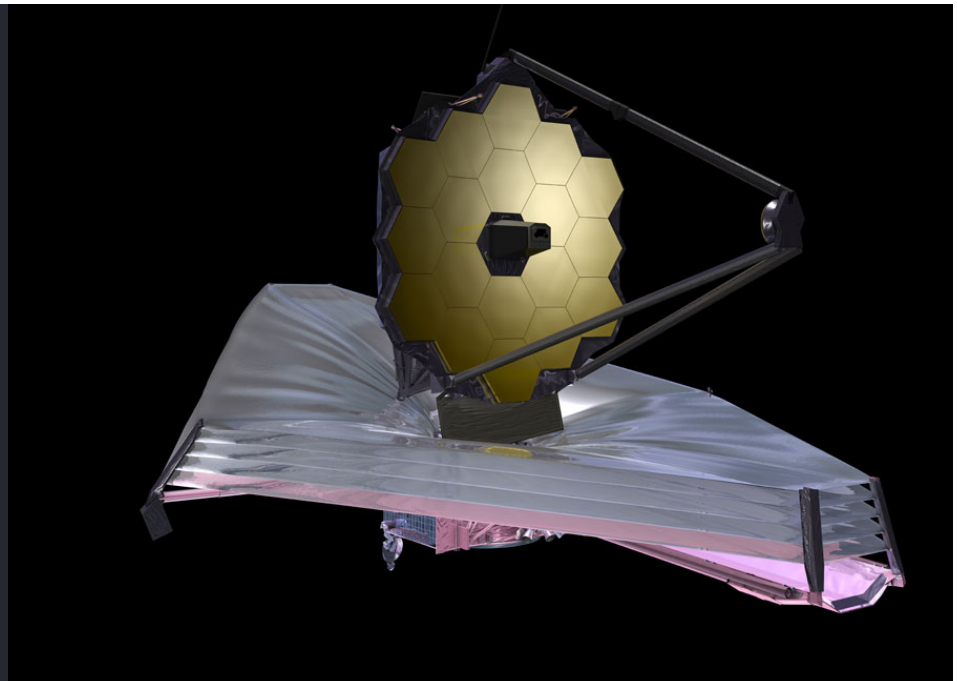
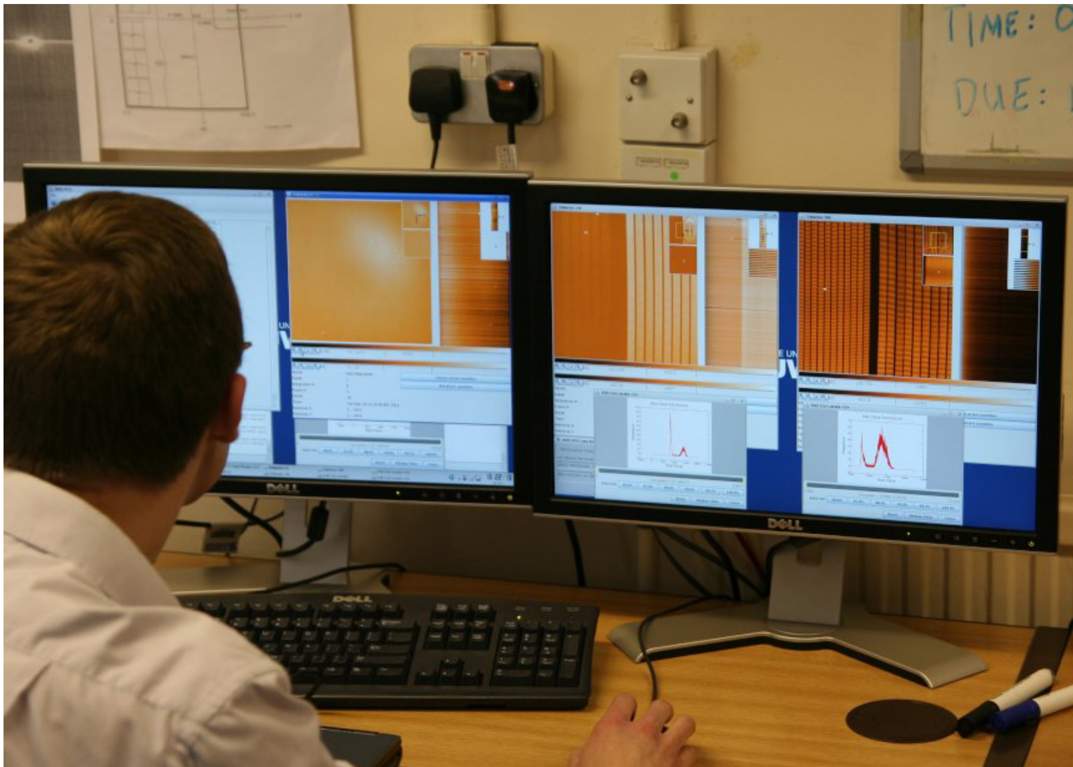
Webb Update

