Status of the James Webb Space Telescope (JWST) Observatory

ESTEC
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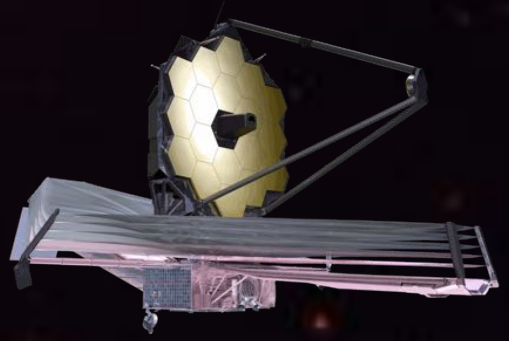


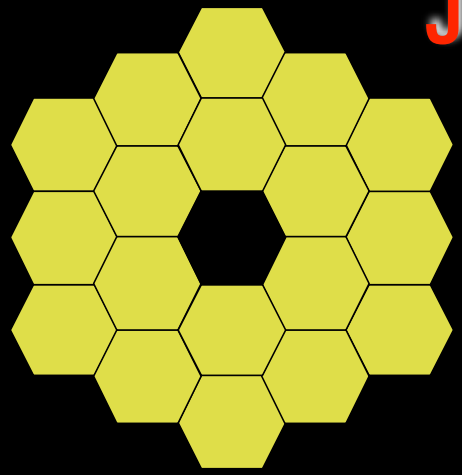
JWST and its Precursors

HUBBLE

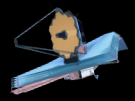
2.4-meter
T ~ 270 K

123” x 136”
$\lambda/D_{1.6\mu m}$~ 0.14”

JWST



6.5-meter
T ~ 40 K



132” x 164”
$\lambda/D_{2\mu m}$~ 0.06”

114” x 84”
$\lambda/D_{20\mu m}$~ 0.64”

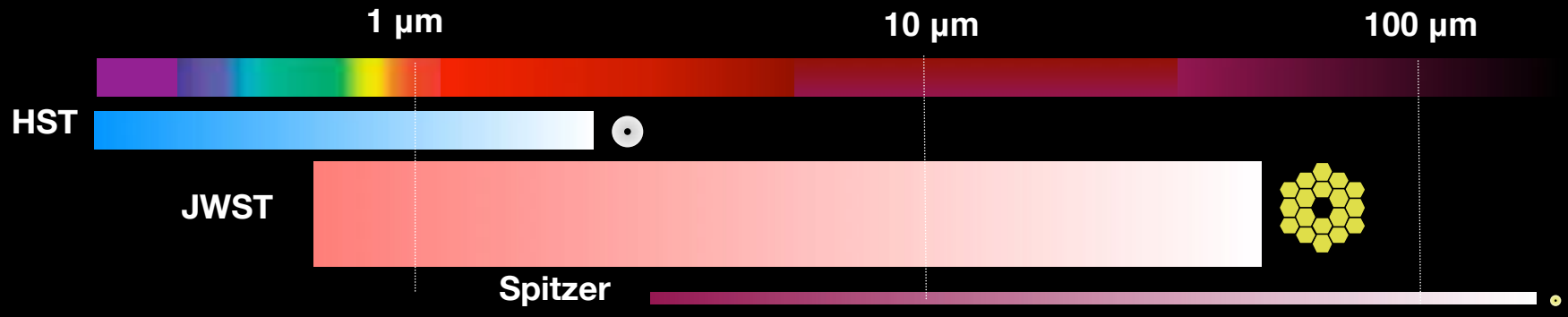
SPITZER

0.8-meter
T ~ 5.5 K

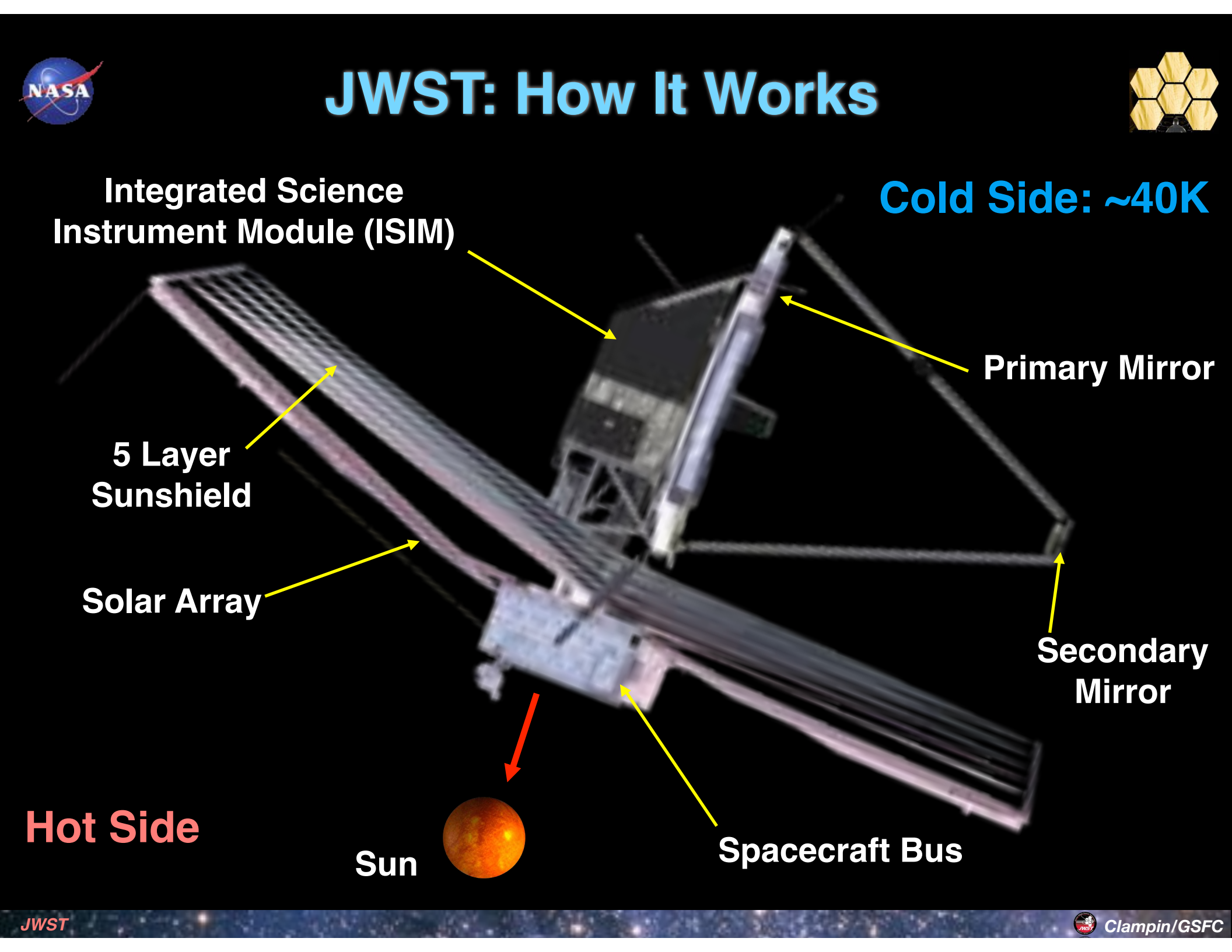
312” x 312”
$\lambda/D_{5.6\mu m}$~ 2.22”

324” x 324”
$\lambda/D_{24\mu m}$~ 6.2”

Wavelength Coverage



JWST: How It Works



JAMES WEBB SPACE TELESCOPE:
DEPLOYMENT SEQUENCE

JWST's Orbit: L2

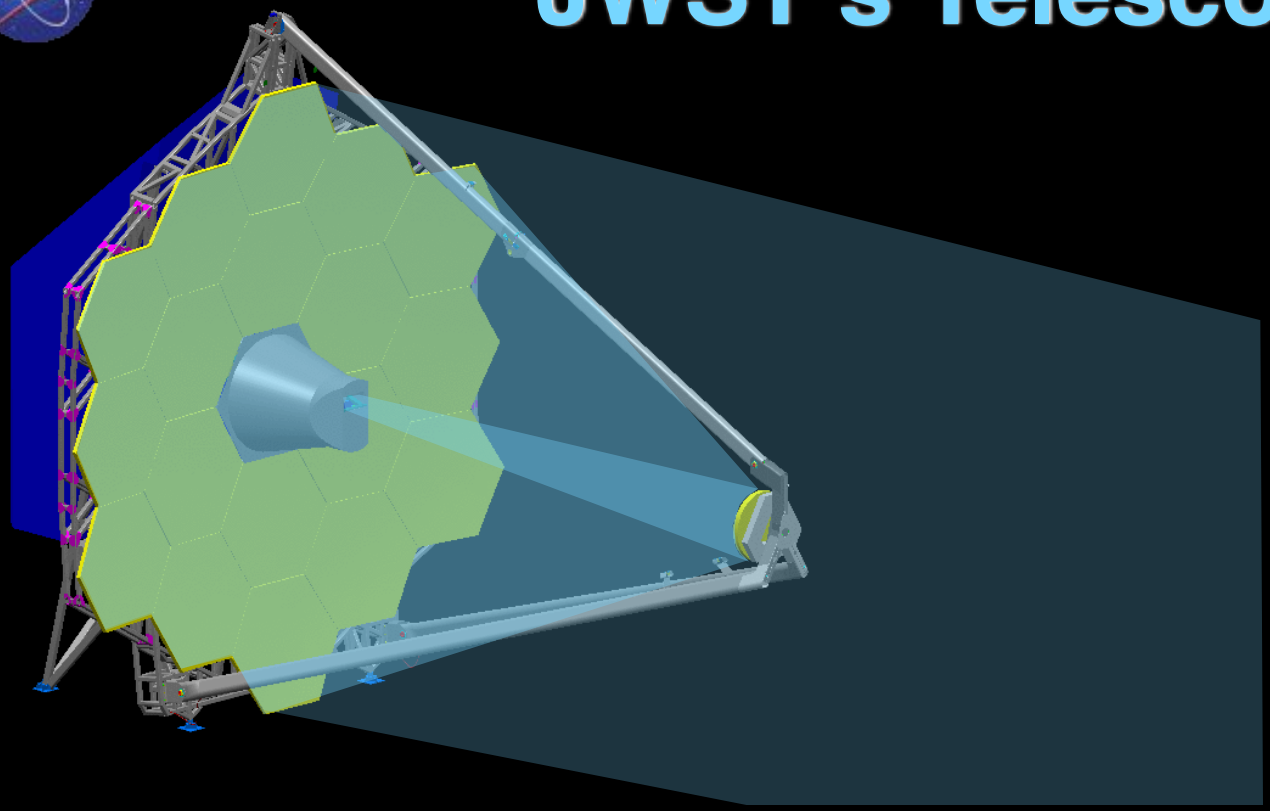
- JWST will be launched by an Ariane 5 to an orbit *around L2*
  - ➡ *Direct insert launch*
  - ➡ *L2 presents a thermally benign environment*
  - ➡ *Science operations: 24/7*

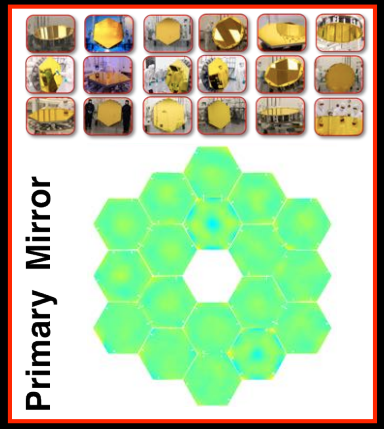
Pointing

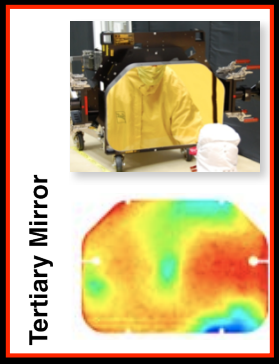
- predicted performance for offsets
- now using FSM offsets for <35 arcsec

