



JWST - Telescope

Gary Matthews

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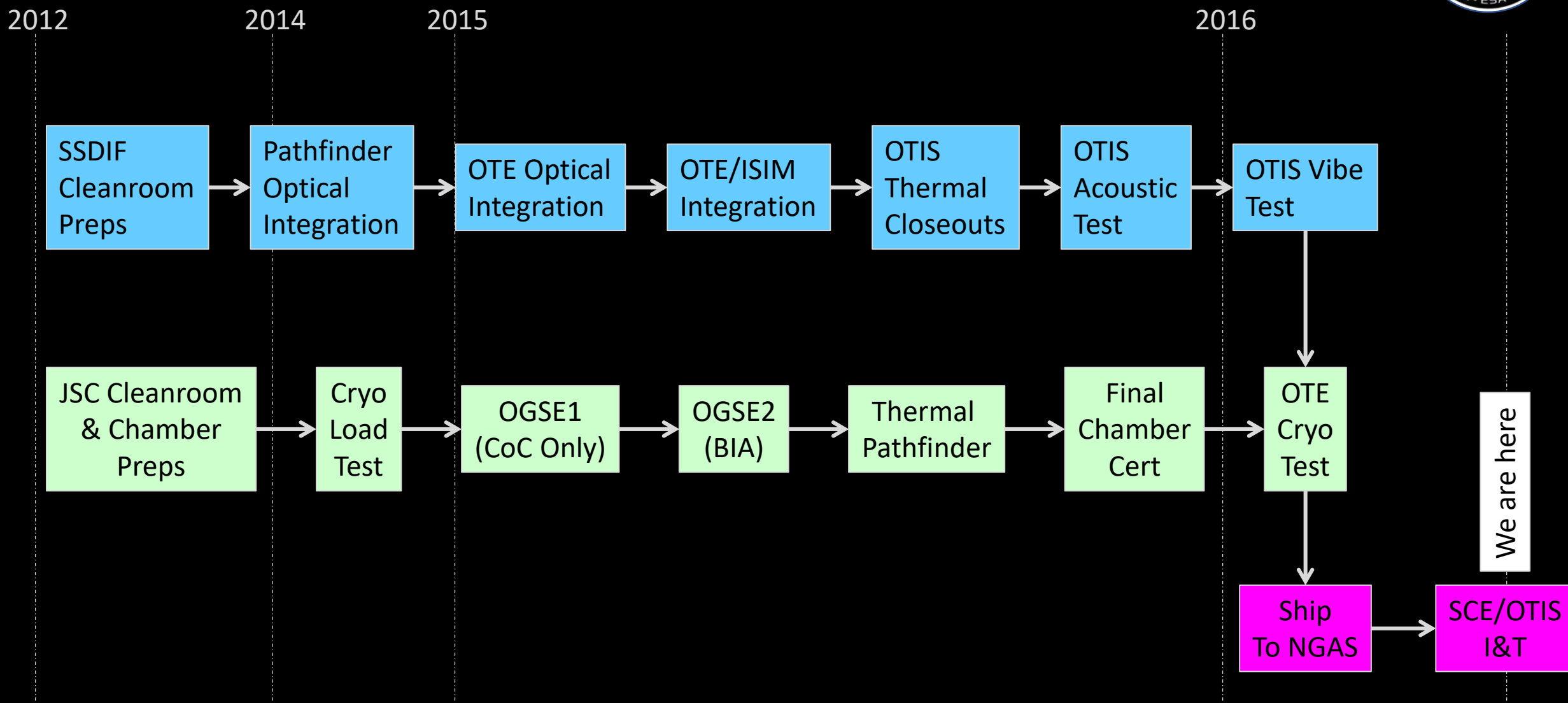


JWST OTE and OTIS Review

- Acronym Review
 - OTE – Optical Telescope Element – The Telescope
 - ISIM – Integrated Science Instrument Module
 - OTIS – OTE/ISIM Integrated Subsystem – The Camera – Payload
- Current Status
 - The OTE/ISIM – OTIS are now part of an Observatory at NGAS
- Historical perspective of OTIS development



Hardware Timeline





- 2012 -

Before we can start

SSDIF and JSC Facility Modifications

SSDIF* pre-OTE



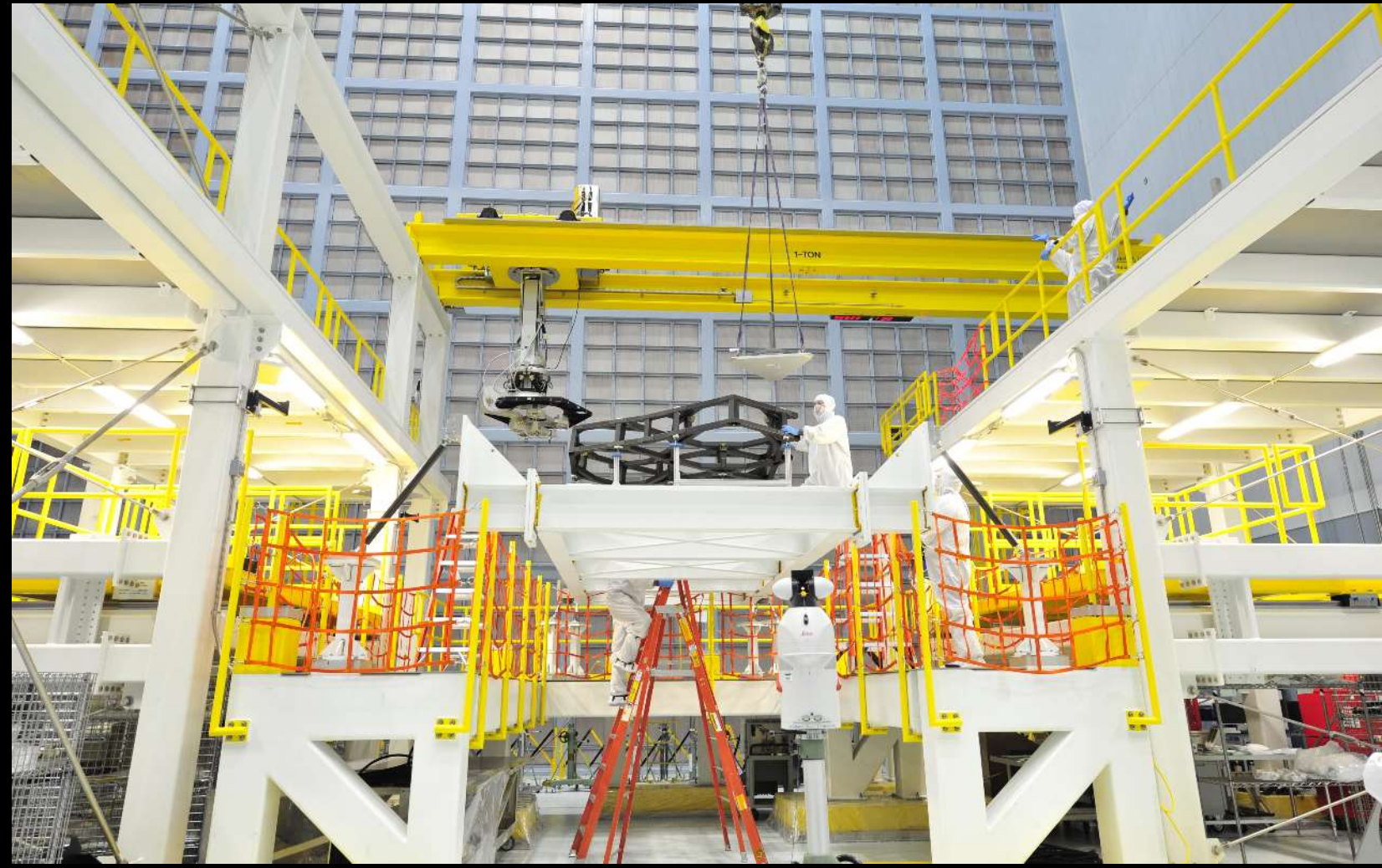
* Spacecraft Systems Development and Integration Facility



AOAS* Installation in SSDIF



*Ambient Optical Alignment Stand



OTE Integration Equipment

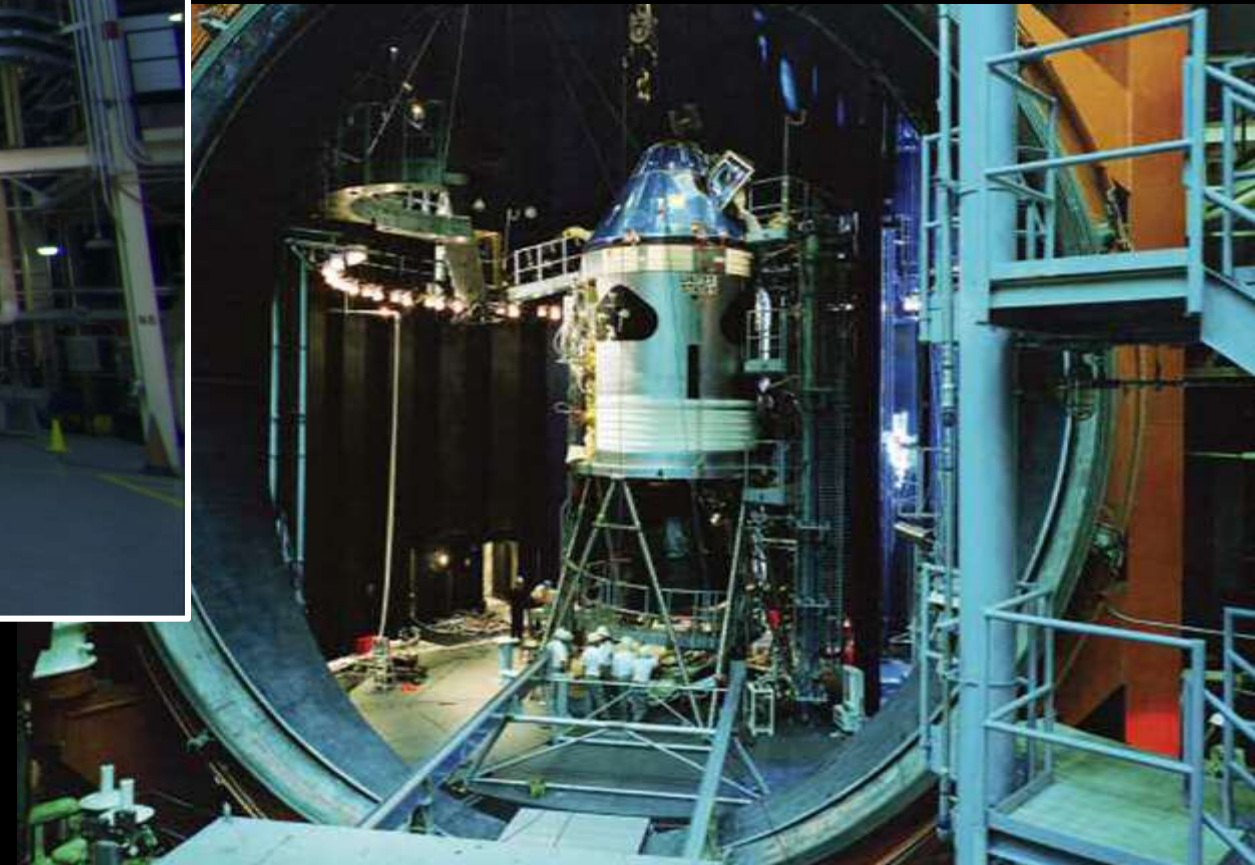
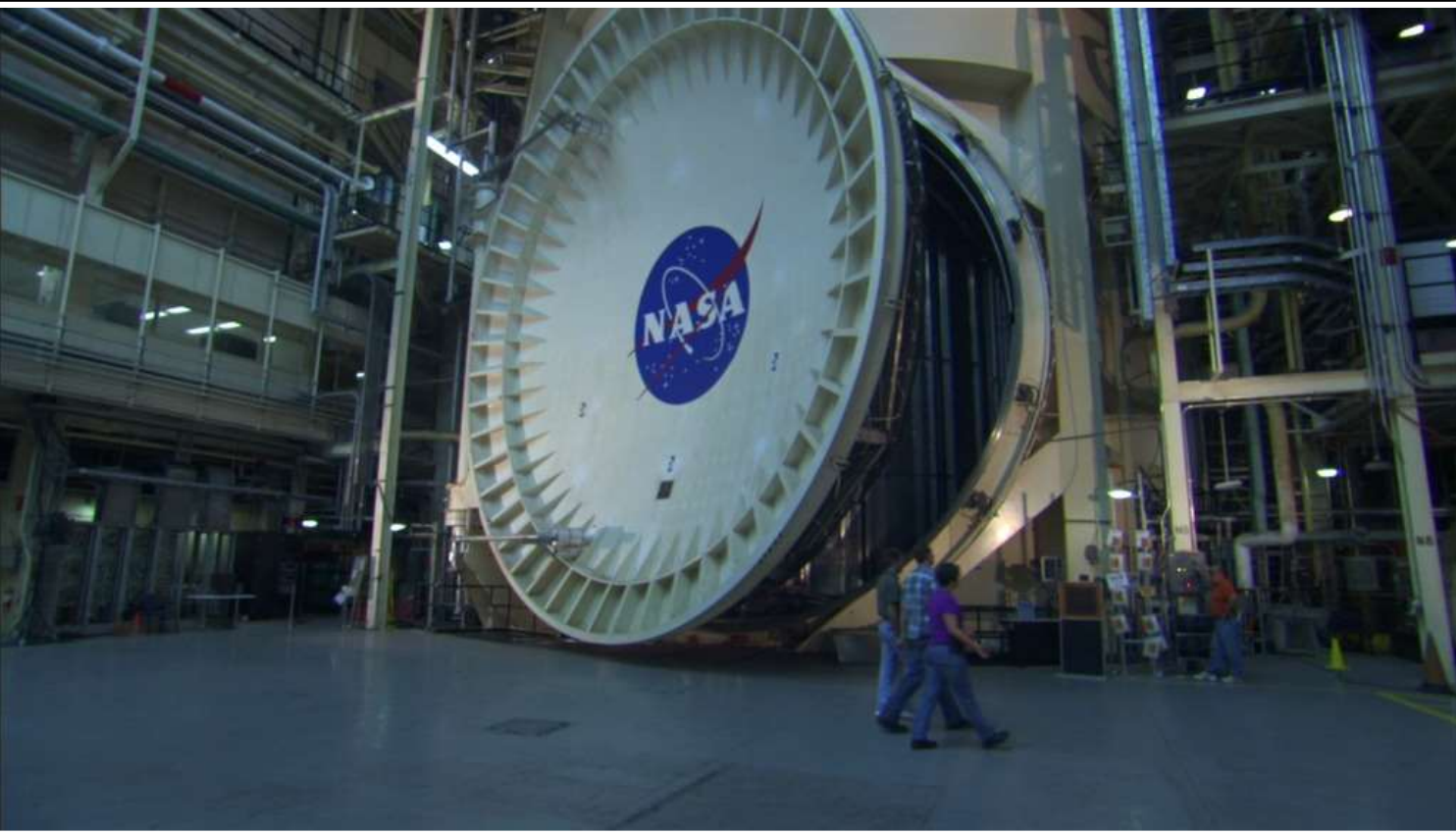


