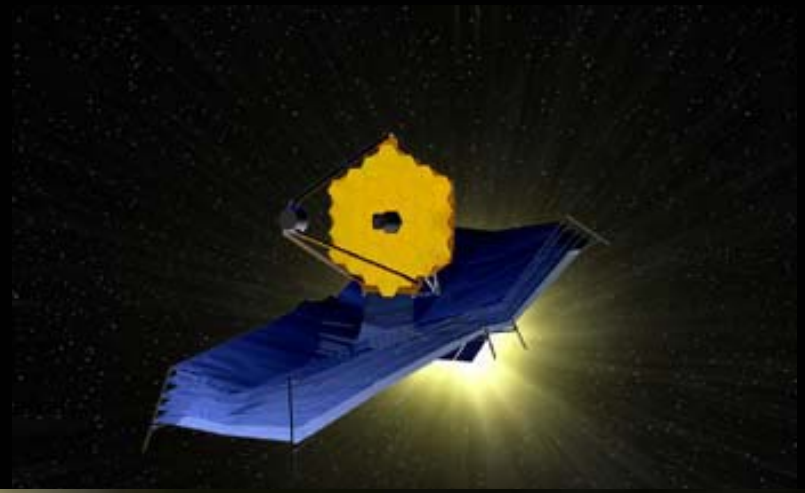
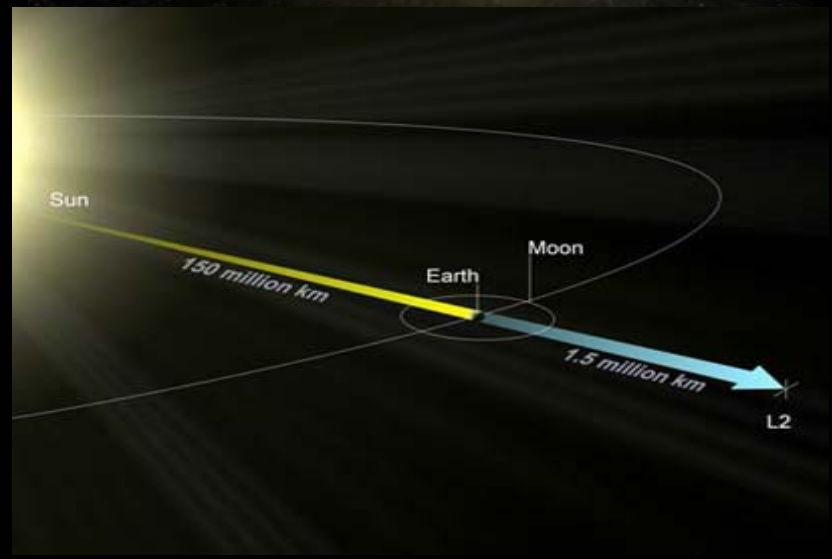
James Webb Space Telescope

Design Challenges and Technological Developments

JWST Mission

- Cosmology and the Structure of the Universe
- Origin and Evolution of Galaxies
- History of the Milky Way and its Neighbors
- Birth and Formation of Stars
- Origin and Evolution of Planetary Systems





JWST Mission

- Launch : August 2011, Ariane 5
- Mirror: 18 Segment, 6 Meter Diameter, Semi-Rigid, Beryllium
- Orbit: Sun – Earth L2 Point (1.5 x 10^6 miles)
- Observations: Infrared Wavelengths(0.6 ~ 28 μm)
- Payload Mass: 5,400 Kg (Hubble = 11,000 Kg)
- Mission Duration: 5 - 10years
- Cost: $ 824.8 Million

Engineering Challenges

- 1. Developing a lightweight, 6-meter-class deployable mirror that will unfold en-route to its Lagrange Point 2 orbit
- 2. Tennis court-sized deployable sunshield, which passively cools instruments and other mechanisms to 35 Kelvin and prevents the electronics from radiating heat and interfering with the collection of extremely faint infrared photons
- 3. Constructing a highly capable spacecraft that weighs about 5000 kg
- 4. Building low-noise, large-area detectors
- 5. Designing, launching and operating JWST at a significantly lower cost than that of its predecessors

Why So Cold?

- JWST Primary Instruments and Mirror will operate at about 30 K
- Impossible to observe in the near- and mid-infrared wavelength bands (0.6 -0.9 microns to 28 microns) at temperatures above 35 Kelvin.
- Anything warmer would create too much of its own infrared “noise” or heat and interfere with JWST’s attempt to detect extremely faint infrared photons.

