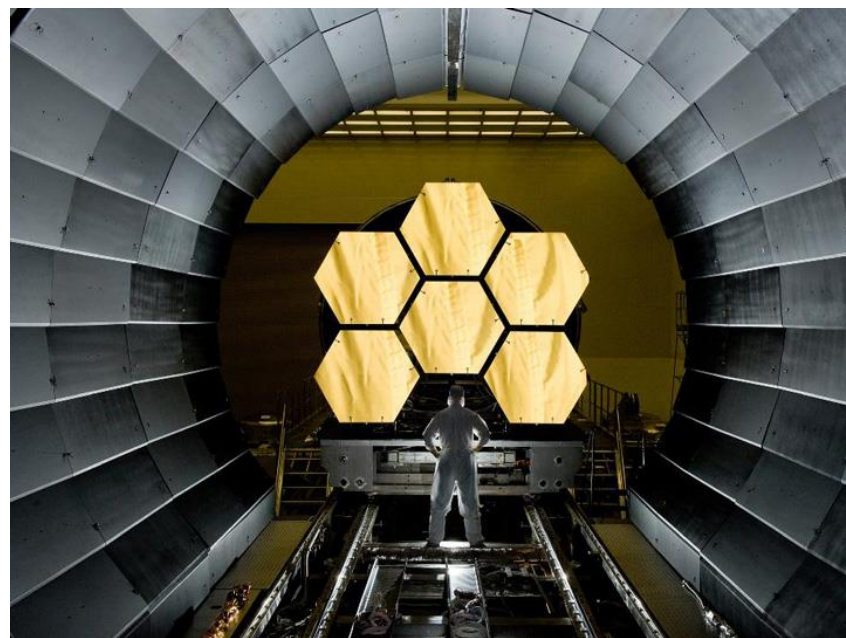
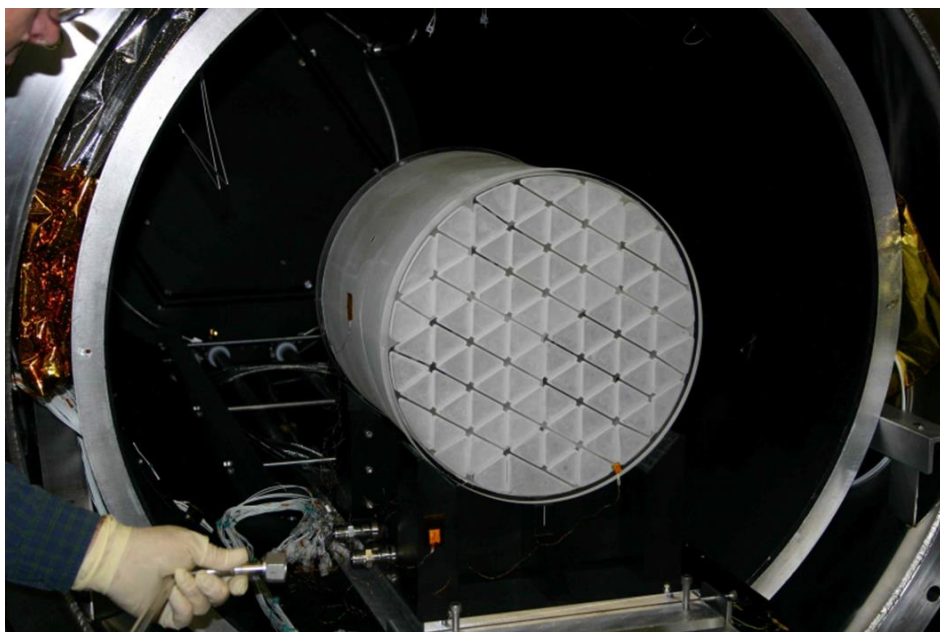


How to get a mirror thermal tested at MSFC?



