EUROMIR
ЕВРОМИР
Missions to Space
with Russia

RKA

The Russian Space Agency (RKA), created in 1992 by presidential decree, is the main civilian governmental entity responsible for implementing Russia's national space policy. Located in Moscow, the RKA coordinates related space research, development and operations activities throughout Russia.

Director: Yuri N. Koptyev

RSC Energia

RSC Energia (Rocket Space Corporation 'Energia') is the leading Russian industrial company in the field of manned space systems and technology. Located in Kaliningrad, north of Moscow, the company was founded by academician S.P. Korolev in 1946. Many 'firsts' in satellites and launch systems were developed here, including the first artificial Earth satellite 'Sputnik,' the first interplanetary probe 'Venera-1,' the first manned spacecraft 'Vostok,' the famous R-7 rocket that later evolved into the present-day Soyuz-TM launcher (still the 'workhorse' of the Russian manned space programme), the Progress-M space transportation vehicle, the heavy-lift Energia launcher, the spaceplane 'Buran' and the space stations 'Salyut' and 'Mir.' RSC Energia is also responsible for the final assembly of the launch vehicles at the Baikonur Cosmodrome.

President: Yuri P. Semenov

TsPK

The Yuri Gagarin Cosmonaut Training Centre (TsPK), commonly referred to as 'Star City,' is located in Shchelkovsky Rayon, 35 km northeast of Moscow. It was established in 1960, one year before cosmonaut Gagarin's first flight on Vostok. The TsPK, placed under the authorities of the Russian Ministry of Defence and RKA, is the prime Russian entity responsible for the selection and training of flight crews. Cosmonauts are trained in all theoretical and practical aspects related to cosmonautics as well as in all spacecraft systems onboard Soyuz and Mir. The Centre maintains sophisticated scientific, research, general training, laboratory and flight training facilities such as spacecraft simulators and trainers, a man-rated centrifuge, a neutral bouyancy facility (the 'hydrolaboratory') and unique aircraft for simulating zero-gravity (the 'flying laboratories'). The highly skilled specialists at the Centre are experienced in training cosmonauts for national and international programmes and in developing methods of Earth observation.

Director: General Pyotr I. Klimuk

TsUP

The Russian Mission Control Centre (TsUP), located north of Moscow in Kaliningrad, is a department of the Central Scientific Research Institute for Machine Building (TsNIIMash), the principal scientific research centre in Russia for space programmes. Founded in 1946, the TsUP has long-standing experience in mission control of interplanetary probes of the Venera- and Mars-types, and of manned Salyut and Mir space stations. Today TsUP not only controls the missions of the cosmonauts onboard Mir, but is also responsible for the coordination of the communications and ground tracking stations, the relay satellites, the launch control centre at Baikonur, and for search-and-recovery services during return and landing of the cosmonauts. The Mir control team at the TsUP is comprised of specialists from RSC Energia, TsNIIMash and other cooperating organisations.

Director: Vladimir I. Lobachev

VKS-Baikonur

The Baikonur Cosmodrome, situated east of the Aral Sea near the ancient Kazakhstan village of Tyuratam (45.6° North latitude), is, in fact, 300 km away from the town of Baikonur.
The sprawling launch complex is operated by the Russian Space Forces (VKS). Beginning with the historic flight of Yuri Gagarin on 12 April 1961, all Soviet and Russian manned spaceflights have been launched from Baikonur.
After completing their training at 'Star City,' the flight crews undergo prelaunch training at Baikonur. Final spacecraft and launch vehicle processing operations are conducted under the supervision of RSC Energia and the VKS.
The Baikonur launch teams perform and control all assembly, prelaunch and launch operations until the separation of the Soyuz and Progress vehicles from the last stage of the launchers. Once the Soyuz and Progress vehicles have reached their orbits, the Baikonur Launch Control Centre hands over flight control to the Mission Control Centre (TsUP). (Return flight landings take place about 500 km northeast of the cosmodrome.) The cosmodrome staff and their families live in the nearby city of Leninsk (founded in 1955), which gradually grew around the Tyuratam railway station. The cosmodrome and the city of Leninsk together form the 'Baikonur Space Complex.' The complex now belongs to the Republic of Kazakhstan, which leased the facillities and property to Russia in March 1994 for 20 years.

Director and Commander-in-Chief: Colonel-General Vladimir L. Ivanov esa BR-107

EUROMIR 95
95 ЕВРОМИР

Missions to Space with Russia

esa

PEACEFUL SPACE

ESA and a New Partnership

The European Space Agency (ESA) is today's realisation of a vision of European scientists and politicians in the 1960's that Europe should have a space organisation to "provide for and promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications."

Through its 14 Member States, ESA has developed international cooperation to a degree not exceeded anywhere in the world. It has learned to combine the political will of governments, the technical competence and skills of European engineers, the outstanding ability of the continent's space science communities, and the ambitions of high-technology industry into a world-class space endeavour.

It is not surprising, therefore, to find that when the opportunity came for a freer cooperation with Russia, ESA was amongst the first to reach out towards a new partnership in space research.

Such a partnership has much to offer to both ESA and the Russian space organisations. ESA and Russia have achieved technological and scientific successes in their respective space programmes.

The combination of their experience and potential could add up to the "whole being greater than the sum of its parts" and gives the concept of 'European cooperation' fuller meaning.

These ideas were approved in the resolution that the Ministers of the ESA Member States endorsed at their meeting in Granada (Spain) in November 1992:

"The (ESA) Council meeting at Ministerial level... wishing to increase the existing cooperation between the Agency and Russia and (to) extend it... also in the areas of manned in-orbit infrastructure, crew transport and the associated communication facilities... endorses the Director General's proposals... to widen and strengthen such active cooperation with the space institutes of the Russian Federation during the period 1993-1995..."

EUROMIR

A Pan-European Idea in the Making

In the Russian language, Mir means, among other things, 'Peace' and 'Universe,' thus embodying in one word the fundamental idea behind the resolution endorsed at the ESA ministerial conference.

Immediately following the Granada meeting, planners from ESA, the Russian Space Agency (RKA), and the main Russian entities in charge of utilising the Russian Mir space station began intensive meetings to discuss potential missions for ESA astronauts and scientific experiments to the Russian space station Mir that would serve the interests of both communities.

For some years, ESA has been considering how best to prepare its astronauts and the user community of scientists from all science disciplines for the advent of the International Space Station using precursor flights, both manned and unmanned. These flights were foreseen as part of ESA's manned spaceflight programme, a major European contribution to the International Space Station effort.

With Russia now joining the United States, Europe, Canada, and Japan as a full partner in the International Space Station programme, the EUROMIR missions take on greater significance as 'precursor flights' to prepare ESA for this new era of space sciences research and international cooperation.

The major objectives of the precursor flights are to:

- prepare the European space user community for the International Space Station era
- provide the user community with continuing flight opportunities as a transition to the utilisation of the Columbus Orbital Facility (COF) and other Space Station facilities

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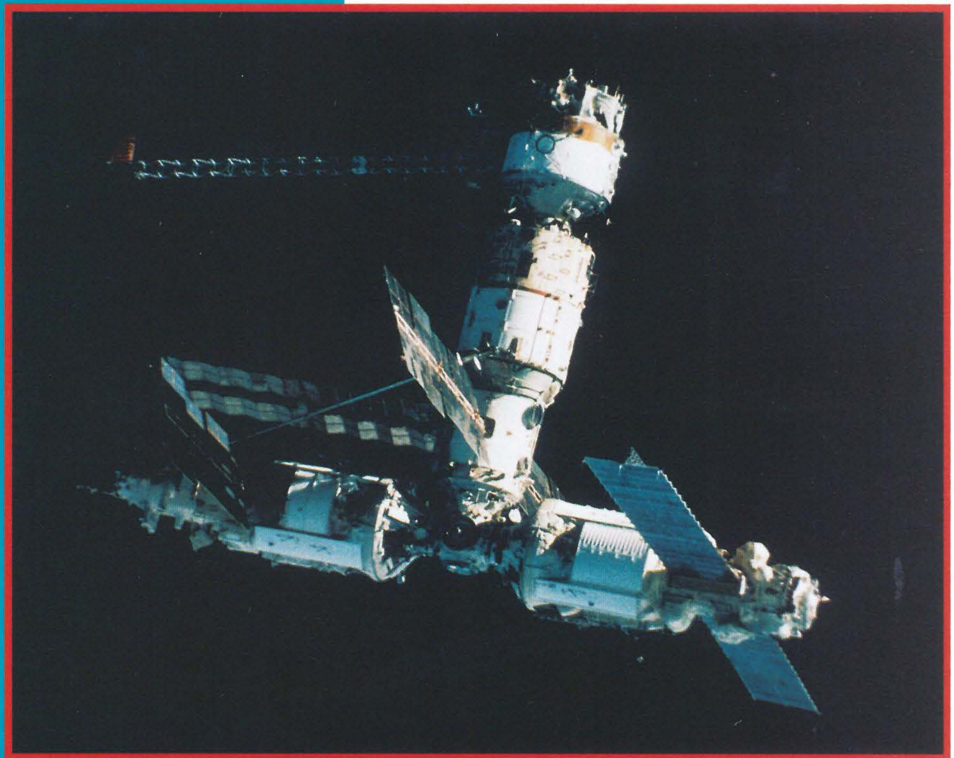

1 – General Klimuk, director of Star City, introduces the ESA Astronauts (right) for the EUROMIR missions to the international press.

