JWST Update

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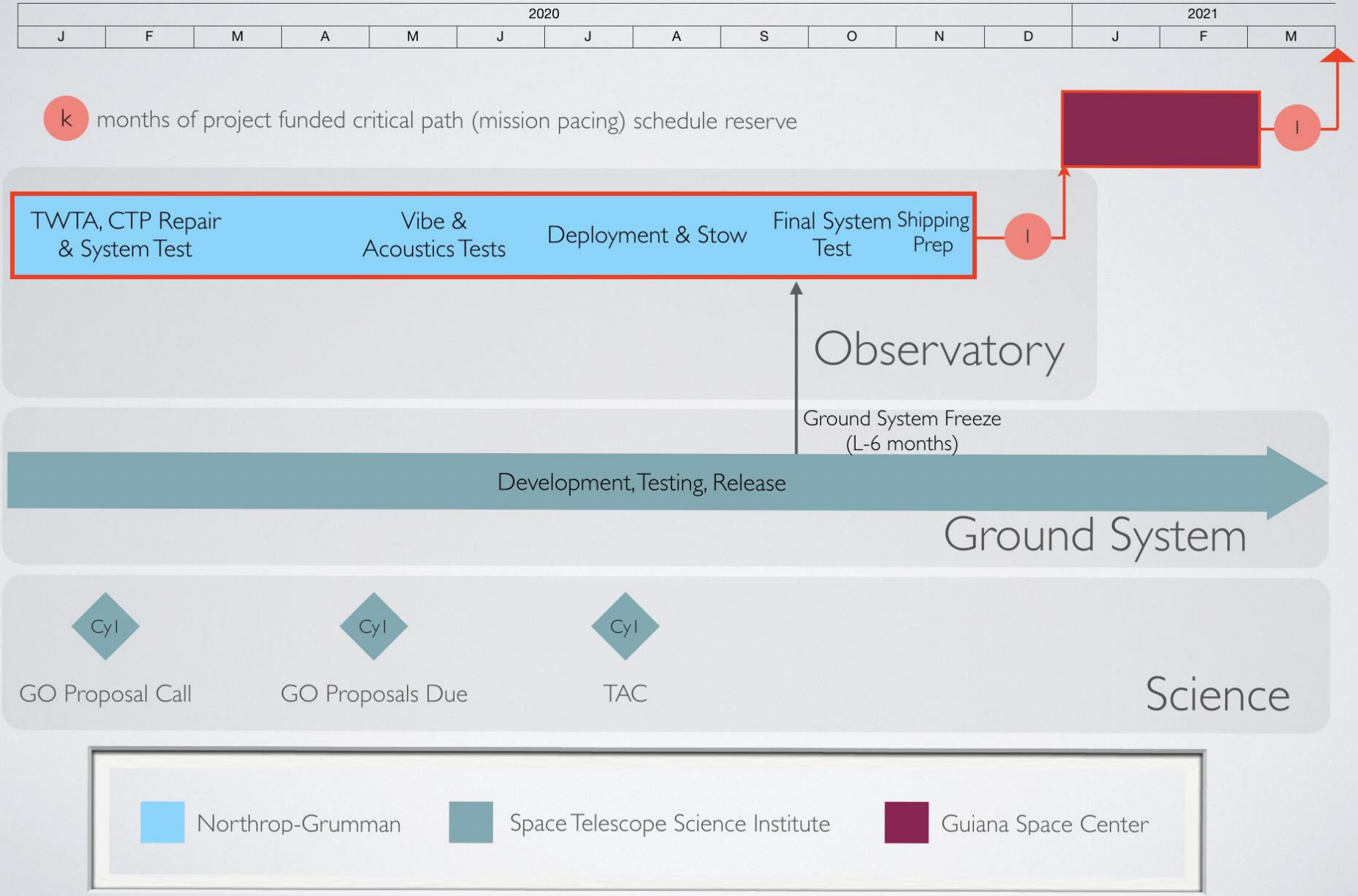
RECENT UPDATES

- Programmatic
  - Agency Program Management Council (APMC) approved Webb to enter phase D (integration and test).
  - Annual GAO audit received. No recommendations. New audit expected to start later this Spring
  - Currently working to March 31, 2021 LRD. Schedule will be assessed in mid-May, prior to entry into Observatory Environments testing
- Observatory
  - Successfully completed post Spacecraft Element testing and repairs
- Science and Operations
  - Ground segment testing and operations rehearsals continuing (e.g., science operations, contingencies, launch and deployments)
  - All Software elements at better than 98% requirements delivered to-date
  - Call for Cycle 1 General Observers released 23-January-2020

