EPSC Abstracts
Vol. 13, EPSC-DPS2019-276-1, 2019
EPSC-DPS Joint Meeting 2019


EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

# Electrostatic Dust Analyzer (EDA) for characterizing dust transport on the lunar surface

**Xu Wang** (1), Zoltan Sternovsky (1), Mihály Horányi (1), Jan Deca (1), Ian Garrick-Bethell (2), William Farrell (3), Joseph Minafra (4) and Lucas Bucciantini (5)
(1) University of Colorado, Boulder, USA, (2) University of California at Santa Cruz, USA, (3) NASA Goddard Space Flight Center, Greenbelt, Maryland, USA, (4) NASA Ames Research Center, Moffett Field, California, USA, and (5) French National Center for Scientific Research (CNRS), Paris, France (xu.wang@colorado.edu)

## Abstract

Transport of charged dust particles on the lunar surface due to electrostatic forces has been suggested to explain several observations from the Apollo missions. Recent laboratory studies show strong support to the occurrence of such electrostatic process on the Moon and other airless bodies. An Electrostatic Dust Analyzer (EDA) is under development for future lunar lander missions to characterize electrostatically lofted dust on the lunar surface, including its charge, mass and velocity. In situ measurements enabled by EDA will greatly advance our understanding of this physical process in space and its effects on the surface evolution of the Moon and other airless bodies.

## 1. Introduction

Electrostatic transport of regolith dust on airless planetary bodies charged by solar wind plasma and solar radiation has been suggested to explain a number of unusual observations [1]. The first set of evidence was from several Apollo observations, including the lunar horizon glow, the high-altitude ray-pattern streamers, and the low-speed dust detection. Since then, observations on other airless bodies, such as the radial spokes in Saturn's rings and the "dust ponds" on asteroid Eros and comet 67P, have also been related to the electrostatic dust transport process. It has remained as an open question for decades to understand mechanisms behind this process and its role in shaping the surface of the Moon and other airless bodies.

Recent laboratory studies [1] have made a breakthrough in understanding the fundamental charging process, showing that electrostatic dust transport can indeed occur on the surfaces of airless bodies including the Moon. Basic characteristics of dust transport and mobilization were measured in simulated space conditions [1-3], providing critical parameter constraints for the design of EDA.

In situ measurements enabled by EDA will provide direct and ultimate evidence of electrostatic dust transport on planetary surfaces and greatly advance our understanding of this process and its effects on regolith physical properties and near-surface dust environments on the Moon. As a universal phenomenon, these measurements will provide implications to surface processes on other airless bodies. In addition, these measurements will help understand potential dust hazards in order to develop mitigation strategies for future robotic and human exploration on the lunar surface.

## 2. Design of the EDA sensor

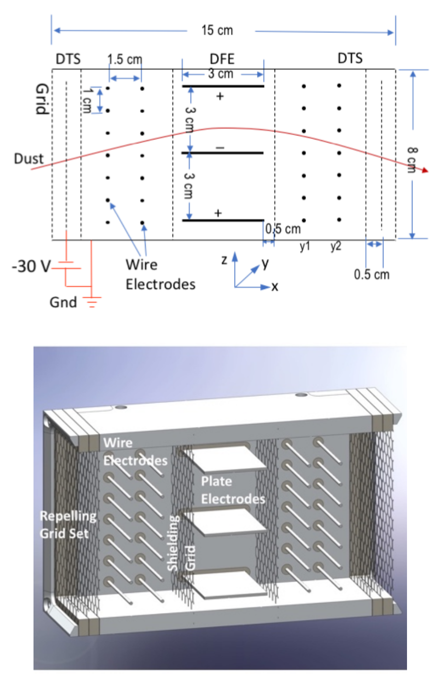


Figure 1. Top: Schematic drawing of the EDA sensor; Bottom: Cut-view of a CAD model.

