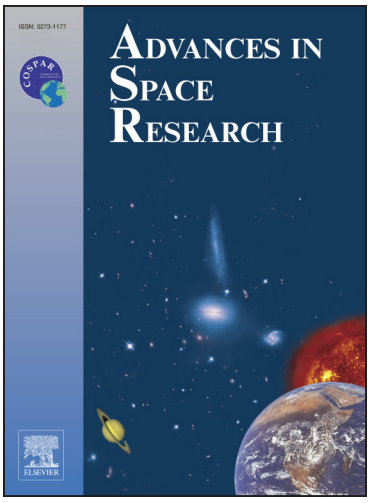

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The Exploration of PHOBOS: Design of a Sample Return Mission

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ABSTRACT

The long-term goal of enabling human exploration of the Moon and Mars drives International space exploration plans. Robotic space missions must therefore develop and demonstrate the feasibility and robustness of the enabling technologies and capabilities.

The Phobos Sample Return mission is a candidate mission of the Mars Robotic Exploration Preparation programme. Its objective is to acquire and return a sample from the Mars moon Phobos. The main science goal of this mission will be to understand the formation of the Martian moons Phobos and Deimos and acquire further data on the evolution of the solar system. From a technology standpoint, it would be a big step forward in the development of many technologies, ranging from low-gravity body landing capabilities to Earth re-entry of samples from deep space, from semi-autonomous robotic acquisition of surface samples to sample preservation and further analysis in dedicated ground laboratories.

Thales Alenia Space represents one of two industrial contractors studying the mission to Phase A level. This phase involves investigation of all aspects of the mission and spacecraft design to ensure its feasibility and robustness. The planned launch date for the mission is between 2025 and 2027. The Ariane 5 ECA launch vehicle will be launched from Kourou. A chemical propulsion module will transfer the spacecraft composite to the Martian system, and will then be separated at Phobos. A full characterization campaign of Phobos at different altitudes from orbit will follow. This will include quasi-satellite orbits and flybys, using a payload suite of cameras and spectrometers. When the preferred landing site is identified, a controlled descent and touchdown onto the surface of Phobos will be performed, with a touchdown accuracy of 50m. A robotic arm and sampling mechanism will obtain and verify a sample of surface regolith, and insert it into the Earth re-entry capsule. Part of the Spacecraft will return to the Earth from Phobos and deliver the re-entry capsule to the Earth's atmosphere. The capsule will perform a fully passive Earth entry, descent and landing in Woomera, Australia. It will then be recovered and transferred to a sample curation facility for sample extraction and analysis. This paper summarises the results of the Thales Alenia Space Phobos Sample Return mission and spacecraft design, with a focus on the key elements and mass drivers.

Keywords: Mars, Phobos, Exploration, Sample Return, Robotic.

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