

The image features a detailed rendering of the James Webb Space Telescope (JWST) in space. The telescope is positioned in the lower right, with its large, segmented primary mirror reflecting a vibrant, colorful nebula. The background is a deep space scene with a starry field, a prominent purple and pink nebula, and a bright yellow star in the lower left. In the upper left, the Earth and the Moon are visible. The text 'James Webb Space Telescope' and 'JSTUCC' is overlaid at the top in white, bold font.

James Webb Space Telescope JSTUCC

Project Status
Dec 11, 2020

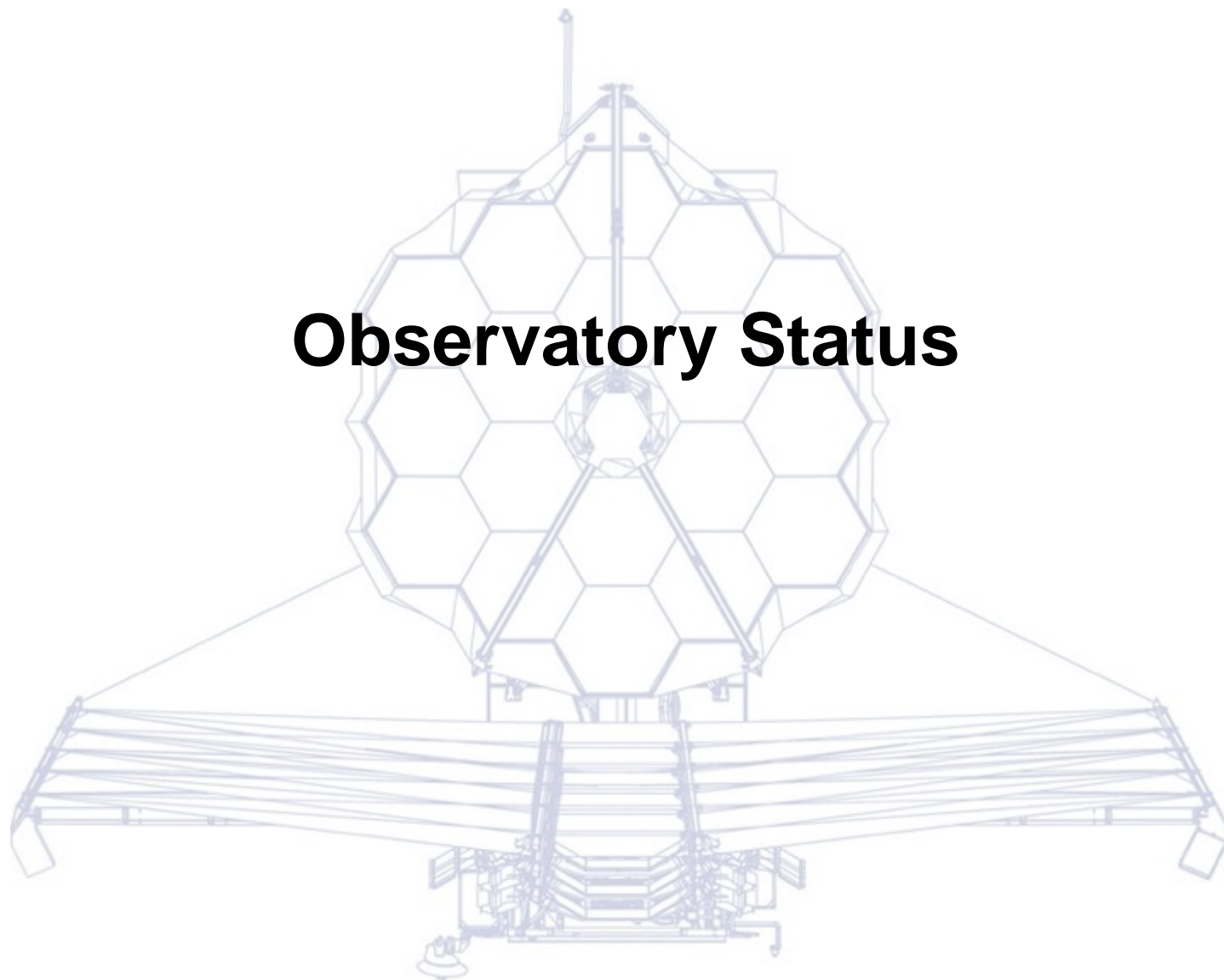


Project Status Topics



- **Observatory Status**
- **Ground System and Operations**
- **Launch Vehicle Status**
- **Launch Site Planning**
- **Commissioning**
- **Top Issues**
- **Schedule**
- **Conclusion**

Observatory Status





Highlights Since June SWG



- **Completed CST #4 – first OBS level CST**
- **Completed GSEG #3 – first OBS test from MOC**
- **Completed Observatory level acoustics test**
- **Completed Observatory sine vibe test**
- **Removed EM battery and installed flight battery**
- **Completed Solar array, GAA, Aft Flap, and STSA deployments**
- **Completed UPS deployments**
- **Completed Membrane Cover Assembly roll-ups**
 - 1 section from each side has been removed to repair pre-existing small tears
- **Completed mid-boom deployments**
- **Initiated Membrane Tensioning**

Transfer to Vibe Table





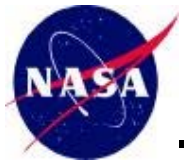
10/29/20: Configured for AFT UPS Deployment





