

RST Optical Telescope Architecture and Build Progress

Mirror Technology Days

L3Harris Technologies

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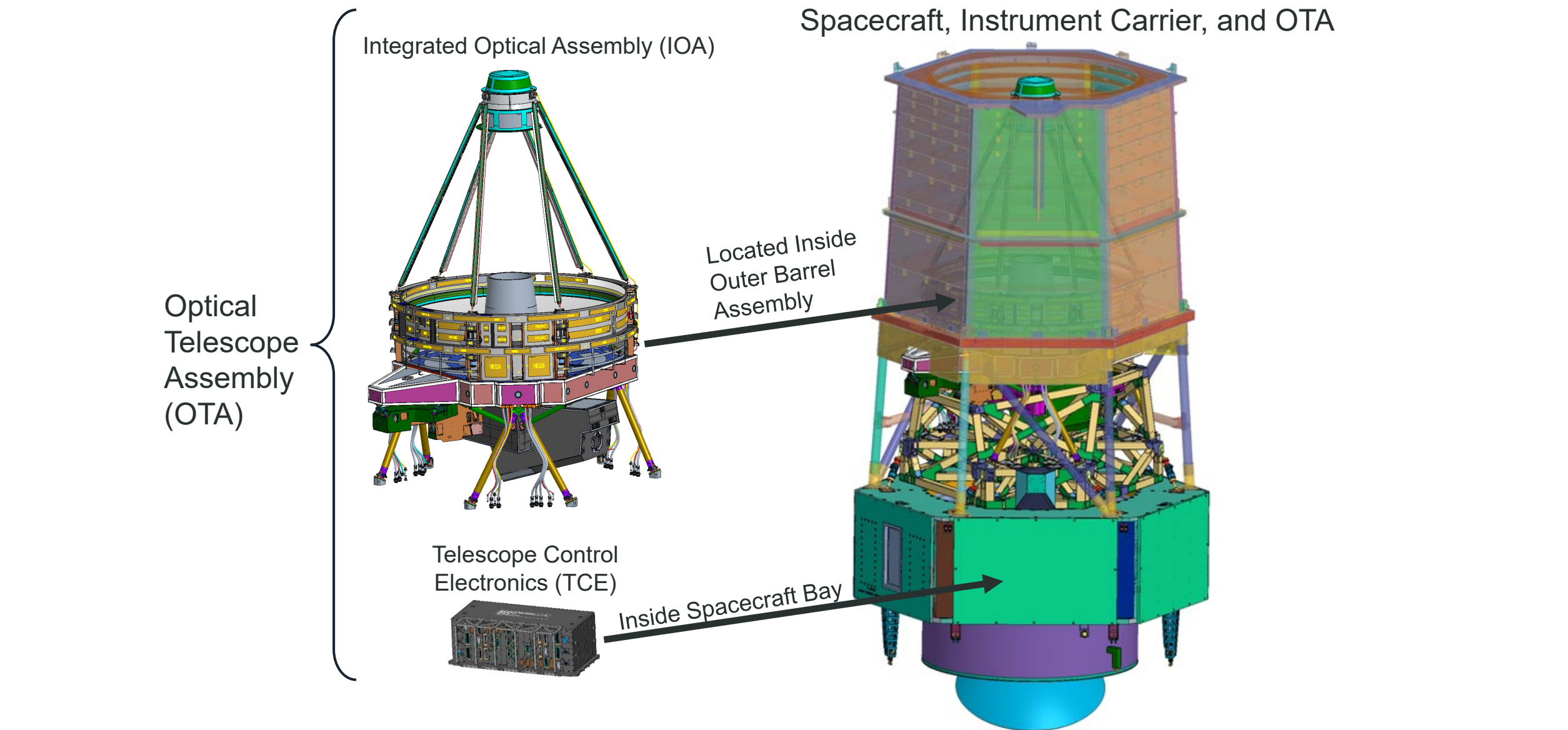
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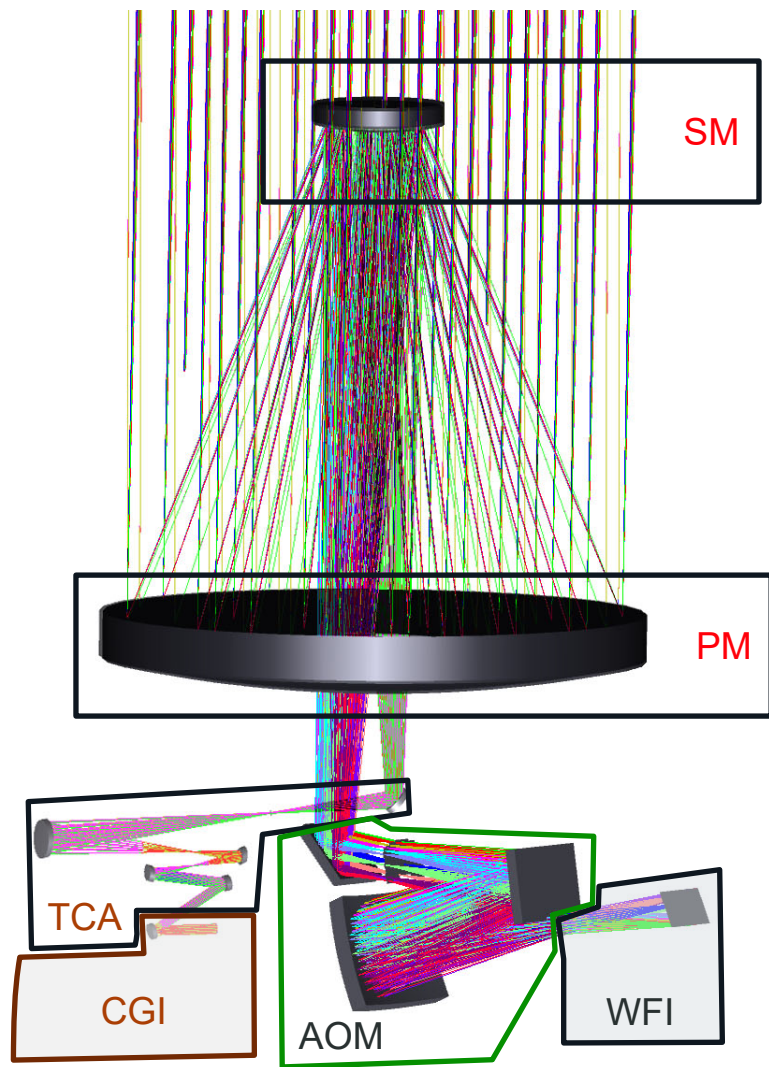
