In Brief

First European woman on ISS

Mission accomplished: The crew of the Russian-French Andromède mission returned safely to Earth on 31 October after a ten-day trip to the International Space Station (ISS). The taxi flight to exchange the Soyuz "lifeboat" on the ISS brought the first European woman to the Station: ESA's Claudie Haigneré described the mission as a "challenging and intensely fulfilling experience". She was also the first non-Russian woman to fly as flight engineer on a Soyuz spacecraft.

Claudie and her fellow crew members Victor Afanassiev and Konstantin Kozeev spent eight days on board the Station and performed a number of experiments in life sciences, biology, material science and earth observation. Their main task was to deliver a new Soyuz vehicle, the Station's lifeboat, and take the one that had been attached to the Station for six months for their return flight to Baikonur in Kazakhstan.

Since August the ISS has hosted the first European experiments. First to arrive was the Advanced Protein Crystallisation Facility (APCF); shortly after followed the Granada Crystal Box Experiment. The ESA funded Granada Crystallisation Facility, in which protein crystals had been growing since the arrival of the mission, has returned to Earth with Claudie, just like some extraordinary passengers on the Soyuz spacecraft: frog and salamander larvae in the Aquarius containers.

But the ESA astronaut was not only busy with scientific experiments, she also had a lot of PR to do. During her stay on the ISS Claudie spoke to the French Minister for Research Schwartzenberg, participated in the ceremony for the Prince of Asturias award via an in-flight call to Spain, answered questions from young students in the Cité de l'Espace in Toulouse during a TV downlink, and gave several interviews to TV, radio and newspapers.

"The Space Station is a remarkable feat of engineering, and is taking shape day by day. We were able to set up experiments and carry out a series of medical tests," said Claudie after her return. "Europe is playing a significant role in the development of the Space Station, which will be a key facility for space-based science and technology development in the coming years". esa

Artemis and Spot-4 chat with laser light

During the night of 21 November, two satellites communicated with each other for the first time through a laser beam. ESA's Artemis satellite, currently in a parking orbit at 31 000 kilometres altitude, and the CNES Earth observation satellite Spot-4, in an orbit at an altitude of 832 kilometres, are the first satellites to exchange data using an optical data transmission link. The Astrium-built SILEX system, with terminals on both spacecraft, is responsible for this novel event.

Through the laser data link, images taken by Spot-4 can be transmitted in real time to the image processing centre at Spot Image in Toulouse, France, via Artemis. This drastically reduces the time between taking the picture and its delivery to the centre. The transmission is possible whenever the two satellites are in line of sight. Without the Artemis relay the images are stored on board in Spot-4's memory and dumped to the ground stations.

The experiment performed in the night of 21 November consisted of establishing the link four times: in the course of four successive Spot-4 orbits, the SILEX terminal on board Artemis activated its optical beacon to scan the area where Spot was expected to be. As soon as contact was made, Spot-4 responded by sending its own laser beam to Artemis. On receiving the Spot-4 beam, Artemis stopped scanning and the optical link was maintained for a pre-programmed period lasting from 4 to 20 minutes.

During the period when the two satellites were "communicating", test data were transmitted from Spot-4 to the ground via Artemis at a rate of 50 000 000 bits per second (50 Mbps). ESA's test station in Redu (Belgium) and the Spot-4 receive station in Toulouse confirmed the extremely high accuracy of the data stream. The main challenge in establishing an optical link between satellites is to point a very narrow beam with extreme accuracy to illuminate the partner spacecraft flying at a speed of 7000 miles per second.

Before Christmas, the ion-propulsion phase is expected to start moving Artemis to its final geostationary orbit at an altitude of 36 000 km. Once the spacecraft has reached that orbit, in the middle of next year, the operational phase will begin and the link between the two satellites will be established at least five times a day. esa

ESA stimulates scientific and industrial relations with four East European countries

The Czech Republic, Hungary, Poland and Romania are going to participate more closely in ESA programmes. The aim of the new agreement between ESA and the four States is to stimulate relations with interested European countries, to expand the overall European scientific and industrial base and to enrich ESA as a research and development organisation.

