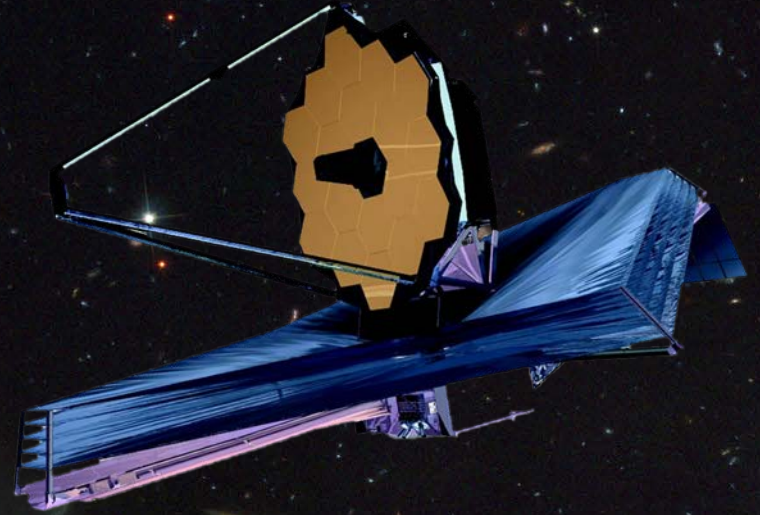


The James Webb Space Telescope Overview



Jonathan P. Gardner

NASA's Goddard Space Flight Center

<http://jwst.nasa.gov>

Space Science Reviews, 2006, 123/4, 485

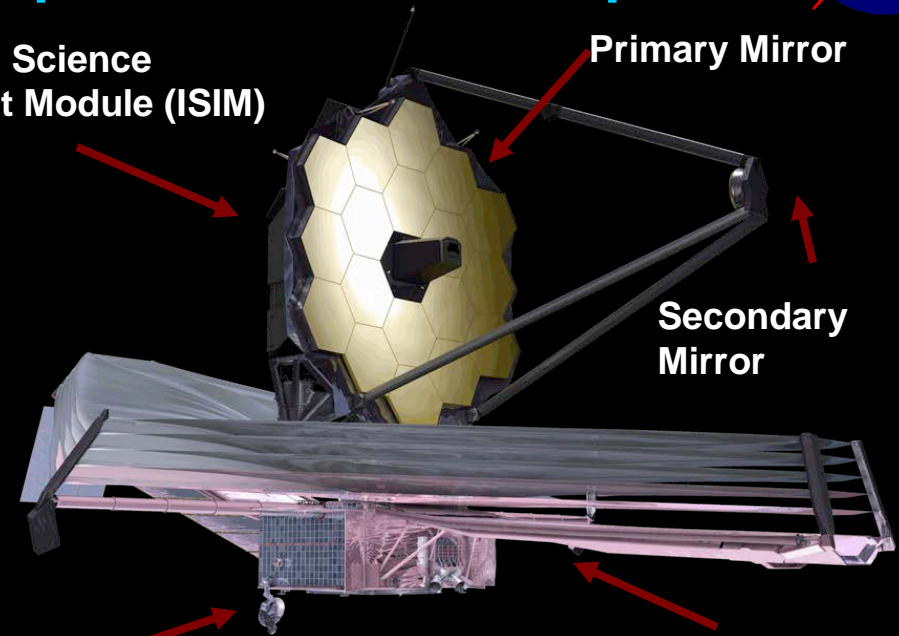
James Webb Space Telescope



Integrated Science
Instrument Module (ISIM)

Primary Mirror

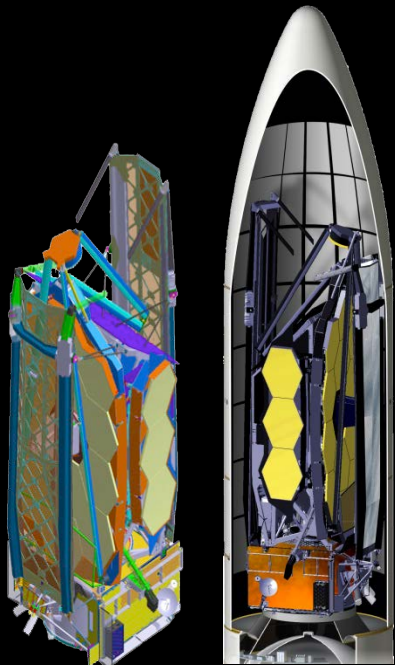
Secondary
Mirror



5 Layer Sunshield

Spacecraft Bus

- 6.6m Telescope
- Successor to Hubble & Spitzer.
- Demonstrator of deployed optics.
- 4 instruments: 0.6 to 28.5 μm
- Passively cooled to $< 50 \text{ K}$.
- Named for 2nd NASA Administrator



- Complementary: 30m, ALMA, WFIRST, LSST
- NASA + ESA + CSA: 14 countries
- Lead: Goddard Space Flight Center
- Prime: Northrop Grumman
- Operations: STScI
- Senior Project Scientist:
Nobel Laureate John Mather
- Launch date: October 2018

SPACE SCIENCE REVIEWS

THE JAMES WEBB SPACE TELESCOPE

JONATHAN P. GARDNER^{1,*}, JOHN C. MATHER¹, MARK CLAMPIN²,
RENE DOYON³, MATTHEW A. GREENHOUSE¹, HEIDI B. HAMMEL⁴,
JOHN B. HUTCHINGS⁵, PETER JAKOBSEN⁶, SIMON J. LILLY⁷, KNOX S. LONG⁸,
JONATHAN I. LUNNIN⁹, MARK J. MCCAUGHREAN^{10,11}, MATT MOUNTAIN⁹,
JOHN NELLA¹², GEORGE H. RIEKE¹³, MARCIA J. RIEKE¹³,
HANS-WALTER RIX¹⁴, ERIC P. SMITH¹⁵, GEORGE SONNEDORN¹,
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(Received: 8 March 2006; Accepted in final form: 15 May 2006)

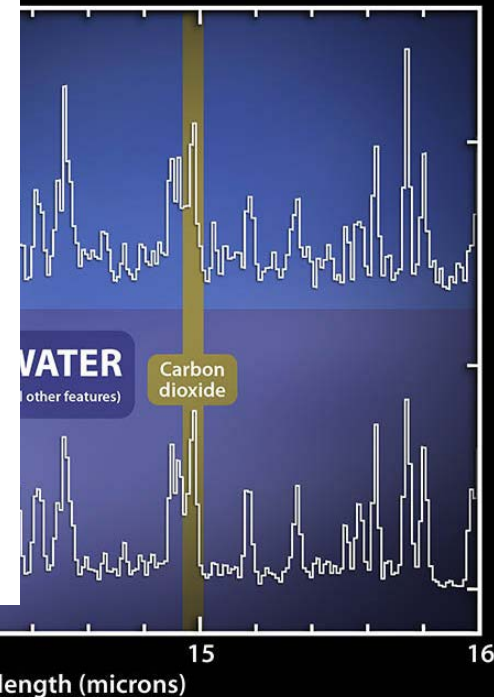
Abstract. The James Webb Space Telescope (JWST) is a large (6.6 m), cold (<50 K), infrared (IR)-optimized space observatory that will be launched early in the next decade into orbit around the second Earth-Sun Lagrange point. The observatory will have four instruments: a near-IR camera, a near-IR multiobject spectrograph, and a tunable filter imager will cover the wavelength range, $0.6 < \lambda < 5.0 \mu\text{m}$, while the mid-IR instrument will do both imaging and spectroscopy from $5.0 < \lambda < 29 \mu\text{m}$.

The JWST science goals are divided into four themes. The key objective of The End of the Dark Ages: First Light and Reionization theme is to identify the first luminous sources to form and to determine the ionization history of the early universe. The key objective of The Assembly of Galaxies theme is to determine how galaxies and the dark matter, gas, stars, metals, morphological structures,

Space Science Reviews (2006) 123: 485–606

DOI: 10.1007/s11214-006-8315-7

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13

14

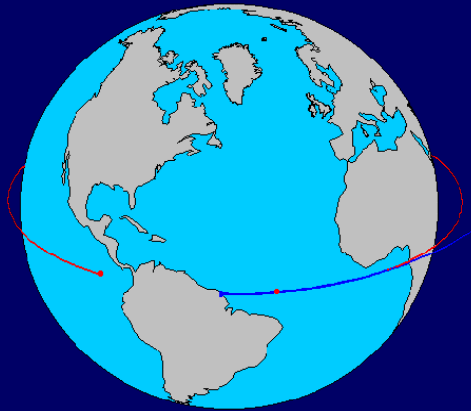
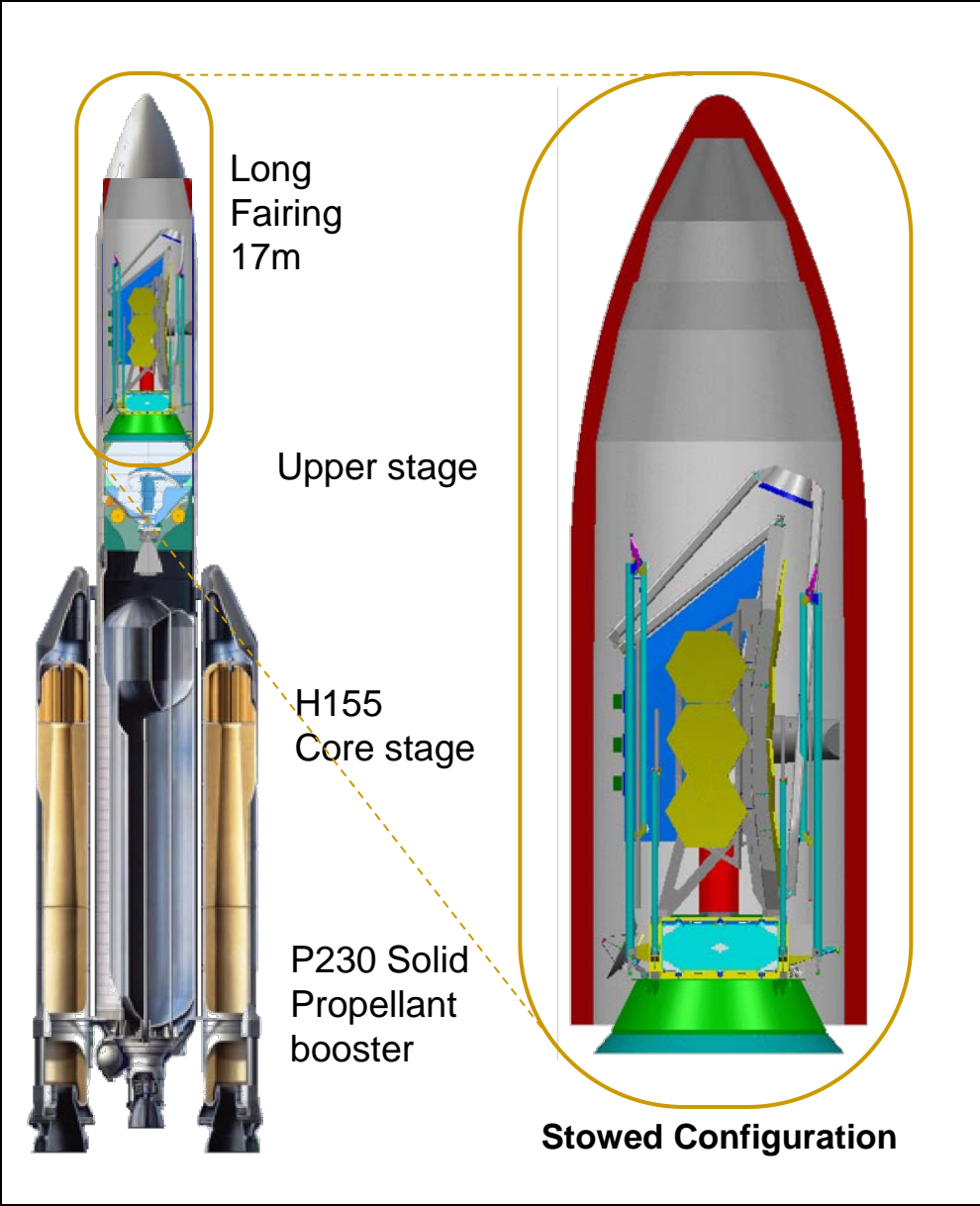
15

16

Wavelength (microns)

