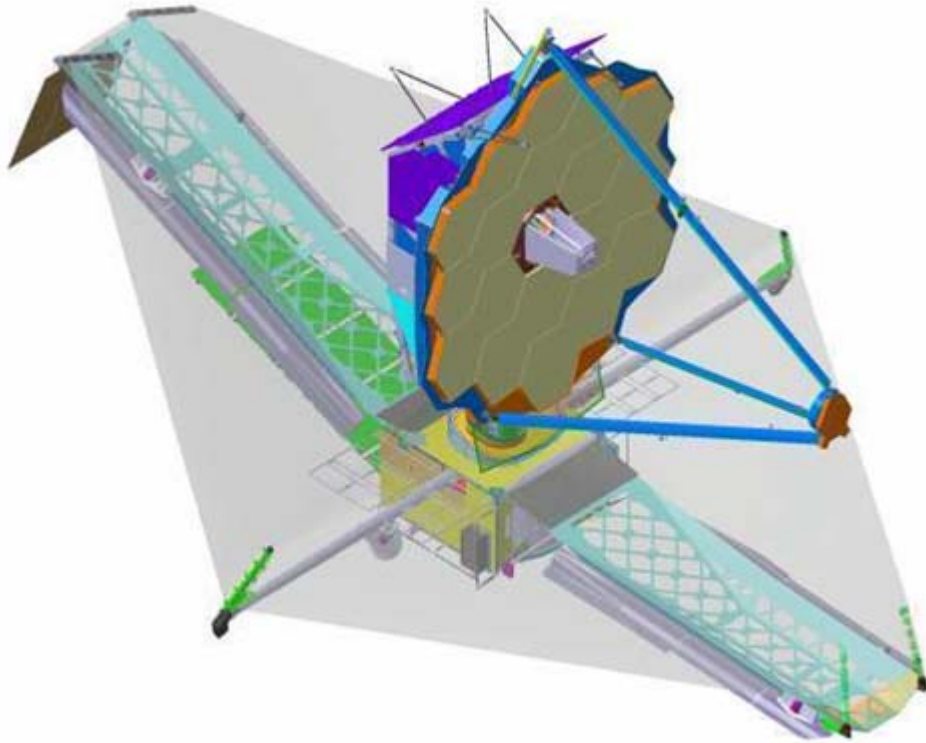




James Webb Space Telescope (JWST) Project Status for the AIAA Working Group on Space Simulation



Phil Sabelhaus
JWST Project Manager
September 2008



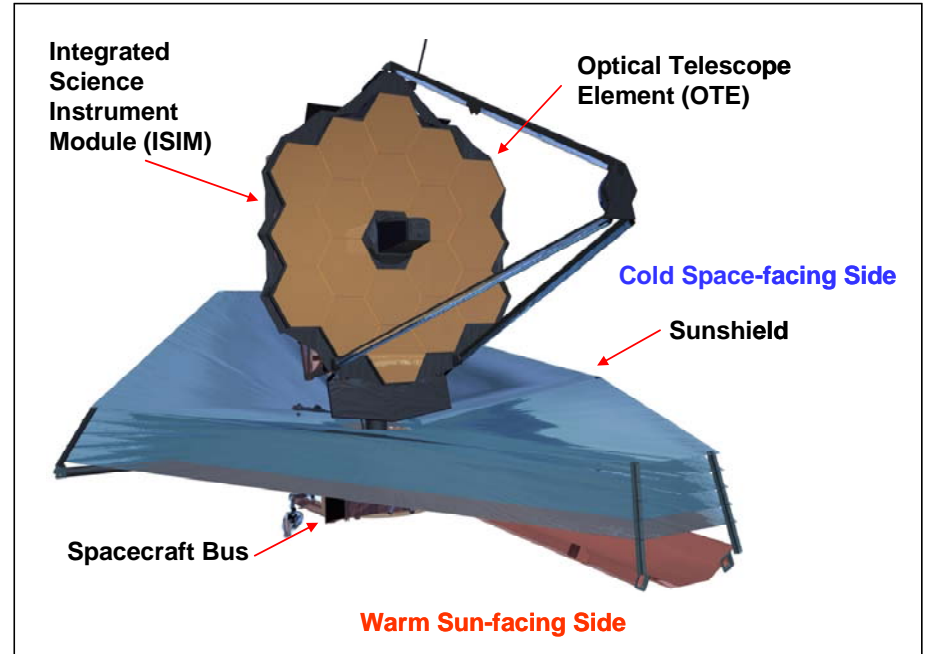
James Webb Space Telescope (JWST)

Organization

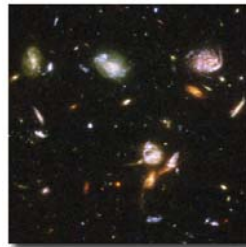
- Mission Lead: Goddard Space Flight Center
- International collaboration with ESA & CSA
- Prime Contractor: Northrop Grumman Space Technology
- Instruments:
 - Near Infrared Camera (NIRCam) – Univ. of Arizona
 - Near Infrared Spectrograph (NIRSpec) – ESA
 - Mid-Infrared Instrument (MIRI) – JPL/ESA
 - Fine Guidance Sensor (FGS) – CSA
- Operations: Space Telescope Science Institute

Description

- Deployable infrared telescope with 6.5 meter diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch June 2013 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2
- 5-year science mission (10-year goal)