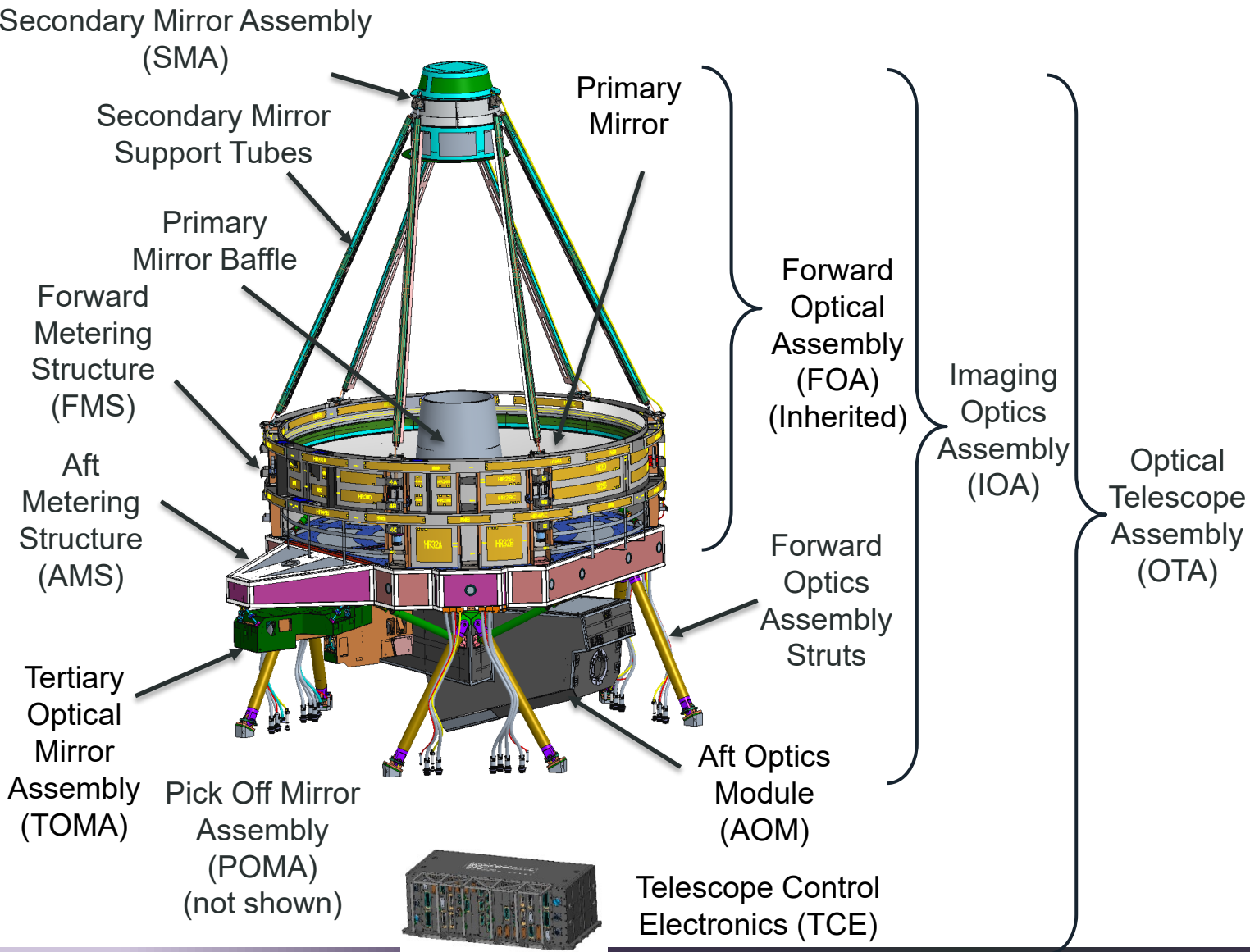
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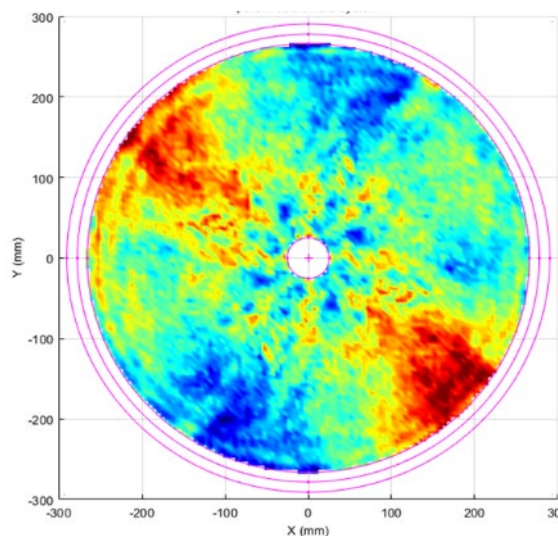
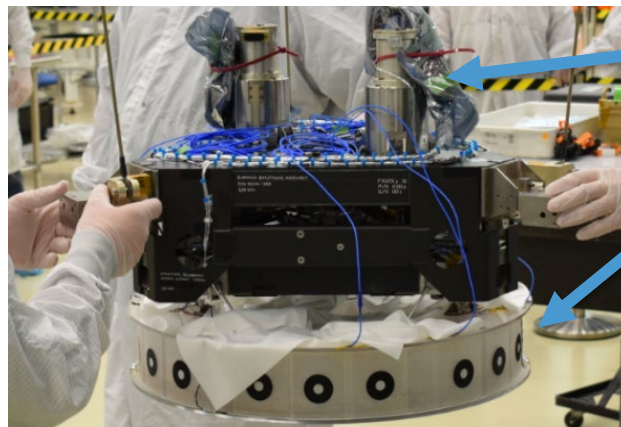
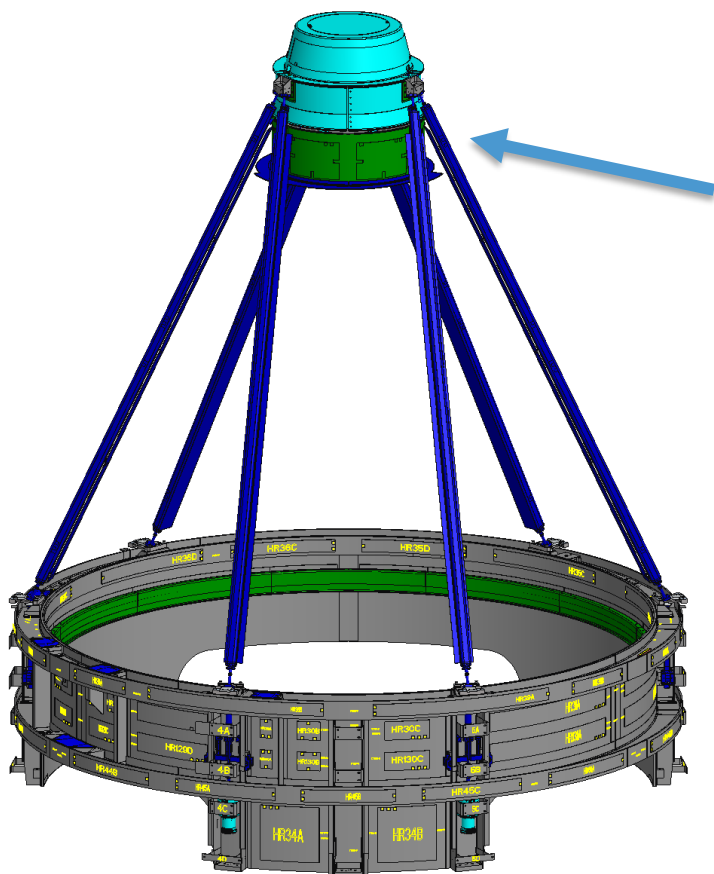
Optical Telescope Assembly In the Observatory