In September the Agency held a workshop in Paris with representatives from the four European Cooperating States (ECS) with the objective of presenting the possibilities of the ECS status and understanding the different views and possible concerns of the countries. To be a candidate for this new agreement, a country must be European and must already have signed a Framework Agreement with ESA. The new ECS Agreement is a bilateral engagement between that country and ESA, and it allows the partner country to participate indirectly in all ESA procurements and activities. In each case, the participation is to be defined in a five-year Plan for a European Cooperating State (PECS) to be jointly agreed by ESA and the country concerned.

Henk Olthof, ESA programme manager, explains, "this new Agreement opens up the possibility to increase the potential synergy between ESA programmes and the future plans in the space field for our four European partners, the Czech Republic, Hungary, Poland and Romania. The ECS Agreement suits their current industrial and financial capacities better than the closer Associate Membership. It creates a natural extension of the existing very fruitful collaboration and allows the four countries to participate in all Agency programmes and enables ESA to benefit from their expertise". esa

World record for ESA

The Dutch solar car Nuna won the World Solar Challenge, a 3010 km race right across Australia for cars powered by solar energy. Having set off from Darwin on Sunday 18 November, Nuna crossed the finish line in Adelaide on Wednesday 21 November in a record-breaking time of 32 hours and 39 minutes.

The average speed of the car was 91.7 kilometres per hour, also a new record. On the fourth day Nuna had to travel 830 km – the longest distance ever accomplished by a solar car in one day. Nuna pushed the limits by driving at a top speed of more than 100 km per hour, setting a new record by finishing in well under 4 days.

43 racing cars were at the start of the 6th World Solar Challenge in Darwin, Australia. The streamlined Nuna verhicle was built by eight Dutch students from the universities of Delft and Amsterdam. It uses advanced space technology, provided to the team via ESA's Technology Transfer Programme, enabling the car to reach a theoretical top speed of over 160 km per hour.

The aerodynamically optimised outer shell consists of space-age plastics to keep it light and strong. The main body is made from carbon fibre, reinforced with Kevlar, a material used in satellites, but nowadays also in high performance equipment like bulletproof vests.

Day 1

Preparing for the start

The car's shell is covered with the best dual junction and triple junction gallium-arsenide solar cells, developed for satellites. These cells have an efficiency of about 24%. ESA will test these cells in space in early 2003, when the technology-demonstrating SMART-1 mission is launched to the Moon.

Nuna also carries Maximum Power Point Trackers, small devices that guarantee an optimal balance between power from the batteries and the solar cells, even in less favourable situations like shade and cloud. Many satellites carry these devices, for instance ESA's Rosetta mission to Comet Wirtanen.

A small strip of solar cells on the side of the car is very special for a different reason: the communication equipment is powered by this strip of cells that were originally on the NASA/ESA Hubble Space Telescope. These cells were part of a large ESA-provided solar array, retrieved by ESA astronaut Claude Nicollier and brought back to Earth in 1993 on a Space Shuttle.

"If Nuna wins the race, it will be due in part to the use of space technology" Ramon Martinez, a mechanical engineering student at the Technical University of Delft and leader of the Alpha Centauri Team, explained beforehand. "But much more important, due to the hard work and dedication of a group of students, it will make a dream come true!"

To fulfil their mission, the student team collected an impressive line-up of supporters. ESA not only provided them with engineering support via its Technology Transfer Programme, but also with general support via the Education Office, headed by former ESA astronaut Wubbo Ockels, who was also adviser to the team. Eric Trottemant, from the Education Office, who developed the strategy software, also joined the team. Dutch energy company Nuon was the main sponsor, and the association of plastic producers APME and the Technical University of Delft strongly supported the team.

After this success, an extensive tour is planned to visit schools in the ESA Member States. This educational programme will emphasise the value of space technology for a more sustainable world and show in a tangible manner how the dreams of youngsters can become reality.

Overtaking 'Aurora'

'Mission Control'

First stop

Day 2

Photos courtesy of: ANP/EPA/Pictor

Charging the batteries

Day 3

Day 4

Royal visit to ESTEC, royal award for the ISS

King Juan Carlos and Queen Sofía of Spain, on a state visit to The Netherlands, came to ESTEC on 25 October with their host Queen Beatrix to see Europe's space agency in action. The royal visitors listened with interest as Antonio Rodotà, ESA's Director General, explained the Agency's role, and watched a wide-screen video presentation summarising current ESA projects. Then the royal party was taken around a life-size replica of Europe's Columbus module, due for launch in 2004.