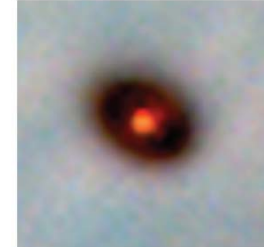
JWST Science Themes



End of the dark ages: First light and reionization



The assembly of galaxies



Birth of stars and proto-planetary systems



Planetary systems and the origin of life



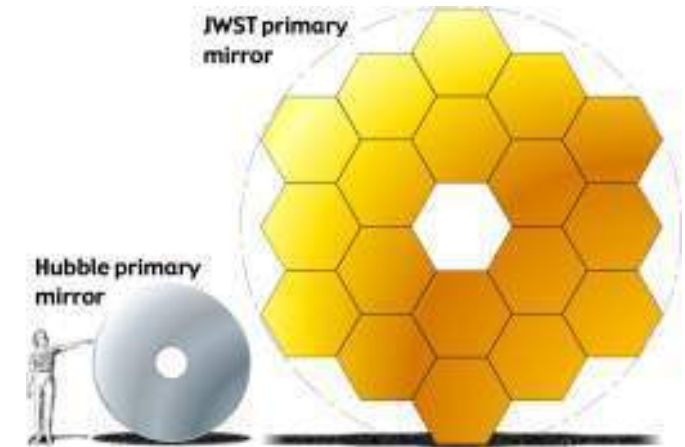
JWST Full Scale Model at the GSFC





JWST Compared with other Telescopes

- Hubble Space Telescope (HST):
 - 2.7 x diameter, 2.7 x longer wavelength
- HST NICMOS:
 - 189 x FoV,
 - 38 x better sensitivity at K band, 8 x at H band
- Spitzer:
 - 8 x Spitzer diameter
 - Diffraction limited at 2 microns vs. 6 microns
 - 8 to 24 x better angular resolution
 - 10 x lower dark current supports $R \sim 1000$ at high redshift
- Ground:
 - JWST and GSMT are complementary where capabilities overlap:
 - HST: Keck diameter ratio \sim JWST:GSMT
 - Background $\sim 1,000,000$ x larger on ground at 5 microns



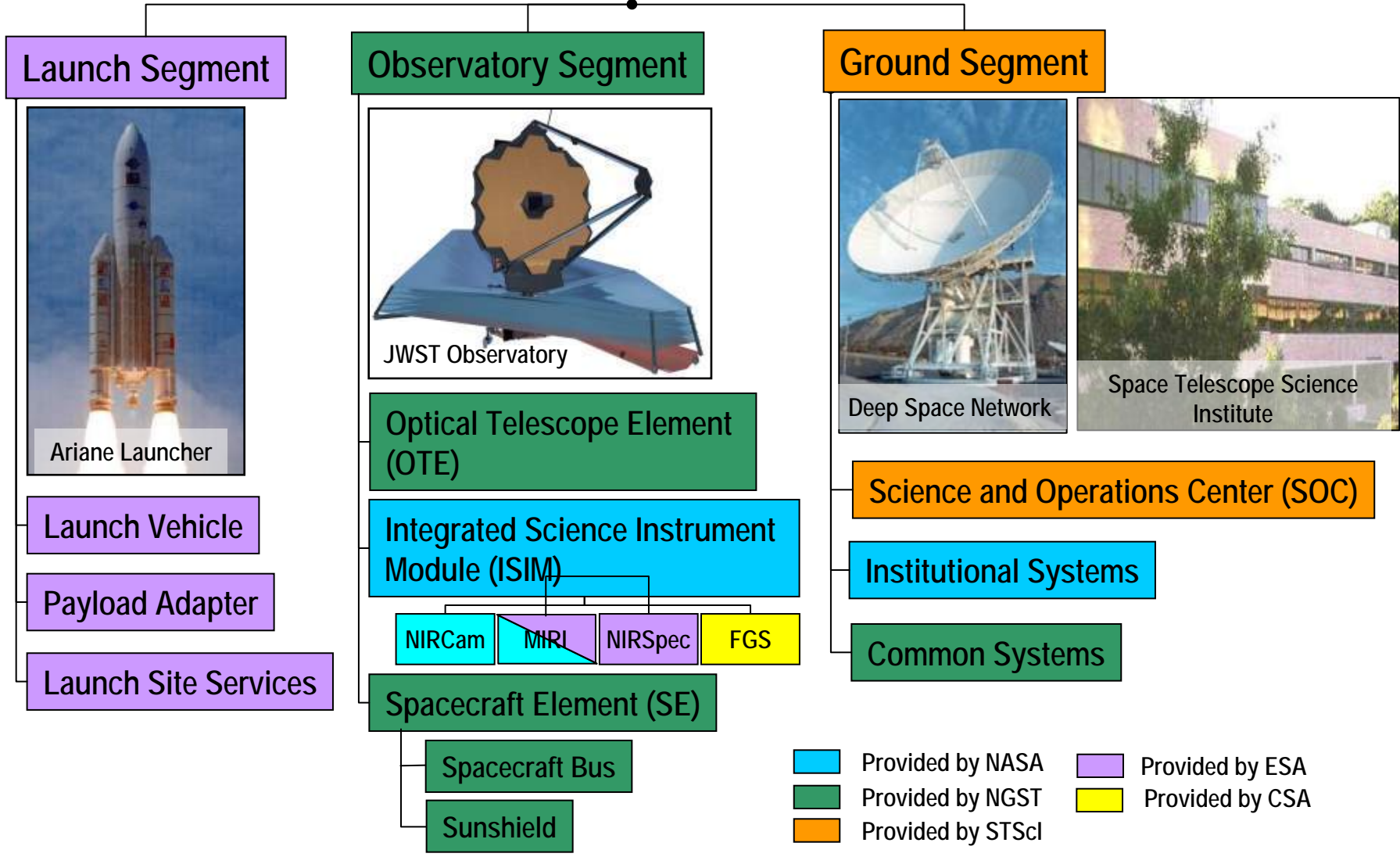
Real data: Spitzer
25 hours



Simulated: JWST
3 hours



James Webb Space Telescope System





JWST System Architecture

Communications Coverage Provided
For all Critical Events



Ariane 5 Upper
Stage Injects JWST
Into Direct Transfer
Trajectory

Observatory - Upper Stage
Separation

Observatory Deployments
-Solar Array
-High Gain/ Medium Antennas
-Sunshield
-Optical Telescope Element

