National Aeronautics and Space Administration

Webb Update

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Critical JWST Test Equipment Prepared for Cryo-Vacuum Test at Goddard

By Randy Kimble

Activities are heating up in NASA Goddard Space Flight Center's largest thermal-vacuum chamber, in preparation for a major cooldown for the cryo-vacuum testing of two critical pieces of JWST test equipment. These items, recently installed into Goddard's Space Environment Simulator chamber, are the Optical Telescope Element (OTE) Simulator (or OSIM) and the Beam Image Analyzer (BIA).

The OSIM plays the vital role in the JWST program of accurately simulating the optical input beam that the Webb telescope will deliver in flight to each of its Science Instruments (SIs), in position, wavefront quality, chief ray angle, and pupil position. It does so using an elegantly designed optical system incorporating just one powered mirror (a simple sphere), several fold flats, and a pupil positioning mechanism. A variety of associated illumination sources allow OSIM to stimulate the SIs with optical input at a variety of wavelengths within their operating ranges. With this simulator, the Integrated Science Instrument Module (the ISIM, which houses all the SIs) will be cryo-vacuum tested, beginning next year, to verify the proper 6-degree-of-freedom alignment (position and tilt) and pupil alignment of the four Webb Science Instruments to the ISIM structure and ultimately to the telescope itself.

In the upcoming cryo-vacuum test, the OSIM will be functionally tested at its intended cryogenic operating temperature and optically tested to confirm the accuracy of its intended emulation of the OTE. In order to make that optical evaluation of the OSIM, another major piece of test equipment is a crucial part of the upcoming test: the Beam Image Analyzer. The BIA incorporates several high-resolution instruments, including a Phase Retrieval Camera and a Point Diffraction Interferometer, both of which incorporate spare HgCdTe infrared sensors from the NIRCam program.

These sensors will be driven around the simulated OTE focal plane with precision stages, to calibrate the OSIM beam at the position and tilt of each of the SIs.

Also supporting the upcoming test will be a sophisticated PhotoGrammetry (PG) camera system. This system incorporates two precision cameras on a rotating boom. By viewing, from a variety of angles, the BIA and a well-calibrated set of metrology targets and scale bars mounted to it, the PG system will confirm the proper positioning of the BIA sensors at each SI's position within the JWST field. The PG system has been used previously during cryo-testing of the ISIM structure and demonstrated outstanding accuracy (~30 microns, less than the diameter of a human hair).

When the OSIM cryo-test is completed later this year, a vital piece of test equipment will have been certified for use in the JWST integration and test program.

JWST Primary Mirror Backplane Support Structure Meets Crucial Milestone

By Mark Clampin and Lee Feinberg

The backbone of the James Webb Space Telescope is the structure that holds the 18 hexagonal primary mirror segments in place. Even the excellent quality of the JWST mirrors will not deliver superb images unless they are held firmly in place. Ground-based telescopes solve this problem with massive, metal structures to provide a rigid backbone for the telescope; however, space telescopes are extremely constrained by mass and this option is not available. One unique challenge for JWST is precisely mounting the mirror segments with a support structure that is light enough to be launched into space. JWST is a cryogenic telescope so the mirror support structure has to operate at cryogenic temperatures (~40 K), and maintain the precise alignment of the mirrors when the structure cools from ambient temperature to its cryogenic operating temperature.

The JWST primary mirror backplane support structure (PMBSS) is the solution to these challenges. It has been designed to precisely mount each of JWST's primary mirror segments and maintain their relative alignment at cryogenic temperatures. The PMBSS is too large to fit in the Ariane 5 launch fairing fully deployed, so the structure is designed as a center section with two wings, each mounting 3 mirror segments that can be folded back to fit the fairing for launch. The three main elements are shown in Figure 1. The PMBSS structure is manufactured from lightweight graphite material by ATK facilities in Magna, Utah. Composite materials like these are used in golf clubs and tennis rackets and even newer airplanes, along with many satellites. JWST's unique contribution to this technology is the development of this composite material that is both very lightweight and has extremely low coefficient of thermal expansion at very cold temperatures. The backplane's center section alone is built from 1,781 composite parts, and 179 metal fittings. ATK have just completed flight subassembly of the PMBSS center section several months ahead of the current baseline schedule. The completed flight assembly is shown in Figure 2, with several ATK technicians providing an idea of the scale of this element of the telescope.

Completion of the PMBSS center section is another important JWST milestone. The PMBSS still has a long journey to the launch. Its next step is a cryogenic test at the Marshall Space Flight Center (MSFC) where it will be thermally cycled to ~40 K several times to validate the structure's integrity at cryogenic temperatures.

