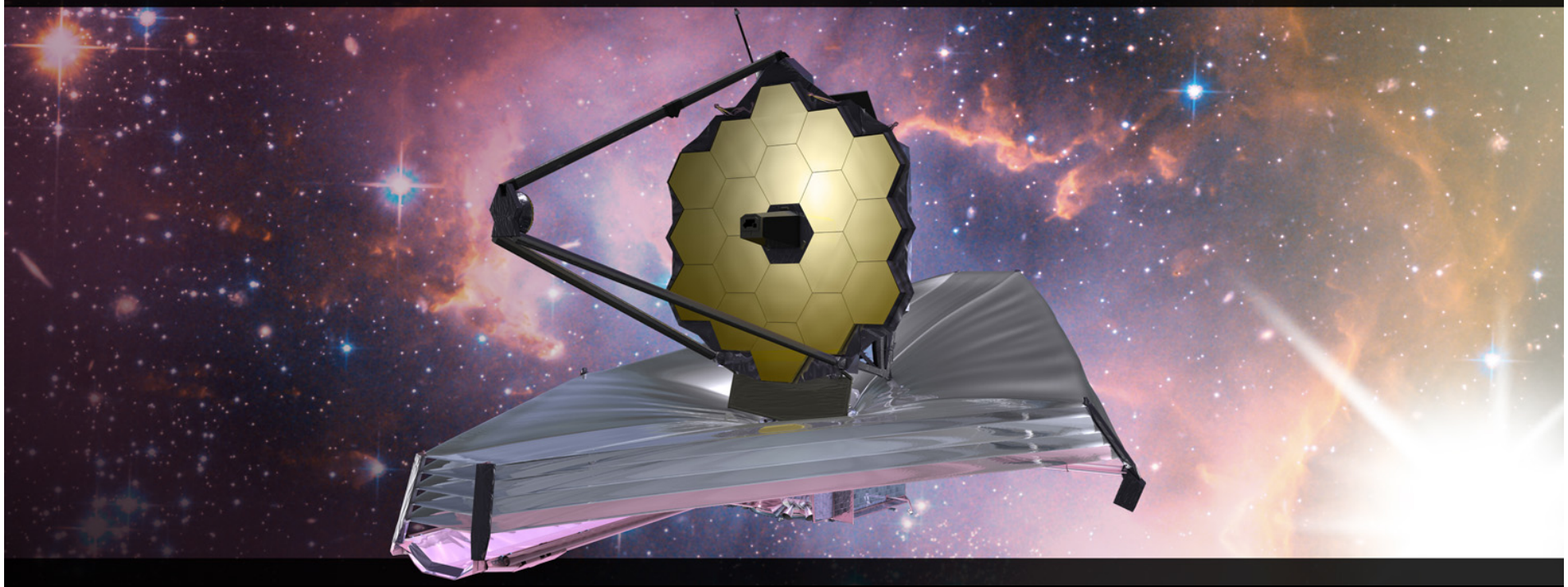
National Aeronautics and Space Administration



James Webb Space Telescope (JWST)

Board on Physics and Astronomy

Rick Howard

November 7, 2011

JWST on a new path

- **NASA has made significant changes in the management of JWST**
  - Response to ICRP report (http://www.ngst.nasa.gov/resources/JamesWebbSpaceTelescopeIndependentComprehensiveReviewPanelReport.pdf)
- **Communications have greatly improved between HQ, Centers and contractors, especially at senior management levels**
  - Open and honest dialogue, quick identification of issues and agreement on fixes
- **Assessment of alternatives completed**
  - JWST still the best value to achieve Level 1 performance
- **Completed a replan (9/23/2011) with an October 2018 launch date**
  - Plan has adequate cost and schedule reserves consistent with ICRP recommendation
  - Additional $44M in FY11 was approved by Congress
  - Replan is on track to support the FY13 budget process
  - Discussions between the Administration and Congress continue on FY12 budget

JWST made great progress in FY2011, achieving milestones within cost and schedule and is now executing to the new plan

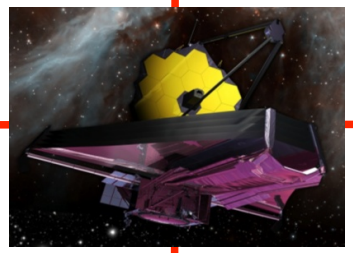
JWST Status

Telescope

- 18 flight (plus 1 spare) primary mirror segments are fully assembled
- All flight optics completed coating and vibration testing
- Final cryo testing of first 12 primary mirror segments has completed
- Final 6 primary segments begin last cryo test 10/24
- Flight backplane structure under development, center section nearing completion

Science Instruments

- MIRI completed all pre-ship tests
- ISIM Integration and Test underway, harness and ISIM command and data handling computer #1 also delivered to ISIM I&T
- Instrument deliveries to GSFC begin Spring 2012
- NIRSpec optical bench cracks delaying that instrument



Sunshield

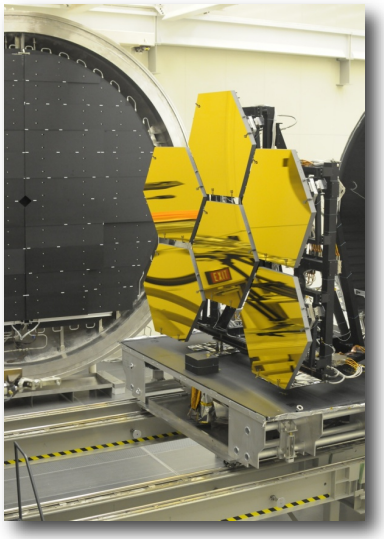
- 1/3rd-Scale Sunshield testing successfully complete (flight Sunshield verification test)
- Engineering Development Unit for layer #3 in test now in AL. Initial shape-under-tension measurements are good.
- All sunshield material for test units and flight layers in house.

