In Brief

139th ESA Council Meeting

The 139th Council meeting was held from 7 to 9 April in Longyearbyen, a town of 1500 inhabitants on Spitsbergen, the largest island of the Svalbard archipelago 1200 km from the North Pole. The ESA Delegations and Executive were there at the invitation of Hugo Parr, Chairman of Council. This first 'far-North' Council meeting was organised by the Norwegian authorities and the Norwegian Space Centre. The exceptional venue undoubtedly made this a very special Council meeting.

The following main decisions were taken:

– The date of the next Ministerial Meeting was confirmed for 11-12 May (see page 8 of this Bulletin) and a final draft agenda for the ministerial meeting was agreed.

– After lengthy discussion, draft Resolutions 1 and 2 on 'Shaping the Future of Europe in Space' and 'The Agency's Evolution and Programmes' were finalised by the delegations for submission to the ministers.

– Council unanimously adopted the Resolution on the ESA contribution to the European Union's Galileo initiative, marking the first official step in undertaking a new ESA optional programme: GalileoSat. The Resolution reaffirms the key role and competence of the Agency in the technical management of the definition, development and validation of the space and related ground segment of a European satellite navigation system. The programme will be carried out in cooperation with the EU on the basis of joint funding. Programme definition activities will start following the May Ministerial Meeting, at which ESA Member States are expected to subscribe for the ESA part of the programme. The decision on the corresponding EU funding is expected to be taken by EU transport ministers in June.

  Luc Tytgat, the Administrator for GNSS policy at the Commission's DG VII (Transport) and the EU representative attending the meeting at Council's invitation, confirmed that a budget was available for the Galileo programme. This followed the adoption of Agenda 2000, including the trans-European and transport network, and the Fifth Framework Programme by the Council and Parliament of the European Union.

– Lastly, a number of delegations expressed interest in the Lunarsat project but asked that the matter be examined further at a future Council meeting.

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Hugo Parr, Chairman of Council (left) and Antonio Rodotà, ESA's DG, enjoying the rugged scenery of Longyearbyen, Norway, site of the 139th Council Meeting

Ariane V116 launched on Friday 26 February carrying satellites Arabsat 3A and Skynet 4E

3 Satellites Successfully Launched

The 116th Ariane launch (V116) took place on Friday 26 February at 07:44 p.m. Kourou time. An Ariane 44L vehicle (equipped with four liquid strap-on boosters), lifting off from the Guiana Space Centre, placed into geostationary transfer orbit Arabsat 3A for the Arab League and Skynet 4E for the British Ministry of Defence.

The 117th Ariane launch (V117) lifted off on Friday 2 April at 07:03 p.m. Kourou time. The launcher, an Ariane 42P (equipped with two solid-propellant strap-on boosters) placed into geostationary transfer orbit the Indian telecommunications and meteorology satellite, INSAT 2A. The flight marked the 44th successful launch in a row for Ariane-4. esa

Beyond 2000: Investing in Space for Europe

Why should Europe invest in space? What challenges lie ahead? What is Europe doing and could it do in areas such as: the search for Earth-like planets, cheaper access to space, disaster warning from space, the threat of cosmic collisions, space energy and space tourism? These and many other questions are explored in the second report drawn up by ESA's Long Term Space Policy Committee (LSPC).

The report, intended to give ESA's Member States a framework for long-term strategic thinking and decisions on space activities, was recently completed and presented at a press briefing on 21 April at ESA Headquarters.

Peter Creola, Chairman of the Long Term Space Policy Committee, Jean-Jacques Dordain, ESA's Director for Strategy and Technical Assessment, and Géraldine Naja, in charge of European Policy and Prospective Studies at ESA, illustrated the content of the report and outlined the initiatives which the Committee would like ESA to pursue.

The report (ESA SP-2000) identifies three challenges which Europe will have to face as it enters the next century: independence, planetary management and expansion beyond present-day horizons. The Committee considers that Europe needs an ambitious space policy and programmes to respond effectively to these challenges and to continue playing a worldwide role commensurate with its economic weight and cultural heritage. esa

ESA Medals Mark the Hipparcos Revolution in Astronomy

At a gathering of top space scientists on 20 May, ESA's Director of Science, Roger Bonnet, conferred medals on four European astronomers for their leading roles in the Hipparcos mission. This pioneering project in space astrometry fixed the positions of the stars far more accurately than ever before.

Catherine Turon and Jean Kovalevsky from France, Lennart Lindegren from Sweden and Erik Høg from Denmark each received a Director of Science Medal. The occasion was a meeting in Bern, Switzerland, of the Science Programme Committee, which brings together senior representatives of space science in the 14 Member States of ESA.

The Director of Science Medal is a new award introduced to recognise extraordinary efforts and achievements by scientists and engineers from universities and research institutes who participate in ESA's space science missions. This year's awards are a tribute to non-ESA scientists' contributions – indispensable to a successful project.

"ESA's Director of Science's very first medals for science are awarded for work with Hipparcos, one of our most distinctive all-European missions," said Roger Bonnet. *"No other agency has attempted anything like it. From the vastly improved positions, distances and motions of stars which Hipparcos provided, scientists all around the world are now making discoveries every day. As team leaders, our medallists were responsible for the largest computing task in the history of astronomy. ESA says thank you to them and to the many other scientists who devoted 20-30 years of their working lives to making Hipparcos a success."*

Conceived and built in Europe, Hipparcos operated in space from 1989 to 1993, repeatedly measuring angles between pairs of stars in widely separated positions in the sky. Before it flew, multinational teams of scientists identified the target stars and prepared the computing techniques that would make sense of a million bits of data coming from the satellite. Motions of the Earth and of the stars themselves, and even the effect of the Sun's gravity on starlight, had to be reconciled in a consistent and precise map of the entire sky.