How to Regulate Temperature

- JW shield
- Opt nally isol
- On the mid

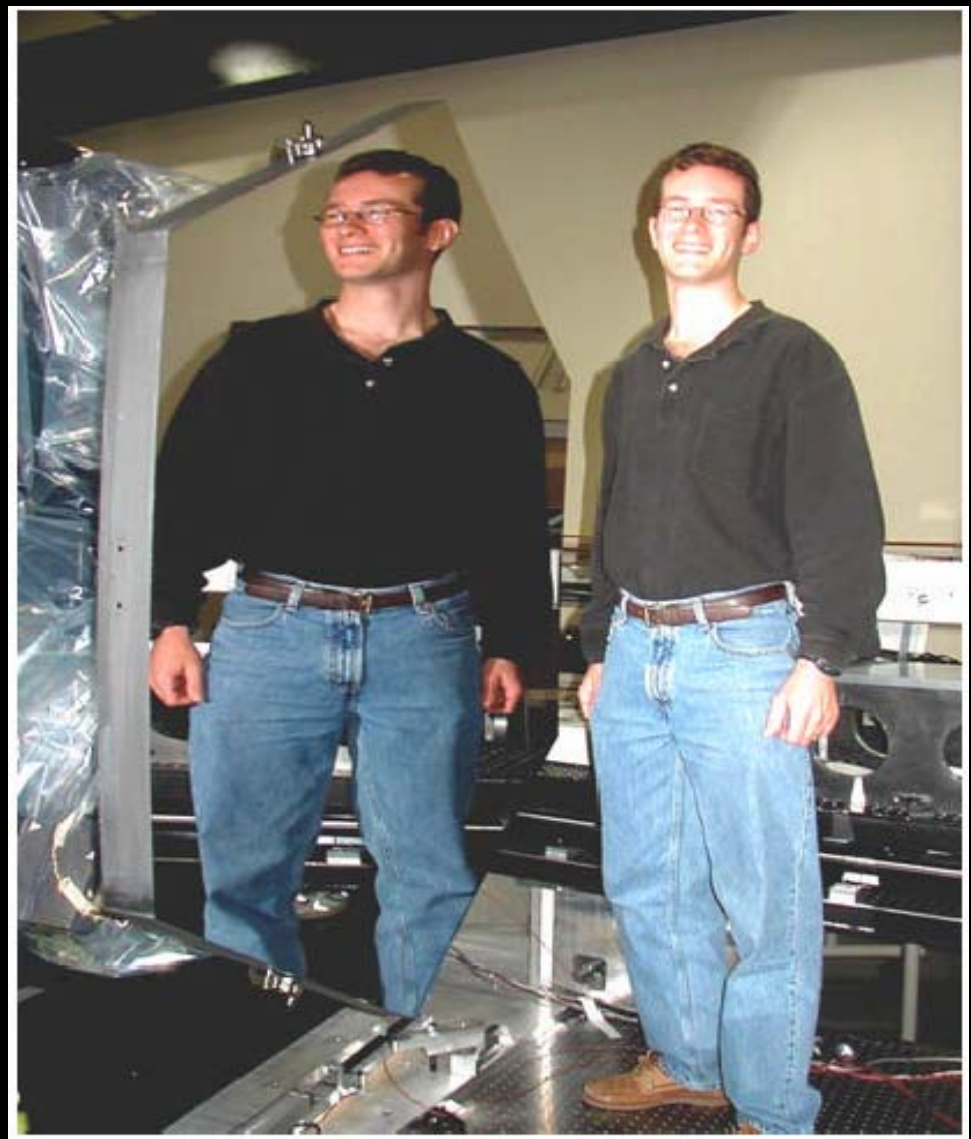
Mirror Challenges

- How to launch a mirror with 6 times the collecting area of Hubble's
- How to provide structural integrity to a mirror with 100 times less mass per square meter than Hubble's
- How to ensure the mirror holds it's shape, especially with the tight pointing requirements (~0.1 arc seconds) and extreme cold temps

Mirror Technology Advances

- Ball Aerospace contracted to create the 18 segment, deployable 6-meter dia. mirror
- Constructed from 18 solid beryllium slabs
- Variable concavity of each segment
- 10 – way control of each segment (tilt, yaw, vertical, horizontal, and curvature)
- Goal is to reduce distortions to less than 0.5 μm (200 x smaller than human hair)