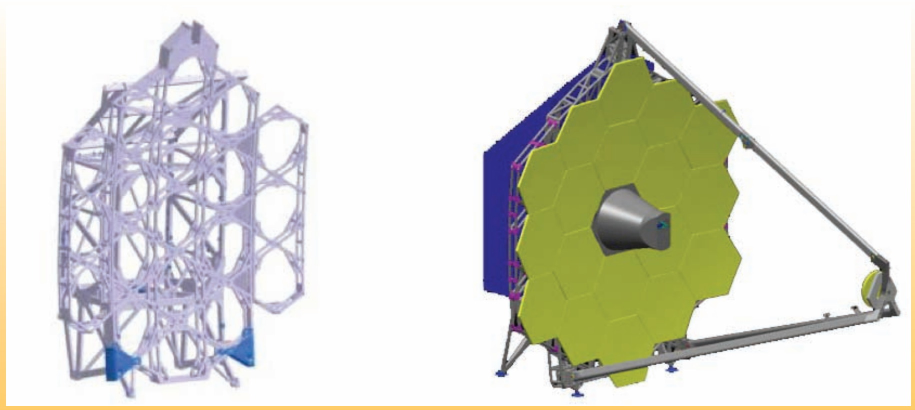

Figure 1: A schematic representation showing the primary mirror backplane structure (PMBSS) on the left, and the primary mirror once the PMBSS is populated with mirror segments.

Figure 2: The center section of JWST's flight backplane structure following its completion at ATK.

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Planning Your Solar System Observations with JWST

By Stefanie Milam, Heidi Hammel, Dean Hines, and Jonathan Lunine

The Science Working Group of the James Webb Space Telescope (JWST) has a dedicated effort to establish the full scientific capabilities of this facility for Solar System Science. Recently, the Science Operations Design Reference Mission (SO-DRM) incorporated realistic science programs in order to approximate the first year and a half of observations for JWST in order to further constrain operations and efficiencies. While not inclusive of the full capabilities for this facility, eight different programs were considered for Solar System studies: NIRSpec studies of the Martian atmosphere, bright comets, icy dwarf planets, Uranus, Neptune, giant planet satellites, Kuiper Belt objects (KBOs), and main-belt asteroids; NIRCam observations of bright comets, Uranus, Neptune, and KBOs; and MIRI observations for all programs.

Themes probed in this preliminary set of programs were diverse and included key science for Solar System studies; some specific cases are listed here. For example, in order to enhance our knowledge of the detailed diurnal cycles of various gasses and aerosols in the Martian atmosphere, a program was designed using NIRSpec and MIRI to obtain synoptic monitoring over the entire disk at varying timescales and seasons. Another focus has been to monitor a large sample of periodic comets and new targets at various distances in their orbit to fully characterize the dust, ice, and gas composition as well as constrain cometary activity at large distances by obtaining images near the nucleus and spectra of various volatile species not easily measured from the ground. A similar program was considered for icy dwarf planets (Pluto, Eris, Haumea, Makemake, and Sedna), where detailed studies of the surface and atmospheric composition, isotope ratios, and distributions of these constituents will be made. While these programs have broad implications for solar system science, they are not inclusive of the full capabilities of JWST.

In order to fully recognize the maximum potential of JWST for Solar System observations, we are seeking experienced observers of solar system targets to participate and provide input in an upcoming workshop being held at the Division of Planetary Science meeting in Reno, Nevada this fall. This workshop will provide you an opportunity to learn about the current instrument specifications and observing modes, as well as the observatory constraints such as brightness limits, moving target tracking, and others. Our goal is to fully consider all targets and key science that could be addressed by JWST for solar system studies. A key output of the workshop will be capability objectives for the JWST team to consider for further pre-launch operational studies. More information on the workshop and the DPS meeting can be found at: http://www.psi.edu/dps12/index.shtml.

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JWST Guest Speakers

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. The JWST project has allocated some funding to pay the expenses for talks in the US; talks in other countries can also be arranged. In addition to the specific topics listed below, 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 NIRISS Science"
- Jonathan Gardner, GSFC, "JWST and Galaxy Evolution"
- Matt Greenhouse, GSFC, "JWST Mission Overview and Status"
- Heidi Hammel, AURA, "Planetary Exploration with JWST"
- Jason Kalirai, STScI, “Resolved Stellar Populations in the Near IR with JWST”
- Jonathan Lunine, Cornell University, "JWST, Exoplanets, and the Solar System"
- John Mather, GSFC, "JWST Mission Overview and Status"
- Bernie Rauscher, GSFC, “JWST and its 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, "First Light, Reionization and Galaxy Assembly with JWST" or "JWST and Supermassive Black Hole Growth"

To arrange a talk, please email jwst-science@lists.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 Pierre Ferruit (ESA Acting JWST Project Scientist, ESTEC, pferruit@rssd.esa.int).

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