Ron Eng, NASA Marshall Space Flight Center

Mirror Tech/SBIR/STTR Workshop

Greenbelt, MD

November 2, 2016



Targeted audience



- Mirror substrate manufacturers
 - Lightweighted mirrors
 - Low density and CTE mirrors
 - High modulus, thermal conductivity
 - Ceramic mirror and structures: Coorstek, ECM, Fantom, POCO, Semplastics, SSG, Xinetics, etc.
 - Low CTE glass mirrors: Corning, Schott,
 - Low density metal mirrors: GD, Peregrine,
 - 3D printed mirrors: ASRC, Dallas Optical, Optimax



Goals and motivation



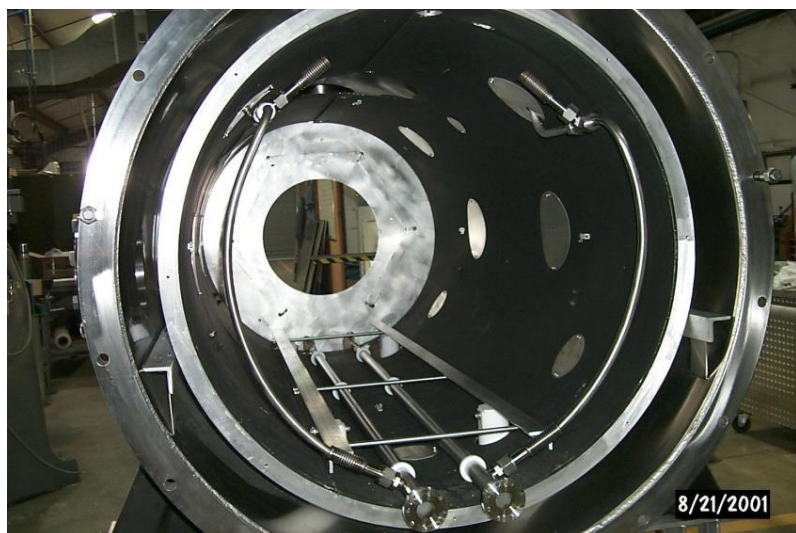
- **OBJECTIVE**

- provide testing using same test setup and facility to characterize competing mirror substrates
 - characterize vendor's process and lot uniformity
 - test up to 12 mirrors on a single test to save \$
- R&D - characterize lightweight mirror substrates
- FEM validation – model prediction correlation
- Mutual benefit – vendors and government

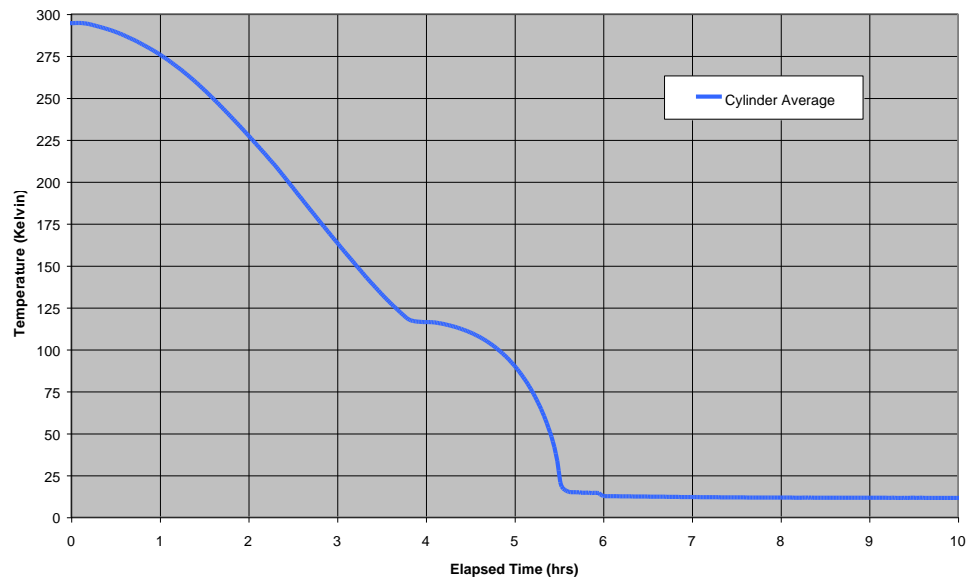
1x3 m cryo test chamber



- **Vacuum Chamber: 1x3 m cylinder with helium shroud**
- **Optical window: 150mm BK7**
- **Temperature range: 290° to 20° K**
- **Operating pressure: ~ 5 E-6 Torr**



