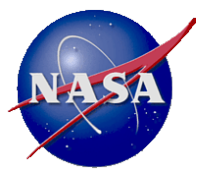
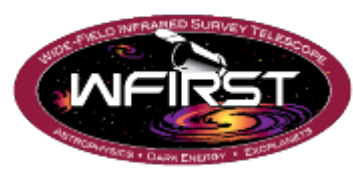


Payload update for FSWG – D. Content

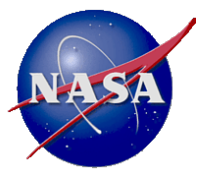


- As instrument updates & a S/C update precede this, this update is confined to the telescope & instrument carrier, and payload specific activities; charts below pulled from actual or draft PDR charts.
- Reminder: IC & WFI PDR's successfully completed; OTA in August, CGI end of September; mission & S/C PDR @end of October
- Payload optical redesign was a tweak for packaging and improving interfaces:
 - Relative to phase A design, optics moved ≤ 5 cm
 - Change in PM conic constant is a small fraction of the HST PM conic error
 - TCA optical redesign relaxes CGI interfaces, improves packaging
- Payload peer reviews successfully completed during phase B
 - Optical verification
 - Signal to noise budget and estimation
 - Integrated modeling verification
- Integrated modeling phase B results peer review planned for September



WFIRST

Wide Field Infrared Survey Telescope



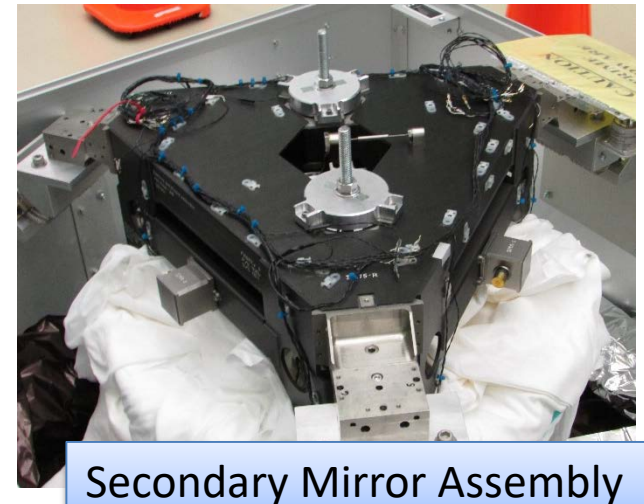
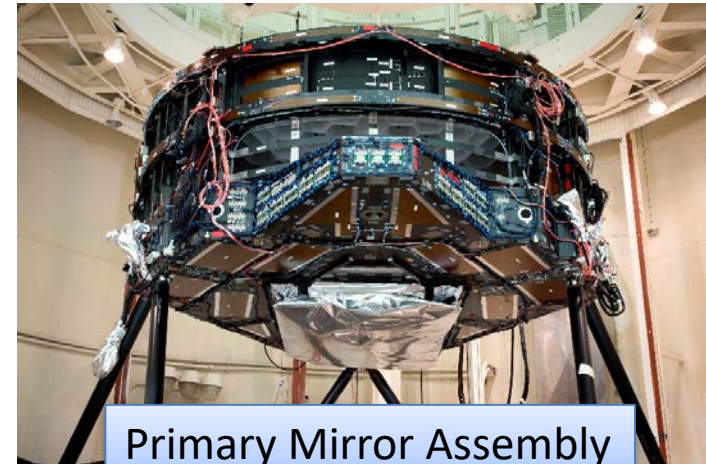
Adapted from Introduction charts for OTA PDR (Dry Run 7/30-31/19)

Scott Smith and Bonnie Patterson

Joe Marzouk & Tony Whitman

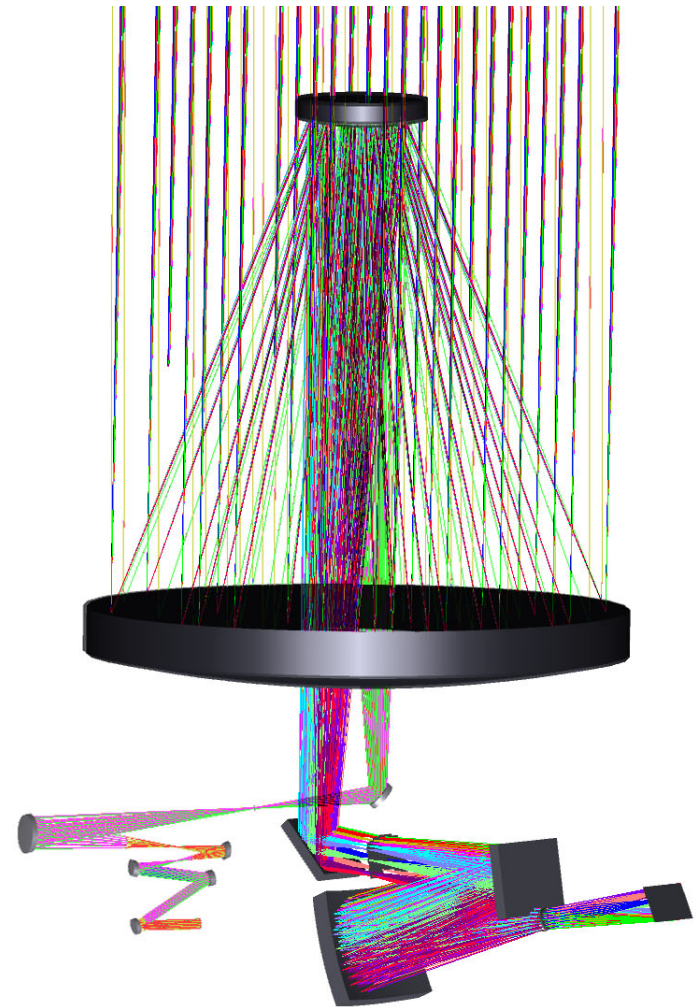
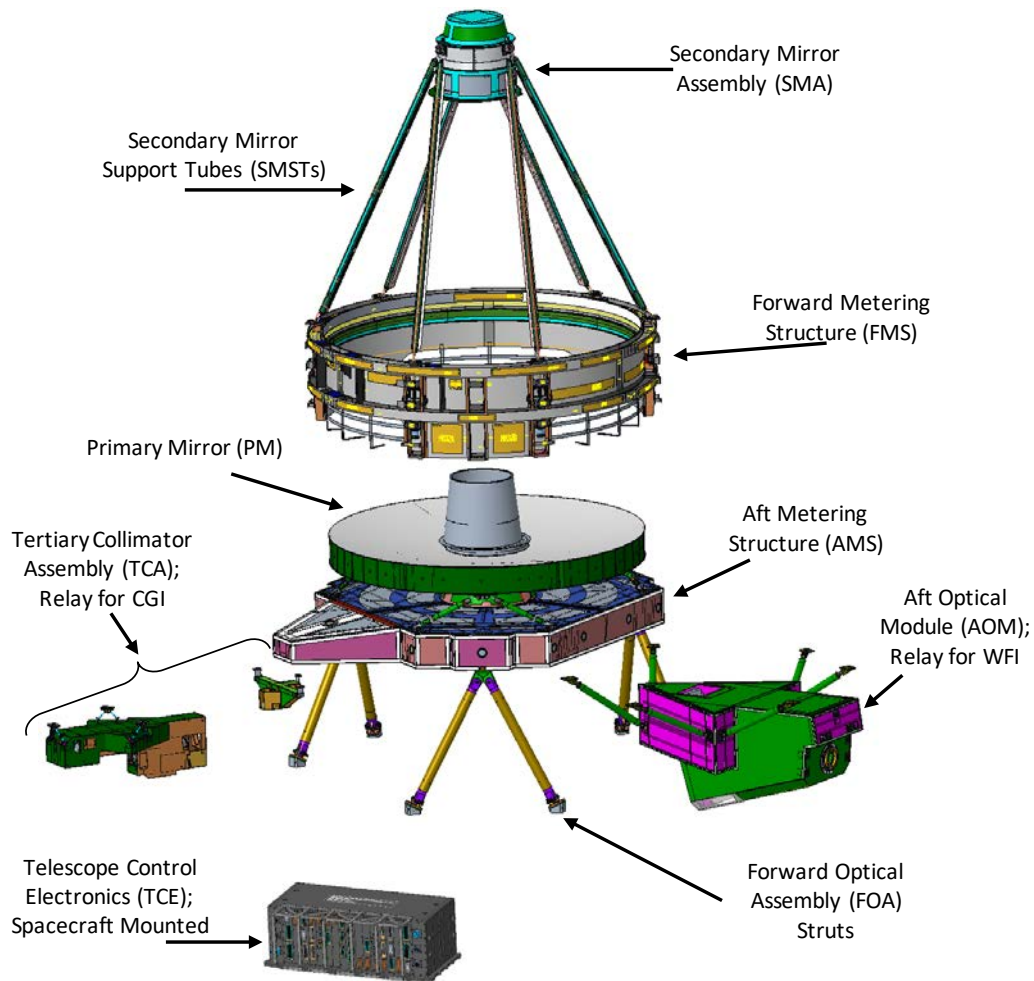
July 30, 2019

