European Space Agency Experiment Programme

The experiments that are carried out by the European Space Agency (ESA) on the International Space Station are governed by the European Programme for Life and Physical Sciences (ELIPS). This programme is financed by 13 of the 17 member states of ESA: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, and Switzerland, with the addition of Canada who has a cooperation agreement with ESA.

ELIPS covers a large range of scientific disciplines, which encompass physics, chemistry, biology, physiology, psychology and related topics.

The uniqueness of the programme is that its orientations are based on the inputs from the scientific and industrial user community in Europe in a process which is supervised by the European Science Foundation (ESF). The ELIPS scientific and industrial user community is of highest international quality and has doubled in the past five years. ELIPS exploits all possible research platforms, like ground-based facilities, drop towers, parabolic aircraft flights, sounding rockets, unmanned capsules and the International Space Station (ISS). The main characteristics of these facilities is their very specific operational and physical environment, especially weightlessness. Weightlessness provides a unique environment for scientific research, giving an unusual opportunity to answer questions that would be impossible to tackle on Earth. Much more processes in physics, chemistry, biology or physiology that are relevant for biological, physical or industrial processes on Earth are effected by gravity than was expected in the early days of spaceflight. Research in weight-lessness is unique and leads to high-level discoveries or changes of commonly accepted scientific understandings. Even Nobel prize-winn-ing hypotheses, like eye movement reflexes, have been found partly erroneous thanks to experiments made by astronauts during spaceflight missions.

Launch of Texus 42 sounding rocket on 1 December 2005 from the Esrange launch site near Kiruna in northern Sweden.
(Image: SSC)

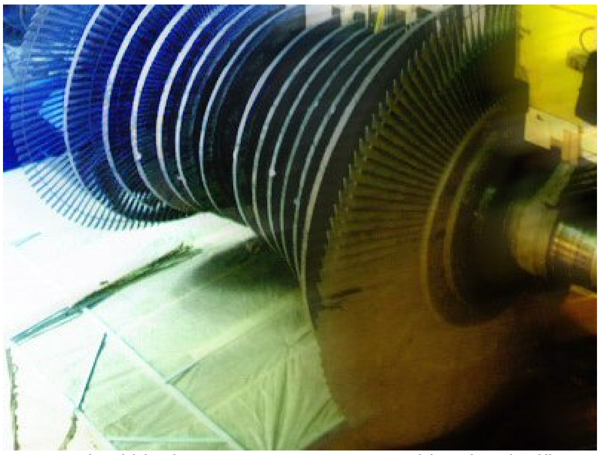
In terms of research topics for experiments on the ISS, addressed by ELIPS, the programme is organised along so-called research cornerstones.

The ELIPS cornerstones in Life Sciences include biological research, focussing on the effects of gravity on fundamental processes in plant and animal cells. From this research a better understanding evolves on how cells adapt to their environment, which in turn can be exploited in medical and biotechnological applications, such as studies on the immune system, food production, etc.

Human Physiology studies aim at research on, often age-related, health problems such as osteoporosis, cardiovascular and respiratory diseases and equilibrium disorders, which are induced or accelerated in weightlessness. The results do not consist only of new diagnostics and treatments that can be used in Earth medical practice, but are also clearly very relevant for the preparation of long-duration human space missions regarding effective countermeasures to retain the fitness of the astronauts.

In Fundamental Physics, novel states of matter such as complex plasma's and solid/liquid dust particles, cold atoms and Bose-Einstein condensates are examined within the ELIPS programme. Careful study of these systems requires weightlessness, since on Earth they are too much influenced by gravitational effects. These studies are very fundamental in nature and will lead to new theories on physical processes. However, practical examples such as very stable atomic clocks that can be used in future navigation systems are also envisaged.

In Material Sciences, the space environment is used to measure thermo-physical properties of metals and alloys with unprecedented accuracy. These properties are being used by industry in numerical models to optimise their production processes and even develop new materials with advanced properties. With European Union funding, a large 5-year research project is carried out within the ELIPS programme for the development of more efficient aircraft engines and hydrogen fuel cells.



Research within the ELIPS programme could make significant developments in turbine blade production for use in, for example, the aerospace industry (Image: AP Photo/Mark Duncan)

Also in fluid physics, the weightless environment on the ISS helps in studying the physics of fluids and interfaces in an undisturbed way. Apart from the theoretical importance, this can be used for example to optimise chemical industrial processes or to optimise combustion process in power plants or car engines. The close link between material and fluids research leads to substantial gains in physical understanding and process advancements.

Finally, the field of exobiology concerns the very fundamental question of the origin, evolution and distribution of life in the Solar system and beyond. It focuses in particular on defining if, where, and how traces of fossil of even existing life could be found during planned robotic and human missions to Mars.