CryoOptical Test Chamber
Shroud Verification Test

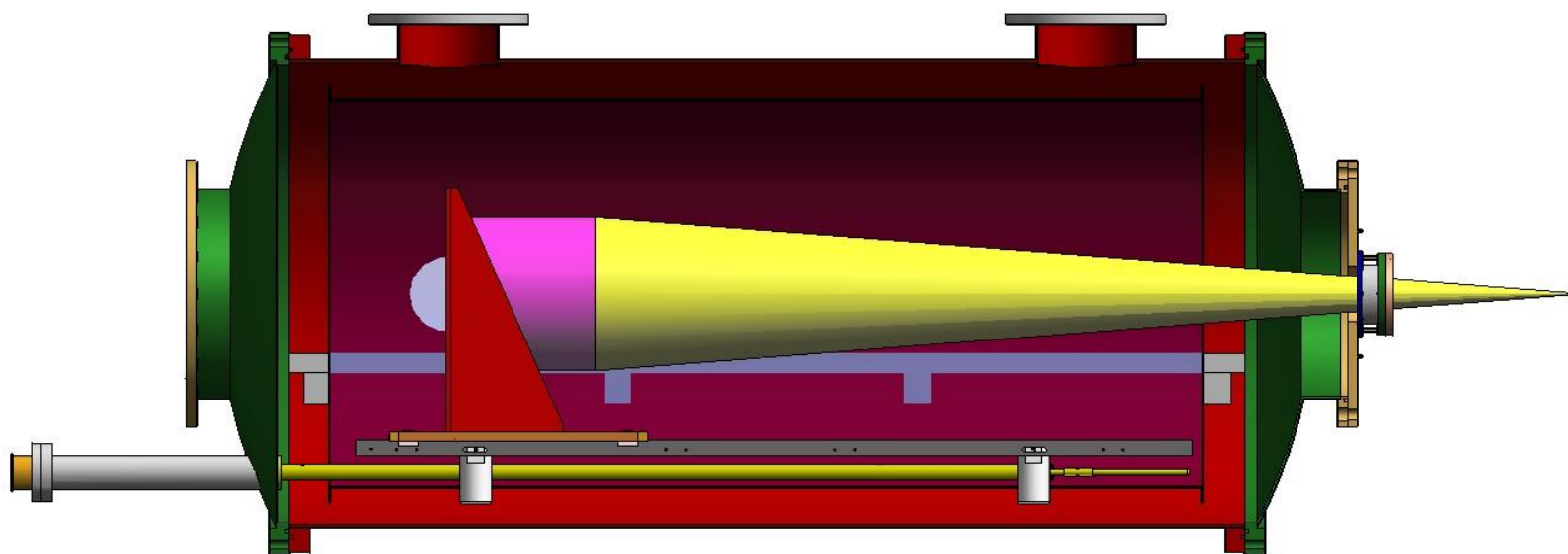




PhaseCam 5010 interferometer

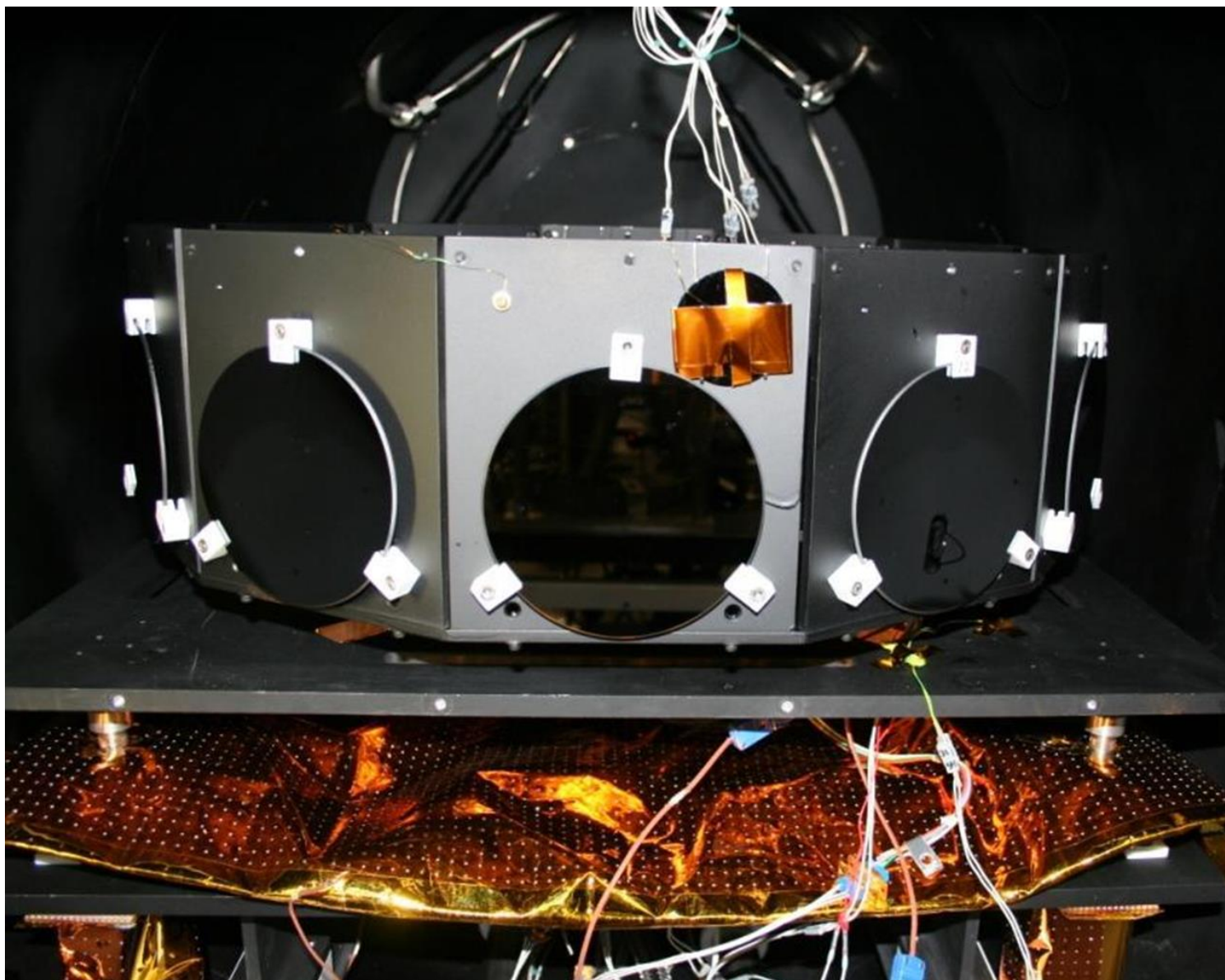
- 1954 x 1967 pixels
- Effective array: 977 x 983 pixels
- diverger: f/6; R/6.25 mirror
- PV uncalibrated accuracy: 15 nm
- RMS uncalibrated accuracy: 3 nm
- PV repeatability: 0.24 nm
- RMS repeatability: 0.05 nm
- PV precision: 2.64 nm
- RMS precision: 0.51 nm

Test configuration # 1: < 800 mm dia. mirror



← 1.5 - 2.5 m ROC →

Test configuration #2: 12 mirrors < 150 mm dia.