10/30/20: AFT MCA Release/Deployment





11/4/20: FWD UPS Deployment



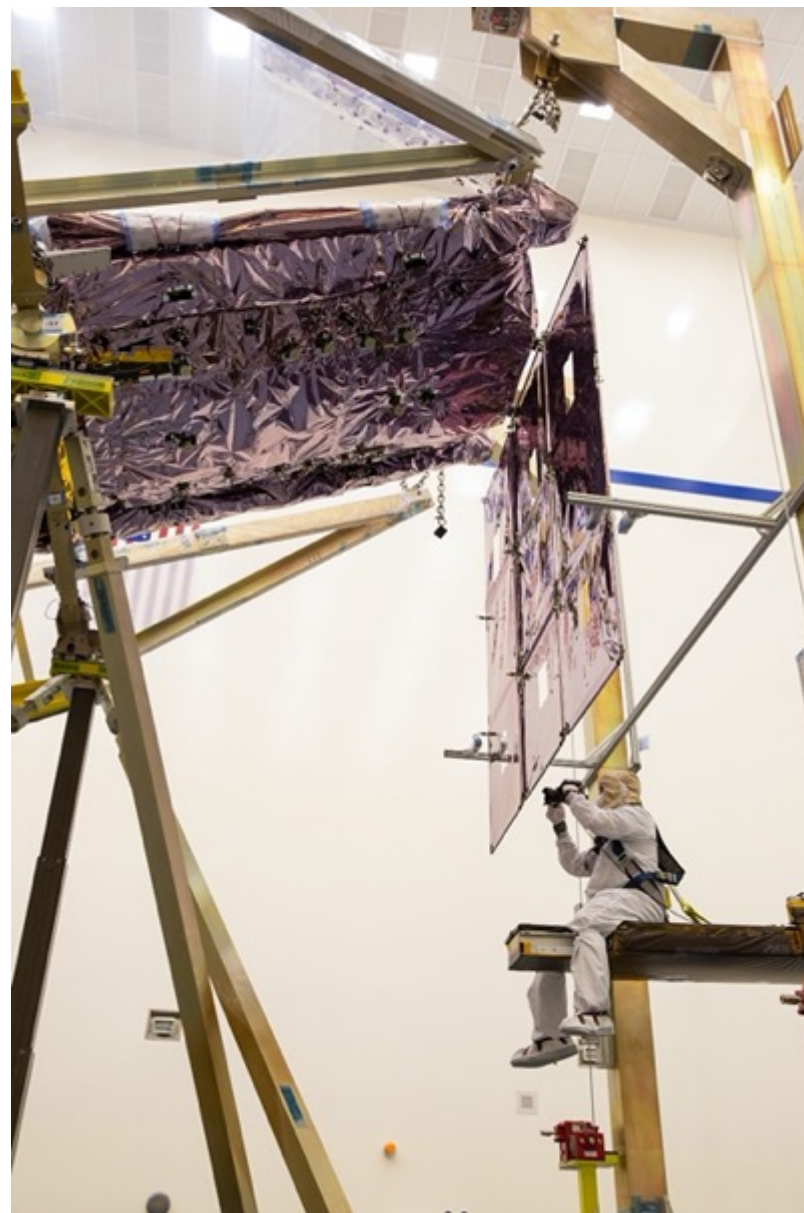


11/17/20: DTA Deployment and Triangle/Extension Install

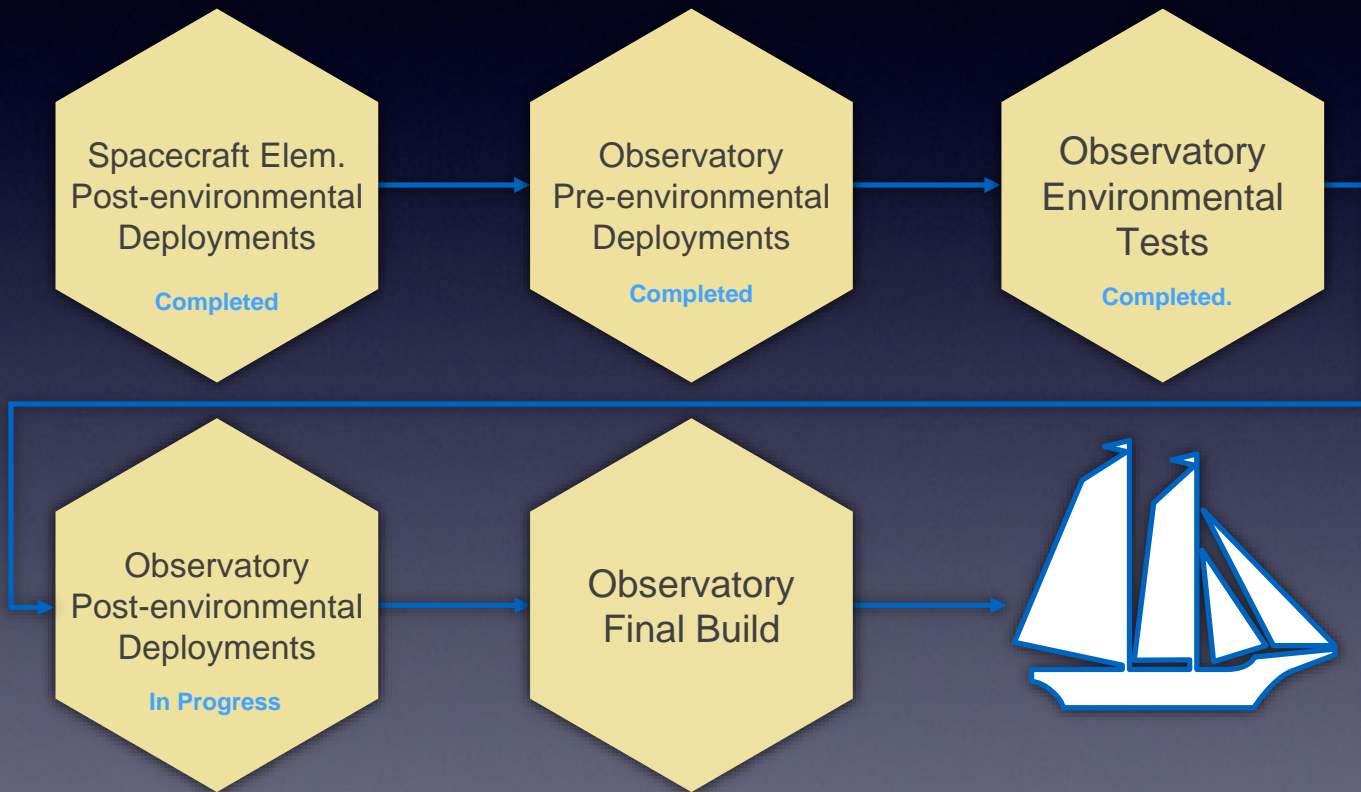




11/17/20: AFT Flap Full Panel Walk-Out

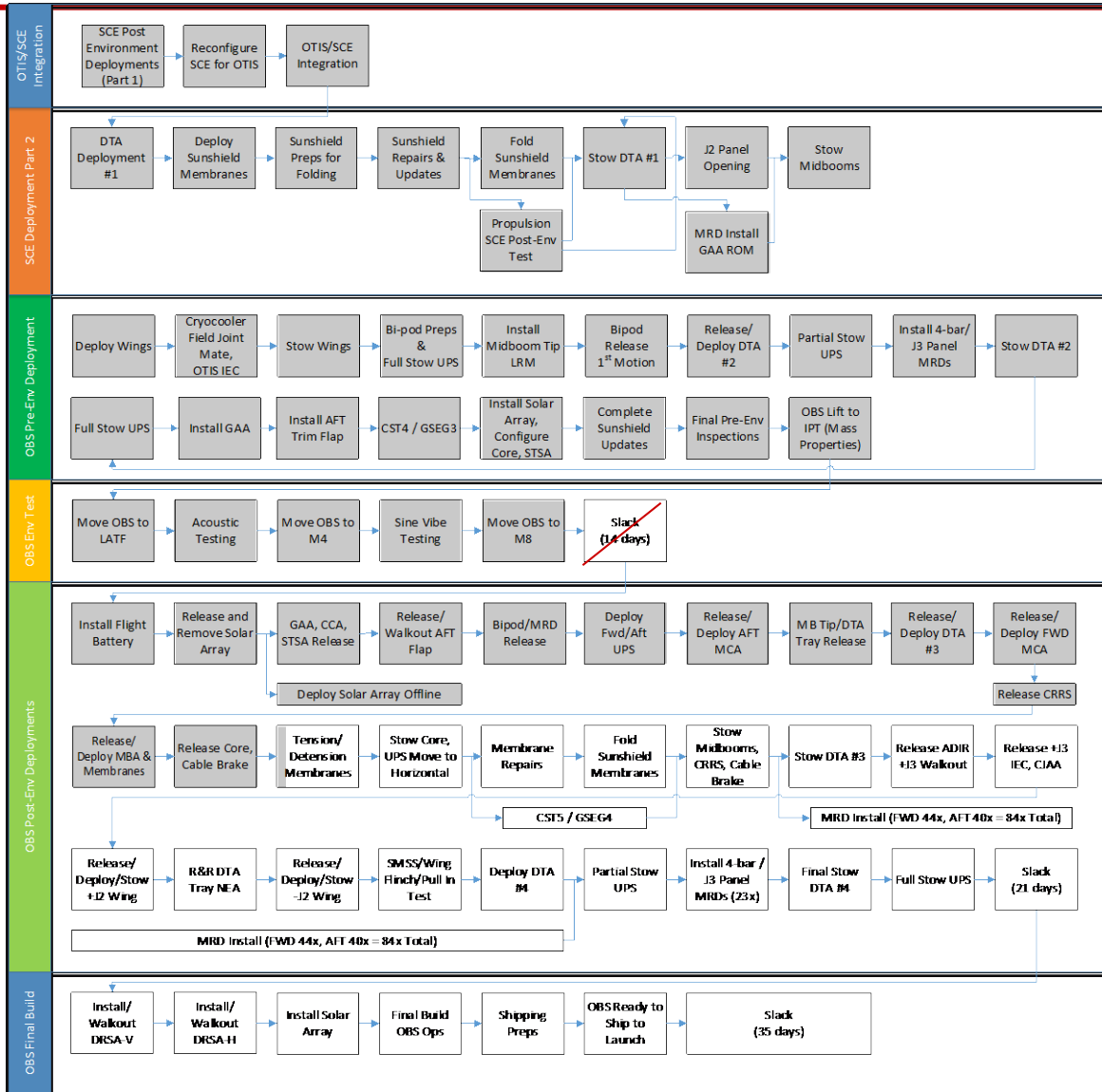


Remaining I&T Activities

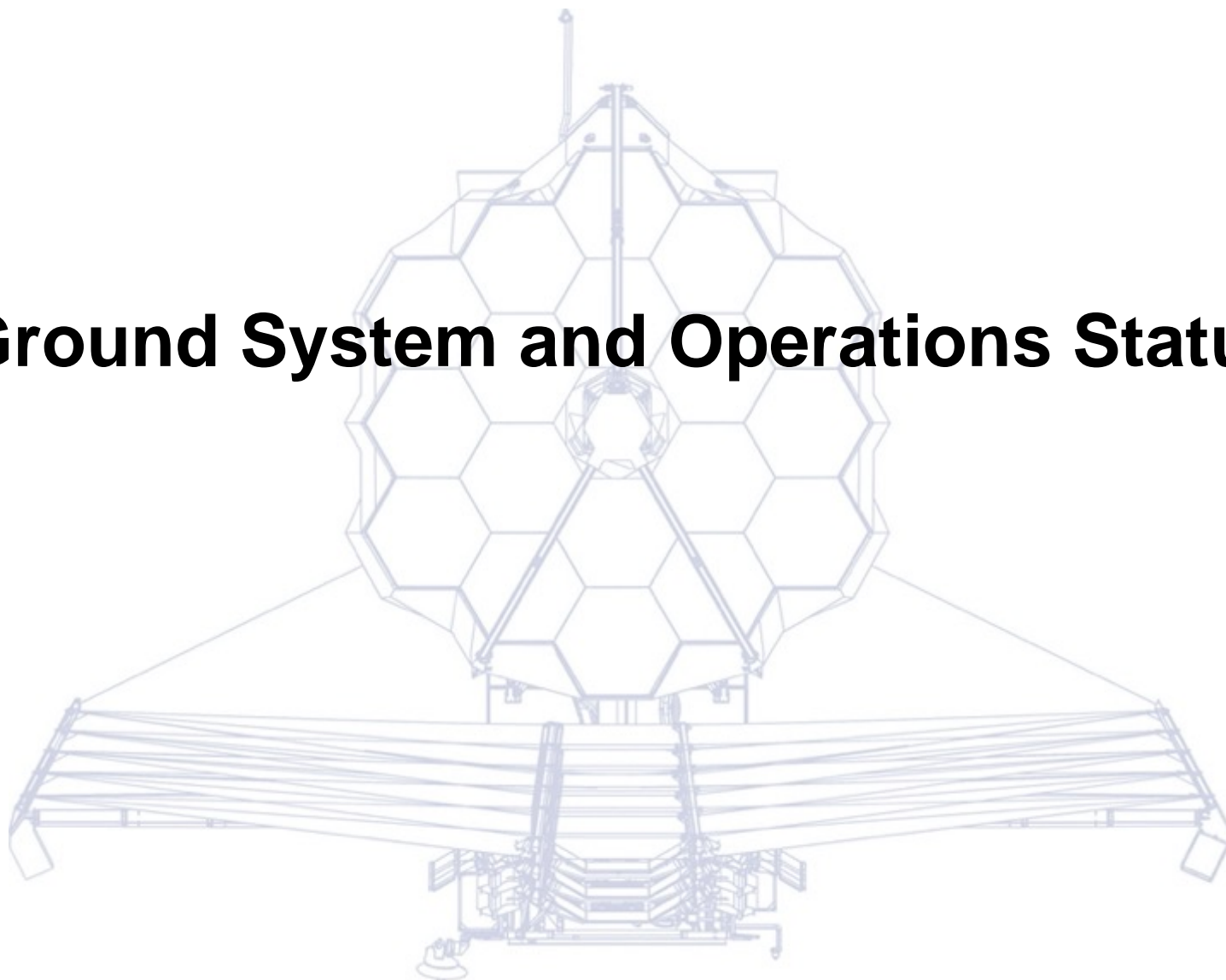




OBS I&T Integration Flow



Ground System and Operations Status





Science and Operations Center (S&OC) and Operations Preparations



● S&OC Status

- All Observatory control, science planning and science data processing operational systems are on schedule.
- S&OC subsystems have been and will continue to be used to support Observatory integration and test

● Testing and Exercises

- Commanded Observatory flight hardware from the Mission Operations Center (MOC) during Ground Segment Test #3 (GSEG-3) July 13-19. All Observatory subsystems were successfully exercised while accommodating COVID protocols and remote access.
- Completed Normal Operations Exercises #8.1 (July) and #9 (August), practicing station keeping, momentum unloads and wavefront visits.
- Executed of Launch Readiness Exercise #1 from the MOC the week of November 2.

Operations Product Development Status

● ISIM flight product status:

- 460 real-time command procedures and 256 standard operating procedures needed for flight
 - 6 products in revision (MIRI, cryocooler)

● SC / OTE flight product status:

- 278 real-time command procedures needed for flight and 184 standard operating procedures
 - 10 new products, 2 in revision

● Deployment flight product status

- 188 real-time command procedures needed for flight
 - Testbed/simulator certification is complete; flight certification will finish up during Observatory I&T

● OSS flight product status:

- 785 scripts are required
 - Testbed/simulators certification is complete; flight certification will finish up during GSEG-4 (January 2021)