SIMPLIFIED SCHEDULE

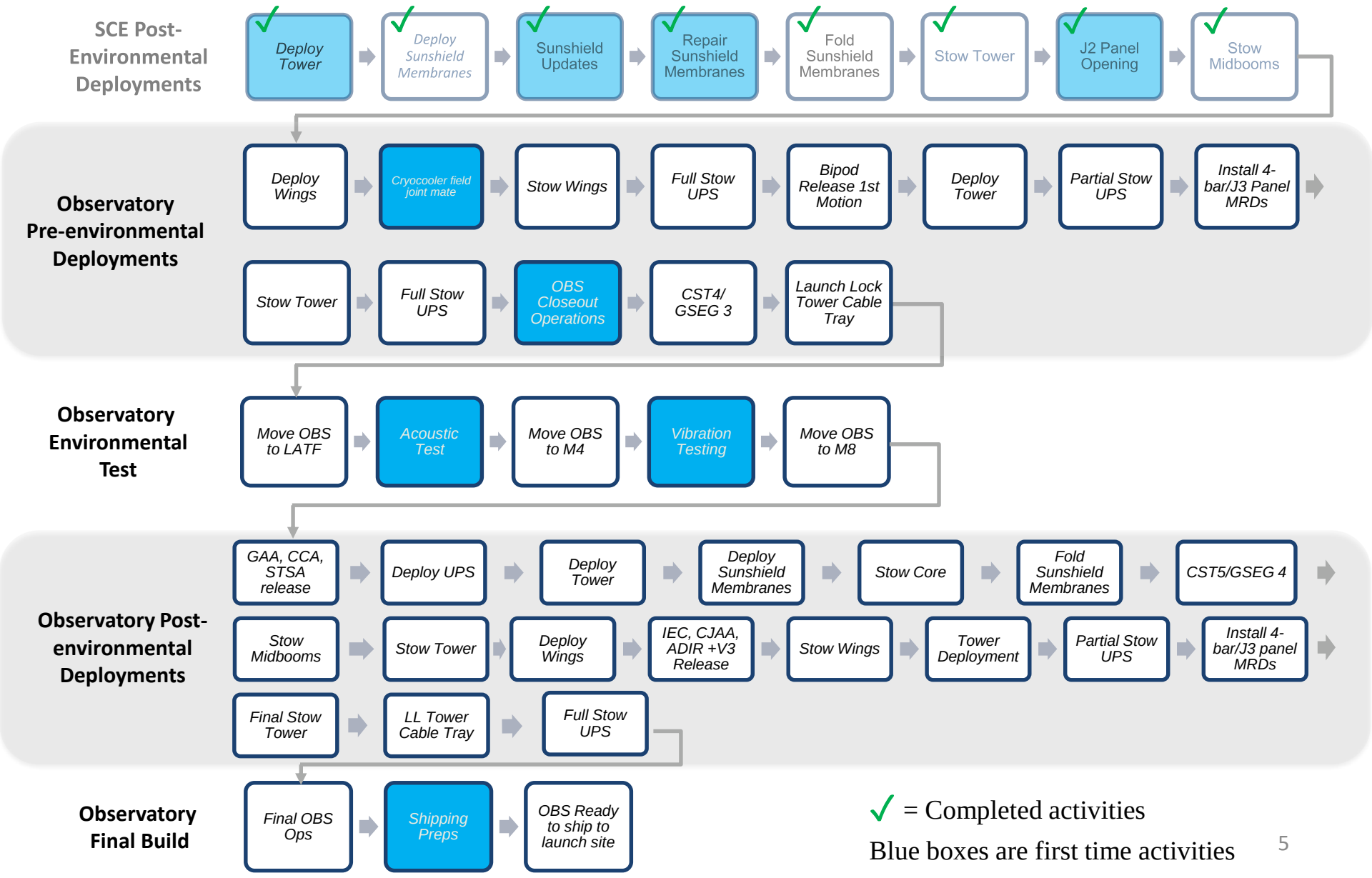


Fiscal Year 2020 JWST HQ Milestones

Month		Milestone	FY2019 Deferral	Comment
Oct-19	1	Spacecraft Element level post-environment deployments complete	•	Completed 10/9/19
Nov-19	2	Flight Software build 3.4 delivered		Completed 8/30/19
	3	Data Management Subsystem build 7.4 delivered		Completed 11/25/19
Dec-19	4	Replacement traveling wave tunable amplifiers (TWTAs) delivered		Completed 11/22/19
Jan-20	5	Spacecraft Element level Sunshield post-environment folding complete	•	Completed 1/22/20
	6	Deployable Tower Assembly deployment #1 complete		Completed 1/28/20
Feb-20	7	Flight coupled loads analysis #2 delivered	•	Completed 2/28/20
	8	Command/Telemetry Processor (CTP) replacement delivered		Completed 1/13/20
Mar-20	9	Replacement CTP & TWTA installed into Spacecraft		Completed 2/24/20
	10	Conduct fourth early commissioning exercise		Completed 2/12/20
Apr-20	11	Deliver Science and Operations Center release 2.1		
May-20	12	Comprehensive System Test #4 readiness review complete		
	13	Full Observatory level acoustics testing complete		
Jun-20	14	Full Observatory level vibration testing complete		
Jul-20	15	Telescope primary mirror wing deployment complete		
Aug-20	16	Final Sunshield membrane tensioning complete		
	17	Evaluation of Cycle 1 General Observers proposals (by Time Allocation Committee)		
Sep-20				

Blue font(underline) denotes milestones accomplished ahead of schedule, orange font denotes milestones accomplished late.