The Astrolab mission is fully embedded in the overall context and the various cornerstones of the ELIPS programme. The selection of the scientific experiments that are conducted on the ISS and on the ground during the Astrolab mission was primarily driven by life and physical sciences and applications, and by research undertaken in the preparation of human space exploration. The Astrolab experimental programme covers several of the ELIPS research cornerstones. The experiment complement involves multi-national science teams comprising in total some 138 scientists from 14 European countries.

Apart of the Astrolab experimental programme, the set of European-built experiment facilities and instruments which are available on the International Space Station are also very important as precursors for the multi-user facilities of the European Columbus laboratory. Some of them are already in use today, others will be prepared for use in the near future. This concerns in the frame of the Astrolab mission the launch and in-orbit commissioning of ESA's so-called Early Utilisation Facilities for the American Destiny laboratory, like the EMCS (European Modular Cultivation System), MELFI (Minus Eighty Degrees Laboratory Freezer for the ISS), PEMS (Percutaneous Electrical Muscle Stimulator), and PFS (Pulmonary Function System). These facilities are very essential for the future execution of ESA's ISS utilisation programme. Most of these facilities or instruments will support directly the future Columbus utilisation. Some of them will even be transferred from Destiny to the Columbus laboratory once it is deployed on orbit.

First MELFI flight unit at the Kennedy Space Center in May 2005. (Image: NASA)

Human Physiology

CARD

It has been demonstrated that salt intake can increase certain cardiovascular measurements such as cardiac output, i.e. the total volume of blood pumped from the heart over a given time period. This experiment aims at assessing the effects of increased blood volume, induced by increased salt intake, on blood pressure, heart rate, cardiac output and the neuroendocrine system.

European-developed elements of the Pulmonary Function System in use. (Image: ESA)

This experiment is planned to be carried out over multiple Expedition Crews requiring six subjects and the utilisation of the ESA/NASA-developed Pulmonary Function System and the European-developed MELFI freezer. This experiment can also help to provide insight into the mechanisms behind certain cardiovascular problems on Earth, such as heart failure.

Science Team

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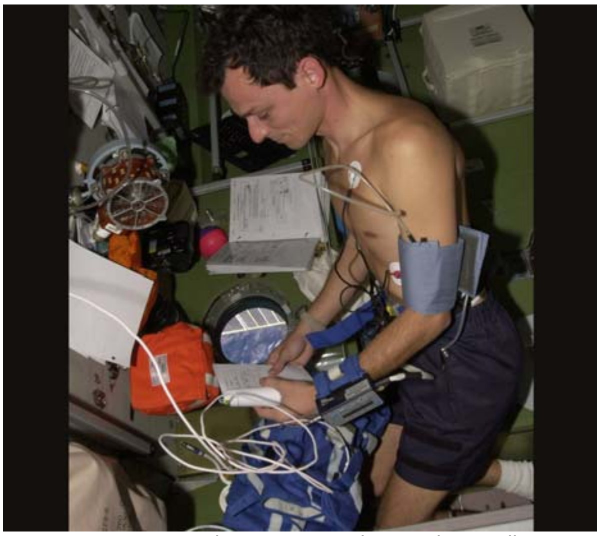
M. Damgaard (DK), A. Gabrielsen (DK),
M. Heer (DK), M. Tangø (DK), N. Gadsbøll (DK).

Cardiocog-2

The Cardiocog-2 experiment studies the consequences of weightlessness on the cardio-vascular system, as well as stress, cognitive and physiological reactions of an astronaut during their space mission.



ESA astronaut Pedro Duque carrying out the Cardiocog experiment on the ISS as part of the Cervantes Mission in October 2003. (Image: ESA)

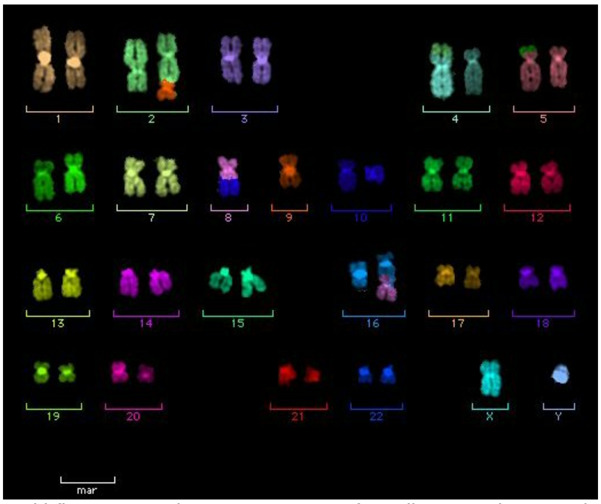
On four occasions over the course of the mission the astronaut will undertake a ½ hour protocol of normal and controlled breathing together with a stress test. Cardiac activity, respiration and blood pressure will be measured continuously during this activity using the Cardioscience equipment already on the ISS. This will be compared against additional data generated during similar and additional ground tests where ECG, blood pressure, respiration and ultrasound measurements are taken. This is a continuation of the previous Cardiocog experiment and is proposed to continue with three additional long-term subjects. This experiment will increase the understanding of orthostatic intolerance (proneness for fainting), a common clinical problem.