OTA Design Overview (December 2020)

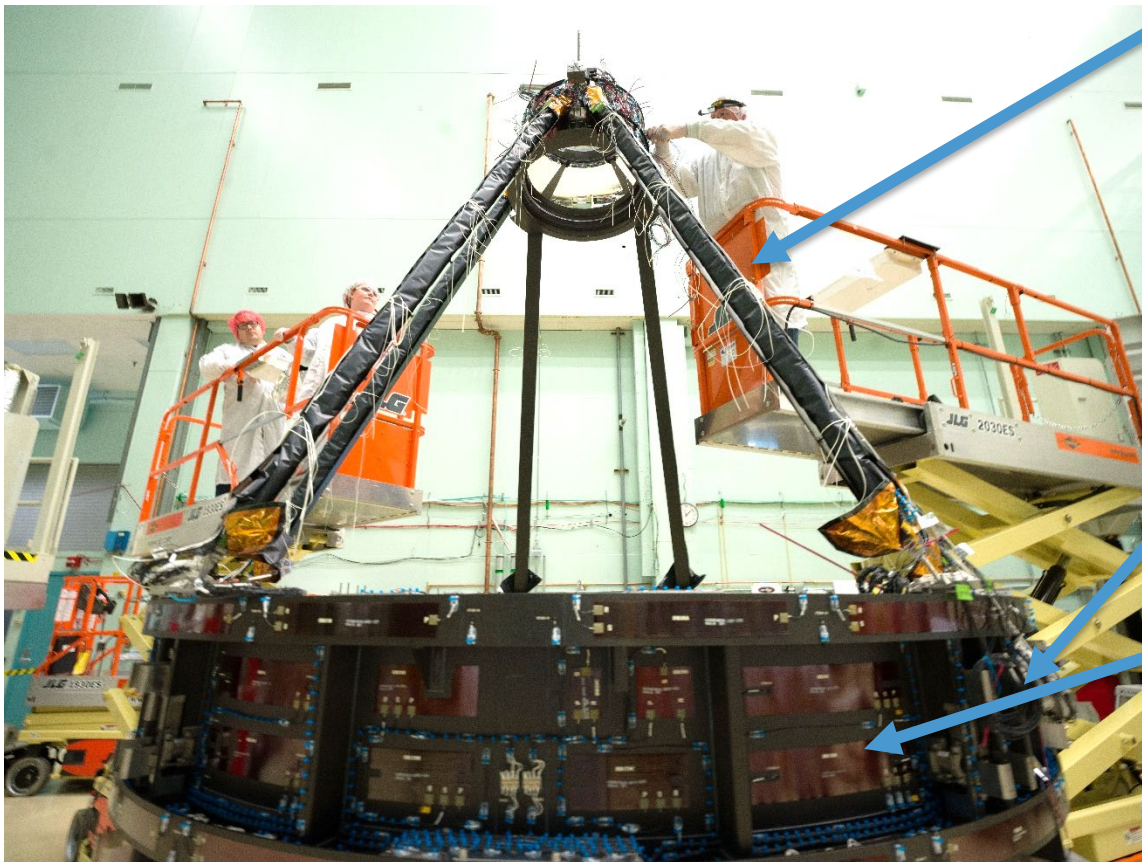


Secondary Mirror Assembly Completed Testing



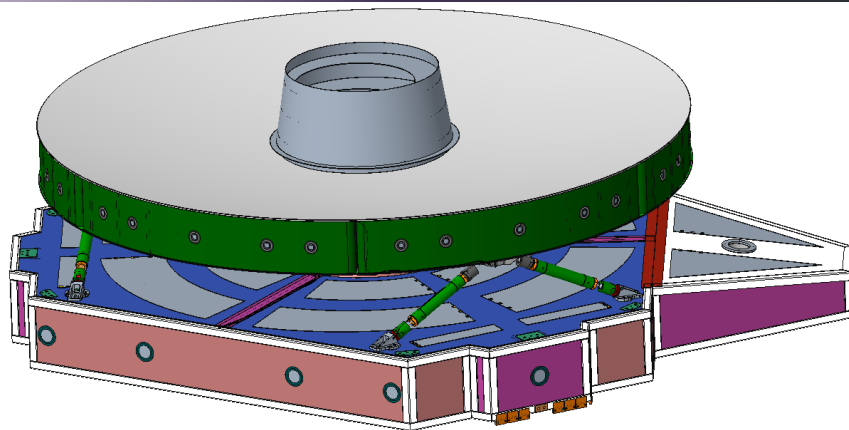
- **Redundant Focus Drive actuators**
 - Fine focus control of secondary mirror keeps WFE drift under 21 nm RMS
- **Mirror**
 - Mirror coating stripped
 - Re-figured to the RST prescription
 - Protected silver coating applied
- **Cover, baffle, and scraper**
 - Supports blankets and heaters to surround mirror with uniform temperature
 - Temperature set to 267 K to lower near infrared emission
 - Scraper designed for RST stray light clipping
- **Mirror assembly**
 - Extrapolated in zero gravity and at temperature, SFE = 12 nm RMS
- **All assemblies thermal cycled and strength tested**

Forward Structure Assembly with Secondary Mirror



- **Secondary Mirror Support Tubes (6)**
 - Design dialed into minimum CTE at RST temperature
 - Wrapped in heaters and insulation to tightly control temperature for optical stability (next presentation from Peter Miller)
 - Stray light scrapers along the length of the ~2.4 m tubes to block stray light reflection off insulation
- **Alignment Drives (6)**
 - Push / pull from bottom of struts for 5 degree of freedom alignment of Secondary Mirror
- **Forward Metering Structure**
 - Inherited assembly stripped of expired and incompatible hardware
 - Supports blankets and heaters to surround Primary Mirror with uniform temperature
- **All assemblies thermal cycled and strength tested**
- **Nearing completion of wiring and cabling before lifting onto the Primary Mirror Assembly**

Primary Mirror Assembly in Mechanical Testing



- **Inherited assembly stripped of expired and incompatible hardware**
- **40 kg / m² Mirror**
 - Mirror coating stripped
 - Re-figured to the RST prescription
 - Protected silver coating applied
- **Struts**

