Telescope, ISIM, Spacecraft & Observatory Development

- Pictorial History -

Gary Matthews

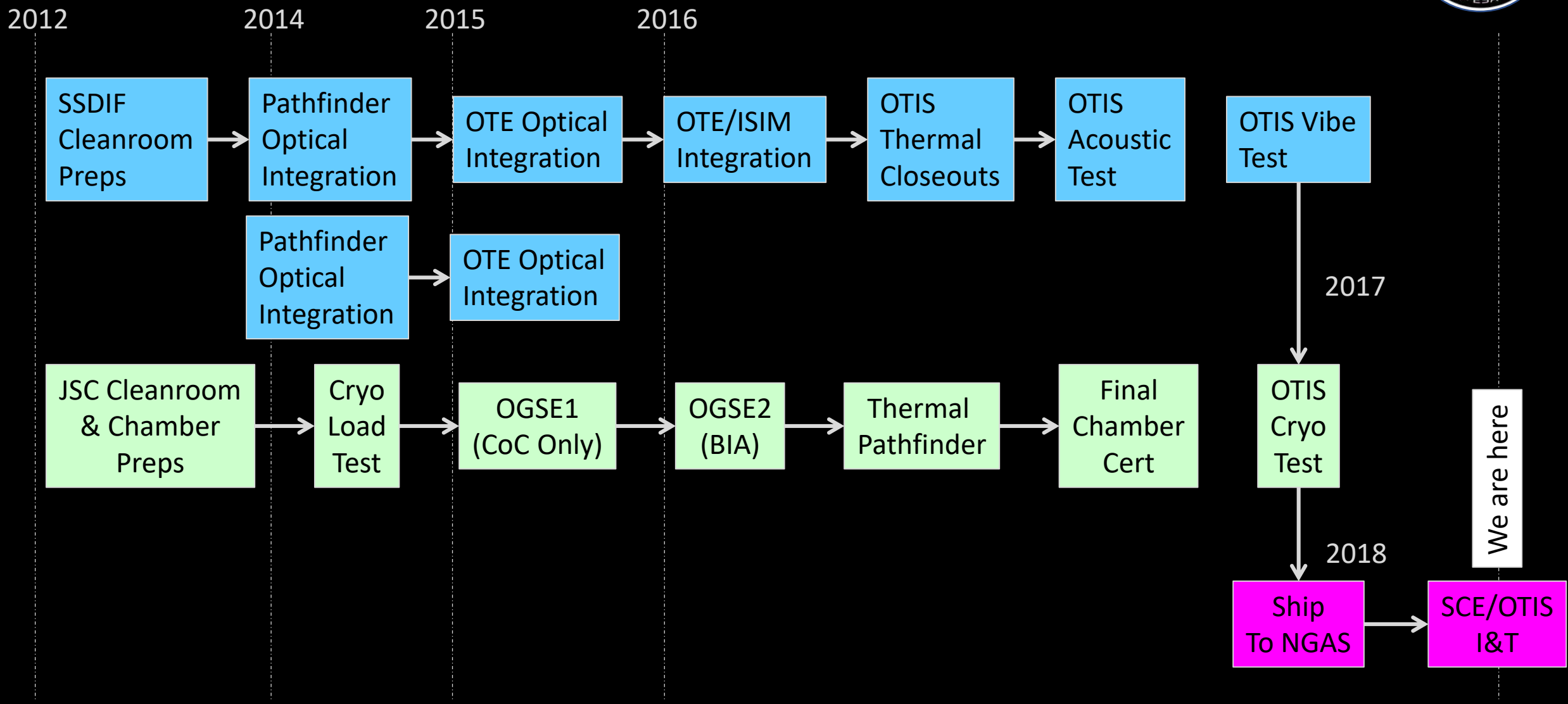
Chris Gunn

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
  - SCE – Spacecraft Element