Remaining I&T Activities



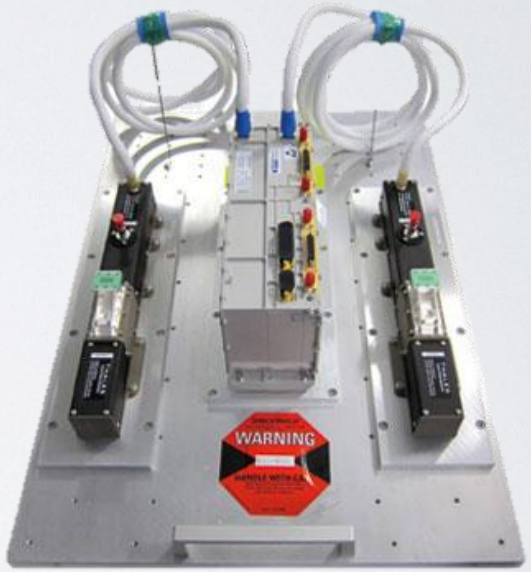
✓ = Completed activities

Blue boxes are first time activities

TECHNICAL ISSUES STATUS

TRAVELING WAVE TUNABLE AMPLIFIER (TWTA)

- Status:
  - During pre-thermal vac ‘on the lid’ testing (Mar ‘19), TWTA-1 unexpectedly powered off after having been operational for hours
  - Decision: procure two new TWTAs from vendor
  - Installation and preliminary testing successfully completed by 24-Feb (on schedule)
  - Unit will be fully tested via the upcoming Comprehensive System Test in late April 2020
  - TWTA-1 unit returned to vendor. People traveling to vendor this week do conduct tests to determine root cause. Results anticipated by end March 2020.



Two TWTAs

Blue underlined text indicates changes from last meeting

CTP REPLACEMENT

- Status:
  - During System Level tests in Dec ’18 through Apr ‘19, Command and Telemetry Process number 2 (CTP-2) exhibited multiple unplanned power-off events. CTP was fully operational prior to the tests. No failures occurred since 24-April-2019.
  - Decision: upgrade an engineering unit to flight specifications and install it
  - Installation and preliminary testing successfully completed by 24-Feb (on schedule)
  - Unit will be fully tested via the upcoming Comprehensive System Test in late April 2020
  - CTP-2 unit undergoing study at Northrop to determine cause for earlier events. Study results anticipated by end-March 2020.

JWST CTP

Blue underlined text indicates changes from last meeting

FAIRING DEPRESSURIZATION

- Issue: Residual air trapped in folded sunshield membrane may cause an over-stress condition at the time of fairing separation due to the residual pressure ($\Delta pressure \leq 90$ pascals, capability 18 pascals).
- Actions:
  - More sensitive pressure transducers flown on three Ariane 5 flights confirm that there is residual pressure within the faring that exceeds the capabilities (measured values ~ 55 pascals).
  - Passive open-vents first flight 18-Feb measured value ~32 pascals (~65 deg opening)
  - Second flight (June) with passive vents will include 1] the new vents (opened to the full 80 deg) and 2] a sealed fairing to trap

Fairing Vent

Blue underlined text indicates changes from last meeting

MEMBRANE RELEASE DEVICES MRD) & NON-EXPLOSIVE ACTUATORS (NEA)

- MRD
  - Evaluation of simultaneous ascent (mechanical, acoustic) and pressure loads show negative margins on some highly-loaded MRDs
  - Will require additional MRD unit proof load tests
  - Building new parts from stronger materials for change out as required
  - Built 5 new MRDs with new material. Three will be installed for Observatory environments (May, June), 2 will be going through a series of offline tests. Existing MRDs will be going through additional tests as well and may meet load requirements.
- NEA
  - The NEA for one sunshield MRD failed to release when actuated using the redundant side only electrical signal.
  - The NEA fired correctly when signaled on the primary side.
  - The anomaly has been localized to the NEA portion of this actuator
  - MRD testing showed release margins on the redundant side were insufficient. Project moving forward with 1) changing wire diameter to increase pull out force and 2) better geometric tolerance controls and inspections.

STSCI EXERCISES AND REHEARSALS

PREPARING FOR OPERATIONS

- STScI conducted 9 launch and commissioning rehearsals in 2019
- In 2020 a similar number will be conducted of increasing fidelity to the actual launch and commissioning timelines.
- MOC hardware being updated this Spring roughly one year before launch.
- Cycle 1 proposals due 1-May-2020
  - Experience from last call indicates that people did not allow enough time to familiarize themselves with Webb proposal tools – start earlier!

