

GLXP BMT: Lunar Lander Mission Definition & Opportunistic Science during Nominal Operations

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Abstract

The GLXP BMT “MoonRaise” mission is the Barcelona Moon Team Lunar Lander and Lunar exploration mission within the GLXP initiative. GMV is the mission technical leader and is in charge of the primary mission analysis that will later derive into the different mission subsystems and elements requirements and specifications for design and manufacturing.

The classical scientific missions pivot around the scientific requirement and most of the mission elements design have the final purpose of fulfilling with the scientific requirements. This has the advantage of producing a dedicated mission to cope with all the scientific objectives (design-to-performance). The main drawback being the usually high mission complexity and cost.

The GLXP BMT “MoonRaise” mission is a low cost mission and, thus, design-to-cost approach is used instead. Even if the “MoonRaise” mission will have some dedicated scientific objectives and dedicated resources, the maximization of the scientific content of the mission is a challenge in itself, and emphasis has to be placed in the imagination and achievement of opportunistic science while in nominal (non-scientific) operational phases.

This paper presents the GLXP BMT “MoonRaise” mission architecture and mission approach and will identify potential opportunistic science targets with minimum impact on the Lunar Lander module and Rover module systems and at quasi-zero cost. The first section/s will be devoted to analyse the mission aspects, while the later section/s will be devoted to identification of interesting opportunistic science.

1. Introduction

From a mission high-level viewpoint, the GLXP BMT “MoonRaise” mission can be described as the concatenation of the operational phases shown in Figure 1 and artistically impressed in Figure 2 and Figure 3.

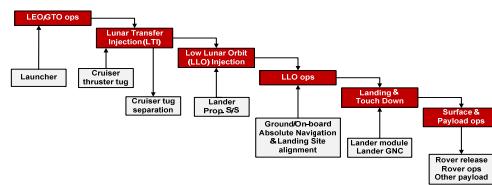


Figure 1: GLXP BMT “MoonRaise” mission architecture.



Figure 2: GLXP BMT “MoonRaise” mission phases artist impression.



Figure 3: Surface Rover Module artist impression.

All phases are subject of potential identification of opportunistic science, although they will be those closer to the Moon offering the better chances, i.e. stay of the Lunar Lander Module (LLM) in the Low Lunar Orbit, Descent and Landing phase, and Surface operations with the Rover Module (RM) and the static LLM.

2. Mission Description

The main mission phases have been already referred in the Figure 1. The LLM will stay for about three days in the Lunar Transfer Orbit before being inserted in the target Lunar orbit.

Once inserted in the Low Lunar Orbit (e.g. 100 km circular altitude orbit), the duration of the stay in LLO will depend on the LLM resources and selected landing site but, in principle, there will be certain flexibility to decide the duration of the LLO stay.

The Descent and Landing (DL) Phase starts by a De-Orbiting Injection burn (DOI) half an orbit before the selected Landing Site (LS) and finalizes with a continuous breaking phase of about 15 minutes. Figure 4 shows a typical Descent and Landing Profile and the potential use of an optical camera for navigation purposes all along the DL phase.

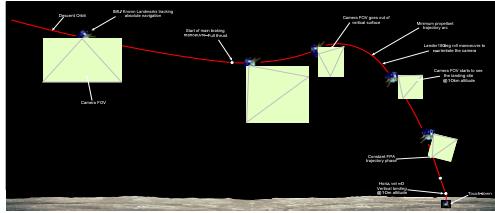


Figure 4: Descent and Landing trajectory and use of optical camera for navigation purposes.

After the landing, it will start the surface operations phase, that includes the deployment and operations of a surface Rover Module (with a dedicated scientific payload) and the landed Lunar Lander Module acting as communications relay and with certain scientific and non-scientific (e.g. panoramic cameras) payload.

3. Opportunistic Science Identification

Once described the different mission phases, we can make the exercise of identifying potential opportunistic science to be developed along the mission.

During the transfer between the Earth and the Moon, the navigation camera can be used as scientific payload to collect Earth and/or Moon limb images and assess atmospheric derived status from Earth and reflectivity and others from Moon.

During the LLO stay, different opportunistic science could be envisaged, e.g. the acquired camera images could be used (apart of dedicated navigation purposes) for topography purposes (e.g. it is well known that the LRO DEMs present some discontinuities in between the different passage strips that could be smooth or better understood by the use of optical images), for gravitational purposes (a precise optical based navigation system ensures a good reconstruction of the LLM trajectory during the LLO stay, that could result in the refinement of the Moon gravitational field characterization) or other (e.g. measures about reflectivity of Moon surface, albedo properties, ...).

During the surface operations phase, the RM equipped with mono- or stereo-vision system could perform fine topography of the landing surrounding. Additionally, the data from the rover wheels motion (needed torque, slippage, ...) could provide interesting data to characterize the terra-mechanics properties of the Moon soil.