PAIF placing primary mirror system assembly (PMSA) onto the Backplane Stability Thermal Assembly (BSTA)



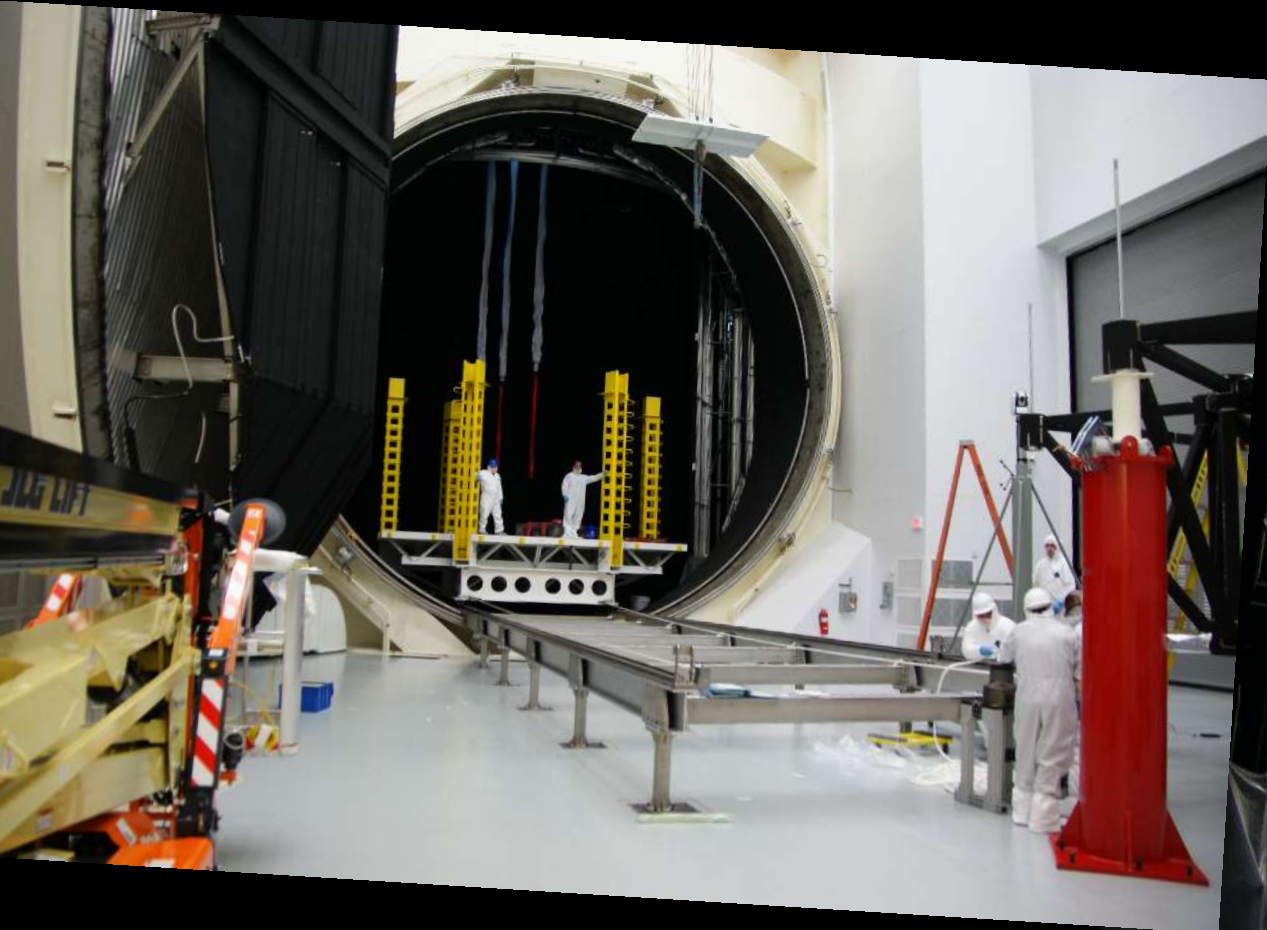
AOAS in the GSFC Cleanroom

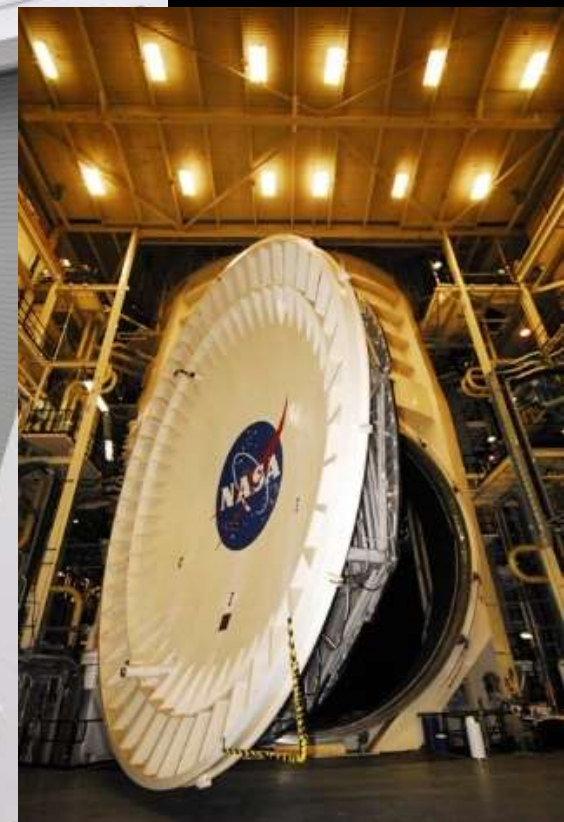
Pre-JWST view of the JSC vacuum chamber





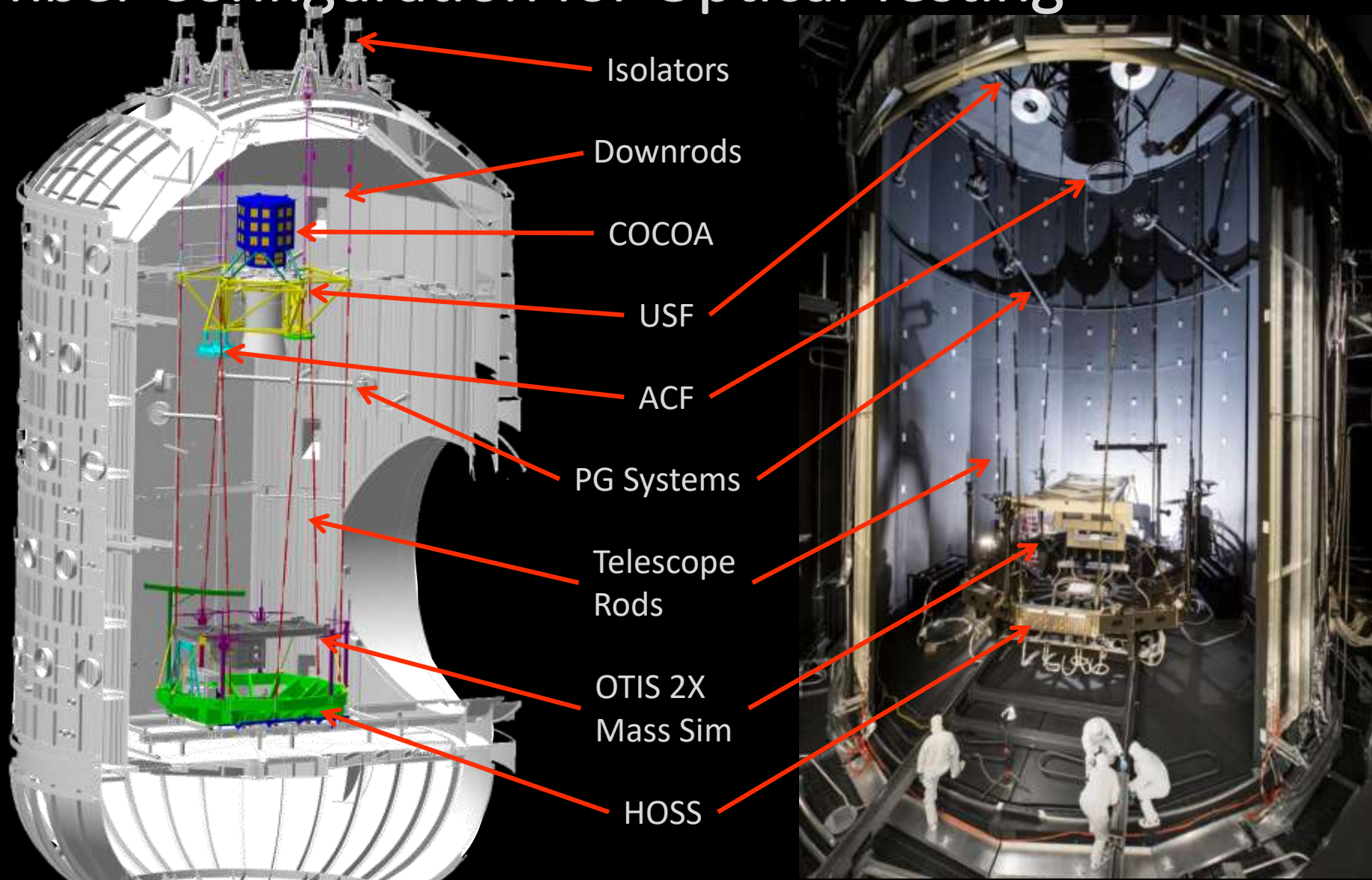
A cleanroom and optical test equipment emerges





Before
and
After

Chamber Configuration for Optical Testing



COCOA* during integration on the cleanroom floor

* Center of Curvature Optical Assembly

- Multiwavelength Interferometer
- Primary Mirror Alignment Aids
- DMI motion detection system
- Three Autocollimating Flats