Summer 2011



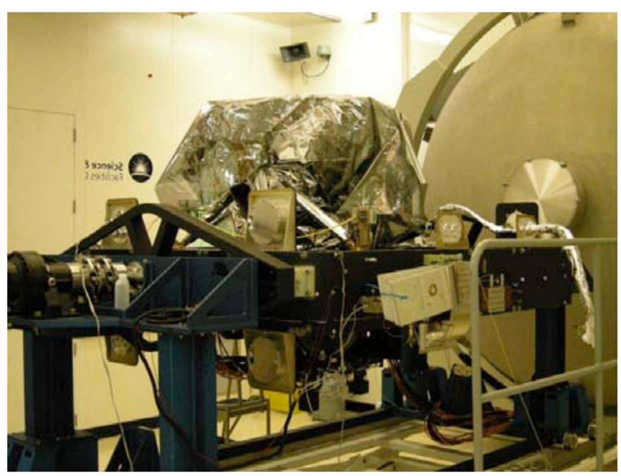


MIRI Testing Almost Finished

by Gillian Wright & George Rieke

One of the four instruments for JWST is MIRI, the Mid-InfraRed Instrument. MIRI contains a camera and a medium resolution integral field spectrograph, both of which cover the wavelength range of 5 to 28 microns (plus coronagraphs and a low resolution spectrometer operating over more restricted spectral ranges). The long wavelength range means that MIRI is unique among the JWST instruments because it has to be cooled to 7K, which also brings challenges for testing the instrument.

The construction of the flight instrument is complete and it has nearly finished its environmental and cryogenic performance tests at the Rutherford Appleton Laboratory in England. To test MIRI thoroughly a special test chamber was constructed that cools the instrument to its 7K operating temperature inside shrouds that represent the 40K environment and background that the instrument will see in operation on JWST. A telescope simulator provides both point sources and extended illumination so that the testing can exercise thoroughly all the different modes of the instrument. An international team of about 30 people from 11 countries is working 24 hours a day, seven days a week to complete the testing. The campaign is progressing extremely well, and the images and spectra indicate that the scientific performance of the instrument is as predicted from modeling and analyses, which is good news for JWST science. MIRI completed the cryogenic portion of its testing on August 3, 2011. This will be followed by warm alignment measurements of the precise position of optical references on MIRI with respect to the JWST alignment fiducials, followed by preparations for the acceptance review and instrument delivery.



Above: MIRI cryogenic test first light images (credit: Mike Ressler, RAL, & the MIRI team). **Right:** MIRI instrument outside the test chamber (credit: RAL, the MIRI European Consortium, & JPL).