The EDA sensor is designed based on a prototype of the Electrostatic Lunar Dust Analyzer (ELDA) [4]. The sensor consists of two identical Dust Trajectory Sensors (DTS) each on one end of the sensor and a Deflection Field Electrodes (DFE) unit lying in between the two DTS, as shown in Fig. 1. A charged dust particle can enter the sensor from either end. Its charge and velocity are measured with two arrays of wire electrodes in the DTS on which the image charge of the dust particle is induced. The charged particle will be then deflected by the DFE and exit through the second DTS on the other end. The mass of the dust particle is derived from its deflected trajectory. Charge signals are measured using Charge Sensitive Amplifiers (CSA). Two sets of repelling grids are used to prevent solar wind electrons from entering the sensor while allowing charged dust particles to come through. The sensor will be pointed away from the Sun to avoid solar UV and solar wind ions from entering the sensor, as described in the following section.

## 3. Design of the EDA system

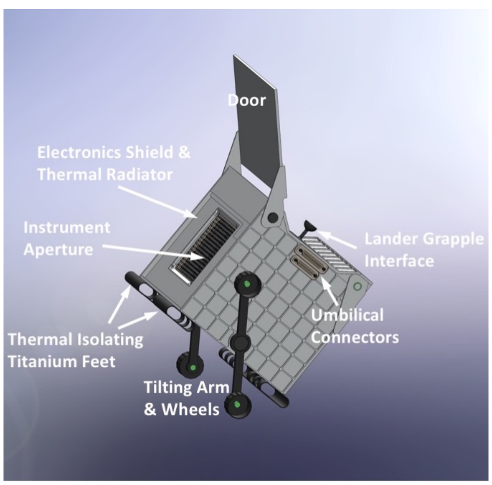


Figure 2. A CAD model of the EDA system configuration.

The dust sensor is housed in an aluminium box which has two doors and a tilting mechanism (Fig. 2). The door on the shadowed side of the sunlight will be opened to allow dust particles to come through the sensor, as described above. The EDA will be tilted to an optimized angle (up to 45 degrees) using either a rotatory direct drive or linear actuation mechanism.

## 4. Summary and Conclusions

EDA is under development for future lunar lander missions to characterize the charge, mass and velocity of electrostatically lofted dust particles on the lunar surface. In situ measurements enabled by EDA will answer a five-decade-long question about electrostatic dust transport and its effects on regolith physical properties and near-surface dust environments on the Moon as well as implications to surface processes on other airless bodies. In addition, these measurements will help understand the impact of potential dust hazards for future robotic and human exploration on the lunar surface.

## Acknowledgements

This work was supported by the NASA Development and Advancement of Lunar Instrumentation (DALI) Program and by the NASA/SSERVI's Institute for Modeling Plasma, Atmospheres and Cosmic Dust (IMPACT).

## References

[1] Wang, X., Schwan, J., Hsu, H.-W., Grün, E., and Horányi, M.: Dust charging and transport on airless planetary bodies, Geophys. Res. Lett., 43, 6103–6110, 2016.

[2] Schwan, J., Wang, X., Hsu, H.-W., Grün, E., and Horányi, M.: The charge state of electrostatically transported dust on regolith surfaces, Geophys. Res. Lett., 44, 3059–3065, 2017.

[3] Hood, N., Carroll, A., Mike, R., Wang, X., Schwan, J., Hsu, H.-W., and Horányi, M.: Laboratory investigation of rate of electrostatic dust lofting over time on airless planetary bodies. Geophys. Res. Lett., 45, 13,206–13,212, 2018.

[4] Duncan, N., Sternovsky, Z., Grün, E., Auer, S., Horányi, M., Drake, K., Xie, J., Lawrence, G., Hansen, D., and Le, H.: The Electrostatic Lunar Dust Analyzer (ELDA) for the detection and trajectory measurement of slow-moving dust particles from the lunar surface, Planet. Space Sci., 59, 1446-1454, 2011.