# The James Webb Space Telescope Mission

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UN Committee on Peaceful Use of Outer Space
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**@NASAWebbTelescp**
**#JWST**

# Webb Science

- What if you could see the Universe create the first stars?
- What if you could study planets around other stars to look for life?

- We are building a telescope that will let you do this and more:

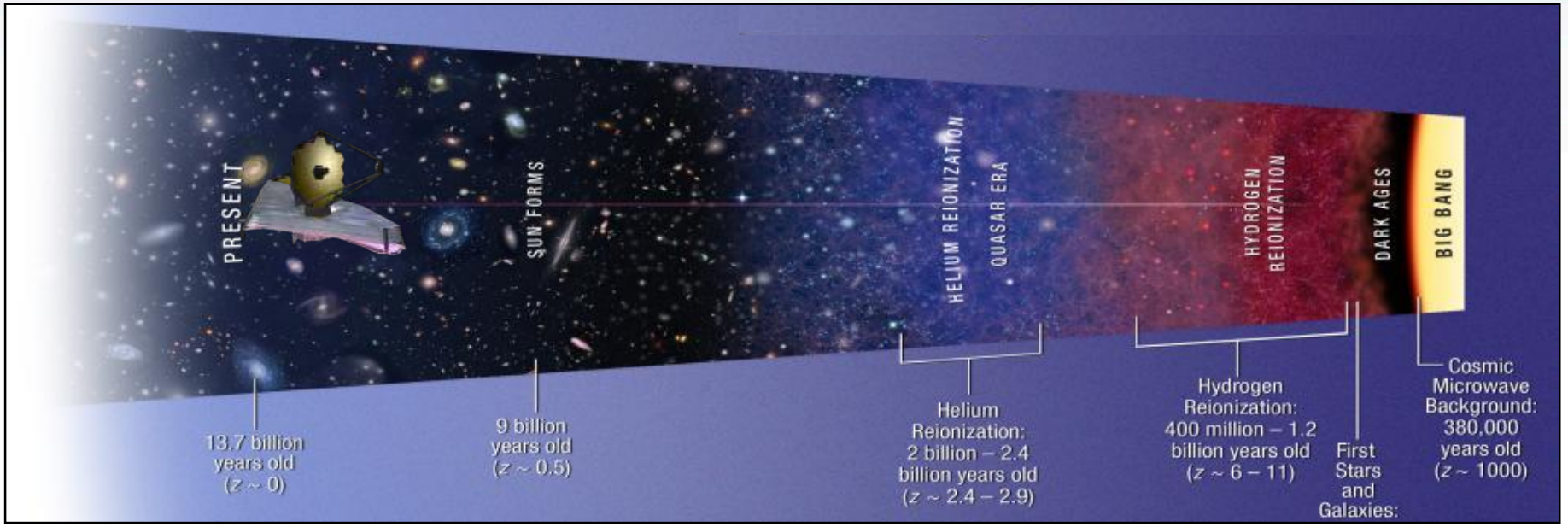
First Light & Reionization

Planets & Origins of Life

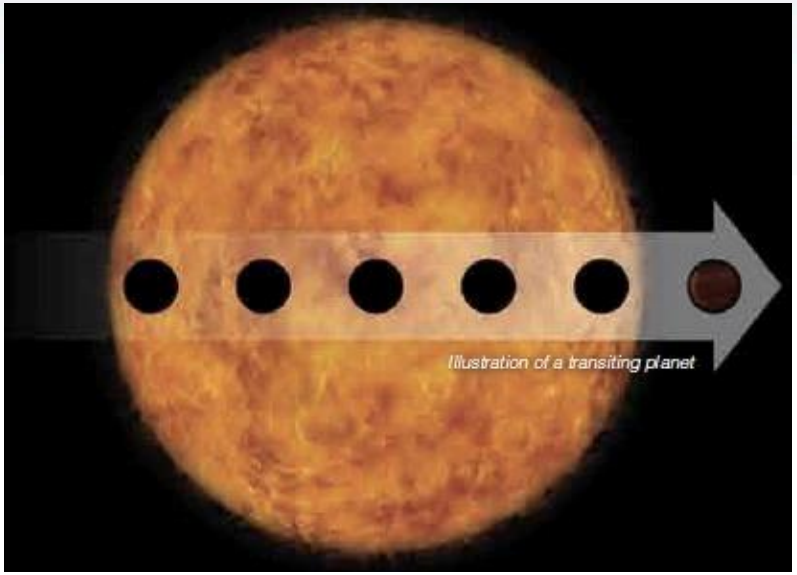
Birth of Stars & Planetary Systems

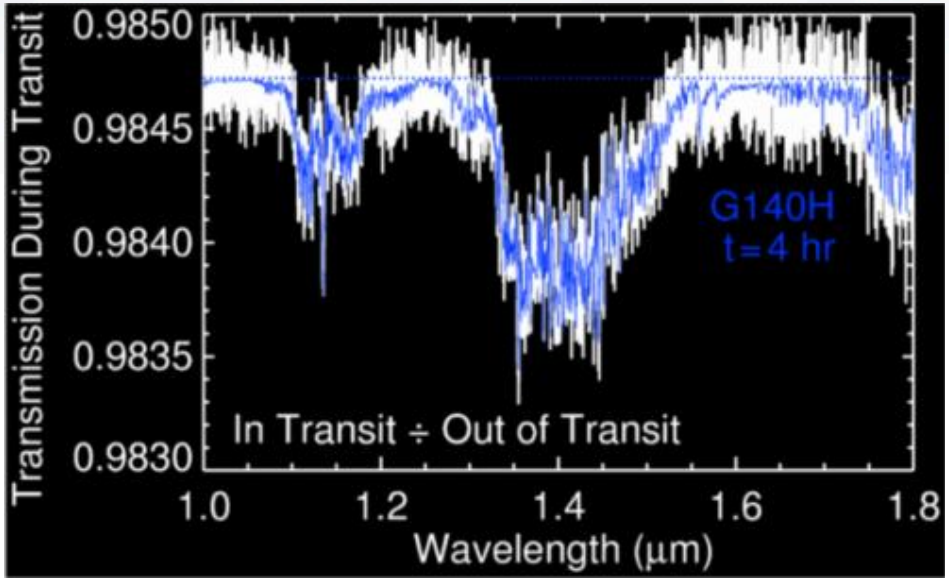
Assembly of Galaxies

# First Light and Reionization



# Planets and the Origins of Life



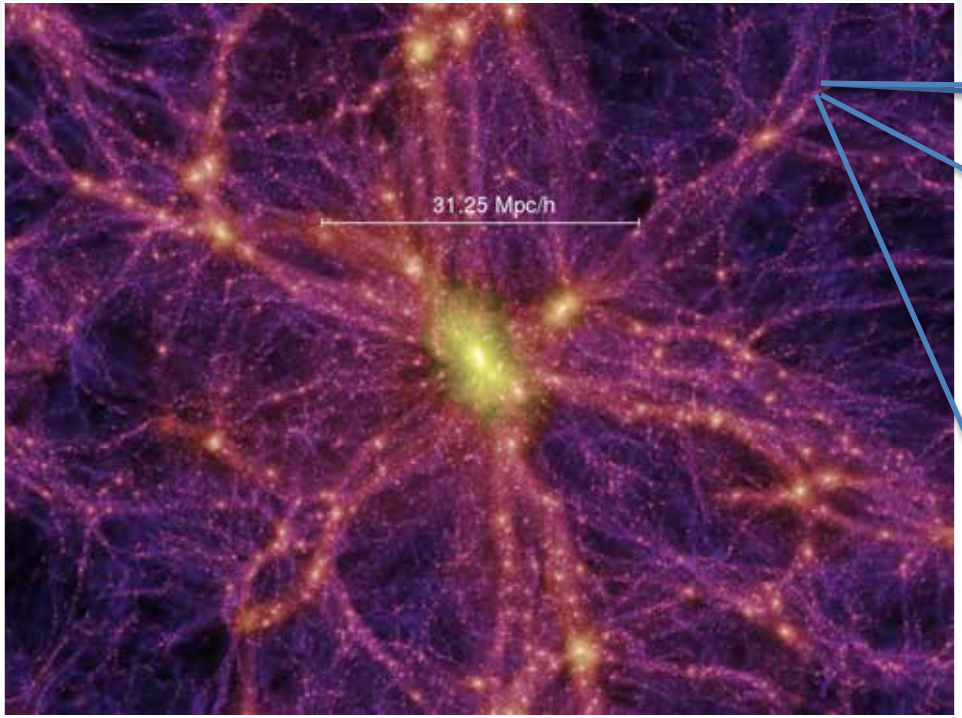

Atmospheric transmission spectrum (4 hours) for HD209458-like Kepler source using NIRSpec (*R* = 3000).