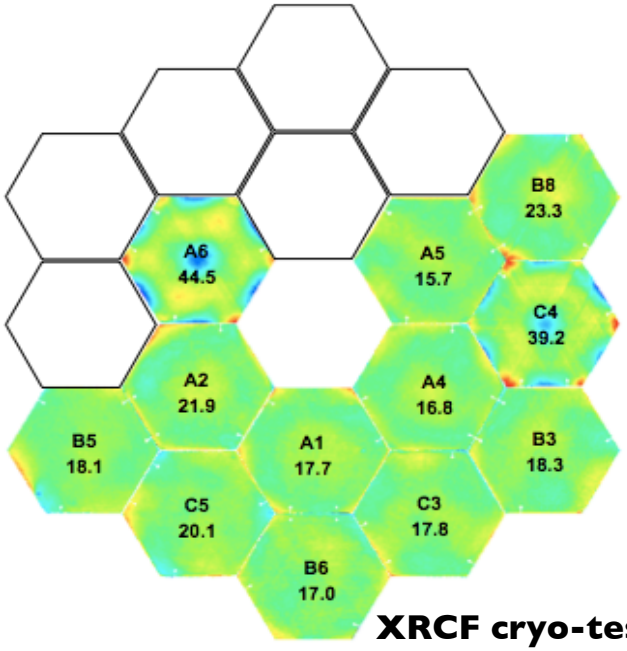
Spacecraft

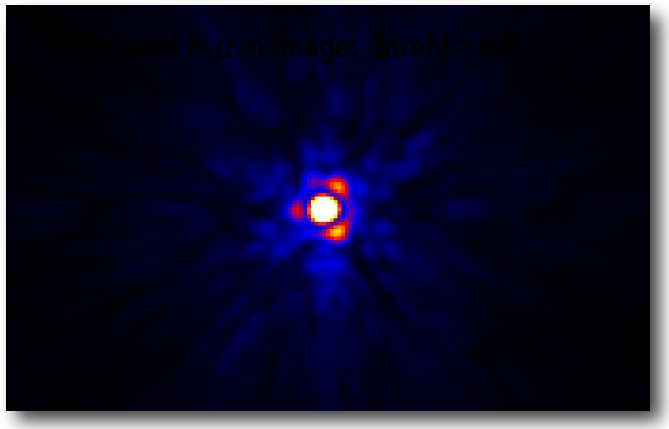
- Spacecraft design continues to mature
- Many components have completed Critical Design Reviews
- Engineering Model development underway/completed
- Flight solid state recorder complete
- Flight Software development underway

Mirror Cryo-Optical Testing

- **XRCF testing of the second batch of 6 PMSAs is complete**
- **Overall surface figure error (SFE) with 12 segments is 24.2 nm RMS**
  - Primary Mirror (18 segment) SFE requirement is = 25.8 nm RMS
  - Projected SFE for 18 segment primary Mirror is ≤ 24.6 nm
  - A6 and C4 PMSA segments do not meet their individual SFE specification, but that is accommodated by allocated margin at the primary mirror level.