- Current Status
  - The OTE/ISIM – OTIS are now part of an Observatory at NGAS

Hardware Timeline



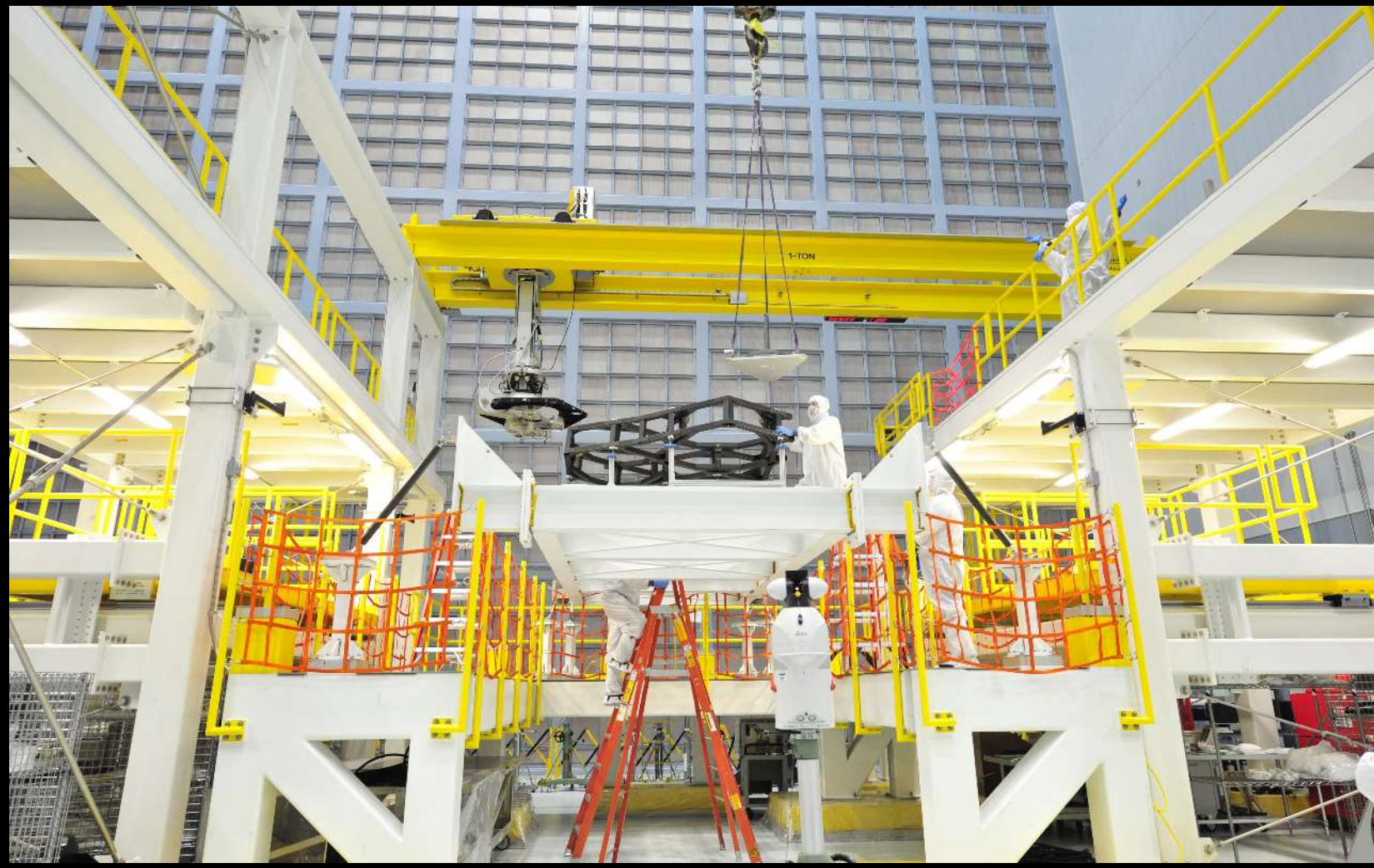
- 2012 -
Before we can start

SSDIF and JSC Facility Modifications

SSDIF* pre-OTE

* Spacecraft Systems Development and Integration Facility

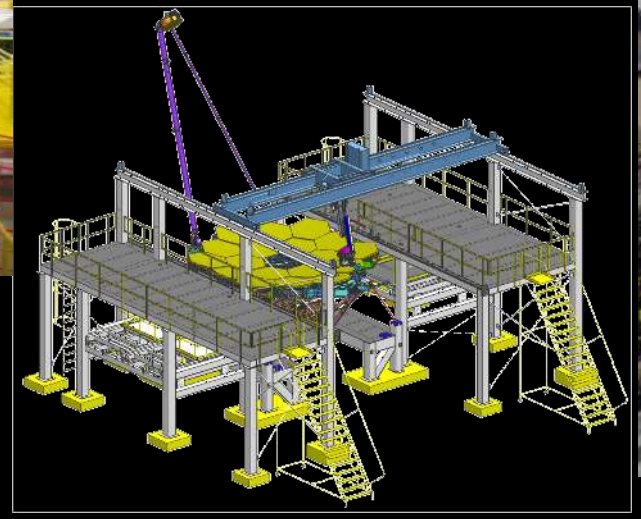
AOAS* Installation in SSDIF



*Ambient Optical Alignment Stand

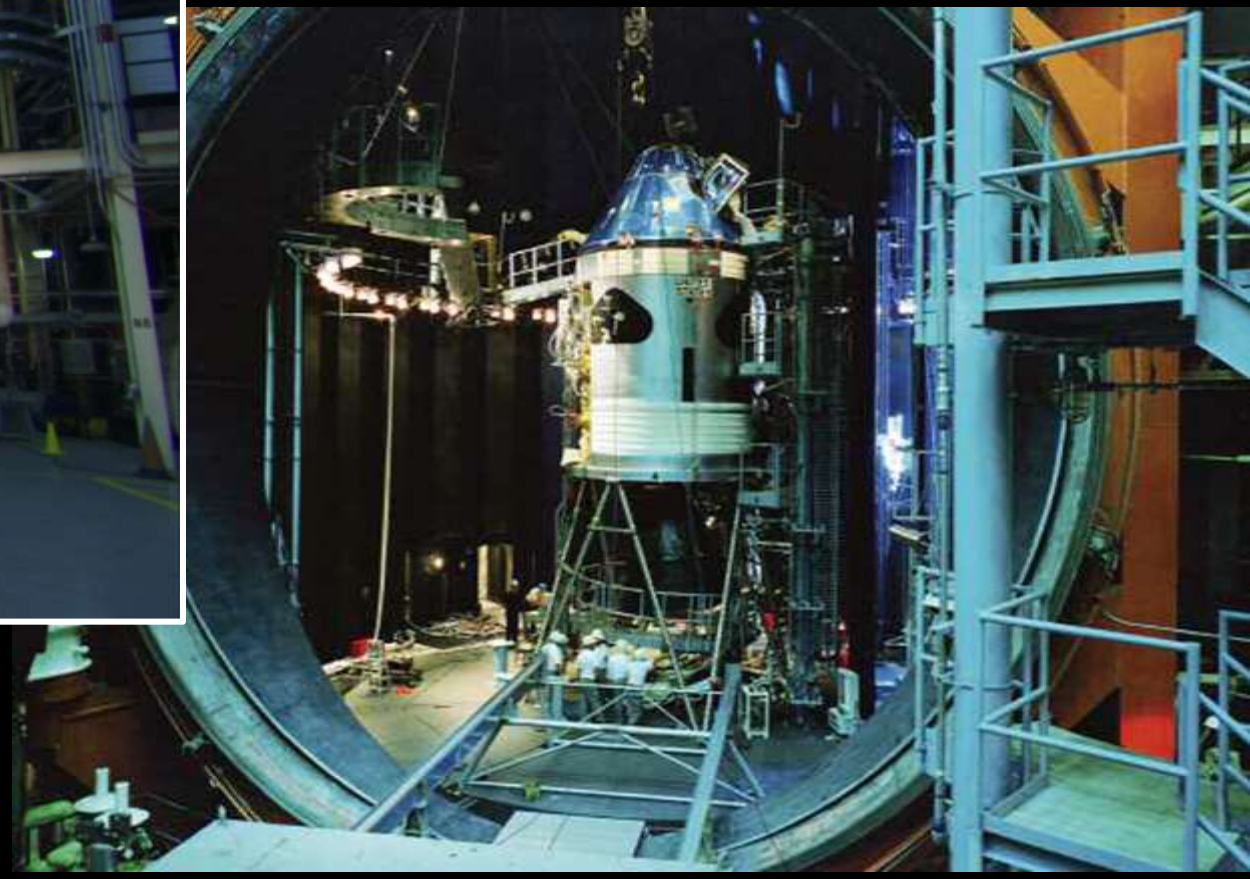
OTE Integration Equipment

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

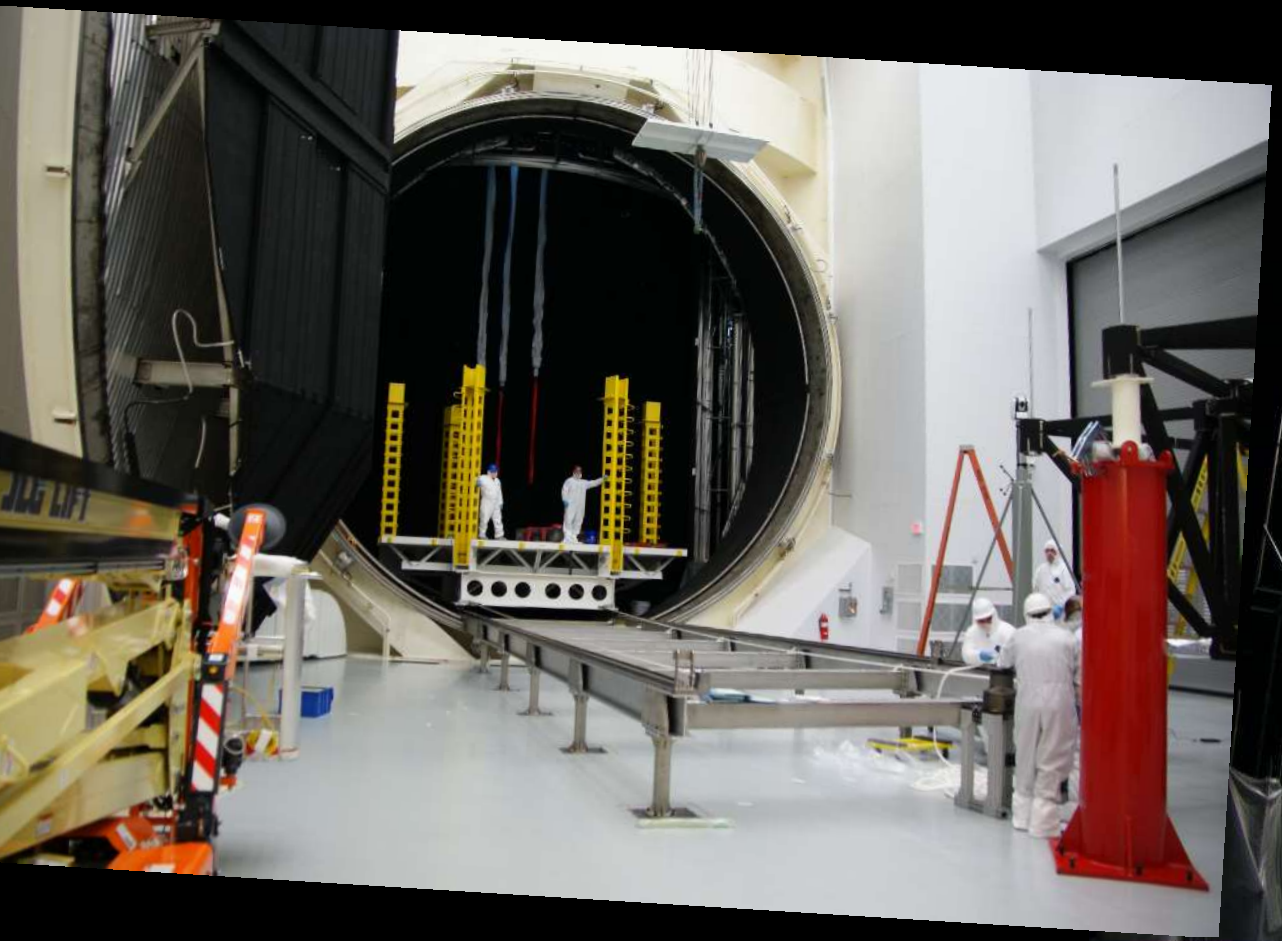


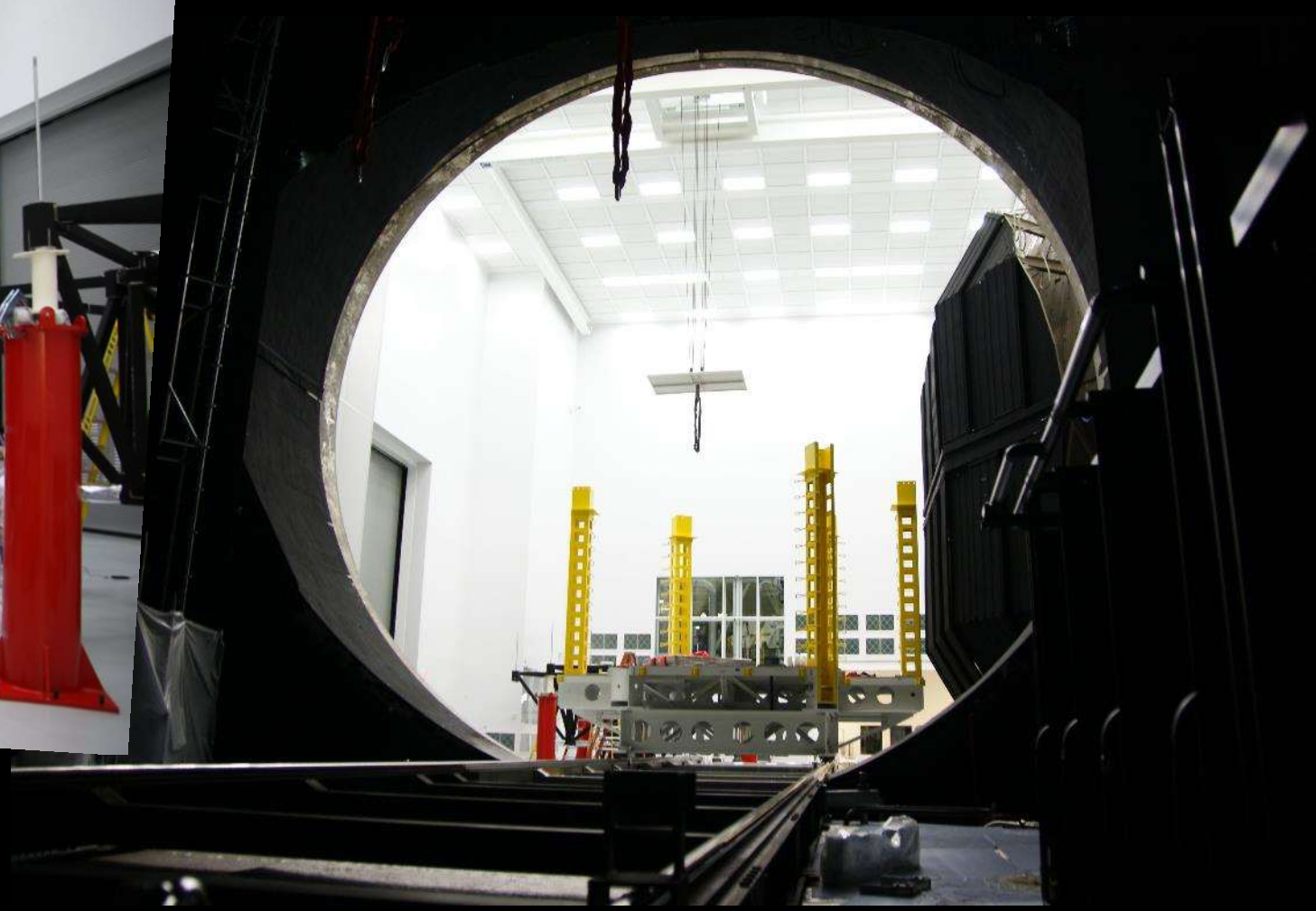
AOAS in the GSFC Cleanroom

Pre-JWST view of the JSC vacuum chamber



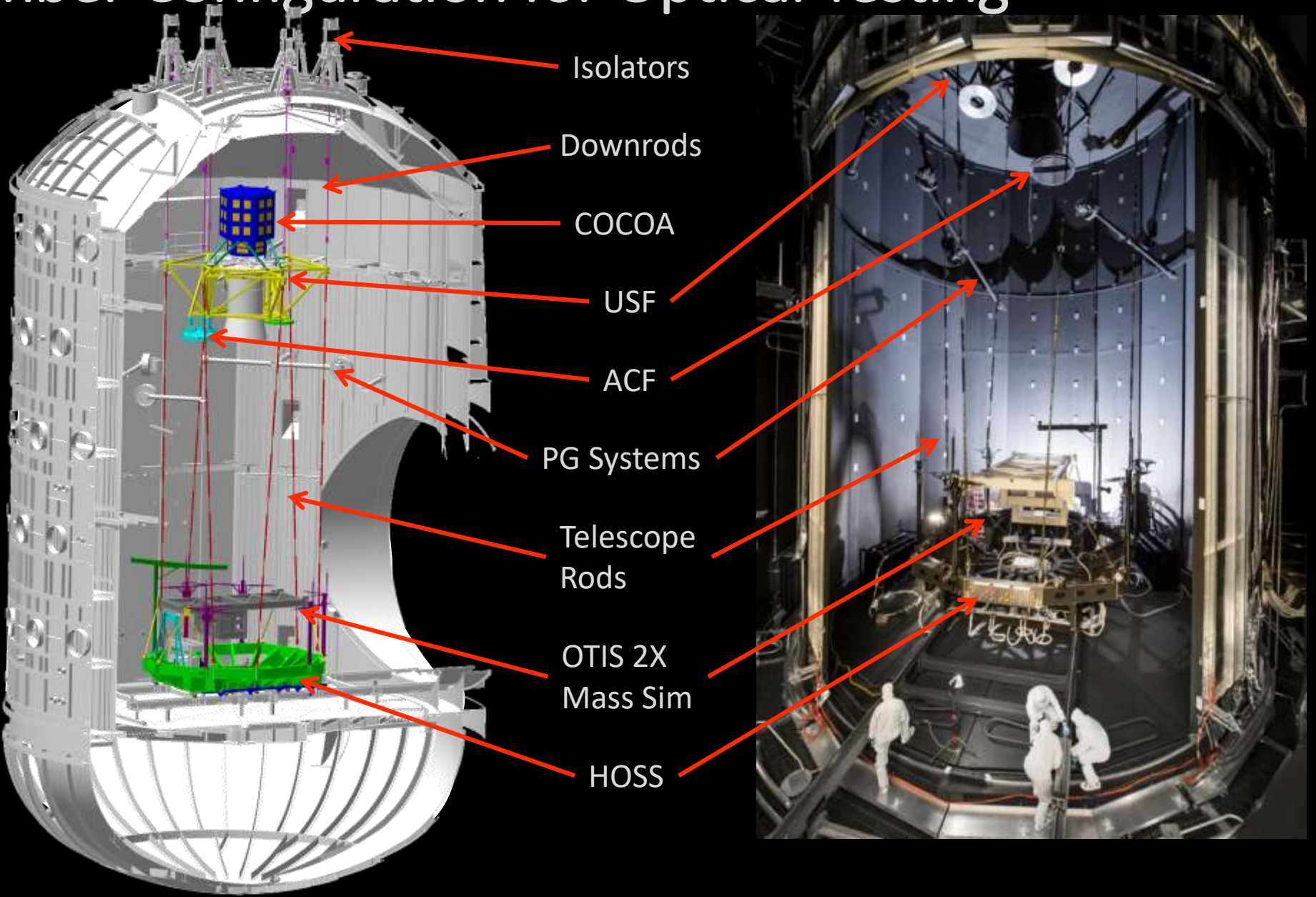
A cleanroom and optical test equipment emerges