2 – Signing the Joint Declaration on Space Cooperation between ESA and the Russian Space Agency (RKA) are (seated) ESA Director General Jean-Marie Luton (left) and RKA Director General Yuri Koptyev, in Paris, 12 October 1992.

3 – European and Russian representatives toasting to international cooperation following the signing of the EUROMIR contract.

4 – RSC Energia President Yuri Semenov (seated at center) signing the EUROMIR contract in Kaliningrad on 7 July 1993 with ESA EUROMIR Programme Manager Wolfgang Nellessen.

5 – The Mir Space Station in an earlier configuration.

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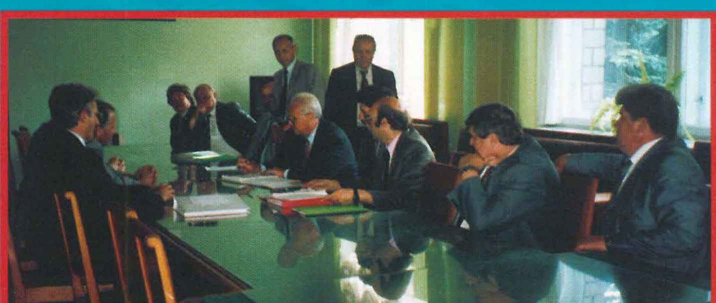

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- provide in-flight validation of design concepts for space station payloads (e.g., serviceability, telescience) and to introduce, as far as feasible, the operational concepts foreseen as part of the support to experimentation onboard the orbiting laboratory
- develop and maintain a core of ESA astronauts, and to provide them with long-duration flight opportunities in order to increase European experience in crew-operated space systems

The decision to carry out two joint ESA-Russian missions to Mir (EUROMIR), one in 1994 and one in 1995, is fully in line with these objectives. Futhermore, familiarising the ESA astronauts with Russian systems on EUROMIR flights will be particularly useful in light of the recent evolution of the International Space Station programme to include a significant contribution of Russian elements into its new configuration.

Mir offers ESA an excellent opportunity for long-term experience in microgravity conditions; ESA astronauts will work in a space station environment, and experimenters will be able to try out their research projects in ways not otherwise available to them. The EUROMIR 94 mission lasted for 31 days; the EUROMIR 95 mission is planned to last 135 days.

The Russian Space Infrastructure

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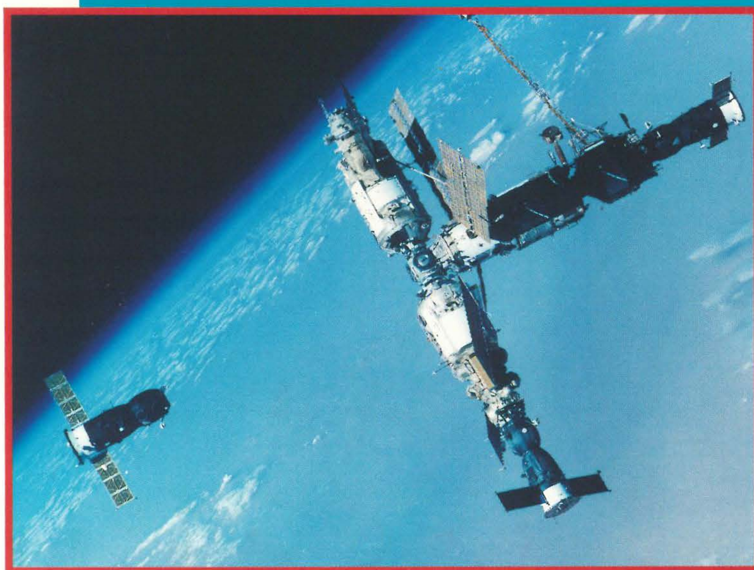

The Space Station Mir

From the early days of space exploration, the Russian manned space programme followed a distinctive evolutionary line. After the first man in space (Yuri Gagarin on Vostok-1 in 1961), the first woman in space (Valentina Tereshkova on Vostok-6 in 1963) and the first extravehicular activity in space (Alexei Leonov on Voskhod-2 in 1965), the then-USSR turned its attention towards the long-term presence of humans in space.

The first Earth-orbiting space station, Salyut-1, was launched in 1971, followed by several other stations during the next ten years. Starting with Salyut-6, the station became permanently manned. Today the Mir orbital complex, a larger and more sophisticated operational base, represents the third generation of Russian space stations. The complex has a modular construction, each module having its own structure and function.

The Mir space station has now entered its tenth year of operations. The habitation module (the core of the station) was, in fact, placed into orbit in early 1986. Since then the complex has grown as additional modules were added: the Kvant astrophysics module, the Kvant-2 re-equipment module and the Kristall habitation module. The most recent addition is the Spektr scientific module, which was docked to the Mir station on 1 June 1995. Future plans call for the addition of Priroda, another scientific studies module, in late 1995 or early 1996. Beginning in late 1997, utilisation of Mir will be slowly reduced as activities shift to the International Space Station as it is assembled.

The Mir complex orbits the Earth at an altitude of 350-400 km with an inclination of 51.6°. The mass of the fully-assembled space station is some 130 tonnes. Mir can accomodate up to six cosmonauts.

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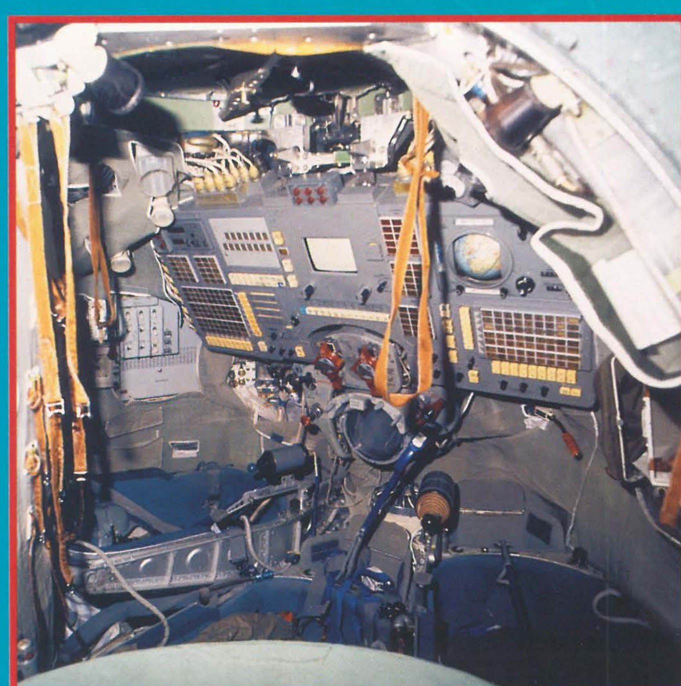

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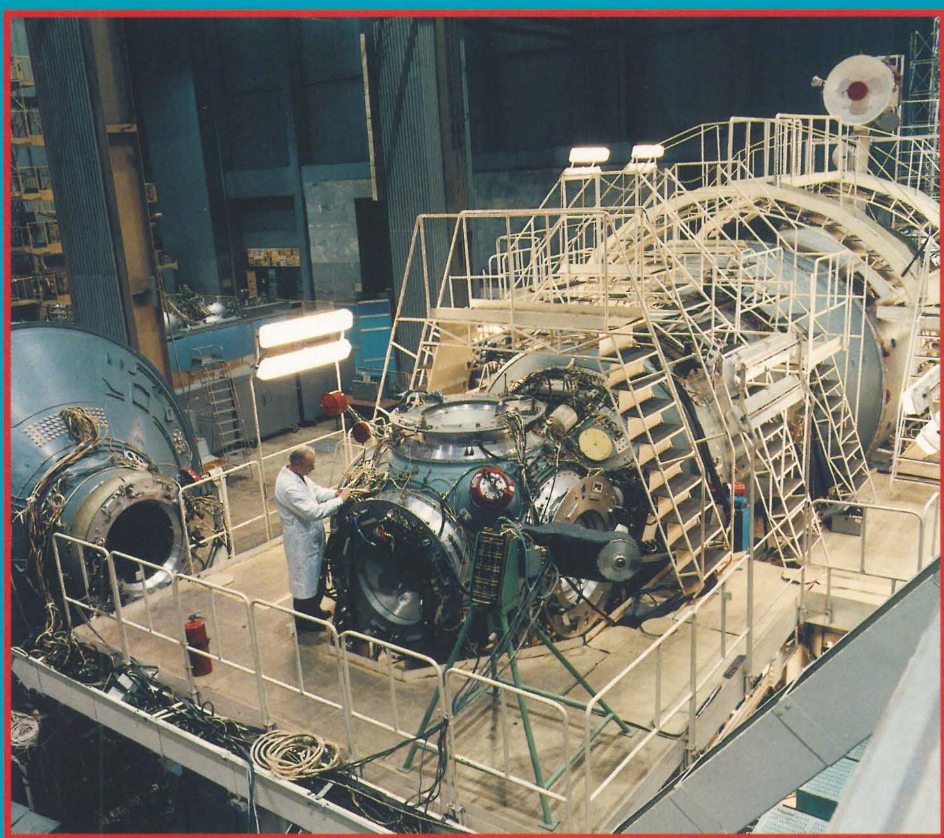

1 – Soyuz-TM transport spacecraft approaching Mir in docking manoeuvres.