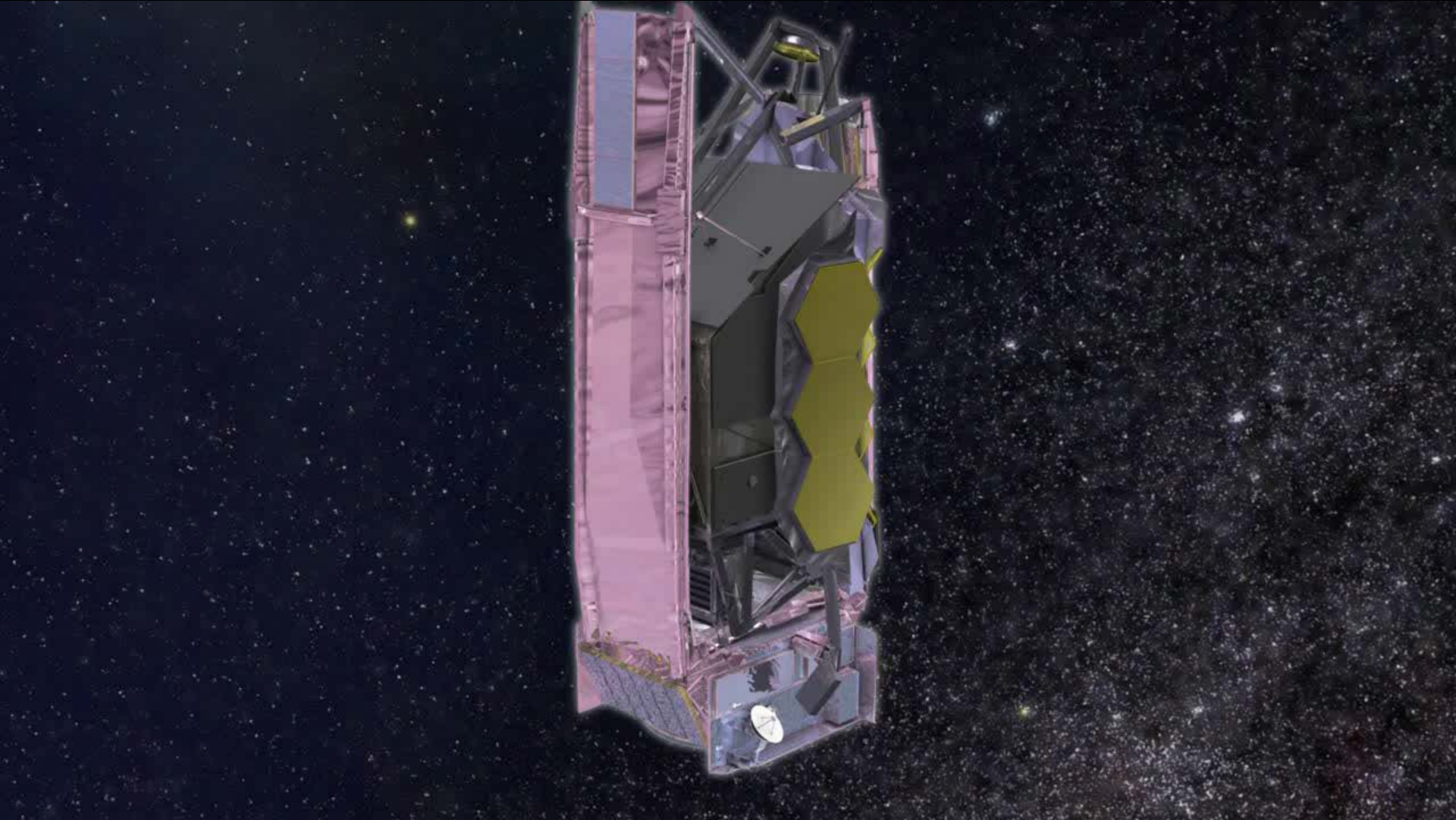
Science Requirements

- Large space telescope, infrared optimized
 - High sensitivity & photometric accuracy, stable PSF
 - Diffraction limited $\lambda > 2$ micron
- Highly capable instruments cover 0.6 to 28.5 microns
 - Broad, medium, narrow band imaging; MOS and IFUs
 - ~ 10 square arcmin field of view
 - Spectroscopy $R \sim 100$, $R \sim 1000$, $R \sim 3000$
 - Coronagraphy, exoplanet transit modes
- Full-sky coverage each year, 10-year lifetime
 - Moving target tracking
 - Targets of opportunity

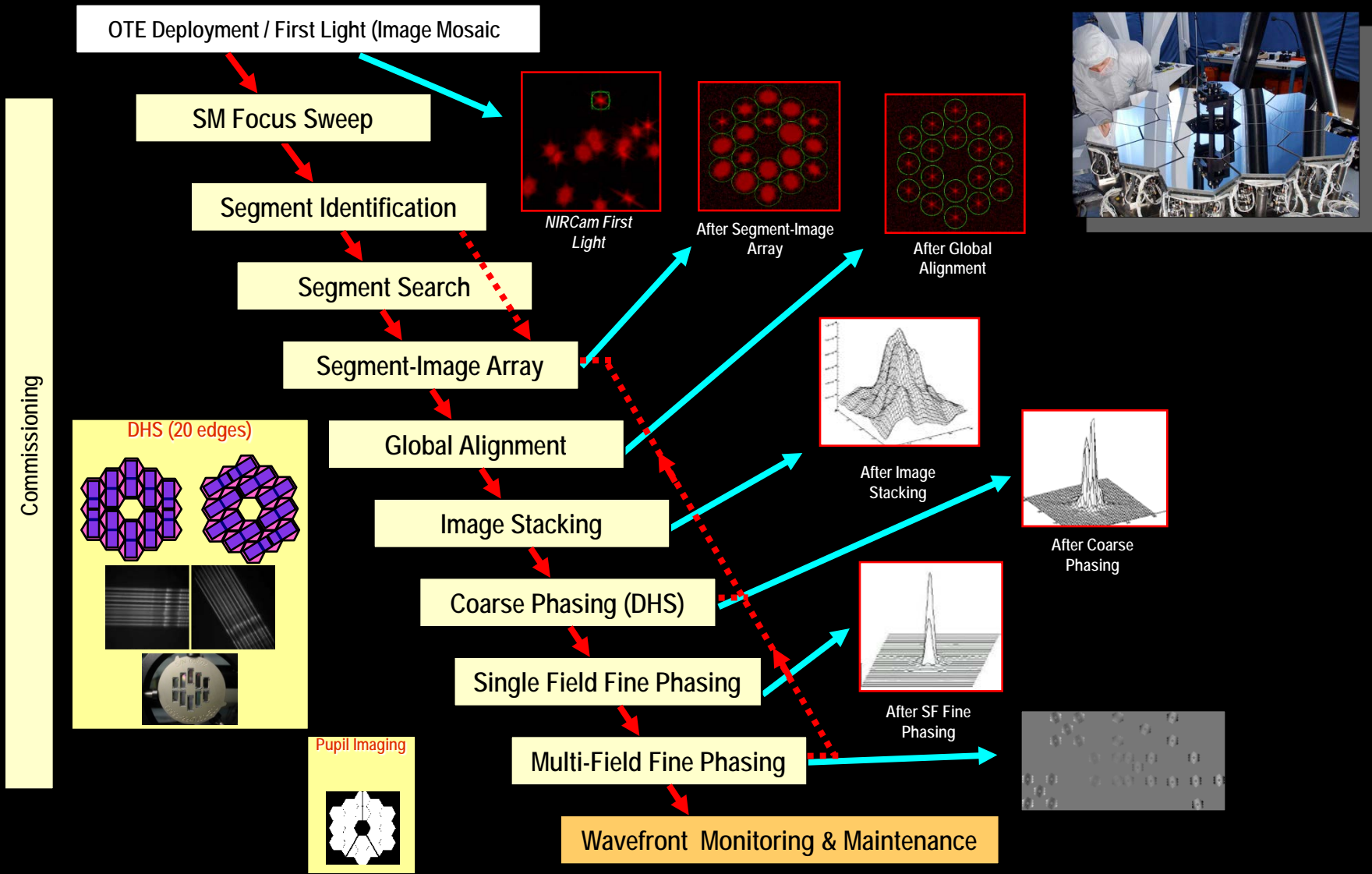


**Ariane V launch
Kourou, French Guiana**





Wavefront Sensing and Control

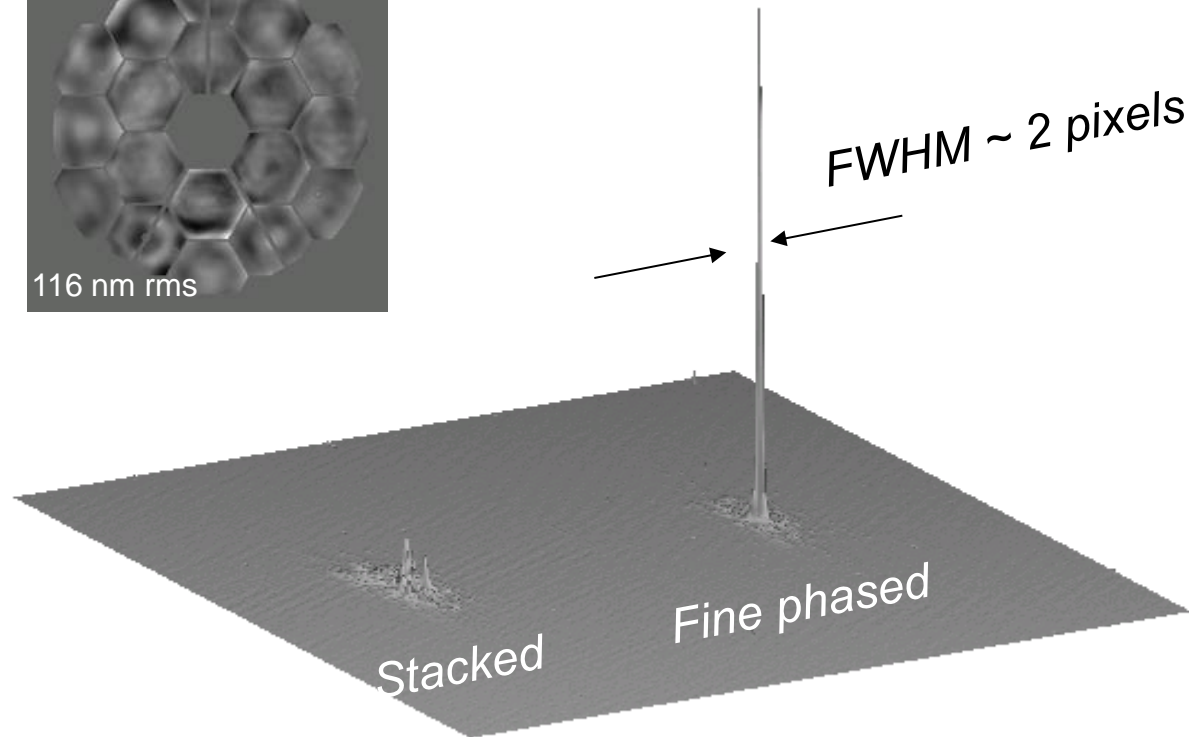
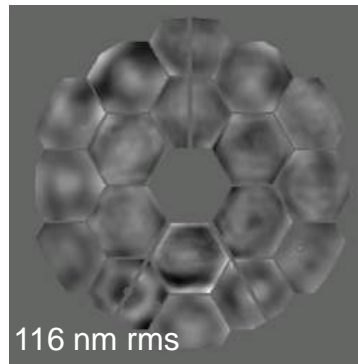




Fine Phasing on JWST Testbed Telescope Clearly (repeatedly) Demonstrates Coherent Image Addition



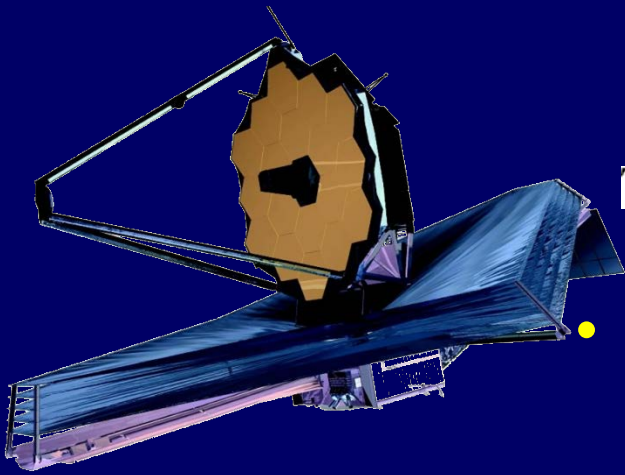
1/6 scale test-bed Telescope



- **Double Pass Phase Retrieval Estimate**
- **~0.95 Strehl ratio**
- **(single pass at 1550 nm on TBT**
- **Flight requirement is >0.8 Strehl @ 2micron**

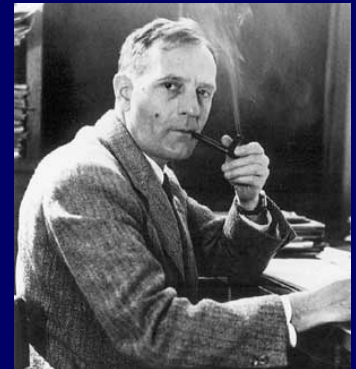
- Stacked Point Spread Function (left) contains random small tip/tilt and piston errors (Before)
- Phased PSF clearly indicates coherent addition and success of closed loop fine phasing (After)

Operations



THE ASTROPHYSICAL JOURNAL

- STScI is the Science Operations Center
- GO, Treasury and GTO programs similar to HST
- Cycle proposals due Feb 2018

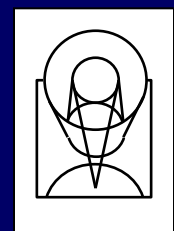


Astronomer

JWST at L2
Ka
S



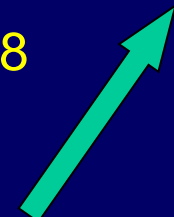
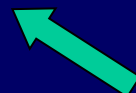
DSN



