Paper ID: 31442
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SPACE PROPULSION SYMPOSIUM (C4)
Joint Session on Nuclear Propulsion and Power (7-C3.5)

Author: Dr. Pierpaolo Pergola
Sitael/Alta, Italy

Prof. Mariano Andrenucci
Sitael Spa, Italy

NEW GENERATION ROBOTIC PROBES FOR SAMPLE RETURN MISSIONS: THE PHOBOS CASE

Abstract

One of the candidate missions in the framework of the the Mars Robotic Exploration Preparation (MREP-2) programme, is the Phobos Sample Return mission. The main mission goal is to acquire and return some semples from Phobos, the larger and inner Mars natural moon. As secondary mission goal the mission could also be extended to Deimos for its global characterization. In addition such a mission would also represent the precursor to a complete Mars Sample Return mission (MSR). The mission is nowadays studied under a cooperation agreement between ESA and Roscosmos concerning cooperation on the robotic exploration of Mars and other bodies in the solar system. The mission has been already studied in some ESA CDF and industrial studies and the aim of the paper is to present a possible mission alternative based on a heavy probe equipped with next generation electric thrusters. The main advantage offered by this architecture is the possibility to have a significant amount of soil samples and possibly also collected by different targets (e.g. Phobos and Deimos). The spacecraft is supposed to be equipped with a large power generator (likely based on nuclear reactors) running a high-thrust electric propulsion system. The spacecraft is composed by a propulsive module (including the power generation system), an orbiter (docked with the propulsive module and remaining in orbit around the moon, acting as data relay with the landing sampling capsule and scanning the moon) and the surface module. The module that actually lands on the surface is composed by the re-entry capsule (with autonomous propulsive capabilities to lift-off form the surface and dock with the orbiter and the propulsive module), a landing system and a soil sampling device. The mission concept considers also re-using the same propulsive module to bring back the samples to Earth, thus autonomous in-orbit docking capabilities are considered for collecting the landing probe(s). The trajectory design and the overall mission architecture would guarantee a significant amount (of the orders of some kilograms) of Phobos samples brought back to Earth. The mission designed can be also used for a multi-target samples collection and for future Mars sample return applications. The paper presents an overview of the concept proposed and a detailed design of the transfer ad of the spacecraft. The sizing of the main system is addressed and particular emphasis is given to the power generator and electric propulsion system.