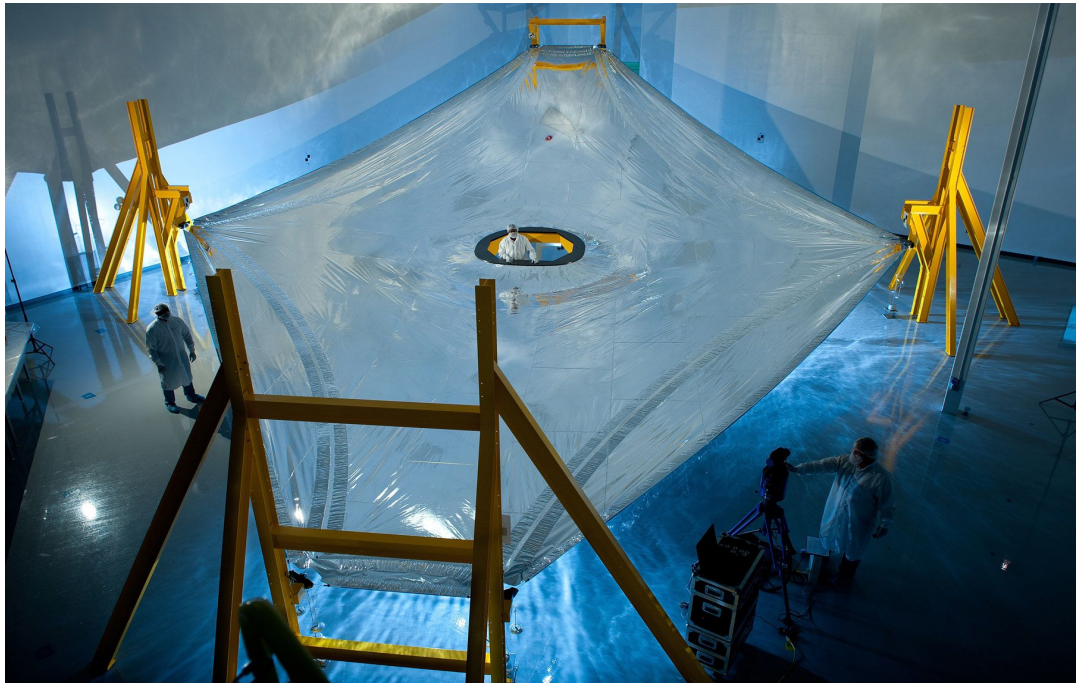




XRCF cryo-test results

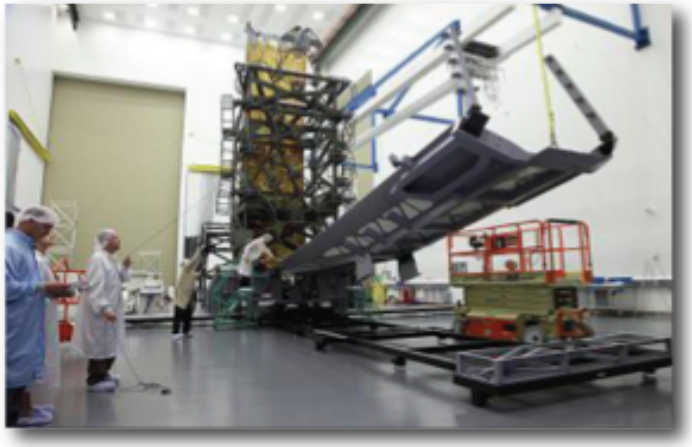
Sunshield

- **Template membrane build to flight-like requirements for verification of:**
  - Shape under tension to verify gradients and light line locations
  - Hole punching & hole alignment for membrane restraint devices (MRD)
  - Verification of folding/packing concept on full scale mockup
  - Layer 3 shape measurements completed

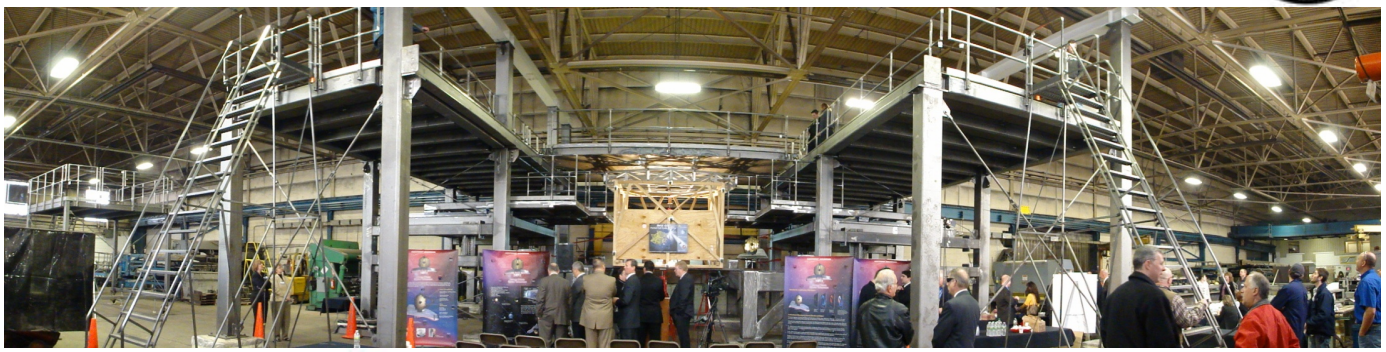


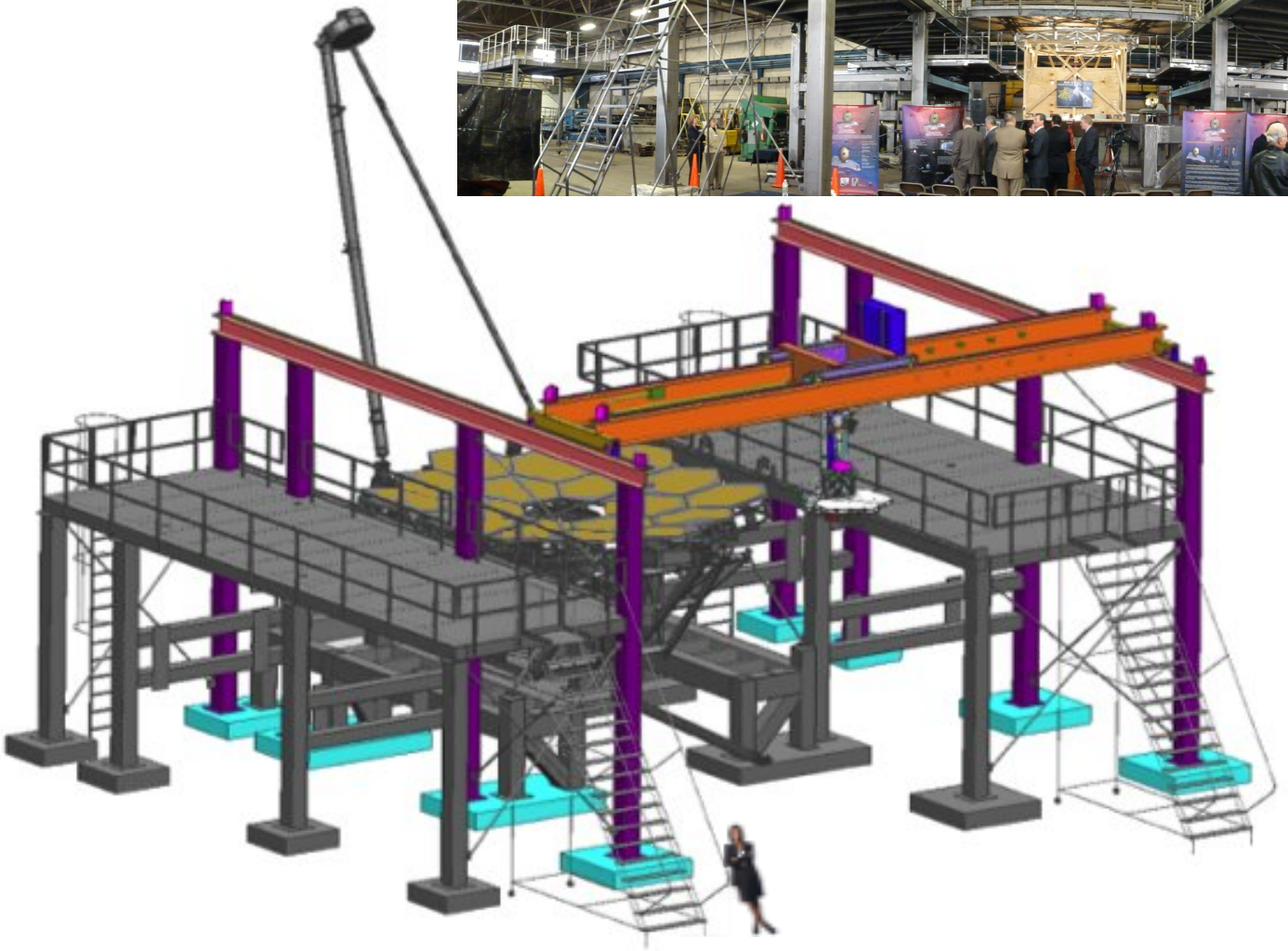
←Layer-3 template membrane under tension for 3-D shape measurements at Mantech

