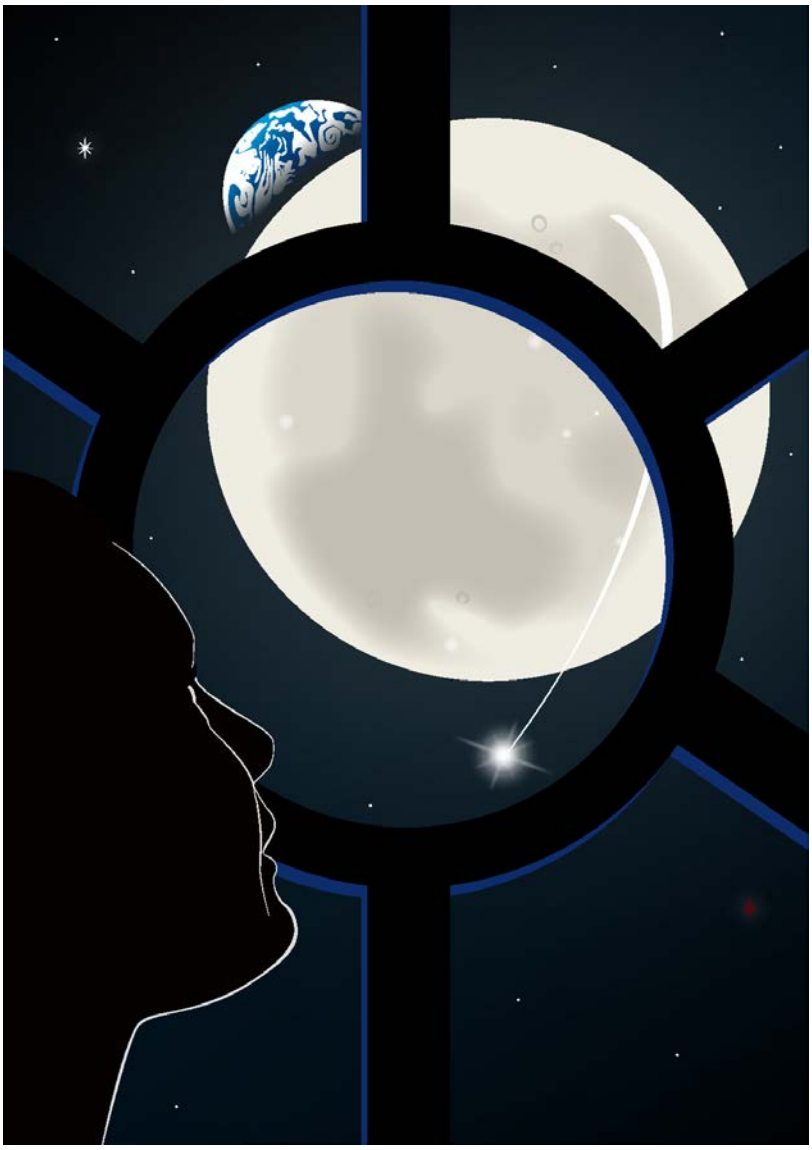
ESA Workshop: Research Opportunities on the Deep Space Gateway



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APPROVAL

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CHANGE LOG

ESA Workshop: Research Opportunities on the Deep Space Gateway	Issue Nr.	Revision Number	Date
Airlock size updated in table 2	1	1	07/08/2017

CHANGE RECORD

Issue Number 1	Revision Number 1		
Reason for change	**Date**	**Pages**	**Paragraph(s)**
Nominal airlock size change	07/08/2017	5	Table 2

DISTRIBUTION

Name/Organisational Unit
General release

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1 INTRODUCTION

ESA is seeking inputs from the European research community to inform the development of the Deep Space Gateway; a spaceship in lunar vicinity, which will host crewed missions and operate without crew in between. The Deep Space Gateway is planned to be built and operated during the 2020's as humanities next step beyond Low Earth Orbit and out into the Solar System.

Inputs received on the scientific and other research which could be performed on this platform will be consolidated at a workshop at ESA ESTEC, in the Netherlands, on 5th and 6th December.

The end product of this consultation will be a compendium of ideas for utilisation and specific recommendations for what would be required to enable the proposed research.

This information will be used by ESA to:

- Inform discussions with international partners and stakeholders on the utilisation opportunities of the Deep Space Gateway
- Establish technical requirements to be considered in the engineering work for the Deep Space Gateway design and development.
- Guide future Announcements of Opportunity and research calls related to the Deep Space Gateway.

2 INTRODUCING THE DEEP SPACE GATEWAY

The Deep Space Gateway is being established as a strategic platform, from which human exploration of the Solar System can set forth. Its location in the lunar vicinity, and outside of the Earth's deep gravity well allow it to be used as a staging post for exploration missions to the lunar surface and eventually to other deep space destinations including Mars. It is also a platform in a location where the human and technological challenges of long duration human missions in deep space can be investigated and addressed. The platform is being prepared through international cooperation, led by the partner agencies of the International Space Station: ESA, NASA, JAXA and CSA.

