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SAMPLE FETCHING ROVER – CONCEPT AND OPERATION OF A LIGHTWEIGHT LONG-RANGE ROVER FOR MSR

Abstract

Plans for a Mars Sample Return Mission are being drafted for the mid 2020s. Such a complex and challenging endeavour calls upon the consolidated effort and flawless operation of a number of robotic elements to capture, transfer, and return the samples back to Earth. The current MSR reference campaign sees surface operations starting in September 2025 with a challenging mission timeline starting shortly before the dust season and a solar conjunction half-way through which will limit Earth communications and therefore rover operations.

The Sample Fetching Rover (SFR) is one these critical systems, built to retrieve and return a sample cache package deposited by the previous ESA/NASA sample caching rover. As part of the preliminary investigation of the various MSR elements, Astrium recently performed a feasibility study for ESA to identify the critical aspects of the design of the SFR platform.

With a strict mission duration of 6 months, to meet the Mars Ascent Vehicle launch and Earth return windows, the SFR platform is calling for an extremely capable and fast rover in a small package. While increasingly large rovers are being sent to Mars, the ESA SFR study aimed at identifying the smallest volume and mass envelope to achieve reliably the mission objectives.

Building on the recent developments of the ExoMars Rover vehicle, the design converged on a lightweight 80kg, 6-wheel rover fitting in a stowed volume less than 1m3. Featuring a 5 degrees-of-freedom arm to pickup the sample cache, the rover is designed to traverse up to 20km in 100 sols without the support of radioisotopic material for either the power generation or thermal control.

This paper will address the key design and operational challenges arising from the development of such a platform, as well as a more detailed description of the reference design. From mission-specific design drivers to implementation options, it will also discuss aspects of on-board autonomy and navigation requirements, drawing parallels with some of the ExoMars navigation system developments.

As the MSR mission architecture firms up, the challenges of the MSR programmes are being assessed, and where possible de-risked, by investigating the feasibility of its core elements. The returning of the sample cache is a particularly complex operation, leaving no room for error, succeeding only with the successful return of the cache to Earth. This SFR study provides therefore a first iteration of the design of a fetching rover with a mission unlike any other before.