Full-scale JWST mockup with sunshield pallette ↓



Completion of Ambient Optical Alignment Stand

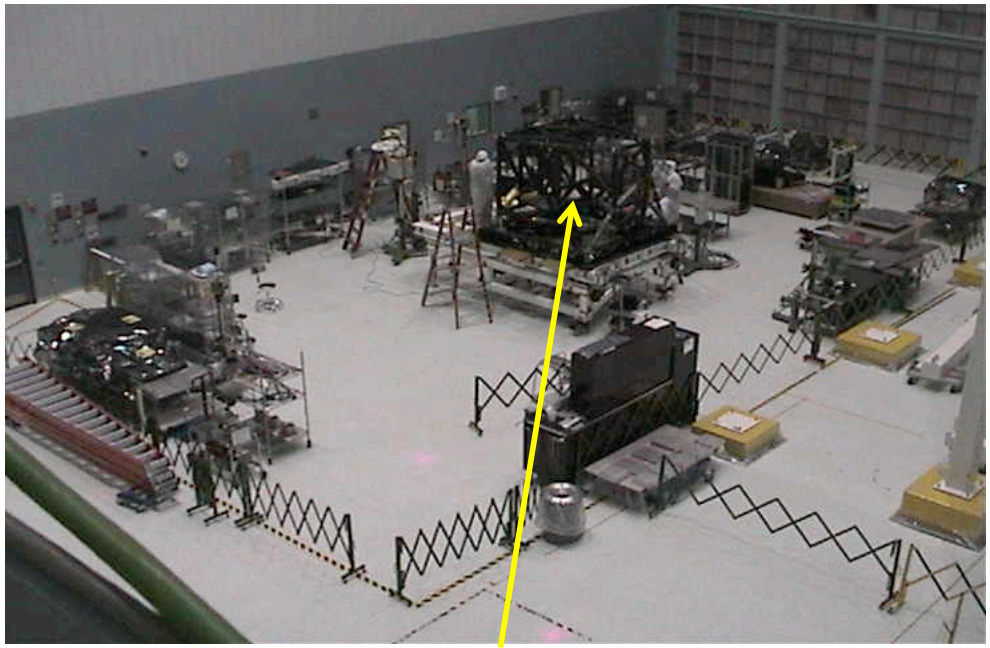




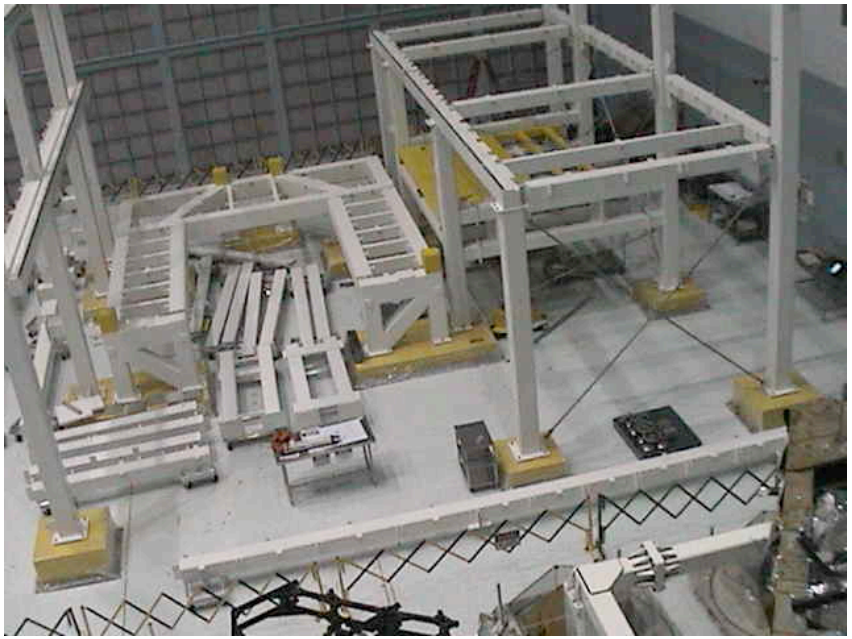
- Media event held at manufacturer in Syracuse, NY.
- Hardware now being shipped to NASA Goddard Space Flight Center test facility, Greenbelt, MD.