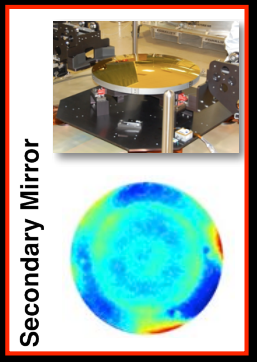
MR-182	OBS-194	FOV Offsets - Small (0-0.5 arcsec)	5.0	4.0	milli-arcsec
MR-181	OBS-1685	FOV Offsets - Medium (0.5 - 2.0 arcsec)	20.0	4.2	milli-arcsec
MR-374	OBS-193	FOV Offsets - Large (2-20 arcsec)	20.0	4.6	milli-arcsec
MR-364	OBS-1161	FOV Offsets - XLarge (20-45 arcsec)	90.0	5.3	milli-arcsec

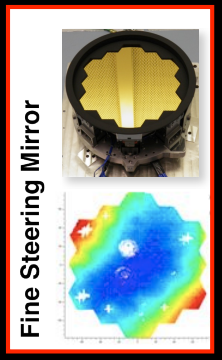
JWST's Telescope







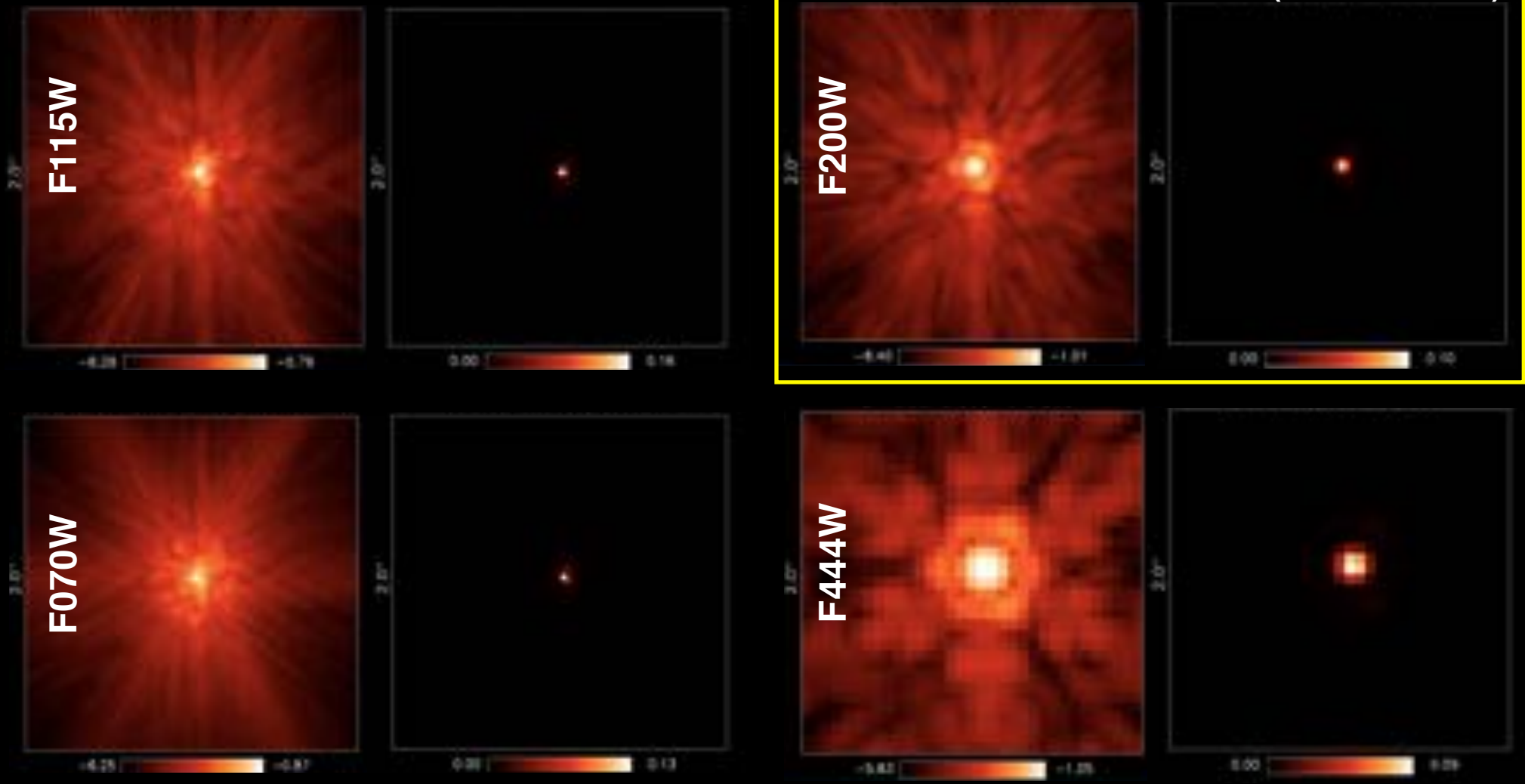




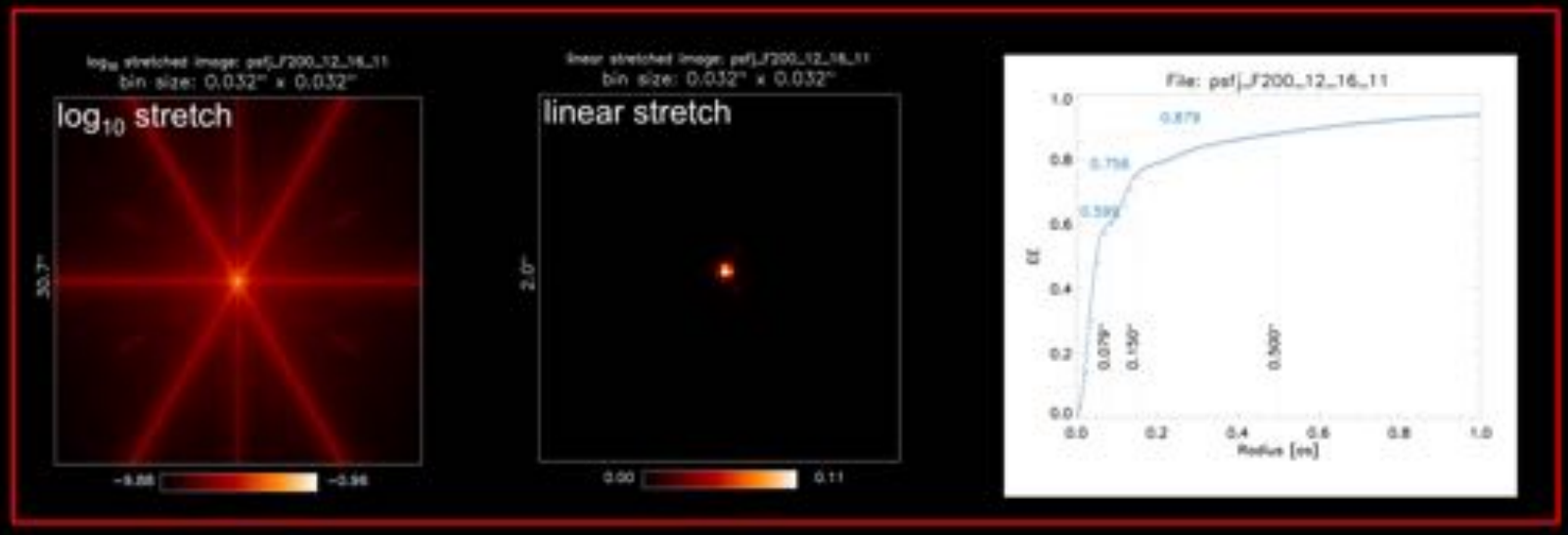
Mirror	Measured (RMS SFE)	Uncertainty (RMS SFE)	Total (RMS SFE)	Requirement (RMS SFE)
18 PM Segments (Composite Figure)	23.6	8.1	25.0	25.8
Secondary	14.7	13.2	19.8	23.5
Tertiary	18.1	9.5	20.5	23.2
FSM	13.9	4.9	14.7	18.7

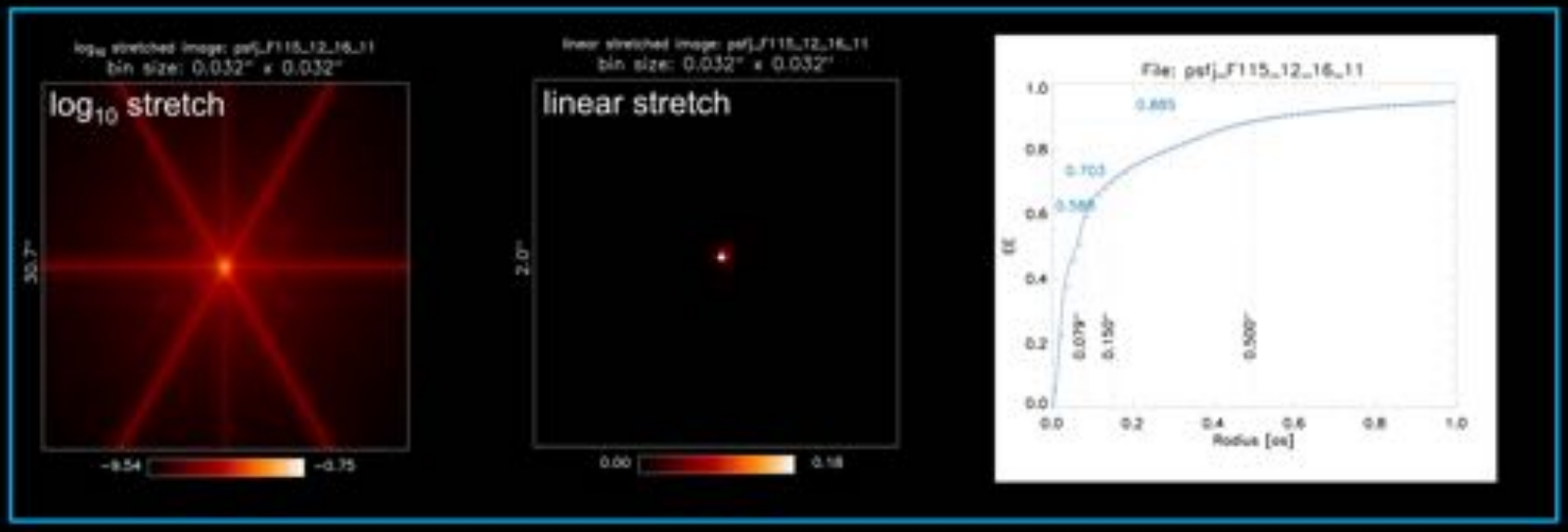
Predicted Image Quality

Diffraction Limited: Strehl > 0.8 (WFE ≤ 150 nm)



