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James Webb Space Telescope

## JWST Science Conference in October – get ready to propose!

***By John Mather***

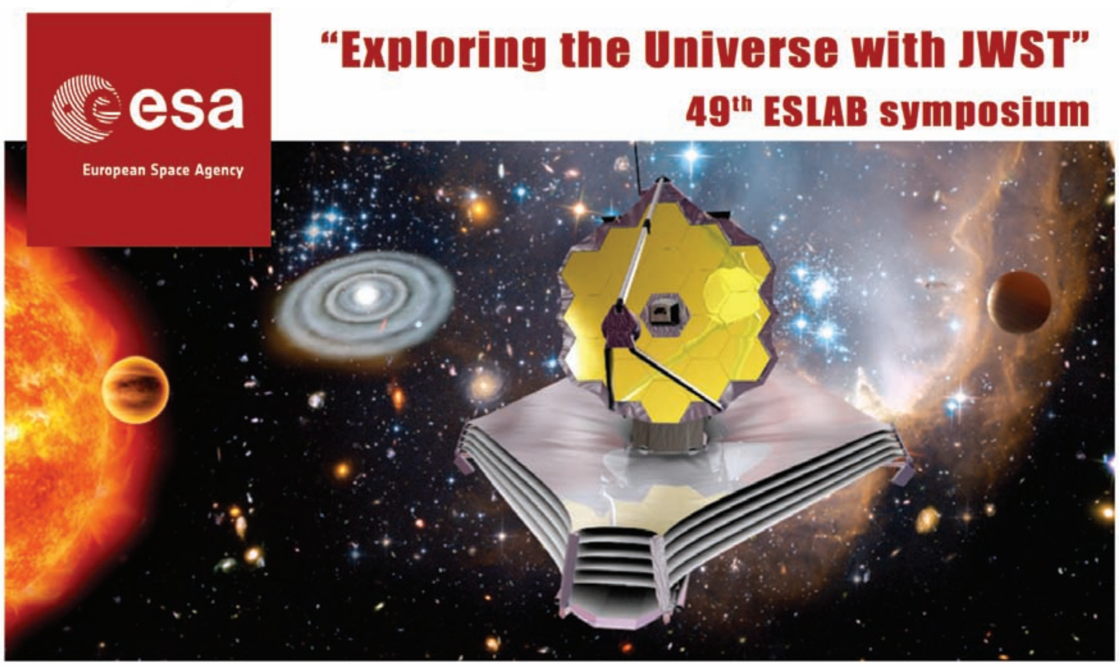
We will hold the next JWST science conference “Exploring the Universe with JWST” on October 12-16, 2015, at ESTEC in Noordwijk, Netherlands, just 35 km from Schiphol airport. For the latest information, please see our web site. The main goal is to bring together scientists to present, highlight and discuss scientific programs that will be made possible by JWST. In about 2.5 years, General Observer proposals will be due (February 2018), and full scientific operations are planned to begin in April 2019, six months after launch (October 2018). So this will be an excellent opportunity for observers, theorists, and students to appreciate the research capabilities that JWST will provide, and to form proposal writing teams.

We will begin Monday morning with invited talks from Project scientists outlining the plans and capabilities of the observatory, and we have organized the rest of the week with a mix of invited and contributed talks, poster sessions, and discussions on five main topics:

•The end of the "dark ages": first light and reionization.
•The assembly of galaxies.
•The formation and evolution of stars and planets.
•Planetary systems and the origins of life (exoplanets).
•Our Solar system.

View schedule of talks.

By the time you get this newsletter the deadline for contributed abstract submission will have passed, but online registration will still be open at this link. The ESTEC conference bureau provides a list of 18 hotels and can book your reservation at their special conference rates. We welcome you to the Conference and look forward to your thoughts in the discussions.



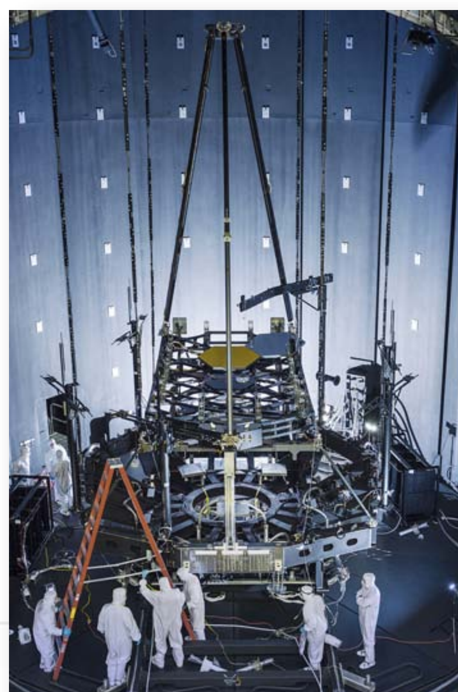
## Pathfinder Tests Completed at Johnson Space Center