Integration and Testing at GSFC

Building 29 Clean Room

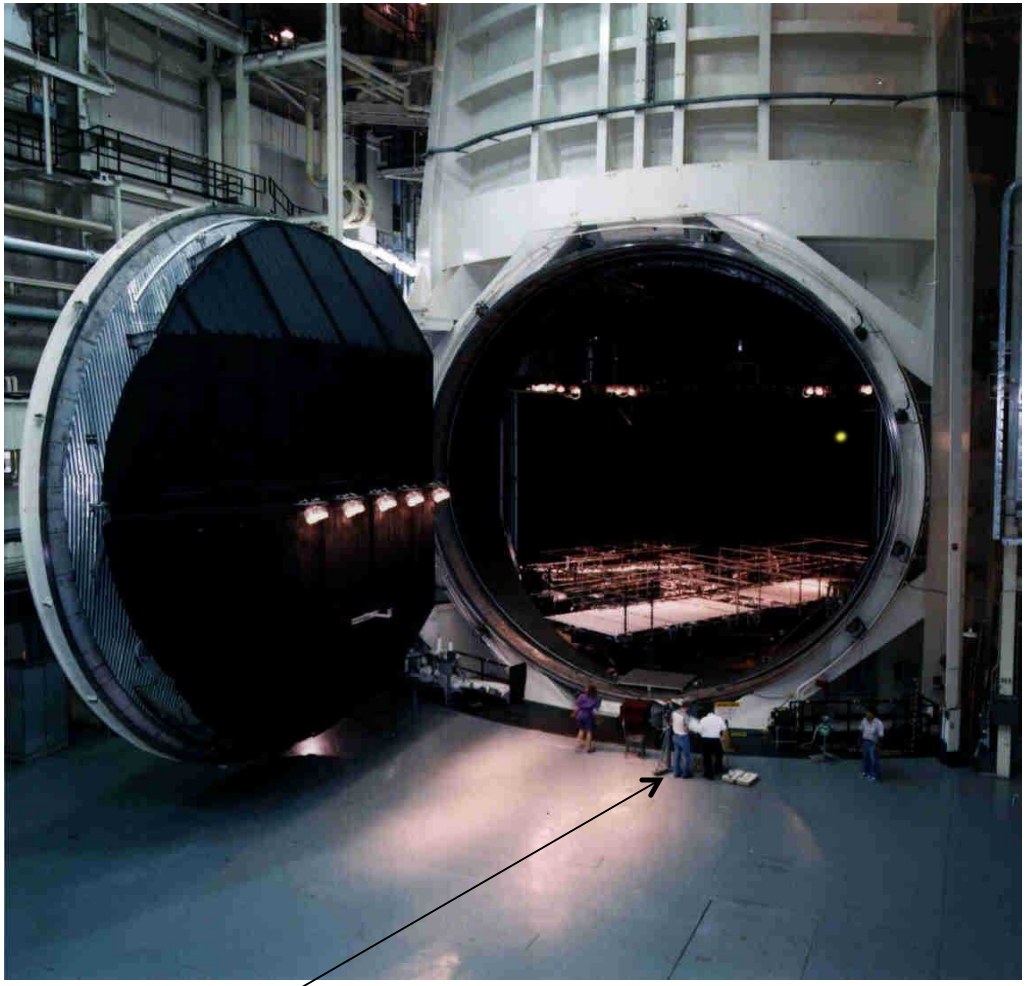


Flight Integrated Science Instrument Module (ISIM)