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

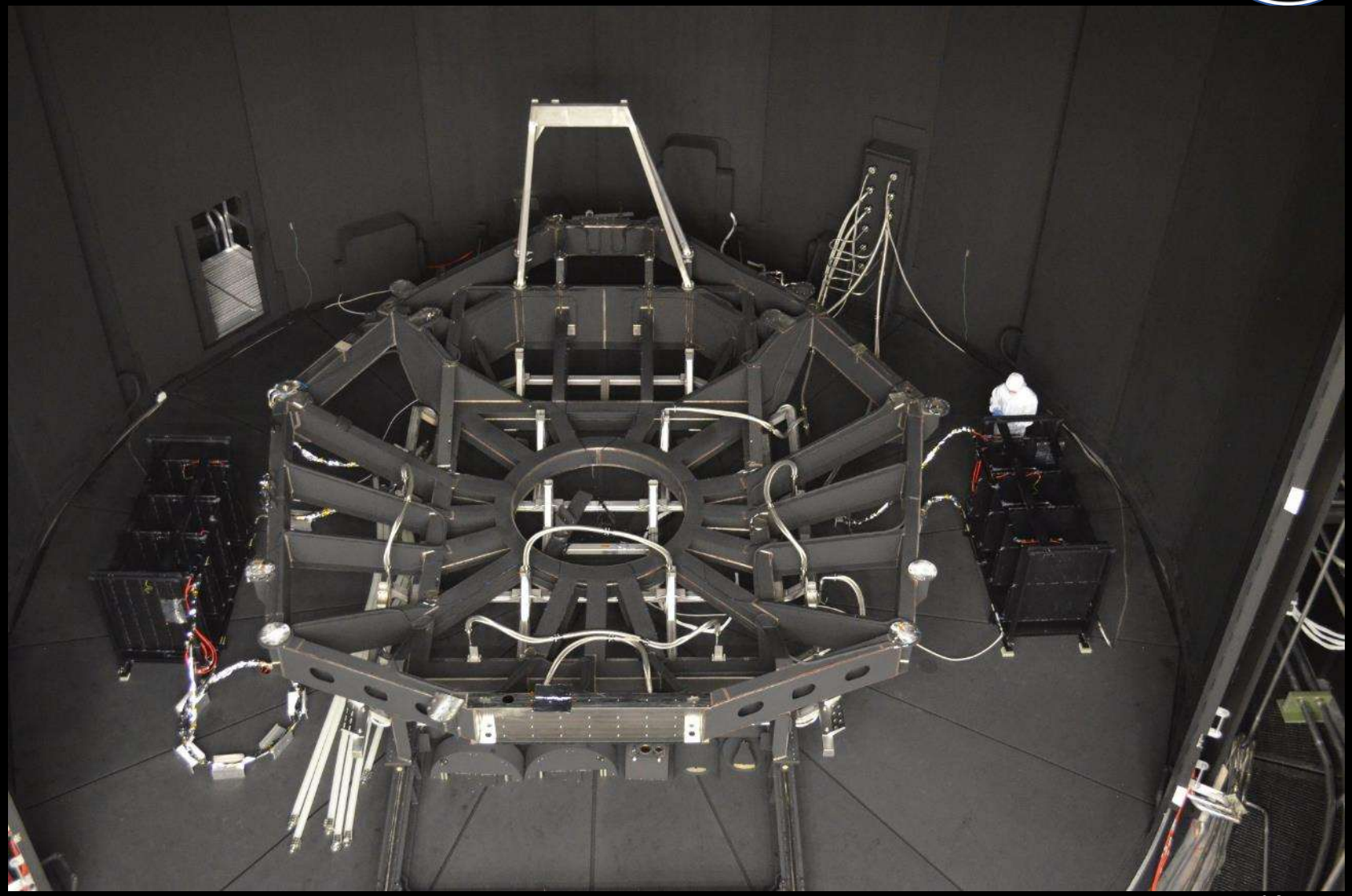
Photogrammetry Systems

- 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

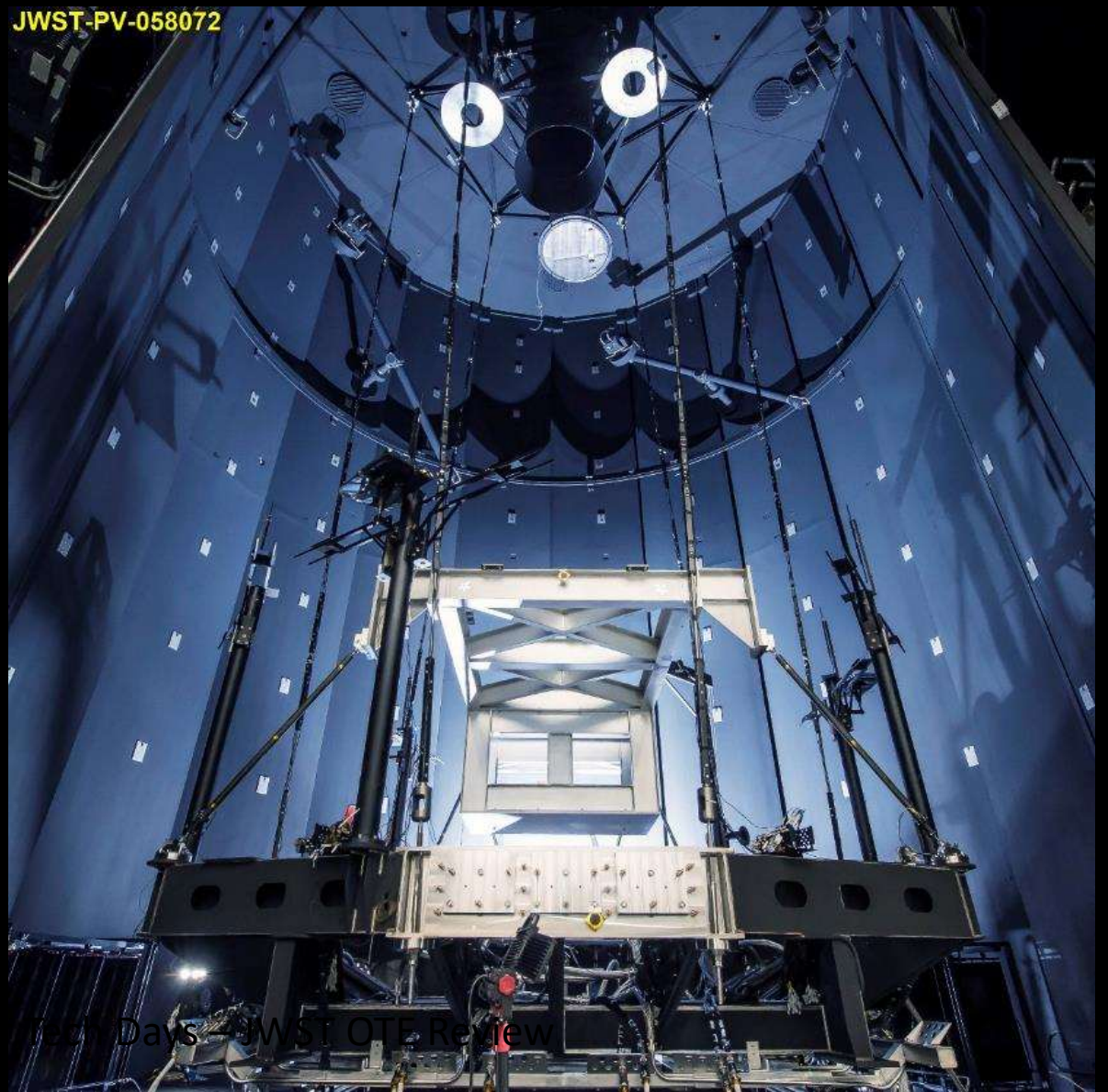
HOSS*

* Hardpoint/Offloader Support Structure

- Welded Stainless Steel 304L structure



Cryo Load Test

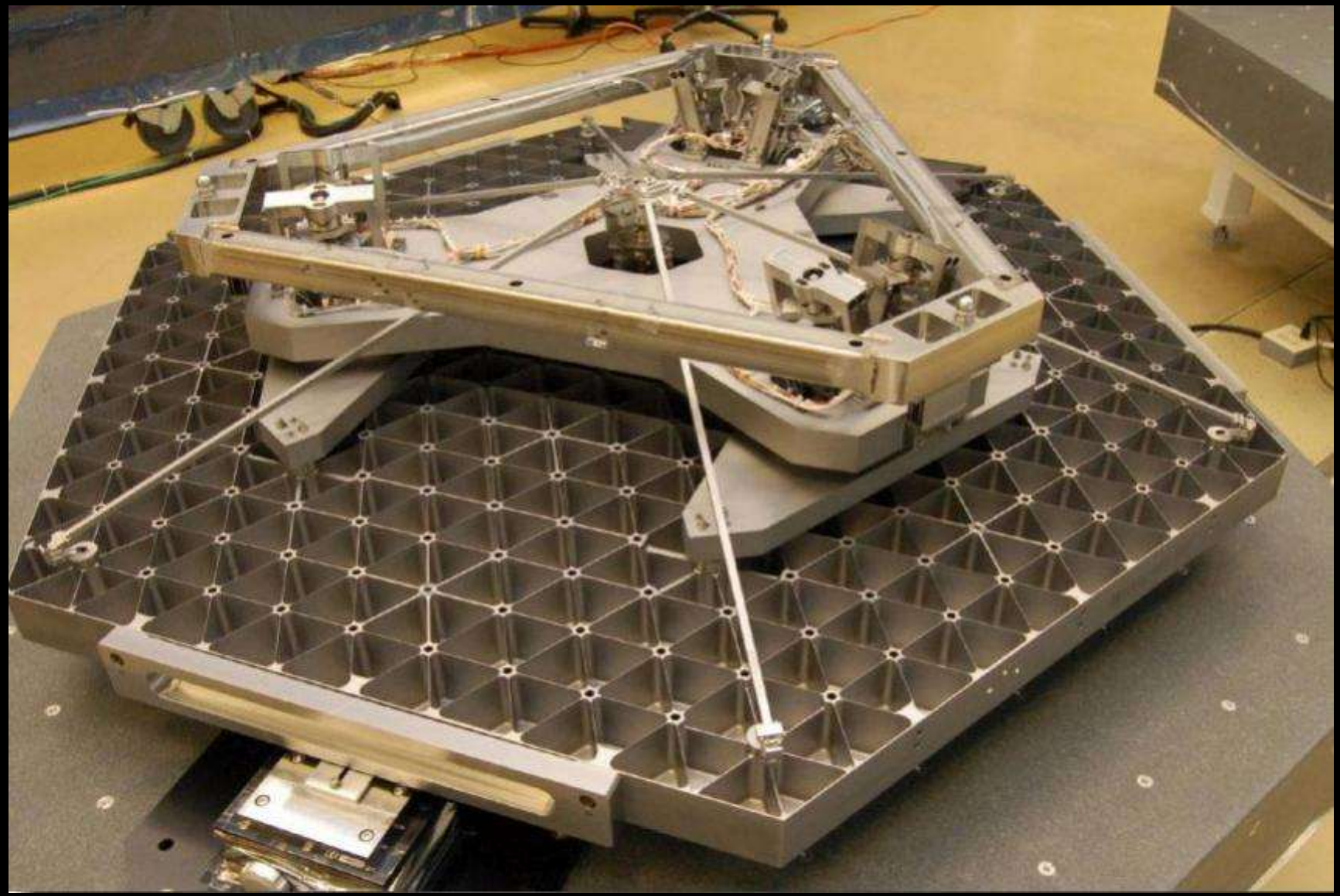


The Early Days

Mirror Development and Pathfinder Integration

Mirrors are beryllium optimized for cryo performance

PMSA* Mechanisms

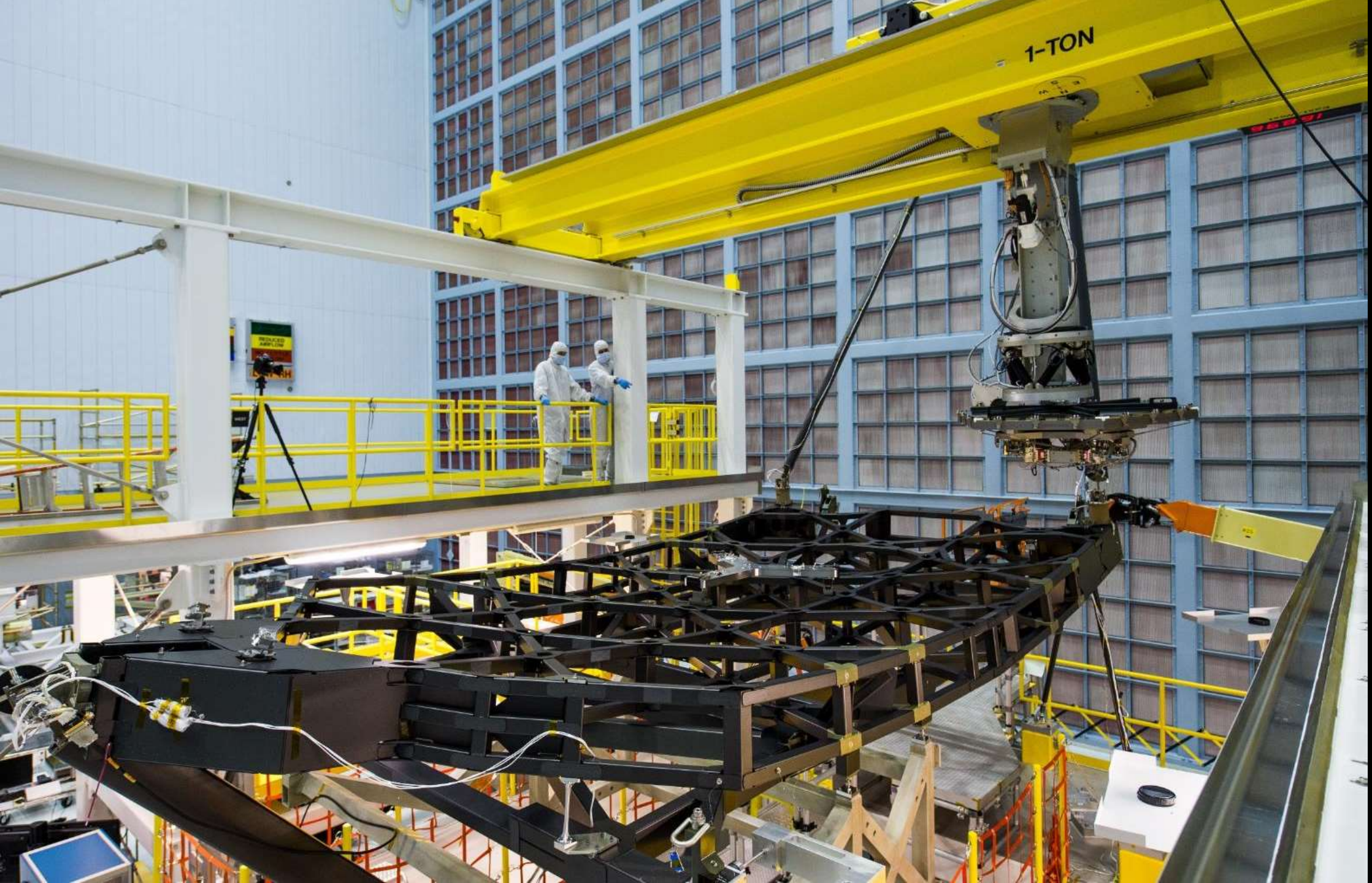


* Primary Mirror Segment Assembly

Cryo null figuring testing at Marshall Spaceflight Center

PMSA 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

OTIS Risk Reduction at JSC

3 Pathfinder Tests/Rehearsals in JSC Chamber to test the test equipment and ready the test team

- Only thing not tested prior to OTIS testing was OTIS itself

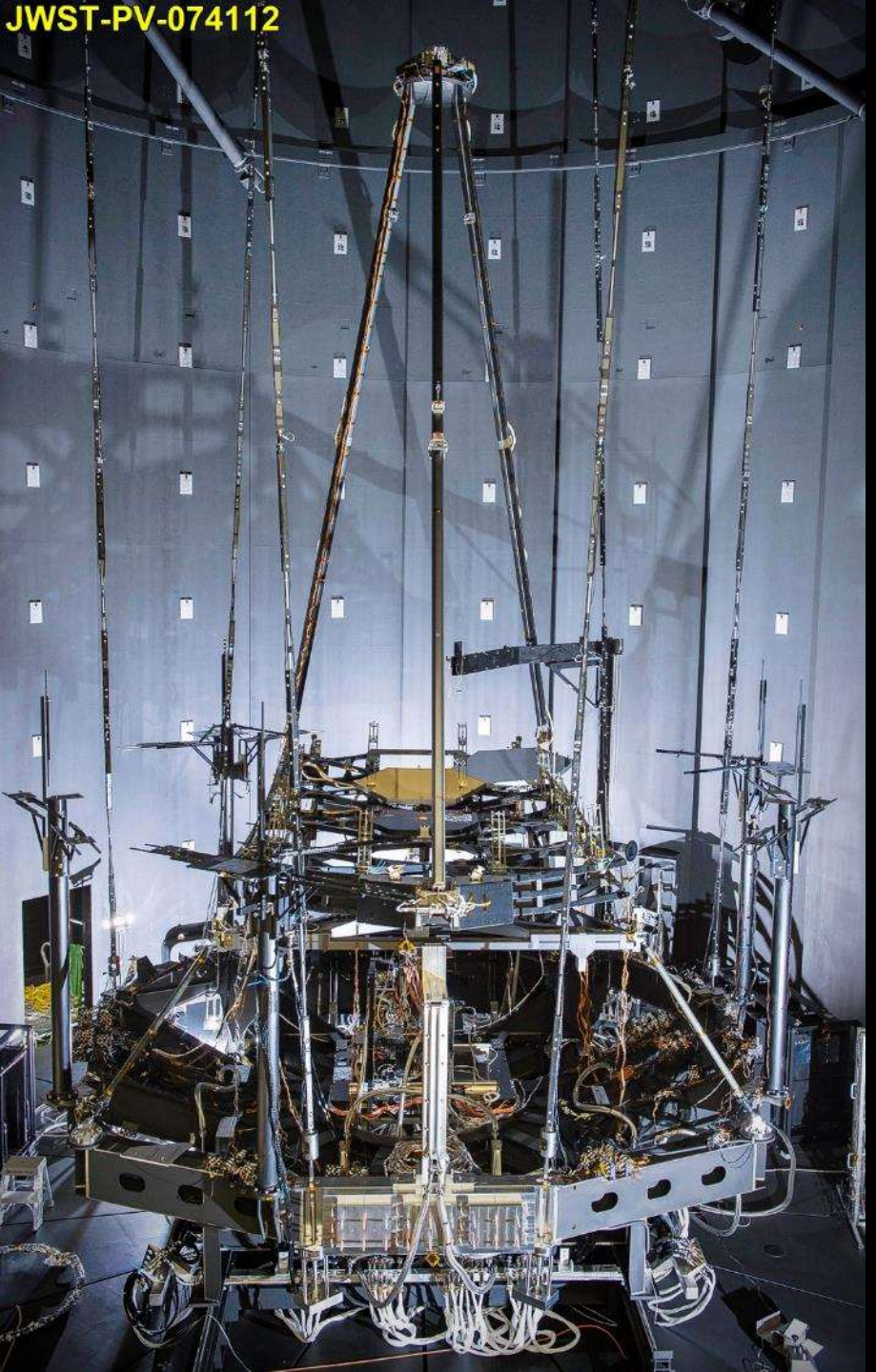
Optical Ground Support Equipment (OGSE) #1: Prove-out optical GSE. Featured Cryo Optical Test on Pathfinder OTE w/ 2 Spare PMSA's and Spare Secondary

