

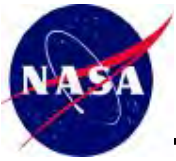
The background of the slide is a composite image of space. In the top left, a portion of Earth is visible. Below it is the Moon. The rest of the background is a deep space scene with a purple and blue nebula and a bright yellow star in the bottom left. The James Webb Space Telescope is shown in the center-right, with its large, segmented primary mirror reflecting the colorful nebula. The telescope's structure and sunshades are visible.

James Webb Space Telescope Mission Status

Bill Ochs
JWST Project Manager
NASA GSFC

JSTUC

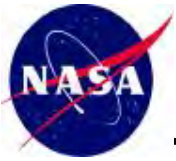
September 14, 2017



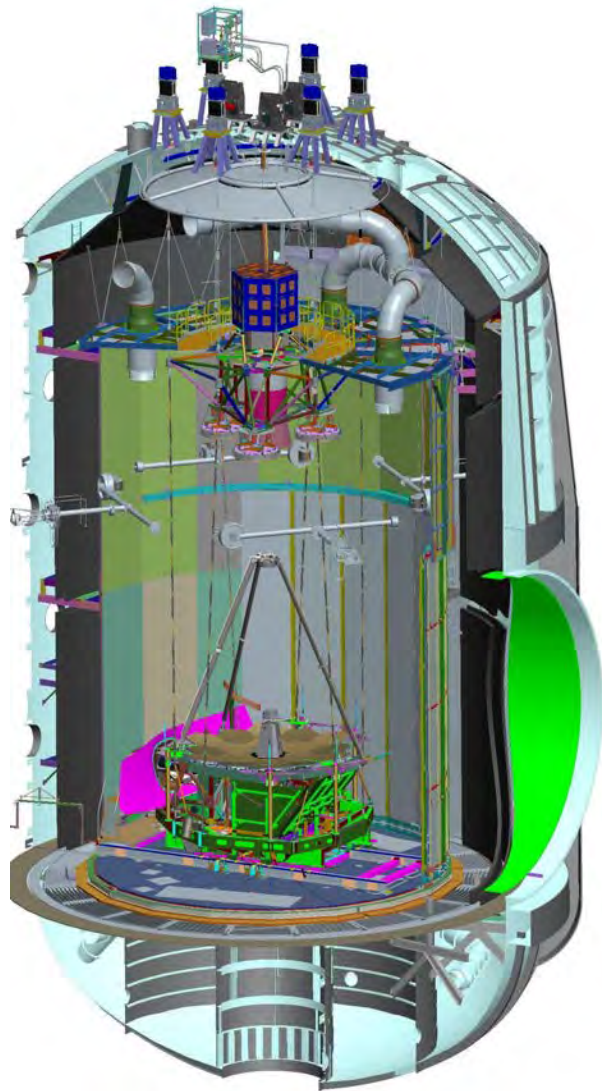
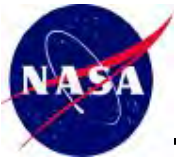
Agenda



