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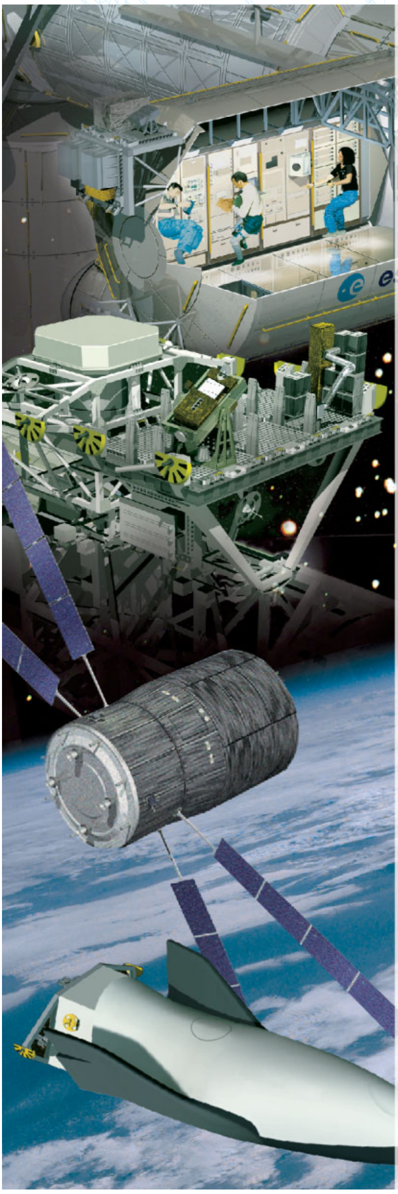
on station

The Newsletter of the Directorate of Human Spaceflight http://www.esa.int/spaceflight



in this issue

European Space Agency
Agence spatiale européenne

Directorate of Human Spaceflight
Direction des Vols Habité

On the Road to Recovery

Jörg Feustel-Büechl
ESA Director of Human Spaceflight

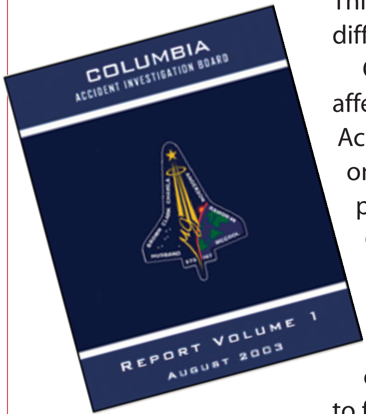
The latest Heads of Agencies meeting, in Monterey, California on 29 July, provided the first opportunity for ESA's new Director General, Jean-Jacques Dordain, to meet the other Heads of Agencies in his new role. As usual at these meetings, each Partner presented a briefing on its activities. I can report that progress is highly satisfactory despite the fact that we are still suffering the consequences of the *Columbia* accident. The ISS is staffed by only two crewmembers, a level we will have to live with until the Shuttle returns to flight. Nevertheless, all the Partners continue to prepare their elements and utilisation activities as normal so that we are all ready to resume full speed ahead as soon as possible. From ESA's side, Node-2 arrived in June at the Kennedy Space Center (KSC) in Florida, and it is now being prepared for launch next year. At the same time, Japan delivered its Kibo research module.

Historically, the Heads of Agencies meeting took place during an important milestone for the Station: this was the 1000th day of human presence aboard the ISS. The resident crew of Yuri Malenchenko and Ed Lu participated in a teleconference to mark the event.

One very important issue agreed in Monterey was the reactivation of the ISS Program Action Plan (PAP). This is the foundation of the technical and programmatic understanding between the Partners, so it is very important. It was also agreed that a further Heads of Agencies meeting would be necessary to direct the Plan's further implementation. That meeting is planned for mid-October in Moscow around the time of the launch of ESA Astronaut Pedro Duque on his Soyuz flight to the Station, along with the eighth resident crew.

In the meantime, we are already discussing with our Partners how the Plan can be reactivated, finalising it as close as possible to the original schedule. The Plan was agreed among the Partners last December to bring the Station back to its original capabilities. During September and early October, we are working on the details in order to turn up in Moscow with a fully consolidated scheme. That critical milestone should clarify the Station's continuing assembly schedule, as well as including the Columbus launch date and utilisation of our Automated Transfer Vehicle (ATV).

The Station crisis resulting from the loss of *Columbia* has led to a much more consolidated ISS Partnership, with absolutely no divergence. This bodes well for the future if there are difficult moments.



Of course, all of our plans will be strongly affected by the report of the Columbia Accident Investigation Board (CAIB), released on 26 August. The CAIB Chairman formally presented the report to NASA, the US Congress, the White House and other interested parties. NASA has received a number of recommendations and it is now up to the agency to implement them and ensure that, before the Shuttle fleet returns to flight, all the important recommendations are satisfied.

The Heads of Agencies expressed their desire for early resumption of Shuttle missions in order to exploit the ISS and complete its assembly in orbit. The CAIB report needs to be translated into a concrete plan with a timeline in order for NASA to determine the date of the Shuttle return-to-flight. As a target, a first launch date is foreseen for 11 March 2004 with

ISS Occupation: 1000 days and Counting

Since the first ISS crew arrived on 2 November 2000, the Station has grown into an unparalleled space laboratory with a size that will eventually more than double. The living and working area has increased by 170 m^3 during the first 1000 days. The Station's 420 m^3 is larger than a three-bedroom house.

The seven Expedition crews, 10 Americans and 10 Russians, have conducted 12 spacewalks from dual Russian and US airlocks, welcomed 11 visiting Shuttles, 10 Russian Progress cargo vehicles and four Soyuz taxi crews. Additions to the Station include solar arrays of unprecedented size; the first space railway, stretching 40 m; and the Destiny science module, more sophisticated than any ever flown in space. With Canadarm2, Canada provided a new generation of space robotics.

29 July 2003: Yuri Malenchenko and Ed Lu celebrate the 1000th day of ISS occupation with a teleconference.

From left: Pedro Duque, Alexander Kaleri, Expedition-8 Flight Engineer (Rosaviakosmos) and Michael Foale, Expedition-8 Mission Commander during a press conference at the Johnson Space Center in August. Duque will return to Earth with the current Expedition-7 crew. (NASA)

the ULF-1 mission using *Atlantis*, followed on 29 July 2004 by mission 12A carrying the P3/P4 Truss.

It now remains to be seen whether all the return-to-flight elements are in place so that NASA can fulfil all the CAIB requirements. The report contains a number of medium- and long-term requirements but many must be fulfilled in the short-term before a Shuttle flies again. We await clarification on how the recommendations will be converted into actions, and I look forward to the 11 March launch date being maintained. Despite all of its recommendations and criticisms, the CAIB also frequently made very strong statements in favour of continuing the Human Spaceflight programme.

In short, the CAIB report clearly identifies the technical issues – such as the foam hitting the Shuttle port wing leading edge – as well as identifying management deficiencies that need to be corrected.

As far as our European elements are concerned, Columbus integration continues as planned and will be ready by Spring 2004. It could then be transported to KSC for launch preparations but, of course, this is unlikely to happen until we know our new launch date (previously manifested for October 2004). Nevertheless, we will endeavour to minimise any delay in order to allow the user communities to perform their experiments as soon as possible.

For ATV, the launch date is still planned to be as early as possible because the vehicle is a major contribution towards sustaining robust ISS logistics. Our ATV industry team is working extremely hard to keep to the projected September 2004 launch date for the ATV-1 mission, called 'Jules Verne'.

We continue to prepare our utilisation facilities, such as Biolab, and experiments for Station utilisation. Indeed, most of the facilities have been successfully processed through the Rack-Level Test Facility at the Columbus prime contractor EADS-ST in Bremen (D), where

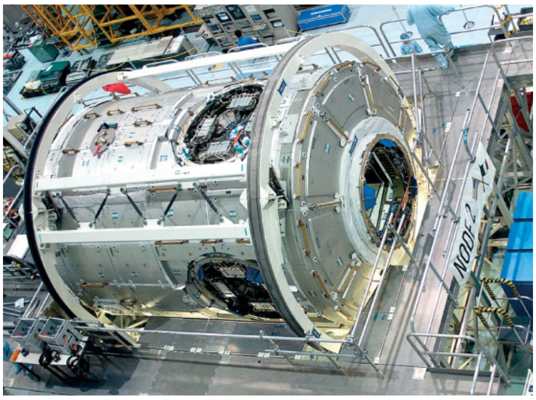
2003: A Year of Anniversaries

2003 is a year for Europe to commemorate a number of firsts in manned spaceflight. A quarter of a century ago, Europe's manned spaceflight history began when Czech cosmonaut Vladimir Remek flew on the first Interkosmos mission with the Soviet Union. He lifted off from Baikonur on 2 March 1978 for an 8-day mission to the Salyut-6 space station. He was followed, on 27 June 1978, by Polish cosmonaut Miroslaw Hermaszewski. On 26 August, East German Sigmund Jähn headed towards Salyut-6. The first West European to fly on a Russian mission was Jean-Loup Chrétien of CNES, who flew on 24 June 1982 to Salyut-7.

20 years ago, Western Europe entered the manned arena with its own orbital laboratory. Spacelab-1 was carried inside NASA's Shuttle *Columbia*, during the mission of 28 November to 8 December 1983. This also saw the first flight by a non-American citizen aboard a US spacecraft – Germany's ESA astronaut Ulf Merbold. He twice returned to space, on the Spacelab International Microgravity Laboratory-1 mission in January 1992 and boarding Russia's Mir station in October 1994.

integration into the Columbus module will begin soon. We are proceeding as planned so that we can fly as soon as the opportunity arises.

The launch date for Pedro Duque's flight to the ISS is still 18 October, and the training for ESA astronauts André Kuipers – backup to Pedro – and Gerhard Thiele continues in Star City, near Moscow. The research programmes for the Spanish-sponsored Duque flight ('Cervantes') in October and the Dutch-sponsored Kuipers flight in April 2004, are maturing according to schedule. Some of Pedro's experiments are already onboard, delivered by unmanned Progress ferry.



The European-built Node-2 in the Space Station Processing Facility at the Kennedy Space Center. (NASA)

Heads of Agencies meeting 29 July 2003. From left: Canadian Space Agency Director, Savi Sachdev; NASDA President, Shuichiro Yamanouchi; NASA Administrator, Sean O'Keefe; ESA Director General, Jean-Jacques Dordain; Rosaviakosmos General Director, Yuri Koptev. (NASA)

The Shuttle flight date of Christer Fugelsang is still under discussion, and we firmly hope that he receives his confirmation without too much delay, while continuing his training in Houston.

On 28 August, ESA launched the ISS Education Fund. For some time now, discussions have been underway with our Participating States on using the Station for educational purposes. The ISS is an ideal educational platform because astronauts can perform fascinating demonstrations in orbit, as well as hosting student experiments. The Participating States have decided to allocate 1% of Europe's ISS resources for such experiments. In addition, we have launched the Education Fund. Our Member States have already given us about €900 000, and we are now looking for industrial and individual backing. In this way, we hope that the ISS can make an outstanding contribution to education and stimulate our students' interest in a unique way. For example, a classroom in space explaining physical phenomena is an exciting prospect!

Further information on the ISS Education Fund is available on the website at *www.esa.int/issef* and in the article in this issue of *On Station*.

In a similar spirit, the ISS Business Club was launched at the Paris Air Salon in June. The Club offers the ISS as a platform with opportunities for European industry to have a 'shop window' for marketing their products and services. This should have the spin-off of the Station becoming more visible to the general public. The Club provides opportunities for ESA and industry to work together to their mutual benefit. Further information is available at *www.european-ibc.com*, and in the article in this issue of *On Station*. ■

‘Cervantes’ to the ISS

Experiments of the Spanish/ESA Taxi Mission

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Introduction

When the latest unmanned Progress ferry was welcomed by the ISS resident crew on 31 August, the stage was set for ESA’s next astronaut visit to the International Space Station. They opened the hatch and began unloading the supplies, including 18 kg to support the ‘Cervantes’ Spanish/ESA mission of ESA Astronaut Pedro Duque. As *On Station* went to press, launch of the Soyuz-TMA3 taxi mission was still scheduled for 18 October. Pedro is accompanied by NASA Astronaut Michael Foale and Russian Cosmonaut Alexander Kaleri, who will become the Station’s new resident crew. Pedro’s 8 days aboard the Station will be packed with a wide range of experiments and activities. He will return on 28 October with the current residents of Yuri Malenchenko and Ed Lu in the older Soyuz-TMA2.

ESA Astronaut Pedro Duque will perform a wide range of experiments aboard the ISS ...