Simulation from J. Valenti

# Birth of Stars and Planetary Systems

Star formation region
in visible light

Same region
in infrared light

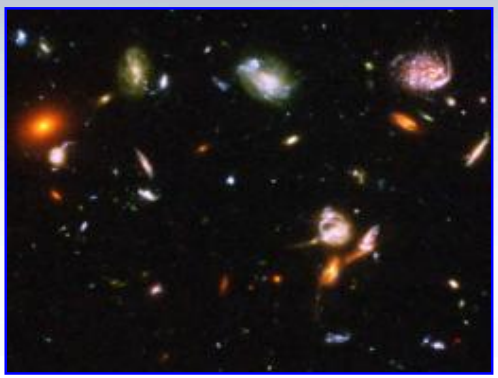
# Assembly of Galaxies



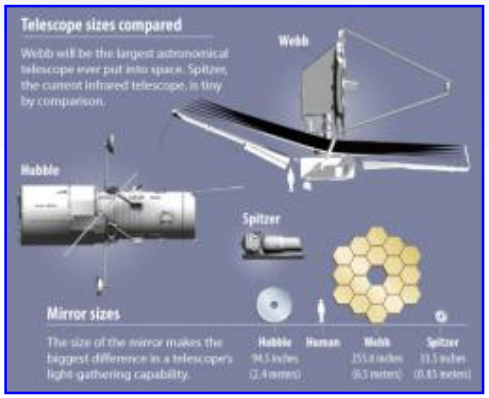

Simulation of filaments of
forming galaxies in the early universe

Observations of galaxies
through cosmic time

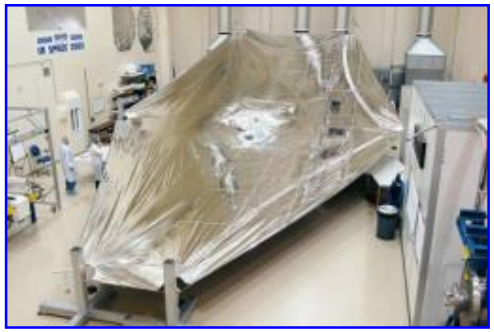
# Key Design Drivers



Sensitivity;
- Detection of First Galaxies




Aperture
- Collection area 25 $m^2$
- Diffraction limited @ 2 μm



Low Backgrounds
- Cryogenic observatory
- Passive cooling

Stowable/Deployable Architecture
- Telescope stowed for launch

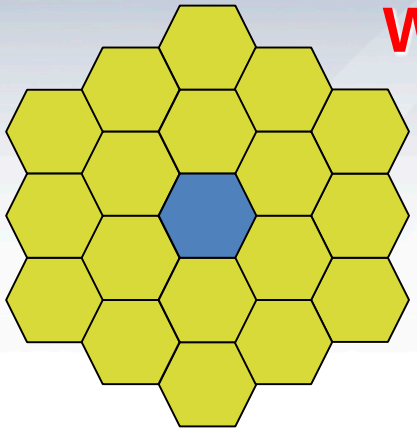
# Webb and its Precursors

## HUBBLE

2.4-meter
T ~ 270 K

123” x 136”
λ/$D_{1.6\mu m}$~ 0.14”

## WEBB



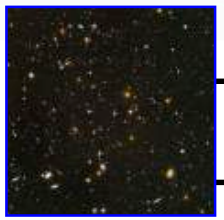
6.5-meter
T ~ 40 K

114” x 84”
λ/$D_{20\mu m}$~ 0.64”