JWST Rehearsal Campaign



	LRE-1	ICE-1 LRE-2 SIR-3	D2	ICE-2 LRE-3 WFR-5	D3	LRE-4 D4	ICE-3 LRE-5* SIR-4	MDR
Timeline/Activity	Nov '20 (~L-12mo)	Feb '21 (~L-8mo)	Mar '21	Apr '21 (~L-6mo)	May '21	Jun '21 (~L-4mo)	Aug '21 (~L-2mo)	Oct '21 (L-4d)
Pre-launch	X	X		X			X	X
L&A and MCC	X	X**		X**			X**	
SC Sys	X	X		X		X	X	
Depl – UPS & DTA			X			X		
Depl – SS		X				X***		
Depl – OTE					X			
Mirror Depl					X			
OTE				X	X			
SI/Cryocooler		X		X			X	
Cooldown		X						
LOS				X			X	
Instruments		X					X	

* LRE5 will contain deployment activities TBD based on previous exercises.

** One shift only for Purple and Green

*** Five days of Sunshield activities.

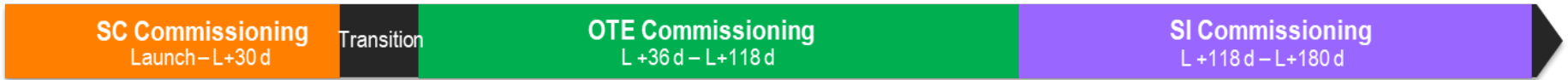
LRE2 Sunshield activities are mid-boom and tensioning.



MOT Completed Rehearsals



- The formal launch rehearsal campaign (6 exercises) began with Launch Rehearsal Exercise #1 (LRE1) in November 2020
- To date, the MOT has completed 19 rehearsals



Jul 18, 2018	ECE-1
Mar 5, 2019	ECE-2
Mar 6-8, 2019	D1
Jun 10-12, 2019	MD1
Oct 8-10, 2019	MD2
Nov 5-7, 2019	ECE-3
Feb 11-12, 2020	ECE-4

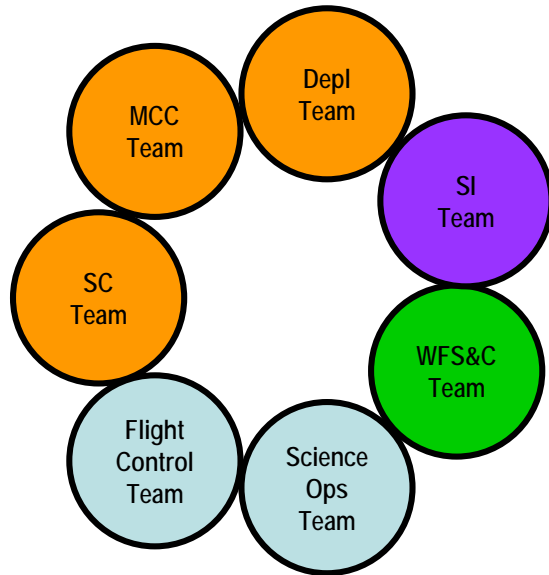
May 7-10, 2018	WFR-1
Oct 4-6, 2018	WFR-2
Apr 9-12, 2019	WFR-3
Dec 9-13, 2019	WFR-4

May 7-10, 2018	WFR-1
Oct 4-6, 2018	WFR-2
Nov 12-18, 2018	SIR-1
May 13-18, 2019	SIR-2

- Focused rehearsals; not specific to one portion of the timeline as the others

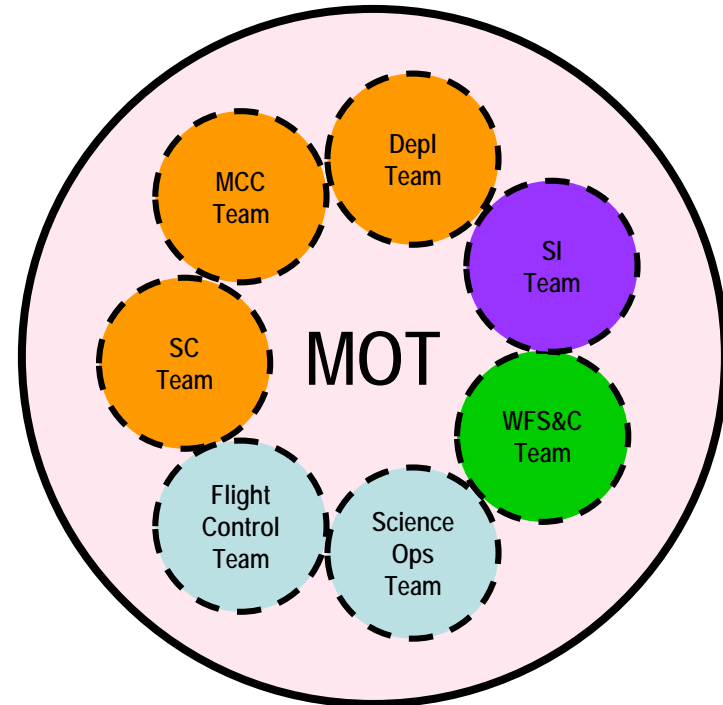
May 2-4, 2017	ORE-1	Normal Ops
Jun 27-28, 2017	ORE-2	Normal Ops
Sep 12-14, 2017	ORE-3	Normal Ops
Dec 5-7, 2017	ORE-4	Normal Ops
Oct 2-4, 2018	CPR-1	Contingency
Sep 23-26, 2019	CPR-2/3	Contingency

Team Exercises



- Led by individual MOT teams
- Internal cross-training opportunities
- Allows focus on specific team activities
- Prepares team for MOT rehearsals
- Exercised with similar simulators and ground system as MOT rehearsals and modified as necessary for individual team needs