**By Chuck Bowers**

The JWST team has just successfully completed the first of three planned, large-scale pathfinder tests at the Chamber A facility at Johnson Space Center in Houston, Texas. These tests are designed to verify the operation of the support and test equipment as well as check critical alignment and test procedures, train personnel, and improve test efficiency in preparation for the final, full scale flight testing of JWST scheduled for Winter, 2016-2017. This first pathfinder test, denoted OGSE1 (Optical Ground Support Equipment test #1), incorporated an engineering version of the JWST composite backplane (the mounting and support system for the telescope), two spares of the eighteen primary mirror segments and a flight spare secondary mirror and support structure. The next pathfinder test (OGSE2 - currently scheduled for Fall, 2015) will add the flight Aft-Optics-System (AOS) incorporating the flight tertiary and fine steering mirrors as well as a set of precisely located sources (AOS Source Plate Assembly, or ASPA) which will be imaged through the telescope system. A third, primarily thermal model validation pathfinder, is scheduled for testing in spring, 2016.

OGSE1 was conducted in the large vacuum test facility (see Newsletter Sept 2012, and accompanying figure) originally built for testing during the Apollo Project that was extensively refurbished and upgraded for JWST. In-flight, JWST will operate under high vacuum and at a nominal temperature of about 40K (-387F) as the observatory is shadowed from the Sun's heat by its large sunshield. These extremely low temperatures have been achieved in the JSC test chamber by successively injecting liquid Nitrogen and Helium into shrouds, inside the chamber and covering its walls. For testing, the pathfinder was suspended on a set of titanium rods that penetrate the vacuum chamber roof. To achieve the low level of vibration, necessary for precise alignment of the telescope mirrors during testing, vibration damping isolators have been attached to the suspension rods along with a magnetic damping system.

*JWST's pathfinder backplane outside Chamber A at NASA Johnson. Credit: NASA/Chris Gunn*



*JWST's pathfinder backplane in Chamber A at NASA Johnson. Credit: NASA/Chris Gunn*

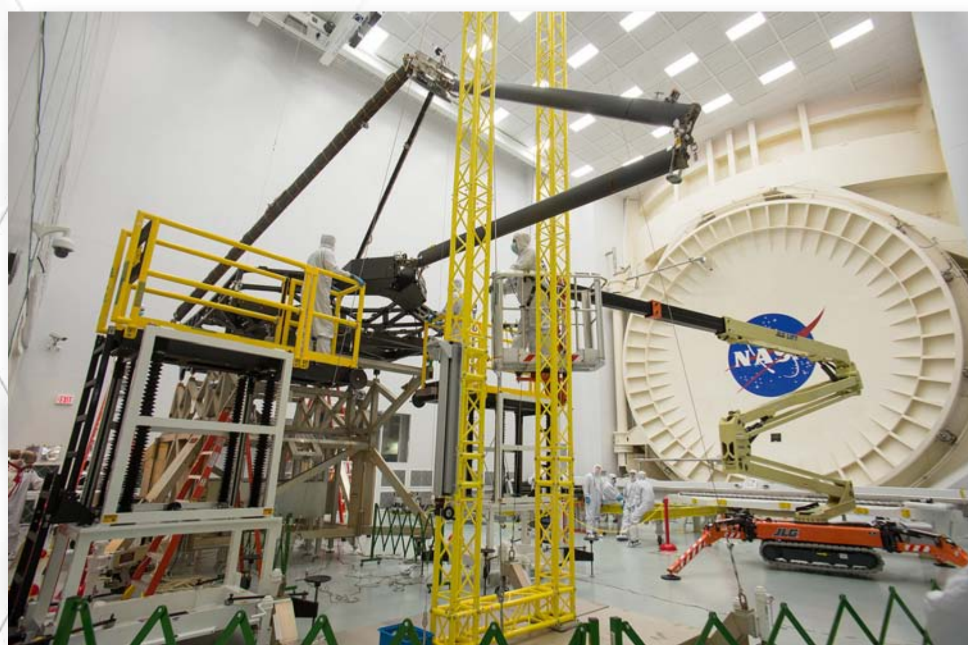
Several systems of test equipment critical for JWST testing have been designed, assembled, and tested over the past several years and were operated successfully with the OGSE1 pathfinder. These include:

(1) the Center of Curvature Optical Assembly (COCOA) interferometer system (Newsletter Dec 2012) placed above the primary mirror at its center of curvature provides information used to 'phase' the primary mirror segments - that is, align them to produce a single, optically correct image.

