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The Planetary Simulation Chamber at DLR, Bremen

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Abstract

The planetary simulation chamber at the DLR Institute of Space Systems, Bremen, is a unique tool for testing of especially instruments for scientific exploration of planetary surfaces under realistic conditions. In addition to standard thermal vacuum chambers used to simulate free space conditions, the DLR chamber can be filled with planetary soil simulants and also be flooded with pressurized gas to e.g. simulate Martian or Titan atmosphere conditions.

Since the chamber can simulate both, free space and landed environments, it is not only suitable for functional testing up to the non-operational limits, but also for performance testing in simulated operational environments. Thus e.g. after verifying the survival of the instruments department (e.g. in a STM) aboard a Martian lander during cruise, the instrument's performance can be assessed and validated, while exposed to changing environmental conditions (thermal, pressure, atmosphere), representing the Martian day night cycle.

Rather large subsystem unit assemblies can be tested ensuring qualification to a high technology readiness level (TRL 6) at a high level of integration (IRL 7). The interior volume usable for tests is 1.8 m height and 1.4 m in diameter and is accessible from the top via a lid. Thus, an integrated subsystem, i.e. the locomotion subsystem unit of the ExoMars rover, or for example the actuator arm of the Mars Science Laboratory Rover, including all instruments, could be tested here. The minimum pressure in the vacuum chamber that can be achieved is < 10-5 mbar. Throughout an experiment the pressure is automatically held stable at a set value by the pressure control system. The chamber walls can be easily cooled down to average Martian temperature (210K), but even to a minimum of 77K. Heating is realized by 8 horizontally mounted 1000 Watt lights.

Overall this paper will elaborate on chamber design details and experimentally validated performance measures e.g. thermal gradients and control and monitoring accuracy. Further multiple application scenarios will be presented and modernisation issues discussed, hoping for interactive development of modernization requirements considering the scientific perspective prominent at the EPSC.