- **First and foremost, the OTA delivers photons to two science instrument in support of astrophysics**
 - Primary Mirror Assembly (PMA) – provides first optic in the path, operating at cooler temperatures to enable IR science
 - Forward Structure Assembly (FSA) which includes Secondary Mirror Assembly (SMA) – provides second optic, with 6-dof alignment correction, also operating cooler than original design
 - Aft-Optics Module (AOM) – new hardware, provides tertiary optical element and converging beam for the Wide Field Instrument (WFI)
 - Tertiary Collimator Assembly (TCA) - new hardware, provides a collimated beam for Coronagraph Instrument (CGI)
 - Telescope Control Electronics (TCE) – leveraged design, actuator and thermal control for the optics
- **The OTA leverages inherited hardware**



OTA will show a highly developed design ready to proceed to CDR

OTA high level view



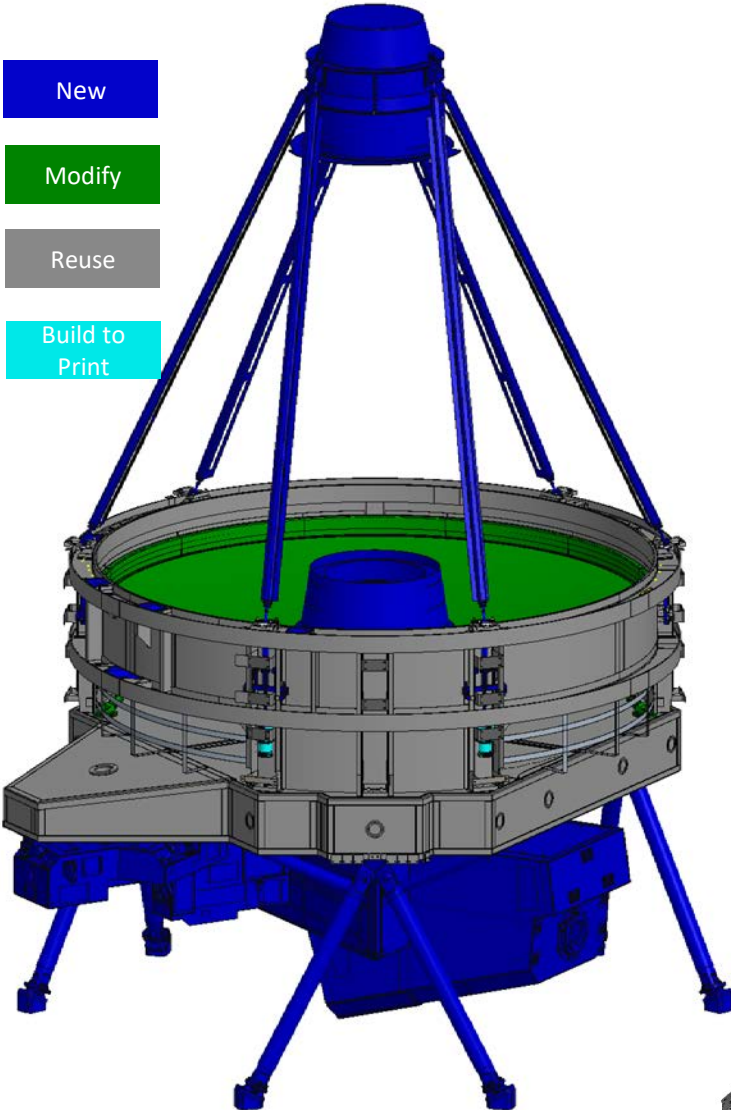
OTA Hardware overview

New

Modify

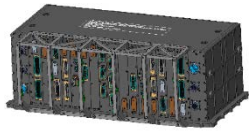
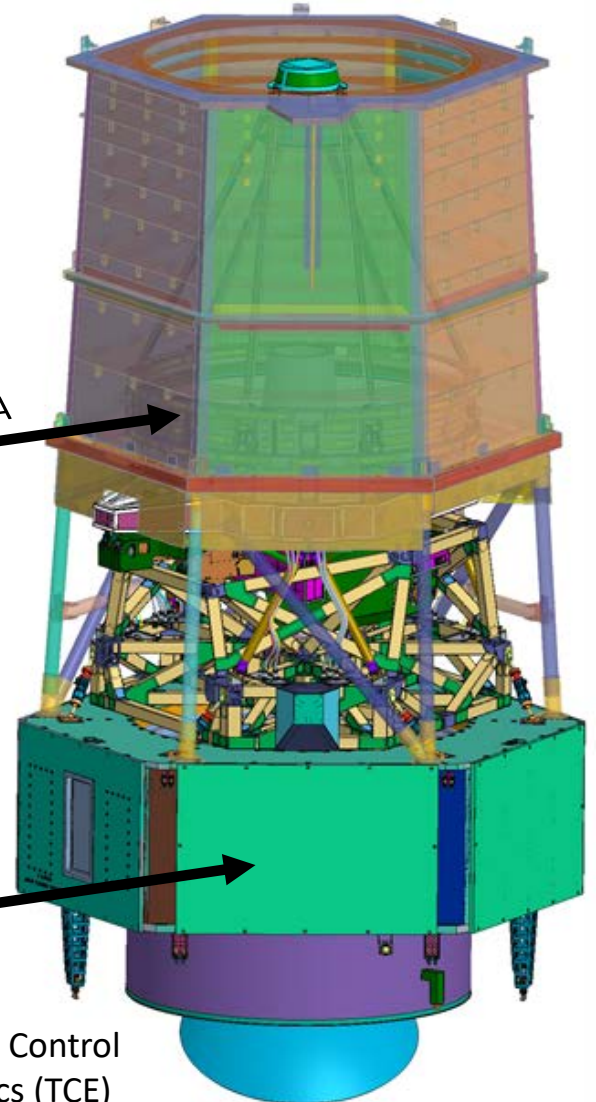
Reuse