ISIM Structure Completes Integration and Testing

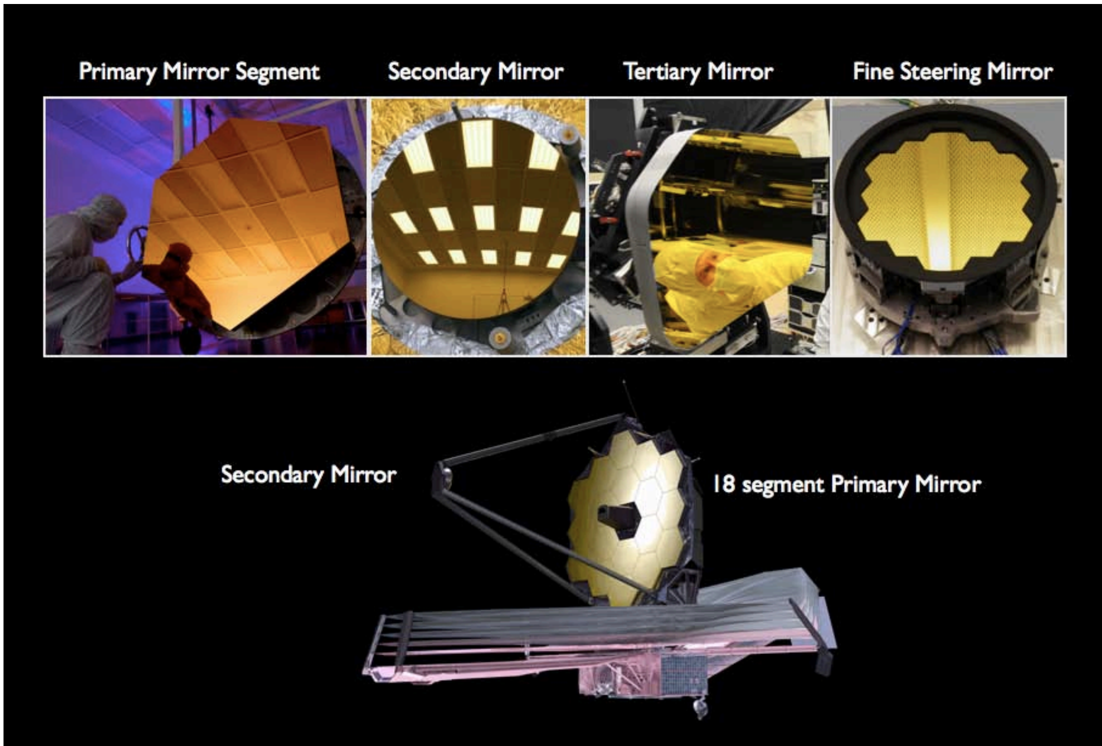
By Eric Johnson

Above: ISIM Structure (inside a protective bag to maintain cleanliness) mounted on the Goddard HCC and ready for one of seven acceleration tests. **Left inset:** cooldown distortions from ambient to 39K over the >2m Structure are less than the width of a pencil lead.

The ISIM Optical Metering Structure (Structure) is a state-of-the-art bonded composite structure which houses the JWST Science Instruments. The Structure holds the instruments in the correct position with respect to each other and the Optical Telescope Element through launch and then through >250 degrees C of temperature swing to operating temperature. It is JWST's first large composite cryogenic structure to be built and tested. The Structure has been through several qualification tests to assure performance prior to installation of the flight Science Instruments. The qualification tests are:

1) The cryo-distortion test completed in May 2010 that measured cool-down distortions and showed that distortions are well within the 0.5 mm limits (the width of a pencil lead),
2) The cryo proof test that completed in October 2010 that demonstrated that the Structure will safely support the instruments during ISIM cryogenic performance testing,
3) The modal survey test completed in March 2011 that characterized the ambient dynamic behavior of the Structure needed to correlate the Structure Finite Element Model, and
4) The ambient proof testing completed in June 2011 that demonstrated that the primary Structure will survive launch.

Proof testing was accomplished using the High Capacity Centrifuge (HCC), which applied a series of centripetal acceleration fields that acted on the Structure and the Science Instruments mass simulators to generate forces that simulated the loads that will be experienced when JWST launches on the Arianne V rocket. The effect is the same as that experienced by children riding a spinning merry-go-round, but many times larger. During HCC testing, the arm rotated at speeds up to nearly 19 rpm, creating acceleration fields of up to 7 times the acceleration of gravity that were applied to the Structure and mass simulators. This resulted in 7 tons of net force at the attachment points to the telescope. Testing was successful, and the Structure is now back in the Goddard cleanroom being prepared for final checkouts prior to delivery to ISIM Integration and Test.



JWST Mirrors Cross Major Milestone

by Mark Clampin

The James Webb Space Telescope (JWST) project has just recently completed polishing all of the mirrors that make up the telescope, a major milestone for the project. Driven by its goal of finding the first galaxies that appeared in the universe, JWST has a three-mirror anastigmat optical design, tailored for wide-field imaging. Due to its size, JWST has to deploy from a stowed configuration after launch and so the primary mirror is built from 18 hexagonal segments permitting the primary mirror to be folded for launch. The 6.5 meter diameter of the 18 segment primary mirror produces a diffraction-limited image at 2 microns. In order to maintain diffraction-limited performance a fourth telescope mirror is employed to correct for image jitter, the fine steering mirror. Figure 1 shows each of the four mirror types that comprise the telescope optical chain.

Each of the 21 mirrors in JWST's optical chain is made of beryllium. Beryllium was selected for its stability at cryogenic temperatures combined with its stiffness and relatively light-weight. Beryllium mirrors are much more difficult to polish than glass, and so the mirror fabrication and polishing phase of the JWST program was initially identified as the longest lead item on the program. Thus, with the completion of the last two mirror segments at Tinsley, the JWST project has completed its longest lead milestone. The resulting composite surface wavefront error of the 18 segment primary mirror meets the 17 nm requirement allocated for this element of the telescope with adequate margin.