STScI



TAC

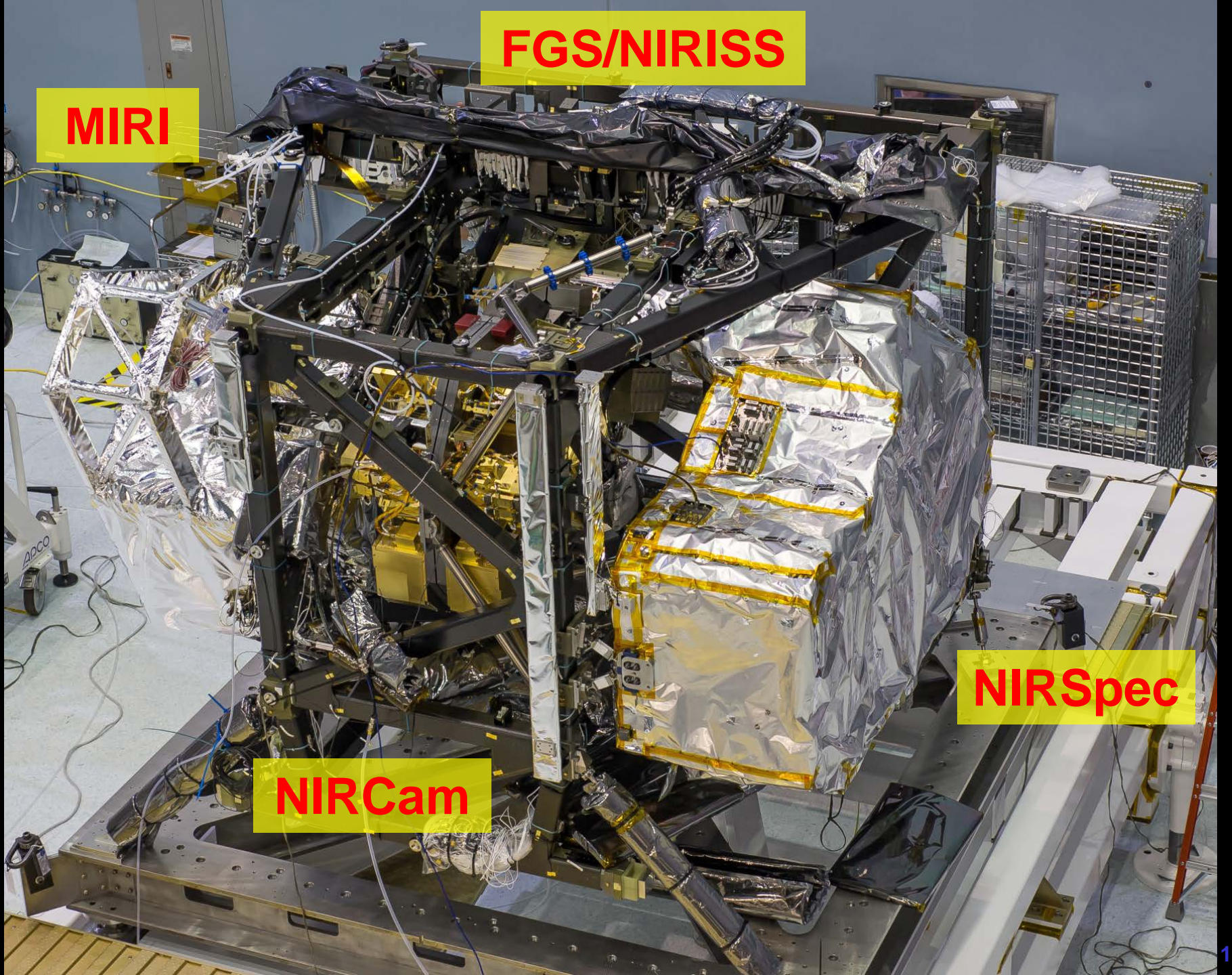


FGS/NIRISS

MIRI

NIRCam

NIRSpec





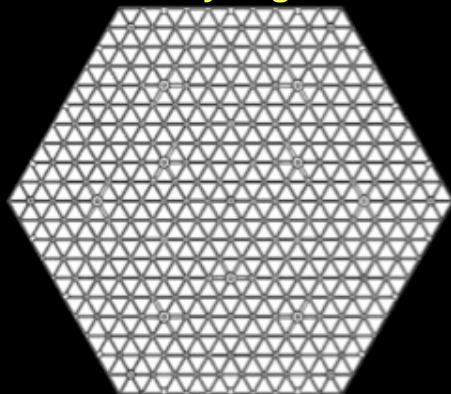
JWST Mirror Fabrication

- JWST Mirrors made of beryllium
- Lightweight and stable at 40 K
- Brush-Wellman

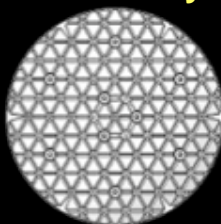
Raw Be billet (two mirrors)



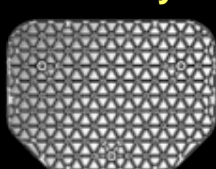
Primary segment



Secondary

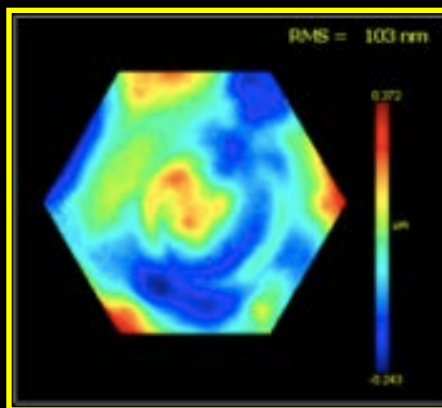


Tertiary

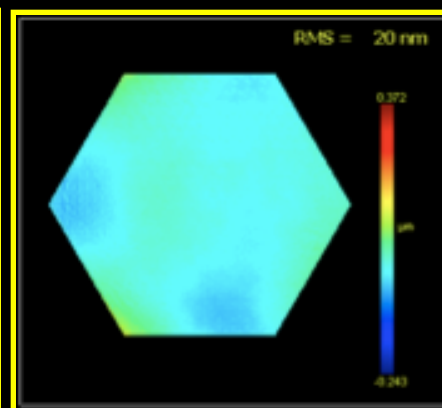


- Machined & lightweighted by Axsys
- 92% material is removed

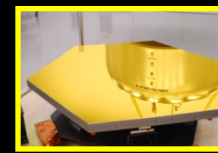
- Mirrors polished at Tinsley
- Segment cryo-figure: 20 nm



Ambient Surface Figure



Cryo Surface Figure





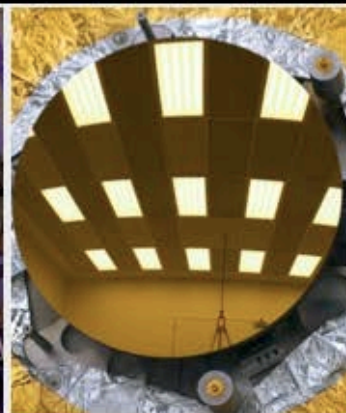
JWST's Flight Mirrors Complete



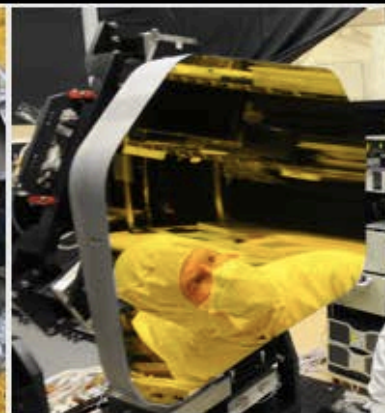
Primary Mirror Segment



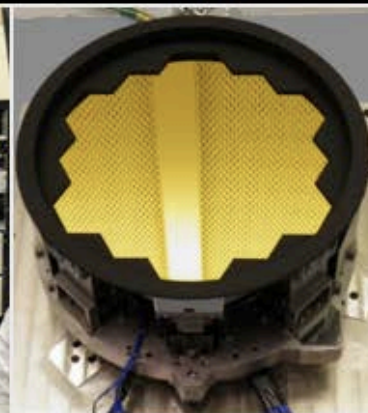
Secondary Mirror



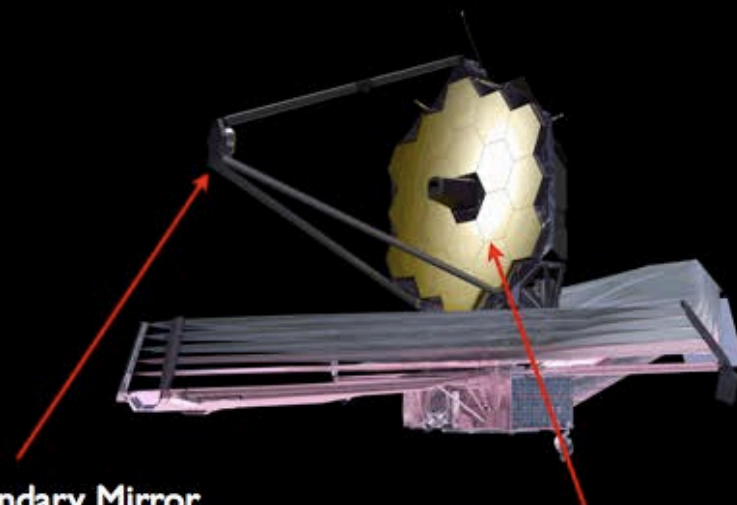
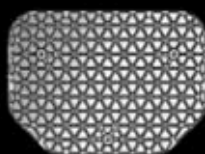
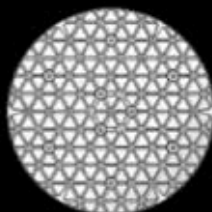
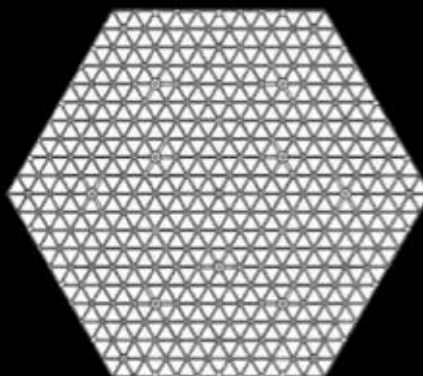
Tertiary Mirror



Fine Steering Mirror



Rear side view of mirrors showing relative size



Secondary Mirror

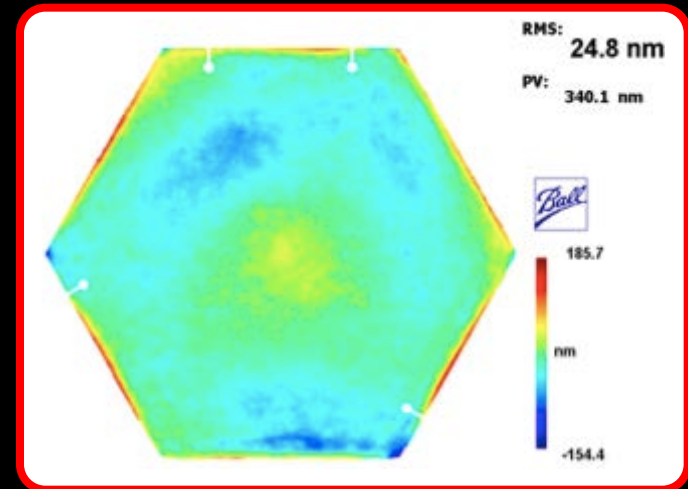
18 segment Primary Mirror



Flight Mirror Status



- All flight primary mirrors completed w/gold coating
 - Acceptance testing completed

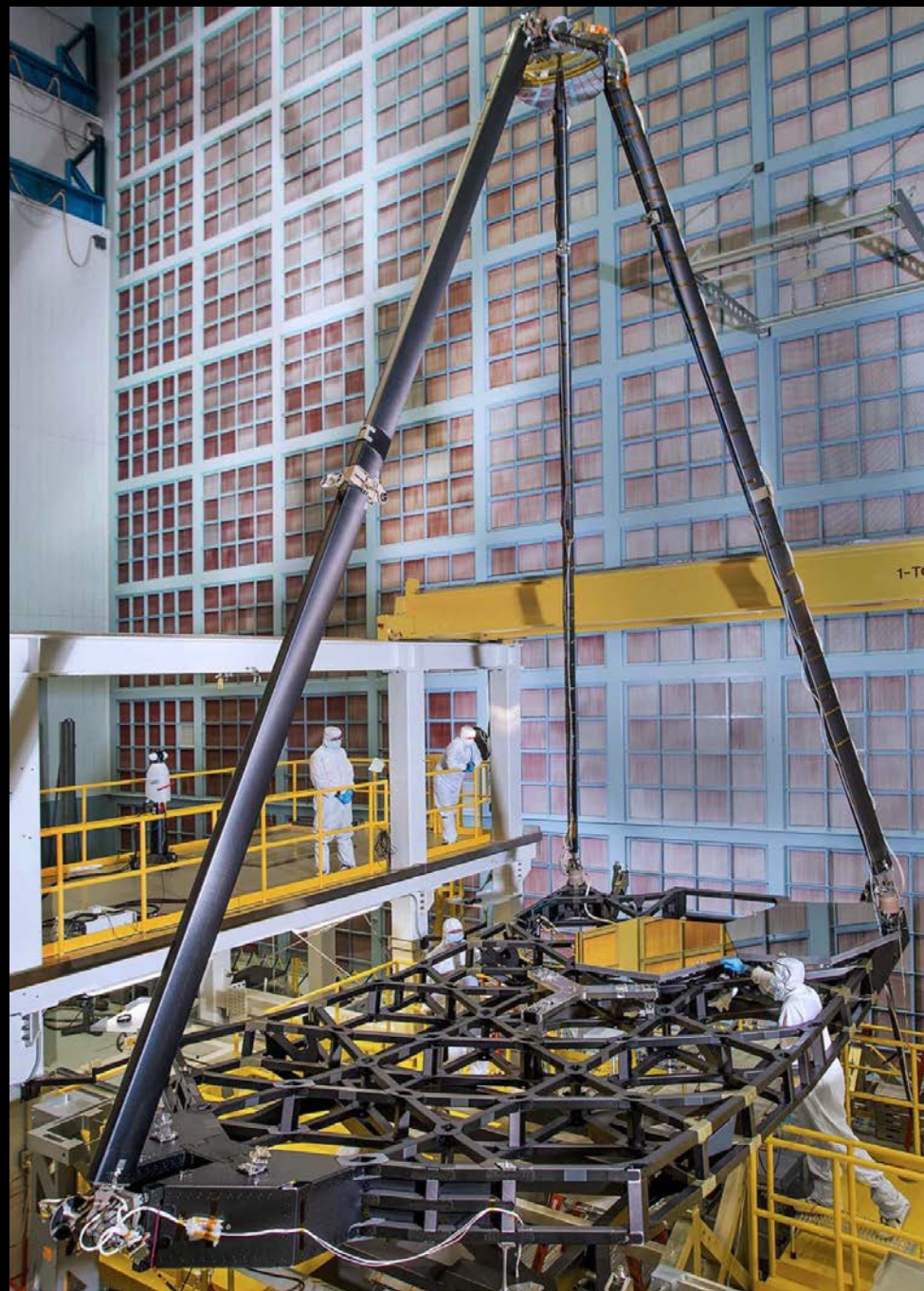
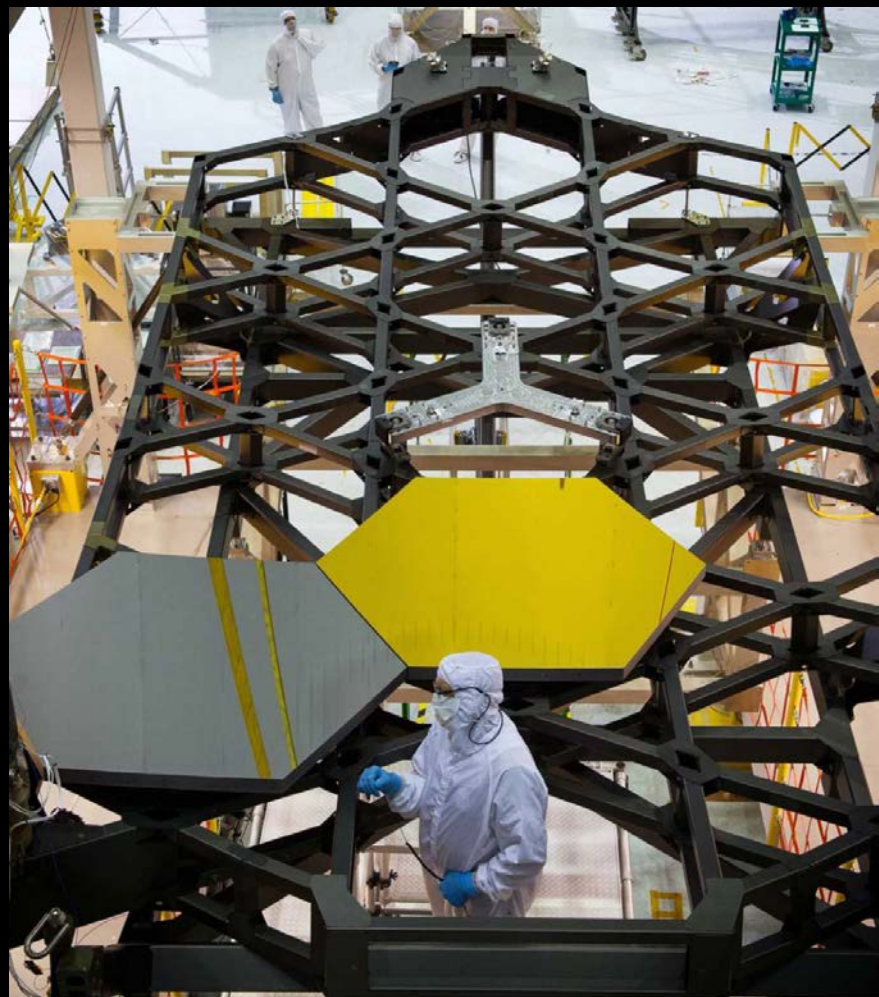