Build to Print



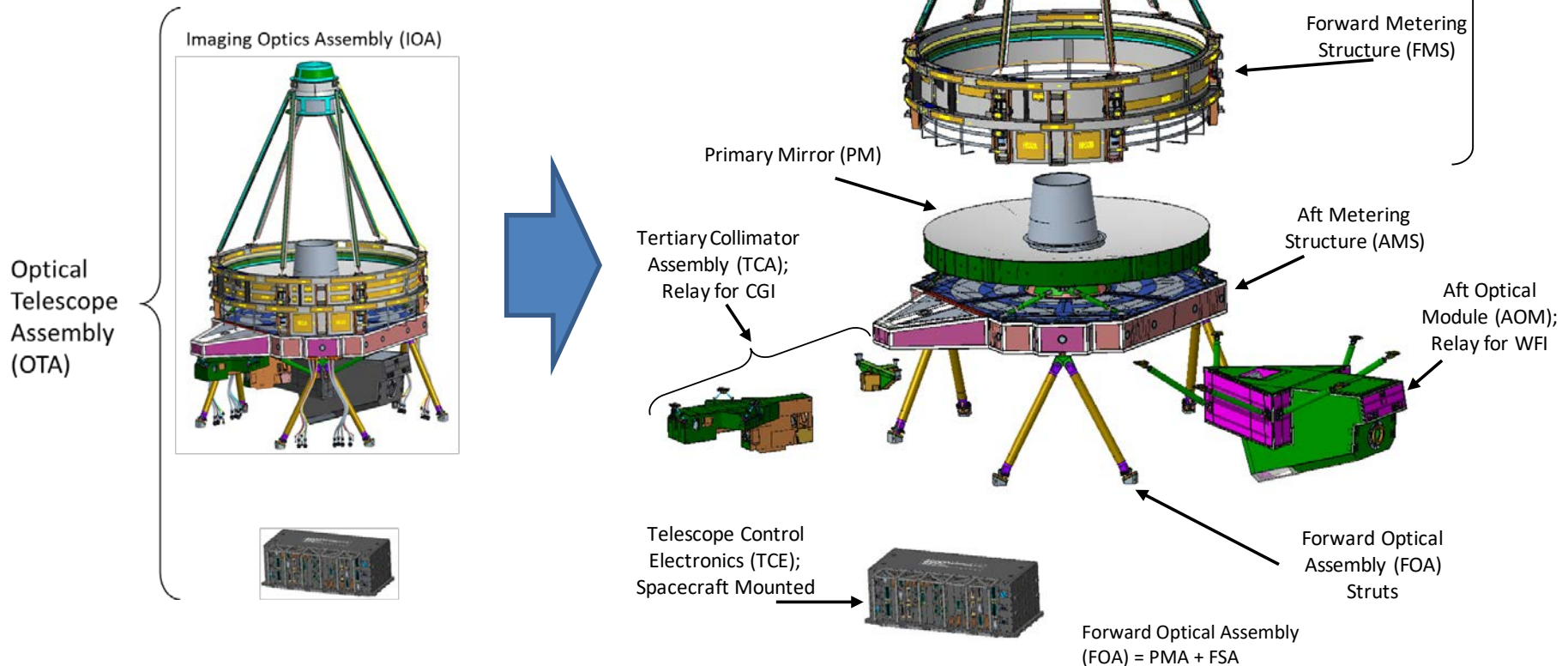
Located Inside OBA

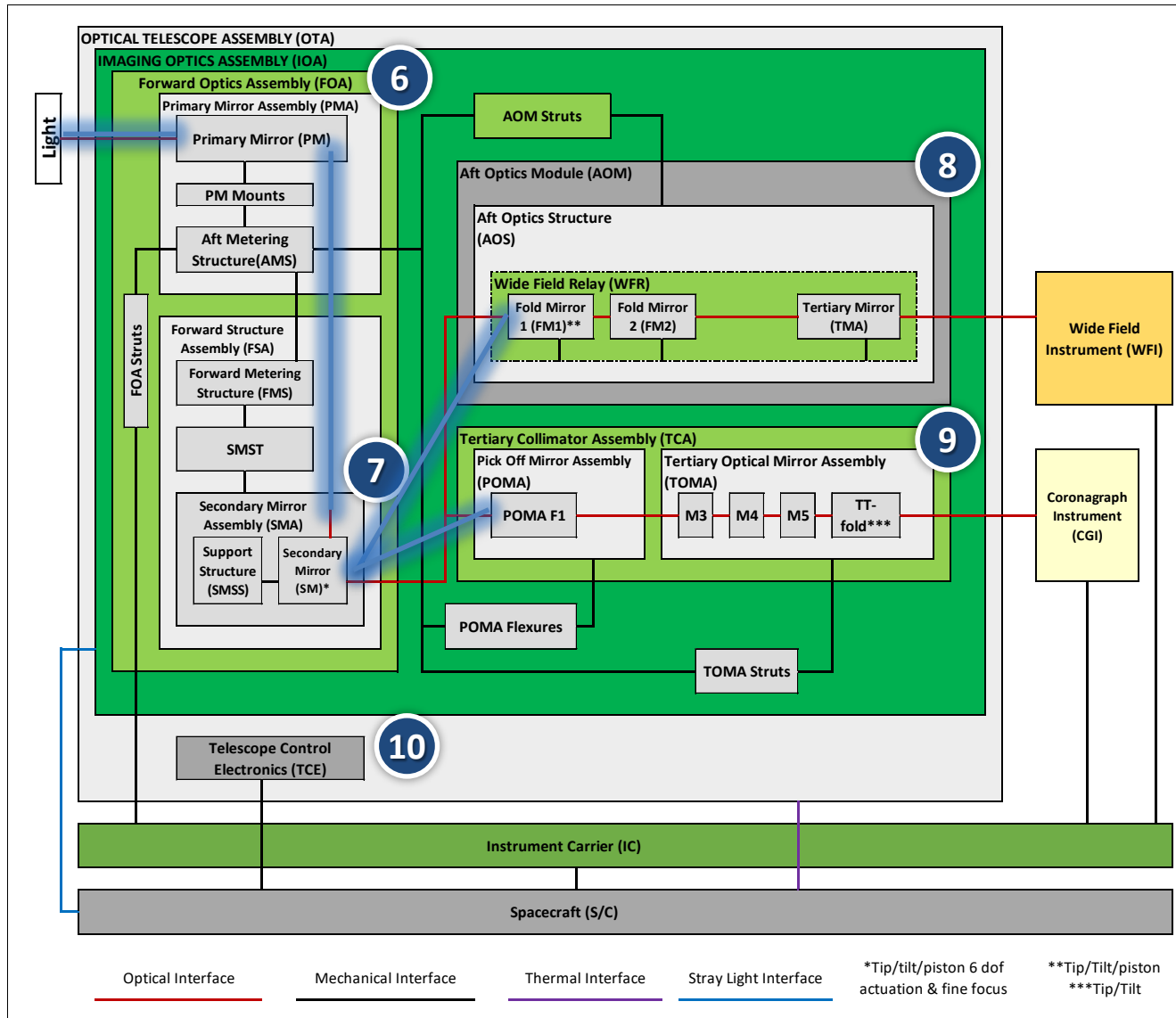
Inside Spacecraft Bay

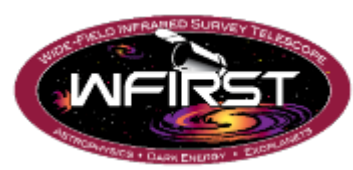


Telescope Control Electronics (TCE)

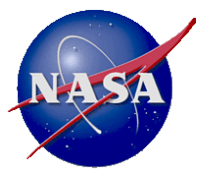
- The scope of this review includes the design of the OTA and integrated subassemblies
 - Heavily leverages heritage Forward Optics Assembly hardware combined with new design to achieve WFIRST Operating Temperatures and provide optical relays for the WFIRST instruments
 - No Flight SW included in the OTA



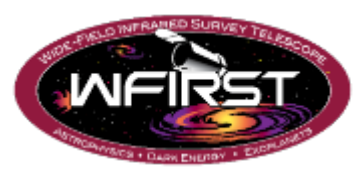




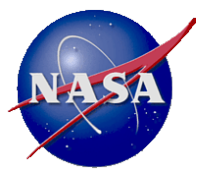
Major Phase B Liens & Trades (1 of 2)



Trade Title	Decision Level	Key OTA Outcome
L.108 – AOM – WFI mechanical interference	Payload	Design change for FM2 assembly and AOM box
L.109 – OBA – OTA mechanical interference	Mission	Moved thermal hardware from FMS to AMS
L.113 – Optical stability	Mission	<ol style="list-style-type: none"> 1. New SMSTs 2. Relaxed CGI stability requirement
L.105 – OTA verification	Payload	Captured in RVM, ORD revision, and programmatic
T.105 – PM gravity offload GSE	Payload	Modify existing equipment
L.110 WFI – OTA closeout	Payload	Interface simplified to snout within ring