L2 Point

L2 Lissajous
Orbit

L2 Transfer
Trajectory

Ariane 5
Launch
System

S-Band Tlm Link (2Kbps)
S-Band Cmd Link (0.25 Kbps)
S-Band Ranging

S-Band Tlm Link (2Kbps)
S-Band Ranging

Ka-Band Science Link (Selectable 7, 14, 28 Mbps)
S-Band Tlm Link (Selectable 0.2 - 40 Kbps)
S-Band Cmd (Selectable 2 and 16 Kbps)
S-Band Ranging

Communications
Services for Launch
(TDRS, ESA, ...)

Deep Space Network

NASA Integrated Services Network

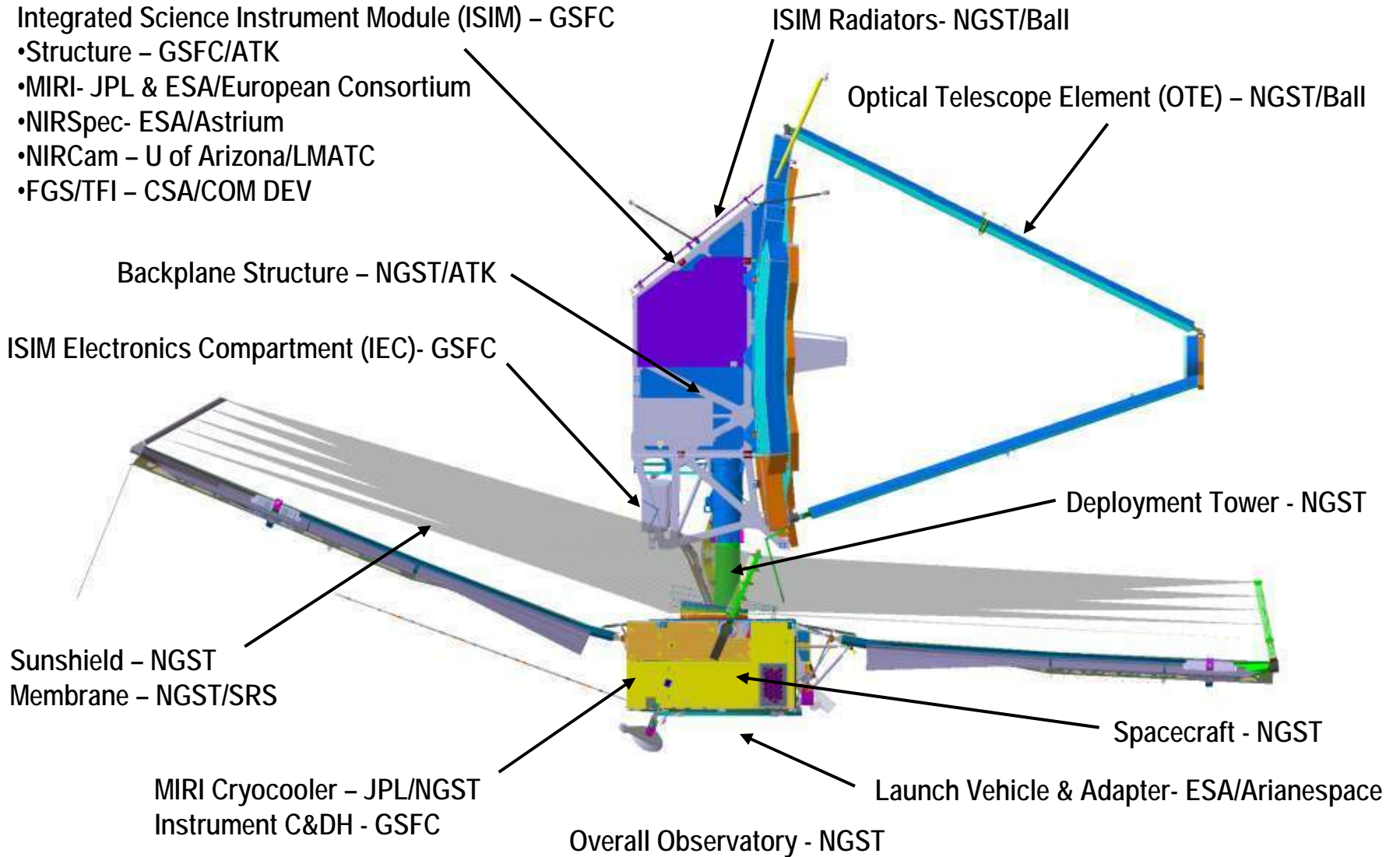
Space Telescope Science Institute
Science & Operations Center