Encircled Energy Stability

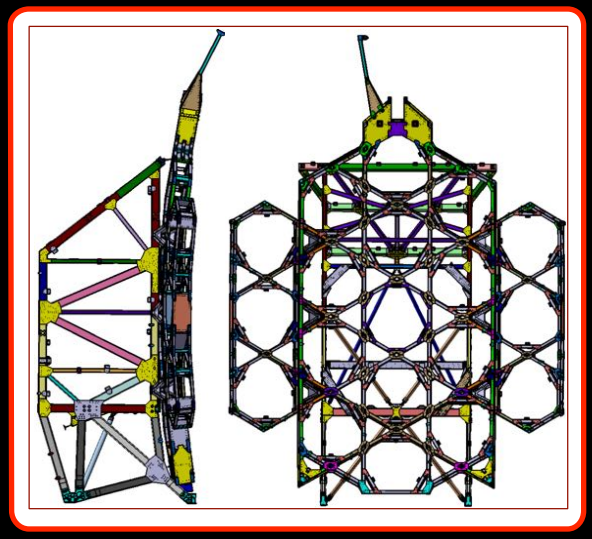




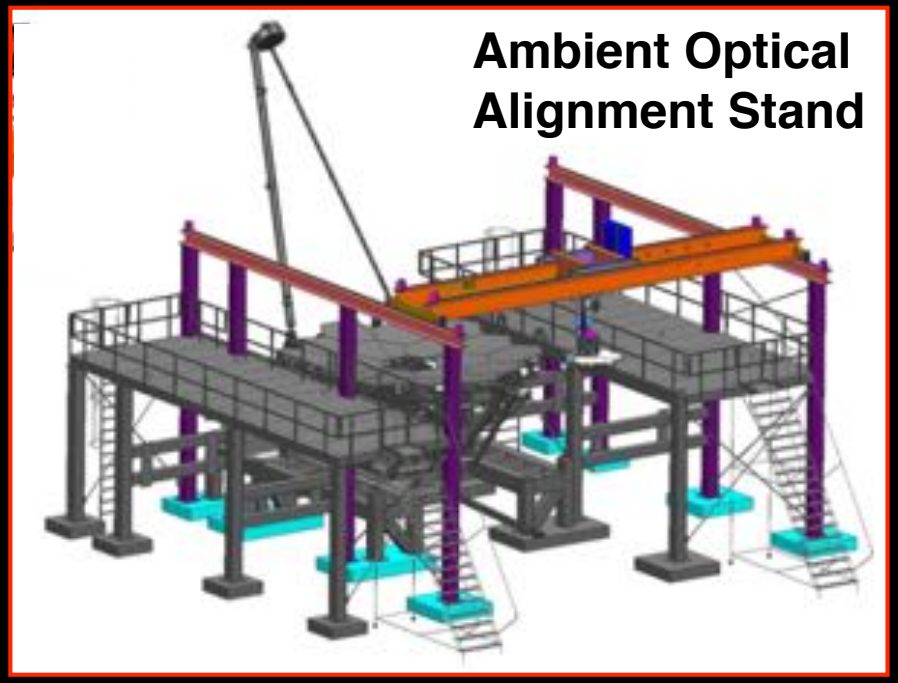
Stray Light Backgrounds

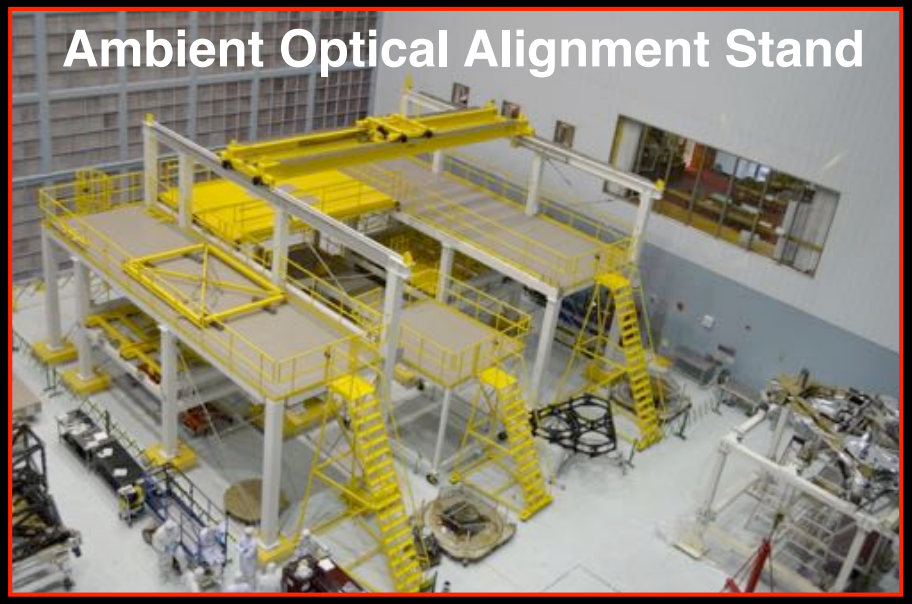
Telescope Structure

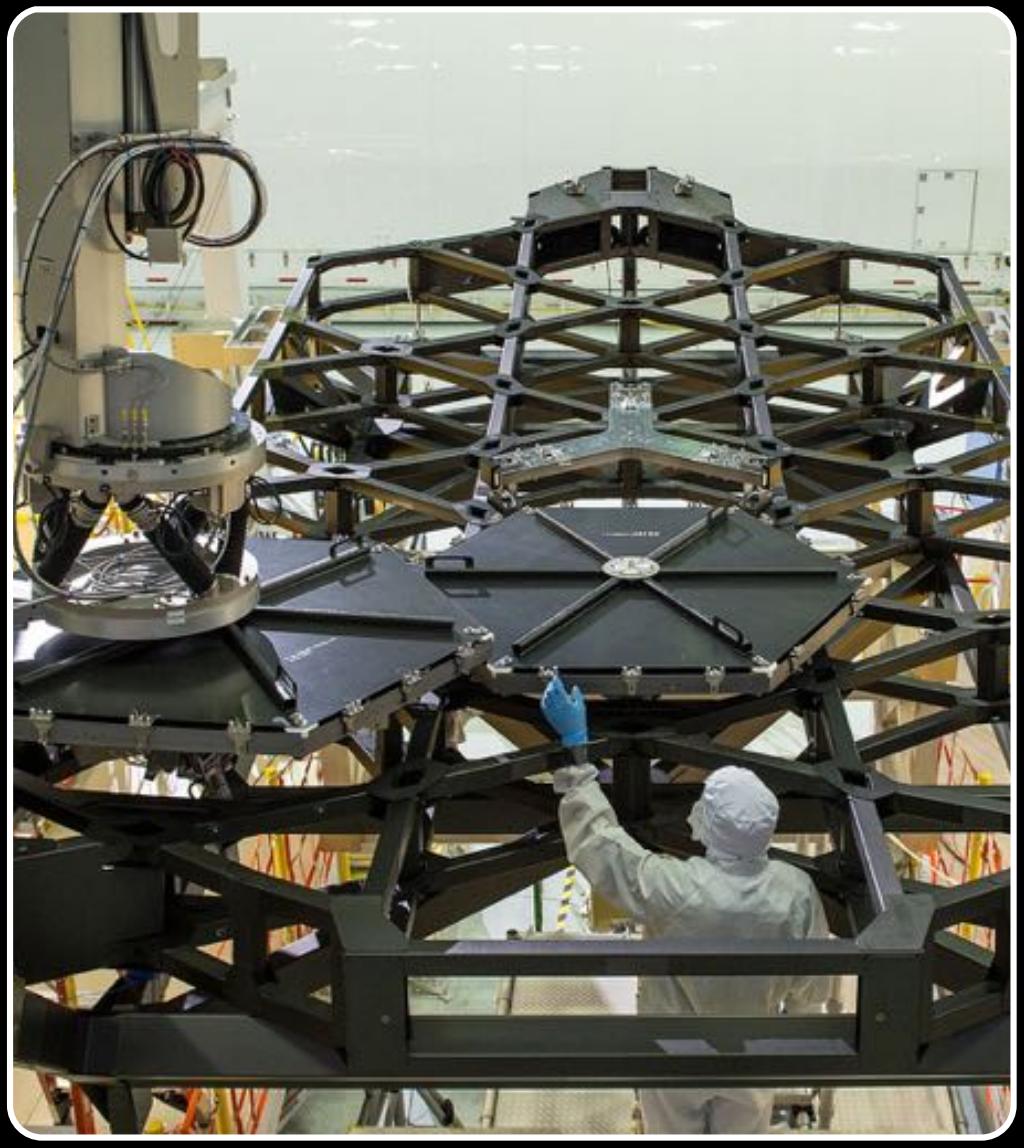
- Telescope structure complete and delivered to GSFC



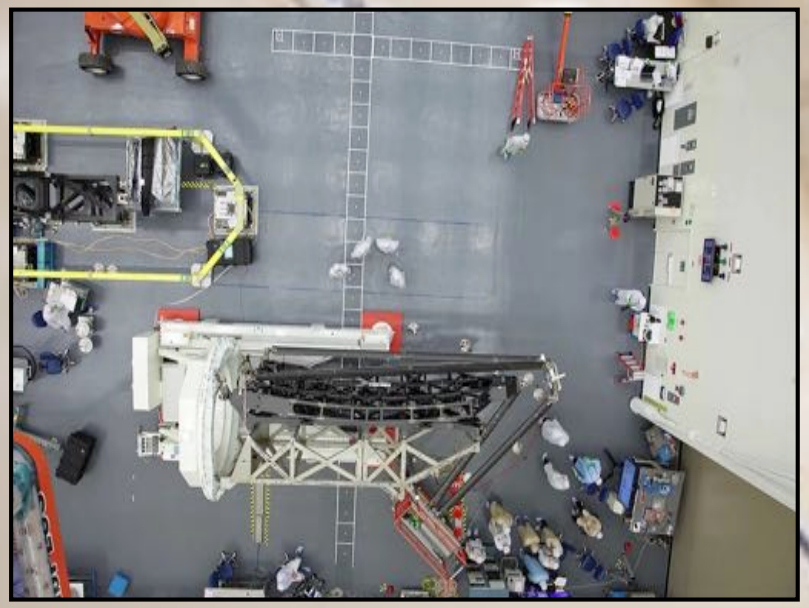
Primary Mirror Integration







Mirror Installation dry-run



Pathfinder Backplane

- **The pathfinder is a backplane section with a secondary mirror support structure (SMSS)**
  - ➡ Verify SMSS deployment
- **Tests integration of primary mirror segment installation with two flight spare mirror segments, plus flight-spare secondary mirror**
- **Pathfinder is scheduled for three cryogenic tests during 2015 in Chamber-A at JSC**
  - ➡ Verify optical test equipment

Phasing the Telescope

Commissioning

OTE Deployment / First Light (Image Mosaic

SM Focus Sweep

Segment Identification

Segment Search

Segment-Image Array

Global Alignment

Image Stacking

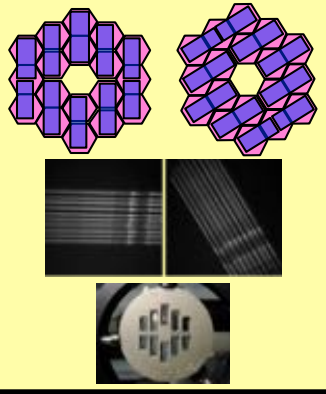
Coarse Phasing (DHS)

Single Field Fine Phasing

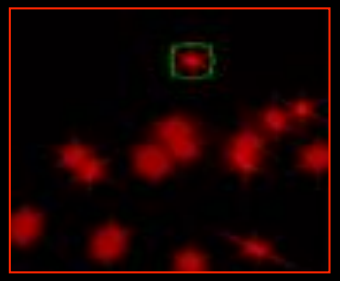
Multi-Field Fine Phasing

Wavefront Monitoring & Maintenance

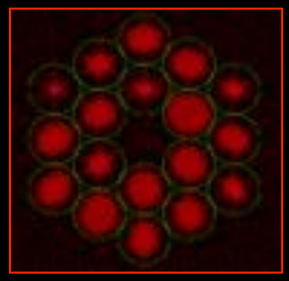
DHS (20 edges)