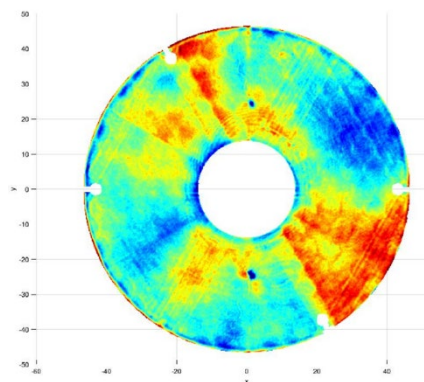
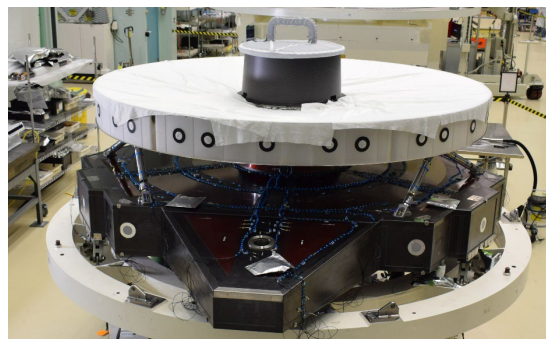
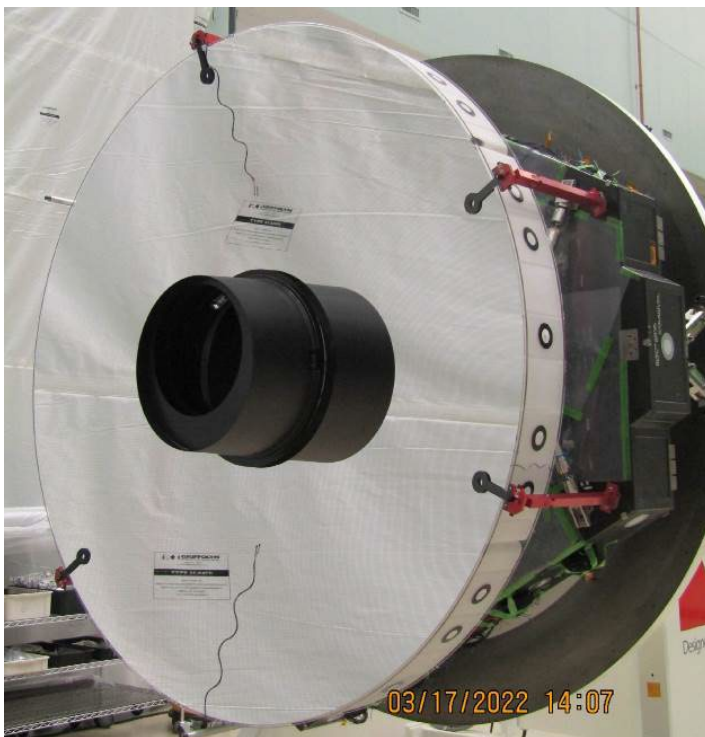
- Designed for low CTE at 267 K

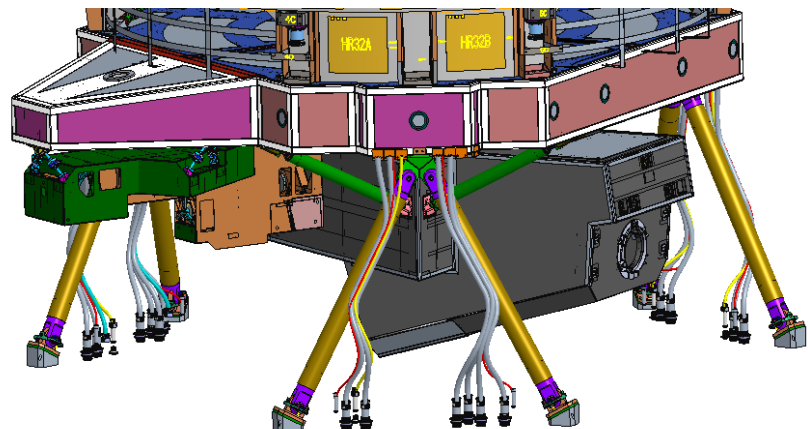
Aft Metering Structure

- 0.28-meter-thick ribbed boxed panel
- Load tested up to 61 kN in 32 unique load configuration

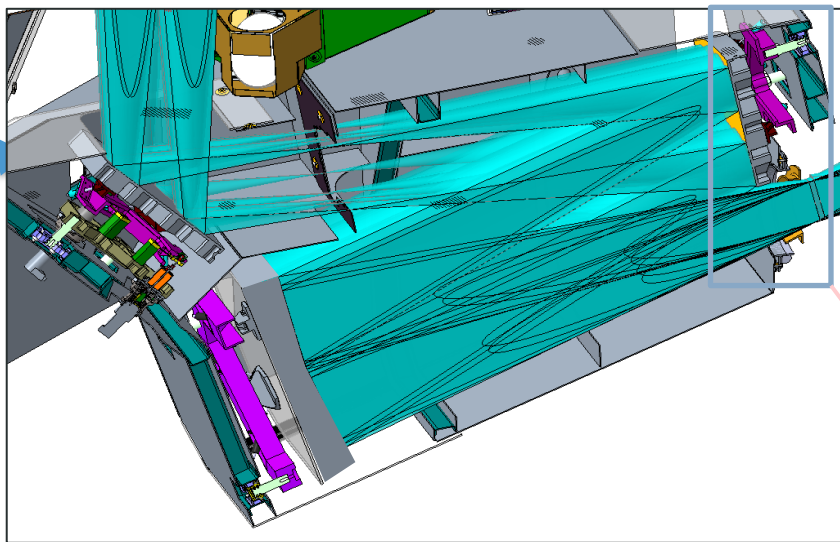
Mirror Assembly

- Optically tested at operating temperature in vertical orientation
- Gravity model validated to < 5%
- Extrapolated surface figure error (SFE) in 0g at temperature is 16 nm RMS with 13 nm uncertainty (total of 21 nm)
- Vibration tested and ready for integration to Forward Structure Assembly