- **Mission Status**
- **Schedule Status**
- **Issues/Concerns**

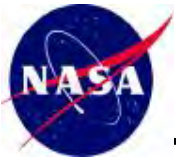


MISSION STATUS



OTIS

**(OPTICAL TELESCOPE
ELEMENT/INTEGRATED SCIENCE
INSTRUMENT MODULE)**



OTIS In Chamber A

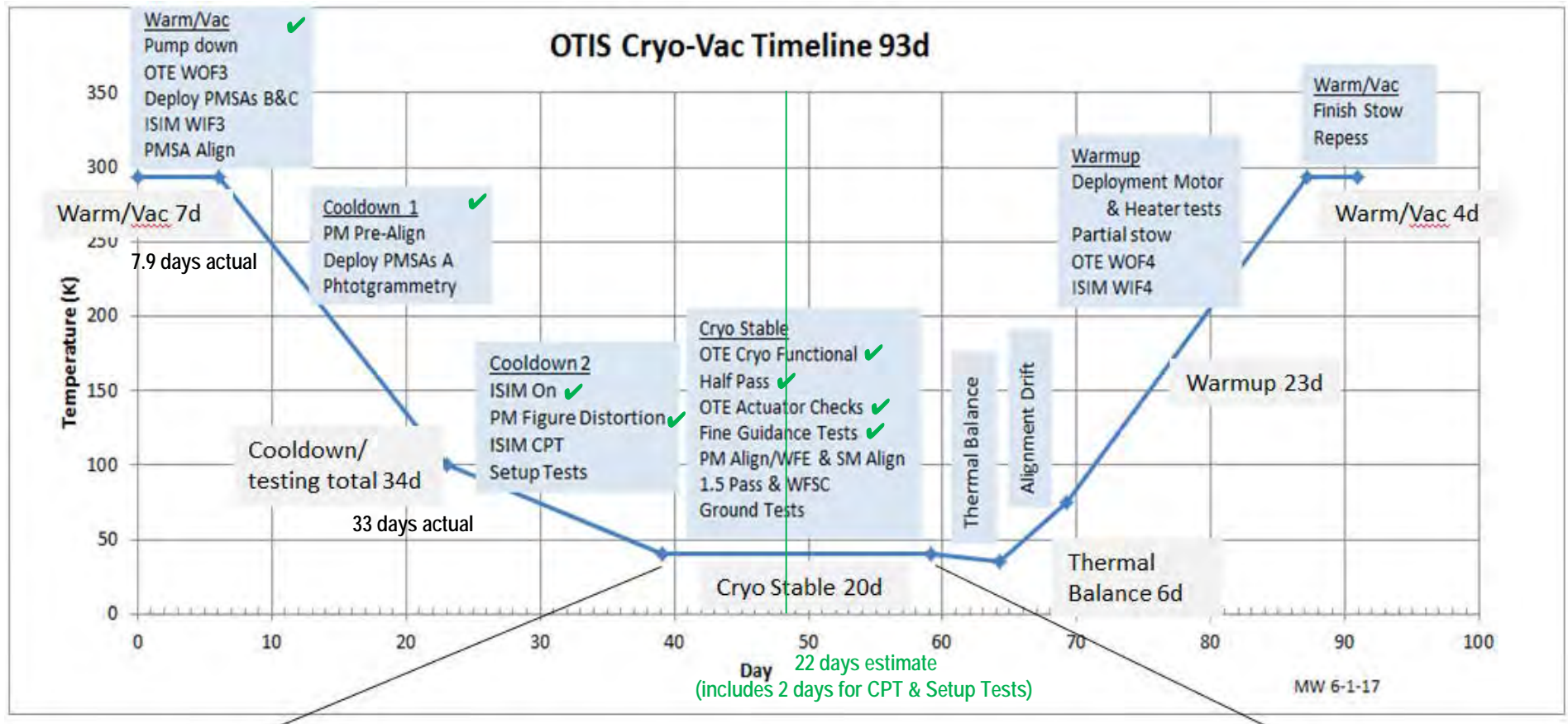


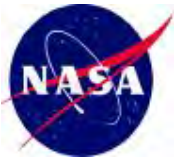


OTIS CV Test Timeline Summary



July 13th at 1:08 AM CDT - Test Start



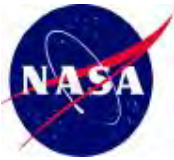


OTIS CV Status



- **Flight OTIS Cryo-Vacuum Testing at JSC**

- Test is progressing very well – data quality is excellent and decision to proceed to cyro-stablization was finalized on Tuesday, August 22nd.
 - Early data during cooldown period did not show any surprises in the OTE to ISIM alignment or OTE internal alignments.
 - Key top priority optical tests completing this week
- 3 Open Issues to Date
 - NIRCam B Shortwave Channel image shift (see slide)
 - Primary Mirror Backplane Structure (PMBS) Cooldown/Gradient (see slide)
 - Primary Mirror Stability (see slide)



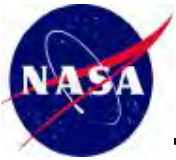
NIRCam Boresight Shift



- **Boresight and Pupil measurements indicated an image shift of ~100 pixels in the NIRCam SW-B channel**
 - Actually improves science with better overlap of SW and LW channels
- **Likely cause is a tilt of 6 arcmins in the NIRCAM B Short Wave Fold Mirror**
 - similar shift was seen from instrument level testing to ISIM CV2 test: ~32 pixels in the opposite direction
- **Likely cause of the tilt is loosening of bottom attach point of mirror 3-point mount**
 - Structural analysis shows that both shifts are consistent with gravity orientation (180 degrees different from ISIM to OTIS CV)
- **Analysis of loads at the Observatory vibe test applied to the mirror with removed bottom attachment showed possible max shift of 42 arcmins**
 - Science analysis by PI and Lockheed Martin showed this conservative max shift is acceptable to science
 - Preliminary analysis of loads and strength indicate plenty of margin for the 2 remaining attach points to survive Observatory vibe and launch.

Remaining work:

- **Using new detailed Finite Element Model, confirm allowable strength margins for the bonded attach point and the Ti bipod flexures at the same point**
- **Complete Wave Front Error modelling to see if the mirror tilt can be seen optically**



PMBS Cooldown/Gradient



- **During cool down**
 - Observed set of sensors on PMBSS composite tube that supports the Instrument Electronics Compartment (IEC) Launch Release Mechanism (LRM) were running 15-20K warmer than predicted and
 - Sensors on the OMNI antenna boom were running colder than predicted
- **Delta between two sets of sensors created the maximum gradient within the PMBSS and near cryo-stable conditions the gradient was increasing beyond the yellow limit**
- **Via structural analysis it was determined the maximum gradient limit in this condition was allowed to increase and new limit was determined.**
 - New gradient limit was maintained throughout cryo-stable phase
- **Next step is to investigate why the two warm sensors were running so far beyond predictions (the cold OMNI antenna boom sensors had since settled into values more in line with predictions).**
 - Working to develop root cause, provide corrective action and provide data to look ahead to flight predictions
 - Investigation is ongoing and expected to stay open through test in order to perform inspections of the hardware configuration following the test