Three ESA astronauts currently based in Noordwijk - Italy's Umberto Guidoni, Spain's Pedro Duque and André Kuipers from the Netherlands - were on hand to explain from first-hand experience just how things worked. "They were all very enthusiastic. I was surprised how much they were interested in the technology as well as the business of living in space", said Kuipers.

Pedro Duque, who has met King Juan Carlos three times before, was less taken by surprise. "He always asks intelligent questions. He's very enthusiastic about space." ESA's Director General and the astronauts met the King again the next day in Oviedo in Spain to receive the 2001 Prince of Asturias Award for International Cooperation together with representatives of the other ISS partner space agencies, from the United States, Russia, Canada and Japan.

Royal visit to the Columbus module at ESTEC.

The Prince of Asturias Foundation granted this Award in recognition of the efforts made "to achieve international cooperation that have been necessary to turn this enormous orbiting laboratory for scientific research for a greater understanding of our planet into a reality". esa

King Juan Carlos and Queen Beatrix chatting with astronauts Pedro Duque and André Kuipers.

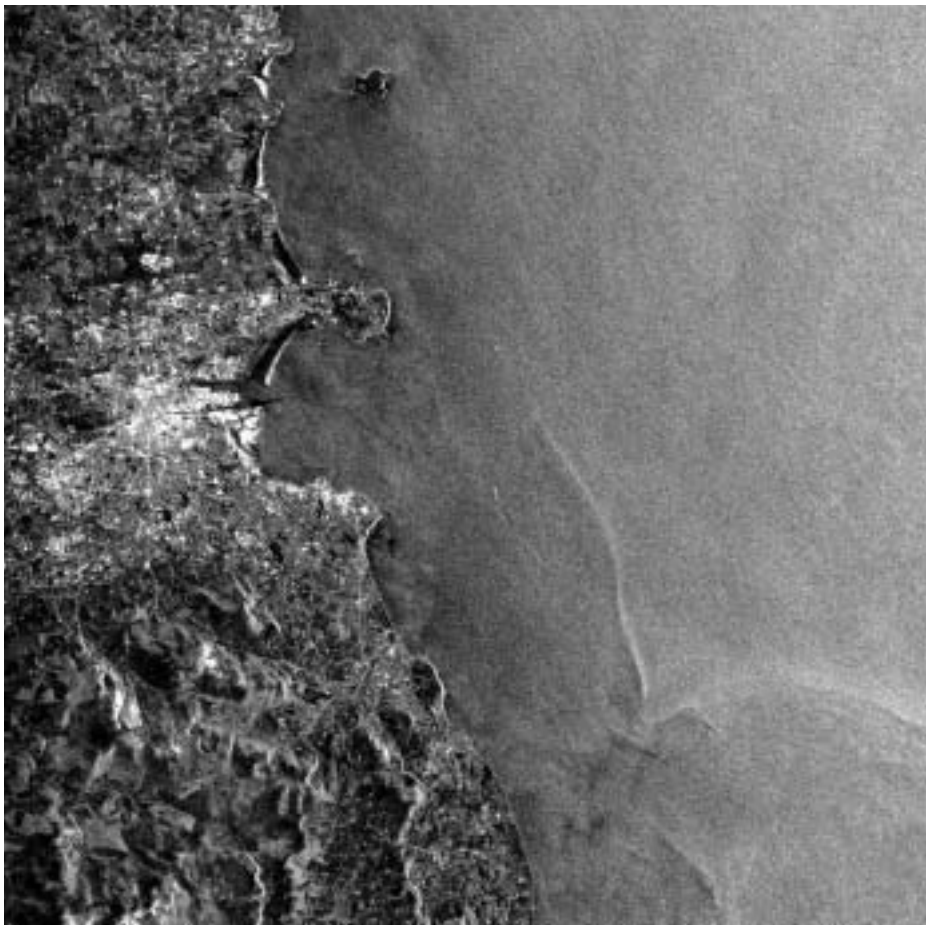
ERS-2 goes gyro-less

ESA engineers have developed a new technique to navigate satellites without the help of gyroscopes and saved the life of ERS-2, the European Remote Sensing Spacecraft launched in 1995. This mode allows ERS-2 to measure the satellite's pointing through the digital earth sensors and payload data, and has led to a considerable improvement on the yaw pointing of the satellite. By January 2000, the spacecraft's gyroscopes – needed to keep the satellite steady in all three axes – had lost their spin; only one still functioned correctly. A team from ESA and Astrium wrote new software to make the new "zero gyro mode" method work: they also had to rearrange onboard memory to free space for the new software, written in an antiquated language from 15 years ago, when ERS-2 was first designed.