Ariane PPF S5

GSFC Flight Dynamics Facility



JWST Teams and Responsibilities

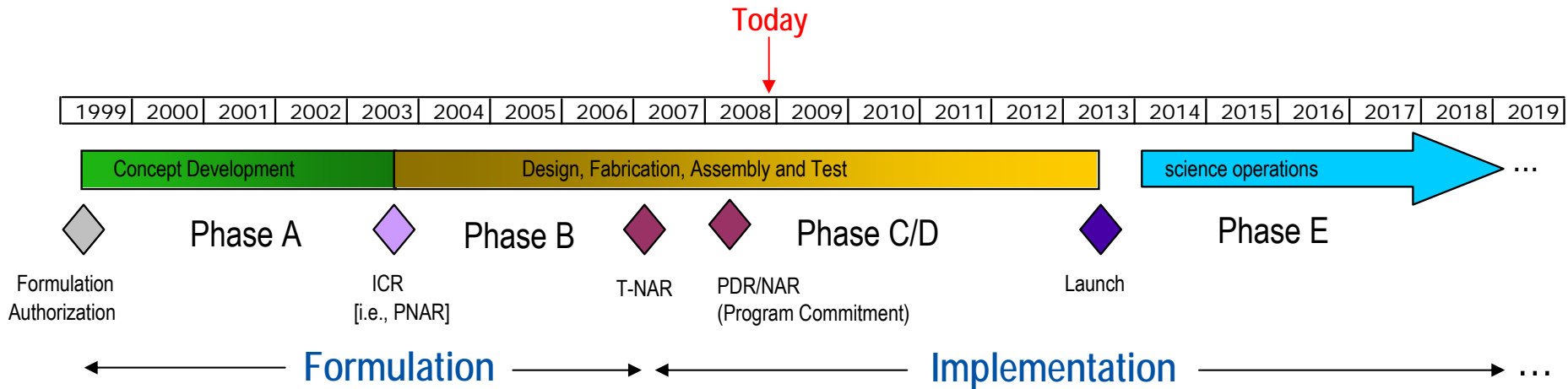




JWST Status



Program Phases

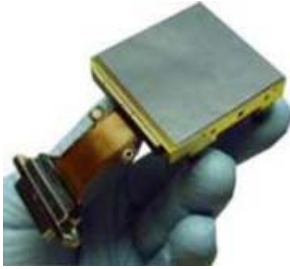


- Currently in Implementation (Phase C)
- Early emphasis on vigorous technology development to retire risk
 - ~50% of Phase A through D total invested so far
 - Pacing items (primary mirror, detectors) already in flight production
 - Successful Technology-Non Advocate Review (T-NAR) in January 2007
- Mission PDR/Non-Advocate Review (NAR) completed last Spring
 - Confirmation Review successfully held in July

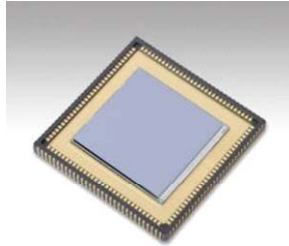


All JWST Enabling Technologies Have Been Developed

Near IR Detectors



Mid IR Detectors



Heat Switch

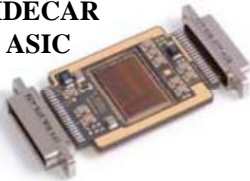


Sunshield Membrane



**Stable Large Cryogenic Structures
Backplane Stability Test Article (BSTA)**

**SIDECAR
ASIC**



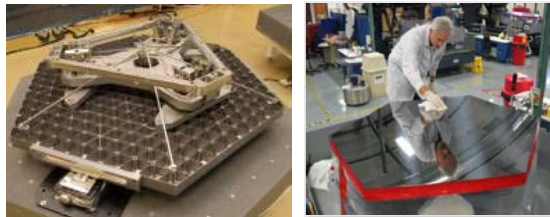
**Wavefront Sensing & Control
Test Bed Telescope**



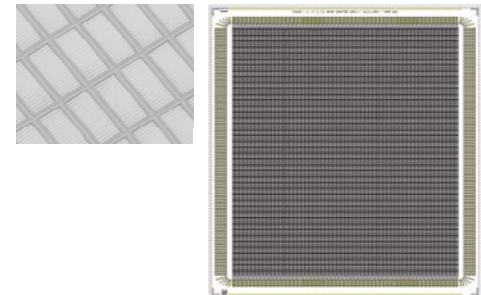
MIRI Cryocooler



Primary Mirror



Micro Shutter





Program Status and Recent Progress

■ General

- Successful Mission PDR, Non Advocate and Confirmation Reviews held
- Preparations for mirror segment testing at MSFC XRCF facility are complete
- Modifications to JSC Chamber A are underway

■ Science

- NASA HQ SMD has decided to add moving target tracking capability to JWST

■ Observatory

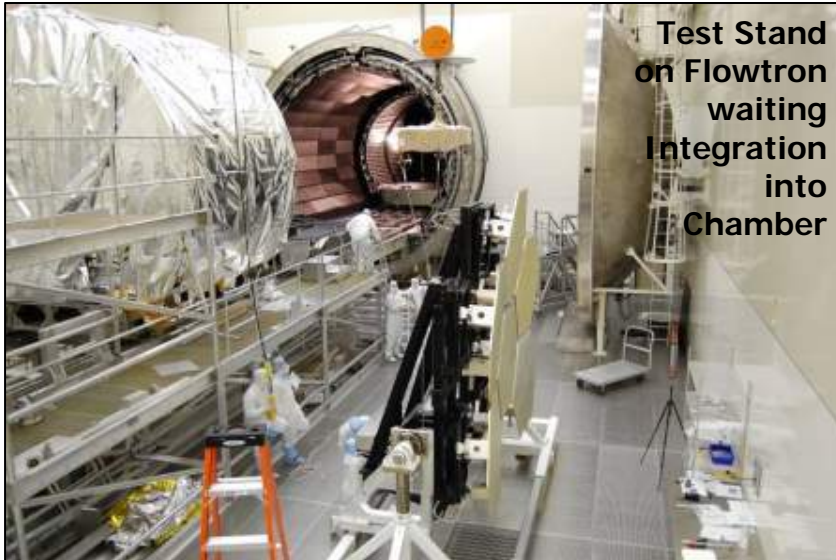
- First spacecraft simulator delivered to the ISIM software lab at GSFC
- Sunshield PDR held in February 2008

■ Ground Segment

- Completed deliveries of all Science Instrument Integrated Test Sets (SITs) and Science Instrument Development Units (SIDUs) to SI teams in the US, Canada and Europe



