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

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SMALL MARS SATELLITE: A LOW-COST SYSTEM FOR MARS EXPLORATION

Abstract

The Small Mars Satellite (SMS) is a proposed mission to Mars, currently under feasibility study promoted and funded by the European Space Agency (ESA). The mission aims at delivering a small, low-cost lander on the surface of Mars by using an innovative "umbrella-like" heat shield concept, known as IRENE (Italian ReEntry NacellE), developed and patented by ALI S.c.a.r.l., which is also the project's

contractor. The lander includes two small payloads, i.e. a particle dust analyzer and aerial drone. The former will be based on an instrument, developed by INAF, the Astronomical Observatory of Capodimonte (INAF-OAC), performing in-situ measurement of the size distribution and the abundance of dust particles suspended in Martian atmosphere. The drone is being designed by the University of Naples and demonstrating low-altitude flight in the Martian atmosphere, as well as multi-mission capability. The project also involves the Space Studies Institute of Catalonia (IEEC), responsible for launch and trajectory design. In this contribution, we illustrate the results of the feasibility study of SMS. Following, the description of its mission profile, we will describe launch and escape phases, interplanetary trajectory, Mars approach on a hyperbolic path, Mars entry, descent and landing (EDL), and payload deployment and operations. Current baseline envisages launching to LEO with VEGA. Then, a dedicated propulsion module will provide a series of apogee raising maneuvers up to Earth escape to Mars. A targeting maneuver will direct the spacecraft to the atmospheric entry with the kinematic parameters suitable for the deployment of the heat shield. The consequently reduced ballistic coefficient, due to the TPS configuration, will enhance the descent and landing performances in the Martian rarefied environment. This allows to decelerate down to subsonic Mach numbers using only the TPS, thus avoiding the use of a supersonic parachute. EDL simulations and aero-thermo-dynamic analysis modeling, conducted by the University of Naples, have provided the physical parameters profiles by implementing 3-DoF models for entry trajectories evaluation and using a suite of engineering and high-fidelity CFD and DSMC analysis tools. Thus, the overall spacecraft concept will be presented according to mission and system requirements with particular attention on the TPS, the structural resistance to thermal and dynamic loads, and to the analysis of technical solutions allowing to embark the selected payloads and deploy them according to the mission profile. Finally, drone and dust particle analyzer design and operation concept will be discussed.