L.111 CGI – OTA closeout	Payload	Open - Interface simplified to garage design – no anticipated changes to OTA side of interface
L.117 Initial charging protection implementation guidelines	Mission	Defined cable shielding requirements
L.116 AOM temperature requirement	Payload	Open – affects AOM thermal control authority margin
L.122 OBA thermal interference	Mission	Open – affects thermal hardware design on AMS

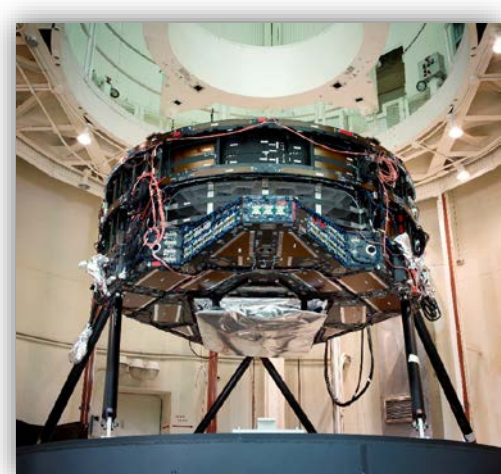


Major Phase B Trades (2 of 2)



Trade Title	Decision Level	Key OTA Outcome
SMST scraper width	Payload	Width defined
TM backplate bonding – Low Temperature Fusion vs. Frit	OTA	Frit
PMA strength verification	Payload	Open – vibe test plan vs. over-test damage risk
New glass material vs. transfer glass material for aft optics (except TM)	OTA	TCA – transfer material AOM - open

Robust trades executed for best technical solutions at appropriate stakeholder levels



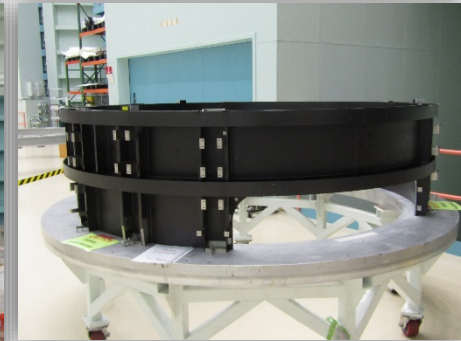
**Primary Mirror Assembly
+ Forward Metering
Structure At SRR/Pedigree
Review**



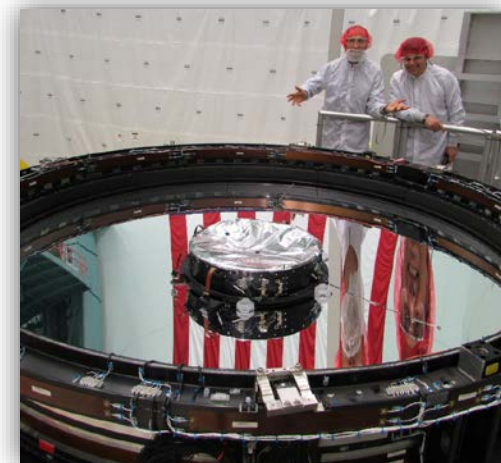
**Removal of PM Scraper
7/2018**



**Forward Metering
Shell Removal
7/2018**



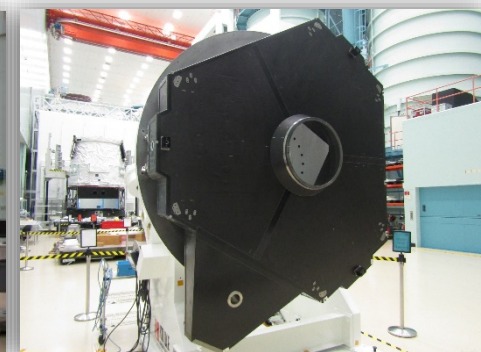
**Forward Metering
Structure June
2019**



