In Brief

ESA and the EC Open Joint Galileo Programme Office

On 4 May ESA's Director General Antonio Rodotà and European Commission Vice-President Loyola de Palacio opened the Galileo Programme Office at 24-26 Rue De Mot, in Brussels, Belgium. The new office will coordinate studies already under way and make preparations for decisions by the Board directing the programme, provide technical support to the Board and the industrial and scientific teams working on Galileo, and prepare the way for decisions on the transition to the implementation phase.

At the opening, Antonio Rodotà noted that *"this marks a step forward in one of Europe's most promising new space programmes",* and Mrs de Palacio added *"the office is the first permanent physical link between the two main European institutions, which are pressing ahead with work on our new satellite-based navigation, positioning and precision timing system, Galileo."*

Less than a year ago, the EU and ESA decided to enter the race to develop the next-generation satellite-based navigation and precision timing system with a European-developed, state-of-the-art design that would set the industry standard for the 21st Century. Galileo's new technology will revolutionise our transport systems, increasing safety and improving efficiency. This will make for a better quality of life and less pollution in our cities. Galileo will also bring benefits to other aspects of everyday life, with precision farming raising yields, improved information for emergency services speeding up response times, and more reliable and accurate time signals underpinning our most vital computer and communications networks. It could also contribute greatly to the improvement of maritime safety issues.

The definition phase of the Galileo programme is being run by the Commission's Directorate-General for Energy and Transport, with ESA as an equal partner in the joint management Board and playing a full role in technical development. Industry has been pushing ahead with the various studies required for this phase, and user groups have been defining their potential needs, which will eventually determine the system performance requirements. The Galileo Programme Office will now serve as the central source of expertise and permanent point of contact for coordination between the various players and parts of the programme. Inauguration of the Galileo Programme Office is also the first step towards an ESA/EC institutional framework for Galileo. esa

New Star in Orbit

Assembly of the International Space Station can now continue apace following the successful docking of the Zvezda ('star') Service Module on 26 July. Zvezda is the first fully Russian Station element and is the cornerstone for the early permanent occupation of the complex. As a result of the new module's arrival, the first long-stay crew is expected aboard by early November. Zvezda's 'brain' is ESA's Data Management System (DMS-R) which, ultimately, will perform overall control of all Russian station elements, and guidance and navigation for the whole Station. Zvezda is also carrying hardware for the first European experiment aboard the Station: the Global Time System will broadcast accurate time and data signals to users on Earth.

Zvezda was launched on 12 July at 04:56 UT from the Baikonur Cosmodrome, Kazakhstan aboard a Proton-K rocket. It was released 580 s later by Proton's third stage into an initial 185x356 km orbit inclined at 51.6° to the equator. For the next 6 min, Zvezda automatically deployed the Kurs rendezvous/docking system and Lira communications system antennas, released the solar wings (which

immediately began tracking the Sun) and activated the power, thermal, command & data handling, communications and life support systems.

During Zvezda's first four passes over the Russian ground stations, controllers in the TsUP Mission Control Centre in Korolyov, near Moscow, first verified that all systems were working properly and then oriented the module to minimise propellant usage while allowing the solar arrays to gather sunlight. They reconfigured Zvezda's attitude sensors and activated its star trackers.

Two test-firings of the manoeuvering engines during 13 July showed that Zvezda was ready to begin the long journey to the waiting Zarya/Unity complex in its 376 km orbit. The first two major rendezvous burns using the two 3070 N main engines were made on 14 July. Beginning at 05:09 UT, the orbit was raised to 183x358 km and then, starting at 05:44 UT, to 269x361 km. The firings were so accurate that a correction burn scheduled for 15 July was not required. Attitude control continued to be provided by 16 of the small, 130 N thrusters.

On 17 July, final tests verified the full operation of the software that manages Zvezda's guidance system. Routine cycling of the five batteries began; the final three will be delivered by September's Space Shuttle mission. Zarya on 18 July practised the final two orbits leading up to docking using its Kurs automatic control system. For this final approach, Zarya was the active partner.

Zvezda made its first correction burn on 20 July, firing the two main engines for 15 s to change its orbit to 290x361 km. A day before docking, it manoeuvered to the docking orientation and the solar arrays rotated into their docking attitude. The Kurs rendezvous system was activated on 25 July and, with Zarya in control, the Station caught up with Zvezda. Docking came at about 00:46 UT 26 July. It then took about 25 minutes for the hooks and latches on the two modules to close fully for the hard mating.

Over the next 16-24 hours, mission controllers planned to monitor the air pressure between the modules to ensure an airtight seal, and then began the work to transfer control of most Station functions from Zarya to Zvezda. In particular, Zvezda assumed responsibility for attitude control and reboost. Soyuz, Progress and ESA's Automated Transfer Vehicle will dock with its aft port. Many of the systems aboard Zarya are deactivated and this first module now provides primarily propellant storage and equipment stowage.

What happens next? Zvezda's success means there will be a rapid sequence of missions in the near future. The first supply ferry, Progress-M1-3, was launched on 6 August from Baikonur, docking with Zvezda 2 days later. Shuttle mission STS-106/2A.2b will dock with Unity in September to continue preparations for the first permanent crew. They will also unload the Progress. STS-92/3A in October will deliver the first Truss section (Z1), four Control Moment Gyros and a second conical docking adapter. The first dedicated Station crew of William Shepherd (Expedition Commander), Yuri Gidzenko (Soyuz Commander) and Sergei Krikalev (Flight Engineer) will appear aboard the Station's first Soyuz in early November. This 'Expedition-1' crew will stay aboard for about 4 months, activating Station systems and the first experiments, and making the first spacewalks from Zvezda's forward airlock. STS-97/4A in November will add the first pair of giant solar arrays, paving the way for STS-98/5A in January 2001 to attach the first science module: Destiny. STS-102/5A.1 in February 2001 will carry Europe's Multi Purpose Logistics Module with supplies and experiment racks for Destiny. The Expedition-1 crew will return to Earth aboard that Shuttle, swapping with the Expedition-2 crew of Yuri Usachev, Susan Helms and Jim Voss. The Soyuz craft will remain attached to the Station as a lifeboat.

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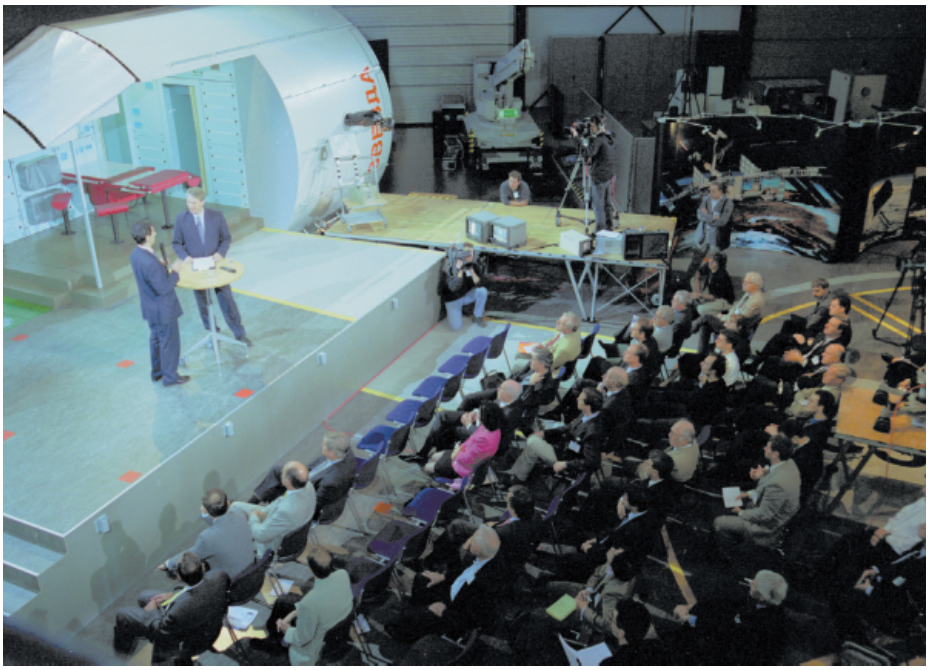
Zvezda launch: TV coverage from the Erasmus User Centre at ESTEC (NL)