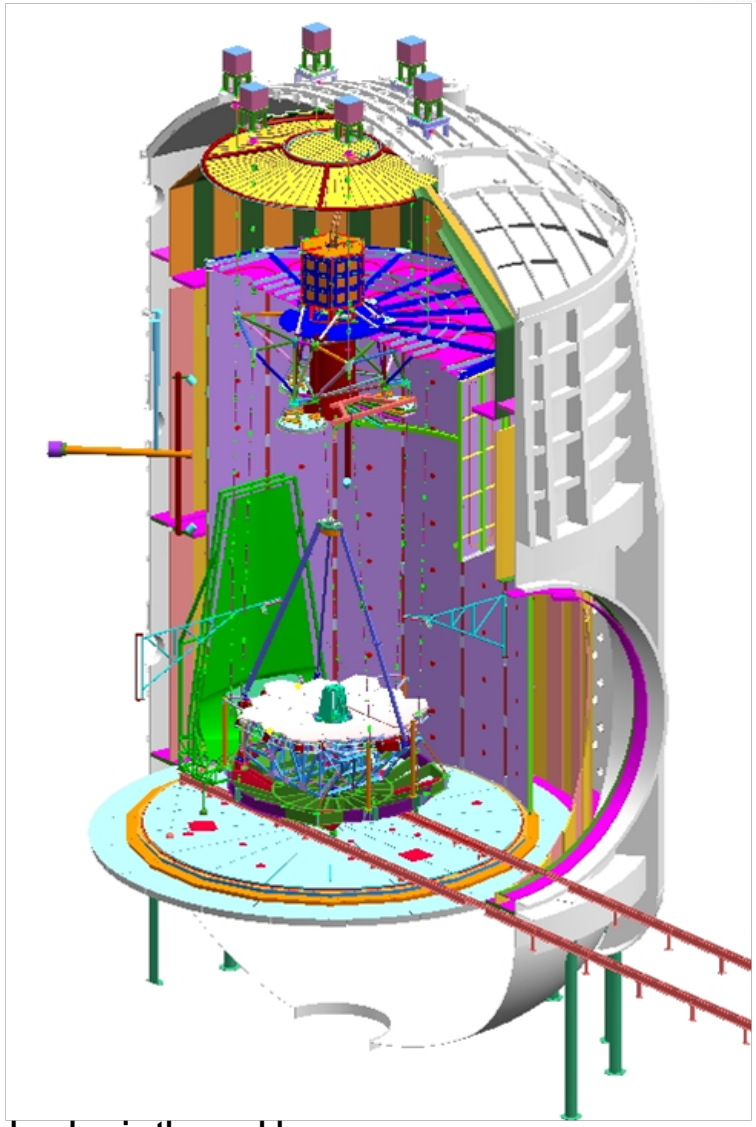


Ambient Optical Assembly Stand
Under construction

OTE Testing – Chamber A at JSC



Notice people for scale



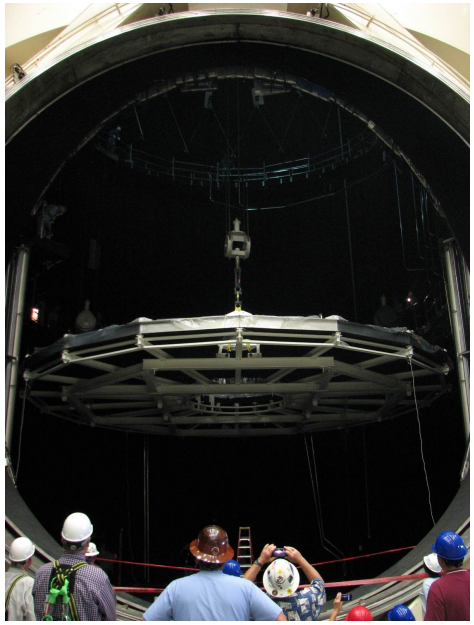
Will be the largest cryo vacuum test chamber in the world

JSC Chamber A

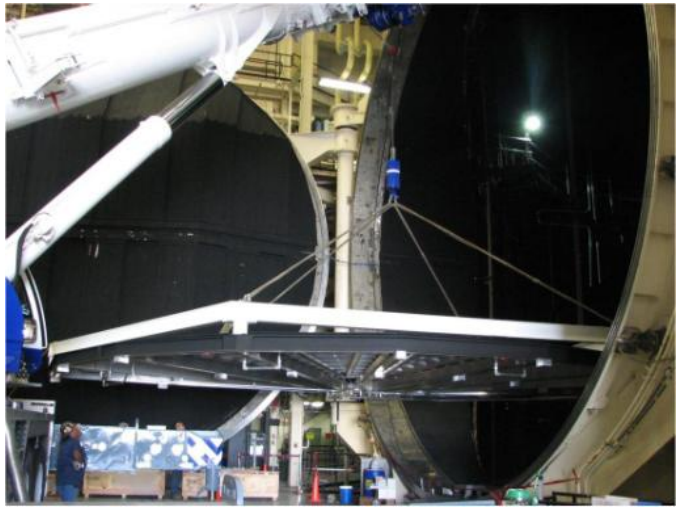
Modifications to Johnson Space Center Chamber are progressing

- Distribution system for LN2 and GHe system under way
- GHe refrigeration system installation completed
- Installation of ceiling shroud completed
- Floor shroud fabrication completed with installation under way
- Wall shroud fabrication completed with installation beginning after the floor installation
- Make-up air units for airflow management systems installed

GHe Ceiling on the lifting cradle



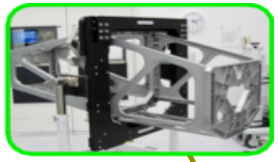
GHe Shroud Floor – Side A



Hardware Fabrication Completion Percentages

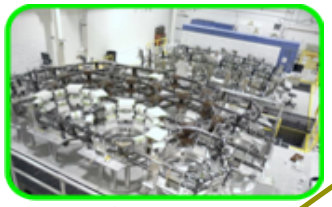
Primary Mirror Segments

100%



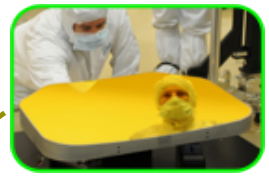
Aft Optics System Bench

100%



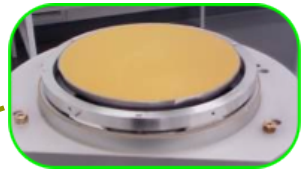
Primary Mirror Support Structure

75%



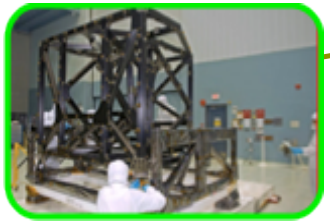
100%

Tertiary Mirror



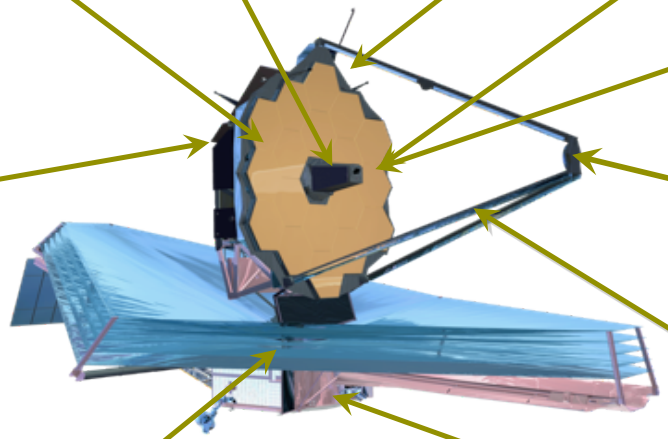
100%

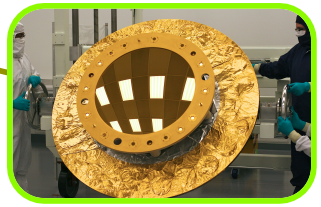
Fine Steering Mirror



Science Instrument Module & Science Instruments

90%





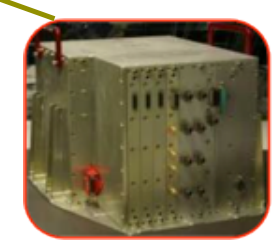
95%

Secondary Mirror

Green borders denote actual spaceflight hardware images, red borders are test equipment

