A FORTHCOMING EUROPEAN MARS SIMULATION WIND TUNNEL FACILITY. J.P. Merrison[1] , C. Holstein-Rathlou[1], H.P.Gunnlaugsson[1], P. Nornberg[1]. [1]Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, bld. 1520, DK-8000 Aarhus C, Denmark, merrison@phys.au.dk,

Introduction: A new and unique European Mars Simulator Facility is in the final stages of construction at Aarhus University in Denmark. Its aim is to reproduce conditions at the Martian surface, specifically atmospheric composition, pressure, temperature, wind-flow and importantly dust aerosol suspension using Mars analogue materials. It is due for completion mid 2009.

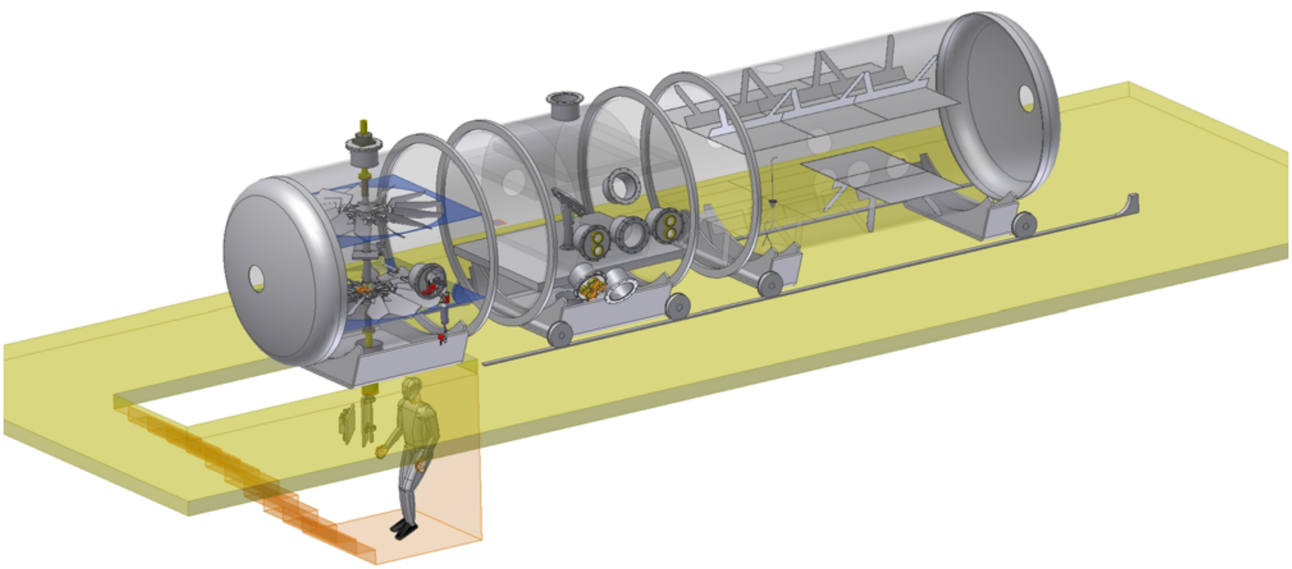

Figure 1. Sketch of the Aarhus Mars Simulation Wind Tunnel showing the, left to right, fan section, test/sample section and wind tunnel section (AWTS2).

Laboratory simulation can contribute to the science of understanding the planets surface by complementing direct observation, by testing/calibrating instrumentation and by providing a test bed for computer modeling. It can also lead to the development of new investigative technologies. In the case of Mars, understanding the structure and evolution of the near surface environment and its interaction with the atmosphere is of fundamental importance to climatology and to the search for extra terrestrial habitats [1,2].
Specifically the facility will be used for the multidisciplinary scientific study of aerosol formation and transport (on Mars and Earth), granular electrification, magnetic properties, erosion, cohesion/adhesion, water transport, UV induced mineralogy, bacterial survival and many others. In addition to this scientific role the facility can aid in dealing with the hazardous environment on Mars with regard to instrumentation and manned exploration. As well as hazards such as the low pressure and temperature, fine grained dust is actively transported though the Martian atmosphere and constitutes a major hazard. This facility will be accessible to national and international collaborators and space agencies for instrument testing, calibration and qualification.