Flight Mirror A4 in acceptance vibe

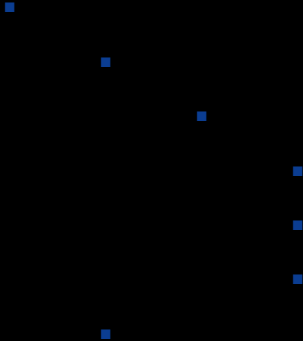
- Mirror segments are now being built up with actuators on the back for installation onto backplane.
- *Flight mirror fabrication program completed in 2011*

Mirror Segments Complete:

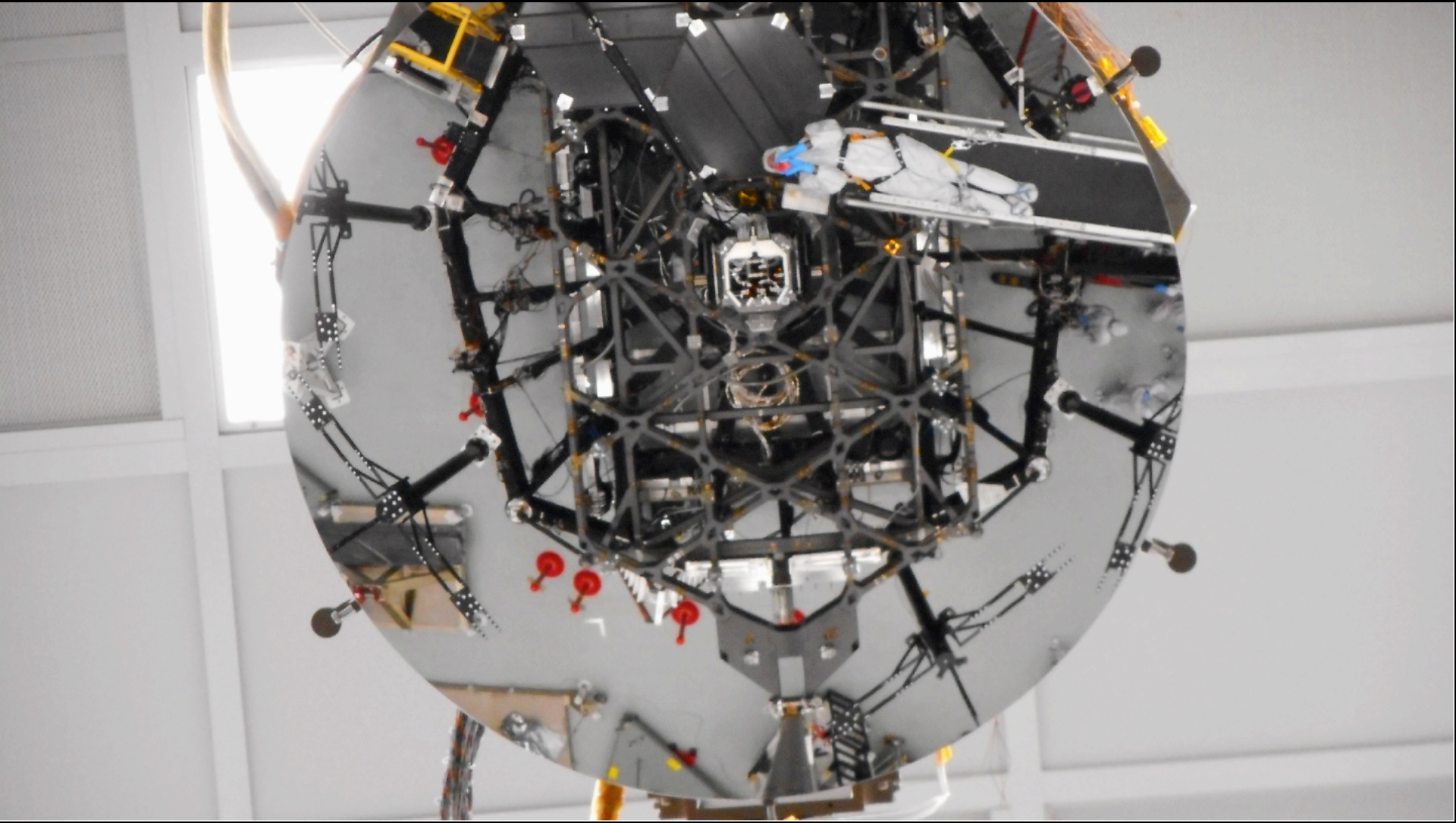
- Cryogenic optical test (post-vibe) meets WFE requirement.