MSFC XRCF Test Chamber Complete



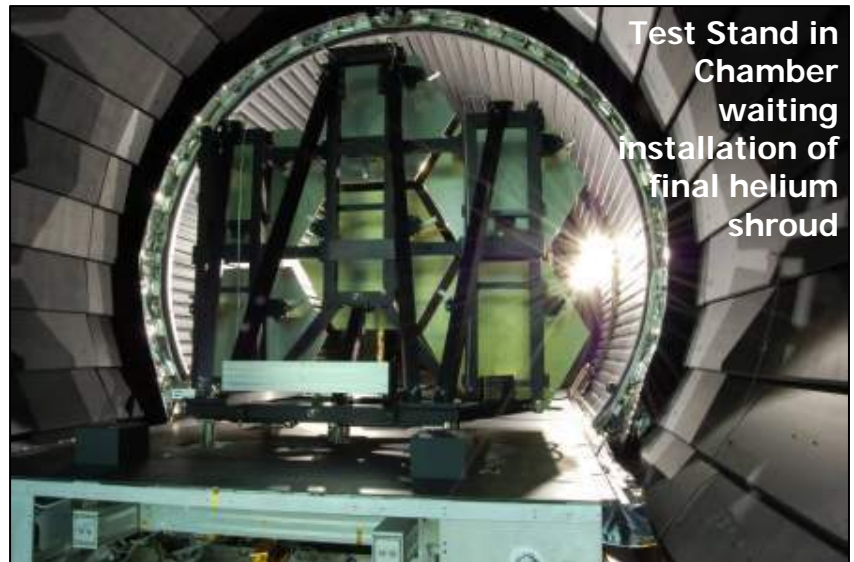
Test Stand on Flowtron waiting Integration into Chamber



Craning Test Stand in Place



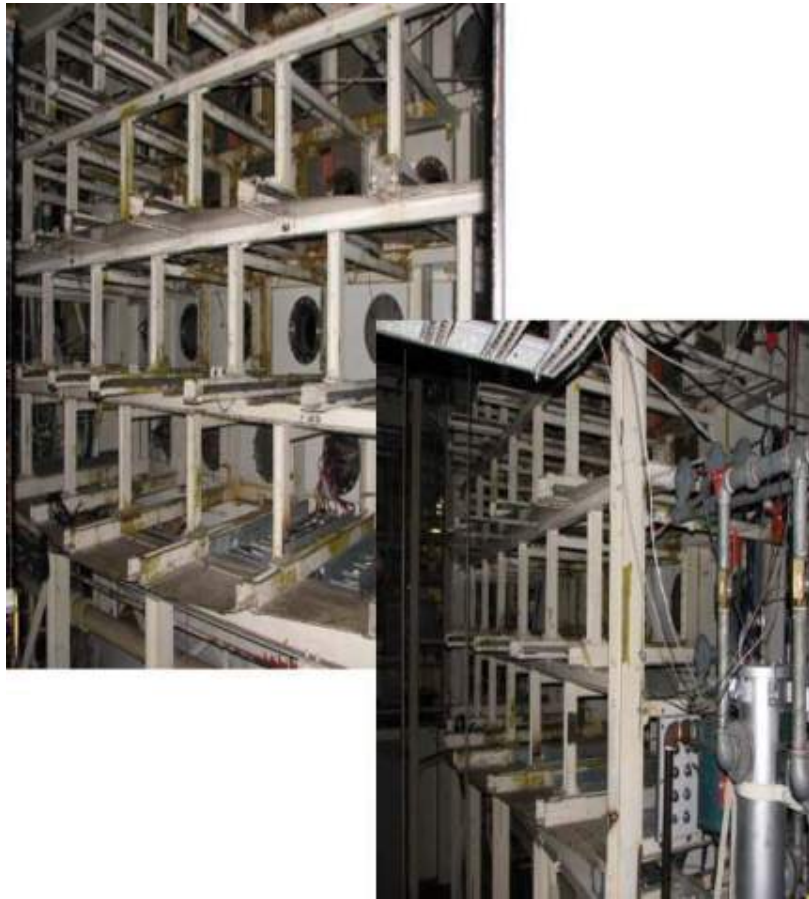
Installing Test Stand into Chamber



Test Stand in Chamber waiting installation of final helium shroud



JSC Chamber A Modification Progress



External chamber modifications – removal of solar simulator structures



Program Status and Recent Progress (Continued)

- **Mirrors and Optical Telescope Element (OTE)**
 - OTE Flight Backplane tube manufacturing continues at ATK
 - PMBSS bonding will probably occur no earlier than late September
 - OTE Pathfinder backplane bonding continues at ATK
 - Tinsley operations are continuing:
 - The A1 primary mirror (PM) was shipped to Ball in late August
 - The B3 and C3 PMs are currently in polishing and planned to be shipped to Ball in September
 - The remaining flight primary, secondary and tertiary mirrors are in various stages of rough polishing, smooth out and figure grinding
 - Ball operations:
 - EDU PMSA build is underway
 - Scheduled to be shipped to the MSFC XRCF in September for pathfinder testing
 - Successful OTE PDR at NGST in November 2007
 - Preparations for PMSA testing at MSFC XRCF are going well

