National Aeronautics and
Space Administration

Marshall Space Flight Center
High Intensity Solar Environment Testing

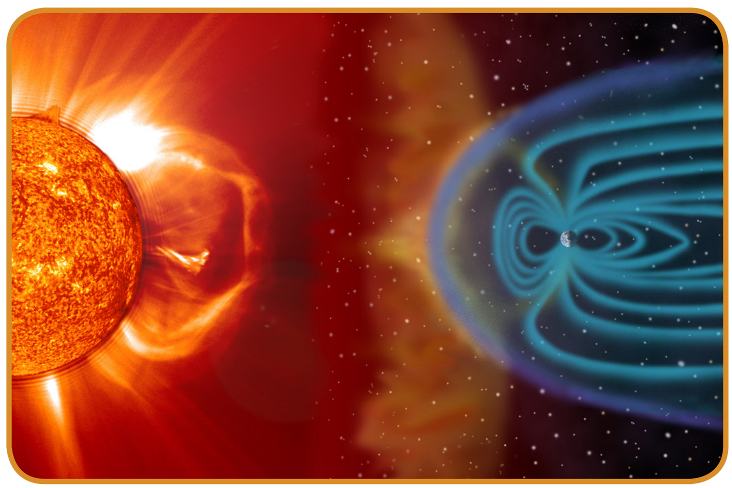




Engineering Solutions for Space Science and Exploration

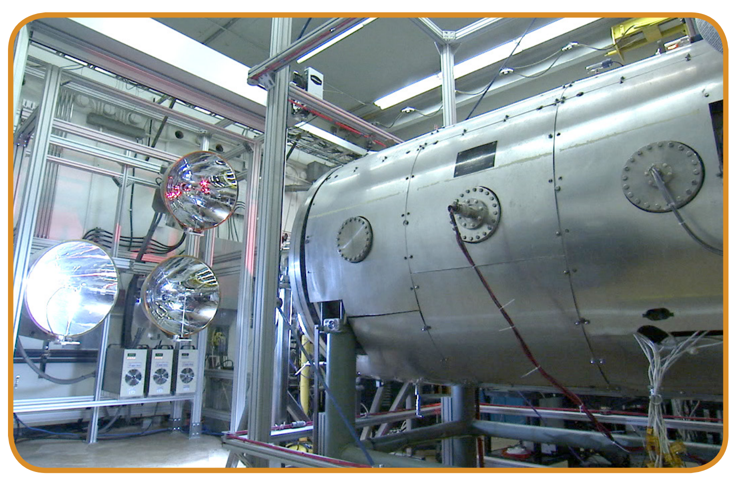
MSFC's High Intensity Solar Environment Test (HISET) System

The Sun impacts all objects in our solar system, including spacecraft. When a space vehicle is exposed to the full brunt of the solar environment outside Earth's atmosphere, high-energy photon radiation and charged particles (the solar wind) can overheat a vehicle, eat away at its insulation and metallic skin, interfere with experiments, blur and blemish optics and windows, and damage electric circuitry that controls power, navigation, and life-support systems.



The solar wind interacts with Earth's magnetic field, impacting our planet and spacecraft.

The effects of the solar environment vary greatly with distance from the Sun. Spacecraft scattered across the solar system, whether orbiting Earth or journeying to the outer planets or approaching the Sun itself, experience dramatically varying conditions. Whatever the destination, spacecraft and crews must have robust, reliable protection from the threats the Sun poses, with the best materials available for spacecraft and heat shields, instrumentation, and spacesuits.

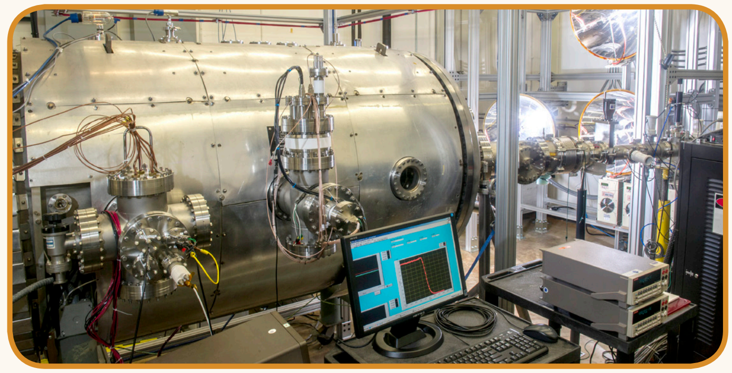


HISET, a truly customizable platform

While some laboratories can simulate solar radiation environments or bombard samples with electrons and protons, only one site in the world combines the solar photon and solar wind environments in the sample plane: the High Intensity Solar Environment Test system at NASA's Marshall Space Flight Center. HISET delivers the full solar spectrum of light and a range of charged particle radiation and thermal conditions under vacuum, creating high-fidelity simulations of diverse combined solar environments, ranging from those inside the solar corona to those beyond the orbit of Jupiter.

