IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 2) (4B)

Author: Ms. Alice Dottori
Politecnico di Milano, Italy

Mr. Francesco De Cecio
Politecnico di Milano, Italy
Mr. Enrico Belloni
Politecnico di Milano, Italy
Dr. Giovanni Zanotti
Politecnico di Milano, Italy
Prof. Michèle Lavagna
Politecnico di Milano, Italy
Dr. John Robert Brucato
INAF - Astrophysical Observatory of Arcetri, Italy
Dr. Fabrizio Fiore
INAF - Istituto Nazionale di AstroFisica, Italy
Dr. Alberto Fedele
ASI - Italian Space Agency, Italy
Dr. Marilena Amoroso
Italian Space Agency (ASI), Italy
Dr. Andrea Meneghin
Italy

DEIMOS IN-SITU SCIENCE: THE TASTE CUBESAT LANDER REGOLITH SAMPLING SUBSYSTEM

Abstract

The sampling and analysis of the Deimos surface regolith would allow to better understand the formation and evolution of the Martian system. The TASTE CubeSat mission, funded by the Italian Space Agency in the framework of the Alcor program, would be the first to attempt this challenge. However, the mission faces the constraint of a limited 1U volume available for the regolith sampling subsystem. To address this issue, a miniaturized drilling system is developed to collect, store, and select samples for analysis. The system is designed to target depths in the order of centimetres.

The sampling unit has an external helicoil that ensures efficient soil penetration. Additionally, an internal helicoil is included to convey the regolith to the collection and storing chamber. Organic compounds are here extracted from the regolith and then moved through fluidic equipment to the Lab-on-Chip analysis subsystem, developed by the Italian National Institute for Astrophysics (INAF). The collection chamber is designed to store the whole sample while ensuring its sealing during fluidic operations. Adapting to the limitations of a 4U CubeSat, the drill design and operations prioritize minimizing the counter-reaction of the soil on the lander, thus reducing the anchoring requirements. The design of the drill itself shall be able to face different conditions once on the Deimos surface, given the uncertainties on the mechanical and physical properties of the soil.

A preliminary model of the drilling unit is currently being developed to account for a wide range of uncertainties. The purpose is to address the challenges of the mission and estimate the forces that will

be exchanged between the sampling system, the lander, and the terrain, thereby informing the need for a potential anchoring system for the CubeSat lander. Additionally, preliminary simulations are conducted to evaluate the performance of the internal helicoil in conveying regolith.

State-of-the-art drilling systems have demonstrated their capabilities in space missions of classical sizes. However, adapting them to meet the CubeSat standards requires extensive re-engineering due to the strict limitations on size, power, and mass. This presents an exciting opportunity to develop innovative solutions that can support planetary exploration using CubeSats as a framework.