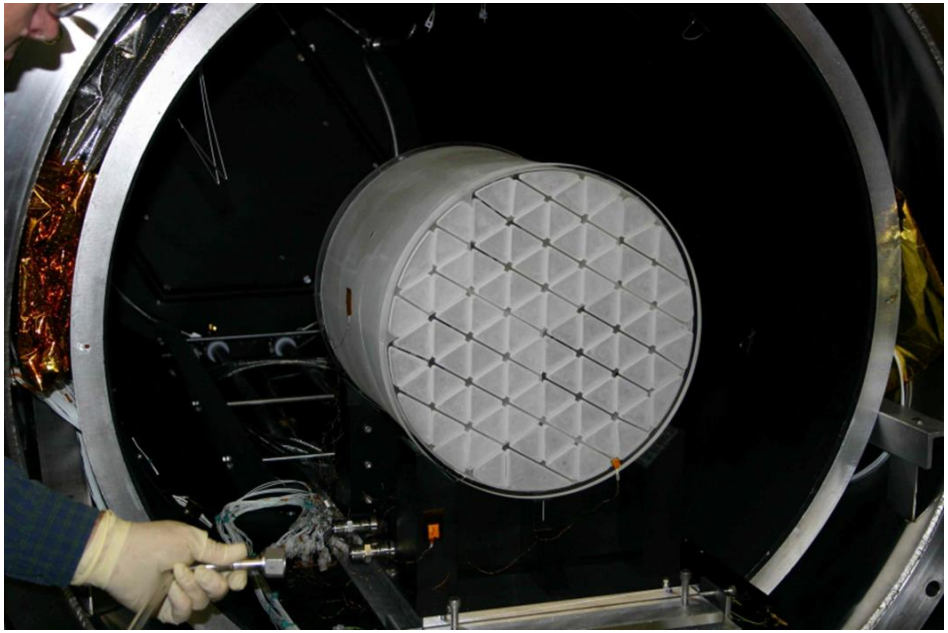
How to get a mirror thermal tested at MSFC?



