In Brief

Cluster-II Launch Contract Signed

The contract between ESA and Starsem for the re-launch of the four Cluster-II satellites was signed on 24 July at ESA Headquarters in Paris.

The shareholders in Starsem, a company founded in Suresnes, France, in August 1996 to exploit the Soyuz launch vehicle family commercially, are: the Russian Space Agency (RKA), the Samara Space Centre, which manufactures the Soyuz rockets, Aérospatiale, and Arianespace.

The four Cluster satellites will be launched in pairs from Baikonur on two Soyuz launchers with Fregat upper stages, between May and August 2000. The nominal launch dates, which should not be more than 42 days apart for orbit-injection-related reasons, are 15 June and 13 July.

The photograph below shows the launch-contract signing ceremony at ESA Headquarters with, seated from left to right: Roger M. Bonnet, ESA's Director for Science, Jean-Yves Le Gall, Chairman of Starsem, and Jean-Marie Luton, Chairman and CEO of Arianespace. Standing behind, from left to right are: Helge Weber of ESA's Contracts Department, Karl-Egon Reuter, ESA's Head of Cabinet, Jean-Charles Vincent of Starsem, and Daniel Sacotte, ESA's Director of Administration. esa

ESA at ILA in Berlin

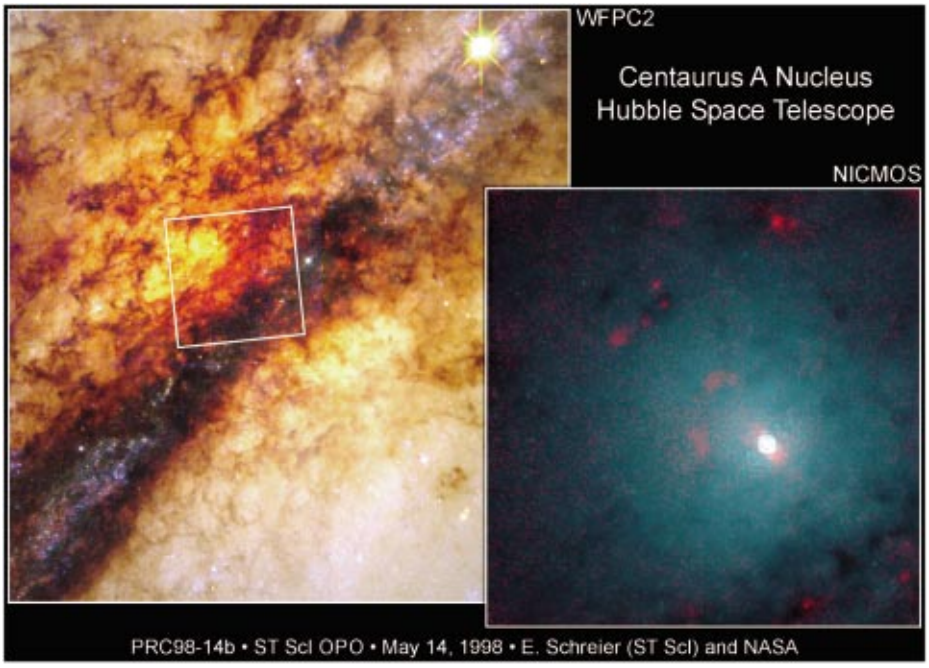
The International Aerospace Exhibition ILA'98 was held in Berlin at Schönefeld Airport during 18-24 May 1998. More than 600 exhibitors from all over the world attended this international trade fair, including leading US aerospace companies and numerous representatives of the aerospace industry from Russia and Eastern Europe, as well as from many Asian countries.

ESA, together with the German Aerospace Centre (DLR), and the German Aerospace Industries Association (BDLI), jointly organised the 'Raumfahrthalle' for the fourth time, the 2000 m^2 Space Activities Hall where current and future European space activities, as well as Germany's national space programmes, were presented to the public. The pavilion featured exclusive spacecraft models and scenery of the Earth and of Saturn's moon Titan. The International Space Station, a special attraction this year, was represented by a detailed full-size mock-up of the European, the US and the Japanese modules. A 1:10 model of the complete Station was suspended overhead, while a 'control centre' fitted with consoles and computers allowed visitors to follow a simulated mission from the ground. esa

Feeding a Black Hole

Astronomers have obtained an unprecedented look at the nearest example of galactic cannibalism: a massive black hole hidden at the centre of a nearby giant galaxy that is feeding on a smaller galaxy in a spectacular collision. Such fireworks were common in the early Universe, as galaxies formed and evolved, but are rare today.

Although the cause-and-effect relationships are not yet clear, the views provided by complementary images from two instruments aboard the Hubble Space Telescope (HST) are giving astronomers new insights into the powerful forces being exerted in this complex maelstrom. Researchers believe these forces may even have shifted the axis of the massive black hole from its expected orientation.



Hubble's infrared NICMOS instrument has penetrated the girdle of dust around Centaurus-A for the first time, revealing a disc of superhot gas being swept up by a suspected black hole

The Hubble wide-field camera visible image of the merged Centaurus-A galaxy shows a dramatic dark lane of dust girdling the galaxy. Blue clusters of newborn stars are clearly resolved, and silhouettes of dust filaments are interspersed with blazing orange-glowing gas. Located only 10 million light-years away, this peculiar-looking galaxy contains the closest active galactic nucleus to Earth and has long been considered an example of an elliptical galaxy disrupted by a recent collision with a smaller companion spiral galaxy.

Using Hubble's infrared vision, astronomers have penetrated this wall of dust for the first time to see a twisted disc of hot gas swept up in the black hole's gravitational whirlpool. The suspected black hole is so dense that it contains the mass of perhaps a thousand million stars, compacted into a small region of space not much larger than our Solar System.

Resolving features as small as 7 light-years across, Hubble has shown astronomers that the hot gas disc is tilted in a different direction from the black hole's axis. The axis is identified by the orientation of a high-speed jet of material, glowing in X-rays and radio frequencies, blasted from the black hole at 1/100th the speed of light. This gas disc presumably fuelling the black hole may have formed so recently that it is not yet aligned to the black hole's spin axis, or it may simply be influenced more by the galaxy's gravitational tug than by the black hole's.