Nearly 120 000 target stars for Hipparcos were chosen by the Input Catalogue Consortium (INCA) headed by Catherine Turon. Two other medal winners, Jean Kovalevsky and Lennart Lindegren, led the FAST (Fundamental Astronomy by Space Techniques) and NDAC (Northern Data Analysis) Consortia, which independently calculated the positions, distances and motions of these stars, from the space observations with the main instrument on Hipparcos. Using an auxiliary star mapper, the TDAC (Tycho

Data Analysis Consortium) produced a further catalogue of a million stars with lesser but still remarkable accuracy, under the leadership of Erik Høg.

Calculations continued for three years after the space operations ended. In 1997, ESA's Hipparcos Catalogue and Tycho Catalogue made the results available to all the world's astronomers, professional and amateur. The American astrophysicist, Philip Morrison, wrote of the outcome: *"Our galactic star precinct has just been well mapped for the first time, ready for a century of searching stars for the promise of life."*

ESA's Director of Science, R. Bonnet, offering the new Director of Science Medal to Erik Høg (DK). Other medal recipients were (background, left to right) Catherine Turon (F), Jean Kovalevsky (F) and Lennart Lindegren (S)

JEAN KOVALEVSKY (Observatoire de la Côte d'Azur): *"Altogether thirty years elapsed until our work was completed by the publication of the Hipparcos Catalogue. For individuals involved from the beginning, it was an extraordinary commitment within the human lifetime. Yet thirty years was a short time in the history of science, to achieve a revolution that has affected every branch of astronomy."*

ERIK HØG (Copenhagen University Observatory): *"In 1981 we were considering the performance of ground-based instruments that would help in preparing the Input Catalogue. That was when I realised that even the auxiliary star mapper on Hipparcos would give far better star positions. But I found it a little embarrassing that we were going to put those helpful ground-based instruments out of business, as far as all the brightest stars were concerned."*

CATHERINE TURON (Observatoire de Paris-Meudon): *"In mid-1985 we presented our colleagues with an incredibly long list of stars that had to be freshly measured from the ground to provide starting positions good enough for Hipparcos. It was a big effort for the project, and bad weather at the observatories did not help us. But with tremendous goodwill, a task that might have taken some decades in normal circumstances was finished in time for the launch of the satellite."*

LENNART LINDEGREN (Lund Observatory): *"The Hipparcos Catalogue is not the end of the story. The revolution in astrometry has only just begun. By conceiving the GAIA spacecraft, which could outperform Hipparcos as thoroughly as Hipparcos beat the ground-based instruments, we are now offering ESA the chance to maintain its world leadership in space astrometry."*

Pictures of the medallists, more information about their contributions to Hipparcos, and brief personal histories, are available on the web at: <http://sci.esa.int/hipparcos> esa

Total Eclipse of the Sun

The last solar eclipse of the millennium will take place on 11 August 1999 with a range of visibility stretching slightly more than one-third of the Earth from Nova Scotia (Canada) to the Bay of Bengal (India).

The zone of totality will begin at sunrise south of Nova Scotia. By about 11:00 (GMT) it will be visible in the southwest of England. Next it travels to northern France, Belgium, Luxembourg, Germany, Austria, Hungary and Romania, where it will be visible the longest. The zone continues through eastern Turkey, northern Iran, Iraq, south Pakistan and central India, ending at sunset in the Bay of Bengal.

In the few minutes leading up to total eclipse, it will be possible to see the shadow of the moon racing westerly, the famous 'Bailey Beads' (the necklace effect of the Sun's light around the moon's mountains, valleys and craters) and the 'diamond ring' (the last visible point of light).

Path of totality for the 11 August solar eclipse

During total eclipse, there will be a glow of light on the horizon where the Sun's light is reflected off the parts of the Earth outside the zone of the eclipse. Planets and stars will be clearly visible. The ring of the Sun's corona will reach out from behind the dark lunar disc and it may be possible to identify the Sun's 'flares' (arched corona structures near the Sun's equatorial area).

The solar eclipse is a spectacular event not to be missed. More information can be found on the ESA Science Programme website: <http://sci.esa.int>. esa

Go-ahead for ESA's New Millennium Space Observatories: Planck and FIRST

European scientific institutes have been given the go-ahead for the development of instruments for two major ESA missions for the new millennium: Planck, a satellite to study the radiation considered to be the 'echo' of the Big Bang and FIRST, an infrared space telescope. ESA's Science Programme Committee (SPC) approved on 17 February the scientific instruments for both missions, which will be built by more than 80 institutes from all over Europe. The go-ahead will also allow ESA and European industry to begin in earnest the development of the Planck and FIRST spacecraft to be launched together in 2007.

Planck is a cosmology mission, designed to test the models describing the origin and evolution of the early Universe. It will study the Cosmic Background Radiation, a light emitted shortly after the Big Bang that fills the whole Universe and can be detected today, like an echo of the primeval explosion. Astronomers consider it a 'fossil' radiation, since it holds a lot of information about both the past and the future of the Universe.

"Planck will determine fundamental characteristics of the Universe, such as its geometry, its density, and the rate at which it expands. It will also provide important clues as to the kind of matter that fills the Universe", explains Planck Project Scientist Jan Tauber, at ESA's European Space Research and Technology Centre (ESTEC). More precisely, the task of Planck will be to measure the temperature of the echo. Though at the time of its emission the Cosmic Background Radiation was very hot, some 3000°C, it has since expanded and cooled, together with the entire cosmos, to a much lower temperature, about -270°C (3° Kelvin). Planck will look for differences in this temperature as slight as a few microkelvin, thin variations like clots that are, in fact, the 'seeds' of the huge condensations of matter in today's Universe. *"It will be like watching the birth of the galaxies, the galaxy clusters, all the large-scale structures that we observe today",* Tauber says.

The two instruments on board Planck, now approved by ESA, are the Low Frequency Instrument (LFI) and the High Frequency Instrument (HFI). They will cover a very broad range of frequencies (between 30 and 857 Gigahertz). The HFI will be designed and built by a consortium of about 20 institutes led by Jean-Loup Puget of the Institut d'Astrophysique Spatiale in Orsay (F). The LFI will be designed and built by a consortium of about 20 institutes led by Reno Mandolesi of the Istituto di Tecnologie e Studio delle Radiazioni Extraterrestri in Bologna (I).