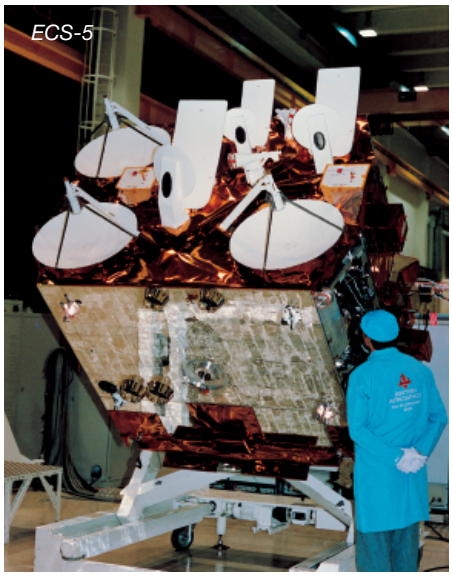


ECS-5 Decommissioned after 12 years of Service

After almost 12 years of successful ECS-5 operations, Eutelsat, the satellite's operator, has decided to retire it. ESA, which was responsible for the satellite's procurement and subsequent in-orbit control therefore initiated end-of-life testing, decommissioning and re-orbiting activities to put ECS-5 into a 'graveyard orbit' at least 150 km above geostationary altitude, thus removing any risk of contributing to debris in this valuable orbit.

The ECS series of spacecraft was the operational successor to ESA's very successful Orbital Test Satellite (OTS) programme of the 1970s. Designed to promote pan-European telecommunications traffic, the four ECS spacecraft (a fifth one was lost because of a launcher failure) have provided services in digital telephony, international television distribution, cable television, trunk telephony, Eurovision transmissions and mobile services. Some of these services have even extended beyond Europe. All four spacecraft have far exceeded their design requirements, in particular their 7-year design lifetime, together accumulating almost 3 million channel-hours of payload operation.

ECS-1 and ECS-2 had already been decommissioned following more than 13 and 9 years of successful operation, respectively. The remaining spacecraft, ECS-4, continues in operation after 12.5 years in orbit and is expected to remain in use for some time to come. esa



ECS-5

Envisat at ILA 2000

ESA at ILA 2000 in Berlin

The International Aerospace Exhibition ILA 2000 took place at Schönefeld airport in Berlin from 6 to 12 June. As in recent years, ESA, the German space agency DLR, and German aerospace industry shared a pavilion under the motto 'The Space Experience'.

Visitors were attracted to the pavilion with a full-size model of ESA's future Envisat Earth-observation satellite, scheduled for launch next year on an Ariane-5 launcher. Inside the 'Space Experience', the flight unit of ESA's Atmospheric Re-entry Demonstrator was on show. This was the actual capsule carried aloft in 1998 on the second Ariane-5 launch and retrieved after a perfect flight and splash-down. Also on show was a model of the X-38 rescue vehicle, which will be the 'lifeboat' for astronauts living and working on the International Space Station (ISS), and a 1:20 model of the Space Station itself. The exhibition also included models of Cluster-II; the X-ray telescope XMM-Newton, which was launched last December; the Huygens spacecraft, currently on its journey to Saturn's moon Titan; and ERS-2, ESA's radar 'eye in the sky' that is monitoring our planet's environment. A special display was devoted to the results of last February's Shuttle Radar Topography Mission, in which DLR and ESA's astronaut Gerhard Thiele were heavily involved.

Experts from ESA, DLR and German industry were joined by ESA astronauts for media interviews on the various programmes being showcased. esa

ESA's Council Extends Directors' Contracts

In restricted session on 20 June 2000, the ESA Council extended the mandates of the Director General and two of his Directors:

The term of office of the Director General, Antonio Rodotà, has been extended for a period of two years from 1 July 2001.

A. Rodotà

Those of Hans Kappler, Director of Industrial Matters and Technology, and Daniel Sacotte, Director of Administration, have been renewed for a period of four years from 1 June 2001. esa

H. Kappler

D. Sacotte

ESA and Canada Extend Cooperation

Canada's Prime Minister, the Hon. Jean Chrétien, attended a special ceremony at ESA Headquarters in Paris on 21 June to celebrate the continuing partnership between Europe and Canada in space applications and technology. The Prime Minister met the Director General, Antonio Rodotà, and the Heads of Delegation representing ESA's 14 Member States. The Prime Minister's visit culminated in the renewal of Canada's association with ESA through the signing of a new 10-year Cooperation Agreement by Antonio Rodotà and William (Mac) Evans, President of the Canadian Space Agency.

The new Agreement acknowledges the long history of cooperation between Europe and Canada and the socio-economic benefits that come from joint promotion of the peaceful development of space activities and technology. The latest Agreement is the fourth since 1 January 1979 between ESA and Canada. As a Cooperating State, Canada participates in ESA deliberative bodies and decision-making and takes part in ESA's programmes and activities. Canadian firms bid for and receive contracts to work on programmes of interest to them. The Agreement contains a specific provision ensuring a fair industrial return to Canada. In addition to Canada's participation in ESA's programmes, the new Agreement makes provision for ESA to take part in Canadian programmes for the first time.

"With this new Agreement, we are building on a proud tradition of partnership in space-based research and development", said Prime Minister Chrétien, *"It is a model of international cooperation, one that will continue to drive innovation, the sharing of knowledge and expertise, and the creation of partnerships between countries, agencies and space-based industries to meet the needs of future generations all over the World"*.

"Cooperation with Canada", said Mr Rodotà, *"is serving as a bridge across the Atlantic, allowing us to draw on our collective strengths, knowledge and expertise to pilot leading-edge research, technology and space-based initiatives that make a positive impact on the lives of all of our citizens"*.

Established in 1989, with its headquarters in Saint Hubert, Quebec, the Canadian Space Agency supports and promotes a highly competitive national space industry as one of its many roles. Canadian companies are expanding their links with European firms in Earth observation and satellite navigation and in building the next generation of satellites offering access to faster and cheaper high-speed communications, multimedia and Internet services. Over the past 20 years, under the successive Cooperation Agreements, ESA has awarded contracts worth in excess of 200 million Euros to space companies throughout Canada. This has spurred the creation of jobs, the acquisition of knowledge and expertise and has led to the development of industrial alliances with European contractors.

