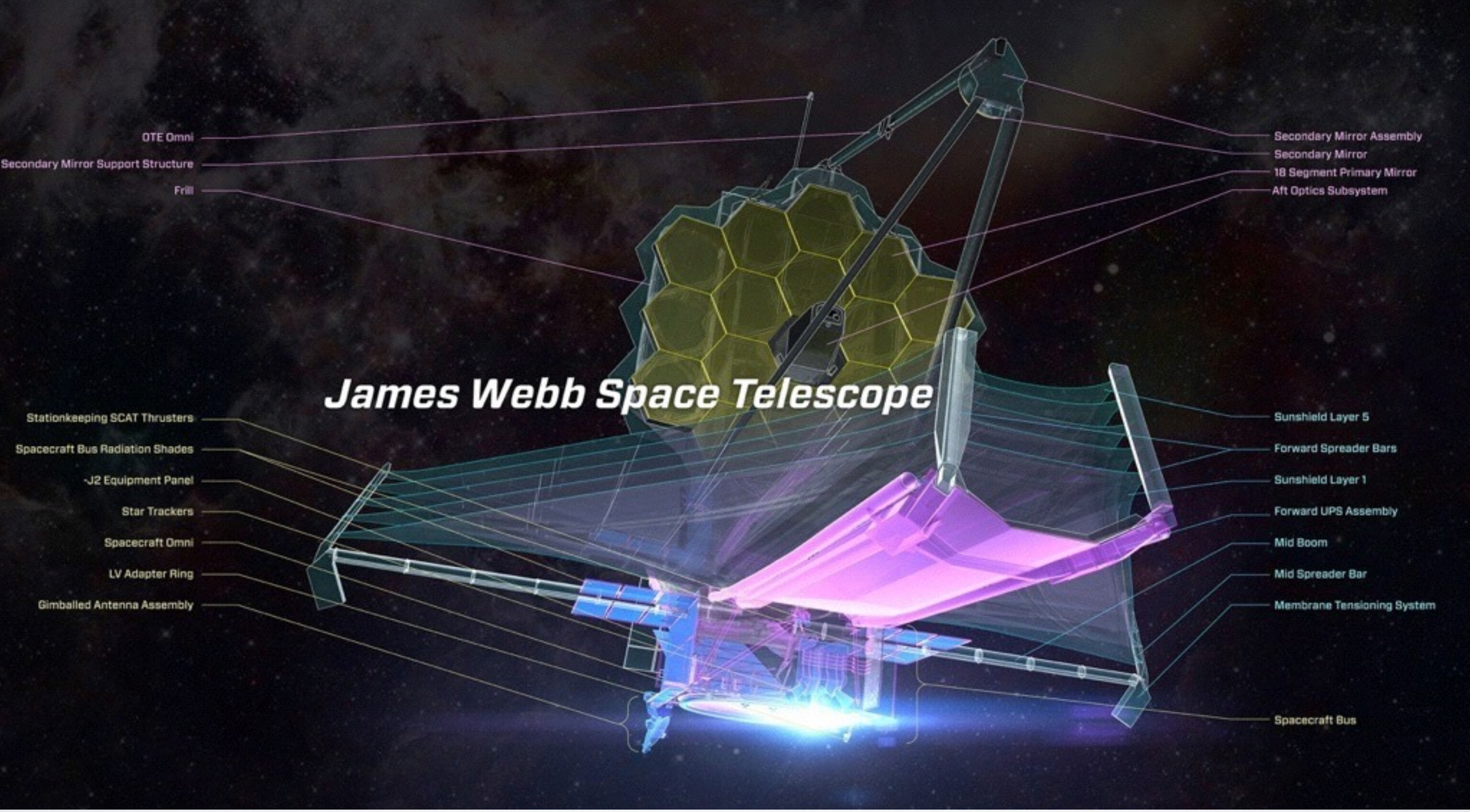


July 21, 2016

Eric P. Smith
JWST Program Director/Program Scientist

TELESCOPE

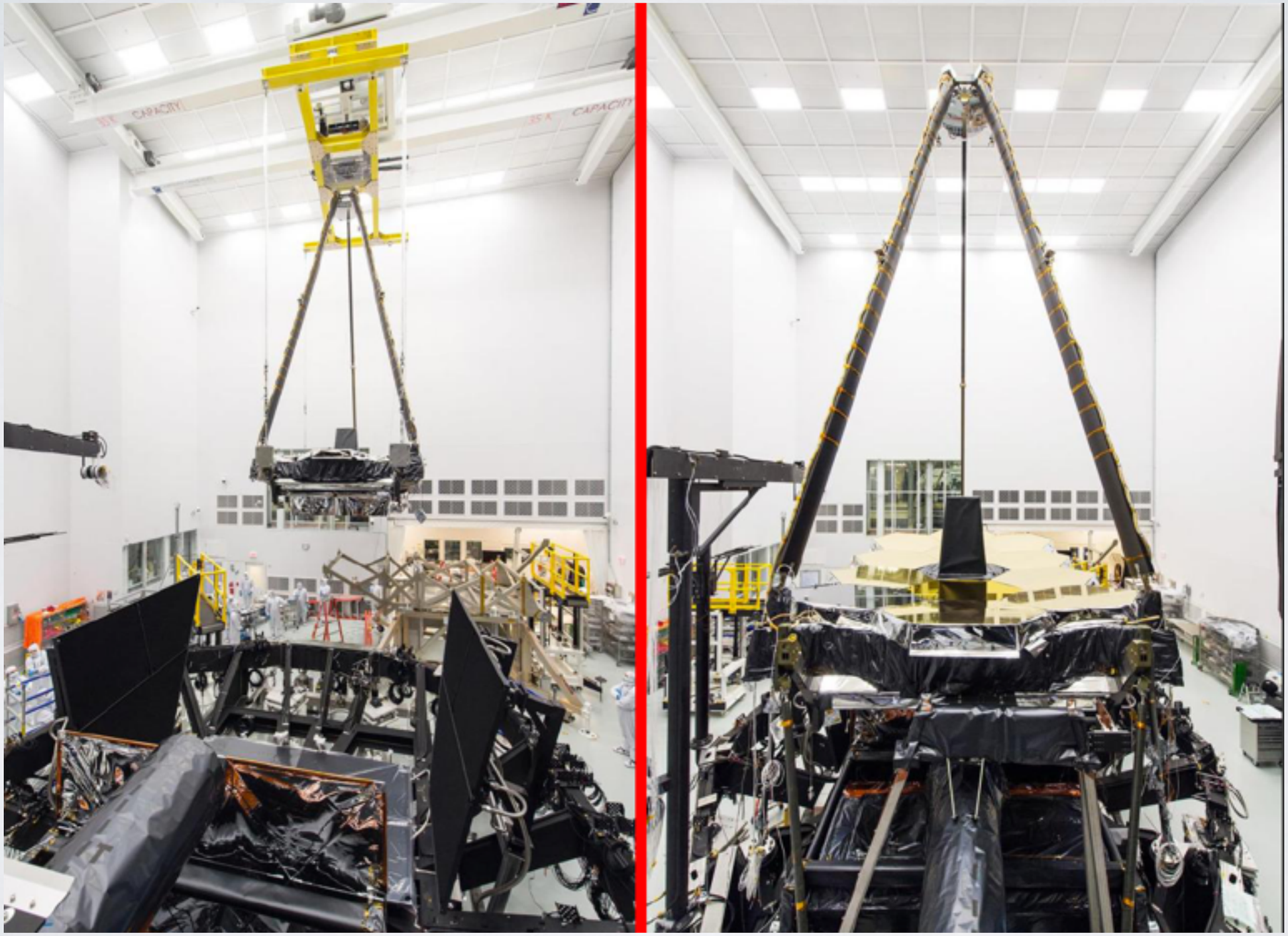
ISIM INSTALLATION

CURRENT OTIS STATUS

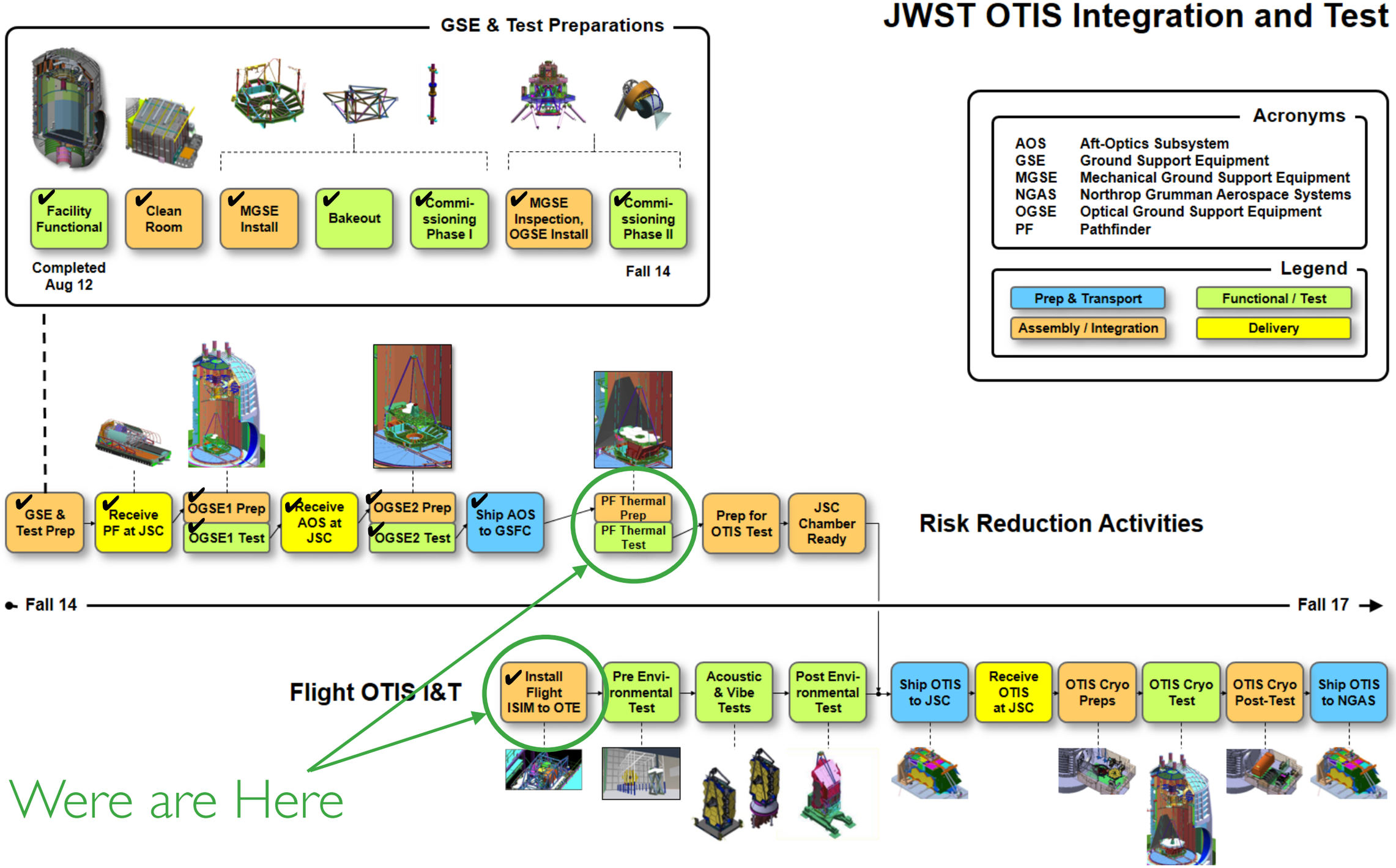