FIRST, the 'Far InfraRed and Submillimetre Telescope', is the successor to ESA's Infrared Space Observatory ISO. It will be more powerful than any of its predecessors, with a primary mirror 3.5 m in diameter – the largest ever for an infrared space telescope. It will observe at wavelength ranges never covered before (from 80 to 670 microns). Like Planck, it will be located about 1.5 million km away from Earth.

FIRST will look for planetary systems and study processes like the evolution of galaxies in the early Universe. It will provide detailed information about the coldest objects in the Universe, and those shrouded by dust. The pre-stellar cores from which the stars hatch at nearly -260°C, or the dusty distant galaxies undergoing violent collisions, are some examples. Also, FIRST will show the composition, temperature, density and motion of the gas and dust of the clouds in the interstellar space.

Its payload will consist of three instruments: two cameras called PACS and SPIRE, and HIFI, a high-resolution spectrometer. *"They are real technological challenges. Instruments like these have never been used in a space telescope",* says FIRST Project Scientist Göran Pilbratt at ESTEC. To avoid the 'noise' caused by the emission of the instruments themselves, a cryostat full of superfluid liquid helium will cool them down to a temperature below -271°C, very close to the absolute zero (at -273°C).

The Heterodyne Instrument for FIRST (HIFI) takes very high-resolution spectra of the astronomical objects in thousands of frequencies simultaneously. It will be designed and built by a consortium led by Thijs de Graauw, SRON, Groningen (NL). The Photo-conductor Array Camera and Spectrometer (PACS) instrument is an infrared camera and a spectrometer that will be developed and built by a consortium led by Albrecht Poglitsch, MPE, Garching (D). The Spectral and Photometric Imaging REceiver (SPIRE) is also a camera and spectrometer, but will observe at longer wavelengths than PACS. It will be developed and built by a consortium led by Matt J. Griffin, Queen Mary and Westfield College, London (UK). esa

The Far InfraRed and Submillimetre Telescope, FIRST, is the successor to ESA's Infrared Space Observatory, ISO

Mission to Mars

Artist's impression of the Mars Express lander, Beagle 2, on the red planet (credit: ESA/MediaLab)

On 30 March, ESA signed a contract with Matra Marconi Space (MMS), that pioneers a more flexible way of building space science missions and is, in this respect, the first trial as an element of a new and ambitious implementation concept which is currently under development for ESA's Scientific Programme. The contract, worth about 60 million Euro, is to design and build the Mars Express spacecraft in time for launch in June 2003. Mars Express will allow European space scientists to investigate whether there is, or ever was, life on the red planet.

ESA took the decision in principle to send a mission to Mars shortly after the loss of the Russian spacecraft Mars '96 with several European experiments on board. The Agency wanted to build on the Mars '96 payload experience to design a mission that would put Europe at the leading edge of Mars exploration and it had to act quickly. Major space missions can take up to 11 years from concept to launch, and there was little more than six years to go before the positioning of the planets in 2003 would offer the shortest travel time to Mars with the highest payload. Budgetary pressures were also forcing ESA to look for cheaper ways of building spacecraft. A Mars mission therefore seemed a good candidate to explore cheaper and faster working methods.

Mars Express (so called because of the streamlined development time) is the first of a new type of 'flexible' missions in ESA's long-term scientific programme, which should be built and launched for about half the budget for previous, similar missions. The global budget for Mars Express will actually be only 150 million Euro including spacecraft development, launch by a Russian Soyuz/Fregat launcher, operations, testing and management costs. Costs are being saved by shortening the time from original concept to launch, re-using existing hardware, adopting new project management practices, and having access to reduced launcher costs.

Selection of the scientific payload by ESA's scientific advisory bodies and mission definition by industry have been performed simultaneously, instead of sequentially as in previous missions. This has cut the time from concept to the awarding of today's design and development contract from about five years to little more than one year. The design and development phase will take under four years, compared with up to six previously.

Mars Express is making maximum use of pre-existing technology, which is either 'off-the-shelf' or has already been developed for the Rosetta mission (also due for launch in 2003). This strategy, in fact, only works when a second mission (i.e. Mars Express), can use, in a recurring manner, technology already applied in a previous mission (i.e. Rosetta). In future, ESA plans to develop new technologies needed for innovative and ambitious missions also in separate, small technology missions called SMART.

It is indeed a totally new concept where programme cornerstones may now become industrial themes spanning over several missions. New technologies are first tested in a small technology mission, then applied in a major mission, whose design and hardware can be utilised in following flexible missions. An industrial cycle is created in this way that gives more launch opportunities and that will also allow implementation in the long term of a global and coherent industrial return for the participants.

A further advantage of this concept applied to Mars Express is that commonalities with Rosetta make it possible to reduce operations costs at ESOC and to streamline project-management by handing over more responsibility to industry. *"European space industry is now sufficiently mature, thanks largely to previous experience with ESA missions, to take on these aspects of Mars Express as well as the associated risks"* says Rudolf Schmidt, ESA Mars Express Project Manager. MMS (Toulouse) is therefore interacting directly with the principal investigators for the scientific payload and with possible launch suppliers to ensure that technical interfaces are compatible. *"Before, ESA was taking the interface role. For Mars Express we have meetings directly with the scientists. This means that we can agree on the solution to any problem very rapidly"* says Philippe Moulinier, Mars Express Spacecraft Manager at MMS.

The use of previously-developed technology means that the number of models can be reduced without substantially increasing risk. This will also shorten the schedule and limit costs. *"Before we were developing every new system. Now we are using off-the-shelf and Rosetta technology which means we can offer both low cost and low risk",* says Moulinier.

For further information on the Mars Express mission, see pages 56-66 of this Bulletin

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ESA Astronauts Selected for HST Servicing Mission

ESA astronauts Claude Nicollier and Jean-François Clervoy have been selected to join a team of Shuttle astronauts on an earlier-than-planned mission to service the orbiting Hubble Space Telescope (HST) in October. Although the HST is operating normally and continuing to conduct its scientific observations, its pointing system has begun to fail.