OPE Pathfinder

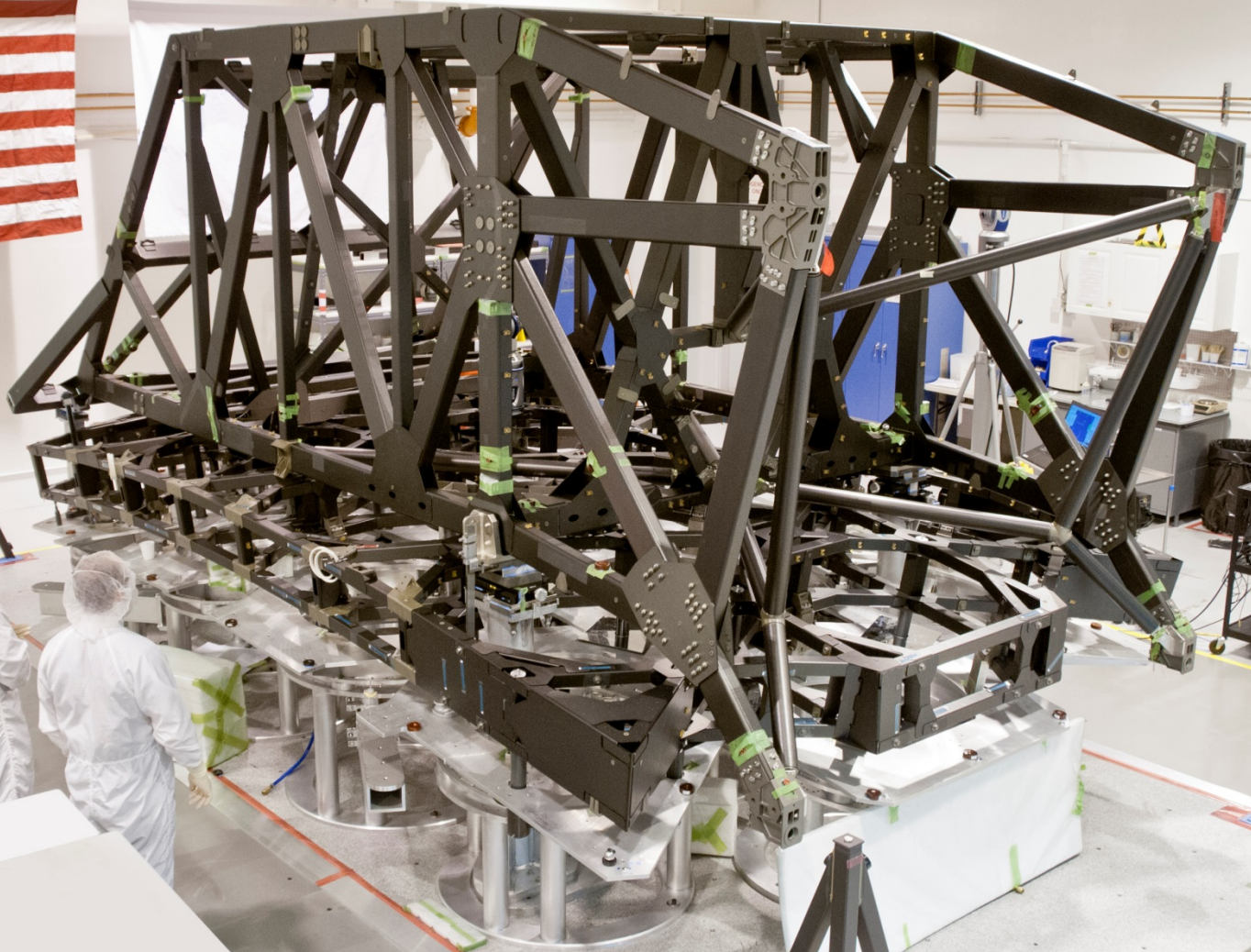








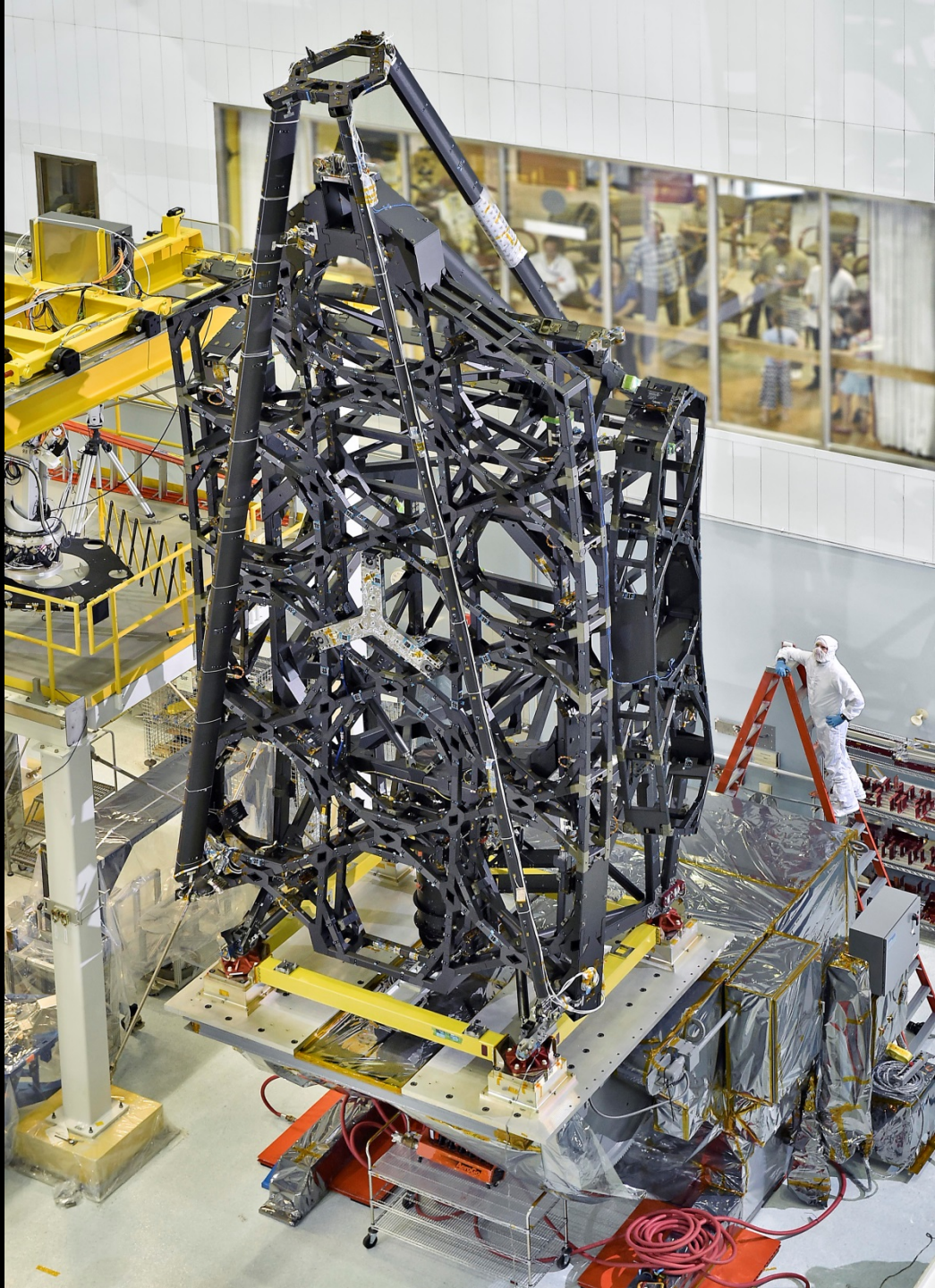
WEST



Wings

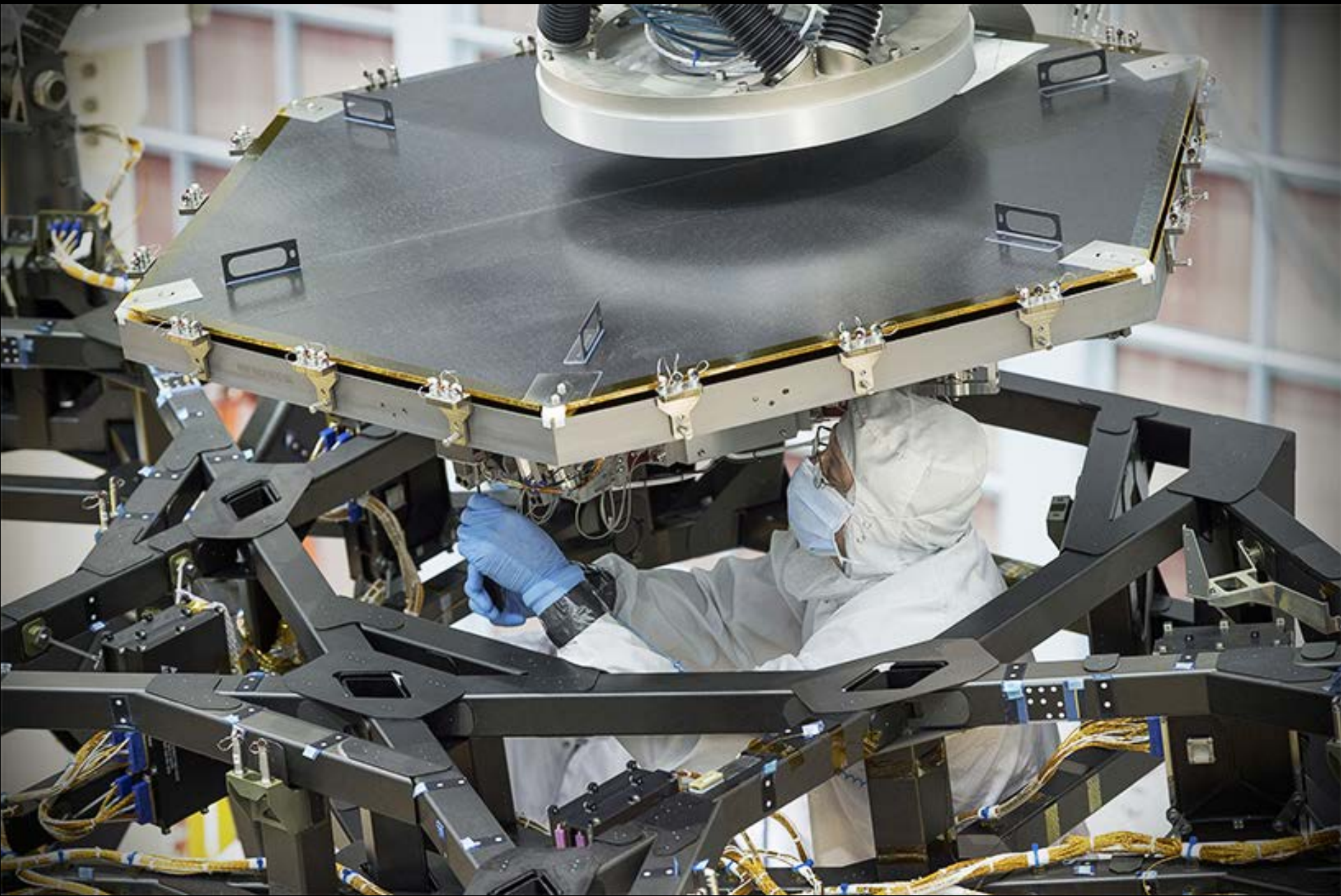


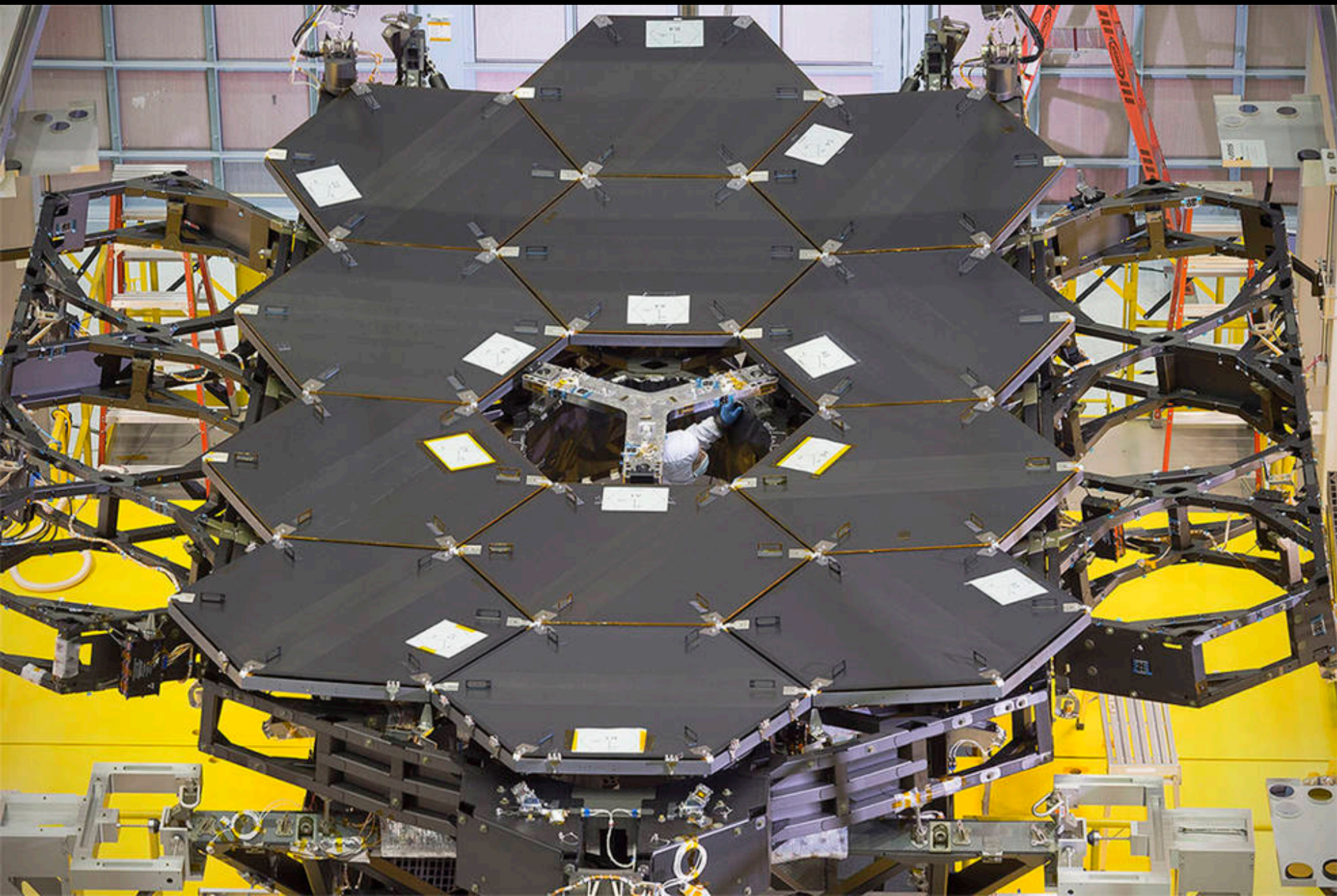


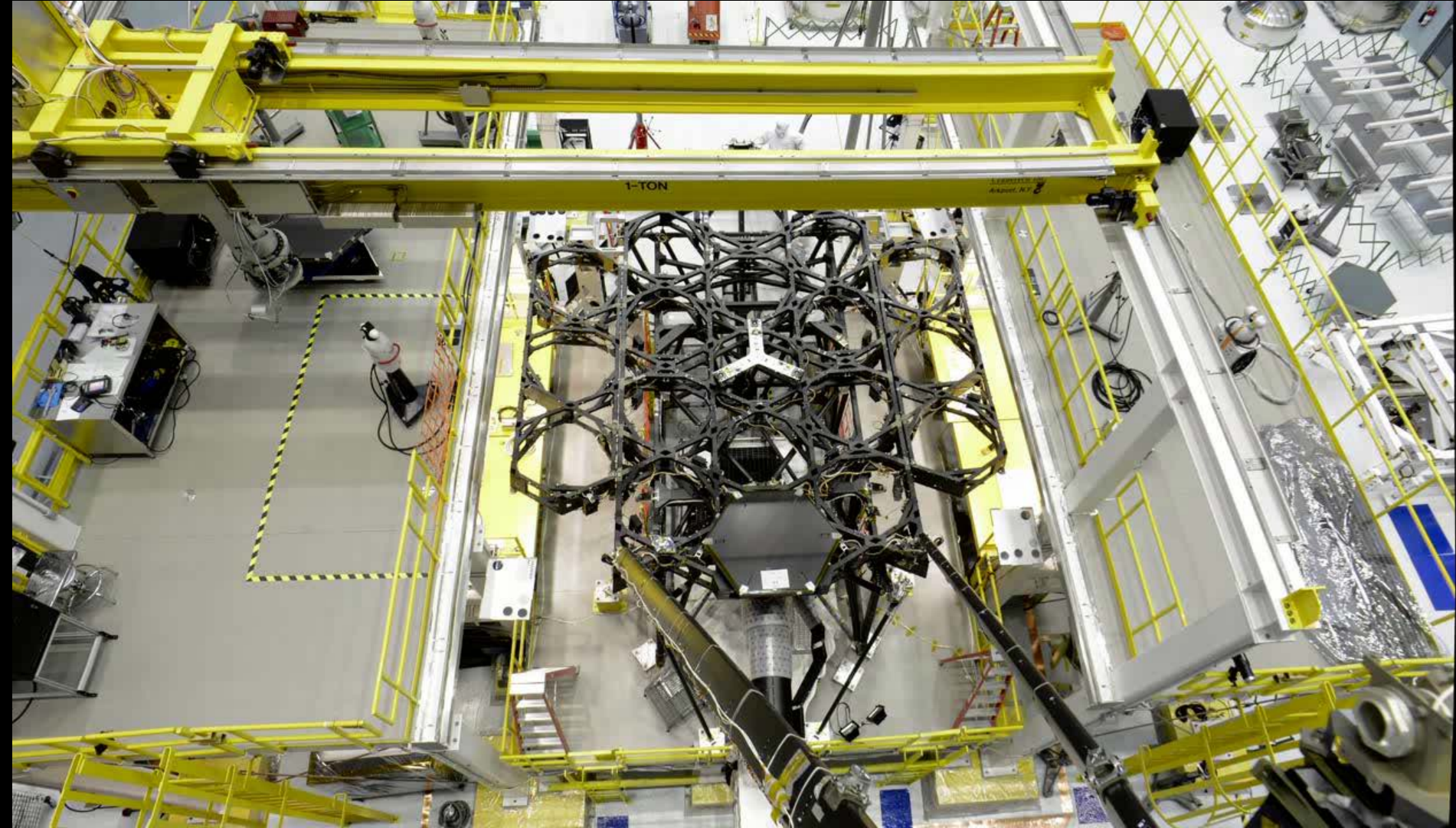


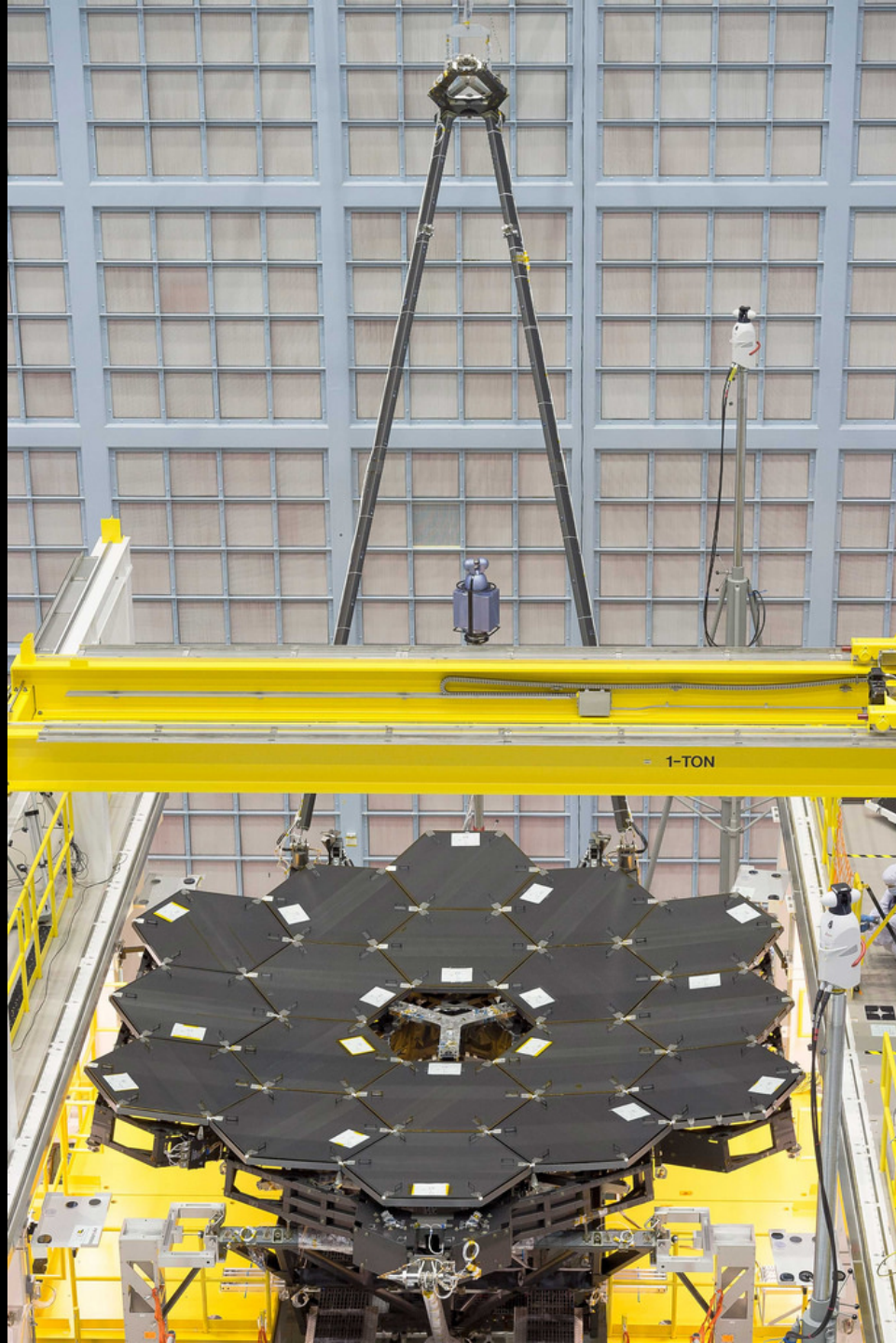




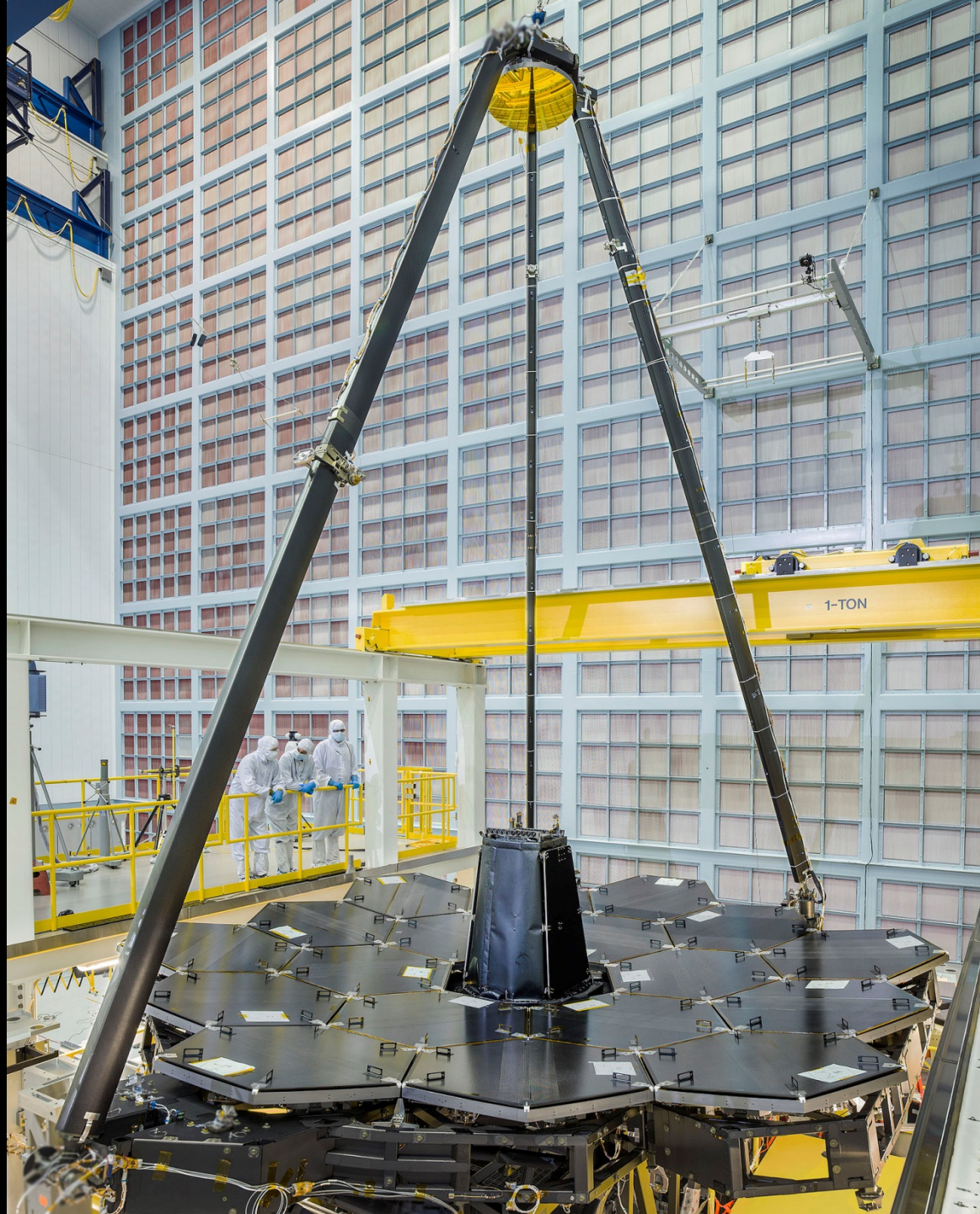




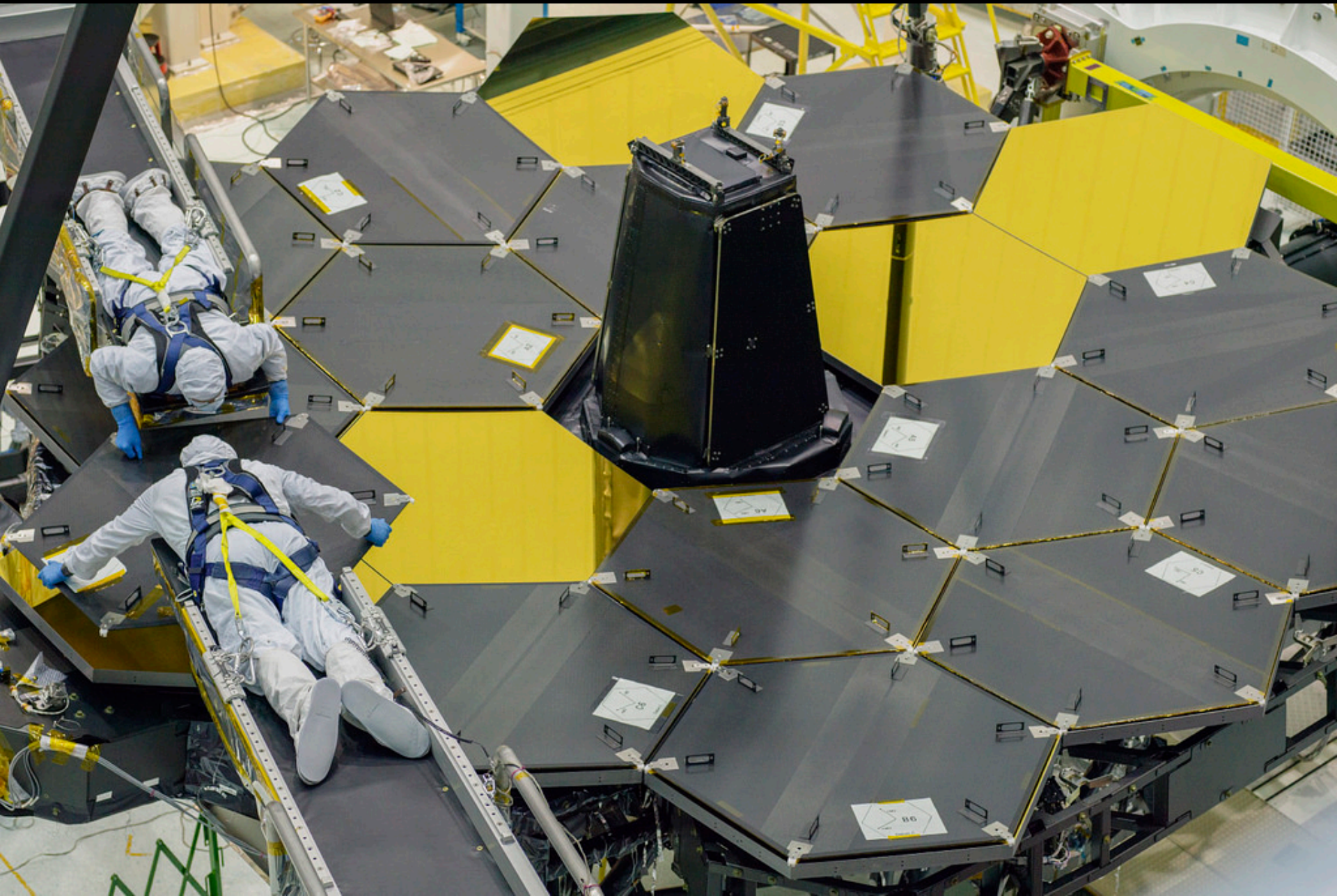


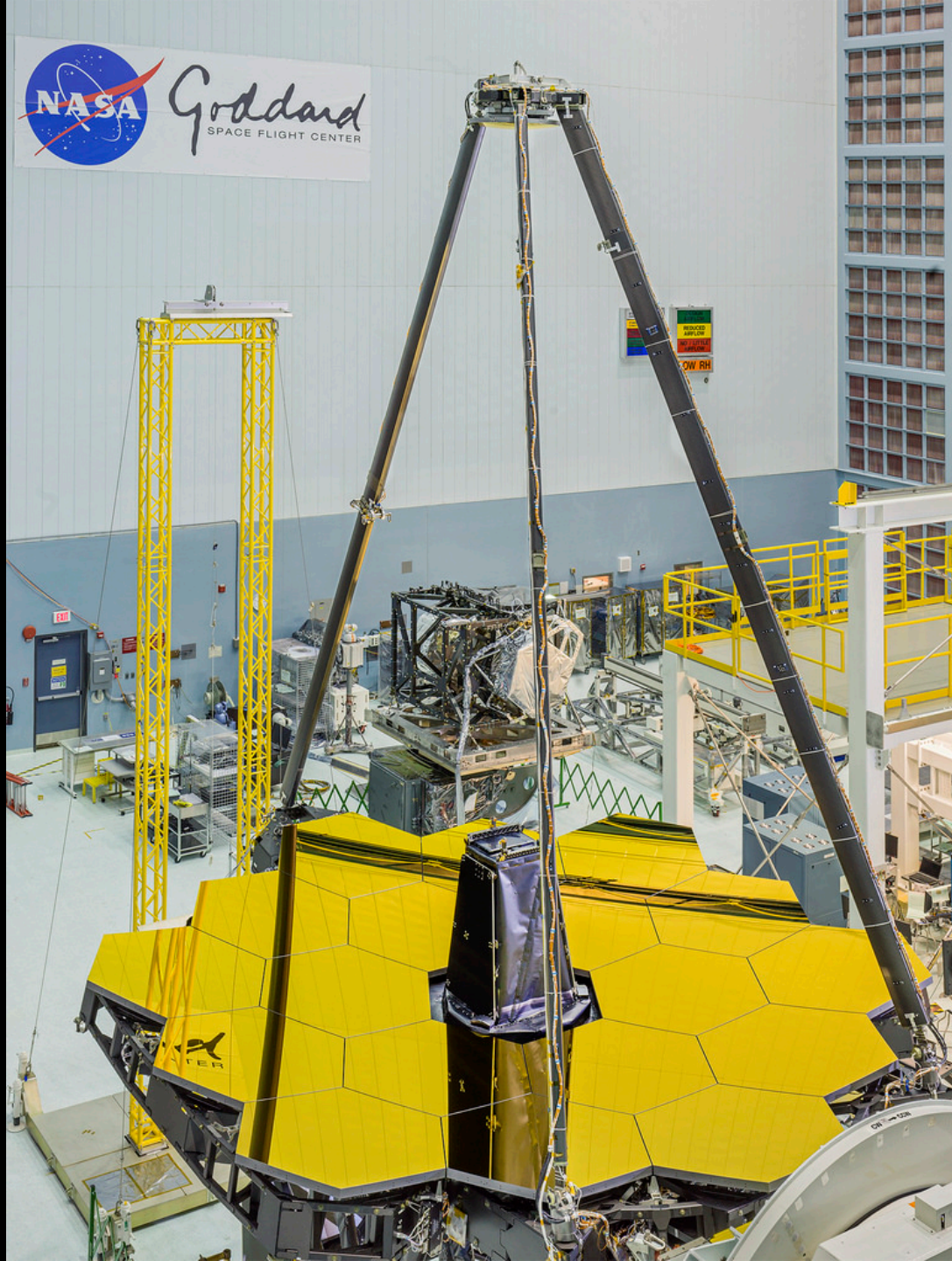


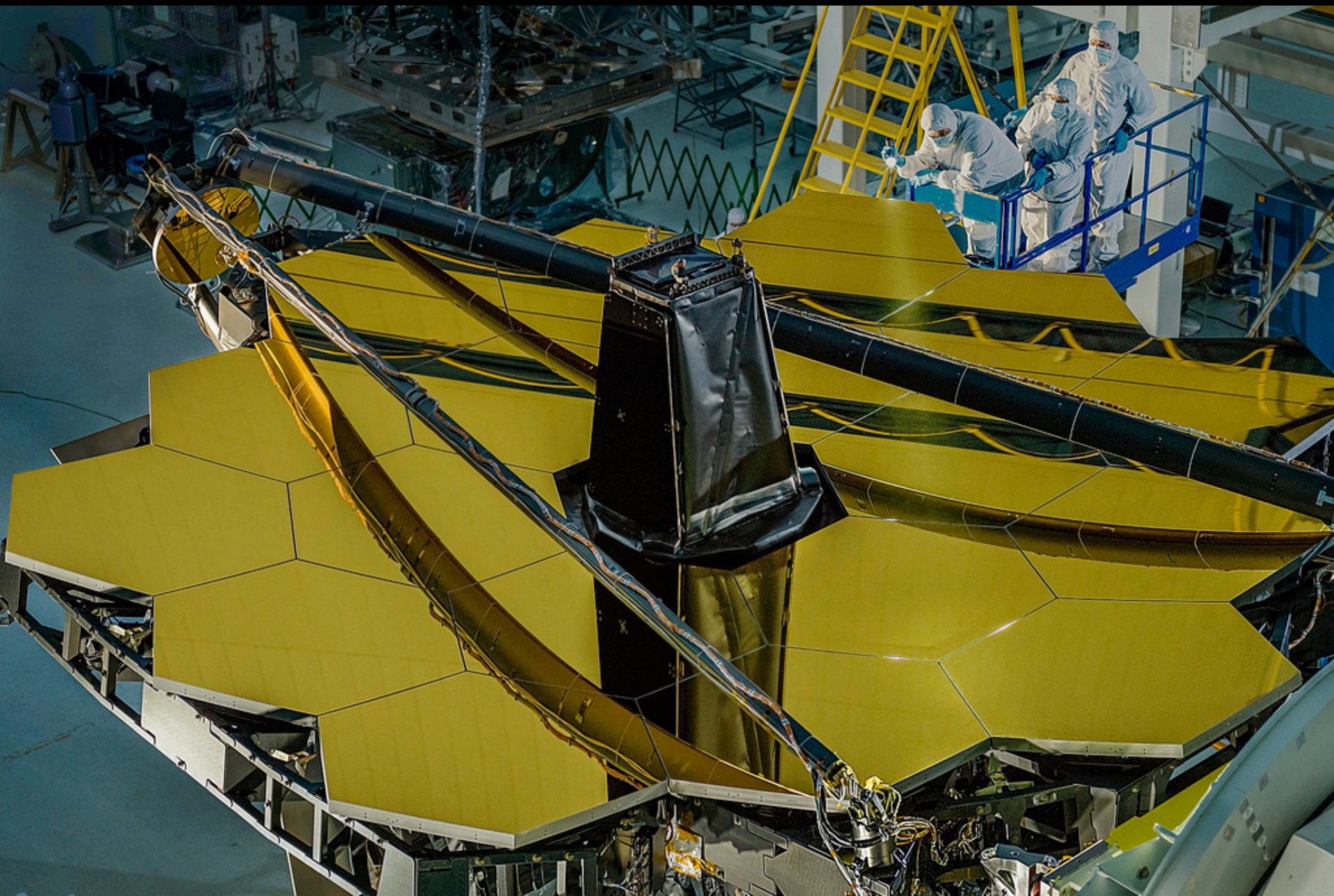




1-TON









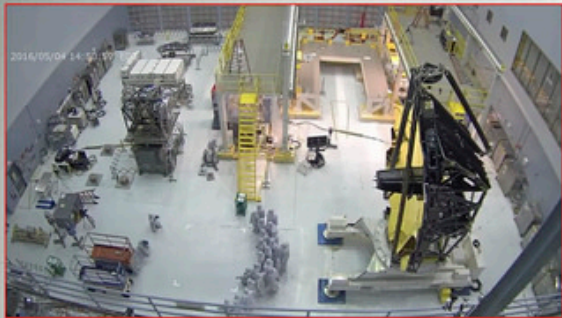
