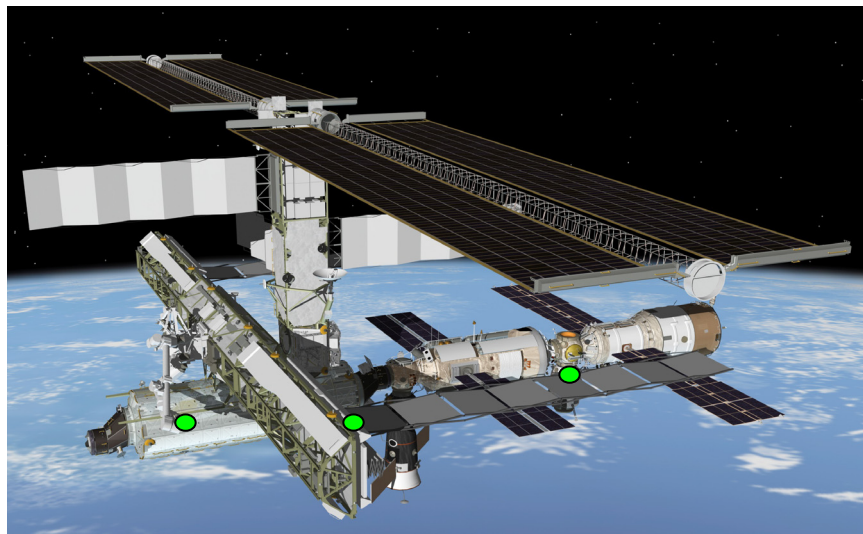


Background

The main goal of manned exploration is to achieve a prolonged stay in space e.g. in an orbital station (such as the International Space Station (ISS)) or in planetary bases on the Moon and/or Mars. It goes without saying that such missions can only be realized when the astronaut's health and well-being is secured. In this respect, the characterization of the microbiological contamination on board spacecraft and orbital stations and the influence of cosmic radiation and microgravity are of paramount importance. Microbial contamination may originate from different sources and includes the initial contamination of space flight materials during manufacturing and assembly, the delivery of supplies to the orbital station, the supplies themselves, secondary contamination during the lifetime of the orbital station, the crew and any other biological material on board e.g. animals, plants, micro-organisms used in scientific experiments. Although most microorganisms do not threaten human health, it has been reported that in a confined environment, such as a space cabin, microorganisms may produce adverse effects on the optimal performance of the space crew and the integrity of the spacecraft or habitat. These effects range from infections, allergies, and toxicities to degradation of air and water supplies. Biodegradation of critical materials may result in system failure and this may jeopardize the crew.

Objectives

The research aims at monitoring the biological airborne and surface contamination during manned space flight. The ISS has been selected as primary test bed for this study. The majority of the investigations are being done by the Russian Institute of Biomedical Problems (IBMP), which is responsible for monitoring the biological contamination in the habitable compartments of the ISS for safety and hygienic reasons. Within the frame of a collaboration between IBMP and the European Space Agency (ESA), SCK•CEN is able to participate in the analyses.



*Artist's impression of the current status of the International Space Station (ISS).
The green dots indicate where the SCK•CEN samples have been taken.*

Principal results

From 1998 till today, IBMP has processed samples from nine main missions and seven Soyuz taxi flights to the ISS. A total of 419 samples from the air and surfaces inside the ISS were screened for the presence of bacteria. Bacteria were recovered in 71% of the cases (*i.e.* 297 samples). In addition, the fungal contamination was investigated by analyzing 378 samples from air and surfaces. Fungi were obtained from 92 samples, which is 24% of all the samples. The large species diversity that was obtained from the environmental samples was more pronounced in the surface samples than in the air samples. A total of 36 and 15 bacterial species were isolated from surface and air samples, respectively. A total of 32 and 5 fungal species were isolated from surface and air samples, respectively. Air samples have also been analyzed at the SCK•CEN. A total of 33 samples were taken at different locations in the ISS during three different Soyuz taxiflights (October 2003, April 2004 and October 2004). Forty eight percent of the samples scored positive for the presence of bacteria.

The highest bacterial concentration amounted to 1.1×10^2 CFU/m³. A total of 66 isolates has been obtained and the bacteria were identified using molecular biology tools. The majority of the population consists of different *Staphylococcus* sp. (at least 60%) and *Enterococcus faecalis* (18%). Generally, the contamination levels reported by SCK•CEN are comparable with the observations made by IBMP and research groups of NASA.



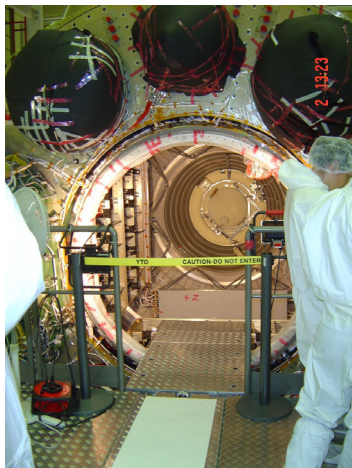
The Russian Surface pipette kit for sampling internal surfaces and structural materials



The Ecosphere kit includes a spaceflight-certified SAS air sampler and sets of Petri dishes containing nutrient-rich media

Future work

Together with ESA, SCK•CEN is extending its activities in bio contamination monitoring. Our current strategy is to monitor microbial presence at the different stages of the lifetime of the habitable space module *i.e.* from development/assembly over the testing campaign to module integration and on-orbit/ground based exploitation of the module. In this respect, SCK•CEN is involved in the characterization of the biological contamination of the Automatic Transfer Vehicle and Columbus that are being constructed and tested in ESA cleanrooms in the Netherlands and Germany. These modules will be coupled to the ISS. Furthermore, monitoring of the ISS bio contamination will be continued. It is envisioned that a systematic bio contamination monitoring will allow a better assessment of bio safety issues during a prolonged manned space expedition.



View inside the ATV module currently assembled at ESA (The Netherlands);



Air samples taken inside the ATV to characterize microbial airborne contamination

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Main reference

N.Novikova, P.De Boever, S.Poddubko, E.Deshevaya, N.Polikarpov, N.Rakova, I. Coninx, M. Mergeay, *Survey of the environmental bio contamination on board the International Space Station.* (2006). Accepted for publication in Research in Microbiology.