Nicollier and three NASA astronauts, who had already been training for a Hubble servicing mission planned for June 2000, have been reassigned to this earlier mission (STS-103). Clervoy and two other NASA astronauts will complete the STS-103 crew.

ESA astronaut Claude Nicollier at RMS controls on the Shuttle's aft flight deck during the first HST servicing mission, STS-62

The repairs and maintenance of the telescope will require many hours spent working outside the Shuttle and will make extensive use of the Shuttle's robotic arm.

Nicollier, of Swiss nationality and making his fourth flight, will be part of the team performing the 'spacewalks'. An astronomer by education, he took part in the first Hubble servicing mission (STS-61) in 1993, controlling the Shuttle's robotic arm (RMS) while astronauts on the other end performed the delicate repairs to the telescope. He also served on STS-46 in 1992 using the robotic arm to deploy ESA's Eureca retrievable spacecraft from the Shuttle, and on STS-75 in 1996 with the Italian Tethered Satellite System. Nicollier is currently the chief of the robotics branch in NASA's astronaut office and ESA's lead astronaut in Houston.

Clervoy, of French nationality and making his third flight, will have the lead role in the operation of the robotic arm for this mission. He previously served on STS-66 in 1994 using the robotic arm to deploy and later retrieve the German CRISTA-SPAS atmospheric research satellite, and on STS-84 in 1997, a Shuttle mission to the Russian Mir space station.

The other STS-103 crew members are: Commander Curtis Brown, pilot Scott Kelly, and mission specialists Steven Smith, Michael Foale and John Grunsfeld.

During the flight, the astronauts will replace Hubble's failing pointing system, which allows the telescope to aim at stars, planets and other targets, and install other equipment that will be ready for launch at that time. A second mission to complete the previously-scheduled Hubble refurbishment work is foreseen at a later date. The crew for that mission has not yet been assigned.

The Hubble Space Telescope, launched in 1990, is one of the most powerful optical telescopes available to astronomers today, producing images and spectral observations at the forefront of astronomy. ESA contributed a 15% share to the development of Hubble and European astronomers receive in return a guaranteed 15% share of observing time (and 20% on average in practice).

For more information, see the following web pages:

- Biographies of ESA astronauts: <http://www.estec.esa.int/spaceflight/astronaut>
- Biographies of NASA astronauts: <http://www.jsc.nasa.gov/Bios>
- Hubble servicing missions: <http://station.nasa.gov/shuttle/future/sts-103.html>
- Hubble Space Telescope: <http://sci.esa.int/hubble>

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Waiting for the Leonids

Once a year, the Earth passes close to the orbit of comet 55P/Tempel-Tuttle. Dust from the comet enters the Earth's atmosphere in the night from 17 to 18 November creating the Leonid meteor shower. For 1998, an extremely high meteor rate was predicted – a so-called 'meteor storm' – the same is expected for 1999.

Last year enhanced activity was indeed observed at the predicted time, but with lower rates than expected. In addition, the previous night (16 November) presented us with a wonderful display of extremely bright meteors.

Current models predict storm level activity for this year, with the best visibility in Europe. While this is no threat on Earth, a particle impact on a satellite could cause severe damage. Spacecraft operators have taken precautions for near-Earth satellites. In addition, scientists of the Solar System Division in ESA's Space Science Department will set up a ground-based observing campaign from the Sierra Nevada Observatory (OSN) and the German-Spanish Astronomical Centre at Calar Alto (CAHA), both in southern Spain. Equipped with intensified video cameras they will study the physical properties of the cometary dust particles. The two stations will allow stereoscopic observations for precise triangulation of the meteor paths. With the OSN telescope, scientists will perform a spectroscopy of the glow that is visible

after the meteor disappeared, the persistent 'train'. One video camera will be dedicated to public relations activities.

In 1998, ESA recognised the public interest for this event. Still images of the night sky were transmitted from an observation site near Utrecht (NL) and a group of scientists was available for interviews, conveying the excitement of the observations.

For the upcoming event in November 1999, we are aiming at:
- having mobile, light-weight, easy to carry equipment
- not being dependent on external infrastructure, in particular all equipment should run on 12 V
- transmitting compressed video frames in real time
- having a low-cost, reusable solution
- directly feeding a real-time video stream to the world wide web (WWW).

To fulfil these requirements, a bandwidth of at least 30 kbits/s is needed. While a Global System for Mobile Communication (GSM) data modem offers the flexibility required, the data rate is still restricted to 9660 Kbit/s and the next generation of GSM data modems will not be available this year. Alternative solutions such as ISDN connections or satellite communication are either quite expensive or do not offer the flexibility and mobility we would like to see. Mobile connect GmbH, Germany, offered a solution using 4 GSM data modems. The Solar System Division and the Science Programme Communications Service will implement this solution in a collaborative effort.

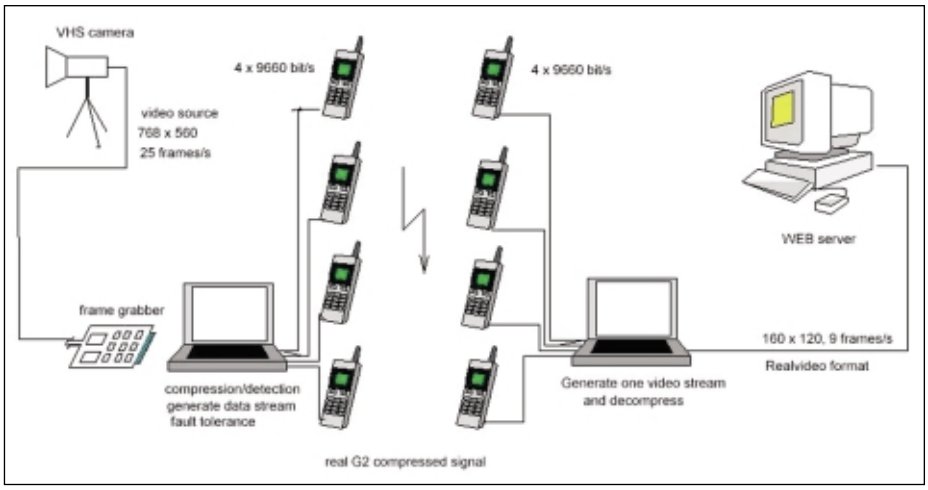
From 11 to 18 November we will operate an image-intensified video camera for public relations purposes from the Calar Alto site. It will provide a wide-angle view of the night sky. This video stream is compressed and transmitted by the four data modems in parallel. The Science Communications Service will operate four data modems at ESTEC, receiving and merging the data streams together. The collected video sequences will be published on the Science web server and can then be watched with the freely-available RealVideo viewer on the Internet.

