National Aeronautics and Space Administration

LETS Lunar Environments Test System

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Introduction

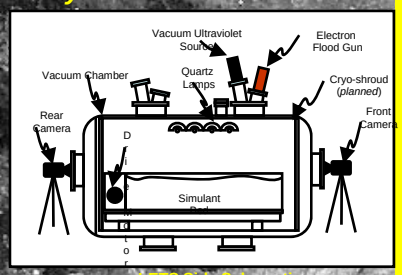
The Environmental Effects Branch (EM50) at the Marshall Space Flight Center has developed a unique capability within the agency, namely the Lunar Environment Test System (LETS). LETS is a cryo-pumped vacuum chamber facility capable of high vacuum (10^{-7} Torr). LETS is a cylindrical chamber, 30 in. (0.8 m) diameter by 48 in. (1.2 m) long thermally controlled vacuum system. The chamber is equipped with a full array of radiation sources including vacuum ultraviolet, electron, and proton radiation. The unique feature of LETS is that it contains a large lunar simulant bed (18 in. x 40 in. x 6 in.) holding 75 kg of JSC-1a simulant while operating at a vacuum of 10^{-7} Torr. The radiation three applications; 1) to study the charging, levitation and migration of dust particles, 2) to simulate the radiation environment on the lunar surface, and 3) to electrically charge the lunar simulant enhancing the attraction and adhesion of dust particles to test articles more closely simulating the lunar surface dust environment. LETS has numerous diagnostic instruments including TREK electrostatic probes, residual gas analyzer (RGA), temperature controlled quartz crystal microbalance (TQCM), and particle imaging velocimeter (PIV). Finally, LETS uses continuous Labview data acquisition for computer monitoring and system control.

Capabilities

Lunar Environment	Planned LETS Capability	Current LETS Capability
High Vacuum	Cryo-pumped vacuum chamber with base pressure of 1 x 10^{-7} Torr	Cryo-pumped vacuum chamber with base pressure of 1 x 10^{-7} Torr
Temperature Range -150 °C to +130 °C	Liquid nitrogen (LN_2) cold shroud (-190 °C), quartz lamp array (+150 C)	System has quartz lamps installed and demonstrated to +150 C. Cryo-Shroud is being purchased.
Solar Radiation	Ultraviolet (UV) and vacuum ultraviolet (VUV) lamps	Vacuum ultraviolet lamps installed and being used for charging of simulant.
Charged Particle Radiation (Solar Wind)	Electron flood gun and low energy proton source	Flood gun has been installed and used for charging simulant. Proton source under design in house.
Regolith (including fine particles)	Regolith simulant up to 75 kg capacity. Consider both JSC 1a and LHT-2m (NASA Highlands Simulant)	Lunar simulant bed completed. 75 kg of simulant in vacuum chamber at 10^{-7} Torr. Negotiations for LHT-2m underway.

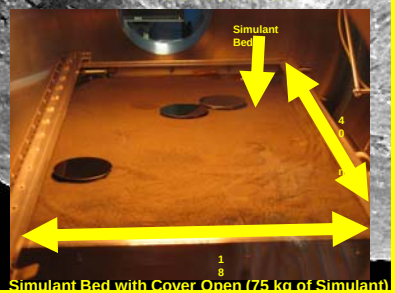
LETS Facility

Overall LETS Photograph



LETS Side Schematic

Simulant Bed with Cover Closed



Simulant Bed with Cover Open (75 kg of Simulant)

Facility Diagnostics

Labview Command Control Center

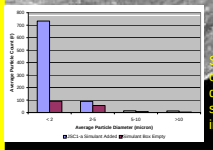
Particle Imaging Velocimeter (PIV) during check-out in the Particles Under Flight Facility (PUFF)

TREK Electrostatic Probes

In-vacuum Temperature Controlled Quartz Crystal Microbalance (TQCM)

Examples of Test in LETS

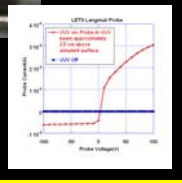
JSC-1 Fall Out Plate



Strategically placed fall-out plates were used to demonstrate migration of small dust particles in the chamber.

Langmuir Probe

Early Langmuir probe tests demonstrated the ability of VUV lamps to charge the JSC-1a Simulant.



Lunar dust migration tests have been run by placing small silicon (Si) wafers at strategically located spots in the simulant bed and looking for dust particles on the surface of the wafers. Our particle counting system has a particle size resolution of less than 2 microns