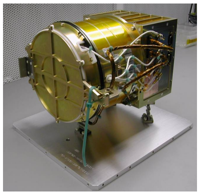

LDEX$^+$: Lunar Dust Experiment with Chemical Analysis Capability to Search for Water

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LDEX is an impact ionization dust detector with a sensor area of ~ 0.01 m^2, derived from the heritage of the dust instruments operating on HEOS 2, Galileo, Ulysses, and Cassini. LDEX is a low risk, compact instrument with no deployable or moving parts, and uses no flight software (Figure 1). In addition to individual dust impacts of grains with radii $r_g > 0.3\ \mu$m, LDEX can identify a large population of smaller grains ($0.1 < r_g < 0.3\ \mu$m) by measuring their collective signal. LDEX resource requirements are summarized in Table 1. The expected impact rates, and the signature of lofted small grains expected over the terminators are shown in Figure 2.

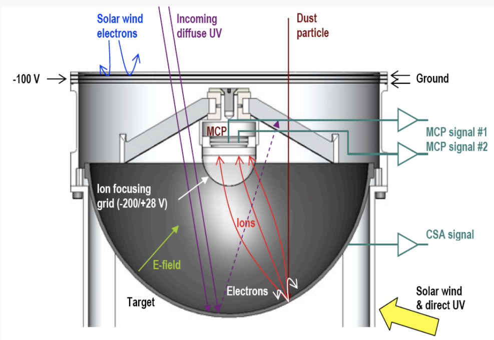

Figure 1. *LDEX* schematics.

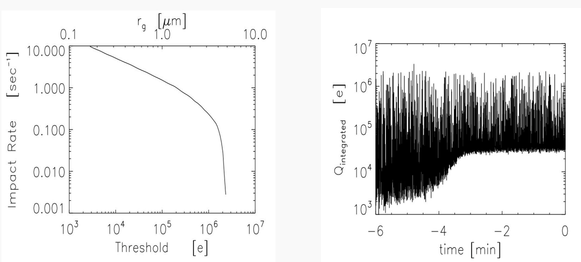

Figure 2. *left:* The expected impact rate on LDEX from meteoroid impact generated ejecta particles ($r_g > 0.3\ \mu$m). *right:* The expected 'collective' signal from lofted grains during LADEE's approach of the terminator ($0.1 < r_g < 0.3\ \mu$m).

Table 1. *LDEX* resource estimates.

Resource	Current Best Estimate	Margin [%]
Mass [kg]	3.6	15
Power [w]	3.7	36
Downlink [Mbits/day]	64	32
Volume [cm^3]	15x15x20	N/A

LDEX$^+$ extends the *LDEX* capabilities to also measure the chemical composition of the impacting particles with a mass resolution of $M/\Delta M > 30$. Traditional methods to analyze surfaces of airless planetary objects from an orbiter are IR and gamma ray spectroscopy, and neutron backscatter measurements. A complementary method to analyze dust particles as samples of planetary objects from which they were released. The source region of each analyzed grain can be determined with an accuracy at the surface that is approximately the altitude of the orbit. This 'dust spectrometer' approach provides key chemical and isotopic constraints for varying provinces on the lunar surfaces. ***LDEX$^+$* is of particular interest to verify from orbit the presence of water ice in the permanently shadowed lunar craters.**

LDEX$^+$ combines the impact detection capabilities of LDEX with a linear time-of-flight system, similar to the Cassini Cosmic Dust Analyzer (CDA) instrument. Figure 3 shows the schematics of *LDEX$^+$*. Figure 4 shows an example time-of-flight mass spectrum of an ice-bearing dust grain.

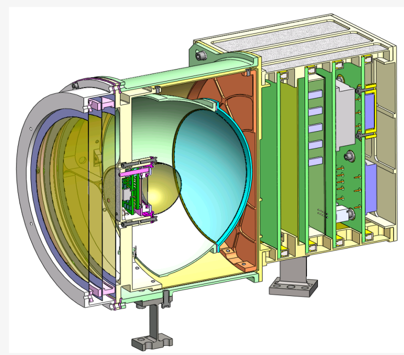

Figure 3. *LDEX$^+$* schematics. The target hemisphere is segmented to accommodate impact detection to determine the mass and speed of dust grains (top segment) and a time-of-flight setup for chemical analysis (bottom segment).

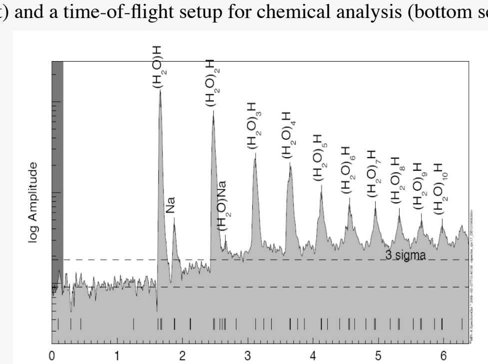

Figure 4. Spectrum of a water ice particle obtained at ~ 4 km/s impact speed by the Cassini CDA instrument in Saturn's E ring The dominant peaks are mass lines of water cluster ions $(H_2O)_nH^+$, generated upon impact of an ice-bearing particle.