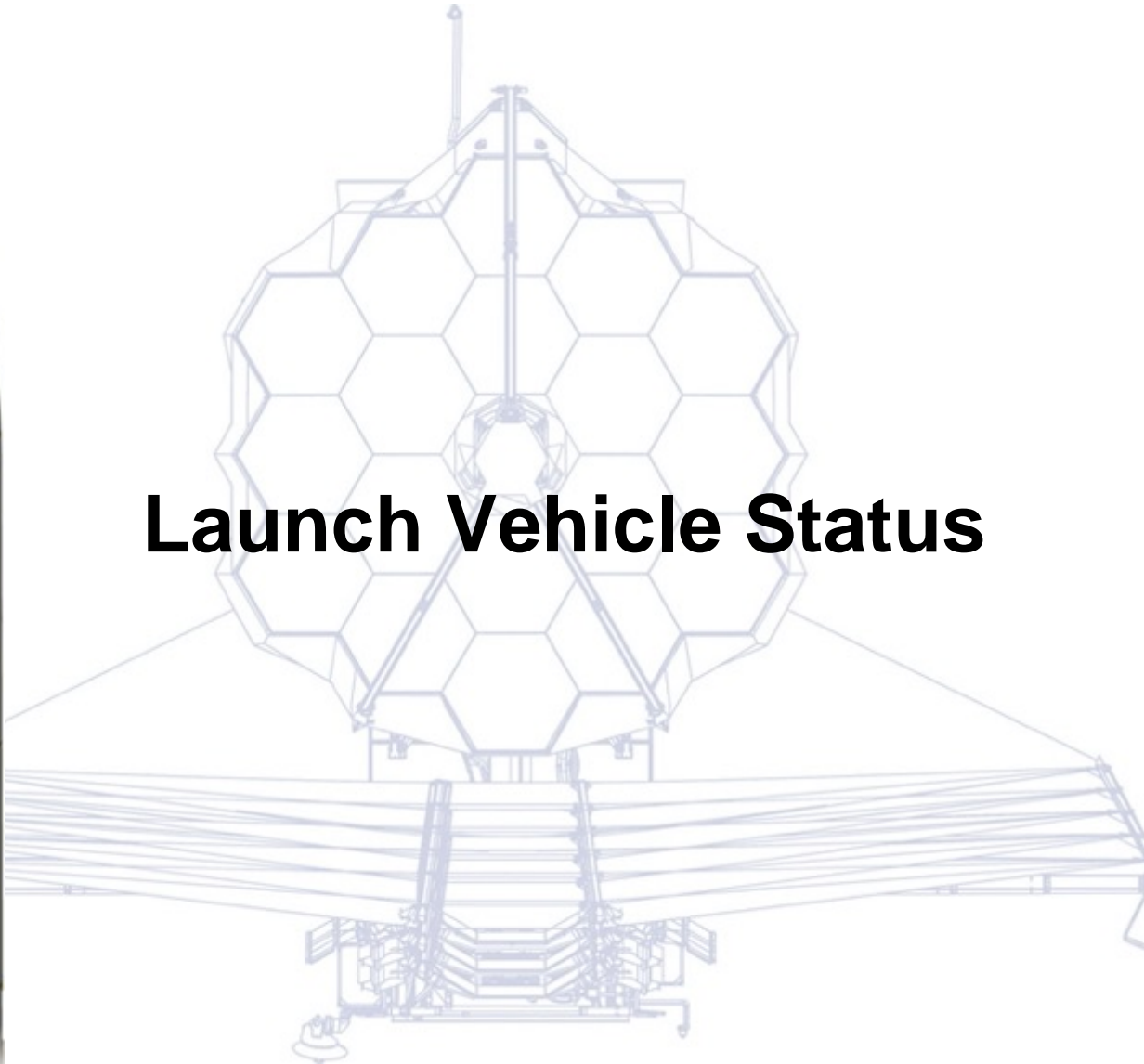
Mission Operations Team (MOT) Rehearsals



- Led by MOT rehearsal team
- Cross-team interactions
- Focuses on critical commissioning activities
- Ensures team can conduct operations through commissioning and normal operations



Launch Vehicle Status





Began Final Mission Analysis Review (RAMF) Cycle



- **Delivered final inputs to Arianespace (AE) for DCI 1/10: baseline for RAMF**
- **Provided summary of Observatory Acoustic and Sine Vibration test results**
 - Assert that Observatory responses match models sufficiently
- **Held virtual RAMF kick-off with AE and ESA on 9/14, solidifying plans for:**
 - Thermal analysis (flight phase; ground phase already completed)
 - Trajectory and Separation
 - CCAM and EOLM
 - RF and EMC (reconfirm previous analyses)
 - LV configuration, with KASSAV-1 (independent LV position) & VIKI camera
- **AE drafted work package and held internal kickoff with ArianeGroup 10/21**
 - RAMF results planned for delivery to NASA L-6 months, review at L-5 months



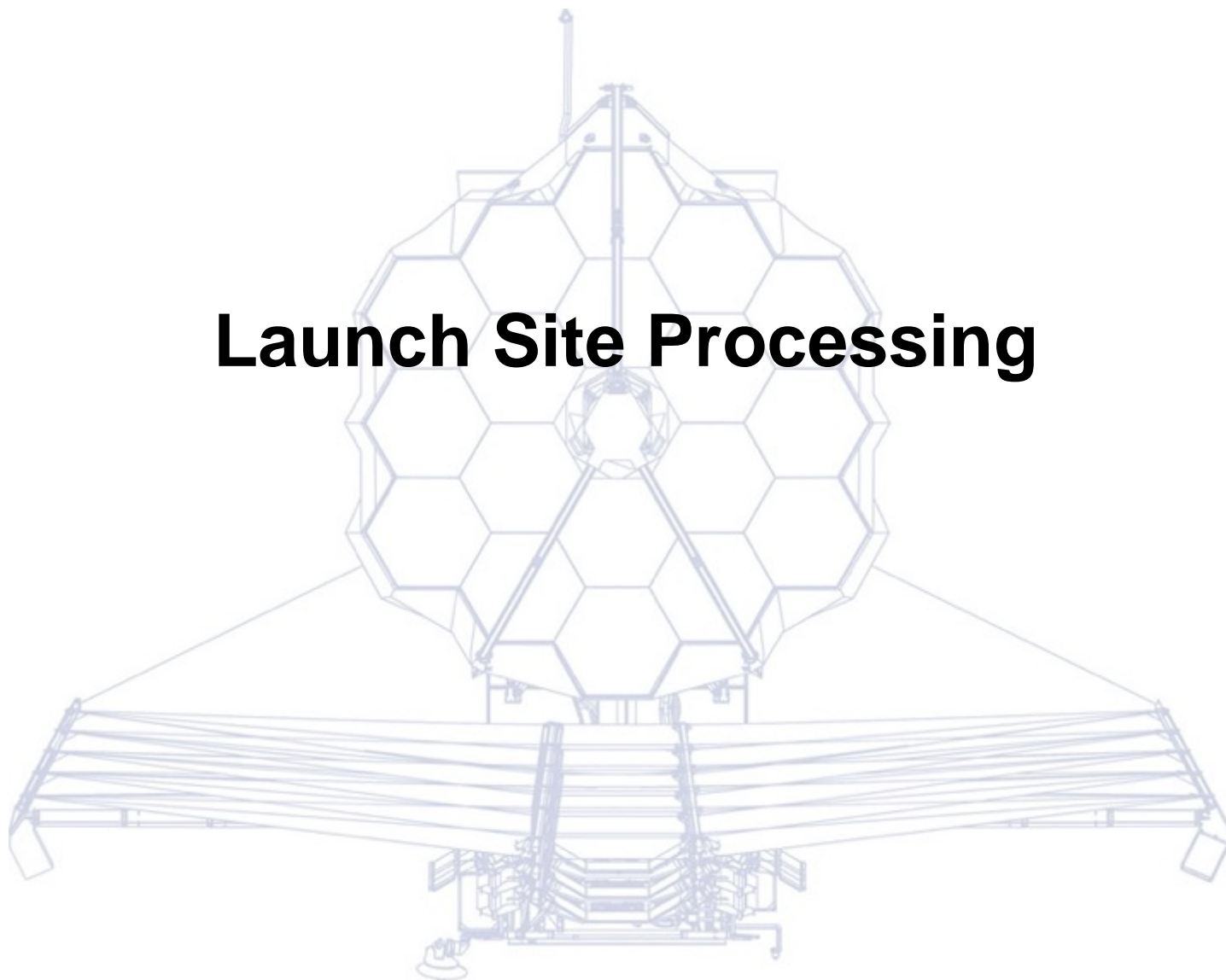
Launch Vehicle Progress July - October



- **JWST rocket hardware status:**
 - PLF in work at RUAG; completion of inspections by February 2021
 - ESC-A+ upper stage electrical integration began September 2020
 - Vulcain II cryo engine has been integrated to the main stage