STSCI SOFTWARE STATUS

S&OC & Subsystem Status						
Subsystem	Build	Development Completion Date	I&T Completion Date	Status	% of Requirements Delivered to Date	% of Requirements Verified to Date
Data Management Subsystem (DMS)	7.3.2	10/08/19	11/25/19	Completed I&T	100%	98%
	7.4	11/25/19	February 2020	In Test		
	7.5	June 2020	September 2020	In Development		
Proposal Planning Subsystem (PPS)	14.8	9/12/19	12/27/19	In Test	100%	97%
	14.9	12/12/19	March 2020	In Test		
	14.10	March 2020	June 2020	In Development		
Wavefront Sensing & Control (WFS&C) Software Subsystem	6.3	10/31/19	12/30/19	In Test	100% (MMS update)	98%
	6.3.1	11/19/19	12/30/19	In Test		
Flight Operations Subsystem (FOS)	6.4	8/16/19	11/5/19	In Test	98%	89%
	6.4.1	February 2020	March 2020	In Test		
	6.5	June 2020	August 2020	Planning		
Operations Scripts Subsystem (OSS)	8.1	8/7/19	11/12/19	Completed I&T	99% (Level 1)	90%/63% (Level 2/Level 3)
	8.2	12/31/19	March 2020	In Test		
Project Reference Database Subsystem (PRDS)	4.16	11/27/17	12/11/17	Sustaining Engineering Release	100%	100%
	4.17	February 2020	February 2020			
S&OC Builds	4.3	6/7/19	7/30/19	Completed I&T	88%	86%
	R2.1		April 2020	Planning		

SNAPSHOT OF SELECT LAUNCH ACTIVITIES

SEGMENTED JWST SHIPPING

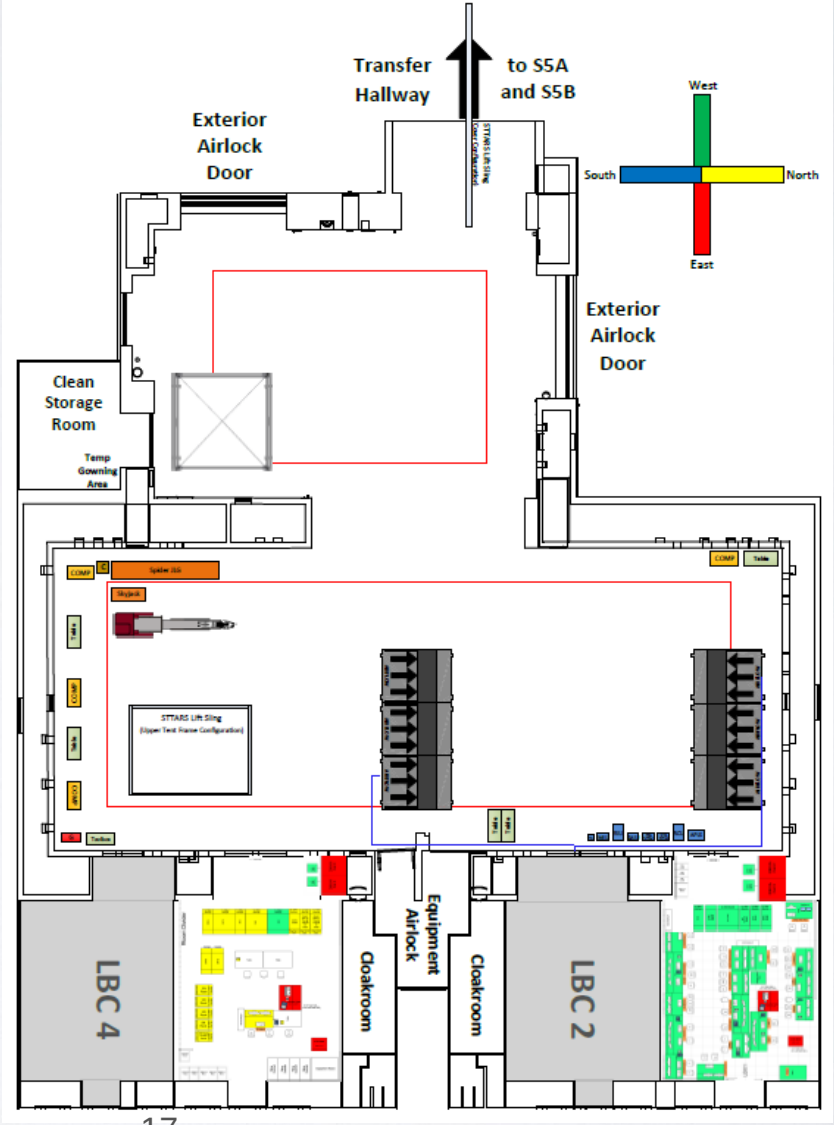
- Chartered ocean vessel (Maritime Nantaise Colibri) – Port of Long Beach to Kourou seaport (12-day trip)
  - JWST Observatory in STTARS, oversized Mechanical Ground Support Equipment (MGSE) on trailers, Ground Support Equipment (GSE) packaged in sea containers, 3 purge tube trailers.
- Chartered air flight (US Air Force C5M Galaxy) – LAX to Cayenne airport.
  - Electrical GSE (EGSE) and select MGSE
- Ocean freight shipped in advance – Baltimore port to Cayenne sea port.
  - HEPA filters, Halo/VLS, Contamination Control equipment, toolboxes, networking equipment in sea containers; 4 Purge Tube trailers.