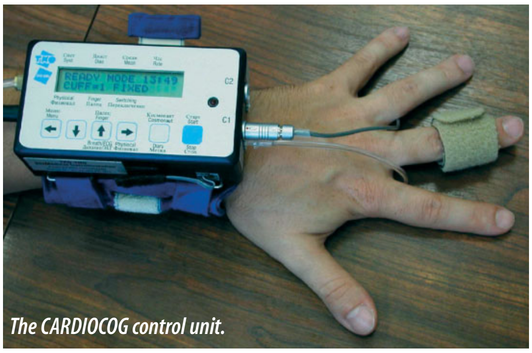
Progress-M48’s delivery in August included:

– ***WINOGRAD***, a student experiment to observe how a column of bacteria grows in weightlessness. On Earth, they stratify as the waste generated by one layer feeds those below. The perishable biological material meant the ESA team could not finalise the package and load it aboard Progress until a few hours before launch. It was activated by Malenchenko and Lu soon after it was transferred into the ISS. Future missions may use such a system to convert waste into air, water and fuel.

The WINOGRAD launch package.

Pedro (right) and Alexander Kaleri (centre) training with PROMISS. ESA Astronaut Reinhold Ewald is at left.

– the activation unit for the biology experiments in the Aquarius incubator, already in orbit since the Belgian/ESA mission of October 2002;
– the CARDIOCOG consumables and power connector to continue the ***RHYTHM*** and ***STRESS*** investigations started during Odissea. RHYTHM will look at how the cardiovascular system adapts to weightlessness and readapts to gravity. STRESS will measure the stress response of humans in space.



The CARDIOCOG control unit.

– ***NEUROCOG*** consumables to continue Odissea research into spatial perception in the absence of a gravitational reference.
– consumables to continue Odissea’s ***Lightning and Sprite Observations*** of visible effects in the ionosphere connected with thunderstorms and earthquakes.
– ***PROMISS-2*** to grow protein crystals by the capillary counterdiffusion technique, recorded by a digital holographic microscope.

- commercial ***Blood-pressure Measurement Instrument*** (BMI) to investigate how circadian rhythms are affected in space.
- ***SYMPATHO*** blood sampling kit to see if the drop in adrenalin during the first 24 hours in space is followed by a rise as a result of a pronounced drop in blood volume.

Progress-M48 was the third ferry to deliver Cervantes hardware. First up was Progress-M47, launched 2 February, with spare parts to repair the Microgravity Science Glovebox (MSG) in time for Pedro's research. At that time, Cervantes was scheduled for 26 April but it was then postponed following the *Columbia* tragedy.

Progress-M1-10, launched 8 June, brought:

- ***NANOSLAB*** electronics unit to replace the failed Odissea hardware to study zeolites. These are crystals with micropores that allow them to absorb or hold onto other materials, an ability of great interest to the petrochemical industry. This experiment aims to create more effective crystals by mixing different zeolite solutions with a range of crystal-forming catalysts.
- ***PROMISS-2*** support equipment.
- ***WINOGRAD*** battery kit.

The APIS launch package.

- ***APIS*** educational experiment to highlight how rotation of an object varies with different mass distributions.
- ***THEBAS*** educational package to show the motions of small spheres or liquids in a sealed transparent container on the end of a spring-loaded pendulum.
- ***VIDEO-2*** educational kit to film Newton's Three Laws of Motion in action.

The THEBAS launch package.

- ***CREW RESTRAINT*** for mounting on a rack in the US Destiny module to see if knee restraints are easier than foot restraints for holding a working position.
- ***3D CAMERA*** to record stereoscopic images of the Station.
- ***SYMBOLIC*** pouch with items for Pedro's public relations events.

More equipment will be carried by Pedro's Soyuz, bringing his mission total to 85 kg:

- biological containers for ***AGEING***, ***GENE*** and ***ROOT***. AGEING studies the accelerated ageing in microgravity of different fruit fly strains. GENE studies the damage to fruit fly genes. ROOTE studies the effects on *Arabidopsis Thaliana* root cells.
- ***MESSAGE*** biological containers to continue Odissea research into the effects of space conditions on metabolic processes in bacteria.
- ***PROMISS-2*** material container.
- ***NANOSLAB*** experiment unit.
- ***CHONDRO*** student experiment to look at growing replacement cartilage in space.

The AGEING fly containers.

Pedro will also take part in medical checks (***MEDOPS***), radio contacts with students using the Amateur Radio on ISS (***ARISS***, see the 'Habla ISS' news item on p23),photographic and video work, and public relations activities. Medical data will be collected before and after flight, for comparison with those recorded in space. This also covers ***CHROMOSOMES***, to assess the genetic impact of ionising radiation on the astronaut's blood, and ***AORTA***, which studies 'orthostatic intolerance', when someone cannot stand for 10 min after a flight because the cardiovascular system has adapted to weightlessness. AORTA's tests will use a computerised tilt table.

Pedro will perform the majority of the experiments in the Station's Russian segment. NANOSLAB and PROMISS experiments will use MSG in Destiny, where CREW RESTRAINT and MEDOPS are also based under dedicated agreements with NASA. ■

Further information on Pedro Duque's mission can be found at: *www.spaceflight.esa.int/cervantes*

Open for Business

The European ISS Business Club is Launched

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Nicola Springorum
Secretariat, European ISS Business Club

Introduction

Officially unveiled at the Paris Air Salon on 19 June 2003, the European ISS Business Club (IBC) is now open for business. ESA's Director of Human Spaceflight, Jörg Feustel-Büechl, together with Europe's industrial contributors to the ISS, presented the IBC's objectives and opportunities publically for the first time.

A new initiative is promoting the ISS and its European industry contributors ...

Against the background of the long-term utilisation opportunities offered by the ISS, Mr. Feustel-Büechl explained before numerous representatives of Europe's space and non-space companies and the press the opportunities that this innovative high-technology network will offer. The IBC provides the companies contributing to the European elements of the ISS with new business opportunities through contacts with other industry sectors and geographic regions and by enabling closer contacts with ESA.

The IBC is an industry club open not only to 'traditional' space industry but also to companies from other sectors and of different sizes. Joining ESA on stage at the Salon were companies representing the broad spectrum of contributors to the Station's European elements: Lufthansa Flight Training, IBM, W.L. Gore and Johann-Maier.

ESA Astronaut Frank De Winne outlined the importance of European suppliers for manned spaceflight activities: 'The products supplied and integrated in international cooperation enable the human presence in space. The ISS is an outstanding example of international cooperation at all levels, and the integration of all technology is the highest requirement to meet. Not only the astronauts, but also the scientists, depend on the reliability and the high quality of the products and services delivered by the suppliers. We must make sure that the system is available at any time, so we have to spend less time on maintenance and repair and can devote more attention to scientific research. The reliability of products and services is essential to the success of human spaceflight.'

Background to the IBC

'Space already exists for Europe, thanks mainly to ESA, so the question is what do we do there,' says Antonio Rodotà, then ESA's Director General. 'It's our job to make sure that all the opportunities are anticipated and all the challenges are met.' During its first 27 years, ESA has raised Europe into a major space player, highly self-sufficient in most aspects of space technology and a world-class innovator. ESA provides a vision of Europe's future in space, and of the benefits for people on the ground. It develops the strategies to fulfil the vision, through collaborative projects in space science and technology.

It was therefore a natural progression to establish the European ISS Business Club under ESA's aegis in order to bring together competence in space technologies and excellence in terrestrial markets. The IBC serves as a networking platform to connect ESA and

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different companies from different sectors and to foster business contacts between them.

Trademark

In addition to services provided to individual members, general promotional activities will establish the IBC logo as a brand in Europe. The registered trademark symbolises the 'value chain' of the suppliers to the ISS, from the smallest contributions, such as bolts or cables, to services and the entire ISS system. Only IBC members are granted the right to use this trademark for marketing and communication purposes.

The Club also offers comprehensive communication services: internet activities, brochures, visual materials, year books, calendars and support services for companies' own communication activities. The coordinated activities offered throughout the year focus on business-to-business services and contents. Under the label '*IBC meets ...*', first-class events will be organised to enable member companies to establish direct contacts with ESA and companies from other sectors. This will give rise to new ideas and business opportunities. The IBC will thus extend the core competences of manned spaceflight into new business areas via concerted and systematic exchanges with other high-tech clubs and sectors, as well as regular meetings with other important players from European industry and politics.

Membership

Apart from the standard services included in the admission fee and the annual membership fee, the IBC offers its members exclusive and tailored services on a reimbursable basis. These include participation in jointly organised trade fair activities, touring exhibitions featuring the products and services of the members, visits to launch events, and the involvement of ESA Astronauts in corporate events.

The European IBC is open to all applicants who contribute products or services to the design, development, operation and utilisation of the European elements of the ISS. All companies from the space and non-space sectors fulfilling this requirement are eligible for membership.

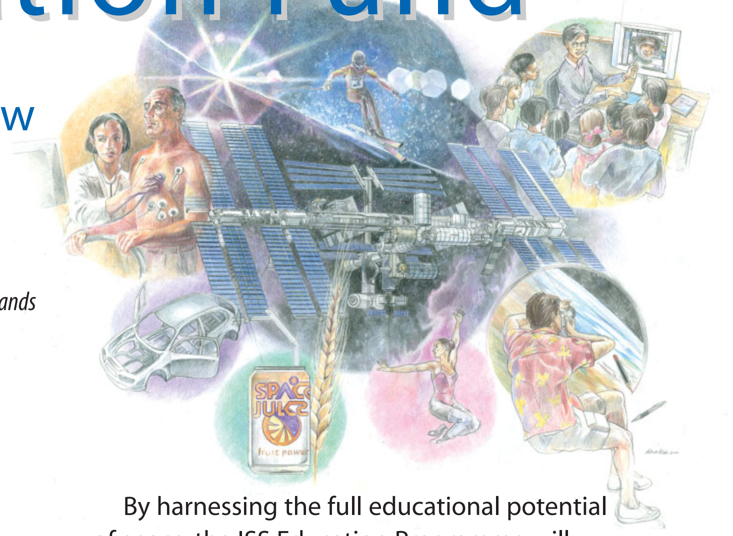
Unveiling the IBC. From left: N. Springorum (IBC-Secretariat); B. Bubelach (Lufthansa Flight Training GmbH); O. Lang (Johann-Maier GmbH); K. Haswell (Moderator); J. Feustel-Büechl (ESA); M. Wahl (W.L. Gore & Associates GmbH); P. Mackin (IBM). (All photos: T. Ernsting/IBC)

Conclusion

The launch of the ISS Business Club has established a new vehicle for ISS promotion, corporate promotion and enhanced business contacts. The IBC represents the interests of its members by actively promoting their excellence as industrial partners in the ISS. ESA invites all suppliers to join, not only to help promote the awareness and importance of manned spaceflight but also to present their contributions to European industry and the general public. ■

The ISS Education Fund

Investing in the Scientists of Tomorrow



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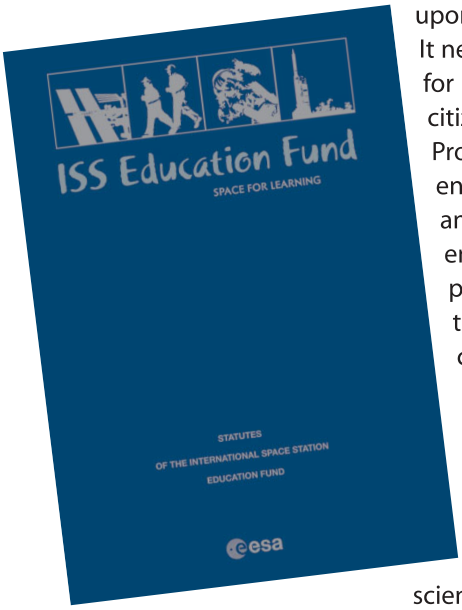
What is the ISS Education Fund?

The ISS Education Fund (ISSEF) was formally established by ESA in July 2002 to complement and fund activities of the ISS Education Programme. It is a purely non-profit entity, which seeks financial support from external individuals and organisations. This support will help the ISS Education Programme to achieve its goals and provide prestige and exposure to the organisations involved.

ESA has established the ISS Education Fund to support its Education Programme ...

Role of the ISS Education Programme

In order to become the leading knowledge-based society, Europe has to build upon its strong tradition of learning. It needs to cultivate the enthusiasm for learning that exists within its citizens. The ISS Education Programme capitalises on this enthusiasm and tradition, by seeing and using Space as more than an environment that holds the potential for discoveries. Space is the ideal classroom where we can capture the interest and imagination of children, building an understanding of natural and scientific phenomena. Once developed, this interest will encourage children to become university students in all scientific spheres.



At university level, the ISS Education Programme will further provide support and encouragement. Above and beyond the tools for learning scientific principles, university students will be able to access space to carry out their own experiments.

By harnessing the full educational potential of space, the ISS Education Programme will provide today's children and university students with the drive and means to become the scientists, engineers and decision-makers of tomorrow in increasing numbers. We will create a future in which European science and technology are at the forefront on the world stage.

What will the Fund do?

