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DIRECTORATE OF HUMAN SPACEFLIGHT

ESA FIRST LUNAR LANDER: REQUEST FOR INFORMATION

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1 OVERVIEW AND PURPOSE

The European Space Agency (ESA) is currently establishing its plans and priorities for the next phase of European involvement in international Human Spaceflight and Exploration. Coordinated by the Directorate of Human Spaceflight (D-HSF), the overarching goal of the European Human Exploration Programme with regards to the Moon is:

“to prepare for and conduct exploration of the Moon, focusing on those elements key to a future European contribution to international human lunar exploration, and to progressively advance our understanding of the Moon itself.”

These plans include the progressive development and demonstration of technologies critical to the future exploration of the Moon. The first mission opportunity in this programme has an expected launch date of around 2018. Given the importance of landing as a technological capability, the candidate missions under consideration are all lunar surface missions.

The purpose of this Request For Information (RFI) is to gather ideas and concepts for experiment or payload elements which can address high level programme objectives, and which might be considered as candidate payload options for Europe’s first lunar lander. At present two possible configurations for the lunar lander exist. The first would launch using an Ariane V launch vehicle and provide approximately 1000 kg of surface payload. The second would share an Ariane V launch vehicle with another mission and provide a reduced payload capacity of approximately 150 kg. Respondents to the RFI are encouraged to explore the range of possibilities offered by these two scenarios.

This RFI is directed towards a broad range of possible respondents, including but not limited to:

- The planetary science community
- Instrumentation developers
- Researchers in the fields of life and physical sciences
- Technology research groups
- Industrial groups (space & non-space) working in fields which may be applicable to future exploration technologies

It is important to note that this RFI is *not* part of a formal payload selection for a lunar lander mission, but is intended to support the detailed definition of mission objectives and requirements, and a *model* payload that meets these requirements. A formal Announcement of Opportunity (AO) for experiment and payload element proposals may follow a provisional mission design phase and feasibility studies.

2 MISSION OBJECTIVES

In support of the programme goals, three high level mission goals have been defined for the first ESA lunar lander mission. These objectives have been prioritised in the context of preparing for future human exploration missions. Some provisional top level mission objectives, associated with

these goals, have been identified to help define the scope of the mission itself. These goals and objectives are given below.

Respondents to this RFI should justify their proposal by expressing how it addresses one or more of the given mission requirements. Alternatively, where none of the given requirements apply a *new* mission requirements may be proposed which should in its self be justified with respect to one of the three top level mission objectives which are described below.

1. To advance European technological capabilities for future human exploration of the Moon

Candidate objectives include:

- Advance European descent and landing capabilities
- Advance European life support technologies and capabilities
- Advance European in-situ resource utilisation (ISRU) capabilities
- Advance European surface operations capabilities, including use of tools & interfacing

2. To characterise the lunar environment and potential in situ resources to identify their implications for future human exploration

Candidate objectives include:

- Characterise and monitor the solar, cosmic and secondary radiation environment on the Moon
- Measure the properties of lunar dust and the processes of charging and levitation
- Monitor meteoroid impacts to determine flux and size distribution
- Characterise and monitor seismic activity
- Identify potential resources, which might be exploited in future exploration missions

3. To increase our understanding of the formation, history and evolution of the Moon

Candidate objectives include:

- Improve estimations of the age and composition of the South Pole Aitken basin
- Increase our knowledge of the structure, composition and temperature of the lunar interior from the crust to the core
- Determine the history of any past internal dynamo

3 POTENTIAL THEMES FOR SUBMISSIONS

The top level objectives of a European Lunar Lander mission address both *technological preparation* for future human exploration of the Moon, and advance *the understanding of the Moon*. As a result the following list of themes is presented, to indicate potential areas of investigation for proposed experiments or payload elements.

- Autonomous and teleoperated surface robotics and mobility systems
- In-situ resource characterisation & utilisation
- Inter-element lunar surface communications networks
- High data rate Moon-Earth communications link
- Life and physical science experiments in support of future human exploration technologies
- Advanced power generation and storage
- Demonstration of technologies for future human habitation elements
- Instrumentation which can enable the environmental characterisation of lunar surface sites, also in preparation for future human exploration
- Experiments and technologies which advance our understanding of the Moon and which exploit its location as a base for further research