"This black hole is doing its own thing. Aside from receiving fresh fuel from a devoured galaxy, it may be oblivious to the rest of the galaxy and the collision," said Ethan Schreier of the Space Telescope Science Institute, Baltimore, MD. Schreier and an international team of co-investigators used Hubble's Near Infrared Camera and Multi-Object Spectrometer (NICMOS) to probe deeper into the galaxy's mysterious heart than anyone has before.

The hot gas disc viewed by Hubble investigators is perpendicular to the galaxy's outer dust belt, while the black hole's own internal accretion disc of superhot gas falling into it is tilted approximately diagonally to these axes. *"We have found a complicated situation of a disc within a disc within a disc, all pointing in different directions,"* Schreier said.

It is not clear if the black hole was always present in the host galaxy or belonged to the spiral galaxy that fell into the core, or if it is the product of the merger of a pair of smaller black holes that lived in the two once-separate galaxies.

Having an active galaxy just 10 million light-years away from Earth rather than hundreds of millions of light-years distant offers astronomers a unique laboratory for understanding the elusive details of the behaviour of supermassive black holes as fuelled by galaxy collisions.

"Though Hubble has seen hot gas discs around black holes in other galaxies, the infrared camera has for the first time allowed us to peer at this relatively nearby, very active, but obscured black hole region," Schreier added.

The team of astronomers is awaiting further Hubble data to continue its study of the disc, as well as ground-based spectroscopic observations to measure the velocity of entrapped material around the black hole. This will allow the astronomers to better calculate the black hole's mass.

The Hubble Space Telescope is an ESA/NASA international cooperation project.

esa

ESA and CERN Strengthen their Relationship

ESA's DG, Mr Antonio Rodotà, visited CERN, the European Laboratory for Particle Physics on 7 May 1998. He was welcomed by Prof. Chris Llewellyn Smith, the Director General of CERN, together with his designated successor, Prof. Luciano Maiani. After fruitful and positive discussions, the Directors General agreed on the creation of working groups to study and propose systematic joint activities to be conducted on a regular basis between the two organisations.

The working groups will reinforce the existing cooperation between the organisations in scientific and technical fields; for example, in data acquisition, handling and networking. The importance of communicating the scientific aims and achievements of both organisations to the general public was underlined by setting up new initiatives to take advantage of joint experience in educational projects and outreach activities. Finally, they agreed to reinforce the exchange of information on administrative issues. The working groups will present proposals to the management of the respective Agencies in September 1998. esa

Mr Antonio Rodotà (right) with CERN's Prof Chris Llewellyn Smith

European Global Navigation Satellite System Receives Go-ahead

ESA, the European Community (EC) and the European Organisation for the Safety of Air Navigation (Eurocontrol) have taken an important step towards the development of GNSS, the Global Navigation Satellite System for Europe.

Meeting at the offices of the Council of the European Union in Luxembourg on 18 June, ESA's Director General, Antonio Rodotà; the President-in-office of the Council of the European Union (Minister of Transport of the United Kingdom of Great Britain and Northern Ireland) Gavin Strang; Member of the European Commission, Neil Kinnock; and the Director General of Eurocontrol, Yves Lambert, signed an agreement formalising cooperation between the three organisations in the field of satellite navigation systems and services, with the aim of establishing a satellite navigation and positioning service for Europe as a contribution to a global effort.

The development of GNSS will be carried out in two main stages. GNSS-1 will be the first-generation system, based on signals received from the existing American GPS and Russian GLONASS constellations, and civil augmentation systems using space-based, ground-based and mobile autonomous-based techniques. The European space-based augmentation system, EGNOS (European Geostationary Navigation Overlay Service), consists of a set of navigation payloads on board geostationary satellites which are continuously monitored by ground stations both within and outside Europe. The system, to be completed by 2002, will be developed by ESA. GNSS-2, the second-generation system, will provide services to civil users, and will be under civil operation and control by 2010. A decision on how to proceed with GNSS-2 will be taken by mid-1999.

Aircraft operators represent one of the main markets for satellite navigation systems, which have the potential to transform air traffic management in many areas. With the services provided by satellites, it will be possible not only to improve navigational accuracy, but also to enhance communication and surveillance capabilities, thus increasing safety, gaining time, and reducing fuel consumption and costs.

Airlines will not be the only beneficiaries. Companies operating transport services by road, sea or rail need to know where their vehicles are at all times. So do police, ambulance and taxi services. Some European car manufacturers are already featuring satellite navigation systems in their top-of-the-range vehicles and inexpensive hand-held receivers are becoming widely used by recreational sailors, climbers and hikers.

As well as improving safety, a European contribution to a global navigation satellite system will contribute greatly to improving economic prosperity, industrial returns, employment and the quality of life in Europe. esa

International Space Station Revisions

Representatives of all nations involved in the International Space Station (ISS) have agreed to move the official target date for the launch of the first ISS component from June to November 1998, and to revise subsequent launch target dates for the remainder of the 43-flight Station Assembly Plan.

In meetings of the Space Station Control Board and the Heads-of-Agency on 30-31 May 1998 at the Kennedy Space Center, all station partners agreed to target launch dates of 20 November for the Control Module (FGB) – now called 'Zarya' (Russian for 'daybreak') – and 3 December for Shuttle mission STS-88 with Unity (Node-1). Changes in the construction schedule for the third station component, the Russian-provided Service Module, led the partners to reschedule these first assembly launches.

The rescheduling of the first launch will have only a minor effect on the target dates agreed upon for many major ISS milestones during the latter portions of the 5-year assembly plan. In addition, several enhancements to the Station's assembly have been made, including an exterior 'warehouse' for spare parts and a Brazilian-provided carrier for exterior Station components that are launched aboard the Shuttle.

The ISS partners set an April 1999 target launch date for the Russian Service Module. This module will house the first Station crews and the ESA-provided Data Management System (DMS-R). The first station crew – Commander Bill Shepherd, Soyuz Commander Yuri Gidzenko and Flight Engineer Sergei Krikalev – will take off aboard a Russian Soyuz spacecraft in summer 1999 to begin a 5-month inaugural stay. Launch of the US Laboratory Module is set for October 1999. Launches of other laboratory modules, provided by Europe, Japan and Russia, will take place later in the assembly sequence. The Canadian-provided Space Station Remote Manipulator System will be launched in December 1999. Scientific research will begin aboard the ISS early in 2000.