Science Team

A. Aubert (BE), P. Arbeille (FR), F. Beckers (BE),
B. Verheyden (BE), S. Van Huffel (BE),
H. Ector (BE), A. Malliani (IT), N. Montano (IT),
B. Morukov (RU), R.M. Beavsky (RU),
I.I. Funtova (RU), A.V. Paschenko (RU)

Chromosome-2

During space flights crew members are exposed to different types of ionizing radiation. To assess the genetic impact of these radiations, this experiment will study chromosome changes and sensitivity to radiation in lymphocytes (white blood cells) of ISS crew members. The Chromosome-2 experiment is planned to be carried out using eight subjects: four subjects from short-duration flights and four Expedition crew members.



Multi-fluorescent chromosome map of a cell exposed to cosmic radiation. (Image: M. Durante)

SCIENCE TEAM

C. Johannes (DE), M. Horstmann (DE)

CULT

This experiment is a study of cultural aspects and leadership styles of ISS crews. Data from crew member questionnaires will be analysed to observe the dynamics of the response as a function of the duration of the flight. Research on ground personnel will be carried out in parallel. Results may provide recommendations on how to interact with multinational crews. The in-orbit study combined with the ground study on mission control personnel may further provide recommendations for communication between the ground and ISS. This experiment is planned to be carried out over multiple Expedition Crews requiring eight subjects.

Science Team

G.M. Sandal (NO), D. Manzay (DE),
V. Gushin (RU)

ETD

The working of our balance system and our eyes are strongly interconnected and understanding their adaptation to weightlessness can help with our understanding of the occurrence of space sickness during human spaceflight and conditions such as vertigo and nausea on earth. Our eyes can rotate around three axes whereas normally only two are used. The name of the coordinate framework which describes the movement of the eyes in the head is called Listing's plane.

ESA astronaut André Kuipers training with the Eye Tracking Device (ETD) prior to launch of the DELTA mission in April 2004. (Image: ESA)

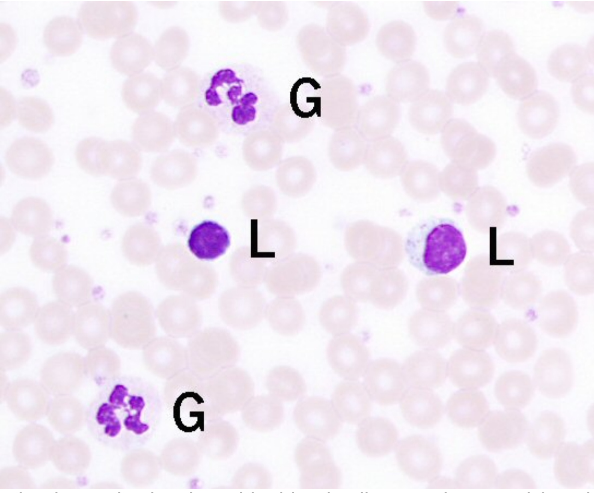
This experiment centres on the evaluation of Listing's plane under different gravity conditions using the Eye Tracking Device (ETD), which is able to record horizontal, vertical and rotational eye movements and measure head movement. This experiment requires eight subjects from long-duration missions and eight from short-duration missions. The experiment started during the European DELTA mission with ESA astronaut André Kuipers in April 2004.

Science Team

A. Clarke (DE), T. Haslwanter (CH)

Immuno

The aim of this experiment is to determine changes in stress and immune responses, during and after a stay on the ISS. This will include the sampling of saliva, blood and urine to check for hormones associated with stress response and for carrying out white blood cell analysis. There will also be a focus on the adaptation of energy metabolism, which can affect immune response.



Blood sample showing white blood cells: Lymphocytes (L) and Granulocytes (G). (Image: A Chouker)

An increased understanding of the coupling between stress and the functioning of the immune system also has relevance for the citizens on earth. This experiment is planned to be carried out over multiple ISS Increment crews requiring six subjects in total.

Science Team
A. Chouker (DE), F. Christ (DE), M. Thiel (DE), I. Kaufmann (DE), B. Morukov (RU) I. Nichiporuk (RU)

NOA 1

Recent research has demonstrated that an elevation of expired Nitric Oxide is an early and accurate sign of airway inflammation especially in asthma but also after occupational dust inhalation. This experiment will utilise improved techniques for analysis of Nitric Oxide in expired air. This will be used to study physiological reactions in humans in weightlessness.


