

Lessons from Mars 500

Source: [DLR](#) press release



Moon to Mars

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Summary: After 520 days in isolation, the hatch was opened on the Mars500 container as the crew completed their mock mission to Mars. The experiment has provided a wealth of information that will help in planning and preparing a human mission to Mars.

days without sunlight, fresh air or direct contact with the outside world - the six test subjects on the [Mars500](#) mission have had to forego plenty of things while 'travelling' to Mars and back to Earth in their virtual spacecraft. After a year and a half of isolation, the sealed hatch of the Mars500 container was finally opened at 11:00 CET on 4 November 2011. The 'cosmonauts' at the Moscow Institute of Biomedical Problems (IBMP) had been simulating a flight through space since 3 June 2010 and carrying out numerous [experiments](#) along the way.

"The crew is doing well," says Peter Gräf of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), Project Manager for the German part of the mission. He is pleased with the research results thus far: "The scientists working on the 11 German experiments have already started their initial assessments and are very satisfied with the quality of the data."



Harmony among the crew



Mars500 experiment facility in Moscow. Credits: ESA/S. Corvaja

exiting the spacecraft, there were still things that they longed for during their isolation in the virtual spacecraft: "Of course, I will be delighted to see my family and friends again," he explained, "But I have also missed seeing unfamiliar faces and getting to appreciate other viewpoints."

Another critical issue for a real flight to Mars is the growth of [microorganisms](#) inside the spacecraft; DLR scientists have been researching this in the MICHA experiment. The test subjects took hundreds of air and surface swipe samples in the living and work areas, in the infirmary and in the sanitation facilities. No microorganisms dangerous to humans have been found among those

The

Mars500 European candidates. Credits: ESA/S. Corvaja, 2010

'spacecraft' in which Europeans Diego Urbina and Romain Charles, Russians Alexey Sitev, Sukhrob Kamolov and Alexandr Smoleevskiy and China's Wang Yue have spent the past 520 days is just 180 square metres in size. During a real flight to Mars, the team on board the [spacecraft](#) would be able to work together without major conflicts. The cosmonauts wore radio sensors on their bodies twice a week, enabling Bernd Johannes from the DLR Institute of Aerospace Medicine to monitor the group dynamic. The sensors provided information on how often, for how long and at what intervals individual crewmembers were in contact with one another. The conclusion so far: "There was no isolation in the isolation chamber." Each cosmonaut had at least a minimum amount of social contact; nobody was excluded from the group or withdrew from it.

"We found a pleasant and unexpected feeling of harmony among the crew. The structure of the relationship between crewmembers remained relatively stable throughout the mission." But, as Italian Diego Urbina explained over the loudspeaker in the control room in the days before

discovered so far. Increased formation of biofilms on structural elements inside the spacecraft (metals and polymers) and on components in the life support system (water tanks and air filters) has been found. This could present a risk for the crew of a long-term space mission, both in terms of potential infection and in terms of damage that might lead to the malfunction of important instruments.

Stress and isolation

These results are also important for another experiment, in which doctors are studying the effects of stress caused by isolation and unusual living conditions on the immune system.

"We have identified significant changes in the test subjects' immune systems, which are comparable with changes we have also seen in astronauts during actual [spaceflights](#)," says Alexander Choukèr of the Ludwig Maximilian University in Munich, summarising the initial results.

To be able to draw conclusions on the condition of the immune system over the course of the 520-day mission, the doctor is analysing blood, urine and saliva samples as well as respiratory gas samples. These results can subsequently be applied to patients who are exposed to stress in intensive care units, for example. The Mars500 cosmonauts are facing yet another study; brain scans will be carried out at the end of November to determine whether the stress of their virtual flight has had any effects on the structure of the brain. "We can compare these with the brain scans taken before the mission, to analyse whether connections between areas of the brain have changed as a result of isolation and stress."



Testing a Martian version of the Orlan spacesuit. Suit has been modified for use in Earth gravity. Credits: ESA/S. Corvaja, 2010



Fitness training for the Mars500 crew. Credit: DLR

predetermined, in the first year their diet was also the subject of an experiment by Erlangen University. Using almost 400 different products that can all be bought at any supermarket, Jens Titze's team put together a specific diet in which the volume of salt consumed was significantly reduced over the course of the year. After assessing the first of 6000 blood and urine samples, Titze is certain: "The salt balance in the human body is significantly more complex than previously thought."

The doctors have determined that the salt consumed by the human body can sometimes be excreted after some time. "This has not been considered in previous clinical studies." Another conclusion of his experiment is that: "It is not only worthwhile reducing the amount of salt added to food for those who are ill - even the blood pressure in healthy individuals such as the [Mars500](#) test subjects was reduced." Limiting salt intake can therefore be effective in preventing strokes, heart attacks and arteriosclerosis.

Eleven German experiments

Additional experiments focused on the study of bone metabolism, the learning of complex control mechanisms on a computer, improvement of physical fitness through vibration training, autonomous emergency medical care and the effects of exercise on stress and isolation. The German Federal Ministry for Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi) is supporting the 11 German Mars500 mission experiments via DLR.

Isolation, stress, unusual light levels and confinement also have a decisive impact on circadian rhythms; that is, the cosmonauts' internal clocks.

"The test subjects' biological clocks tick differently in the [Mars500](#) container," says Hanns-Christian Gunga of the Charité university hospital in Berlin.

The scientists recorded the subjects' body temperatures as they changed over the year and a half. The temperatures dropped by 0.4 degrees Celsius on average and temperature minima and maxima moved to different times of day.

"The temperature is the conductor and the rest of the body is the orchestra," explains Gunga. "During isolation, this orchestra has become slightly off beat." The results of this experiment will also be applicable to shift workers, among others.

Not only was the test subjects' daily routine strictly



Saliva samples from the Mars500 crew. Credit: DLR