Ron Eng, NASA Marshall Space Flight Center

Mirror Tech/SBIR/STTR Workshop Greenbelt, MD November 2, 2016

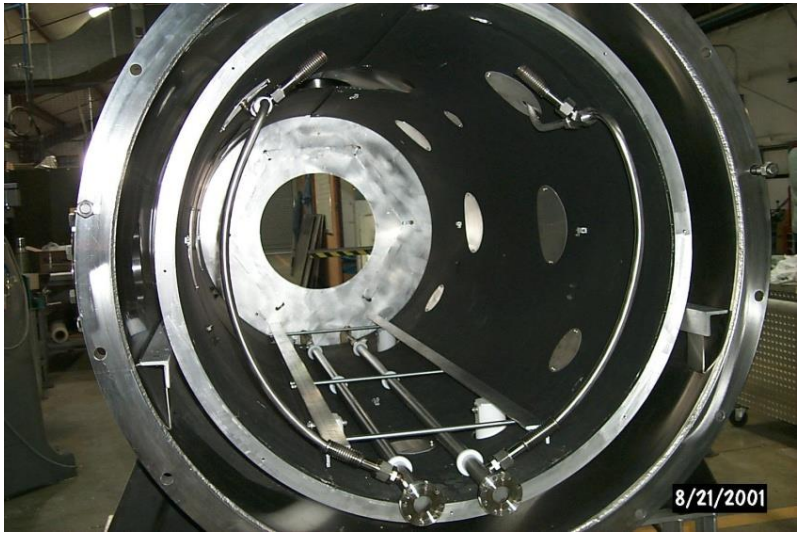
Targeted audience

- 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

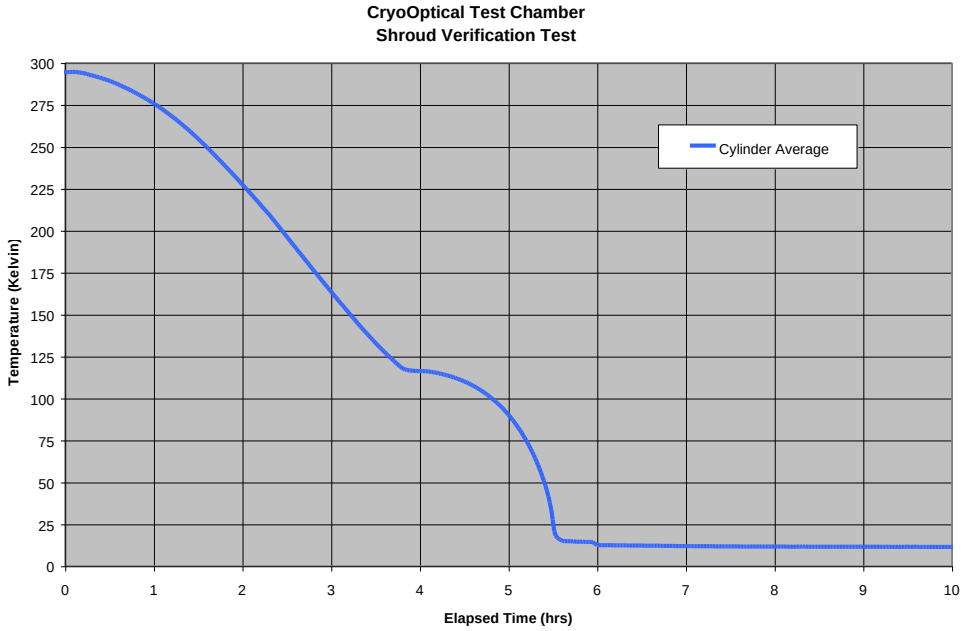
Goals and motivation

- **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: 290º to 20º K**
- **Operating pressure: ~ 5 E-6 Torr**