The expansion from a 3-person crew to a 6-person capability is planned for November 2002 and the final launch in the assembly sequence is set for January 2004, only one month later than in the previous assembly plan. Some issues in the assembly sequence remain under review and will be resolved at a Space Station Control Board meeting in September 1998. For example, ESA's Columbus laboratory is now targeted for February 2003, but the Agency would prefer to return to the previously-scheduled October 2002. Therefore, the final date is subject to further revision.

NASA continues the development of an Interim Control Module (ICM) as a contingency against further delays in the Service Module and to provide a potential additional propellant capability for a more robust Space Station. A decision concerning the configuration of the ICM will be made later this year.

During the Heads-of-Agency meeting, the Russian Space Agency (RSA) stated that the Russian government has made the ISS its number one civil space priority. RSA noted that progress on the Service Module continues to meet the launch target of April 1999. RSA is also working to deorbit Mir as early as safely possible, aiming to have the capability by July 1999. The International Partners expressed their concern with delays to the ISS programme to date and brought to the attention of RSA that it is critical to all participating nations that the programme schedule is met. The agencies' leaders also acknowledged the atmosphere of cooperation, the accomplishments and the successful achievements of the Shuttle-Mir Program (Phase 1) and look forward to the smooth transition to Phases 2 and 3 of the International Space Station. In addition, they highlighted the ongoing ISS training under way for the first four station crews. esa

ISO 9001 Certification Process at ESOC

The Director of Technical and Operational Support (D/TOS) has taken the initiative of implementing a Quality System certified to the ISO 9001 standard at the European Space Operations Centre of ESA to substantiate the quality and value of its products and services in the international space operations market.

The ISO 9001 standard is an internationally recognised benchmark for the management and performance of all activities necessary to ensure that the needs of a customer are satisfied. To prepare for certification, the first phase of activities are focused on the preparation of a Quality Manual and internal procedures to document the work practices within ESOC.

Since November 1997, the ISO 9001 Working Group has been analysing the internal functioning of ESOC and preparing the necessary documents. The Working Group consists of 16 staff members from ESOC and ESTEC Quality Assurance Division, and reports to a Steering Group composed of 7 members chaired by Mr David Dale (D/TOS).

In a second phase, the group will work with all staff to implement the ESOC Quality System. This will include the deployment of tools and the provision of training to support the implementation of the procedures in ESOC. Internal audits will be performed to verify and document that all ESOC staff are working together to provide outstanding mission operations services and space data products.

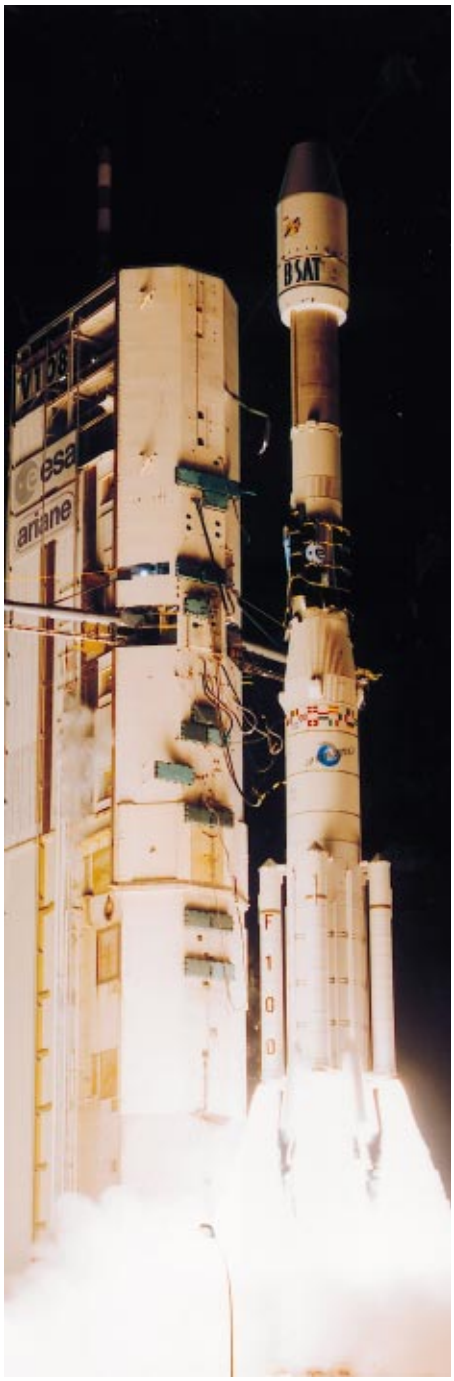
The third and last phase will be an independent audit of ESOC by an internationally accredited registrar to verify compliance with the ISO 9001 requirements. A successful audit will result in a certificate with a validity of 3 years. It is intended to achieve this official certification by the end of 1999.

There are three expected benefits:

- to clarify for all existing and future ESOC staff members the activities to be performed and their relationships to successfully deliver ESOC's products and services
- to provide a documented baseline for future analysis and improvement of methods and procedures used at ESOC
- to independently attest to the excellence of the work processes and staff at ESOC. esa

Ariane 108 Launches Nilesat and BSat

The 108th Ariane launch (V108) was completed successfully at 22:53 UT on 29 April 1998 from the Guiana Space Centre in Kourou, French Guiana. The Ariane-44P vehicle (the '44P' indicating that it was equipped with four solid-propellant strap-on boosters) delivered the Egyptian Nilesat 101 and Japanese BSat-1b telecommunications satellites into the required geostationary transfer orbit. esa



The LLMS user terminal

First European Payload for Worldwide E-mail Service Launched

ESA's LLMS (Little LEO Messaging System) payload was launched with the Russian Earth observation satellite 'Resours-N4' on 10 July at 08:30 hrs CEST, from the Baikonur launch site in Kazakhstan on board a Zenit launcher. This new telecommunications payload will provide a low-cost, worldwide electronic mail (e-mail) commercial service dubbed IRIS (Intercontinental Retrieval of Information via Satellite).