From SM

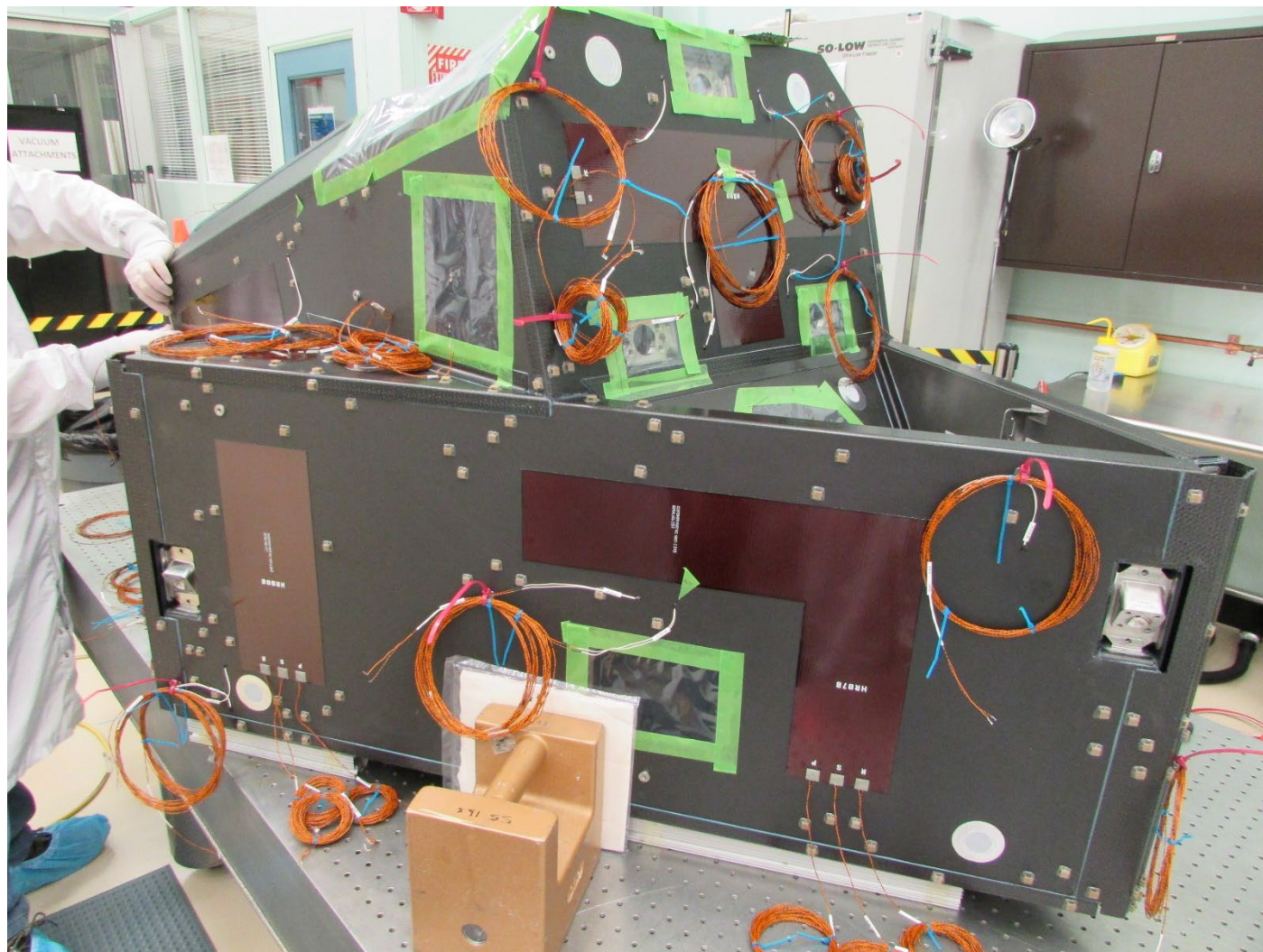


To WFI



- Optical path compressed to fit within the space constraints of the instrument carrier and the Wide Field Instrument
- Mounts to the underside of the AMS using three bi-pod strut pairs
- 47 K gradient from AMS mount to AOM structure
- First fold mirror has three (3) actuators for tip, tilt, and focus compensation

Aft Optics Structure



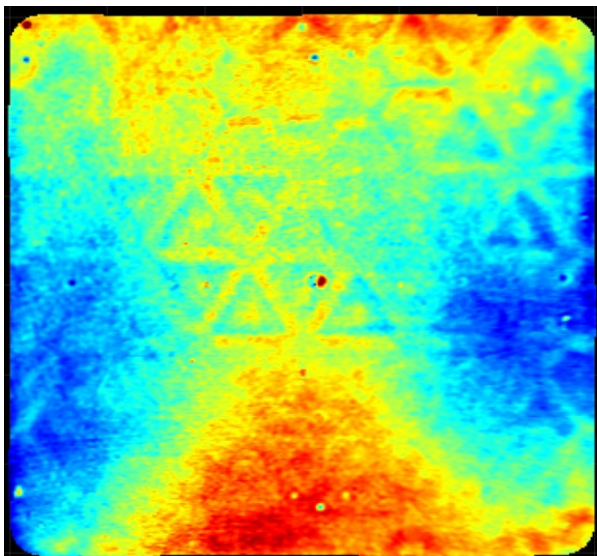
- **Struts**
 - Thermal cycled
 - Load tested

- **Structure**
 - Thermal cycled
 - 18 load test cases
 - Modal survey completed
 - Thermal and electrical hardware installation underway

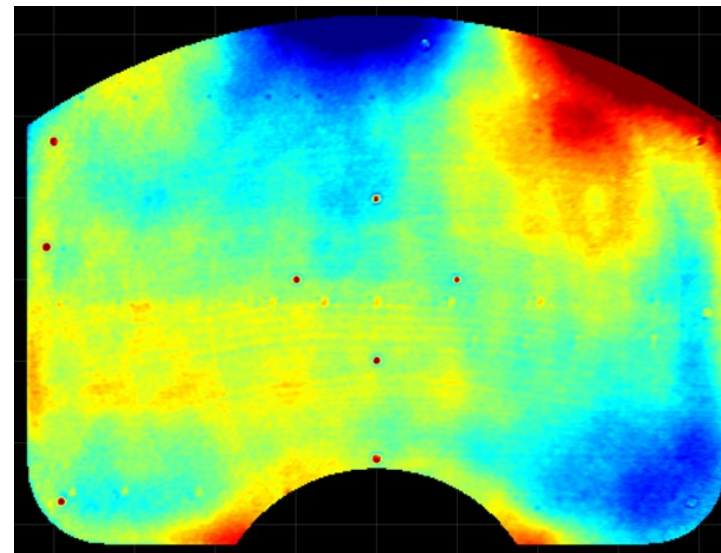
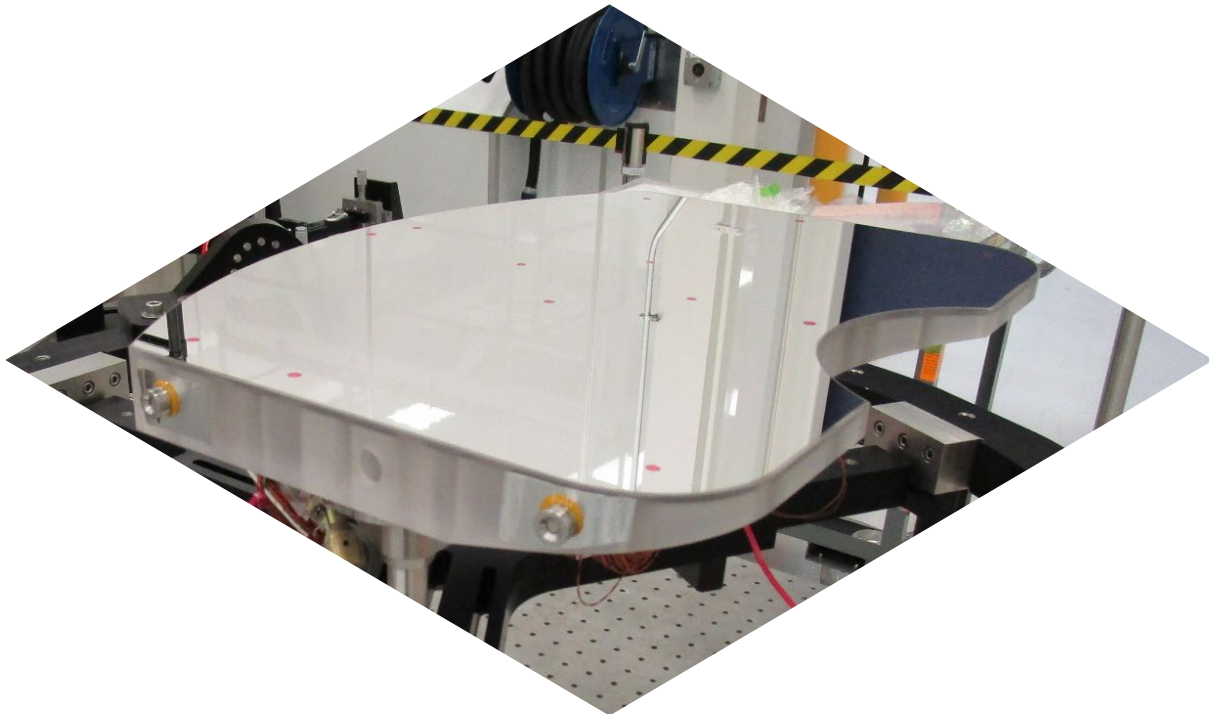
AOM Fold Mirror 1



- Coated and assembled with reaction structure
- Ready for integration when the actuators complete testing
- Extrapolated surface figure error is 5.4 nm RMS including uncertainty over the beam footprint