OTIS = **O**ptical **T**elescope + **I**ntegrated **S**cience Instrument Module

Image of current clean room configuration will go here.

PATHFINDER TELESCOPE



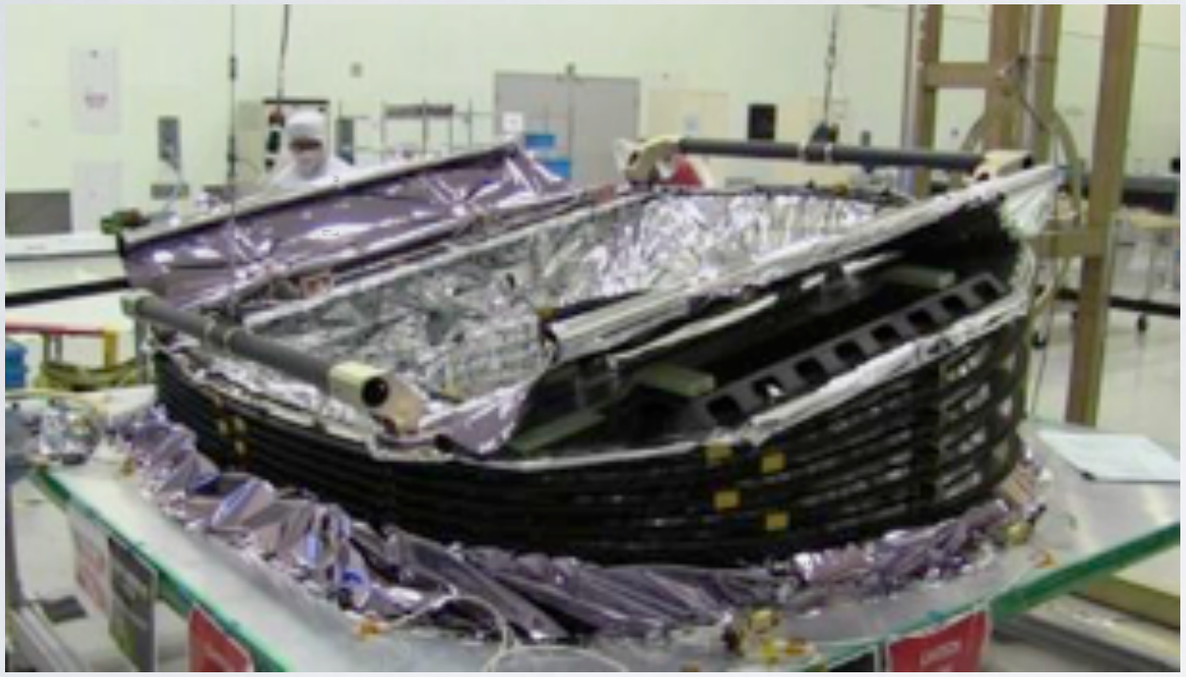
OTIS CHALLENGES



SUNSHIELD

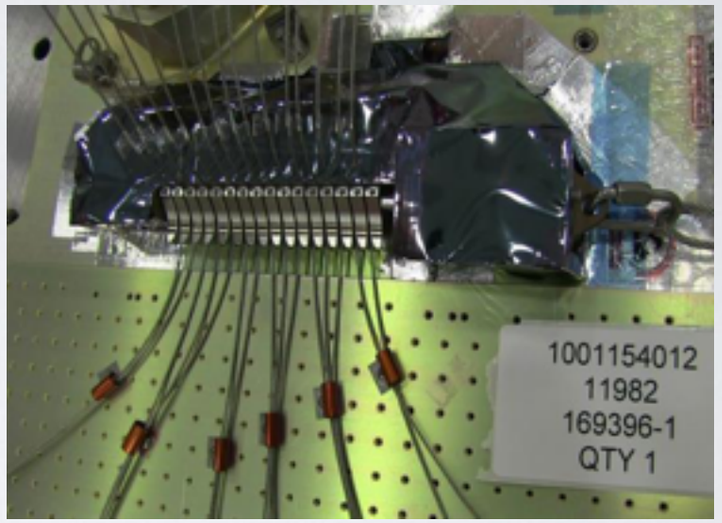
3 of 5 flight layers delivered to Northrop-Grumman