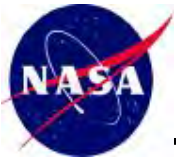
Primary Mirror Stability



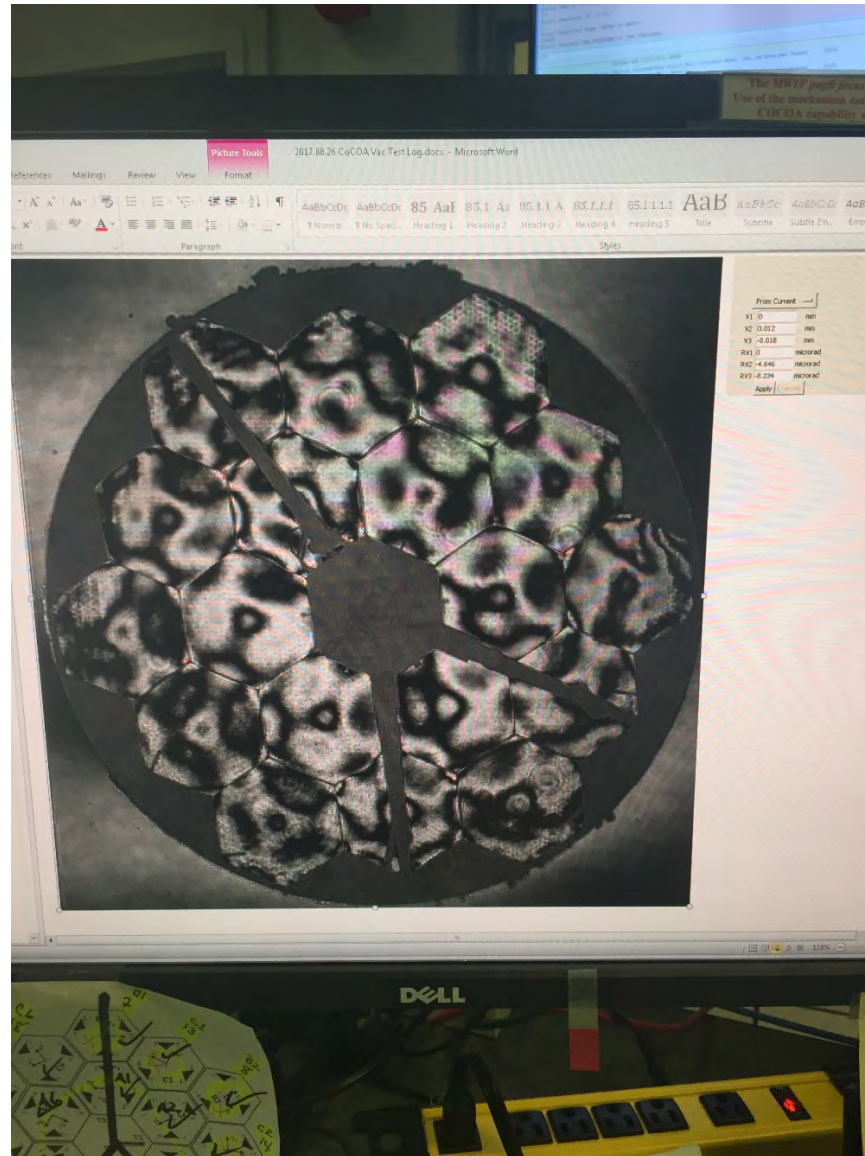
- **Measured primary mirror stability has been lower than expected over 10's of minutes to hours, the level of stability has varied at times**
 - Includes a long term drift component and a cyclic component

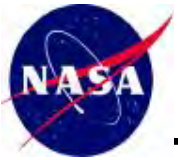
- **Identified multiple possible effects causing the instability**
 - Drift:
 - Center of Curvature Optical Assembly (COCOA) shutter at top of chamber being opened and left open causes figure drift of PM for about 12 hours, confirmed by measurement
 - Mechanical interferences of Photogrammetry targets with PMSA closeout on one mirror segment could be a contributor
 - Cyclic component:
 - IEC heaters cycling (+/- 1C) correlated to cyclic component, evaluating a smaller amplitude (+-.25C, in progress), early indications are this change has made a significant difference in improving the RMS, data is in review
 - Changes to the jitter in the chamber over time, possibility driven by facility changes (eg, LN2 valves which cycle, etc)

- **Current activities include**
 - Studying archived data looking for correlations
 - Special Primary Mirror Stability test is being executed and is completing Sunday night, data in evaluation
 - Will have taken enough data to bound the stability measurements
 - Cyclic component can be dealt with by taking enough data and averaging
 - COCOA shutter drift mitigated by keeping COCOA shutter closed when not in use
 - Evaluating IEC heater amplitudes