Photogrammetry Systems

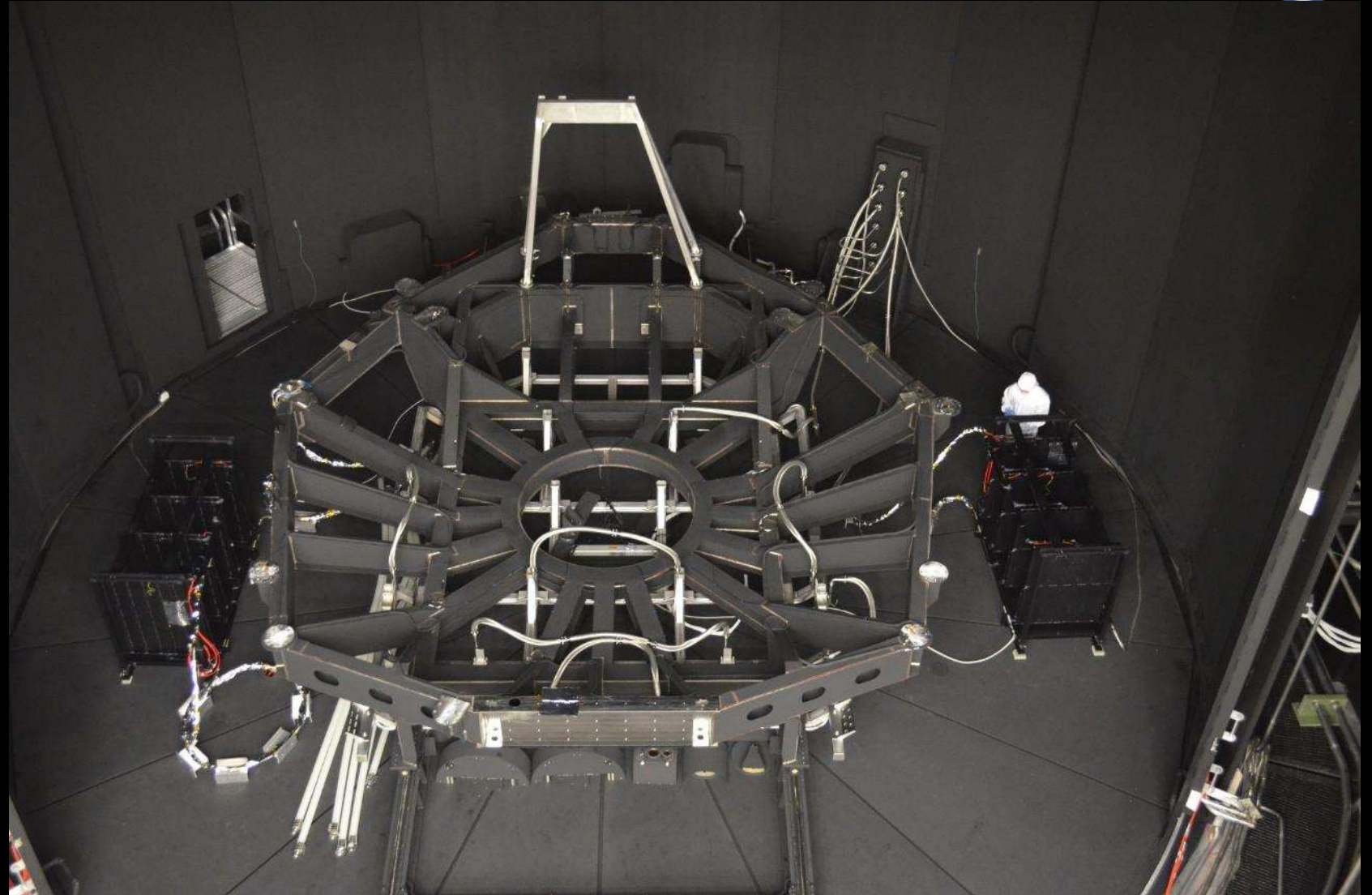
- 4 rotating “windmills” containing canisters with photogrammetry cameras installed
- Provides angular diversity
- Allowed absolute measurement of the system to ~100 microns at 40K in vacuum
- Minimal heat leakage with coated double window configuration



HOSS*



- * Hardpoint/Offloader Support Structure
- Welded Stainless Steel 304L structure





Cryo Load Test

JWST-PV-058072





The Early Days

Mirror Development and Pathfinder Integration

Mirrors are beryllium optimized for cryo performance

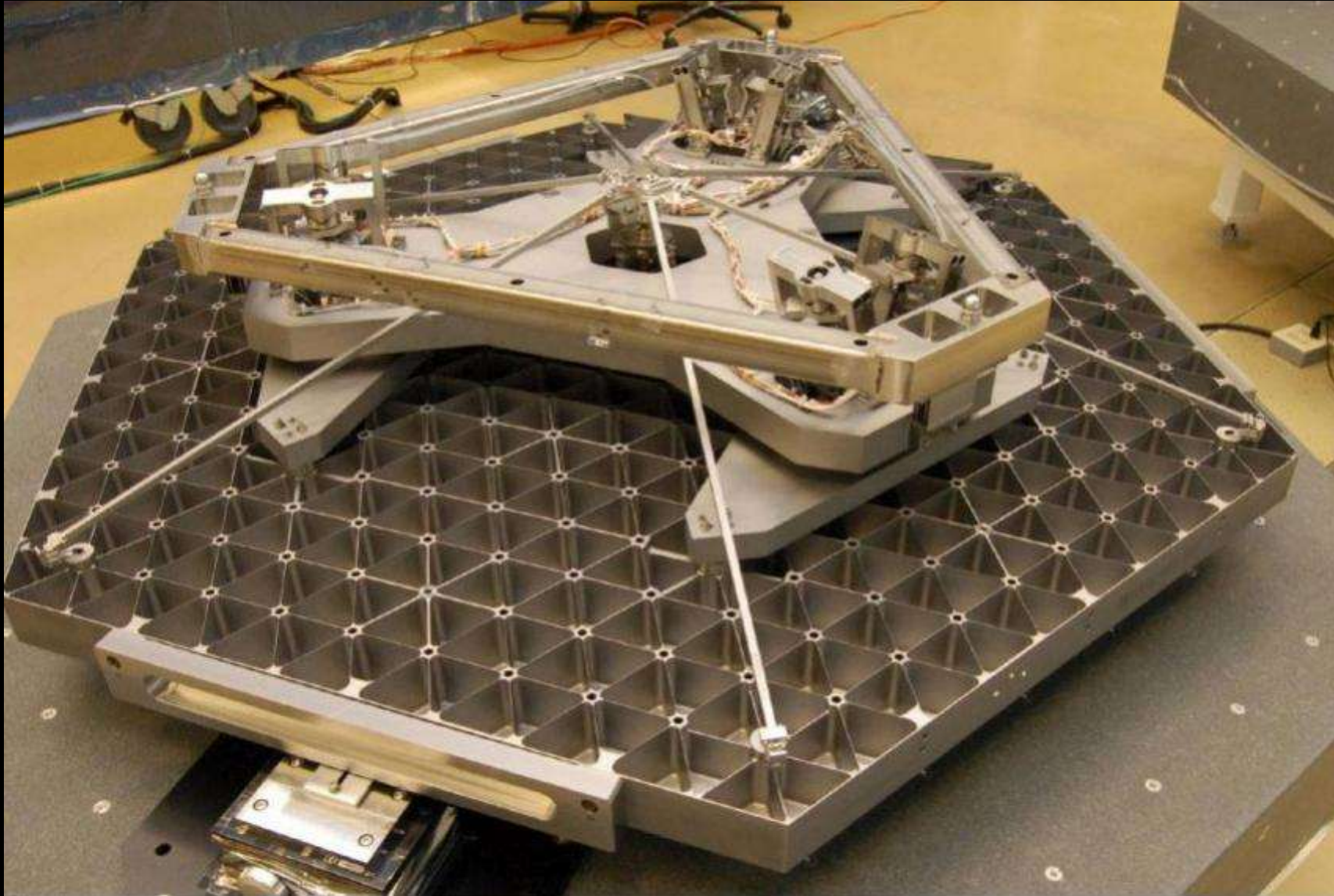


2019 Mirror Tech Days – JWST OTE Review

PMSA* Mechanisms



* Primary Mirror Segment Assembly





Cryo null figuring testing at Marshall Spaceflight Center

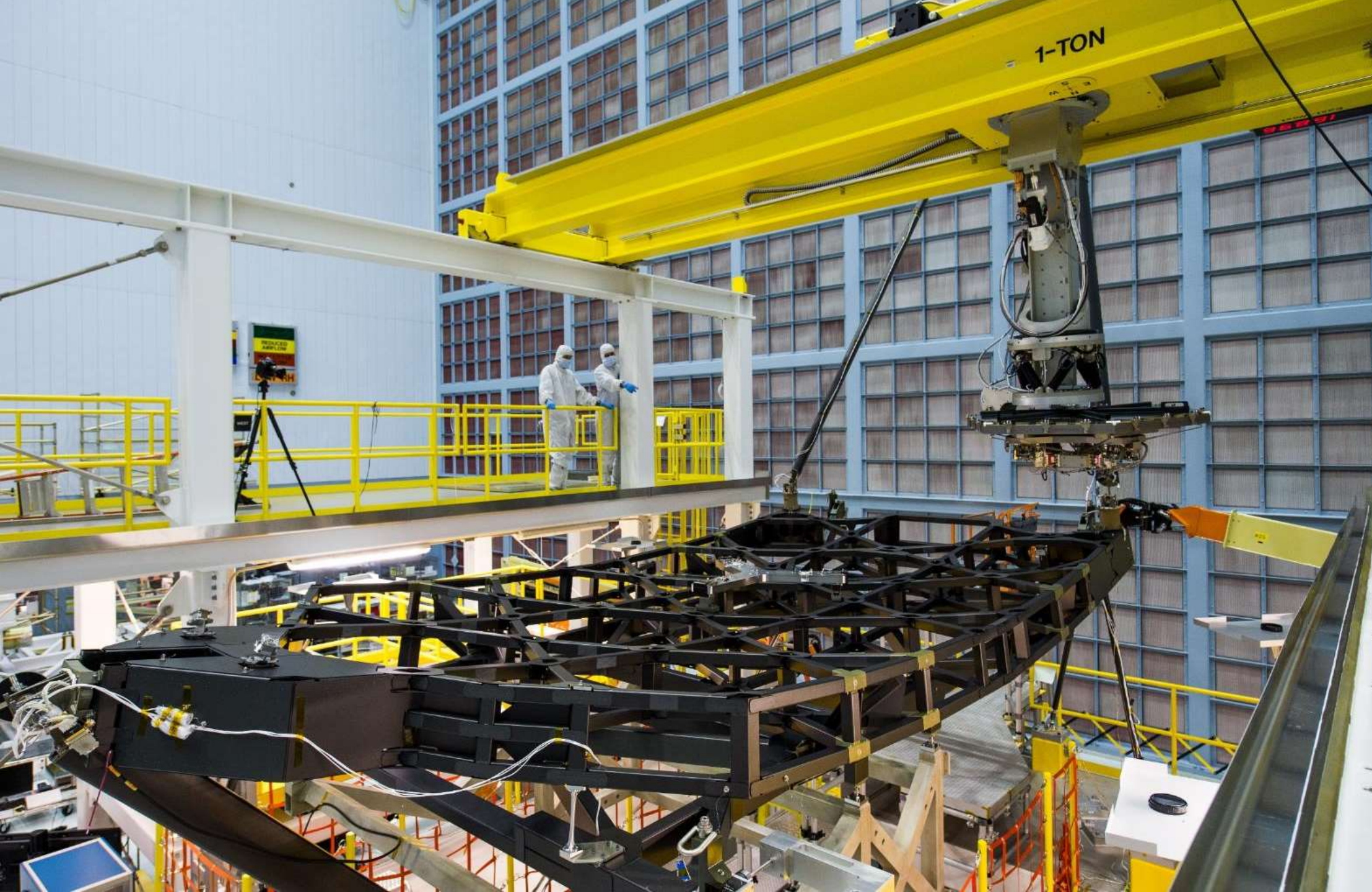
PMISA Alignment Metrology on a CMM





Pathfinder Mirror Integration





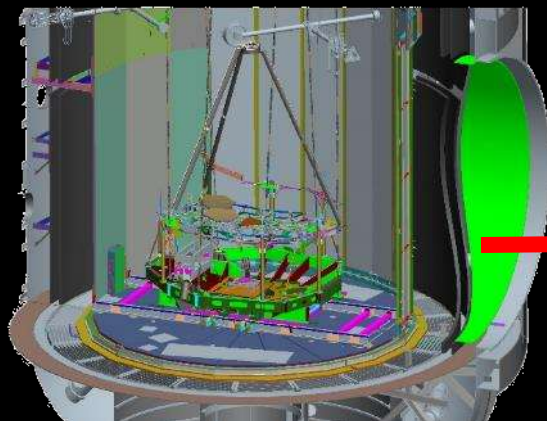
Pathfinder
PMSA mirror
integration
in the AOAS
using the
PAIF
(Primary
Mirror
Alignment &
Integration
Fixture)
robotic arm