The software was exhaustively tested on simulators before being uplinked to the satellite. Even then, they only dared run it in pieces, over the course of a week. Part of their design involved a device called the Digital Earth Sensor (DES), set to our planet's horizon for extremely basic positioning checks. But the engineers knew they could get a lot more precise data out of the DES than just the horizon line. The DES signal was cleaned up to filter out noise, and then used to estimate pitch and roll errors.

That still left the final yaw (or downward) pointing error, which could no longer be measured by the gyro-less spacecraft. The team realised they could check yaw drift themselves, by analysing Doppler frequency shifts in the ERS-2 radar instrument signals. They monitored ERS-2 over a 105-day 'shakedown cruise', totalling three 35-day repeat tracks over the Earth's surface. Recurring patterns of spacecraft 'depointing', caused mainly by terrestrial magnetic field variations as well as pressure from the solar wind, were rendered into a detailed model uplinked to the satellite. This enables depointing to be anticipated and compensated for.

The gyro-less technique should extend the lifespan of numerous other ESA missions, and preserves ERS-2 to operate with its scheduled successor Envisat and to provide wind measurement until Metop-1 takes over in 2003. esa



Ireland: Dublin Bay
Image taken by ERS-2 on 10 September 2001 at 11:19 GMT

Future engineers fly to Kourou

Life in the Universe, an event planned by the same organisations as last year's Physics on Stage, was another huge success. Students from all across Europe designed websites, wrote essays, performed scientific studies, created artwork, theatre plays and even musical compositions – all about life in the Universe in the widest sense. The final event, held at CERN in Geneva from 7 to 10 November, brought together the more than 200 finalists from 23 participating countries and science experts in search of extraterrestrial life. In a fair, in presentations and workshops the 14 to 18 year-olds presented their ideas and opinions – all of them extremely impressive and often innovative. The organisers CERN, ESA and ESO had originally planned to sponsor two first prizes for the best projects, but were so impressed with the quality and originality of the students' ideas that they spontaneously decided to offer four additional second prizes.

The winners are the Austrian team of Jan Stuller and Felix Ferdinand Mikl, who won a trip to ESA's Kourou Spaceport in French Guiana to see an Ariane-5 launch. Their project was a design proposal for a self-sustainable human settlement in space, called "Columbiat". The winners of the artistic category were Mihály Kristóf, Katalin Lövei and Adám Orbán from Hungary, with their imaginative board game "Entropoly". They won a trip to the European Southern Observatory's Paranal facility in Chile.

The participants from Portugal who won a second prize for their performance "Science Please!"

Second prizes were awarded to: Ricardo Moreno Luquero, Alberto Orejana Martin and Roberto Sanchez Garvin from Spain, for their project, 'Meteorites, Craters and Life in the Universe'; Edwin Kite from the United Kingdom for his investigation, 'Could Mars support advanced Life?'; Vitor Ferreira, Joao Dias, Cristiana Azevedo and Catia Lopes from Portugal for their theatrical performance, 'Science Please!', and Ivar Marthinusen from Norway for his essay 'The Caricon from Oxium'. esa

Glovebox to the States

The Microgravity Science Glovebox (MSG), one of the first ESA elements for conducting science on the International Space Station, has been shipped from the European Astium consortium in Bremen to NASA's Kennedy Space Center (KSC) in Florida

The MSG will enable astronauts on board the ISS to perform a wide variety of materials, combustion, fluids and bio-technology experiments and investigations in the microgravity environment. It is slated for launch in the mini pressurised logistic module in May 2002.