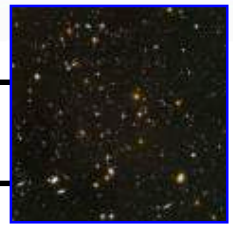
132” x 264” λ/$D_{2\mu m}$~ 0.06”

## SPITZER

0.8-meter
T ~ 5.5 K

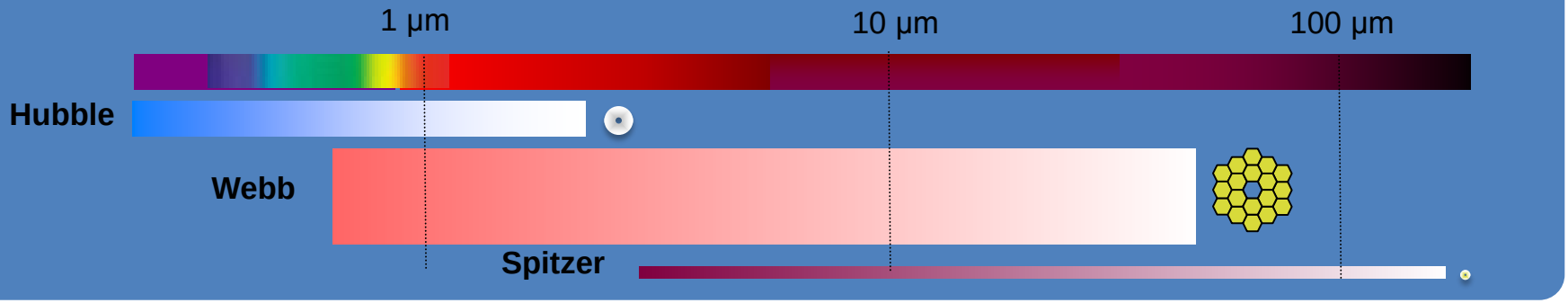


312” x 312”
λ/$D_{5.6\mu m}$~ 2.22”



324” x 324”
λ/$D_{24\mu m}$~ 6.2”

Wavelength Coverage



# The Webb space vehicle consists of three elements

**Optical Telescope Element (OTE)**
Collects star light from distant objects

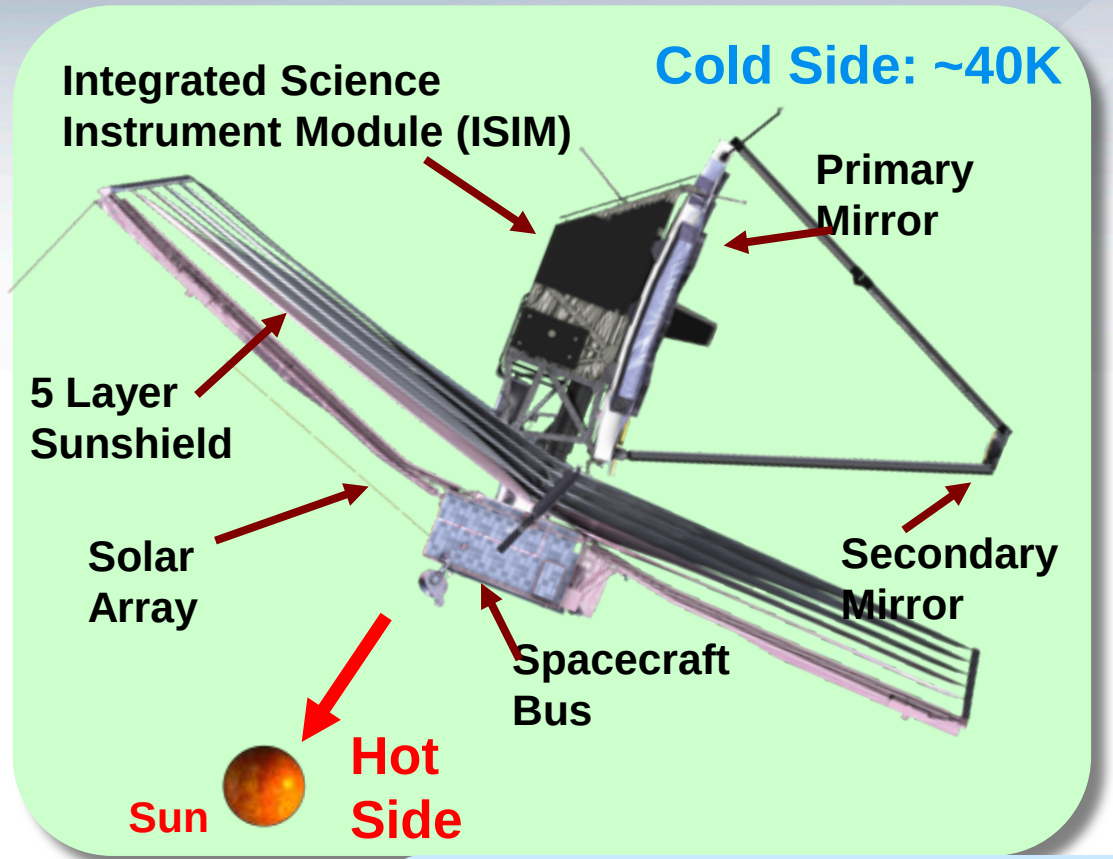
**Integrated Science Instrument Module (ISIM)**
Extracts physics information from star light