2 – View inside a Soyuz-TM integrated simulator/trainer at the Yuri Gagarin Cosmonaut Training Centre (TsPK).

3 – The Mir space station integrated simulator used for training at TsPK (with Kvant-1 module in the foreground).

4 – Soyuz-TM integrated simulator/trainer at TsPK used in systems training for the transport spacecraft.

5 – Technician checking one of the Mir station nodes, used in connecting modules and for docking of visiting spacecraft.

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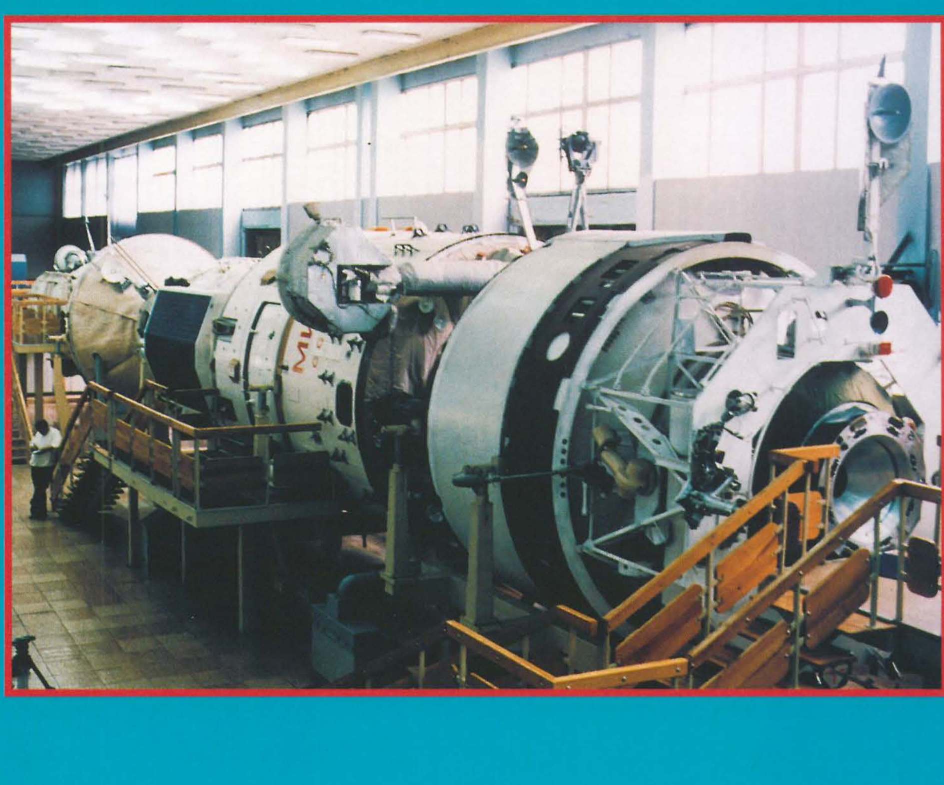

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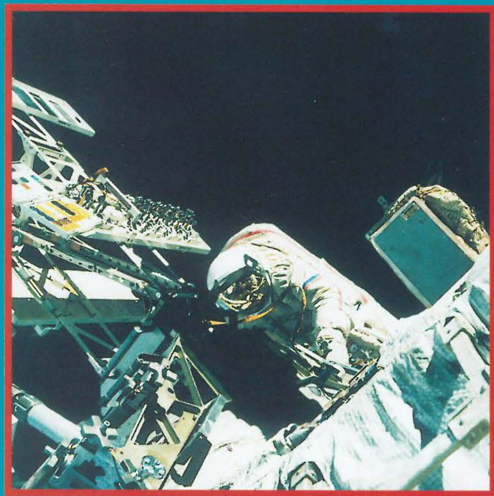

1 – Cosmonaut performing an extravehicular activity (EVA) for station maintenance on Mir's exterior.
2 – Russian Soyuz launcher and Soyuz-TM payload with crew for EUROMIR 94.
3 – Rocket engine clusters of the Russian Soyuz launcher.
4 – Successful launch of Soyuz for the EUROMIR 94 mission, from the Baikonur Cosmodrome, 4 October 1994.
5 – Russian spacewalk to install and remove experiments on Mir's exterior.
6 – Dawn at the Baikonur Cosmodrome sees the roll-out of the Soyuz launcher for EUROMIR 94.
7 – Soyuz launcher and Soyuz-TM for EUROMIR 94 being transported via rail to the launch pad.

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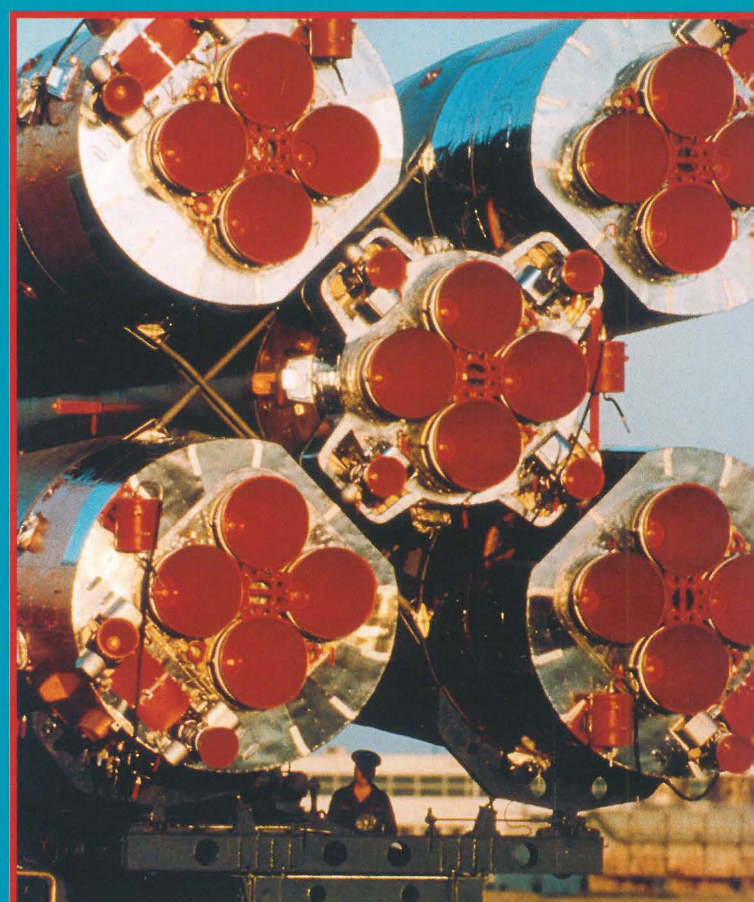

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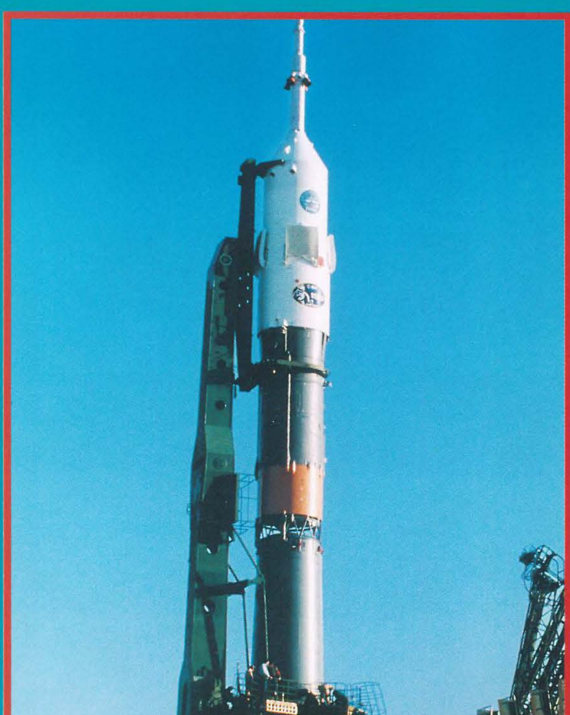

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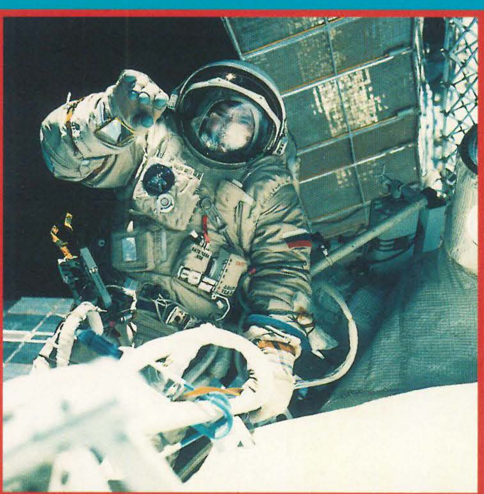

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To and From the Station

The Soyuz-TM vehicle is a compact, cost-effective and reliable crew transportation vehicle used to ferry cosmonauts from Earth to the Mir space station and back to Earth. The vehicle can accomodate three crew members and is capable of carrying an additional payload of up to 200 kg.

The Progress-M cargo spacecraft carries replacement scientific equipment, food for the cosmonauts, propellants for the station, and other consumables and commodities needed by the crew. Progress-M vehicles are normally launched at two- to three-month intervals and dock automatically to Mir. The vehicles are not recovered, but are loaded with used consumables and unneeded equipment, and are allowed to burn-up in the Earth's atmosphere in controlled re-entries.

