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THERMAL DESIGN OF DREAMS SCIENTIFIC PAYLOAD FOR EXOMARS 2016

Abstract

DREAMS (Dust characterization, Risk assessment and Environment Analyser on the Martian Surface) is an integrated multi-sensor scientific payload devoted to the characterization of the Martian landing site environment during the dust storm season. It is designed by a consortium of institutions led by the Italian Space Agency and it will be accommodated on the Exomars 2016 Entry Descent and Landing Demonstrator Module (EDM), which will prove landing capability of Europe on Mars and will guarantee science capabilities as well, once the module will be operative on ground. Package sensors, exposed to the external atmosphere, will monitor the meteorological state parameters (such as pressure, temperature, wind velocity) and the potential electric activity close to the surface. Shielded with respect to the external atmosphere, primary batteries and a Common Electronics Unit (CEU) will be placed on a common bench inside the so-called Warm Compartment. One of the most critical issues in the design of the suite is the thermal aspect, since DREAMS will operate in a severely harsh environment, characterized by an extremely wide temperature range (the temperature of the Carbon Dioxide which mainly constitute the atmosphere varies in the range -90C up to 10C). Passive thermal control devices (such as insulating foam panels) will be employed along with active systems (such as heaters and a thermostat) for the thermal conditioning of the batteries and the CEU. The major criticality in the thermal analyses is given by the convective heat exchange with the Carbon Dioxide at 6 mbar pressure present inside and outside the Warm Compartment: external sensors can be subjected to wind velocities up to 25 m/s and are located in a forced-convection regime, whereas thermal exchange between internal components and internal Carbon Dioxide could be mainly due to conduction or free convection. The presented thermal modeling strategy allows to chose between the two regimes, determining the most critical condition, considered as a baseline for the design. Thermal and fluid-dynamics simulation results, which allow to determine the thermal regime with the best accuracy, are presented. To support the design, an experimental test-bed has been developed in order to reproduce the thermal boundary conditions indoor, test the Flight Model and validate the thermal models.