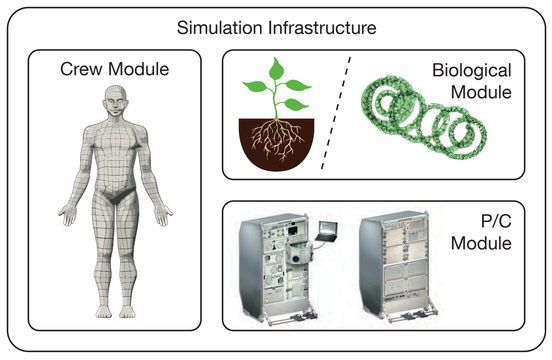
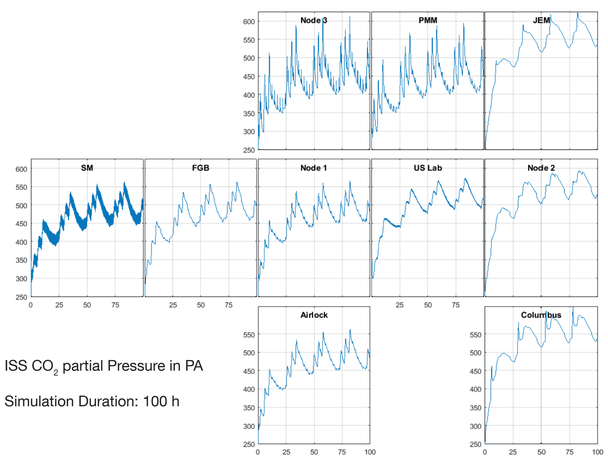
Virtual Habitat

The Virtual Habitat (V-HAB) life support system (LSS) simulation tool has been under development at TUM since 2006. The MATLAB®-based software enables dynamic simulations of spacecraft and spacesuit life support systems including their interactions with the environment and the humans inside. Built upon an object-oriented framework, V-HAB provides the capability for holistic, multi-domain simulations for many applications in closed environments. Using a set of intelligent, variable time step solvers, a wide variety of physical, chemical and biological effects can be simulated. V-HAB also includes a dynamic human physiology model to provide realistic inputs to the LSS.

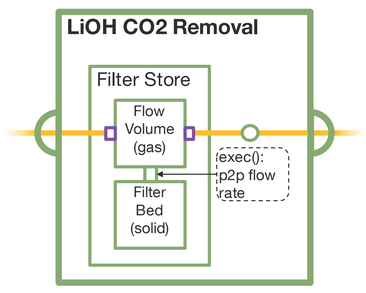


A V-HAB model of the International Space Stations LSS has been validated using flight data provided by NASA and ESA.



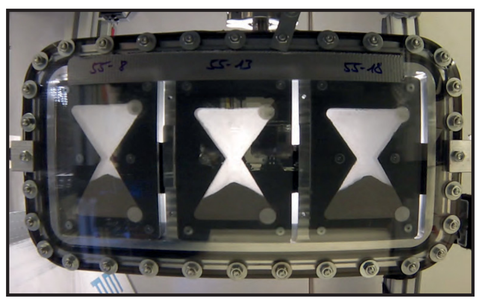
ISS CO_2 partial Pressure in PA

Simulation Duration: 100 h

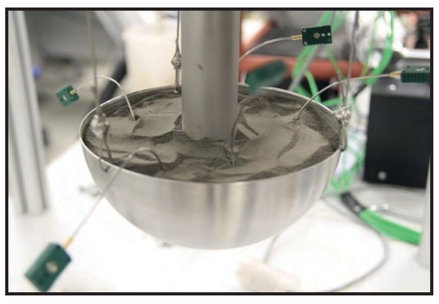


Lunar regolith handling and thermal gas extraction

Since 2009, TUM has been leading the DLR-funded research project LUISE (Lunar In-Situ Resource Experiments), which covers supporting studies for future access to lunar resources and possible utilization of such. LUISE and related projects include the study of thermal properties of the lunar regolith and the development of thermal extraction processes to release volatiles from lunar regolith (e.g. OH, H, H_20, SWIP). Furthermore the handling and transport of lunar samples is being investigated to evaluate possible volatile loss along the sampling chain and to improve sample delivery to scientific instruments.

