Successful Odissea to the Space Station

ESA astronaut Frank De Winne came back to Earth on Sunday 10 November after a successful Soyuz mission to the International Space Station involving nine days of ground-breaking scientific research and the delivery of a brand new TMA-1 Soyuz spacecraft.

The Odissea mission crew – Frank De Winne and the Russians Sergei Zaletin, Soyuz Mission Commander, and Yuri Lonchakov, Soyuz Flight Engineer – were lifted into orbit on the first ever flight of the new Soyuz model TMA and returned in the old TM-34 Soyuz that had been attached to the Space Station as an emergency return vehicle for the last six months.

Safely descending to Earth in their Soyuz TM-34 capsule, the crew ended a 11-day mission with a flawless night landing near the town of Arkalyk on the plains of Kazakhstan at 06:04 local time (00:04 GMT).

ESA astronaut Frank De Winne, a former Belgian Air Force fighter pilot, described his first voyage into space as “the most intense, challenging and unbelievably fulfilling 11 days of my professional life.” During his nine-day stay on the Space Station, De Winne worked on a substantial programme of 23 scientific experiments, including four physical sciences experiments with the newly installed Microgravity Science Glovebox (MSG) facility. He also made several in-flight calls to schools and TV stations in Belgium and the Netherlands, and performed educational experiments.

Foton M-1 launch failure

A Russian Soyuz launcher exploded some 20 seconds after lift-off from the Russian Plesetsk cosmodrome on 15 October at 20:20 CEST, killing a Russian soldier.

The unmanned Foton M-1 research satellite, using capsules of the Foton/Bion family containing 44 experiments supported by ESA. The experiments covered a wide range of scientific disciplines, including fluid physics, biology, crystal growth, radiation dosimetry and exobiology.

ESA’s contribution included the FluidPac Physics Facility with four experiments, Biopan hosting nine experiments, the upgraded Telescience Support Unit to assist both FluidPac and the German AGAT furnace, six Autonomous Experiments (three developed by university students), Stone simulated meteorites, and the ‘Soret Coefficient in Crude Oil’ experiment.

The report of the State Inquiry Board headed by Russian space officials is expected to report soon on the causes of the accident. A press conference given by the Head of Rosaviakosmos, Yuri Koptev, on 18 October provided initial information. One of the strap-ons took 2 s to reach full thrust, pulsed for 1.5 s and 4 s after launch lost all power. It then fell away from the vehicle, as it is designed to do when thrust no longer holds it in place. It fell back to Earth, where the ruptured tanks led to a large fire that significantly damaged the pad. The launcher automatically shut down the other three strap-ons 20 s after launch, and it struck the ground about 1 km from the pad and exploded.

Preliminary analysis indicated that the hydrogen peroxide supply to the propellant turbopumps was blocked by a metallic object. France’s IBIS biological incubator, Germany’s AGAT, Russia’s Polizon furnace and five Russian experiments (Biokont, Komparus, Mirage-M, Sinus-16 and Chistata) brought the spacecraft’s overall payload to a total of 650 kg.

Sadly, a soldier watching from the integration building was killed. Fortunately, all of the engineers and experts from ESA, the French space agency CNES and the German space agency DLR involved in the preparation of the spacecraft in Plesetsk were unharmed.

Frank De Winne and his fellow crew members after landing

Frank De Winne during his mission in the ISS
The recent eruptions of the Mount Etna volcano in Sicily are throwing huge amounts of ash and gases into the atmosphere. Instruments on three different ESA spacecraft – ERS-2, Envisat and Proba – have acquired imagery of the eruptions, shedding new light on the event and its impact on the Earth’s environment.

Data from the Global Ozone Monitoring Experiment (GOME) sensor onboard ESA’s ERS-2 spacecraft reveal that levels of sulphur dioxide from the eruptions at the end of October are at least 20 times higher than normal.

The normal background level of sulphur dioxide is typically below 0.5 Dobson Units (DU), a measure of atmospheric gas concentrations from ground level to the top of the atmosphere, about 70 km in altitude. “In the plume, we measured the atmospheric content of sulphur dioxide at about 10 DU”, said Werner Thomas, an atmospheric scientist with the Remote Sensing Technology Institute of the German aerospace centre (DLR).

Sulphur dioxide in the troposphere, the lowest part of the atmosphere where most weather changes occur, is known to be responsible for the so-called “acid rain” phenomenon. Etna is one of the most prominent sources of natural sulphur dioxide worldwide.

The Italian government declared a state of emergency in Sicily in the wake of a series of earthquakes, measuring between 3.6 and 4.3 on the Richter scale, that forced the evacuation of approximately 1000 homes, according to reports from BBC and Italian newspapers.

Meanwhile, three streams of lava from the eruption flowed down the south, northeast and northwest slopes of the mountains, the media reports stated.

Europe’s highest and most active volcano (3370 m) hurled lava and ash from several craters into the sky with speeds between 350 and 450 metres per second, exceeding the speed of sound. According to data from volcanologists, the lava and ash were ejected from the main crater and from at least nine new craters that developed in the mountain at between 2300 and 2700 metres in altitude.

