Paper ID: 64275
oral

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 1) (4A)

Author: Mr. Fabian Buse
German Aerospace Center (DLR), Germany, fabian.buse@dlr.de

Dr. Stefan Barthelmes
German Aerospace Center (DLR), Germany, Stefan.Barthelmes@dlr.de
Dr. Maxime Chalon
German Aerospace Center (DLR), Germany, maxime.chalon@dlr.de
Mr. Viktor Langofer
German Aerospace Center (DLR), Germany, Viktor.Langofer@dlr.de
Mr. Wieland Bertleff
German Aerospace Center (DLR), Germany, Wieland.Bertleff@dlr.de
Dr. Roy Lichtenheldt
German Aerospace Center (DLR), Germany, Roy.Lichtenheldt@dlr.de
Mrs. Juliane Skibbe
German Aerospace Center (DLR), Germany, juliane.skibbe@dlr.de
Mr. Markus Bihler
German Aerospace Center (DLR), Germany, markus.bihler@dlr.de
Mr. Roman Holderried
German Aerospace Center (DLR), Germany, Roman.Holderried@dlr.de
Mr. Josef Reill
German Aerospace Center (DLR), Germany, Josef.Reill@dlr.de
Mr. Bernhard Vodermayer
German Aerospace Center (DLR), Germany, Bernhard.Vodermayer@dlr.de
Mr. Leon Stubbig
German Aerospace Center (DLR), Germany, Leon.Stubbig@dlr.de
Mr. Jean Bertrand
Centre National d'Etudes Spatiales (CNES), France, Jean.Bertrand@cnes.fr
Dr. Simon Tardivel
Centre National d'Etudes Spatiales (CNES), France, Simon.Tardivel@cnes.fr
Dr. Pierre Vernazza
Laboratoire d'Astrophysique de Marseille, France, pierre.vernazza@lam.f
Dr. Naomi Murdoch
ISAE-Supaero University of Toulouse, France, Naomi.MURDOCH@isae-supaero.fr
Dr. Stephan Ulamec
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, stephan.ulamec@dlr.de
Dr. Patrick Michel
University of Nice-Sophia Antipolis, CNRS, Observatoire de la Cote d'Azur, France, michelp@oca.eu

WHEELED LOCOMOTION IN MILLI-GRAVITY: A TECHNOLOGY EXPERIMENT FOR THE MMX ROVER.

Abstract

For the Martian Moons eXploration (MMX) mission of the Japan Aerospace Exploration Agency (JAXA), the French Centre National d'Études Spatiales (CNES) and the German Aerospace Center (DLR) jointly develop a wheeled exploration rover. This paper will discuss the planned analysis of wheeled locomotion of the MMX Rover. The focus will be on the expected challenges, the methods to overcome them and the plans on how to achieve a better understanding of wheeled locomotion in a milli-g environment by performing and analyzing a set of driving activities on Phobos.

With the MMX Rover being the first wheeled system landing on a small body, there is no experience on how such a system will behave. Topography, rocks and regolith at the landing site will have a large impact on the achievable performance. To ensure safe operations, the locomotion system, developed at DLR-RMC, is designed to master a large variety of environments: The wheels are designed for optimal traction on soft regolith and the legs are actuated individually. Thereby, advanced maneuvers like inching locomotion allow the rover to climb slopes beyond its regular traction limits. In parallel to the hardware and software development, a detailed simulation environment was established, which both assists in the design of the rover and will serve as a planning tool during driving operations.

During the mission, specific locomotion maneuvers are performed and the downlinked data is then analyzed in detail to obtain a comprehensive understanding of the achieved performance and its constraints. The telemetry from the rover will be used to reconstruct the situation in simulation. After correlation, the simulator is used to get a deeper understanding of the wheeled locomotion dynamics under milli-g conditions. Of particular interest are the control strategies chosen and the influence of environmental characteristics on the rover's maneuverability, traction achieved, obstacle traversal, and controllability. Furthermore, the performance of specific components, like the traction generated by the wheels and the actuator performance, will be compared against expected behavior.

During the mission, the findings will be directly used to improve the day-by-day planning of the rover's driving phases. Later, the results will be further analyzed and published to enable better designs with reduced uncertainties for future wheeled locomotion in low gravity environments. The paper will give details on the planned maneuvers, strategies to analyze them as well as the expected results.