The host satellite, on an inclined polar orbit at an altitude of 850 km, will 'view' any point on the Earth's surface at least twice a day and will collect and distribute e-mail. Subscribers will need a relatively inexpensive dedicated small satellite modem (half the size of a portable PC). Automatic data collection will also be possible. The hub station, located in Spitsbergen (N), will load and retrieve messages from the satellite once per orbit and interface with public data networks to connect users via a service centre in Brussels (B).

The target customers for the service are travellers in remote areas or at sea and do not have access to terrestrial communications. Large organisations with staff in remote areas of the world are a typical example.

For ESA, this is a new type of small project for which special efforts have been made to reduce development duration and costs, and to capitalise on several years of spread-spectrum technology development. The contractual aspects are also innovative, with a commitment by the prime contractor to offer a commercial service.

Under an ESA ceiling-price, turnkey contract, the prime contractor SAIT Systems of Brussels (B), undertook not only to develop, but also to launch and commercially operate LLMS/IRIS for an initial period of 3 years. This concept is in line with the evolution of ESA's procurement approach in which industry fully assumes the programmatic, technical and financial responsibility for close-to-market missions.

Development of this advanced communication payload under the leadership of SAIT systems, was carried out by European companies in Belgium (SAIT Devlonics, Alcatel Bell), Germany (OHB), Spain (SEMA), and the UK (Warberry Communications). IMEC vzw, Barco-Silex and Verhaert D&D, also of Belgium, were involved at the level of the LLMS modem, while subcontracts with NPP WNIIEM of Moscow (R) and with the Norwegian Space Centre covered the payload accommodation with launch and the hub station installation in Spitsbergen, respectively. esa

European Astronaut Selected for Third Hubble Space Telescope Servicing Mission

ESA astronaut Claude Nicollier from Switzerland will be aboard the US Space Shuttle Columbia when it lifts off from Cape Canaveral in May 2000, on flight STS-104, for the third servicing mission to the Hubble Space Telescope. Nicollier has been selected as one of the four mission specialists for STS-104, together with three NASA astronauts - Steven L. Smith, Michael Foale and John M. Grunsfeld.

The STS-104 crew will rendezvous with the orbiting Hubble Space Telescope, capture it using the Shuttle's robot arm, and secure it in Columbia's payload bay. Then, working in teams of two, the four astronauts will leave the Shuttle's pressurised cabin and venture into the payload bay, where they will perform a variety of tasks that will improve both Hubble's performance and its reliability.

To increase Hubble's scientific capability, Nicollier and his fellow crew members will remove the European-built Faint Object Camera (FOC), which has worked faultlessly since the launch in 1990, and replace it with a new-generation instrument known as the Advanced Camera for Survey. With its three electronic cameras and complement of filters, this camera is expected to improve the telescope's sensitivity tenfold.

Other primary tasks to be accomplished during the STS-104 mission include the replacement of the existing solar arrays with rigid, high-efficiency arrays for which ESA will deliver the mechanisms, manufactured by Daimler-Benz Aerospace/Dornier, and the replacement of Fine Guidance Sensor no. 2, one of three such devices that help to point the telescope at a celestial target with an accuracy of 0.007 arcsec. This is equivalent to keeping Hubble pointed at a candle in Amsterdam from Vevey, Switzerland, about 700 km away, where Nicollier was born.

Both Smith and Nicollier have previous in-orbit experience with Hubble: Smith performed three EVA sorties during the STS-82 mission to Hubble, and Nicollier operated the Shuttle's robot arm during the first servicing mission on the STS-61 mission in 1993. Foale has conducted EVAs from both the Space Shuttle and the Russian Mir space station. Grunsfeld has two previous space flights to his credit.

Claude Nicollier

For Nicollier, who was selected by ESA in 1978 as one of the first group of European astronauts, it will be his fourth flight into space, more than any other European astronaut to date. Prior to taking part in the first Hubble servicing mission in December 1993, he was a Mission Specialist on the August 1992 STS-46 mission during which Eureca — ESA's European Retrievable Carrier platform — was deployed and the first Tethered Satellite System test flight conducted. In February 1996, he participated in STS-75, which carried the US Microgravity Payload experiments and undertook the second flight test of the Tethered Satellite System.

Commenting on Claude Nicollier's selection, Mr Jörg Feustel-Büechl who, as ESA Director of Manned Spaceflight and Microgravity, is responsible not only for the European Astronaut Corps, but also for the European participation in the International Space Station, said:

"Together with the selection of Pedro Duque for the STS-95 mission in October this year,……the selection of Claude Nicollier, who is one of ESA's most experienced astronauts, is a clear signal of the high esteem in which NASA holds the high professional skills and human qualities of Claude and the other European astronauts. This is a sound basis for fruitful cooperation of mutual benefit on the International Space Station, where astronauts from the USA, Russia, Europe, Japan and Canada will work together closely as a single integrated crew. It is also very useful to the development work on the European-built Station elements."

Jörg Feustel-Büechl also pointed out that: *"The Hubble servicing mission shows that men and women can significantly augment the efficiency and lifetime of complex systems in space. Humans have two essential 'built-in tools' that make them superior to any robot: their brain and their hands. No robot offers a comparable combination of high intelligence, adaptability to unexpected situations, mobility, dexterity and tactility. Robotic systems can perform pre-defined routine tasks and even support astronauts in their work, as the Shuttle's robotic arm shows, but they soon reach their inherent limitations when it comes to evaluating results and deciding what to do next. That is one of the key reasons why we are building and operating a manned Space Station."*

esa

Emergsat Contract Signed

The signing of the Emergsat (Emergency Management satellites) project took place on 15 July at the offices of the Spanish Delegation (CDTI, Madrid). The contract was signed by Mr Anthony Dickinson, representing ESA's Director of Applications, and Mr José Martín Fluxá, CEO of Indra Espacio. Acting as witnesses were Mr Vicente Gómez, Head of the Spanish Delegation to ESA, Mr Juan San Nicolás, Director General of the Spanish Civil Protection Agency, Mr Juan Pedró, Technical Counsellor of the Spanish Civil Protection Agency and permanent Correspondent of Spain at the EUR-OPA Agreement on Major Hazards and Mrs Emilia Buergo, Director of Strategic Planning at CDTI.

