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Automated ion analyzer for space missions

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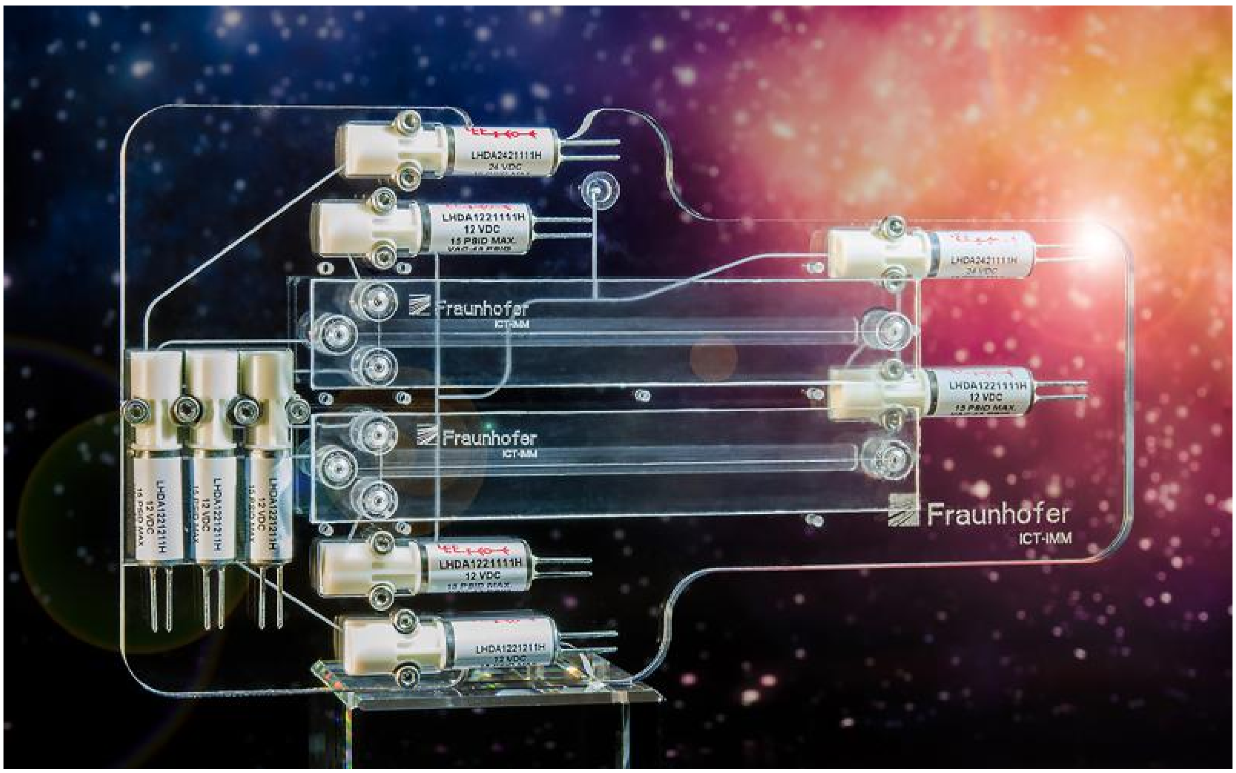

A microchip developed by Fraunhofer will monitor the growth of tomato plants during an experimental space mission due to be launched in 2017. Credit: Fraunhofer ICT-IMM

The German Aerospace Center (DLR) is scheduled to launch its Eu:CROPIS research satellite into orbit in early 2017. Its purpose is to test a biological life-support system for future human space missions. The satellite's payload includes an ion analyzer developed by Fraunhofer.

This compact device will automatically monitor all of the system's internal processes. The scientists will present the analyzer at ACHEMA 2015 from June 15 to 19 (Hall 9.2, Booth D64).

As on Earth, people living in spacecraft need a regular supply of fresh food to survive. For short trips into space, astronauts can simply carry the food they need with them. The situation becomes more complicated when the crew has to spend months or even years voyaging through space. In this case, they require technical solutions to sustain the supply of vital food resources for as long as possible. The three partners in the Eu:CROPIS project, led by the German Aerospace Center (DLR), are developing a life-support system capable of transforming biological waste products into oxygen and food. It will be tested during a one-year space mission in 2017. The other project partners are the Friedrich-Alexander University of Erlangen-Nürnberg (FAU) and the Mainz branch of the Fraunhofer Institute for Chemical Technology ICT-IMM.

Recycling urine as tomato fertilizer

Bacteria and algae in an automated closed-loop recycling system decompose a mixture of synthetic urine and water to produce fertilizer for tomato plants. Meanwhile, the satellite, designed, built and operated by the DLR, will rotate at different speeds to simulate the differing gravitational forces on Moon and Mars. The closed-loop recycling system requires constant monitoring to ensure that the tomato plants receive precisely the right dose of nutrients to grow and flourish during all stages of the space mission. This is the part of the project for which the ICT-IMM scientists are responsible. They use a technique known as capillary electrophoresis to determine the concentration of different substances in the fertilizer. These substances are identified on the basis of the characteristic pattern of movement exhibited by ions of different polarities and sizes by applying an an electric field. It is equally important to ensure that the dose of fertilizer received by the tomato plants is adapted to their various stages of growth. "The key to this project's success is implementing an autonomous system that will enable the tomato plants to survive without outside intervention," emphasizes ICT-IMM project manager Dr. Karin Potje-Kamloth.

For applications on Earth, capillary electrophoresis is a standard method of chemical analysis. But additional requirements apply to its use aboard an unmanned space mission such as Eu:CROPIS, where all processes have to be fully automated and the instruments must be adjusted to a minimum of space. "The prototype ion analyzer we are presenting at ACHEMA occupies a space of 20x20x10 centimeters, weighs no more than 2.4 kilograms and includes fully automated functions for sampling and capillary electrophoresis," says Potje-Kamloth. Its special feature is a microchip no bigger than a credit card on which the whole analytical process is conducted. It is rinsed at regular intervals, permitting its reuse throughout the entire space mission. Normally, on Earth, these microchips are discarded at the end of each sampling and analysis cycle.

Quite apart from its intended use in space, this technology has many potential applications on Earth. "A compact ion analyzer with automated sample extraction could be used, for example, to monitor the quality of drinking water or control industrial processes," says Potje-Kamloth.

The project partners plan to launch the satellite into orbit at an altitude of 600 kilometers in early 2017. The researchers have built a duplicate of their system that will enable them to reproduce every stage of the space mission back home on Earth. All processes carried out onboard the satellite can be controlled from the ground. After it has completed its one-year mission, the satellite will be guided into a controlled descent and burn up in Earth's atmosphere.

According to the mission's scientific director, Dr. Jens Hauslage from the DLR Institute of Aerospace Medicine, "The experiments onboard

Eu:CROPIS will deliver important results that will improve our understanding of the biological systems needed to support life under the conditions of gravity that prevail on Moon or Mars. This in turn will enable us to provide support for future space exploration missions and develop new biological recycling systems for use on Earth."

Provided by Fraunhofer-Gesellschaft

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