Platon Device, the Nitric Oxide detection hardware used in the NOA experiments. (Image: ESA)

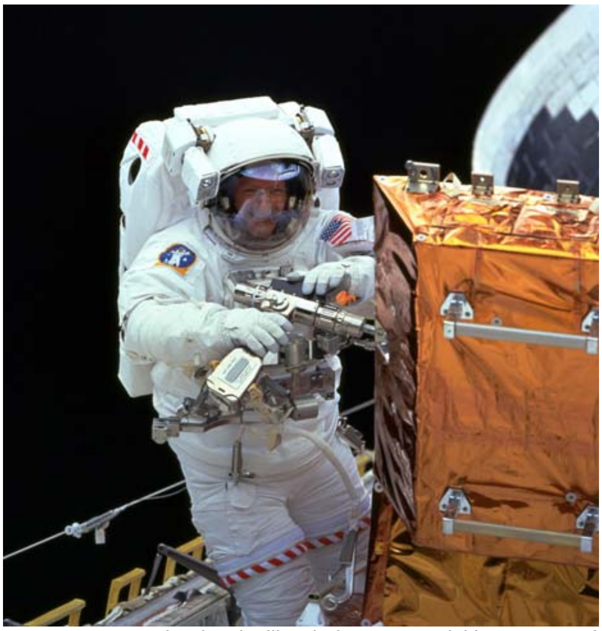
Since dust never settles in weightlessness, it is likely that there is an increased exposure of the human airways to inhaled particles in such an environment. The crew members will perform a simple inhalation-exhalation procedure on a bi-weekly basis during their stay on the ISS. Elevated levels of expired Nitric Oxide compared to preflight levels would indicate airway inflammation. Data will be stored on a credit-card size memory unit. This experiment, which started during Expedition 12, is planned to be carried out over multiple Expedition Crews requiring eight subjects.

The Platon device, developed for spaceflight, has a dual use, as it is now also used to improve the treatment of asthma by allowing monitoring of patients at home.

Science Team
D. Linnarsson (SE), L. E. Gustafsson (SE), C. G. Frostell (SE), M. Carlson (SE), J. Mann (SE)

NOA 2

The occurrence of gas emboli (bubbles) in divers' bloodstreams as a result of decompression is well-known and can be prevalent after normal dives with no subjective signs of decompression sickness. The occurrence of decompression sickness in astronauts following decompression in connection with extravehicular activity (EVA) is not known but it has been demonstrated that the corresponding decompression techniques on ground give rise to overt symptoms of decompression sickness in approximately 6% of the cases. This suggests a much higher frequency of gas emboli without overt symptoms of decompression sickness. A non-invasive and simple technique for assessing current decompression techniques before and after EVA would be beneficial.



ESA astronaut Claude Nicollier during EVA activities as part of the STS-103 Hubble Space Telescope servicing mission in December 1999. (Image: ESA)

In this experiment astronauts will perform a simple inhalation-exhalation procedure (as in the NOA 1 protocol) as late as possible before standard EVA preparations start, and as soon as possible after EVA completion. An increased level of expired Nitric Oxide compared to pre-procedure levels will indicate the presence of gas emboli and, if so, may suggest an adaptation of existing EVA procedures.

Science Team
D. Linnarsson (SE), L. E. Gustafsson (SE),
C. G. Frostell (SE), M.Carlson (SE), J. Mann (SE)

In addition to the European experiment programme in human physiology, Thomas Reiter will undertake two experiments on behalf of NASA.

Epstein-Barr

This experiment covers the reactivation of the latent Epstein-Barr Virus of which approximately 90% of the adult population is infected. This investigation will assess the immune system function using blood and urine samples collected before and after spaceflight.

Science Team
R. Stowe (USA)

Renal Stone

Exposure to weightlessness may increase the risk of renal stone development in humans during and immediately after spaceflight. This experiment will test the use of potassium citrate as a countermeasure to reduce the risk of renal stone formation during spaceflight. Potassium citrate is a proven Earth-based therapy used to minimise calcium-containing renal stone development.

Science Team
P. Whitson (USA)

Biology

Kubik Incubator training model. (Image: ESA)

Kubik Incubator

The following biology experiments will be carried out using two European incubators called Kubik that were flown to the station in March. The samples for the experiments will be flown on Soyuz flight 13S to the ISS in September and will be returned on flight 12S from the ISS some 10 days later.

Kubik is a small facility for performing biology experiments. The incubator provides a controlled thermal environment that can be varied from 6°C to 37°C. For the biology programme, the Kubik incubators will be set at a temperature between 22 and 25°C.

Each incubator has a centrifuge (though the incubators can be configured without it). This allows for the storage of 24 experiment containers in each incubator, eight loaded on the centrifuge and 16 in a static position. The centrifuge provides the ability to run 1g control experiments whilst in orbit and can be configured to provide an acceleration between 0.2g and 2g.