The ISS Education Fund will complement ESA's ISS Education Programme, which is developing educational activities for primary, secondary and higher education students of ESA member states. Such activities will focus on:

- developing, producing and distributing teaching materials in all 11 ESA languages for primary and secondary school students, with special efforts being made to target 12-15 year-old students of both sexes;
- helping to implement experiments submitted by university students and chosen by ESA to be carried out aboard the ISS, parabolic flights, sounding rockets or drop towers. This applies particularly to the life and physical sciences and their applications in space.

Where do the Fund Monies come from?

The money in the ISS Education Fund comes from two sources: ESA itself and external supporters. The initial seed funding of almost €1 million was supplied by ESA, along with additional administrative support.

Additional external funding can come from either individuals or organisations. This is

welcomed by ESA at all times to further the work of the ISS Education Programme. Participation is open to those individuals and organisations who recognise the importance of stimulating and harnessing the imagination and intellect of Europe's youngsters, and to those who want to support the creation of a more scientifically and technologically literate population.

Who can Become a Participant?

There are two categories of participation: honorary and funding.

Honorary participation is open to individuals from ESA member states with the appropriate qualities, expertise and experience. They will join by ESA invitation only.

Funding participation is open to organisations from industry, commerce, education and government. It is also open to individuals with the appropriate qualities.

Benefits of Participation

There are many benefits from becoming a participant in the ISS Education Fund. These include strategic, tangible and targeted benefits, such as:

- the prestige of being part of a major European space education programme;
- the opportunity to gain exposure for an organisation within high-level institutional organisations across Europe (including government ministries, the European Commission, educational bodies, and teacher associations);
- networking opportunities within industries and formal and informal events with senior representatives and key decision-makers;
- recognition in ISSEF publications and media;
- an invitation to sit on the Board of the ISS Education Fund;
- the opportunity for input into specific ISSEF projects.

How do Participants get these Benefits?

On the ISSEF website at *www.esa.int/issef* potential participants have access to information outlining the range of participation options.

For More Information

If you would like to know more about the Fund and how you can become a participant, please contact Fiona Wilson at Tel +31 71 565-6042; Fax +31 71 565-4499; *Fiona.Wilson@esa.int*

For further information:
www.esa.int/issef

Freezing Conditions

Cryosystem First Crew Review

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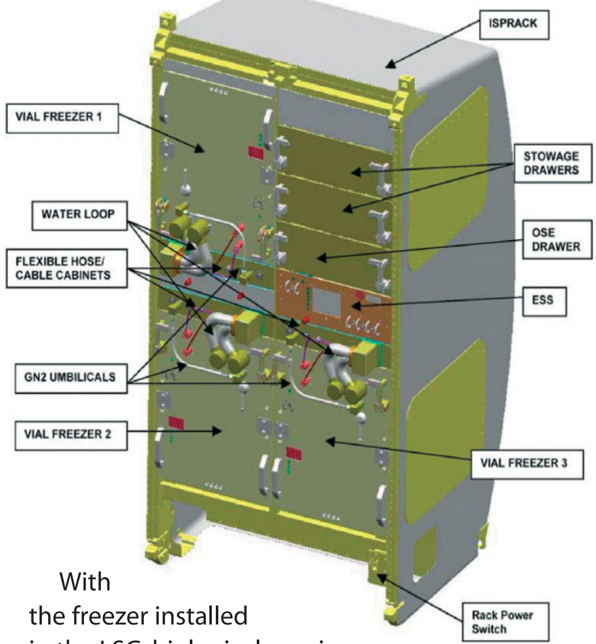


On track towards a cryogenic freezer for life sciences research aboard the ISS ...

Introduction

Once research aboard the ISS is in full swing, scientists will need a means for deep-freezing their biological samples. Cryosystem brings together a unique set of freezers for preparing, preserving and storing biological samples and protein crystals at ultra-low (–180°C) temperatures. It consists of the Cryogenic Vial Freezer (CVF), the Orbital Support Equipment (OSE) and the Cryorack.

ESA is providing Cryosystem to NASA as part of the barter agreement for the launch of Columbus and early access to research facilities aboard the ISS. Delivery of the first Flight Unit to the Kennedy Space Center (KSC) is planned for April 2007, and launch on utilisation flight UF-7 in late 2007. The first Crew Review for Cryosystem took place at KSC during 19-20 May 2003.

The Cryosystem

The heart of the system is the Cryogenic Vial Freezer. Contained within a drawer, it will offer:

- ultra-rapid cooling and snap-freezing of specimens such as tissues, eggs and cells;
- storage and preservation of pre-frozen biological samples and supplies in vials;
- transportation to and from orbit of specimens and supplies;
- transportation of specimens to/from other ISS racks, such as the Life Science Glovebox (LSG) and X-Ray Diffraction Facility (XCF).

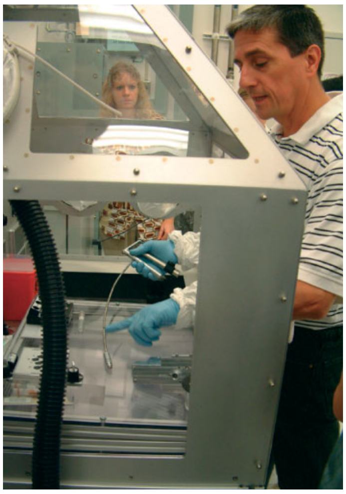
The CVF includes a Dewar capable of holding more than 800 2-ml or 500 5-ml vials, or a combination. Cooling is based on a high-capacity Stirling Cryocooler developed by Thales Cryogenics (NL).

With the freezer installed in the LSG, biological specimens will be removed surgically from a host, inserted into a specimen container and rapidly frozen over a period of several seconds to minutes. The crew will remove the quick-freezing tools from the freezer, transfer the sample from the surgical table to the dedicated tool and then insert the specimen container into the freezer using another tool.

If snap-freezing is chosen, the process is so rapid that the sub-cellular structure of exposed plant or animal tissue is preserved. During standard freezing, the water in cells forms large ice crystals that destroy the sub-cellular structures. With snap-freezing, the surface of the material is frozen almost instantaneously, producing only amorphous ice or very small ice crystals. Since the cooling begins at the surface and then propagates through the material, 'good freezing' is limited to a shallow surface region about 15 microns deep.

Snap-freezing uses a 'cryogenic gun' powered by a spring, which hammers the specimen down onto a postage stamp-sized copper block directly inside a vial.

The Cryorack, based on an International Standard Payload Rack (ISPR), provided by NASA, accommodates up to three CVFs plus two passive International Subrack Interface Standard (ISIS) storage drawers for the OSE and additional hardware. Cryorack will be housed in the Station's Centrifuge Accomodation Module. The CVFs and their valuable contents will be transported in the Multi-Purpose Logistics Module by the Shuttle.



Astronaut Don Thomas testing the specimen vials extraction tool.

The Crew Review

The Cryosystem Preliminary Design Phase (Phase-B) started in February 2002 and will be concluded by the Preliminary Design Review, planned for end 2003-beginning 2004. The industrial team consists of Astrium (D, Prime), L'Air Liquide (F, Vial Freezer), Damec/Innovision (DK, OSE and the scientific results) and Thales (NL, cooling system).

The project's main challenge is the combination of complex interfaces with other ISS facilities, particularly the Life Science Glovebox, severe cryogenic requirements and demanding operational scenarios that require intensive and crucial participation by the crew. For this reason, it was agreed with NASA to hold an informal crew review very early on in order to present most of the OSE prototype designs for an initial evaluation by the crew and the Human Factors Integration Team (HFIT). This evaluation will help to refine the crew interfaces and possibly reduce the development risks.

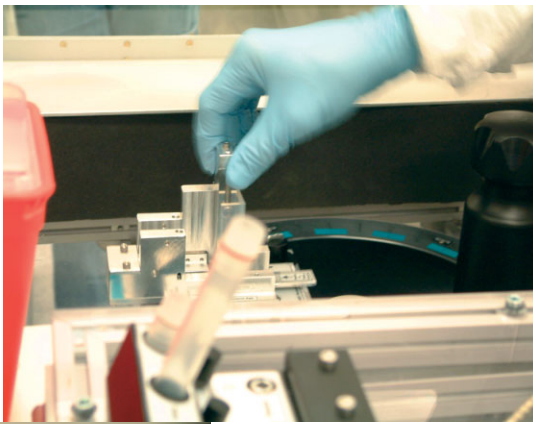
The prototype tools, together with a rough mock-up of the LSG working volume, provided by NASA, were integrated in the off-line laboratory for payload preparation reserved for the ESA freezers at KSC. Two HFIT teams followed the basic series of procedures prepared by Damec. One team included Don Thomas, one of the most experienced (four Shuttle missions) NASA astronauts. Their attention focused on:

- evaluation of the assembly and mounting of tools in the LSG Working Volume and any required access through the airlock;
- evaluation of tool handling, ease of use and compliance with performance requirements;
- evaluation of the CVF and tool interfaces with respect to the LSG;
- initial evaluation of the safety aspects in using the tools.

All of these tests were performed under ambient conditions – the cryogenic performance and safety issues were not evaluated.

Despite the prototype nature of the tools, all the basic operations could be performed and evaluated, showing that the design approach is correct. However, some important details need to be reviewed and modified in order to satisfy ergonomic constraints and the very strict timing requirements. In addition, some requirements established in a 'theoretical' way by similarity with ground operations proved to unrealistic.

All parties agreed that the review was well prepared by the developers and provided useful insights, both for refining the technical requirements and the more detailed design of the tools and system.

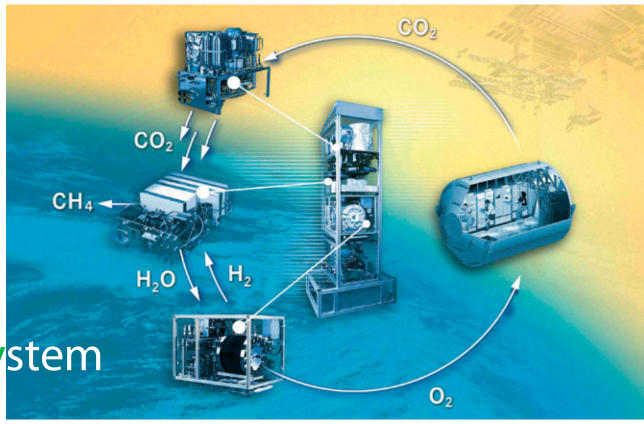


Preparing a vial for snap freezing.

Placing a specimen on the copper block for snap freezing.

The next Crew Review, to be held in the course of 2004, will provide practical confirmation of the design. The crew will then operate under more realistic and constraining ultra-cold conditions in order to verify satisfaction of the scientific requirements and operational safety.

ARES



Europe's Closed-Loop Air Revitalisation System

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Introduction

Mankind has been living on Earth for thousands of years without having to care much about fresh air. The vast ecosystem, with its well-balanced interaction between animals, plants and chemical processes in soil, sea and atmosphere, ensures a constant supply of oxygen and removal and transformation of exhaled carbon dioxide. It is little more than 100 years ago that humans began to live in confined spaces like submarines and aircraft, where fresh air does not come for free. The advent of manned spaceflight required new technology, because carrying air along into space comes at hefty weight and cost penalties: each kg costs $22 000 to deliver into orbit. An astronaut consumes about 800 g of oxygen per day and generates 1 kg of carbon dioxide.

Ideally, a closed-loop spacecraft life-support system would mimic Earth's ecosystem, reprocessing all waste into something useful. However, this is not possible with today's technology. We still need to design separate systems to address specific needs. Europe's Air Revitalisation System (ARES) is being developed to remove carbon dioxide from the cabin and to maintain the oxygen level.

A new life-support unit offers impressive savings for long space missions ...

The ARES Demonstrator Unit. CO_2 Concentration (top), CO_2 Reduction (middle) and Oxygen Generation in a half-width ISS Rack.

Atmosphere Revitalisation on the ISS

The baseline life-support systems of the ISS are spread around several modules. Units in the US Destiny and Russian Zvezda modules remove CO_2 and dump it overboard. Oxygen is produced by the 'Elektron' electrolyser in Zarya; the future Node-3 will carry a US-built electrolyser. These units electrically split water into hydrogen and oxygen; oxygen is fed into the cabin and hydrogen is vented overboard. Although some of the water comes from recycled waste water and condensate from the cabin, the system is basically an open loop. All the O_2 molecules in the exhaled CO_2 are vented overboard and thus lost to further use by the Station. As a consequence, more than 2 t of water has to be supplied to the ISS per year to generate oxygen for a crew of seven. The current grounding of the Shuttle fleet highlights how sensitive the Station is to water resupply – the predicted water shortage has forced a reduction in crew size to two.