- HAZMAT (propellant) ocean freight shipped in advance – Fort Lauderdale, FL to Cayenne
- Common carrier shipper (DHL) – any local facility to Arianespace
  - Miscellaneous shipments (small packages, emergency equipment)

S5 COMPLEX AT CSG

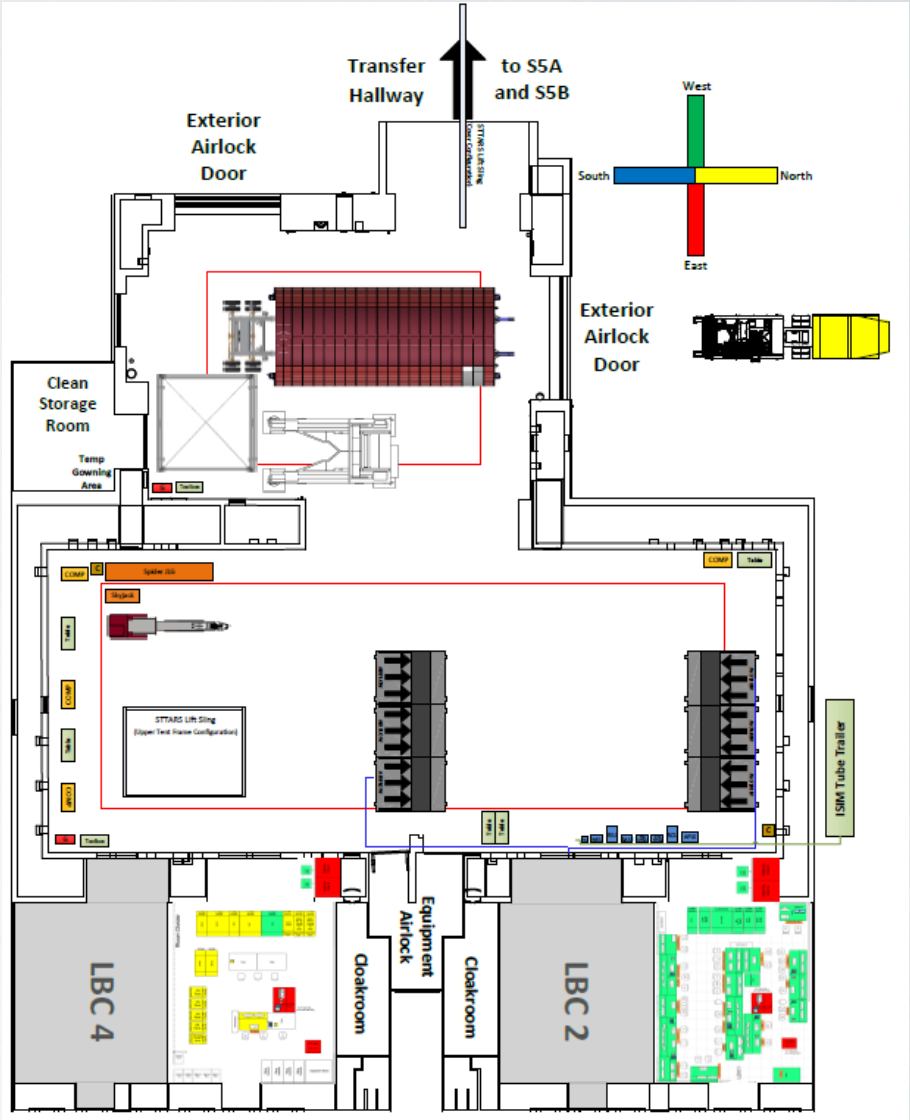
PRE-SHIP ARRIVAL HIGHBAY (L-72 DAYS TO L-66 DAYS)

- AE and NASA certify S5 cleanroom and airlock as per CCIP/SPORT
- Set up HEPA Units in S5 Cleanroom
- Set up Contamination Control measuring equipment
- Pre-stage Scissor lifts, manlifts, lift slings, toolboxes, purge units, etc.
- Run power lines in LBC
- EGSE arrives begin to set up in LBC