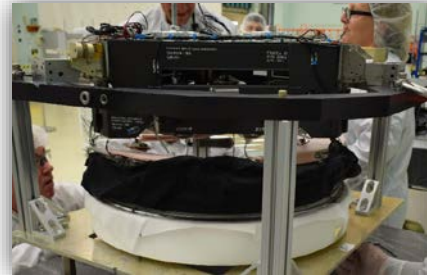
**Removal of PM Baffle
Adaptor 7/2018**



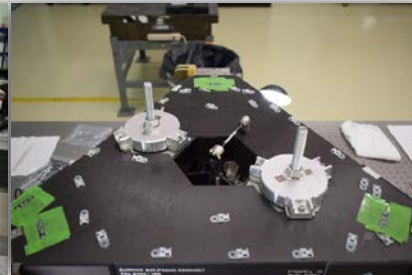
**Removal of Spare PM
from Aft Metering
Structure May 2019**



**Aft Metering
Structure June 2019**



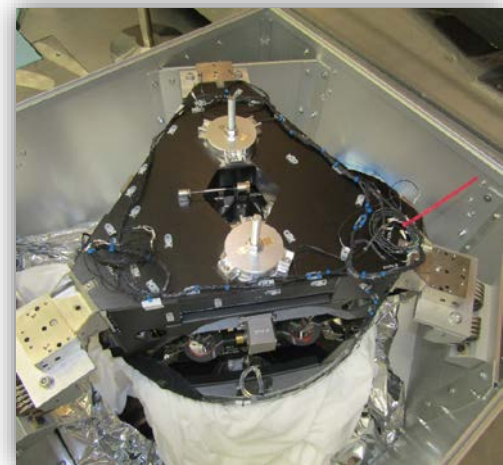
Disassembly of support structure from mirror



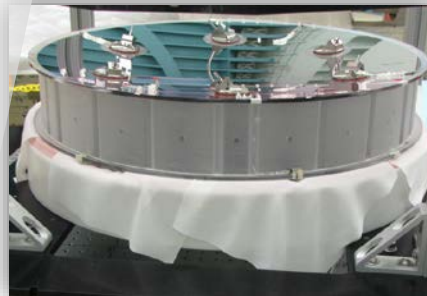
Removal of thermal-electric hardware



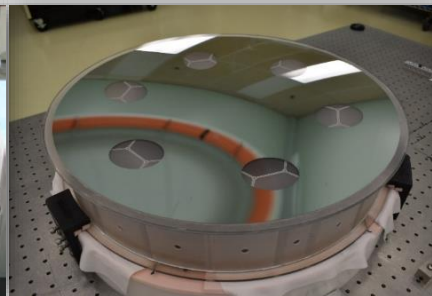
Secondary Mirror Support Structure (SMSS) ready for re-use



Secondary Mirror Assembly At SRR/Pedigree Review



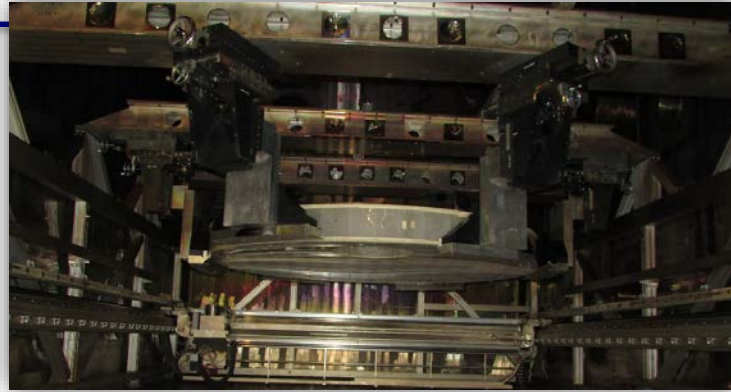
Secondary Mirror (SM) de-configured from support structure



Back Pad Removal



In process shaping of SM to WFIRST prescription



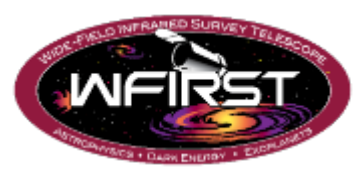
*Ion Figuring -
Ongoing*



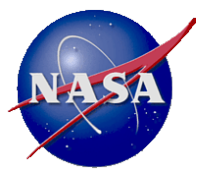
*Flight Primary Mirror (SN#3)
As received*



Full Tool Polish May 2019



Technical Status – Primary Mirror



- **Prior accomplishments since SRR: Baselined SN#3, 2 ion figuring runs to adjust to WFIRST design; Pathfinder horizontal test (SN#1) proves ability to cross check gravity sag**
- **Recent Accomplishments**
 - Full tool polish complete and objectives satisfied
 - Surface cosmetics improved to final requirements
 - Surface roughness brought into specification
 - Ion figuring parting lines removed
 - Optical test #3 completed
 - Confirmed full tool removed targeted high frequency errors (parting lines, etc.)
 - Lower frequency errors remaining are readily addressable in ion figuring
- **Next Period Plans**

Process Step*	Ion Run #1	Ion Run #2	Full Tool Polish	Ion Run #3	Ion Run #4**	Ion Run #5**	Ion Run #6**
Surface Figure Error							
Radius of Curvature							
Optical to Mechanical							
Micro-roughness							

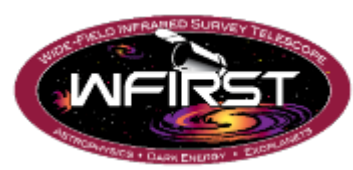
* Each step includes subsequent optical testing
 ** Includes cold and ambient optical testing

Currently Meets Requirement	On Plan To Meet Requirement	Not On Plan to Meet Requirement
-----------------------------	-----------------------------	---------------------------------