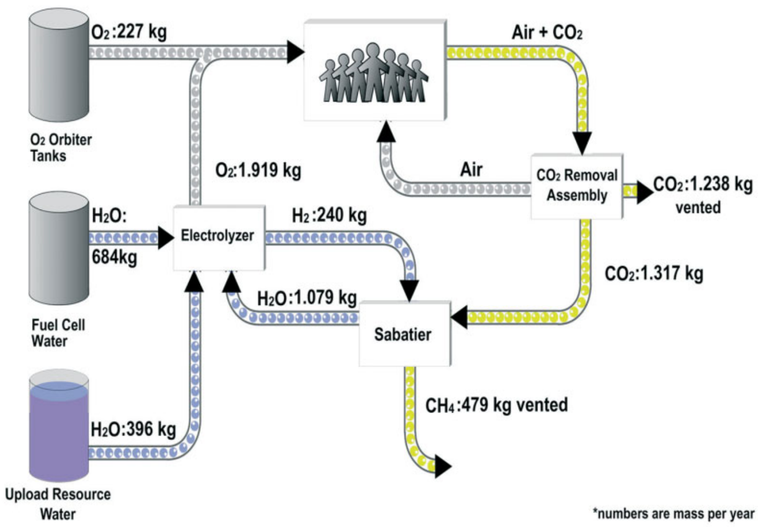
ARES

In Europe, work on closed-loop air revitalisation started 1985 using ESA and national funding. We now have a design capable of recycling carbon dioxide and recovering part of the oxygen used by the astronauts.

ARES has three functions: CO_2 concentration, CO_2 reduction and O_2 generation. The concentrator passes cabin air over a special solid amine resin to adsorb CO_2. Once the adsorber is fully loaded, the ventilation stream is switched to the second adsorber while the first is heated with steam. This drives out the adsorbed gas, which is fed into the reprocessing stage. This stage applies the Sabatier process: CO_2 and hydrogen react over a catalyst to form methane and water. The water is routed back to the oxygen generator; the oxygen produced there is added to the cabin air while the hydrogen is returned to the CO_2-reprocessing stage.

ARES can produce significant savings for long missions: more than 1000 kg of water per year for a crew of seven, which translates into launch-cost savings of $30 million. The methane in the present system is vented

The ARES principle: oxygen is recovered from carbon dioxide in a 3-step process.

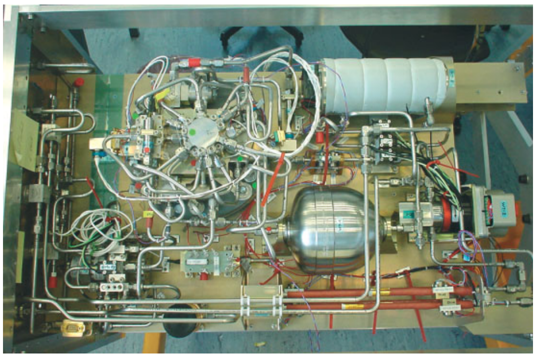


ARES for a crew of seven. The Sabatier process can save 1079 kg of water per year.

overboard. A future add-on could reprocess the methane to raise the level of loop closure.

During the selection of technologies, special care was given to their integration into a complete system. No special interfacing hardware like compressors or storage tanks are required in ARES. A condensate recovery stage with no moving parts is integrated directly into the CO_2 adsorber beds. Special design features ensure a constant CO_2 desorption flow for good compatibility with the CO_2 reprocessing stage. This stage contains a new catalyst, which can operate efficiently at moderate temperatures. Together with the chosen two-bed design, this results in low power consumption.

The oxygen generator is a 'fixed alkaline electrolyser'. The liquid feed water and the product gases always remain separate, so no gas-liquid separators are required. This produces a much simpler and more compact system, which has the additional benefit of lower noise and microgravity disturbance.



The Favorite electrolyser experiment during assembly.

Development Status and Plan

The ARES technology has been demonstrated as an integrated system, with all three subassemblies integrated into a demonstrator and tested as a system. An 800 h test in a closed chamber confirmed that all systems work together efficiently.

A joint study with NASA has shown the benefit of ARES technologies for the ISS. Although it has the added function of CO_2 reprocessing, the lighter ARES would occupy half a rack less and use considerably less power than the baseline system.

In order to increase the maturity of system design and integration, an Elegant Breadboard of ARES will now be developed. All hardware will be similar to Flight Models in form and function. Electrical and electronic assemblies, however, will be laboratory-standard hardware. It will be assembled into a Station rack simulator to prove the packaging concept. By the end of 2004, the complete system will have been integrated and tested.

The ARES Elegant Breadboard is partially financed within ESA's STEP (Studies, Technology and Evolution Preparation) programme, with participation from Belgium, The Netherlands and Switzerland. Verhaert (B), Bradford Engineering (NL), Iberespacio (E) and HTS (CH) are subcontractors . System responsibility is entrusted to EADS-Space Transportation (Friedrichshafen, D).

Some elements of the electrolyser are potentially sensitive to microgravity, so the 'Favorite' experiment will test a scale version on the Foton-M2 mission in 2005. Favorite will demonstrate critical operations like start-up, shut-down and day/night cyclic operation. On the ISS, the electrolyser will probably be operated only during orbital daytime when the solar panels deliver power. Favorite is funded jointly by ESA and EADS-ST.

After this phase, we will be ready to begin building the ARES Flight Model.

Conclusions

By steady technology development and an integrated system approach, Europe has created a highly competitive closed-loop air revitalisation system. ARES technology will reduce operations costs on long space missions; it is essential for planetary missions and bases. It can also be valuable on Earth. For example, CO_2 concentration is already being used aboard submarines and studies show that ARES can cut the fuel consumption of commercial aircraft by reducing the need for external air supply to passenger cabins.

More information on ARES can be found at *http://www.ecls.de*

European Transport Carrier

Supporting ESA's Science Facilities on the ISS

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Introduction

ESA's European Transport Carrier (ETC) will be launched aboard Columbus as part of the 1E mission complement of five ESA payload racks and two external platforms. It will carry payload items that cannot be launched within the ESA facilities because of stowage or transport limitations. In orbit, ETC will serve as a workbench and stowage facility to support experiments with Biolab, Fluid Science Lab (FSL), European Physiology Modules (EPM) and European Drawer Rack (EDR).

The European Transport Carrier will be one of ESA's five facilities aboard Columbus at launch ...

ETC's secondary use is within the Multi-Purpose Logistics Module (MPLM) after it is eventually replaced in Columbus by an active experiment rack. (ESA currently 'owns' five rack positions, all are active/powered positions.) It will then act as a logistics carrier between Earth and the ISS for the Columbus ESA payload racks. It is designed for 15 launches, and can be reconfigured on the ground to the specific stowage needs of each flight.

In general, ETC will stow and transport commissioning items, complementary instruments, consumables, flight and orbital support equipment, orbital replaceable units, resupply items and science items like experiment containers and consumables.

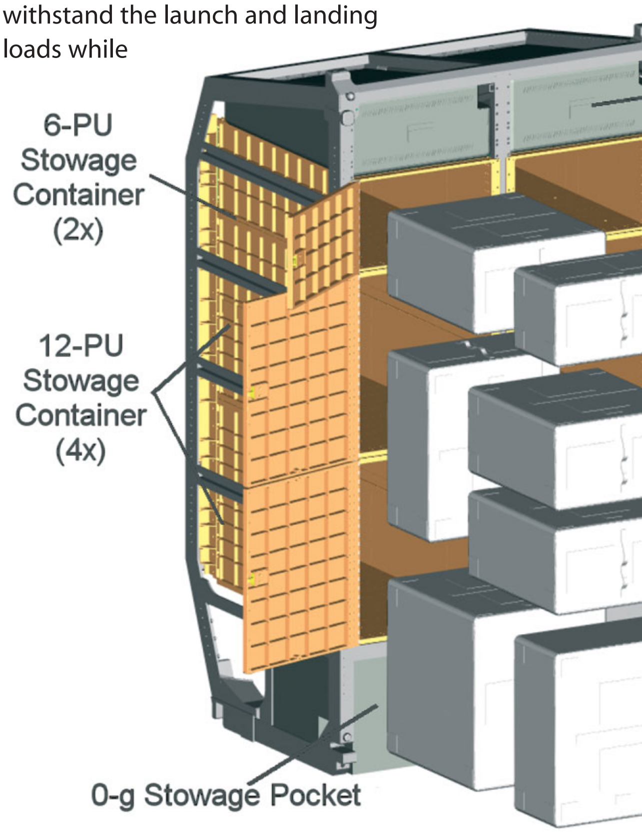
The ETC frame at OHB-System.

ETC Concept

All European payload items will be transported and stored in ESA's Cargo Transfer Bags (CTBs). These are Nomex bags in four standard sizes (half, full, double and triple) with removable, reconfigurable dividers. ETC, MPLM and the Automated Transfer Vehicle (ATV) can carry them. Aboard the Station, they will be used extensively for 'small item' transportation and storage.

ETC's design is based on the Japanese International Standard Payload Rack, equipped with rigid stowage containers in optimised sizes for flexible accommodation of CTBs. There are two smaller containers of 6-PU (1 Panel Unit = 44.45 mm height) for full- and half-size CTBs. Their inner volume is about 1.5 middeck locker equivalents (MLE, referring to the CTB-compatible Shuttle middeck lockers). The four 12-PU containers offer about 3 MLE. They can be filled with any combination of CTBs, up to the triple-size.

All stowage containers are designed to withstand the launch and landing loads while



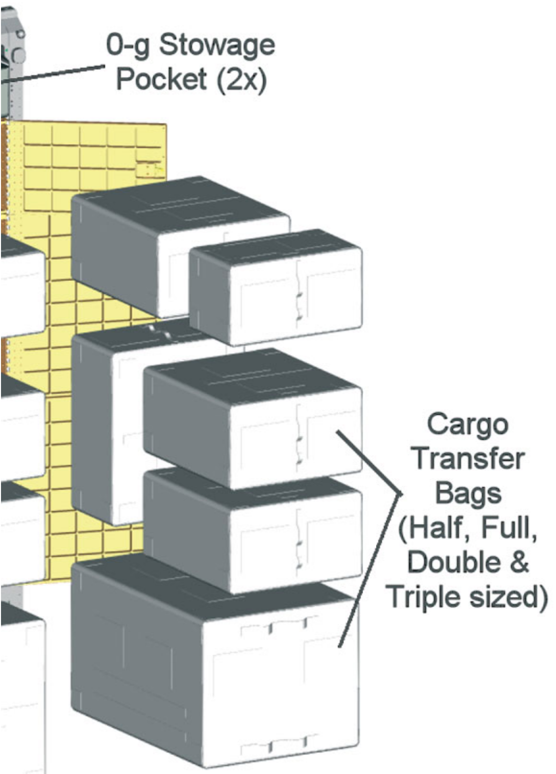
Full-size Cargo Transfer Bag (CTB).

carrying their stowage contents. In addition, ETC's Zero-g Stowage Pockets (ZSPs; two upper, one lower) allow on-orbit use of the remaining internal volume. They can be filled only in weightlessness and cannot be used for transport.

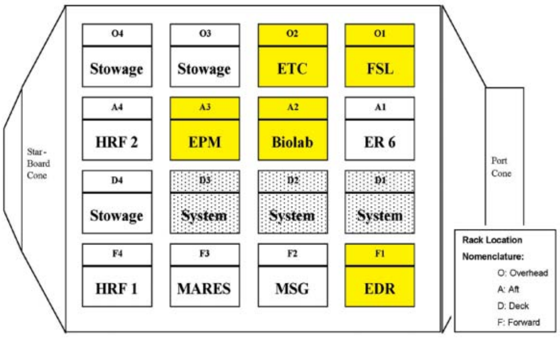
OHB-System is ETC's prime contractor, and is also responsible for packing the CTBs and the ETC for launch. Phase-C/D began 6 November 2002, with the Preliminary Design Review 25/26 February 2003 and the Critical Design Review 17/18 July 2003. ETC, fully outfitted with its CTBs and their contents, will be delivered to Astrium in Bremen (D) in January 2004 ready to be slotted into Columbus.

Cargo Transfer Bag dimensions and capacities.

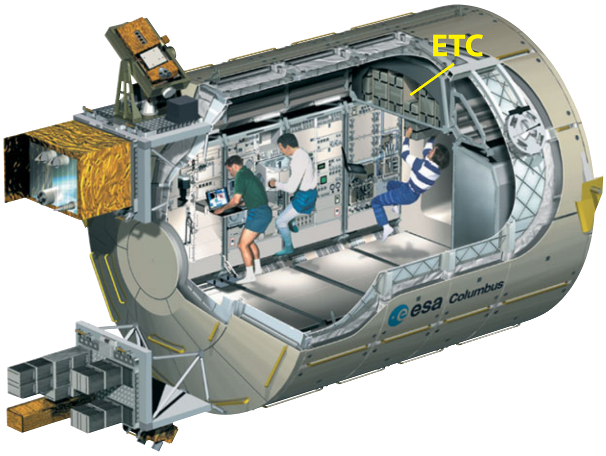
	Approximate Sizes		Mass	
CTB type	External L x W x H [mm] / [l]	Internal L x W x H [mm] / [l]	Max (total) [kg]	Bag (tare) [kg]
Half	248x425x235 / (24.8)	232x410x219 / (20.8)	13.62	1.0
Single	502x425x248 / (53.0)	486x410x232 / (46.2)	27.24	1.7
Double	502x425x502 / (107.0)	486x410x460 / (91.6)	54.48	2.0
Triple	749x425x502 / (159.8)	733x410x460 / (138.2)	81.72	2.7



European Transport Carrier: facility overview.