Beryllium Mirror Segment



Ball Advanced Mirror System Demonstrator Assembly

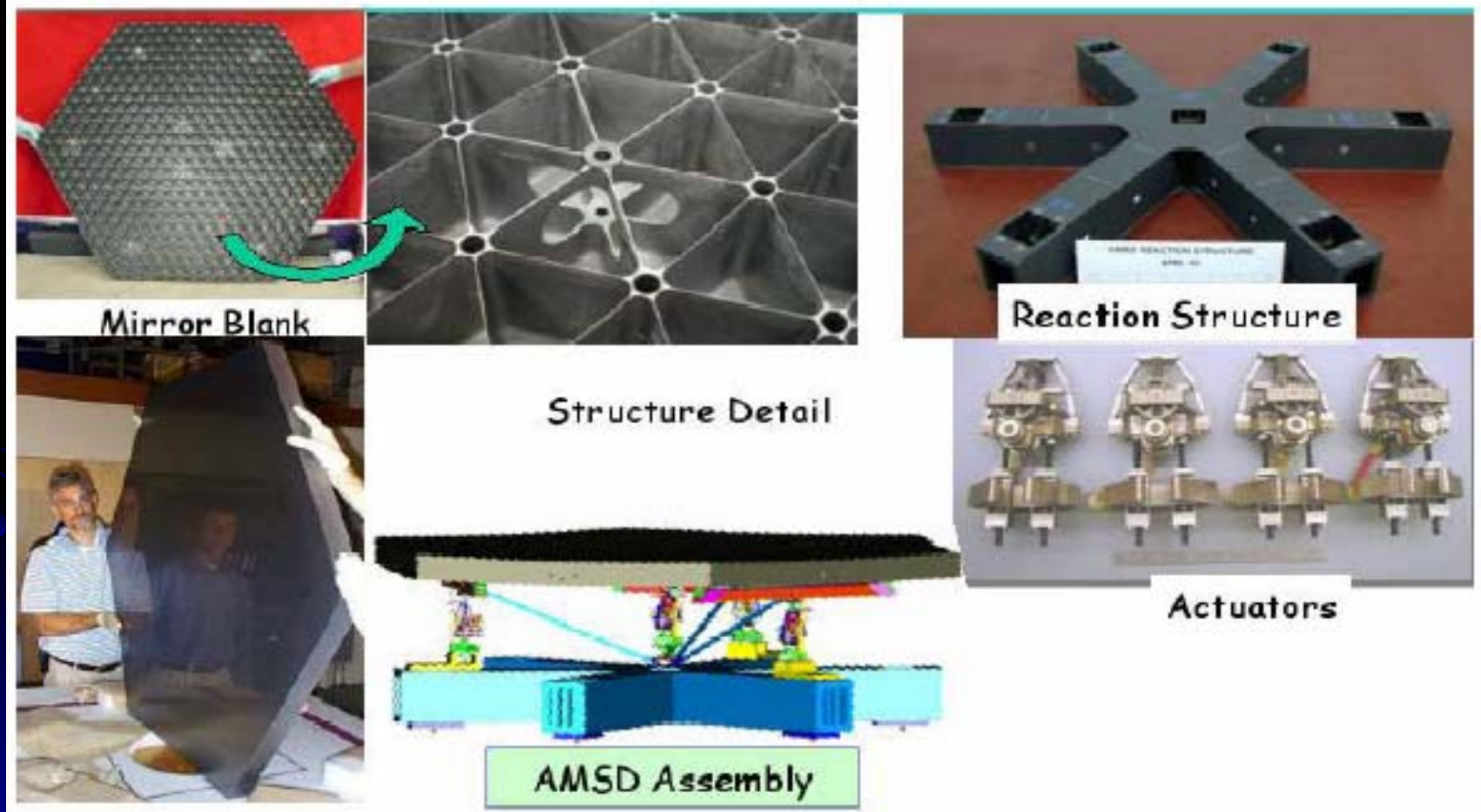
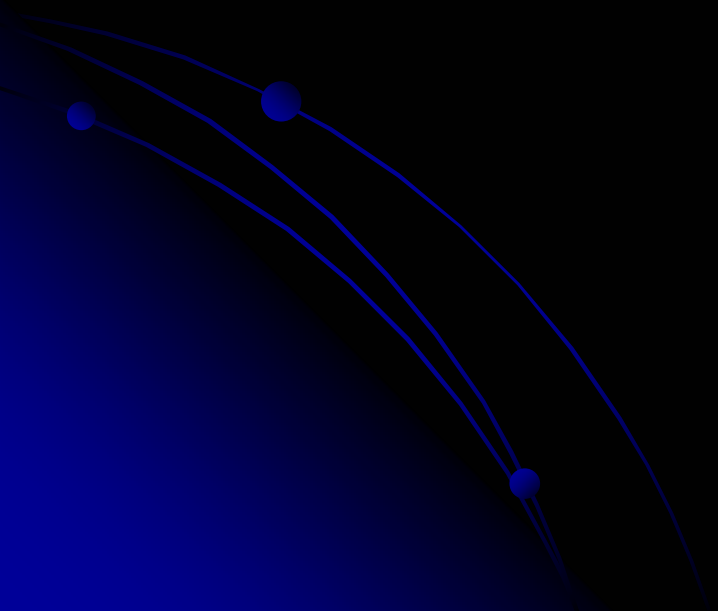


Fig. 2: Ball AMSD Hardware

Mirror Deployment Movie

Questions?



References

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- **The James Webb Space Telescope Home Page.** http://www.jwst.nasa.gov/
- **Ball Advanced Mirror System Demonstrator (AMSD) Overview.** http://www.jwst.nasa.gov/Ball-AMSD/Ball_AMSD.pdf
- **The James Webb Space Telescope Site.** http://nextgen.stsci.edu/
- **Ball Aerospace Website.** http://www.ball.com/aerospace/jwst.html
- **Northrop Grumman Space Technology Website.** http://www.st.northropgrumman.com/markets/page.cfm?PageID=5286&SiteSectionID=0