Using standard compression algorithms, we expect a data rate of 160x120x3 (width x height x frames/s), with a transmission aim of up to 8 frames/s, taking into account the image characteristics of the night sky and the meteors. The necessary algorithms are being developed and implemented in the Space Science Department.

Having decided on this solution, we realised that the setup is flexible and mobile enough to be used as a general communication tool within the Space Science Department for a variety of astronomical events, the first one being the solar eclipse on 11 August. esa

A Perseid meteor recorded by an intensified video camera

Collected video sequences of the Leonids will be available at: <http://sci.esa.int>



ESA Successful in Advanced Space Robotics Experiment

A team of ESA staff and contractors, operating from Japan, has successfully performed a novel experiment in space robotics. From an ESA control station in the National Space Development Agency of Japan (NASDA) Tsukuba Space Centre, they commanded the robot arm on the Japanese Engineering Test Satellite 7 (ETS-VII) using several advanced techniques, which will be essential in future applications of space robotics. The experiment data collected will provide a basis for quantifying the performance that can be achieved using these control modes.

ETS-VII is the latest in NASDA's series of engineering test satellites. It is dedicated to the in-orbit assessment and demonstration of novel technologies in rendez-vous/docking and space robotics. ETS-VII is, in fact, a pair of satellites, a larger chaser and a smaller target satellite. The larger satellite carries a robot arm with a stretched length of about 2 m and a set of experimentation equipment to test the robot's capabilities: a task board on which typical robot manipulation activities can be performed and measured, an Orbital Replacement Unit (ORU) to be removed and reinstalled, a truss structure to be erected, an antenna assembly mechanism to be actuated, and an advanced robot hand.

The ESA experiments concern advanced schemes for planning, commanding, controlling and monitoring the activities of a space robot arm system. One set of experiments tests an operational mode called 'interactive autonomy', whereby the robot motions are split into typical tasks of medium complexity. Ground operators can interact with the tasks (parameterising, commanding, rescheduling, monitoring, interrupting them as needed), relying on the fact that each task will be autonomously executed using appropriate sensor-based control loops (it having been programmed and extensively verified in advance by simulation). This significantly reduces the amount of data traffic over the space link. In fact, ETS-VII offers only a few short communications windows per day. Data from ESA experiments will be used to assess the performance of tasks executed with

'interactive autonomy' compared with the more traditional tele-manipulation at lower control levels.

The second group of experiments concerns vision-based robot control. Using the Japanese-provided onboard vision system (which includes one hand camera and one scene-overview camera), it has been demonstrated that reliable automatic object localisation and grasping can be performed even without the artificial markers which are typically used to guide tele-manipulation. This is an important capability for robotically servicing 'non-cooperative' targets.

The success of these experiments is an important step towards the development of a number of ESA space robot systems which will be launched and installed on the International Space Station in the next few years. Looking beyond the ISS, the functional demonstration of satellite capture by robotic means could also inspire novel applications for space robotics on free-flying servicing vehicles.

Development work for the ESA experiments was funded by Belgium under the ESA Technology Demonstration Programme (TDP) and the ESA General Support Technology Programme (GSTP). After competitive tendering, the contract was awarded to a team led by TRASYS Space with SAS and two institutes at the Catholic University (KUL) in Louvain, Belgium as subcontractors.

ETS-VII was launched in November 1997. It operates in a circular orbit at an altitude of 550 km and is controlled from the Tsukuba Space Centre via NASA's Tracking and Data Relay Satellite. In the course of 1998, NASDA successfully performed a range of experiments in space robotics and rendez-vous/docking.

In an effort to strengthen international cooperation NASDA offered ESA an opportunity to participate in the ETS-VII experiments. ESA responded positively with several proposals and, in 1997, an ESA/NASDA Memorandum of Understanding was concluded concerning the joint robot experiment. esa

Spacelab: A Piece of Space Heritage Returns to Europe

After 22 trips into space, Spacelab – Europe's first step into human spaceflight – has returned to Europe. On 16 April, NASA Administrator Daniel Goldin officially handed the space laboratory over to ESA's DG, Antonio Rodotà, in the presence of German Chancellor Gerhard Schröder, during a ceremony at Bremen airport in Germany, the city where the module was built more than two decades ago.

The laboratory, to be housed in a special exhibition hall at the airport, will be the 'foundation stone' for the Space Academy Bremen, a new educational venture between DaimlerChrysler Aerospace and Bremen University. The academy will give students and the general public the opportunity to learn first-hand about Europe's achievements in the human exploration of space.

Europe's involvement in human spaceflight began shortly after the Apollo moon landings in 1969 when the future of space exploration was being determined. Europe and the US agreed that NASA would build a re-usable space plane, the Space Shuttle, while ESA would contribute the laboratory carried in the Shuttle's cargo bay where astronauts could conduct scientific research in the unique environment of space. ESA entrusted the development of Spacelab to a consortium of European companies led by ERNO of Bremen, today a part of DaimlerChrysler Aerospace.

Two Spacelab flight units were built. The laboratory returned to Europe flew on the final Spacelab flight, the Neurolab mission in April 1998, and was used for both German Shuttle missions, D-1 and D-2, among others. The second flight unit, which flew on Spacelab's maiden mission in 1983, will be preserved along with other pieces of American space history at the Smithsonian Institute's National Air and Space Museum in Washington, D.C.

