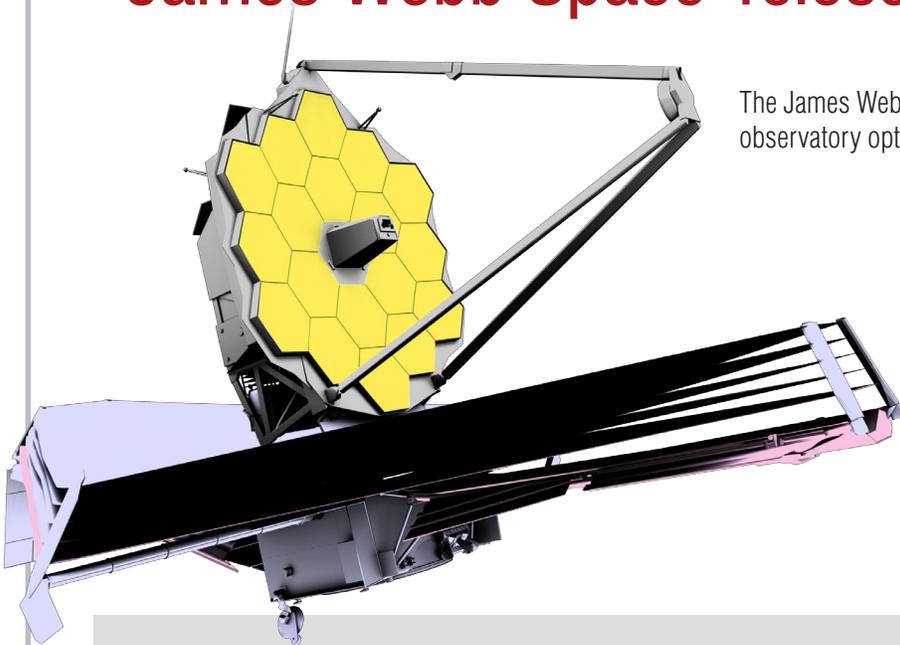


NASA's James Webb Space Telescope: Optics



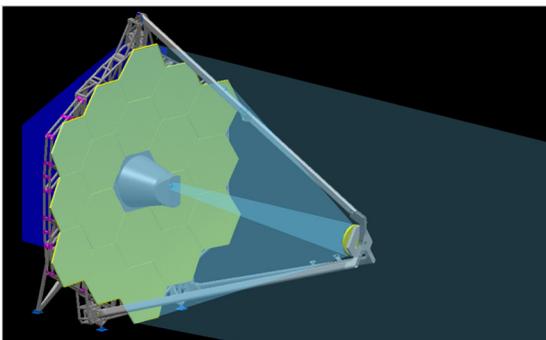
The James Webb Space Telescope (JWST) is a 6.5-meter-aperture observatory optimized for infrared astronomy (0.6 - 28 μm).

Science Themes:

- ▶ Discover the First Stars and Follow the Universe's Ionization History
- ▶ Track the Assembly and Evolution of Galaxies Across Cosmic Time
- ▶ Study the Birth of Stars and Protoplanetary Systems
- ▶ Measure Planetary Atmospheres and Study the Origins of Life

JWST is the first infrared space telescope to employ passive cooling to achieve its operating cryogenic temperature of 40 K. Passive cooling is achieved by locating the telescope beyond the orbit of the Moon at the Second Lagrange Point, where a sunshield consisting of a deployable array of Kapton membranes can block the infrared radiation of the Sun, Earth and Moon.

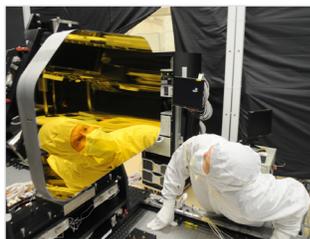
Optical Systems



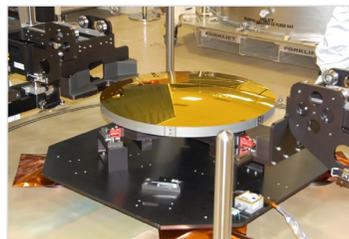
JWST's telescope features a 3-mirror anastigmat optimized for wide field-of-view imaging. The telescope's optical train feeds a fine steering mirror that compensates for spacecraft jitter. The tertiary and fine steering mirrors are mounted on the aft-optical system bench, which also serves as a stray light baffle. The primary and secondary mirrors are an active optical system. Each primary mirror segment is mounted on an actuator array that provides six degrees of freedom motion, and an additional mirror radius of curvature adjustment. The secondary mirror is also mounted with actuators to provide six degrees of freedom. JWST has a segmented mirror architecture that facilitates folding and stowing of the primary mirror for launch.



