MSFC/EV44 Natural Environment Capabilities

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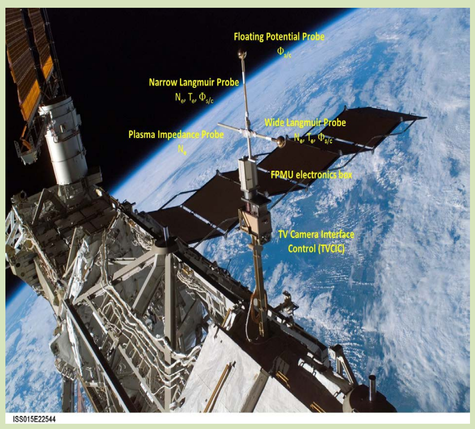
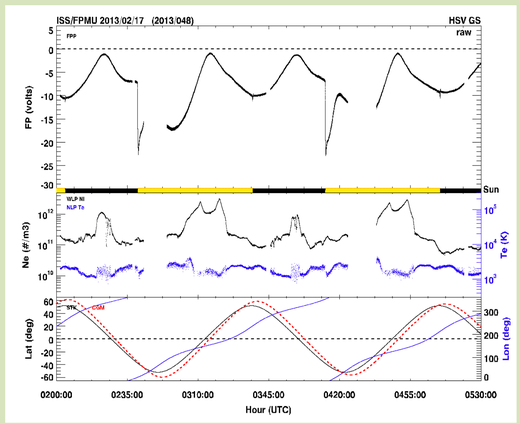
Summary

The Natural Environments Branch at Marshall Space Flight Center is an integral part of many NASA satellite and launch vehicle programs, providing analyses of the space and terrestrial environments that are used for program development efforts, operational support, and anomaly investigations. These capabilities include model development, instrument build and testing, analysis of space and terrestrial related data, spacecraft charging anomaly investigations, surface and internal charging modeling, space environment definition, and radiation assessments for electronic parts. All aspects of space and terrestrial design are implemented with the goal of devising missions that are successful from launch to operations in the space environment of LEO, polar, GEO, and interplanetary orbits.

ISS Floating Potential Measurement Unit (FPMU)

MSFC operates one of two FPMU ground stations to acquire FPMU data from live ISS video telemetry. The data is processed and analyzed in-house for use in investigating plasma interactions with the ISS high voltage solar arrays, EVA plasma hazard support, monitoring charging due to visiting vehicles and ISS payloads, anomaly investigations, ISS auroral charging studies, and collaborations with ISS science payloads.





We actively seek collaborative opportunities in ionospheric research with other spacecraft and ground based facilities. Efforts are underway to compare FPMU data with the iMESA, Canary, and RAIDS science instruments on ISS. We frequently operate during ISR World Day periods obtaining Ne,Te measurements near the F2-region peak. We provide FPMU data to NASA's CCMC space weather group for validating physics based ionosphere models such CTIPe and to test the ability of CCMC space weather products to predict environments responsible for solar array and auroral charging along the ISS orbit.

Anomaly Investigation and Environments Analysis

MSFC developed 1-D internal charging model is used to investigate charge accumulation on materials under thin shielding in LEO orbits including charge loss through conduction and arcing. Use of the model with NOAA POES electron flux as input provides a technique for evaluating electric fields due to charging against dielectric breakdown strength and estimating electrostatic discharge rates in LEO.

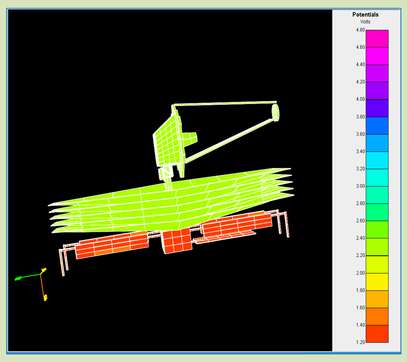
MSFC developed the terrestrial and space environment design specifications for a number of NASA programs including Shuttle, Mars Transportation, JWST (low energy radiation and spacecraft charging sections), Constellation, as well as the current SLS and MPCV programs.