The aim of the Emergsat project is to demonstrate the use of near-real-time (space-borne) Earth observation data in the management of emergency situations.

Additionally, meteorological updates and information from GIS databases will be delivered via satellite links to the emergency manager at the Control Centre to aid the decision-making process. The Emergsat Pilot Network will be implemented making maximum use of existing technologies. The emergency applications selected will offer a concrete opportunity for later migration to an operational Decision Support Network using satellite communication links with realisable cost benefits.

The project will be based on a Spanish-French consortium of industries led by Indra Espacio (E). Acting as subcontractors are INSA (E), GMV (E), Alcatel (F) and Scot-Conseil (F). Active support is provided by the Spanish Civil Protection Agency and the Regional Centre of Civil Protection of the Southwest of France which will host Control Centres in Spain (Madrid) and France (Bordeaux) respectively. This architecture will serve to make the pilot validation even more representative of the operational network.

Left to right: Mr Juan San Nicolás, Spanish Civil Protection Agency, Mr Vicente Gomez (CDTI), Mr Anthony Dickinson (ESA) and Mr José Martin Fluxá (Indra Espacio)

This collaboration is the result of several months of fruitful discussions and joint work. It is expected to lead to a future, wider cooperation with ESA as its possible focal point. Therefore, the project should be seen within the framework of the current policy of rapprochement with all organisations involved either directly or indirectly as potential users of satellite technologies, in Europe and beyond, and it should serve as a template in the search for new partners for advanced applications esa

The ESTEC Site

ESTEC Celebrates 30 Years

The festivity at ESTEC was a successful 'family event', prepared by staff for staff. The full day's activities included sporting events, demonstrations, entertainment, international food, and relaxation for both children and adults, rounded off with dancing in the evening. It was also a time for reflection and recognition for the commitment of all ESTEC staff over the past 30 years.

People and projects: these are the keywords when looking back with pride at the ESA success story in which the Noordwijk establishment continues to play a very important part.

A small history exhibition recalled the many highlights, emphasizing the European team spirit. Six ESA Directorates are strongly represented at ESTEC with their specialists, project groups and extensive technical support facilities such as the unique Test Centre.

Starting with ESRO-1, 39 spacecraft have been designed and placed into orbit with the backing of ESTEC expertise. A further 8 satellites and various elements for the International Space Station are under development at Noordwijk at the present time.

Thirty years to remember – and still going strong – with the enthusiasm for a fortuitous future for Europe in space. esa


T'ai Chi Ch'uan

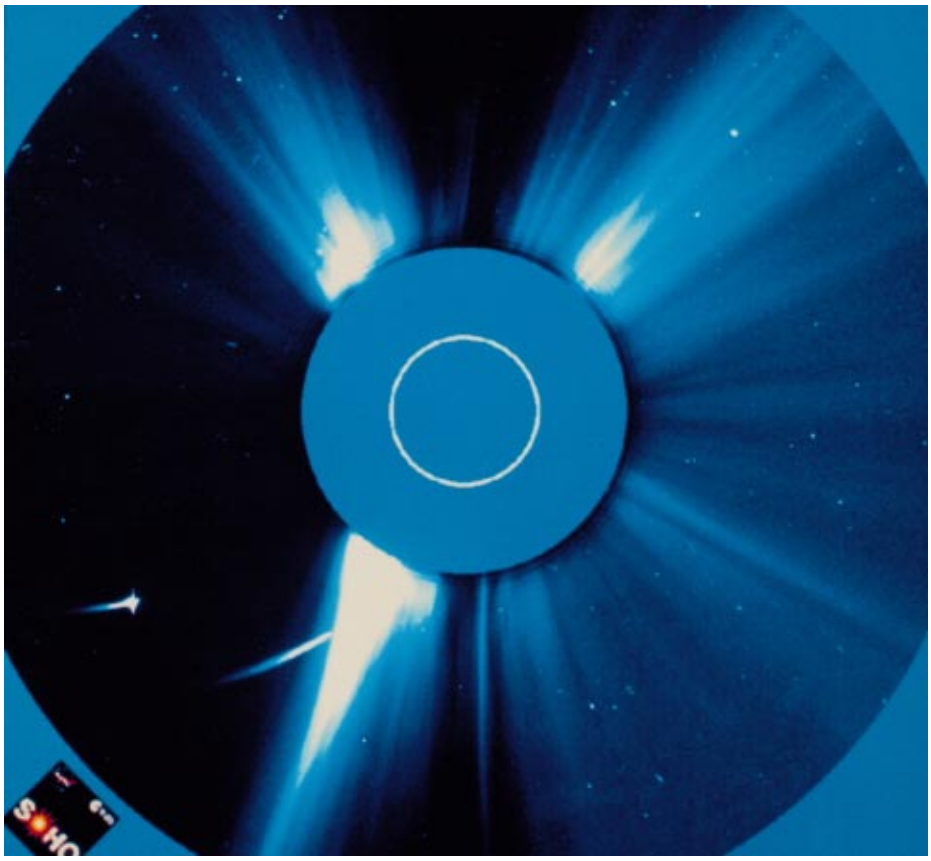
SOHO Observes Solar-Deaths of Two Comets

In a rare celestial spectacle, two comets have been observed plunging into the Sun's atmosphere in close succession, on 1 and 2 June 1998. This unusual event was followed on 2 June by a probably-unrelated but dramatic ejection of solar plasma and magnetic fields on the southwest limb of the Sun.

All the observations were made by the LASCO coronagraph aboard the ESA/NASA SOHO spacecraft. The observatory has discovered more than 50 comets, including many so-called Sun-grazers, but none in such close succession. The eruption of solar plasma was directed away from Earth and posed no hazard to our planet or orbiting astronauts.