**Spacecraft**
Attitude control, telecom, power & other systems



**Webb telescope at Goddard Space Flight Center**

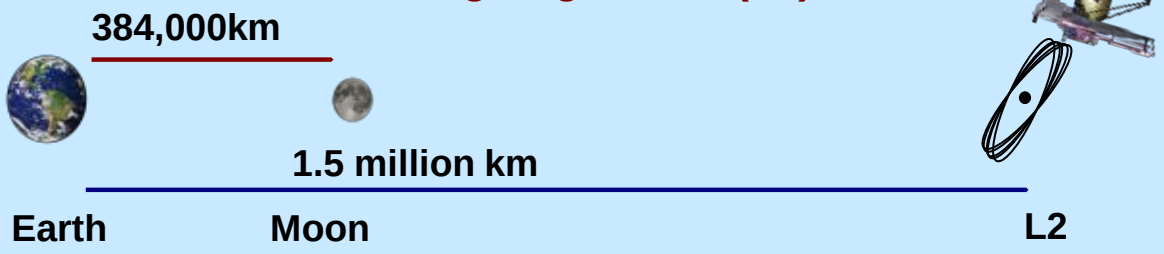
# How the Webb Telescope Works




Webb is folded and stowed for launch

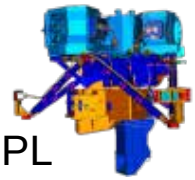
Observatory is deployed after launch

## Webb Orbits the 2nd Lagrange Point (L2)

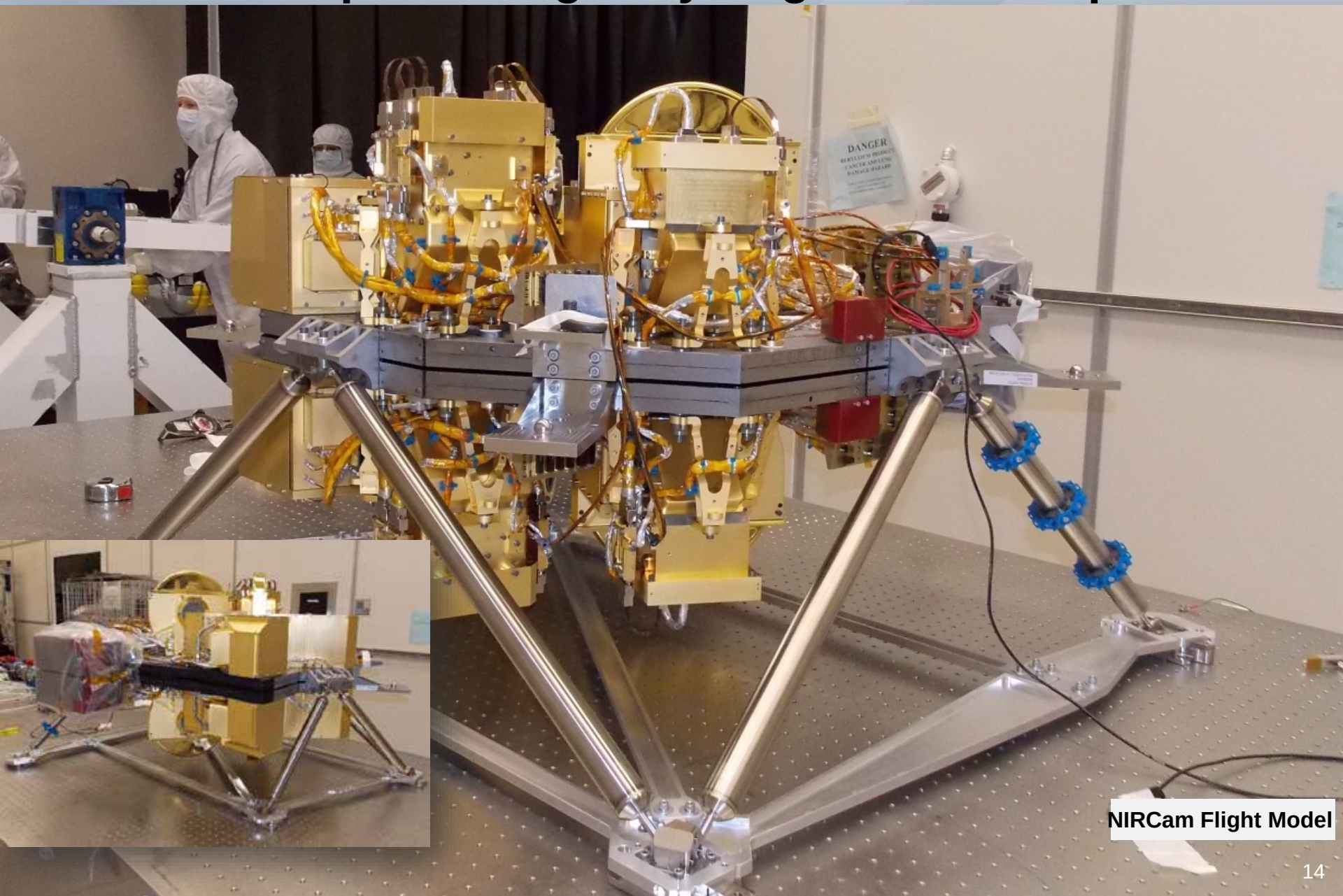


# Completed Telescope

# Webb Instrumentation

| Instrument | Science Requirement | Capability |
|---|---|---|
| **NIRCam**<br>Univ. Az/LMATC  | Wide field, deep imaging<br>› 0.6 μm - 2.3 μm (SW)<br>› 2.4 μm - 5.0 μm (LW) | Two 2.2' x 2.2' Ω (SW)<br>Two 2.2' x 2.2' Ω (LW)<br>Coronagraph |
| **NIRSpec**<br>ESA/Astrium  | Multi-object spectroscopy<br>› 0.6 μm - 5.0 μm | 9.7 Sq arcmin Ω + IFU + slits<br>100 selectable targets: MSA<br>R=100, 1000, 3000 |
| **MIRI**<br>ESA/UKATC/JPL  | Mid-infrared imaging<br>• 5 μm - 27 μm<br><br>Mid-infrared spectroscopy<br>› 4.9 μm - 28.8 μm | 1.9' x1.4' with coronagraph<br><br>3.7"x3.7" – 7.1"x7.7" IFU<br>R=3000 - 2250 |
| **FGS/NIRISS**<br>CSA  | Fine Guidance Sensor<br>› 0.8 μm - 5.0 μm<br>Near IR Imaging Slitless Spectrometer,<br>› 1.6 μm - 4.9 μm | Two 2.3' x 2.3'<br><br>2.2' x 2.2'<br>R=100 with coronagraph |