 *Goddard*
SPACE FLIGHT CENTER



Follow
Tweet
Follow



- Has a diameter of 3.5 meters
- Has a mass of 1.5 tons
- Composed of 18 hexagonal panels
- Made of aluminum and carbon fiber
- Has a thickness of 10 cm
- Has a surface area of 100 m²
- Has a weight of 1.5 tons
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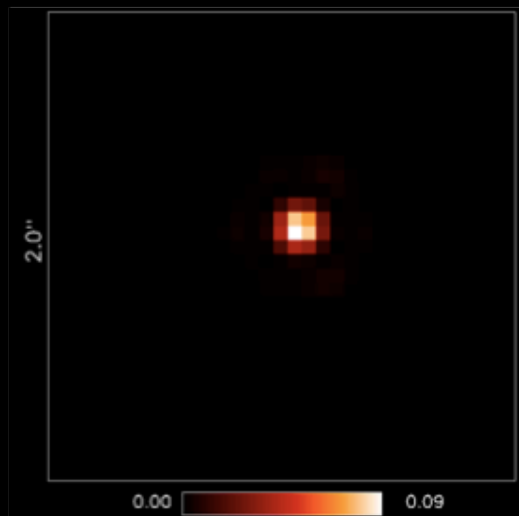


Predicted Image Quality: 2 μm & 4 μm

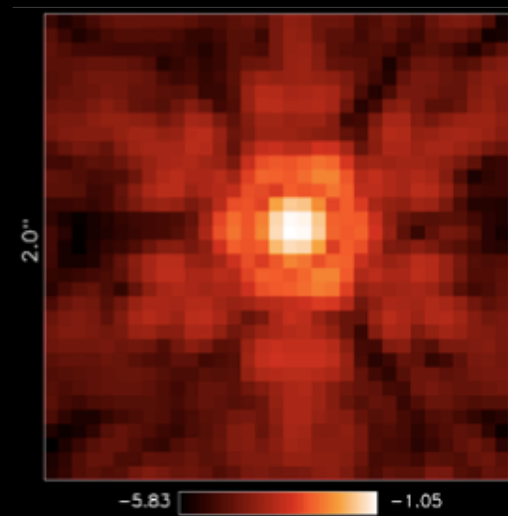


F444W

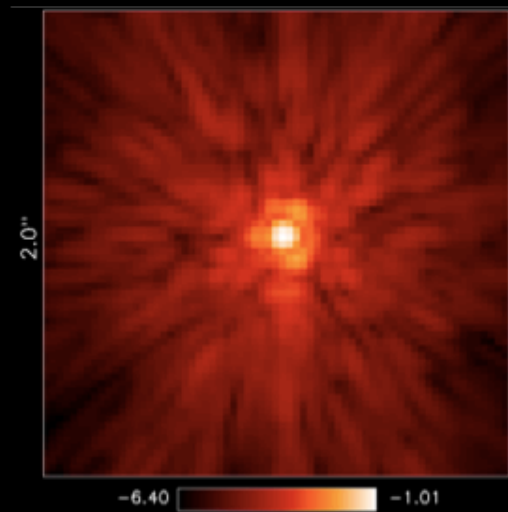