SUNSHIELD PROGRESS

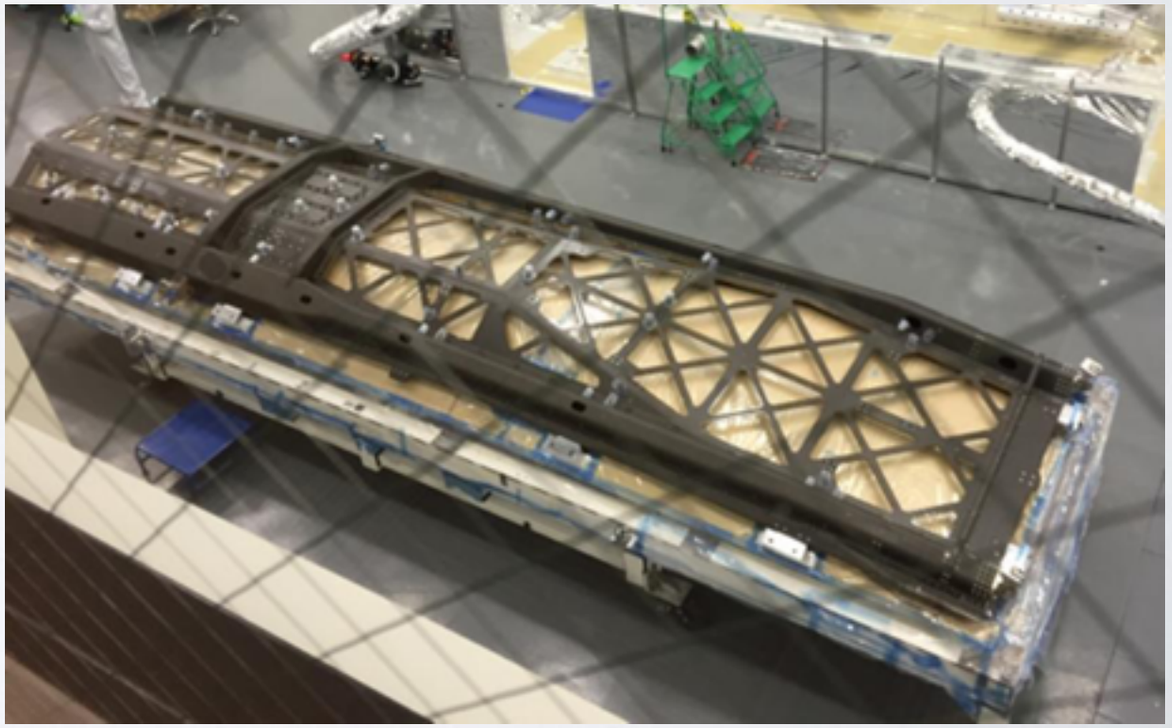


Flight Core Assembly

Vacuum deployment testing complete
Thermal Balance testing underway



Cable Brake

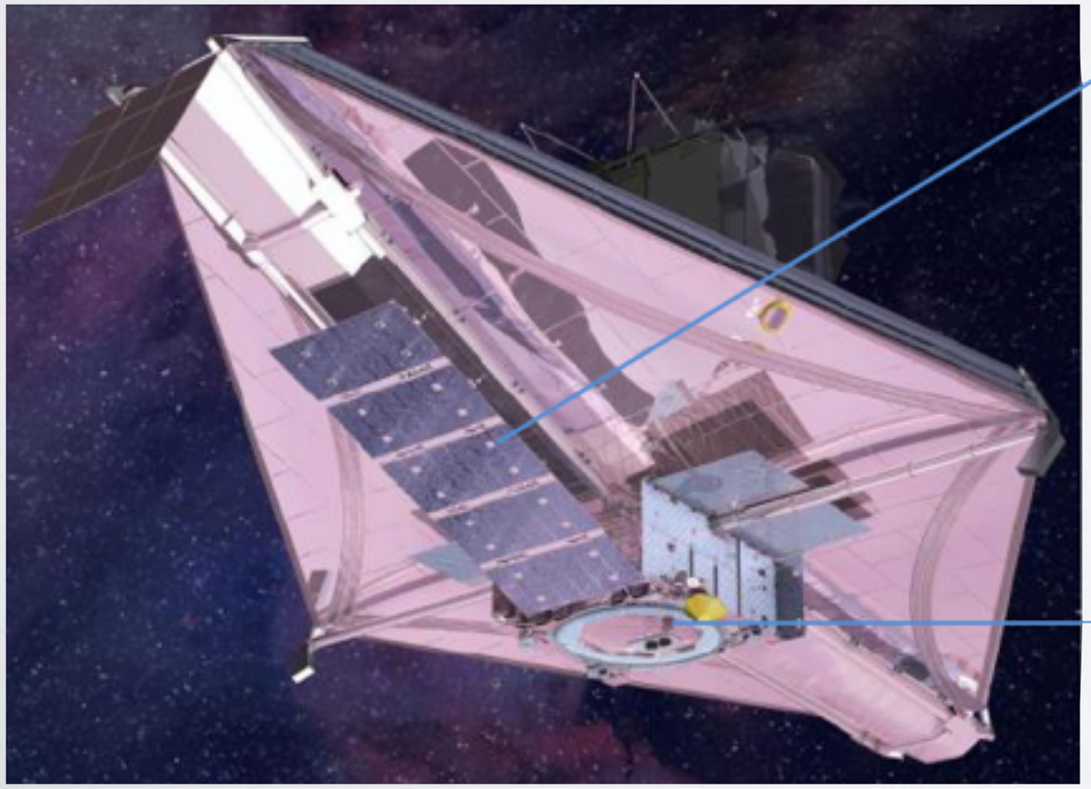


Unitized Pallet Structures

Completed, I&T underway

SPACECRAFT

- All electronics and harnessing installed except MIRI cryocooler (final installed item)
- Solar Array spring deployment testing successful
- Propulsion tanks installed, lines welded and system leak checked
- Reaction wheel drive electronics exercised
- Fine sun sensors exercised



SPACECRAFT/SUNSHIELD CHALLENGES

- Spacecraft build progressing well, on schedule for Sept delivery, solar array is pacing item
- Membrane tensioning system component remanufacturing is the pacing item for the sunshield

