Improved cultivation system for future life science experiments on ISS: Development of modular test-bed

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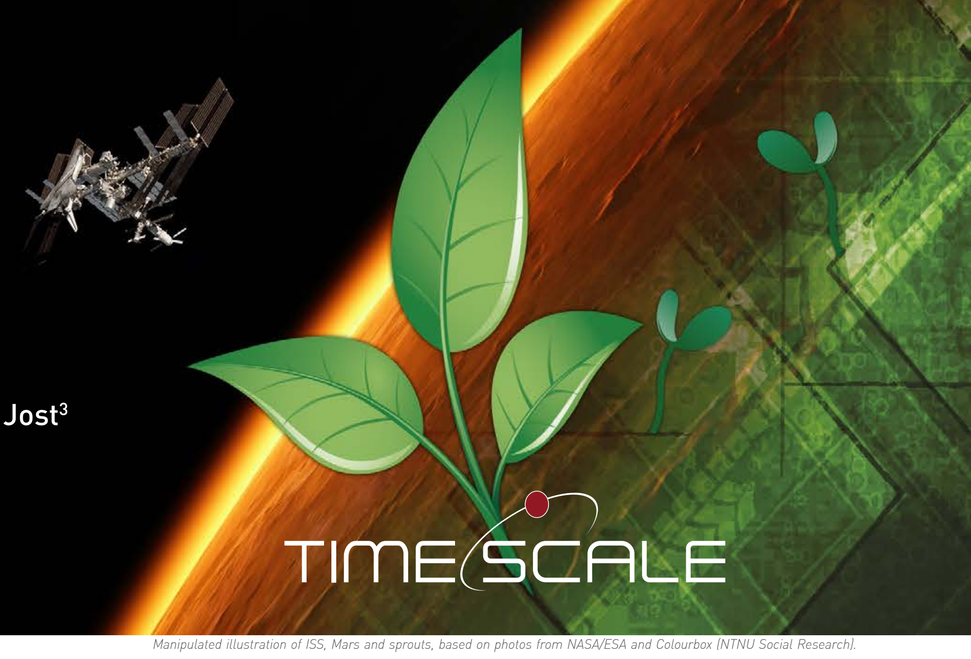
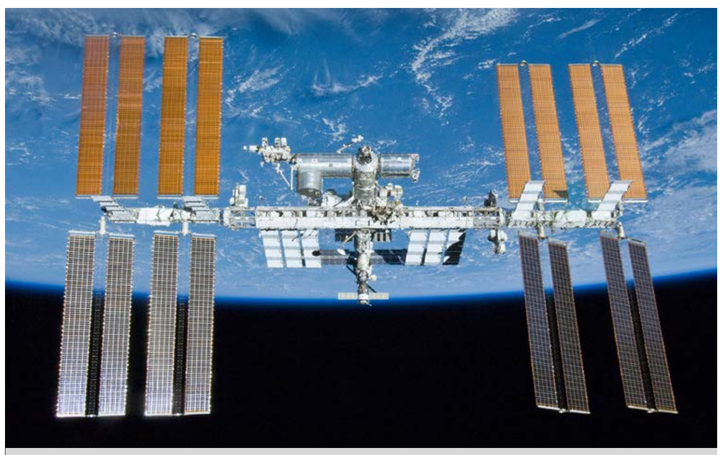


Manipulated illustration of ISS, Mars and sprouts, based on photos from NASA/ESA and Colourbox (NTNU Social Research).

For long term missions in space, humans will need an efficient, safe and reliable life support system to recycle water, nutrients, air and waste.

From a land-based perspective, the horticulture industry needs new knowledge and technology to optimize plant production and minimize waste as the pressure on limited resources increases.

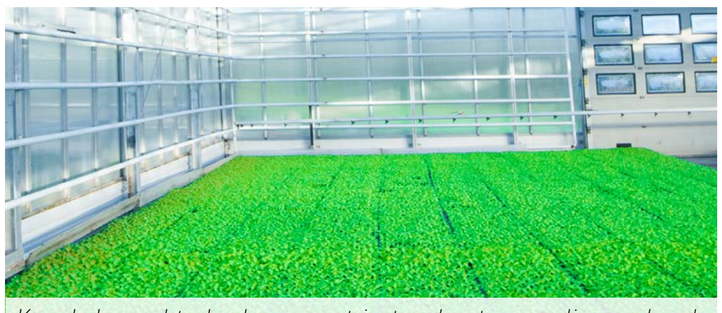
The TIME SCALE project (2015 - 2018) develops concepts and technology for both Earth applications and next-level life science experiments on the International Space Station and beyond: Crop cultivation and algae photobioreactor concepts, and advanced technology for plant health monitoring and water and nutrient management. A breadboard system and a modular test-bed will validate and demonstrate operational capability for the International Space Station.



Food production and life support systems are crucial for future long term missions in space. The International Space Station is site for scientific experiments and technology demonstrations. Photo: NASA.

Crops will be essential for future food supply and life support systems for long term missions in space. Photos: Colourbox.

TIME SCALE relates to the need for both future space missions and sustainable food production on Earth.



Knowledge and technology on nutrient and water recycling, and early warning for crop suboptimal growth conditions have significant relevance for terrestrial greenhouse systems. Photo: Colourbox.