This science facility provides an enclosed and sealed work volume fitted with lighting, mechanical, electrical, data, gas and vacuum connections, and thermal control for the operation of experiments. The work volume is accessible through built-in gloves which isolate the experiment from the environment and the operator. The MSG is integrated into an International Standard Rack (ISPR) and can operate in open mode, with air circulating from the work volume to the Space Station cabin, or in closed mode, with air circulating within the MSG only. In addition, the MSG has the capability to maintain an inert atmosphere with dry nitrogen such that the oxygen volume is kept equal to or less than 10%.

The MSG facility was built for NASA for a projected operational use of ten years. It will be accommodated initially in the United States Laboratory (USLab) but could be moved later to ESA's Columbus Laboratory. ESA will have utilisation rights over this facility and will pre-screen European proposed experiments that could be accommodated by it.

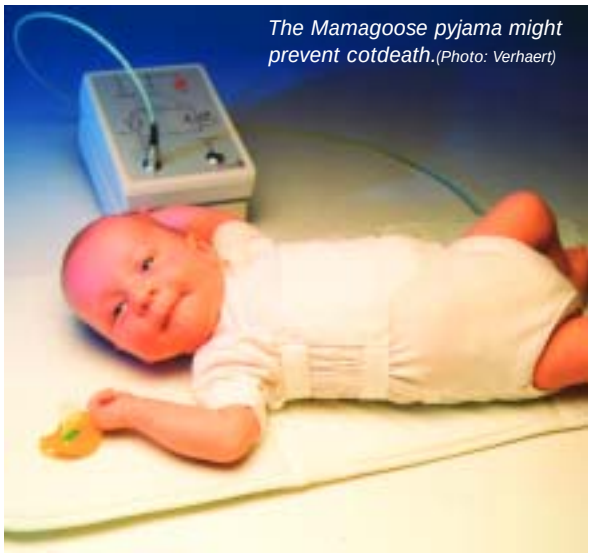
After arrival at KSC, the MSG will undergo a long series of tests on interfaces with the Space Station. If all goes according to plan, on 18 February 2002 the MSG will be installed in the mini pressurised logistic module and will be ready for its long operational life on board ISS. esa

Space research could save babies' lives

Technology used in space could help to prevent Sudden Infant Death Syndrome (SIDS), commonly known as 'cot death'. The Belgian company Verhaert Design and Development and the University of Brussels (ULB) have developed a new type of pyjamas that monitor babies during sleep.

In the United Kingdom, cot death affects around four out of every 10 000 healthy babies, 86% of whom are less than six months old, while in the United States more than 2500 babies die each year within the first 12 months of life from suspected SIDS.

The new pyjamas are very aptly called "Mamagoose", and they draw on technology used in two space applications: the analogue biomechanics recorder experiment and the respiratory inductive plethysmograph suit. This transfer of technology designed for space to Earth application is part of the ESA Technology Transfer Programme. The Mamagoose project is also partially financed by the German Space Agency and IWT, the Belgian institute for the promotion of scientific and technological research in industry.



The Mamagoose pyjama might prevent cotdeath.(Photo: Verhaert)

The Mamagoose pyjamas have five special sensors positioned over the breast and stomach: three to monitor the infant's heart beat and two to monitor respiration. This double sensor system guarantees a high level of measuring precision. The special sensors are actually built into the cloth and have no direct contact with the body, thus creating no discomfort for the baby.

The pyjamas are made of two parts: the first, which comes into direct contact with the baby, can be machine-washed and the second, which contains the sensor system, can be washed by hand. The pyjamas come in three sizes, are made of non-allergic material and have been especially designed to keep the sensors in place during use.

The control unit with alarm system is connected to the pyjamas and continuously monitors and processes the signals received from the five sensors. It is programmed with an alarm algorithm which scans the respiration pattern to detect unexpected and possibly dangerous situations. If found, an alarm system is activated. In addition, the selective memory records data for a certain period before and after the alarm to help physicians to make a diagnosis.

Mamagoose prototypes have been tested on many babies in different hospitals, environments and conditions. These include babies of various weights and sizes, when they are in different 'moods' such as calm, nervous or upset, and when they are sleeping in different positions. To date, the results have been extremely promising.