TECHNICAL PERFORMANCE

Performance / Resource Parameters	Capability / Requirement	Estimate or Predict 6-16	Comments
Sensitivity Parameters			
NIRCam SI Sensitivity @ 2 microns (nJy)	11.4	9,8	Prediction at EOL from 5-4-16 SI TPM Report
MIRI SI Sensitivity @ 10 microns (nJy)	700	583	Prediction at EOL from 5-4-16 SI TPM Report
Straylight (MJy/ster @ NIR 2 microns)	0.091	0.089	Prediction from 4-7-14 Integrated Modeling Review
Straylight (MJy/ster @ NIR 3 microns)	0.07	0.066	Prediction from 4-7-14 Integrated Modeling Review
Straylight (MJy/ster @ MIR 10 microns)	3.9	0.74	Predict from 3-9-15 AWG including LTO
Straylight (MJy/ster @ MIR 20 microns)	200	174	Predict from 3-9-15 AWG including LTO
OTE Transimission* Ap m^2	22	22.219	2013 03 20 Transmission X Budget - RevE.xlsx predictions at 2 microns min margin wavelength
Image Quality Parameters			
Strehl (NIR 2 microns)	0.80	0.853	Strehl at λ = 2.0 μm From 9-28-15 AWG
Strehl (MIR 5.6 microns)	0.80	0.938	Strehl at λ = 5.6 μm from 9-28-15 AWG
NIRCam ChannelWavefront Error (nm)	150	129	From 9-28-15 AWG
NIRSpec Channel Wavefont Error (nm)	238	221	From 9-28-15 AWG
NIRISS Channel Wavefront Error (nm)	180	139	From 9-28-15 AWG
MIRI Channel Wavefront Error (nm)	421	226	From 9-28-15 AWG
EE Stability at 2 microns Over 24 hours	2.30%	0.40%	From 9-28-15 AWG
EE Stability at 2 microns Over 14 days	3.00%	2.40%	From 9-28-15 AWG
Image Motion rms for 15 sec Slidinging Window for NIRCam (mas)	6.6	5.3	From SLR
Operations Parameters			
Observing Efficiency	70%	77.0%	From "Observation Efficiency Allocations Report JWST-RPT-004166, Revision F"
Slew Time for 90 Degree Slew with 5 RWAs (min)	60.0	57.3	Prediction as cited in Pointing Budget D36177 RevH Para 5.1
Momentum Accumulation LV1 (Nms/d)	22	18.10	Updated on 8-1-2013 (13-JWST-207D) from Torque Tables for SC Bus IM Cycle (Nom+rss)*MUF
Momentum Accumulation LV4 (Nms/d)	23	18.50	Updated on 8-1-2013 (13-JWST-207D) from Torque Tables for SC Bus IM Cycle (Nom+rss)*MUF
Thermal Parameters			
Cryo Parastic Margin (NIRCam)	60%	76.3%	Predicts with Liens and Accepted Opportunities per 2016.04.13_Obs_v5.5m_LTO-P2_v71.xlsx
Cryo ParasiticMargin (NIRSpec FPA)	60%	70.1%	Predicts with Liens and Accepted Opportunities per 2016.04.13_Obs_v5.5m_LTO-P2_v71.xlsx
Cryo Parasitic Margin (FGS/NIRISS)	60%	68.2%	Predicts with Liens and Accepted Opportunities per 2016.04.13_Obs_v5.5m_LTO-P2_v71.xlsx
Cryo-Cooler Line Load Margin (Pinch Point / Steady State)	83%	113%/146%	Cryo-Cooler Predicts from K. Banks and S. Thomson Mar 2015 Predict + Liens)
Cryo-Cooler OM Load Margin (Pinch Point / Steady State)	83%	114%/55%	Cryo-Cooler Predicts from K. Banks and S. Thomson Mar 2015 Predict + Liens)
Data and Link Parameters			
S-Band Uplink Margin (dB)	3.00	6.80	Adverse Margin AS OF 3-23-16 (SC Omni at 2000 bps)
S-Band Downlink Margin (dB)	3.00	5.90	Adverse Margin AS OF 3-23-16 (Both Omni's at L2 at 200 bps)
Ka-Band Downlink Margin (dB)	3.00	6.47	Adverse Margin AS OF 3-23-16 (28 Mbps)
Observatory Resources			
Observatory Wet Mass (kg)	6620	6069	Estimate with Pendings From 6-9-16 Mass Report
Observatory CG Offset (mm)	Area in DCI	36.6	CG uncertainty ellipse to 5 mm margin Ariane Static Unbalance Domain with Pendings (6-9-16)
Observatory Power Load (W)	1808	1510	Estimate + Pendings, 4-21-16 Power Report vs SA at 6 years
Observatory Power Generation (W)		2055	Power Generation at 6 Years, 4-21-16 Power Report
I&T Parameters			
JSC Timeline (Days)	120	95	12-2105 Monthly Repoort

Fiscal Year 2016 JWST HQ Milestones

Month		Milestone	FY2015 Deferral	Comment
Oct-15	1	Start Integrated Science Instrument Module (ISIM) cryovacuum test #3	•	Completed 10/27/15
	2	Deliver update for launch and activation sequence of events for JWST commissioning		Completed 10/29/15
Nov-15	3	Deliver the Observatory Operations Handbook Vol 1&2 updates		Completed 10/30/15
	4	Deliver new build of the proposal planning software for Telescope plus ISIM (OTIS) testing		Completed 10/30/15
	5	Complete second test of Pathfinder Telescope equipment at the JSC Chamber A		Completed 10/31/15
	6	Complete Solar Array panel #2 cell installation		Completed 12/24/15
Dec-15	7	Complete Sunshield Mid-Boom Assembly #1 functional test		Delayed to July because of late thermal chamber from vendor
	8	Complete Delivery of Reaction Wheel Assemblies to Observatory Integration and Test (I&T)	•	Completed 5/11/16
	9	Deliver Data Management Subsystem build for basic data search and distribution functionality		Completed 11/30/15
	10	Deliver flight Aft Optics System to Telescope I&T		Completed 12/14/15
	11	Complete final checkout of new GSFC vibration shaker table		Horizontal shaker table accepted 3/3/2016, Vertical shaker acceptence delayed to September
Jan-16	12	Sunshield Flight Layer #4 shipped to Northrop-Grumman		Completed 12/3/15
	13	Sunshield Forward Cover Assembly shipped to Northrop-Grumman	•	Delayed till August. Membrane cover repairs
	14	Complete Flight Operations Subsystem System Design Review #2		Completed 12/17/15
	15	Complete Mission Operations Center construction at STScI		Completed 12/29/15
	16	Deliver Aft Deployable Instrument Radiator to Observatory I&T		Completed 2/15/16
	17	Deliver Command & Telemetry computer to Observatory I&T		Completed 4/28/16
Feb-16	18	Deliver Secondary Mirror Support Structure verification report to GSFC		Completed 1/28/16
	19	Complete deliveries of Spacecraft wire harnesses		Completed 1/22/16
	20	Deliver spare Cryocooler Compressor Assembly to JPL	•	Completed 5/7/16
	21	Start Spacecraft Panel Integration		Completed 10/26/15
Mar-16	22	Complete Sunshield Mid-Boom Assembly #2 functional test		Forecasting August completion date due to latch and detent pin redesign and tubessegment rebuild
	23	Complete cryocooler thermal performance acceptance testing		Completed 3/5/16

