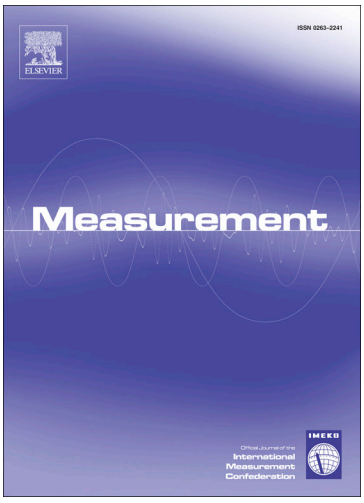

MarsTEM sensor simulations in Martian dust environment

Giacomo Colombatti, Carlo Bettanini, Alessio Aboudan, Stefano Debei, Francesca Esposito, Cesare Molfese, Anselmo Cecere, John Merrison, Jens Jacob Iversen

PII: S0263-2241(17)30814-X
DOI: https://doi.org/10.1016/j.measurement.2017.12.043
Reference: MEASUR 5174

To appear in: *Measurement*

Accepted Date: 29 December 2017

Please cite this article as: G. Colombatti, C. Bettanini, A. Aboudan, S. Debei, F. Esposito, C. Molfese, A. Cecere, J. Merrison, J.J. Iversen, MarsTEM sensor simulations in Martian dust environment, *Measurement* (2017), doi: https://doi.org/10.1016/j.measurement.2017.12.043

MarsTEM sensor simulations in Martian dust environment

Giacomo Colombatti,
Carlo Bettanini,
Alessio Aboudan
and Stefano Debei
CISAS "Giuseppe Colombo"
Università degli Studi di Padova
Italia
Email: giacomo.colombatti@unipd.it

Francesca Esposito
and Cesare Molfese
INAF - OAC
Napoli Capodimonte,
Italia

Anselmo Cecere
Dip. di Ingegneria Aerospaziale
Università di Napoli "Federico II"
Napoli,
Italia

John Merrison
and Jens Jacob Iversen
Aarhus wind test facility
Aarhus University,
Denmark

***Abstract*—A wind tunnel test campaign has been conducted prior to the landing of the Exomars2016 EDM module on the Meridiani Planum on the 19^{th} of October 2016. Test were perfomed in the Mars wind tunnel facility at Aahrus University (DK) under the 2015 Europlanet Call. The facility was available for a 5 days campaign where different environmental configurations were tested and both a full scale DREAMS (Dust Characterisation, Risk Assessment, and Environment Analyser on the Martian Surface) Metmast model and a Descent Module mockup were studied. In particular the MarsTEM (Mars TEMperature sensor), the temperature sensor of the DREAMS package onboard Exomars2016, was studied for different wind velocities and directions, effect of light sources and presence of dust. The test showed that the sensor response is dependent on wind direction but only slightly on wind velocities. It also seems that the presence of the dust in the wind and the consequent dust deposit on the Metmast and the sensor itself uniforms the response for different wind velocities and directions. Light is also affecting the measurements but it is still not so clear what will be the effect on Mars due to the particular light sources used for the test.**

***Index Terms*—Exomars2016, DREAMS, MarsTEM, Wind tunnel chamber.**

I. Introduction

The DREX esperiment (DReams EXperiment) was an experiment conducted under the 2015 Europlanet Call for testing space instrumentation in specific facilities. The goal of the experiment was the testing of the performance and functionalities of the DREAMS payload (see [1] and [2]) in a Martian like environment using the Planetary Environment Facilities available at Aarhus University.
The principal objectives were:

- to investigate the effects of Martian wind (velocity and direction) and dust on DREAMS sensor measurements;
- to investigate the effects of light sources on DREAMS sensors measurements;
- to investigate the influence of the EDM (Entry Descent Module) module on DREAMS measurements (in particular flow distortion and thermal effect).

In particular, for the MarsTEM sensor the first two objectives are going to be discussed in this paper. To our knowledge in the Aarhus facility only the Phoenix mission's Telltail wind sensor has been tested other than the entire DREAMS package. The DREAMS suite is therefore one of the most complex instruments that has been tested in this martian like environment. Other Mars temperature sensors have been used on other Mars missions, like NASA Vikings V1 and V2 in the '70s [3], Mars Pathfinder in the end nineties [4], the two MERs in the first 2000s [5], Phoenix in 2012 [6] and MSL since 2014 [7]. The first three missions used thermocouples while MERs measured thermal spectras with the Miniature Thermal Emission Spectrometer (Mini-TES) and Phoenix had again thermocouples measurements at three heights, 0.5m, 1m and 1.5m; MSL has two thermistor (Pt1000) rods. MarsTEM sensor uses RTD thermistors, and specifically 2 custom designed Pt30 [8].

II. Facility description

A complete description of the wind tunnel facility can be found in [9] and [10]. The available test section is $0.9 \times 2.0 \times 2.0m$ wide; the complete DREAMS masts with the CEU (Central Electronic Unit) was fixed in the center of the test area (see Fig. 1). For our tests the wind tunnel facility was equipped, for the first time, with a new air cooling system that allowed to control directly the fluid temperature (see Fig. 2). The set-up for the monitoring of the temperatures of the DREAMS package considered 3 Pt100, one positioned on the base of the CEU supporting structure and the other two on the circular plate supporting the Metmast, positioned near the base of the mast itself, one facing DREAMS-H (the humidity sensor of DREAMS) sensor and the other one on the side of the MarsTEM sensor.

The fluid temperature is monitored with two floating Pt100 sensors near the Metmast and positioned downwind respect to the sensors and in the middle of the height of the test section. Thermal response of the different sensors depend on the particular environment, for this reason the chamber is filled with CO_2 maintained at a pressure of about $8mbar$. Furthermore, two pairs of halogen lamps (a low power and a