REMS, AN INSTRUMENT FOR MARS SCIENCE LABORATORY ROVER.
J. Gómez-Elvira[1] (gomezej@inta.es), L. Castañer[2], A. Lepinette[1], J.Moreno[3] , J. Polko[4], E. Sebastian[1] , J. Torres[1], M.P.Zorzano[1] and REMS Team. [1] Centro de Astrobiología (CSIC-INTA) Carretera de Ajalvir km.4, 28850 Torrejón de Ardoz, Madrid, Spain, [2] Universidad Politécnica de Cataluña, [3] EADS-CASA, [4] Finnish Meteorological Insitute.

Introduction: REMS (Rover Environmental Monitoring Station) is part of the MSL (Mars Science Laboratory) instrument suite, which will be launched by NASA on 2011. REMS has accomplished all qualification and protoflight tests and the flight model (FM) will be delivered to JPL early 2009. This extended abstract describes the flight instrument and the calibration tests performed until now. REMS scientific objectives have been presented in 2008 LPSC [1].

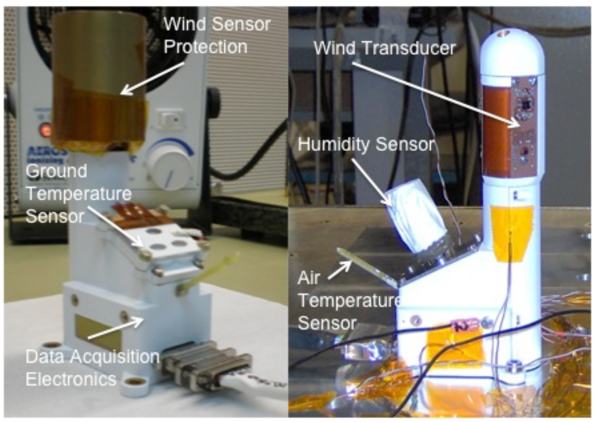

Figure 1. Boom FM units. On the left, Boom 1 is depicted during the integration phase, on the right Boom 2 before Thermal Vacuum Tests tests. Both Booms are similar in their mechanical configuration, the only difference is Boom 1 houses the GTS and Boom 2 the Humidity Sensor (HS). On the Boom 1 the GTS calibration plate (white plate with three holes) is highlighted where can be seen the heater used for flight calibration purpose. On the Boom 2, the HS protection against Mars dust (white Teflon film), is shown. On Boom 1, the aluminum cap protection is shown, to protect the WS from any handling damage along integration phases, including rover ATLO.

Flight Instrument: REMS is composed of four units: Boom 1, Boom 2, Ultraviolet Sensor and ICU (Instrument Control Unit). Information about the location of each one on the rover is included in [1]. Booms mechanics are designed to support sensors and electronics (Figure 1 shows both Booms in different phases of the integration and tests) and they have a shape which minimize perturbation in the wind flow. Hereinafter all sensor hardware is described.

Wind Sensor (WS) has three wind transducer plates, each one measure the local wind in two orthogonal directions and from thses set of measurements wind speed and direction can be recovered. Each wind transducer is based on hot film anemometry [2]. All plates are interconnected among them and with the data acquisition electronic, by flexible circuit.

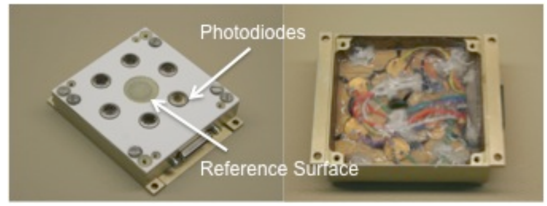

Figure 2. On the left, the top view of the UVS. Reference surface is the area, which is going to be used to estimate the amount of dust deposited over the sensor. On the right, its back view.

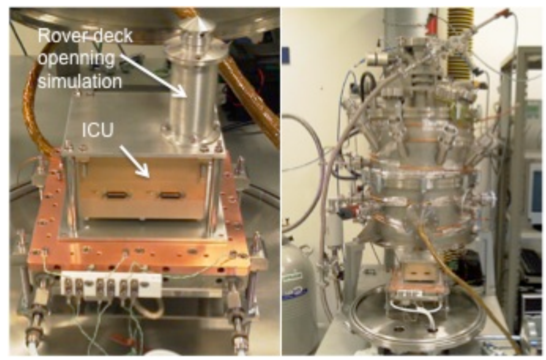

Figure 3. ICU test for checking the influence of the rover interface. To prevent PS contamination by dust, a small chimney will be place on the rover deck, with four small holes at its top. For planetary protection reasons, a HEPA filter is included inside the chimney. On the left image is shown the ICU with an aluminum cylinder over the PS, which try to simulate the rover deck opening and at the top the small chimney. On the right the chamber where test was carried out.

Ground Temperature Sensor (GTS) has three thermopiles (in the bands of 8-14, 15, 16-20 microns) and a thermistor to measure local temperateraure. They record the infrared radiation emitted by Mars ground and atmosphere, with this information and the temperature sensor, it makes an estimation of ground temperature and emissivity within this range (temperature range 133 to 313 K with an accuracy of 5 K). In flight, thermoiles calibration is done heating the Calibration Plate (see Figure 1) up to a known temperature.

Air Temperature Sensor (AS) consists of a thin FR4 rod with two thermistors (PT1000) bonded to it; one at an intermediate position and the other one at the free end, out of boom boundary layer. Air temperature is retrieved with a model based on the reading of both temperatures (150 to 300 K with an accuracy of 5 K).