Verhaert will be responsible for producing Mamagoose clothing once the tests currently being carried out in Germany have been completed. The biomedical physics laboratory of ULB will be responsible for improving the processing algorithm and for providing paediatricians with feedback on the research results

According to Stefaan Devolder from Verhaert Design, the plan is to have the first Mamagoose products on the market within the next year, and Verhaert and ULB are already in negotiation with potential distributors interested in commercialising the product. Once in production, Mamagoose will be an important tool in increasing understanding of the cause of and in preventing cot deaths. esa

Simulation of a Manned Martian Mission in the Arctic Circle

The closest you can get to a Mars landscape down on Earth is on Devon Island in Canada. It isn't exactly a holiday resort, but a group of six scientists, engineers, space enthusiasts and journalists nevertheless decided to spend a week in the cold to simulate a Mars mission. Author Vladimir Pletser was one of them.

Devon Island is an uninhabited island in the Canadian province of Nunavut, at a latitude of 75 degrees North in the Arctic Circle. This island is as large as Sicily, and the Haughton Crater, a geological structure about 20 km in diameter, formed by the impact of a meteorite 23 millions of years ago, is its most impressive landmark. Devon Island's strange geology and ecosystem and the harsh climatic conditions make you think of a Martian environment, except for the presence of a breathable atmosphere. Polar bears and a few other arctic animals are the only sign of life on this island.

NASA took an interest in using this Mars analogy on Earth several years ago. Research programmes have been initiated by the NASA Ames Center and the SETI Institute under the umbrella of the NASA-Haughton Mars Project (HMP). Last year, The Mars Society, a privately funded non-profit organisation, joined the NASA-HMP to establish a Martian Habitat, the Flashline Mars Arctic Research Station (MARS), on the rim of the Haughton Crater.

In this framework, the Mars Society organised this summer an international simulation campaign of a Martian mission consisting of several human crews living and working in a confined environment. International crews of mixed gender and professional qualifications had the same tasks that would be on the to-do list of a Martian crew, including scientific field experiments. Operations were performed just like during a real mission to Mars, including delays in radio communications with the Mission Control Center (located in Denver, Colorado) and Extra-Vehicular Activities (EVA) with specially designed unpressurised suits.

Some 250 scientists, engineers and space enthusiasts answered the call for volunteer candidates issued in November 2000. Only ten candidates, including three Europeans, were selected to join scientists and engineers from The Mars Society, NASA-HMP and the SETI Institute. The author was selected to be a crew member in the second rotation from 10 to 17 July 2001.

The Flashline MARS Habitat with the ESA flag (Photo V. Pletser).

One of the objectives of future Mars missions is the search for water. Water on the surface of Mars exists as ice in the polar caps, but cannot exist in its liquid form due to the low atmospheric pressure. However, liquid water is suspected to exist under the surface, possibly in underground pockets or trapped in rocks. Detecting liquid water under the Martian surface at a depth accessible to a human crew would be important for two reasons. First, under the adage "Find the water, and you may find life", detecting liquid water would increase the chances of finding evidence of past or present life, possibly in a bacterial form somehow similar to terrestrial extremophile bacteria. Second, water sources close to the first Martian human settlements would help to sustain the presence and operations of human crews in terms of consumption and fuel generation.

One of the experiments during this simulation campaign was proposed by Dr Philippe Lognonné (Institut de Physique du Globe de Paris, IPGP, Institute of Geophysics of Paris), Dr Véronique Dehant (Royal Observatory of Belgium, ROB) and the author: "Subsurface Water Detection by Seismic Refraction". It aimed at assessing the feasibility of a human crew conducting an active seismology experiment to detect the presence of subsurface water. A line of 24 seismometer sensors was deployed in several directions on the surface of the edge of the Haughton Crater to record seismic signals generated by a mini-quake, similar to experiments conducted in the past on the Moon. The seismic instrumentation was provided by the IPGP. This experiment can be seen as a possible continuation of the future automatic Seismology and Gravimetry Experiment (SEIS) aiming at characterising the deep internal structure of Mars and its subsurface and searching for the presence of water. The SEIS experiment will be conducted by teams from IPGP, ETHZ (Switzerland), JPL (USA) and ROB scientists during the Netlander mission, a cooperative programme between France, Germany, Finland, Belgium and the USA, to be launched in 2007.