The signature of the Cooperation Agreement. Left to right: Front row: Marco Ferrazzani (ESA), William (Mac) Evans, Antonio Rodotà and André Farand (ESA). Back row (standing): Jean Chrétien, Alain Bensoussan, Chairman of the ESA Council, and Brian Walker (ESA) (behind André Farand).

Three 'Wise Men' to Advise ESA

Thanks to ESA's successes over the last thirty years, Europe's space systems are providing increasingly competitive solutions for implementing environmental, transport and communications policies. The European Union too is evolving rapidly, extending its competence to the defence sector, regulating a Europe-wide knowledge-based economy, enlarging its membership and reforming its operating procedures. In the light of these converging developments, a first step was taken towards a closer relationship between ESA and the EU when the Councils of both organisations asked for a European space strategy to be prepared jointly by the end of 2000.

ESA is an 'open' organisation that has grown and will keep on growing: with Portugal now joining, the original membership of 11 States in 1975 has already expanded to 15, Canada is a Cooperating State, and cooperation agreements have already been signed with Greece, Hungary, Poland, Romania and the Czech Republic. This is therefore considered an appropriate moment for ESA to reflect on the links between its potential enlargement and the directions in which it needs to evolve to meet Europe's future expectations.

To help with these reflections and to provide independent advice, ESA's Director General, Antonio Rodotà, has set up a Committee of three 'Wise Men', comprised of Carl Bildt (Chairman), former Swedish Prime Minister and United Nations Envoy to the Balkans, Jean Peyrelevade, President of Crédit Lyonnais, and Lothar Späth, CEO of Jenoptik. This Committee, which represents a formidable combination of high-level political, economic and industrial expertise, has already held its first meeting, at ESA Headquarters in Paris, on 27 June.

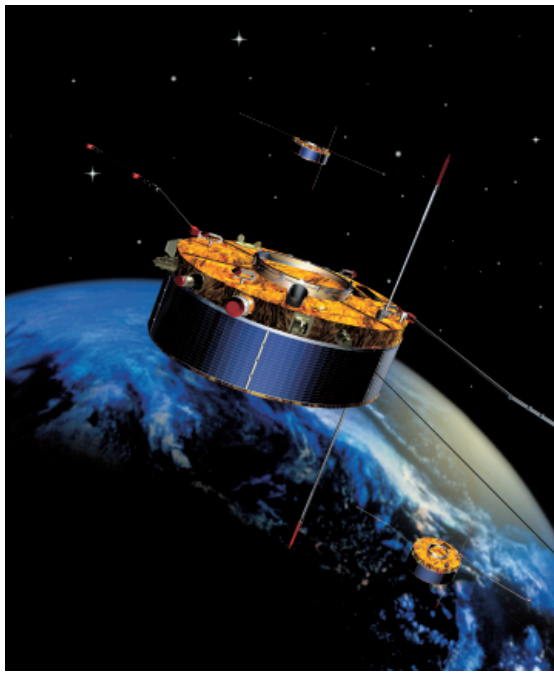
The Wise Men are expected to make their recommendations to the Director General by October this year, in line with the calendar for the European space strategy being prepared jointly by ESA and the European Union.

All Four Cluster-II Spacecraft Safely in Orbit

The ESA Cluster-II mission to explore the Earth's magnetosphere in three dimensions successfully got underway on 16 July. At 14.39 CEST, a Soyuz-Fregat launch vehicle provided by the French-Russian Starsem Consortium lifted off from the Baikonur Cosmodrome in Kazakhstan carrying the first pair of Cluster-II satellites, 'Salsa' and 'Samba' (see accompanying panel). Approximately 90 minutes into the mission, the rocket's Fregat fourth stage fired for a second time to insert the spacecraft into a 240 km x 18 000 km parking orbit. A few minutes later, the ground station in Kiruna, Sweden, acquired the two spacecraft and started to receive telemetry, confirming that the satellites had successfully separated from the Fregat and were flying independently.

Over the next week, the two spacecraft used their own onboard propulsion systems to reach 19 000 km x 119 000 km orbits above the Earth, taking them almost one third of the way to the Moon at their furthest point (apogee) from the Earth. Five engine firings were required to enlarge the initial orbits and change their inclination so that the spacecraft would pass over the Earth's polar regions.

Less than a month later, at 13.13 CET on 9 August, the second pair of Cluster-II spacecraft were safely lifted into orbit from Baikonur aboard a similar Soyuz-Fregat vehicle. Approximately 75 minutes into this mission, the Fregat transfer module was



fired again to insert the spacecraft into a 250 km x 18 000 km separation orbit. About 20 minutes later, the ground station in Kiruna confirmed that this pair of satellites had also successfully separated from the Fregat and were in good health.

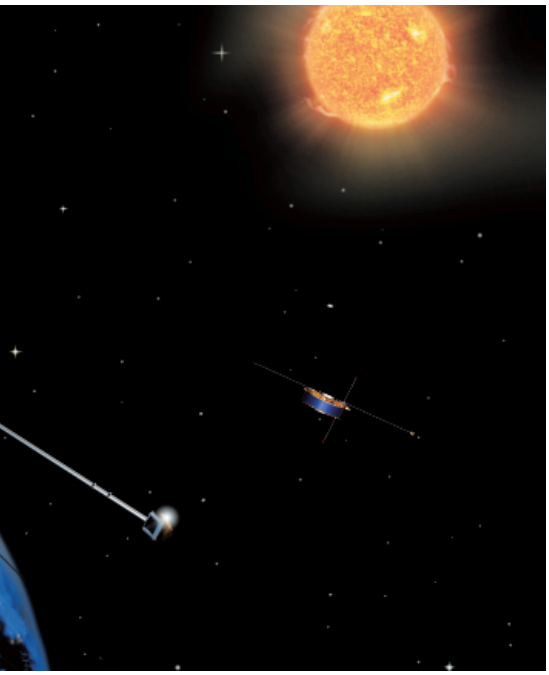
After five major orbital manoeuvres per spacecraft executed in just five days, this second pair, 'Rumba' and 'Tango', had been successfully inserted into their operational polar orbits, completing the rendezvous with the first pair, Salsa and Samba, launched on 16 July. Before the four Cluster spacecraft could come together, four apogee-raising manoeuvres had to be carried out. These raised the high points of the orbits to approximately 120 000 km above the Earth.

'Name the Cluster Quartet' Competition Winner Announced

The winner of ESA's 'Name the Cluster Quartet' competition was announced on the day of the first Cluster-II launch (16 July), during a special launch event for the media at the European Space Operations Centre (ESOC) in Darmstadt, Germany.

After an exhaustive examination of more than 5000 entries from all 15 ESA Member States, Prof. Roger Bonnet, Director of the ESA Science Programme, selected the winning entry from a short list of 15 national prize winners recommended by the international jury. The lucky winner was Raymond Cotton of Bristol (UK), who had suggested the names of four dances - Rumba, Salsa, Samba and Tango - for the individual satellites of the Cluster quartet.