The rocket which carries both manned Soyuz-TM crew transport vehicles and unmanned Progress-M cargo transport vehicles into space is the Soyuz launcher. Its development can be traced back to the famous R-7 (Semyorka) rocket of the 1950s. It is 51 metres high and, together with a Soyuz-TM, weighs 310 tonnes.

In preparation for a launch, the rocket with transport vehicle is moved on rails to the launch pad and readied for flight. Following the launch of the cosmonauts, the Soyuz-TM vehicle separates from the launcher. The crew checks the onboard systems during the first three orbits. Orbital manoeuvres to match Mir's orbit are conducted during orbits four and five. The crew then sleeps for five orbits. Station-approach manoeuvres are performed during orbits 17 and 18. Final docking manoeuvres are completed on the 33rd orbit, culminating in rendezvous and docking with Mir on the next orbit (about two days after launch).

Science in Space

A New Environment for Research Laboratories

When early pioneering space scientists first had satellites orbiting above the Earth's atmosphere, a new universe, quite literally, opened up before them. Now, thanks to the presence of humans in space, other sciences, particularly the life sciences and materials sciences, are developing new avenues of research.

Onboard the Mir complex, the gravitational pull of the Earth is compensated for by the centrifugal forces resulting from Mir's circumterrestrial flight path. This equilibrium of forces results in 'weightlessness' or, more correctly, 'microgravity.' Offering an entirely new environment for scientific research, the orbital laboratories can host experiments in many science disciplines, including biology, botany, medicine, human physiology, fluid physics, material science, astrophysics and Earth observation.

In particular, basic research in the life sciences will focus on the ways in which gravity affects the development and functioning of living organisms. Much research is also directed towards the effects that microgravity exerts on the human cardiovascular system, muscle and bone structures, and the nervous system.

Material science studies also benefit greatly from a microgravity environment. Gravity seriously impedes a number of processes associated with the material sciences. The influence of gravity is nullified under microgravity conditions so scientists can learn more about solidification and crystal growth from a melt, crystal growth in solutions, the behaviour of fluids near their critical points, and the purification and crystalisation of biological macromolecules. Such research holds the promise of developing new applications for future long-term space missions and of improving these processes on Earth.

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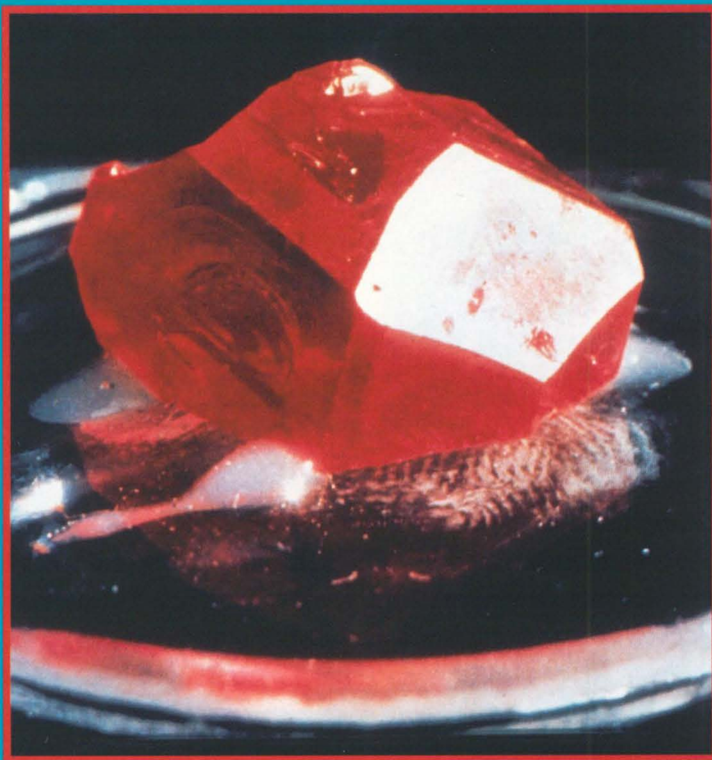

1 – The Mir complex in orbit, photographed from an approaching Soyuz-TM.

2 – The large, almost perfect crystals grown in the microgravity environment of Mir cannot be produced on Earth.

3 – Welcome to Mir: Kasakh cosmonaut Talgat Musabayev, ESA astronaut Ulf Merbold (center) and Russian cosmonaut Elena Kondakova shortly after their arrival to Mir.

4 – Cosmonaut Elena Kondokova takes a moment to rest from her work.

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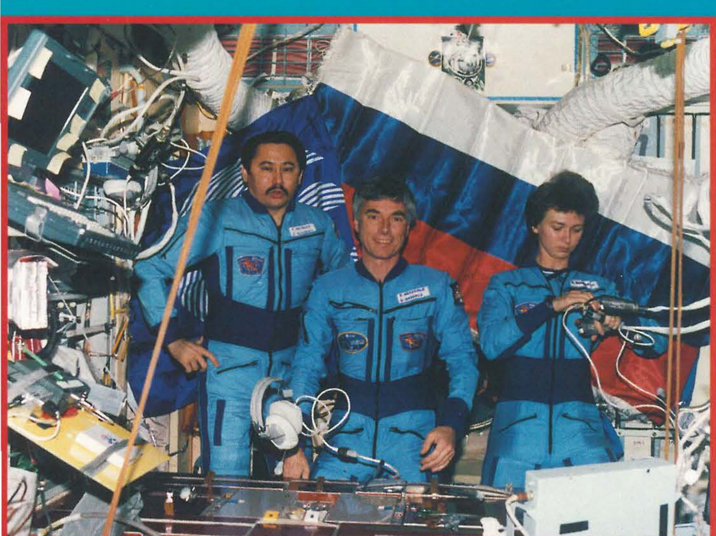

EUROMIR 94 Mission Results

With the safe landing of the Soyuz TM-19 capsule on 4 November 1994 near Arkalyk, Kazakhstan, ESA astronaut Ulf Merbold concluded his 31-day mission onboard Mir. During this time, he conducted a variety of experiments in the life and material sciences and in new technologies; ESA also gained valuable experience in long-term spaceflight and ground operations which will be applied towards future longer-term missions.

The EUROMIR 94 scientific programmes were completed successfully and most objectives were met as planned, with only a few exceptions. Twenty-one life sciences experiments were conducted. These physiological investigations studied the effects of spaceflight on the cardiovascular system, neurovestibular system, immune system, muscle physiology, bone formation, circadian rhythm, and cognitive functions. Some 34 blood, 85 urine and 125 saliva samples were collected inflight, frozen and returned to Earth for analysis. In addition, numerous measurements were taken of many physiological parameters. These will be compared with samples and measurements taken before and after the flight (pre- and post-flight baseline data collection).

One technology experiment investigated the long-term performance of a mass-spectrometer in space and another demonstrated the use of sticky surfaces to prevent small tools from drifting freely in the space station. Radiation experiments studied the influence of particle radiation on the performance of lap-top computer electronics and the effects of the radiation environment on the human body.

Only four material science experiments could not be conducted due to the malfunctioning of an onboard facility. These and other related experiments will be conducted during the EUROMIR 95 mission using the facility, which has since been repaired by the cosmonauts onboard.

In the area of ergonomics, statistical data control sheets and supporting films have been collected to permit further studies of human motion and reactions in microgravity and under various stress-inducing conditions. Such studies are required for the design of space station working facilities and in planning workloads and activities. As an immediate result of the EUROMIR 94 mission, adjustments were made to the timeline for EUROMIR 95 to allow additional physical training for the ESA astronaut.

The EUROMIR 94 mission also demonstrated the Columbus/International Space Station flight operations concept. Payload flight control authority was exercised from the remote payload operations centre (SCOPE) at the French Space Agency's (CNES) facilities in Toulouse, France. SCOPE was linked to the main Russian control centre (TsUP) in Moscow, as well as to the German Aerospace Research Establishment's (DLR) Microgravity User Support Centre (MUSC) in Porz-Wahn, Germany. All centres were interlinked via the EUTELSAT satellite using the DICE conference system (Direct Inter-establishment Communications Experiment), backed-up by the ground system of ESA's European Space Operations Centre (ESOC). This permitted direct communications with the space station crew. The performance of this operational system was very satisfactory and enabled the viewing of exceptional video transmissions from the station crew throughout the mission.

From the scientific viewpoint, this mission gave western European scientists the opportunity, for the first time, to perform biomedical investigations for prolonged periods in space. Moreover, ESA gained new technical experience in preparing for and operating experiment equipment on long-duration space flights. Technically, this mission allowed ESA the opportunity to train its astronauts for the upcoming International Space Station era and to gather first-hand experience in the operations of space station systems. The concept of remote and decentralised payload operations, as envisaged for the Columbus Orbital Facility, was demonstrated satisfactorily.