Wind Tunnel Design.
The wind tunnel facility consists of a re-circulating (fan driven) wind tunnel housed within an environmental chamber. The design is based on a prototype Aarhus Wind Tunnel Simulator (AWTS) which has been in operation since 2000 [3]. It has been used for science and in connection with recent Mars lander missions, most recently the Aarhus Mars Simulation Laboratory has been responsible for the development, construction and testing/calibration (within the AWTS) of a wind sensor (called a Telltale) flown to Mars on the Phoenix mission 2008, this was in collaboration with NASA and CSA [6].
The forthcoming facility includes a low pressure (0.02-1000 mbar) chamber 50 m^3 in volume capable of cryogenic cooling (down to -120ºC), which houses a wind tunnel capable of wind speeds up to 30 m/s. The wind tunnel cross section is around 2×1 m.

Mars Simulation
The atmosphere of Mars is significantly lower density than Earths, with measured surface pressure in the range 6-9 mbar. The temperature on Mars is typically

low (140 K-300 K) with an average of 210 K (around -60°C). The composition of the atmosphere is 95% CO_2, with trace amounts of N_2 (2.7%), Ar (1.6%), CO (0.07%) and O_2 (0.13%). As a result of the thin atmosphere short wavelength solar UV light penetrates to the surface on Mars, an important feature with regard to organic materials.

There are several analogues to the Martian surface (dust/sand) material, though with only limited similarity to that seen on Mars. For wind tunnel testing a naturally occurring iron-oxide rich material called Salten Skov-I is typically used because it has a particulate size distribution close to that observed on Mars [3].

The Martian environment provides stringent physical challenges to instrumentation (whether for solar power generation, measurement or otherwise). Similarly reproducing these conditions in a laboratory presents technological challenges. Specifically these are with regard to the large (cryogenic) temperature range, the low pressure, low humidity and importantly the heavily dust laden wind. In the present wind tunnel design (rapidly) moving mechanics are required that are compatible with extremely low temperatures while maintaining low pressure conditions at very low contamination (leak) rates.

Since measurement and control are crucial to accurate and reproducible simulation, sensors capable of operating effectively and reliably under these conditions are also necessary.

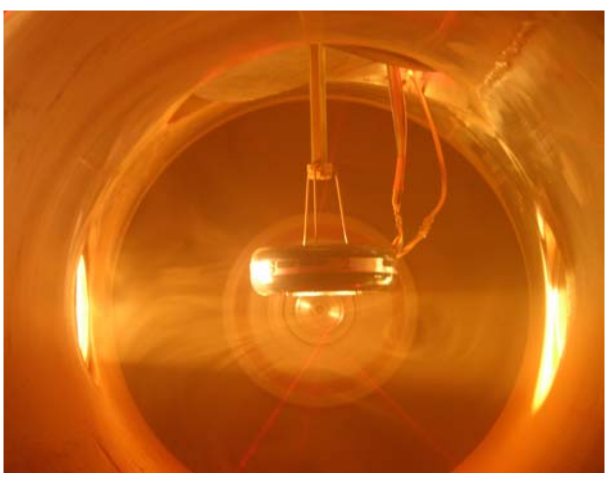

Figure 2. Picture of instrument testing in the current Mars wind tunnel simulator.

Although for temperature and pressure such sensing/control technology is (commercially) available, wind sensing and the quantification and characterisation of suspended and deposited dust is more problematic. It has been necessary to develop research level (prototype) instrumentation and specific sensor technology compatible with the Martian environment.

Dust Sensing Instrumentation

For testing the response of instruments to dust (or sand) exposure it is desirable that an experimental simulator be capable of repeatable and controlled reproduction of the Mars dust aerosol and wind flow. This requires quantifying the suspension, deposition and removal of granular material. This can be achieved using a combination of sensor techniques.

Specially designed and constructed instrumentation has been developed at AWTS for quantifying dust deposition under Martian environmental conditions. This instrumentation (called LAMDA; Laser Anemometer and Martian Dust Accumulator) has been developed through several prototype stages for the express purpose of quantifying dust deposition and also measuring dust properties under Martian conditions. Specifically suspended particulate concentration, flow rate (wind speed) and electrification or magnetic properties have been quantified [5].

At present the most likely transport mechanism for Martian dust involves the formation of (electrostatically bound) sand sized aggregates which have a low effective mass density and therefore have a significantly reduced threshold wind speed for entrainment. Aggregate breakup then results in re-suspension of electrified dust grains [3,4]. For calibration a commercial Laser Doppler Anemometer (LDA) is routinely used for monitoring wind velocity and dust concentration.

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