(2) a photogrammetry system to provide precise locations of a number of fiducial points, helping to determine the alignment of JWST and provide accurate determination of structural changes with temperature. The system includes a set of cameras and light sources mounted on a 'windmill' structure, which are positioned in different locations.

(3) a set of over 500 thermal sensors and cryogenic accelerometers that permit correlation of thermal models and monitor system vibration throughout the test.

Detailed analyses of the test results are currently underway; however the general goals of the test were met. The suspension and damping systems reduced vibration to sufficiently low levels so that two primary mirror segments could be phased and alignment maintained over many hours. The primary mirror segments were repositioned by their attached, high precision actuators using positional data from the photogrammetry system and COCOA interferometer. The thermal and acceleration monitors provided data throughout the test, which can be compared with test models. And in preparation for the next pathfinder, important verification of mass loading of the AOS and successful operation and calibration of a movable, imaging system to be used with the ASPA sources was accomplished. While the final test results from OGSE1 are determined, preparations for the next pathfinder (OGSE2) are underway incorporating the valuable lessons learned from this first JWST pathfinder test.




*JWST's pathfinder backplane outside Chamber A at NASA Johnson. Credit: NASA/Chris Gunn*

# ISIM Enters Final Sequence of Pre-Delivery Environmental Tests

**By Randy Kimble**

The JWST Integrated Science Instrument Module (ISIM) has entered into a climactic sequence of activities – the final pre-delivery environmental tests of the integrated system. These activities verify the ability of the ISIM to withstand the rigors of launch (vibration and acoustics testing), confirm its electromagnetic compatibility with launch and in-flight operational systems (Electromagnetic Interference/Electromagnetic Compatibility testing), and verify its health and performance under the expected flight temperature and vacuum conditions (cryo-vacuum testing). All of the ISIM subsystems have already undergone such tests during their development, but the full-up system-level tests nonetheless are a critical part of the final ISIM verification.

The ISIM enters this final testing sequence in its full flight configuration. After some precursor integration and test activities, which included two very successful cryo-vacuum campaigns (called CV1-RR and CV2, the latter of which was in a nearly-final configuration), the ISIM underwent a series of activities to upgrade its instruments and systems to full flight readiness. These activities included:

•completion of the upgrade of the near-infrared detector arrays in NIRCam, NIRSpec, and FGS/NIRISS to a newer, more robust design that eliminates a dark current degradation mechanism suffered by the earlier generation arrays,

•installation of new Microshutter Arrays in the NIRSpec with improved stability against the acoustic loads of launch,

•installation of new grisms in the NIRISS instrument, including a new grism for exoplanet spectroscopy with 2-3 times higher throughput than the original optic,

•upgraded electronics boards in several instruments for improved performance or reliability,

•installation of the flight cold head of the MIRI cryocooler system (the Heat Exchanger Stage Assembly, mounted to the ISIM structure).

With these upgrades, along with other tweaks to harnesses, thermal strap joints, and flight software, the ISIM is now in what is planned to be its final state for launch. A photo of the fully re-integrated “ISIM prime” module (the term for the part of the ISIM comprised of the structure and the science instruments) is shown in Figure 1. The other ISIM elements – the ISIM Electronics Compartment (IEC) and Harness Radiator – are also in their flight configuration.

The first phase of this final environmental test sequence, vibration testing, was completed in June, with vibration of the “ISIM prime” module. Sinusoidal sweep testing was carried out in each of three axes, with amplitudes up to ~2.5g in some frequency bands, in order to verify workmanship by subjecting the system to the low frequency structural dynamic spectrum of the launch environment. Figure 2 shows a photo of the ISIM on the vibration table.

*Figure 1: The ISIM structure and flight instruments, re-integrated and ready for environmental testing. Credit: NASA/Chris Gunn*

*Figure 2: The ISIM prime module (the ISIM structure plus the science instruments) on the vibration table for sinusoidal sweep testing. As the vibration facility is not a clean room, the ISIM is carefully bagged and purged for contamination control.*

*After vibration testing, the ISIM returned to the JWST clean room for optical metrology (looking for any vibration-induced shifts) and for a System Functional Test that will exercise the system and check its health and performance to the extent possible under ambient conditions. Next, it will be on to acoustic testing, where the ISIM will be exposed to the extreme sonic environment (143 dB total sound level) of an Ariane rocket launch. Credit: NASA/Chris Gunn*

Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) testing will follow, in which the electromagnetic emissions and susceptibility of the ISIM systems are assessed. This test will verify that the emissions from the ISIM will not interfere with the launch or flight communications systems, and conversely, that the electromagnetic environment in flight will not interfere with ISIM performance. One of the key aspects of flight performance is detector noise. Although infrared detectors have very high dark current under the room temperature conditions of the EMI/EMC test, methodologies have been developed to adjust the detector bias and readout settings for test in a way that nevertheless permits a sensitive assessment of the noise susceptibility of the bulk of the signal chain.