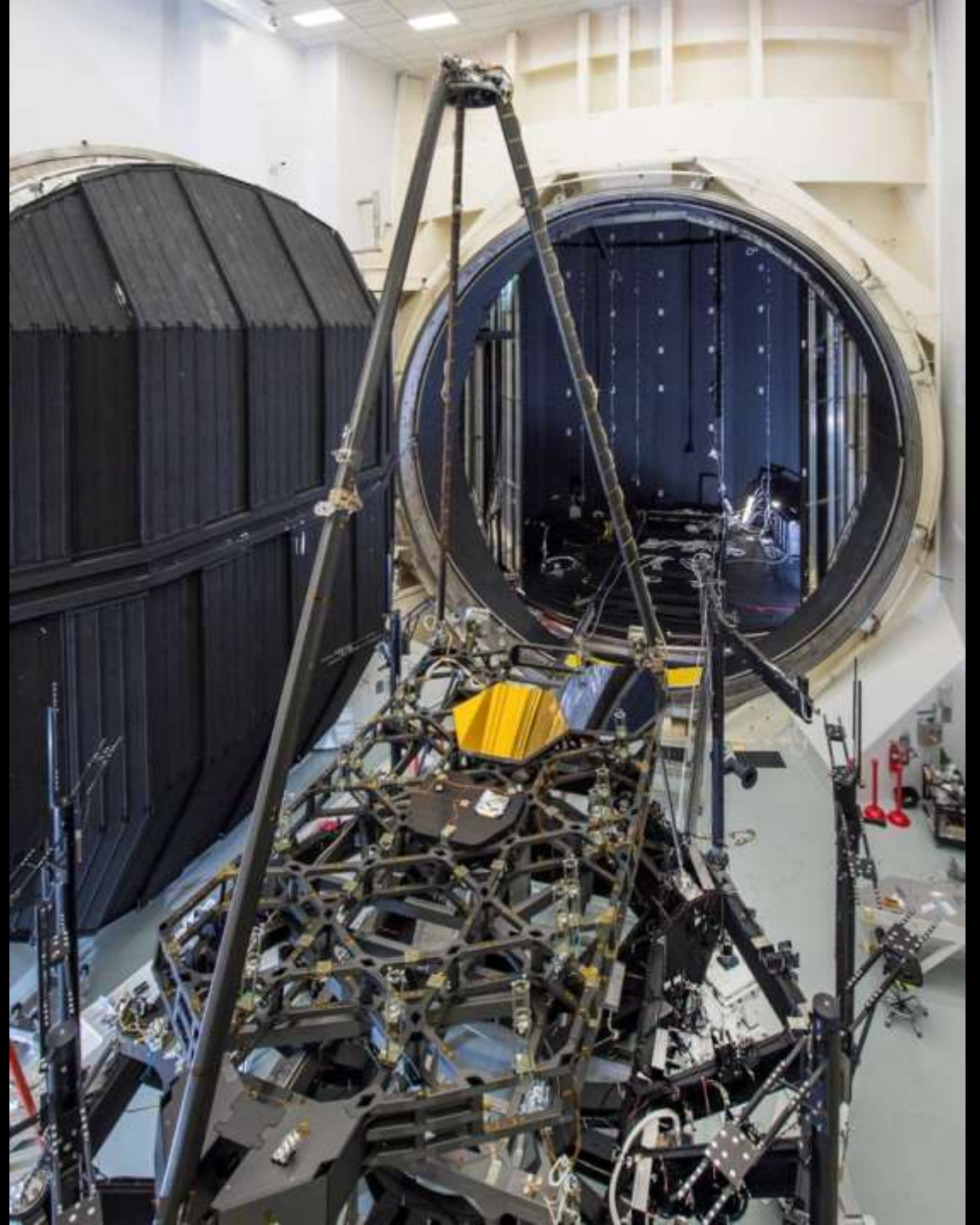
OGSE #2: 2nd Cryo Optical Test but w/ Flight Aft Optics System and AOS Source Plate Assembly. Full check-out of optical GSE and measurement schemes

Thermal Pathfinder: Verified all thermal environment/boundary conditions (e.g., sunshield layer 5 thermal simulator, ISIM radiator sinks)

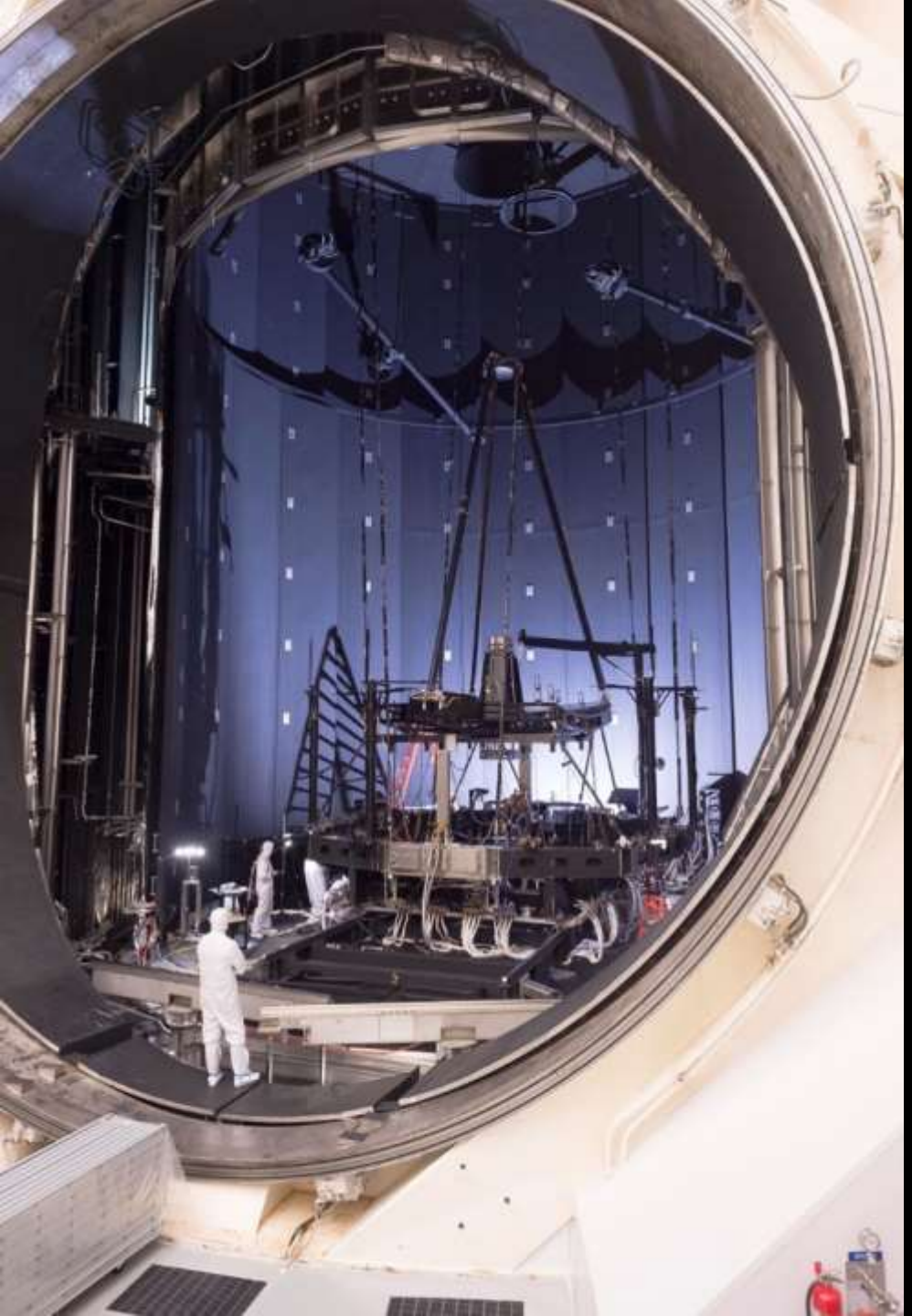
- *Learned a lot about vibration isolation, facility readiness, and GSE performance*
- *Successful "Ready to Receive OTIS" review at JSC on 3/15/2017*

Pathfinder ready to roll into the chamber for OGSE-1

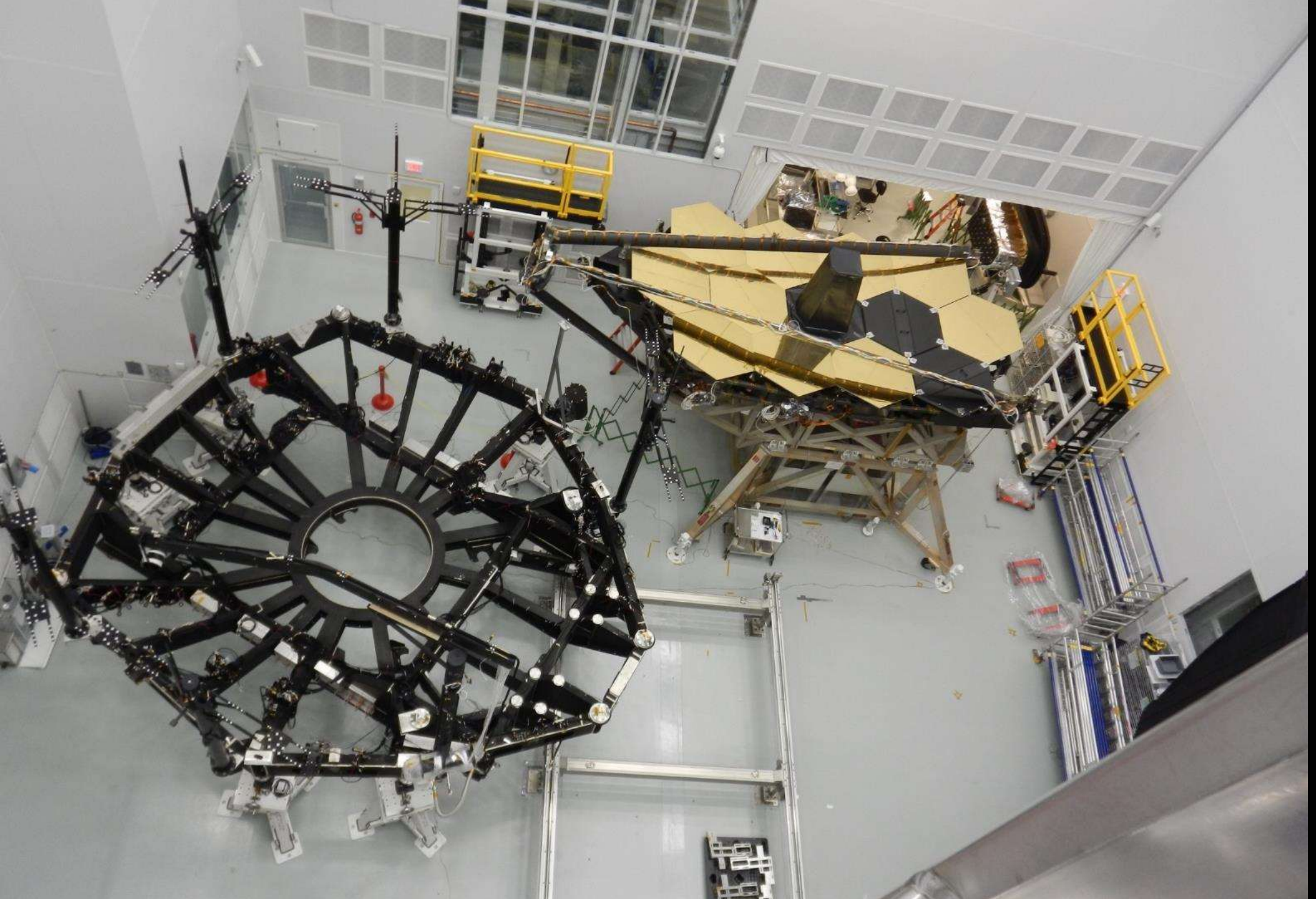




OGSE-1 Test Configuration



OGSE-2 Test Configuration With the Flight AOS



Thermal Pathfinder Test Configuration

Telescope Integration

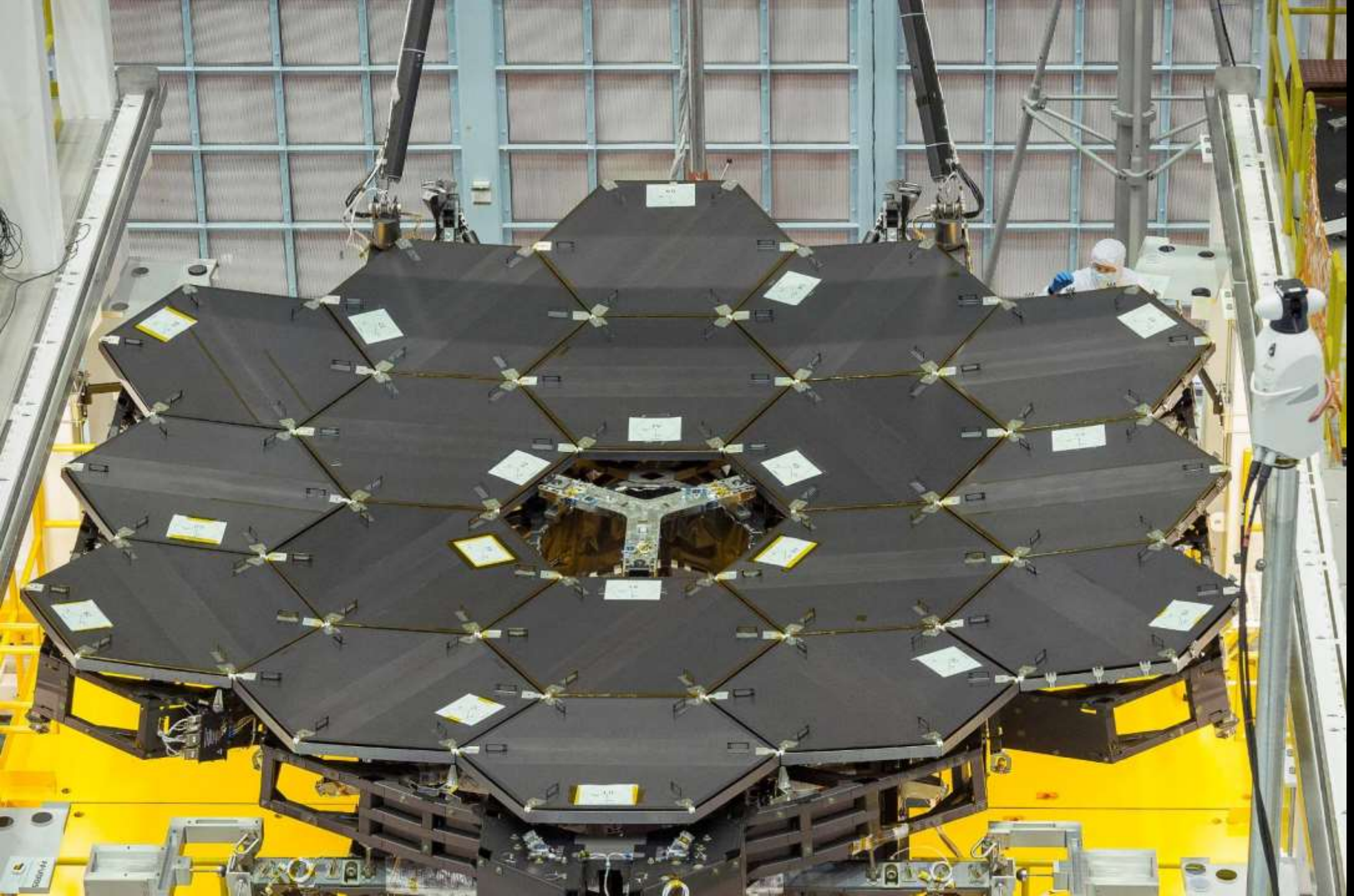
Unloading the PMSA from their hermetically sealed shipping container

PMSA shown in the flip-over and handling cart

First flight PMSA integration.