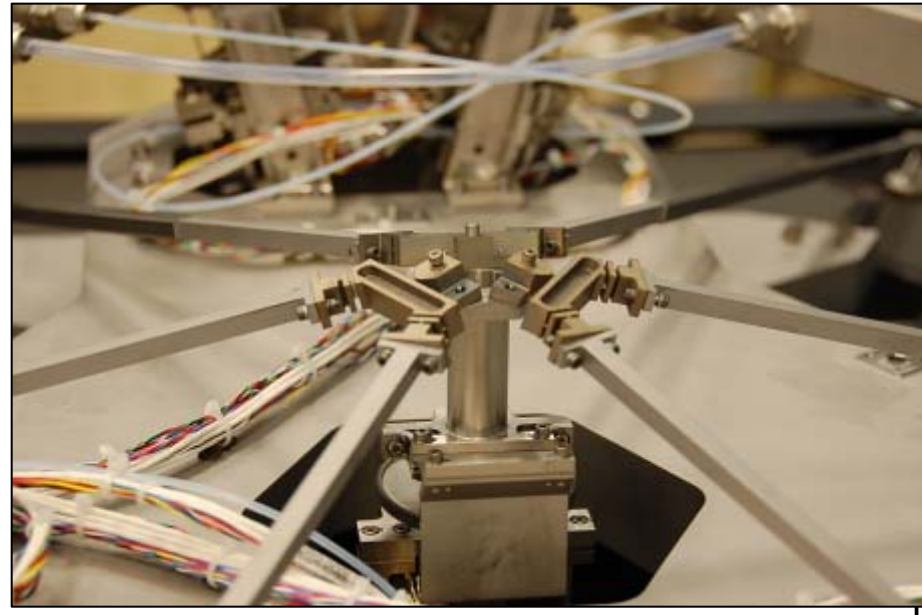
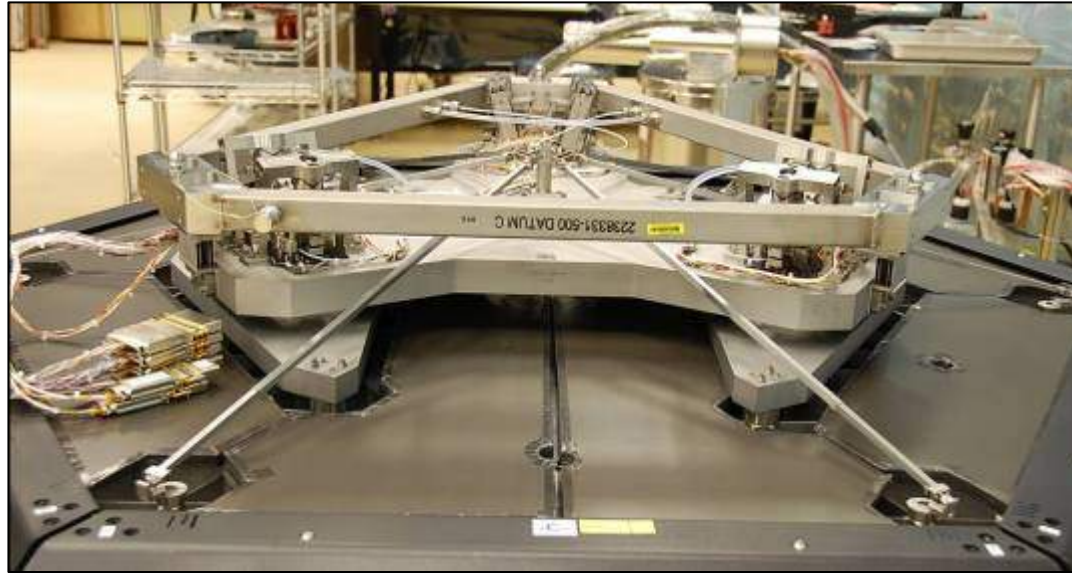


PM EDU in Optical Test at Ball





PM EDU PMSA





Recent Backplane and Space Vehicle Accomplishments

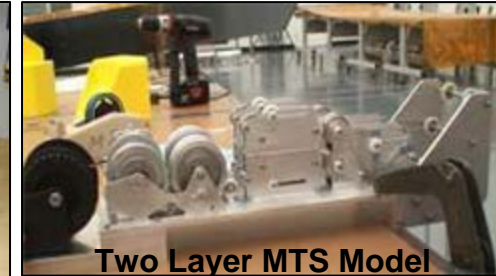
**PF and Flight Backplane Assembly Tools
Complete and PF Bonding Started**



Sunshield UPS Shell Machined in Fabrication



**Full Scale Core Area
Test Article**



Two Layer MTS Model



**Spacecraft Solar Array
Release and Reaction
Wheel Isolator
Development Articles**



**Soft Sunshield Membrane Covers
Decrease Mass and Stowed Volume**

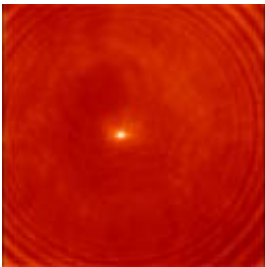




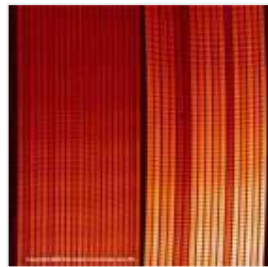
Program Status and Recent Progress (Continued)

- **Integrated Science Instrument Module (ISIM)**
 - **MIRI Verification Model achieved 6.2K operating temperature during it's first cryo test last winter**
 - Achieved first light!
 - **Completed CDR for NIRSpec Focal Plane Electronics and Software**
 - **Selected flight detectors for MIRI**
 - Held Cryo Cooler PDR
 - **Selected flight shortwave detectors for NIRCам**
 - **Completed Microshutter CDR (part 1) covering Arrays and Quads**
 - ESA concurred with priority ranking of Microshutter Flight Candidates

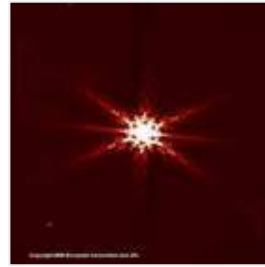
Sample MIRI flight detectors



MIRI detectors 1st Light!

