National Aeronautics and Space Administration

Environmental Test

Customized Tests To Meet Challenging Schedules

Marshall Space Flight Center customizes tests with a demonstrated ability to rapidly adapt and reconfigure systems to meet customers' needs by applying the broad experience and variety of test systems, facilities, and equipment available.

Understanding the effects of the space environment on materials, structures, and systems is fundamental and essential to mission success. If not correctly comprehended and designed for, the effects of the space environment can lead to degradation of materials, reduction of functional lifetime, and system failure.

The environmental test systems, facilities, and equipment combined with capabilities such as nondestructive evaluation, failure analysis, and mechanical testing make Marshall a one-stop shop for materials and flight hardware analysis.

The Discipline of Test Engineering

Experience with many classes of test applications (launch, ground environment, propulsion, in-space, crew cabin) gives Marshall exceptional versatility in defining the right test for the right application. The Center's comprehensive environmental test capabilities support a range of organizations, including NASA, other government agencies/entities, commercial customers, and academia. These capabilities are maintained and operated by highly trained and experienced personnel with a reputation for delivering what the customer needs when the customer needs it.

Capabilities have been used to support projects from many NASA mission directorates such as Chandra, Space Shuttle, James Webb Space

At-A-Glance

Integration and test is one of the most challenging phases of mission development and must be executed adaptively and efficiently to maintain schedule and allow for resolution of issues that threaten mission success. With broad expertise and a wide array of test systems, facilities, and equipment available, Marshall is able to customize tests with a demonstrated ability to rapidly adapt and reconfigure systems to meet customers' needs.

Marshall's expertise in environmental testing ensures that projects get the analysis needed on schedule and within budget.

Telescope, Phoenix, FASTRAC, International Space Station, Space Launch System, and Solar Probe Plus. Other government agencies that have used Marshall's broad spectrum of test capabilities include the Department of Defense, the U.S. Army Aviation and Missile Research Development and Engineering Center, Naval Sea Systems Command, and Naval Air Systems Command.

Commercial customers coming to Marshall include Space Systems/Loral, Aerojet, Ball Aerospace, Emcore, SpaceX, Virgin Galactic, and Sierra Nevada. Academic institutions using the capabilities at Marshall include the University of Delaware, the University of Mississippi, and Johns Hopkins University Applied Physics Laboratory.

One-Stop-Shop Expertise

The broad range of environmental test capabilities at Marshall offers programs the ability to develop and implement stringent customized tests along with expert results analysis. From piecemeal or end-to-end/comprehensive tests and analysis, the Center offers one location to cover almost any test need.

Marshall's Environmental Test Facility (ETF) provides various environments allowing a customer to test and qualify hardware prior to launch. The environments include the vacuum environment of space, the in-cabin environment of spacecraft, and the natural environment seen by a vehicle on the pad prior to launch.