Fiscal Year 2016 JWST HQ Milestones

Month		Milestone	FY2015 Deferral	Comment
Apr-16	24	Deliver ISIM to OTIS		Completed 3/31/16
	25	Complete Sunshield Aft Pallet Structure assembly		Delayed till October: membrane tensioning system component rebuild
	26	Complete Spacecraft Panel integration		Completed 5/25/16
May-16	27	Deliver Optical Telescope Element (OTE) to OTIS		Completed 3/9/16
	28	Begin OTIS integration (install ISIM onto OTE)		Completed 3/28/16
	29	Complete Flight Battery Manufacturing Readiness Review		Completed 1/12/16
	30	Deliver Flight Operations Subsystem build with real-time command and telemetry functions		Completed 3/28/16
	31	Deliver Proposal Planning Subsystem build supporting GTO call for proposals		Completed 4/29/16
Jun-16	32	Start Thermal Pathfinder test At JSC Chamber A		Delayed to September because of change to how Chamber A cool down specifics will be handled
	33	Deliver Fixed ISIM Radiator Panels to OTIS		Completed 11/30/15
	34	Complete flight software verification Test Readiness Review (moving targets)		Completed 6/30/16
	35	Complete Science and Operations Center System Design Review #2		Completed 5/18/16
Jul-16	36	Deliver Spacecraft Structure/Propulsion subsystem to observatory I&T		Completed 6/28/16
	37	Deliver Data Management Subsystem build for advanced data search and distribution		Completed 6/1/16
	38	Complete initial shape testing on final flight Sunshield membrane		
Aug-16	39	Deliver cryocooler and associated electronics to Spacecraft I&T		Completed 5/26/16
	40	Complete test of model Observatory core assembly thermal performance		
	41	Deliver flight Observatory core assembly to Observatory I&T		
	42	Deliver Operations Scripts Subsystem build for Telescope commanding and Spacecraft attitude control		Completed 6/13/16
Sep-16	43	Complete Thermal Pathfinder test at JSC		Delayed to Nov., assuming Sept start
	44	Deliver Forward Sunshield Pallet Structure to Observatory I&T		Delayed to Nov because of membrane tensioning system component rebuild
	45	Deliver Aft Sunshield Pallet Structure to Observatory I&T		Delayed to Oct because of membrane tensioning system component rebuild
	46	Complete command procedures for initial test of real-time control of Observatory		

Blue font(underline) denotes milestones accomplished ahead of schedule, orange font denotes milestones accomplished late. "•" denotes 2015 milestones carried forward.

SIMPLIFIED SCHEDULE

2016												2017												2018											
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

k months of project funded critical path (mission pacing) schedule reserve

SC Assembly & Test → Spacecraft I & T (2) → Observatory I&T → 3 → I

1

Sunshield Fabrication → Sunshield Integration

Spacecraft

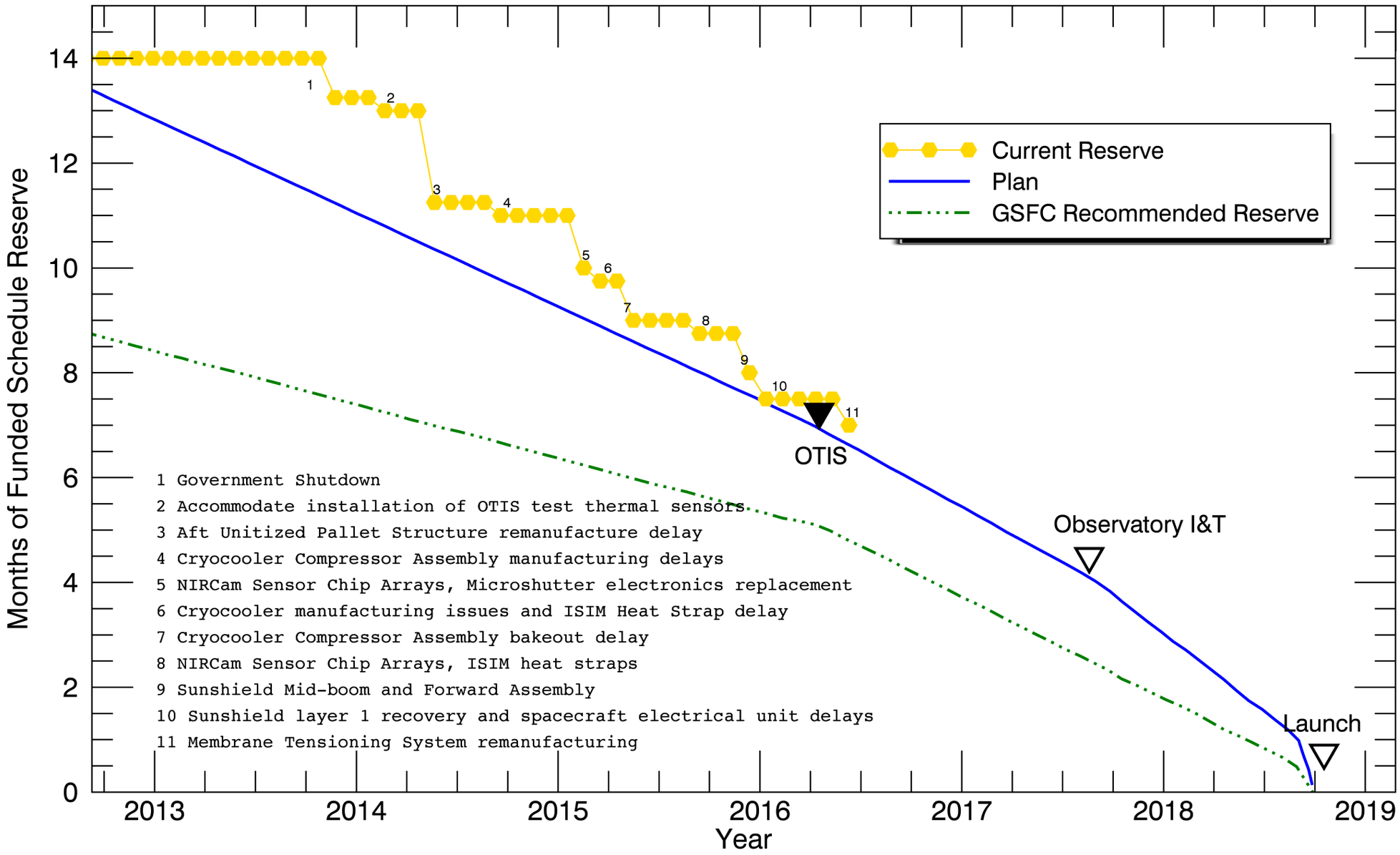
OTIS = Optical Telescope + ISIM

OTIS — 3.5

Telescope + Science Instruments

- Northrop-Grumman
- Goddard Space Flight Center
- Johnson Space Center
- Guiana Space Center