The technical definition of the Deep Space Gateway is driven by the technical needs of preparing deep space human exploration. It could also support opportunistic scientific research. This research could relate to a wide range of scientific disciplines. Investigations related to these various research areas will carry with them specific technical implications for the Deep Space Gateway.

2.1 Nominal resources available on the Deep Space Gateway

The initial Deep Space Gateway concept incorporates the resources listed Table 1. The Gateway's configuration is expected to evolve to meet future needs, and make additional resources available to science.

Resource	Initial Gateway	Possible Gateway Evolution
Crew Time	Crew stays up to 42 days	Crew stays up to 180 days
Crewed mission frequency	Approx. 1 per year	
Power	4 KW for internal payloads (more when crew not present)	4 KW for internal payloads (more when crew not present)
Communications with Earth	Uplink: TBD Downlink: tens of Mbps (not continuous)	Uplink: TBD Downlink: tens of Mbps (not continuous)
Internal volume for payload	~1 m^3	Max TBD
Up mass with initial habitat launch	150 kg	n/a
Up-mass per logistics flight	200 kg	400 kg
External Attachment Points	Locations on outside of Gateway accommodating payloads up to TBD kg, with power and data.	Additional locations, with resources.

Table 1 Notional resources available on the Deep Space Gateway. Values provided are indicative only.

2.2 Preliminary capabilities of the Deep Space Gateway

The Deep Space Gateway will have the capabilities presented in Table 2. These capabilities can be made available for scientific utilisation.

Capability	Value
Science airlock	57x57xTBD cm^3
Down mass with Orion	100kg /mission
Ability to relocate Gateway in lunar vicinity	NRHO and other stable orbits, such as EML_1 and EML_2.
Robotic Arm	yes
High Definition Video	yes
Cubesat deployment	potentially
Window (not scientific optical performance)	Hatch windows with TBD configuration and optical properties
Moon surface teleoperations	yes

Table 2 Notional capabilities of the Deep Space Gateway. Values provided are indicative only.

2.3 Deep Space Gateway notional orbits

A number of potential orbits have been reviewed for the Deep Space Gateway, to determine their suitability for missions on terms of the operations of a habitat, access and return for crew and access to the lunar surface. These various orbit types are illustrated in Figure 1. Some relevant properties of these orbits are provided in Table 3. The Deep Space Gateway should have the ability to move between orbits as needed for different missions.

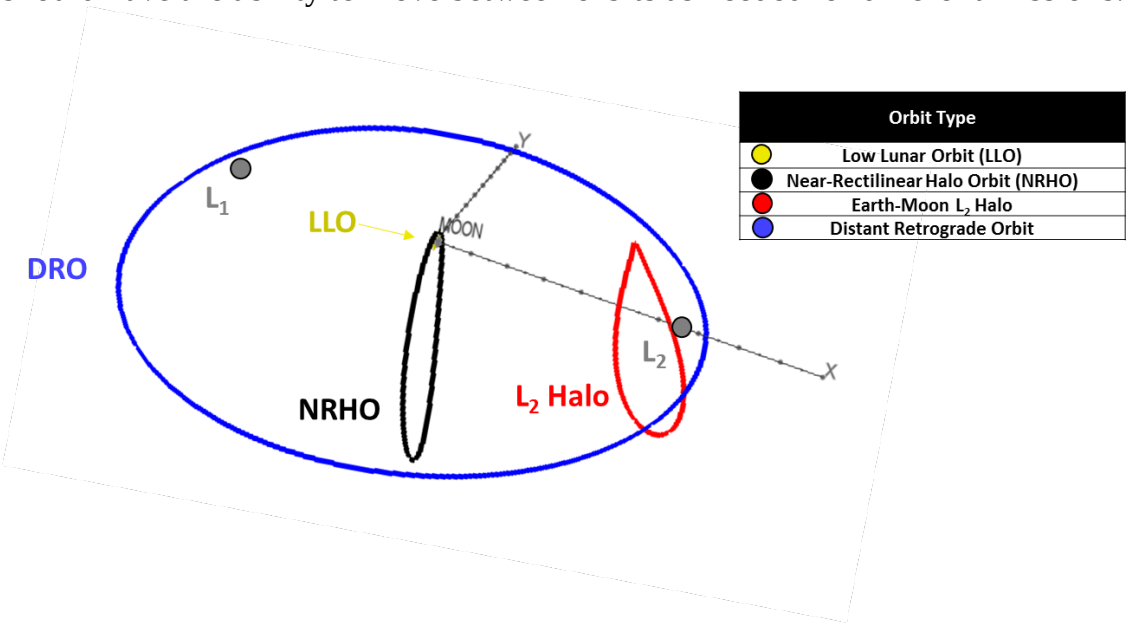

Figure 1 Orbit types reviewed for the Deep Space Gateway. Of those reviewed Near Rectilinear Halo Orbits and Earth-Moon L2 Halo orbits were found to be technically favourable.

