FEASIBILITY STUDY ON THE DEVELOPMENT OF MOON / MARS PLANETARY SURFACE SIMULATOR SUBSYSTEMS.

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Executive Summary Report

Version1

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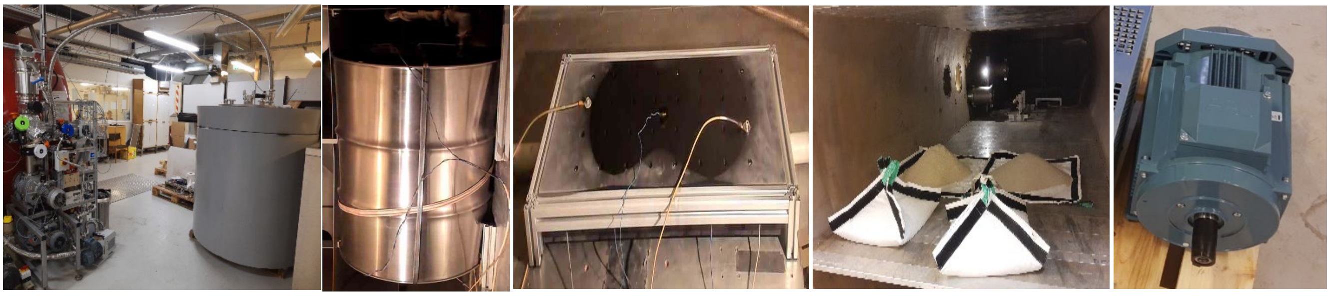
1. Scope of the document

This report outlines the results of the ESA funded feasibility study aimed to develop crucial enabling technologies for constructing potential large scale Moon and Mars Planetary surface simulators.

2. Executive Summary

This study involved the Design, Construction and Testing of five enabling technologies, two are related to the simulator chamber design (Task 1) and 3 involve modular sub-systems (Task 2). To summarize, despite several technical challenges functional solutions have been found for each of the five target technologies. Together these constitute vital components for future construction of a (low cost) large scale Mars/Moon test facility.



The five main components of the study are summarized below and are illustrated above (left to right);

Concrete Vacuum Chamber (Task 1 WP2.1-4.1):
Goal; Conventional vacuum chamber construction involves welding stainless steel plates, this is expensive and increasingly difficult for large scale chambers. The primary goal here was to demonstrate a low cost, easily manufactured and large (up-scalable) concrete vacuum chamber allowing it to function as a Mars simulation chamber.
Outcome; This involved modifying the concrete with epoxy coating which was successfully evacuated (to 0.14mbar) and showed low ultimate outgassing rate. This is a simple and viable solution for large scale low pressure construction.

High Vacuum Chamber: (Task 1 WP2.2-4.2)
Goal; To develop a low cost, easily manufactured sub-system for allowing Lunar (high vacuum) simulation within a Mars-like (low pressure) environmental chamber. Thereby allowing both Lunar and Mars-like simulations.
Outcome; This involved procuring a thin walled (low cost) chamber which was successfully tested within a Mars simulator (chamber) and demonstrated more than 5 orders magnitude reduction in pressure to (below 10^{-6}mbar).

Cryogenic Cooling Unit (Task 2 WP2.4-4.4):
Goal; To develop a low cost, easily manufactured sub-system which would allow temperature control under Mars/Lunar conditions and be scaled up for large scale applications.

Outcome; This involved designing and constructing a cryogenic cooling/heater module which was tested under both Lunar and Mars-like conditions. Efficient and effective cooling/heating was demonstrated (-120C to +110C) with high cooling/heating rates (> 2C/minute) and good stability and uniformity.

Regolith Module (Task 2 WP2.5-4.5)
Goal; To design, construct and test a modular system for rapidly and efficiently replacing a Mars, Lunar (or other) regolith from storage and creating a realistic planetary surface within a large area simulator.
Outcome; A simple, easily manufactured and effective system has been constructed based upon foldable textile sheets with Velcro seals. The system has been successfully demonstrated with a set of 4 modules inside the a simulator chamber. This system could be scaled up (e.g. up to 2x2 m^2) giving rapid un-packing and packing rate (of order $1m^2$/min) and increased regolith depth (up to 10cm).

Fan Motor Module (Task 2 WP2.3-4.3)
Goal; To design, construct and test a low voltage high power motor which would be suitable for operating inside a low pressure (Martian) environment. This would allow wind generation using easily installed modular fan systems, a solution capable of upscaling and using arbitrary geometries.
Outcome; A solution has been found in which a commercial high power AC motor can be driven at low voltage and therefore be compatible with function within a low pressure (Mars like) environment. Testing demonstrated that this system functioned. Further testing should be performed under Mars-like conditions especially to determine if over-heating occurs.