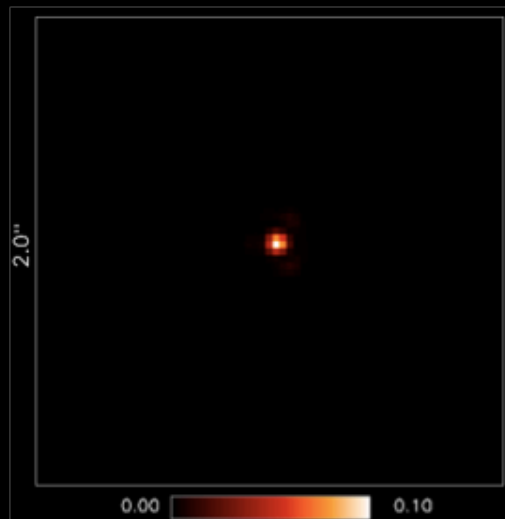
Linear Scale



Log Scale



F200W





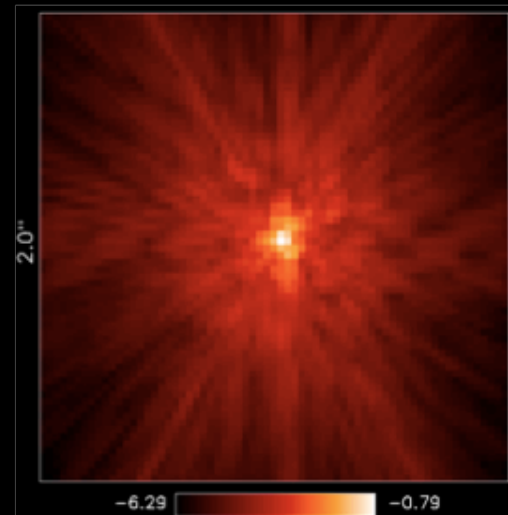
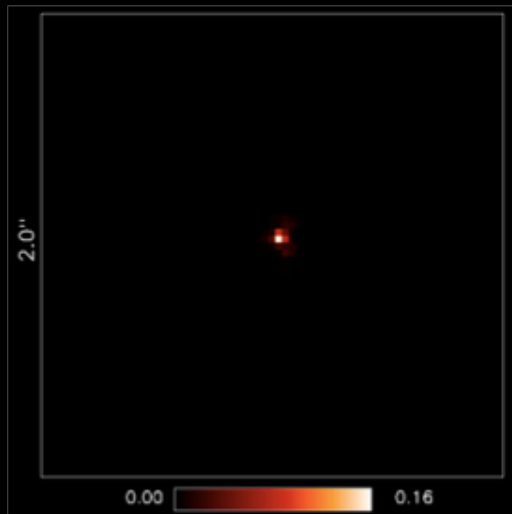
Predicted Image Quality: 0.7 μm & 1 μm



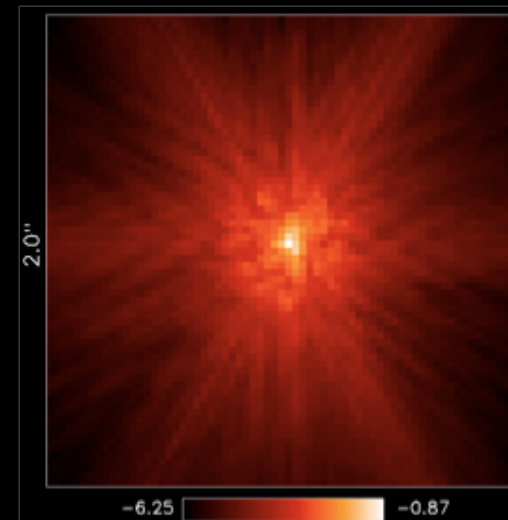
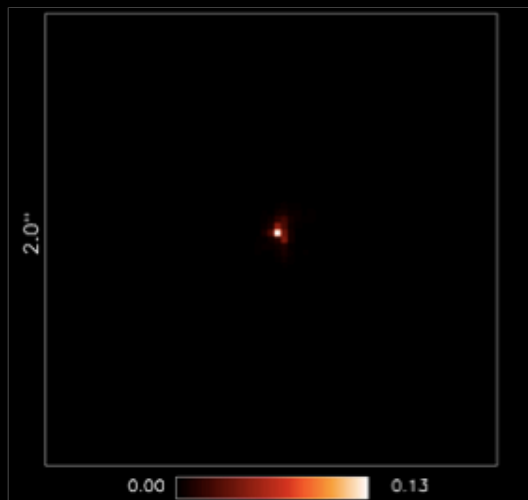
Linear Scale

Log Scale

F115W



F070W





1/3rd Scale Sunshield

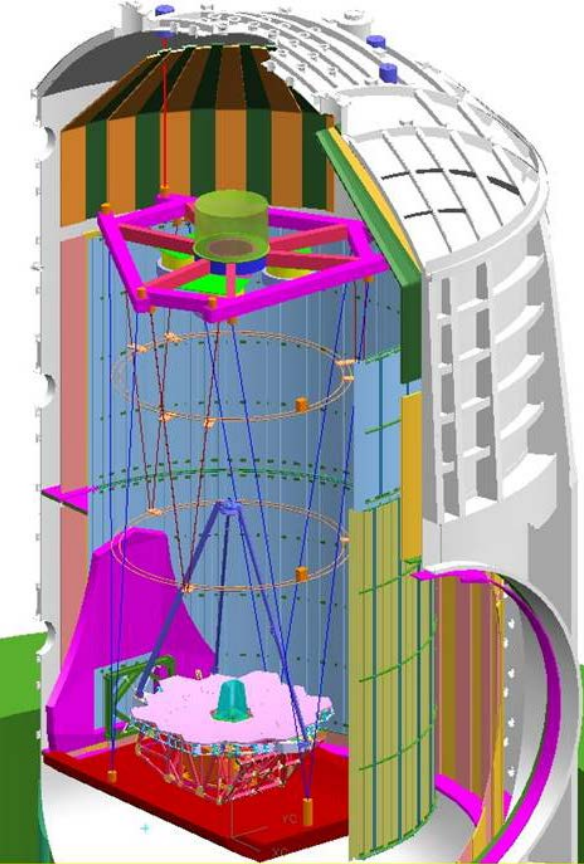




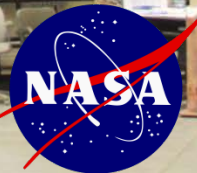




Observatory level cryo-vacuum testing will occur at the Johnson Space Center in Houston