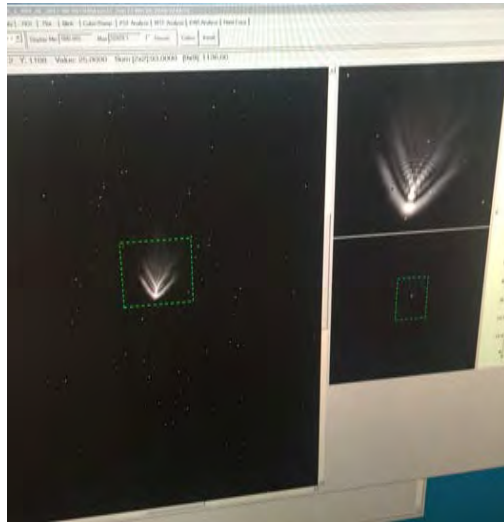


Primary Mirror Fringes Fully Aligned

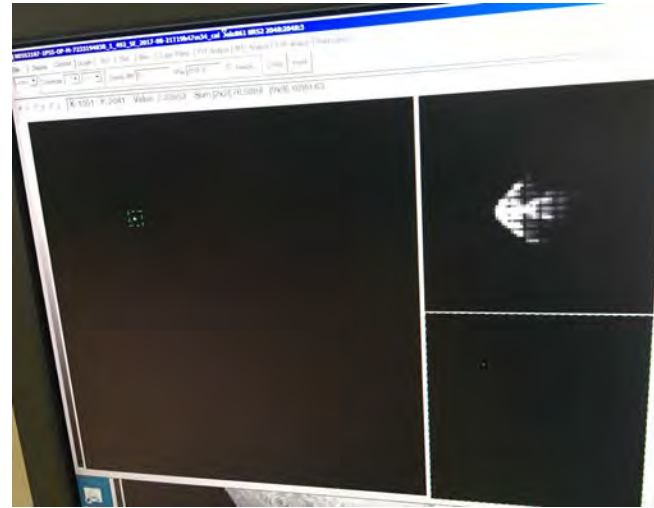




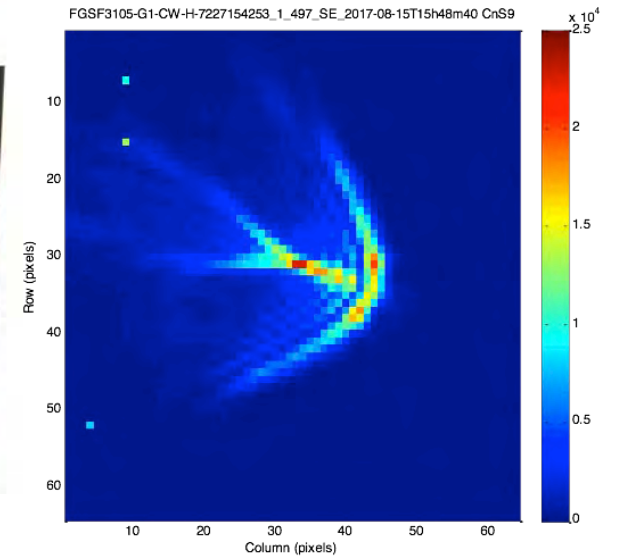
Instrument First Light



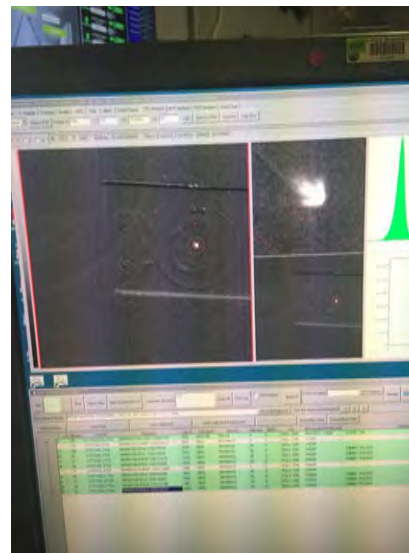
NIRCam



NIRSpec



FGS/NIRISS



MIRI

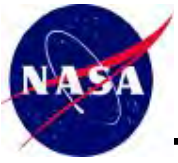


Hurricane Harvey Summary



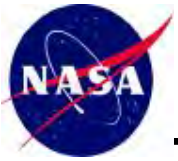
- **All JWST team members supporting OTIS CV testing were managed to maintain safety**
 - JSC personnel experienced more flood conditions at their homes than the traveling team members who were staying closer to JSC.
 - All test staffing decisions were consistent with eliminating and minimizing the risk of being on the road. For example worked two vs. three shifts. Trucks and large SUVs were used to transport team members safely.