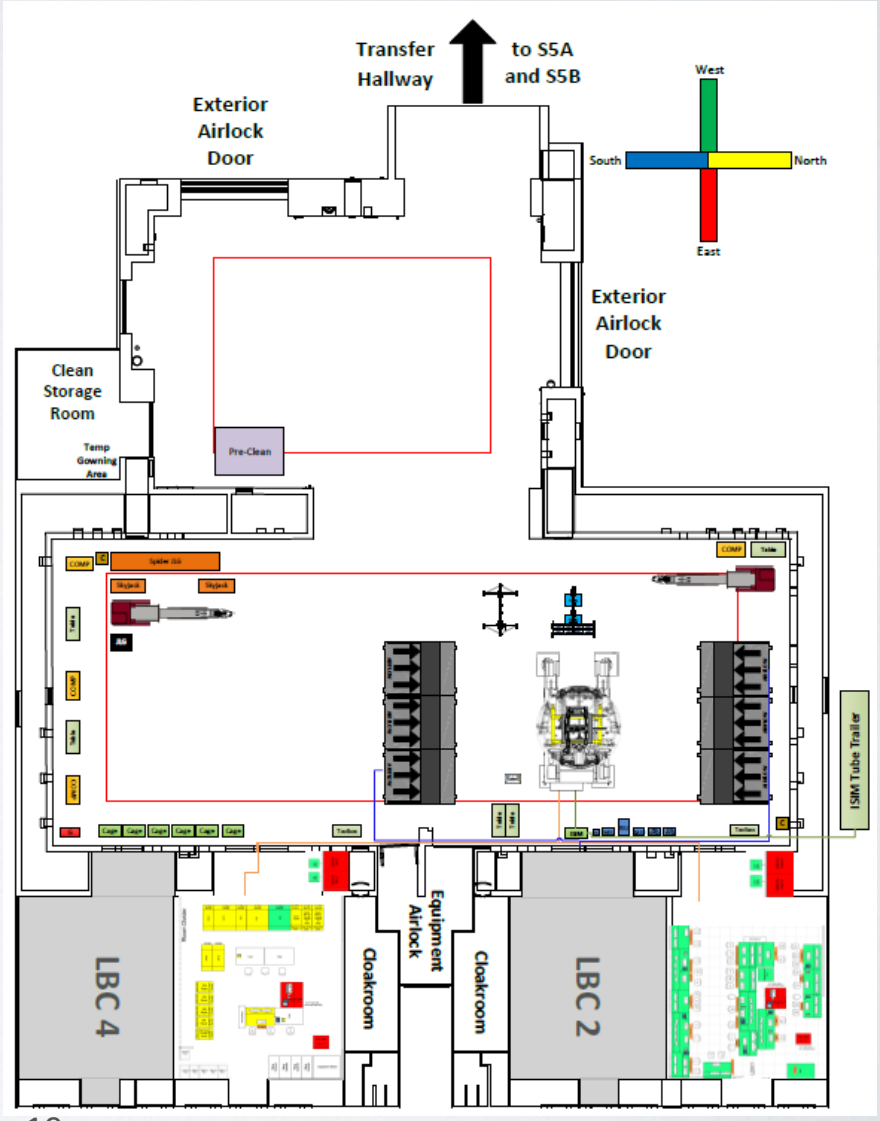
STTARS ARRIVAL (L-66 DAYS)

- STTARS arrives outside the airlock
- Outside of the airlock remove the rear bogie and install the rear steerable
- Open airlock door and reverse into airlock
- Detach front truck and drive it out of the airlock
- Close airlock door
- Precision cleaning and blacklight inspection