Protective mirror covers used during integration operations

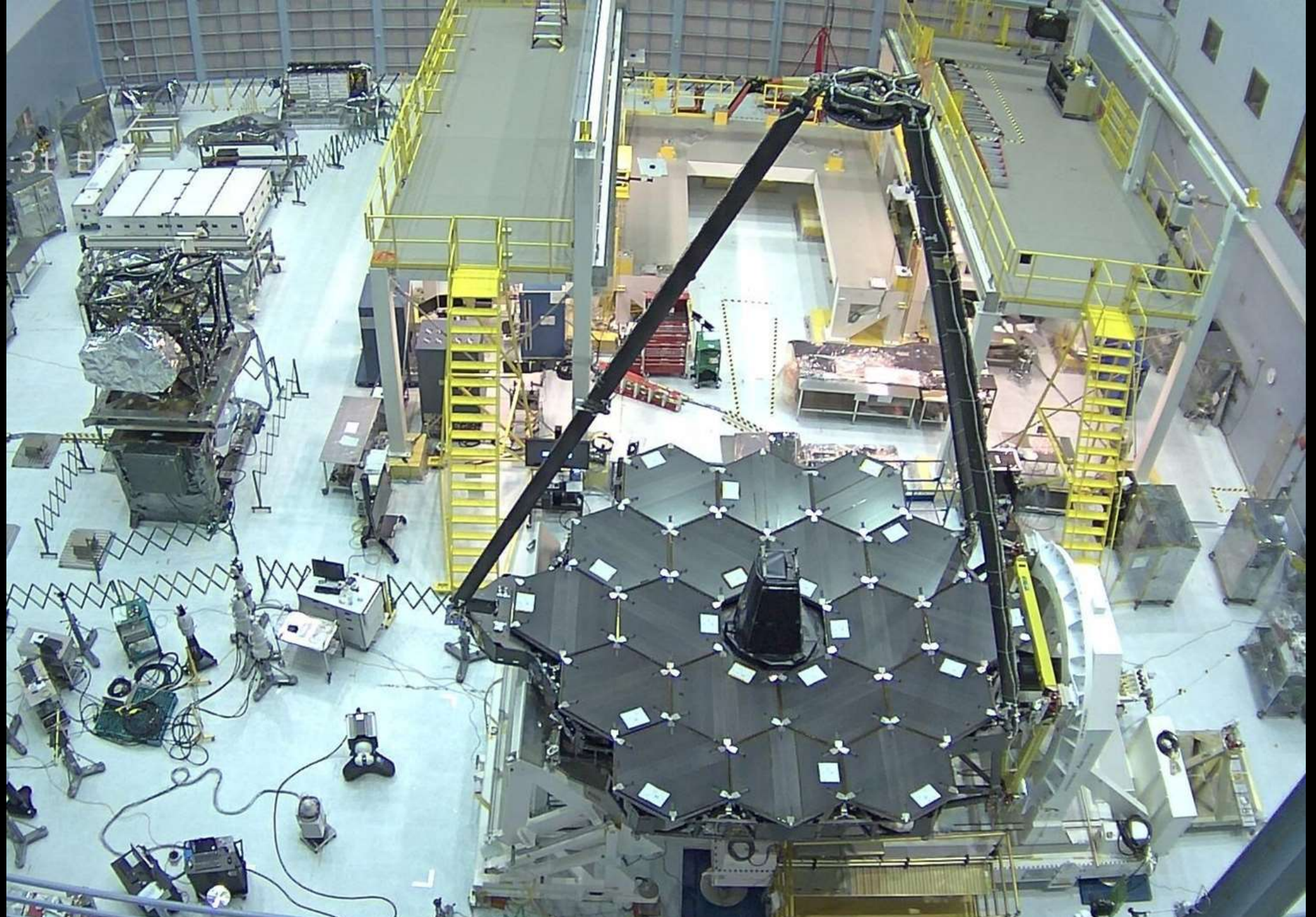
Last flight PMSA integration



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

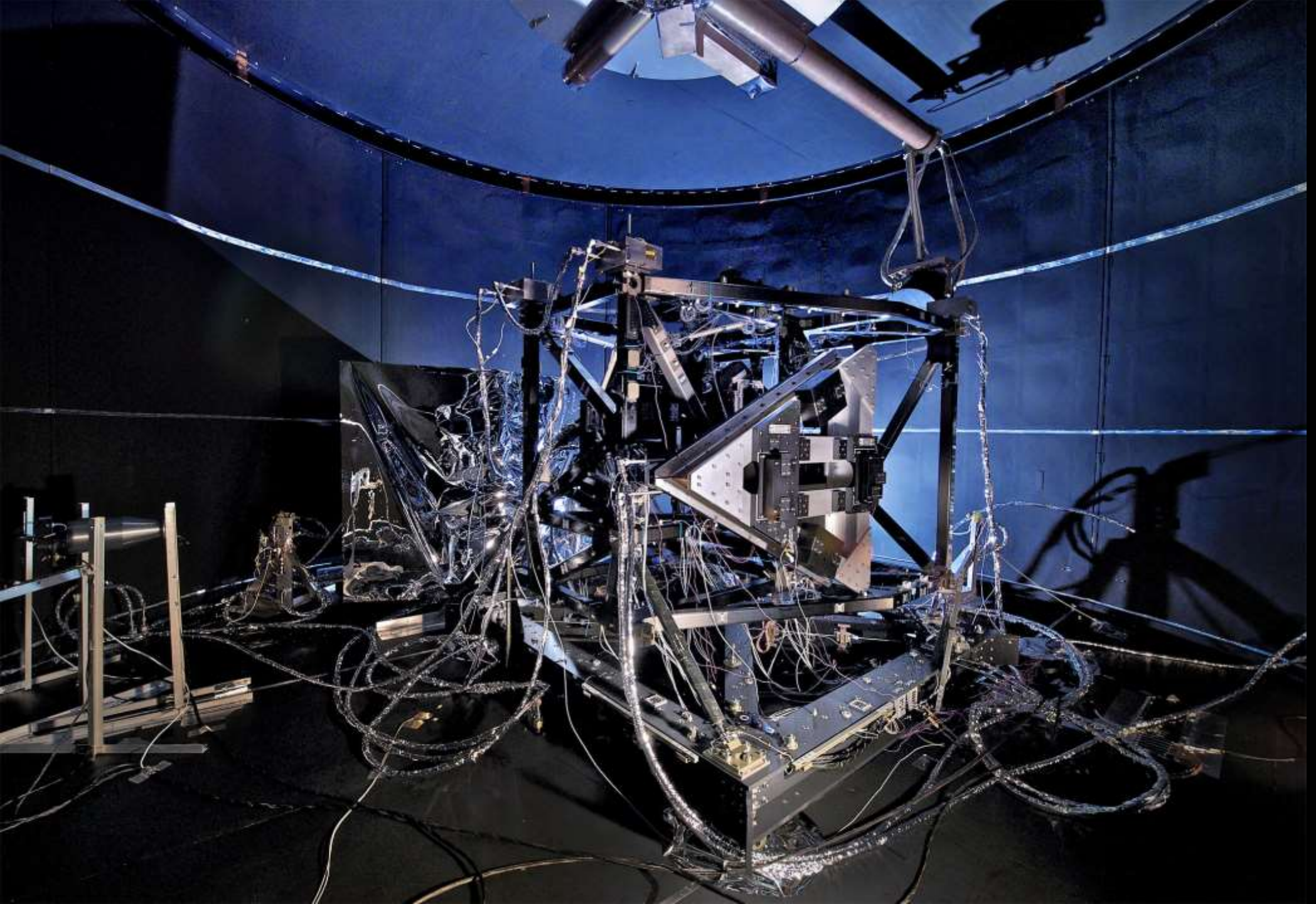


Ready for the grand reveal of the golden primary mirror

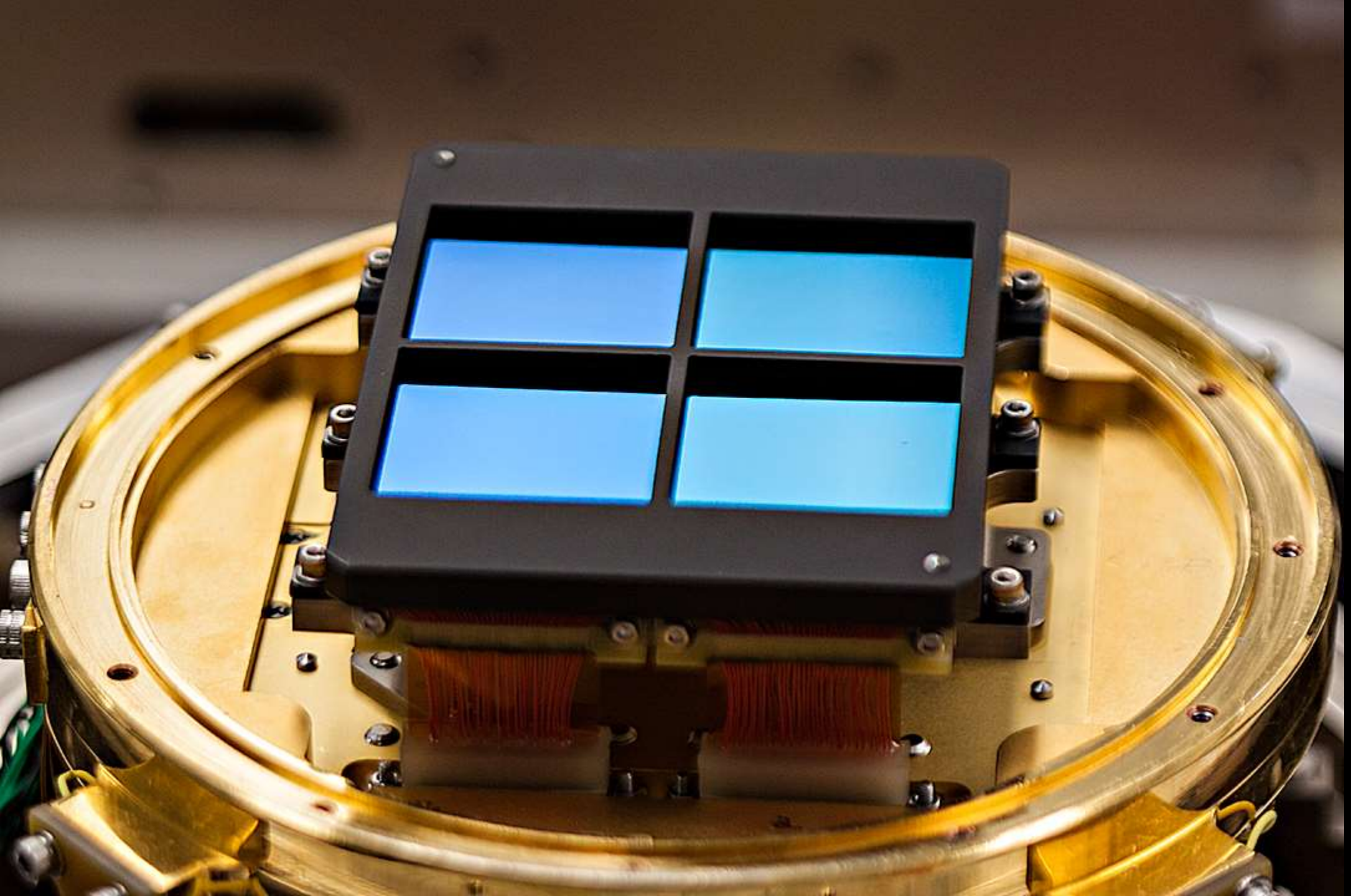
Protective cover removal

Completed telescope with ISIM in the background ready for installation

ISIM Integration



ISIM Structure cryo load test configuration



NIRCam focal plane

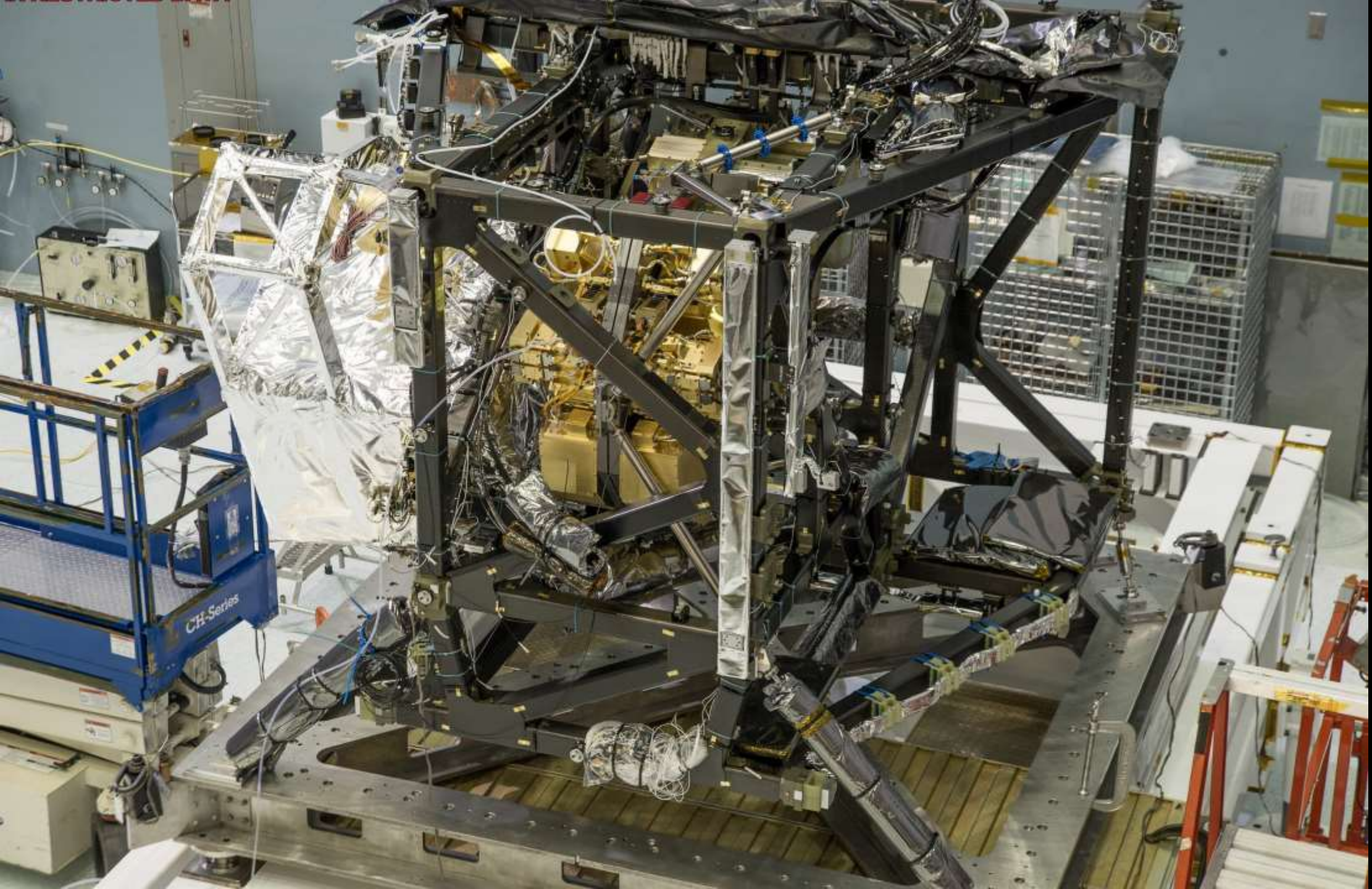
MIRI integration Delivered May 2012

FGS integration Delivered July 2012

Flight NIRCam delivered to ISIM I&T July 2013

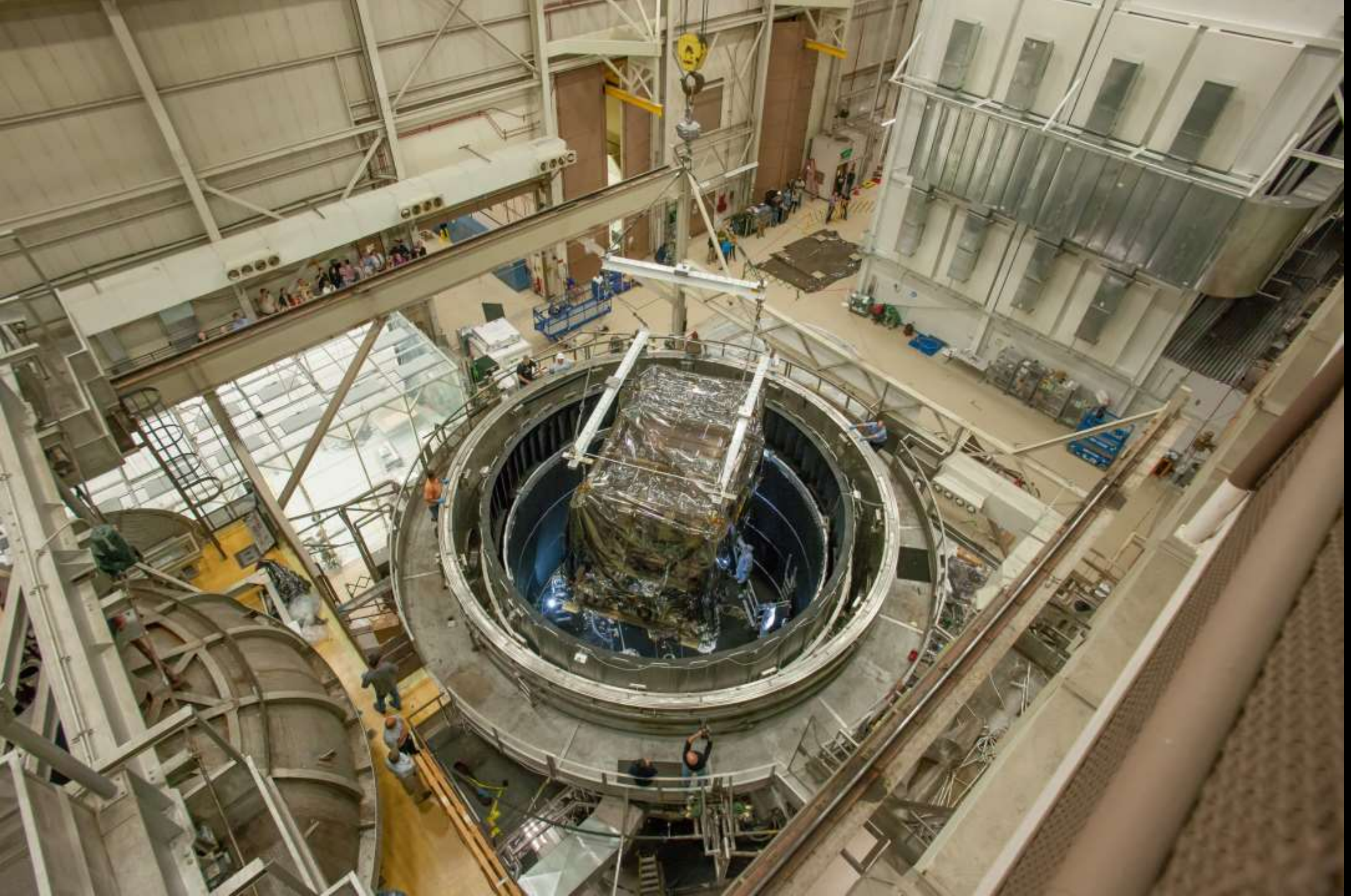
NIRSpec Arrival in the SSDIF, September 2013