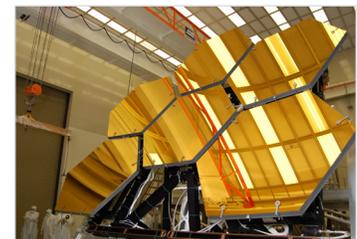
Fine Steering Mirror



Tertiary Mirror

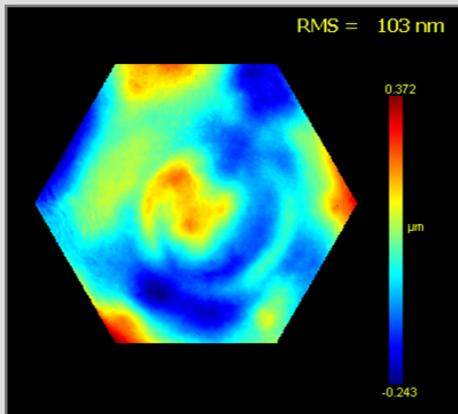


Secondary Mirror

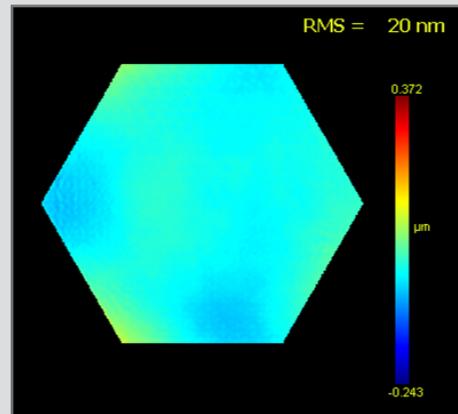


Primary Mirror Segments

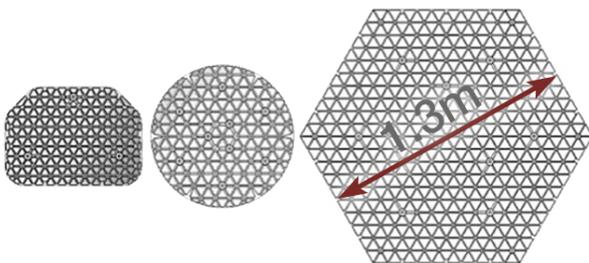
Building the Mirrors



Ambient SFE

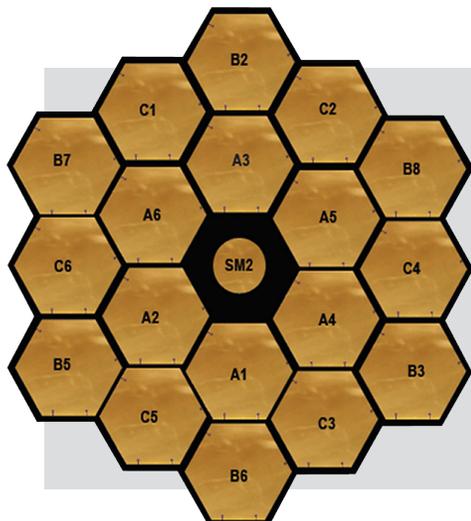


Cryogenic SFE at 40 K



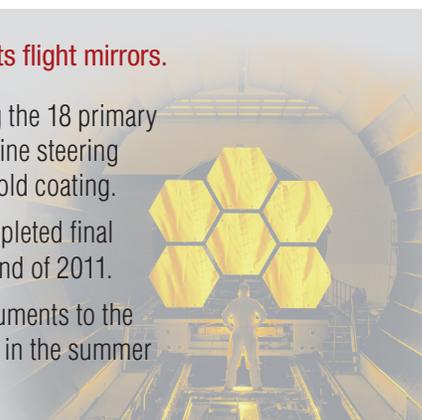
View of mirror rear surfaces showing hexagonal wall structure after lightweighting. Mirrors are shown to same relative scale.

JWST mirrors are made of beryllium, selected for its stiffness, light weight and cryogenic stability. The mirror billets are generated from beryllium powder using a hot, isostatic press process. Each billet is sawed in half to yield two mirror blanks. Each blank is machined to lightweight the mirror in a process that removes ~92% of its mass. The mirrors are then polished by SSG-Tinsley in Richmond, CA. JWST's mirrors must operate at cryogenic temperature (40 K), but they are polished at room temperature. When the polishing reaches a surface figure error (SFE) of ~100 nm, the mirrors are shipped to the X-Ray Calibration Facility (XRCF), where their cryogenic SFE is measured. This SFE is then used to generate requirements for the final polishing phase, so the mirrors will meet their 17 nm SFE at cryogenic temperature. Each mirror is then gold-coated to provide maximum infrared reflectivity. Finally, the mirrors undergo three-axis sine-vibration testing followed by a final cryo-optical measurement of the mirror's SFE.



The JWST project has completed polishing its flight mirrors.

- ▶ All of the JWST flight mirrors, including the 18 primary segments, the secondary, tertiary, and fine steering mirror, have completed polishing and gold coating.
- ▶ The JWST flight segments have all completed final cryo-optical acceptance testing at the end of 2011.
- ▶ Delivery of the first JWST science instruments to the Goddard Space Flight Center will occur in the summer of 2012.



Follow the Webb Space Telescope at jwst.stsci.edu and jwst.nasa.gov



Images courtesy of NASA