Pupil Imaging

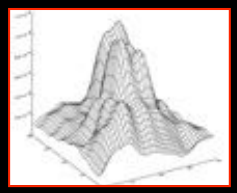


NIRCam First Light

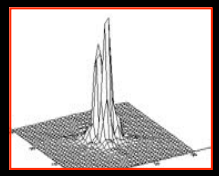


After Segment-Image Array

After Global Alignment



After Image Stacking



After Coarse Phasing

After SF Fine Phasing

Sunshield Membranes

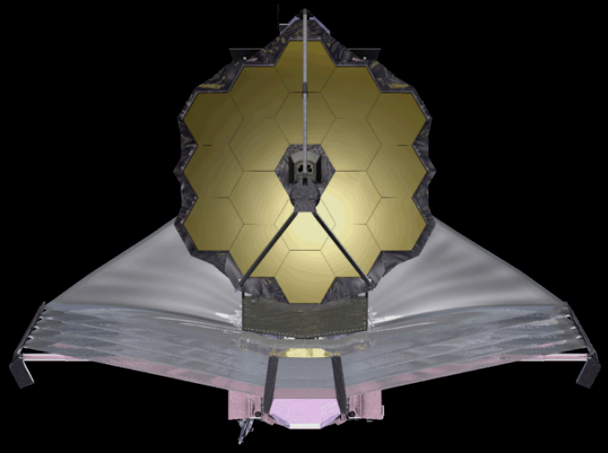
- Five flight-like Template Membrane layers manufactured
  - ➡ Template layers tensioned to flight-like configuration
    - 3-D membrane shapes measured by Lidar
    - Critical for layer-to-layer spacing ➠ thermal performance
    - Edge alignment ➠ thermal performance & stray light
- Flight membranes under construction (#3 completed)

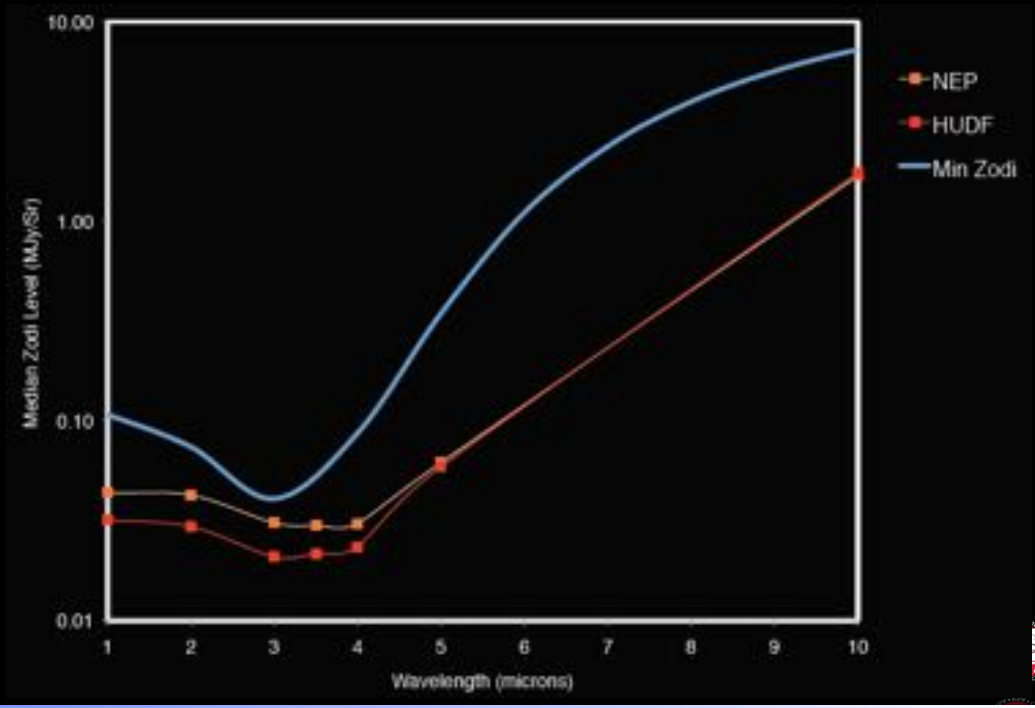
Tensioned to 3x flight tension for shape measurement by Lidar

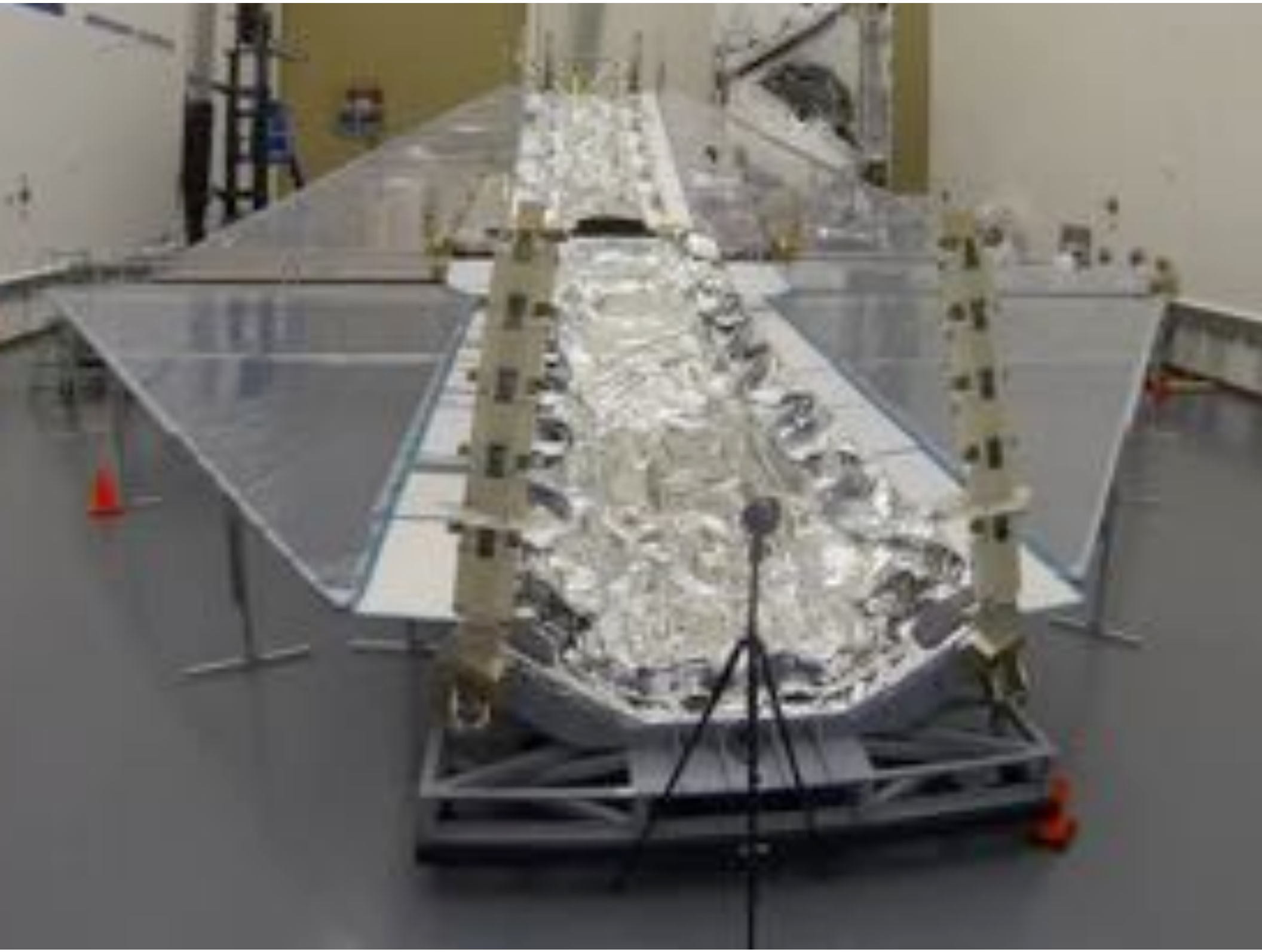
(3x tension counteracts gravity sag)

Sky Background

- JWST should be zodi-limited at λ < 10 μm
  - ➡ Background levels will include contribution from stray light
- NIR stray light is controlled by baffling and contamination control of optical surfaces e.g. OTE, baffles, & sunshield
- MIR stray light is controlled by thermal control of critical surfaces and contamination control of surfaces e.g.





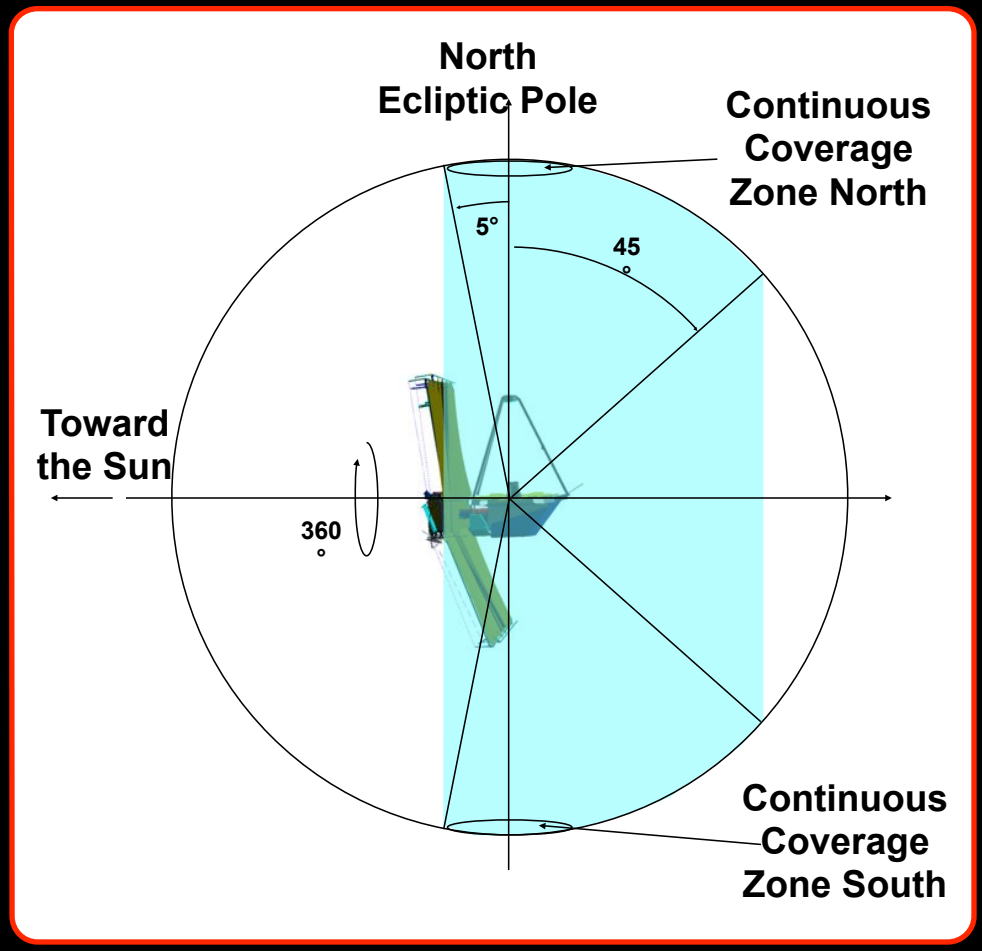


Spacecraft Bus Structure Complete

Spacecraft-Telescope: Fit Check

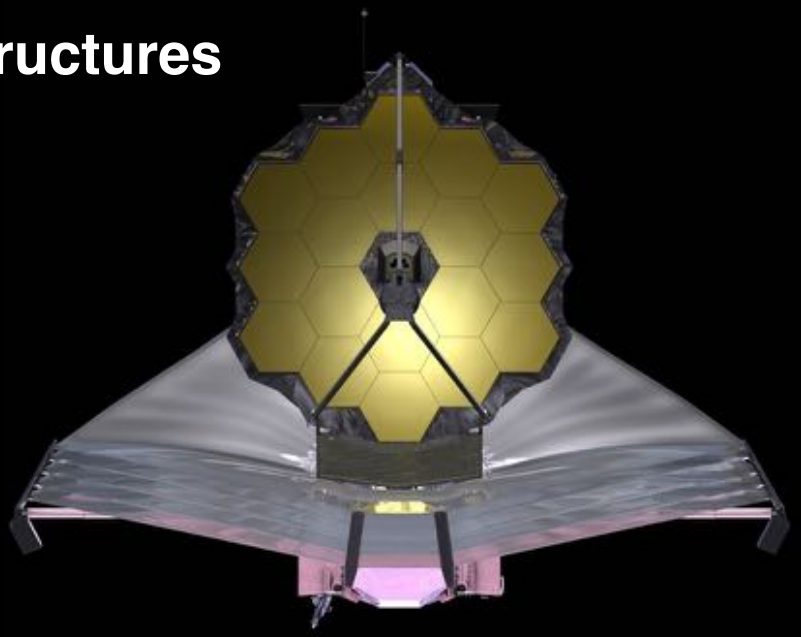
Observing Constraints

- Field of Regard is an annulus with rotational symmetry about the L2-Sun axis, 50° wide
- Sun angle constraints yield 35% instantaneous sky coverage
  - ➡ Full sky coverage achieved over a sidereal year
- Observations interrupted for:
  - ➡ Orbit maintenance
    - ➡ station-keeping burns
  - ➡ Momentum management
    - ➡ reaction desaturation burns