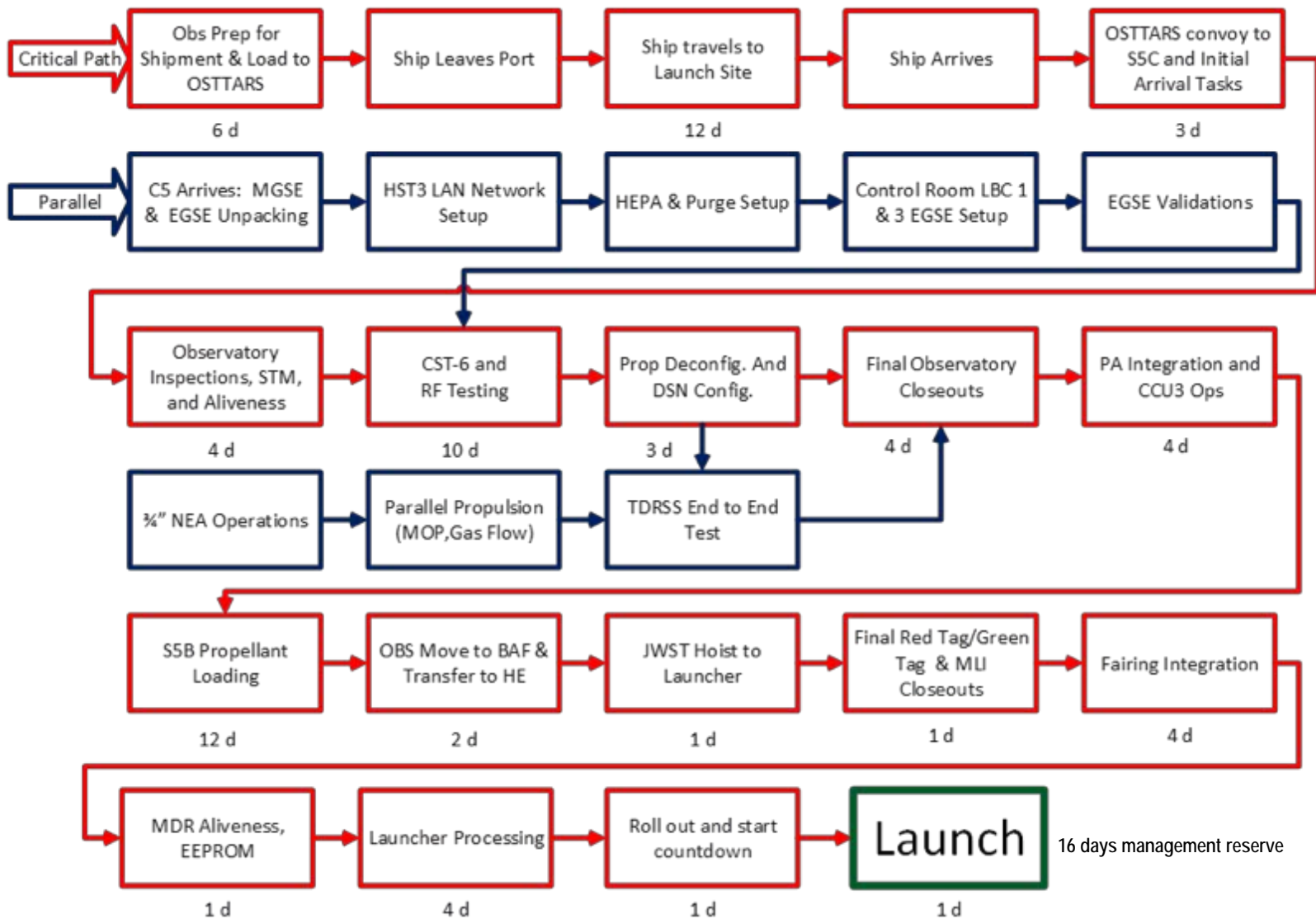
- **Delta-qualification of A5ECA+ completed by ArianeGroup (AG); internal System Qualification Review successfully completed July 2020 (ESA/AG/AE)**

Launch Site Processing





Launch Site Operations Overview



55 days total OBS processing at LS (includes weekends)
 28 days Processing S5C
 12 days Propellant Loading S5B
 15 days Integration to Launcher and Launch



Launch Site Planning Critical Milestones



- **March**

- ✓ HEPA Filters Received at Godard
- ✓ Import/Export Initial Review
- ✓ Launch Site BOE's delivered
- ✓ MN Contract Definitized

- **April**

- ✓ Engaged US Transportation Command on Route Assessment
- ✓ Finalized Master Equipment List
- ✓ HEPA Dolly Delivery to GSFC
- ✓ HEPA Performance Test Plan Complete
- ✓ Power Management Module (PMM) final check out at NGSS

- **May**

- ✓ HEPA Unit Systems Testing in B29
- ✓ Master Equipment List ITAR Classification

- **June**

- ✓ OSTTARS Proof Testing
- ✓ HEPA Unit S5B Configuration Complete
- ✓ Hot Flow procedures delivered to KSC

- **July**

- ✓ ¾ NEA reach and access verified at NGSS
- ✓ HEPA Testing completed in B9
- ✓ OSTTARS completed proof testing
- ✓ Submitted and approved work package to Center for access to begin packaging launch site equipment

- **August**

- ✓ OSTTARS racking study and shim prescription
- ✓ Update Contamination Predictions
- ✓ Completed Small Rack (NASA network rack)

- **September**

- ✓ PMM Final check out
- ✓ Complete Tall Rack (NASA Network)
- ✓ OSTTARS Pathfinder Ops-1x mass

- **October**

- ✓ OSSTARS road test
- ✓ Oxidizer and Fuel sampling system completed

- **November**

- Review US TRANSCOM recommendations
- OSTTARS delivery to NGSS
- Drape demo at TF-2 (VLS, drape, lift train)
- ITAR Equipment Import/Export Review

- **December**

- System Verification Networks (GSFC)
- MN Nantes Contract Signed

- **January**

- Package HEPA units/CC equipment
- Hot Flow Test at KSC
- Spare Procurement

- **February**

- Final procedures for propellant to AE
- Refurbish NGSS propellant cart (PCMU)
- Package all GSE at GSFC for shipment to LS
- NGSS perform MOP and Thruster Test

- **March**

- Ocean container's to NGSS
- LS Purge Review (configuration)

- **April**

- Ship to LS-HEPA, CC equipment, Tube Trailers, Propellant
- Observatory Transportation Plan Review



OSTTARS: (Observatory Space Telescope Transportation Air Road and Sea)



- ✓ Completed modifications to OSTTARS: new tombstone, spacers and tent frames
- ✓ Completed the fabrication and assembling
- ✓ Completed the proof testing
- ✓ Completed the distortion testing
- ✓ Defined shim prescription
- ✓ Completed 1x mass sim demo
- ✓ Completed the instrumentation
- ✓ Completed road testing
- Next - shipment to NGSS



Distortion and shim prescription tombstone



Proof testing tombstone, arms and HCROF



1x Mass simulator on tombstone on HCROF



Hoist 1x mass sim with tombstone/arms and tent to pallet



1x mass sim in OSTTARS



Launch Site HEPA Wall Completed



- Completed assembly of 6 HEPA filter dollies (2 units per dolly)
 - Each dolly is 18' high x 10' wide
- Contamination testing was performed in GSFC B29 high bay to confirm performance.
- CCE refined predicted fallout rates for contamination budgeting and EOL determination
 - ✓ **S5B Fallout Reduction:80%**
 - ✓ **S5C Fallout Reduction:93%**
 - ✓ **BAF Fallout Reduction:91%**
 - ✓ **ISO 7 air particle levels achievable around the JWST Observatory using the portable HEPA walls at launch site**
 - ✓ **Molecular contamination expected to meet or do better than 50 Å maximum accumulation**
 - ✓ **Particle fallout rates expected to meet maximum accumulation for the Secondary Mirror and Primary Mirror**
- Units will be packaged (heat shrink) at GSFC and stored in ocean containers until ready to ship to launch site
- No hearing protection is required (70db) OSHA requirement is 85db while in use at launch site