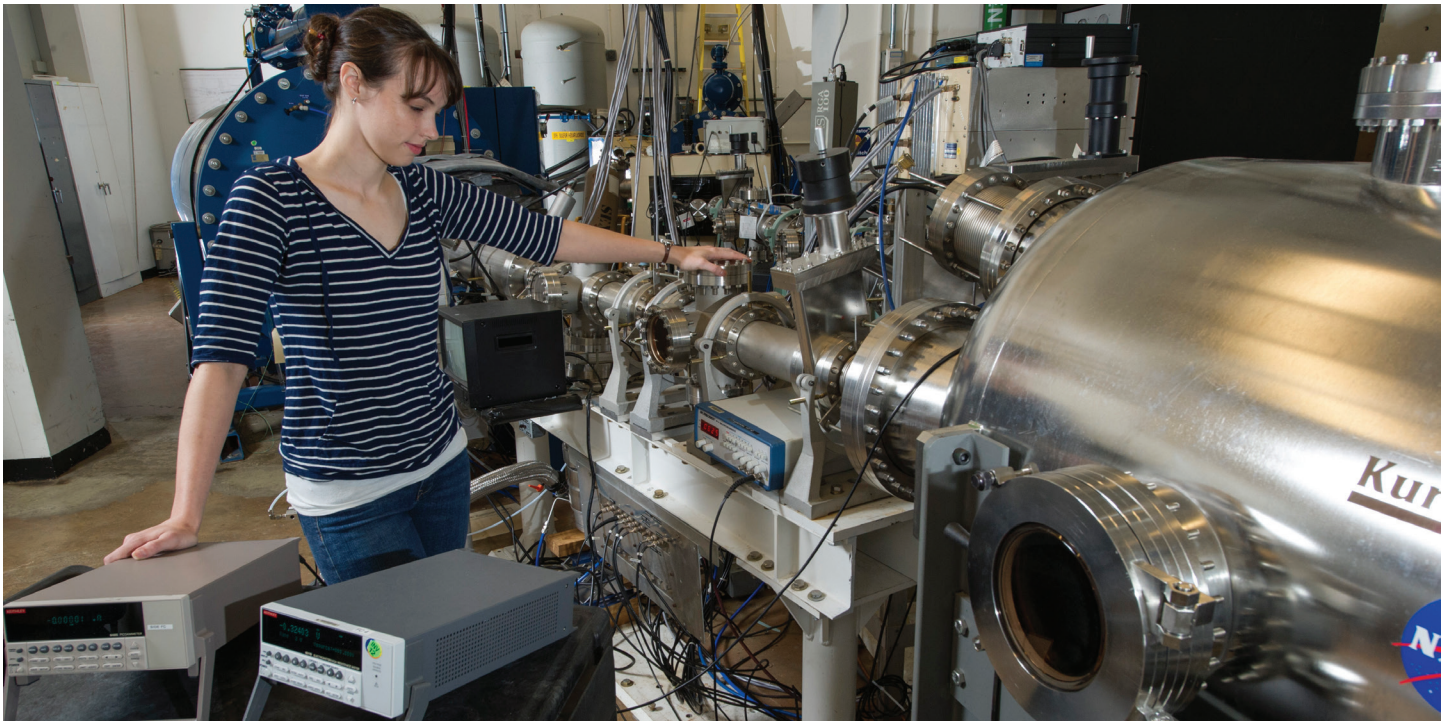
The Aerodynamic Research Facility (ARF) provides a low-cost test alternative relative to much larger wind tunnel facilities for early database development of aerospace systems, such as SLS. It also supports the entire agency as well as outside commercial and DOD customers. Other available testing capabilities include:

- Life cycle
- Launch simulation
- Thermal-humidity-altitude
- Charged particle radiation
- Ultraviolet radiation
- Vacuum outgassing
- Atomic oxygen
- Plasma interactions
- Planetary and extraterrestrial environments
- Impact testing

The aggregation of space environmental test capabilities at Marshall is a comprehensive set allowing for simultaneous exposures of multiple space environments.

Many are capable of conducting classified tests. The engineers, scientists, and technicians working in and running these facilities are award-winning, nationally recognized experts in their respective fields and have a proven record of dealing with contingencies to maintain mission success.

XRCF tested JWST mirrors to validate performance in extreme space environments.



The Pelletron particle accelerator exposes test articles to the simulated radiation conditions of space.

Resources To Develop and Conduct Tests Essential to Mission Success

Marshall's X-ray and Cryogenic Facility (XRCF) is a unique optical, cryogenic, and X-ray vacuum test facility. The vacuum chamber is a horizontal cylinder, 20 feet in diameter and 65 feet long, that is capable of achieving temperatures from 20 Kelvin to 160 F and vacuum levels less than 10-6 Torr. The chamber has liquid nitrogen panels and heater panels to simulate deep space environments and to maintain accurate thermal stability. Tests performed at XRCF are crucial to mission success, such as those performed on the James Webb Telescope to ensure that the mirrors and components will be able to withstand the extreme cold temperatures of space.

The Pelletron Combined Environmental Effects Facility irradiates materials with simultaneous exposures. The Solar Wind Test Facility exposes materials to low-energy protons, low-energy electrons, and ultraviolet radiation concurrently.

Marshall's micro light gas gun (MLGG) is capable of accelerating small particles to velocities of 8 km/sec to quantify micrometeoroid and orbital debris. It is the only functional one of its kind in the United States. Micrometeoroids and space debris can puncture manned spacecraft, pit windows and telescope mirrors, and damage solar arrays and thermal radiators. Marshall's MLGG can quantify the damage caused by debris particles or qualify debris protection systems. It has been used to study debris impact effects for the International Space Station.

The Hydrometeor Impact Gun is used by the Department of Defense for its weather encounter testing and evaluation. It is the only hydrometeor gun of its type in the country. It can provide rain impact performance data with a defined single droplet size.