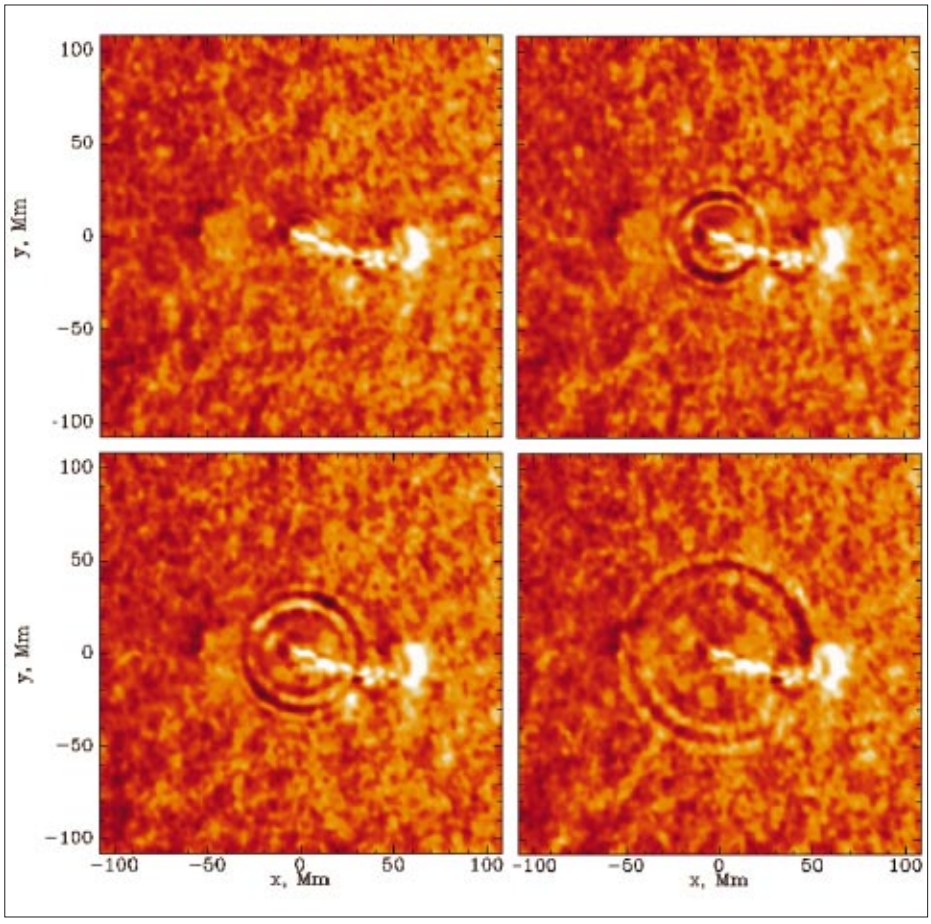
Development of the LASCO instrument was coordinated by the US Naval Research Laboratory. Dr. Donald Michels of the LASCO science team led the team that observed this rare phenomenon. Images of these events can be seen via the World Wide Web at:

http://sci.esa.int/missions/soho/



Two comets plunging into the Sun's atmosphere in close succession in June 1998

Solar flares producing seismic waves in the Sun's interior, which ripple outwards for thousands of kilometres



Solar Flare Leaves Sun Quaking

Scientists have shown for the first time that solar flares produce seismic waves in the Sun's interior that closely resemble those created by earthquakes on our planet. The researchers observed a flare-generated solar quake that contained about 40 000 times the energy released in the great earthquake that devastated San Francisco in 1906. The amount of energy released was enough to power the United States for 20 years at its current level of consumption, and was equivalent to an 11.3 magnitude earthquake, scientists calculated.

Dr. Alexander G. Kosovichev, a senior research scientist from Stanford University (US), and Dr. Valentina V. Zharkova from Glasgow University (UK) found the tell-tale seismic signature in data on the Sun's surface collected by the Michelson DOPPLER Imager aboard the ESA/NASA SOHO spacecraft immediately following a moderate flare on 9 July 1996. Over the course of an hour, the ripples travelled a distance equal to 10 Earth diameters before fading into the fiery background of the Sun's photosphere. Unlike water ripples that travel outward at a constant

velocity, the solar waves accelerated from an initial 35 000 km/h to a maximum of 400 000 km/h before disappearing.

"People have looked for evidence of seismic waves from flares before, but they didn't have a theory so they didn't know where to look," says Kosovichev. Several years ago, Kosovichev and Zharkova developed a theory that can explain how a flare can generate a major seismic wave in the Sun's interior. According to the currently accepted model of solar flares, the primary explosion creates high-energy electrons. These are funnelled down into a magnetic flux tube and generate X-rays, microwaves and a shock wave that heats the solar surface. Kosovichev and Zharkova developed a theory that predicts the nature and magnitude of the shock waves that this beam of energetic electrons should create when they slam down into the solar atmosphere.

Although their theory directed them to the right area to search for the seismic waves, the waves they found were 10 times stronger than they had predicted. *"They were so strong that you can see them in the raw data,"* Kosovichev commented. The solar seismic waves appear to be compression waves like the 'P' waves generated by an earthquake. They travel throughout the Sun's interior. In fact, they should recombine on the opposite side of the Sun to create a faint duplicate of the original ripple pattern, Kosovichev predicts.

Now that they know how to find them, the SOHO investigators say that the seismic waves generated by solar flares should allow them to verify independently some of the conditions in the solar interior that they have inferred from studying the pattern of waves that continually ruffle the Sun's surface. esa

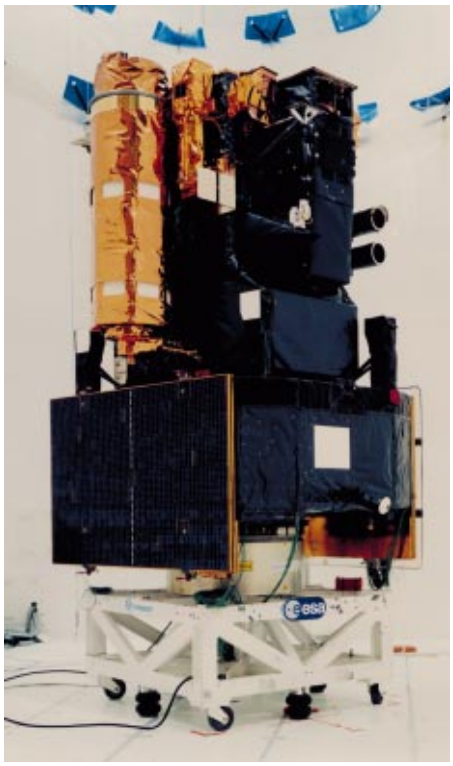
SOHO – Lost and Found

In April, ESA's Solar and Heliospheric Observatory (SOHO), launched on 2 December 1995, successfully completed its nominal two-year mission to study the Sun's atmosphere, surface and interior. The major scientific highlights of this joint ESA/NASA mission have included: the detection of rivers of plasma beneath the surface of the Sun; the discovery of a magnetic "carpet" on the Sun's surface that seems to account for a substantial part of the energy that is needed to cause the very high temperatures in the corona, the Sun's outermost layer; the first detection of flare-induced solar quakes; the discovery of more than 50 Sun-grazing comets; the most detailed view to date of the solar atmosphere; and spectacular images and movies of Coronal Mass Ejections, which are being used to improve our ability to forecast the "weather in space".

