The space exposure platforms BIOPAN and EXPOSE to study living organisms in space

Wolfgang Schulte (1), Pietro Baglioni (2), René Demets (2), Ralf von Heise-Rotenburg (1), Petra Rettberg (3)

(1) Kayser-Threde GmbH, Wolfratshauser Str. 48, 81379 Munich, Germany, wolfgang.schulte@kayser-threde.com, Phone: +49-89-72495-225, Fax: +49-89-72495-215; ralf.von.heise-rotenburg@kayser-threde.com, Phone: +49-89-72495-341, Fax: +49-89-72495-215

(2) European Space Agency ESA/ESTEC, Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands, pietro.baglioni@esa.int, Phone + 31-71-565-3856, Fax +31-71-565-3141; rene.demets@esa.int, Phone +31-71-565-5081, Fax +31-71-565-3141

(3) German Aerospace Center (DLR e.V.), Institute of Aerospace Medicine, Linder Höhe, 51147 Köln, Germany, petra.rettberg@dlr.de, Phone +49-2203-601-4637, Fax +49-2203-61970

BIOPAN and EXPOSE are two European space exposure platforms, developed for the European Space Agency by Kayser-Threde GmbH, Munich/Germany to offer flight opportunities to the science community of exo/astrobiology research in low earth orbit. Both platforms are conceived for the research on the behaviour of living organisms in the environment of space and on simulated conditions of other planets (Mars). The conditions for a possible transfer of life between planets can be studied. Both facilities can also be used for materials and components validation and as test bed for advanced technologies envisaged for future exploration missions (radio-protection, miniaturized devices, electronic components).

Since 1992 BIOPAN has flown five times aboard the Russian FOTON re-entry capsule. 25 experiments in exo/astrobiology, radiation biology and radiation dosimetry have been conducted so far. The pan-shaped experiment container BIOPAN can be installed onto the outer surface of its carrier satellite. The orbital flight duration is typically two weeks. The re-entry capsule with its experiments is recovered after landing and the experiment samples are returned to the ground laboratories of the scientific investigators for post-flight analysis. Experiments flown so far with BIOPAN include bacterial spores mixed with Martian soil analogues to test the alleged toxicity of the Martian soil while irradiated in space by solar UV at dose and wavelength levels comparable to those on Mars (experiment MARSTOX), permafrost soil samples with their embedded natural ancient bacterial spores (experiment PERMAFROST), lichens, a symbiosis of fungi and algae (experiment LICHENS), and yeast (experiment YEAST) where the biological effects of low-energy protons on yeast cells are investigated. Another 10 experiments have been selected and are now being prepared to fly with the

next BIOPAN mission in 2007. Some of the experiments are related to in situ life detection experiments on Mars, e.g. to test components of the so-called Life Marker Chip, an analytical instrument under development for ESA's ExoMars mission.

EXPOSE, a second-generation exposure platform, has been developed for flights on the International Space Station with a duration of one to three years. The first flight model was completed and delivered to ESA in 2004, and it was integrated on the European EUTEF pallet to be launched with Columbus. Another flight model is presently being built to fly aboard the Russian segment of the ISS, with a target launch date in mid 2007. The EXPOSE facility hosts twelve sample carriers accommodated in three independent trays. Hundreds of biological samples are placed in different types of sample compartments within the sample carriers and are exposed to the harsh space environment behind a variety of windows and filters. EXPOSE supports in situ studies of microbes in artificial meteorites, as well as of microbial communities from special ecological niches, such as endolithic and endoevaporitic ecosystems. The experiments selected for the first flight fall into three groups: ROSE, AMINO and ORGANICS. They focus on the study of photobiological processes in simulated radiation climates of planets – e.g. early Earth, early and present Mars, on the role of the ozone layer in protecting the biosphere from harmful UV-B and UV-C radiation –, on the study of behaviour and survivability of aminoacids, peptides and other organic compounds to interplanetary and interstellar conditions.

This paper illustrates the space exposure facilities BIOPAN and EXPOSE and describes the possibilities to accommodate experiment samples. An overview on planned and recently conducted experiments is given.