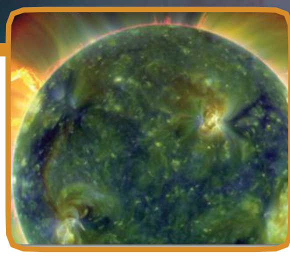
National Aeronautics and
Space Administration

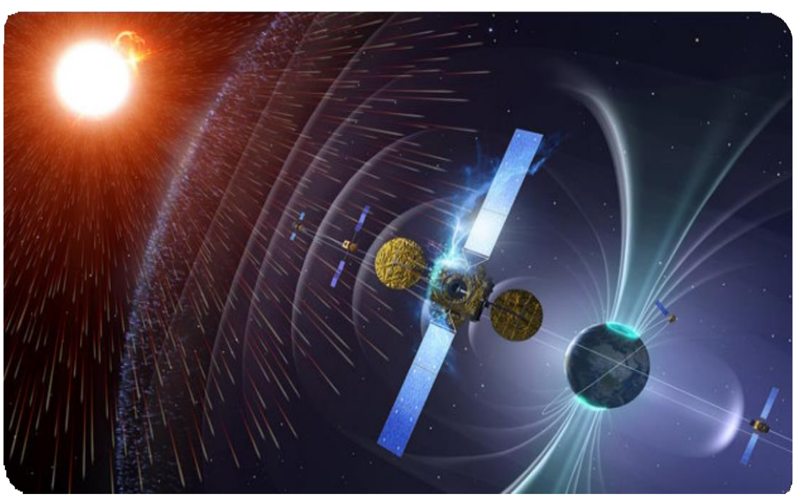
Marshall Space Flight Center
Space Environmental Effects


Engineering Solutions for Space Science and Exploration

MSFC’s Space Environmental Effects Team

The space environment is not just vacuum but includes a host of challenging conditions that affect spacecraft materials and systems. Charged particles (protons, electrons, and heavy ions) with a wide range of energies are come from both the Sun as solar wind and from deep space as galactic cosmic rays; these raise concerns for ionizing radiation damage and spacecraft charging. Ultraviolet radiation causes changes to thermo-optical and mechanical properties of materials. Micrometeroids and debris present impact hazards. Planetary and lunar surfaces present unique dust and contamination concerns.



The impacts of the space environment vary greatly depending on your location in the solar system (for example, LEO, GEO, Jovian, near-Sun, lunar surface…). Whatever the destination, spacecraft and crews must have reliable protection from the threats that outer space poses, with the best materials available for spacecraft and heat shields, instrumentation, and spacesuits.

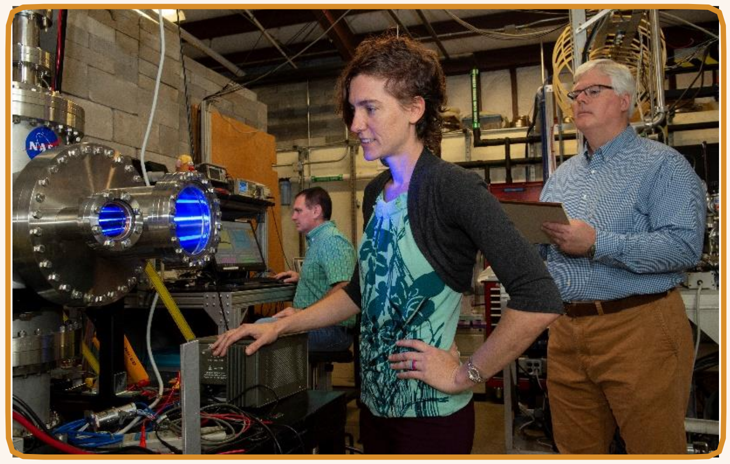
MSFC’s Space Environmental Effects team has one of the most complete capabilities in the world for replicating space environments in the lab. Our multiple unique test systems can be configured for individual and combined effects testing for materials, components, sub-systems, and instruments, from research stage to qualification and verification. Post exposure testing and analysis for optical and mechanical property changes is available on site, which minimizes cost and sample handling concerns.

We enable a wide variety of missions and projects to meet their science and exploration objectives with comprehensive space environment testing and can raise hardware TRL to 6.

Space Environmental Effects Testing Capabilities

Combined Environmental Effects Facility (CEEF)

- Low-energy electron source: 1–100 keV
- High-energy electron source: 250 eV–2.5 MeV
- Proton source: 40–700 keV
- VUV radiation: 115–165 nm
- 109.7-cm sq (17-in. sq) exposure area
- Temperature range 25C to -175 C



Solar Wind Test Facility

- Low-energy electron source: 1–100 keV
- Low-energy proton source: 1–20 keV
- VUV radiation: 115–165 nm
- NUV radiation: 230–500 nm
- Solar simulator
- 77.4-cm sq (12-in. sq) exposure area

Impact Testing Facility (ITF)

- Hypervelocity Impact Testing
  - > Micro Light Gas Gun up to 7.5 km/s
- Ballistic Impact Testing

Lunar Environment Test System (LETS)

- Low-energy electrons: 1–100 keV
- Low-energy protons: 1–30 keV
- LN2 shroud; quartz lamp heating
- Regolith simulant test bed with capability to charge regolith via VUV or e^-

Multiple Combined NUV/VUV Radiation Systems

- VUV source spectrum: 115–165 nm
- NUV source spectrum: 230–500 nm
- VUV intensity: 5 ES (15-cm (6-in.) beam spot)
- NUV intensity: 3 ES (15-cm (6-in.) beam spot)
- Sample temperature control available

High Intensity Solar Environment Testbed (HISET)

- Solar wind environment:
  - > Low-energy electron source: 0.05–20 keV
  - > Ion source: 0.2–10 keV (Ar, N2, H2, and Xe ions)
  - > NUV intensity: 5 ES (15-cm (6-in.) beam spot)
  - > VUV intensity: 3 ES (15-cm (6-in.) beam spot)
- Solar intensity: 4 ES over 0.6-m (2-ft) beam spot
- High-temperature materials/components testing (space and terrestrial applications): >1,000 °C (>1,832 °F)
- Calibration and qualification of science instruments to a relevant space environment (Technology Readiness Level-6)
- Cold Shroud with LN2 Capability. Samples can be at high temperature or low down to -175 C.

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

www.nasa.gov

For more information, contact:

Mary K. Nehls 256–544–6578, Mary.Nehls@nasa.gov
EM41/Marshall Space Flight Center
Huntsville, AL 35812