FUNDED SCHEDULE RESERVE



SIMPLIFIED SCHEDULE

2016												2017												2018											
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

k months of project funded critical path (mission pacing) schedule reserve

SC Assembly & Test → Spacecraft I & T (2) → Observatory I&T → 3 → I

1

Sunshield Fabrication → Sunshield Integration

Spacecraft

OTIS = Optical Telescope + ISIM

OTIS — 3.5

Telescope + Science Instruments

Development, Testing, Release

Ground System

Northrop-Grumman

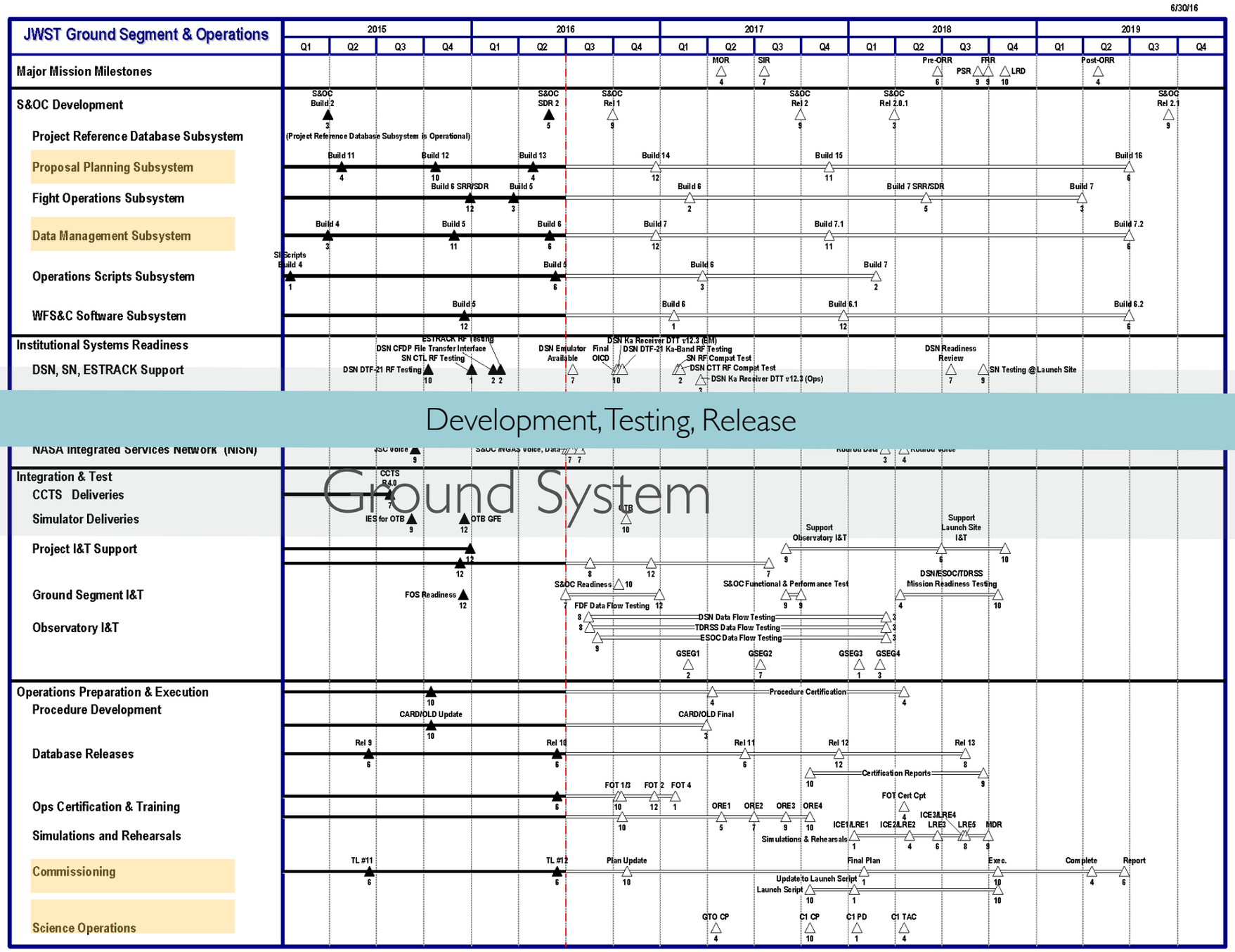
Johnson Space Center

Space Telescope Science Institute

Goddard Space Flight Center

Guiana Space Center

GROUND SYSTEM SCHEDULE



Development, Testing, Release

Ground System

MISSIONS OPERATION CENTER

SCIENCE & OPERATIONS CENTER

The Science and Operations Center (S&OC), located at the Space Telescope Science Institute (STScI), is responsible for operating the JWST observatory and enables the scientists to plan and command the observatory to execute their scientific investigations.

These activities are accomplished via the following S&OC subsystems:

- **Proposal Planning Subsystem (PPS)**: This provides the proposal solicitation, processing, and planning functions required to generate the science program and generate the Observation Plan. It also provides for submitting and administering grants.
- **Flight Operations Subsystem (FOS):** This provides the command uplink and telemetry capture functions; performs telemetry processing necessary to monitor observatory status; monitors observatory and ground status; and detects and notifies operations personnel in the event of an anomaly (observatory or ground). It also contains the Common Command and Telemetry System (CCTS).
- **Data Management Subsystem (DMS):** This provides the data processing, archive, catalog, calibration, distribution, and analysis functions required to support the science program and maintenance of observatory performance.
- **Project Reference Database Subsystem (PRDS):** This is comprised of the Project Reference Database (PRD) and database tools. It is the repository for all JWST data and information required for observatory operations, such as telemetry descriptors, commands, parameters, algorithms, and characteristics. It provides the configuration management, change process management, and data distribution functions required to provide operational data to the S&OC systems.

- The S&OC also houses other components, developed by other elements, such as the WFSC Executive Subsystem and observatory simulators.

FY16 S&OC MILESTONES

- PPS Build 12 for OTIS testing (due Nov 2015)*
- DMS Build 5 for basic data search and distribution (due Dec 2015)*
- Flight Operations Subsystem Design Review #2 (due Jan 2016)*
- Complete Mission Operations Center Construction (Jan 2016)*
- Deliver FOS build 5 with real-time command and telemetry functions (due May 2016)
- PPS Build 13 for GTO Call for Proposals (due May 2016) *
- Complete Science & Operations Center System Design Review #2 (due June 2016)*
- DMS Build 6 for advanced data search and distribution (due July 2016)*
- OSS Build 5 for Telescope commanding and Spacecraft attitude control (due Aug 2016)*
- Command procedures for initial test of real-time control of the Observatory (due Sep 2016)

* Completed ahead of schedule

S&OC SUBSYSTEMS

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)	5	October 2015	May 2016	I&T completed	72%	31%
	6	May 2016	December 2016	Development completed		
	7*	December 2016	April 2017			
	7.1	November 2017	February 2018			
Proposal Planning Subsystem (PPS)	12	October 2015	April 2016	I&T completed	91%	62%
	13	April 2016	October 2016	Development completed		
	14*	December 2016	February 2017			
	15	November 2017	February 2018			
Wavefront Sensing & Control (WFS&C) Software Subsystem	5.1	March 2016	May 2016	Development completed	100%	96%
	6*	January 2017	May 2017			
	6.1	December 2017	February 2018			
Flight Operations Subsystem (FOS)	5	March 2016	July 2016	Completed site acceptance test	47%	47%
	6	February 2017	July 2017	Under development		
	6.1*	August 2017	December 2017			
Operations Scripts Subsystem (OSS)	5	May 2016	September 2016	In Level 1 Certification	73% Level 2 certified	58% Level 3 certified
	6*	March 2017	August 2017			
Project Reference Database Subsystem (PRDS)	4.10*	November 2015	November 2015	Latest Sustaining Engineering release	100%	100%

*Flight Build

S&OC COMMUNITY SUPPORT

- Proposal timeline
- Science Community Outreach Events
- Proposal tool development and simulators

OBSERVATION CATEGORIES

Guaranteed Time Observers (GTO)

- Observing program already selected through peer review (no further review)
- GTO's will get first pick at targets for Cycle 1
- One year exclusive use period

General Observers (GO)

- Will be picked through peer review (Time Allocation Committee)
- One year exclusive use period