Humidity Sensor (HS). Boom 2 hosts the HS (see Figure 1), which is based on a Vaisala capacity sensor mounted in a small PCB and covered by a Teflon film (white cylinder in Figure 1) to protect from dust. In order to guarantee that humidity conditions are equal at both sides of the film several holes have been made around the cylinder (accuracy of 10% in the 203 – 323 K range).

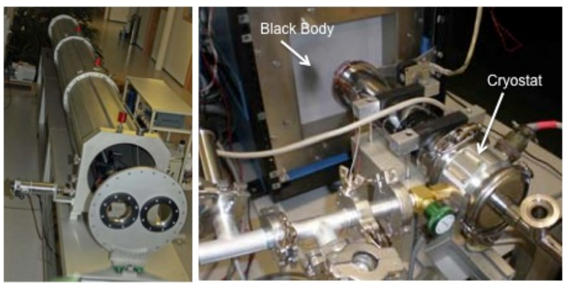

Figure 4. Specials set up have been prepared for calibration purposes. On the left, the WS calibration set up, where Reynolds and Prandtl number expected on Mars could be reproduced. A boom will be translated, at known speed, inside a 6 m long cylinder, where Mars pressure and atmospheric composition are reproduced. Calibration parameters will be get by a correlation between WS reading and boom speed. On the right, the GTS calibration set up, where the GTS model parameters are identified by using a calibrated blackbody and a cryostat; also, the calibration plate has been verified.

Boom Data Acquisition Electronics. Both booms should operate at Mars ambient conditions (very low temperatures) and faraway from the REMS main electronics (booms are in the rover mast and electronics inside the rover body). Due to both requirements, the acquisition electronics should be located in the booms and must survive and operate at very low temperatures. A mixed ASIC was the design option, which has been tested to verify its survival at all expected temperatures cycles. ASIC operation at low temperature is assured by a heater, which raises it up to the operational one.

Ultraviolet Sensor. UVS is depicted on Figure 2, it made up by six photodiodes (335-395 nm (UVA), 280-325 nm (UVB), 220-275 nm (UVC), 210-380 nm (total dose), 245-290 nm and 310-335 nm), six magnets located around the photodiodes and an additional one in the middle (see reference surface on Figure 2) to evaluate the level dust deposited on the box and therefore estimates the UV transmission losses. It has very simple mechanical configuration: a small box, to support photodiodes and magnets and a thermistor, close to them, to know their temperatures, which it will be used during data reduction.

Instrument Control Unit and Pressure Sensor. Instrument electronics box has three boards: analog, CPU and power (see Figure 3). In addition to these boards, the ICU Box houses the Pressure Sensor. The PS is based on a Vaisala chip (1 to 1150 Pa with and accuracy (end-of-life) of 20 Pa.) The rover deck has an opening to connect the PS with the atmosphere. A small chimney, over the deck, prevents dust deposition in the PS.

Calibration: A Calibration Plan has been elaborated for each sensor, based on the model defined for each one. In addition, a reduced number of end-to-end tests have been identified for checking that there are not cross interferences between them or with the main electronics.

Pressure and Humidity Sensors. Both have been calibrated at FMI premises, prior to the integration in the instrument. Nevertheless, once REMS is integrated a tests at know conditions will verify its behavior. Figure 3 shows the set up used for testing PS chimney against quick pressure changes; tests results show a very good behavior.

Ultraviolet Sensor. FM Photodiodes have been calibrated before integration to know their spectral response at different temperatures, radiation intensity and incident angles.

Ground Temperature Sensor. As the previous sensors, FM components have been calibrated before integration with the set up shows in Figure 4. The tests have been performed with the FM thermopile assembly, including the calibration plate in some of them.

Wind Sensor and Air Temperature Sensor. For these tests a special calibration unit will be used, in order to minimize the risk of damage the FM units. The set up is shown in Figure 4 will be used for calibration; different Reynolds numbers and different boom orientation will be used to sweep most of the expected operational conditions.

References: [1] LPSC 2008 #1647, [2] Planetary and Space Sciences, Vol. 56, Iss.8 , 1169-1179 (2008).

REMS Team: J. Alves[1] , C. Amies[1], F. Gomez[1] , B. Haberle[3], A. Harri[4] ,V. Jimenez[2] , J. Martinez-Frias[1], C. Left[1], M. Genzer[4], l. L. Kowalski[2], A. Lepinette[1], L.Mora[1], J. Martin[1], S. Navarro[1], V. Peinado[1], M. Pumar[2], M. Ramos[6], N. Renno[7], M. Richardson[8], J. Ricard[2], J.A Rodríguez-Manfredi[1] , J. Romeral[1], J. Serrano[5] , J. Sobrado[1], R. Urqui , [1] Centro de Astrobiología (CSIC-INTA) Carretera de Ajalvir km.4, 28850 Torrejón de Ardoz, Madrid, Spain, [2] Universidad Politécnica de Cataluña, [3]NASA Ames Research Center, [4] Finnish Meteorological Insitute, [5] EADS-CASA, [6] Universidad de Alcala de Henares, [7] Michigan University, [8] California Insitute of Technology

Acknowledgement. The CDTI, Science and Innovation Ministry (ESP2007-65282) and Defense Ministry of Spain found this project. Thanks to the CAB(INTA-CSIC) director for it continous support in the development of the project. Thanks ot Prof. L. Vazquez, former P.I., for its contribution to the project.