Finally, the environmental test program will conclude with a comprehensive cryo-vacuum test. As noted, two previous very successful cryo-vacuum campaigns have already been executed, so the upcoming test is designated CV3. In addition to performing a final cryo-verification of the ISIM with the various upgraded systems highlighted above, CV3 will make critical verifications of the optical stability of the ISIM system across exposure to launch-like vibration and acoustic environments, by means of comparison of alignment and wavefront data taken during CV3 with analogous data from CV2. CV3 will also provide essential calibration data (such as detector linearity and flat-fields) that will be needed for science data reduction in flight. In addition, CV3 will provide the data to confirm the closure of Problem Reports and Problem Failure Reports from CV2, as well as for the correlation of the ISIM thermal and structural models.

With an estimated duration for CV3 of ~100 days, the final environmental test program for the ISIM is thus scheduled to conclude early in 2016. At this point the ISIM will be ready for delivery to the next phase of integration. In that next phase, which will also take place at Goddard, the ISIM will be integrated with the structure and optics of the Optical Telescope Element.

*Figure 3: The acoustic test facility at Goddard Space Flight Center, where the ISIM will undergo testing later this summer. Note the huge feed horns that reproduce the acoustic environment of a rocket launch. Credit NASA/Chris Gunn*

# Progress on the JWST Primary Mirror Backplane Support Structure

**By Mark Clampin**

At the heart of the James Webb Space Telescope (JWST) is the telescope structure, or its skeleton. Constructed from graphite composite, the structure holds both the telescope's mirrors, and the flight instruments precisely in alignment, at the cryogenic operating temperature. During launch, parts of this structure are folded and stowed, so that JWST can fit within the Ariane 5 launch fairing. Consequently, in the first few days after launch, the telescope structure has to be deployed and then latched into place. The telescope structure's primary role is to provide a stable mounting platform for the telescope's mirrors so that they remain aligned after phasing, when they are each adjusted so the primary acts as a single mirror.

In Figure 1 we show the immense JWST telescope structure viewed from above, in the cleanroom at Northrop Grumman. In this configuration we see the primary mirror backplane support structure (PMBSS) comprising a center section and two wings. The center section of the PMBSS supports 12 primary mirror segments, while each wing supports three additional primary mirror segments, giving a total of 18 mirrors. The wings are able to fold back through 90 degrees, so they can be stowed for launch. The secondary mirror is mounted at the apex of the three struts that comprise the secondary mirror support system (SMSS). Final installation, and alignment of the wings and the secondary mirror support structure has been completed. The alignments have to be maintained over many stow and deploy cycles of these structures.

The PMBSS is also the structure that houses the Integrated Science Instrument Module (ISIM). ISIM, shown in Figure 2, is a metering structure that holds the four flight instruments in alignment with the telescope structure. A view of the telescope structure seen from below, in Figure 3, shows the volume in which ISIM is installed behind the primary mirror.

In order to reach cryogenic temperatures, after launch the telescope structure must be raised above the spacecraft bus, in order to achieve thermal isolation. This is achieved by means of the final component of the telescope structure known as the deployable tower assembly (DTA). The final phase of the telescope structure assembly has seen the DTA installed and tested.

*Figure 1: The JWST telescope structure in a clean room at Northrop Grumman, showing the fully deployed secondary mirror structure and the deployed primary mirror backplane wings. Credit: Northrop Grumman*

*Figure 2: (at right) The Integrated Science Instrument Module (ISIM). Toward the front left, we see the edge of MIRI, while at the right is NIRSPec. NIRCam and FGS/NIRISS are mounted in the central section, with NIRCam visible at the front. Credit: NASA/Chris Gunn*