Optical test setup

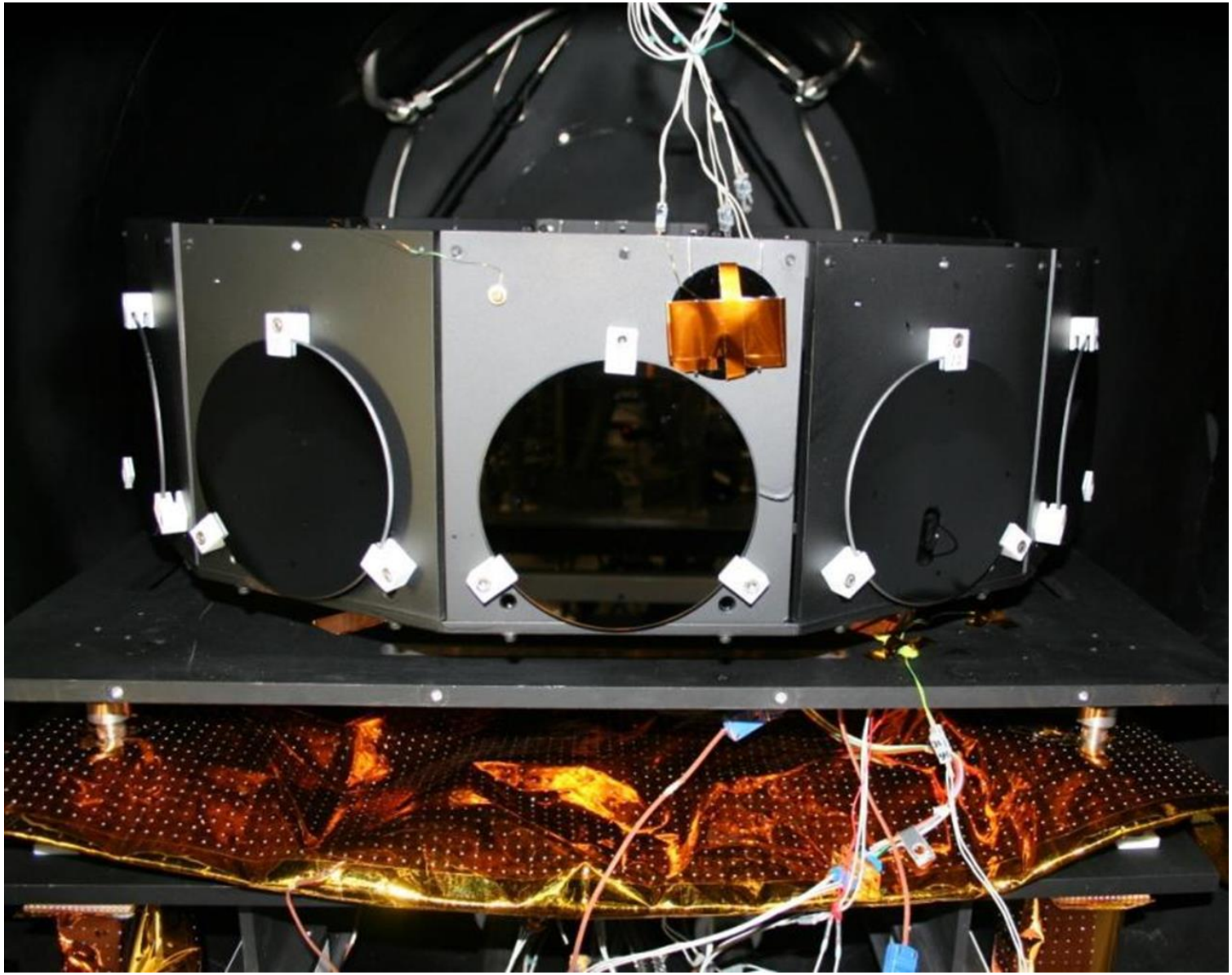
PhaseCam 5010 interferometer

- 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

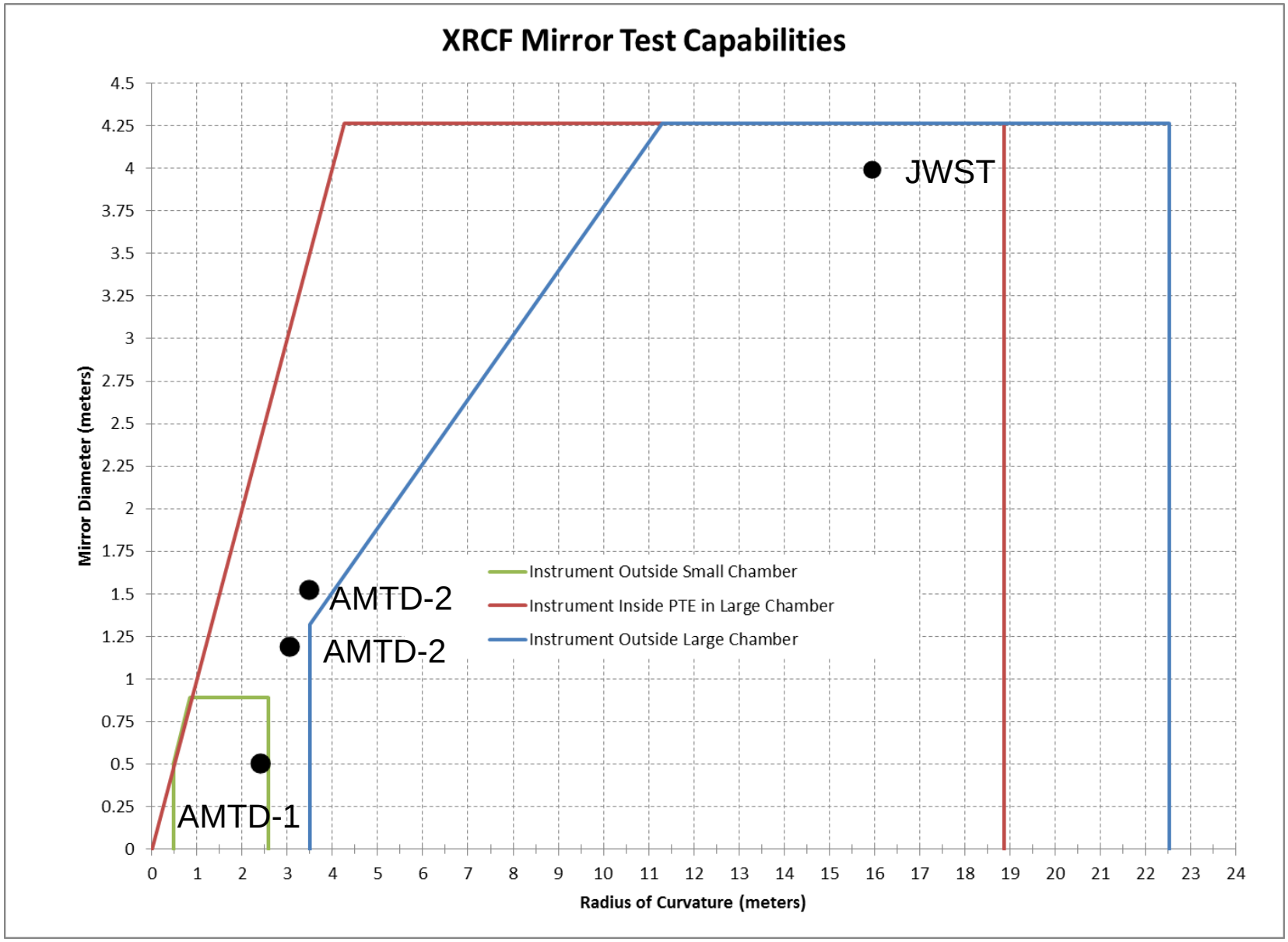
Test configuration # 1: < 800 mm dia. mirror

