German Aerospace Center



# Eu:CROPIS – Growing tomatoes in space

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A symbiotic community of bacteria, tomatoes and single-celled algae, synthetic urine and a satellite that simulates the gravity of the Moon or Mars by rotating around its axis – these elements make up the German Aerospace Center (Deutsches Zentrum für Luft und- Raumfahrt; DLR) Eu:CROPIS (Euglena and Combined Regenerative Organic-Food Production in Space) mission. Two greenhouses are scheduled for launch into space in 2016. In them, a combined life-support system will utilise the waste product recycled urine to manufacture fertiliser and help grow tomatoes for a lunar and Mars habitat, also on long duration missions. This project will run for a year, after which the satellite will burn up in Earth's atmosphere.

The DLR scientists will use the cooperation between bacteria and the single-celled alga euglena gracilis to supply the plants with important nutrients. Synthetic urine will be added to the system at regular intervals and then passed through the lava plates in the trickle filter, integrated within the water circulation mechanism and home to countless microorganisms waiting hungrily for these nutrients. Initially, these bacteria break down ammonia into nitrite, and subsequently into nitrate to remove elements that are toxic for the plants and produce precisely the appropriate fertiliser to allow the tomato plants to bear fruit and produce new seeds. Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) contributes its euglena to counteract the precipitous rise in ammonia levels: euglena are insensitive to ammonia and assist to its rapid breakdown. "We exploit the properties of these organisms to convert substances into nutrients that are needed to sustain other organisms," explains the mission's Scientific Director Jens Hauslage from the DLR Institute of Aerospace Medicine.

**Growing in a lunar and Mars environment**

Seeking to simulate the differing levels of gravity on Mars and the Moon, engineers at the DLR Institute of Space Systems and the DLR Institute of Composite Structures and Adaptive Systems are developing and building a 250-kilogram lightweight satellite, designed to rotate around its longitudinal axis while orbiting at an altitude of roughly 600 kilometres. In doing so, it will replicate lunar gravity, that is 0.16 times Earth's, or 0.38 times – the gravity on Mars – depending on the rotational speed. The first of the two greenhouses will operate under lunar conditions over the first six months, while the second greenhouse will operate in a Martian environment for the following six. During the entire period, the two greenhouses will be fitted in a pressure container made of carbon-fibre composite materials, built to maintain a constant internal pressure of one bar.

Eu:CROPIS carries two other experiments: the DLR Institute of Aerospace Medicine will use the radiation detector RAMIS (Radiation Measurement in Space) to collect data on long-term exposure to cosmic radiation over the course of the space flight. The radiation field in space presents a limiting factor for the long-term deployment of astronauts and every other biological system – whether it is plants, animals, or microorganisms. This is why DLR radiation biologists will measure the radiation field on the outer shell and inside the satellite. The data will be used as a basis for further development of radiation field models, also to register the radiation dose to which the symbiotic community will be exposed during its flight on board Eu:CROPIS. The US space agency NASA will contribute an experiment to measure photosynthesis in algae.

**Greenhouses under observation**

Numerous cameras and sensors will observe what is occurring inside the greenhouses during the mission: are the tomatoes growing properly, and is their photosynthesis satisfactory? What is the pH value and oxygen concentration in the water circulating continuously to transport nutrients throughout the entire greenhouse? Other cameras will observe the single-celled algae, how they are swimming and hence responding to gravity. Regular sampling will permit fully automatic analysis at the genetic level.

"We intend to demonstrate that waste products can be used in reduced gravity environments found on Mars and the Moon, also in long duration missions, in this case to cultivate tomatoes. The experiments on board Eu:CROPIS will deliver important results to enable humankind to survive in hostile environments – whether it be in space or here on Earth," says Hauslage. For instance, the trickle filter C.R.O.P. is currently being successfully used in the Faculty of Agriculture at the University of Bonn (Agrohort) to produce valuable fertiliser from waste products.