"We thought of these names because my wife and I both like ballroom dancing, and they seemed to fit with the movement of the satellites through space," Mr Cotton said, *"The names are also international and will be recognised in any country."* Prof. Bonnet explained that: *"It was an extremely hard decision. There were some excellent suggestions, but I considered the short-listed entry from the UK to be the best because it is catchy, easy to remember, and reflects the way the four satellites will dance in formation around the heavens during their mission."*



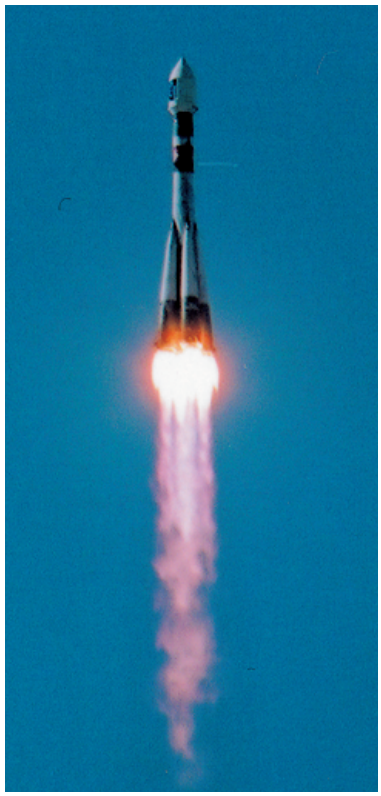
The spacecraft are now in their final elliptical orbits, with perigees around 17 200 km and apogees of about 120 600 km. The distances between the individual spacecraft vary between 125 km and 2000 km. The Cluster armada completes one orbit of the Earth every 57 hours. A series of trim manoeuvres will take place in the second half of August to place the quartet into its operational tetrahedral (three-sided pyramid) flying formation. Three months of instrument calibration and checkouts will follow in preparation for beginning Cluster's two-year scientific programme of investigating the interaction between the Sun and our planet in three dimensions and in unprecedented detail.

"This second perfect launch within less than four weeks means that Cluster is on track for a highly successful mission," said Prof. Bonnet, Director of ESA's Science Programme. *"We are now looking forward to receiving the unique three-dimensional data that will give new understanding of the interaction between the Sun and Earth."*

The four Cluster-II spacecraft have been built for ESA by European industry under the prime contractorship of Astrium (formerly Dornier Satellitensysteme GmbH, Germany). Detailed descriptions of the four spacecraft, their scientific payloads and their operations were published in the May issue of ESA Bulletin (No. 102) and are also available at: *sci.esa.int/cluster*

The Starsem Soyuz-Fregat lancher carrying 'Rumba' and 'Tango' on the pad shortly before launch on 9 August

Clamp release, and lift-off of the Soyuz-Fregat



ISS Commercialisation

ESA took a major step on 16 June towards commercialisation of the International Space Station (ISS) when it released two Calls for Interest aimed at creating an organisation to market Europe's commercial allocation and to share in the generated income. The Calls are targeted at distinct market segments. The *Commercial Research and Technology Development* element is aimed primarily at space and research companies operating in the space and microgravity fields. The *Innovative Markets* element emphasises sponsorship, advertising, entertainment and education. The goal here is to attract communications, sponsorship and multimedia companies in developing the unique opportunities offered by the ISS in terms of image, brand visibility and public interest.

An ISS Information Day at ESTEC's Erasmus User Centre (EUC), also on 16 June, supported the release of the Calls for Interest, and was attended by companies from both market segments. ESA astronaut Pedro Duque helped to describe the Space Station, its facilities and the EUC, adding his own experiences in space and a virtual reality tour of the Station.

This event marks the first time that ESA has publicly declared its intention to create strategic partnerships for commercial exploitation of the Station. Business proposals were due in by the end of July, to be followed at the end of the year with high-level commitments from invited organisations, and kick-off the ISS Commercialisation Programme in 2001. The Information Day also saw the creation of a forum among participating companies, promoting interactions that should generate detailed proposals covering a wider range of commercial activities.

The ISS Commercial Development Organisation could be a single entity or a more complex structure such as a Consortium, a Joint Venture with other industrial or semi-industrial entities, or a Public-Private Partnership. As the R&D and innovative sectors likely require different knowledge and expertise, more than one Business Developer may be appointed. If so, ESA may appoint a Business Development Coordinator to act as the Agency's sole interface.

ESA astronaut Pedro Duque (right) describes what the Space Station offers potential commercial developers.

The companies that have already expressed interest include Alenia Aerospazio, Astrium GmbH, BEOS AG & Co.oHG Space Operators, Bikker, Carlo Gavazzi Space, CMP Cientifica s.l., D3 Group GmbH, ESYS, Intospace GmbH, Kesberg, Bütfering & Partner, National Aerospace Laboratory (NL), OHB System GmbH, Publicis Consultants, Space Channel and Verhaert.

The Calls for Interest and company contact details are available at: www.estec.esa.int/spaceflight/isscommercialisation esa

ATV Launch Contract

ESA and Arianespace signed a contract in June worth more than 1 billion Euros to launch nine Automated Transfer Vehicles (ATVs) to the International Space Station over a period of 10 years. Following the maiden flight in late 2003, ATVs will be launched every 15 months to resupply the Station, boost its orbit and remove waste.

Currently under development by a consortium led by Aerospatiale Matra Lanceurs of Les Mureaux (F), the ATV will be Europe's payment 'in kind' rather than in cash for its 8.3% share of the common ISS operating costs. The nine ATVs will be produced and operated by European industry under a single ESA contract to be awarded in 2001. This contract will later include the launch services contract.

The 20.75 t ATV will be launched by the Ariane-5 Plus version of the heavy-lift launcher, equipped with the reignitable EPS upper stage, directly into a 300 km circular orbit inclined at 51.6°. From there, ATV will use its own propulsion system to reach the 400 km orbit of the ISS and dock with the Russian Zvezda Service Module. The cargo can include up to 5.5 t of dry cargo in the pressurised carrier, 840 kg water, 100 kg air, oxygen or nitrogen, 860 kg propellants for Station refuelling, and 4 t of propellants for its own engines to provide Station reboost and attitude control during the 6-month attachment. At the end of its mission, ATV can remove 5.5 t of waste for disposal during the destructive reentry. esa

(Right) The launch contract for nine ATV missions was signed on 7 June at the ILA 2000 air show in Berlin. Centre is ESA Director General Antonio Rodotà, left is Director of ESA Manned Spaceflight & Microgravity Jörg Feustel-Büechl, right is Arianespace Chairman/CEO Jean-Marie Luton.

The assembled astronauts

Dr. Ernst Messerschmid, Head of EAC, opening the Celebration

Astronauts Past and Present Celebrate Tenth Anniversary of the European Astronaut Centre

On 17 May, more than 20 astronauts from eight European countries gathered at ESA's European Astronaut Centre (EAC) in Cologne, Germany, to celebrate the Centre's 10th Anniversary.

On the threshold of the new era for space exploration being ushered in with the International Space Station (ISS), pioneers from the early days of Europe's involvement in manned spaceflight and today's 16-strong European Astronaut Corps came together for the first time to discuss Europe's preparations for the years ahead.

These astronauts represent more than two decades of Europe's endeavours in space flight and research. To date 27 Europeans have taken part in 31 space flights. From the days of the Soviet Salyut stations to Russia's Mir, from the first Space Shuttle flights to the International Space Station now under construction, they have had a hand in writing the history of man's presence in space. As the European astronauts' home base, EAC provides training and medical support to ESA's astronauts, both on the ground and during missions.