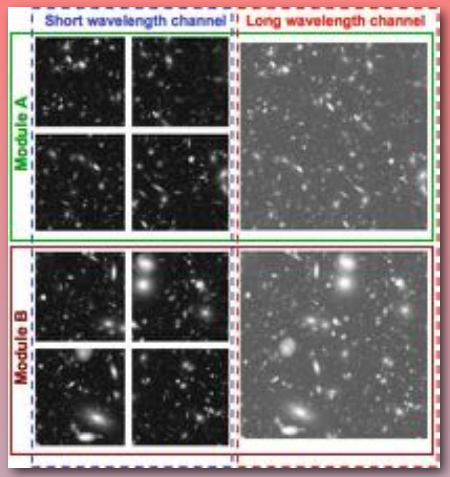


Sky Background & Stray Light

- JWST will be zodi-limited at λ < 10 μm
  - ➡ Background levels include contributions from stray light
  - ➡ NIR stray light is controlled by baffling and contamination control of optical surfaces e.g. OTE, baffles, & sunshield
  - ➡ MIR stray light is controlled by thermal control of critical surfaces and contamination control of surfaces:
    - primary mirror, sunshield & structures
- Near-IR (< 5 μm) stray light predictions meet requirements
- In mid-IR 10 μm and 20 μm meet requirements