BASE

In the BASE (Bacterial Adaptation to Space Environments) experiment, the science team will study how bacteria cope with and adapt to the different space flight environmental parameters (e.g. weightlessness, cosmic radiation, space electromagnetism, space vibrations). Based on

these results, scientists will try to assess how such adaptations might influence their potential to contaminate and biodeteriorate the space habitat, their potential to endanger crew health, or their function in waste recycling or food production systems. In the BASE project, scientists will also study the physiology, gene expression, gene re-arrangement and gene transfer of cultures of several model bacteria grown under microgravity and other space flight conditions.

Science Team
M. Mergeay (BE), R. Wattiez (BE), J. Mahillon (BE), P. Cornelis (BE), N. Leys (BE)

Example of Kubik incubator with centrifuge configuration loaded with experiment containers. (Image: ESA)

LEUKIN

The aim of this experiment is to study the signal transduction pathway of the activation of T-lymphocytes. The focus is on the role of the IL-2 receptor and on the determination of its genetic expression. The hypothesis to be tested is that the lack of expression of IL-2 R is the major cause for the loss of activation in re-suspended cells in weightlessness. This experiment will help us better understand the mechanisms by which spaceflight alters immune cell function, which may help devise more adequate preventative or corrective measures for immune suppression during long term space missions.

Science Team
A. Cogoli (CH), L. R. Bisset (CH), P. Pippia (IT), O. Mueller (CH), M. Hughes-Fulford (US)

YING

This experiment will study the influence of weightlessness on “Flo processes”, cell-surface interaction on solid and cell-cell interaction in liquid media in yeast cells (*Saccharomyces cerevisiae*). Weightlessness will have a direct impact on the yeast cell physiology due to a changed gravitational micro-environment and in the case of yeast cell cultivation in liquid media, also the changed shear environment in microgravity will have an effect. The overall goal is to obtain a detailed insight into the importance of gravity and shear stress on the formation of organised cell structures, such as yeast flocs, biofilms and filaments, which are of considerable interest for both fundamental science and industry as well as the medical field.

Science Team
R. Willaert (BE), F. Delvaux (BE), J. Nielsen (DK), M. Reuss (DE), L. Wyns (BE)

Biology experiments will utilise the European-built Portable Glove Box, which will be launched to the ISS on the STS-121 mission. It will be used for handling various biology experiments with the European Modular Cultivation System and Kubik. It provides an adequate enclosure to perform manual operations during safety-critical steps of any experiment.

The European Portable Glove Box. (Image: ESA)

The Portable Glove Box has an airtight volume of 21 litres, with two gloves mounted on standard glove rings for experiment manipulations inside. It is equipped with removable top and bottom with transparent windows for insertion of experiments. The internal filter system allows removal of hazardous substances in case a spillage occurs.

Radiation Dosimetry

ALTCRISS

ALTCRISS (Alteino Long Term monitoring of Cosmic Rays on the International Space Station) is an ESA experiment to study the effect of shielding on cosmic rays in two different and complementary ways. The detector of the Alteino device will monitor differences in the flow of cosmic rays with regard to the position and orientation of the Alteino device and also with regard to different shielding materials placed over the particle acceptance windows of the Alteino instrument.

AST/Sileye-3 cosmic ray detector shown in the Pirs Module on the ISS.

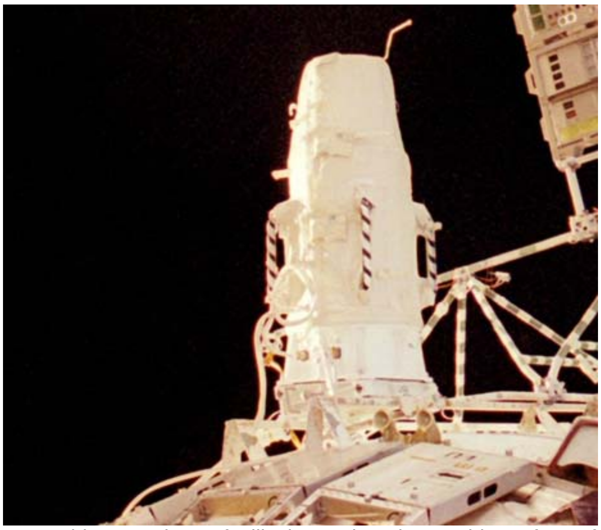
The Alteino detector was operational during the European Marco Polo and Eneide missions with ESA astronaut Roberto Vittori. It is composed of a cosmic ray detector (AST/Sileye-3) and an Electroencephalograph (EEG), though the Electroencephalograph will not be used in the Altcriss project. The obtained data will be used to better understand the radiation environment in spacecraft and how to provide efficient shielding against it.