SOHO's mission had only recently been extended to 2003 – to cover the period of maximum solar activity that is expected to occur in 2001 – when, on 25 June, during routine maintenance operations, the ground controllers at NASA Goddard Space Flight Center (GSFC) in Maryland lost contact with SOHO and the spacecraft went into Emergency Sun Reacquisition (ESR) mode. This mode is activated automatically when an anomaly occurs and the spacecraft loses its orientation towards the Sun. The spacecraft then tries to point itself towards the Sun again by firing its attitude control thrusters under the guidance of an onboard Sun sensor.

The immediate efforts to re-establish nominal operations did not succeed and telemetry was lost. Subsequent attempts using the full NASA Deep Space Network (DSN) capabilities were also unsuccessful. A team of experts from ESA and Matra Marconi Space, prime contractor for the SOHO spacecraft, therefore gathered at GSFC to assist the NASA Flight Operations Team in assessing the situation and analysing the spacecraft status should contact be re-established.

The engineers concentrated first on gaining a complete understanding of the events that had led to the loss of signal, information that might help them to devise procedures which could re-establish contact with SOHO. Commands



The SOHO spacecraft shortly before launch

were sent to SOHO about once per minute, using the DSN's 34 m antennas, instructing the spacecraft to activate its transmitters. Based on the last telemetry data that had been received from SOHO, the engineers thought it likely that the spacecraft was spinning slowly in such a way that its solar arrays were not receiving adequate sunlight to generate power. It appeared, however, that SOHO's solar panels might be exposed to increasing amounts of sunlight each day as it orbited the Sun, in which case within a few weeks sufficient sunlight might be shining on the solar panels to generate enough power to charge the spacecraft's batteries.

In the meantime, the SOHO incident had become the subject of a joint ESA/NASA inquiry, by a Board co-chaired by Prof. Massimo Trella, ESA's Inspector General, and Dr. Michel Greenfield, NASA Deputy Associate Administrator for the Office of Safety and Mission Assurance, and with members drawn from ESA, NASA and the scientific community. This SOHO Mission Interruption Joint ESA/NASA Investigation Board focussed in on three errors that seemed to have led to the loss of communications with SOHO. The first error was in a pre-programmed command sequence that lacked a command to enable an on-board software function

designed to activate a gyro needed for control in Emergency Sun Reacquisition mode. The second error, which was in a different pre-programmed command sequence, resulted in incorrect readings from one of the spacecraft's three gyroscopes, which in turn triggered an ESR. At that stage of the investigation, the Board believed that these two anomalous command sequences, in combination with an errroneous decision to send a command to SOHO to turn off a gyro in response to unexpected telemetry values, caused the spacecraft to enter a series of ESRs, and ultimately led to the loss of control. The efforts of the Investigation Board were then directed at identifying the circumstances that had led to the errors, and at identifying and effecting the necessary changes and pursuing corrective actions to prevent similar occurrences in the future.

ESA and NASA engineers still believed the spacecraft was spinning with its solar panels nearly edge-on to the Sun, and thus not generating any power, but that the power situation would improve over the next few months, increasing the probability of successfully establishing contact. In an attempt to recover SOHO as soon as possible, the Flight Operations Team at Goddard began uplinking commands to the spacecraft for approximately 12 hours every day.

With the encouragement of Dr. Alan Kiplinger of NOAA's Space Environment Center in Boulder, researchers at the US National Astronomy and Ionosphere Center in Arecibo, Puerto Rico, used their facility's 305 m-diameter radio telescope to transmit a signal towards SOHO on 23 July. The DSN's 70 m dish in Goldstone (USA) acted as a receiver, locating the spacecraft's echo and tracking it using radar techniques for more than an hour. SOHO had finally been found. Preliminary analysis of the radar data indicated that SOHO was still in its nominal halo orbit, near the L1 Lagrangian point, and turning at roughly one revolution per minute.

To facilitate the recovery procedure, a joint team was established at GSFC under the direction of ESA's Francis Vandenbussche, the ex-SOHO System Engineering Manager. The team consists of ESA, Matra Marconi Space, NASA and Allied Signal staff.

On 3 August, signals sent to SOHO via the DSN station in Canberra, Australia, were answered at 22:51 GMT in the form of bursts of signal lasting from 2 to 10 seconds. These signals were recorded both by the NASA station in Canberra and ESA's own ground station in Perth (W. Aus.). Although the signals were intermittent and did not contain any data information, they showed that the spacecraft was still capable of receiving and responding to ground commands. The slow process of regaining control of the spacecraft and restoring it to an operational attitude commenced immediately, with attempts to initiate data transmissions and to coax information from the spacecraft concerning its on-board status.

The spacecraft initially responded to the attempts to activate its on-board telemetry data system only by sending a simple carrier signal in 10 second bursts. These signals were, however, tracked consistently from ESA's Perth and Redu (Belgium) ground stations, as well as by NASA DSN stations around the world. Initially, the carrier-signal bursts were too short to allow the sensitive ground-station receivers to 'lock-on' to the signal and ESA engineers began assessing ways of obtaining a more continuous signal from the spacecraft. The intermittent nature of the signal is caused by the cyclic variation in the on-board power supply as the solar arrays are shadowed due to the spacecraft's unintentional spin motion.

ESA's Head of Scientific Projects, John Credland, assessed the situation at that point as follows:

"Recovery will be a slow and careful operation. The main thing is that the spacecraft is now responding to us and we will take one step at a time to bring it into a more favourable attitude before assessing any damage which may have been caused by its unforeseen six-week hibernation".