Replacing and upgrading ISS cultivation system

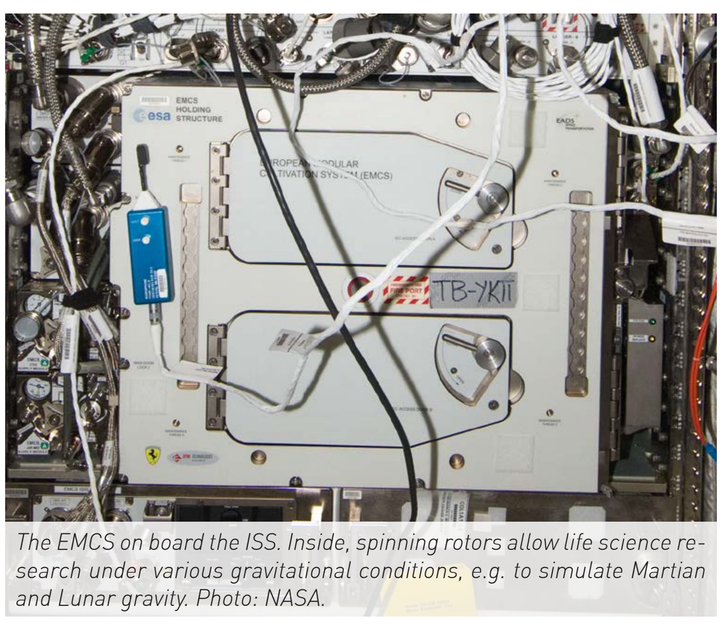
Plant research is being conducted onboard the International Space Station (ISS). The European Modular Cultivation System (EMCS) has been successfully operated on the ISS since 2006. In this system, cultivation chambers affixed to spinning rotors allow life science research under various gravitational conditions, e.g. microgravity and simulation of Martian and Lunar gravity. The EMCS modular design provides the possibility to replace and upgrade individual subsystems.

TIME SCALE will develop next-level technology for life science research in space.

New technology for Space and Earth

TIME SCALE will develop a water and nutrient recirculation supply for an improved cultivation system, including new sensor technologies to monitor plant nutrient availability. The project includes research and development of remote sensing diagnosis of plant health. This will be implemented using sensors, imaging techniques and analysis technology such as selected ion flow tube mass spectrometry and compact gas chromatography.

Today's experiment container of the EMCS. The TIME SCALE project will develop improved cultivation system concepts and technology for next-level life science experiments. Photo: NTNU Social Research.



The EMCS on board the ISS. Inside, spinning rotors allow life science research under various gravitational conditions, e.g. to simulate Martian and Lunar gravity. Photo: NASA.

Towards a new crop cultivation system

TIME SCALE will develop a crop cultivation system concept for EMCS, which includes:

- Water and nutrient management system
- Plant health monitoring system
- Light system
- Plant cultivation chamber, *or*
  Algae cultivation chamber

For bringing technology faster towards flight, TIME SCALE puts special emphasis on the plant cultivation chamber and the water and nutrient management system.

A crop cultivation system breadboard and a modular test-bed are being developed for ground testing to validate and demonstrate operational capability. The modular test-bed includes the crop cultivation system breadboard and all interfaces, supporting structures, data aquisition and remote control capabilites needed for breadboard assembly and ground testing.

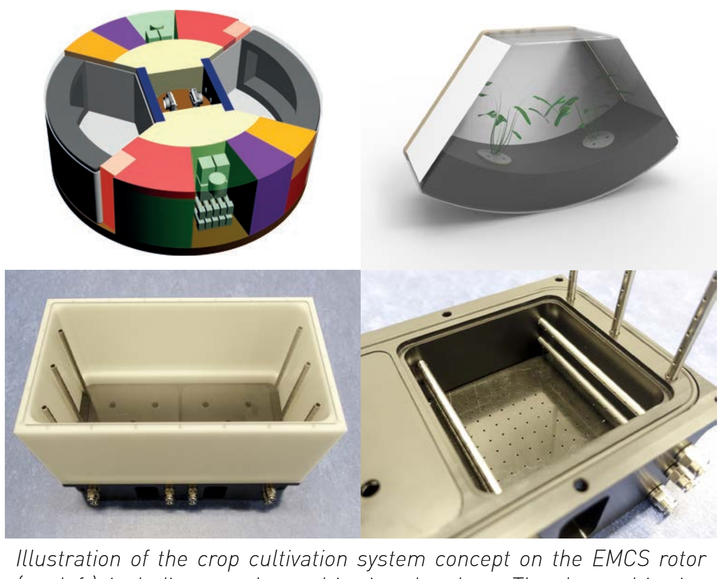


Illustration of the crop cultivation system concept on the EMCS rotor (top left), including two plant cultivation chambers. The plant cultivation chamber is designed as a flight concept (top right) for the EMCS rotor and is being produced as a breadboard model (bottom left and right) for on-ground testing in the modular test-bed. Illustrations and photos: DTM and Prototech.

A breadboard model and a modular test-bed will validate and demonstrate operational capability.

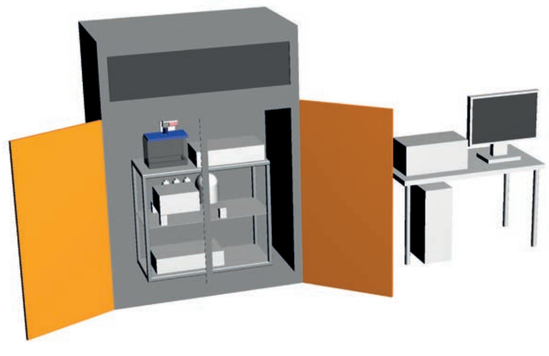


Illustration of the modular test-bed with the breadboard model inserted into an inclubator controlling temperature and relative humidity. Data aquisition and remote control capabilities are offered by an external computer which serves as a user interface for the breadboard system. Illustration: DTM

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