Space environment analysis tools used by MSFC include Nascap-2k and NUMIT (MSFC version) charging models, AP8/AE8, AP9/AE9, HZETRN, SRIM, SHIELDOSE2, Integrated Tiger Series, NOVICE, and CREME96 as well as in-house custom charging and radiation codes.

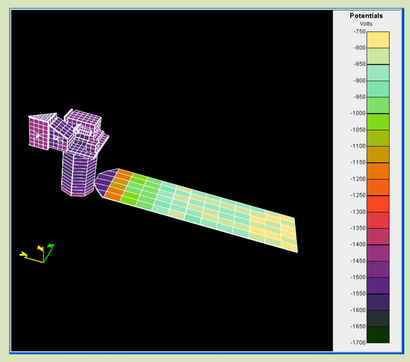
Additional capabilities include terrestrial environment analysis, day of launch space and terrestrial environments support, and meteoroid environments characterization and modeling.

Nascap-2k Surface Charging Analyses

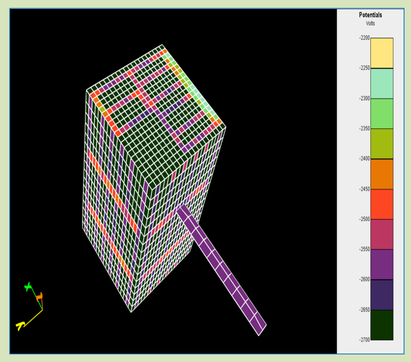
The Space Environments Team uses Nascap-2k, along with satellite environment data and available material definitions, to generate surface charging analyses for spacecraft designs ranging from simple to complex. Both surface and wake charging analyses for LEO, Auroral, GEO, and Interplanetary environments have been performed for NASA programs.



James Webb Space Telescope (JWST) using an interplanetary environment



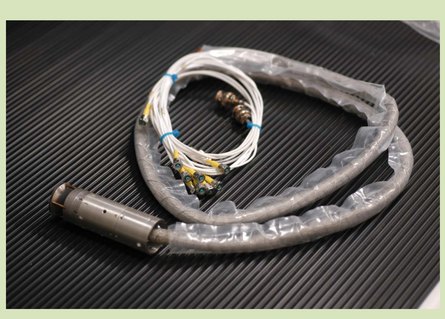
Landsat Data Continuity Mission (LDCM) using a LEO auroral environment



Edison Demonstration for SmallSat Networks (EDSN) using a LEO auroral environment

Low-Energy Electron and Ion Facility (LEEIF) Capabilities

The LEEIF Lab is designed for testing and calibration of single or multiple particle detectors over their complete range of particle energy, mass flux, and angular acceptance. The facility includes electron, ion, and UV sources, clean tent, environmental vacuum chamber, two-dimensional rotation and two-dimensional translation system, beam-imaging diagnostics, and automated data acquisition and analysis capability. In particular, the spatially broad ion source with particles ranging from 1 eV - 35 keV along with the clean class area and large vacuum chamber allows for a high-precision calibration of particle detectors. Personnel in EV44 are also familiar with design and fabrication of various types of particle analyzers.



Thermal Ion, Electron Capped Hemisphere Spectrometers (TICHS, TECHS)

Plasma Modeling and Data Analysis

Data from a variety of operational and research spacecraft provide the environment inputs to our models including Chandra, GOES, POES, DMSP, STEREO, ACE, SOHO, LANL, GPS, IMP8, POLAR, Wind, and COSMIC. One example of an ongoing effort is characterizing auroral charging in LEO polar orbits using the SSJ and SSIES instruments on the Air Force DMSP spacecraft. We have modified SSJ software provided by NOAA and developed our own SSIES routines for reading and processing the DMSP data distributed by NOAA. Here we show examples of identifying auroral charging in the SSJ data by searching for the "ion line" charging signature and extracting information on the charging event including event duration, peak potential, and mean potential. This information is automatically compiled into an ongoing statistical database of auroral charging events to better characterize the environment for future missions.

The MSFC's NUMIT internal charging code allows multiple layers of materials and environment input from satellite data sets to evaluate electric fields as a function of depth in multi-layer insulting materials.

This example is an evaluation of internal charging risk for a candidate spacesuit design for possible use in future human missions to repair satellites in GEO. Electron data from a LANL GEO satellite provides the electron environment for the 8 hour period of an EVA.