The International Space Station crews will spend time at EAC to be trained in the operation of the ESA contributions to ISS, namely the Columbus Laboratory, the Automated Transfer Vehicle (ATV) and numerous payload facilities for scientific experiments. The first ISS crews are expected to begin training at EAC in about two years' time.

A full article on EAC's role and the Anniversary celebrations will appear in the November issue of the ESA Bulletin (No. 104).

New ESA Antenna in Spain Inaugurated

On 18 May, the newly refurbished antenna to be used to support ESA's latest scientific mission Cluster-II, consisting of four satellites, was inaugurated in Spain. The antenna (VIL-1), located at the Agency's Villafranca del Castillo Satellite Tracking Station (VILSPA) near Madrid, will provide the prime communications link with the four spacecraft and will therefore play a vital role in their monitoring and control, as well as receiving the vast amounts of scientific data that will be returned to Earth during the planned two years of Cluster operations.

The upgrading of VIL-1 has included the replacement of the 60 dish panels, the subreflector, the antenna equipment room and other parts of the main structure. One of the most significant modifications has been the replacement of the servo and tracking systems in order to follow the four Cluster-II satellites, which will move in highly elliptical orbits (perigee 19 000 km, apogee 119 000 km) and therefore require high-speed tracking.

The four satellites will be visible for an average of about 10 hours per day from VILSPA, but only one satellite can be in communication with the ground at any given time, which reduces the available time per satellite each day to around two and a half hours. Further challenges arise from the need to send new instructions to the 11 scientific instruments on each spacecraft, and from the vast amount of data to be returned each day from the 44 experiments. Over two years of operations, this adds up to 580 Gigabytes (580 000 000 000 bytes!) of data, equivalent to 290 million pages of printed text.

Built in 1975, VILSPA is major part of the European Space Operations Centre (ESOC) Tracking Station Network (ESTRACK). In the last 25 years, it has supported many ESA and international satellite programmes, including the International Ultraviolet Explorer (IUE), Exosat and the Infrared Space Observatory (ISO). In addition to supporting the Cluster-II mission, it has been designated as the Science Operations Centre for ESA's XMM-Newton mission, launched in December 1999, and for the Far-Infrared Space Telescope (FIRST), due for launch in 2007.

Various European companies participated in the relocation and upgrading of the VIL-1 antenna hardware. MAN (D) was responsible for dismantling the antenna at its original site in the Odenwald, in Germany, and for the installation of the dish at VILSPA, while Vitrociset (I) handled the transfer of the antenna back-end equipment, which included the satellite telemetry and telecommunication signal computers. These companies were supported by Spanish contractors and local industry. esa

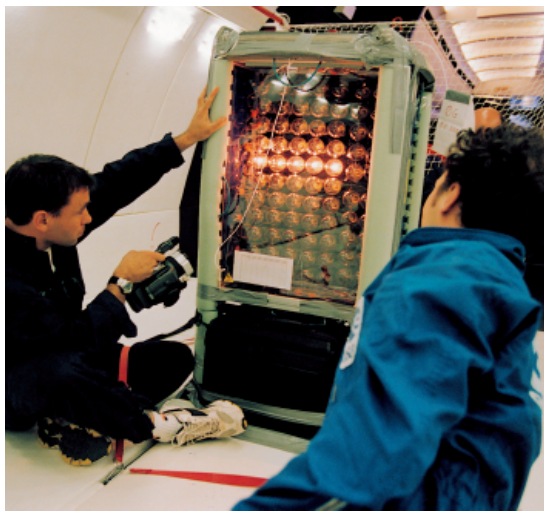
Twelve Physics and Biology Experiments Flown on 28th ESA Parabolic Flight Campaign

On 23 May, a specially adapted Airbus A-300 took off from Bordeaux-Mérignac airport in France to begin a four-day long campaign of parabolic flights designed to carry out experiments in weightlessness and test instruments and equipment before they are operated in space, either on sounding rockets or on the International Space Station (ISS). This 28th parabolic flight campaign organised by ESA focussed on the physical sciences and biology, with twelve experiments provided by international teams of investigators (see accompanying table).

Parabolic flights are practically the only means of reproducing on Earth the weightlessness experienced in space. The 'Zero-g Airbus' pilot - flying at an altitude of approximately 6000 metres, usually in a specially reserved air-corridor above the Gulf of Gascogne - first performs a nose-up manoeuvre to put the aircraft into a steep climb (7600 m). This generates an acceleration of 1.8 g (1.8 times the acceleration of gravity on the ground) for about 20 seconds. Then the pilot reduces engine thrust to almost zero, injecting the aircraft into a parabola. The plane continues to climb until it reaches the apex of the parabola (8500 m), before it starts descending. This condition lasts for about 20 seconds, during which the passengers in the cabin float in the weightlessness resulting from the free fall of the aircraft. When the angle below the horizontal reaches 45°, the pilot accelerates again and pulls up the aircraft to return to steady horizontal flight. These manoeuvres are repeated 30 times per flight.

The 27 previous campaigns that ESA has conducted since 1984 have provided a total of more than 2650 parabolas and almost 15 hours of weightlessness, the equivalent of flying around the Earth (in low Earth orbit) nearly 10 times. A total of 360 experiments have been carried out so far. With Europe and its international partners now building the International Space Station, onboard which research will be carried out for the next 15 years, parabolic flights are crucial to the preparation of experiments, equipment and astronauts, and allow scientists to have their experiments tested before they are actually flown on a space mission.

Over the next four years, ESA will be running two parabolic campaigns a year, for which the scientific community will be regularly invited to submit experiment proposals for peer review and selection for flight. The next ESA parabolic-flight campaign (the 29th) is scheduled for November 2000 and will feature a mix of experiments in the life and physical sciences, focusing mainly on physiological and medical topics. esa



Experiments Flown on the 28th ESA Parabolic-Flight Campaign

"Hydrodynamics of Wet Foams", *from Dr B. Kronberg (Inst. for Surface Chemistry, Stockholm, S) and Dr M. Adler (Univ. of Marne la Vallée, Paris, F)*
Studied different types of foams and tested a new method of forming foams by injecting $C0^2$ into different liquids. The foam-generation technique cannot be tested on the ground as foams are transient and collapse rapidly in 1-g conditions.

"Interfacial Turbulence in Evaporating Liquids", *from Prof. J.C. Legros and Dr P. Colinet (Univ. of Brussels, B)*
Studied the three-dimensional temperature field in an evaporating liquid (ethanol) caused by turbulent motions at the liquid/gas interface, known as Marangoni convection.

"Vibrational Phenomena in Inhomogeneous Media", *from Dr P. Evesque (CNRS, Ecole Centrale, Paris, F), Dr D. Beysens (CEA, Grenoble, F) and Dr Y. Garrabos (CNRS, Pessac, F)*
Investigated the effect of vibrations in weightlessness on inhomogeneities in two-phase fluids and granular matter. This is one of the experiments recommended to fly in the Fluid Science Laboratory currently being developed for ESA's Columbus Laboratory.

"Liquid Diffusion Model Experiments with the Shear Cell Technique", *from Prof. G. Frohberg, Dr A. Griesche (Berlin Technical Univ., D) and Dr G. Matthiak (DLR, Cologne, D)*
Continued a previous experiment flown on the Russian satellite Foton-12. Diffusion is the main process in metallurgy and crystal growth, but the diffusion coefficient of liquids is difficult to measure on the ground due to other mass transport phenomena resulting from gravity-induced natural convection.