# NIRCam provides the deepest near-infrared images ever and identifies primeval galaxy targets for NIRSpec

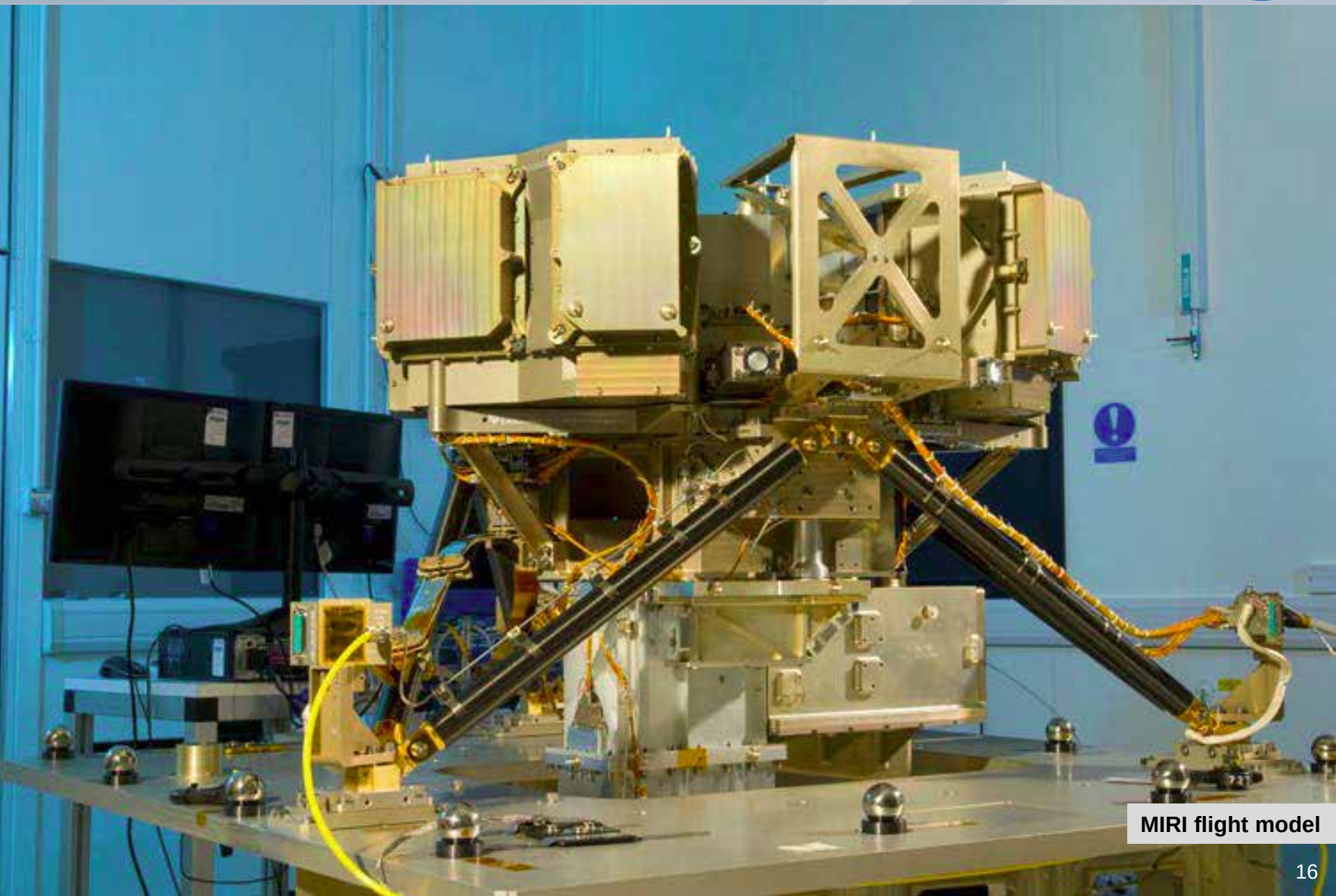



NIRCam Flight Model

# NIRSpec acquires spectra of up to 100 galaxies in a single exposure


FM2 test Jan 2013

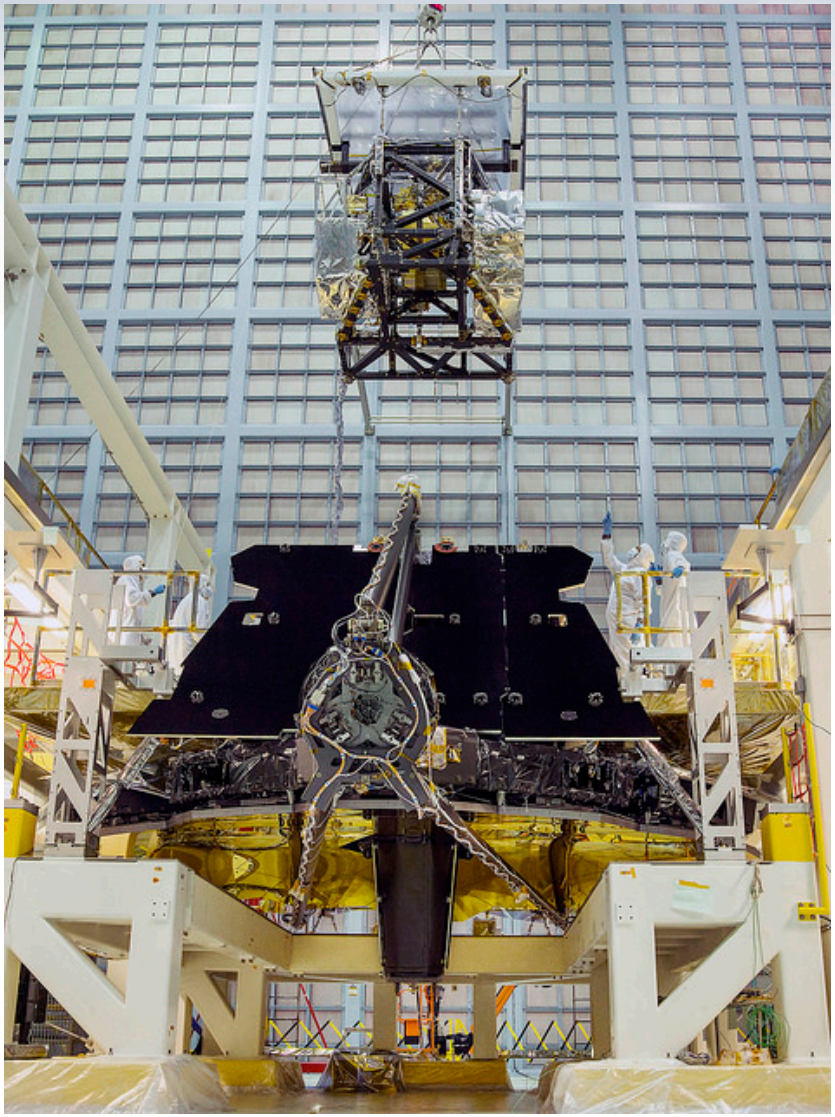
# MIRI will provide humanity's first high definition view of the mid-infrared universe