ISIM Gravity Release Test



ISIM Structure with instruments integrated

OSIM (Optical Simulator) installation into the GSFC SES vacuum chamber

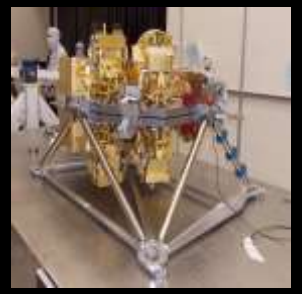


ISIM cryo vacuum testing

ISIM in the thermal vacuum chamber

ISIM Fully Integrated, March 2014

MIRI



NIRCam

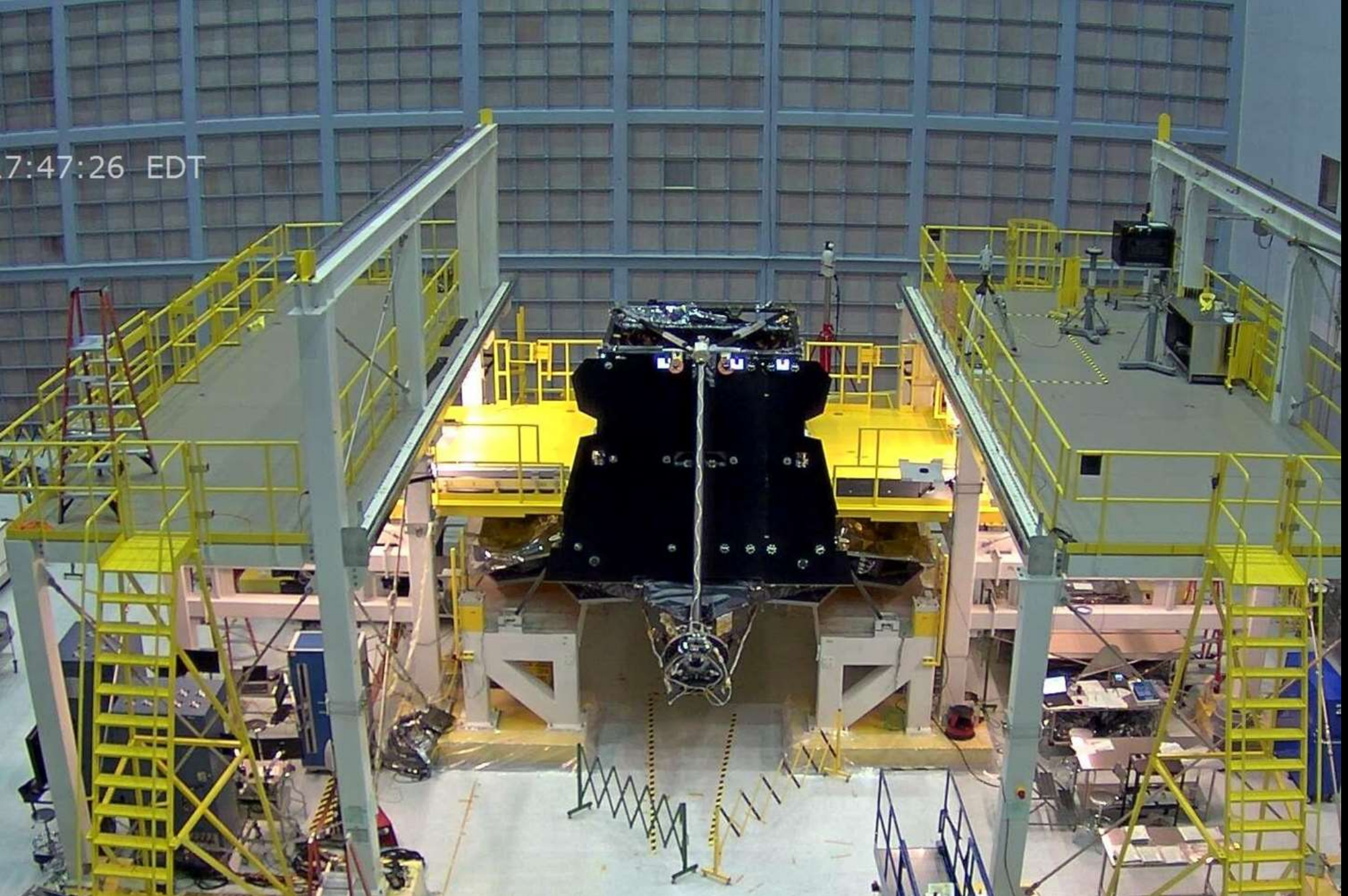
FGS/NIRISS

NIRSpec

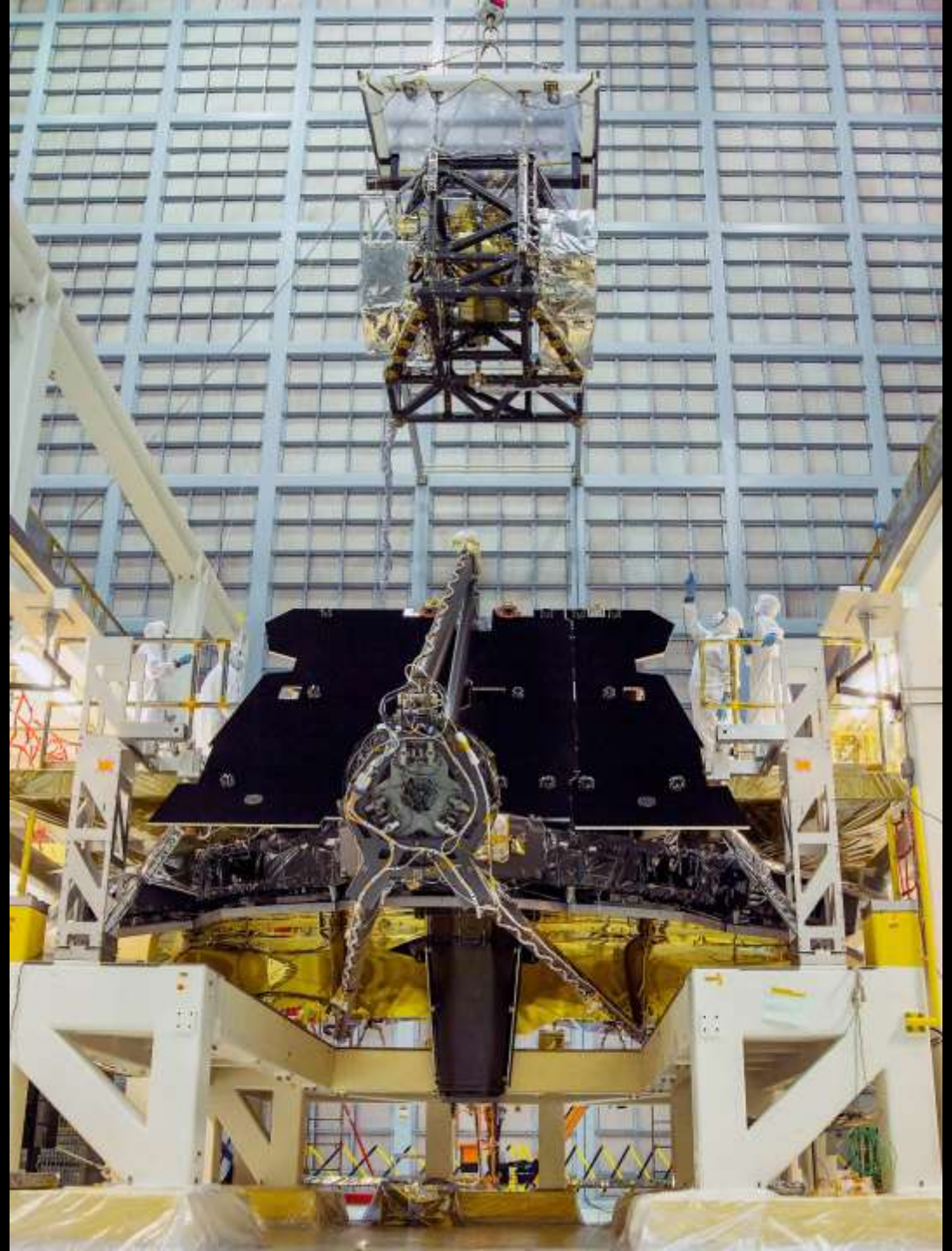
ISIM Ready
for integration

OTIS Integration

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



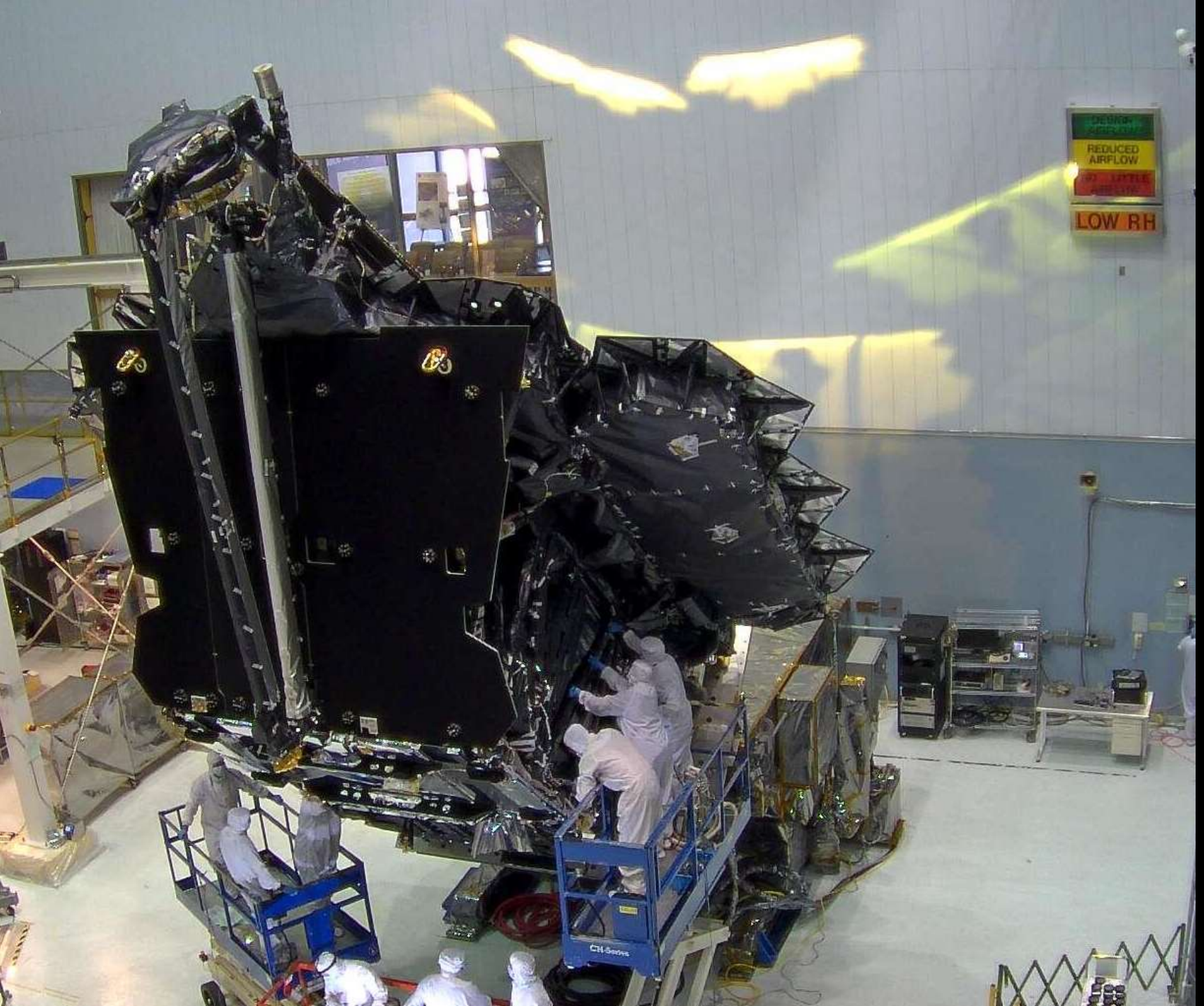
Telescope cup-down in the AOAS



ISIM being lowered into position