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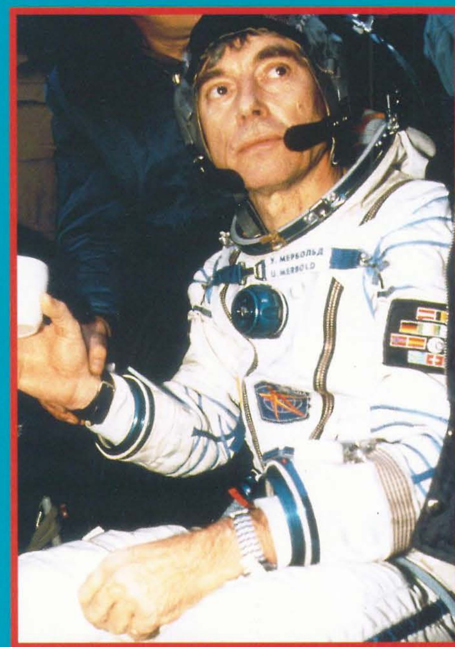

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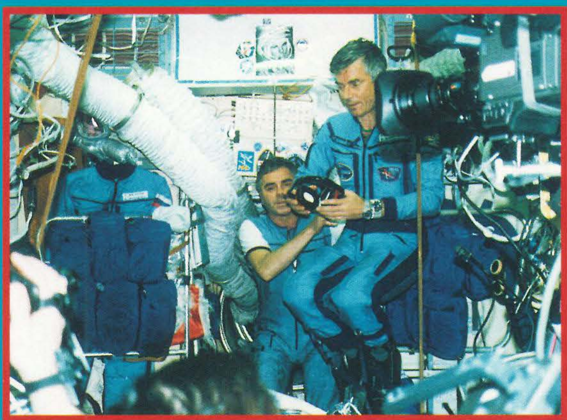

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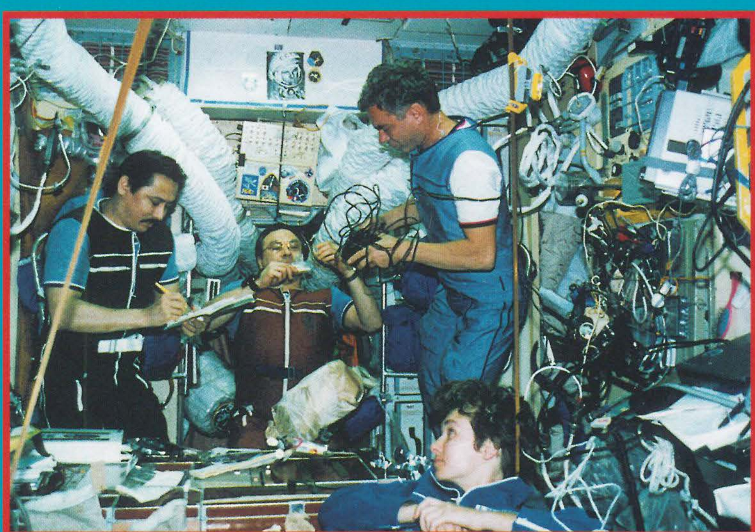


1 – ESA astronaut Ulf Merbold shortly after his landing and recovery.

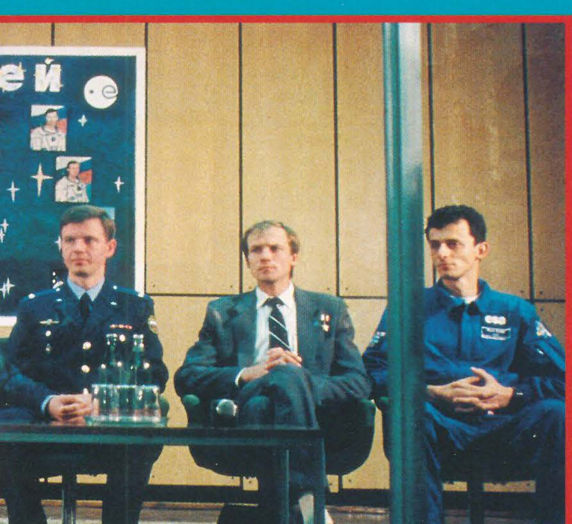
2 – Activities inside the Mir space station.

3 – Confirming the final crew selection for EUROMIR 94 at Baikonur the day before launch: ESA astronauts Ulf Merbold (far left) with the prime crew (crew 1) and Pedro Duque (far right) with the stand-by crew (crew 2).

4 – Final medical check-up at Star City for Ulf Merbold, in a head-down tilt position simulating body fluid shift in microgravity.

5 – EUROMIR 94 cosmonauts (left to right) Musabayev, Polyakov, Viktorenko and Kondakova (below).

6 – Cosmonaut Aleksandr Viktorenko (left) assisting Ulf Merbold in preparations for a physiology experiment.



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Euromir 95

The Mission

The ambitious EUROMIR 95 mission builds upon the experience gained in EUROMIR 94 and extends ESA's knowledge of long-term spaceflight with additional experiments, longer inflight duration and, for the first time for an ESA astronaut, an extravehicular activity (EVA) outside of the space station. In a mission scheduled to last 135 days, more than four times longer than the EUROMIR 94 mission, ESA astronaut Thomas Reiter (the designated crew member) will conduct science experiments, operate and maintain crucial space station systems as the flight engineer, and perform a spacewalk to install an ESA experiment package on the exterior of Mir. On Earth at the Russian Mission Control Centre (TsUP), ESA astronaut Christer Fuglesang (stand-by crew member) will monitor and assist with the onboard activities.

A total of 41 experiments, proposed by the European scientific community, will be performed in the areas of human physiology/medical sciences (life sciences), fluid physics and material sciences, space sciences, astrophysics, fundamental physics, and space-related technologies, as well as Earth observation. Medical experiments on the Mir crew are aimed at improving knowledge of the effects of microgravity and the space environment on the human body. Such knowledge helps in preparing for longer duration manned missions in space (such as establishing countermeasures to offset the deleterious effects of long-term exposure to microgravity and space radiation) and provides insight into the mechanisms of medical disorders suffered by many people here on Earth (heart disease, bone disease, muscular, circulatory or neurological disorders, and other afflictions).

The ESA astronaut and his fellow cosmonauts will conduct the medical experiments upon themselves. Studies will include:

- fluid shift in the body and central venous pressure changes in microgravity (cardiopulmonary studies)
- renal function (fluid excretion) and drug metabolism
- calcium depletion and changes in bone density

1 – ESA astronauts Thomas Reiter (left) from Germany and Christer Fuglesang from Sweden training in the Soyuz-TM simulator.

2 – EUROMIR 95 crew 1: ESA astronaut Thomas Reiter is flanked by cosmonauts Yuri Ghidzenko (left) and Sergei Avdeev.

3 – EUROMIR 95 crew studying training hardware.

4 – EUROMIR 95 crew 1 in the Mir space station trainer.

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- neurological studies on spatial orientation and space adaptation syndrome ('motion' sickness)
- changes in basic vestibulo-oculomotor mechanisms
- muscle physiology and motor control
- effects of radiation exposure during spaceflight.

The material science experiments will make use of the furnace facility on Mir. Eight experiments will investigate phenomena such as:

- solidification of metal matrix composites *in situ*
- solidification of various alloys (Al, Al/Pb, Ge-Si)
- specific heat and thermophysical properties of undercooled melts
- liquid-liquid phase separation in glasses
- convection-less chemical vapour transport.

Five experiments will study the effects of exposing materials to the space environment using the European Scientific Environment Facility (ESEF). The ESEF platform had been pre-mounted on the external surface of the Spektr module prior to its launch. Additional ESEF hardware, as well as instruments and experiment cassettes holding the samples to be exposed, will be attached to the ESEF platform during an EVA by the European astronaut. Several experiments are designed to collect particles (grains) encountered in orbit, both of terrestrial (space debris) and extraterrestrial (cometary and asteroidal) origins. The captured particles will be analysed in laboratories after they are returned to Earth. Impacts of micrometeoroids and space debris, as well as the effects of highly corrosive atomic oxygen on exposed materials, are studied *in situ*.

The ten technology experiments include a wide range of studies from radiation environment monitoring to robotic control and from smart gas sensors to a magnetic levitator using ferrofluids. Several technology investigations in the life sciences fields include the verification of microbiological contamination, studies in biological kinetics and of human posture in microgravity, and an analog biomechanics recorder. Two other experiments, the crew support computer and the video integrated service controller, are designed to support many other experiments with data collection via their video and computing devices.

The data sheets included in this folder provide detailed descriptions of the EUROMIR 95 mission experiments.

Training

Astronaut Training

The astronaut and cosmonauts onboard Mir have two prime functions: they operate systems and perform experiments which cannot be done automatically or remotely, or are done more efficiently by humans, and they themselves serve as the 'test subjects' for many experiments. A distinct advantage of having science experiments conducted manually in space is that the crew members are able to use their initiative and resourcefulness in understanding and correcting problems, interpreting new requests from the scientists on the ground, and taking advantage of unexpected or fortuitous situations.

Four ESA astronauts were chosen for the two EUROMIR missions, each mission having one ESA-designated astronaut (for crew 1) and one stand-by astronaut (for crew 2): Ulf Merbold (crew 1) and Pedro Duque (crew 2) for EUROMIR 94, and Thomas Reiter (crew 1) and Christer Fuglesang (crew 2) for EUROMIR 95. They began training preparations in early 1993 at ESA's European Astronauts Centre (EAC) near Cologne, Germany, with introductory courses on Russian space operations and safety issues, and intensive instruction in the Russian language as future training and mission operations would be conducted in Russian.