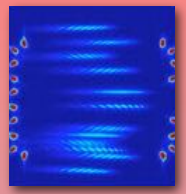


JWST's Science Instruments



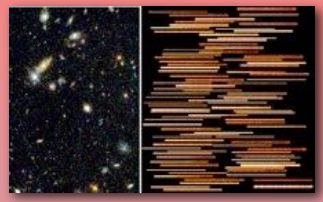
Deep, wide field imaging

WFSC

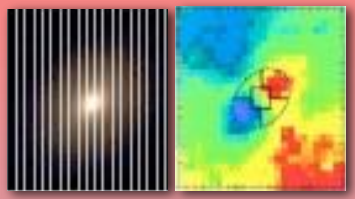


Coronagraphic Imaging

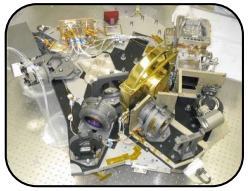
Multi-Object, IR spectroscopy



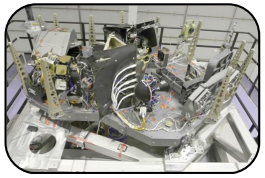
IFU spectroscopy



NIRCam

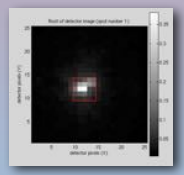


NIRSpec

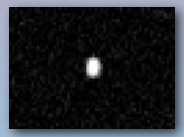


Long Slit spectroscopy

Fine Guidance Sensor

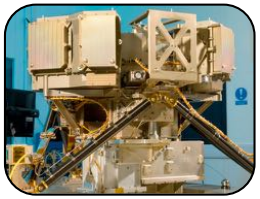


Moving Target Support



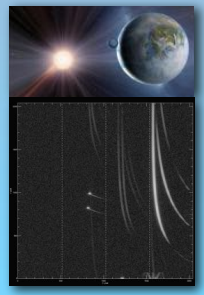
FGS/NIRISS

MIRI



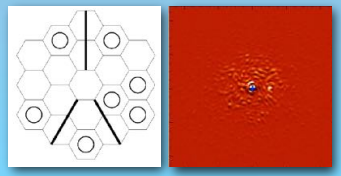
Mid-IR, wide-field Imaging

Slitless Spectroscopy



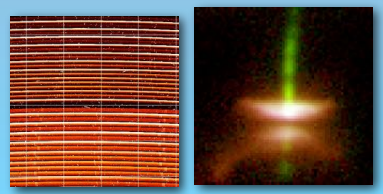
Near-IR imaging

High Contrast Imaging



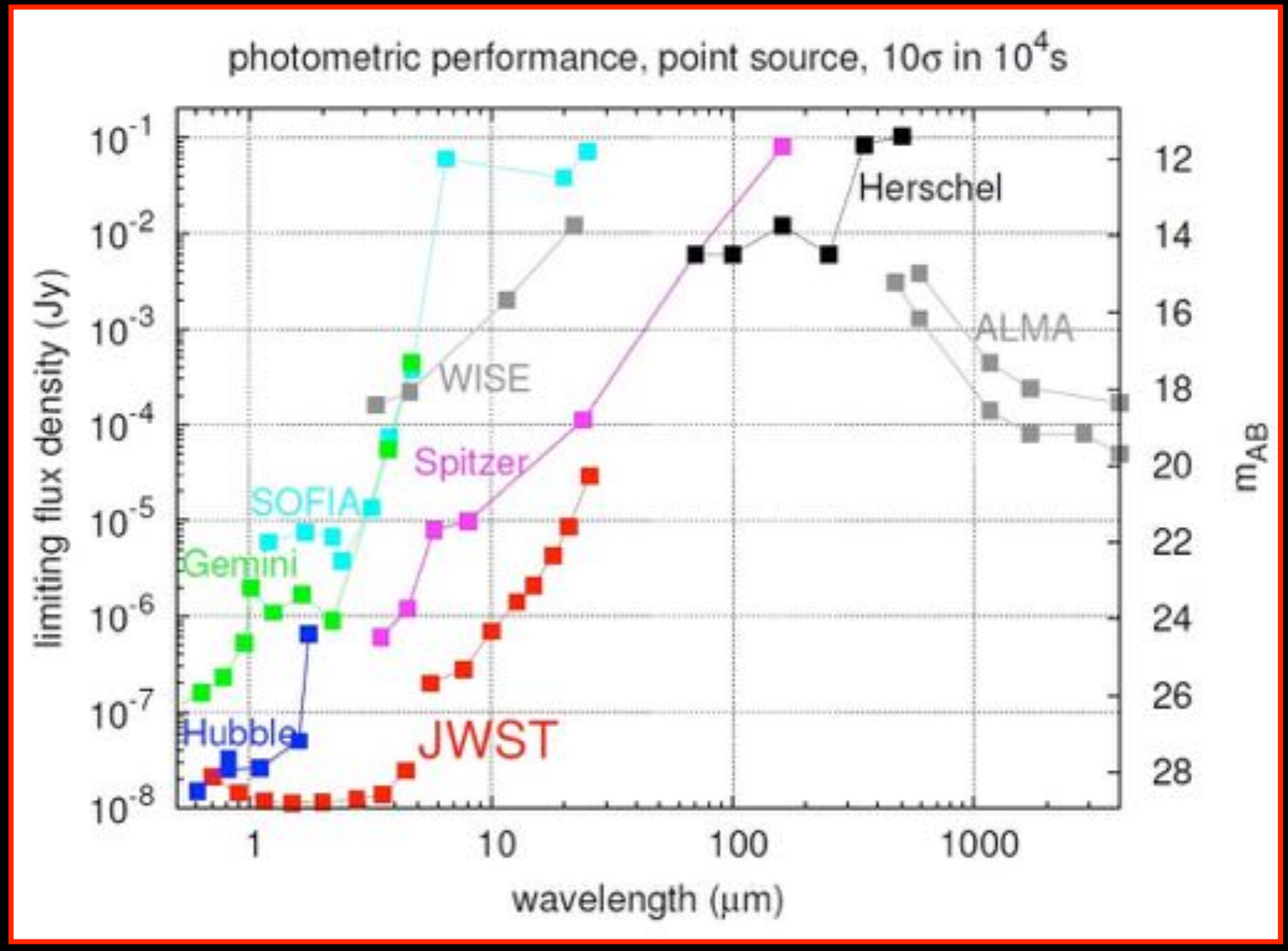
Mid-IR Coronagraphic

IFU spectroscopy

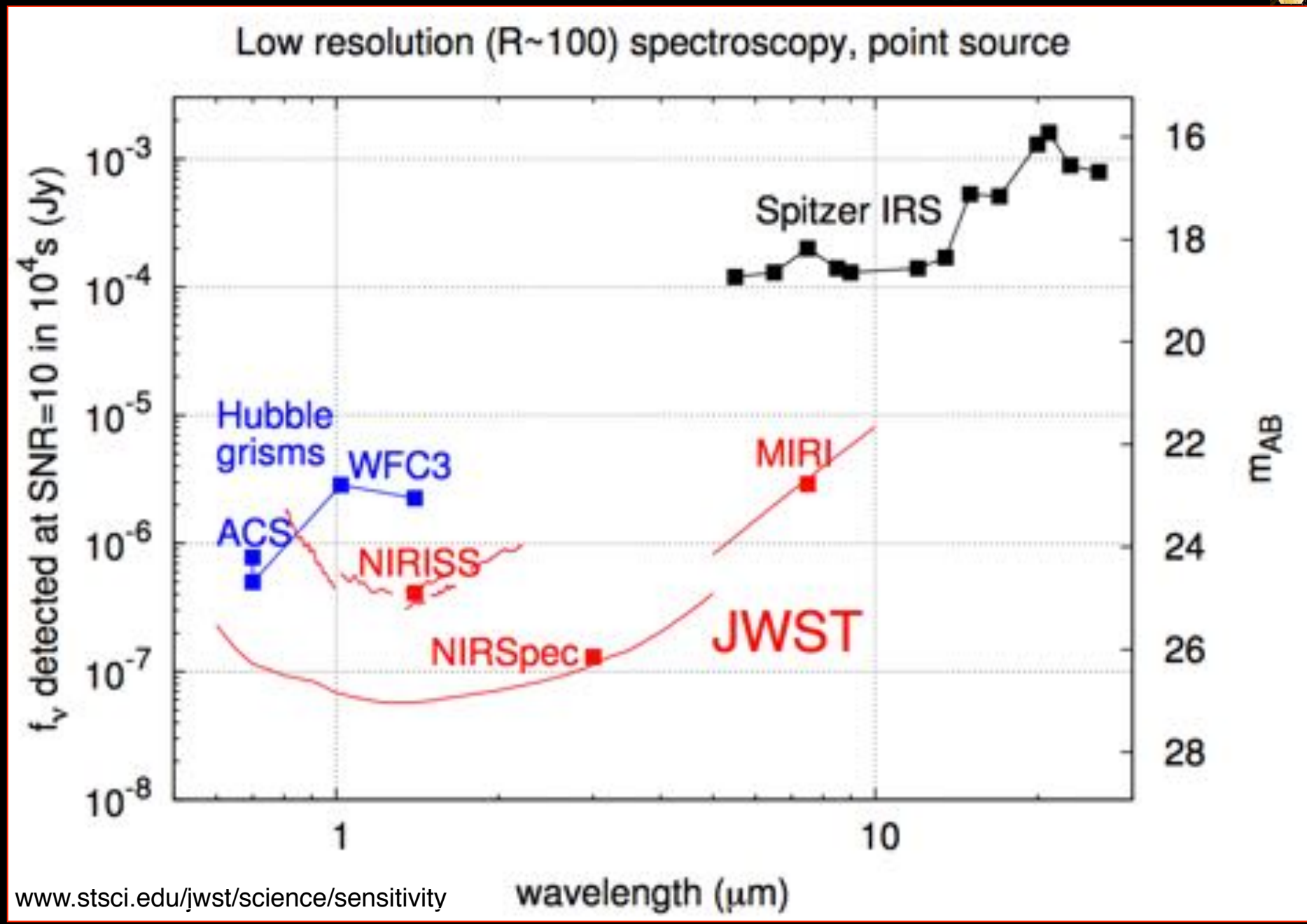


Observatory Sensitivity: Imaging

- Point source detected at 10 sigma for a 10^4 s integration



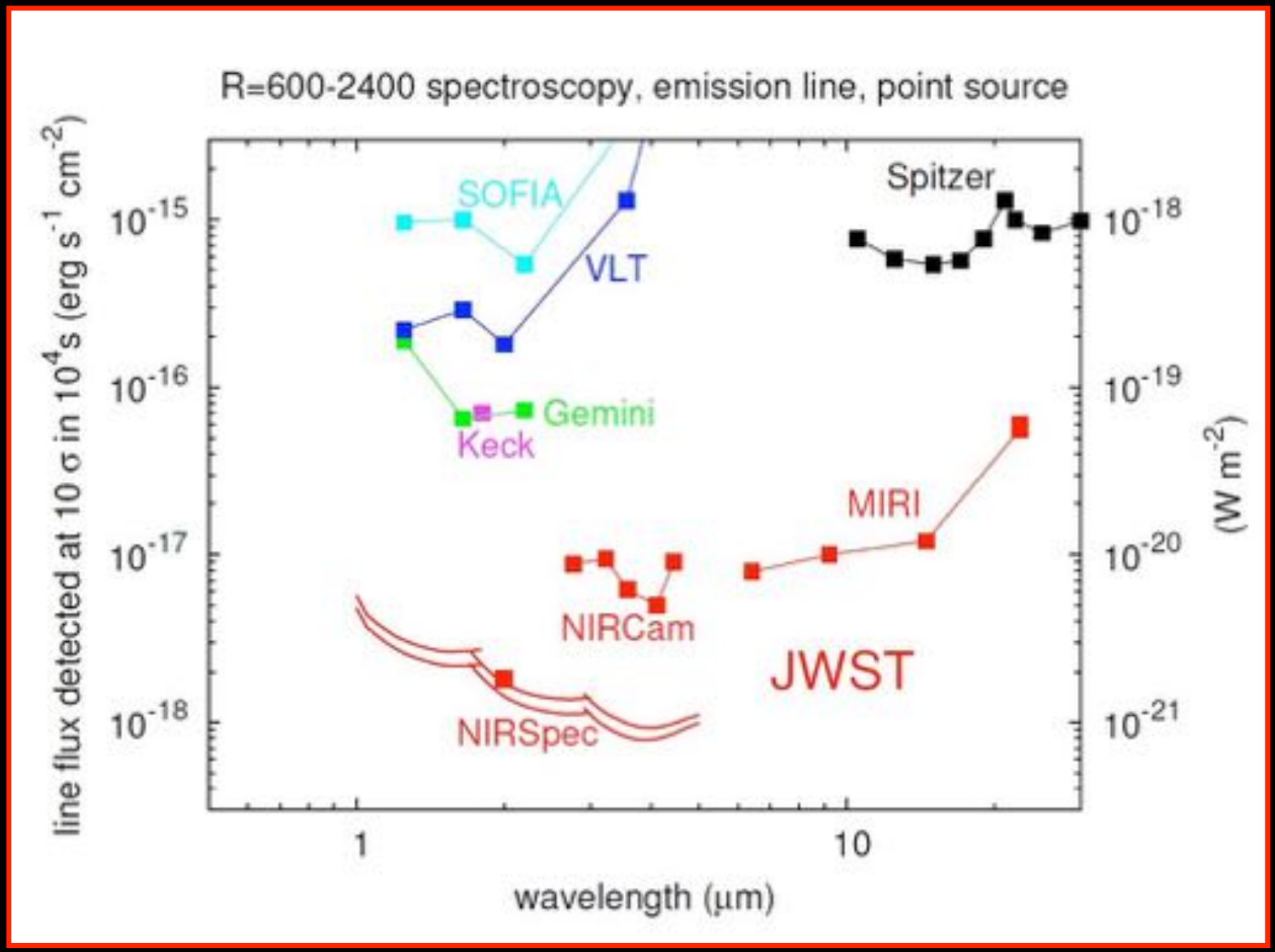
Observatory Sensitivity:



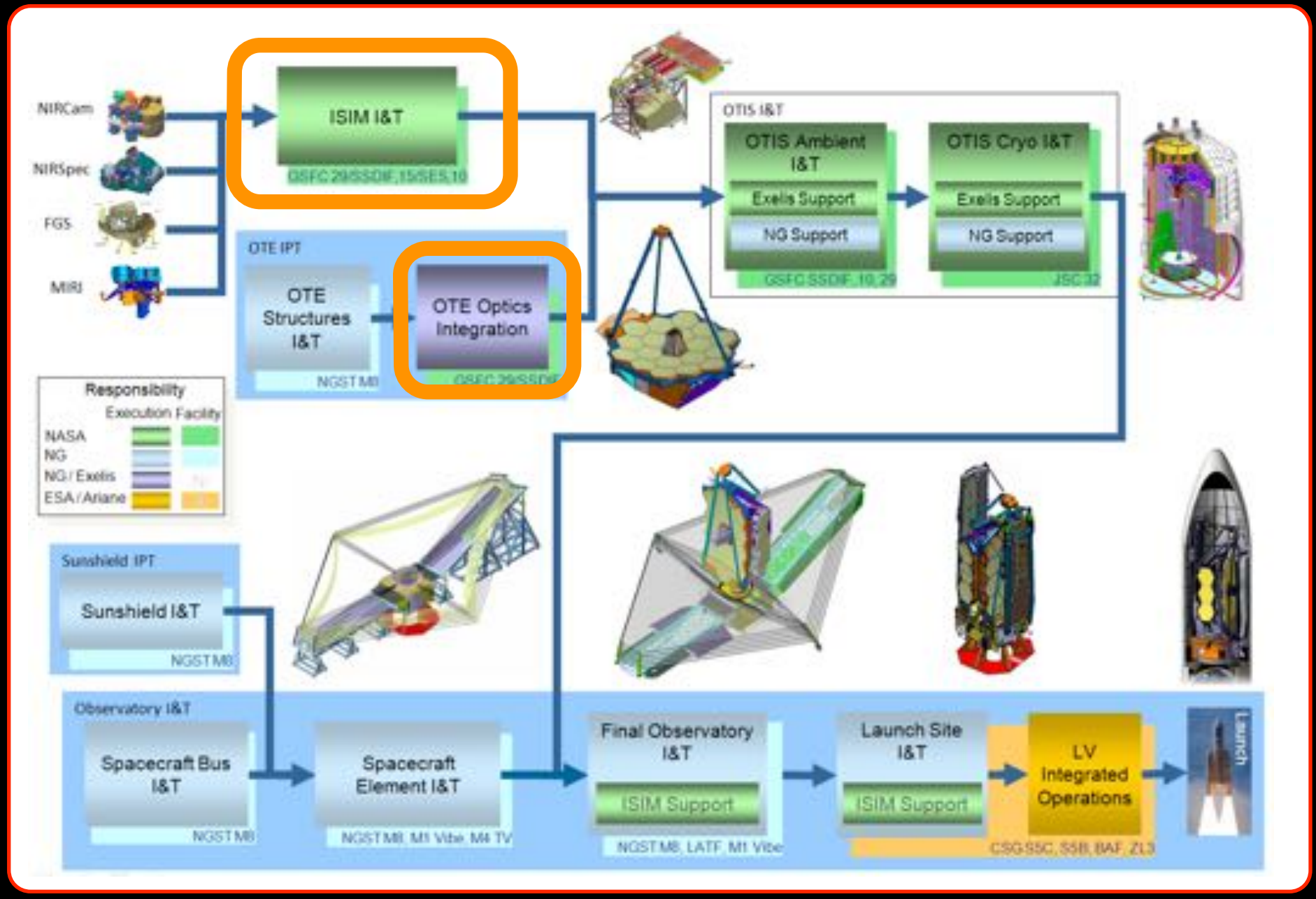
www.stsci.edu/jwst/science/sensitivity

Observatory Sensitivity

- Line flux that can be detected at 10σ for a point source in 10^4 s

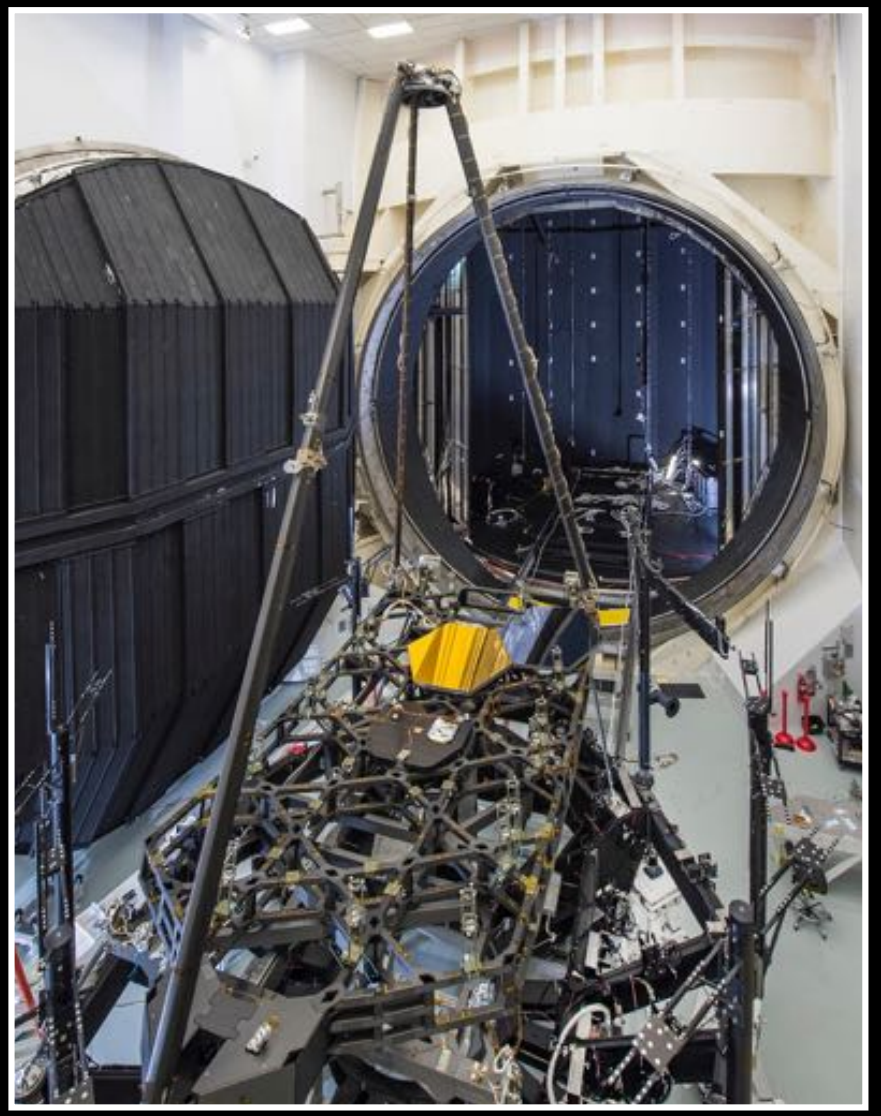


JWST Integration: Path to Launch



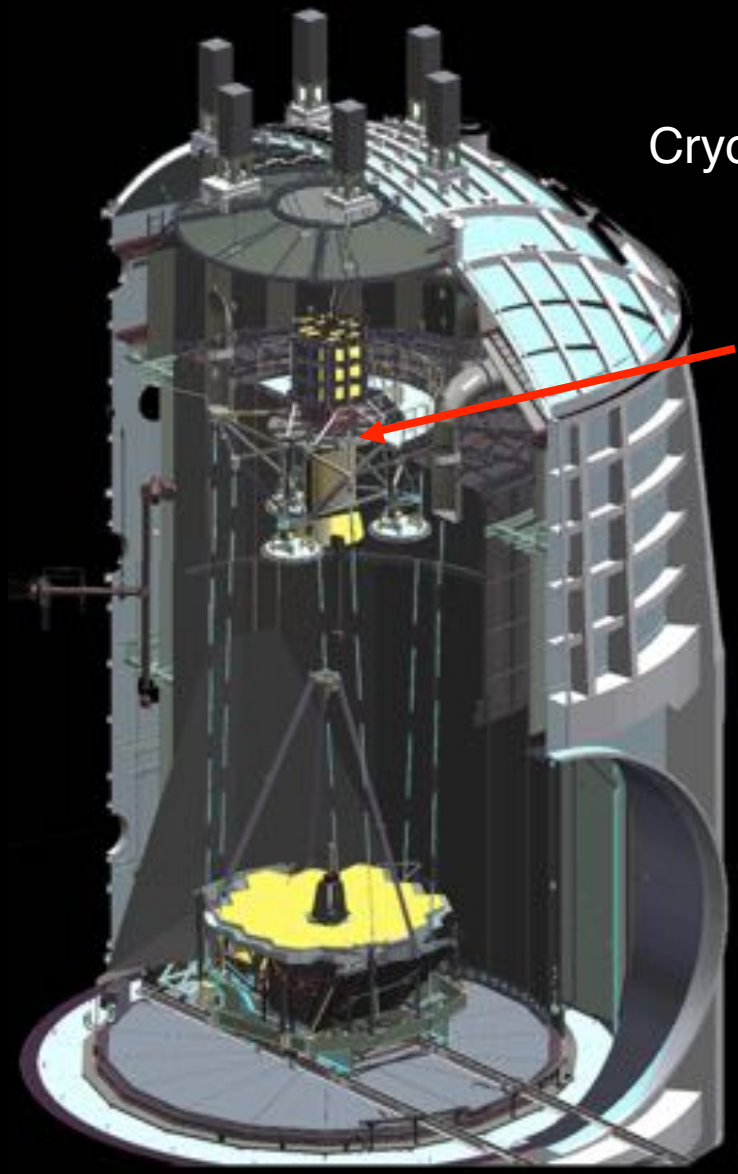
How Do We Test the Telescope ?

- Cryogenic Optical Test will be conducted at JSC's Chamber A
- Goals of Cryogenic Optical Test
  - ➡ **Optical workmanship** - check on assembly of the telescope e.g. mechanical interference
  - ➡ **Optical alignment** - are we inside the capture range of the telescope's active optics ?
  - ➡ **Thermal balance** - will the telescope cool to 40K ?