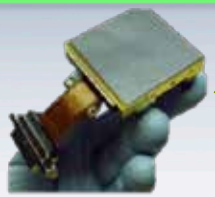
MIRI flight model

# FGS senses pointing to 1 millionth degree precision NIRISS images exoplanets that are too close to their star for coronagraphs

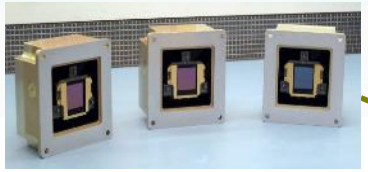
# Instruments Being Installed



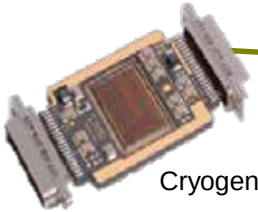
# Technological Advances



Advanced Near Infrared detectors



Advanced Mid-Infrared detectors



Cryogenic ASICs

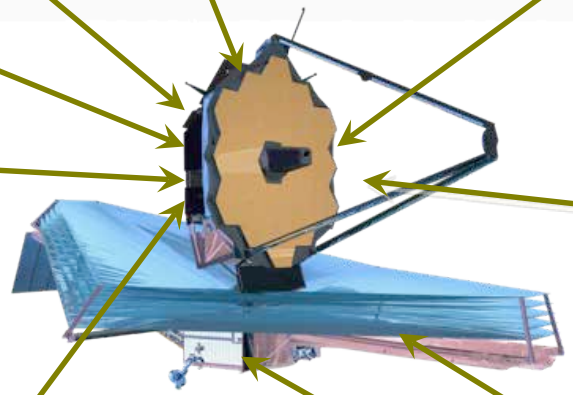
Ultra-sensitive detectors on Webb could see a single candle on the Moon from 1 million km.

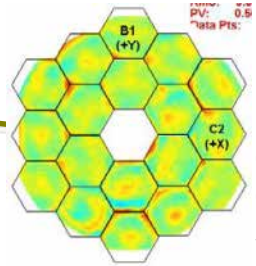
Mirror Support Structure

Structures hold mirrors and science instruments super stable, behavior must be known to ~38 nanometers (~1/10,000th of a human hair!)

Segmented Beryllium Mirror

Mirrors so smooth that if "stretched" to the size of the continental US largest deviation from perfection would be ~2 inches in height.

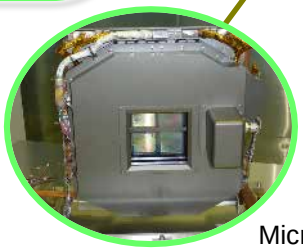





18 mirror segments computer controlled to operate as one mirror in space

Mirror phasing and control

A cooler to chill the mid-infrared detectors to just 6 degrees above absolute zero.



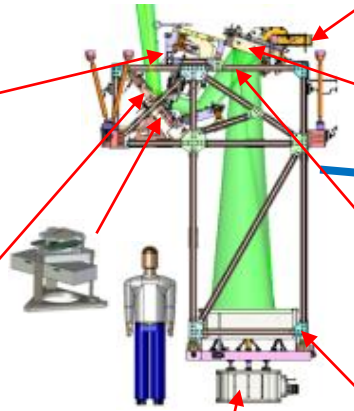
Microshutters

~100,000 computer controlled shutters, the width of a human hair enable optimal science return

Sunshield Membrane

5 thin membranes (each less than half the thickness of a piece of paper) protect the side in the extreme of cold space from the warm sunlit side [Equivalent Sun Protection Factor (SPF) of 1,000,000]