Very tight clearances during this operation. MLI rubbed during integration

ISIM integration and nail biting contest



OTIS Blanket Closeouts

Aft Deployment ISIM Radiator (ADIR) Integration

ISIM Electronics Compartment (IEC) Integration

Harness Radiator (HR) Integration

OTIS on its way to acoustics and vibe testing

Final pose prior to pack and ship to JSC

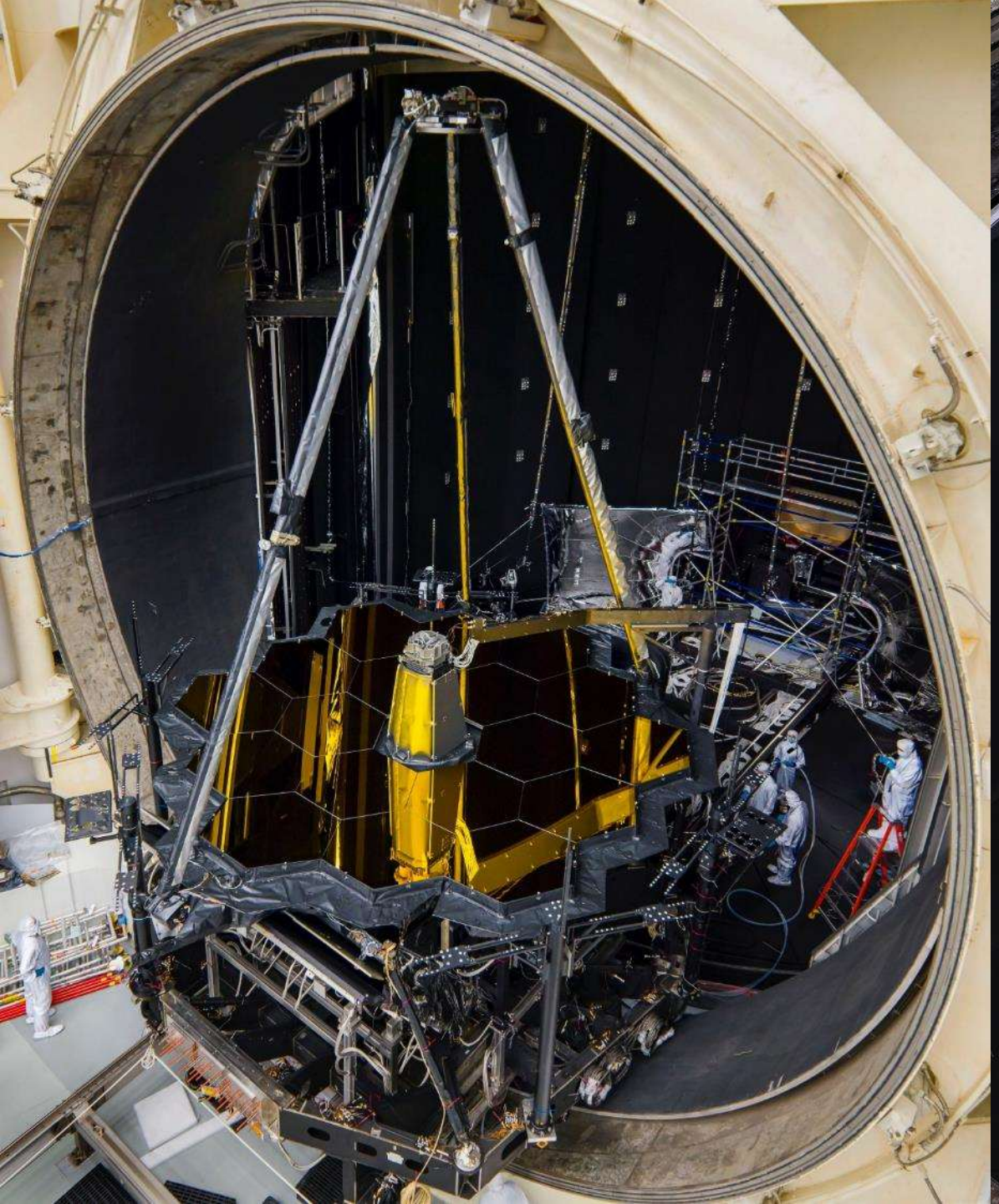
OTIS Cryo-Optical Test

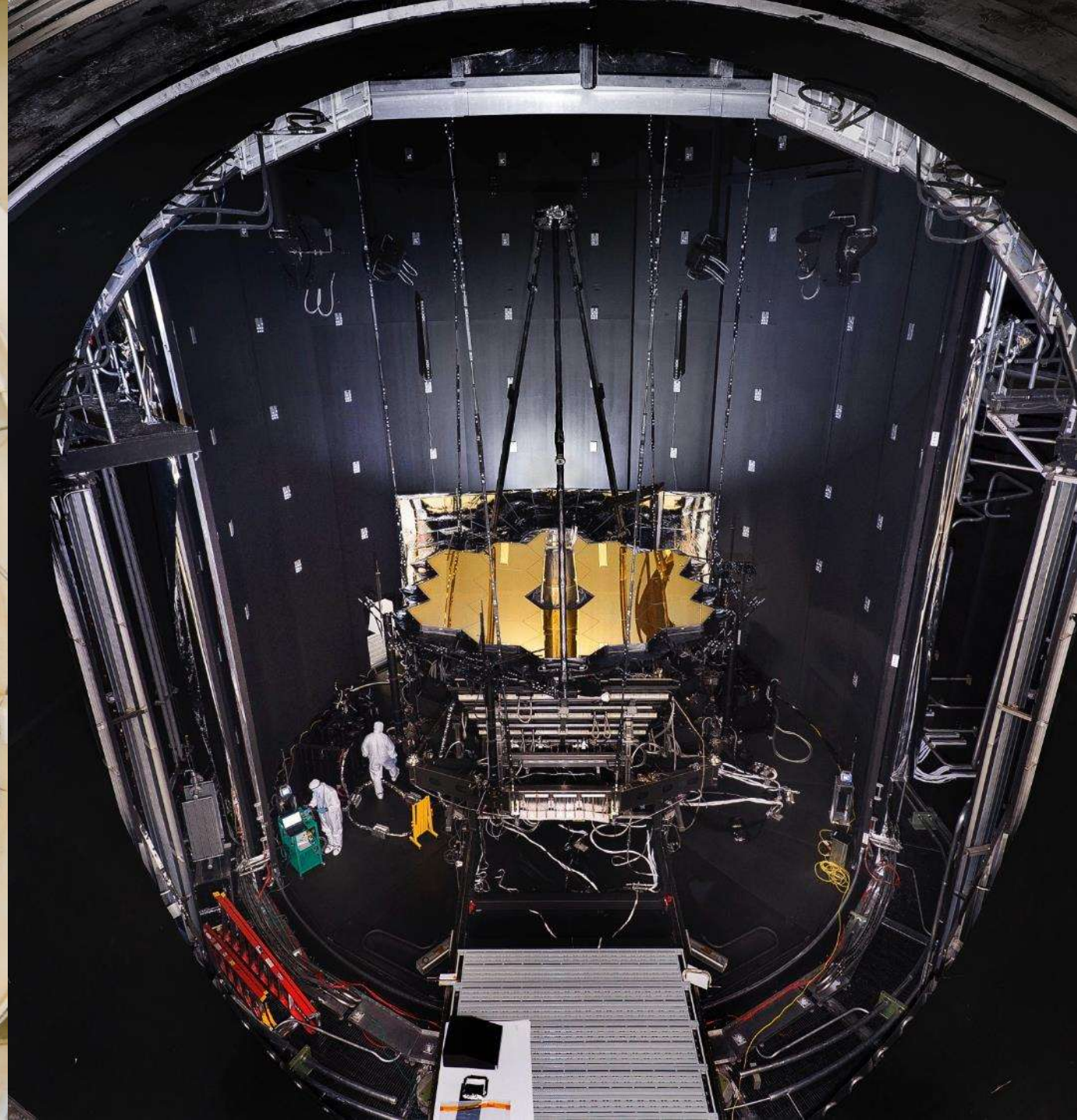
The view from the cameras in the JSC cleanroom

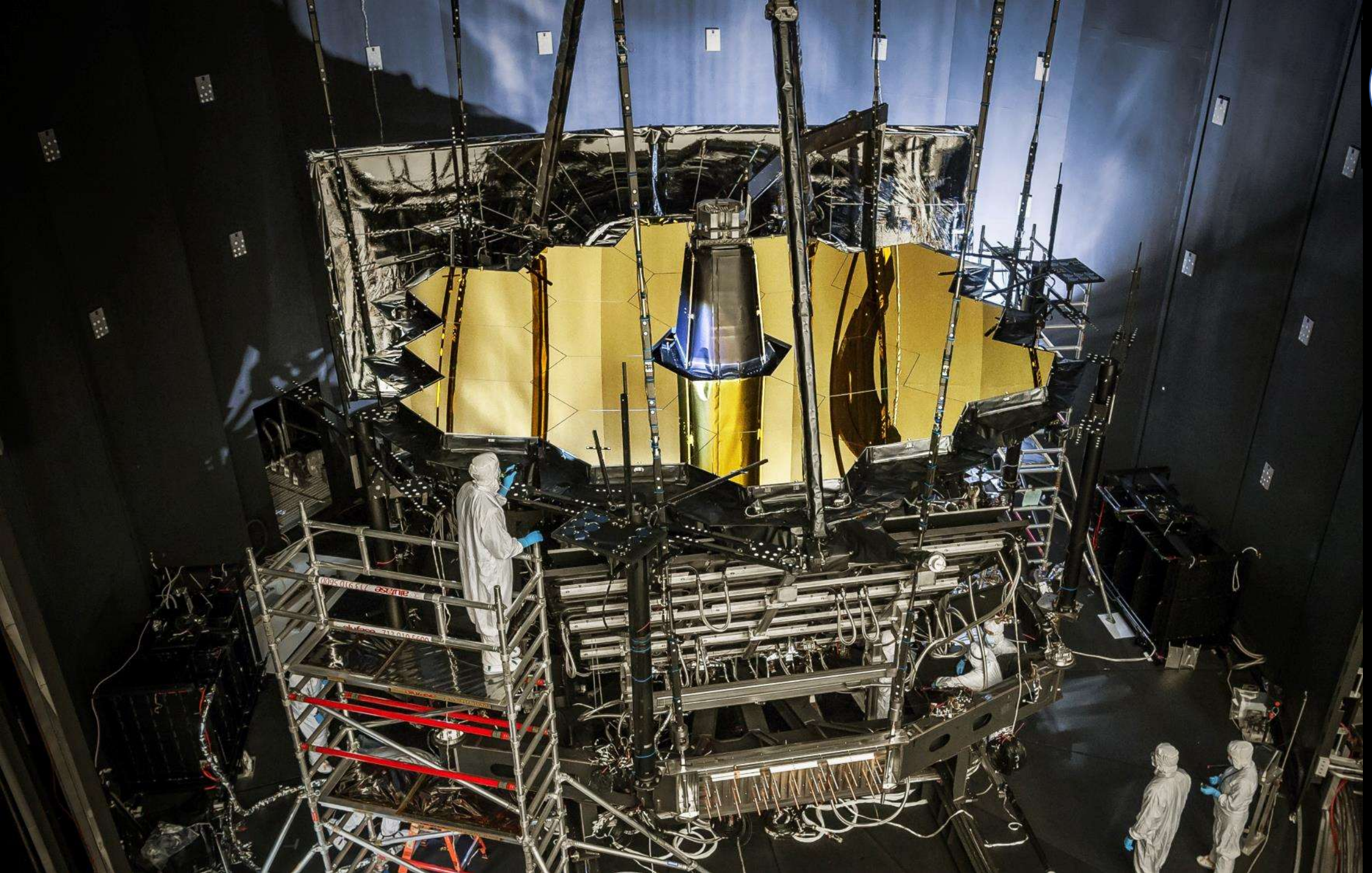
Reflective view off the secondary mirror in the JSC cleanroom