"Study of Synthesis of Carbon Species in Microgravity", *from Prof. J.P. Issi, Dr J.C. Charlier and Dr J.M. Beuken (Univ. of Louvain, B)*
Investigated the synthesis of new forms of carbon, such as fullerenes, nanotubes and diamonds, by applying a strong electrical discharge between two graphite electrodes. Similar experiments conducted during previous parabolic flights showed that the process of obtaining these different carbon forms could be improved to some extent.

"Recrystallisation of Tungsten Filament", *from Dr R. Van Wijk and P. Dona (Philips, NL)*
Studied aspects of processing tungsten filaments to improve the performance of new lamps. This is one of the first experiments conducted directly by an industrial company in weightlessness, and shows the potential of applied research and development in microgravity.

"Laminar Diffusion Flames Representative of Fires in Microgravity Environments", *from Prof. P. Joulain (CNRS, F) and Dr J.L. Torero (Univ. of Maryland, USA)*
Continued a series of combustion experiments conducted during previous parabolic-flight campaigns, sounding-rocket flights and drop-tower tests. The final experiment goal is to provide the scientific background necessary to evaluate material flammability in microgravity, enabling the risk of fire on board manned space vehicles to be reduced.

"Real-time Physiological and Molecular Biological Measurements of Osteoblast-like Cells under Microgravity using Fluorescence Techniques", *from Prof. D. Jones (Univ. of Marburg, D) and Prof. Vander Sloten (Univ. of Leuven, B)*
Investigated bone cells stimulated mechanically in microgravity. Osteoblasts are responsible for the regeneration of bone tissue, while osteoclasts are responsible for resorption of used bone tissue. The results will help to shed light on the mechanisms of bone resorption and regeneration, which are not yet fully understood.

"Effects of Gravity at the Biomolecular Level", *from Prof. P. Vanni (Univ. of Florence, I)*
Investigated whether microgravity can affect enzyme reactions, complementing a previous experiment on a sounding rocket in 1996.

"Lipoxygenase Activity in Microgravity", *from Dr M. Maccarone and Prof. A. Finazzi-Agro (Univ. of Rome, I) with the support of Profs. G.A. Veldink and J.F.G. Vliegenhart (Univ. of Utrecht, NL)*
Investigated the role of microgravity in enzyme catalysis reactions, as enzymes play important regulatory roles in all living cells, in both plants and animals.

"Postural Control in Flat Fish", *from Prof. A. Berthoz (CNRS, F)*
Studied the behaviour of flat fish swimming in a large pressurised aquarium. This experiment is related to the study of the inner-ear vestibular system and complements previous investigations to bring more information on the central mechanisms of imbalance compensation, postural balance and asymmetries in the gravistatic system, thought to be the cause of space sickness.

"Testing of the Mirsupio Crew Support Pouch", *from the European Astronaut Centre (ESA/EAC)*
Mirsupio is an improved multi-functional, wearable equipment pouch worn around the waist to support the astronaut in his daily life in orbit. An early version of this pouch was flown on Mir during the Perseus mission with ESA astronaut J.P. Haigneré.

ESTEC 'Capital of the Moon' for a Week

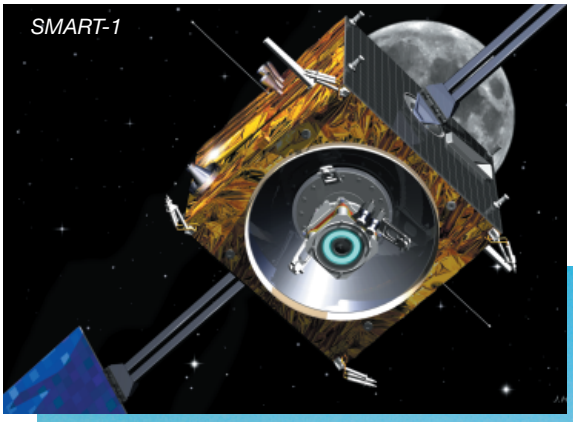
From 10 to 15 July, ESA's European Space Research and Technology Centre (ESTEC) in Noordwijk (NL) became the 'Capital of the Moon' when it hosted the Fourth International Conference on Exploration and Utilisation of the Moon (ICEUM4). Organised by the International Lunar Exploration Working Group (ILEWG), the ICEUM4 Conference brought together lunar explorers (young and old), scientists, engineers, industrial firms and other organisations to review recent activities and to prepare for the next steps on the Moon.

At the Young Lunar Explorers Session, on 10 July, young professionals from all over the World – many specially invited by ESA and the ILEWG – presented their ideas, dreams and work concerning lunar and Solar System exploration. During the Lunar Science and Technology Sessions, on 11 and 12 July, the most recent scientific discoveries on the Moon – notably the possible presence of water – were discussed and the participants reviewed the key questions regarding the origin and evolution of the Earth-Moon system that still remain unanswered.

On 13 July, several ILEWG Splinter Groups held dedicated sessions on all aspects of lunar exploration, including: Science of, from and on the Moon, Living on the Moon, Key Technologies, Utilisation of Lunar Resources, Infrastructures for Lunar Bases, Lunar Role in Human Expansion in the Solar System, and Social, Cultural, Artistic and Economic Aspects. On 14 July, these Groups reported their findings and recommendations to the ICEUM4 participants and the Press.

At the close of the Conference, the participants formulated the 'ILEWG 2000 Lunar Declaration', which proposes a specific action plan for international lunar explorers and space agencies in the years to come.

The complete Proceedings of the ICEUM4 Conference will be available from ESA Publications Division in September as ESA Special Publication SP-462. esa



SMART-1

What do Students see as the Next Projects in Space Astronomy?

56 students from ESA Member States attended the annual Alpbach Summer School, from 18 to 27 July in the mountain village of Alpbach in the Austrian Tyrol, sponsored by the Austrian Federal Ministry for Transport, Innovation and Technology, the Austrian Space Agency and ESA and its Member States.

The participants at this year's Summer School, with the theme 'Extragalactic Astronomy and Cosmology from Space', were set the task of defining future X-ray and gamma-ray as well as infrared missions. As part of the curriculum, 25 European experts provided them with an overview of the evolution of the Universe, including many aspects of black holes, supernovae and the cosmic microwave background. The eminent cosmologist Sir Martin Rees, Astronomer Royal and

The ICEUM4 participants, gathered at ESTEC (NL)

Professor at the University of Cambridge, presented this year's keynote lecture, on 'Cosmology and Dark Matter'. The students also learned about the scientific instruments that are used in space astronomy as well as some of the engineering and operations tools with which space missions are designed. The scientific aims and technological challenges of several current ESA science missions, including the recently launched XMM-Newton (giant X-ray telescope), Integral (the International Gamma-Ray Laboratory, to be launched in 2002), and some later missions looking at the cold Universe (FIRST and Planck), were also presented.