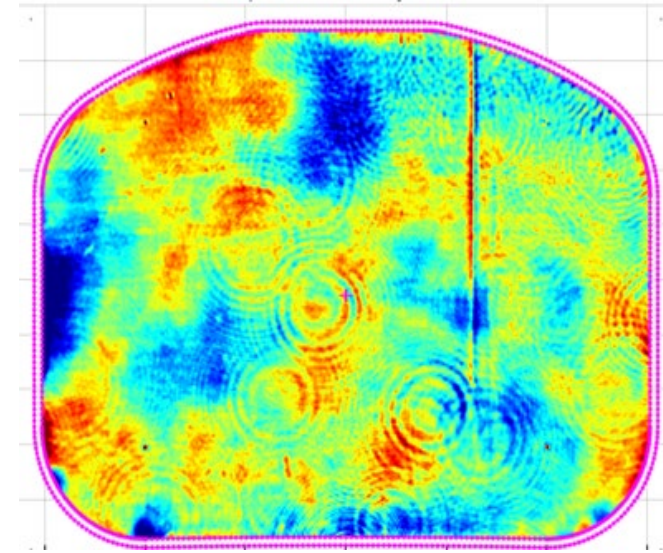


AOM Fold Mirror 2



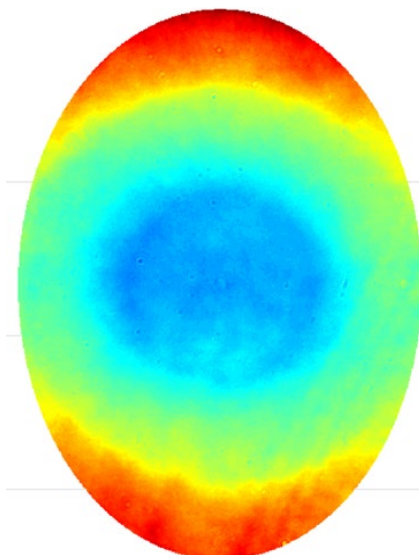
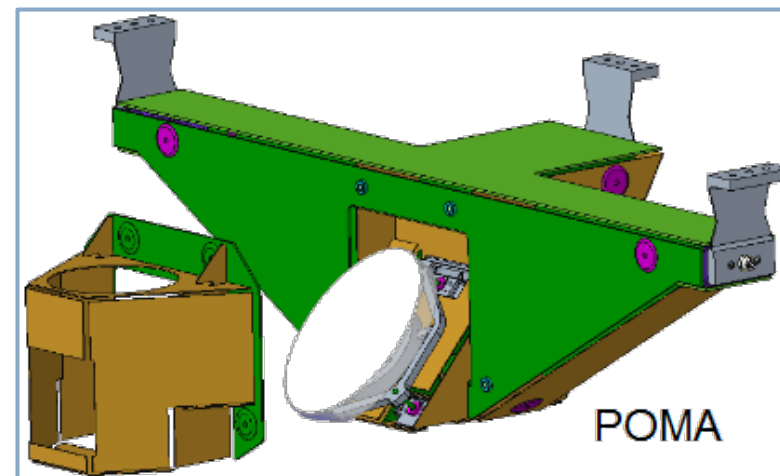
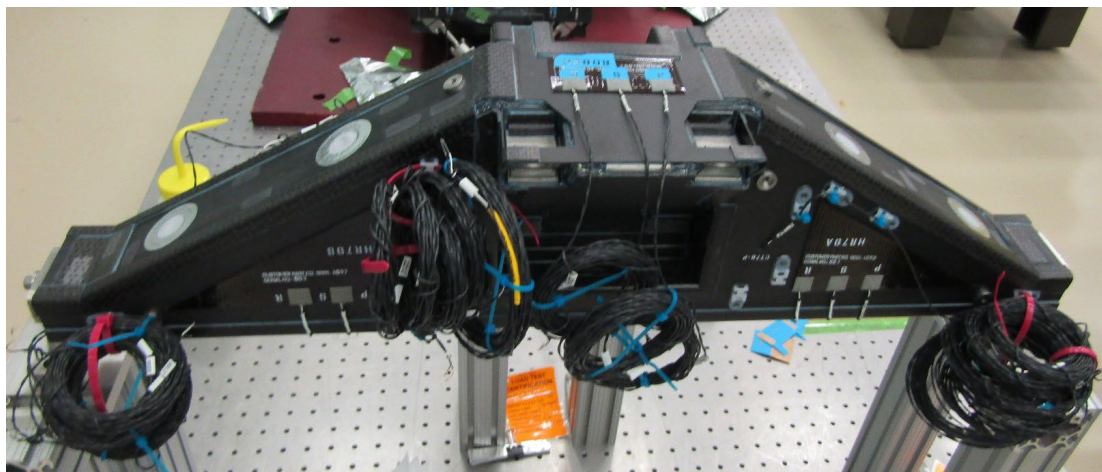
- Mirror assembly complete and thermal cycled
- Currently in vibration testing
- Extrapolated surface figure error is 4.4 nm RMS including uncertainty over the beam footprint

AOM Tertiary Mirror



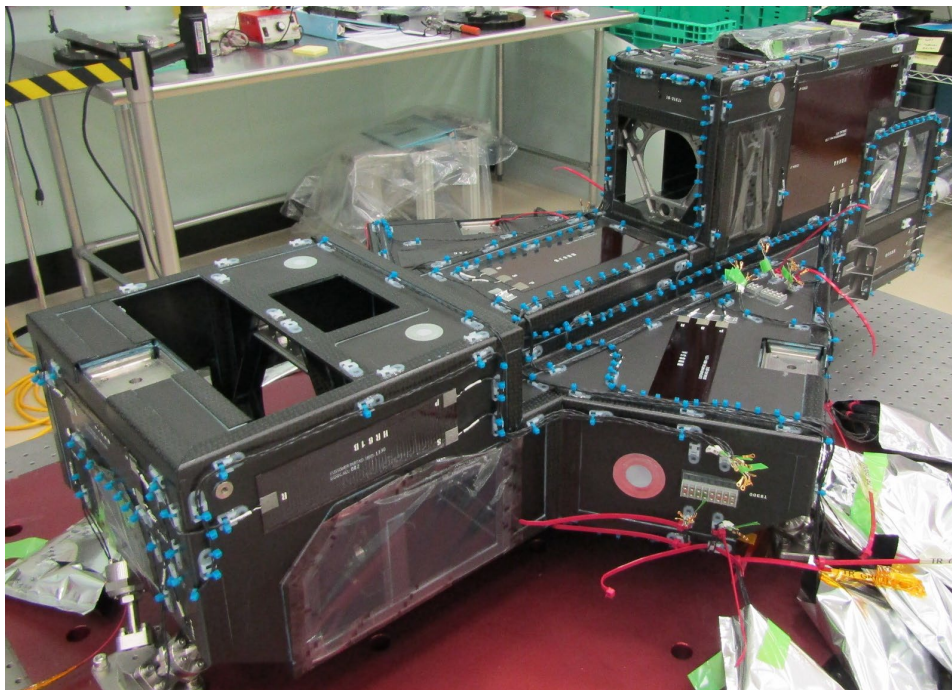
- Aspheric mirror assembly complete completed thermal cycling
- Preparing for optical test at operating temperature
- Extrapolated surface figure error is 9.2 nm RMS including uncertainty over the beam footprint

