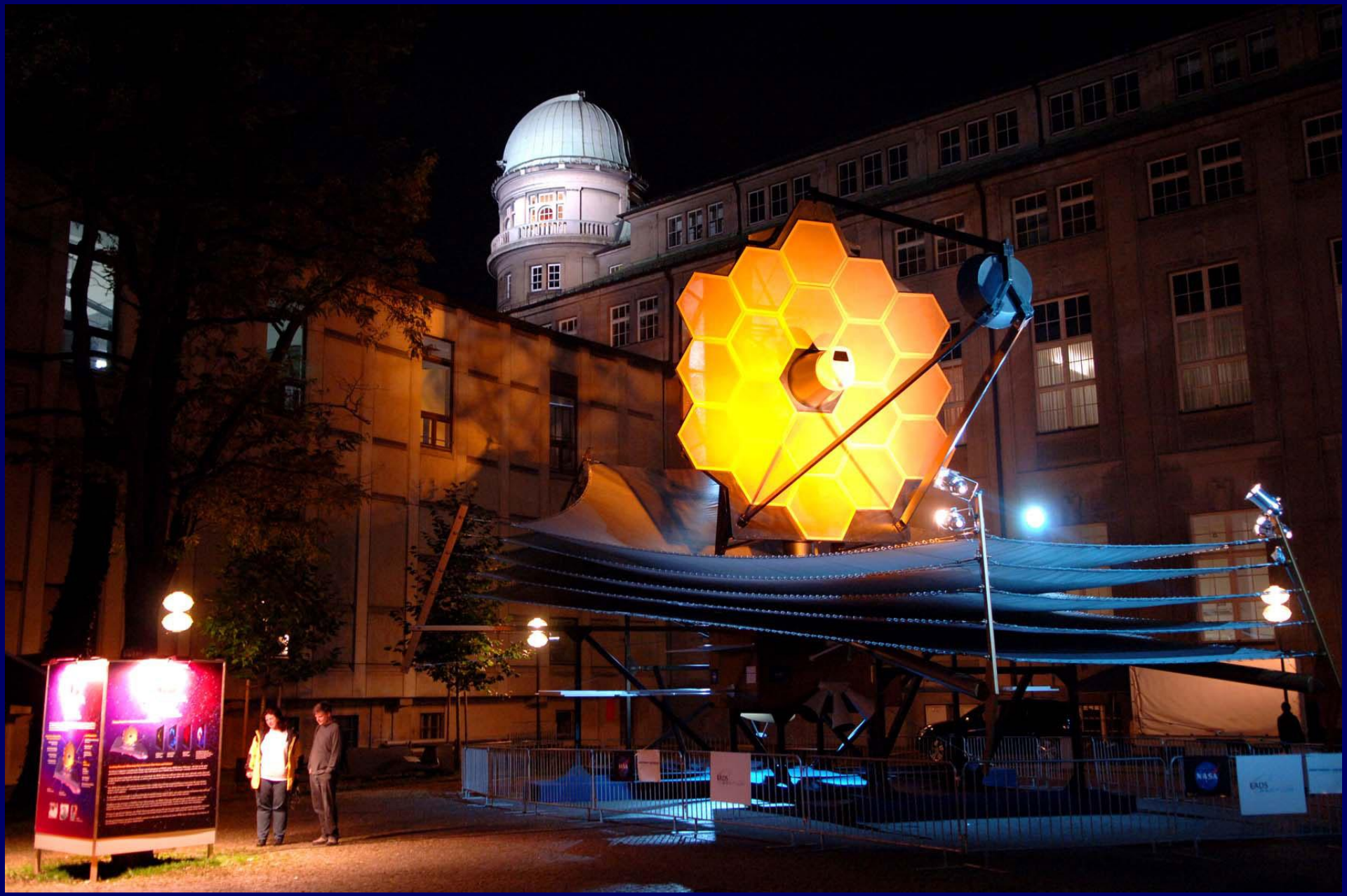






JWST: Origami Gone Awry

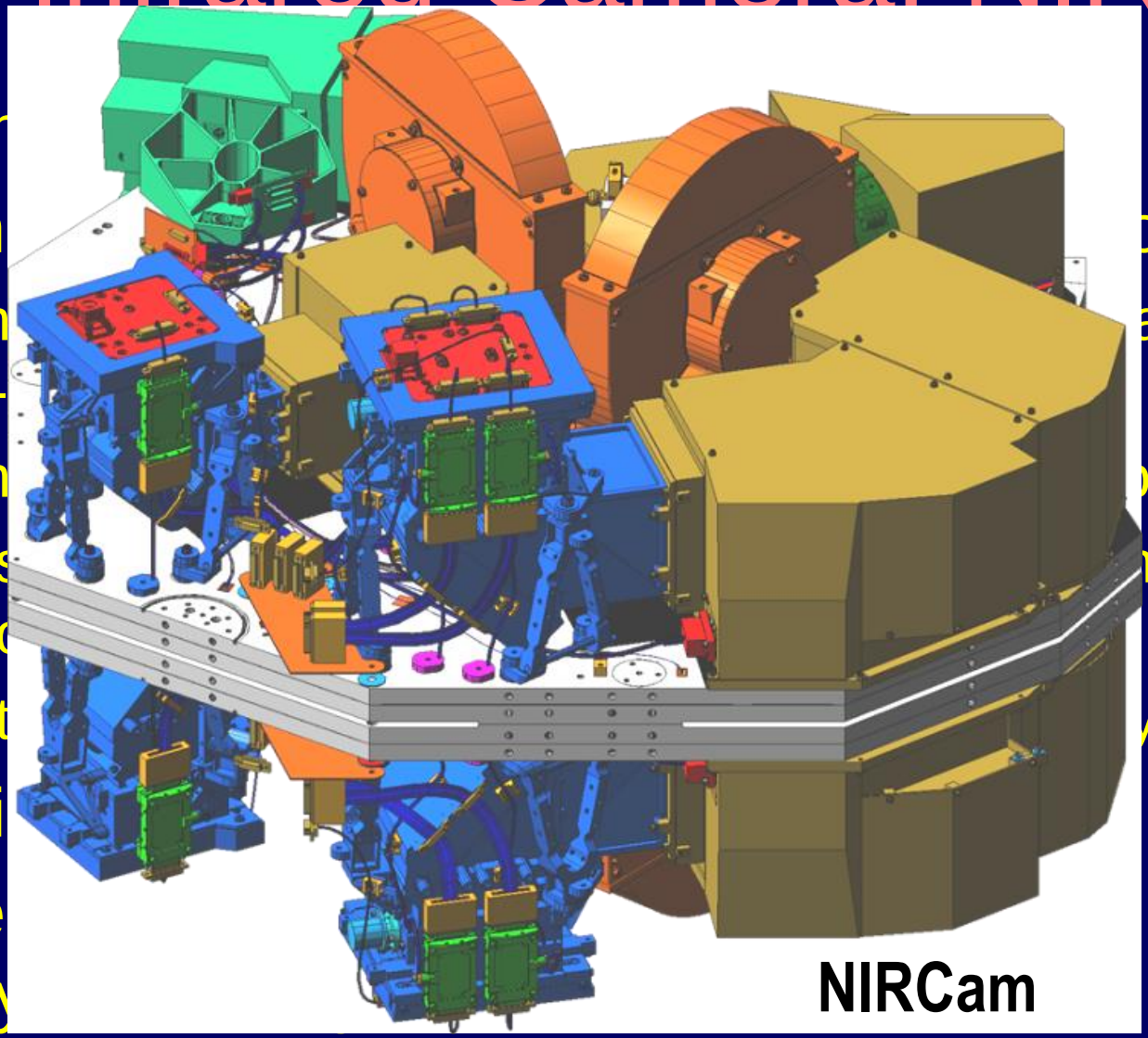



NASA