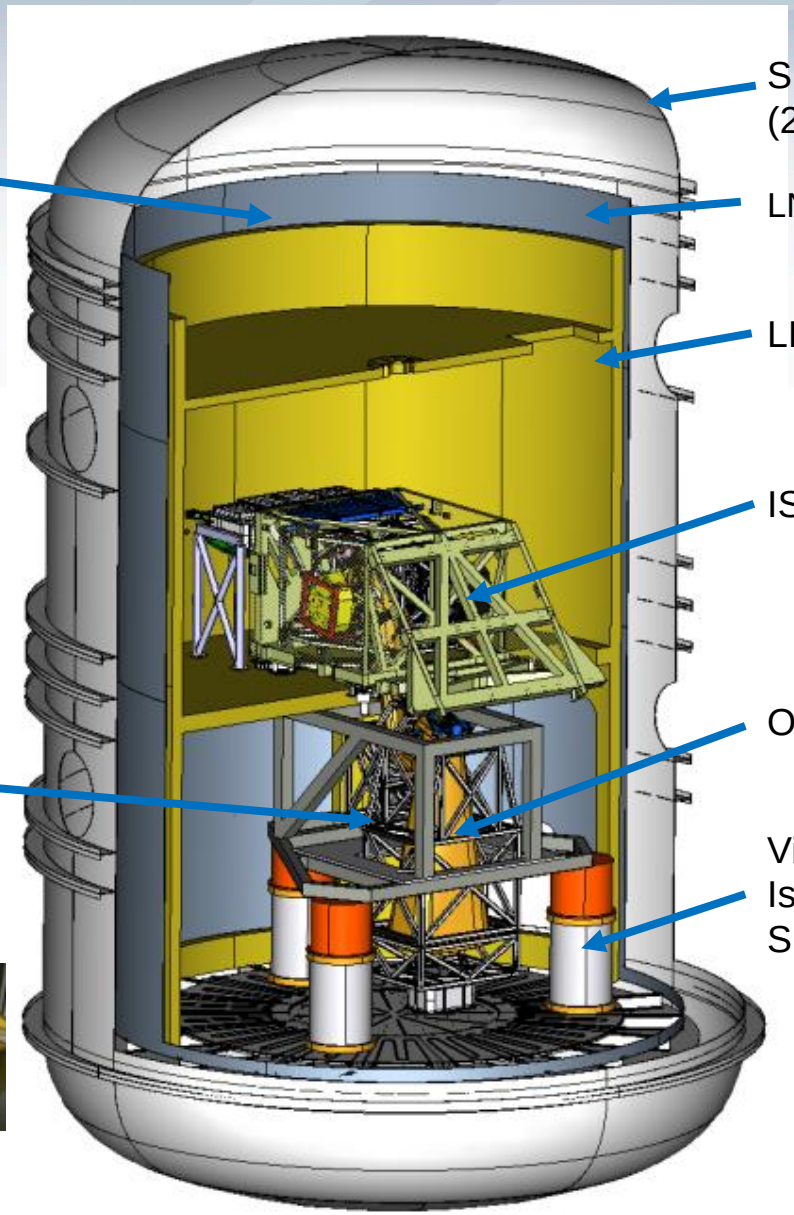
# ISIM was tested at ~35 K in the GSFC SES chamber using a cryogenic telescope simulator (OSIM)