Formal mission training began in August 1993 at the Yuri Gagarin Cosmonaut Training Centre (TsPK) at 'Star City,' near Moscow. In the first phase, all four ESA astronauts went through basic training together. This included crew training in general technical and biomedical subjects, and in Soyuz and Mir systems on Soyuz-TM and Mir simulators/trainers. The astronauts also gained experience in working under microgravity conditions during training sessions on a Russian Ilyushin IL-76 aircraft (the 'Flying Laboratory') performing parabolic flights.

1 – The ESA astronauts for the EUROMIR missions at Star City: Pedro Duque (Spain), Thomas Reiter (Germany), Christer Fuglesang (Sweden) and Ulf Merbold (Germany).

2 – Training on the Ilyushin-76 'Flying Laboratory' included how to do everyday activities, such as putting on one's space suit, in microgravity.

3 – Practical sessions in survival skills are part of cosmonaut training.

4 – Regular physical fitness training is an essential part of the programme.

5 – The ESA astronauts enjoying their moments of microgravity conditions on the Ilyushin-76 'Flying Laboratory' during parabolic flight.

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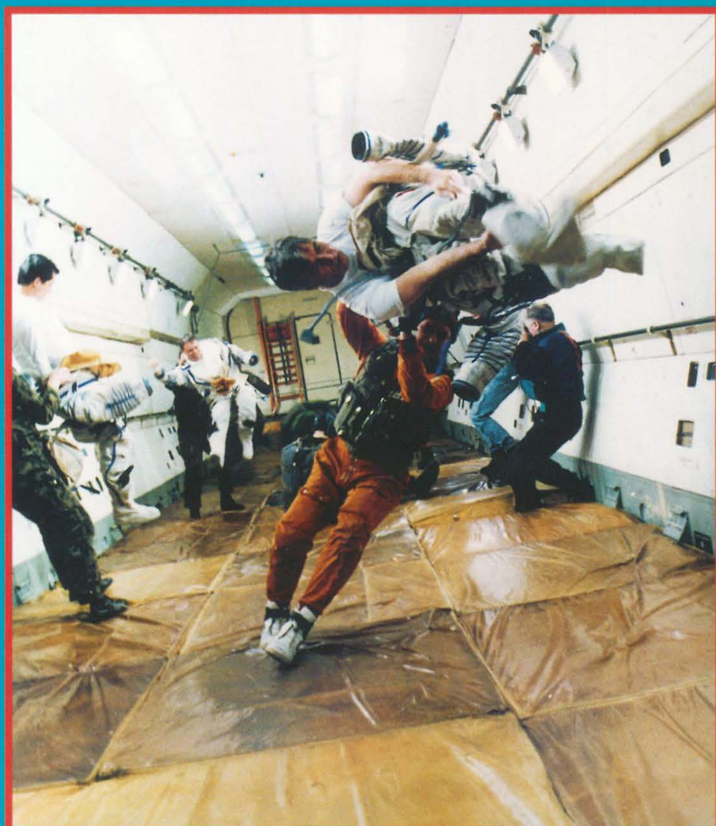

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Upon completion of basic training in May 1994, the crews of each EUROMIR mission began their separate mission-specific training in conducting experimental ground and flight programmes. This included obtaining physiological and medical data on the astronauts in the Baseline Data Collection (BDC) programme. Additionally, experiment data were collected on training hardware during experiment training sessions; these data will be used as ground comparisons to those from the inflight experiments.

SPACEWALK
A First for ESA

EUROMIR 95 is like no other previous manned European space mission. The mission's training programme has, of necessity, been extensive and intense due to the new challenges of EUROMIR 95: a mission duration of 135 days, some 40 experiments to perform and with new hardware, added responsibilities for Mir space station systems and engineering operations activities and, not least of all, a spacewalk.

EUROMIR 95 marks the first extravehicular activity (EVA) by an ESA astronaut. In preparation for this planned five-hour spacewalk, which is required in order to secure a European space exposure experiments package to the exterior of the Mir station, the two ESA astronauts participated in one of the most challenging aspects of the programme: full EVA training. Courses in space suit systems and maintenance were followed by many hours of simulation practices using specially-modified space suits in the Neutral Buoyancy Facility ('Hydrolaboratory'). This facility at Star City, a large deep water tank (23 metres in diameter, 12 metres deep, and holding 5000 cubic metres of water) containing mock-ups of the Mir station and modules, permits cosmonauts and the ESA astronauts to practice EVA manoeuvres and procedures in a simulated weightless environment. Additional practice with actual space suits in a vacuum chamber enabled the astronauts to experience suit movement and joint mobility in a simulated space environment.

This mission also marks the first time a visiting astronaut will have the responsibility of operating and maintaining Mir space station systems. As the flight engineer for EUROMIR 95, the ESA astronaut is expected to spend about two hours per day in performing onboard engineering tasks such as operating the critical life support systems which keep the station habitable. The ESA astronauts trained on a number of dedicated systems and studied engineering procedures in preparation for becoming an integral part of the onboard crew.

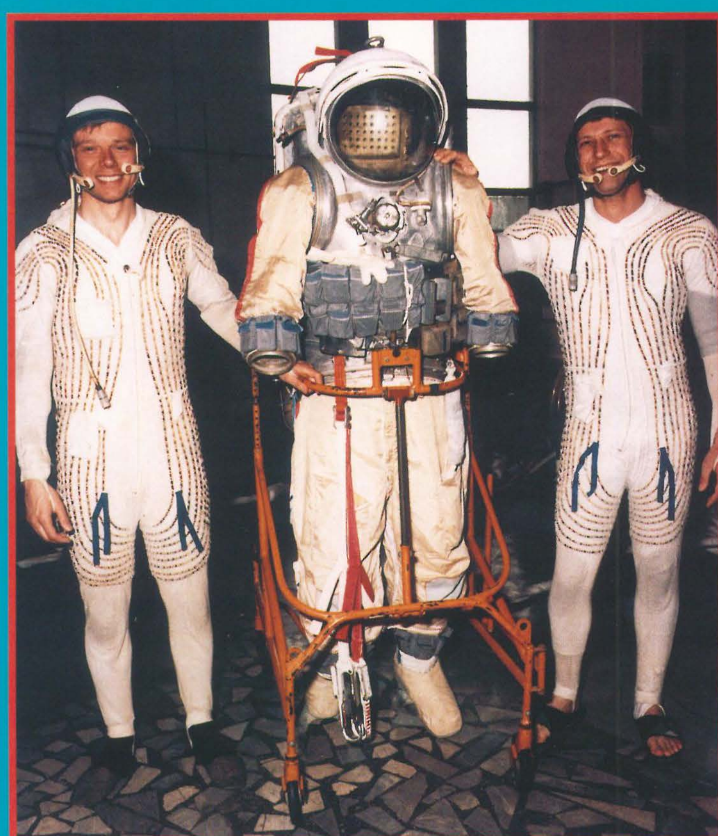
1

1 – ESA astronaut Thomas Reiter emerging from the Soyuz-TM simulator.

2 – The astronauts modelling their thermal control undergarments as they prepare to 'suit up' for EVA training.

3 – Wearing specially-modified and neutrally-buoyant space suits, the EUROMIR 95 crew members practice for their spacewalk on mock-up hardware of Mir in the simulated space environment.

2

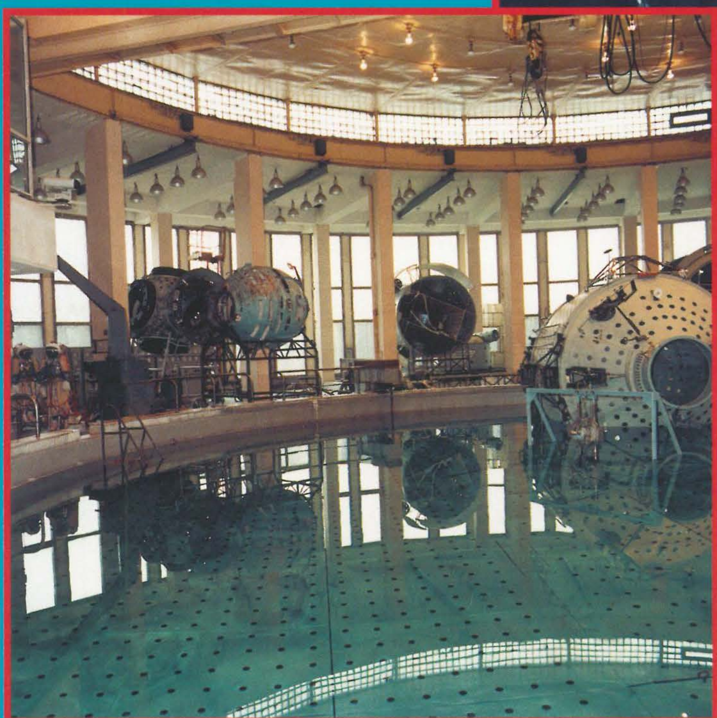


4 – The Neutral Buoyancy Facility ('Hydrolaboratory') at Star City (TsPK) and submersible hardware for EVA training; the tank contains over 5000 cubic metres of water.

5 – Experiencing moments of microgravity conditions during parabolic flight on the Ilyushin-76 'Flying Laboratory' aircraft is ESA astronaut Thomas Reiter.