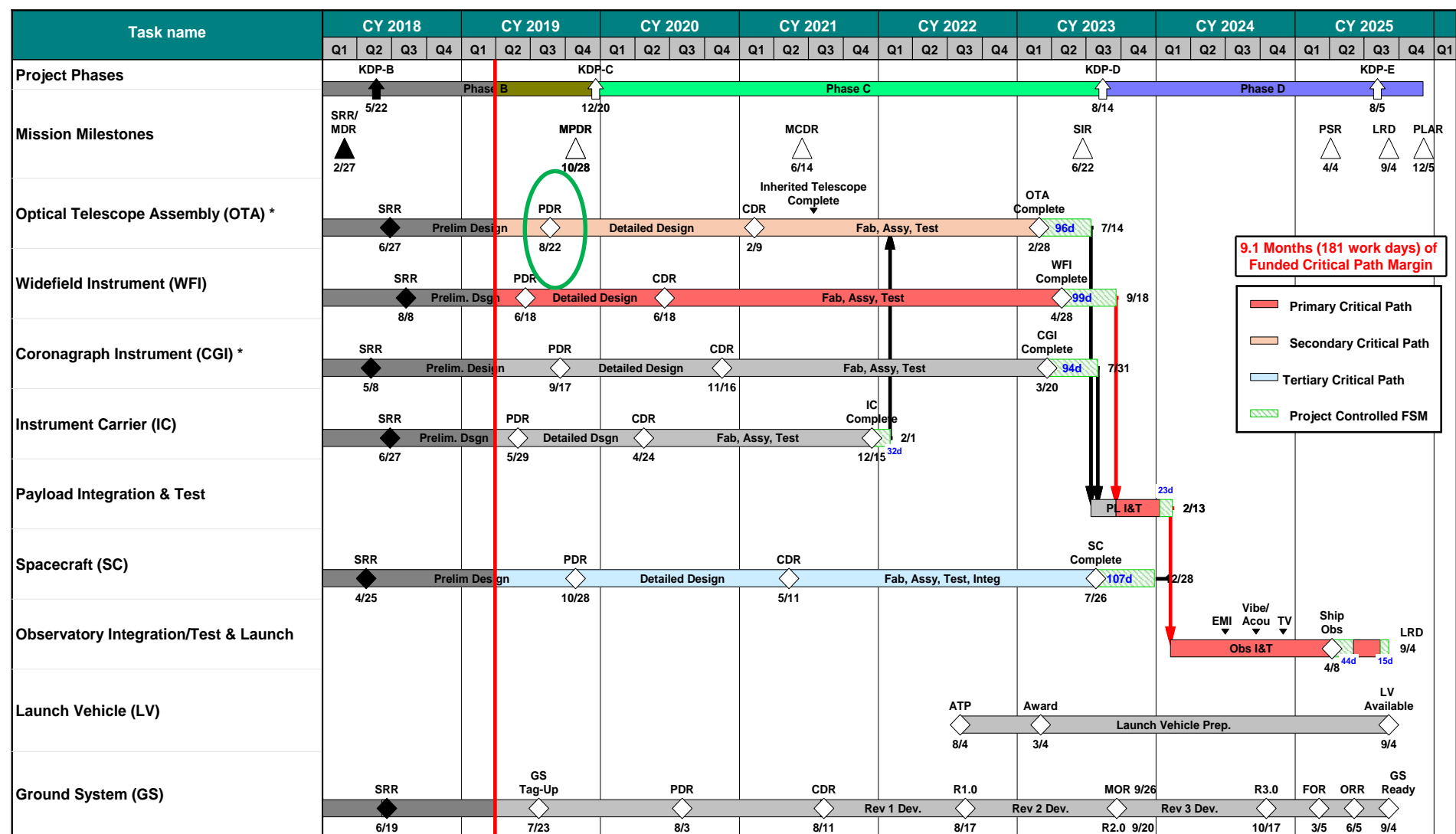
PM Finishing Convergence Summary

- 2 Ion Iterations and 1 full tool polishing iteration complete
- 4 Ion iterations remaining in plan (inclusive of 2 cold figuring iterations)
- Expect all parameters within specification per baseline plan
- PM Completion Milestone:
 - Plan: 9/30/2020
 - Current ECD: 5/20/2020 (as of 7/22/2019)

Full Tool Polishing Successful. PM Tracking Overall Plan.



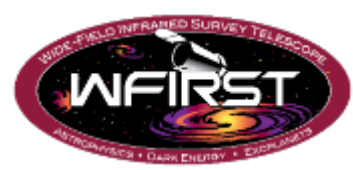
OTA is Two Months off Critical Path



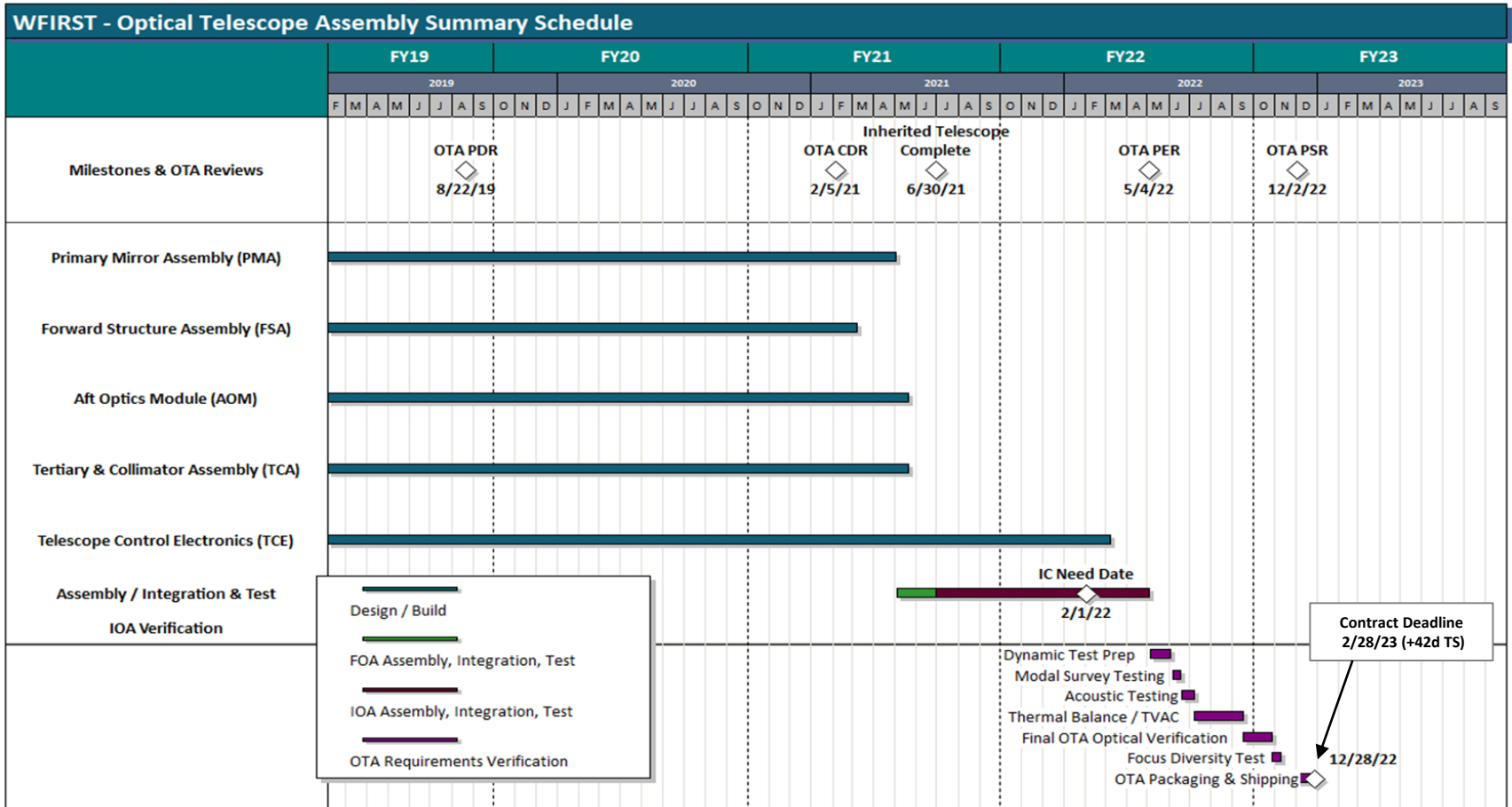
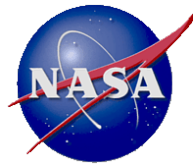
9.1 Months (181 work days) of Funded Critical Path Margin

