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Lunar Dust Analysis Package - LDAP

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Abstract

The Lunar Dust Analysis package (L-DAP) is a suite of payloads which have been designed to operate in synergy with each other at the Lunar Surface. The benefits of combining these payloads in a single package allow very precise measurements of a particular regolith sample. At the same time the integration allows mass savings since common resources are shared and this also means that interfaces with the Lander are simplified significantly leading to benefits of integration and development of the overall mission.

Lunar Dust represents a real hazard for lunar exploration due to its invasive, fine microscopic structure and toxic properties. However it is also valuable resource which could be exploited for future exploration if the characteristics and chemical composition is well known. Scientifically, the regolith provides an insight into the moon formation process and there are areas on the Moon which have never been ex-plored before. For example the Lunar South Pole Aitken Basin is the oldest and largest on the moon, providing excavated deep crust which has not been found on the previous lunar landing missions.

The SEA-led team has been designing a compact package, known as LDAP, which will provide key data on the lunar dust properties. The intention is for this package to be part of the payload suite deployed on the ESA Lunar Lander Mission in 2018. The LDAP has a centralised power and data electronics, including front end electronics for the detectors as well as sample handling subsystem for the following set of internal instruments :

- Optical Microscope - with a 1µm resolution to provide context of the regolith samples
- Raman and LIBS spectrographic instrumentation providing quantification of mineral and elemental composition information of the soil at close to grain scale. This includes the capability to detect (and measure abundance of) crystalline and adsorbed volatile phases, from their Raman signature. The LIBS equipment will also allow chemical identification of other ejecta in the vicinity of the Lander.
- Atomic (Magnetic) Force Microscope – providing nano-scale measurement of the fine particles and presence of nanophase Fe which is potentially toxic to humans
- Lenseless Microscope, a novel, low mass technology based on combining diffraction patterns derived from a laser illumination of the sample to give high resolution 3D images of the regolith presented.

In this paper we cover the high level science requirements and explain how this has driven the overall package design as well as the specific payload features. The complex sample handling system which allows the co-located payloads to share rego-lith samples and be able to make physical measure-ment in the sub micron scale.

The use of micro-machining and MEMS technology is covered. The paper also discusses the harsh environmental conditions at the Lunar South Pole and the impact this has on the operation and survivability of an externally mounted package.

The expected performance of the whole package, including the use of LIBS under lunar vacuum conditions is also presented.