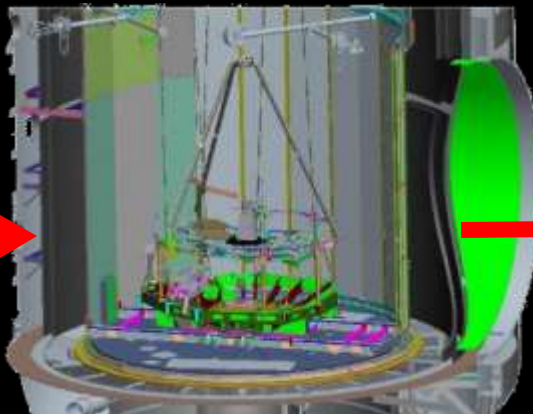
Pathfinder Optical Testing

OGSE Test Program

OGSE-1

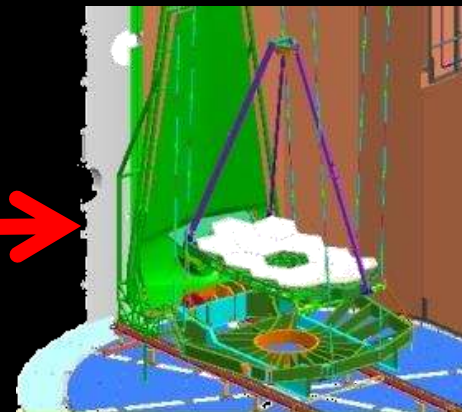


OGSE-2



Pathfinder Thermal

PF Updated
to be more Flight Like



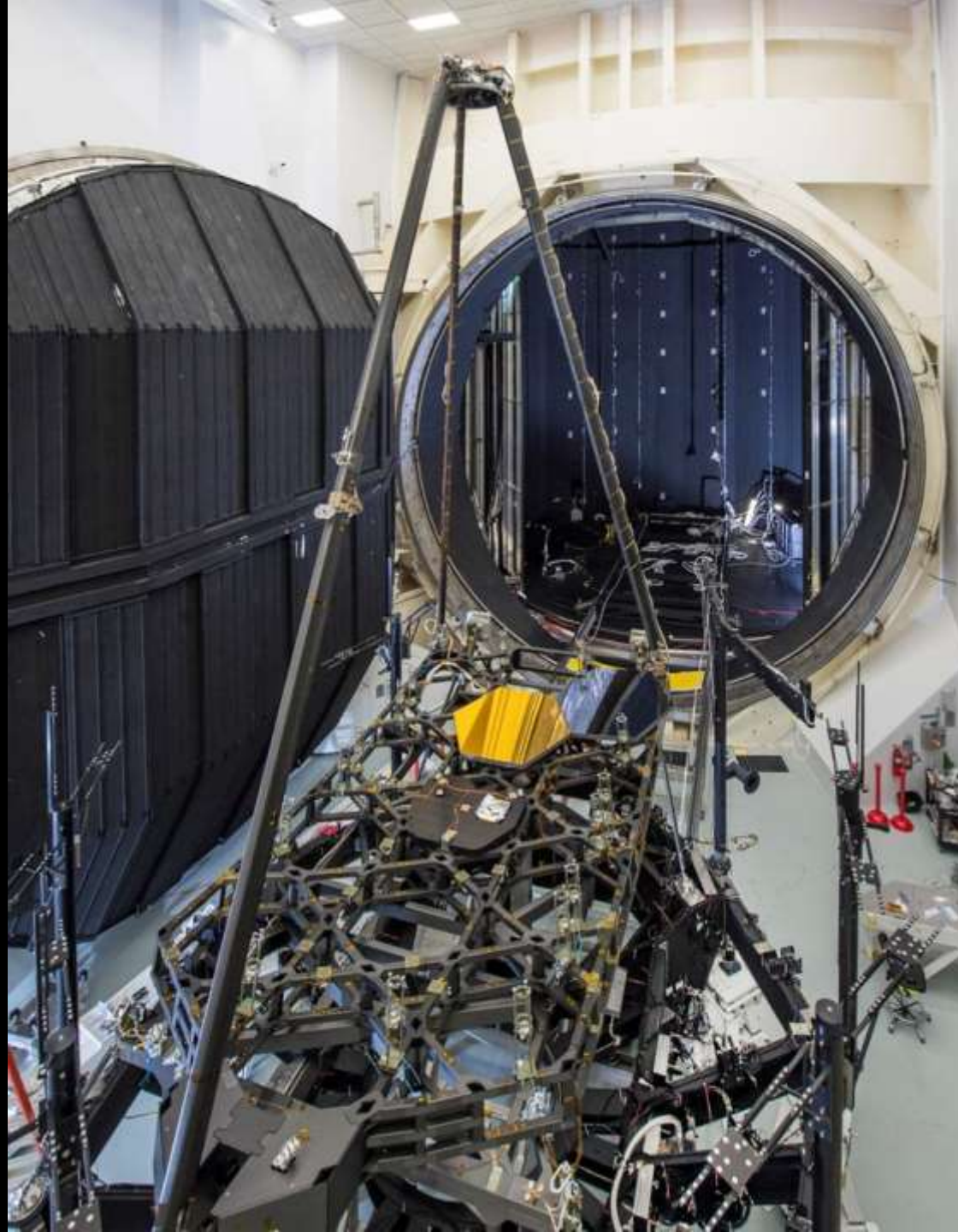
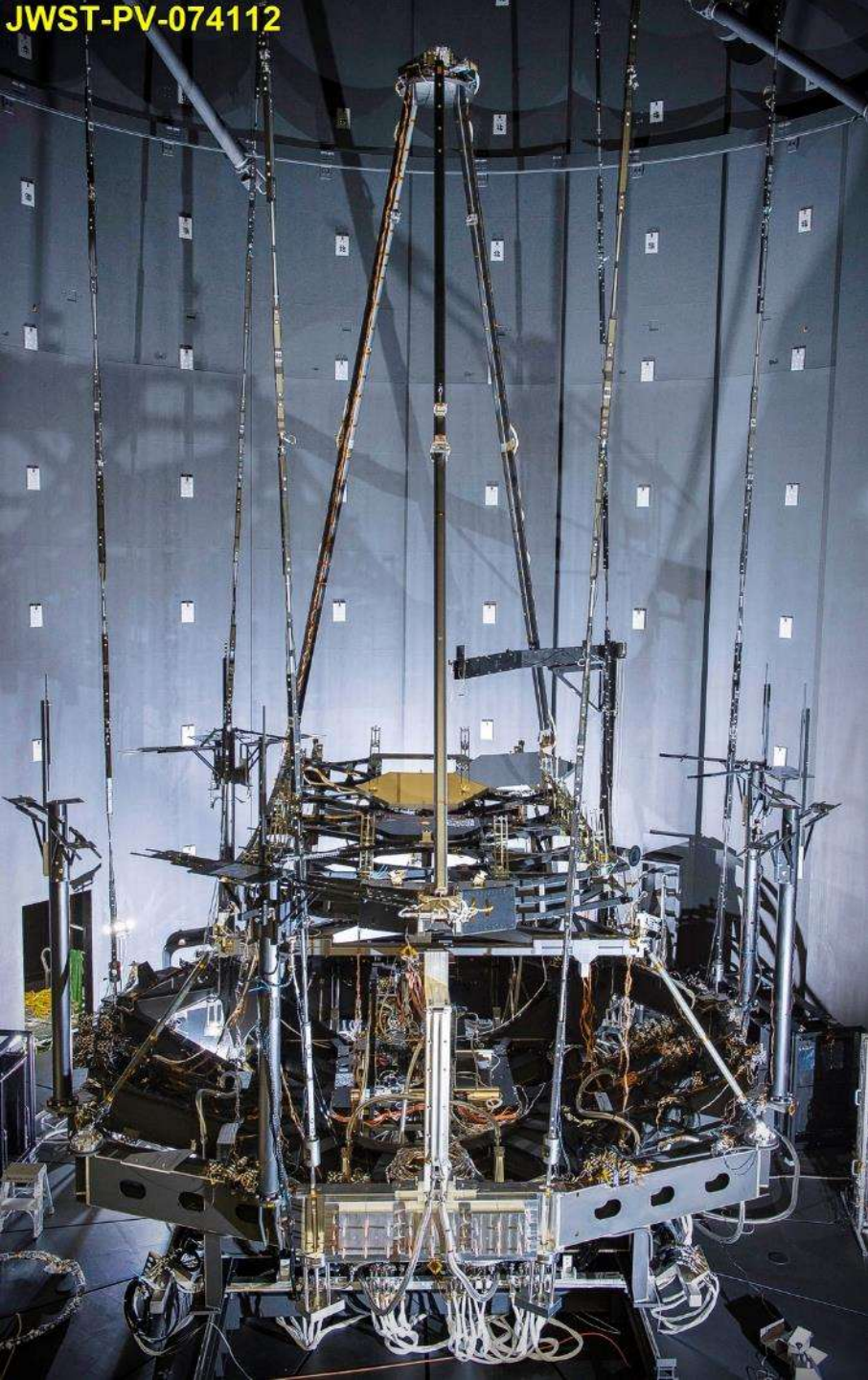
- Checkout Optical GSE that has not seen cryo before: CoC test, Hanging Config, Photogrammetry
- No flight hardware except flight spare PMSA/SMA
- Dynamics and Thermal Distortion portion of PF Augmentation occur here

- Checkout Pass and a half test with flight AOS and GSE source plate system
- Uses BIA camera as SI simulator

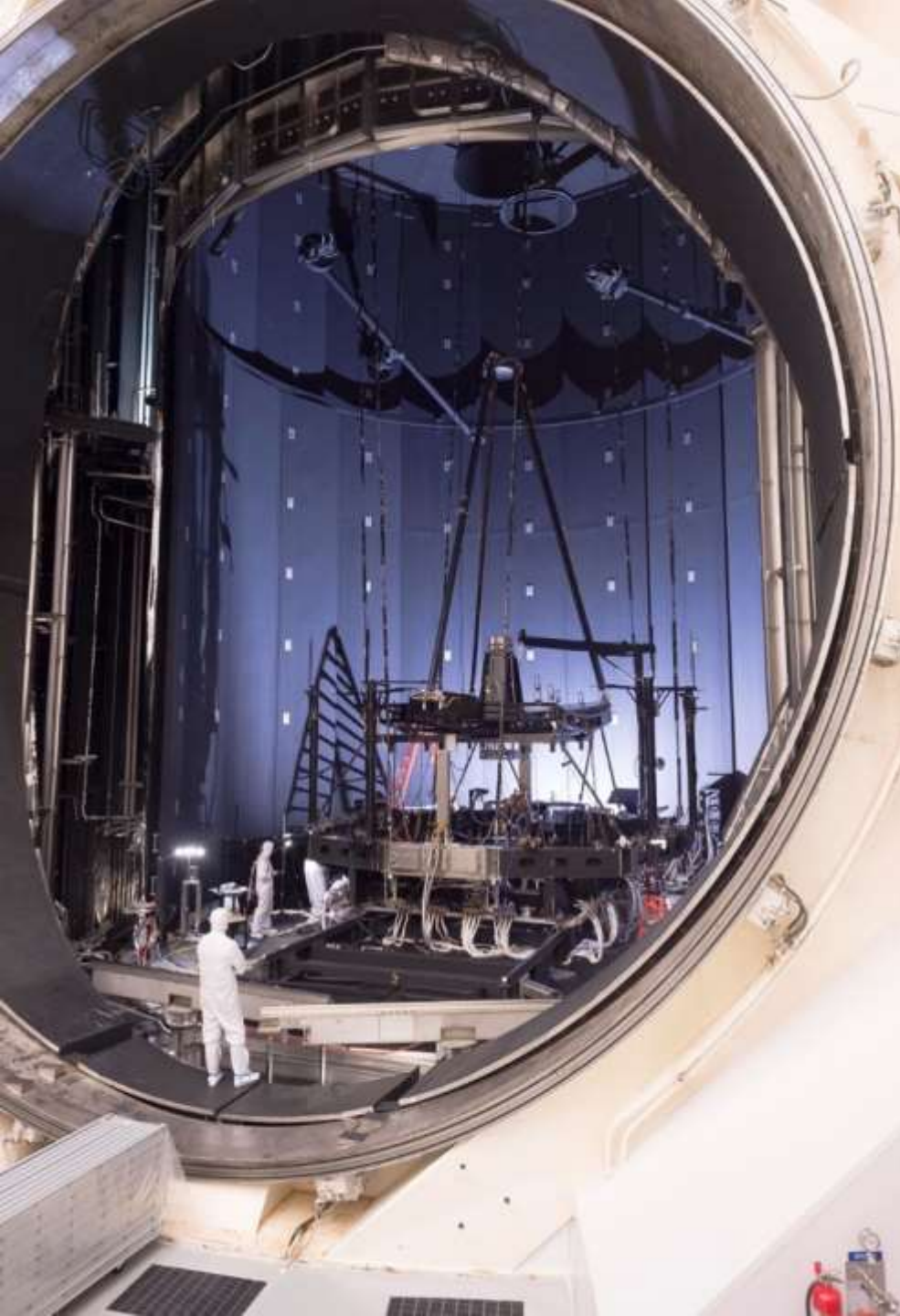
- Thermal GSE Checkout (includes SVTS)
- Dry run cooldown and warmup
- Will allow risk reduction of some OTE Thermal Balance (design validation off the critical path)