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





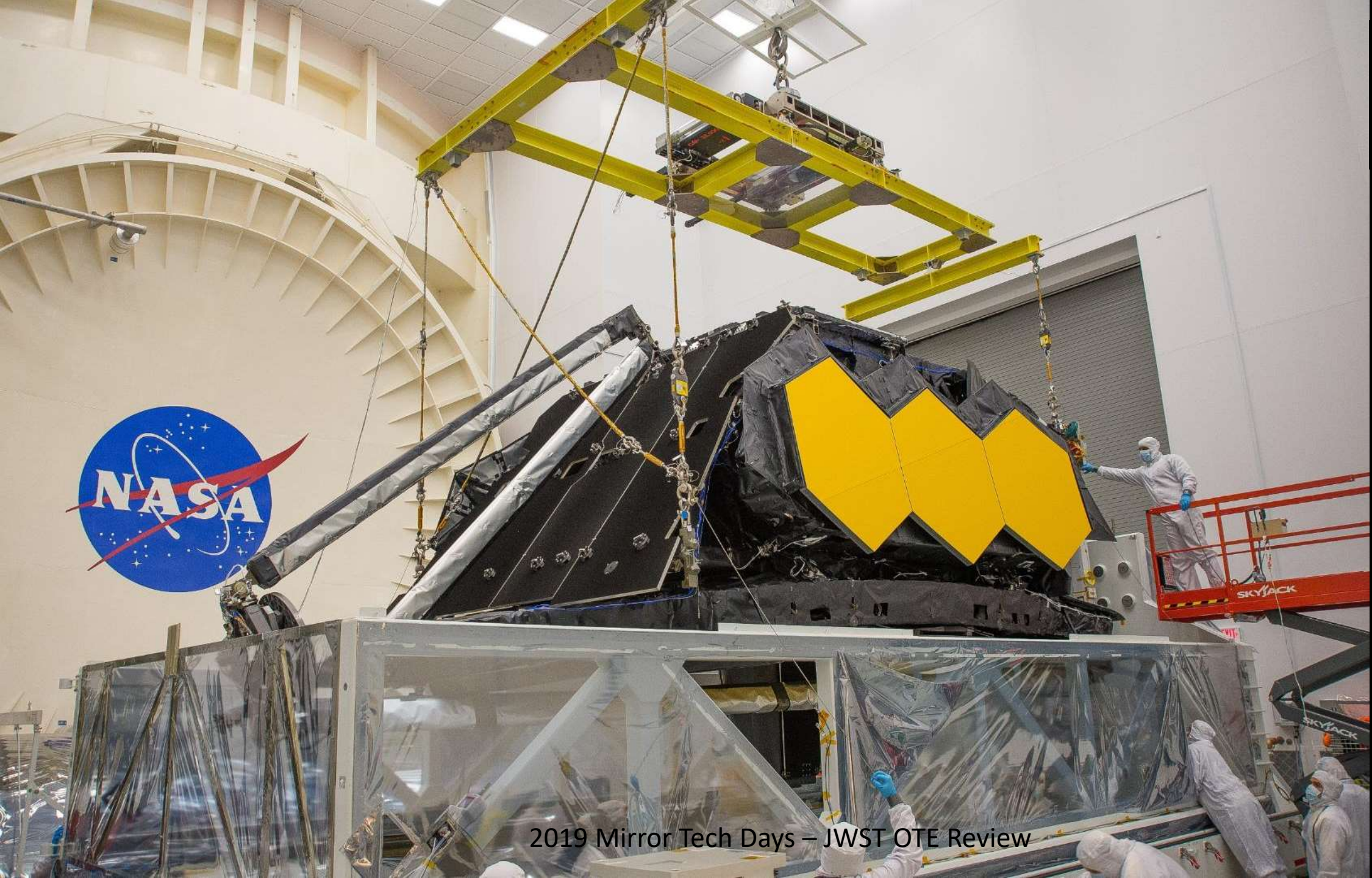



2017-09-15 15:58:01
2017/09/15 15:58:01 CDT
Chamber Temperature*
-423.670°F
-253.150°C 20.000 K
Houston Temperature
93.000°F
33.889°C 307.039 K
NASA

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

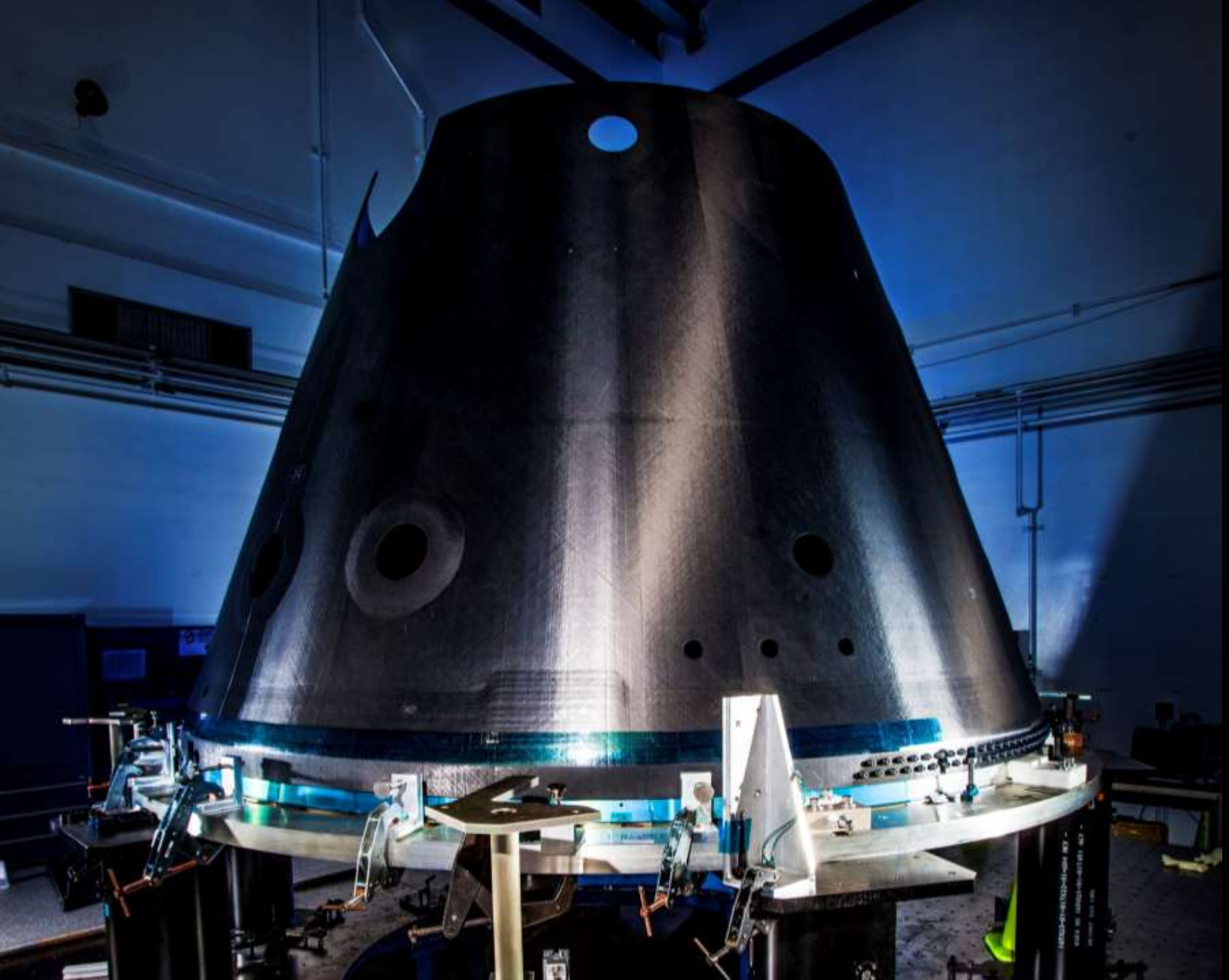
Secondary Mirror deployment test.

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

OTIS ready for Observatory Integration

OTIS being integrated into the spacecraft

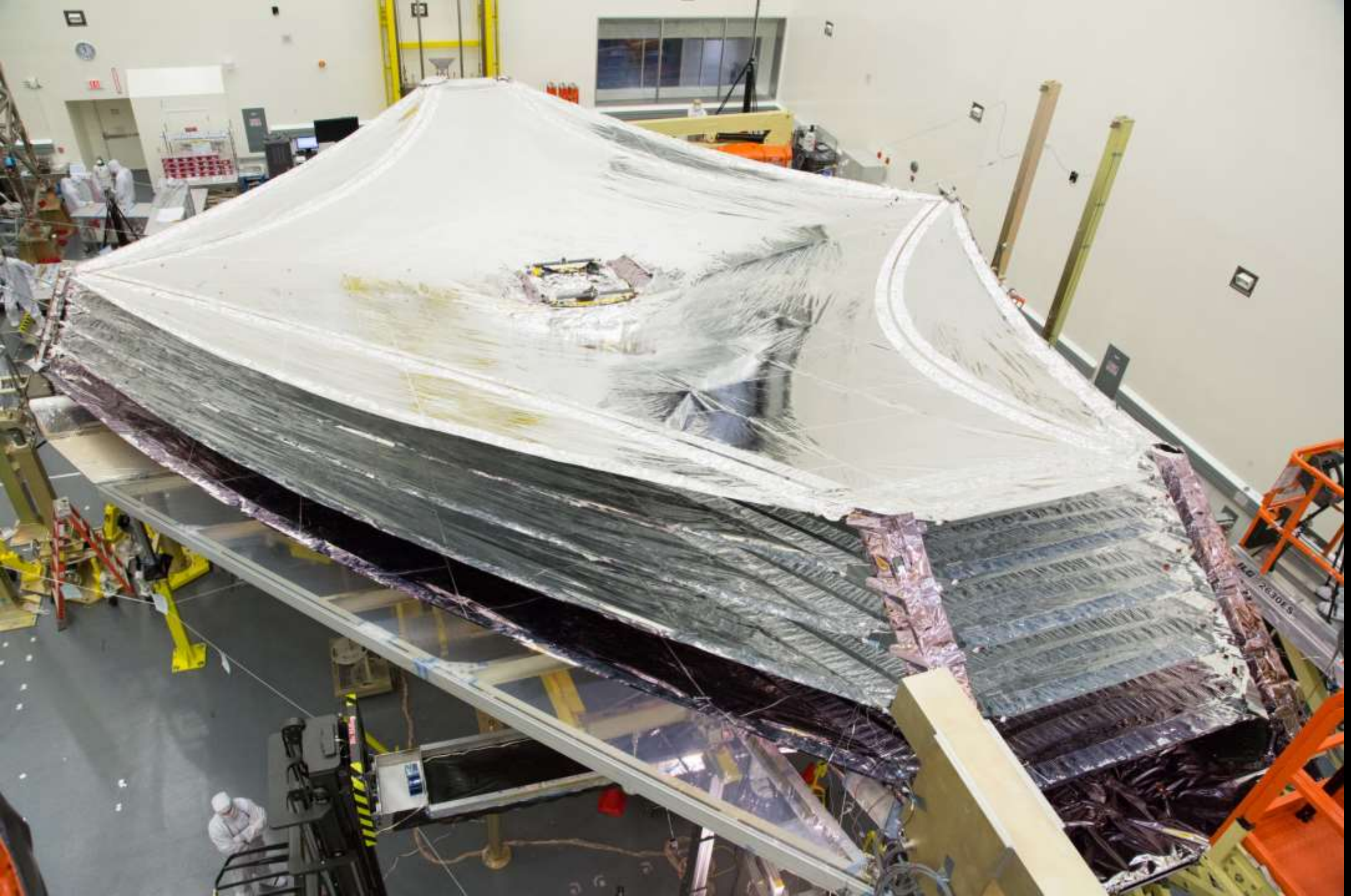
Spacecraft and Sun Shield



Spacecraft core composite structure

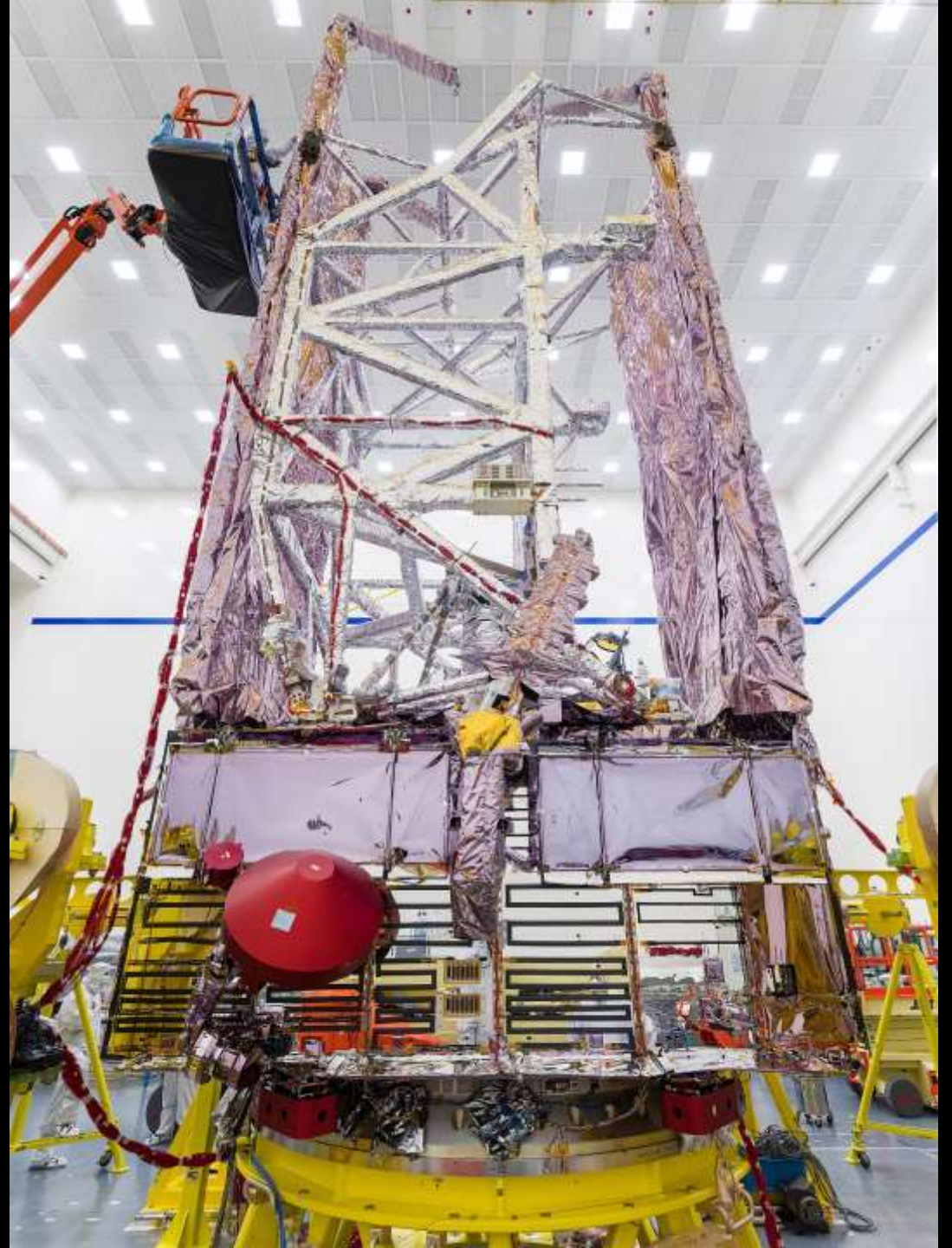
Sunshield layers being placed during initial integration

Tensioned flight sunshield prior to spacecraft integration



Fully tensioned sunshield after spacecraft integration

Technicians working on the spacecraft



OTIS simulator with the sunshield being prepared for environmental testing

Unitized Pallet Structure (UPS) retains the sunshield during launch

Spacecraft being moved in its mobile cleanroom to the environmental test facilities at Space Park

Observatory

OTIS being integrated into the spacecraft

The Observatory

The Observatory

The Observatory with deployed and tensioned sun shield


20 TON CAP

Thank you to all JWST team members for their contributions to the JWST design, development, integration, and test!