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SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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MSR IOD STUDY: AN END-TO-END IN ORBIT DEMONSTRATION OF KEY TECHNOLOGIES FOR THE MSR MISSION

Abstract

The Mars Sample Return (MSR) mission is the number one goal for Mars planetary science and will present a major milestone in the exploration of the solar system. Despite the varied scientific instrumentation brought to the surface of Mars by previous and planned missions, studying unaltered Martian materials using the huge array of sensitive scientific equipment on Earth may result in a paradigm shift in planetary science, helping to answer questions about the nature of Mars, its formation, and the possibility of life on another planet. Various mission architectures are under consideration, and are evolving. However, all such mission concepts have a common fundamental requirement – the launch of the sample container into Mars orbit and its retrieval by an orbiter. A feat in itself, the Sample Container (SC) - the size of a football - must be found thousands of kilometres away, approached and captured by a capable orbiter, before being further packaged before its return to Earth. All of this must be done autonomously. Such operation represents a major risk that must be mitigated before the mission begins, and that is not possible to replicate on-ground or in the limited environment and time of a parabolic flight or drop tower. This paper will address the outcomes of a study that has been initiated and funded in the frame of the ESA General Studies Programme, and that is focused on investigating an end-to-end demonstration in Earth orbit of the autonomous Mars sample capture. The mission aims to provide a cost efficient demonstration of key technologies such as long range optical detection, autonomous GNC for rendezvous & capture of uncooperative target, capture and securing of the free-flying Sample Container, and on understanding their applications on similar missions, e.g. debris removal. A clear definition of the main mission objectives and of the associated benefits in terms of risk mitigation and TRL improvement will be provided, together with an overview of the mission architecture and of the full operations concept to be implemented. An in depth assessment of the representativeness with respect to the actual Mars Sample Return mission will be also described, identifying the main commonalities and differences and how those have been addressed in order to guarantee useful results. Finally, a phase-0 design of the sample capture payload will be discussed, including the preliminary engineering budgets.