Pathfinder ready to roll into the chamber for OGSE-1





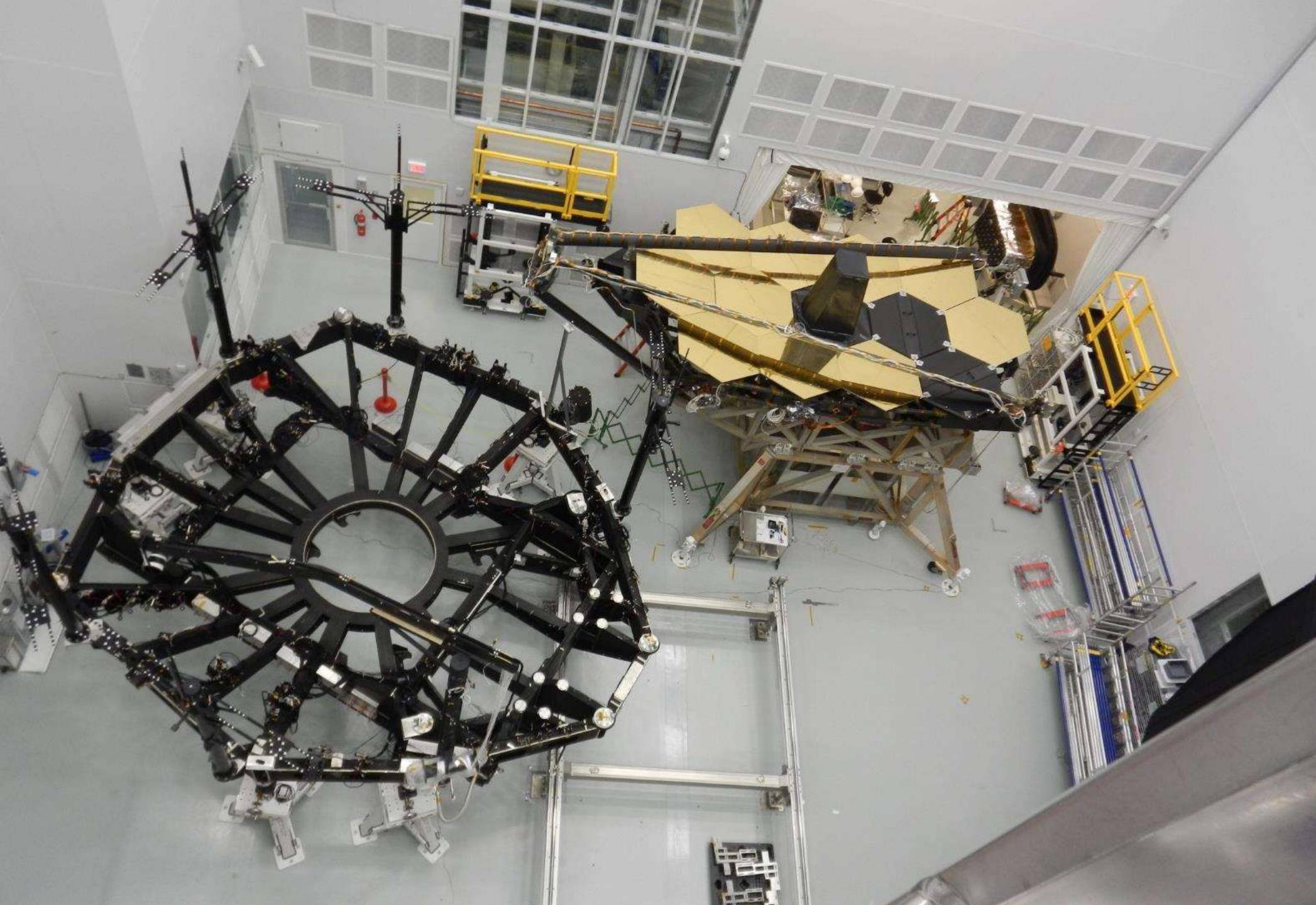
OGSE-1 Test Configuration



OGSE-2 Test Configuration With the Flight AOS

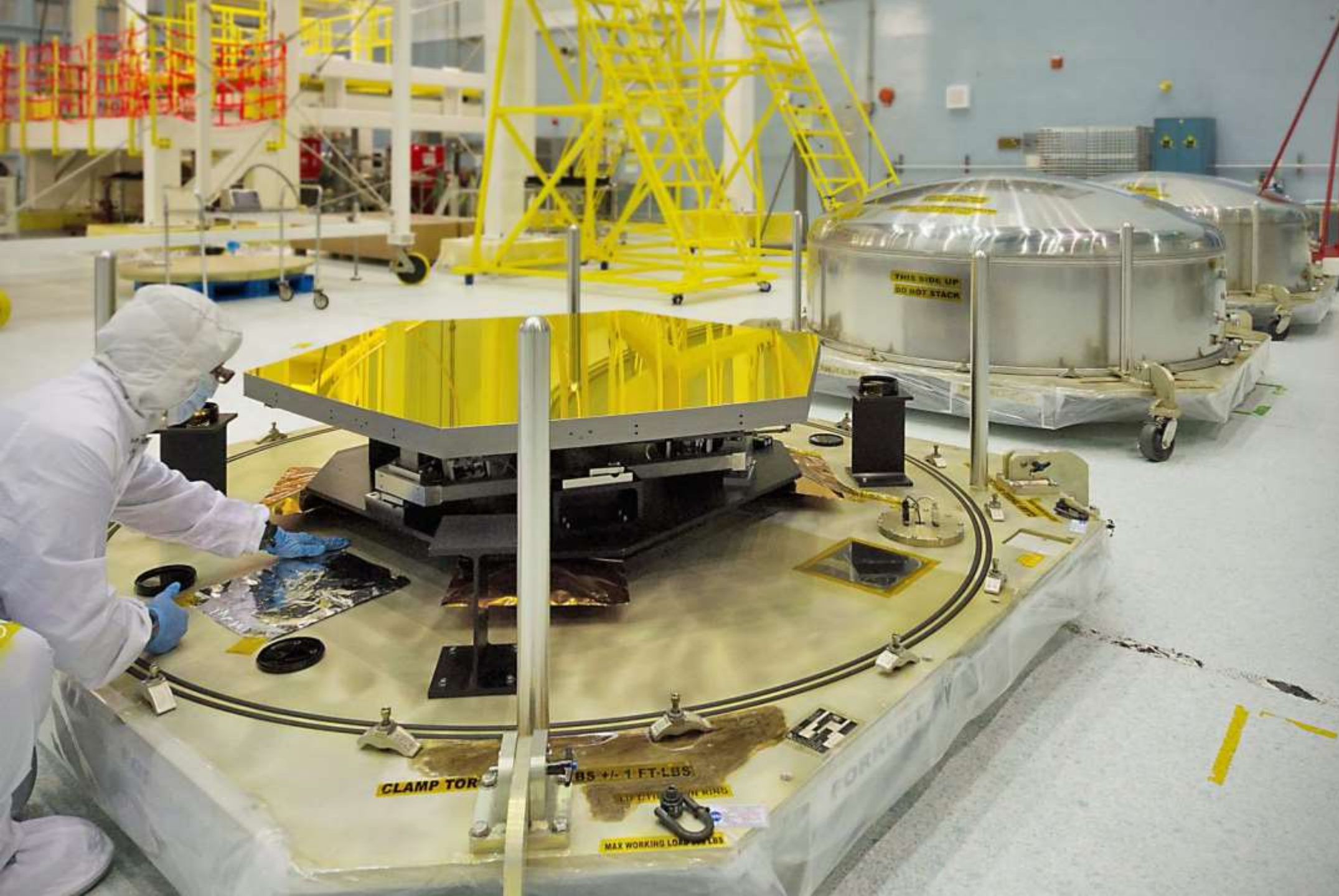


Thermal Pathfinder Test Configuration





Telescope Integration



Unloading the PMSA from their hermetically sealed shipping container

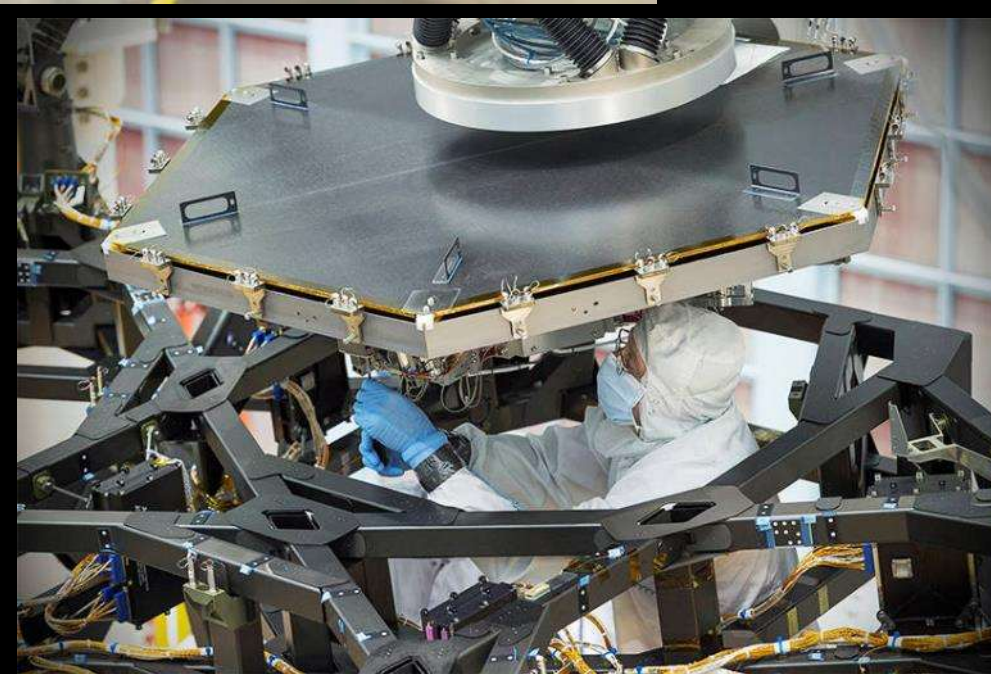


PMSA shown in the flip-over and handling cart



First flight PMSA integration.

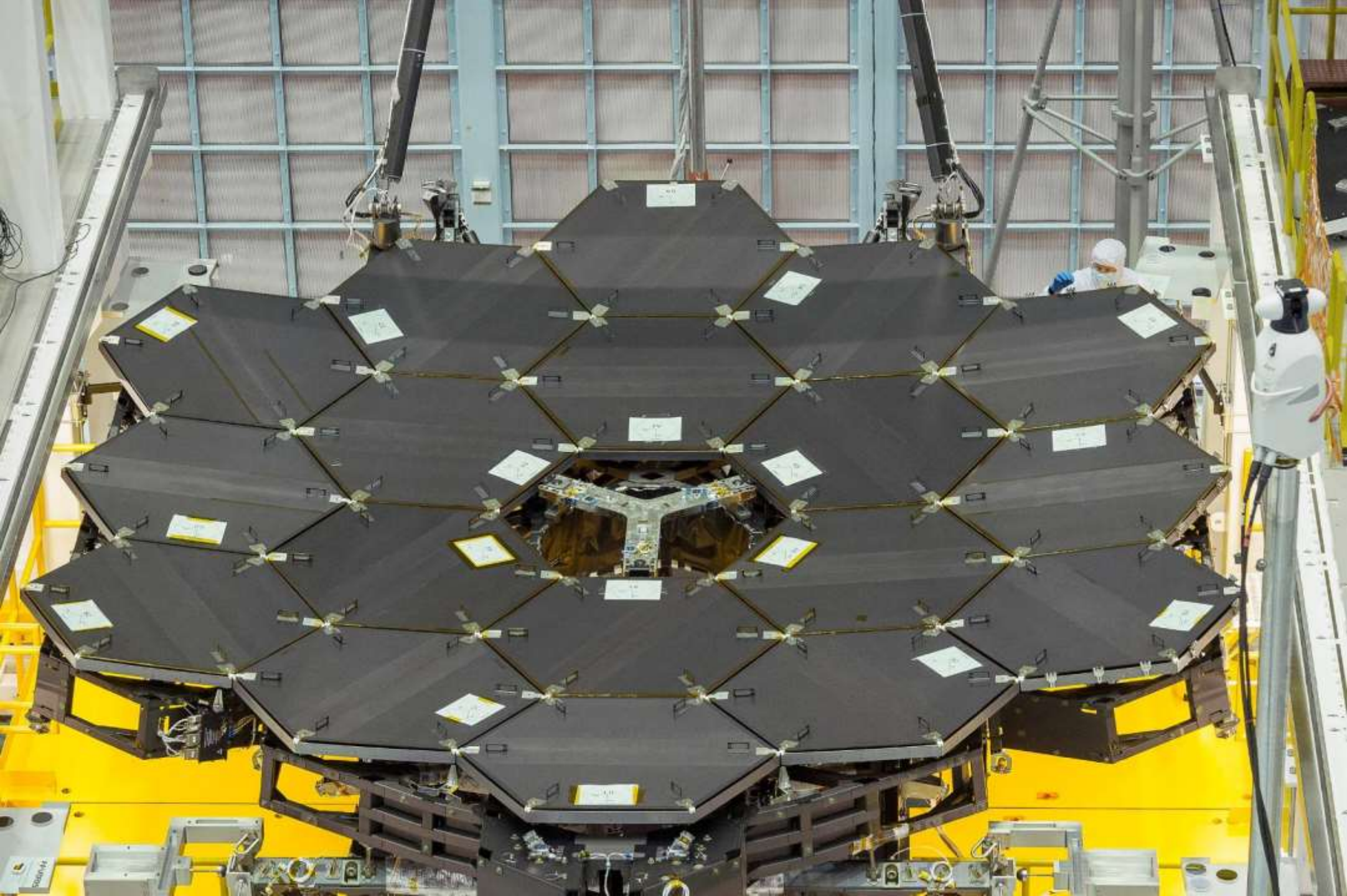
Protective mirror covers used during integration operations