1.5 - 2.5 m ROC

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



Test envelop for large and small chambers

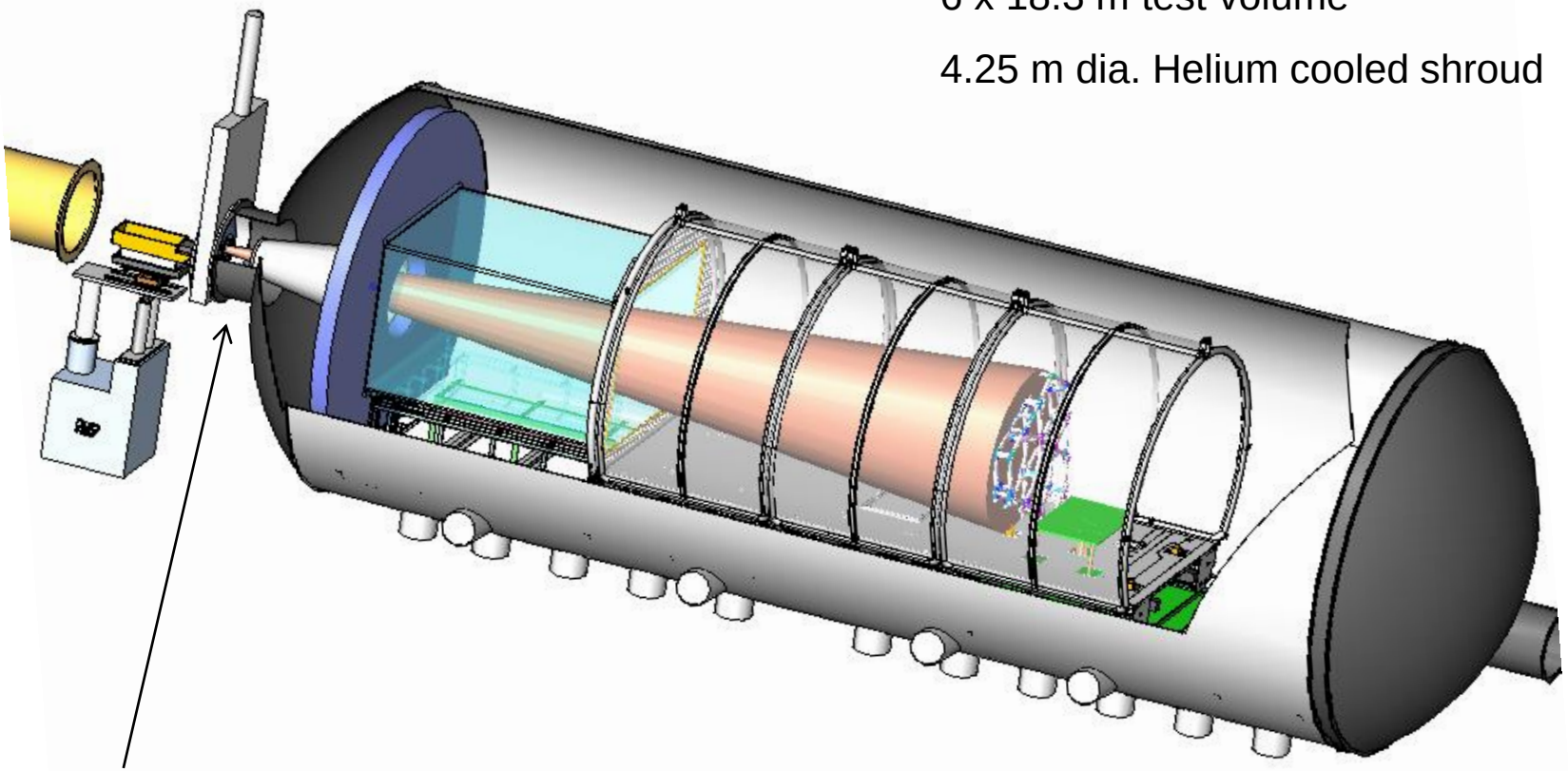


JWST PMSA test configuration at XRCF