Columbus will be launched with five ESA payload racks. The configuration has changed since the artwork was created; the line drawing shows the new baseline.



ETC Performance

ETC can carry more than 400 kg of payload and experiment items, totalling up to about 800 litres. On-board the ISS, ZSPs extend capacity to about 1000 litres:

Up/download capacity	410 kg
Columbus launch capacity	275 kg
Total transport/stowage volume	797 litres
ZSP volume	200 litres
Total usable volume on-orbit	997 litres

Conclusion

The ETC facility accommodates items for transport and stowage based on standardised Cargo Transfer Bags. The CTBs are compatible with the ISS standards for transport (MPLM, ATV) and use onboard Partner modules (Destiny, Kibo, Columbus). The modular ETC design, based on rigid stowage containers, offers maximum flexibility for handling different CTB sizes. The ETC configuration for the Columbus launch (ISS assembly flight 1E) has already been selected and optimised for the items that are needed by the European payload facilities during their first on-orbit increment. ■

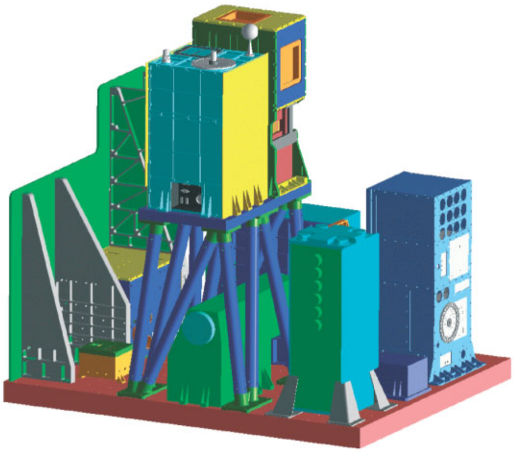
ETC's planned cargo for the Columbus launch.

Facility	# of items	Mass [kg]	Vol [l]
Biolab	55	81	99
EPM	48	65	248
FSL	40	53	104
EDR	10	?	?
EPM - NASA box	1	30	35
Total (ex-EDR)	**154**	**229**	**486**

Total launch mass: 500 kg (ETC empty 225 kg; CTBs empty 23 kg; payload 252 kg)

EuTEF

The European Technology Exposure Facility



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Introduction

The European Technology Exposure Facility (EuTEF) will be mounted outside the Columbus module carrying experiments requiring exposure to the space environment. Following ESA's 1997 *Announcement of Opportunity for Early Utilisation of the Space Station*, a grouping of 18 experiments, including a robotic arm, was selected to become EuTEF, flying before Columbus was available. They were to be carried on an Express Pallet by the Space Shuttle for installation on the Station's Truss S3 zenith site. The continual shifting of the launch dates of Station elements and the delay in producing the US Express Pallet forced serious reconfigurations upon EuTEF. The robotic arm, intended to manipulate and monitor some experiments, was removed, so all the robotic experiments were deleted. The Express Pallet delays pushed departure beyond the launch of Columbus, when ESA's own Columbus External Payload Facilities (CEPF) would become available. As a result, EuTEF and the SOLAR Sun telescopes were shifted to CEPF.

Columbus will be accompanied at launch by a set of experiments for exposure to space conditions ...

Mock-up of MEDET.

Facility

The experiments and facility infrastructure are accommodated on the Columbus External Payload Adapter (CEPA), consisting of an adapter plate, the Active Flight Releasable Attachment Mechanism (A-FRAM) and the connectors and harness. The experiments are mounted either directly on the Adapter plate or a support structure that elevates them for optimum exposure to the ram (direction-of-flight) and zenith directions.

The facility infrastructure consists of a Data Handling and Power Unit (DHPU) and its thermal control system, which translates the services from Columbus. It receives two feeds of 120 Vdc from the CEPF via the A-FRAM connectors. Feed 1 is converted to 28 Vdc as the experiments' primary supply; feed 2 is only for survival heaters, in case feed 1 is lost. Inside EuTEF, the DHPU distributes data using a MIL-1553B interface, providing a serial RS422 link for specific interfaces. The link to the CEPF uses an Ethernet connection and a MIL-1553B.

Additionally, temperatures are measured autonomously at several points on EuTEF while the assembly is unpowered.

Experiments

EuTEF can accommodate six 'standard' experiments, each of 30x30 cm footprint, 60 cm height and up to 30 W continuous (50 W sequenced) power. Unlike the later additions, the experiments remaining from the original configuration do not conform to these values. In total, the payload mass is < 350 kg, requiring < 450 W peak. The first round of experiments consists of:

– MEDET, material degradation in space (CNES, ONERA, Univ. Southampton, ESA);
– DOSTEL, radiation measurements (DLR Institute of Flight Medicine);
– TRIBOLAB, tribology properties of materials in space (INTA, INASMET);
– EXPOSE, photobiology and exobiology (Kayser-Threde, under ESA contract);
– DEBIE-2, micrometeoroid and orbital debris detection (Patria Finavitec, under ESA contract). Shares a standard berth with FIPEX;
– FIPEX, atomic oxygen detector (Univ. Dresden). Shares a standard berth with DEBIE-2;

- PLEGPAY, plasma electron gun payload for plasma discharge in orbit (Laben, under ASI contract);
- EuTEMP, an experiment candidate to measure EuTEF's thermal environment during unpowered transport from the Shuttle to the CEPF. (EFACEC, under ESA contract).

Integration and Installation

The experiments are being qualified separately before installation on EuTEF, where they will then be functionally tested with the facility electronics. The integrated facility will, after electromagnetic compatibility tests and possibly a system-level thermal-vacuum test, undergo Columbus Rack-Level Test Facility interface verification to be accepted for installation on the CEPF. After receiving the Flight Readiness Certificate from ESA, EuTEF will be shipped to Spacehab, Inc in Florida to meet the Integrated Cargo Carrier (ICC)-lite that will host it in the Shuttle cargo bay. After installation of EuTEF and SOLAR on the ICC-lite, they will be handed over to NASA's Shuttle team. Aboard the Shuttle, 28 Vdc will power the 'stay-alive' heaters.

Mission 1E will first attach Columbus to the ISS and power it up. A spacewalk on day 6 will install, first, EuTEF and then SOLAR. Before EuTEF is moved, its stay-alive heaters will prepare for the unpowered 5 h phase (the battery-powered EuTEMP will monitor the temperatures). An astronaut strapped to the Station's Canadarm2 will release EuTEF from the ICC by activating the A-FRAM. It will then be pulled from its soft-dock magnets and hand-delivered to the CEPF. Power feed 2 will immediately activate to ensure survival of the payload in cold conditions.

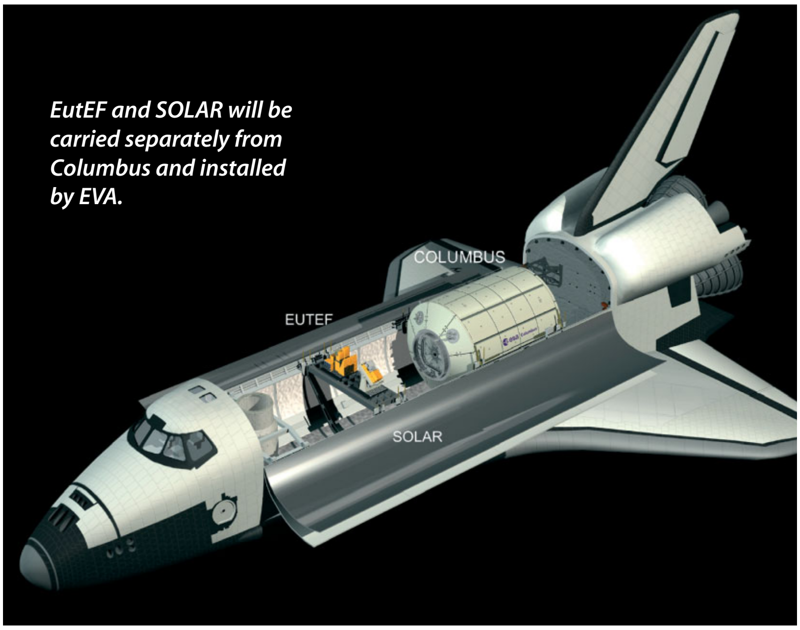
Operation

The survival heaters will raise the temperature so that the DHPU can be switched on after about 24 h to receive power from feed 1. The DHPU will sequentially power up all the experiments, allowing for the specific needs of several that could endanger the whole payload complement. Thirty days after switch-on, EuTEF will be considered as operational. After about 3 years, the experiments will be swapped for a new batch, yet to be selected.

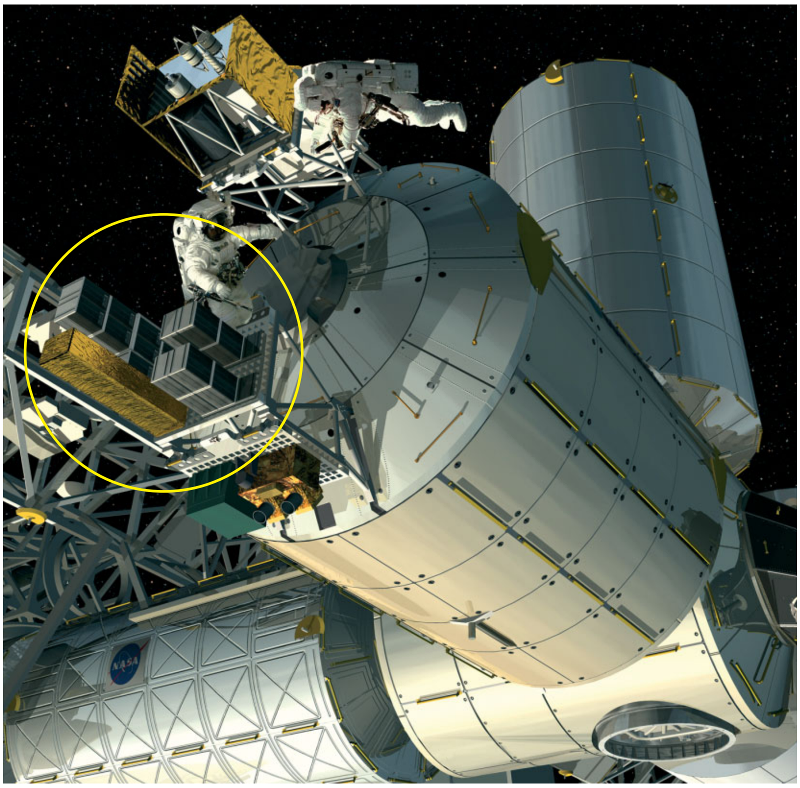
Ground Operations

The scientific and housekeeping data will be downlinked via the Columbus Data Management System into the ISS. The Columbus Control Centre in Oberpfaffenhofen (D) will relay them to the EuTEF Facility Responsible Centre (FRC) in ESTEC's Erasmus Center. Here, the required data will be extracted and forwarded, for example, to the respective Principle Investigators (PIs).

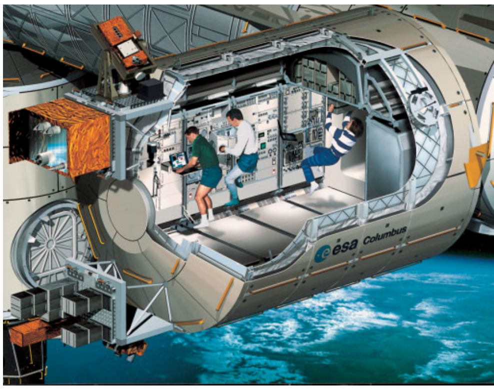
EuTEF commands, restricted to parameter uploads to change, for example, experiment modes, will come from the PI sites into the FRC. The validation of commands and resources and verification of timelines will be performed in the EuTEF Control Centre (ECC), which will then return them to the FRC for upload, using the Columbus/ISS channels.



EutEF and SOLAR will be carried separately from Columbus and installed by EVA.


EuTEF (circled) will be attached to Columbus. (ESA/D. Ducros)

Experiment Planning for ISS and Columbus



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Introduction

Although Europe's Columbus laboratory is not yet in orbit, European experiments are already being performed aboard the International Space Station, and more are in preparation. European Soyuz Taxi Flights provide a continuing and significant number of experiment opportunities, and agreements with NASA are important, in particular, for experiments in human physiology. Beyond these, the experiments for the increments after Columbus is attached to the ISS are being prepared. This article describes the selection and planning process for the various opportunities, the facilities used and the planned experiments per discipline.