The Lunar Environments Test System (LETS) is the first and only operational test system to examine the lunar surface environment, including dust/regolith effects. LETS was designed to address lunar environment effects on materials and systems as well as to enable study of the effect of lunar dust charging on materials and mechanisms.

The Inducer Test Loop and the Pump Test Equipment facilities are the only water flow test facilities in the agency. The Turbine Test Equipment is a blowdown air facility with a much larger scale and wider operating range than any existing shock tube facility in the United States.

High Intensity Solar Environment Test System (HISET)

Flexible, Customizable Test Solutions

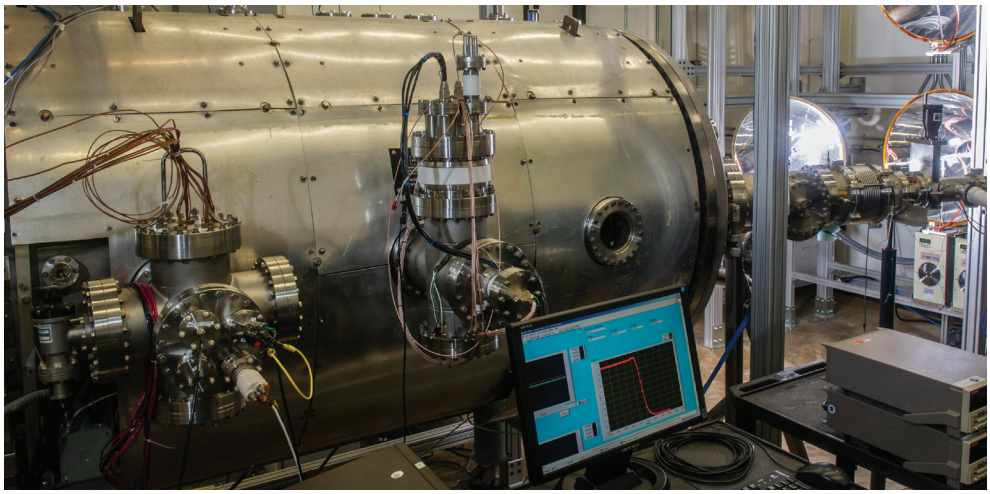
Bringing together elements of the solar space environment — including charged particles and concentrated sunlight — the High-Intensity Solar Environment Test system is an innovative test platform designed to meet a wide range of testing challenges from spacecraft instrument qualification to high-temperature terrestrial materials development. Designed for maximum flexibility, HISET offers customizable solutions from single environment focused test conditions to complex combined environments.

Featuring an impressive 18,000-watt solar light radiation source, HISET offers product and instrument developers a means of testing at temperatures as high as 1,000 C. The solar simulator radiation source is composed of three individual light sources that offer exceptional configurability from single source operation at low power to all sources operating at full power. Capable of being focused into a vacuum chamber, the solar simulator output can be concentrated to a spot as small as 10 centimeters in diameter or expanded to 1 meter in diameter. In addition, HISET can accommodate solar simulator testing in ambient pressure conditions to facilitate systems tests of terrestrial products — from concentrator solar arrays to automotive materials and coatings.

When the solar simulator is coupled to the solar wind environment systems, a completely unique capability is formed. Encompassing a wide range of energy and flux conditions, the solar wind systems provide charged particles (protons and electrons) that cover mission environments from Mercury to Saturn and everything in between. By employing the integrated cryogenic shroud in the vacuum chamber, it is possible to seamlessly test materials and systems from 100 C to +1,000 C.

Solar Probe Plus, a planned mission designed to explore space weather is being tested in HISET. Testing has included aiming a beam of proton particles at the instrument and measuring its response. In order to control the beam location, a system of Helmholtz coils has been arranged to produce a region of nearly zero magnetic field, nullifying the effects of Earth's magnetism. That allows the test particle beam at any energy level to be precisely aimed and moved around on the instrument.

Equipped with a suite of computer data acquisition and diagnostic systems, HISET is poised to meet the needs of the most demanding test applications. It is built for spacecraft systems engineers, science instrument developers, thermal system designers, and materials scientists. Tests of particle instruments, heat pipes, solar power systems, radiators, high-temperature materials, and solar sails are but a few of its potential applications. Created to help advance technology development for both space and terrestrial customers, HISET stands ready to meet the most extreme test requirements.



HISET can be rapidly reconfigured for testing a wide range of solar environmental conditions.

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