Throughout the two weeks, the students participated in a series of workshops, teaching them the basic skills necessary to become Europe's future space-mission designers. The students had to come up with their own ideas for scientific space missions, culminating in the design of two infrared and two X-ray astrophysics space missions:

SNOOPY (Submm N Observation Of Polarimetry): This is an all-sky-survey infrared astrophysics mission, designed to fit within the framework of an ESA flexi-mission. The mission demonstrates how to achieve an optimal scientific return for minimum cost using space technology already developed for existing space missions. SNOOPY's key objective is to understand the Inter-Stellar Matter (ISM) structure and to detect galactic magnetic field lines by measuring polarisation effects in the infrared region of the spectrum.

Mi-3 (Mission Interferometer with 3 baselines): This is an ambitious L2 Lagrangian point orbiting, infrared interferometry mission consisting of a total of four spacecraft, carrying three telescopes and the beam-combiner optics. The mission provides high angular resolution and high-resolution spectroscopy for imaging active and merging galaxies, as well as galactic and extragalactic star-formation processes, to improve our understanding of the physics of accreting systems throughout the history of the Universe.

In.XS: This is an all-sky-survey space mission in the X-ray band (2 - 80 keV) to detect obscured Active Galactic Nuclei (AGNs) and to measure the X-ray background radiation. It uses innovative X-ray multi-layer optics currently under development at ESA.

ASTeRIX (Alpbach Summer-school Telescope Realising Interferometry X-rays): This X-ray interferometry mission uses a revolutionary X-ray optics concept developed at the Summer School, which can provide milliarcsecond resolution capabilities. In combination with a second spacecraft, microarcsecond resolution can be achieved. The mission would be launched to the L2 Lagrangian point by an Ariane-5 vehicle.

These four missions were presented on the last day of the Summer School to a distinguished Review Panel – including Dr. Roger Bonnet, Director of ESA's Scientific Programme, and Dr. Bo Andersen, Chairman of the ESA Science Programme Committee (SPC) – which congratulated the students on their remarkable achievements during their ten days of work in Alpbach.

A more detailed article will appear in a forthcoming issue of the ESA Bulletin. Meanwhile, further information can be obtained from:

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The Ethics of Outer Space

In 1998, the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) – the UNESCO body charged with studying the social and ethical implications of the applications of science and technology, chaired by Mrs Vigdis Finnbogadottir, former President of Iceland (1980-1996) – decided to examine ethical issues related to the exploration of extra-atmospheric space. This Commission had previously studied the topics of energy and water. In the same spirit, in December of that year ESA's Director General, Antonio Rodotà (who inspired the initiative), and Federico Mayor, Director General of UNESCO, created a working group on the ethics of extra-atmospheric space. This multi-disciplinary group was tasked with preparing a report on the ethical implications of space activities. Its work was coordinated by Prof. Alain Pompidou, former Member of the European Parliament and a member of the French 'Conseil Economique et Social'.

ESA and UNESCO have recently published this report, which draws on the experience and knowledge of international experts wordwide, including representatives of the United Nations, national space agencies and industry. On Monday 10 July, the report was presented to the media by Prof. Pompidou and Antonio Rodotà during a Press Conference at ESA Headquarters in Paris.

The report examines the ethical problems posed by the utilisation of outer space and addresses such topics as life in space (manned space flight, the search for extraterrestrial life and the return of samples from other celestial bodies), space debris, Earth monitoring, environment and security, and the public image of space exploration.

In Mr Rodotà's words:

"Ethics is a fundamental aspect of human society. For those who are involved in space activities, ignoring this debate is not an option……We at ESA are committed to ensuring that the ethics of space science and technology are considered in our decisions and in our programmes".

Further information can be obtained from:

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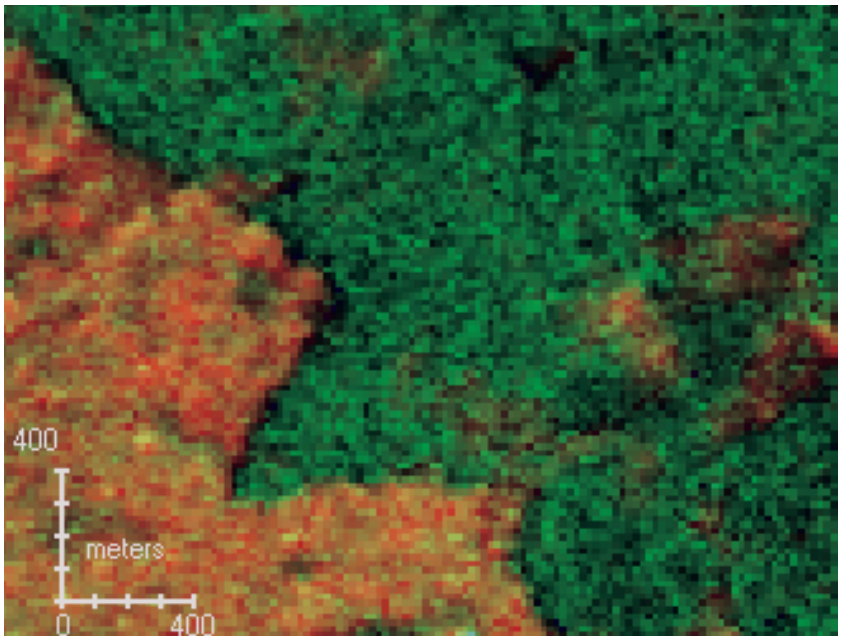

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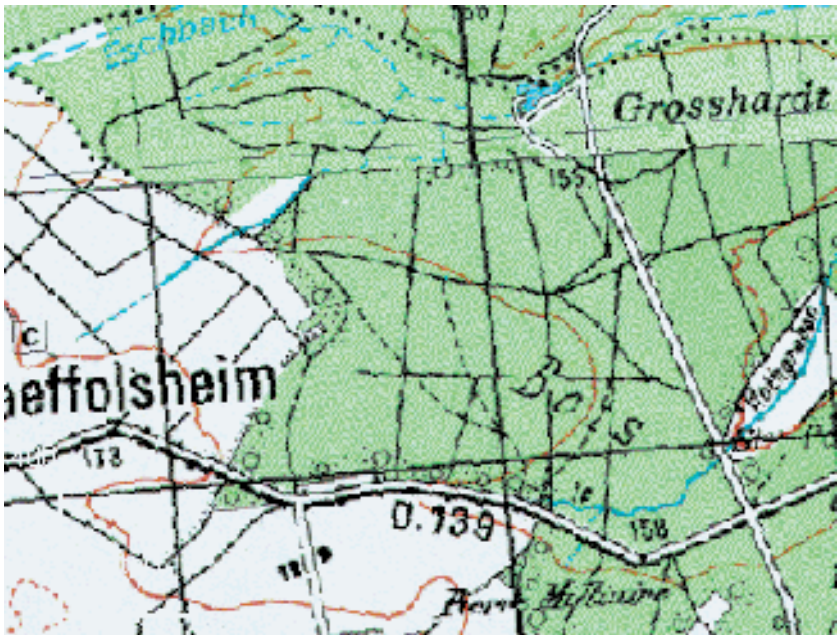