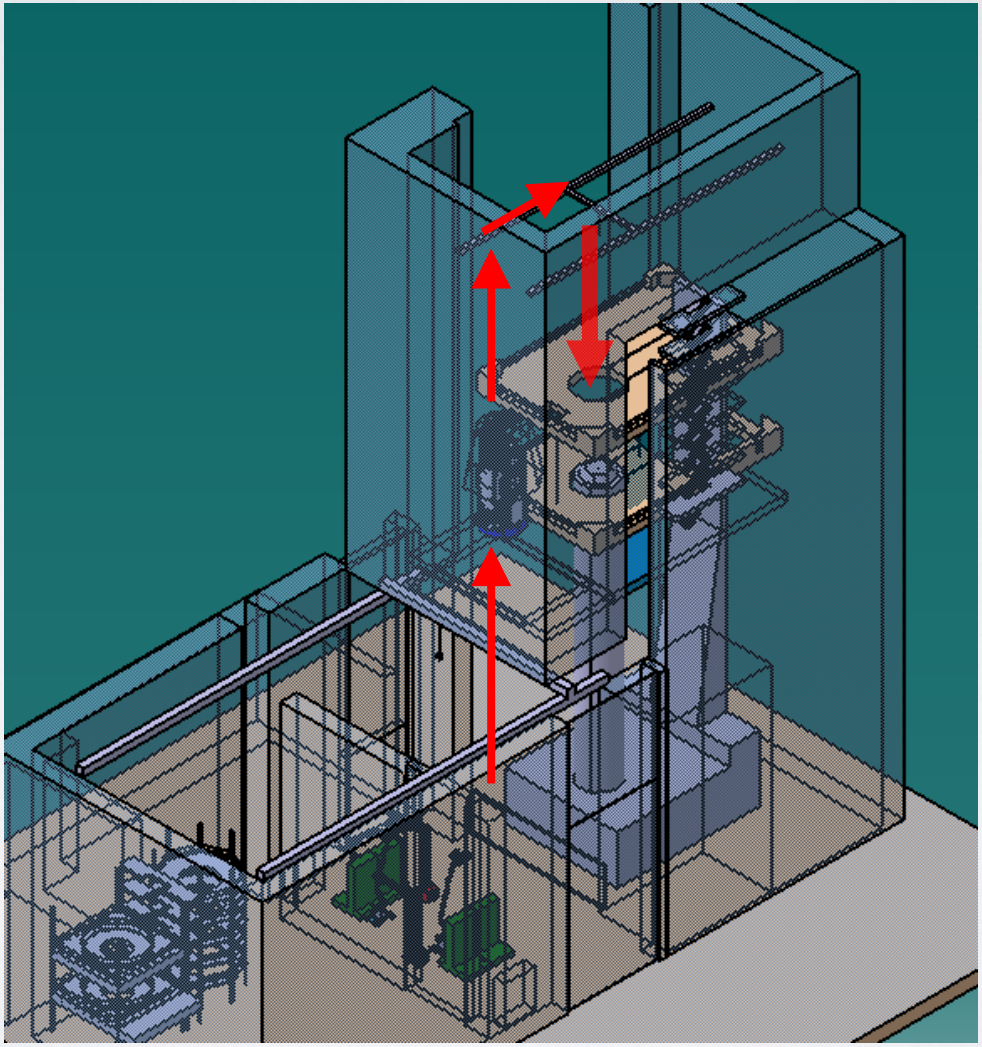


NEA INSTALLATION & POST-SHIP FUNCTIONAL (L-60 DAYS TO L-51 DAYS)

- Perform Post-ship functional testing
- MLI closeouts from transportation accel removal
- NEA Operations
  - Rotate observatory on HCROF
  - Remove solar array and reconfigure MLI
  - Rotate observatory on HCROF for NEA access
  - Install ¾” NEA’s

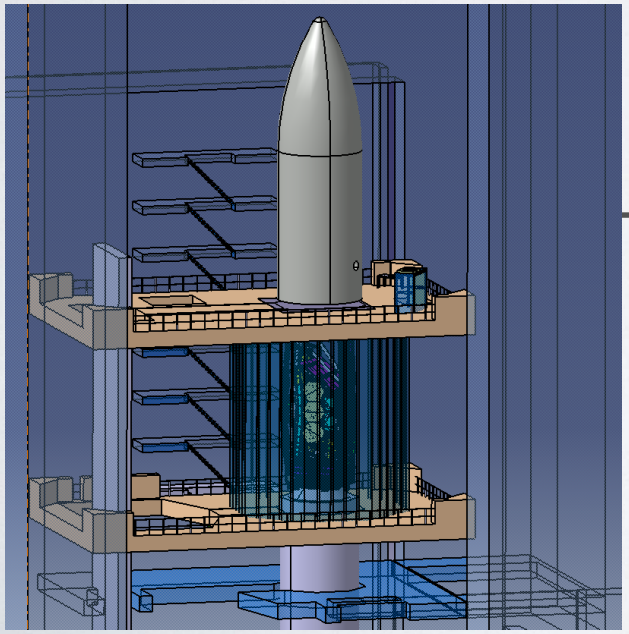


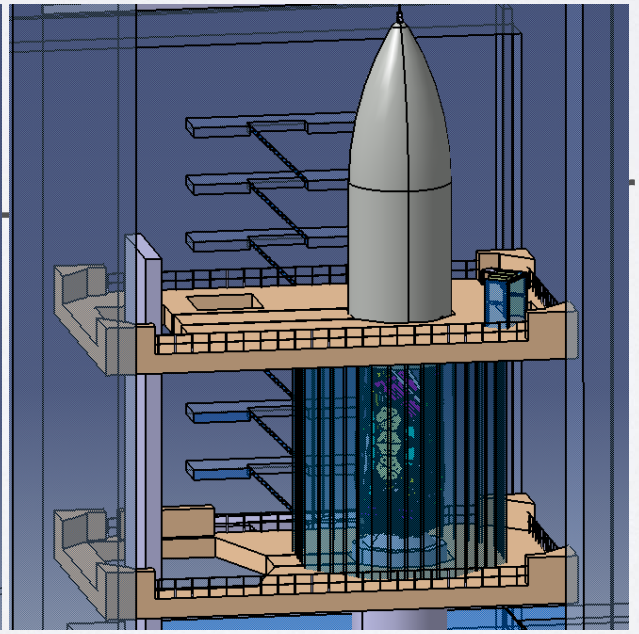
D-9: HOIST OBSERVATORY ONTO LAUNCH VEHICLE