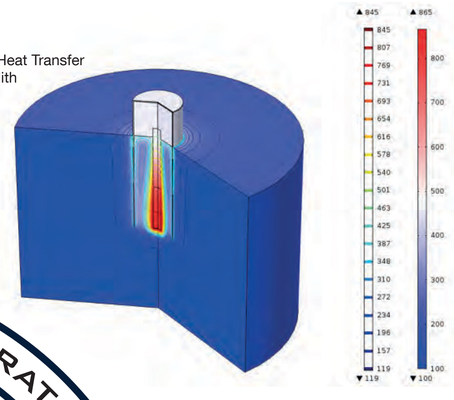


Sample transport experimentats on partial-g parabolic flight

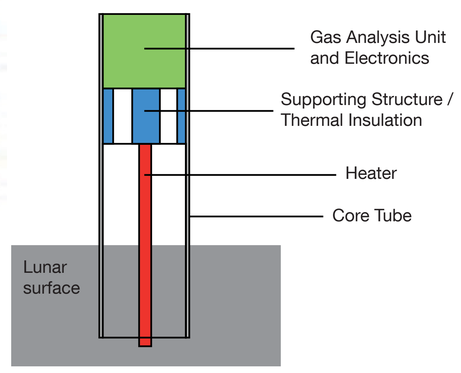


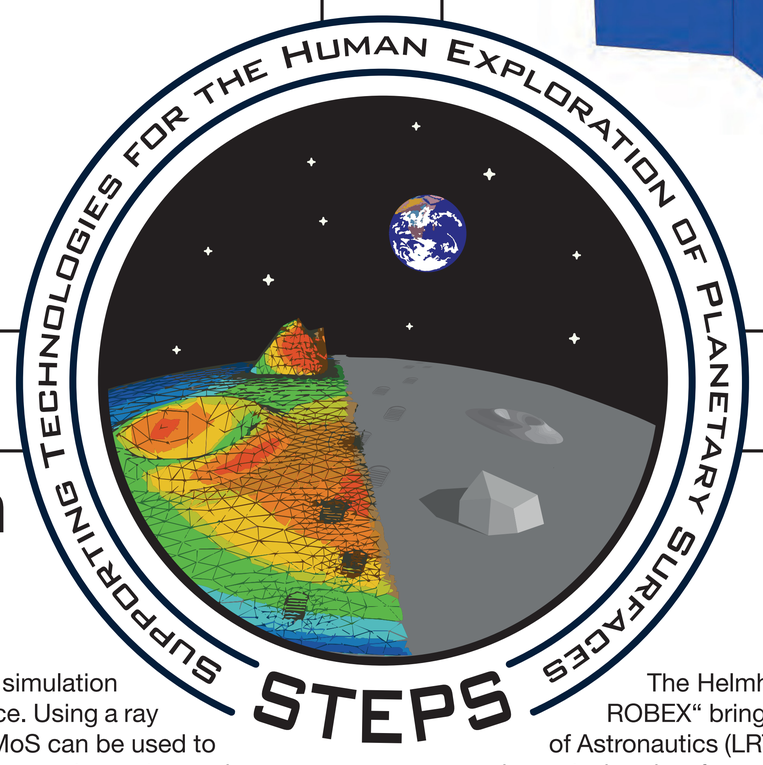
Lunar regolith heating and gas extraction experiments

Simulation of Heat Transfer in Lunar Regolith



Stamp heater concept for in-situ thermal extraction of volatiles





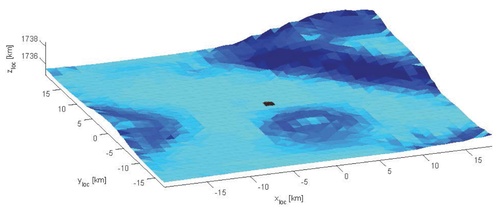
Thermal Moon Simulator

The Thermal Moon Simulator (TherMoS) is a dynamic thermal simulation tool, specifically focused on moving objects on the lunar surface. Using a ray tracing algorithm based on the Nvidia OptiX framework, TherMoS can be used to calculate the dynamic radiative heat transfer between rovers or astronauts moving through the lunar terrain made up of boulders and craters which create a varied thermal environment.

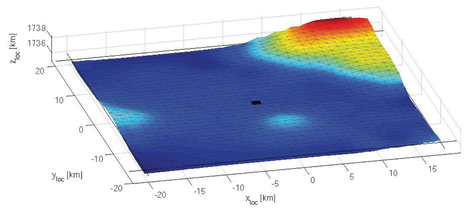
In order to accurately calculate the temperatures of the lunar surface, TherMoS includes a sophisticated thermal model of different kinds of lunar regolith coupled with an orbit propagator, so for any point in time the surface temperatures can be determined. This model has been validated against data from the DEVINER instrument on the Lunar Reconnaissance Orbiter.