- **JWST OTIS hardware and GSE are safe and operational**
 - The largest issue was managing the water leaks which was primarily a result of a seam in the building between the office space and the highbay
 - Lost a number of shifts over the first weekend when called off testing due to personnel safety concerns but completed some ISIM Comprehensive Performance Test (CPT) testing when the weather conditions allowed testing to be done safely
 - JSC did not lost primary power and all critical facility systems (LN2, backup air, roughing, facility emergency power) allowed 5 days of operation
 - JSC worked LN2 replenishment with GSFC and KSC to re-establish LN2 delivery to maintain adequate reserves



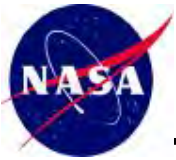
Harvey





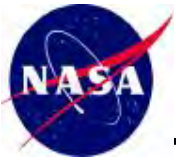
MIRI Team Before and After Moving





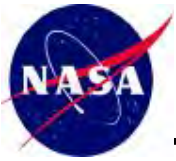
OTIS Control Room Optical Test Station Tent





A Lighter Moment





JWST Harvey Relief Volunteers

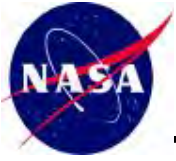




Looking Ahead



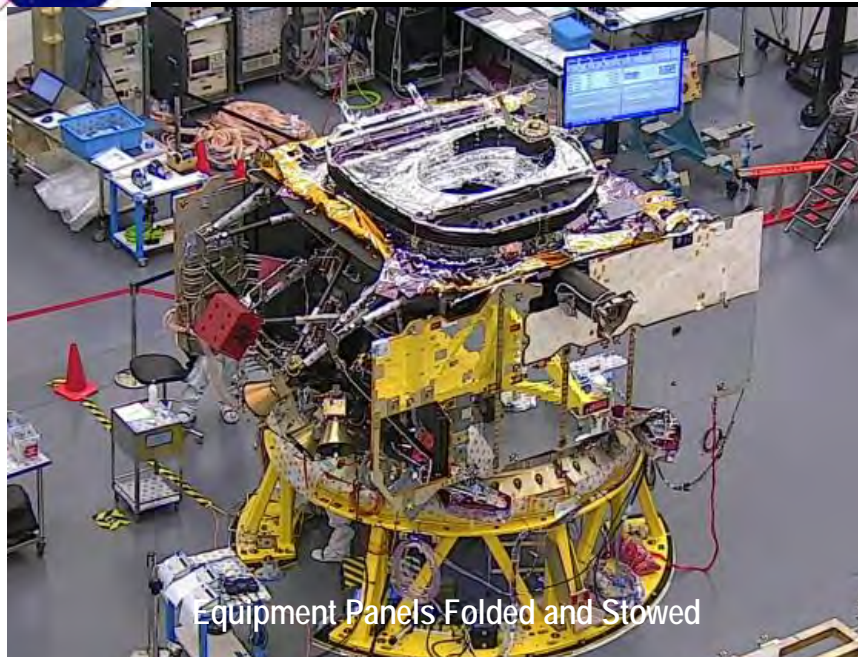
- **OTIS CV Test Completion and Chamber A door open – 10/2017**
- **OTIS rolled out, de-configured, and loaded in STAARS – 11/2017**
- **OTIS Pre-Ship Review (JSC to NGAS) – 11/2017**
- **OTIS Ship from JSC to NGAS – 11/2017**
- **OTIS Post Ship Functional Testing Complete at NGAS – 12/2017**
- **OTIS Ready for Integration to Spacecraft – 12/2017**



SPACECRAFT ELEMENT

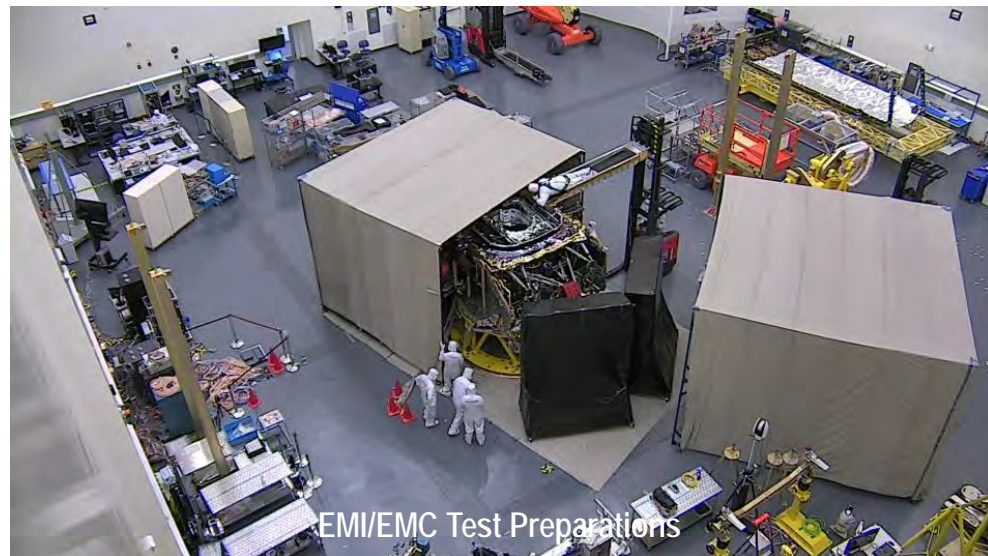


Spacecraft Status



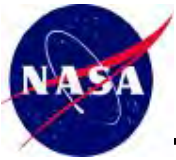
Equipment Panels Folded and Stowed

- Spacecraft electrical I&T complete and equipment panels closed.
- Comprehensive performance test (CST-1) successfully completed.
- EMI/EMC testing successfully completed
- Dual Thruster Modules (DTM) removed for valve replacement and DTM retrofit
- Next Steps (by end September)
 - Install Solar Array
 - Finalize DTM/Valve repair technique and installation schedule
 - Finalize DTM verification plans



