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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – missions current and future (3A)

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PHASE-A DESIGN OF ICE CREAM: A COST-EFFECTIVE MARS SAMPLE RETURN MISSION

Abstract

One of the most thorough strategies to search for water sources on other planets and to track their geological history is to analyze in depth their soil and subsurface. This technique has been widely used by past Mars missions with great profit. However, none of those missions have ever had the opportunity to bring samples back on Earth, preventing scientists from analyzing borings in a full-scaled laboratory.

With increasing concerns about the cost effectiveness of such science missions, minimizing the cost of a Mars Sample Return (MSR) project will be fundamental. In the next decade, sampling multiple sites on Mars could allow mankind to gather the knowledge necessary for the creation of self-sufficient Martian colonies, with the major advantage of avoiding black swan events and other drawbacks.

It is clear that the optimization of all the subsystems is going to be the major challenge that research and development must focus on, keeping as a top priority the maximization of the valuable scientific data return.

Given the previous experiences, an undergraduate student team from Politecnico di Milano, with the guidance of the university space association PoliSpace and the Department of Aerospace Science and Technology (DAER), entered the American Institute for Aeronautics and Astronautics (AIAA) Team Space Design competition, completing the Phase-A design of a MSR mission called ICE-CREAM: ICE Collection and Retrieval Expedition Aimed at Mars.

This paper presents the Phase-A design of the ICE-CREAM mission, intended to retrieve 2.5 kg of pure ice while meeting a 1-billion-US dollar (FY20) cost threshold. The research includes the preliminary analysis and the trade-off process for the possible architectures, as well as the constraints and requirements used in designing the cruise stage, the ground segment, and the ascent module. In addition to this, a detailed focus on the budget and cost analysis is exposed, showing how the reusability of some stages could enhance the potential of the mission. The in-situ analyses of the mined samples and the strategy to keep the material in solid state to avoid any change that could impact its scientific value are also discussed and outlined.