Images from the Medium Resolution Imaging Spectrometer (MERIS) onboard ESA’s Envisat satellite show that the eruptions spewed significant amounts of ash into the atmosphere. The larger volcanic ash particles are expected to settle out in a short period of time, but the sulphuric acid aerosols produced by the sulphur dioxide will persist for several years.

Aerosols containing black graphite and carbon particles are dark, thus absorbing sunlight. As these atmospheric particles reduce the amount of sunlight reaching the planet’s surface, they increase the amount of solar energy absorbed in the atmosphere, thus simultaneously cooling the surface and warming the atmosphere.

The ability of the MERIS instrument to observe the spatial distribution of these aerosol plumes can be exploited to measure the amounts of airborne particles and to examine the role of these aerosols as cloud condensation nuclei and their impact on the hydrologic cycle through changes in cloud cover, cloud properties and precipitation.

Just 60x60x80 cm and weighing only 94 kg, ESA’s Project for On-Board Autonomy satellite, better known as Proba, is one of the most advanced small satellites ever flown in space. Since its launch exactly one year ago, Proba’s high-performance computer system and technologically advanced instruments have enabled it to demonstrate and evaluate onboard operational autonomy, with new spacecraft hardware and software, and to test new Earth observation and space environment monitoring instruments in space.

The imagery captured by Proba demonstrates the capabilities of CHRIS, the Compact High Resolution Imaging Spectrometer, which is providing important information on the Earth and its environment, and will be a valuable remote sensing tool during the extended mission.
EIROforum and education

EIROforum was formally established on 12 November with the signature of a common EIROforum Charter by the Directors General of the seven European intergovernmental research organisations (CERN, EMBL, ESA, ESO, ESRF, ILL and EFDA) during the EU-conference on “European Research 2002 – The European Research Area and the Framework Programme”.

A few days prior to this ceremony, the Directors General had met to discuss the areas of EIROforum collaboration. One of the key points on the agenda was the formation of a European Science Teachers Initiative (ESTI). This Initiative aims to pool the EIROforum’s considerable expertise and resources in a coordinated approach towards the European science teaching community.

Previous joint education projects such as ‘Physics on Stage’ have identified the need of Europe's science teachers to have access to cutting-edge science and to receive support in bringing the excitement of new scientific discoveries into classrooms. The EIROforum organisations are natural focal points for public interest in science and they emphatically support Europe-wide efforts to raise interest in science and technology and to secure a sound recruitment base for European research efforts in the future.

With this in mind, the Directors General agreed on a Statement of Principles for ESTI, which will form the basis of an application to the European Commission for collaboration in this major initiative.

“The establishment of EIROforum is a concrete example of the dynamics created by the European Research Area. Europe has unquestioned excellence in science. By working together, Europe’s leading research organisations can make that more visible on the European and world stage,” commented EC Commissioner for Research Philippe Busquin.
ESA’s Science Programme Committee (SPC) has given the final go-ahead for the Venus Express mission. On 5 November, the SPC unanimously confirmed its strong will to undertake the mission. Furthermore, the Committee endorsed and agreed on a solution to the financial issues that had cast serious doubts on the mission.

Venus Express will reuse the Mars Express spacecraft design and needs to be ready for launch in 2005. Since the last meeting of the SPC in July 2002, ESA has invested 7 million Euros to start the first mission design phase. However, the mission’s fate was not yet sealed because one nation, Italy, had still not confirmed its participation in the payload. To rescue the mission, the ESA Science Directorate in collaboration with the Italian Space Agency (ASI) came up with several financial proposals, one of which was eventually endorsed by the SPC.

The Italian contribution to Venus Express will consist of parts of the VIRTIS and PFS experiments and the ASPERA instrument. ESA will contribute 8.5 million Euros, covering the integration and testing of the parts of the instruments Italy has agreed to provide and other items needed to allow the Italian instruments to fly. In exchange for ESA’s support, the VIRTIS Science Team will be further Europeanised.

DeVIL inside:
Satellite technology “prêt à porter”

The European Space Agency (ESA) has started a 50-million-Euro initiative to bring together Europe’s leading aerospace companies for the next four years. The aim of DeVILS is to develop ‘intelligent’, lightweight spacecraft systems that ESA can use on future missions. Having these ‘plug- and-play’ systems will allow Europe to create lighter spacecraft that perform better.

The aim is to reuse similar systems on many different spacecraft, which has already proven to save time and money. For example, the recently launched Integral gamma-ray observatory has reused part of XMM-Newton’s design. Mars Express reuses hardware designed for Rosetta. The Venus Express mission is likely to use the same hardware design again.