- Primary Critical Path
- Secondary Critical Path
- Tertiary Critical Path
- Project Controlled FSM

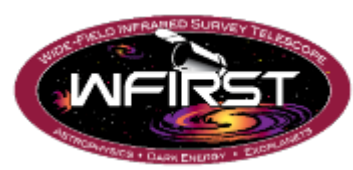
*Secondary critical path is occupied by the Optical Telescope Assembly (OTA) in lieu of the Coronagraph Instrument (CGI), which is designated as a technology demonstration



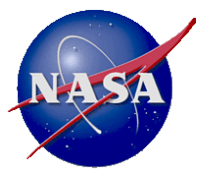
OTA Schedule



Progress against OTA Schedule is tracked weekly with focus on critical path, late starts/finishes, and key milestone dates



Context for the OTA – PDR

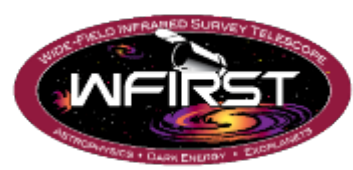


- **Inherited Hardware**

- WFIRST has inherited hardware: inherited components and heritage design, processes, and GSE for Forward (Cassegrain-like) Optics, actuators, and metering structures. These would drive mission critical path if they did not exist already.
- The inherited hardware enables the WFIRST mission to achieve an additional 3x in collecting area and 2x resolution over the decadal design, and support for the second instrument, i.e. the coronagraph.
- LOTAYH: Love the Optical Telescope Assembly You Have

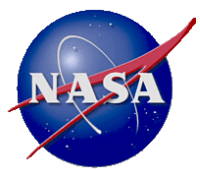
- **WFIRST is a cost-capped mission**

- WFIRST is a cost-capped mission and is operating in an environment where costs are scrupulously evaluated at all levels from multiple independent entities.
- The WFIRST mission must find a technical and programmatic solution that fits with-in the cost cap.



WFIRST

Wide Field Infrared Survey Telescope



Adapted by D. Content from
Ryan McClelland - §02 IC Overview
WFIRST Instrument Carrier (IC) PDR
5/29-30/2019

Outline

- IC Architecture
- Changes since SRR
- Procurement Strategy
- Highlights of Work Since SRR

Structure

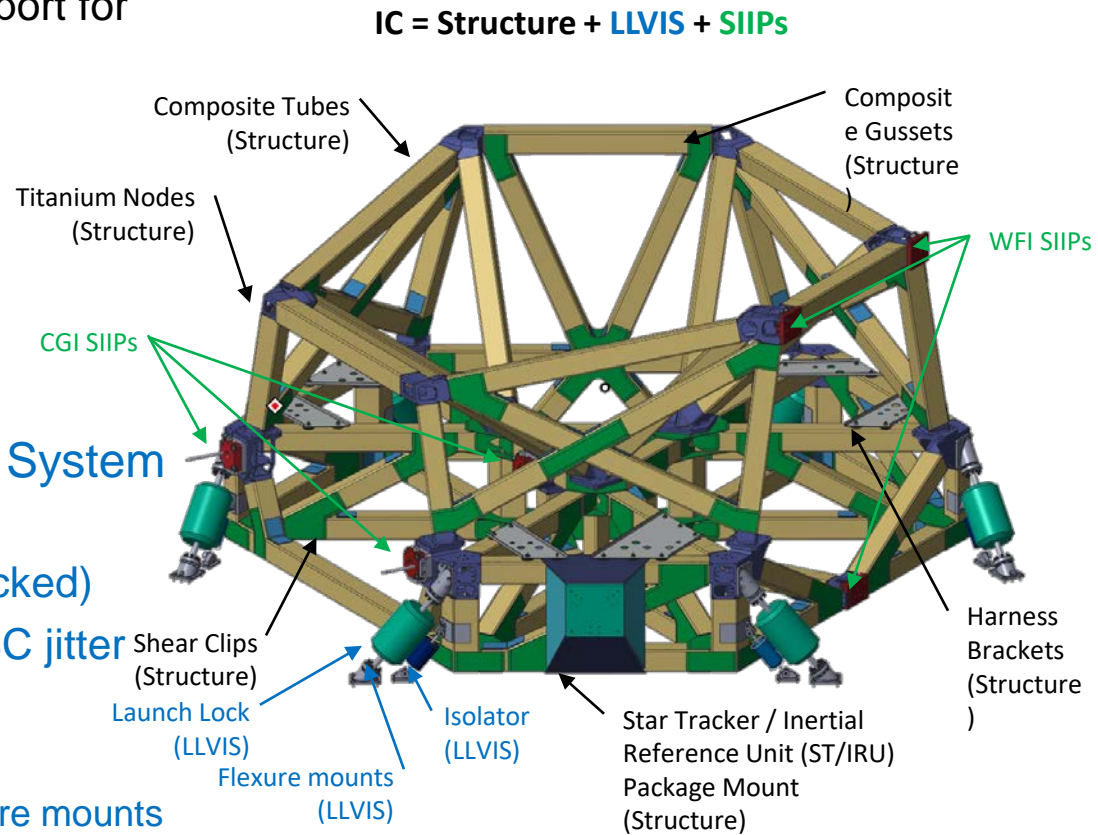
- Provides stiff, strong, and stable support for WFIRST Payload
- Similar construction to JWST ISIM
 - Leveraging lessons learned
- Includes:
 - Composite tubes and gussets
 - Ti nodes and clips; Harness brackets
 - ST/IRU mount

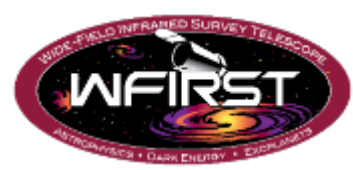
Launch Lock and Vibration Isolation System (LLVIS)

- Mounts Payload to SC for launch (locked)
- Isolates the WFIRST Payload from SC jitter (unlocked)
- Includes:
 - Launch lock; Vibration isolator; Flexure mounts to IC and SC

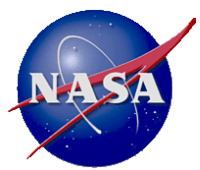
Science Instrument Interface Plates (SIIPs)

- Align instruments to telescope pupils
- Similar to ISIM SIIPs
 - Leveraging lessons learned