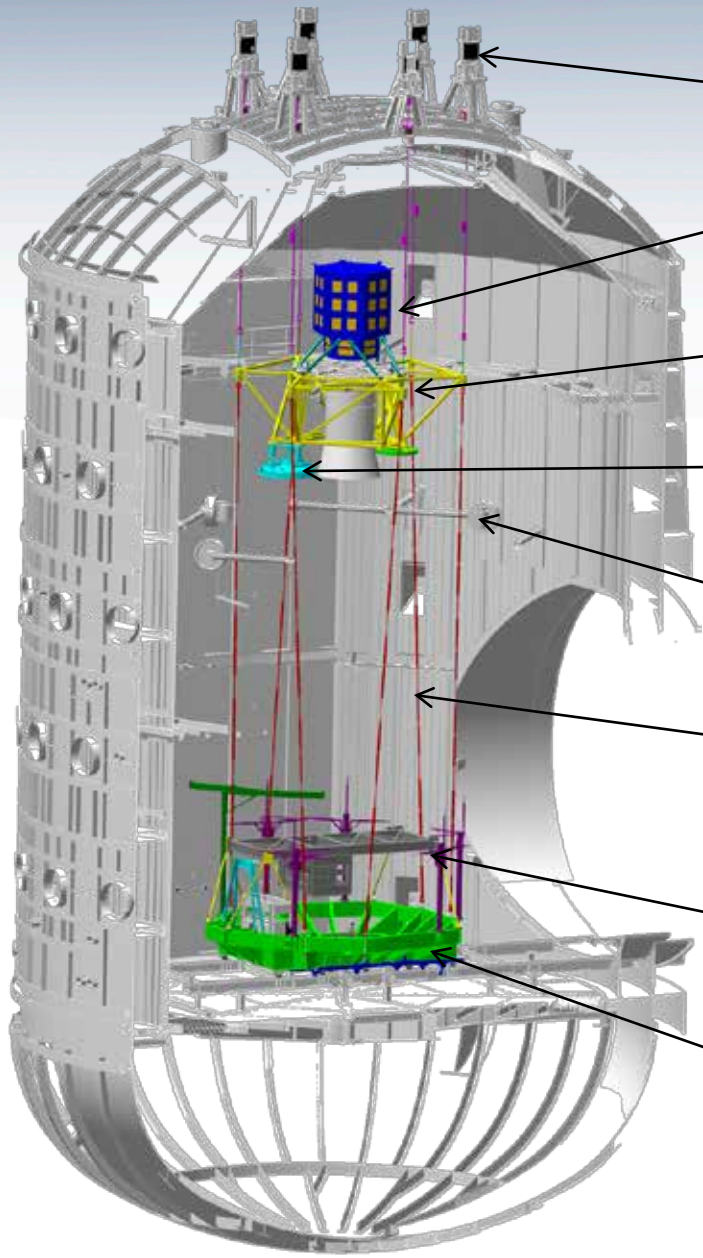
Fold Mirror 3 Tip/Tilt Gimbal Assembly

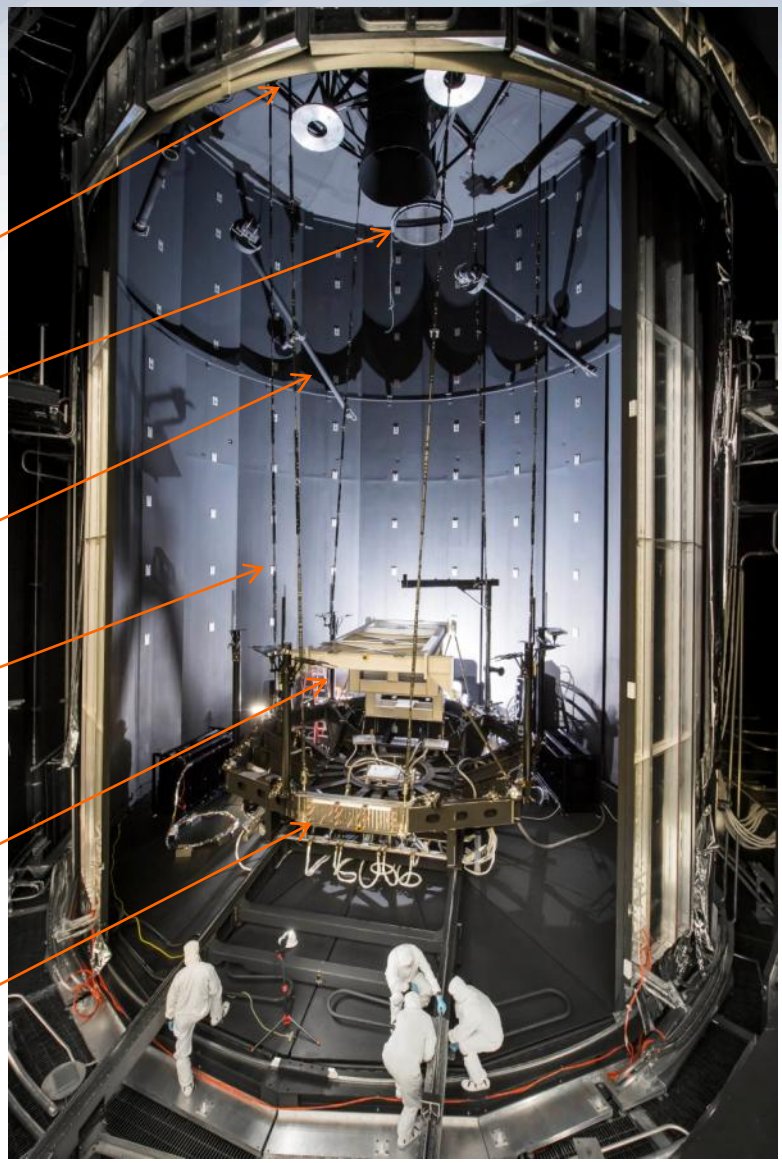
Alignment Diagnostic Module

OSIM Primary Mirror



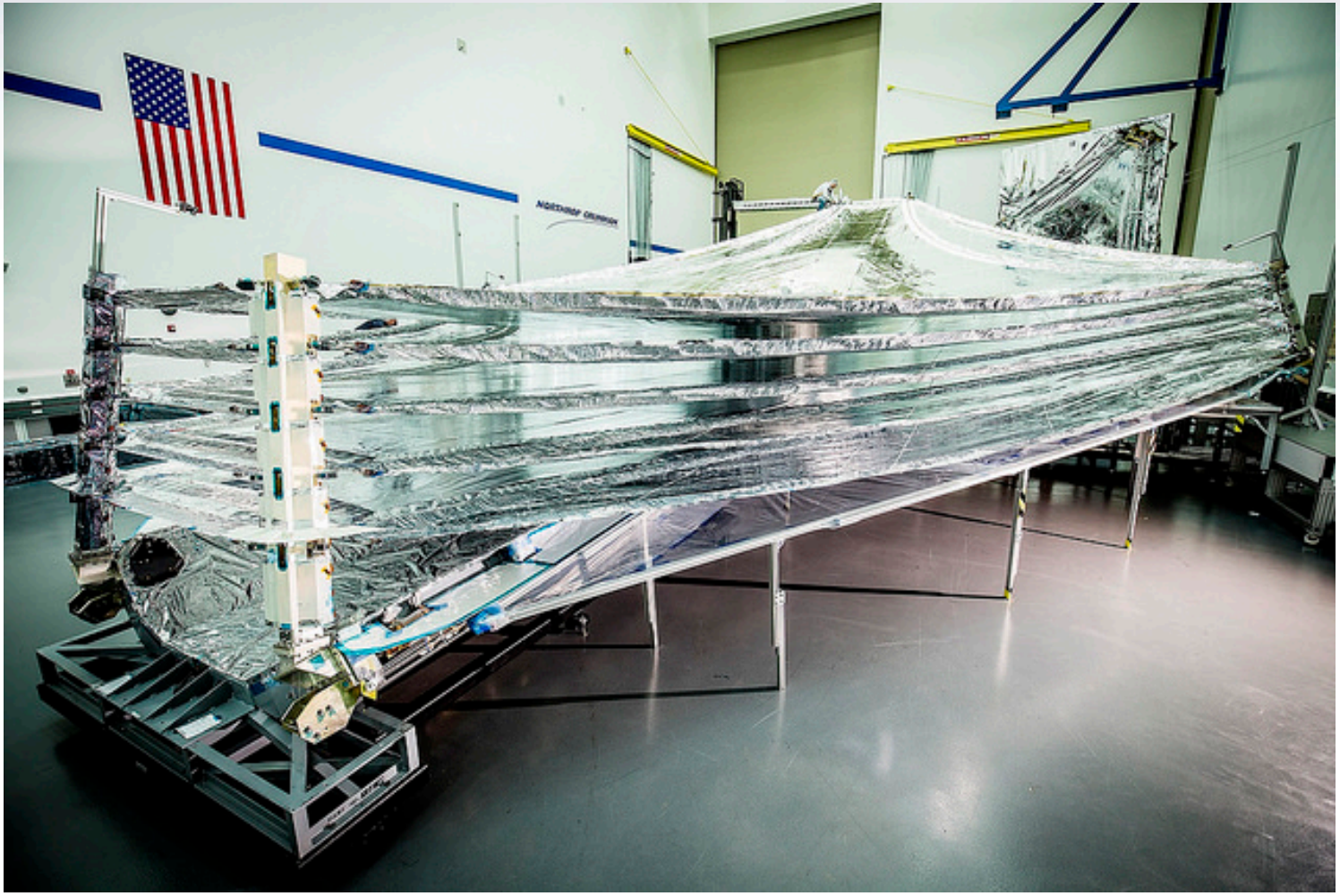
# Chamber Commissioning Test Configuration



# Spacecraft Bus at Northrop-Grumman

# Engineering Model Sunshield



# Webb Launch

- Launch vehicle is an Ariane 5 rocket, supplied by ESA
- Site will be the Arianespace's ELA-3 launch complex near Kourou, French Guiana
- Date is October 2018

*Arianespace – ESA - NASA*

# The End (of this presentation)

but

with the James Webb Space Telescope,
we will see the beginning of *everything*

The first galaxies
The origins of galactic structure
The birth of stars
The creation of planets
and more …

You can follow the action: @NASAWebbTelescp #JWST

**http://jwst.nasa.gov/**

# Deployment Sequence Overview