Pick Off Mirror Assembly Ready for Integration to PMA



- **Structure and optical assembly completed all tests and ready for integration to the Primary Mirror Assembly**
- **Structure and optical assembly separately integrated into the Primary Mirror Assembly**
 - Mirror assembly aligned to Primary and Secondary mirrors using optical metrology prior to integration
- **Extrapolated surface figure error including power is 15 nm RMS**
 - Power will be compensated by the integrated alignment

Tertiary Optical Mirror Assembly Structure Ready for Assembly

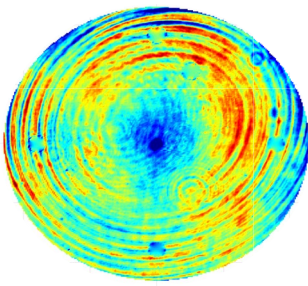
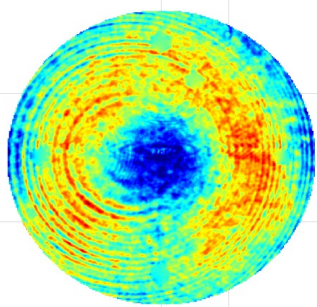
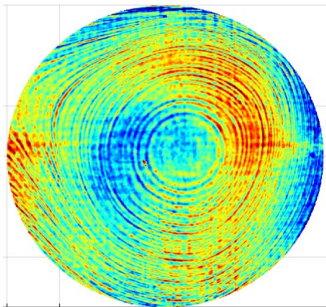
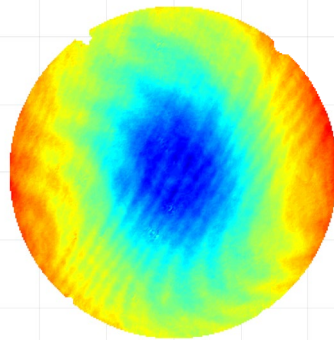
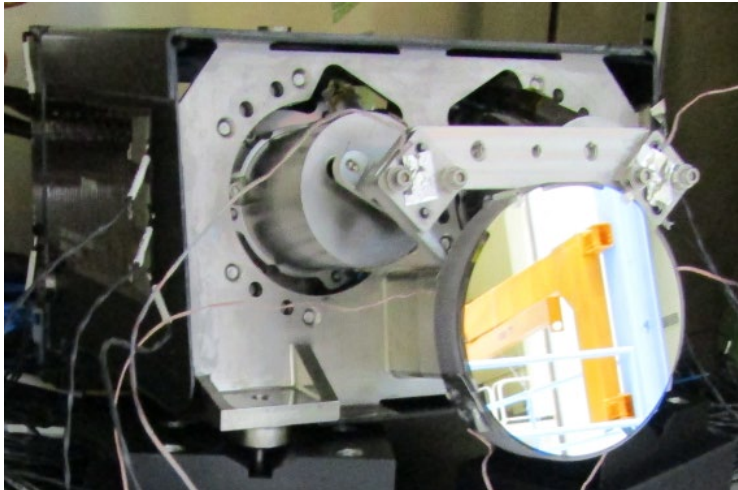
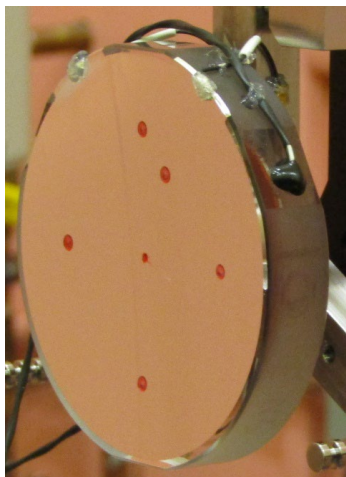
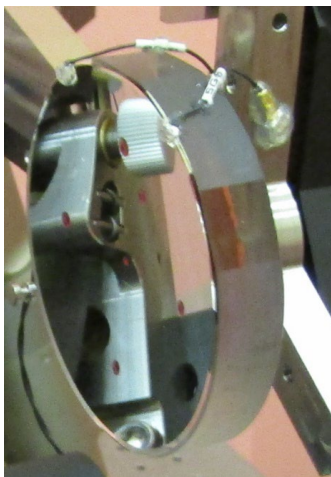
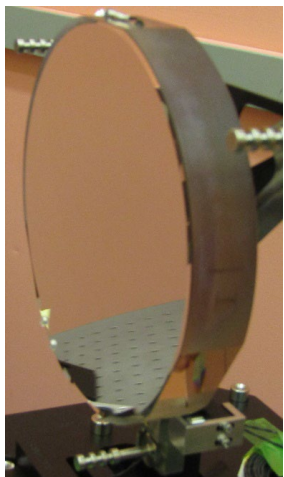


- Mounts to the underside of the AMS turtle tail with three bi-pod strut pairs
- Operates at room temperature with a 28 K gradient from TOMA to AMS mount
- Thermal and strength tested with 7 load configurations



- Thermal hardware and electrical hardware installed
- Currently aligning and integrating optical assemblies to complete when actuators are complete and integrated
 - Final flat mirror to be actuated with tip/tilt to move pupil position for the Coronagraph Instrument
- Followed by optical test of assembly

