The Lunar Environment Monitoring Station (LEMS). M. Benna[1,2], N. C. Schmerr[3], M. Sarantos[1], D. DellaGiustina[4], S. Bailey[4], D. Gershman[1], M. Horányi[5], Jamey Szaley[6], and R. Weber[7], [1]NASA Goddard Space Flight Center, Greenbelt, MD, mehdi.benna@nasa.gov, [2]University of Maryland Baltimore County, Baltimore, MD, [3]University of Maryland College Park, College Park, MD, [4]University of Arizona, Tucson, AZ. [5]University of Colorado, Boulder, CO, [6]Princeton University, Princeton, NJ, [7]NASA Marshall Space Flight Center, Huntsville, AL.

Introduction: The Lunar Environment Monitoring Station (LEMS) is an instrument suite that underwent technical maturation at the Goddard Space Flight Center's Planetary Environment Laboratory (PEL) with funding from NASA's Development of Advanced Lunar Instrumentation (DALI) Program (Figure 1).

LEMS is a compact, autonomous, and self-sustaining instrument suite that enables long-term, in situ monitoring of the lunar geophysical environment for multiple years on the surface of the Moon. LEMS will directly measure the geophysical indicators needed to address key questions about the internal structure of the Moon and origin of its seismic activity, and the state of the exosphere and its response to external processes. Additionally, LEMS will provide a long-term assessment of environmental hazards to future human exploration of the Moon. LEMS is also a technical demonstrator of low-cost, sustainable, long duration science operations at the Moon and a first step in creating a multi-station lunar geophysical network.

LEMS is a flight-ready, opportunistic investigation that can be deployed by robotic or crewed lunar missions. Once delivered and deployed on the lunar surface, LEMS will require no additional support in order to operate.

Instrument Description: The LEMS station is comprised of five elements: (a) neutral gas mass spectrometer (MS), (b) broadband seismometer (SEISLEMS), (c) electrostatic solar wind ion analyzer (LEIA), (d) large-area meteoroid impact detector (LMM), and (e) Instrument Suite Platform (ISP). The ISP support all the subsystems that provide power, thermal, and communication resources to the four sensors. The architecture of the platform leverages substantial GSFC investments in smallsat/cubesat subsystems that can be easily modifiable for a variety of architectures and mission requirements. The LEMS sensors leverages extensive heritage from past instrumentation flown on previous missions.

With DALI funding, the LEMS project team built an engineering unit of the station to demonstrate its autonomous self-sustaining operation in the lunar surface conditions. LEMS was successfully subjected to vibration tests to simulate the mechanical stresses of launch and Moon landing phases and subsequent deployment on the surface. Thermal vacuum and balance tests were used to replicate the thermal conditions that LEMS must survive unassisted on the surface of the Moon.

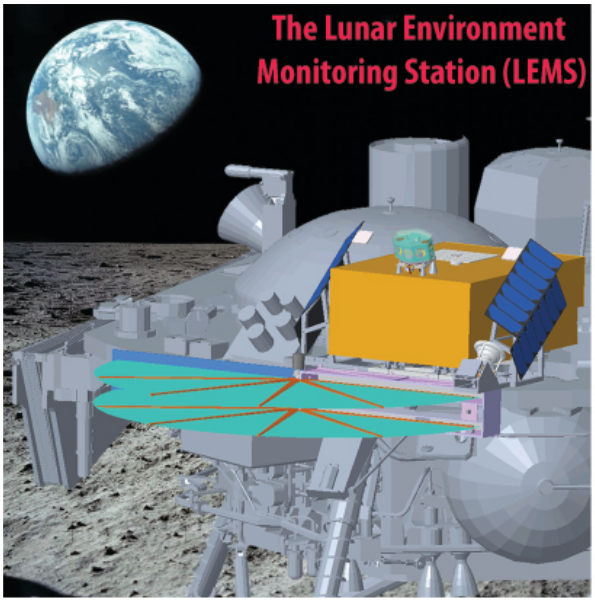

Figure 1: Artistic rendering of the fully deployed Lunar Environment Monitoring Station (LEMS) after delivery to the Moon by a CLPS lander (gray structure).

Operational Autonomy and Long-term Sustainability

The LEMS architecture is power-sufficient and does not require external power from the carrying asset to operate. Photovoltaic cells generate power during daytime and a high-efficiency battery sustains operations at night. LEMS is also thermally self-sustained and does not require radioisotopic heaters nor active thermal dissipators to continuously operate during the hot lunar days or cold nights. Additionally, LEMS manages its thermal and power states by alternating periods of low-power operations, during which only minimal science is conducted, with daily periods of high-power operations during which all station subsystems are active and power-demanding tasks are conducted. Balance between high and low power periods allows LEMS to remain power-positive and within operational temperature limits.

LEMS collects and stores science data onboard. One monthly 2-hour direct-to-Earth communication session allows LEMS to relay collected data to the ground station.