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Mars Sample Return Engineering – A reference architecture for joint ESA-NASA studies and early mission concepts

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Abstract

1. Introduction

The analysis in Earth laboratories of samples that could be returned from Mars is of extremely high interest to the international Mars exploration community. The NASA Mars 2020 sample-caching rover mission is the first component of a potential Mars Sample Return (MSR) campaign, so its existence constitutes a critical opportunity. On April 26, 2018, NASA and ESA signed a Statement of Intent[1] to work together to formulate, by the end of 2019, a joint plan for the retrieval missions that has a sufficient level of technical and programmatic maturity that will lead to an international agreement between the two agencies in time to be submitted for approval to their respective authorities at the end of 2019. This abstract describes the reference engineering architecture of the MSR campaign, which forms the basis on which ESA and NASA will be performing joint studies over the next 18 months. Some concepts for the retrieval flight elements will also be presented based on the recent and on-going studies.

2. The MSR reference architecture

The architecture is based on three major flight elements and one ground element as depicted in Figure 1.

The Mars 2020 sample caching rover mission, which would be the first element of this campaign, is already in full flight development and is planned for launch in 2020 with a nominal 1.25 Mars-year mission to collect, analyze and cache samples for possible later retrieval.

The following two flights elements, not yet approved missions are the main subjects of the joint studies.

The Sample Retrieval Lander (SRL) element is assumed to be led by NASA and would carry the Mars Ascent Vehicle (MAV), as well as an ESA-provided Sample Fetch Rover (SFR) and Sample Transfer Arm (STA).

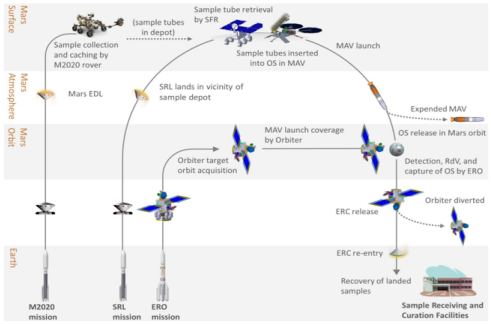

Figure 1: MSR reference architecture for joint ESA-NASA studies

The Earth Return Orbiter (ERO) element is assumed to be led by ESA and would carry a NASA-provided Sample Capture, Handling and Containment system as well as an Earth Entry Vehicle.

For the purposes of the joint studies, launch dates as early as 2026 for both the SRL and ERO missions are being considered, which could allow samples to be returned to Earth before the end of 2029.

The fourth element of MSR, based on the ground, would constitute all post-landing handling, sample receiving and curation activities, collectively known as Mars Returned Sample handling (MRSH).

A key driver for the MSR campaign will be the backward planetary protection requirements as it falls

under the COSPAR Category V "Restricted Earth Return" categorization.

The information provided about possible Mars sample return architectures is for planning and discussion purposes only. NASA and ESA have made no official decision to implement Mars Sample Return.

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References

[1] https://mepag.jpl.nasa.gov/announcements/2018-04-26 NASA-ESA SOI (Signed).pdf