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EVOLUTION OF THE EXOMARS SAMPLE CRUSHING UNIT FROM BREADBOARD TO FLIGHT MODEL

Abstract

This paper describes the development and testing of a jaw crusher (Crushing-Station). The mechanism is part of the Sample Preparation and Distribution System (SPDS) of the ExoMars Rosalind Franklin Rover. The ExoMars Rover and Surface Platform Mission, planned for launch in 2022, is a mission of international cooperation between ESA and ROS, with a contribution from NASA. Thales Alenia Space is Prime Contractor to ESA.

One of the main purposes of the mission is the analysis of Martian subsoil samples, drilled from a depth of down to two meters, aiming at finding traces of organic life. The SPDS task is to collect the sample from a drill and process it such that every kind of Martian sample can be analysed by the payload instruments inside the rover. In the SPDS chain of sample preparation, the Crushing-Station has the task to pulverize the collected sample to a powder with a defined grain-size distribution (90

The Crushing-Station's main function is the crushing of samples, which can have a maximum strength of 110MPa. This is realized by a jaw crushing system. Briefly, this kind of milling system consists of two conical arranged profiled plates (jaws), one fixed and one moving, which form a funnel through which the sample is forced to move. The moving jaw is actuated by a rotating cam which both narrows the funnel (sample compressing or crushing phase) and promotes the movement of the sample through the CS jaws towards the outlet. Due to this repetitive process, the sample becomes crushed to grains with a defined grain-size distribution.

If a collected sample cannot be crushed because of high hardness, strength or a sample is collected which shall not be crushed, a second function is implemented into the Crushing-Station: the De-Jamming. This function provides the possibility to open the funnel formed by the jaws to become a tube such that any sample that can be collected by the drill can pass or fall straight through the CS. This functionality has also been implemented to reduce the contamination of the currently processed sample with the sample that has been processed before (cross-contamination) as remaining uncrushed material can be dropped

out of the system. To improve this cleaning an additional shock mechanism has been implemented into the Crushing-Station to loosen sample material that still adheres to the jaws after the crushing process.

The paper will focus on the design and its evolution through the different stages from Bread Board to FM. Special attention is given to the improvement of the crushing performance and crushing kinematic. Additionally it provides a detailed summary of the testing results from the BB, QM and FM phase.