While polishing of the mirrors is complete, there are still many steps to complete construction of the JWST telescope. The primary mirror segments have to be coated with a thin layer of gold for optimum infrared reflectivity (15 of 18 segments have been coated at the time of publication), and then assembled into a mirror assembly which requires the installation of the seven actuators that provide both six degree of freedom authority for the mirrors, combined with a radius of curvature adjustment. The primary mirror segments then undergo a 3-axis sine-vibration test (12 of 18 segments have passed their vibration test at the time of publication) to demonstrate they can survive launch in the Ariane 5, followed by an cryogenic optical test at 40 K to verify they meet their optical specification. The first six flight mirrors to undergo their cryogenic optical acceptance test are shown in Figure 2 as they are rolled into the X-Ray calibration facility at the Marshall Space Flight Center. The second set of six mirrors went into the thermal vacuum chamber on July 29.

Scientists Gather for JWST Frontiers Workshop

by Jason Kalirai

The Space Telescope Science Institute in Baltimore, MD hosted the "Frontier Science Opportunities with JWST" meeting on June 6-8th, 2011. The meeting brought together nearly 200 astronomers from around the world, including many students and postdoctoral researchers, to engage one another in the science potential of JWST. The 3 day meeting contained over 20 talks, dedicated poster sessions and presentations, and over 1/3 of the total time devoted to discussion.

The science presented at the Frontiers meeting amplified the unique role that JWST will play in the future of astronomy. Speakers discussed how the multiple imaging, spectroscopic, and coronagraphic modes would enable new breakthroughs in astrophysical topics ranging from characterizing Solar System planets and Kuiper Belt Objects, to searching for the first cosmic explosions in the Universe. Several speakers also took advantage of the newly released JWST Prototype Exposure Time Calculators to establish a reasonable feasibility of their science programs. In addition to strengthening the core science themes of JWST, speakers revealed new possibilities to improve our understanding of fundamental stellar relations such as the initial mass function, the hydrogen burning limit, the star formation law, and feedback on both stellar and galactic scales. JWST studies of the flatness of the Universe through high precision (~1% accuracy) measurements of the Hubble constant will also impact dark energy research in the future. All of the presentations and slides from the "Frontier Science Opportunities with JWST" meeting can be downloaded from http://webcast.stsci.edu/webcast/ and interested scientists are encouraged to explore the newly released JWST Exposure Time Calculators at http://jwstetc.stsci.edu/etc/.

Would you like a colloquium at your university on JWST? How about a talk at a conference you are organizing? These JWST scientists are willing to give a talk. All expenses will be paid by the JWST project for talks in the US; talks in other countries can also be arranged.

To arrange a talk, please email contactswg@jwst.nasa.gov or contact the speaker directly.

For European universities and institutions interested in inviting speakers to give talks covering the full range of scientific topics addressed by JWST, please contact Peter Jakobsen (ESA JWST Project Scientist, ESTEC, pjakobse@rssd.esa.int).

The speakers are also available to give JWST Mission Overview talks and talks at the general public level.

- Mark Clampin, GSFC, "Exoplanets with JWST"
- Rene Doyon, Universite de Montreal, "JWST Tunable Filter Science"
- Jonathan Gardner, GSFC, "JWST and Galaxy Evolution"
- Matt Greenhouse, GSFC, "JWST Mission Overview and Status"
- Heidi Hammel, AURA, "Planetary Exploration with JWST"
- John Hutchings, DAO, "JWST's Guider and Tunable Filter Imager"
- Jonathan Lunine, Cornell University, "JWST, Exoplanets and the Solar System"
- John Mather, GSFC, "JWST Mission Overview and Status"
- Bernie Rauscher, GSFC, "JWST and it's HAWAII-2RG and SIDECAR ASIC Detector Systems"
- George Rieke, University of Arizona, "Debris Disks and the Evolution of Planetary Systems" or "The Place of JWST in the growth of Infrared Astronomy"
- Marcia Rieke, University of Arizona, "NIRCam for JWST: Exoplanets to Deep Surveys"
- Jane Rigby, GSFC, "Gravitationally Lensed Galaxies and JWST" or "AGN and JWST"
- George Sonneborn, GSFC, "Imaging and Spectroscopy with JWST"
- Massimo Stiavelli, STScI, "Studying the first galaxies and reionization with JWST"
- Amber Straughn, GSFC, "JWST and Galaxy Assembly"
- Rogier Windhorst, Arizona State University, "JWST and Reionization" or "JWST and Supermassive Black Hole Growth"