5

4



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The longer mission duration and increased resources available for EUROMIR 95 mean that more experiments can be performed than were planned for EUROMIR 94. Most of the scientific equipment for EUROMIR 95 was not completed until relatively recently, and it was decided to minimise travel time and transport costs for the scientists and their hardware by undertaking much of the experiment training at the EAC in Germany. These training sessions served several important functions: they provided a forum for discussing the scientific basis of experiments between the astronauts and the experiments' principal investigators, they enabled the astronauts to familiarise themselves with experiment hardware, and they permitted collection of experiment 'baseline' data, which will allow the scientists to compare these ground-based results with those obtained later in space.

Mission Control and Support

1 – The main control room of the Russian Mission Control Centre (TsUP) in Kaliningrad, Russia.

2 – The SCOPE control room at the DLR German Space Operations Centre (GSOC) in Oberpaffenhofen, Germany, has supported numerous space missions.

3 – Overview of the communications architecture for EUROMIR 95 payload operations activities: a complex network scattered around the world.

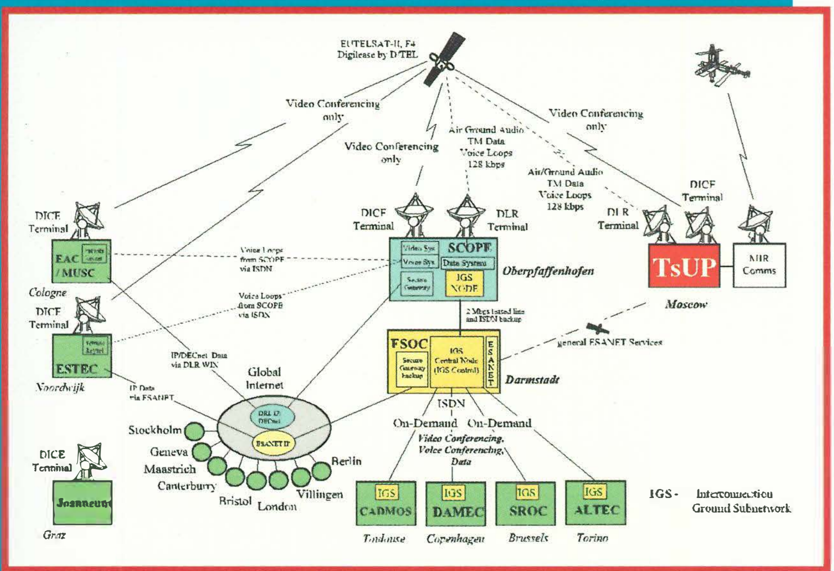
1

All space ventures, particularly manned missions, call for precise planning and execution of operations. As missions become more complex, so does the control aspect, especially in today's environment of widely distributed operations facilities. Ground operations for the EUROMIR 95 mission will be particularly challenging, with a host of European space operations facilities monitoring onboard activities and experiments, and supporting the Russian mission control operations.

TsUP – Russian Mission Control Centre

The Russian Mission Control Centre (TsUP), located in Kaliningrad (near Moscow), has responsibility for the overall operations of the Mir space station. Since the start of Mir operations in 1986, the TsUP has been providing around-the-clock support and control of space station activities. As such, it is at the top of the hierarchy for the EUROMIR 95 mission. All data from Mir are received by and processed at TsUP, transferred to the ESA control centre for payloads operations (SCOPE) and then distributed as required to the payload operations teams and scientists. Some members of the SCOPE mission operations team from ESA work at TsUP to provide a direct interface with the TsUP Mir Mission Control Centre. The ESA crew 2 astronaut, in his role as an ESA crew interface communicator, is an integral member of this team at TsUP.

3



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SCOPE – System for Control of Operations of Payloads for EUROMIR 95

The 'System for Control of Operations of Payloads for EUROMIR 95' (SCOPE) is used to execute the central mission management functions and coordinate all payload-related activities among the other operations organisations (e.g., the TsUP, the EAC, and the scientists (principal investigators) located at operations centres or at scientific institutions throughout Western Europe). SCOPE is based at the German Aerospace Research Establishment's (DLR) German Space Operations Centre (GSOC) in Oberpfaffenhofen, Germany (near Munich).

EAC – European Astronauts Centre

ESA's European Astronauts Centre (EAC), located near Cologne, Germany, and home base of the ESA astronauts, monitors mission operations and provides astronaut support, via the ESA mission operations team located at the TsUP, for medical and other matters as required.

ESOC – European Space Operations Centre

ESA's European Space Operations Centre (ESOC) in Darmstadt, Germany, established the communications infrastructure among the sites in Europe and Russia. The network consists of the Interconnection Ground Subnetwork (utilised during Space Shuttle missions ATLAS-2, ATLAS-3 and IML-2) and additional very small aperture terminals (VSATs) utilised during EUROMIR-94. ESOC is responsible for maintaining and operating this network during the EUROMIR-95 mission.

USOC – User Support and Operations Centres

It is impractical and often a hardship to require scientists to stay at the mission control centre for the duration of the mission. In order to stay closer to their laboratories, the Principal Investigators (PIs) will spend much of their time in User Support and Operations Centres (USOCs) throughout Europe. There they can monitor experiment performance on-line and support the SCOPE as and when required. The USOCs include:

- ASI (Italian Space Agency) Logistics, Technology and Engineering Centre (ALTEC), Torino, Italy
- Centre for Assistance to Development for Micrograviy Operations in Space (CADMOS) at CNES, Toulouse, France
- Danish Aerospace Medical Centre (DAMEC), Copenhagen, Denmark
- European Space Research and Technology Centre (ESA/ESTEC), Noordwijk, The Netherlands
- Microgravity User Support Centre (MUSC) at DLR, Cologne, Germany
- Space Remote Operations Centre (SROC), Brussels, Belgium

Many other users can access their experiments' science data via Internet and be connected to the operational voice system via ordinary telephone. This system enables science data from experiments on Mir to be delivered directly to the scientist's laboratory or home institution. DLR provides the satellite link between SCOPE and TsUP for voice and data.

ESTEC – European Space Research and Technology Centre

ESA's European Space Research and Technology Centre (ESTEC) is 'home base' for the EUROMIR 95 Management Team. The Management Team has ultimate decision-making authority for programme changes if deviations from the planned mission activities occur. As a USOC, ESTEC supports the ESA technology experiments and provides engineering support for the onboard experiment facilities.

1 – Scientists can monitor their EUROMIR 95 experiments onboard Mir from a number of User Support and Operations Centres.

2 – The European Space Research and Technology Centre (ESTEC), home of the EUROMIR 95 Project and Mission Management team, is also a user support centre for technology experiments.

3 – ESA astronaut Pedro Duque in a Soyuz-TM trainer.

Back Cover:

Cosmonaut Valery Polyakov looks out from Mir's window during rendezvous operations with the Space Shuttle Discovery (STS-63) in the first Shuttle rendezvous with the Russian space station. (Photograph courtesy of NASA.)

1

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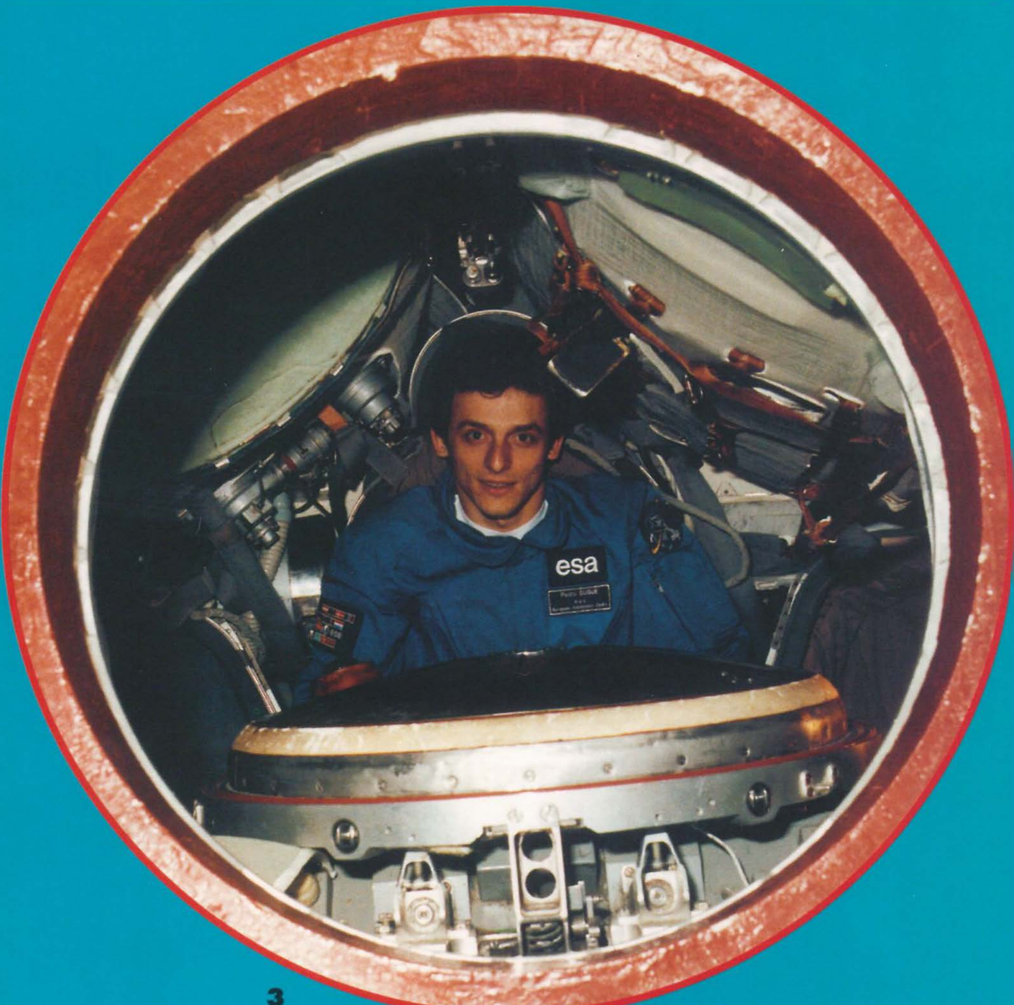