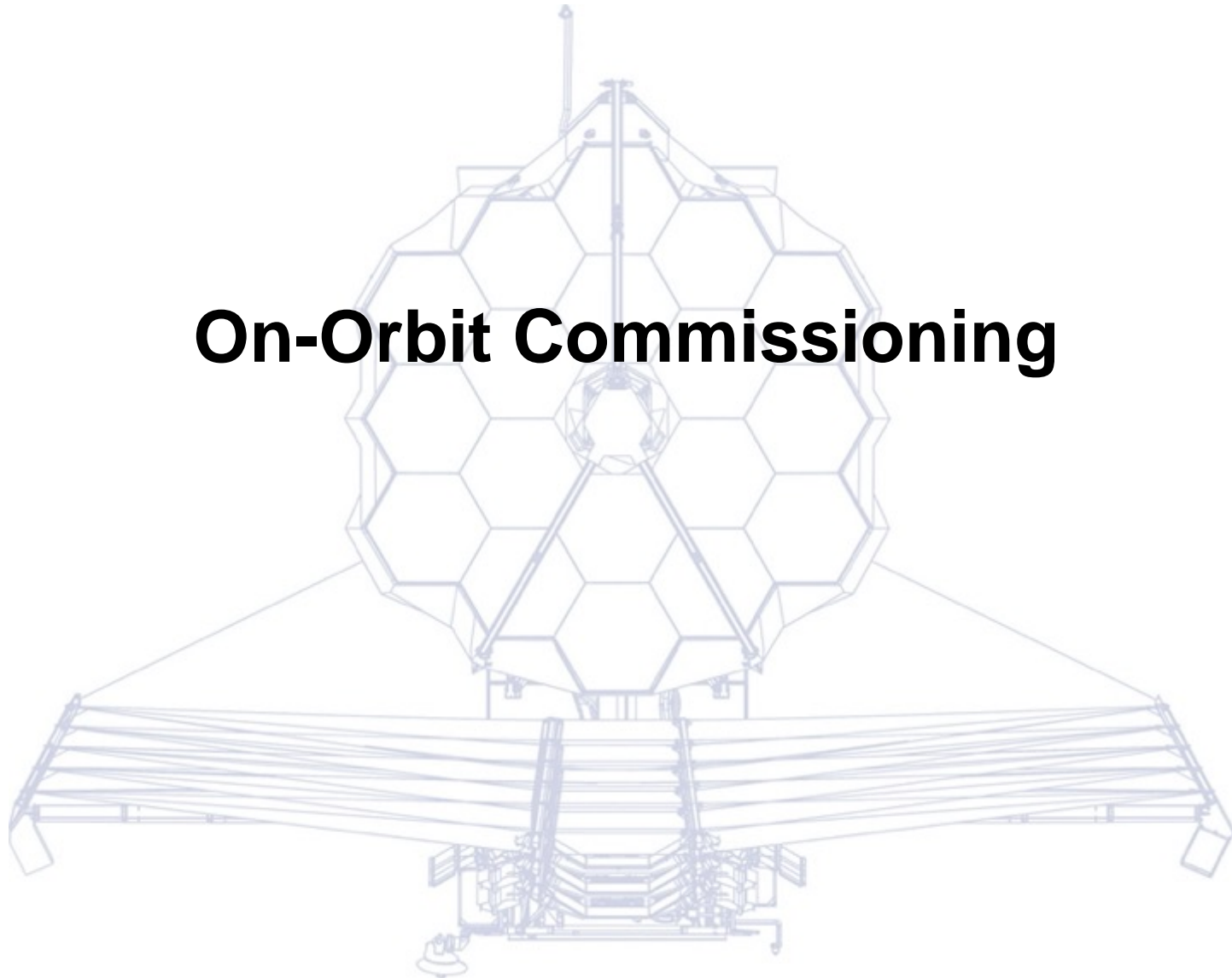


One side of HEPA filter wall (3 dollies 2 HEPA units per dolly)



Six HEPA Dolly Push-Push Configuration using RST mock-up

On-Orbit Commissioning



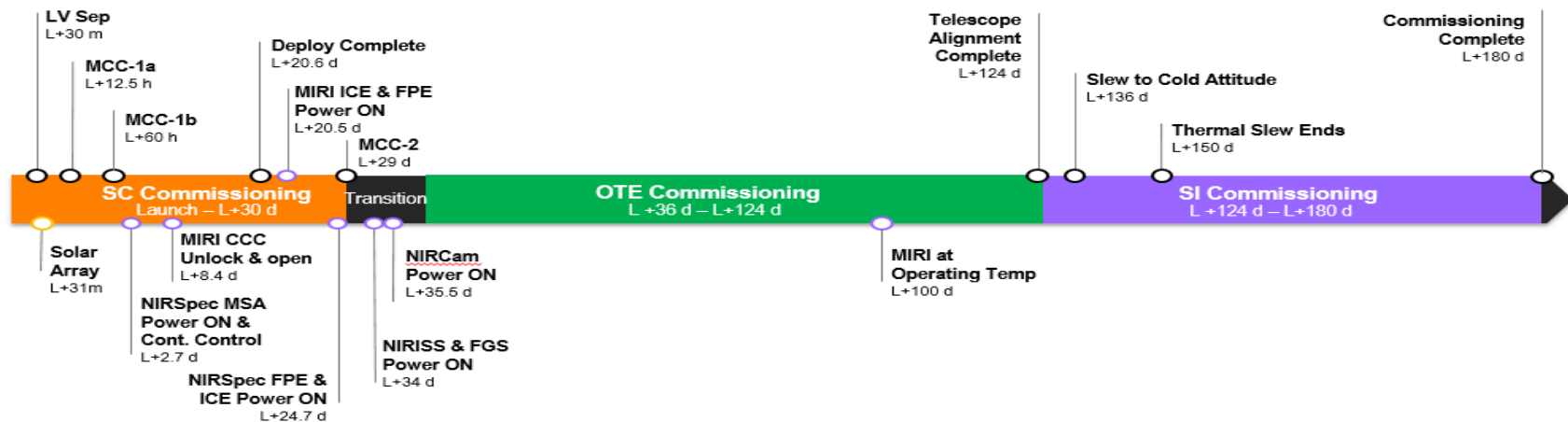


Commissioning Planning Status



● Commissioning Reviews

- Detailed audits and technical review of all Commissioning activities complete
 - April 20-23 – Spacecraft Commissioning (Launch and Ascent, Mid-Course Corrections, Spacecraft Subsystem Activation and Checkout)
 - April 28-30 – Wavefront Control/Line of Site (Attitude Control and Fine Guiding)
 - May 12-14 – ISIM Systems, Cooler, Cool-Down
 - September 1-2 – Deployments
- Commissioning Roll-up Summary Review complete
 - October 26-27
- Released L-1 Timeline
 - Incorporates all trades, risk reductions, and lessons learned from prior rehearsals

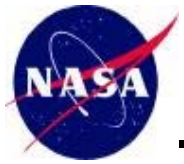




Commissioning Planning Status



- **All engineering trades complete and incorporated into timeline.**
- **Kicked off final deployment study related to audit actions.**
 - Refine on-orbit response to specific partially deployed solar array configurations
 - Assess and develop preferred partially deployed configuration for MCC2 burn.
 - Prior study in 2016 determined burn possible in all configurations.
 - Assess efficacy of twirl/shimmy on non-time critical deployment example (i.e. Sunshield UPS release), to assess analysis times and develop tools needed to support operational contingency decisions.
 - Investigating benefit/risk of earlier ADIR deployment
- **Remaining Work**
 - Complete final deployment contingency study
 - Support rehearsals
 - Closeout all audit actions
 - Complete and review all necessary documentation (contingency plans, launch commit criterial, early orbit mission rules)



TOP ISSUES

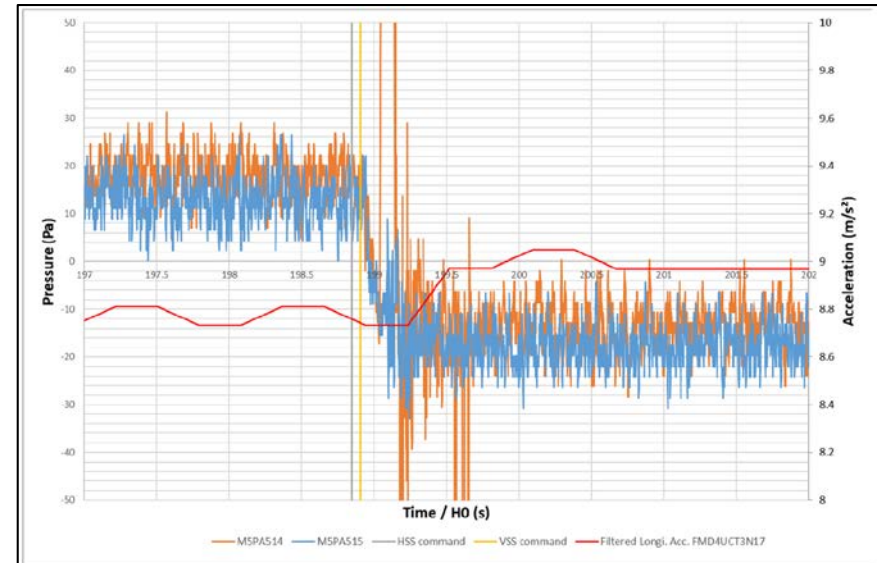


Fairing Depressurization Issue



- **Pressure data from Ariane Flight VA 253 (launched in July) showed a pressure drop at fairing jettison of 0.31 mBar, unfortunately higher than expected for this flight.**
 - Fairing had vents fully open and honeycomb was sealed
- **Analytical models correlated to previous flights predicted pressures below 0.20 mBar.**
 - These models assumed negligible contributions from the payload and from a fully sealed fairing honeycomb.
- **The Project initiated efforts to determine if the observatory could tolerate pressure drops of 2X previous requirement of 0.18 mBar or higher, and if not make appropriate modifications**
 - Primary areas of interest were the Sunshield Membrane Release Devices (MRDs) and membranes.
- **Analysis is currently on going (to be concluded this month)**
 - A number of MRDs may need to be replaced with stronger material (new MRDs already being manufactured)
 - Some locations on the SS will require “doublers” to be installed

Pressure Data at Fairing Jettison from Flight VA 253





Fastener Torque Issue



- **Based on issues encountered on other NGAS programs where fastener “run in torque” (RIT) was specified and not recorded, NGAS conducted a reach audit for JWST. This resulted in an explicit change in process that requires the measurement of run in and final torque which took effect in Oct 2018.**
 - JWST has many fasteners with callouts on their drawing specifying applied torque over RIT: “torque to XX above run-in torque”
- **Fasteners torqued prior to Oct. 2018 were evaluated assuming values for running torque determined by lot sample averages for given fastener types vs measuring each specific fastener.**
- **NGAS audited all fasteners with RIT requirements installed prior to Oct. 2018 and GSFC has been performing an independent cross-check audit**



Fastener Torque Audits



● **NGSS Audit Summary**

- Completed Top-Down Audit
 - 12,321 Fasteners with Over Running Torque Requirements
 - Pre-Environments
 - » 454 fasteners were re-torqued
 - Post Environments (these were fasteners which were determined safe to defer until after environments)
 - » 160 found to require re-torque
 - Alignment Exoneration Complete - no recommended rework or measurements above baseline plan
 - Deployment Exoneration Complete – no additional work identified

● **NASA Independent Audit Summary**

- The team identified and assessed individual run-in-torque items for their risks to flight performance.
 - 95% of these have been successfully exonerated as good for flight.
 - Risks of the remaining 5% can be mitigated by burn-down steps recommended by the GSFC Team.
 - Burndowns cover: Improved documentation, additional inspections, gap checks, additional alignment measurements, refined analyses, review of deployment test data, review of post deployment test alignments data, potential retorques
- Recommendations and burndowns will be implemented and completed before observatory final stow.