40%

Sunshield Membranes



25%

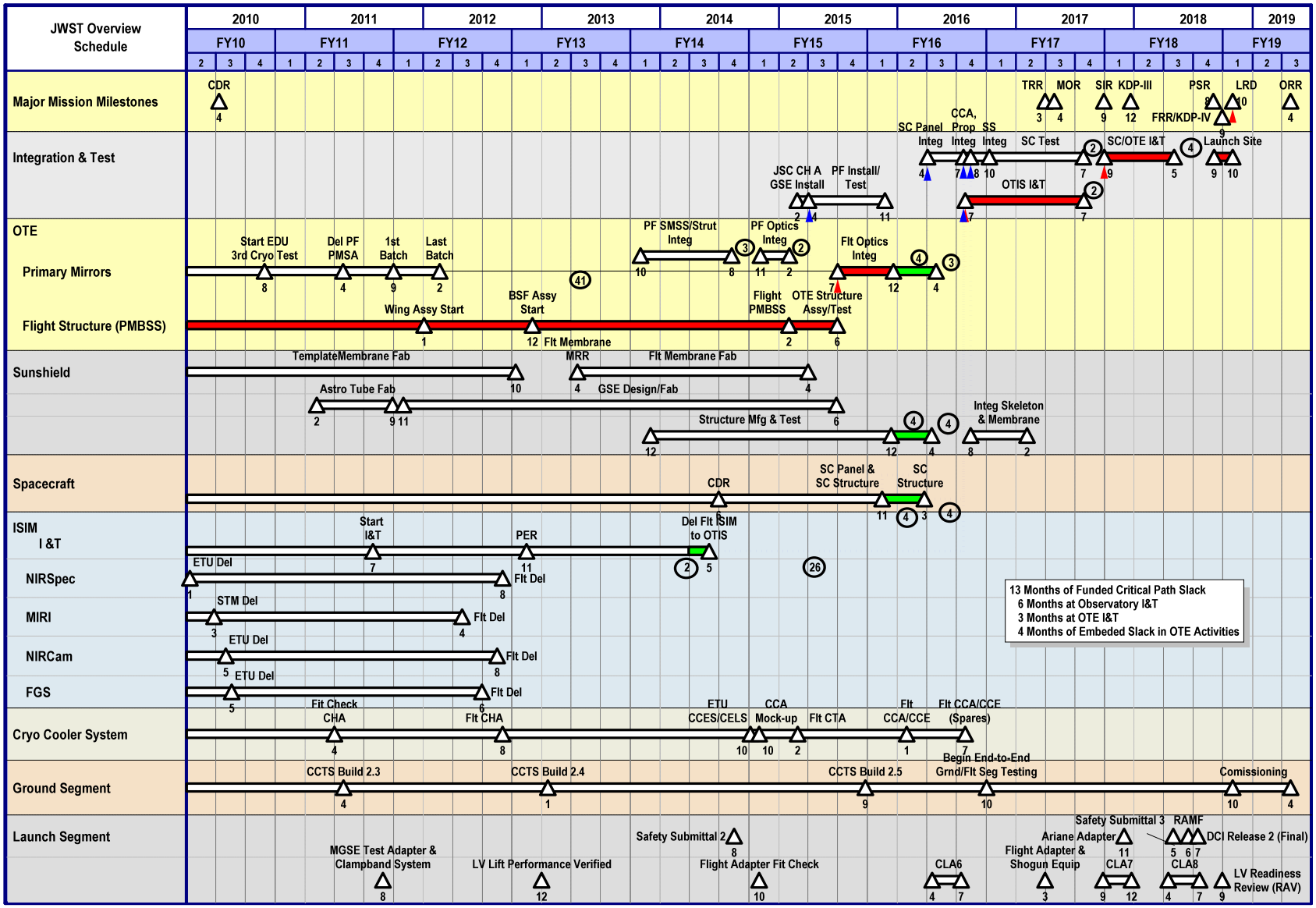
Spacecraft Bus

Secondary Mirror Supports

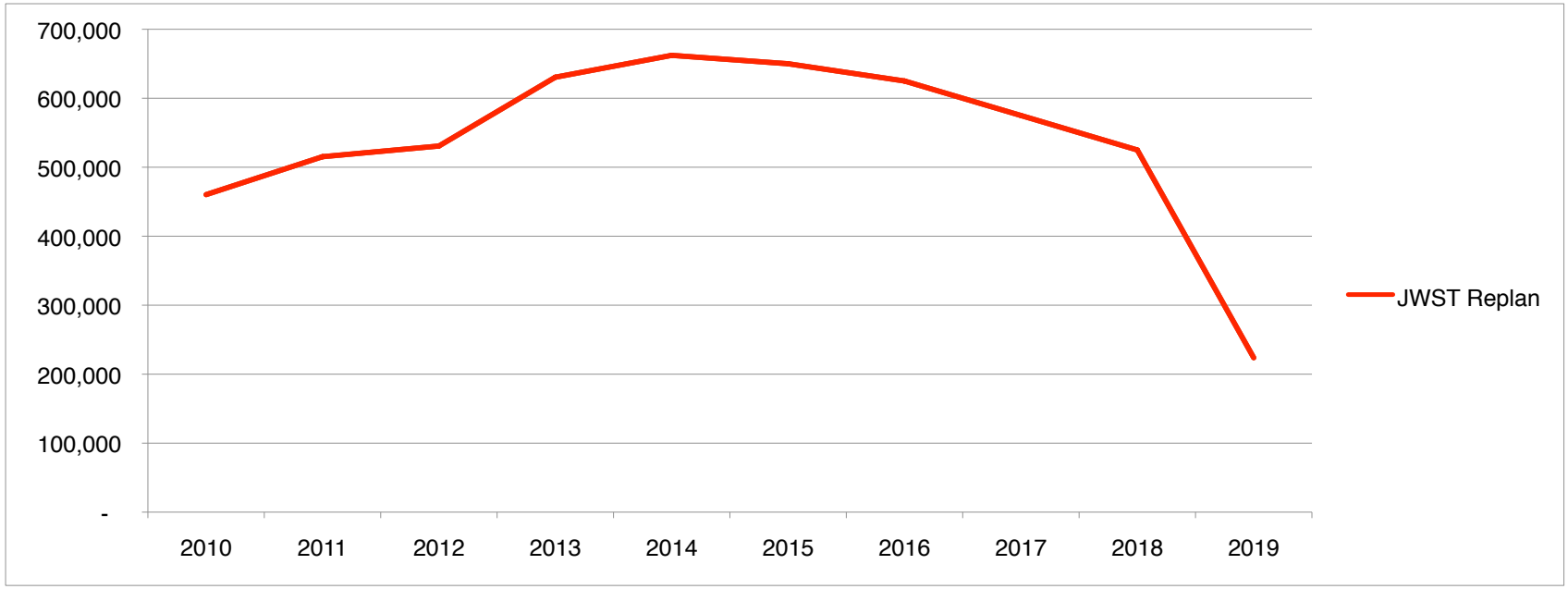
90%

As of 10/10/2011

JWST Master Schedule



JWST Budget Profile (July 2011)



- **The replan addresses the findings of the SRB and the ICRP report**
  - Avoids making the mistakes identified by ICRP by providing adequate funding in early years
  - Provides a profile that can retire risk earlier by accelerating critical activities

Summary of JWST Breach Report (1 of 3)

Provided Report to Congress under Sec 103(d)(2) of PL 109-155 ("Breach Report") on October 24, 2011

- Projected cost and schedule for completing the program
- Assessment of broad range of alternatives to the program

- **New baseline supports an October 2018 LRD for a total LCC of $8.8B**
  - Includes 13 months of funded schedule reserve
  - Includes funding in base to cover all high probability threats
  - Cost reserves are consistent with ICRP recommendation (80% cost confidence)

- **New baseline will require approximately $1.2B in additional funding in FY12-FY16**
  - This is above the FY12 President's Budget Request ($375M per year)
  - NASA proposes to redirect funds from within its budget
    - Half from the Science Mission Directorate programs (none from Earth Science)
      - would delay some future missions that are currently planned for launch beyond 2015
    - Half from Cross-Agency Support account
      - would leave that account at about the FY10 level
    - NASA and the Administration continue to discuss the budget adjustments (will be finalized in the FY13 President's budget request)

Summary of JWST Breach Report (2 of 3)

Provided Report to Congress under Sec 103(d)(2) of PL 109-155 ("Breach Report") on October 24, 2011

- Projected cost and schedule for completing the program
- Assessment of broad range of alternatives to the program

Table 1a: JWST Development Cost and Schedule

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
James Webb Space Telescope	2009	2,581.1	2011	6,197.9	140%	Launch Readiness	06/2014	10/2018	52

Table 1b: JWST Life-Cycle Cost