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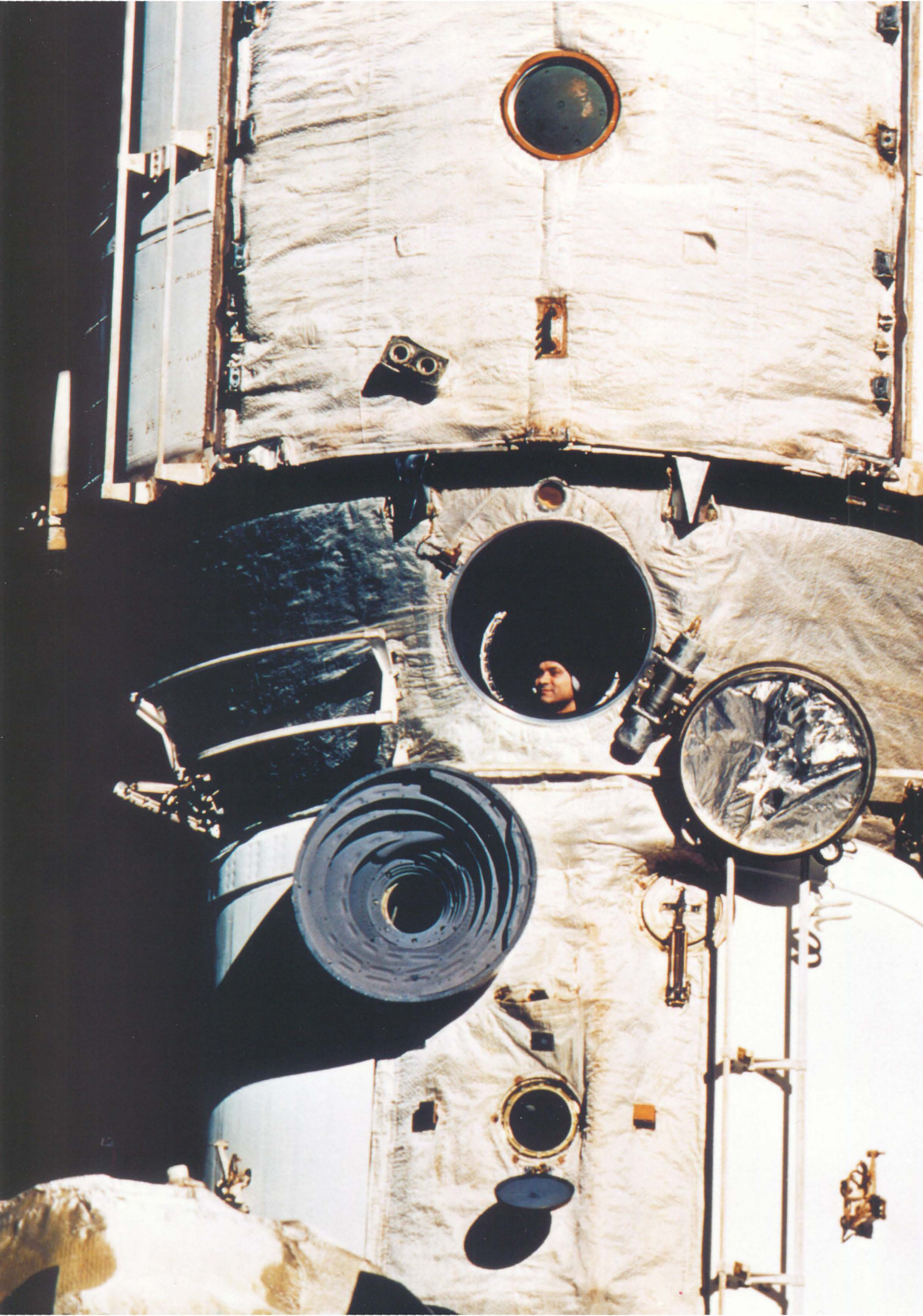

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The European Space Agency

ESA was created in 1974 from two earlier space organisations: the European Space Research Organisation (ESRO) and the European Organisation for the Development and Construction of Space Vehicle Launchers (ELDO). Today, ESA's Member States include: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom; Canada participates as a Cooperating State.

The ESA Convention stipulates that: "The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications with a view to their being used for scientific purposes and for operational space applications systems..."

The Agency is directed by a council composed of representatives from the Member States and managed by the Director General, ESA's chief executive. The Director General is supported in his duties by the Inspector General, the Director of Science, the Director of Observation of the Earth and its Environment, the Director of Telecommunications, the Director of Launchers, the Director of Manned Spaceflight and Microgravity, the Director of ESTEC, the Director of Operations and the Director of Administration.

The ESA Head Office is in Paris, France. The major establishments are:

- the European Space Research and Technology Centre (ESTEC), Noordwijk, The Netherlands
- the European Space Operations Centre (ESOC), Darmstadt, Germany
- the European Space Research Institute (ESRIN), Frascati, Italy
- the European Astronauts Centre (EAC), near Cologne, Germany

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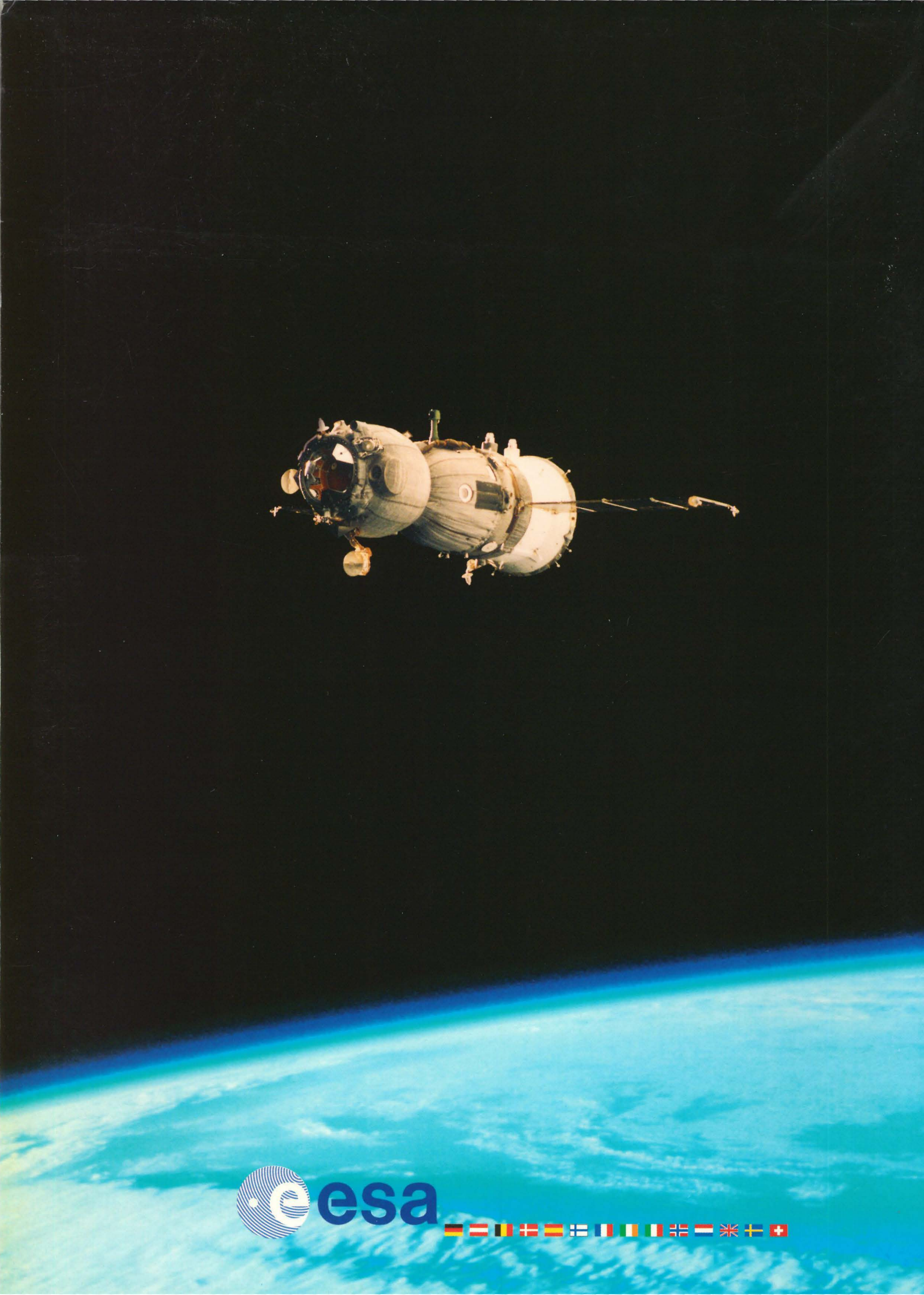
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