Europe's experience with building Spacelab has inspired the Columbus laboratory, to be added to the International Space Station in 2003. Columbus is based on the same concept and technologies, but in contrast to Spacelab's eight-day to two-week missions, it will serve as an outpost for continuous research in orbit.

For online information on ESA and its manned spaceflight activities see: <http://www.esa.int/spaceflight/> esa

On Spacelab D-1 (STS-61A), astronauts conducted 75 individual experiments on material science, fluid physics, biology and medicine. Working on experiments here are Wubbo Ockels, ESA, and Bonnie Dunbar, NASA.

XMM – One Step Closer to Lift-off

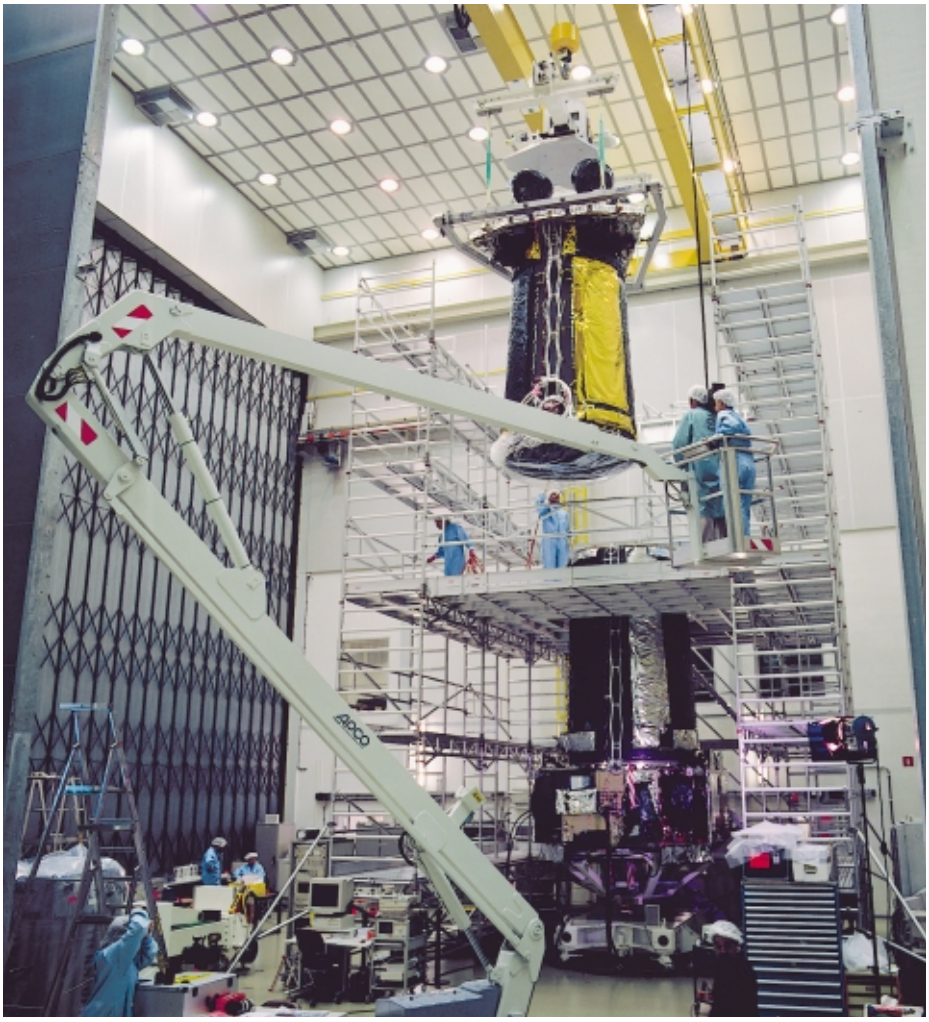
With the most sensitive X-ray space telescope ever conceived, ESA's X-ray astronomy mission, XMM, is about to revolutionise X-ray astronomy. The XMM mission will conduct prolonged observations of more than one million X-ray sources in the universe, violent and changing places such as black holes, binary stars and vestiges of supernovae, where temperatures reach millions of degrees.

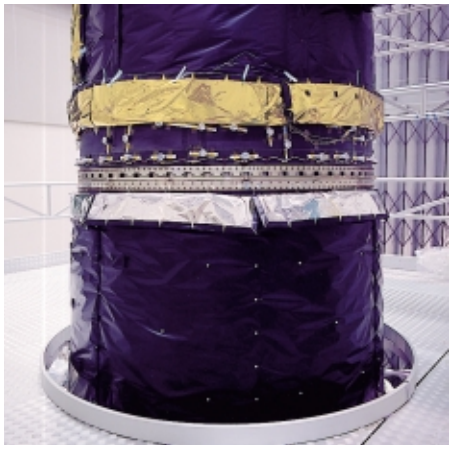
Over the past months, both parts of the spacecraft – its focal plane assembly and the module with its mirror support platform, each with a section of the 7.5m telescope's central tube – have independently and successfully completed their environmental tests at ESTEC. The three mirror modules and an optical telescope were also installed.

On 26 May, the two halves of XMM, both approximately 5 m long, were mated at ESTEC in the XMM integration area. The upper focal plane assembly was hoisted by a gantry crane above XMM's lower section, itself surrounded by scaffolding. As it slowly descended, controlled with infinite caution by specially-trained technicians, the scene was watched from a visitors gallery by members of the XMM team, several of the mission's principal investigators and representatives from Arianespace, including Arianespace XMM mission manager Daniel Biedermann.

After being lowered into place, the first of 64 bolts around the 6 m diameter interface plane was inserted. To mark this new milestone in the programme, three years after the start of construction of flight hardware, a special 'golden bolt' was positioned by Dr Hubert Hofmann, Executive Vice President Science, Earth Observation and Meteorological Satellites, Dornier Satellitensysteme, the XMM prime contractor:

"It is an exciting moment to see the XMM satellite ready for the last tests in Europe. I would like to thank all members of the XMM team for reaching this significant milestone. I'm convinced that the upcoming launch campaign will also be conducted in a positive spirit. I'm sure that XMM will deliver excellent data to the scientific community", Dr Hofmann said.