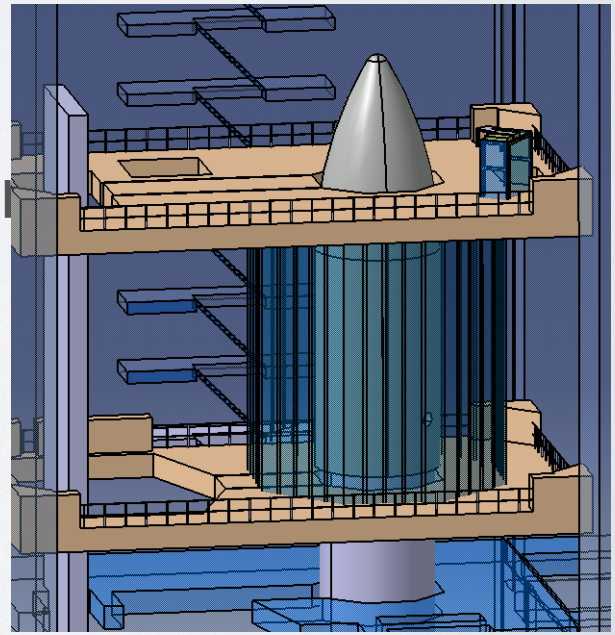


D-6: ENCAPSULATION

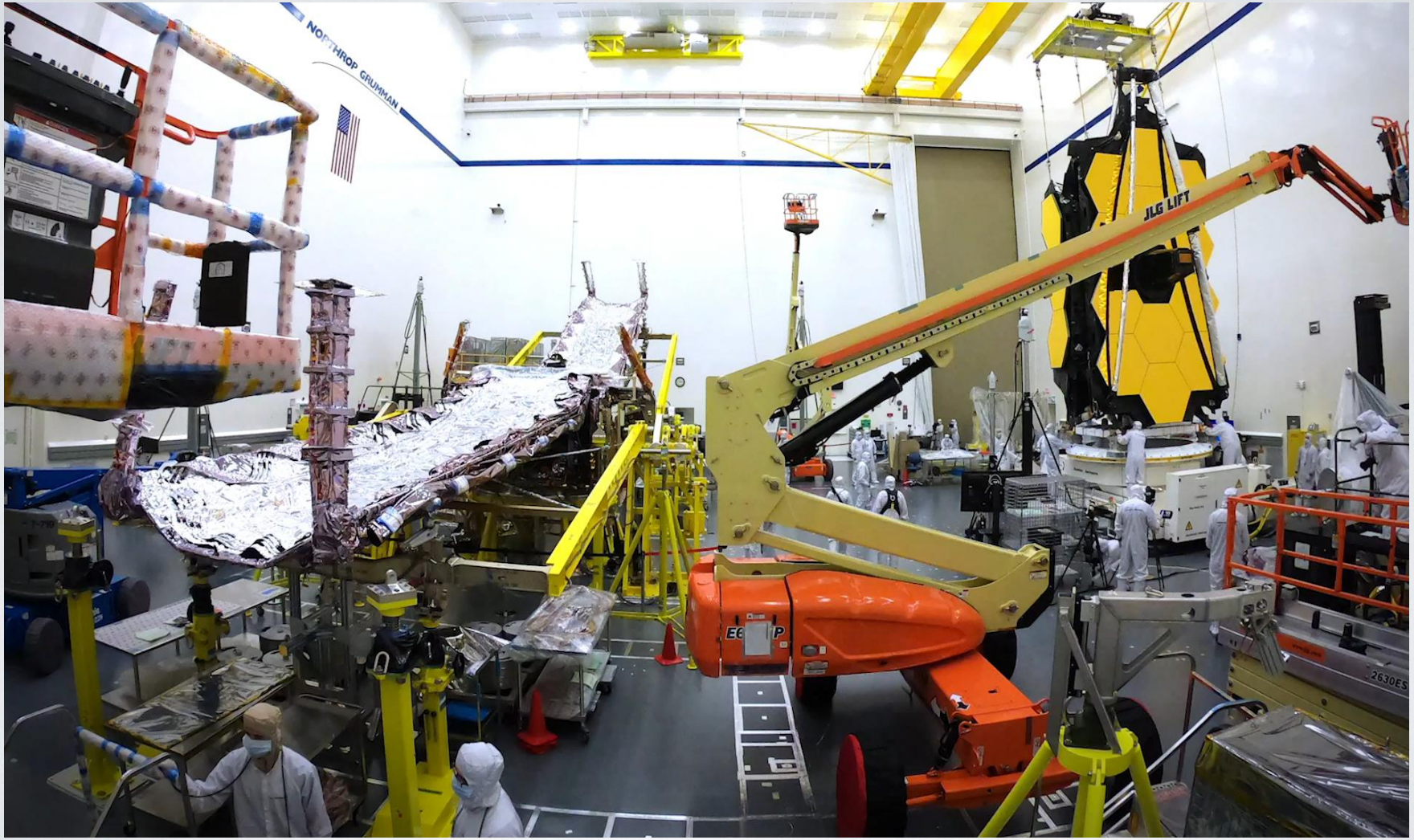
- Manhole cover is removed
- Instrument purge temporarily disconnected
- Fairing lowered for encapsulation and torqued to launcher
- Reconnect instrument purge through fairing ISIM access door







BACKUP


NORTHROP GRUMMAN
JLG LIFT

Milestone Performance

- Since the September 2011 replan JWST reports high-level milestones monthly to numerous stakeholders

	Total Milestones	Total Milestones Completed	Number Completed Early	Number Completed Late	Deferred to Next Year	Deferred more than one quarter
FY2011	21	21	6	3	0	0
FY2012	37	34	16	2	3	3
FY2013	41	38	20	5	3	2
FY2014❖	36	23	10	8	11	10
FY2015	48	44	22	12	4	3
FY2016	45	39	25	7	6	2
FY2017	38	32	12	13	8	5
FY2018	31	18	7	2	13	13
FY2019	25	22	10	10	3	2
FY2020	17	10	5	0	0	0

❖ Milestone accounting in FY2014 was complicated by the government shutdown and multicomponent milestones