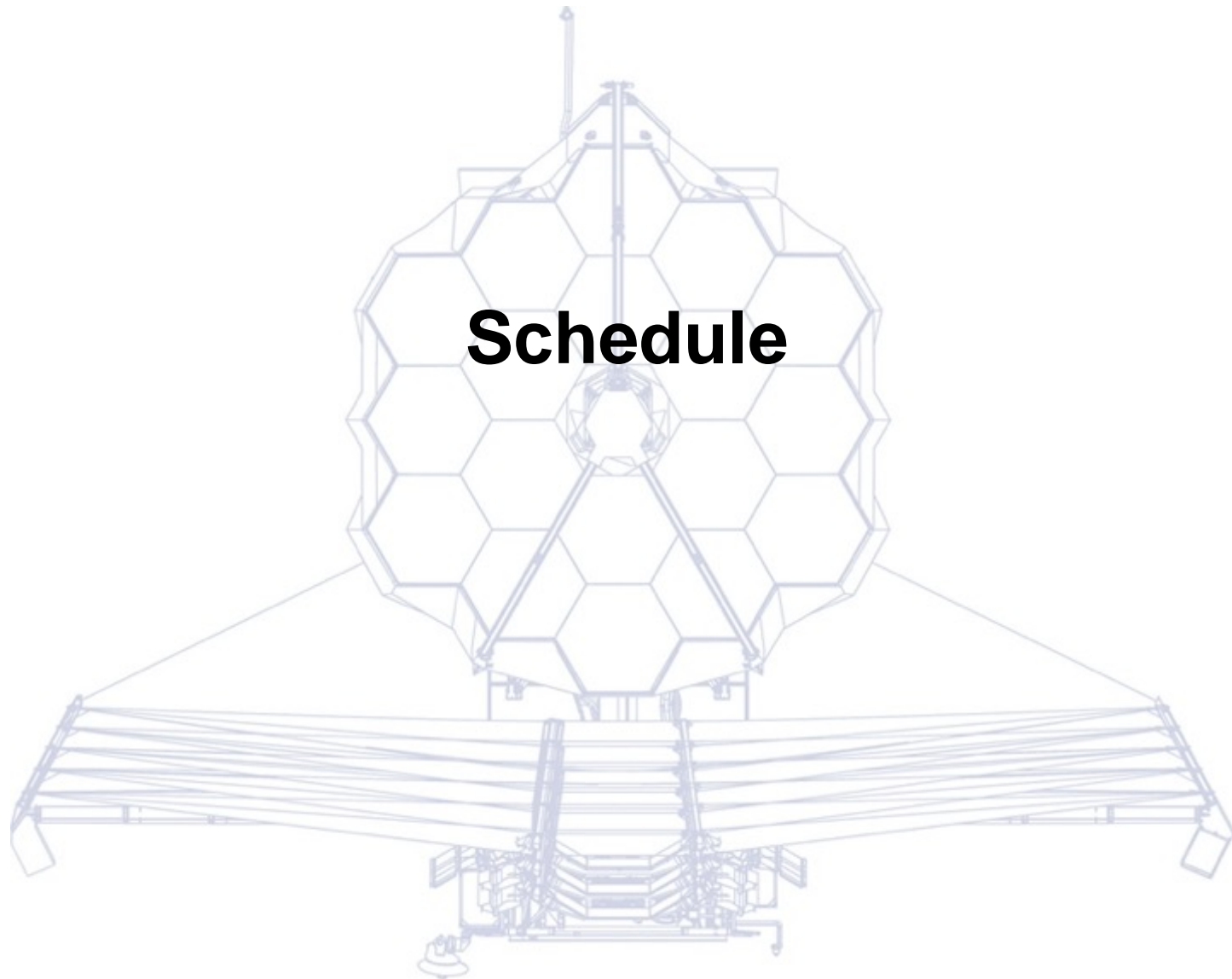
K-Band Power Loss Issue



- **RF output power measurements taken after June 2020, have consistently shown a power decrease between 0.45 dB (10% loss) and ~1.00 dB (20% loss).**

- **NG opened a Failure Review Board to address the issue**
 - NG independent review believes 0.8 dB is more likely to be attributed to calibration equipment due to the large losses and calibrating at much lower power levels than expected
 - Finding 0.8 dB of additional loss in the flight path would indicate a large increase of loss in the flight path. However, finding 0.8 dB of additional loss in the test path would indicate a small increase of loss in the test path.

- **NASA Independent Conclusions on Ka-Band Power Loss**
 - Based on time domain reflectometry (TDR) measurements to detect the location of faults in transmission, it is unlikely that a problem exists in the flight network.
 - This would imply a gross waveguide misalignment or obstruction and would likely show a signature on the TDR results.
 - NASA believes the more likely cause lies in the electrical ground support equipment (EGSE) waveguide and or cables.
 - NASA has called for additional investigations to further isolate the issue to the EGES and are currently being implemented