DeVILS uses ‘intelligent’ systems on-board satellites. These are multipurpose components that perform the same tasks as a number of previous units. In this way, you reduce the number of components, the size and hence the mass of individual spacecraft, enabling cheaper missions. Industry is the creative catalyst in the project, by telling ESA what they can do to make spacecraft cheaper, lighter and perform better. Besides improved science missions, this could well lead to more efficient applications in telecommunications, global navigation, and Earth observation.
For the first time, XMM-Newton has been able to measure the influence of the gravitational field of a neutron star on the light it emits. This measurement provides much better insight into neutron stars and might be able to prove the theory that the primordial soup of dissolved matter that existed a fraction of a second after the Big Bang can still be found in today’s Universe, in the core of certain very dense neutron stars.

Neutron stars are among the densest objects in the Universe. They pack the mass of the Sun into a sphere just ten kilometres across. A sugar-cube-sized piece of neutron star weighs over a billion tonnes! Neutron stars are the remnants of exploding stars up to eight times more massive than our Sun. They end their life in a supernova explosion and then collapse under their own gravity. Their interiors may therefore contain a very exotic form of matter.

Scientists believe that in a neutron star, the densities and temperatures are similar to those existing a fraction of a second after the Big Bang. They assume that when matter is as tightly packed as it is in a neutron star, it goes through important changes. Protons, electrons, and neutrons – the components of atoms – fuse together. It is possible that even the building-blocks of protons and neutrons, the so-called ‘quarks’, get crushed together, giving rise to a kind of exotic plasma of ‘dissolved’ matter.

Scientists have spent decades trying to identify the nature of matter in neutron stars. To do this, they need to know a star’s mass and radius, or the relationship between them, to obtain its compactness. However, no instrument has been advanced enough to perform the measurements needed, until now. With ESA’s XMM-Newton observatory, astronomers have been able for the first time to measure the mass-to-radius ratio of a neutron star and obtain the first clues to its composition. These clues suggest that the neutron star contains normal, non-exotic matter, although they are not conclusive. The authors say this is a “key first step” and they will keep on with the search.

The way that they made this measurement is a first in astronomical observations and it is considered a huge achievement. The method consists of determining the compactness of the neutron star in an indirect way. The gravitational pull of a neutron star is immense – thousands of million times stronger than the Earth’s. This makes the light particles emitted by the neutron star lose energy. This energy loss is called a gravitational ‘red shift’. The measurement of this red shift by XMM-Newton indicated the strength of the gravitational pull, and revealed the star’s compactness.

The result was obtained by observation of the neutron star EXO 0748-676. XMM-Newton detected the light in the form of X-rays. In particular, thanks to analysis of this X-ray radiation, the astronomers were able to identify some chemical elements, namely iron, present in the material surrounding the neutron star. They then compared the distorted signal emitted by the iron atoms in the neutron star with the one produced by iron atoms in the laboratory. In this way, they could measure the actual degree of distortion due to the gravity of EXO 0748-676. Their work is published in the 7 November 2002 issue of Nature.

To gain a better understanding of ESA, the students visited ESTEC on 8 October 2002 before leaving for the United States. They were given presentations on Earth Observation, Science, Navigation and the International Space Station and visited the main facilities.

Thousands of delegates participated in the various sessions of the World Space Congress and activities over ten days, and more than 10000 were involved in various aspects of the exhibition or education outreach programme. The students sent by ESA attended as many sessions as they could, and some presented their research on the special Student Stand. 70 of them were even given the opportunity to make presentations in the IAF Technical Sessions.
A special poster session on the ESA Education Office stand was organised for student projects. Many of the regular participants had a look what the new generation of space experts had to offer. One of them was so impressed by Italian Andrea D’Ambrogio’s experiment on “vibration effects on bone metabolism in astronauts” that they are discussing the possibility of flying it on the ISS. “It would be a dream come true!” says the biotechnology student. If it happens, there would be “a formal agreement, this will be my final project for my M.Sc degree in Biotechnology, and we will prepare the protocols, we will train astronauts in performing the experiments, and we will assist the astronauts during the mission.” His success story has already appeared in the Italian press.

The competition was announced earlier this year and a lot of European students, studying various disciplines, responded to it. From all of the entrants, 50 students were selected, on the basis of a written essay, to participate in the second phase of the competition.

These students who were selected for the second phase were invited to ESTEC for an introductory visit, during which lectures were given by various ESA scientists and engineers. The lecture topics varied from the International Space Station in general to already conducted and future experiments, as well as personal experiences on board. There was also the chance for the students to share their ideas for an experiment in the form of a presentation to other SUCCESS 2002 participants. Many students considered the in-flight call with the ISS the climax of their visit. There were two opportunities during which the students were able to talk to Frank De Winne for 15 minutes.

During a workshop the students had the opportunity to talk personally with ESA scientists in a more relaxed environment. They also took a guided tour through ESTEC’s spacecraft testing facilities.

The overall aim of the SUCCESS 2002 Student Contest visit to ESTEC was to teach them about the ISS and the experiments already conducted, to stimulate international cooperation, and to provide the motivation for writing a detailed experiment proposal in the second phase. This detailed experiment proposal should be delivered at the beginning of December, after which the selection of the contest winners can commence. They will be announced early next year.