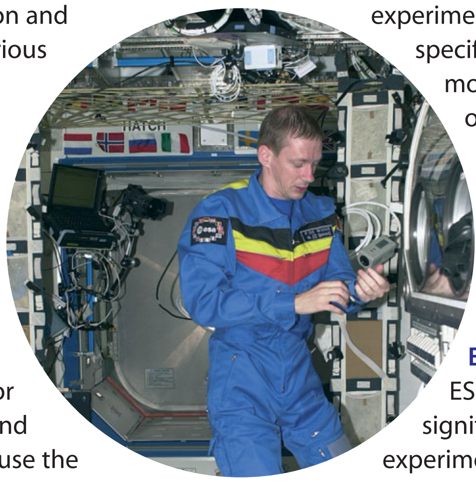
The first sets of experiments for Columbus are being prepared for flight ...

Selection and Planning

ESA publishes Announcements of Opportunities (AOs) in life and physical sciences at regular intervals, plus AOs for science, Earth observation and technology experiments to use the external platforms on Columbus. All proposals are 'peer reviewed' by external experts using a very thorough procedure. In many cases, this is now done in an international setting, involving proposals from all ISS Partners. At this stage, an initial technical assessment is also made of facility and resource requirements in order to identify possible show-stoppers. On average, some 15-20% of all proposals survive this review process.

For the endorsed projects, the next step is a definition phase. This is a more detailed accommodation study, which identifies the most appropriate experiment facility, and the hardware and resource requirements for each experiment. Following this, if needed, the definition and development of experiment-specific equipment is carried out. For example, this can be the development of standalone equipment for a Soyuz flight, an insert for one of the Columbus facilities or dedicated items for human physiology experiments. Depending on the complexity and the overall mission schedule, this phase can take between 6 months and 3 years.

Roughly 3 years before flight, the experiment will be manifested for a specific ISS increment. From that moment on, it appears in the overall ISS experiment planning, which is formally baselined by NASA with input from ESA and other Partners.



Soyuz missions provide one route for experiments to the ISS.

Pre-Columbus Experiments

ESA has already performed a significant number of experiments through Europe's three Soyuz flights so far (Claudie Haigneré, November 2001; Roberto Vittori, April 2002; Frank De Winne, October 2002). Almost 50 experiments covered medical research, materials sciences, biotechnology, Earth observation and technology. Several educational experiments were carried out in cooperation with schools in Europe, explaining the basic facts of space, weightlessness and the fun of science in general. Two more European Soyuz flights are imminent, carrying 30 experiments: Pedro Duque (October 2003; see pp4-5 of this issue for further information) and André Kuipers (April 2004).

These Soyuz missions are very restrictive in terms of up/download, crew time and preparation time, particularly if dedicated equipment has to be developed. In general, the time between mission approval and launch date is (sometimes significantly) less than a year. Nevertheless, experience shows that it is still possible to define and carry out a mature scientific programme. It is expected that building up the 'furniture' of the ISS with more experimental facilities will increase the efficiency of this type of mission. A good example is the ESA-developed Microgravity Science Glovebox (MSG), which has provided the basic services and environment for seven physical science facilities that otherwise would have been too cumbersome to be developed or launched as part of a Soyuz mission.

In the aftermath of the *Columbia* accident, studies are under way to exploit the knowledge gained during Europe's Soyuz missions to define experiments requiring virtually no upload at all.

In addition to the Soyuz flights, NASA carries out European human physiology experiments on the ISS as part of agreements in the International Life Sciences Strategic Working Group (ISLSWG). Two have been completed, and ten more are planned.

First Columbus Experiments

Columbus will be launched carrying its major scientific facilities. This unique feature ensures that research can begin immediately after the commissioning phase. As a result, the first batch of experiments are now being prepared, the intention being that the experiment-specific inserts and consumables be launched on the UF-3 utilisation flight a few months after Columbus arrives. The second batch of experiments is already defined, to fly about a year after the first.

A 'scorpionaut' will fly on Columbus to aid research into biological clocks.

The facilities being carried by Columbus are: Biolab, Fluid Science Lab (FSL), European Physiology Modules (EPM) and European Drawer Rack (EDR). The Materials Science Lab (MSL) will be delivered to the US Lab Destiny a few months later. The European Modular Cultivation System (EMCS) will also have been in use for a few months by then.

All of the experiments currently in preparation are described briefly below and in the tables.

Biology

Several experiments are planned for EMCS and Biolab, which will also host some US experiments under the ISLSWG agreement.

EMCS experiments deal primarily with the effects of gravity on plant cells, roots and physiology. They have the potential of finding applications in food production on Earth and in space. Biolab, as a highly versatile facility that can process all kinds of biological samples almost automatically, will accommodate a variety of biology experiments on cells and small organisms. They include the first 'scorpionaut' in space, to study the influence of the space environment on the

Biology

The Internal Coupling of Biological Clocks and its Susceptibility to Gravity Deprivation	E.R. Horn (D), G. Fleissner (D)	Exposure of scorpions to µg will help the analysis of entraining and coupling mechanisms of biological clocks and will contribute to the analysis of disturbances of clock systems in humans, by measurement of physiological parameters with circadian patterns (i.e. locomotion, eye responsiveness, O_2 consumption, cardiovascular activity) without nutritional care: scorpions tolerate a total lack of food and water for >6 months.	Biolab
Threshold Acceleration for Gravisensing	G. Perbal (F), D. Driss-Ecole (F)	The goal is to determine the threshold acceleration provoking a significant curvature, and to analyse the movement of statolith to estimate the potential energy dissipated in lentil (Lens culinaris).	Biolab
Gene, Immune and Cellular Combined Space Flight Conditions: Triple-Lux Assay	B. Hock (D), G. Horneck (D), P.D. Hansen (D), P. Rettberg (D), C. Baumstark-Kahn (D), G. Reitz (D)	To understand further the cellular mechanisms underlying the aggravation of radiation responses, and the impairment of the immune functions under spaceflight conditions, through induction of gene activation, phagocytosis and DNA repair, following DNA damage in vertebrate and invertebrate immune cells. The biosensor test battery Triple-Lux will be used.	Biolab
Waving and Coiling of Arabidopsis Roots: Interaction of Circumnutation and Gravitropism in 1g and Uncoupling in µg	G. Scherer (D)	To observe how wild type Arabidopsis roots grow in space and predict that without interfering gravity they will grow in spirals, verifying the endogenous nature of circumnutation-like growth imbalances in this plant root.	Biolab
Cellular Response to Radiation in Space: the effect of single and combined spaceflight conditions on mammalian cells	C. Baumstark-Khan (D), D. Horneck (D), G. Reitz (D), G. Obe (D), C. Johannes (D)	The experiment will investigate the influence of spaceflight conditions on gene expression, radiation-induced apoptosis, DNA damage and repair, and chromosome damage in mammalian cells (radiosensitive Chinese hamster ovary cells). New hardware for attached cell cultures will be developed, allowing (automatic) in-flight radiation exposure to a radioactive source (63-Ni), and either fixation, or immediate on-board analysis, of green fluorescent protein.	Biolab
Mechanisms and Functional Consequences of Protein Kinase C Isoform Translocation Inhibition in Monocytes Exposed to µg	M. Hughes-Fulford (USA), J.P. Hatton (USA), A. Cogoli (CH)	The experiment aims to: 1) characterise the µg effect on the activation of Protein Kinase C (PKC) isoforms and their spatial distribution; 2) determine the µg-effect on PKC-regulated genes controlling monocyte differentiation, initiation of apoptosis and cell cycle arrest; 3) restore µg-inhibited PKC isoforms by application of translocation enhancers and determine whether these agents can restore expression of genes perturbed by µg.	Biolab
Involvement of Rho Family GTPases in Gravity Perception and Reaction	B.V. Nusgens (B), C.M. Lapiere (B), L. Vico (F), A. Guignandon (F), M. Aumailley (D), T. Krieg (D), B. Eckes (D)	The µg-effect on GTPase participation in early cell-matrix interactions, nucleation of focal adhesins and formation of stress fibres in human fibroblasts and osteoblasts will be analysed. A µg-induced RhoA-dependent effect of signalling from integrins to GTPases and to the cytoskeleton is expected. The long-term objective is to devise pharmacological tools to prevent space pathologies and related terrestrial diseases.	Biolab
Characterisation of the Effects of Microgravity on the Mechanism of Action of Vitamin D in Osteoblasts	R. Bouillon (B), G. Carmeliet (B)	Three aspects of the changed gene expression in mouse bone cells observed in previous flights will be studied in more detail: 1. the subcellular (re)distribution of the Vitamin-D receptor; 2. the role of the nuclear matrix proteins in the gene expression; 3. the interaction between the Vitamin-D receptor and its co-activators.	Biolab
Microgravity and Bone Cell Mechano-sensitivity	J. Klein-Nulend (NL), P. Veldhuijzen (NL)	The mechanism of mechanotransduction in bone cells under weightless conditions, and the phenomenon of µg-related osteopenia will be studied. The experiment will test whether µg affects the sensitivity of human bone cells to mechanical stress through a decrease in the early-signalling molecules involved in the mechanical loading-induced osteogenic response.	Biolab
Molecular and Plant Physiological Analyses of the µg Effects on Multi-Generation Studies of *Arabidopsis thaliana*	T.-H. Iversen (N)	There are 3 goals. The first tests the Plant Cultivation Chamber (PCC), designed for the test phase of EMCS, with Thale Cress (*Arabidopsis*) plants under space conditions. The second maps the variable gravity effects on the gene expression by cDNA microarrays. The third examines the circumnutations of different ecotypes and mutants of *Arabidopsis* hypocotyls using the EMCS video system in µg and on the 1g centrifuge.	EMCS
Analysis of a Novel Sensory Mechanism in Root Phototropism	J.Z. Kiss (USA), R.P. Hangarter (USA), R.E. Edelmann (USA)	The experiment deals with the influence of red light on root phototropism, and with the effects of red light added to blue light on hypocotyl phototropism. These tropisms are usually masked by gravitropism on the ground.	EMCS
Transgenic Plant Biomonitors of Space Flight Exposure	R.J. Ferl (USA)	Investigation to use reporter gene technology for molecular analysis of development and stress in plants during spaceflight. Design of second-generation of sensor promotors to refine definition of cellular biological impact of µg and spaceflight, including real-time and non-destructive observation of reporter gene activity.	EMCS
Early Development of Fern Gametophytes in Microgravity	S.J. Roux (USA)	The main goal is to further document the effects of µg on gene expression and on polarity development in single spore cells of the fern *Ceratopteris richardii*. A reflight of BRIC-12 (STS-93), with a 1g centrifuge (Biopack).	EMCS
Gravity Regulated Genes in *Arbidopsis thaliana*	G. Perbal (F), R. Ranjeva (F), A. Graziana (F), E. Carnero-Diaz (F), M. Pages (E), A. Goday (E)	The existence of gravity-regulated genes, whose experession depends (at least) upon the mechanism of gravisensing and the redistribution of hormones, are addressed. In transgenic *Arabidopsis* plants, several biomonitors will report the distribution of IAA and ABA at the tissue level in µg or in the 1g centrifuge.	EMCS
Short- and Long-Term Effects of µg on the Development of Rotifers and Nematodes	C. Ricci (I), F. De Bernardi (I), A. Zullini (I), G. Melone (I)	The experiment addresses the effects on the developmental process and morphology of a rotiferand and a nematode species.	EMCS


Biolab will be launched with Columbus.

biological clock. Furthermore, several experiments will try to unravel the influence of gravity on cellular mechanisms such as signal transduction and gene expression. These two effects are important steps in the reaction of a cell to changes in its environment, so the results are important for finding causes or treatments for diseases on Earth.