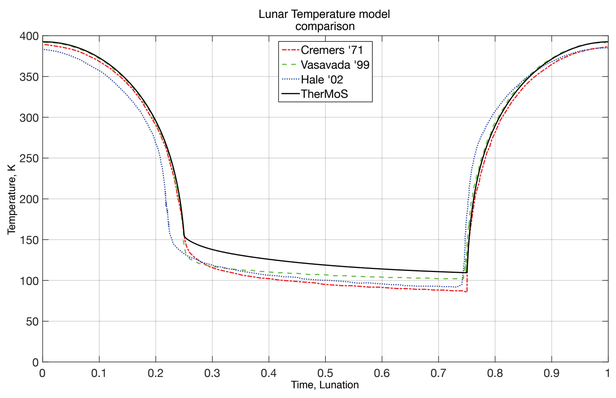
TherMoS is being used for path planning and optimization on the lunar surface as well as in combination with a V-HAB-based spacesuit simulation called V-SUIT.

Hadley Rille Surface Temperatures

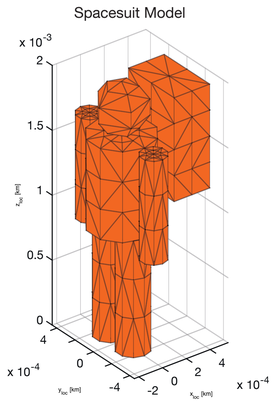


Hadley Rille Elevation Map





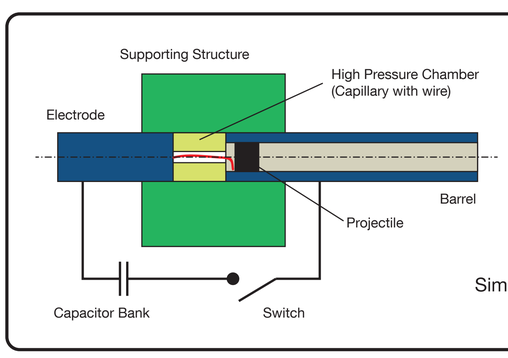
Spacesuit Model



ROBEX & Accelerators

The Helmholtz Alliance „Robotic Exploration of Extreme Environments – ROBEX“ brings together space and deep-sea research. At the TUM Institute of Astronautics (LRT), several different optical and metallic materials are tested for impact abrasion from lunar regolith. To achieve this, particles of the lunar regolith simulant JSC-1A are accelerated to speeds of up to 360 m/s using an electromagnetic eddy current accelerator developed at LRT. Investigations included changes in sample mass, surface roughness and transmissivity, as well as the effect of different impact angles.

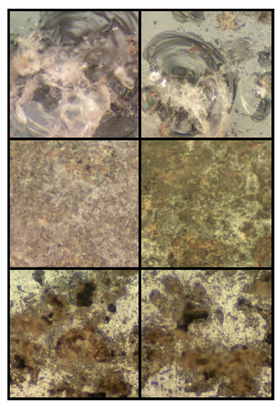
Results show that even relatively low impact velocities below 150 m/s cause significant deterioration. The results also indicate that the irreversible adhesion or lodging of dust particles is a major contributor to surface degradation, especially for ductile materials.



Electrothermal Accelerator
Mass Range: mg - g
Velocity: < 5.5 km/s
Particle Impacts

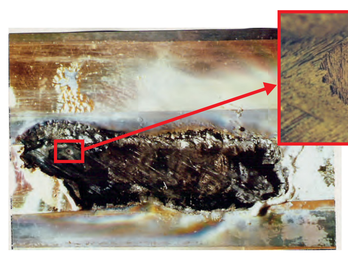
Coaxial Plasma Accelerator
with Compressor Coil

Mass Range: µg
Velocity: 5 - 12 km/s
Simulation of Micrometeoroids and Space Debris



Microscopic imagery of three targeted materials (from top to bottom): glass, Makrolon®, Aluminum

Impact of a 2 mm steel sphere @ 280 m/s on a TiAl alloy turbine blade



Impact induced arcing of a solar cell bus bar

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