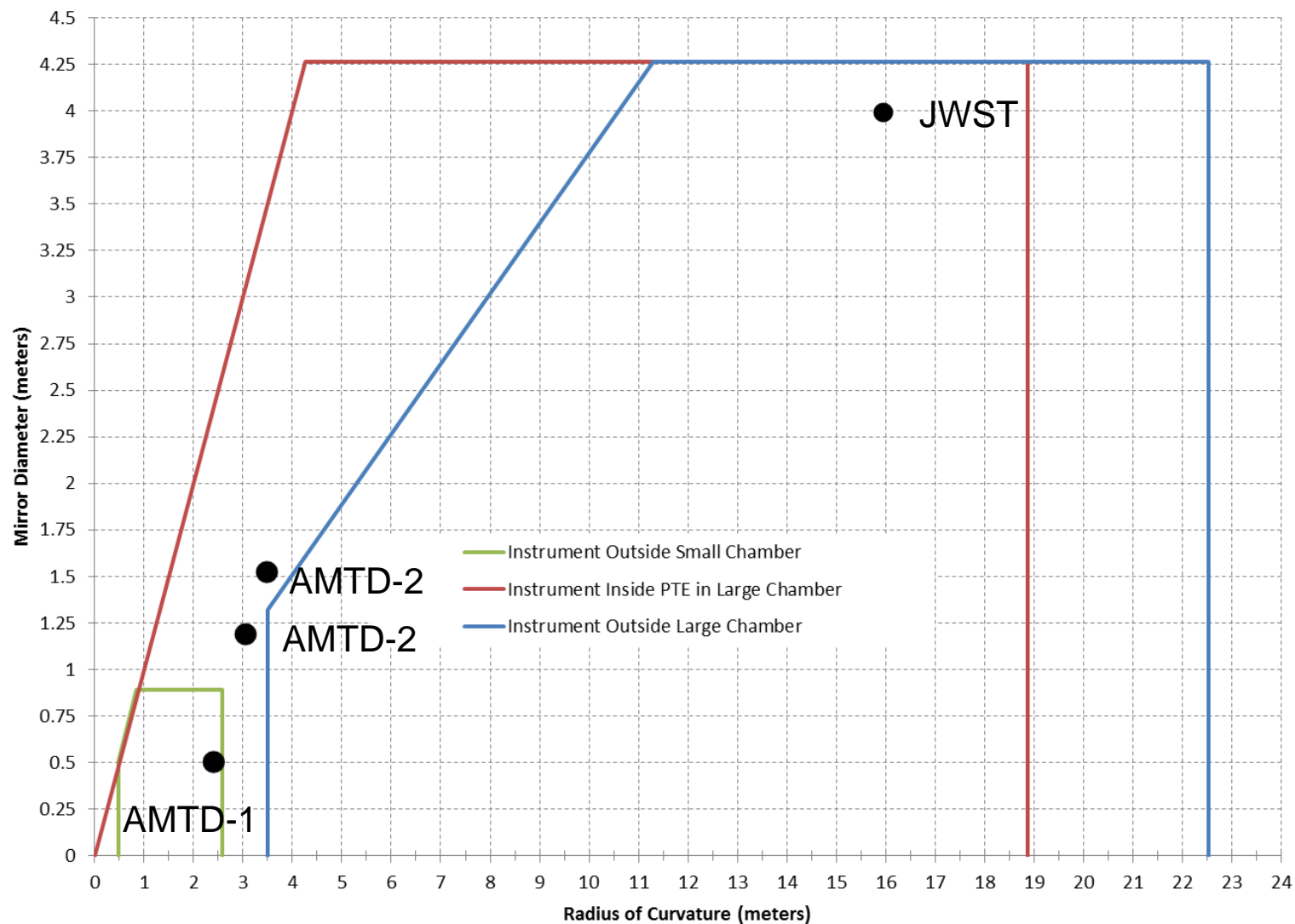




Test envelop for large and small chambers



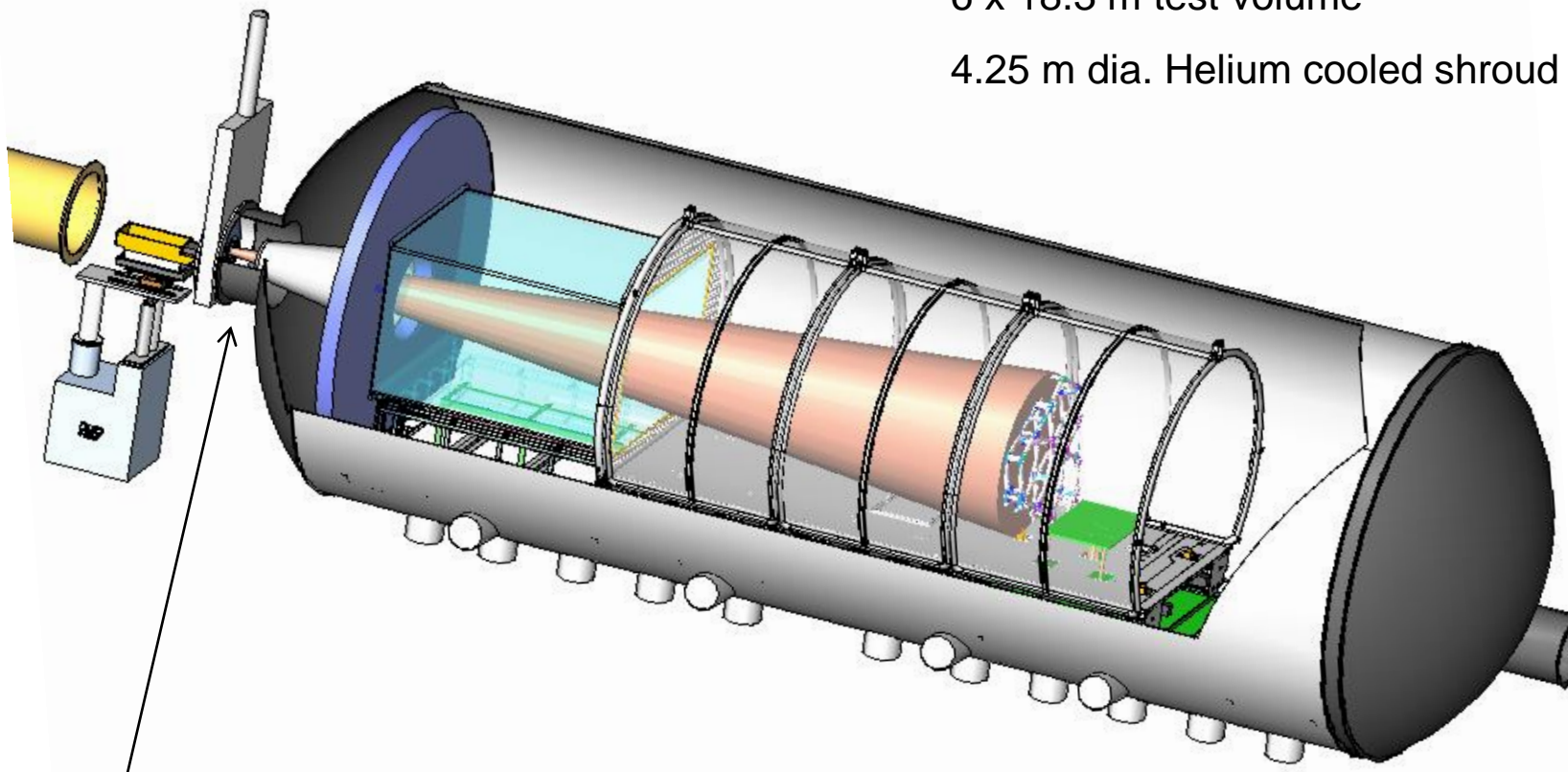
XRCF Mirror Test Capabilities



16 m ROC; ~4 m dia.

6 x 18.3 m test volume

4.25 m dia. Helium cooled shroud



Existing structure prevents testing mirrors with ROC < 3.5 meters

A pressure tight enclosure (PTE) configuration to test mirror with short ROC < 3.5 meter



X-ray cryogenic facility (XRCF)



History

Testing grazing-incidence x-ray telescopes (Chandra, Solar X-ray Imager, Solar B) since 1992.

Testing normal incidence, visible & IR optics & components (NMSD, AMSD, JWST, AMTD) since 1999.

Large test chamber:

7.3 x 22.9 m (O.D. x L) horizontal cylinder

6 x 18.3 m (I.D. x L) test volume

4.25 x 9.4 m (I.D. x L) Helium shroud

< 22.5 m ROC without modification

Up to 30 m ROC with modifications

Cryo shroud enclosure: 320° to 20° K

Refrigeration system: 2 gaseous helium refrigerators; each capable of ~1 kW at 20K.

Vacuum systems: 10^{-8} Torr

527 m guide tube

(starshade testing in vacuum)

Clean Rooms:

6000 sq. ft. Class 2,000

2000 sq. ft. Class 10,000



<https://optics.msfc.nasa.gov>



X-ray & Cryogenic Facility

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Apps MSFC Guest Network RSIC Redstone Sci... Google graph21.png (1163×6

PRE-FLIGHT TESTING FOR:

HEAO-2


CHANDRA

JWST

SKI-M

CON-X

SOLAR A / B



X-ray & Cryogenics Facility


MARSHALL SPACE FLIGHT CENTER

NAVIGATION

- HOME
- Capabilities
- Projects
- Working With Us
- XRCF Data
- Mirror Technology Days
- Contacts