Science Team

M. Casolino (IT), F. Cucinotta (US), M. Durante (IT), C. Fuglesang (SE), C. Lobascio (IT), L. Narici (IT), P. Picozza (IT), L. Sihver (SW), R. Scrimaglio (IT), P. Spillantini (IT)

Matroshka 2

The ESA Matroshka facility was installed on the external surface of the ISS on 27 February 2004 with the aim of studying radiation levels experienced by astronauts during spacewalk activities. It consists of a human shape (head and torso) called the Phantom equipped with several active and passive radiation dosimeters. This is mounted inside an outer container of carbon fibre and reinforced plastic to simulate a spacesuit. The facility was brought back inside the ISS on 18 August 2005 as part of Expedition 11 EVA activities. Passive radiation sensors were removed and returned to Earth with the Expedition 11 Crew. New passive sensors were installed and the Matroshka facility is currently stored inside the ISS to taking similar measurements related to the radiation environment inside the ISS. In September 2006, active sensors will once again be installed and activated to take time dependent readings.



Matroshka experiment facility located on the outside surface of the ISS Zvezda Service Module in September 2004.
(Image: NASA)

Science Team

G. Reitz (DE), R. Beaujean (DE), M. Luszik-Bhadra (DE), V. Petrov (RU), D. Bartlett (UK), D. O'Sullivan (IE), P. Olko (PL), P. Bilski (PL), S. Deme (HU), I. Apathy (HU), J. Palvalvi (HU), N. Vana (AT), M. Casolino (IT), M. Durante (IT), C. Lobascio (IT), L. Sihver (SW), T. Berger (DE), A. Nagamatsu (JP), K. Fujitaka (JP), Y. Uchihori (JP), E. Benton (US), J. Miller (US), M. Golighy (US), S. McKeever (US), E. Yukihara (US)

Project Team

ESA: J. Dettmann, DLR: G. Reitz, J. Bossler, Kayser Italia: M. Porciani, F. Granata

Complex Plasma Physics

PK-3+

Plasma is the most disordered and ubiquitous state of matter in our universe, being composed of charged electrons and ions. An important area of research within this field is the study of complex plasmas, which are plasmas enriched with micro-particles. This component adds special properties to the plasma, providing the possibility for undertaking fundamental investigations under weightless conditions. In addition to its benefits of increasing understanding of fundamental physics, this research has many applications across many scientific disciplines such as plasma processing and fluid dynamics.

The PK-3 Plus facility will carry out research on complex plasmas under weightless conditions over a broad range of fundamental parameters. The experiment was built under the responsibility of the German Aerospace Center, DLR and will replace the PK-3 (PKE-Nefedov) facility, which was in use on the ISS since March 2001.

Sergei Krikalev, as ISS Expedition 1 Flight Engineer (Expedition 11 Commander) with the PKE-Nefedov experiment on the ISS. (Image: RSC Energia)

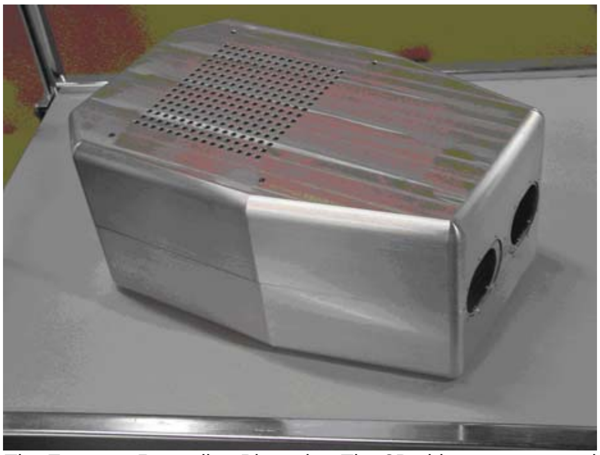
Science Team

V. Fortov (RU), G.E. Morfill (DE), U. Konopka (DE), H. Rothermel (DE), H. U. Thomas (DE), M. Zuzic (DE), V. Molotkov (RU), O. Havnes (NO), F. Melandsø (NO), J. Goree (US), G. Joyce (US), M. Lampe (US), G. Ganguli (US), G. Kroesen (NL), A. Bouchoule (FR), L. Boufendi (FR), A. Piel (DE), A. Melzer (DE), U. de Angelis (IT), B. Annaratone (DE), D. Resendes (PT), V. Steinberg (IL), R. A. Quinn (DE), I. Schweigert (RU), V. Schweigert (RU), D. D. Goldbeck (DE), D. Samsonov (DE), A. Ivlev (DE), S. A. Khrapak (DE), K. Nishihara (JP), V. Zhakhovskii (JP), Y. Hayashi (JP), A. G. Khrapak (RU), D. I. Zhukhovitskii (RU), S. Zhdanov (RU), G. Lapenta (US), P. Shukla (DE), F. Jenko (DE), W. Bunk (DE), C. Räth (DE), R. Treumann (DE), S. Hamaguchi (JP), U. Motschmann (DE), J.E. Hammerberg (US), M. S. Murillo (US), L. Ratke (DE).