It took us two and a half days to reach the Canadian Arctic. The distance travelled within Canada from Edmonton to Resolute, the most northern Canadian city frequented by regular airlines, was greater than the transatlantic crossing. Upon arrival in Resolute on Wednesday 5 July in the early morning, we were amazed by the constant daylight and the apparent absence of vegetation and fauna. All human activities in the Arctic, also travelling, are very much conditioned by the ever-changing weather. The warm (5 to 10 degrees) sunny summer weather changed to snow, sleet and rain for the next three days, grounding the one plane that could fly to Devon Island. The weather eventually cleared up on Sunday

The purposes of The Mars Society are "to further the goal of the exploration and settlement of the Red Planet, by:
(1) broad public outreach to instil the vision of pioneering Mars;
(2) support of ever more aggressive government-funded Mars exploration programs around the world;
(3) conducting Mars exploration on a private basis."

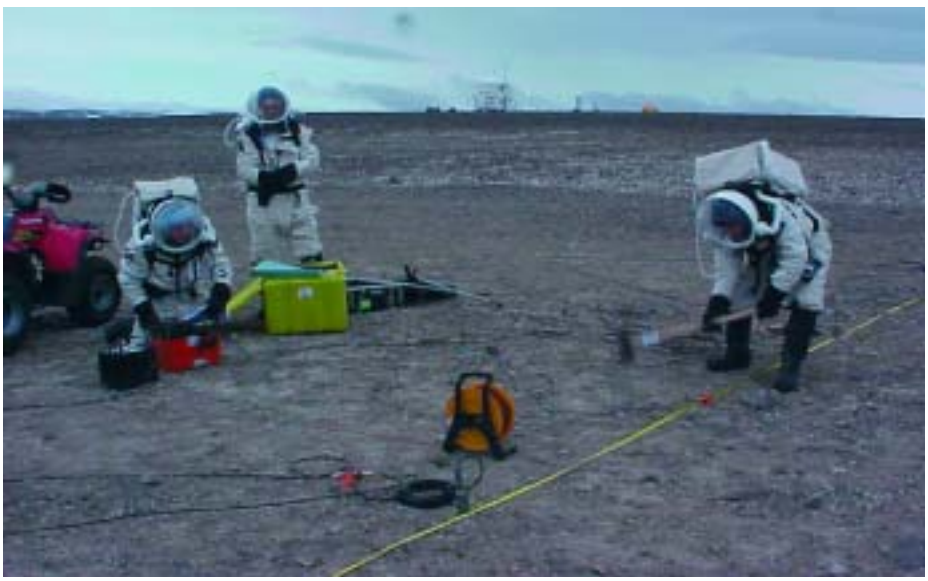
morning, allowing the crew gathered in Resolute to fly to Devon Island. After landing on a muddy track in front of the NASA-HMP base camp, one of the first things we learned was the use of the camp shotguns, handy to know in case polar bears get too close, and riding the four wheel ATVs (All Terrain Vehicles) used for transportation and expeditions outside the base camp. The base camp consisted of three large tents and the "tented village", made of individual sleeping tents where thick sleeping bags provided a warm welcome. One of the large tents was used as kitchen, mess and warm gathering place; the second was used as a working area by Mars Project researchers involved in field work. The third large tent served as a TV studio for Discovery Channel crews following the simulation campaign. All waste was collected and returned by plane to Resolute in order to preserve as far as possible the pristine conditions of this desert island.

After two days of exploring the area, verifying the scientific equipment and conducting a dry run with the seismic experiment, the second rotation crew was ready to enter the Flashline MARS Habitat, on which the ESA flag was mounted. The Habitat is a cylindrical building with two floors, approximately 6 m in diameter and 6 m high, with two doors. The first floor accommodates the working and living area, with a kitchen and six small rooms just large enough for a sleeping bag. The ground floor is made up of a laboratory and working area, an EVA preparation room, two unpressurised airlocks, a small bathroom, and an incinerator toilet. Problems in the setting-up of satellite links did not allow the delayed communications with the Mission Control Center in Denver. Contact with the outside world was only possible by radio with the base camp and by e-mail with the Control Center and the rest of the world.

