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The European Mars Wind and Dust Simulator

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Abstract

Laboratory simulations are an invaluable complement to in-situ observations from extreme environments such as Mars, this is true for science as well as technology. Together with Aarhus University in Denmark, the European Space Agency has developed this facility as the most advanced Mars-environment simulator.

1. Motivation

Scientifically the purpose of a planetary simulator is to recreate the observed phenomena in a controlled environment where the phenomenology can be studied in detail and models/predictions can be tested (and new ones developed). A few specific science issues which have been studied in detail using a Mars environment (wind tunnel) simulator are the mechanisms of dust (and sand) transport (and its effect on the atmosphere), the mineralogy and chemical evolution of the surface, the transport of water and other volatiles [1]. This facility is supported by the EU Europlanet network to allow science exchange.

Figure 1 The new Mars Simulation Facilities at AU

Mars presents challenges to current technology with regard to instrumentation and/or landing/roving platforms. For example the effects of the cryogenic temperatures, low pressure, dusty and windy environment, solar UV, frost, surface properties. Thorough and realistic laboratory testing could be highly beneficial in ensuring successful operation if the simulation environment is suitably representative.

2. Simulator Design

The simulator has been loosely based on a previous smaller facility operating since 2000 and consists of an environmental (thermal-vacuum) chamber within which a re-circulating wind tunnel is housed [2,3]. The wind is generated by a set of two 1.8m diameter fans which draw flow down the 2m×1m tunnel section and return it above and below. The test section can be fully removed for access.

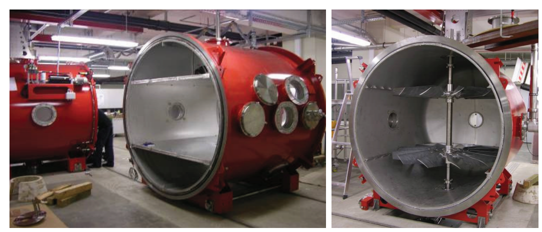

Figure 2 simulator Test and wind generation sections.

An important aspect of simulating the Martian environment is a suitable Mars analogue dust material. Salten Skov I has been used extensively since it is similarly fine grained to Martian dust [4].

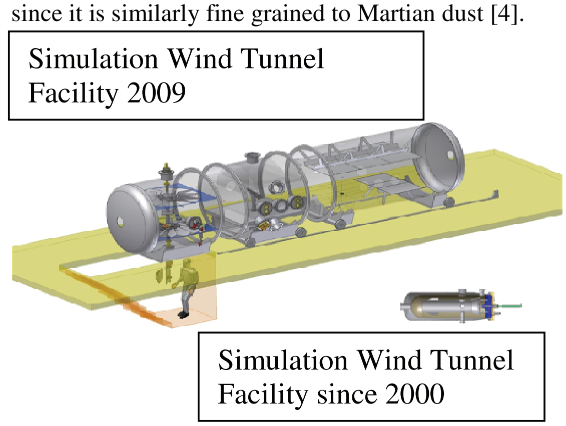

Figure 3 Mars Simulation Wind/Dust facilities at AU.

A server based control system provides both control over wind flow, temperature, pressure, lighting, etc., but also acts as a data logger. Cooling is achieved by a novel liquid nitrogen flow system which has achieved temperatures below -120ºC, an electric heater system is also employed. The inner chamber is thermally isolated from the vacuum chamber. Wind speeds in the range 1-20 m/s have been demonstrated.

3. Instrumentation and Dust

The most important aspect of simulation is quantification and reproduction, this requires a system of sensors to measure the various physical parameters in the simulator. Some of these parameters such as temperature and pressure are readily available, others such as composition (Rest Gas Analyser) and wind speed (Laser Doppler Anemometer or Pitot tube) are typical wind tunnel instrumentation. However for this simulator there are environmental parameters for which it has been necessary to develop specialised instrumentation, most importantly an instrument has been developed which can measure dust deposition rate, dust electrification as well as suspended dust concentration (LAMDA4) [5].

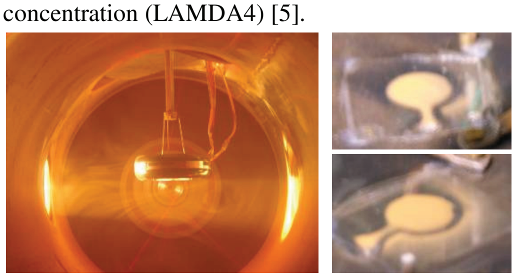

Figure 4 Laser based wind/dust sensor (left) with electrodes capturing suspended electrified dust.

The use of pulsed (high pressure) gas-dust injection has been the only reproducible and quantifiable way to produce suspended dust within the wind tunnel [2]. An automated system allows either quantified dust exposures or a constant suspended dust concentration.

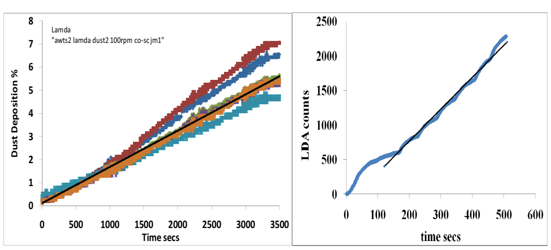

Figure 5 left; continuous (1m/s) dust deposition, right; semi-continuous dust injection (10m/s).

This system allows reasonably uniform dust suspension and deposition rates over a broad wind speed range.

4. Lighting System

There are many advantages to the unique internal LED based lighting system developed here. It can generate single narrow band wavelengths for optical studies, or be adjusted to simulate various lighting conditions such as a (crude) solar simulator. It consists of a large array of seven different wavelength high power light emitting diodes; deep-red, red, amber, green , blue and near-UV.

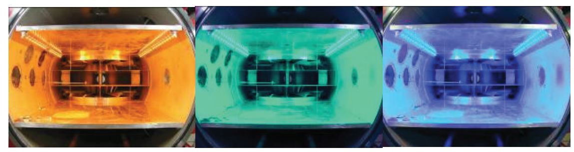

Figure 6 Overhead Red, Green and Blue LEDs in Test section.

Conclusion

This new European Mars simulation facility has many unique features which make it the most advanced simulator of its kind allowing new science and technology development/testing to be performed. It is supported by ESA and the EU.

References

[1] J.P. Merrison et al., Icarus **191**, 568 (2007),

[2] J.P. Merrison et al., *Planet. Space. Sci.* **56**, 426 (2008)

[3] J.P. Merrison et al., *JGR,* **107**, 5133 (2002)

[4] P. Nornberg et al., *Planet. Space. Sci.* **57**, 628 (2009)

[5] J.P. Merrison et al., *Planet. Space. Sci.* **54**, 1065 (2006)