SCIENCE AND PAYLOAD ACTIVITIES IN SUPPORT OF THE ESA LUNAR LANDER.

J.D. Carpenter[1], R. Fisackerly, A. Pradier, B. Houdou, D. De Rosa, B. Gardini., [1] ESA-ESTEC, Keplerlaan 1, 2201AZ, Noordwijk, The Netherlands (E-mail: james.carpenter@esa.int).

Introduction: ESA's Human Space Flight and Operations directorate is continuing with preparations for its Lunar Lander project. The Lunar Lander is an unmanned precursor mission to future human exploration, whose purpose is to drive the development of key technologies and generate scientific knowledge that will position Europe as a participant in future exploration of the Moon and beyond.

The primary objective of the mission is to demonstrate soft precision landing with hazard avoidance. Once on the surface the mission provides an opportunity for the operation of a scientific payload which addresses the major unknowns for future exploration activities.

The mission targets a landing site close to the Luna r south pole in order to demonstrate precision landing and to make use of the favorable illumination available at key locations in this region. A detailed description of landing site identification and characterisation is provided in a parallel presentation [1].

The mission has been studied at Phase B1 level with Astrium (Bremen) as the prime contractor, since August 2010.

Figure 1. Artist's impression of the ESA Lunar Lander at the Lunar South Pole.

Scientific topics for investigation: The scientific topics that have been defined for the mission emphasise areas which will be of importance for the future of exploration but where significant unknowns remain. These include the integrated dusty plasma environment at the surface of the Moon and its effects on systems [e.g. 2]; lunar dust as a potential hazard to systems and human explorers [e.g. 3]; potential resources which can be utilized in the future including both volatiles (e.g. water) and those derived from minerals; and radiation as a potential hazard for human activities. Each of these topics is supported by an independent science Topical Team. These Topical Teams continuously review the science requirements and activities of the mission in the wider context of research into a scientific topic including other space platforms and research in terrestrial laboratories.

Model payload: In order to address these scientific topics and meet the associated requirements a model payload has been defined. This model payload is used to inform the mission study in advance of a formal selection in order to ensure that challenges associated with accommodating candidate experiments are properly accounted for. In addition the model payload provides a reference point for further investigations into optimal ways to address unknowns associated with the identified scientific topics. A list of instruments in the model payload is provided in Table 1.

The model payload includes a number of experiments for which design effort and further definition is required. In addition optimization of both scientific return and utilization of mission resources can be accomplished through increased integration of instruments with synergistic operations and scientific outputs. In order to address these issues a number of activities are ongoing to investigate packages of instruments. As well as detailing the scientific measurements to be made at the surface of the moon, these payload studies provide preliminary concepts for payloads, identify the major challenges for their development and ensure that the mission study properly accounts for the payload and its interfaces. The payloads under study are described below and are included in Table 1.

The Lunar Dust Analysis Package (L-DAP) is an instrument package to determine the microscopic properties of lunar dust including the size distribution of particles from tens nm – 100s µm, the shape and structure of grains, chemical and mineralogical composition of particles. The activity builds on significant experiment heritage obtained through the MECCA experiment package developed for NASA's Phoenix mission (originally defined as a human exploration precursor experiment) [4], the microscope developed for Beagle 2 [5] and MicroOmega on Exomars, the Raman-LIBS elegant breadboard developed in the frame of Exomars [6].

The Lunar Dust Environment and Plasma Package (L-DEPP) is a package to determine the charging, levitation and transport properties of lunar dust, in-situ on the Moon, and the associated properties of the local plasma environment and electric fields. Measurements include charges, velocities and trajectories of levitated dust particles, the temperature and density of the local plasma, electric surface potential, and observations of the radio spectrum (with an additional goal to prepare for future radiation astronomy activities). The L-DEPP study builds on extensive heritage in instrumentation for measurement of space plasmas and the associated environments, dust instrumentation and expertise in radio astronomy [e.g. 7 – 11].

The Lunar Volatile Resource Analysis Package (L-VRAP) is a package to measure the species of volatiles present close to the lunar surface, their abundance and distribution and demonstrate their extraction. The primary mechanism for performing such an analysis is expected to be mass spectroscopy, although additional complimentary measurements may be considered. The potential effects of contamination by the Lander may be critical and so quantifying the likely contamination and its effects are also being investigated. The system applied in the model payload is derived from the Gas Analysis Package on Beagle 2 [12] and the Ptolemy Instrument on Rosetta [13].

Summary: We report on the status of the ESA Lunar Lander mission, emphasizing related science and payload activities.

References: [1] De Rosa et al. (2012) LPSC [2] Horanyi and Stern (2011) PSS [3] Khan-Mayberry (2008) Acta Astronautica [4] Hecht et al. (2008) JGR, [5] Thomas et al. (2004) PSS [6] Courreges-Lacoste et al. (2007) Molecular and Biomolecular Spectroscopy [7] Srama et al. (2007) Dust in Planetary Systems [8] Grün et al (2009) Experimental Astronomy [9] Holback et al (2001) Ann. Geophys. [10] Eriksson (2007) Space Sci. Rev. [11] Rothkaehl et al (2008) Journal of Atmospheric and Solar-Terrestrial Physics [12] Wright et al (2000) LPSC [13] Todd et al (2007) Journal of Mass Spectroscopy.

Package	Instrument
Lunar Dust Analysis Package (L-DAP)	AFM
	Micro Raman-LIBS
	Microscope
	External Raman-LIBS
Lunar Dust Environment and Plasma Package (L-DEPP)	Dust Sensor
	Langmuir Probes
	Radio Antenna
	Ion/Electron Spectrometer
Lunar Volatile Resource Analysis Package (L-VRAP)	GCMS
	Ion trap mass spectrometer (TBD)
Other experiments not studied within packages	Panoramic stereo camera
	High resolution camera
	Robotic arm camera
	Radiation monitor
	Dust chemical reactivity
Other Payload	Mobile payload experiment

Table 1. Model payload applied in the Lunar Lander mission study prior to formal selection and experiment packages currently under investigation.