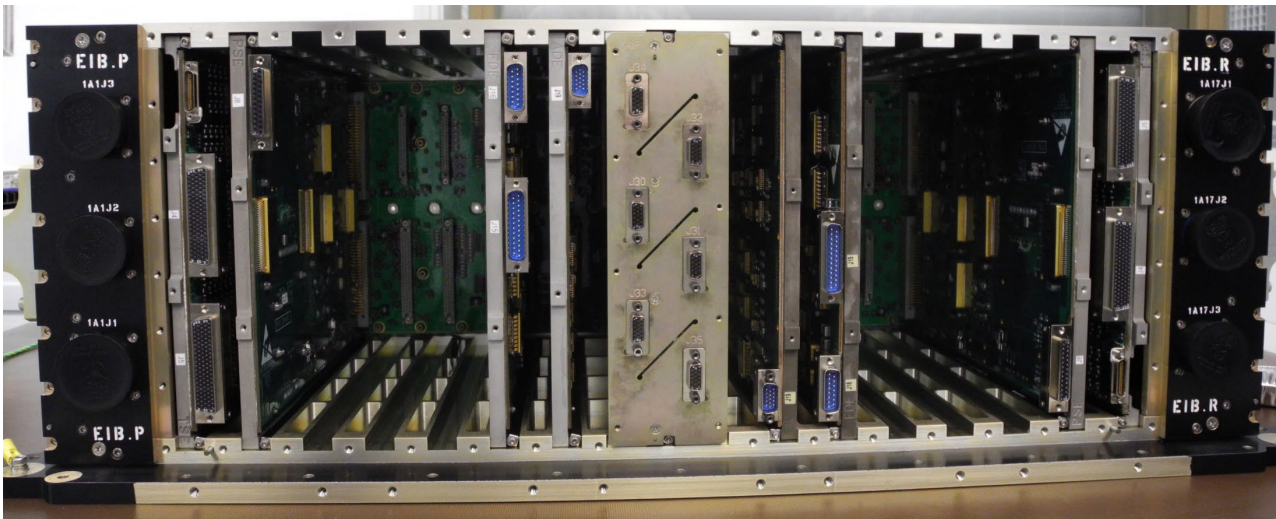
TOMA Mirror Assemblies



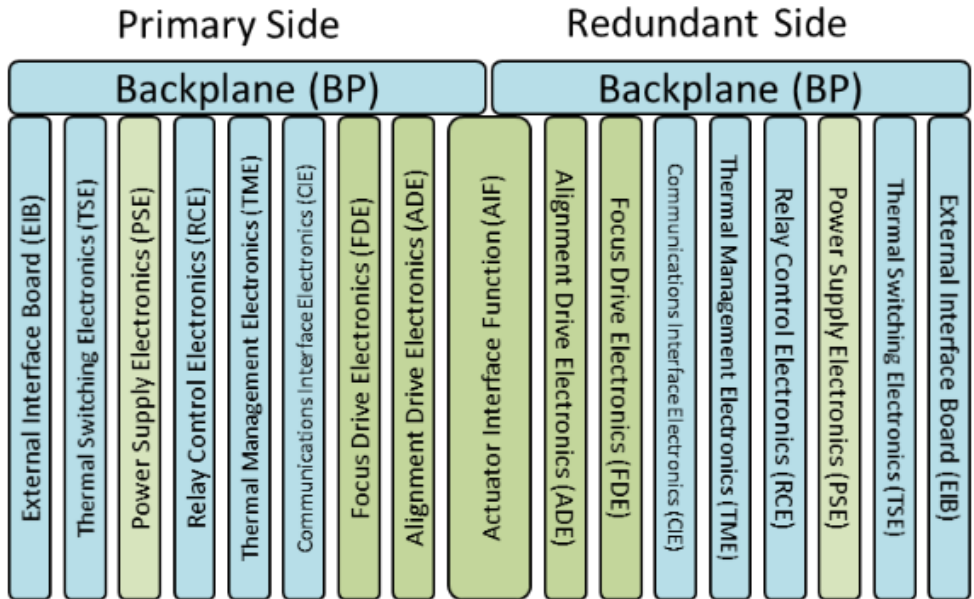
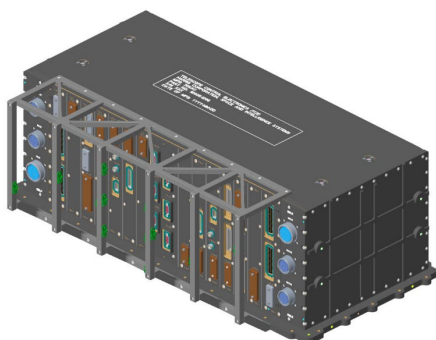
Mirror Assembly	Predicted Surface Figure Error over Footprint (nm RMS)	Including Uncertainty (nm RMS)
M3	12	4
M4	5.4	2.5
M5	6.7	3.1
TTF	17 (including power)	3.6

- **Three powered mirror assemblies tested and integrating into TOMA**
- **Tip Tilt Fold mirror assembly**
 - Tested and dry fit into TOMA
 - Complete when actuators completed and integrated

Telescope Control Electronics Assembly in Process

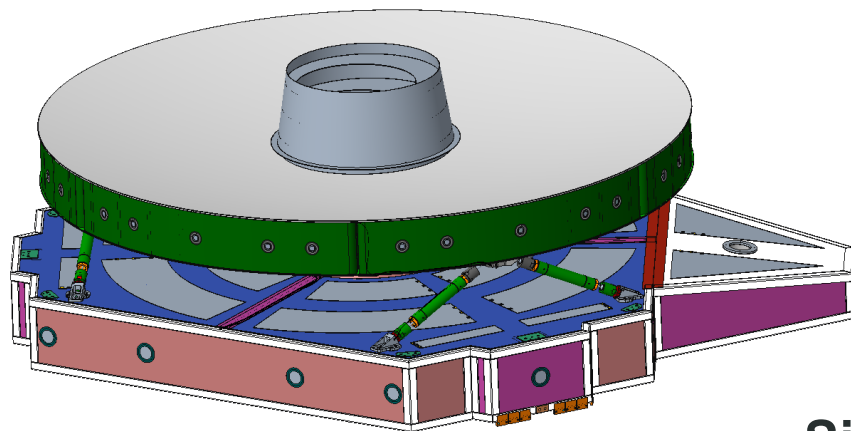


- Manages up to 96 heater zones per side with pulse-width modulation
- Includes thermal calibration sensing for RST optical stability requirements
- Drivers and position sensing for 13 actuators
- ~ 1 mK stability demonstrated with brassboards and thermal simulators in thermal vacuum chamber (next presentation by Peter Miller)



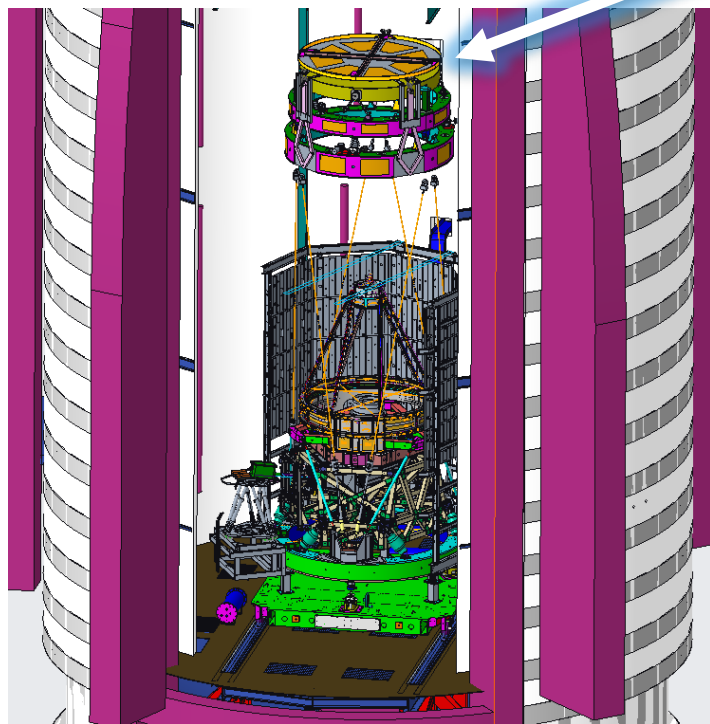
- Boards assembled, tested, and installing in chassis
- Then moving to environmental testing after an initial functional test

Struts between Optical Telescope and Instrument Carrier



- **Six bi-pod strut pairs with bearing at each end to support optical telescope mounted to instrument carrier**
 - Shown during thermal cycling
- **Load tested**
- **Preparing for thermal and electric hardware installation**

Thermal shroud partially removed



- FSA with SMA, POMA, TOMA, and the AOM structure with the actuated fold mirror integrated to the PMA outside of the chamber
- TOMA and rest of the AOM optical assemblies optically aligned using interferometry through telescope and auto-collimating flat mirror
- Optical alignment includes wavefront, pupil alignment and image position
- Primary mirror is gravity offloaded during interferometer testing
- Alignment checked at operating temperature
 - Some adjustment, if necessary
- Telescope is acoustic tested, sine vibration tested, and thermal balance tested
- Auto – collimating flat coated, mounted, and optically tested
 - Ready for integration to test equipment assembly
- Test equipment design and procurement under way

- **All mirrors and structures complete**
- **Nearly all the assemblies are complete or in testing**
- **TOMA integration started**
- **Forward Structure Assembly soon integrated on the Primary Mirror Assembly**