EMI/EMC Test Preparations





Sunshield Status

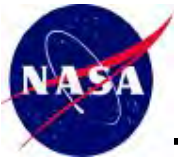


All Sunshield hardware has been delivered with nearly complete integration



Skeleton level folding and deployment complete

- All primary structure installed and functionally tested
- Membranes installed and folded
- Cover installation and Membrane Release Devices (MRDs) installation underway
- Next Steps (by end of September)
 - Support final stowage and pre-environmental deployment
 - Support install of DRSA-H

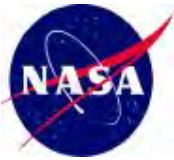


Spacecraft Element I&T

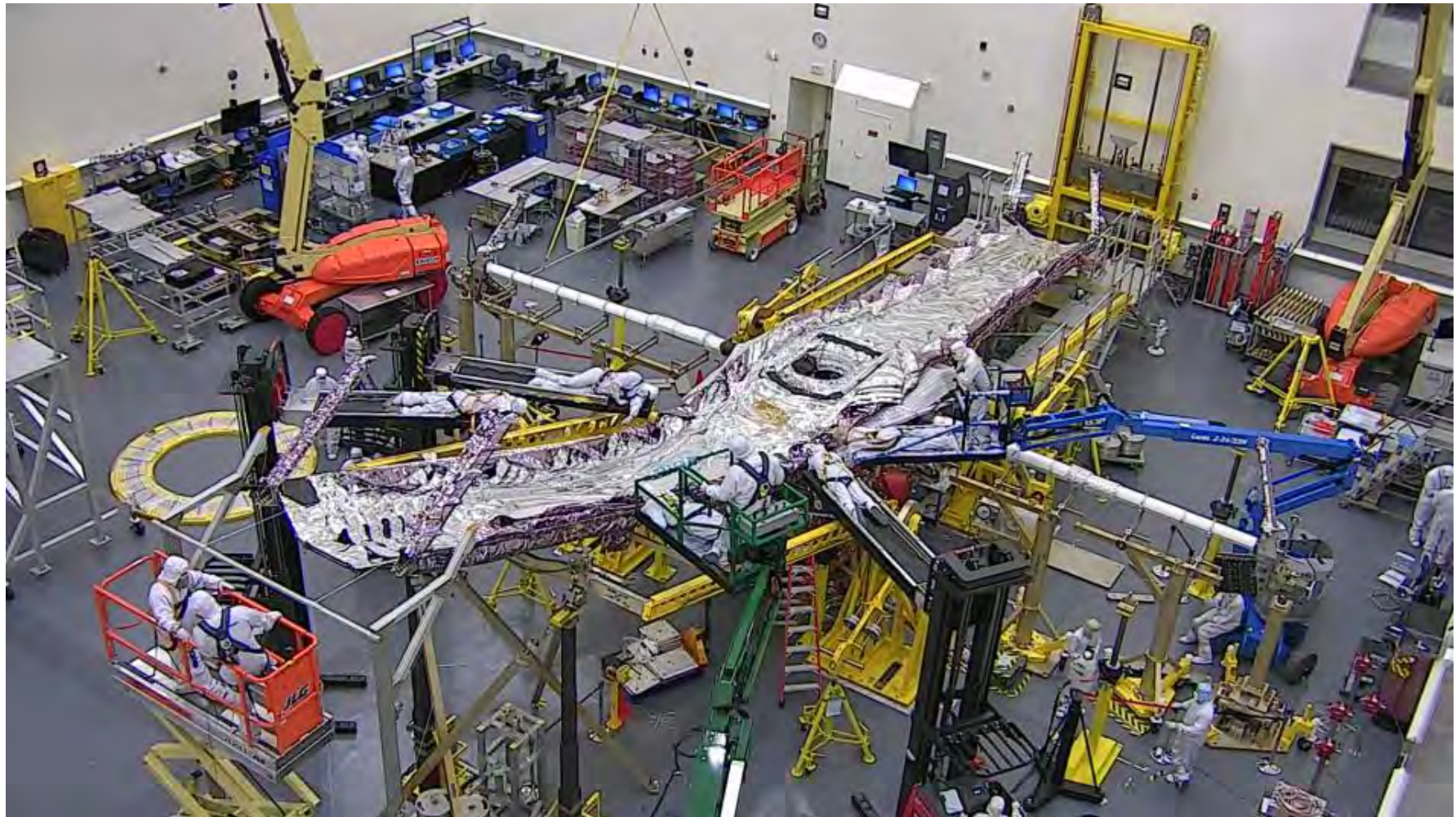


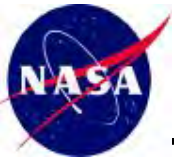
- Completed installation and folding of membranes
- Completed Thermal Vacuum Trailblazer risk reductions
- Completed DSN testing and first ground segment end to end test.
- Next Steps (by end of October)
 - Complete acoustic risk reduction testing
 - Complete stowage and deployment of Sunshield
 - Complete modal testing
 - Complete launch vehicle interface fit check and separation shock testing