JWST: Science Instruments

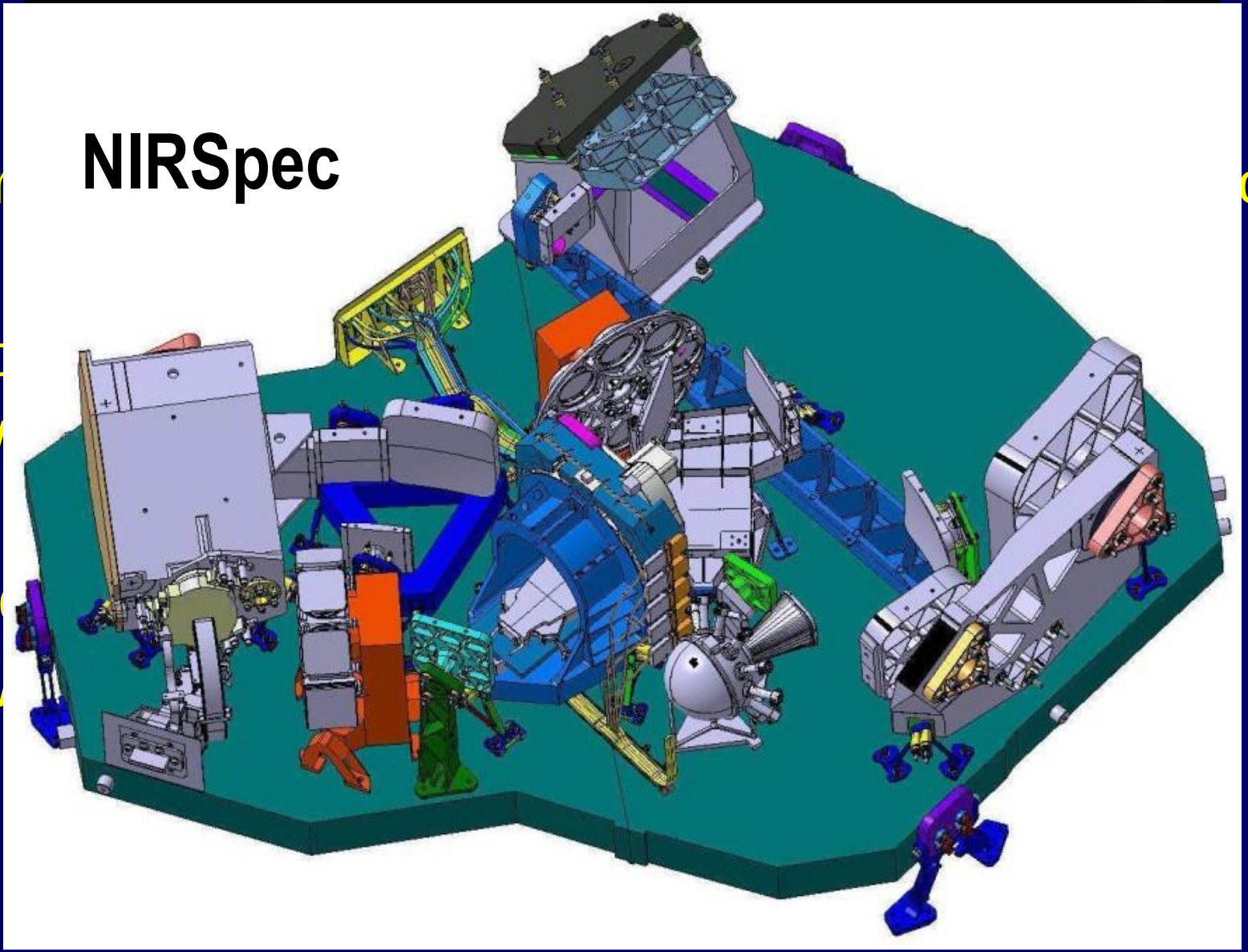
Near-Infrared Camera: NIRCam

- Filter ir
- Two m odules
  - Each and 1 long-
  - Each ix)
  - The s e same part o
  - The t y
- Total fi
- Will be the primary



Near-Infrared Spectrograph:

- Pr
- Fi
- Lo
- W
- M
  in
- Tw



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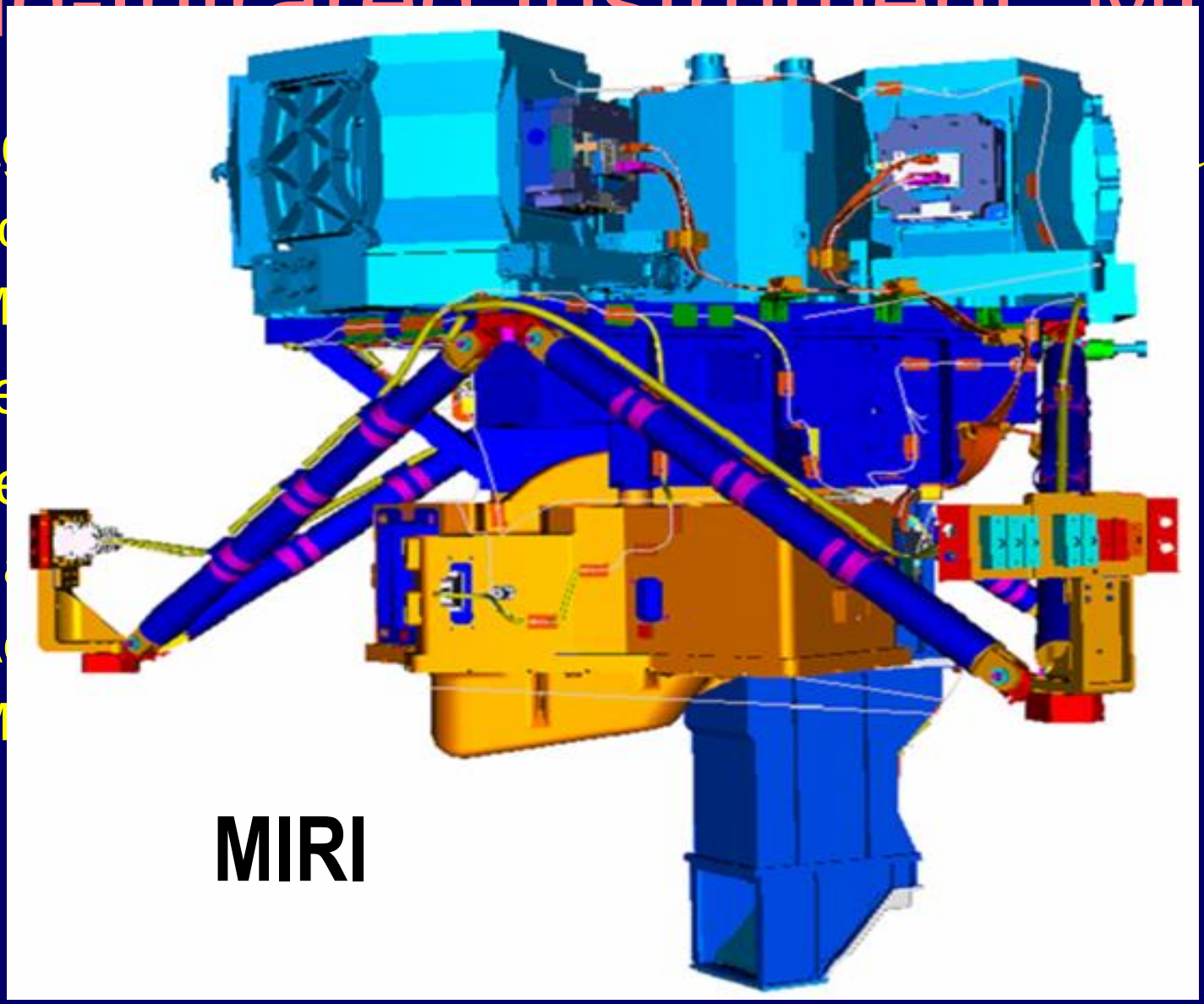
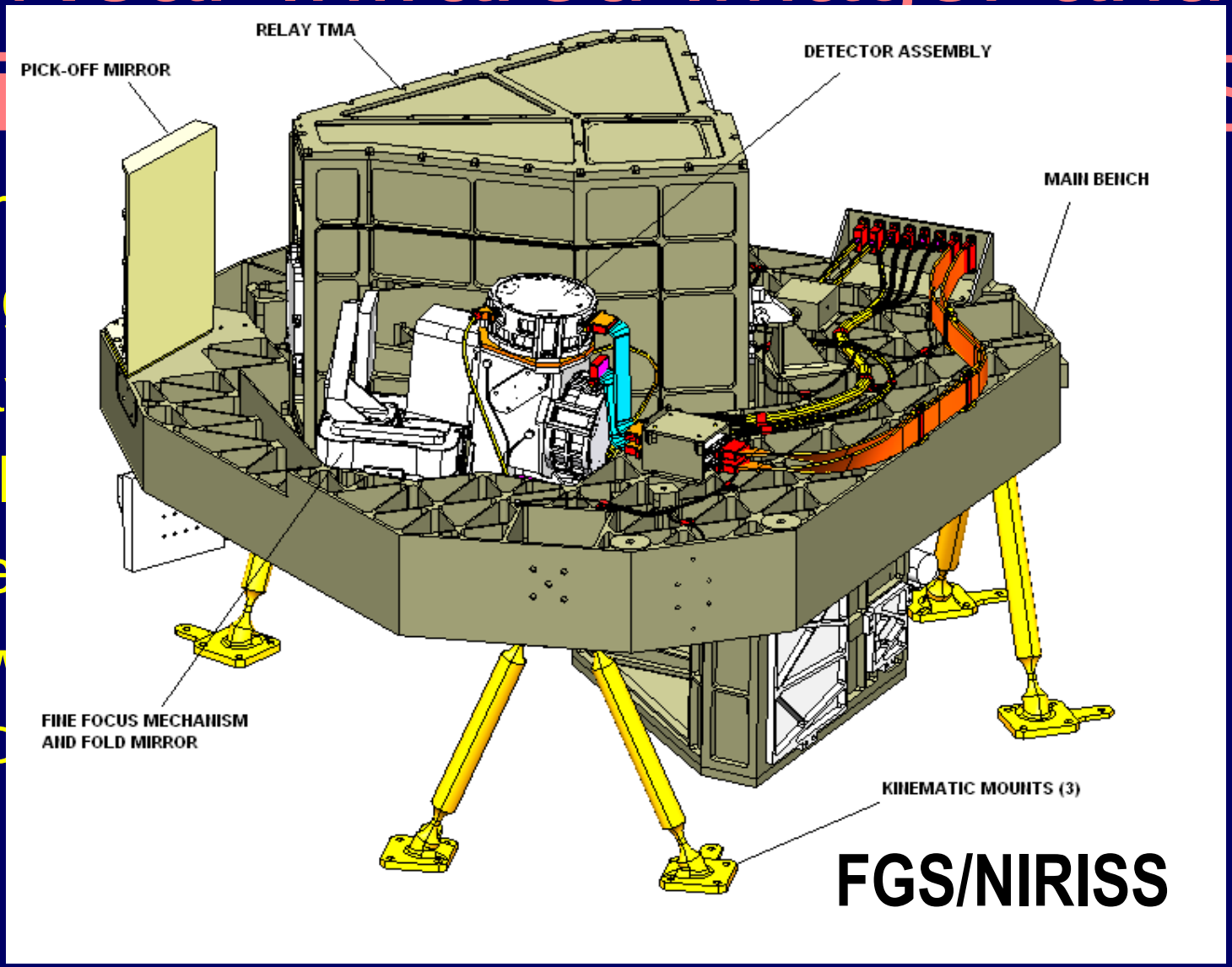
Mid-Infrared Instrument: MIRI