Human Physiology

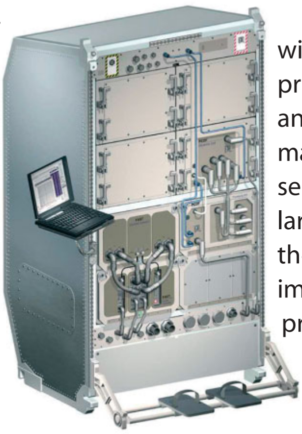
Long-Term Microgravity: A Model for Investigating Mechanisms of Heart Disease with New Portable Equipment	P. Norsk (DK), N.J. Christensen (DK), B. Pump (DK), A. Gabrielsen (DK), J.G. Nielsen (DK), Ch. Drummer (D), M. Kentsch (D), N. Gadsboll (DK) DAMEC Research (DK)	Addresses cardiovascular phenomena observed in cardiac patients and astronauts. The team is developing a portable monitoring system to determine simultaneously a number of cardiovascular parameters. Besides its applications in the care of ailing patients, this equipment would also be useful to study adaptive changes in humans during prolonged spaceflight.	EPM
Airway Nitric Oxide in Microgravity	D. Linnarsson (S), L.E. Gustafsson (S), C.G. Frostell (S), M. Carlson (S), J. Mann (S), Aerocrine AB (S), Sigma Design & Development (S)	This pulmonary research will improve a technique for NO analysis to unmask NO physiological actions in humans under µg. These changes may indeed not be apparent when lung deformation and movements are influenced by gravity. The applications are in clinical research and in potentially monitoring asthmatic patients.	EPM
Microgravity Effects on Human Skeletal Muscle Function Investigated by Surface EMG and Mechano-myogram	R. Merletti (I), P. Di Prampero (I), G. Antonutto (I), P. Tesch (S), C. Orizio (I), C. Dario Farina (I), A. Rainoldi (I), M. Pozzo (I), Burratto Advanced Technology Srl (I)	The upgrading of prototypes of electromyo--graphic (EMG) and mechanographic (MMG) techniques for the non-invasive characterisa-of human skeletal muscles. The two techniques, jointly used, are a powerful tool for quantitative monitoring of muscle deconditioning owing to spaceflight. They complement the ESA MARES, PEMS and HGD hardware. The applications are in quantitative monitoring of muscle deconditioning/ reconditioning during exercise, for age-related muscle atrophy, and injured patients.	EPM
Development and Application of a Miniaturised Sensor System for Respiratory Investigations	S. Fasoulas (D), D. Essfeld (D), R. Hemker (D), U. Hoffmann (D), C.P. Kretschmer (D), D. Linnarsson (S), M. Paiva (B), F. Ritthaler (D), R. Stoll (D), N. Stoll (D), M. Sauer (D), E. Sommer (D), R. Stangl (D), PARI GmbH (D), Cortex Biophysik GmbH (D), Escube S (D)	To expand on a new technology that has emerged from the development of small, solid electrolyte oxygen sensors for environmental monitoring. This sensor can be incorporated in miniature, portable measurement devices for simultaneous determination of total gas flow rates, and of oxygen and carbon dioxide concentrations, without the need for additional pumps, tubing or valves. The applications are in cardiopulmonary physiology, sports medicine and rehabilitation medicine.	EPM
Sodium Retention in Microgravity	M. Heer (D), N. Kamps (D), F. Baisch (D), P. Norsk (DK)	A continuation of extensive research into the mechanisms of fluid and salt retention in the body during general salt loading and in particular during spaceflight. It is a metabolically controlled study.	EPM

Human Physiology

Some research requires the EPM, to study the influence of gravity on the human body, in particular the respiratory system, the cardiovascular system and muscles. Their titles (see table) highlight their clear relevance for addressing health issues on Earth. For example, the study on heart diseases forms part of a comprehensive programme that includes clinical trials of possible new treatments of certain forms of heart failure.

Material Sciences

A large number of proposals targets MSL in the US Destiny module. The various MSL furnaces will be used to study material properties and details of solidification and casting processes for various materials such as alloys and semiconductors. It is interesting to see large, trans-national teams combining their efforts in this area, which has important applications in industrial processing and the development of new materials. In the future, the IMPRESS proposal submitted by ESA



The Protein Crystallisation Diagnostics Facility is the first payload for the European Drawer Rack.

Material Science

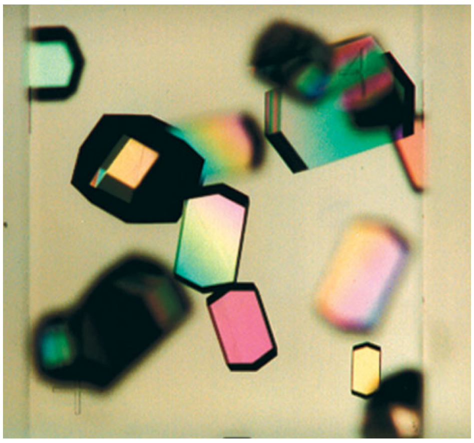
Microstructure Formation in Casting of Technical Alloys under Diffusive and Magnetically Controlled Convective Conditions	G. Mueller (D), Y. Fautrelle (F), M.D. Dupouy(F), L. Ratke (D), A. Roosz (H), G. Zimmermann (D)	Microstructure formation during casting of technical alloys under diffusive and magnetically controlled conditions. The results, together with parametric studies using numerical simulations, will be used to optimise industrial casting processes.	MSL
Columnar-Equiaxed Transition in Solidification Processing	B. Billia (F), A. Gandin (F), M.D. Dupouy (F), J. Hunt (UK), K. Kassner (D), A. Wheeler (UK), G. Zimmermann (D) D. Brown (IRL)	The research programme's ultimate objective is to improve the integrated modelling of grain structure in industrially important castings. This will be achieved by increasing the quantitative understanding of the basic physical principles governing microstructure formation in solidification processes, under diffusive conditions and with melt fluid flow.	MSL
Metastable Solidification of Composites: Novel Peritectic Structures and In-Situ Composites	D. Herlach (D), M. Kolbe (D), A. Ludwig (D), W. Kurz (CH)	To improve the processing of commercial peritectic alloys through microstructure control, e.g. through the development of a phase selection model, and of a model predicting the pushing/engulfment of particles by a growing dendritic front. The output of these microstructure models will be compared with experimental data obtained in 1g and in 0g.	MSL
Solidification Along a Eutectic Path in Ternary Alloys	S. Rex (D), U. Hecht (D), G.J. Schmidt (D), G. Faivre (F), L. Froyen (B), L. van Vugt (B), R. de Vos (B), L. Ratke (D)	To elaborate a tool for predicting the micro-structure features of a solidifying ternary alloy. A precursor experiment on Maxus-6 is planned.	MSL
Influence of Containment on Defects in GeSi Crystals: Comparison of Detached Bridgman and Floating-Zone Growth	P. Dold (D), A. Croell (D), K. Benz (D), B. Roux (F), D. Lyubimov (F), T. Lyubimova (F), W. Grill (F), D. Rivas-Rivas (E), C. Vasquez (E), F. Szofran (USA)	The growth of Si- and Ge-rich GeSi crystals for the investigation of fundamental material properties. Even today, most GeSi devices (e.g. integrated circuits for mobile phone and wireless applications) are grown epitaxially on Si substrates because no large dislocation-free GeSi crystals are available. The scientists hope to establish the reasons for this, and to propose means to overcome the problems.	MSL
Solidification Morphologies of Monotectic Alloys	L. Ratke (D), A.A. Wheeler (UK), A. Ludwig (D)	Monotectic and peritectic solidification are emerging areas of research. The monotectic reaction is observed in a wide class of alloys exhibiting a miscibility gap in the molten state. This liquid decomposition at the monotectic reaction front, into a solid and a liquid, is subject to convection, even in µg, due to Marangoni effects. The goal is to obtain a thorough theoretical understanding of monotectic solidification morphology.	MSL
Weak Convection Influencing Radial Segregation	T. Carlberg (S), G. Amberg (S)	The radial segregation occurring in crystals grown under µg. The ISS residual gravity will be used to perform experiments for different angles of the acceleration vector relative to the crystals' growth axes.	MSL
Crystallisation of CdTe and Related Compounds	K. Benz (D), M. Fiederle (D), T. Duffar (F), J.L. Santailler (F), P. Dusserre (F), J.C. Launay (F), T. Arnoux (F), X. Lagoueyte (F), G. Roosen (F), Ph. Delaye (F), E. Dieguez (E), L. Zanotti (I), C. Paorici (I), J.P. Collette (B)	To develop new growth technologies for producing high yields of large, high-quality CdTe crystals for electro-optical applications, e.g. X-ray detectors, photo-refractive devices and IR sensors.	MSL
Defects in Biomolecular Crystals Induced by Growth in Space and on Earth	A.A. Chernov (USA), J-M. Garcia-Ruiz (E), S. Weinkauff (D), L. Carotenuto (I), M. Ries-Kautt (F), B.R. Thomas (USA), Z. Hu (USA), I. Robinson (USA), R. Thorne (USA), P. Segre (USA)	Over the past decades, silicon has been one of the most important industrial materials. The electronics industry has striven to increase the size of ingots to lower the cost of chip production. However, larger diameters mean costlier production plants. Recently, an idea to reduce the cost has been proposed: mount the integrated circuit on the surface of a small spherical silicon crystal. The scientists wish to establish the conditions under which good-quality, spherical silicon crystals can be grown. This can be determined only in a µg environment.	PCDF

Fluid Physics

Fundamental and Applied Studies of Emulsion Stability	A. Passerone (I), D. Clausse (F), L. Liggieri (I), G. Loglio (I), R. Miller (D), A. Steinchen (F), A. Di Lullo (I), ENI Tecnologia (I)	These studies address single and multiple interfaces, as affected by various surfactants. An important part of the programme aims at establishing links between emulsion stability and physico-chemical characteristics of droplet interfaces. Further experiments are planned to investigate droplet dispersion in emulsions and phase inversion. On the basis of these studies, the team will generate a model of emulsion dynamics to be transferred to industrial applications.	FSL, FAST
Convection and Interfacial Mass Exchange	J.-Cl. Legros (B), G. Lebon (B), P. Cerisier (F), M. Bestehorn (D), P. Stephan (D), A. Delil (NL), SABCA (B)	The study of mass-transfer processes through interfaces and their coupling with surface tension-driven (Marangoni) flows and instabilities. The modification of mass-transfer efficiency by interfacial flows and instabilities is of utmost importance in a variety of chemical engineering applications, e.g. phase separation, absorption/desorption, liquid-liquid extraction. This work also addresses some of these industrial concerns.	FSL
Simulation of Geophysical Fluid Flow under Microgravity	Ch. Egbers (D), P. Chossat (F), R. Hollerbach (UK)	Investigate the flow of a viscous incompressible fluid between two concentric spheres rotating about a common axis under the influence of a simulated central force field. This is of importance for astrophysical and geophysical problems, such as global-scale flow in the atmosphere, oceans, and in the liquid nuclei of planets. There is also an applied interest: the electrohydrodynamic force that simulates the central gravity field is useful to track a variety of technical issues	FSL
Columnar-Equiaxed Transition in Solidification Processing	B. Billia (F), A. Gandin (F), M.D. Dupouy (F), D. Browne (IRL), G. Zimmermann (D)	The ultimate objective is to improve the integrated modelling of grain structure in industrially important castings. This will be achieved by increasing the quantitative understanding of the basic physical principles governing microstructure formation in solidification processes, under diffusive conditions and with fluid flow in the melt.	FSL
Metastable Solidification of Composites: Novel Peritectic Structures and In-Situ Composites	D. Herlach (D), M. Kolbe (D), A. Ludwig (D), L. Granasy (H), M. Rappaz (CH), G. Eggeler (D)	To improve the processing of commercial peritectic alloys through microstructure control, e.g. through the development of a phase selection model, and of a model predicting the pushing/engulfment of particles by a growing dendritic front. The output of these microstructure models will be compared with experimental data obtained in 1g and in 0g.	FSL
Study of an Imposed Electrostatic Field on Pool Boiling Heat Transfer and Fluid Management	W. Grassi (I), P. Di Marco (I), D.B.R. Kenning (UK), B. Roux (F), I. Iakovlev (RUS), F. Stoian (RO), L. Tadrist (F) (consolidated by members of the Topical Team on Boiling)	Electric fields remarkably enhance the heat transfer in single-phase convection and in pool boiling processes. However, the responsible mechanisms for this enhancement are not well understood. This project addresses the deficiency and explores the possibility of using electric fields to improve fluid management and heat transfer equipment in space.	FSL
Pool Boiling Heat Transfer in Microgravity, With and Without Electric Field Effects	C. Herman (USA), J. Kim (USA), M. Zell (D), J. Straub (D)	Boiling is a highly effective mode of heat transfer, allowing high heat flux levels driven by relatively small temperature gradients. In spite of its efficiency, cooling based on liquid-vapour phase change has not yet found wide application in aerospace engineering because of remaining questions associated with μg.	FSL
Vibrational Phenomena in Inhomogeneous Media	P. Evesque (F), D. Beysens (F), Y. Garrabos (F), C. Chabot (F), V. Kozlov (RUS), B. Roux (F), D. Lyubimov (RUS), T. Lyubimova (RUS), S. Fauve (F)	The study of periodic accelerations on two-phase fluids and on granular matter. Do vibrations enhance, damp or organise inhomogeneities? What is the influence of the size and nature of the inhomogeneities on the response to vibrations? The final objective is to be able to control the localisation of the interfaces in a low-gravity environment. The coupling between heat transfer and vibrations will also be investigated. For granular materials, the goals are to construct a phase diagram for granular gases under vibrations, to understand the dynamical coupling between granular matter and the surrounding fluid, and to characterise the segregation mechanism in granular binary mixtures. This work has direct applications for the management of heterogeneous fluids on Earth and in space.	FSL
Influence of Vibrations on Diffusion in Liquids	J.-Cl. Legros (B), V. Chevtsova (B), B. Roux (F), D. Lyubimov (F), T. Lyubimova (F), S. van Vaerenbergh (B), Z. Saghir (CDN)	The effects of vibrations on liquid diffusion. In the ISS, there are residual vibrations (g-jitter). Although they seem to have a major impact on the measurement of the diffusion coefficient, very few studies have been carried out. Hence, the researchers plan to characterise the special influence of g-jitter. The experiment will increase understanding of the kinetic mechanisms influencing diffusion effects in the presence of vibrations.	FSL
Vibrational Phenomena in Near Critical and Supercritical Fluids	D. Beysens (F), Y. Garrabos (F), C. Lecoutre (F), P. Evesque (F), V. Nikolayev (F), D. Chatain (F), B. Roux (F), A. Gorbunov et al. (RUS)	Vibrations in a fluid can direct inhomogeneities parallely or perpendicularly to the vibration direction. These inhomogeneities can be due to density differences, such as those induced by temperature gradients, or the coexistence of two phases. Vibrations can play the role of artificial gravity. The objective is to understand the coupling between heat transfer and high-frequency vibrations using a single fluid in the presence of a thermal gradient. Other goals are to predict and control the localisation of fluid interfaces under vibration, and to analyse their effect on phase separation.	FSL

to the European Commission will also make extensive use of MSL, for example, to develop new materials for more efficient turbine blades in aircraft and power plants.