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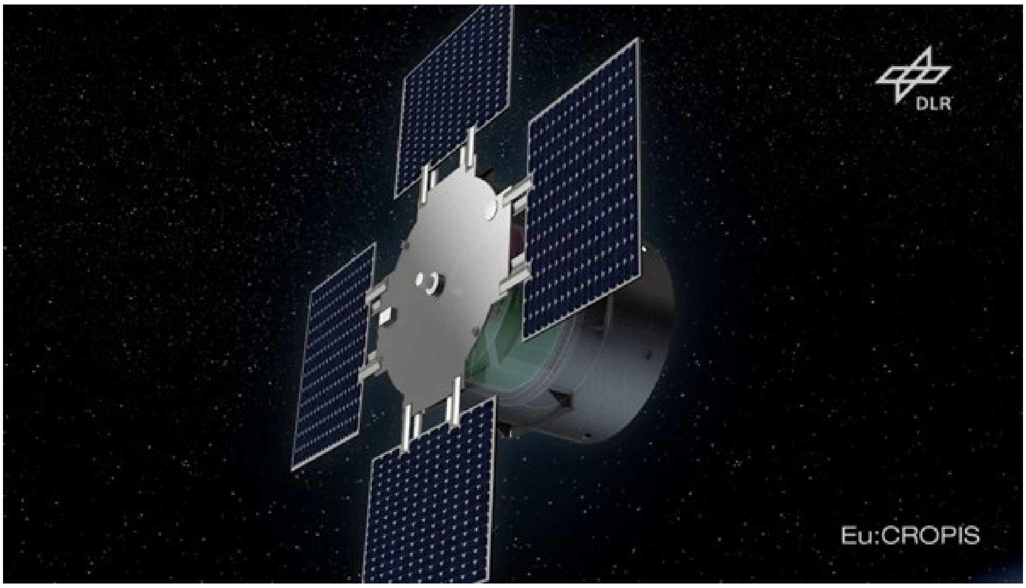
### Eu:CROPIS satellite



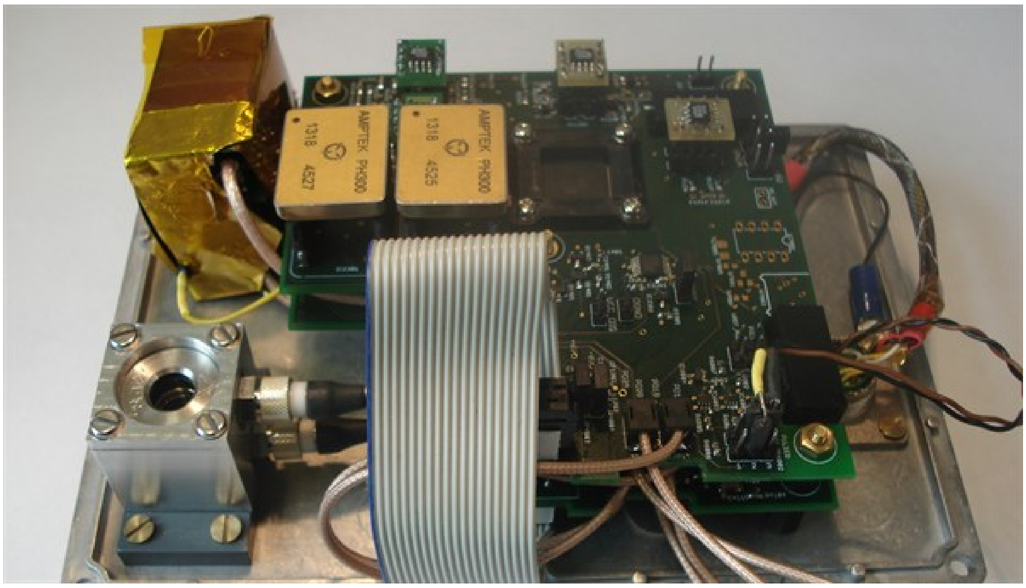

The German Aerospace Center (DLR) Eu:CROPIS satellite is scheduled for launch in 2016. On board will be two greenhouses in which bacteria and algae will convert synthetic urine into fertiliser to promote the growth of tomato plants. Variations in rotational speed around its longitudinal axis will simulate lunar and Martian gravity.

**Tomatoes for lunar and Mars habitats**

The German Aerospace Center (DLR) Eu:CROPIS Mission will enable scientists to conduct experiments to determine whether tomato plants will grow and bear fruit in a closed life support system under lunar and Martian conditions. The satellite with two greenhouses on board is scheduled for launch in 2016.

Credit: DLR (CC-BY 3.0).

**Radiation detector RAMIS**



Scientists from the German Aerospace Center (DLR) will use the radiation detector RAMIS to measure the radiation field during the Eu:CROPIS Mission.

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