(top) Infinite precaution is taken during the mating of the upper and lower halves of ESA's X-ray astronomy satellite, XMM, at ESTEC (middle) The two halves are sealed by 64 bolts around the 6 m diameter interface plane (bottom) To mark this new milestone, the first of the 64 bolts, specially made of gold, is inserted by Dr Hubert Hofmann (right) of Dornier Satellitensysteme, assisted by Robert Lainé, ESA's XMM Project Manager

Robert Lainé replied: *"I would like to congratulate everybody at Dornier. It's an exceptional achievement to have built such a large spacecraft and to have reached this stage only three years and two months after we signed the industrial contract".*

The fully-assembled satellite is currently undergoing acoustic tests at ESTEC. Final verifications will last virtually until it is time to pack XMM for its journey to French Guiana. The present schedule is to have the satellite in Kourou by end September, with a campaign leading to a launch at the end of this year. esa

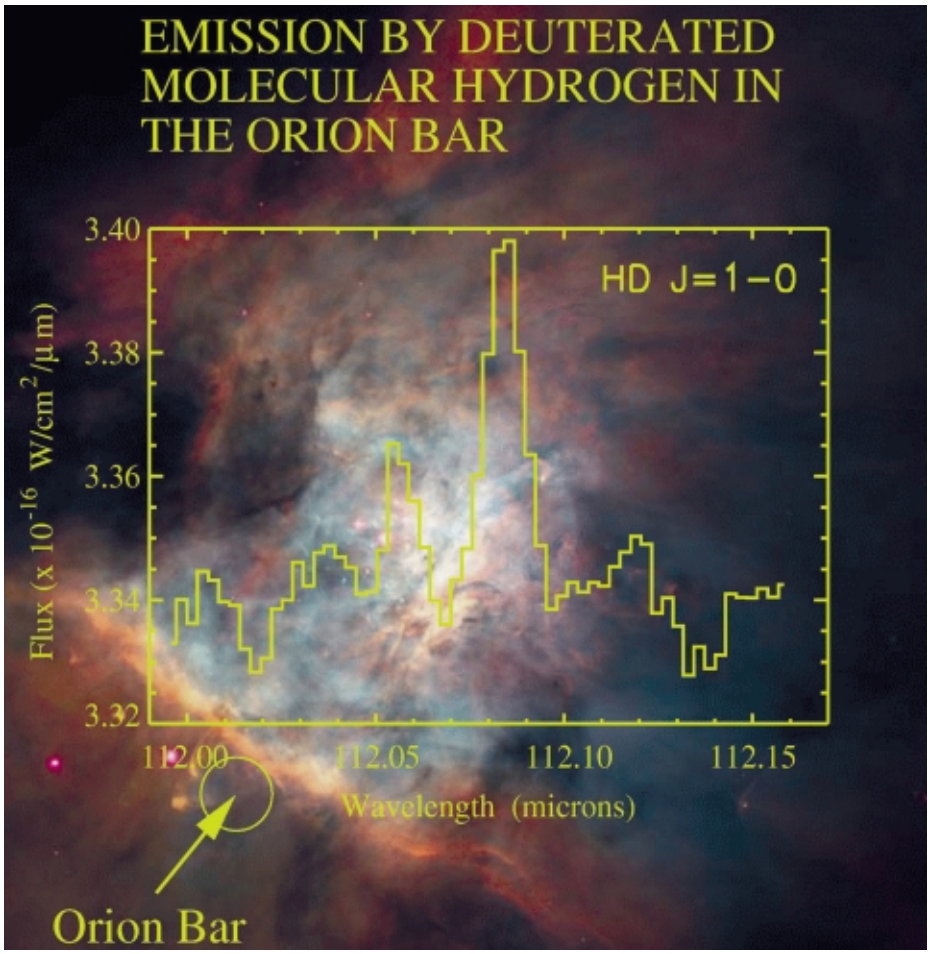
ISO – Latest Results

From near-Earth asteroids to water on Mars

Near-Earth Asteroids – asteroids whose orbits bring them close to Earth – very likely originate from collisions between larger asteroids that orbit the Sun between the planets Mars and Jupiter. This result, obtained by ESA's infrared space telescope ISO, was presented on 10 May at the workshop on ISO results on the Solar System, held at ESA's Villafranca Satellite Tracking Station in Spain. Other findings related to the atmosphere of Mars and the giant planets – Saturn, Jupiter, Neptune and Uranus – were also presented during a press conference on the same day.

Astronomers debate diamonds in space

Most chemical elements in the Universe are produced in the stars, and thus the stars' environments act as huge chemical factories. ISO has detected, in the dust surrounding a star, the chemical signature of a mysterious compound made of carbon, whose nature is being actively debated by astronomers all over the world. While some say it could be a very tiny diamond, others think it is the famous football-shaped molecule called 'fullerene' or 'buckyball'. If either of these hypotheses is confirmed it will be interesting news for industry as well.



The element deuterium has been detected for the first time in an active star-forming region, in the Orion Nebula about 1500 light-years away. The 'signature' of the element appears in the spectra overlaid on the optical image of the Orion Nebula. (Spectra: ESA/ISO/LWS & E. Dishoeck, C. Wright et al.; Optical image: NASA/ESA/HST, O'Dell & S.K. Wong (Rice University))

There is not enough normal matter in the Universe to cause a 'Big Crunch'

The fate of the Universe depends on the total amount of existing matter. New clues on this value have been obtained by an international team of astronomers, using ISO, by measuring for the first time the abundance of a particular chemical element, deuterium, in a very active star-forming region in the Orion nebula. Their result confirms that the total amount of normal matter is insufficient to stop the expansion of the Universe and cause it to collapse into a 'Big Crunch' in the future.

Online information on these topics and more can be found at:
<http://www.iso.vilspa.esa.es>
<http://sci.esa.int/iso>

ESA Council Elects New Chairman

Mr Alain Bensoussan, currently President of the French Space Agency CNES (Centre National d'Etudes Spatiales), will be the next Chairman of the ESA Council, for two years from 1 July 1999.