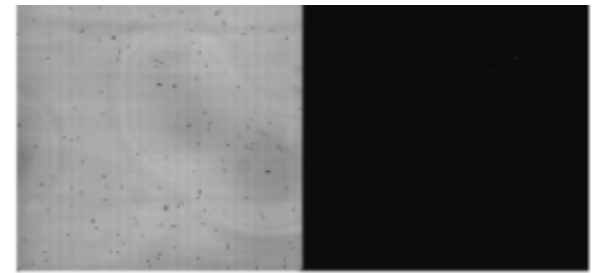


Spectrometer



Imager

Microshutter flight candidate



WFO OPEN
Failed closed RT: 2.0E-05% | Failed hot closed RT: 0.0E+00% |
WFO CLOSE
Failed open RT: 2.0E-05% | Failed hot open RT: 0.0E+00%



MIRI Verification Model prior to Cryo Vac Test





Program Status and Recent Progress (Continued)

- **Integrated Science Instrument Module (ISIM) Continued:**
 - Successful ISIM Command and Data Handling (ICDH) CDR in October 2007
 - Successful ISIM Flight Software CDR in April
 - ISIM, ISIM Electronics Compartment (IEC) and ISIM Remote Services Unit (IRSU) PDR's successfully completed
 - Harness Radiator breadboard completed cryo-vac test
 - Held FGS System CDR at COM DEV
 - ISIM Structure bonding started in August
 - Completed manufacturing of NIRSpec Qual Unit Optical Bench
 - Completed bonding of the NIRCам ETU Optical Bench
 - ETU I&T began in July

NIRCам ETU Optical Bench



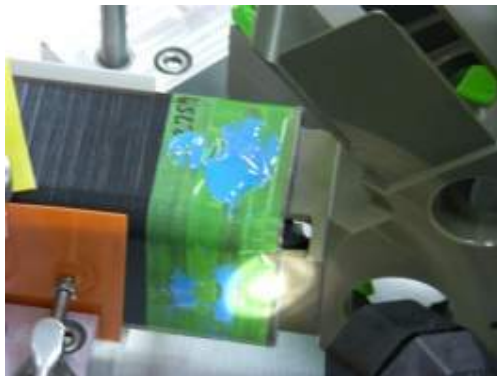
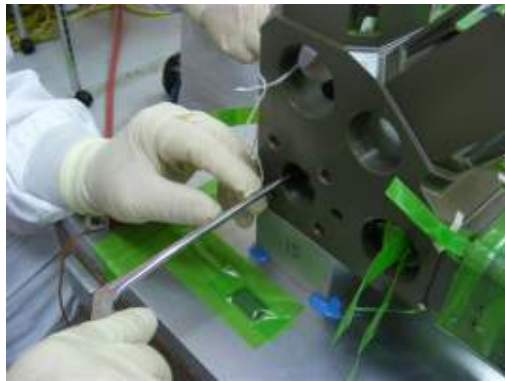
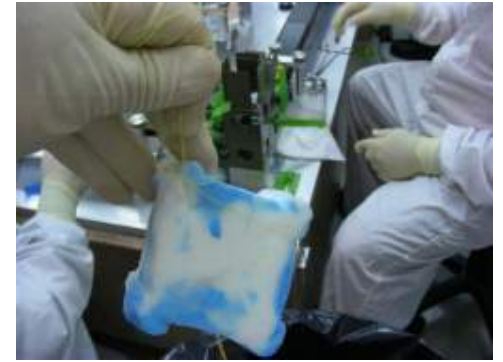
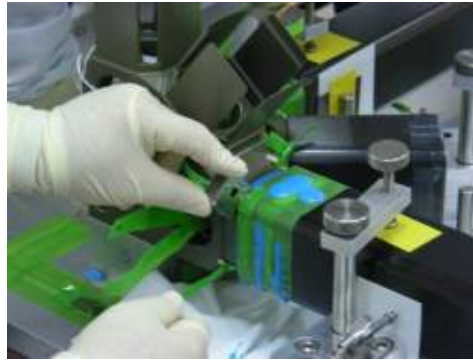