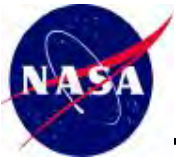
Sunshield Membrane Release Device Installation



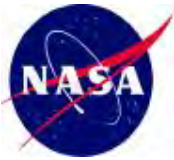


Sunshield Membrane Release Device Installation





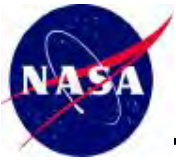
GROUND SYSTEM AND OPERATIONS



Science and Operations Center (S&OC)



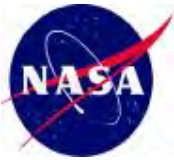
- **All Observatory Control, Science Planning And Science Data Processing Operational Systems Are On Schedule**
 - Continue to use all S&OC to support Integration and Test:
 - All subsystems are being exercised during OTIS JSC testing: Wavefront Software Subsystem (WSS), Operations Scripts Subsystem (OSS), Project Reference Database Subsystem (PRDS), Proposal Planning Subsystem (PPS), Data Management Subsystem (DMS), Flight Operations Subsystem (FOS)
 - Continuing to conduct S&OC interface testing over operational networks
 - Conducted extremely successful Ground Segment Test #1 (GSEG-1) between the Mission Operations Center and the JWST spacecraft in May and June
 - Utilized TDRS (via SN antenna at NGAS) and DSN (via the DSN Test Trailer); both SN and DSN were able to verify compatibility with JWST at all rates/configurations
 - The Flight Operations Team commanded the spacecraft during the test and was able to verify numerous requirements and ops products



Science and Operations Center (S&OC)



- **All Observatory Control, Science Planning And Science Data Processing Operational Systems Are On Schedule**
 - Continuing to conduct S&OC interface testing over operational networks
 - Conducted interface tests with ESA Malindi ground station in March and July
 - July test was conducted to resolve problem encountered with Space Link Extension (SLE) authentication during March tests; problem has been corrected
 - Successfully continuing routine interface tests with Deep Space Network, Space Network, Flight Dynamics Facility
 - Mature S&OC subsystems have been integrated into a single system which enable the conduct of science
 - Guaranteed Time Observer programs are being submitted
 - Six out of an expected 94 programs received to date
 - The deadline for Early Release Science proposals was August 18
 - TAC will meet in October, with results being announced November



Operations Preparations

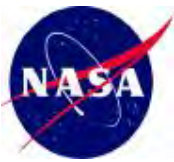


Operations product development well underway

- **ISIM flight product status:**
 - 346 realtime command procedures needed for flight
 - Overall certification - 90% complete
 - 121 standard operating procedures needed for flight
 - Overall certification - 31% complete
- **SC / OTE flight product status:**
 - 308 realtime command procedures needed for flight
 - Overall certification - 71% complete
 - 205 standard operating procedures
 - Overall certification - 37% complete
- **Deployment flight product status**
 - 214 realtime command procedures needed for flight
 - Overall certification - 71% complete
- **OSS flight product status:**
 - 786 java scripts needed for flight
 - Overall certification – 79% complete

Ops Products Used Extensively During I&T

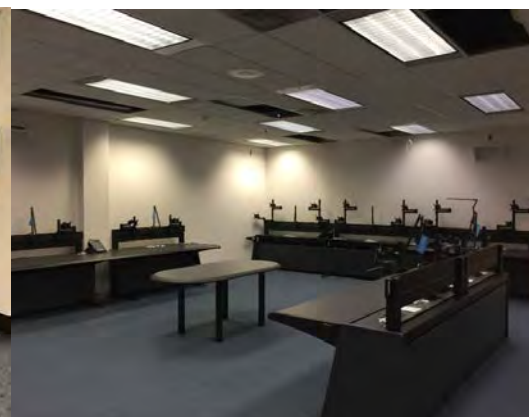
- Commissioning Timeline Support
 - FOS training for NASA civil servants on mission operations team conducted throughout period
 - NASA-led Commissioning Activity Request (CAR) Adjudication meetings continue at STScI to refine commissioning timeline
 - Two day detailed review of launch script scheduled for September
- FOT training
 - Completed first two Operational Readiness Exercises (OREs) which rehearse the flight operations team in nominal and anomaly operations
 - Preparations underway for ORE-3 in September and a dedicated wavefront exercise in November
- Facilities
 - Networks, phones, furniture and artwork installed in backup Mission Operations Center (bMOC) in GSFC Building 32
 - Computer hardware scheduled for delivery in September, testing will occur in October and facility should be ready for use in November



