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DREAMS for the ExoMars 2016 mission: a suite of sensors for the characterization of Martian environment

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Abstract

The DREAMS package is a suite of sensors for the characterization of the Martian basic state meteorology and of the atmospheric electric properties at the landing site of the Entry, descent and landing Demonstration Module (EDM) of the ExoMars mission. The EDM will land on Meridiani Planum in October 2016, during the statistical dust storm season. This will allow DREAMS to investigate the status of the atmosphere of Mars during this particular season and also to understand the role of dust as a potential source of electrical phenomena on Mars. DREAMS will be the first instrument to perform a measurement of electric field on Mars.

1. Introduction

The ExoMars mission is carried out by European Space Agency (ESA) in cooperation with the Russian federal Space Agency (Roscosmos). It is a two-steps mission. It includes an orbiter, the *Trace Gas Orbiter*, and an EDM, that will be launched on January 2016, and a descent module and surface platform, plus a rover, to be launched in 2018.

The mission will allow Europe to acquire the technologies necessary for the entry, descent and landing of a payload on the surface of Mars, to move on the Martian surface with a rover, to penetrate into the subsurface and acquire samples, to distribute the collected samples to on-board instruments for analysis. From the scientific point of view, the mission will search signs of extant or extinct life forms, will monitor the trace gases in the atmosphere of Mars and their sources, will study the Martian environment during the dust storm season and will perform the first ever measurement of electric field on Mars. The last two represent the scientific objectives of the DREAMS payload on-board the EDM 2016.

2. The DREAMS scientific suite of sensors

DREAMS (*Dust characterization, Risk assessment and Environment Analyzer on the Martian Surface*) is a meteorological station with the additional capability to perform measurements of the electric field close to the surface of Mars. It is an autonomous system that includes its own battery for power supply. It is constituted by the following subsystems (see Figure 1): MarsTem (thermometer), DREAMS-P (pressure sensor), DREAMS-H (humidity sensor), MetWind (2-D wind sensor), MicroARES (electric field sensor), SIS (Solar Irradiance Sensor), a CEU (Central Electronic Unit) and a battery. All systems in DREAMS have a solid heritage from other missions and have very high TRL.

The ExoMars 2016 EDM mission is foreseen to reach Mars during the statistical dust storm season. DREAMS will have the unique chance to make scientific measurements able to characterize the Martian environment in this dust loaded scenario. DREAMS will perform:

• Meteorological measurements
- The measurement of pressure, temperature, wind speed and direction, humidity and dust opacity will supply the needed parameters to characterize the basic state meteorology and its daily variation at the landing site.
- Such information will directly be ingested by climate models.
- Characterization of the Martian boundary layer in dusty conditions.

• Hazard monitoring
- DREAMS will provide a comprehensive dataset to help engineers to quantify hazards for equipments and human crew: velocity of windblown dust, electrostatic charging, existence of discharges, and E.M. noise potentially affecting communications, intensity of UV radiation.

• The first ever investigation of atmospheric electric phenomena at Mars
- A global atmospheric electrical circuit is likely to exist on Mars, between the surface and the ionosphere, with similarities and differences with the Earth's circuit. Atmospheric ionization should be similar to that of the Earth's stratosphere but impact charging through collisions between dust particles moved by the wind and the surface, or between dust particles themselves, is expected to be the dominant charging mechanism. Intense electric fields, possibly capable of producing electrical breakdown, are expected at the time of dust storms and in the vicinity of dust devils.
- Atmospheric electricity is also involved in several processes that have a noticeable impact on the surface and atmosphere. At times of dust storms, electrostatic forces on fine electrically charged dust grains may become larger than aerodynamic forces due to the wind. They are expected to play a significant role in the dynamics (including lifting) of suspended dust particles and their interaction with the surface, thus on the processes that contribute to the erosion and long-term evolution of the surface.
- By energizing the free electrons, the atmospheric electric fields control their interaction with both the surface and the atmospheric gases. They have thus a definite role in the chain of physical and chemical processes that govern the chemical state of surface materials and the production of oxidized constituents in the atmosphere with consequences on the sustainability of proper conditions for life.

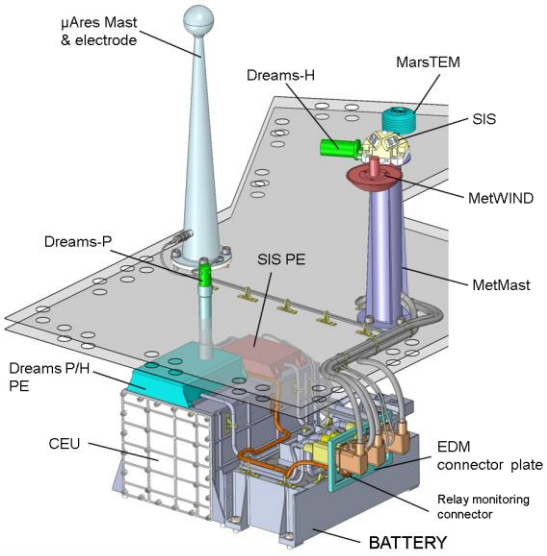

Figure 1: DREAMS payload accommodated on the EDM.

DREAMS is in an advanced state of development. The Flight Model will be delivered to ESA on February 2014.

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