Schedule

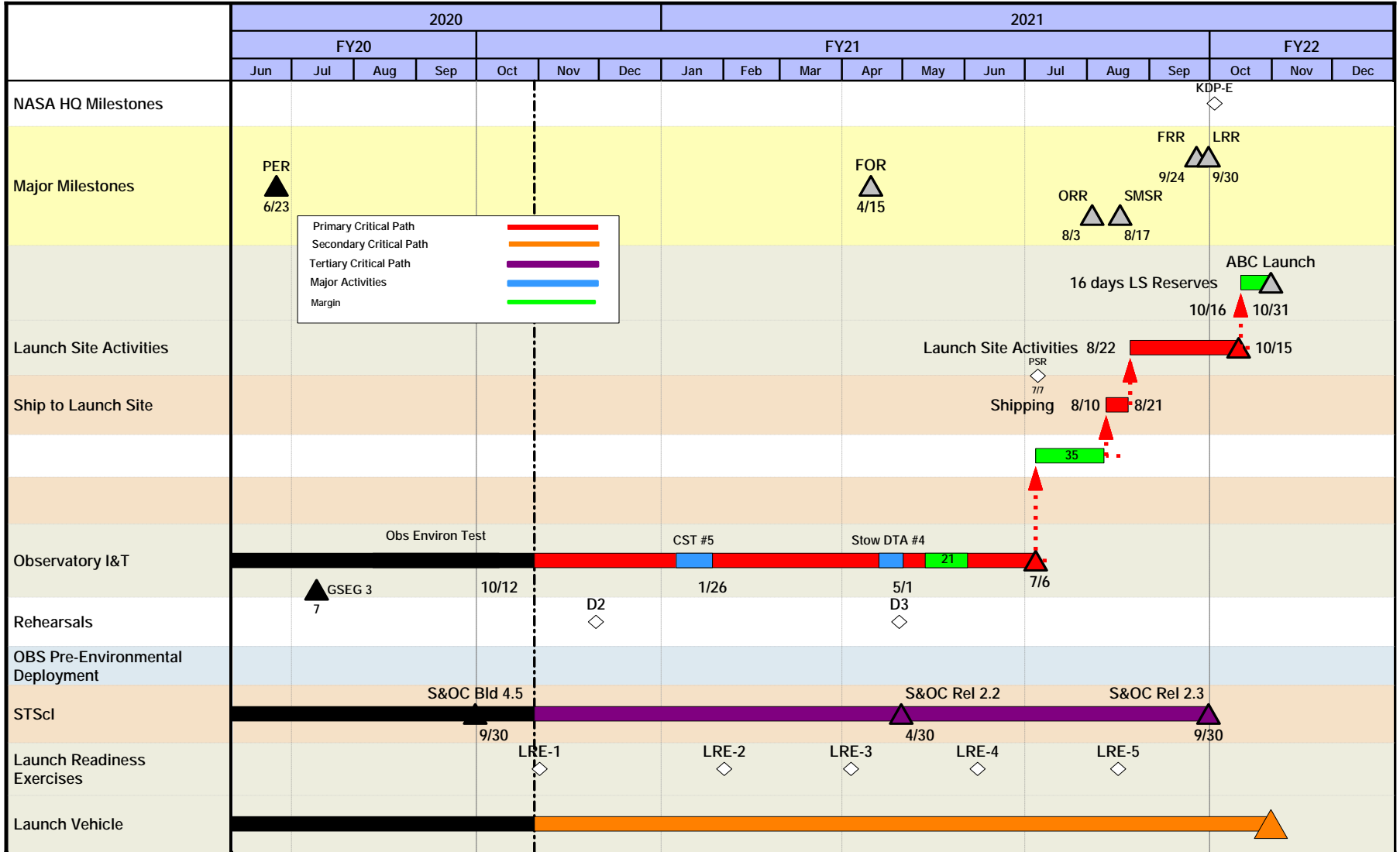


Schedule Reserve Status



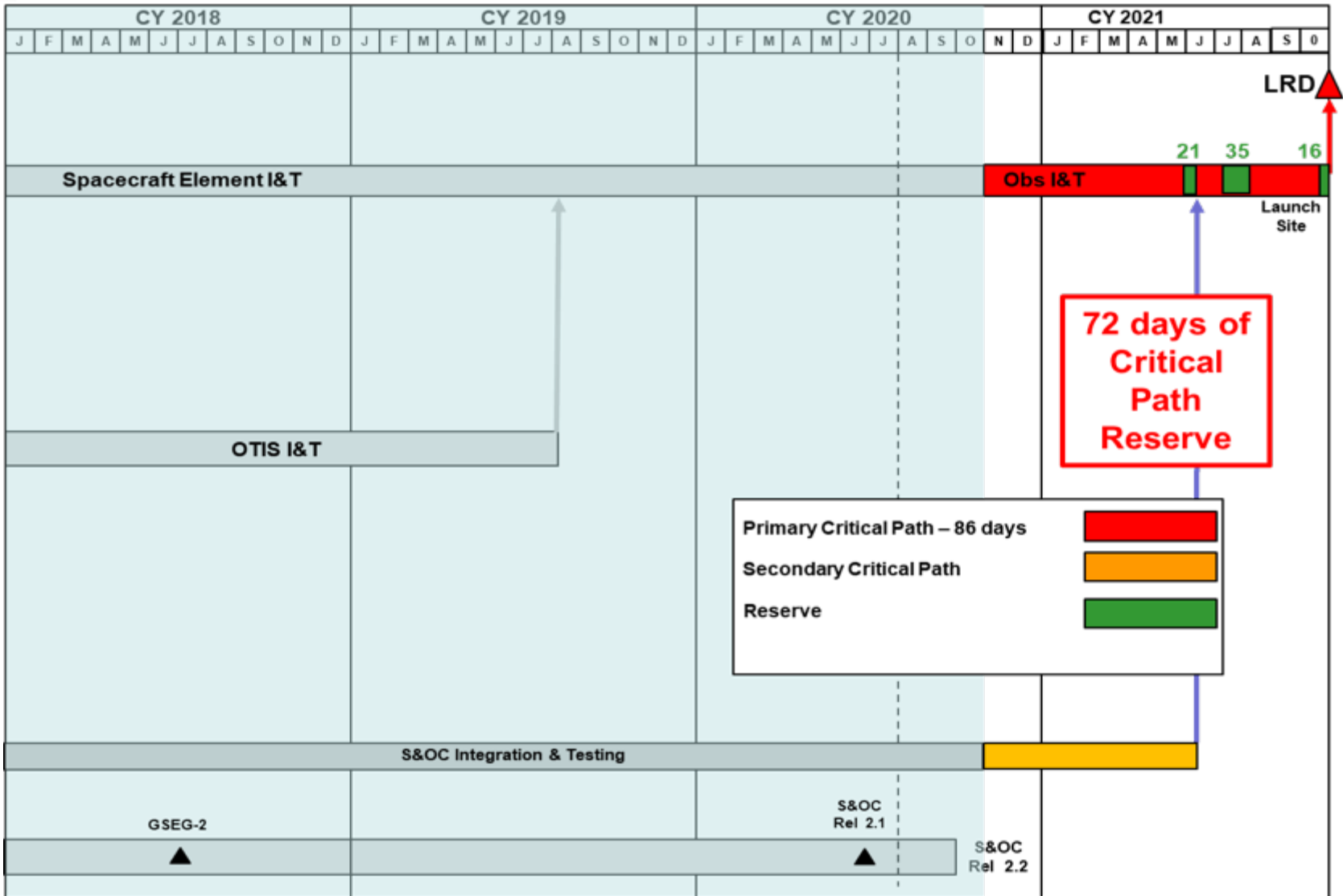
- **70 days of schedule reserve to ship at beginning of replan**
 - 14 Days of reserve dedicated to Environmental Testing were encumbered
 - Actualized Vibe testing delays (10d)
 - Grounding issue investigation
 - Contamination 'spike' investigation
 - Test set issue (Telemetry issue)
 - Additional Z-axis vibe run
 - Z-axis to X-axis configuration took longer than planned
 - Getting back to Integration Stand (4d)
 - Ka-Band Power (ARB investigation)
 - J2 Panel Alignments (ARB investigation)
 - Reaming APCO adapter bolt holes
 - Strain gauge investigation
 - Working Single Swim Lane (Environments) Did Not Allow For Re-Sequencing Optimization
- **56 days of reserve to ship remain unencumbered**
- **Schedule Liens (future work approved but still looking at ways to reduce impact)**
 - 13 Days Future Work
 - Re-Torques for ORIT (3d currently, originally 20d then 5d)
 - Battery Diode Module installation (4d)
 - ESD discovery that had reach across to battery umbilical discovered post schedule risk assessment
 - Sunshield tear mitigations (6d)
- **Schedule threats (potential future work not approved, working to mitigate/eliminate)**
 - Preemptive SS Patches
 - Fairing Depress SS Doublers

JWST MASTER SCHEDULE



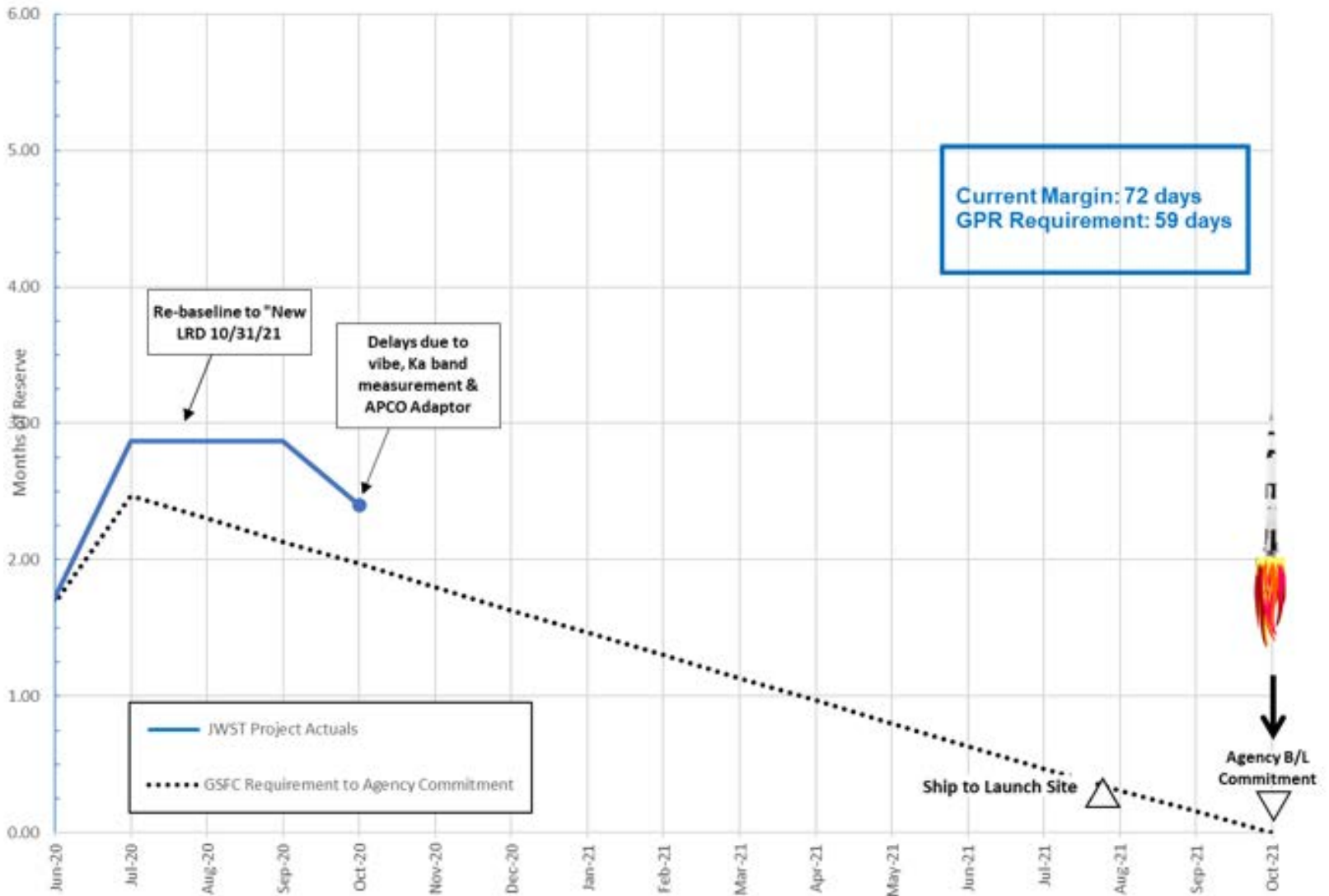


JWST Schedule





JWST Schedule Reserve Burndown





Conclusion



**JWST made excellent progress in spite of impacts
from COVID-19**

JWST Is On Track For October 2021 Launch!