JSC Chamber A



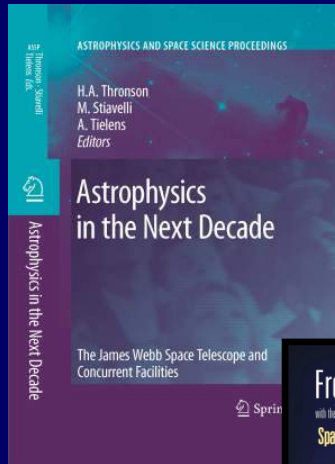








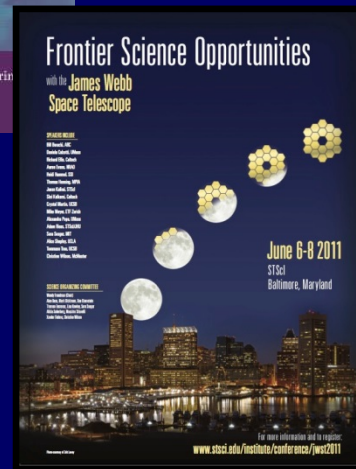
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2007 Conference Proceedings
Read on-line

White Papers:

- JWST in Decadal Survey
- Solar System Objects
- Dark Energy
- Transiting Planets
- Coronagraphy
- Planetary Systems
- Stellar Pops
- Star Formation
- Galaxy Assembly
- First Light
- Astrobiology
- Scientific Capabilities
- Observation Planning



2011 Conference Presentations and video on-line at STScI

Science White Papers
<http://www.stsci.edu/jwst/science/whitepapers/>

Gardner et al. 2006,
Space Science Reviews, 123/4, 485
<http://jwst.nasa.gov/scientists.html>

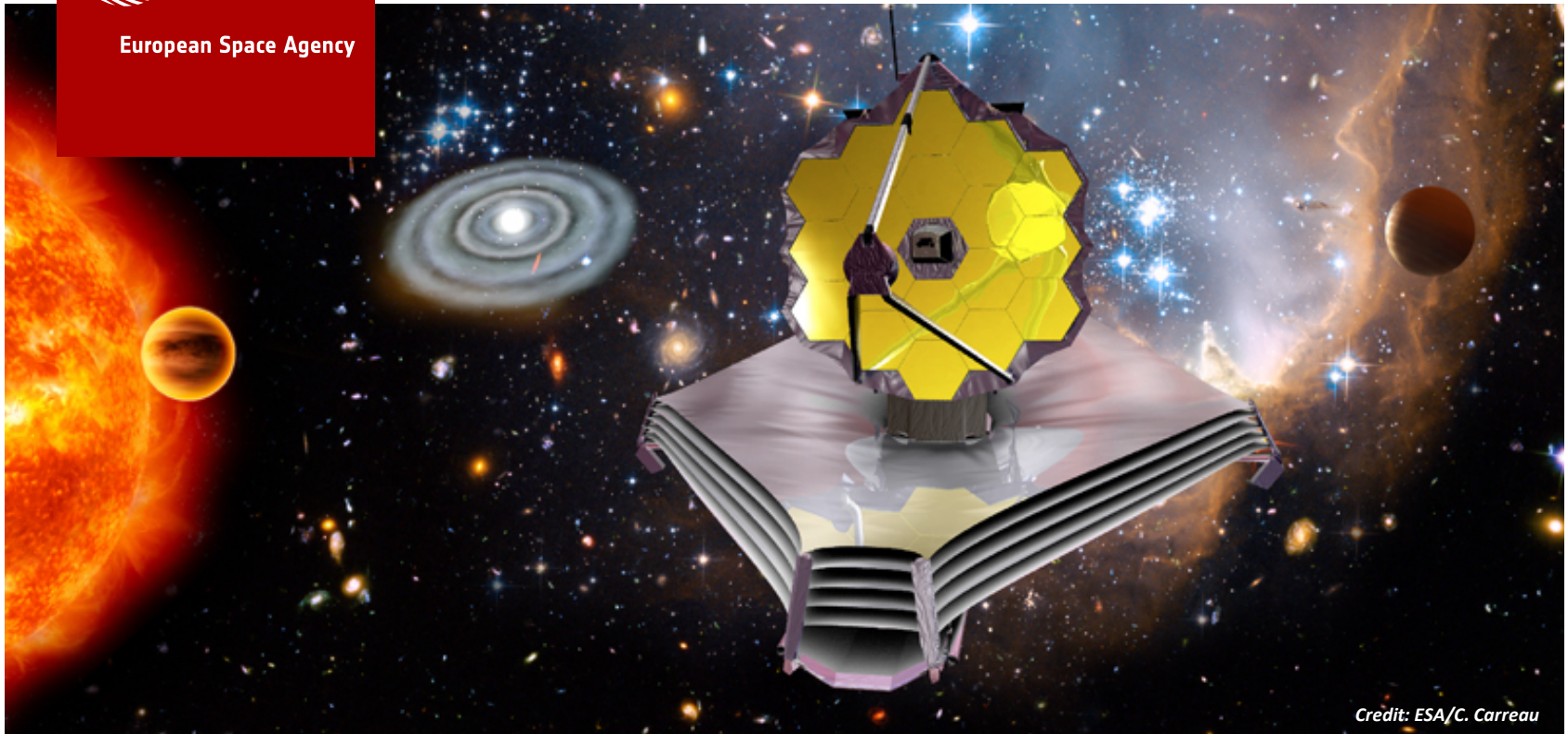
Annual Sessions at AAS and SPIE meetings
October 2016 JWST Conference in Montreal



European Space Agency

“Exploring the Universe with JWST”

49th ESLAB symposium



Credit: ESA/C. Carreau

ESA/ESTEC

October 12-16
2015

Noordwijk,
The Netherlands

An international conference dedicated to the presentation and discussion of future scientific research that will be enabled by the James Webb Space Telescope.

Talks now available for download:

<http://congrexprojects.com/15a02>



Exploring The Universe with JWST - II

24 - 28 October 2016

Montréal, Canada

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Scientific contributions may be presented in oral or poster form. Due to constraints of time and scheduling, there is a limit of one oral contribution per participant. Since the SOC must limit the total number of oral presentations, in cases where an oral contribution cannot be scheduled, the registrant's abstract will be accepted as a poster contribution.

Note that the maximum dimension of posters is 100x120 cm.

**Please enter your email address and password
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Latest News

Project Milestones updated monthly

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www.stsci.edu/jwst

Astronomy Software Tools ETC, PSF, APT

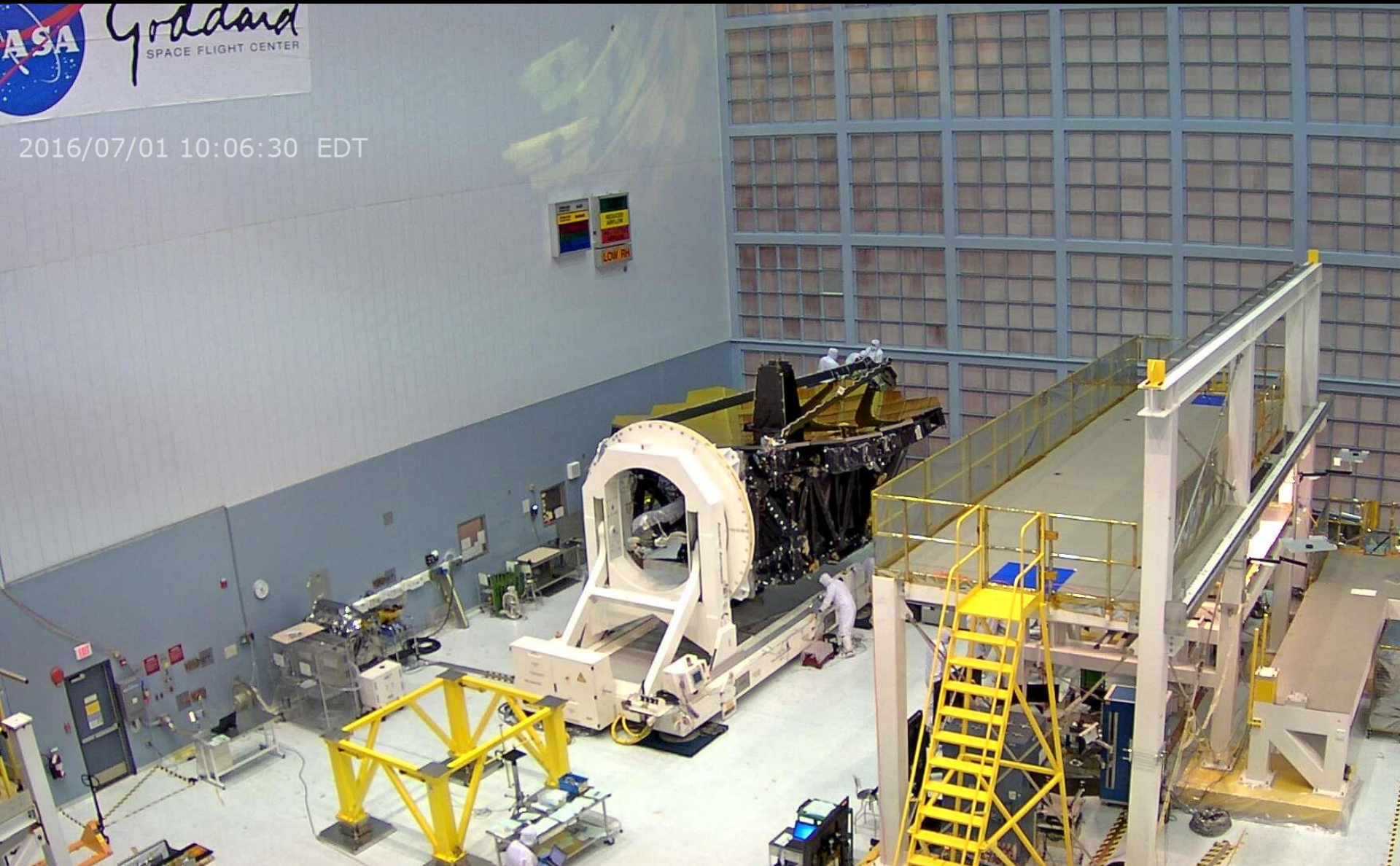
The screenshot shows the top navigation bar with the NASA logo and 'Explore JAMES WEBB SPACE TELESCOPE'. A sidebar on the left contains several menu items: HOME, STATUS (highlighted in orange), Recent Accomplishments, What's Next?, NEWS, ABOUT THE WEBB, SCIENCE, INSTRUMENTS, FEATURES, IMAGES & VIDEOS, MEET THE TEAM, FOR SCIENTISTS, FOR EDUCATORS, FOR PRESS, JWST SOCIAL MEDIA, RSS, Twitter, Facebook, YouTube, Flickr, and Instagram. The main content area is titled 'Recent Accomplishments' and includes a date 'Updated August 7, 2014'. Below this is a table with columns for years (2014, 2013, 2012, 2011) and a description of hardware components. A diagram of the telescope is shown with labels for various parts: Science Instrument Module (ISIM), Trim flap, Solar power array, Earth-pointing antenna, Primary Mirror, Secondary Mirror, Multilayer sunshield, and Optical Telescope Element (OTE).

The screenshot shows the 'SPACE TELESCOPE SCIENCE INSTITUTE' website. The main heading is 'James Webb Space Telescope JWST Software'. A navigation menu on the left includes: JWST Overview, Advisory Committee, Science, Optical Telescope Element, Instruments, Operations, Software Tools (highlighted in orange), Instrument Arch, Glossary, and Meetings. The main content area features three software tools: 'WebbPSF', 'Astronomer's Proposal Tool', and 'JWST Prototype ETC'. At the bottom, there are social media icons for Facebook, Twitter, and YouTube (highlighted in orange), and a search bar.

Webbcam

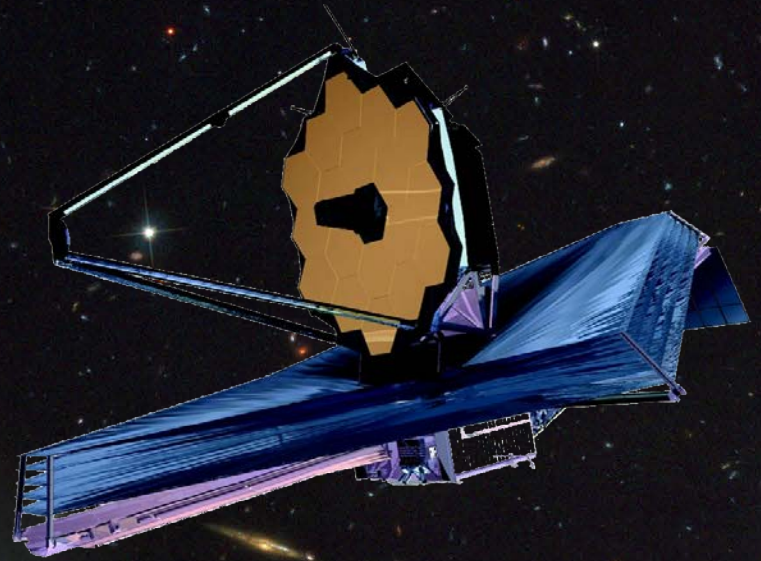


2016/07/01 10:06:30 EDT



Live update every 60 seconds <http://jwst.nasa.gov/webcam.html>.

The James Webb Space Telescope



Jonathan P. Gardner

NASA's Goddard Space Flight Center

<http://jwst.nasa.gov>

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