HISET Capabilities

A large-diameter vacuum system with a cryogenic shroud holds the sample. A high-intensity solar simulator focuses three high-power xenon arc lamps on the sample, and particle radiation is provided by a steerable proton source and multiple electron sources. A Helmholtz coil array surrounding the vacuum chamber reduces the effect of Earth's magnetic field, allowing particle beams of a wide range of energies to be aimed precisely and moved around a sample. The sample can be positioned in three axes inside the chamber. Researchers can modify and combine all HISET systems to meet the most demanding customer requirements. HISET can be configured to focus on one component of the solar environment or to capture synergistic effects associated with combinations of environments. In addition, HISET can also be converted between space and terrestrial applications.



HISET

HISET Systems

Solar Wind Particles

- Electrons:
  - > 3 beam sources (electron flood guns or collimated beams)
  - > Flux range: 10 pA/cm^2 – 10 nA/cm^2
  - > Energy range: 50 eV – 100 keV
- Protons/Ions:
  - > Source with focus and steering control
  - > Flux range: 10 pA/cm^2 – 5 nA/cm^2
  - > Energy range: 200 eV – 10 keV

Solar Photon Radiation

- Solar simulator: 6.5-kW xenon arc lamps (3) with ellipsoidal reflectors to focus beams
- Intensity: >500 kW/m^2
- Adjustable beam spot size: 10-cm to 50-cm diameter
- Radiative heating: >1,000 °C

High Vacuum System

- 1.2-m diameter
- Pressure: ≤10^{-7} torr
- Integrated liquid nitrogen cold shroud, with radiative cooling to –100 °C
- Adjustable target plane mounting
- Oil-free pumping system
- Helmholtz coils for particle drift suppression
- Reconfigurable to test in atmosphere

Diagnostics

- Spectral radiometer
- High-temperature thermocouples
- Femto-amp current detectors
- High-intensity light power meters

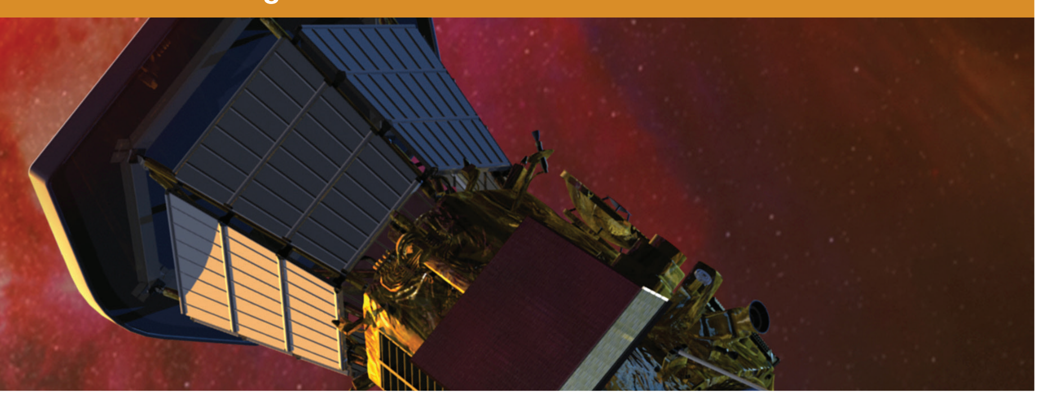
Operation

- Remote for high-radiation testing (ultraviolet and X-ray)

HISET Applications

- > High-temperature materials testing for both space and terrestrial applications
- > Concentrator solar array systems testing
- > Solar sail force measurements
- > Materials research through calibration and qualification of science instruments to a relevant space environment (supports Technology Readiness Levels 1–6)
- > Radiator and thermal management system testing
- > Science instrument development

For more information, please visit www.nasa.gov/centers/marshall/about/business.html



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George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

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