X-ray & Cryogenic Facility

NASA's X-ray and Cryogenic Facility (XRCF) is an adaptable space environment simulation facility that has been enabling technology development and pre-flight verification of space missions since 1991. As the Agency's premier cryogenic optical test facility, the XRCF enables the development and pre-flight evaluation of large direct-incidence telescope mirrors and structures in relevant thermal environments to 20 Kelvin. As the world's largest x-ray optical test facility, the XRCF enables development, performance, and calibration testing of grazing-incidence x-ray optics, detectors and telescopes.




Since construction in 1989, the facility's capability has been utilized in the development and verification activities of NASA flagship missions such as the Chandra X-ray Observatory and the James Webb Space Telescope. Technology evaluation and readiness demonstrations have been performed on advanced x-ray mirrors, composite cryogenic structures, advanced video guidance systems, solar thermal propulsion inflatable structures, and advanced UVOIR mirrors. Key to the XRCF success is the optimized, highly trained, technically diverse, flight hardware qualified crew of the test engineers and technicians that are dedicated to customer satisfaction.

Curator: Ron Eng

NASA Official: Jeff Kegley

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11



XRCF Handbook for more information



XRCF Capabilities | optics X

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NAVIGATION

- HOME
- Capabilities
 - X-Ray Test Capability
 - Cryogenic Optical Test Capability
 - Space Simulation Chamber
 - Guide Tube (Illumination Beam Line)
 - Clean Room
 - Other Capabilities
- Projects
- Working With Us
- XRCF Data
- Mirror Technology Days
- Contacts

Home

XRCF Capabilities

X-Ray & Cryogenic Facility (XRCF)

Marshall Space Flight Center (MSFC) has maintained and operated a world-class x-ray and visible optic and detector testing facility since the mid 1970's. The XRCF as it stands today, was built in 1990 to perform the ground test and calibration of the Chandra X-ray Observatory. It includes an optically clean, thermally controlled vacuum chamber 22.9 meters (75 ft) long and 7.3 meters (24ft) in diameter; a 518 meters (1700 ft) vacuum tube connects an x-ray source to the vacuum chamber. The vacuum chamber has liquid nitrogen panels and heater panels to simulate deep space environment and to maintain accurate thermal stability.



Aerial view of XRCF Facility.
[click image for larger view]

The original purpose of the XRCF was to simulate x-ray emissions from distant celestial objects and it is the largest facility of its kind in the world. In 2005 the XRCF added 2 kw of helium refrigeration and cryogenic shrouds to test James Webb Space Telescope optics at cryogenic temperatures of 35 Kelvin (-397 degrees F), without compromising the existing x-ray testing capability. Additionally, several wave front measuring devices and a 6DoF cryo-capable optical mount were added to increase the facility capability in the visible spectrum as part of the James Webb Space Telescope mods.



Advanced CCD Imaging Spectrometer is rolled into the XRCF

For additional information see the following attachment:

[XRCF Handbook](#)

Curator: [Ron Eng](#)

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Mirror tech days presentations





Tech Days | optics

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PRE-FLIGHT TESTING FOR: HEAO-2 CHANDRA JWST SXI-M CON-X SOLAR A / B



X-ray & Cryogenics Facility

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NAVIGATION

- HOME
- Capabilities
- Projects
- Working With Us
- XRCF Data
- Mirror Technology Days
- Contacts

Home

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- Technology Days 2014 - [Presentations](#)
- Technology Days 2013 - [Presentations](#)
- Technology Days 2012 - [Presentations](#)
- Technology Days 2011 - [Presentations](#)
- Technology Days 2010 - [Presentations](#)
- Technology Days 2009 - [Presentations](#)
- Technology Days 2008 - [Presentations](#)
- Technology Days 2007 - [Presentations](#)
- Technology Days 2006 - [Presentations](#)
- Technology Days 2005 - [Presentations](#)
- Technology Days 2004 - [Presentations](#)
- Technology Days 2003 - [Presentations](#)
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Thank you



Ron Eng

<https://optics.msfc.nasa.gov>

ron.eng@nasa.gov

256-544-3603