Last flight
PMSA
integration





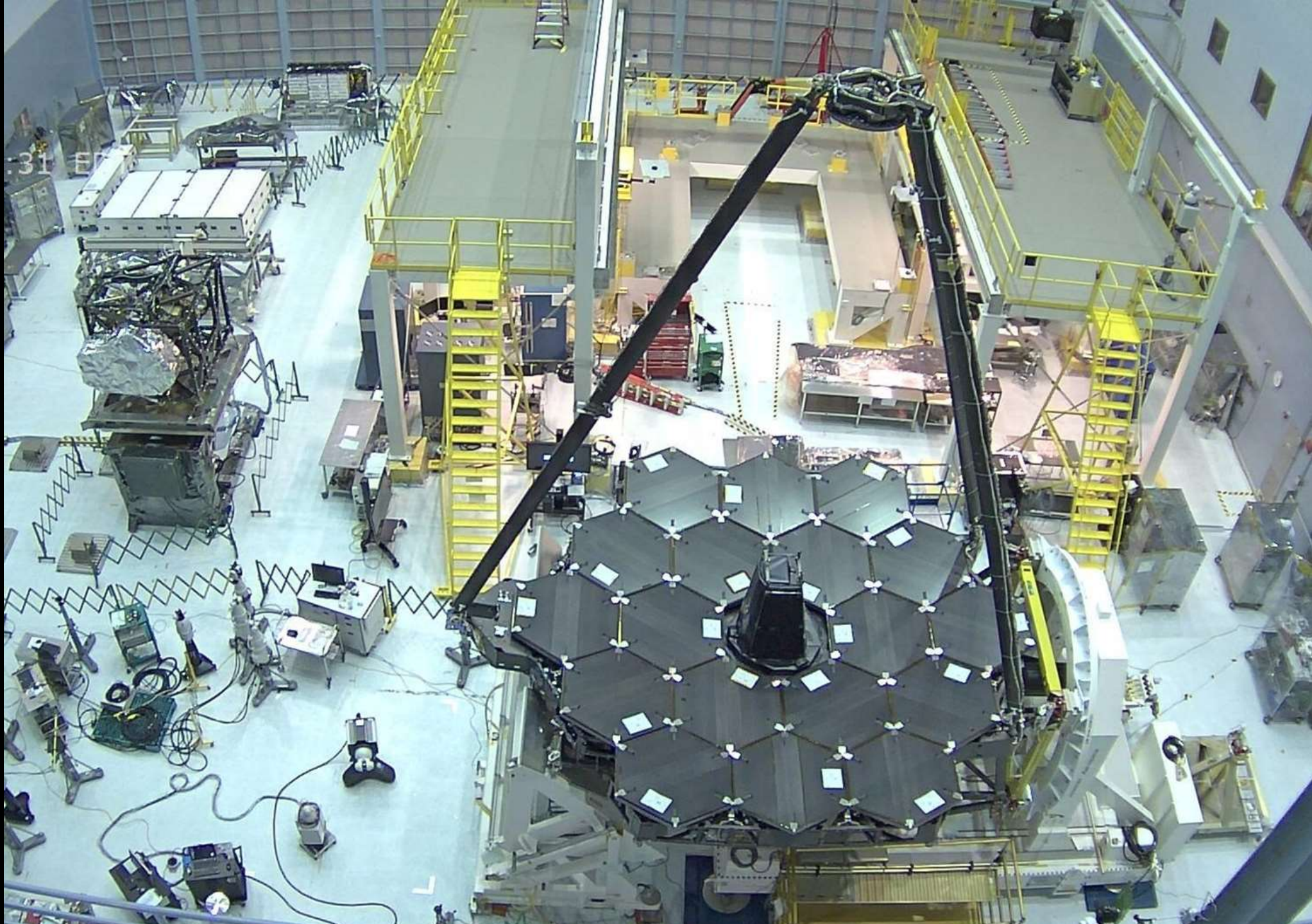
Completed primary mirror with protective covers still in place



Secondary
Mirror
integration



Completed telescope being removed from the AOAS in preparation for ISIM installation after mirror protective cover removal



Ready for the grand reveal of the golden primary mirror



Protective cover removal



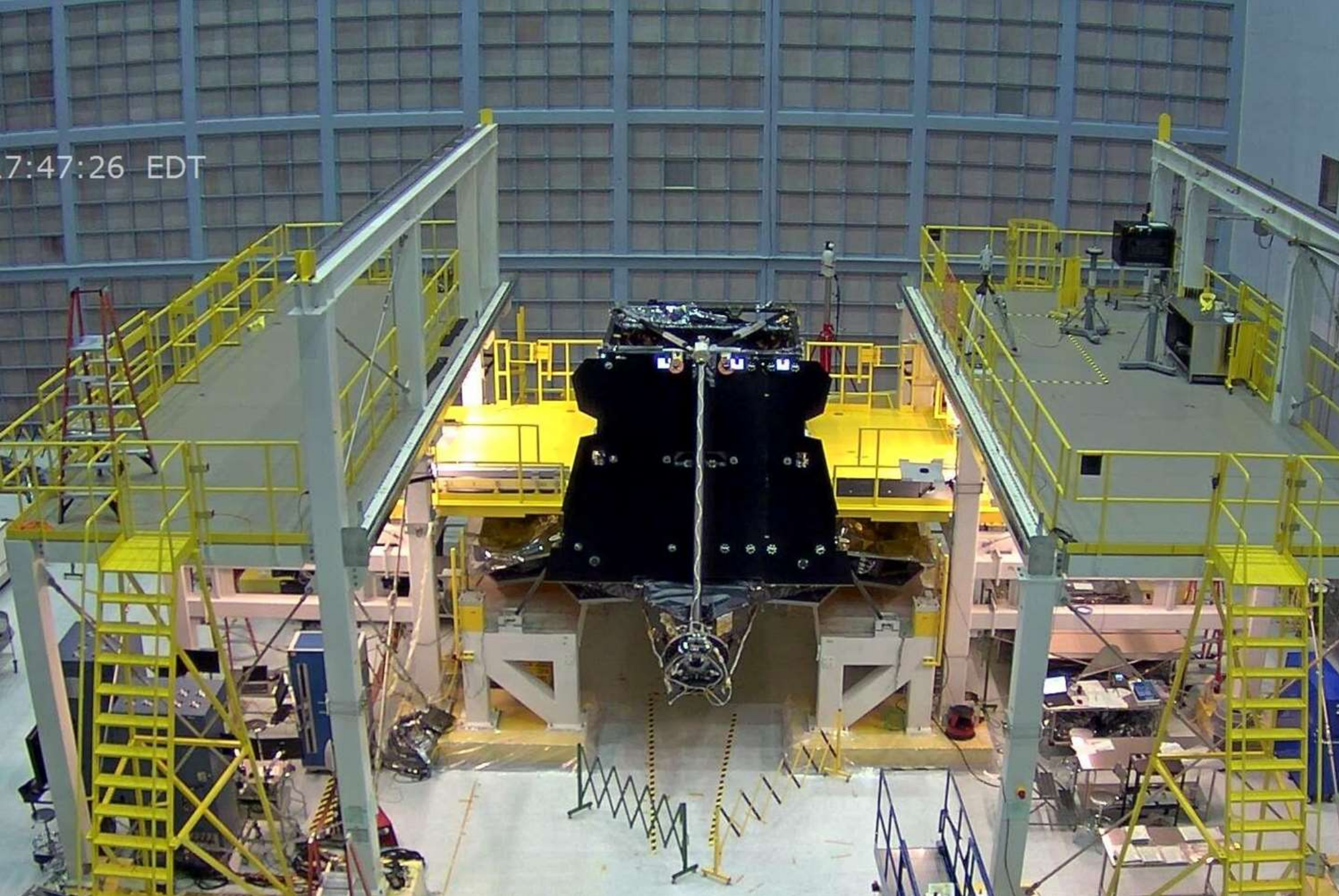
Completed telescope with ISIM in the background ready for installation