- Imag… …um
  - Lo…
  - M…
- Thre…
- Dete…
  - P…
  - A…
  - M…

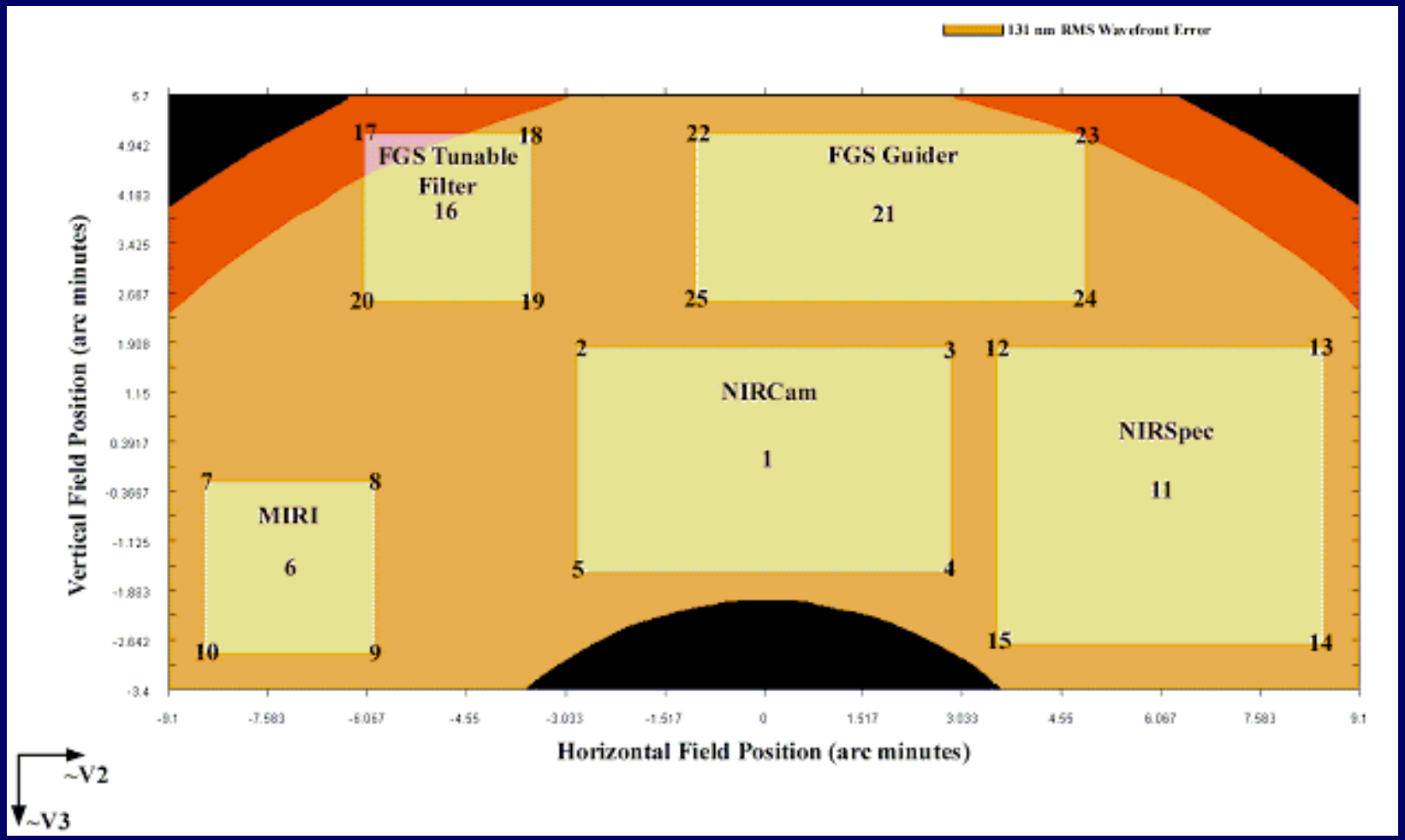


Near-Infrared Imager and Sli…ss

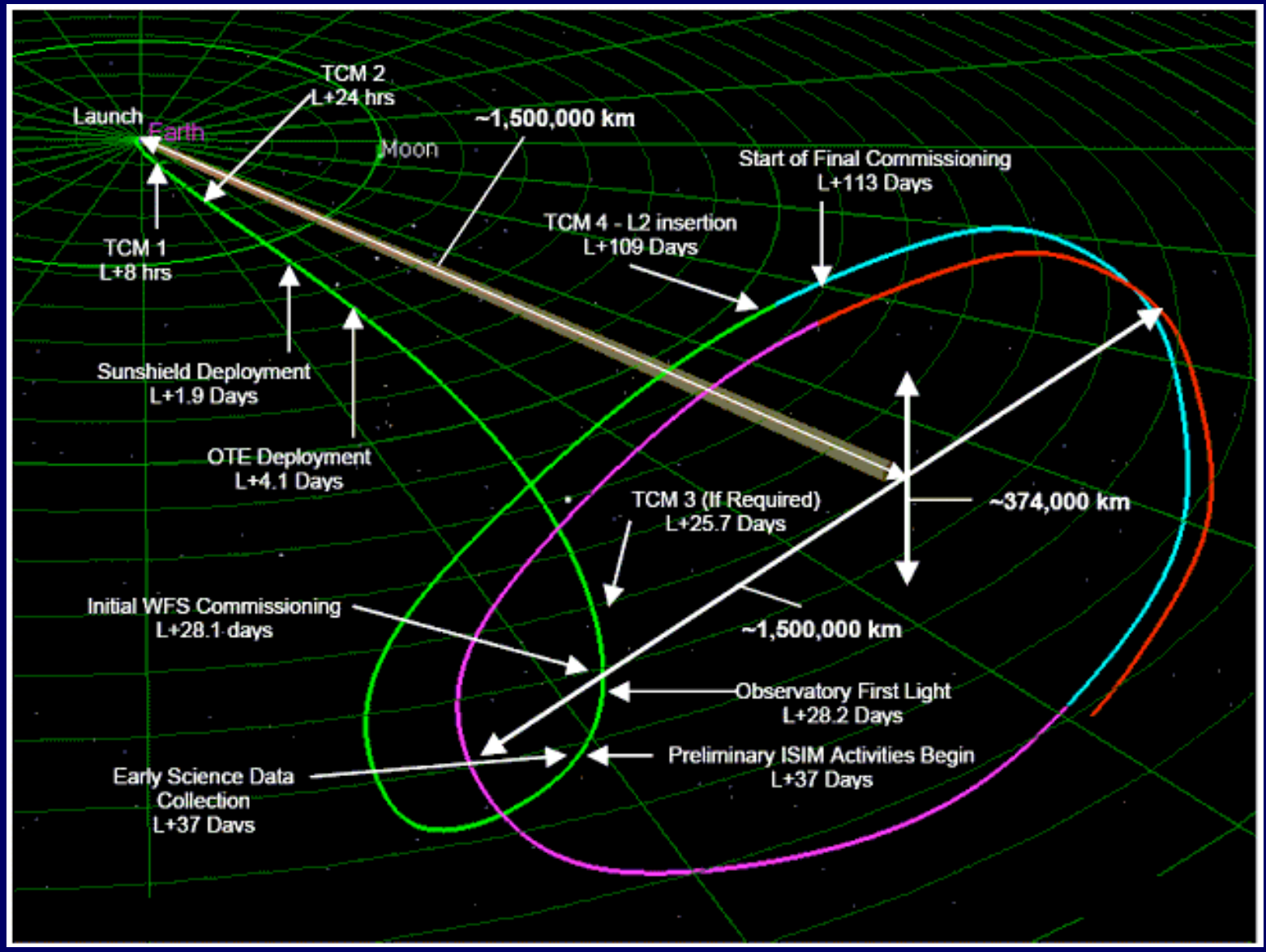
- Par…
- Sin…
- Wa…
- Fiel…
- Inte…
- Low…
  - D…



JWST: Focal Plane



JWST: Orbit


TCM 2
L+24 hrs
Launch
Earth
Moon
~1,500,000 km
Start of Final Commissioning
L+113 Days
TCM 4 - L2 insertion
L+109 Days
TCM 1
L+8 hrs
Sunshield Deployment
L+1.9 Days
OTE Deployment
L+4.1 Days
TCM 3 (If Required)
L+25.7 Days
~374,000 km
Initial WFS Commissioning
L+28.1 days
~1,500,000 km
Observatory First Light
L+28.2 Days
Preliminary ISIM Activities Begin
L+37 Days
Early Science Data
Collection
L+37 Davs

JWST: Future

- 2013 - 2015: ISIM Integration and Test
- 2015 - 2016: Flight optics integration
- 2016 - 2017: Telescope plus ISIM Testing
- 2017 - 2018: Observatory Testing
- 2018: Launch!
- 2018 - 2023: Primary mission
- 2023 - 2028: Extended mission

JWST Fun Facts

- JWST is approximately the size of a tennis court
- The sunshield provides an equivalent “SPF” of 1.2 million for the telescope
- Each mirror segment is ground and polished so its figure error is less than 20 nm across its surface. On a relative scale, if the mirror were to be enlarged to the size of the continental United States, this is equivalent to smoothing out its highest point, Mount Whitney at 14,500 ft, to a height of about 2 inches.
- When taking an image, the Observatory has a pointing instability of less than 3.7 milliarc-seconds. This would be like painting a 5 ½ inch diameter circle on your friend’s helmet in New York City with a laser tag gun in Los Angeles.
- There is nearly a 500 deg F temperature difference between the bottom of the sunshield and the top
- Each Beryllium mirror segment starts out at a weight of 273 kg (600 lb). Precision machining removes 93% of the weight so the final segment weighs only 20 kg (44 lb).