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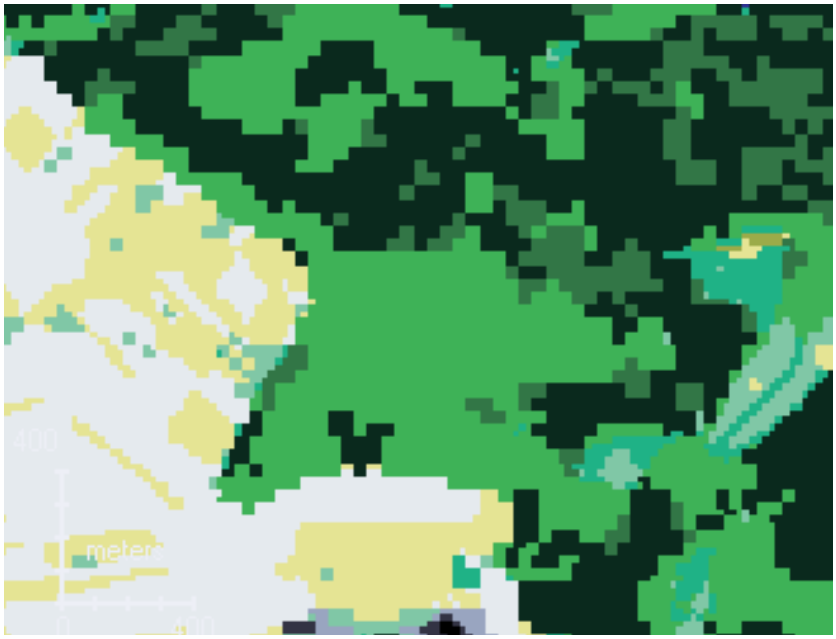

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Forest Damage Mapping in North Eastern France

The devastating storms that struck France in December 1999 destroyed vast areas of forest and woodland (Fig. 1). Mapping of the damage was an immediate high priority, both for short-term clear-up actions as well as for long-term reforestation planning.

Coherence products derived from space-based Synthetic Aperture Radar (SAR) imagery can discriminate forested and non-forested areas accurately, and by applying a multitemporal approach various levels of damage can be identified. This approach, based on the exploitation of the coherence product developed by Spot Image with the support of ESA, was applied over the forest of Haguenau, 30 km north of Strasbourg, France's second largest forest. The results obtained from the processing of two coherence products derived from two ERS-1/ERS-2 tandem image pairs acquired before the storm, on 31 October and 1 November 1999, and after the storm, on 9 and 10 January 2000, allowed damage maps to be produced at 1:25 000 scale. The results were validated by regional forestry services.

Coherence can be related to vegetation density in SAR imagery: wooded areas generally show a low coherence, appearing green in a standard coherence product, while bare soils and cultivated areas are usually associated with high coherence, appearing orange-red (Fig. 2). The coherence product from archive data therefore allows one to separate forest/non-forest areas, to be compared with the topographic map, the land-use map and Spot XS imagery (Figs. 3-5). The

post-storm coherence product shows a strong increase in the coherence level within forested areas (Fig. 6). A 'damage image' was produced based on the ratioing of the two coherences, and the averaged SAR intensity (Fig. 7). In this image, pink tones provide an immediate estimate of the degree of damage. In this case a damage level of 50% had been reported by the forestry service, which corresponds well statistically with the observed increase in coherence over the area.

Acknowledgement
This work was carried out by A. Herrmann, K. Fellah, P. de Fraipont and H. Yésou of the Service Régional de Traitement d'Image et de Télédétection (SERTIT), and J. Bequignon of ESA/ESRIN, Frascati, with both Spot Image and ESA support. ESA organised the special tandem satellite ERS acquisition campaign and provided the ERS data, while Spot Image provided the coherence products. The help of the French forestry service during the product validation phase is gratefully acknowledged by the authors.

Figure 1. The dramatic damage caused by the December 1999 storms in the Haguenau forest

Figure 2. Coherence product before the storm

Figure 3. Topographic map

Figure 4. Land cover map

Figure 5. SPOT XS image

Figure 6. Coherence product after the storm

Figure 7. Damage image, in which the affected areas are highlighted in pink

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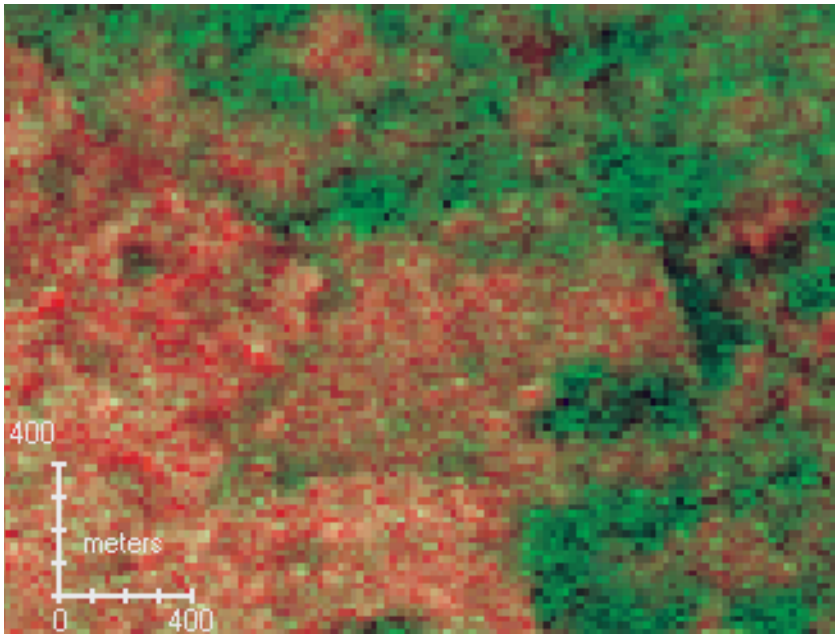

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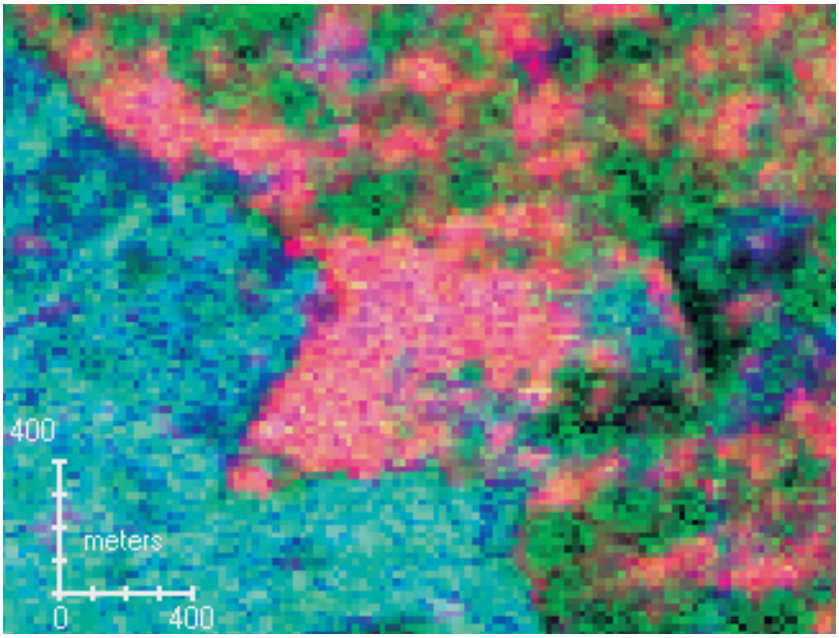

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