ISIM Integration



7:47:26 EDT



Telescope
flipped over in
the AOAS



ISIM being lowered
into position

Very tight clearances
during this operation.
MLI rubbed during
integration



ISIM
integration
and nail
biting
contest

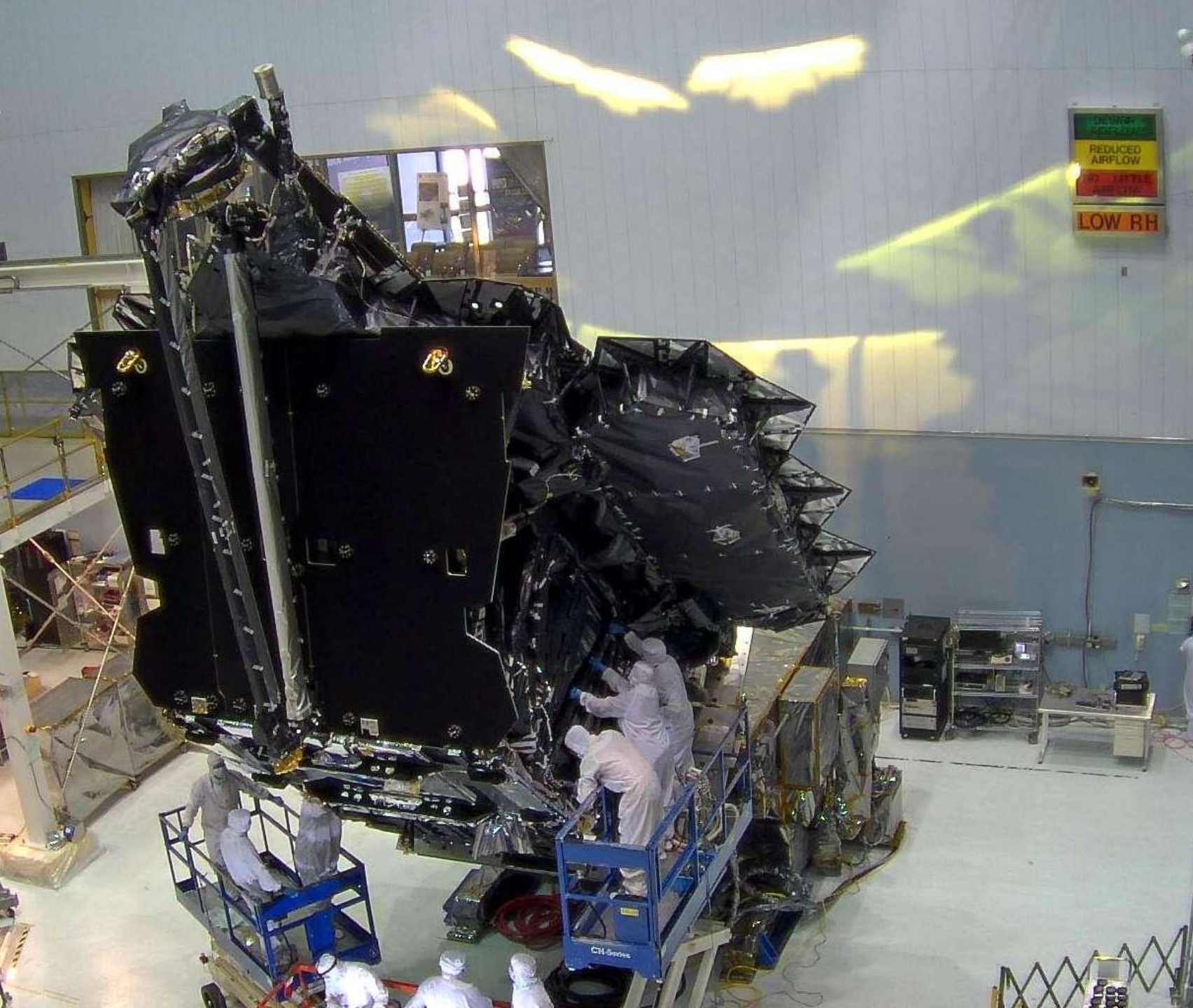


OTIS Integration



Final OTIS thermal closeouts

The large FIR (Fixed ISIM Radiator) is integrated onto the telescope structure



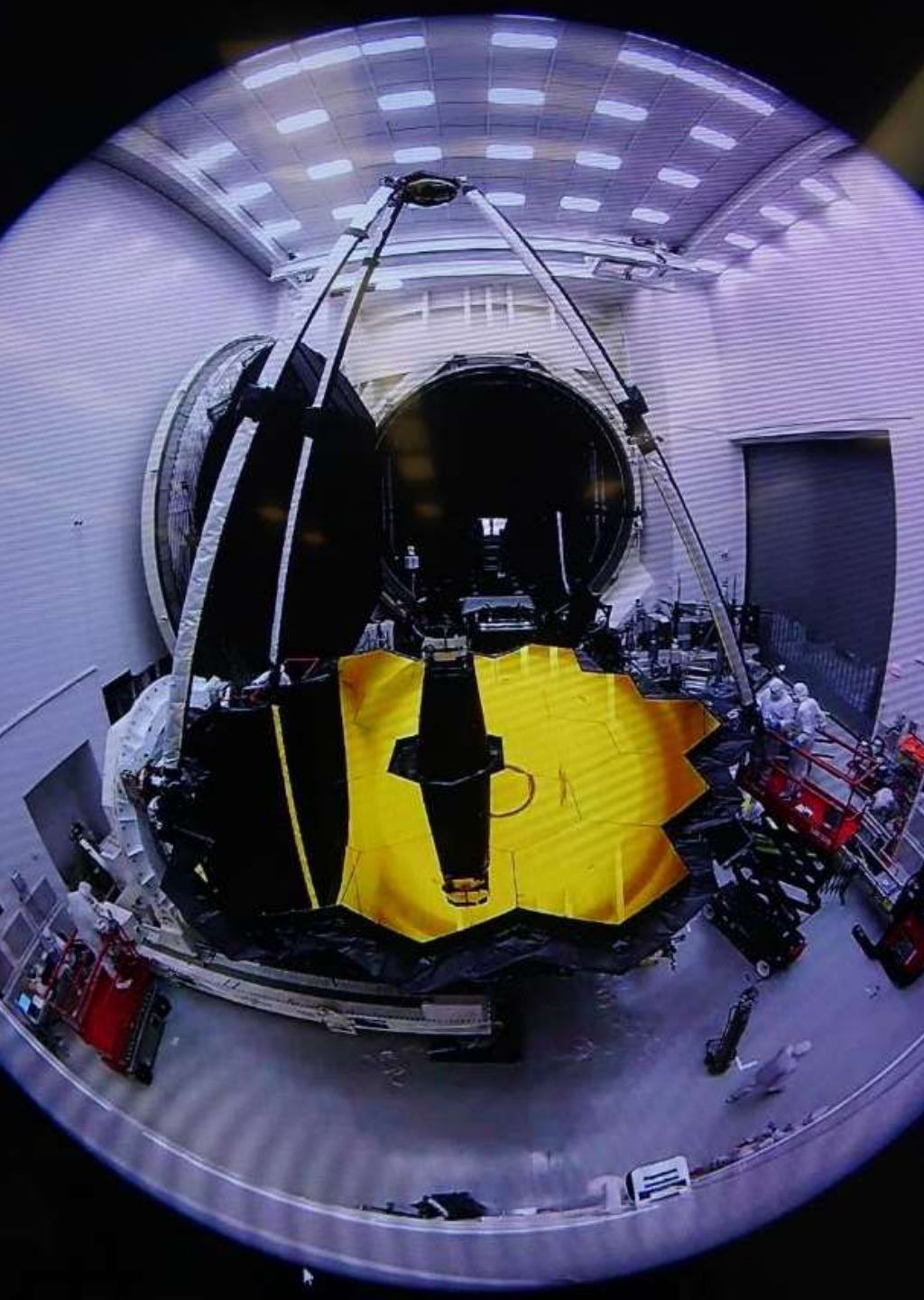
OTIS Blanket Closeouts



Final pose prior to pack
and ship to JSC



OTIS Cryo-Optical Test



The view from the cameras in the JSC cleanroom

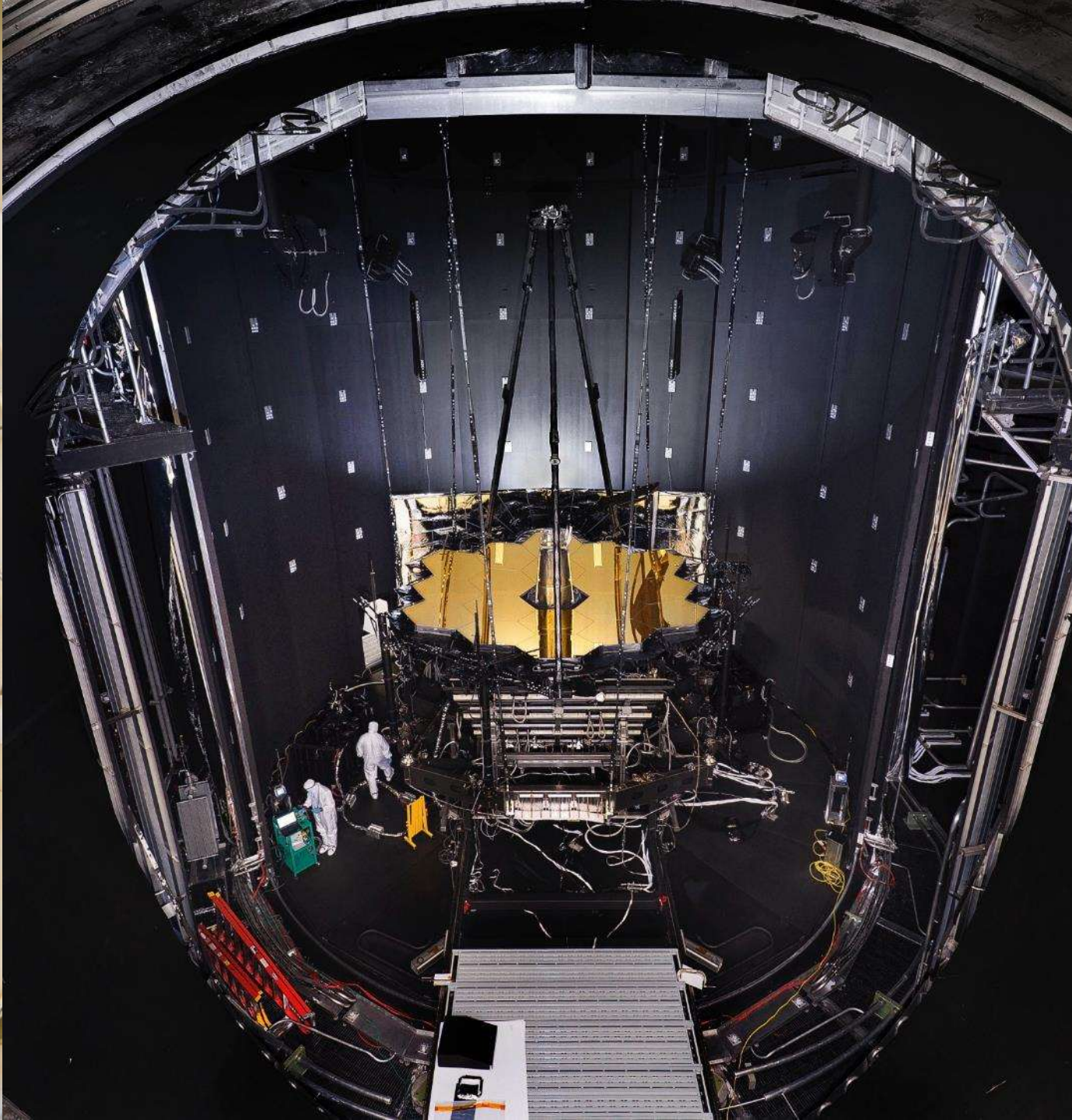
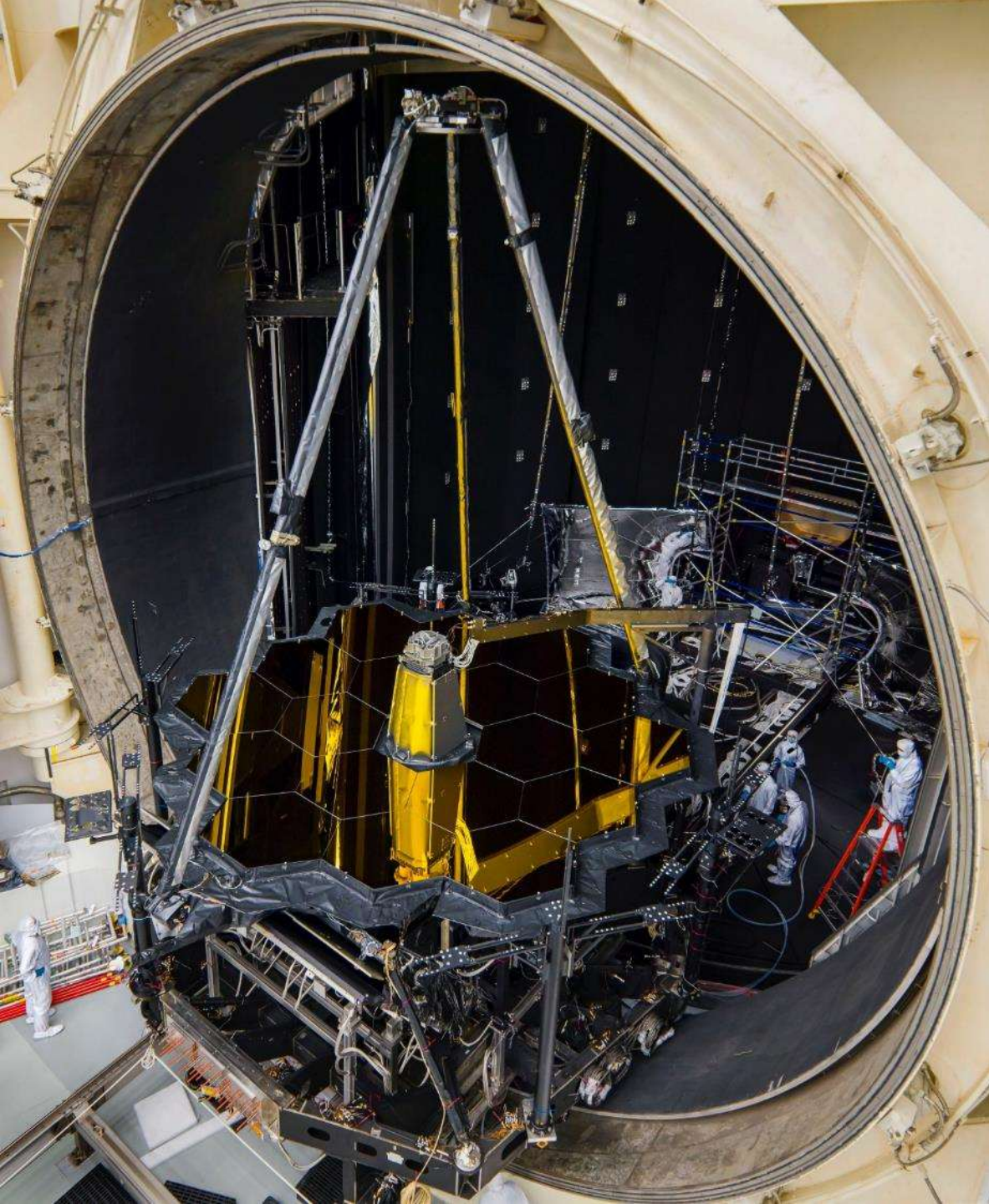