Director's Discretionary Time (DD)

- Allocated by STScI Director for high priority observations (*e.g.*, Target of Opportunity)
- No exclusive use period

Early Release Observations (ERO)

- Demonstrate observatory capabilities
- No exclusive use period

Early Release Science (ERS)

- Observations selected by STScI Director using DD time with community input to provide data quickly to scientific community to enable early science and familiarize scientists with Webb data so they can propose high quality science for Cycle 2. (https://jwst.stsci.edu/science-planning/early-release-science-program)

PROPOSAL TIMELINE

GTO CP release
Jan 2017

GTO proposals due
April 2017

GTO Cycle 1
target list avail.
June 2017

General Observer (GO) CP
Nov 2017

GO Cycle 1 deadline
Feb 2018

GO TAC
May 2018

Commissioning

Cycle 1
Observations
April 2019

2017 *2018* *2019*

ERS-DD
initial CP
release
2017Jan

ERS-DD Letters
of Intent due mid 2017Feb

ERS-DD final
CP release 2017May

ERS-DD
props due
2017Aug

ERS-DD TAC 2017Oct

Launch Oct 2018

FUTURE MEETINGS

Major International Science Conferences (~Annually)

October 24-28, 2016 in Montreal; Exploring the Universe with JWST II
March 20-24, 2017 in Venice; HST + JWST Conference

Topical Science Meetings

2-3 day workshops on major JWST science themes will be organized at STScI throughout 2016-2018 and will include a component to introduce users to software and systems

User Training

September 26-28, ESAC, Madrid: Mastering the science instruments and the observing modes of JWST
Annual workshops at STScI and AAS on JWST data analysis tools - next November 8-11, 2016.
2017 - workshops on JWST planning tools (ETCs, simulators)
2017-2018 - workshops on APT, single stream, documentation
Annual workshops in Europe on JWST capabilities, proposal tools, and data analysis tools

JWST Community Days

Open call to US institutions to host hands-on JWST 1-2 workshops (w/ optional science meeting) Examples include ERS program planning, JWST modes and flight capabilities, observing techniques, etc.

USER TOOLS HIGHLIGHTS

Astronomer's proposal tool (APT)
- Smart overhead accounting
- New visibility tools
- New JWST graphics

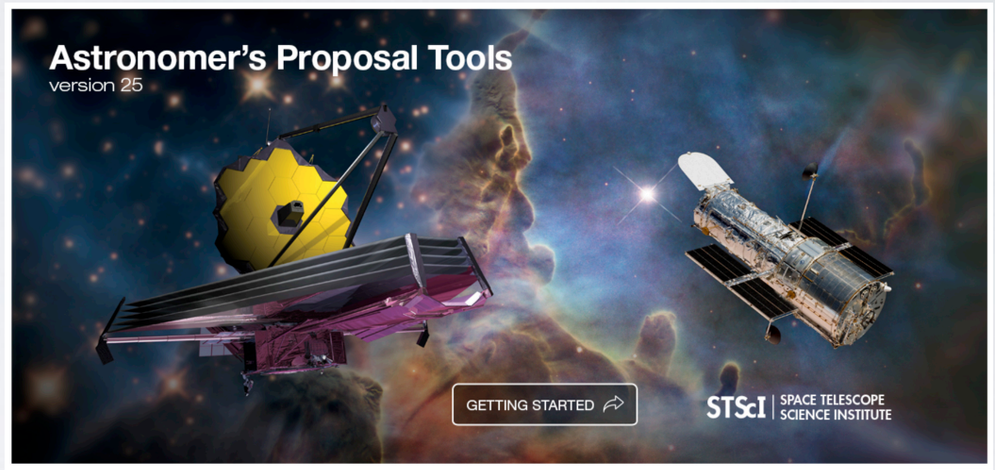
Exposure time calculator (ETC)
- All science modes complete
- First release for WFIRST
- Quantitative verification in review
- Package being prepared for release

Data simulators
- Space Telescope Image Project Simulator (STIPS) imaging modes to be released
- Exoplanets Simulator

Calibration pipelines
- New plan with better prioritization and workflows

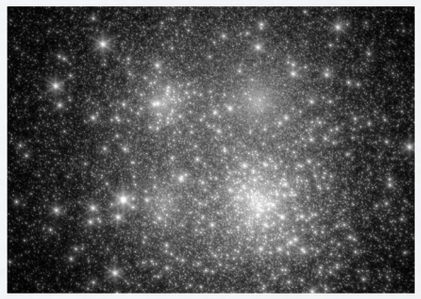
User documentation (JDOX)
- Wikipedia-style integrated web documentation
- First batch of instrument and background articles in review

Data analysis tools
- Many new applications, including spectroscopic viewer, multi-object and IFU tools