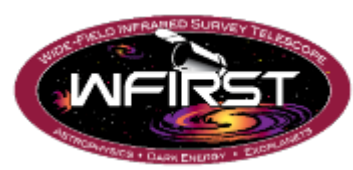




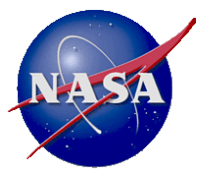
Changes Since SRR



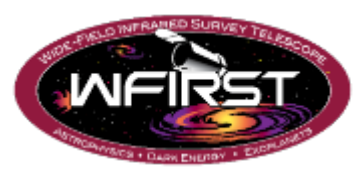
- LLVIS (Launch Lock and Vibration Isolation System):
 - Changed from refurbished inherited Honeywell D-struts (sole source) to parallel Launch Lock and Isolator (build-to-Spec, competitive procurement)
 - CTE mismatch between Composite IC and Aluminum SC caused thermal distortion that bottomed out the D-struts and shorted isolation
 - Previously called Payload Vibration Isolation System (PVIS)
- WFI Interface:
 - Interface plane changed from horizontal to vertical
 - IC added beams and moved nodes
 - Latches changed from 3-2-1 to 2-2-2 flexures
- CGI Interface:
 - Latches changed from 3-2-1 to 2-2-2 flexures
- Heaters added to IC structure
 - IC was going below 170 K survival limits as thermal design and analysis matured



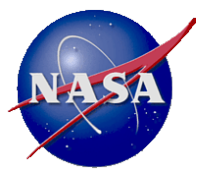
Procurement Status



- Structure
 - Risk reduction activities completed or in-work
 - Coupon testing to verify composite properties
 - Coupon testing to verify bond and material strength
 - Tube fabricated to flight dimensions and requirements (made by ATK)
 - Test fabrication of most complex node to prove out machining and heat treatment process (SRR RFA)
 - Large Titanium forgings for nodes received at GSFC
 - Released RFI; Vendor responses meet IC cost and schedule
 - Released Structure RFP
- LLVIS
 - Build-to-Spec competitive procurement for Launch Lock and Isolator (cost-plus)
 - Honeywell contract kickoff at GSFC this week (8/1)
 - Flexure mounts fabricated in-house
- SIIPs
 - Fabricated in-house



Highlights of Work Since SRR – normal phase B scope, moving into phase C



- **Systems**

- Released IC RD Rev A
 - Reflects changes since SRR
- Drafted ICDs and MICDs
 - Reviewed with stakeholders

- **Structure**

- Matured design and analysis
 - Draft drawings of tubes, gussets, clips, and selected nodes completed
 - Detailed FEM of several nodes completed
- Delivered FEM models to support IM
- Purchased and received Titanium for nodes
- Released RFI
 - 3 vendors responded, responses meet cost and schedule allocations
- Held Structure EPR

- **SIIPs**

- Closed liens on Latch designs
- Matured design and analysis
- Develop plan for alignment and metrology
- Held Latch/SIIPs EPR
- Transferred flexure responsibility to instruments

- **LLVIS**

- Closed lien on design
- Released RFP and received vendor proposals
 - Held Tabletop review of requirements
 - Released Spec, SOW, and DILs
 - Currently in procurement black-out
- Matured design of LLVIS mounting to IC and SC

- **Thermal**

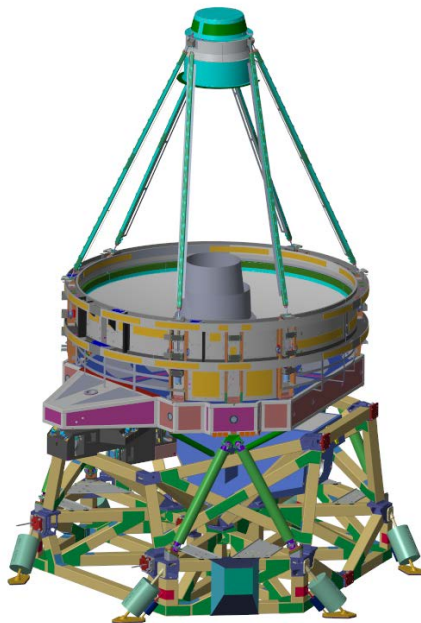
- Added heaters
- Matured analysis
- Supported STOP analysis
- Held Thermal EPR

- **AI&T**

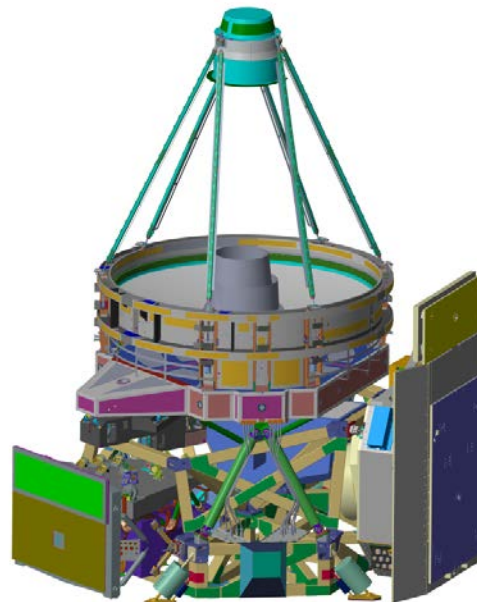
- Matured AI&T plan
- Developed metrology plans
- Identified requirements and started development of MGSE

IC Post Delivery Configurations

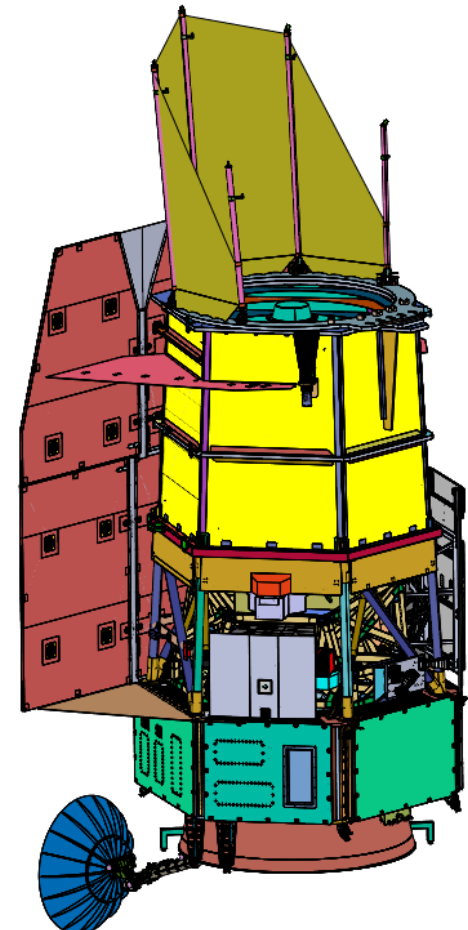
- Shipped to Harris for integration with Imaging Optics Assembly (IOA)
 - Performance and environmental testing of IC+IOA
- IC+IOA shipped back to GSFC
 - Instruments aligned and integrated to form the Integrated Payload Assembly (IPA)
 - Final set of SIIPs machined
 - Performance and environmental testing of IPA
- IPA integrated to SC at GSFC to form the Observatory
 - Performance and environmental testing of Observatory
 - Release test of LLVIS being developed



IC+IOA



IPA



Observatory



Instrument Carrier Summary Schedule