JWST Mission Operations Activities and Facilities



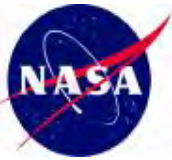
Successful GSEG-1 utilized SN antenna (left), DSN test trailer and dedicated personnel (right)



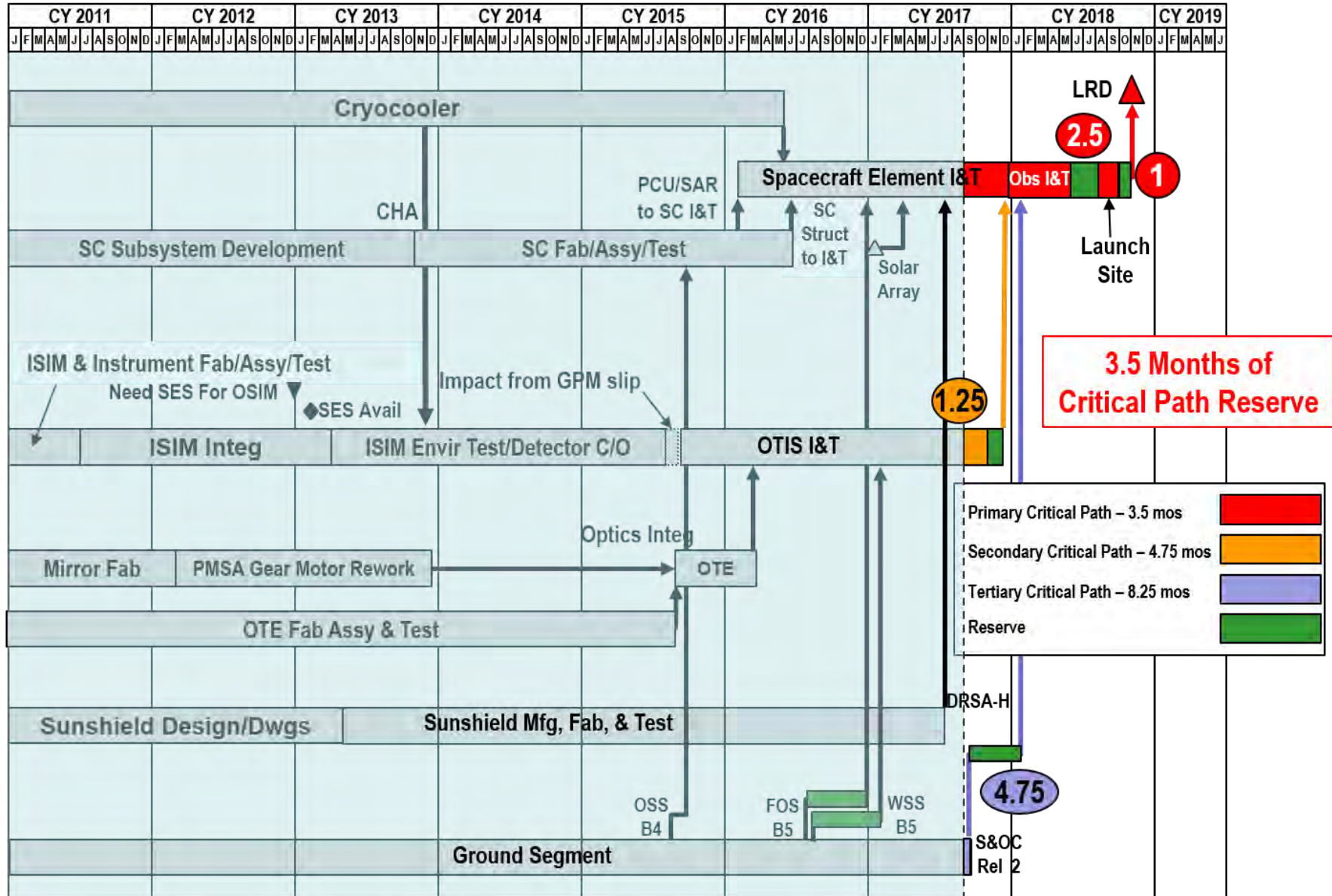
Backup Mission Operation Center (bMOC) in GSFC Building 32 is nearing completion

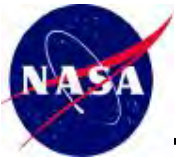


SCHEDULE

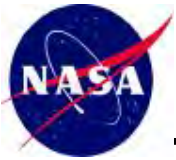


JWST Master Schedule





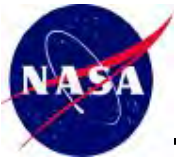
ISSUES/CONCERNS



Issues/Concerns



- **Propulsion Valve Leak**
 - Need to repair/replace leaky valves in thruster units
 - Failure Review Board has been formed and is controlling the investigation process
 - Identifying the root cause is proving elusive. Reinstallation of thruster units is complicated and schedule impacts could be significant
- **Schedule Reserve**
- **Bepi/JWST launch conflicts**



CLOSING REMARKS



Closing Remarks



Great Progress Continues To Be Made

**Biggest Challenges Ahead: Thruster Valve
Issue and Schedule**