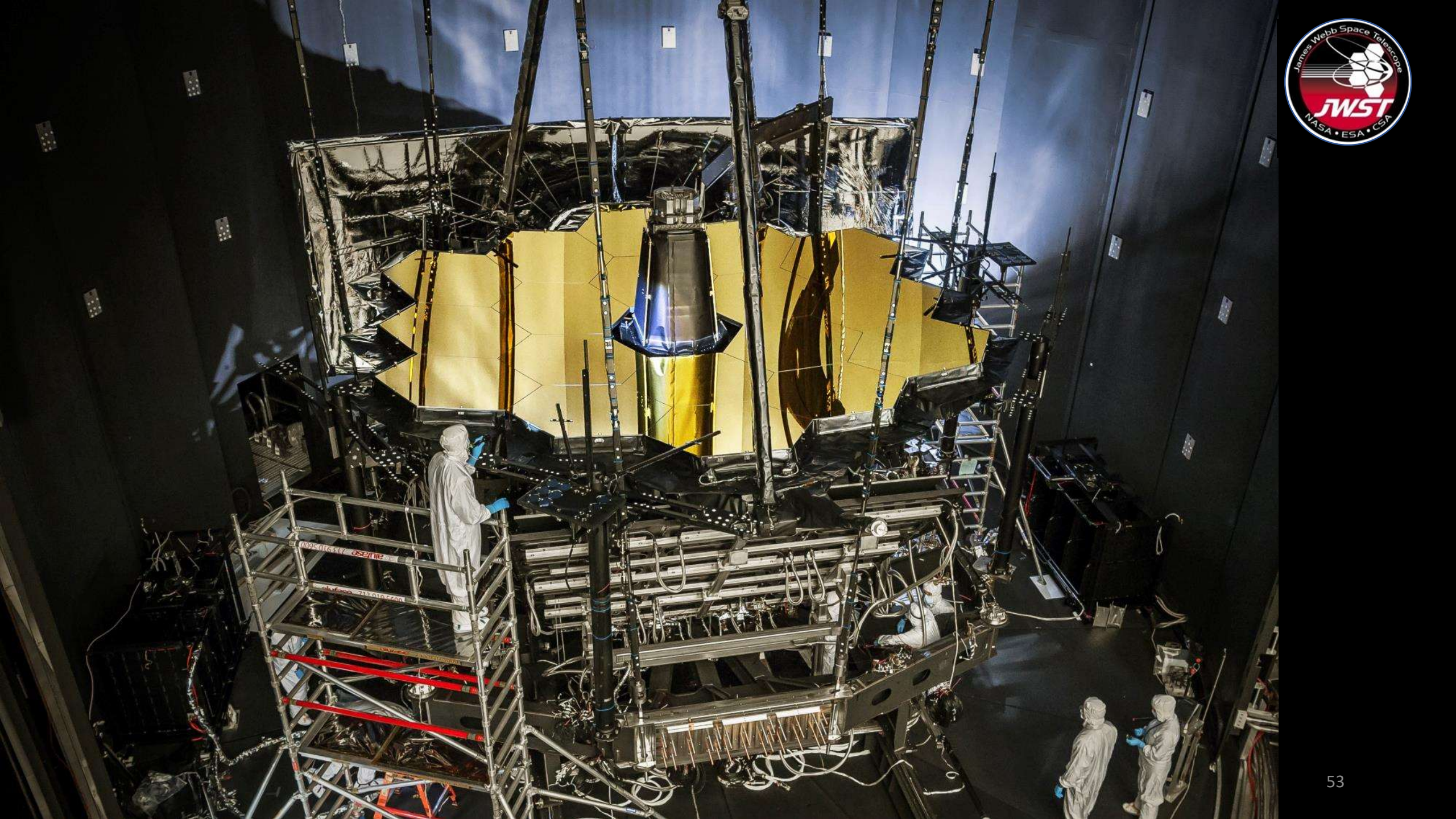
Reflective view
off the
secondary
mirror in the
JSC cleanroom



OTIS being placed on the HOSS in preparation for tolling into the chamber

The SVTS (Space Vehicle Thermal Simulator) can be seen in the background





Chamber Temperature*

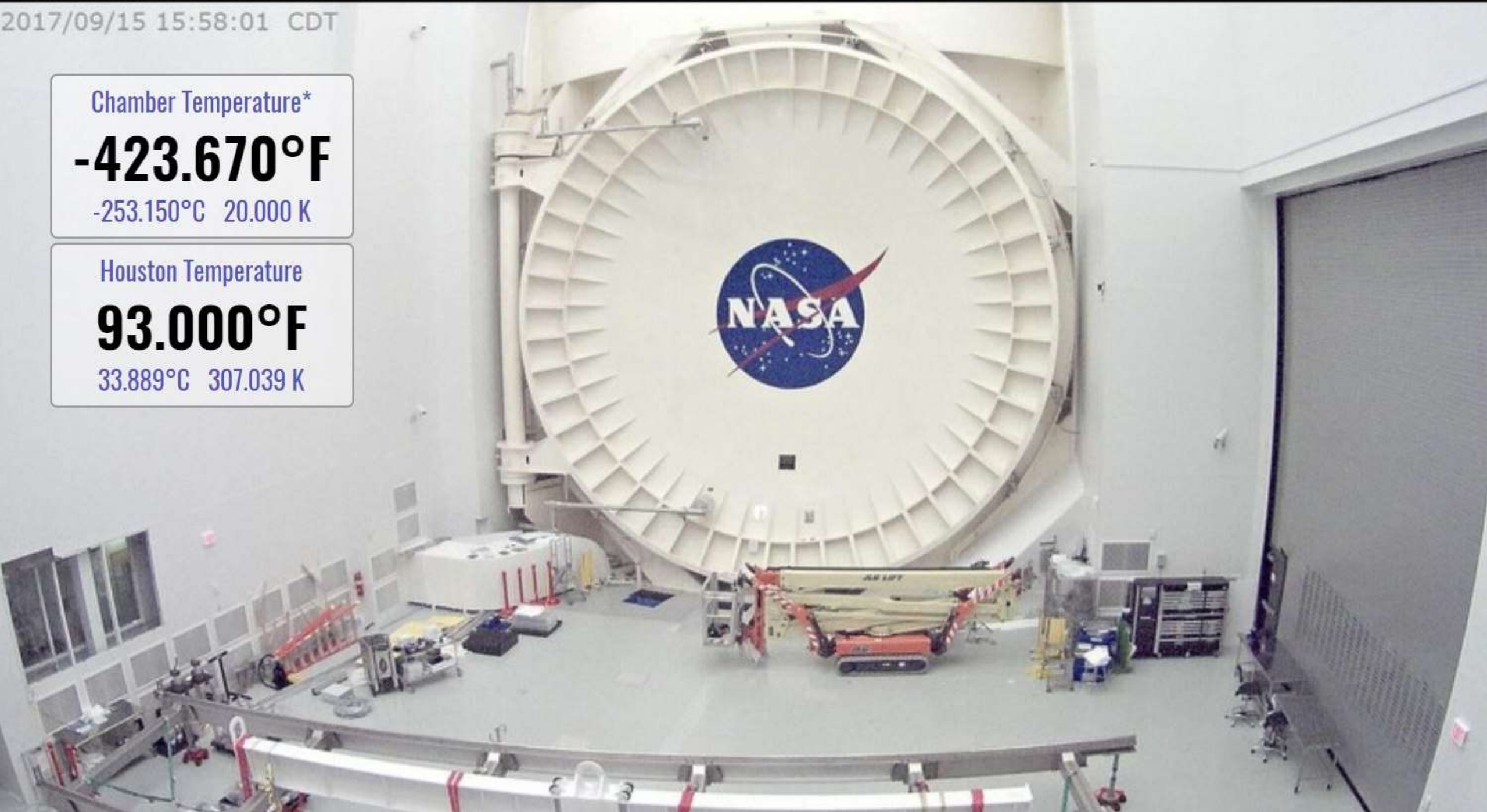
-423.670°F

-253.150°C 20.000 K

Houston Temperature

93.000°F

33.889°C 307.039 K



JSC Cryo Test Control Room



JSC Control Room during Harvey



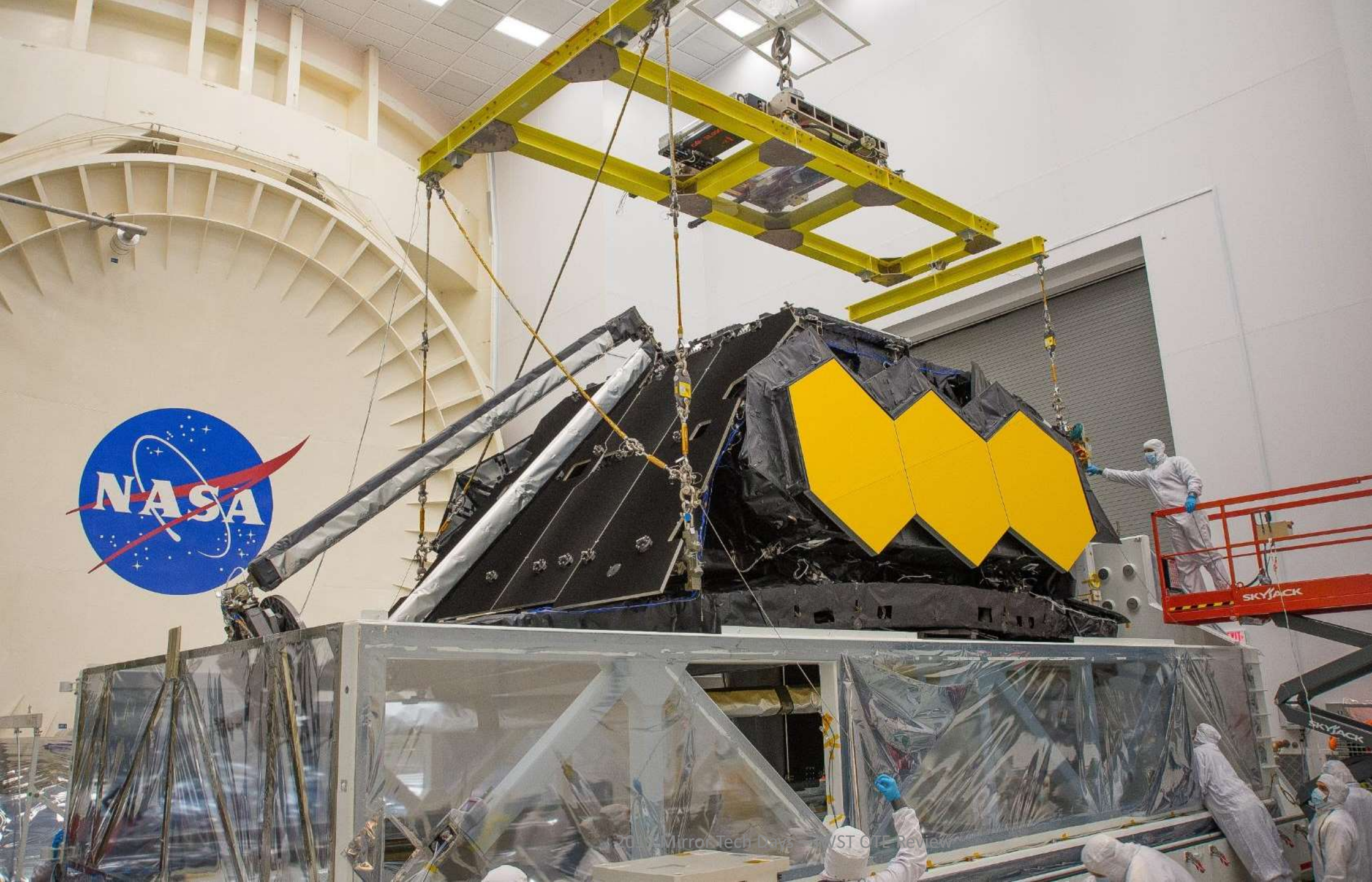




Path to the Observatory



Packing Up At JSC





Good Bye
Houston



A very tight fit in the C5 aircraft



Unpacking at Northrop Grumman in the M8 high bay cleanroom





Secondary Mirror deployment test.

NOTE: The next deployment of the SMSS will be on the way to L2!



OTIS ready
for
Observatory
Integration





Closing Comments

- For LUVOIR - Integrating the mirrors onto the wings was difficult
 - Even though we had local references on the wings, the stability was not as good as the core region
 - The removable references on the sides of the mirror segments worked very well.
- Pathfinders pay off
 - Even though management hates to pay for them
 - The Pathfinder and OGSE test program were invaluable to work the kinks out prior to flight operations (and large marching army costs)
 - If you think you are going to do something new and difficult without a robust Pathfinder program within rational cost and schedule parameters, you are wrong
- The OTIS has been integrated onto the Spacecraft
- The sun shield has been fully tensioned
- The march to launch is proceeding