Technology Demonstrations

ERB

The main objectives of the experiment are to test a 3D video camera (the Erasmus Recording Binocular) in weightlessness on the ISS as well as accurately mapping the interior of the ISS in its current configuration. To achieve this, images from three cameras shall be used: the ERB 3D video camera, a Sony PD-150 video camera and a Nikon 3D still camera.



The Erasmus Recording Binocular: The 3D video camera used in the ERB experiment. (Image: ESA)

These images will be used to improve the models available on the ground as well as improving the fidelity of the ISS 3D virtual reality simulator at the Erasmus User Centre of ESA's Directorate of Human Spaceflight, Microgravity and Exploration Programmes located at ESA/ESTEC in the Netherlands. Of special interest is filming of subjects and/or objects moving to and from the camera and filming of objects protruding from a surface such as cables on experimental racks.

Project Team
ESA-HME Erasmus User Centre and Communication Office (NL)

Special Event Meal

The goal of this CNES sponsored project if to provide the ISS crew with high quality food cans that could be the core of celebration meals such as New Year event, arrival of new crew, birthday etc. This will give to the crew the possibility to break the monotony of ISS standard daily food, thus helping also for psychological support (a positive effect for long duration flights).

Project Team
A. Maillet (FR)

Industrial/Business Development Activities

Global Transmission Services 2 (GTS-2)

GTS is a technology experiment for the test, validation and demonstration of radio transmission techniques for the synchronisation of earth-based clocks and watches from the ISS. In addition the GTS data services, based on a unique coding scheme, could ultimately lead to commercial services, such as blocking of stolen cars or lost credit cards, directly from space.

GTS-2 is a continuation of the Global Transmission Services experiment, which will be possible when a new electronic unit is launched on Progress flight 22P to the ISS. On 5 December 2005, the current GTS was re-activated, after a long time of theoretical investigations and practical tests to find out the reasons and successfully introduce corrective measures for the weaker than expected transmitted signal strength experienced by GTS receivers on the ground.

Project Team: F. Huber (DE)

SkinCare

SkinCare is a human physiology experiment, which aims at characterising different parameters of human skin (i.e. hydration grade, transepidermal water loss, skin surface video imaging) in weightlessness and inside the International Space Station. With regard to already known effects on skin of a long duration stay on the ISS and the physiological effects of weightlessness, the investigators will test the applicability of the space environment as a model of the aging skin. Non-invasive medical equipment will be used in flight to support this experiment.

Project Team: M. Massow (DE)

Education Programme (University)

CASPER

The objective of the CASPER (Cardiac Adapted Sleep Parameter Electrocardiogram Recorder) experiment is to test and evaluate a method of monitoring sleep disturbance and sleep stability in weightlessness. CASPER combines objective physiological data and subjective inputs. Physiological data is obtained through a specially adapted vest, worn by the astronaut, with embedded sensors and cabling that connects ECG electrodes, for measuring heart rate, to a PDA for storing the heart rate data. Subjective inputs are obtained via a questionnaire, that runs on the same PDA. One questionnaire is completed both prior to and after each sleep period, during which the heart rate is measured.

Data collected on this mission can help to establish and distinguish the reasons and patterns of astronaut sleep disruption and facilitate the development of relevant countermeasures to monitor and ensure astronaut sleep stability during long-term spaceflight.

Science Team
M. O'Griofa (IE)
ESA-HME Education Office (NL)

UTBI

During the UTBI (Under The Background Influence) experiment, the background radiation is measured inside the modules of the International Space Station using a new type of radiation sensor. Radiation models, that predict these radiation levels, will be verified and, if necessary, corrected with the experimental data.

The new type of sensor that measures the radiation is made of an alloy of Cadmium, Zinc and Tellurium. The advantage of this specific detector is that it is compact and does not require cryogenic cooling. The UTBI experiment will demonstrate this specific sensor technology for the first time in space and possibly act as a precursor for an instrument of ESA's Atmospheric-Space Interaction Monitor (ASIM), which is planned to be accomodated on an external payload adapter on the outside surface of the European Columbus laboratory once it is launched to the ISS.

Radiation can have severe health consequences for astronauts. Understanding radiation, its inter-action with the ISS and its impact on the human body shall therefore be considered as an important factor that has to be taken into account for longer duration flights around the Earth as well as flights and stays towards and on the Moon and Mars.