Mr Bensoussan was elected at the 142nd Meeting of the ESA Council, held at the Agency's Headquarters in Paris on 23 and 24 June. He will take over from Hugo Parr, Director General in the Norwegian Ministry of Trade and Industry, who has presided over the ESA Council for the last three years and whose term of office ends on 30 June.

Alain Bensoussan, born on 12 May 1940, is an engineer by training. He graduated from the 'Ecole Polytechnique' and the 'Ecole nationale de la statistique et de l'administration économique' and holds a doctorate in mathematics. He is a correspondent Member of the French Academy of Sciences. Prior to becoming President of CNES in 1996, he was President of INRIA (Institut national de recherche en informatique et en automatique), from 1984 to 1996. He has been a member of the ESA Council since 1996.

European Space Activities on Show 'Under One Roof' at Le Bourget

For the first time in the long history of the Paris Air Show, ESA, CNES and Arianespace joined forces this year in setting up a 2000 m^2 Pavilion in order to present together the many accomplishments – past, present and future – of European space efforts.

Some of the highlights of this joint exhibition, lasting from 12 to 20 June, were: the display of the Atmospheric Reentry Demonstrator (ARD), the capsule launched on the Ariane-503 flight and returned to Earth on 21 October 1998; full-scale models of several satellites, including Envisat, and of the Ariane-5 launcher; scale models of the International Space Station and Artemis; plus other attention-grabbing exhibits and demonstrations devoted to European space activities in the fields of telecommunications, satellite navigation, Earth observation and technology transfer.

The joint Pavilion opened its doors to the general public at the weekend on 13, 19 and 20 June, whilst during the week it was open solely to aerospace professionals and the media. Sunday 13 June was designated 'Astronauts Day', and several

The 'Europe in Space' Pavilion

The full-scale models of Envisat and Ariane-5 outside the Pavilion

Envisat

Interior of the Pavilion, with the Atmospheric Reentry Demonstrator (ARD) on the right

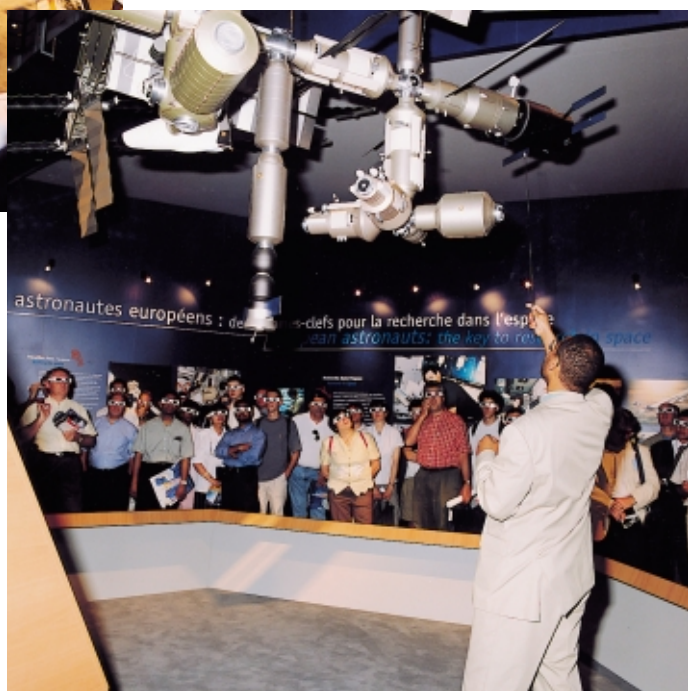
European astronauts were on hand to give presentations to the public, and to talk to the many children present.

A special effort was made to provide media representatives with plenty of opportunities to meet ESA, CNES and Arianespace directors and managers at a series of Press Conferences/Briefings and Round Tables scheduled throughout the week. The Press Conference on 16 June, for example, had the theme 'Satellite Navigation for Europe: The Galileo Programme'. It was followed later that same afternoon by the signature of the industrial contract for EGNOS – the European Geostationary Navigation Overlay Service (see accompanying photograph). The Press Briefing on 17 June on atmospheric reentry technologies and the initial results of the Atmospheric Reentry Demonstrator (ARD) mission was followed by an Appreciation Award ceremony in which the ARD heads of project and their teams were recognised for their outstanding contributions (see accompanying photograph).

Distinguished visitors to the Pavilion during the week included Mr Claude Allègre, France's Minister for Education, Research and Technology.

The accompanying photographs show just a small selection of the activities that took place within the ESA-CNES-Arianespace Pavilion at this unique biennial gathering catering to both the professional aero-space community and the general public.

General view of the interior of the Pavilion



'Three-dimensional' presentation of the International Space Station Programme, by Eric-Joseph Gabriel (ESA)

The 'Earth Observation: Europe for a Living Planet' Press Conference on 16 June; from left to right: Marc Pircher (CNES), Guy Duchossois (ESA) and Philippe Munier (Spot Image)

The visit of Minister Allègre (second from right) to the 'Europe in Space' Pavilion

The 'Satellite Navigation for Europe' Press Conference, being addressed by Claudio Mastracci, ESA's Director of Application Programmes

Signature of the industrial contract for the development of EGNOS, Europe's first-generation regional contribution to GNSS, by Jean-Claude Husson (seated left), President and Chief Executive Officer of Alcatel Space Industries, and Antonio Rodotà, ESA's Director General

The Round Table on 'Space Developed Technologies and Technology Transfer', hosted by Hans Kappler (extreme left), ESA's Director of Industrial Matters and Technology Programmes

The ARD Appreciation Award ceremony. The five recipients were, from left to right: Patrice Amadieu, ESA; Gérard Lagrenée, CNES; Gérard de Wailly, French Navy; Gérard Bréard, Aerospatiale Matra; and Christian Cazaux, ESA. Holding the microphone is Pierre Moskwa, Director of Space Techniques at CNES, and on the extreme right is Jörg Feustel-Büechl, Director of ESA's Manned Spaceflight and Microgravity Programme