Budget Authority ($millions)	Prior	FY 2010 Actual	FY 2011 Enacted	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC Total
Revised Profile	2,552.3	461.4	515.3	527.6	627.6	659.1	646.6	621.6	2,223.6	8,835.0

- **Cost through FY11 - $3,536M Cost to Go (FY12 through on-orbit commissioning) - $4,462M**
- **Phase A/B (Formulation) Cost: $1,800M**
- **Phase C/D (Development) Cost: $6,198M**
- **Phase E (5 years ops plus 2 years data analysis): $837M**

Summary of JWST Breach Report (3 of 3)

- **Assessment of Alternatives**
  - Analysis done by independent group (Aerospace Corp)
  - Detailed study performed to ensure that the broadest possible set of options considered
    - Four broad categories (airborne, ground, space, variants to the JWST baseline) and hybrid combinations were considered
    - Performance measured against JWST Level 1 science requirements
      - Baseline Science Requirements are in Section 1 of the Breach Report
    - Following a thorough search of all potential alternatives by Aerospace and a group of external scientists and engineers, filters based on ability to meet the mission science requirements and technical feasibility resulted in a total of 12 alternatives being analyzed in detail (including three variants to the baseline JWST and two hybrids)
  - NASA agrees with the results of the Aerospace analysis
  - The JWST baseline is the best value, even at the higher cost to go.

JWST Near Term Program/Project Office Efforts

- **Provided Report to Congress under Sec 103(d)(2) of PL 109-155 ("Breach Report") on October 24, 2011**
  - Projected cost and schedule for completing the program
  - Assessment of broad range of alternatives to the program
- **Capitalize on new plan as we transition from re-planning to building**
  - Already have accelerated final tests of 6 remaining Primary Mirror Segment Arrays at the XRCF. Will start 10/24 and complete before year end.
  - Letter sent to Northrop-Grumman instructing them to pull in schedule on Primary Mirror Backplane Assembly by ~6-8 months.
  - Discussions underway to accelerate spacecraft Critical Design Review [CDR] (last remaining major element not past it's CDR) by 4-6 months.