NIRSpec Qual Unit Optical Bench Ready for Delivery



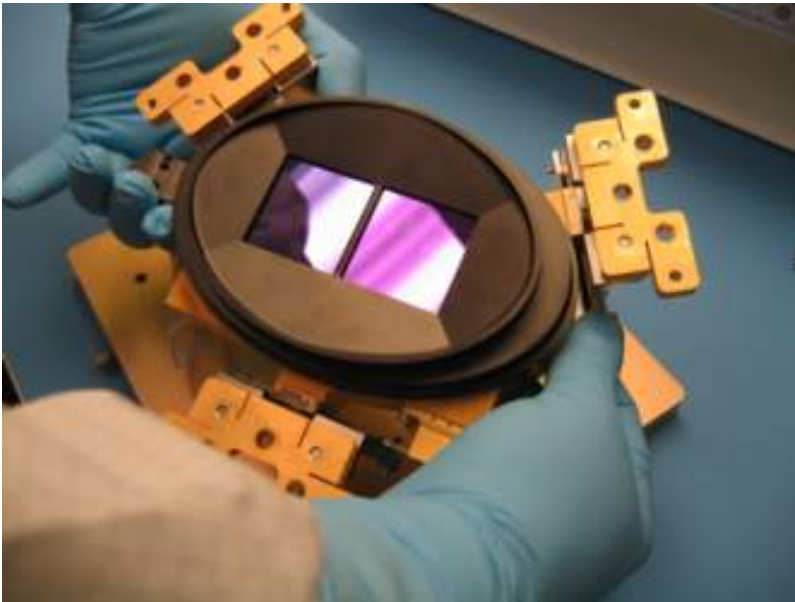


ISIM Structure Deck A Buildup





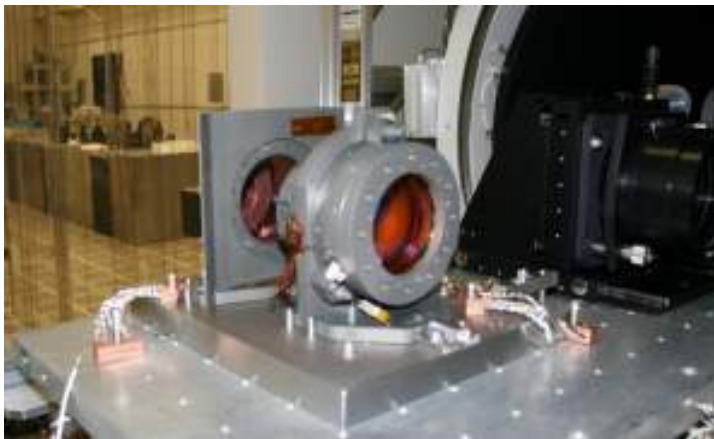
ETU Hardware Queuing Up for Instrument I&T



NIRSpec Focal Plane Assembly



NIRCam PIL Mechanism



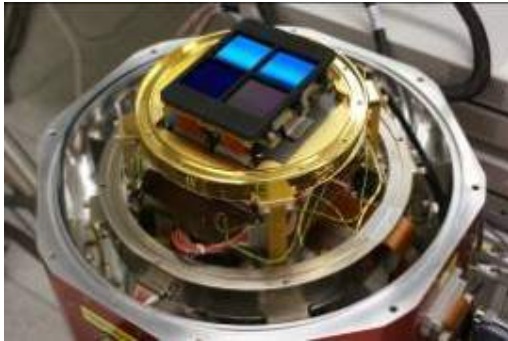
NIRCam Shortwave Camera Triplet & Beamsplitter



NIRSpec Fore Optics



Additional ISIM Hardware



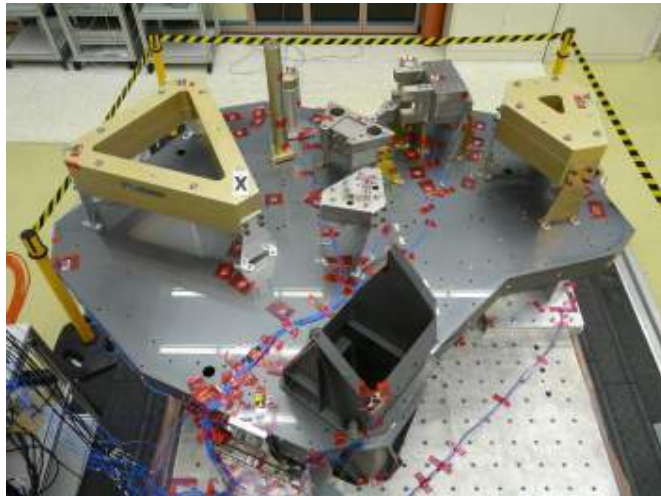
NIRCam Qual Focal Plane Assembly



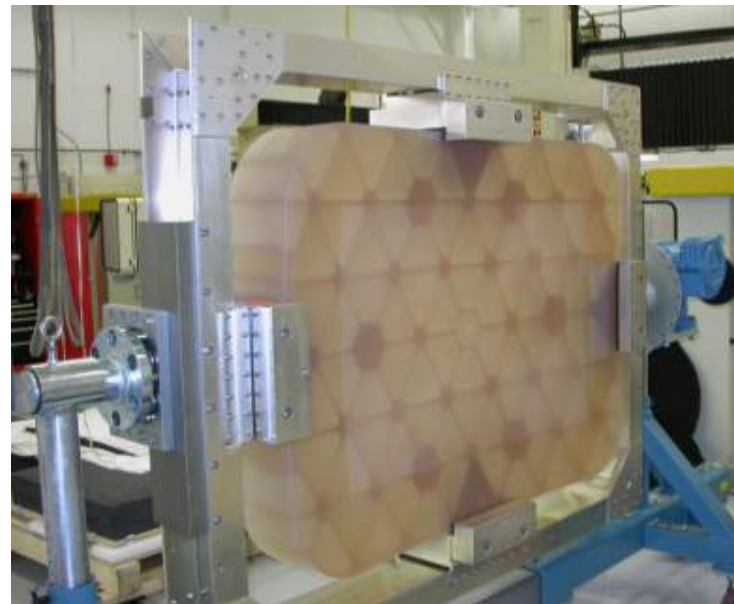
NIRCam Focus Adjust Mechanism Actuators



IEC Composite Mirror



NIRSpec DM/ETU Optical Bench Proof Testing



OSIM Primary Mirror



Project Status (continued)

■ Upcoming events

- OSIM PDR/CDR in October 2008 at GSFC
- NIRSpec CDR in October 2008 at ESTEC
- ISIM Structure CDR in December 2008 at GSFC
- ISIM CDR in January 2009 at GSFC
- Sunshield MMS IDR-2/PDR in January 2009 at NGST
- Mission CDR scheduled for late Summer/Fall of 2009



Summary

- JWST is a flagship science mission; the highest priority large mission in astronomy and a worthy scientific successor to Hubble
- JWST is an engineering challenge, and the challenge is being met
 - All ten of our mission enabling technologies achieved Technology Readiness Level 6 by February 2007 – more than a year ahead of the NASA required date (mission PDR) and 6 years plus before launch
 - Engineering or Verification Models for all the instruments are being assembled and tested this year
- Mission Preliminary Design, Non-Advocate and Confirmation (KDP-C) Reviews successfully held this year
 - In phase C!
- Continuing to make good progress on critical path items
- JWST is well underway and on track for a launch in June 2013