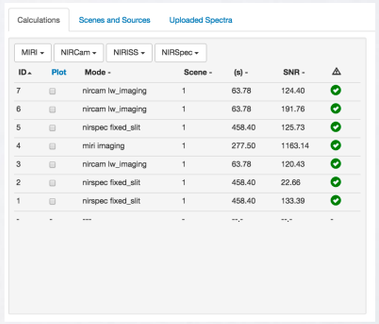


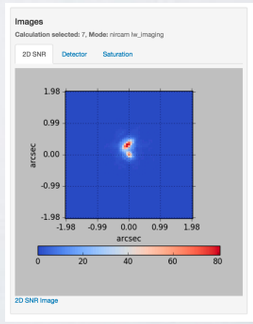
JDOX

STIPS



ETC



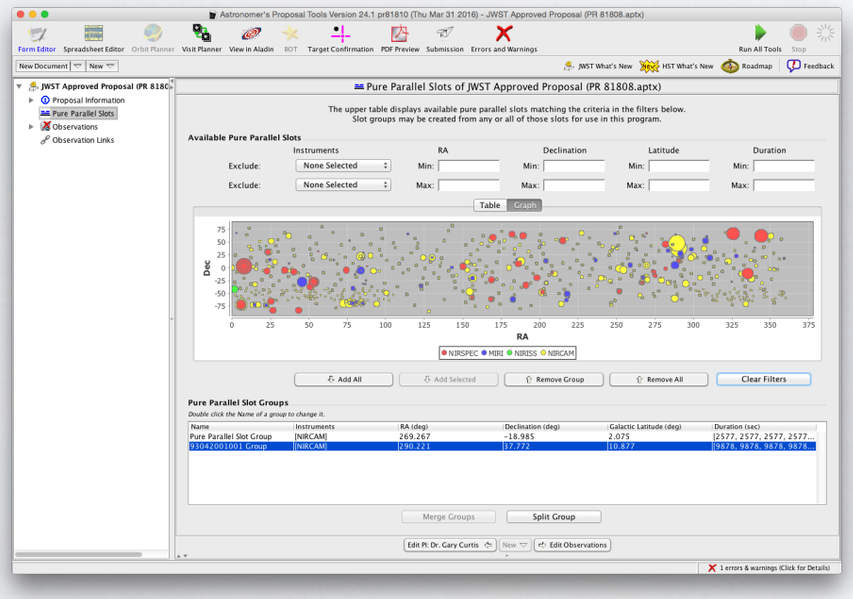


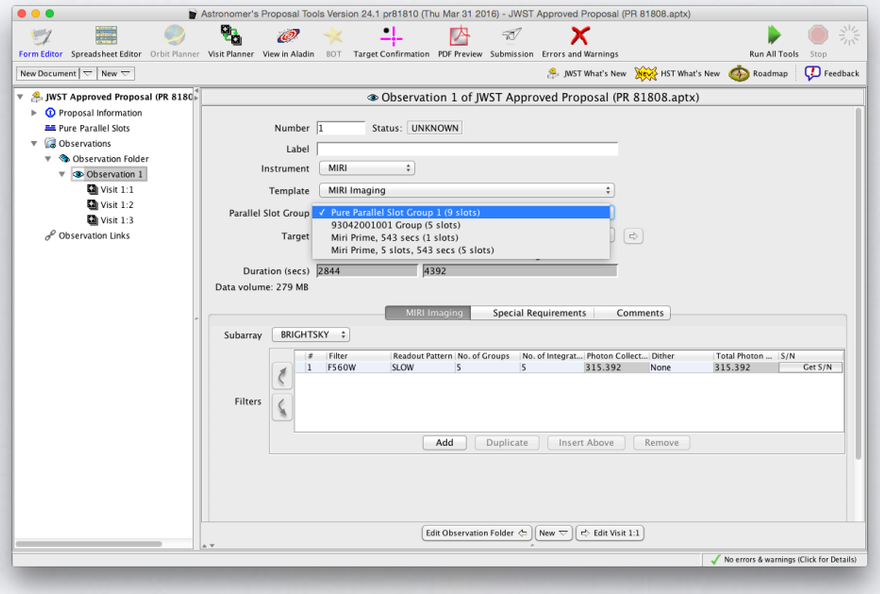
SCIENCE PARALLELS

- Cycle 1 will include pure-parallel (= manually crafted) support for all science modes that make sense to be used in parallel

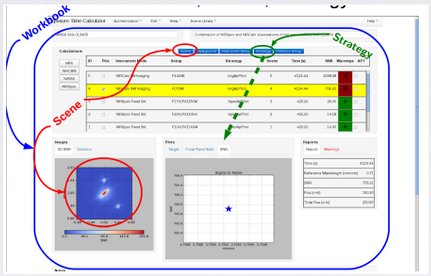
- Will include coordinated parallel (= joint coordinated template) support for 3-4 parallel combinations. (NIRCam Imaging-MIRI Imaging, NIRCam Imaging-NIRISS WFSS, MIRI Imaging-NIRISS WFSS and possibly NIRCam Imaging-NIRSpec MSA)

- Additional coordinated parallels will be supported in Cycle 2.





USER TOOLS TIMELINE



ETC Web App

ETC Engine Release

beta

Cycle 1 CfP

ERS Deadline

2016 2017 2018 2019

227th AAS

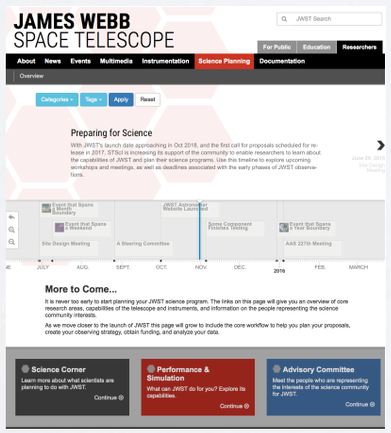
STIPS release

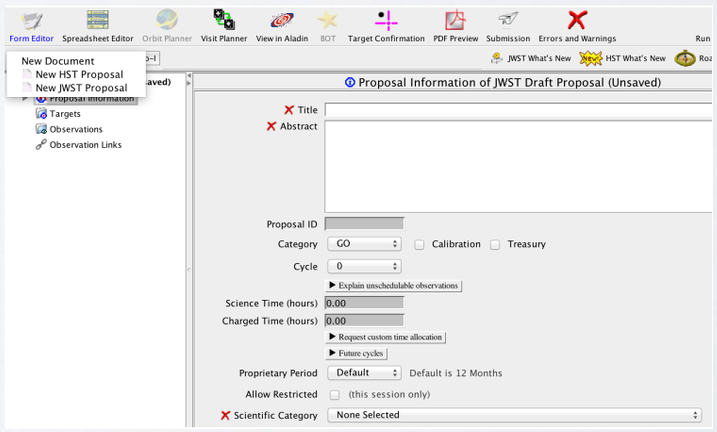
APT flight release

Cycle 1 deadline

Exoplanet simulator release

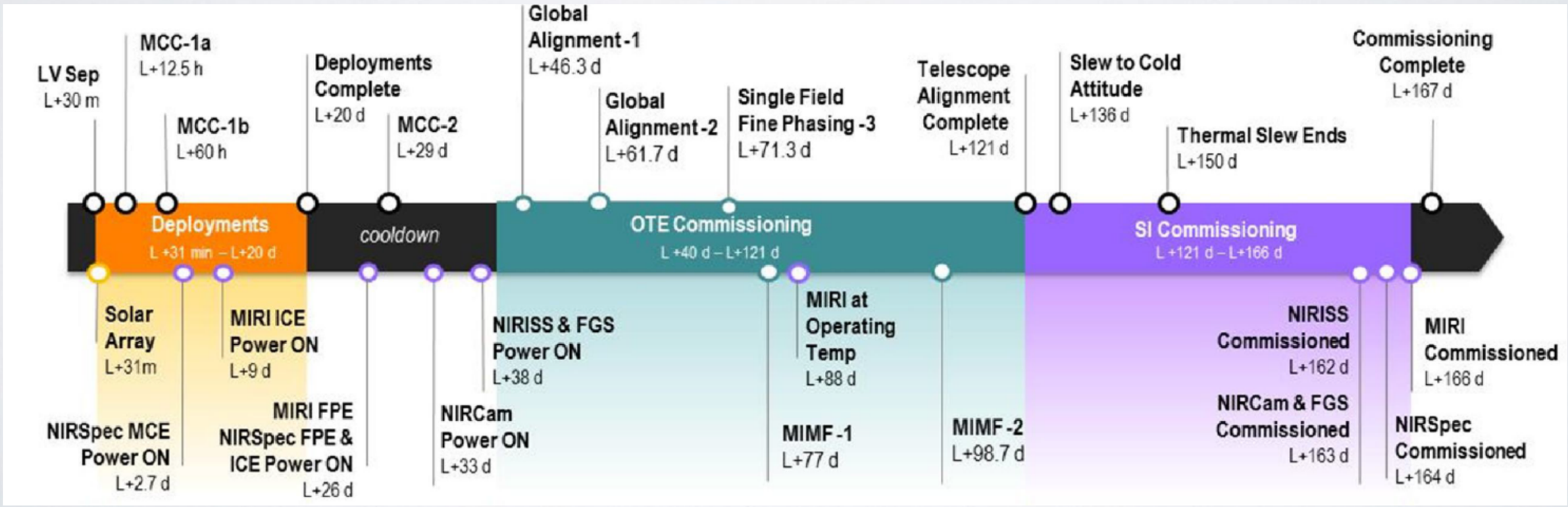
1st User Docs release





COMMISSIONING TIMELINE

- Soon after launch the spacecraft is controlled from the MOC at STScI
- OTE commissioning will take almost 3 months
- Commissioning of the science instruments will start 4 months after launch and is completed in 1.5 months.
- 0.5 months are held on reserve to the nominal start of Cycle 1 science in April 2019



SUMMARY

- Program remains within replan budget and on time for October 2018 launch readiness date

- Project is concluding manufacturing phase and about to full transition into I&T. There are new first time challenges associated with this phase

- STScI is making excellent progress at preparations for launch and operations. Community engagement will rapidly increase in the next two years.