THE DLR GROUND BASED FACILITIES FOR THE SIMULATION OF SPACE AND PLANETARY ENVIRONMENTS Petra Rettberg[1], Elke Rabbow[1], Jens Hauslage[2], Ruth Hemmersbach[2]
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Introduction: The general astrobiological question deals with the understanding of life and the processes that lead to its origin, evolution and distribution on Earth and beyond, as part of cosmic evolution. Our fully equipped and monitored Planetary and Space Simulation facilities allow a broad range of tests with biological and chemical material individually or integrated into space hardware [1, 2]. In the focus of interest are defined and controlled conditions like ultra high vacuum, different gas atmospheres and pressures, low and high temperatures, temperature oscillations, extraterrestrial UV radiation and X-rays, well defined gravitational accelerations, ranging from simulated microgravity to hypergravity as well as life support system [3]. The Planetary and Space simulation facilities allow the reproducible and standardized investigation of a much wider variety of samples than in space experiments. These simulation facilites offer the possibility to discriminate between the effects of individual space parameters and selected combinations. Results of ground based experiments increase our knowledge for the search for life within the universe and complement the parameters enabeling longterm manned missions to e.g. Mars.

The facilitities: The analysis of our exposure tests support the design, optimisation and verification of spacecraft devices and enable the selection of the most promising biological candidates and chemical compounds for flight experiments in low Earth orbit or other space destinations [1,2].

Several vacuum chambers of different sizes are connected to different high-performance pumping systems to generate a lowest possible vacuum for the simulation of representative space conditions or to simulate variable gaseous atmospheres, e.g. Mars: 7 hPa CO_2, for the planetary simulation. An array of powerful lamps can reproduce the extraterrestrial sunlight at high intensities and a sophisticated filter system allows the selection of desired wavelength bands or attenuates the intensity of the radiation. Furthermore temperature controlled accommodation plates approximate the cryogenic temperatures of space continuously or oscillate for the realization of temperature variations during missions. The facility parameters are recorded and available in real time for the operators to monitor the test. The facilities also offer the possibility to investigate the chances for development of life on Mars under simulated surface and climate conditions.

Gravity as a constant and permanent environmental factor cannot be eliminated. However, rotation of a sample (particles, cells, small animals and plants) perpendicular to gravity results in a compensation of sedimentation assuming that a system does no longer perceive gravity and the condition of simulated microgravity is achieved. Our clinostat devices are equipped with various operational possibilities with respect to the experimental demands (observation, fixation, controlled atmosphere, etc.). This simulation approach works for different systems, as revealed by verification in real microgravity but also has some limitations [3]. Increased gravitational stimulation > 1g (hypergravity) can be achieved by centrifugation. DLR provides various centrifuge devices for investigation of materials, cells up to humans. Research activities focus on the development of countermeasures against gravity-induced physiological changes as well as adaptation phenomena. The DLR projects C.R.O.P. (Combined Organic Food production) and the compact satellite platform Eu:CROPIS - Euglena : Combined Regenerative Organic-food Production in Space will enhance our knowledge of the long-term usage of combined life-support systems as oxygen source, carbon dioxide sink and food source under reduced gravity conditions (Mars and Moon accelerations) which is a prerequsite for manned exploration missions.

Technical details:
http://www.dlr.de/me/en/desktopdefault.aspx/tabid-7207/
http://www.dlr.de/me/en/desktopdefault.aspx/tabid-1961/

References:

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[3] Herranz R, Anken R, Boonstra J, Braun M, Christianen PCM, de Geest M, Hauslage J, Hilbig R, Hill RJA, Lebert M, Medina FJ, Vagt N, Ullrich O, van Loon JJWA, and Hemmersbach, R. (2013) Astrobiology, 13, 1–17.