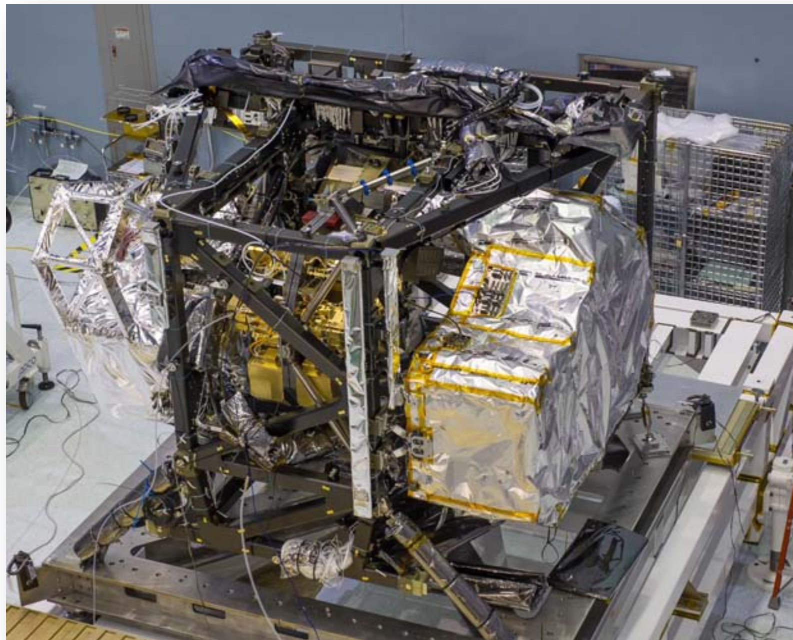


*Figure 3: (below) Rear view of the JWST telescope structure showing the backplane support fixture (BSF). The yellow structure is a mass simulator for the Integrated Science Instrument Module (ISIM) which was installed for modal testing of the telescope structure. The stowed deployable tower assembly (DTA) is seen to the left of the standing figure. Credit: Northrop Grumman*

As this newsletter went to press, assembly and alignment of the telescope structure had been completed. Currently, the structure is undergoing testing to verify the performance of the deployable elements. The telescope structure will be shipped to the Goddard Space Flight Center (GSFC) at the end of the summer aboard an Air Force Transport.

Upon arrival the telescope structure will be installed in the GSFC Building 29 cleanroom and then the installation of the primary mirror segments will begin. Over the summer the JWST telescope team determined the optimum backplane location for each of the 18 mirrors in order to optimize imaging performance. Each mirror will be moved into precise position for installation by means of a robotic arm. The JWST schedule calls for completion of the demanding process of mirror installation early in 2016, at which point the telescope structure is ready for installation of the ISIM.

Would you like a colloquium at your university on JWST? How about a talk at a conference you are organizing? Or a public lecture about JWST? Please email:
jwst-science@lists.nasa.gov

In the coming year, watch the mirror installation take place in Goddard's cleanroom live on our WebbCam at jwst.nasa.gov

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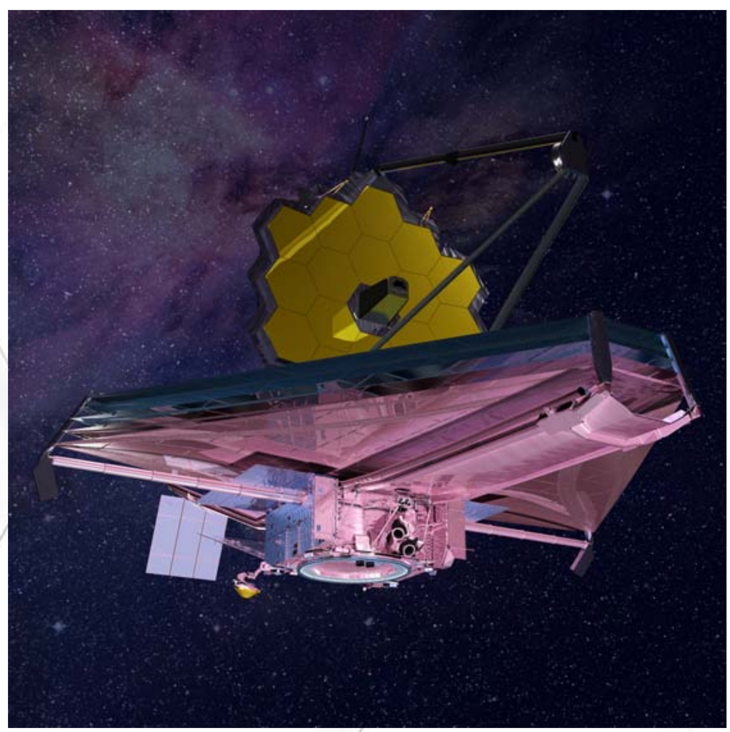

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