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: 320º to 20º K

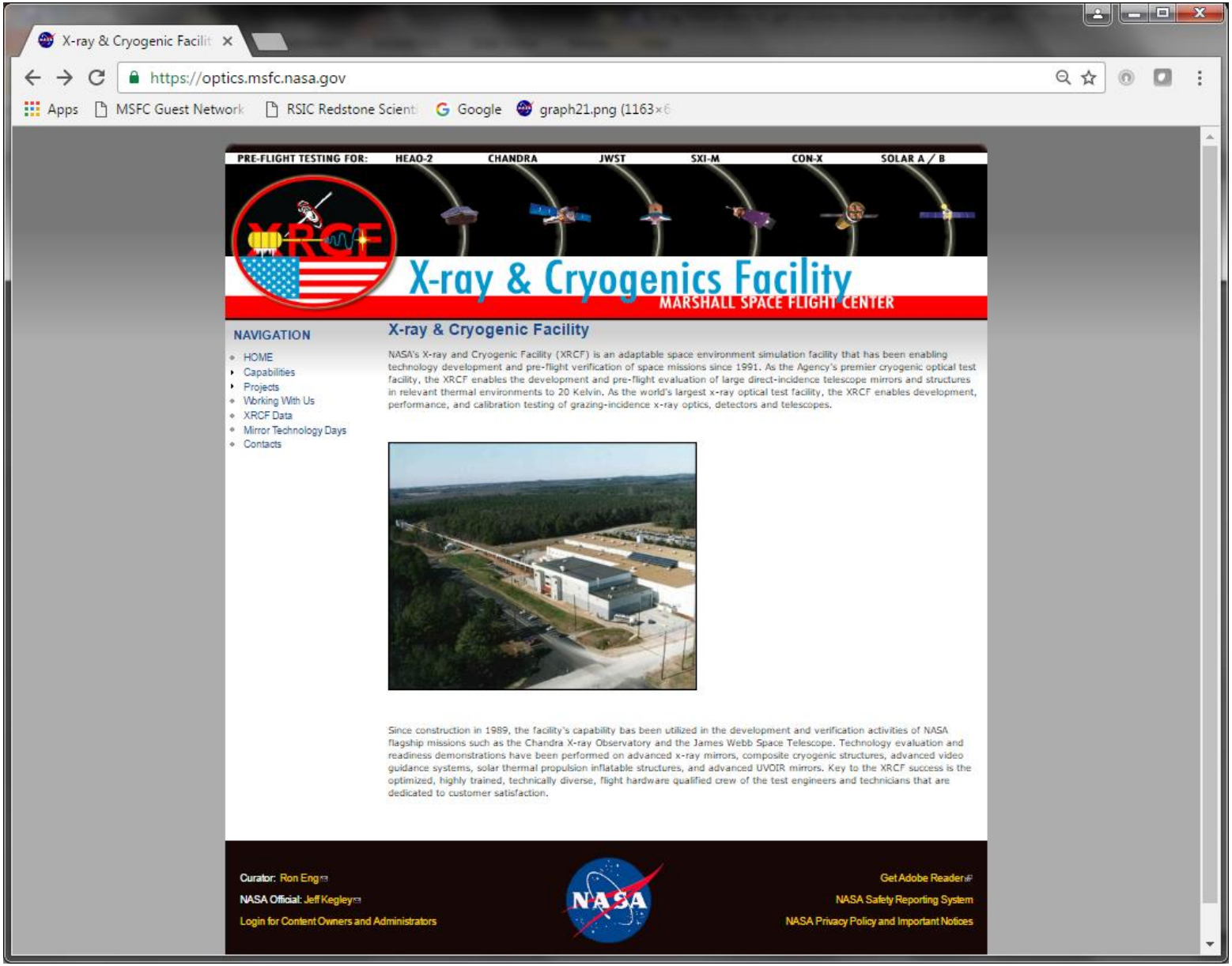
Refrigeration system: 2 gaseous helium refrigerators; each capable of ~1 kW at 20K.

