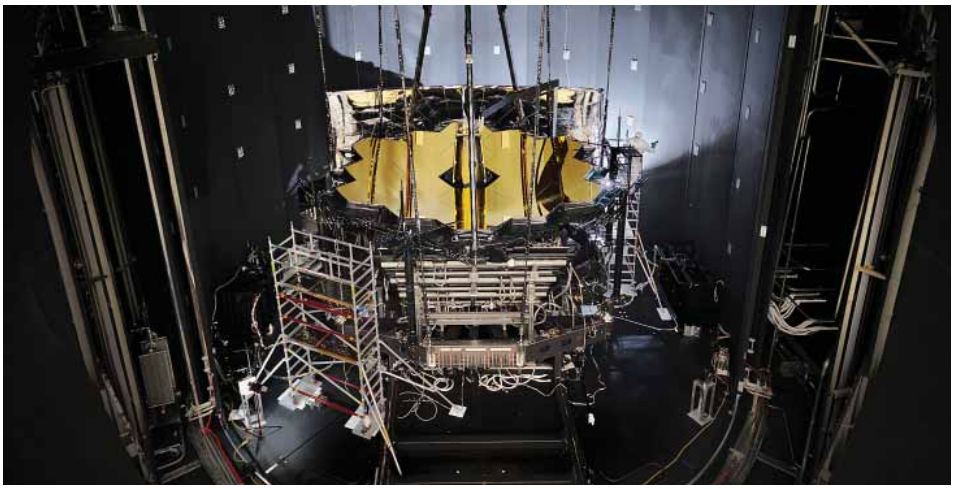
Dynavac Contributes to Mission Critical Operations on Webb Telescope

The Christmas Day launch of the James Webb Space Telescope (JWST) was a welcome and long-awaited gift for the many people and companies involved in this program since serious planning began in the early 1990s. As a successor to the Hubble Space Telescope, the JWST has ambitious goals that include looking back in time for infrared light from the first stars and galaxies formed in the Big Bang – making for a novel spacecraft with a most challenging mission.



The James Webb Space Telescope emerging from NASA's Chamber A after the full operational test.
Image: NASA/Chris Gunn

Observing faint infrared signals demands instrumentation operating at temperatures on the order of 40-50 K. Several key aspects of the mission are driven by this thermal consideration – including the orbital position at the L2 Lagrange point, which allows the massive solar shield to protect the telescope and instrumentation from radiation emitted from the sun and the earth/moon.

Unlike Hubble, there is no possibility of repair missions now that the JWST is on station at the L2 point 1,500,000 km from earth. Accordingly, a rigorous test program in advance subjected the components, subsystems, systems and the entire spacecraft to the vacuum and cold of space. Existing thermal vacuum testing systems at several US locations were upgraded to meet the test requirements, which included presenting a thermal background of 40 K, absorbing the radiated energy from the spacecraft and working with test articles with sizes up to the entire assembled spacecraft.

Major JWST partners including Northrop Grumman, Ball Aerospace, Lockheed Martin, and NASA Goddard tapped Dynavac to outfit their existing thermal vacuum systems with cryogenic cold walls to support testing as low as 30 K. Dynavac designed and fabricated the cryogenic cold walls for the critical environmental testing of JWST's many sub-systems, including the Near-Infrared Camera (NIRCam), the Integrated Science Instrument Module (ISIM) and the Solar Shield. Typical space missions are tested with cold walls using liquid or gaseous nitrogen, giving a thermal background of 70-80 K. For JWST testing, Dynavac built cold walls cooled with gaseous helium (GHe) to operate as low as 20 K. The GHe-cooled walls operate inside of liquid nitrogen (LN_2) cooled shrouds to minimize thermal load on the cryogenic walls.

Following integration of all systems, the fully assembled JWST was tested for nearly 100 days in the historic Chamber A at NASA's Johnson Space Center (JSC). Originally built for the Apollo program, Chamber A is the world's largest thermal vacuum facility. The chamber underwent extensive upgrades, including installing a combined nitrogen-helium refrigerated cold wall to present a deep space environment for full operational testing of the mechanical, electronics and radiation cooling systems aboard the vehicle.

Test requirements dictated a working envelope inside the chamber of 43-foot diameter by 65-foot high, resulting in one of the largest cryogenic walls ever built. NASA and its primary contractor, Jacobs Engineering, turned to Dynavac to construct this unprecedented LN_2/GHe shroud system. The interior cryogenic wall is fabricated from aluminum sheet and angle/I-beam and is built from an array of panels, each approximately 12 feet wide and 40 feet long. Dynavac built the panels at its 50,000-square-foot Hingham MA facility and then performed the extensive assembly and commissioning on site at the JSC.

A massive and specialized refrigeration system cools gaseous helium below 20 K to power the thermal shroud environment. The gaseous helium passes through a network of extruded tubing welded to the aluminum panels. The shroud – with its 23 metric tons of aluminum – can be cooled down to 20 K from room temperature in 24 hours and can maintain 20 K with a stability of +/- 0.1 K.

Dynavac collaborated extensively with Jacobs Engineering to optimize the design for the operating and thermal performance specifications. More than 7,000 critical welds were needed to fabricate the wall, with each weld subjected to X-ray inspection. Further, the interior side of each panel was coated with special high optical absorptivity/emissivity black paint meeting stringent thickness and uniformity requirements.

An impressive collection of skills, technologies, people, and organizations made contributions to the JWST. With the spacecraft now on station so distant from earth, and as telemetry relays a primary mirror temperature of 62 K, it is satisfying to think of the role cryogenic cold walls played in the critical testing of this magnificent instrument of discovery.

"Dynavac is honored to have played a part in the mission, and with many, many others, we look forward to the first images from the dawn of the universe," the company added in a release. ■