On 8 August, at 23:15 h GMT, six days after receiving the first signal from the dormant SOHO, several blocks of telemetry data giving the spacecraft's on-board status were acquired, prompting Roger Bonnet, ESA's Director of Science, to comment:

"This is the best news I've heard since we lost contact with SOHO on 25 June. I never gave up hope of some recovery of this fantastic mission. We must just hope that the damage sustained due to SOHO's enforced period of deep freeze does not affect the scientific payload too much."

Following analysis of the expected on-board conditions by ESA and Matra Marconi Space (builders of the SOHO spacecraft) engineers, a series of command sequences was up-linked to the spacecraft to divert all available solar array power into a partial charging of one of the on-board batteries. After 10 hours of such battery charging, SOHO's telemetry was commanded on and seven full sets of onboard-status data were received. After just 1 minute, the telemetry was switched off again by the ground controllers in order to conserve onboard resources. Further data on the onboard conditions were obtained the next day (9 August) in two telemetry acquisitions lasting 4 and 5 minutes, respectively. These data included payload temperature and voltage information, which is currently still being analysed.

With the battery-charging technique having proved successful, the SOHO team requested full 24-hour coverage of the spacecraft in an attempt to achieve more complete charging. During this period extensive data sets were obtained detailing the current onboard status, including temperatures, which were much as expected. Further data has been acquired on the current spacecraft attitude, following the successful switching on of one of the Attitude Control Units. The team is currently (12 August) working on the next series of procedures, aimed at thawing out the spacecraft's hydrazine fuel, currently at 0ºC, to enable attitude control to be re-established. This will only be attempted once full charging of both onboard batteries can be confirmed, hopefully in the next few days. esa

Birthday Wishes for a Former ESA Director General from Helmut Schmidt*

When Reimar Lüst was born on 25 March 1923, a wave of passive resistance against the French occupation was sweeping across the Ruhr region. That autumn, the old paper currency was replaced by a new German mark, at the rate of a million millions to one! Sixty years on, Lüst was appointed Director General of the European Space Agency in Paris, where scientists and engineers from Germany and France work together in harmony alongside other European colleagues. Between those two dates lie the calamities unleashed upon the European peoples by Hitler, but also the process of conciliation generously carried out by France.

When Lüst left ESA at the age of 67, he might have been justly proud of a life dedicated to the pursuit of excellence: as a scientist, as a research administrator, as a pioneer in Franco-German co-operation, and as a proponent of internationalism. But he refused to rest on these laurels. Today he leads the Alexander von Humboldt Foundation, supporting talented scientists from all over the World who come to Germany to conduct their research.

Lüst is himself a dedicated research scientist. He started out in nuclear physics, then changed his field of work to plasma physics and astrophysics. He has an office in the Max-Planck Institute that investigates global climate change. He has served as Professor at universities in Germany and the USA. Before going to Paris, he was Chairman of the Scientific Council of the Max-Planck Society for three years running. He headed the Society as President for a total of twelve years. In both of these offices he combined a quiet, modest manner with single-minded tenacity, establishing a legacy that continues to inspire respect.

Lüst never yielded to the temptation to justify basic research (including space exploration) with the promise of technical, economic or military spin-offs. Instead, his main preoccupation has always been the quest for scientific advancement. At the same time, he has worked to promote international co-operation and exchanges between research scientists from different countries. He started to forge personal ties to Russian scientists in the 1950s and to Chinese colleagues in the 1970s. Still, he is a staunch champion of competition in scientific research. "Competition is indispensable", he says.

…… When interviewed by FAZ-Magazin and asked to fill out their questionnaire, he described his motto thus: *"Stay on course, show the flag whenever necessary, fire a shot across the bows if needed".* And yet, Reimar Lüst is a sincere and friendly individual. He possesses a gift for communicating to others his enthusiasm for science. When I first met him, a quarter of a century ago, it was thanks to the scientific curiosity of my wife. I remember how Lüst showed us the giant parabolic antenna in Effelsberg and explained to us how it had been used to find protein molecules deep in interstellar space. Since then we have become firm friends, jointly founding the German National Foundation for contributing to the re-emergence of a joint national identity for Germans from East and West alike. Much remains to be done.

To Reimar Lüst, my warmest congratulations - Ad multos annos! esa

* Translated extract from an article in the German daily newspaper "Die Zeit" on 27 March 1998

Cassini/Huygens

The Cassini/Huygens spacecraft performed its first Venus flyby on schedule on 26 April 1998 so successfully that the planned 14 May trajectory correction manoeuvre was not needed. The spacecraft is continuously monitored through NASA's Deep Space Network (DSN) and its health remains excellent. Over the past few months, Cassini's routine flight operations have been devoted mainly to housekeeping and maintenance activities. The spacecraft continues to fly with its fixed High Gain Antenna (HGA) pointing towards the Sun in order to keep Cassini and the Huygens Probe in shadow.

The second Huygens Probe check-out was executed on 27 March in the blind, as the HGA could not be used for high-rate communications with Earth. The data were recorded on the craft's Solid State Recorder (SSR) and played back to Earth during nine DSN passes.

The Probe's housekeeping data processed at ESOC showed nominal behaviour except for some Automatic Gain Control (AGC) levels on both receiver chains: a drop of 3-5 dB and periodic fluctuations. Similar behaviour was noted during the first check-out on 23 October 1997 and was already under investigation. Based on these new measurements, an investigation team under project chairmanship was created and met on 16 April 1998.

The first findings indicated a strong correlation between the induced solar noise picked up by Cassini's HGA and the observed AGC variations during both check-outs. In order to confirm this possible cause, a special contingency check-out with the HGA pointed at least 10 degrees from the Sun was performed on 28 May. The complete set of test measurements was successfully retrieved at ESOC. The AGC values measured on both chains were found to be highly stable, with values by far the best ever obtained during on-ground and in-orbit tests. These confirmed that both receivers performed as expected in a radio noise-free environment and in the presence of solar-induced noise.

It can be concluded that the Probe and associated receivers are in excellent state of health. The next Huygens check-out is scheduled for 22 December 1998. r