Orbit	Property	Value
Near Rectilinear Halo Orbit	Period	6-8 days
	Orbits around	Moon
	Distance to lunar surface	Approx. 2,000 to 75,000 km
	Inclination	Approx. 90°
	Earth visibility	Constant
Earth-Moon L_2 Halo Orbit	Period	8-14 days
	Orbits around	Earth-Moon 2nd Lagrange point
	Distance to Moon	60,000 km
	Earth visibility	Constant

Table 3 Some qualities of two notional orbits for the Deep Space Gateway

3 RESEARCH OPPORTUNITIES

It is important that the scientific and other research opportunities offered by the Deep Space Gateway are understood and taken into account during the early phases of definition. If research is to be performed on the Deep Space Gateway then it must be designed and prepared with an understanding of the capabilities that enable this research to be performed. As the Deep Space Gateway is not driven by research the opportunities will be limited to those that have limited impact on design and resource requirements. The platform will be optimised to perform the exploration enabling tasks for which it has been defined. Research enabling capabilities may then be incorporated into the system where programmatic, operational and technical parameters allow.

This call has been prepared to consult the European scientific community to identify where opportunities could exist for utilisation of this new crewed platform near the Moon and to specify the capabilities and facilities that would need to exist to enable this research to be performed.

3.1 Identified possible research areas

The International Space Exploration Coordination Group[1] has conducted a consultation to establish scientific opportunities associated with the various destinations and mission associated with the Global Exploration Roadmap[2].

This has resulted in the publication of a white paper on the Scientific Opportunities of the Global Exploration Roadmap[3]. This document includes high level descriptions of a number of scientific areas that could benefit from human operations in lunar vicinity. These include:

- Lunar surface science using tele-presence
- Collecting and returning planetary material
- Understanding the Effects of Deep Space Radiation and Fractional Gravity
- Observation post for monitoring Earth's climate
- A platform for astronomical observations
- Fundamental physics

[1] www.globalspaceexploration.org
[2] www.globalspaceexploration.org/wordpress/wp-content/uploads/2013/10/GER_2013.pdf
[3] www.globalspaceexploration.org/wordpress/wp-content/isecg/Scientific%20opportunities%20beyond%20LEO.pdf

- Heliophysics

In addition a number of opportunistic investigation areas were identified for the cruise phase to the Moon including:

- Monitor lunar exosphere evolution of the whole Moon through a monthly cycle
- Quantify impact flashes through the lunar night (clouds get in the way on Earth)
- Monitor human physiology and biomedical changes as the habitat or vehicle moves from within to outside the Earth's magnetic field (assuming humans are present);
- Install cosmic dust/micrometeorite collectors
- Target the habitat trajectory to facilitate a lunar eclipse of the Sun to study coronae/Sun composition that is undistorted by Earth's atmosphere
- Monitor Earth exosphere (geocorona) in the far UV which extends half way to the Moon and try to estimate the radiation pressure and its accurate extension which might change with solar activity

Responses to this call can address any area of scientific research and do not need to be related to those indicated here.

4 SUBMITTING IDEAS FOR THE WORKSHOP

Members of the broad science and research community are invited to propose ideas for investigations that could be performed using the Deep Space Gateway. These ideas will be collated into a compendium to be used as an input for future activities and will be presented and reviewed in a workshop at ESA ESTEC on 5-6 December 2017.

Submissions may be submitted for presentation at the workshop or as written submissions only.

The received submissions shall be reviewed by a nominated Science Advisory Team and the authors of those submissions which are considered to be of sufficient quality will be invited to present their idea at the workshop. Authors who do not wish to present their idea are asked to indicate this when submitting their idea.

The workshop will review submissions in the areas of Life Sciences, Physical Sciences, Solar System Sciences, Earth Sciences and Astronomy as well as technology and other areas of a more applied nature. Education and public engagement will also be represented. This review in the workshop will be used to establish recommendations to ESA on the major areas of research that could be enabled by the Deep Space Gateway and what needs to be in place to enable that research.

Registration for the workshop will open on 1st September.

A template providing a format for submissions and details of the information requested is provided. Some of the information requested in the template is fairly technical and it is

understood that this may not always be available or known. Information is only required where it can be estimated. If the information is not available please submit your idea anyway.

Submissions can be submitted at any time by emailing completed submission templates to the following e-mail address DSGateway@esa.int. Any questions can also be sent to the same address. The deadline for submissions is Friday 29th September.

5 TIMELINE

1 August: Call for ideas submissions opens
1 September: Workshop registration opens
29 September: Call for ideas submissions closes
2 October – 27 October: review of submissions and workshop programme preparation
1 November: Workshop programme published
5-6 December: Workshop at ESA ESTEC