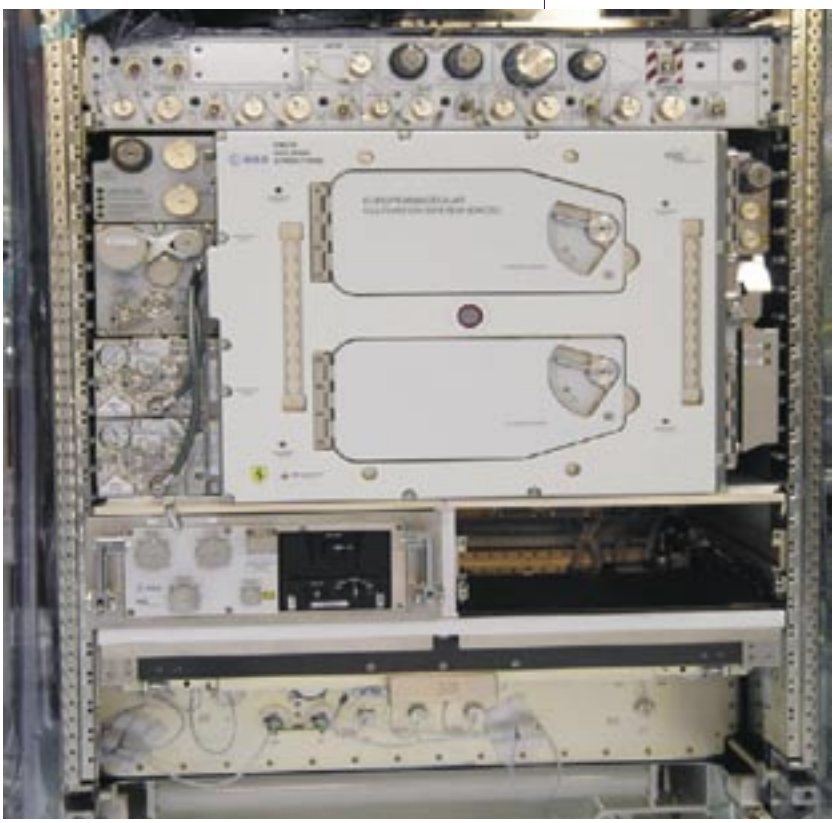
which is connected over Internet to the N-USOC. The users thereby have the possibility of real-time monitoring and control of the experiment. To operate the EMCS facility and the experiments therein, the N-USOC is supported by the EMCS' payload developer, which provides experiment support from their industry site (EADS, Friedrichshafen, Germany) or on the N-USOC site when required.

The link between N-USOC, ISS and sub-partners is via Huntsville Operations Support Center located at the Marshall Space Flight Center in the USA. From the ISS via Huntsville, data from the experiments performed are transferred to N-USOC and finally to the scientists. The N-USOC is also connected to the Mission Control Center in Houston which is responsible for the real-time command and control of the ISS overall. The N-USOC is continuously receiving information on the EMCS conditions (e.g. temperature, pressure, air composition etc.) and also for the entire ISS.



At right.A picture of the EMCS during the final tests at Kennedy Space Center. Picture courtesy: EADS, Friedrichshafen, Germany.

Is it possible to grow plants on ISS from seeds to seeds?

A plant experiment proposed by a scientific group at the Department of Physics and one at the Department of Biology (Plantebiosenteret) using the model plant Arabidopsis thaliana has been selected as the first Norwegian biological experiment on the ISS. The ultimate goal of the experiment – which has been subdivided into three parts - is to examine if dry seeds brought onto the ISS can be germinated in the EMCS and develop, during a 2-3 months period, new plants, which produce viable seeds.

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When growing this model plant in the experiment containers (ECs) in the EMCS on the Earth, the germination and growth process goes smoothly and it takes less than 2 months to produce new seeds. Is it possible to obtain the same results under the weightlessness and cosmic radiation on the ISS – or will technical constraints in the fully automatic EMCS prevent the success of the experiment?

One of the first tasks for the N-USOC (Norwegian User Support and Operations Centre) located at Plantebiosenteret, NTNU, will be to support two scientific NTNU-groups in their specific plans for performing a complete life cycle study in the EMCS (European Modular Cultivation System). The preparative work for this experiment, which has been accepted by ESA and NASA, has been going on for a period of time. The experiment called MULTIGEN consists of three parts:

A picture of the experiment container (EC) with the "flower pot" (PCC) as experiment-specific hardware that will be placed in the EMCS during the MULTIGEN Part I experiment on the ISS. A drawing of an Arabidopsis plant growing in the PCC is also shown.

Part I.

A seed-to-seed experiment using the EMCS and observations of circumnutations in shoots.

Part II.

Microarray analysis to reveal genes that are differentially expressed as an adaptation to micro-g conditions.

Part III.

Observation and 3-D reconstruction of plant circumnutations in roots.

As a consequence of limited experimental conditions, space and crew time, it has been decided that only the MULTIGEN Part I experiment is scheduled to take place in the initial functional period of the EMCS and be flown to the ISS in July 2007. In this experiment, the plant *A. thaliana* will be grown on the ISS for a complete life cycle, i.e. from seed-to-seed. A 1g onboard control will be used for comparative studies. During the initial growth period, analysis of the rotational plant stem movements around the plumb line (circumnutations) will be mapped. The question is, if they will occur as they do on the Earth, but now independent of gravity. Additionally, control plants will be grown in the EMCS ERM-1 located on the ground at the N-USOC. This will hopefully elucidate the gravity effects on the morphological development and circumnutation movements. The experiment will also provide knowledge of the utmost importance for all other studies planned on the ISS using the EMCS.

The growth of the plants in MULTIGEN 1 will take place in a Plant Cultivation Chamber (PCC I), i.e. a "flower pot" that can support different types of plants. The prototype was originally developed by staff members at Plantebiosenteret but the flight version is presently being built by Prototech a.s. in Bergen, Norway. The PCC interfaces with the EMCS and will automatically provide the plants with water and nutrients when it is needed.

In MUTLIGEN Part II, microarray technology will be applied to monitor the global gene expression profile (i.e. to detect which genes are switched on and off) and in this way provide new basic knowledge about what metabolic processes are altered as *A.thaliana* adapts to the gravity stresses and the space environment in general.

Circumnutations are also a key element in MULTIGEN Part 3, but in this case in the roots. The movements seem to be driven by inherent oscillatory processes but are also modified by the acceleration force (gravity or centripetal forces).

The circumnutations in Arabidopsis thaliana stems. The flower stalks complete one ellipse in 84 minutes, i.e. the flower stalk moves 50% of the height horizontally in 40 minutes!

Photos: Bjarte Gees Bokn Solheim