OTIS Test Preparations

Chamber Isolator Units

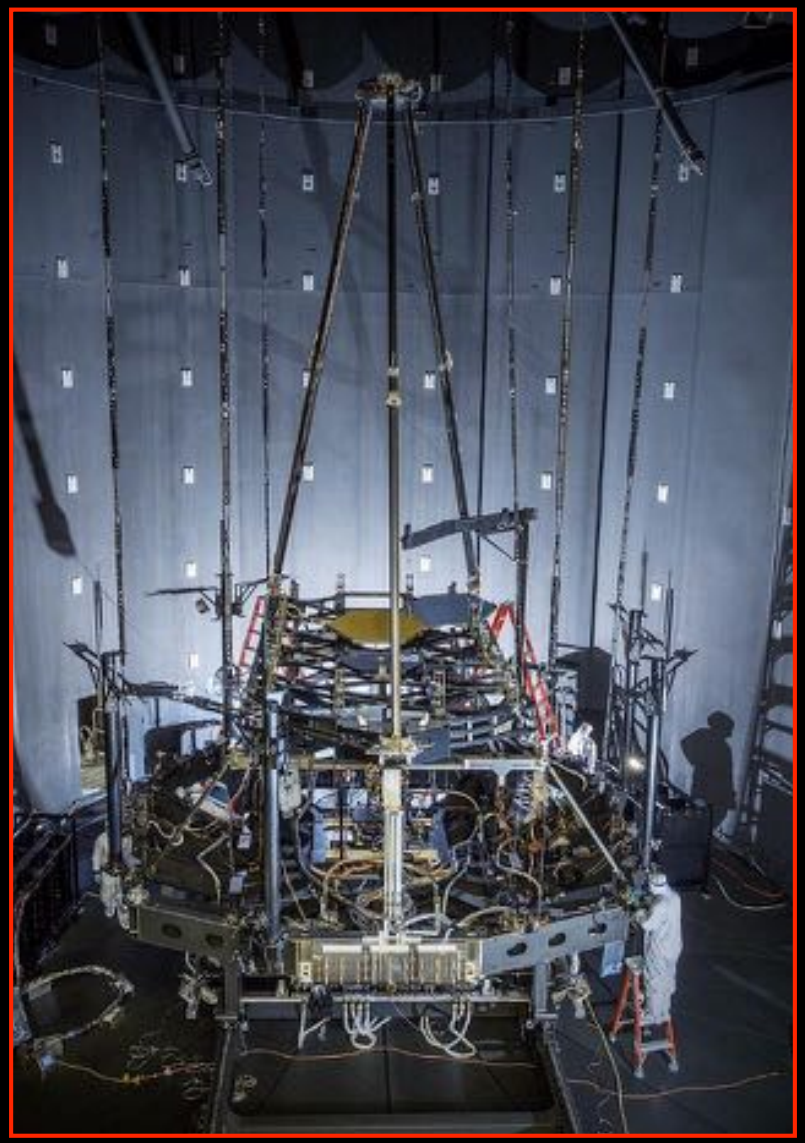


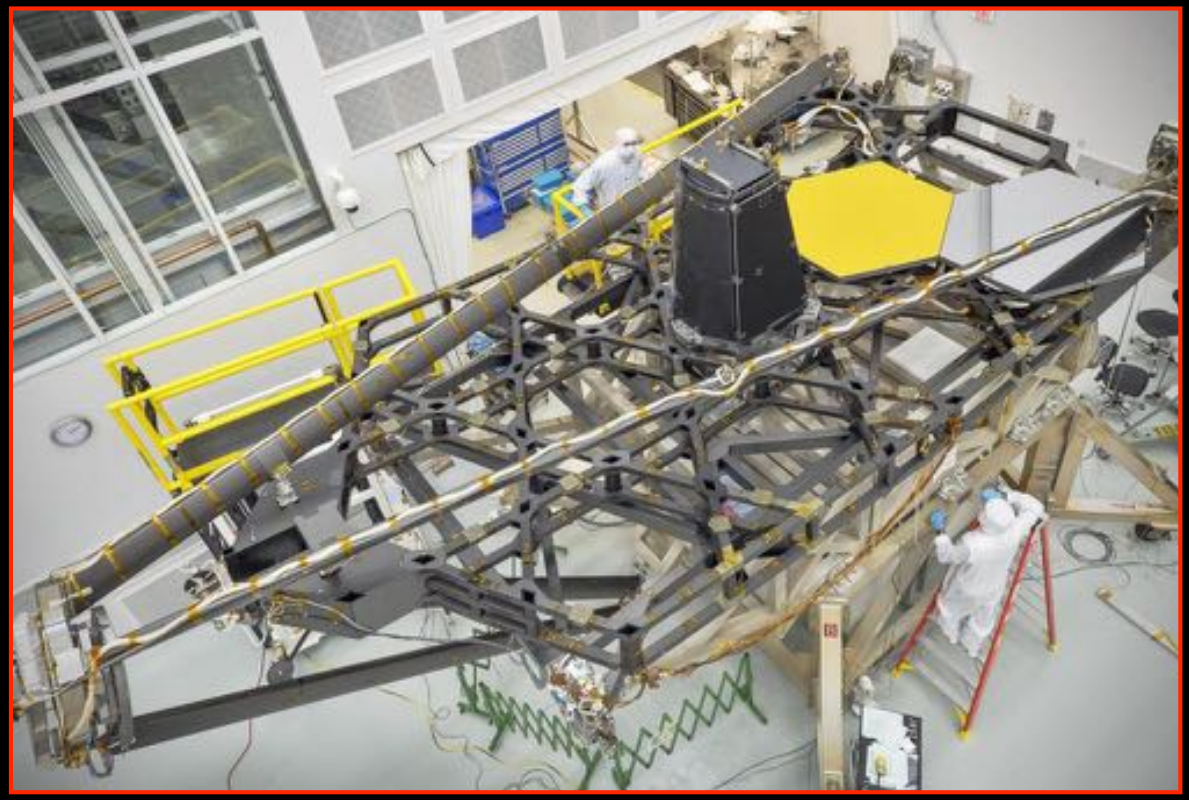
Cryo Position Metrology

Center of Curvature Optical Assembly

Dry Run testing w/Chamber-A

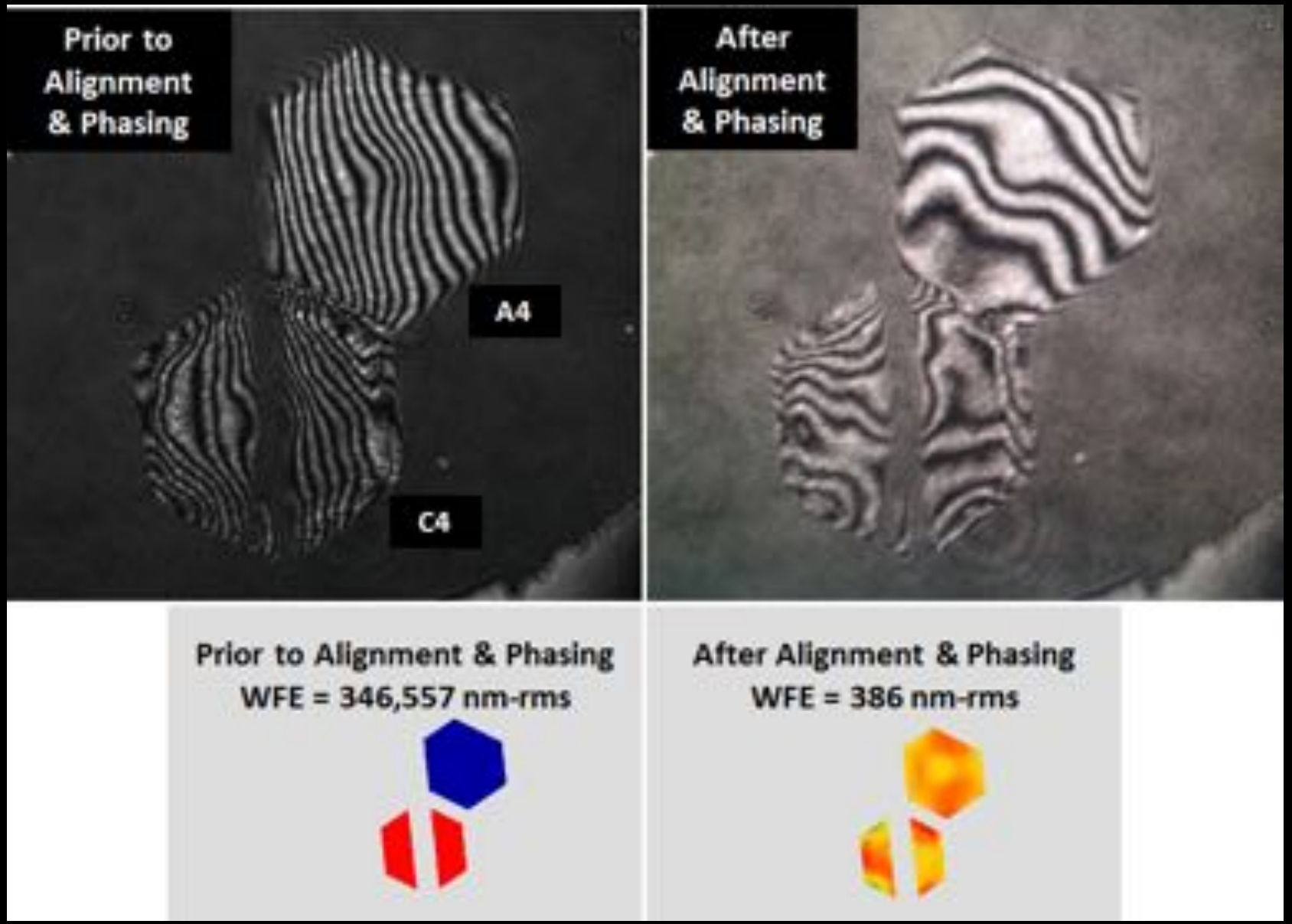
➡ 1) First dry run test- phasing mirrors





➡ 2) Dry run imaging with flight AOS

➡ 3) Test thermal monitoring equipment


Prior to Alignment & Phasing
A4
C4
After Alignment & Phasing
Prior to Alignment & Phasing
WFE = 346,557 nm-rms
After Alignment & Phasing
WFE = 386 nm-rms

Overall Commissioning Schedule

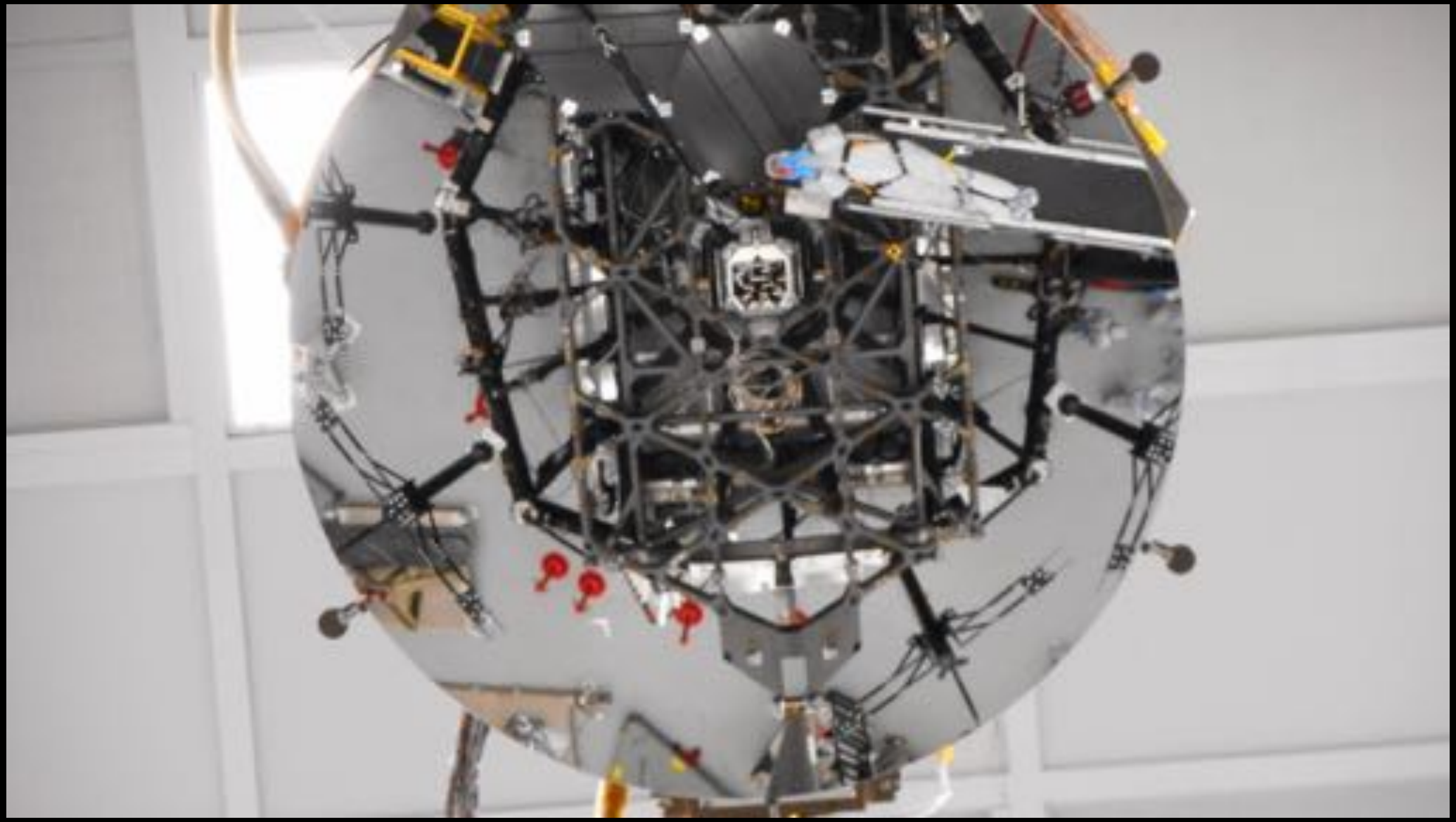
Month 1	Month 2	Month 3	Month 4	Month 5	Month 6

Observatory Deployments

Telescope Phasing

Observatory& Instrument Commissioning

- Phased Instrument power-on with Temp.
- Observatory check-out & calibrations
  - ➡ Attitude control, acquisition, thermal ....
- Instrument check-out and calibration




JWST will do transformational science and change our view of the Universe
JWST ➠ Launch 2018
JWST
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Where To Follow JWST

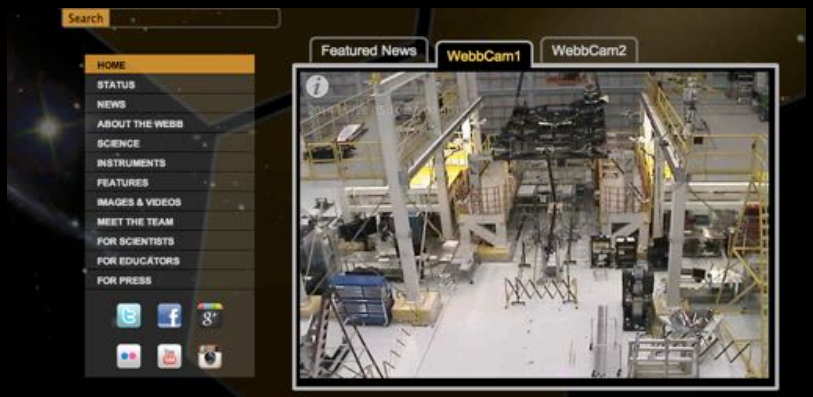
Web pages

www.jwst.nasa.gov

webbtelescope.org

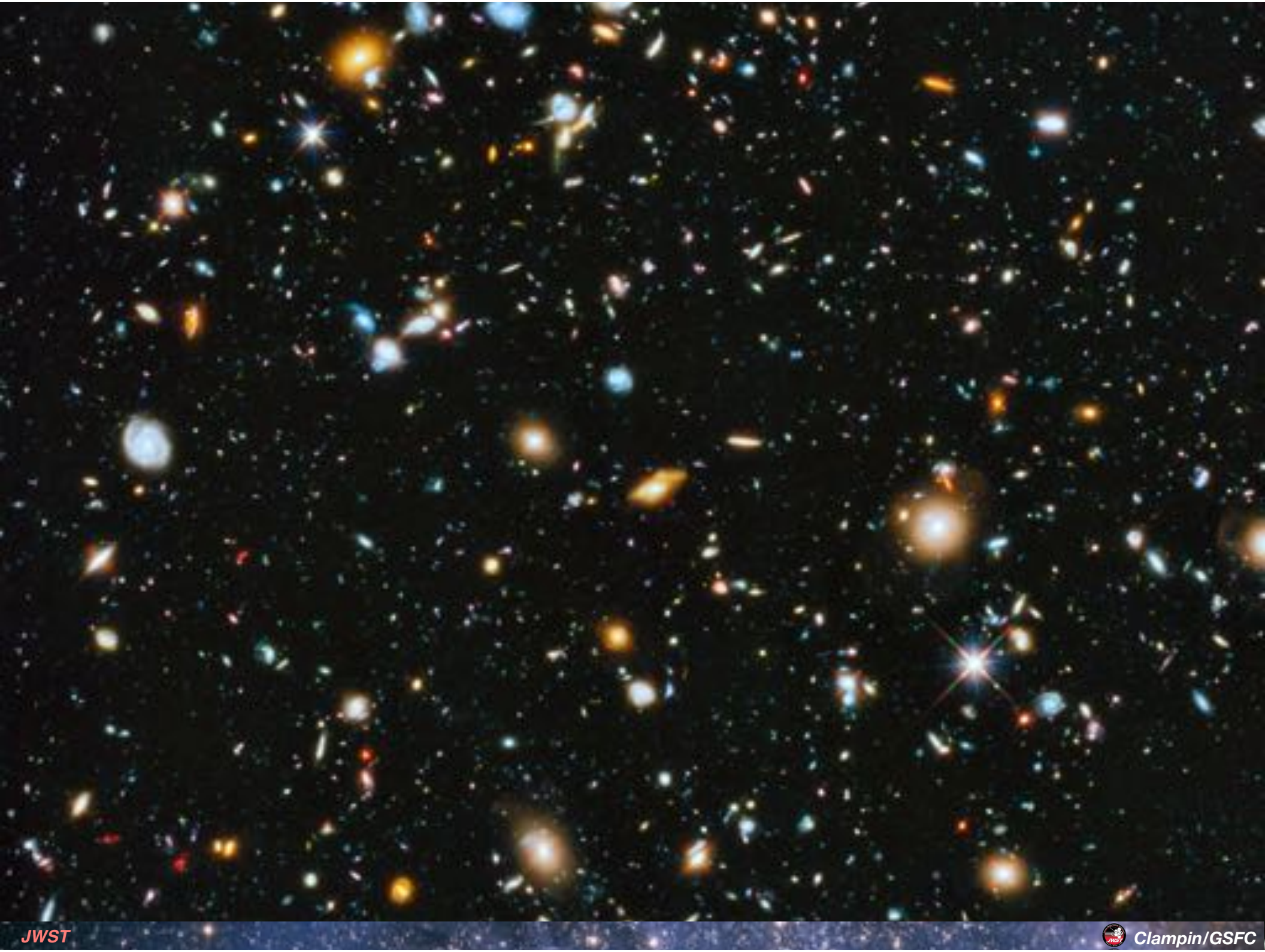
Social Media

Webcam



www.jwst.nasa.gov/webcam.html

ibook ➠ itunes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