Our crew of six consisted of Robert Zubrin (Mars Society President and Simulation Commander), William Clancey (Computer Scientist, NASA-Ames), Charles Cockel (Biologist, British Antarctic Survey), Stephen Braham (Simulation Chief Engineer, Simon Fraser University, Canada), Katy Quinn (Geologist, MIT, Boston), and myself. The scientific programme included several field expeditions under simulated EVA conditions for biology and geophysics experiments and participation as subjects in various psychology and human factors investigations.

We conducted our first, two-hour EVA on Wednesday, 11 July, to collect rocks in search of fossils and other biological evidence of past life. During the second, four-hour EVA on Thursday, 12 July, a three-member crew conducted the seismic experiment in rough rain and wind conditions. The 24 sensor line was deployed in the Haynes Ridge plain in front of the Flashline MARS Habitat and we made three tests with mini-quakes generated by sledge hammer blows. The third, three-hour EVA took place on Saturday, 14 July, to deploy radio-biology dosimeters inside the Haughton Crater. During the EVA we also visited other potential locations for deployment of the seismic experiment inside the crater. The fourth, two-and a half-hour EVA expedition on Sunday, 15 July, was a scouting EVA to find other locations to deploy the seismic experiment in the Von Braun Planitia, a few kilometres away from the Mars Habitat and the NASA-HMP base camp. After assessing the merits and disadvantages of several locations visited, taking into account the seismic interest, the access possibilities by ATVs and the terrain conditions – which were rather muddy in some places due to the severe rains of previous days – we decided that the fifth EVA of Monday, 16 July, would take place in the Haughton Crater. It would be the most ambitious EVA planned, with deployment of the sensor line in two perpendicular directions and six tests, including sledge hammer blows and thumper gun shots at each of the test locations. The four-member EVA crew left for the crater in the morning. When we were inside the Haughton crater, the trailer with the 130 kg instrumentation got stuck in the Arctic mud to a depth of half a metre. We lost more than one hour trying to pull the trailer out. After this, we were exhausted and the terrain conditions had become even worse, so we decided to abort the EVA and to return to the Habitat. On the way back, the instrumentation trailer got stuck a second time in the mud and was salvaged again only after quite some time. This EVA eventually lasted three and a half hours and was concluded, alas, without any results. The sixth and last EVA took place on Tuesday, 17 July, and lasted two and a half hours. A three-person crew deployed the seismic experiment in the Haynes Ridge plain, at the same location as the second EVA, allowing a complete three-dimensional characterisation of its underground structure.

We could not find any water under the Haynes Ridge ground despite the humid conditions at the surface. However, a first result analysis showed that the average signal velocity was 2600 m/s, consistent with Calcium Carbonate and Dolomite, commonly found in this area. Other results of this campaign simulation concerned the ergonomics of the equipment used, which was not initially adapted for use with EVA suits and required the use of extra tools like screwdrivers and pliers to activate switches, turn knobs and push on computer keyboards. We noticed as well



Geologist K. Quinn using the sledge hammer in the rain during the second EVA on 12 July, while V. Pletser operates the IPGP acquisition system under the supervision of R. Zubrin; the MARS Habitat is visible in the background (Photo V. Pletser).

that conducting the seismic experiment under EVA conditions was physically very demanding. This has a direct consequence on the choice of conditions for the interplanetary travel between Earth and Mars that would last several months. An interplanetary flight under microgravity conditions would have well-known debilitating effects on the musculo-skeletal system to a point where a crew, after landing on Mars, could no longer carry out physically demanding activities. Therefore, an Earth-Mars mission would benefit from either effective counter-measures during a 0g flight or an artificial gravity system in the design of the interplanetary spacecraft.
In view of the success of this first simulation campaign, the Mars Society intends to conduct further simulation campaigns in the coming years and to install other Mars Habitats in remote locations on Earth, one of them also planned in Europe (Iceland or Greenland). Several ESA project teams have also expressed their interest in conducting tests in similar extreme polar environments. So in small steps, Mars is getting closer.

R. Zubrin and V. Pletser pushing the instrumentation trailer out of the mud in the Haughton Crater during the fifth EVA on 16 July (Photo Discovery Channel).

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ESA Directorate of Manned Space and Microgravity

Further information can be found at:
http://www.arctic-mars.org
http://arctic.marssociety.org
http://www.arctic-mars.org/team/2000/index.htm