The Protein Crystallisation Diagnostics Facility (PCDF; see On Station #13, June 2003, pp18-19) will be EDR's first payload, to tackle the problems of protein crystallisation in space via novel diagnostics techniques. Since protein crystals are essential for identifying the molecular structure and thereby obtaining a deep understanding of their biological functionality, these studies may have applications on Earth in science and medicine.



Understanding the mechanisms of protein crystallisation is a goal.

The Fluid Science Laboratory.

Fluid Physics

Almost all phenomena in which gravity plays a role involve its influence on the behaviour of liquids, so it is no surprise that many experiments are in Fluid Physics. Good examples are the model substances that mimic the behaviour of molten alloys about to solidify. By using these model materials, different parameters can be adjusted without the need for high-temperature experiments and therefore with much more diagnostic possibilities. This enables us to develop theories and computer models that can later be used for optimising not only the space experiments in MSL, but also for similar processes on Earth.

Another experiment studies the behaviour of liquids between two rotating spheres under the influence of a central force. This simulates, for example, the geophysical flows in the Earth's interior, and is also relevant to studies in oceanography, atmospheric dynamics and astrophysics.

An FSL experiment container.

Other experiments deal with the detailed understanding of boiling under various circumstances. Emulsions will be studied not only in the FSL, but also in EDR's dedicated Facility for Adsorption and Surface Tension

Frank De Winne performs the NEUROCOG experiment aboard the ISS.

Solar Physics			
SOVIM (Solar Variable and Irradiance Monitor)	C. Fröhlich (CH) Co-Is from B, F, CH, USA and ESA	Measurement of near-UV, visible and thermal regions of the solar spectrum).	SOLAR
SOLSPEC (Solar Spectral Irradiance Measurements)	G. Thuillier (F) plus Co-Is from B, F, D, CH, UK and USA	Measurement of solar spectrum in the 180-3000nm range with high spectral resolution.	SOLAR
SOL-ACES (Solar Auto-Calibrating EUV/UV Spectro-photometer)	G. Schmidtke (D) Co-Is from D and USA	Measurement of the extreme-UV and UV solar spectral regime in the 17-200nm range with moderate spectral resolution.	SOLAR
Technology			
TRIBOLAB	R. Sanz (E)	Studies on liquid lubrication, including fluid losses from cages, and porous reservoirs by evaporation. Studies on solid lubrication tests in zero gravity.	EuTEF
PLEGPAY	G. Noci (I)	Study of spacecraft/space environment interactions in LEO with reference to electrostatic charging/discharging phenomena.	EuTEF
MEDET	V. Inguimbert (F) Co-Is from F, UK and ESA	Evaluation of the effects of the complex space environment on the optical and thermo-optical properties of materials considered for LEO spacecraft. Monitoring of size distribution and origin of solid particles impacting spacecraft surfaces in LEO.	EuTEF
FIPEX	Fasoulas (D)	Measurement of atomic oxygen flux and oxygen molecules in the ISS environs.	EuTEF
DEBIE-2	G. Drolahagen (ESA) Co-Is from NL and UK	Monitoring of space debris and micrometeorid impacts.	EuTEF
Exobiology			
Photochemical Processing of Amino Acids in Earth Orbit	A. Brack (F), B. Barbier (F)	The main objective is to determine whether a porous material protects amino acids and peptides from degradation and racemisation, i.e. the conversion of L-amino acids into a mixture of L- and D- molecules.	EXPOSE
Evolution of Organic Matter in Space	P. Ehrenfreund (NL), B. Foing (ESA), F. Behar (F), M. Breitfellner (ESA), E. Jessberger (D), F. Robert (F), W. Schmidt (D), P. Sonnentrucker (F)	The effects of UV radiation, low pressure and heavy ion bombardment on organic molecules of astrophysical and exobiological interest: Polycycli Aromatic Hydrocarbon (PAH) molecules (stable & reactive species), fullerenes, kerogens of different origin, and complex mixtures: analogues of organics in meteorites.	EXPOSE
Exposure of Osmophilic Microbes to Space Environment	R. Mancinelli (USA)	To understand the response of microbes to space vacuum (desiccation) and solar radiation, focusing on osmophilic bacteria: Synechococcus a halophilic cyanobacterium and Haloarcula-G, an extreme halophilic bacterium. It will assess whether the gypsum-halite and halite salts in which these microorganisms live, as well as their high intracellular potassium concentration, play a role in protecting halophile DNA from desiccation.	EXPOSE
Spores in Artificial Meteorites	G. Horneck (D), B. Hock (D), F. Wänke (D), P. Rettberg (D), P. Häder (D), G. Reitz (D), T. Dachev (BUL), D. Mishev (BUL)	To assess the protection of bacterial (Bacillus subtilis), fungal (Penicilium expansum, Thermomyces lanuginosum, Xeromyces bisporus) and lycopodial (Selaginella sp.) spores by meteorite material against space conditions: UV, vacuum, and ionising radiation.	EXPOSE
DNA Photodamage. Measurements of Vacuum Solar Radiation-Induced DNA Damages within Spores	J. Cadet (F), T. Douki (F), J.-L. Ravanat (F), S. Sauvaigo (F)	To assess the yield and kinetics of formation of photoproducts resulting from exposure of dry DNA samples, or bacterial spores, to solar UV vacuum radiation. The samples will be exposed 'naked', or within artificial meteorite materials, clays and halites.	EXPOSE
Mutational Spectra of Bacillus subtilis Spores and Plasmid DNA Exposed to High Vacuum and Solar UV Radiation in Space Environment	N. Munakata (JPN), K. Hieda (JPN)	This experiment will determine the mutational spectra of B. subtilis spores and of plasmid DNA induced by high space vacuum and solar UV radiation. It will also study the molecular differentiation between vacuum-induced and UV-induced mutations, using a DNA-repair wild-type and a repair-deficient strains of B. subtilis.	EXPOSE
Responses of Phage T7, Phage DNA and Polycrystalline Uracil to Space Environment	G. Rontó (H), A. Fekete (H), P. Gróf (H)	The prime goal is to determine whether Phage T7, T7 DNA and poly-U may be used as 'biological dosimeters' for measuring biologically effective UV dose in the space environment.	EXPOSE

studies (FAST). Again, it is clear that many of these projects will not only advance fundamental knowledge, but will also find important applications on Earth.

External Payloads

Although the large majority of experiments will be conducted inside Columbus, there will also be two units launched on the External Platforms attached to the laboratory: the SOLAR package and the European Technology Exposure Facility (EuTEF; see pp16-17).

SOLAR is mounted on the Course Pointing Device and consists of three instruments to study the Sun. Together, they will measure solar irradiance from the extreme-UV to the IR, as well as the variability of the Solar Constant.

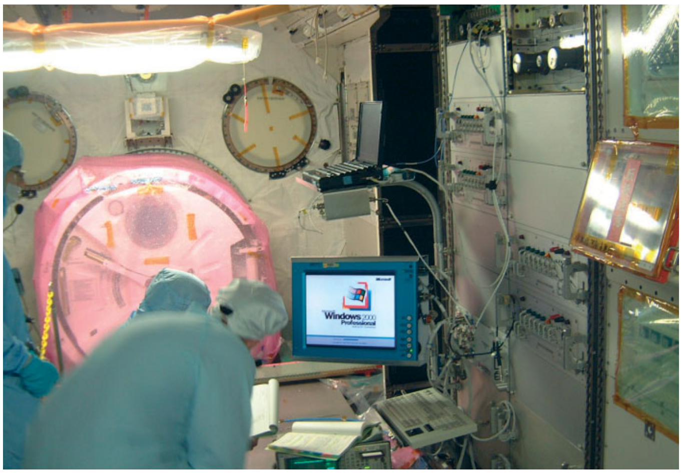
EuTEF is an exposure facility mainly for technology. It will be launched with five experiments, mainly proposed by industry to test new technologies: degradation of materials in space; space debris detection; tribology (lubrication) techniques in space; an electron plasma gun to control charging effects; and an experiment to quantify the atomic oxygen flux and interaction with surfaces. EuTEF also houses the EXPOSE facility, which is dedicated to exobiology. Seven experiments are currently selected, all dealing with the influence of the space environment, including radiation and vacuum on spores, bacteria and other biologically active molecules. These experiments will help us to understand the existence or emergence of life on, for example, other planets and comets. ■

The SOLAR payload.

Recent & Relevant

HRF Checkout in Columbus

Preparations are under way to test a major NASA ISS research rack, the Human Research Facility (HRF), in Europe's Columbus module at the Astrium site in Bremen (D) next February. Columbus will not carry HRF at launch, so the intention is to ensure a smooth installation in orbit.



HRF testing in Japan's Kibo module.

HRF is a life sciences laboratory to study human physiological, behavioural and chemical processes as they adapt to weightlessness. HRF-1 has been operational aboard NASA's Destiny module since March 2001. HRF-2 is due to be launched on STS-114/ULF-1 as soon as the Shuttle fleet returns to flight.

Both HRF racks will be transferred into Columbus soon after the module has completed its on-orbit commissioning. ESA's European Physiology Modules (EPM), launched with Columbus, will support complementary life sciences research.

To prepare for these installations in space, the NASA Payloads Office has already tested the HRF Flight Prototype Rack in the Destiny module at the Kennedy Space Center and, earlier this year, in Japan's Kibo module. ESA and NASA recently agreed that similar interface tests should be made in Columbus. The main goal is to check that a US-built International Standard Payload Rack can be integrated without major problems. The testing will include physical accommodation; direct interfaces for water cooling, power and video signals; data; rack maintenance; fire detection; command and data handling. NASA has requested an extra test on the US Local Area Network and Bus lines that are not used by the ESA payload racks. ■

SUCCESS 2002 Winners

The winners of ESA's SUCCESS 2002 Student Contest were announced on 28 August. European university students, up to Masters level in any discipline, had been invited to propose experiments that could be flown on the ISS.

100 students entered the first phase and submitted essays describing their potential experiments. The second phase saw the 40 selected visiting ESTEC before writing their detailed proposals. The winners were announced as:

First Prize: Adalberto Costessi (Univ. Trieste, I), "Cellular and Molecular Study of Osteoblasts' Behaviour in Microgravity";

Second Prize: Roberto Rusconi (Politecnico di Milano, I), "Thermal Lens Measurement of the Soret Effect";

Third Prize: Eric Belin de Chantemèle (Univ. Lyon 1, F), "Energy Requirement during a Three-Month Spaceflight".

The First Prize is a one-year internship at ESTEC, where Adalberto will work on his experiment with the possibility of qualifying it for flight on the ISS or an alternative research facility. Second Prize is a visit to the European Spaceport in Kourou, French Guiana, the Ariane launch site. Third Prize is a laptop computer. ■

'Habla ISS' Winners

More than 250 Spanish primary school classes entered ESA's 'Habla ISS' contest to win a chance to talk live via radio with ESA astronaut Pedro Duque during his stay aboard the ISS in October. The winners were announced in August.

The winning paintings were from Class 1 of the CP Ramon Laporta school, Sinarcas, and Class 3 of the CP El Centro Ingles school from El Puerto de Santa María. The winning stories were from Class 5 of the CEIP Santa Mariña school in Vigo, and Class 6 of the CP Matilde de la Torre school in Ganzo-Torrelavega. An extra prize was given to Class 2 of the CP Jose Ma de Lapuerta school in Cartagena for their papier maché rocket. A separate prize was reserved for Portugal, won by Class 3 of the E.B. 1/ J.I de Casal do Cotão school, Sintra, Lisboa.

All the winners are invited to a one-day event in the Verbum museum in Vigo. Twenty children will have the chance to question to Pedro directly while he flies far above their heads.

The pictures, stories and poems can be seen at *www.esa.int/hablaiss* ■

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