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



XRCF Handbook for more information

XRCF Capabilities | optics

https://optics.msfc.nasa.gov/capabilities

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

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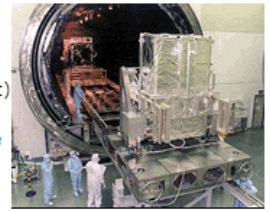
XRCF Capabilities

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.



Advanced CCD Imaging Spectrometer is rolled into the XRCF

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.

For additional information see the following attachment:

XRCF Handbook

Curator: Ron Eng

NASA Official: Jeff Kegley

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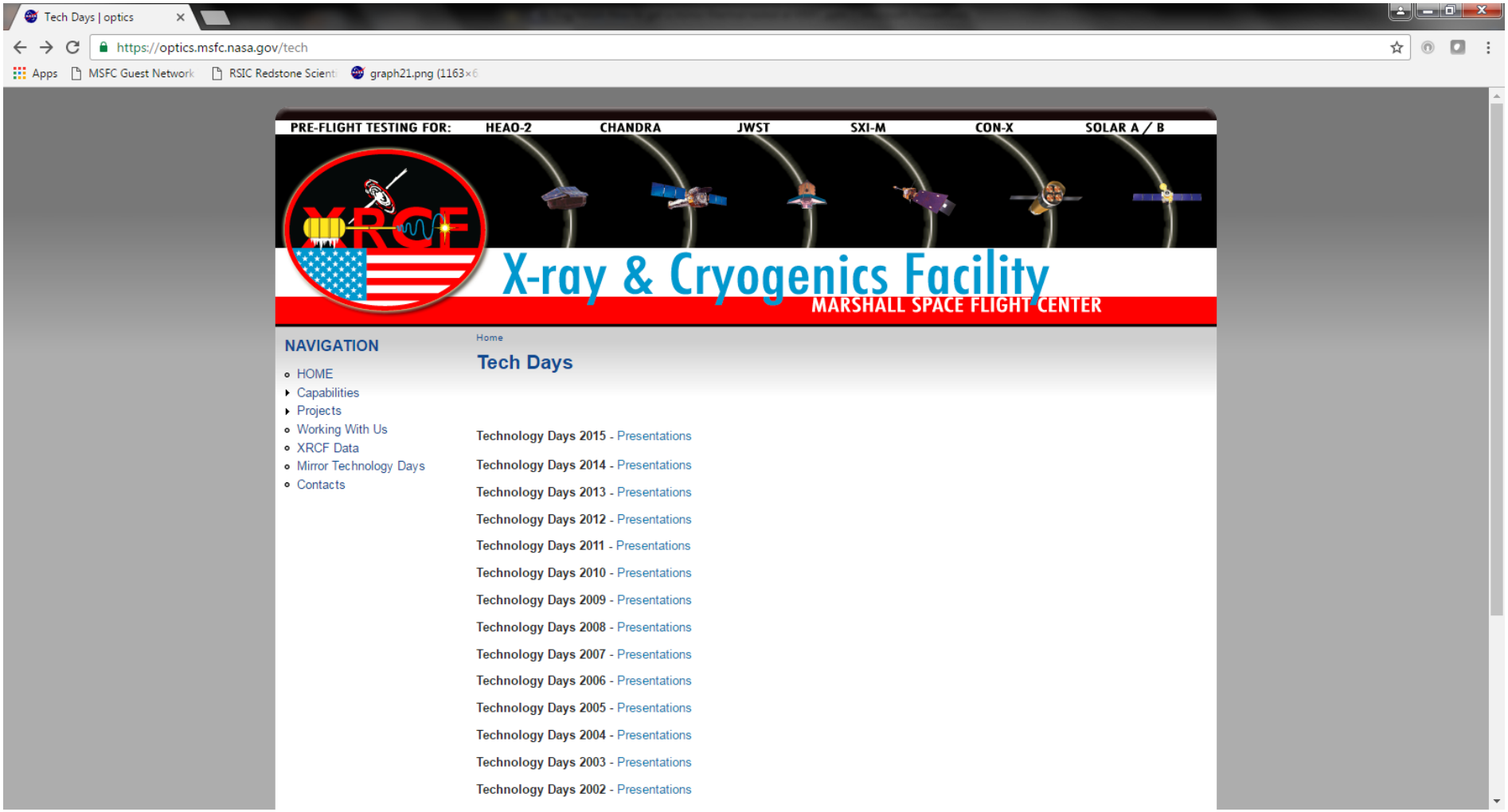

Thank you

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