Science Team
N. Escobar (ES), A. Russu (ES)
M. Moreno (ES), R. Gisbert (ES)
F. Monrabal (ES), J. Sanchís (ES)
ESA-HME Education Office (NL)

Education Programme (Primary/Secondary)

ARISS

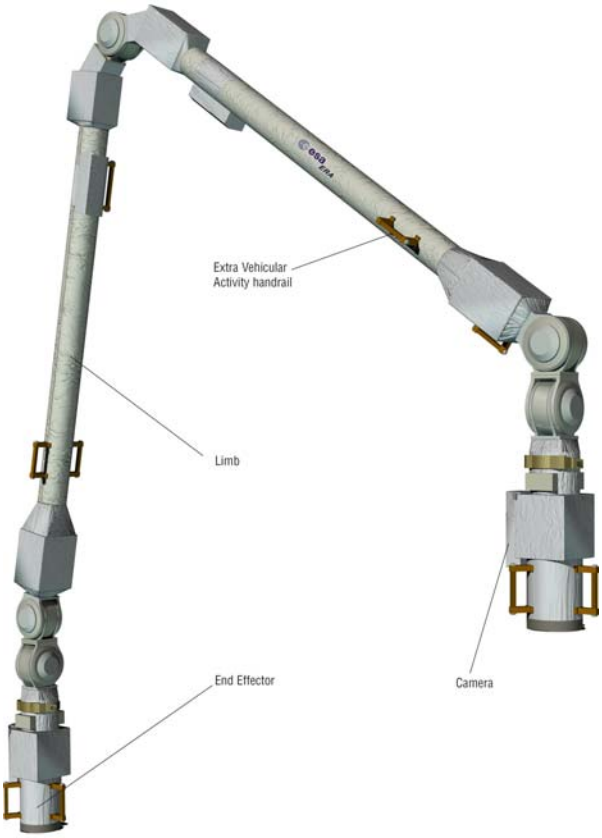
ARISS is an international association of national amateur radio societies of the countries participating in the ISS programme. For this mission, the specific objectives of ARISS are: to provide real time radio transmissions from the ISS, during which pupils in selected German, and Swiss primary schools will put questions to the ESA astronaut; and to build, develop and maintain the amateur radio activities on board the ISS. Among the children chosen, are the winners of national space-oriented competitions set up by ESA's ISS Education Office. The ground stations will be provided by local amateur radio clubs.

Competition winner at ESA's ESRIN facility in Frascati, Italy puts a question to ESA astronaut Roberto Vittori on the ISS. 21 April 2005. (Image: ESA)

Project Team
G. Bertels (BE)
ESA-HME Education Office (NL)

DVD-4

To demonstrate the use of robotic applications in weightlessness by means of filming with basic robotic demonstrations using a model of the European Robotic Arm (ERA) and other equipment on the ISS. This includes the Robotic Work Station of the Space Station's robotic arm (Canadarm) in the US segment of the ISS, and different features and functions of the NASA SPHERES experiment.



Artists's representation of the European Robotic Arm, which is scheduled to be launched to the ISS in November 2007 (Image: ESA)

Footage of the demonstrations will be used to produce a DVD Lesson on robotics for use by teachers and their pupils aged 12-18 years across ESA Member States.

Project Team
ESA-HME Education Office (NL)

E-learning session

The e-learning session is currently scheduled as an "Earth-based" lecture during which there will be a live audio/video link-up with ESA astronaut, Thomas Reiter, on board the ISS. The lecture will be presented to European university students following the EuMAS Masters Programme in Aeronautics and Space by Dr. Hubertus Thomas of the Max-Planck-Institute in Garching, Germany. The lecture will be on plasma crystals and complex plasmas, with reference to the PK-3+ plasma crystal experiment that will be performed during the Astrolab mission.

During the live link-up with the ISS, Thomas Reiter will demonstrate the PK-3+ hardware, and the students will have to possibility to put questions to Thomas Reiter in real time and receive feedback.

Project Team
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Oil Emulsion

This experiment will be carried out by school pupils (11-14 years old) on Earth and by Thomas Reiter during his long-duration mission on board the ISS. The space section of ‘Oil Emulsion’ will be filmed and downlinked. This experiment will highlight how an oil/water emulsion behaves differently in weightlessness and under gravity conditions respectively. A sealed container holding two immiscible fluids, clear oil and ink-coloured water, will be shaken until the two fluids are slightly mixed.

Container used in the Oil Emulsion experiment. (Image: DLR)

The fluids’ behavior in space will be filmed within defined time slots during a maximum of two weeks. The data will be down linked and the results will be shown in a specialized childrens programme on German public TV. The different kinds of segregation that occur during the experiment, in space and on Earth, can be observed and then explained by the teacher. This experiment can form the basis of further physics lessons, (concerning weightlessness, density, other fluid parameters) and maybe even lessons in other scientific areas. The Oil Emulsion experiment was introduced by DLR and is a cooperation between the German and the European Space Agency.

Project Team
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