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MISSION OUTLINE

<i>Mission Type</i>	Lunar lander mission
<i>Timeframe</i>	2017 – 2020
<i>Landing Site</i>	<p>Landing site selection remains open, and is not the subject of this RFI, however the following impacts of certain locations should be noted:</p> <p><i>Polar (> 80 deg):</i> possibility of ~80% illumination conditions, thus near continuous solar power; it should be noted that the mission will <i>not</i> land in a permanently dark-crater</p> <p><i>Non-polar:</i> implies ~ 14 ‘days’ per month in lunar night, with no illumination and very challenging thermal conditions</p>
<i>Landing Accuracy</i>	<p>Since demonstration of landing technologies is a major objective of the mission; the following accuracy will be targeted:</p> <p>≤ 500m</p>
<i>Payload Range</i>	<p>1) An Ariane V class mission is likely to provide a surface payload capacity of ~1000 kg.</p> <p>2) A shared Ariane V class mission is likely to provide a surface payload capacity of ~150 kg.</p>
<i>Scale of Mobility</i>	<p>In the case of a ~1000 kg payload mass, robotics and mobility concepts which serve the objective of off-loading and transporting cargo payloads (> 100 kg) may be considered.</p> <p>In the case of a ~150 kg payload mass, mobility may be accommodated, if warranted by the requirements of the selected payload elements.</p> <p>In both of the above cases the mass of a rover will be considered as part the <i>payload</i> allocation described above.</p>
<i>Surface Resources</i>	<p>Photovoltaic power generation is assumed. Limited power may be available during lunar night.</p> <p>Some resources for thermal control of payloads will be provided, however it should be noted that the thermal environment on the lunar surface can vary from 100K to 400K.</p>
<i>Mission Duration</i>	The provisional mission duration is 1 year.

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SUBMISSION AND EVALUATION

Concepts for payloads, experiments or technology demonstrations should be submitted by completing the attached template, and sending to explorationcall@esa.int by 14 April 2009.

Submissions should justify the proposed instrument/technology/experiment by relating it to at least one of the mission objectives and ultimately to one or more of the mission goals. Additional detailed mission objectives can be proposed, provided they can be justified in terms of one of the three mission goals given.

Responses to this RFI may include alternative payload configurations, addressing the different possibilities offered by the different payload masses available in each of the two candidate mission classes.

Once received the submissions shall be sorted into the themes they address, and reviewed by a panel comprised of individuals from relevant scientific and technology areas. The review will consider the following major criteria:

- Relevance to key mission goals and objectives, in their order of priority, and to overall programme objectives
- Compatibility with timeframe of the mission as outlined
- Potential scientific or technological impact

Recommendations of the review panel will then be assessed by ESA and a model payload will be selected, considering compatibility with the programme objectives and mission candidates.

The selected model payload will be used as a reference for the phase A study of the lunar lander mission. Groups whose proposals have been selected, or used as a basis for the model payload may be contacted for further information on their concept, and may be invited to provide support to the mission's Payload Definition Team (PDT).

ESA will not release details of information collected through this RFI without prior approval from the proposers. Copyright and ownership of submitted materials will remain the property of the submitting party.

For more information contact:

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SUBMISSION TEMPLATE

The following template should be used to describe the various aspects of the proposals.

<i>Concept Title</i>	Title of the concept being proposed
<i>Concept short title/acronym</i>	Short title or acronym (<i>optional</i>)
<i>High level objective and justification</i>	Describe how the proposed experiment or payload element addresses one of the given mission objectives or in some other way addresses one of

	the mission goals.
<i>Working principle</i>	Describe the technique employed and/or the technology implemented.
<i>Mass</i>	The mass of the proposed experiment or payload element.
<i>Volume</i>	The volume and dimensions of the proposed experiment or payload element.
<i>Data</i>	The data rate expected from the proposed experiment or payload element.
<i>Operations</i>	Key aspects of the operational cycle.
<i>Mission driving factors</i>	Describe aspects of the proposed experiment or payload element which are likely to drive the design of the mission (e.g. dependence on landing site, minimum duration of operations, requirements for mobility, high power requirements etc.).
<i>Current TRL¹ estimate, and effort to reach TRL 5-6</i>	Give the current Technology Readiness Level (TRL) of the concept (1-9). For inclusion in the mission a TRL of 5-6 should be achievable by 2013. Include a brief description of the necessary steps and effort required to achieve this.
<i>Current status, ongoing work and parallel applications</i>	Describe of the current status of the concept, previous and ongoing activities and applications to other areas (space and non-space related). This field should also be used for notification of any patents existing or pending relating to any part of the proposed concept.
<i>Related publications and past funding</i>	Provide a list of relevant publications and describe present or previous funding for the development of the technique.
<i>Anticipated impact in the field</i>	
<i>Anticipated risks</i>	
<i>Additional Information</i>	
PROPOSER DETAILS	
<i>Name</i>	
<i>Group/Institute/Industry & address</i>	
<i>Email Address</i>	
<i>Contact telephone</i>	
<i>Co-Proposers</i>	
<i>Relevant experience of proposer & co-proposers</i>	

¹ TRL = Technology Readiness Level; definition available at: