Spring 2011 Issue 31

space:uk

Alone:

Mars experiment in Antarctica

Seeing stars with the World's largest camera

Lifeline from space when disaster strikes

Plus: The tiny satellite with big ambitions, broadband from space, ice mission success and what now for the UK's new astronaut?

UK SPACE AGENCY

CONTENTS

Front cover image: Teacher Tim Miall's isolated tent in Antarctica

Credit: Tim Miall

FROM THE EDITOR

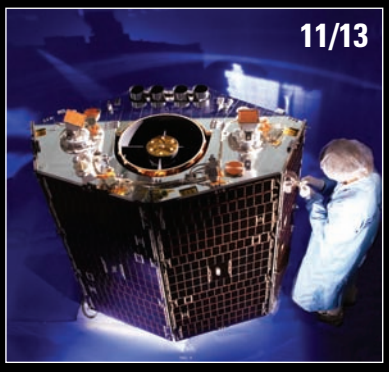
The UK space industry must be one of the country's best-kept secrets. When someone suggests to me that the UK's not involved in space, I can't stop myself enthusing about the spacecraft we build or missions we lead. The satellites that help rescue efforts following disasters or provide broadband and satellite navigation services. A British company is even building the World's largest space camera. People sometimes start backing away as I explain all this and it's perhaps why I don't get invited to many parties.

The establishment of the new UK Space Agency has produced a genuinely exciting time for the space industry. Despite the recession, it shows every sign of flourishing. You can read about the UK's involvement in a number of missions in this latest issue of *space:uk*. We also find out why a teacher has been stuck on his own, in a tent, in Antarctica (and what it's got to do with space) and discover what can you eat in orbit.

So, when you've finished reading this issue, I hope you'll agree with me that the UK does 'do' space, and it does it very well.

Richard Hollingham
Editor

Credit: ESA, NASA



Credit: SSTL

The UK Space Agency is an agency of the Department for Business, Innovation and Skills

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NEWS

BROADER BROADBAND

Credit: Arianespace

The launch of Hylas-1

Thousands of people living in Europe's most remote rural communities will soon have access to broadband thanks to a new UK-built satellite, Hylas-1. Launched on a European Ariane 5 rocket from French Guiana in November, the satellite is now undergoing a series of orbital tests before it starts operating commercially.

Hylas-1 has been partly funded by the UK Space Agency and built by Astrium UK for Avanti Communications. "Europe's first broadband satellite will begin to bridge the digital divide," said Avanti Communications' Chief Executive, David Williams. "In doing so, it will create new wealth and employment in the digital economy."

Hylas-1 will automatically allocate power and bandwidth to different regions within its footprint, reacting to dips and peaks in demand. This means that up to 300,000 users across Europe can be online via Hylas at the same time.

"Bringing innovative ideas to life requires the right mix of specialist knowledge, public support and opportunity," said Science Minister David Willetts, who also welcomed the launch. "Hylas is a great example of how strategic investment in space technology can yield benefits for the wider economy."

Avanti is currently developing a second satellite, Hylas-2, which is due for launch in Spring 2012. Once operational, the combined capacity of both satellites will be one million customers.

EXPLORING EARTH

After a year in space, CryoSat – Europe's first mission to study our planet's ice – is performing well and sending back useful scientific information. The satellite uses radar to bounce signals off the Earth's polar regions and an international, UK-led, science team is using this data to produce a 3D view of ice cover and provide new insights into our changing climate.

"We have high hopes that CryoSat is going to provide us with a higher resolution picture of the ice surface than we can see with current instruments," said Seymour Laxon, head of the Centre for Polar Observation and Modelling at University College London (UCL). A team from UCL is also about to go the Arctic to verify the accuracy of the satellite measurements.

CryoSat is a European Space Agency (ESA) Earth Explorer mission. These also include the GOCE and SMOS satellites, both launched in 2009 and with significant UK involvement.

Data from SMOS (Soil Moisture and Ocean Salinity) recently helped produce a map showing areas of soil saturation during the floods in Australia. Meanwhile, its salinity measurements are providing an insight into ocean circulation. "Our achievements are twofold," said Meric Srokosz, from the National Oceanography Centre, Southampton. "We have measured salinity from space for the first time and we are now able to start mapping salinity on a global scale."

GOCE (Gravity field and steady-state Ocean Circulation Explorer) is mapping variations in the Earth's gravitational field. Oceanographers are now using the new and improved gravity field measurements to determine ocean currents in unprecedented detail.

Credit: Hollingham/SAMS

CryoSat is measuring the Earth's ice cover

NEWS

WELCOME

David Williams (Acting) Chief Executive of the UK Space Agency, talks about recent highlights and looks forward to the months ahead…

Welcome to the spring 2011 edition of *space:uk*. In the last issue I explained the thinking behind the creation of the UK Space Agency and interest in the Agency remains high across Government, industry and with the public. The team continues working hard towards launching, from April 2011, as a full executive agency of the Department for Business, Innovation and Skills.

Last autumn, the newly convened Parliamentary Science and Technology Committee held an evidence session to look at what we are doing. It concluded that space has an important role to play in the economy, in science, and in encouraging children to seek careers in science and engineering. The importance of space to the economy was reinforced in the 2010 'Size and Health of the UK Space Industry' report. The British space industry grew by nearly 8% through the recession and is now worth over £7.5 billion to the economy.

Broadcasting continues to be the primary application for space technology but other areas are developing, including satellite broadband. I attended the launch event in London last November to watch as Hylas-1 was launched on an Ariane 5 rocket. Partly funded by the UK Space Agency and built by Astrium UK for Avanti, this is the first dedicated broadband satellite to be launched outside the United States. Hylas-1 is an excellent example of how strategic investment in space technology can yield benefits for the wider economy.

Credit: BIS

"The British space industry grew by nearly 8% through the recession"

David Williams,
Chief Executive (Acting)
of the UK Space Agency

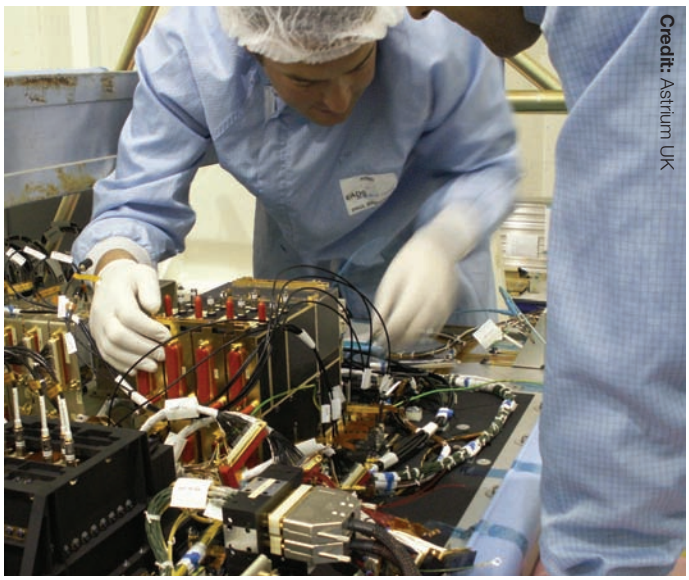
The satellite has the capability to fill the small gaps in rural and urban areas where it is difficult to get reasonable fixed cable broadband. It will give many homes and businesses across the UK access to broadband for the first time.

Someone who has blazed a trail in his own science and engineering career is the UK's Tim Peake who graduated from basic astronaut training with the European Space Agency (ESA) in November. Selected for training in 2009, Tim was selected out of around 8,000 other applicants and is a fantastic ambassador for the UK and an inspiration to children and adults alike. Tim is certainly a popular topic of conversation when the Agency team visits schools to talk about space, and we will follow his progress closely as he embarks on the next stage of training.

On the science front, the Herschel and Planck satellites are now giving a new insight to the origins of the Universe, and a UK scientist also leads the science team using the CryoSat satellite to measure and monitor the status of the World's ice sheets.

The economy and education will be two of our major areas of focus over the coming months and will be at the core of the inaugural UK Space Conference, which takes place in July. You can follow progress on this and all the other stories at our new website:

www.bis.gov.uk/ukspaceagency



Credit: Astrium UK

Putting the finishing touches to Hylas-1

NEWS

SPACE AGENCY: UPDATE

In April the UK Space Agency becomes an executive agency of the Department for Business, Innovation and Skills. Over the past year, the UK Space Agency has operated as a shadow agency to consolidate the space-focused threads from former British National Space Centre partners.

The UK Space Agency is taking over responsibility for the majority of the UK's commitment to space science and exploration from the Science and Technology Facilities Council (STFC). Scientific advancement in space technologies and exploration is one of the Agency's prime responsibilities and ensuring that the programme teams are properly supported has been a priority.

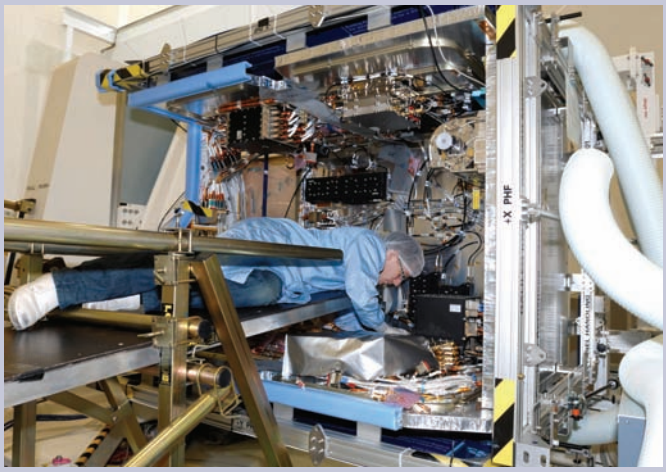
Another Agency priority will be to better understand our own planet from space, through Earth observation spacecraft such as Envisat, GOCE and CryoSat. The UK's programme in this area has been managed by the Natural Environment Research Council (NERC), and this is also transferring to the UK Space Agency.

Credit: ESA

Envisat image of the UK and Ireland

The Agency carries on working – as it has done over the last year – to build links between industry and the research community and will continue working with other UK organisations such as the Technology Strategy Board, the Research Councils, and the International Space Innovation Centre, as well as the Met Office and overseas agencies such as ESA and NASA.

Once the transfer of resources is complete, the Agency's efforts will be targeted at areas that have the greatest potential for delivering economic benefits, scientific excellence and national security. The real strength of the Agency will be to provide a single voice to link investment in long-term basic research and in near-term applications; harnessing the skills and experience of universities, national laboratories and industry to grow a stronger UK capability in space.

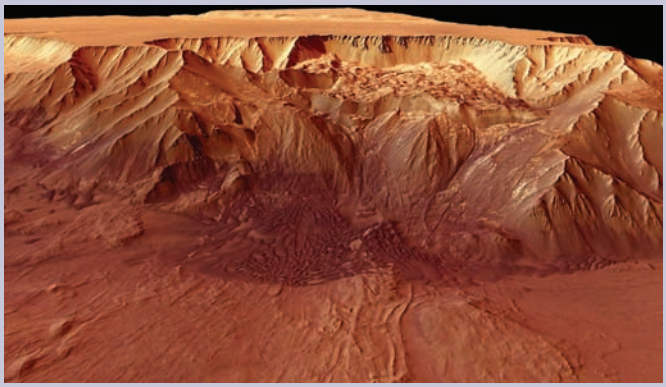


Credit: Astrium UK

One of the new Galileo satellites under construction at Astrium UK

During these difficult economic times, the principal driver of the UK Space Agency is economic growth – growth through export and innovation, and supporting science as an enabler for growth. It will also seek out new opportunities for UK involvement across the sector and will help to raise the profile of space across the Government, to deliver shared services more cost-effectively.

Perhaps most importantly, the Agency will provide inspiration and discovery through its involvement in programmes that explore the Universe and study planet Earth. For the next generation, the growth of space in the UK will create opportunities for rewarding careers and open students' imaginations to the exciting possibilities of tomorrow.



Credit: ESA

Mars Express took this picture of Melas Chasma, part of the huge Valles Marineris rift valley on Mars

NEWS

NEWS IN BRIEF

UK Space Conference

A major conference bringing together space scientists, industry and Government is being held in the UK this summer. Running from 4-5 July, the 2011 UK Space Conference will highlight connections between the space sector and other areas of the UK economy. The event will provide a platform for policy announcements and the latest innovations and space science research. Students interested in space-related careers will also have the opportunity to meet representatives from the UK space industry. To register, visit the UK Space Agency website.

Baking Bepi

Crucial components for an international mission to Mercury have been 'baked' in a special testing chamber to simulate the harsh conditions the spacecraft will eventually have to face. BepiColombo is being led by ESA in partnership with the Japanese space agency and will be only the third spacecraft to visit Mercury in the history of space exploration. The spacecraft will have to endure intense sunlight and temperatures of up to 350°C.

Testing BepiColombo's Mercury Magnetospheric Orbiter

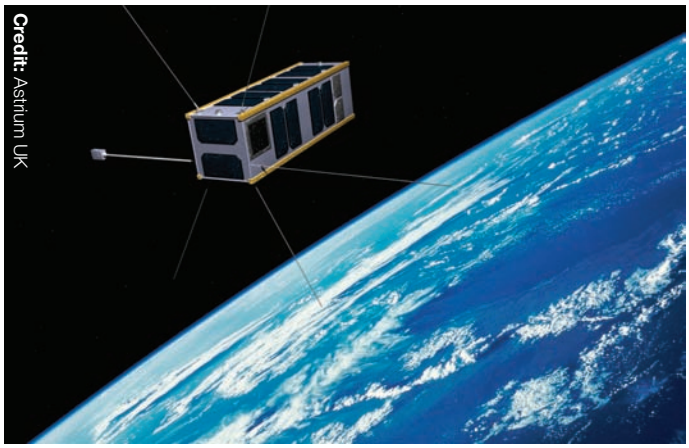
BepiColombo has significant UK involvement, with satellite manufacturer Astrium responsible for many of the key elements of the spacecraft.

Docking success

Europe's second cargo spacecraft has docked successfully with the International Space Station (ISS). The 20 tonne unmanned Automated Transfer Vehicle (ATV), which brought supplies to the station, is equipped with docking sensors built by UK company e2v. The ATV will remain attached to the ISS until June where it will serve as an additional module for the crew. Its engines will be used to boost the entire complex to a higher orbit.

ESA astronaut Paolo Nespoli and his colleague Aleksandr Kaleri getting ready for the docking of the ATV

BIG PLANS FOR TINY SATELLITES



Cubesats are around the size of a shoebox

A typical satellite is complex, bulky and expensive but a national challenge is underway to make them simple, small and cheap. Cubesats are so small that they are about the size of a shoebox, weigh some four kilograms and cost only a few thousand pounds to build.

The UK is already a leader in small satellites but Cubesats take the concept even further. Some 30 Cubesats are currently in orbit and now a pilot mission, called UKube-1 (UK Universal Bus Experiment 1), is underway to examine the benefits of a national Cubesat programme. "These satellites give you the opportunity to have fast access to space for new research at low risk compared to traditional satellites," UKube Programme Manager Ronan Wall told *space:uk*. "They're a playground for innovation, if you've got an idea they offer an ideal way of testing it."

This pilot project is supported by the UK Space Agency and is based around a satellite developed by Glasgow company, Clyde Space. Academic research groups and the space industry have been encouraged to come up with ideas for satellite payloads such as a scientific experiment or instrument. The winners of the competition, due to be announced in March, get to fly their payloads in space. If a national Cubesat programme is then established, the aim is to include students in some of the projects – enabling them to be involved in the design and construction of real space missions.

The final UKube-1 satellite will be 'piggybacked' on the launch of a larger satellite in 2012 and Wall said he was enthusiastic about the concept: "Cubesats are fast and cheap ways of demonstrating technology, investigating science and performing education outreach – why wouldn't you want to build them?"

NEWS

WHAT NEXT FOR UK ASTRONAUT?

The UK's newly qualified ESA astronaut, Tim Peake, has been talking to *space:uk* about his role now he's graduated. Peake admitted that it will probably be some years before he gets to fly in space but said he has plenty to do in the meantime: "Since graduating in November, life has not become any quieter!"

Peake told *space:uk* that he now has three main tasks: to train as a Eurocom – the person who communicates with astronauts on board the International Space Station (ISS); to help teach ground and flight crew about working as a team; and to provide astronaut support to ESA's medical division.

"We all felt that our graduation was not just a personal achievement but also an enormous accomplishment for the European Astronaut Centre as the only ISS partners outside of America and Russia to have completed their own astronaut basic training," said Peake. "The benefit now is that we have the opportunity to put all of that training to good use, working alongside our colleagues who have such diverse and interesting areas of expertise."

So when will he get a space mission? "It could be a long wait," conceded the former helicopter test pilot. "The good news is that there are plenty of interesting and exciting projects within ESA where I can use my previous skills in addition to those learnt during basic training, to good effect."

"The training never really stops…I don't think I'll get bored!"

Credit: ESA/Crobu

Tim Peake during his survival training in Sardinia

TELESCOPE TEST

Testing is well underway on a UK-built camera for Hubble's successor: the James Webb Space Telescope. The sophisticated MIRI instrument, a key component of the new telescope, is designed to investigate the origin and evolution of galaxies, stars and planetary systems.

The tests, at the Science and Technology Facility Council's Rutherford Appleton Laboratory in Oxfordshire, involve subjecting MIRI to the sorts of conditions it will face during launch and orbit. The instrument must also meet its targets for scientific performance.

"I am absolutely delighted with the progress we have made," said MIRI's Lead Investigator, Gillian Wright, from the UK Astronomy Technology Centre in Edinburgh.

MIRI passed its vibration tests after being subjected to the equivalent of 80 times the force of gravity. "Everyone on the team is really pleased," said Wright, "as it shows our instrument will be able to withstand the forces during launch."

Credit: NASA

The James Webb Space Telescope will have 18 of these mirrors

The next phase – the cryotest - involves cooling the instrument to its operating temperature of just seven degrees above absolute zero (7 Kelvin) and giving it simulated stars to observe. "The cryotest campaign is a very exciting time as we will start to learn how to really use the instrument for science."

NEWS

NEWS IN BRIEF

Help from space

A global agreement that uses satellites to help respond to disasters is due to be led by the UK. In times of emergency, the International Charter Space and Major Disasters can be triggered by governments or the United Nations to deliver data from satellites, for free, to those affected by natural or man-made disasters. Member nations take it in turns to lead the organisation. "The Charter has uniquely filled a need," said Alice Bunn, Assistant Director of Earth Observation for the UK Space Agency. "We are really looking forward to leading the Charter," she said. **See feature on pages 11-13**

Credit: clockworkremovals

The Charter was activated to help with the rescue efforts following February's earthquake in Christchurch, New Zealand

Hi-tech space centre for Leicester

Universities and Science Minister, David Willets, has officially opened a new space research facility in Leicester. The buildings at the Space Research Centre include five new state-of-the-art laboratories for Earth Observation science, gamma-ray astronomy and development of detectors and electronics. A Space Ideas Hub will also operate from the facility, bringing space scientists and engineers together with businesses.

Comet mission okay

After a brief scare, ESA's Rosetta spacecraft has now completed its final manoeuvres to send it on its way to rendezvous with a comet. On 18 January, while its thrusters were operating, it unexpectedly switched to safe mode – an automatic reset of the spacecraft. After several days work, the flight operations team managed to get it on its way again. Rosetta will shortly go into 'hibernation' before its arrival at comet 67P/Churyumov-Gerasimenko in 2014. Rosetta comprises an orbiter and a small lander, which will anchor itself onto the comet's icy, dusty surface. One of the key instruments on board was built in the UK.

SEEING THE BIG PICTURE

Two ESA space telescopes, both benefiting from UK scientific and industrial involvement, are producing exciting insights into the nature of our Universe.

The Herschel Space Telescope is the largest telescope ever launched into space. By studying distant galaxies as they formed stars, it recently measured how much dark matter is needed to help a galaxy form – about 300 billion times the mass of our Sun. The discovery was made by analysing images from the UK-led SPIRE (Spectral and Photometric Imaging Receiver) instrument. SPIRE's Principal Investigator, Matt Griffin from Cardiff University, said: "This is an important breakthrough in our understanding of mysterious dark matter and how it has influenced the birth and growth of galaxies like our own."

The Planck Surveyor is surveying the skies at longer wavelengths of light to observe the Cosmic Background Radiation left over from the Big Bang. In January, Planck's first scientific results were released at a major science conference in Paris. This allowed scientists to begin examining the coldest and furthest reaches of our Universe and 20 previously unknown clusters of galaxies.

For more on Herschel and Planck, see our pull-out poster.

Credit: ESA

The UK-led SPIRE instrument observed an area of the sky called the Lockman Hole in the northern constellation of Ursa Major, The Great Bear. Almost every dot is an entire galaxy, each containing billions of stars

NEWS

SPACE FOR INNOVATION

The International Space Innovation Centre (ISIC) is due to start operations in April at the heart of a 'cluster' of space-related activities at the Harwell Oxford Science and Innovation campus. The Centre will bring together industry, national laboratories, international space agencies and Government to maximise the benefits from space technology. ISIC will reinforce the UK's position and spearhead national growth in the global space market.

"Establishing a centre like ISIC as part of the Harwell space cluster can only help strengthen the thriving space sector in the UK," said Minister of State for Universities and Science, David Willetts. "Bringing together vital components of Earth observation, security and resilience and space science know-how will make it easier for small companies to grow more quickly and help manifest and drive innovative ideas."

ISIC will complement the work at Harwell of the Science and Technology Facilities Council's Rutherford Appleton Laboratory and ESA's new UK office, including its Business Incubator Centre.

"In the UK, academia and industry are working together productively, rather than as separate elements," said ESA Director of Science and Robotic Exploration, David Southwood. "We're setting up here to learn how things are done in the UK and to spread that across Europe."

Credit: STFC

TEST AHEAD FOR UK'S SKYLON

Crucial tests of key components for a UK spaceplane are due to take place this summer. The unmanned Skylon system is being developed to carry more than 15 tonnes into orbit and take off and land using a traditional runway. The spaceplane is designed by Reaction Engines in Oxfordshire with around 20 per cent of the financial backing coming from the UK Space Agency and ESA.

A workshop was held in September, bringing together some 100 experts from around the World to review progress so far and scrutinise the technical and economic case for the project. Although the final report is yet to be published, the review is considered to have been very successful.

Credit: Reaction Engines Limited

Skylon in orbit

Reaction Engines' Managing Director, Alan Bond said: "It was a frightening prospect having so many experts review our work in such detail but we are proud that Skylon came through with flying colours and was shown to be a technical and economically viable route to a reusable fully commercial launch system."

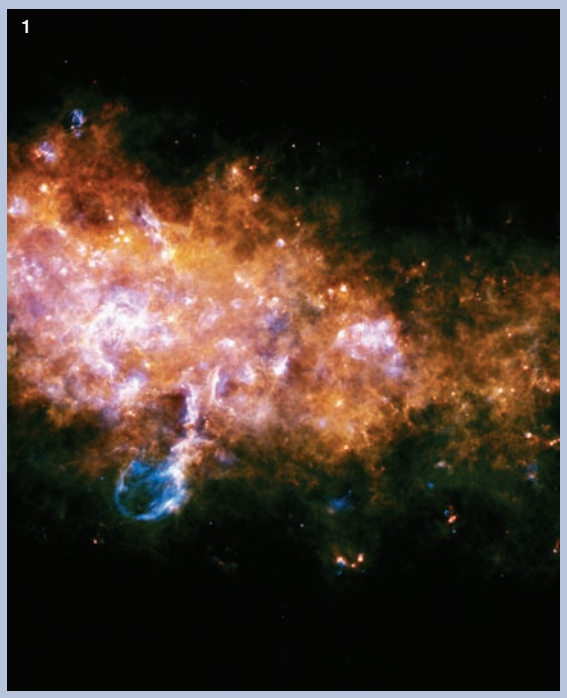
This summer tests are due to be carried out on the air-breathing engines' high performance heat exchangers and other crucial engine technologies. If successful, it's hoped the project will attract further funding to make Skylon a reality.

Seeing Stars

Imagine being able to pinpoint the exact location of more than a billion stars, writes Sue Nelson. By gathering information about these and any other stellar objects nearby, it would result in the most accurate three-dimensional map of the Milky Way ever seen and improve our understanding of the Galaxy.

“It will find oodles of new planetary systems,”

Gerry Gilmore, Cambridge University



The European Space Agency’s (ESA) Gaia mission is nothing short of ambitious and UK space scientists and engineers are at the heart of its endeavours – from engineering work on the spacecraft’s propulsion, electronics and electrical systems, to designing the crucial sensors that detect the starlight.

The high-resolution survey will give the chemical elements, ages, speeds, masses and orbits for hundreds of millions of stars and other celestial objects to help determine the composition, formation and evolution of the Milky Way.

“Gaia will revolutionise studies of galaxies, supernovae, planets, asteroids, quasi stellar objects and active galactic nuclei,” says Gerry Gilmore from Cambridge University’s Institute of Astronomy. “It will find oodles of new planetary systems and will tell us, for the first time, how massive they are.”

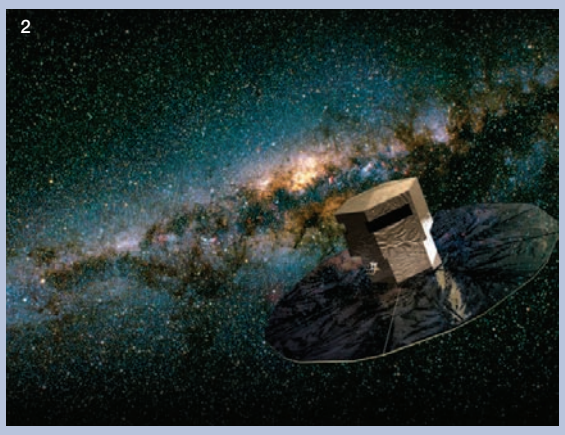
Gilmore, a member of the original team that proposed the mission, is understandably excited. “Most of all, also for the first time, Gaia will measure how things move with accuracy,” he adds. “This is unique. From movements we derive gravity and dark mass. So Gaia will not only measure what we can see, it measures everything else, too.”

The Gaia spacecraft, due for launch in 2013, will be able to see objects 400,000 times fainter than those seen with the naked eye. Its payload includes two optical telescopes and instruments that will measure and analyse the light from stars, minor planets, variable stars and supernovae.

“It’ll be the biggest camera in space,” says Jon Kemp from e2v, the Chelmsford company supplying the detectors for the mission. Gaia will carry an array of one hundred and six (Charged Couple Devices) CCDs – around twenty times more than normal missions. These CCDs detect light and convert it into electrical signals. “Our CCDs are also onboard Hubble and many other missions.”

Each individual detector, with its blue anti-reflective hafnium oxide coating, is only slightly larger than a matchbox. “Each sensor will take pictures of several stars,” says Kemp. “As a star moves across an image area you can gather signals from its first location, and then the second and third, without losing any signal integrity.”

Once known as the English Electric Valve Company, e2v has a long and illustrious history with technology. Its ‘image orthicons’ were used to film the Queen’s Coronation in 1953. It now specialises in the medical and space science industries, first working with ESA on the Envisat mission, and since providing detectors for the STEREO spacecraft, the Mars Reconnaissance Orbiter, numerous ground-based telescopes and ESA’s Automated Transfer Vehicle recently launched to the International Space Station.



Main image: New stars are being born all the time
Credit: ESA/NASA

1. This Herschel image shows the formation of hundreds of new stars
Credit: ESA

2. Gaia, seen here with its sunshield deployed, will map millions of stars in our Galaxy
Credit: ESA

3. Gaia will also be on the lookout for killer asteroids
Credit: ESA

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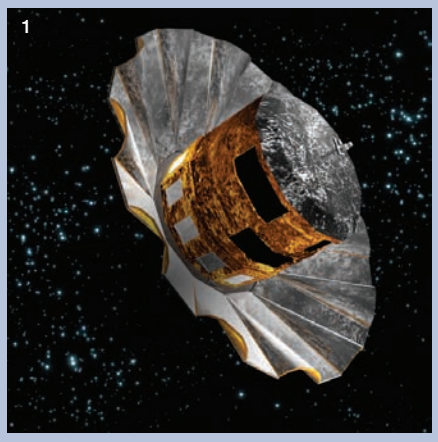
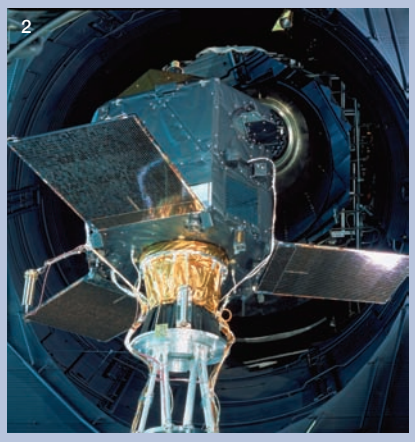
Seeing Stars
continued





1. The Gaia spacecraft with sunshield deployed
Credit: ESA

2. The 1.4-ton European Hipparcos satellite operated in space from 1989 to 1993. It's shown here being tested, prior to launch
Credit: ESA

3. The Kepler Space Telescope is prepared for launch
Credit: NASA

"NASA's Kepler has the biggest detector array in space," adds Kemp. "Gaia's will trump that."

All 106 detectors, assembled and packaged in five clean rooms in Chelmsford, have now been delivered to University College London's Mullard Space Science Laboratory, which is making the electronics to drive the devices. Other parts of the spacecraft are also made in the UK. Astrium's Portsmouth team worked on the cold gas micropropulsion system. "The electrical stuff – the clever bit – was led from engineers here in Stevenage," says Astrium's Ralph Cordey mischievously. "That governs the computing, the data handling, the attitude and orbit control system, the control of the electrical power and the engineering for the communications link back to Earth."

"Gaia may even save the World!"
Gerry Gilmore

The data handling system is built around an extremely powerful piece of kit called a video processing unit. "It's essentially a bespoke computer," Cordey says, "which does all the image pre-processing of stars on board the spacecraft in order to convert the billion pixels - a thousand times more than an average digital camera – into a manageable volume. We have to get all the data from Gaia into a communications link that uses a bandwidth of between 4 and 8 mega bits per second, similar to what people use on home broadband."

As UK Principal Investigator for the Gaia data processing consortium, Gerry Gilmore will be in charge of processing and delivering all this real time science data. "It's a huge software task," he admits. "Bigger than anything comparable in astronomy yet attempted."

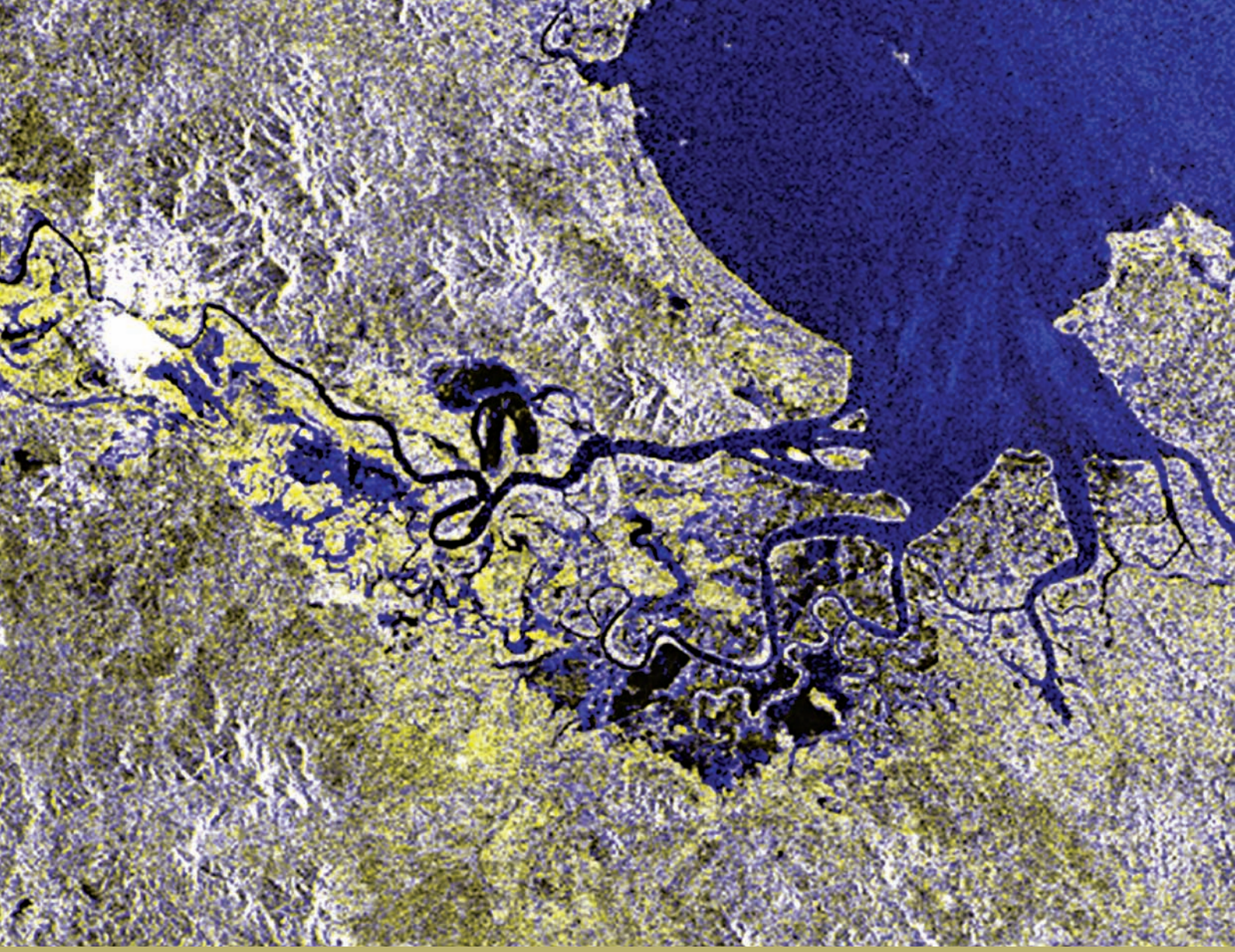
The processing centre is based in Cambridge and currently involves 400 people across Europe. The team is experienced, having processed data from Gaia's predecessor, Hipparcos. This was the first spacecraft dedicated to measuring the positions and motions of stars and set the stage for Gaia, which will produce 10,000 times more data.

"The UK is not only getting a lot of science out of Gaia, but UK PLC is making a substantial return of high-tech high-interest work," says Gilmore. "It's triggering future improved products, profits and new future contracts."

The spacecraft is currently being put together in Toulouse. It passed a critical design review in October and has now started its flight model assembly, integration and testing. "It's a very exciting stage," enthuses Astrium UK's Cordey. "It's not a paper spacecraft any more it's really coming together to make a spacecraft that will go into space."

According to Gerry Gilmore, the spacecraft could also be a potential lifesaver. "It is the only way to find the seriously dangerous killer asteroids which orbit near the Sun and so are invisible to us, being in the daytime sky," he says. "Gaia may even save the World!"

For an insight into working at e2v, see the Career File on page 21.



When disaster strikes

continues >

Richard Hollingham reports on how satellites have transformed the way the world responds to major disasters:

Main image: Envisat image showing the extent of flooding in Queensland
Credit: ESA

When disaster strikes
continued

1. UK DMC2 being prepared for launch
Credit: SSTL

Toowoomba, Queensland, January 2011… A wall of water sweeps a car along what was once a road. The last remaining residents cling to the sloping roofs of their homes – the waves lapping at the windows. From the air, the houses look like islands in a muddy sea. But it's only when you look at the area from space, that the full extent of the disaster becomes apparent, with vast areas of the country – (the size of France and Germany put together) - under water.

It's estimated that 30 people lost their lives in the recent Australian floods. Tens of thousands had their homes, possessions, crops and livestock destroyed. It was just one of seven major global disasters in the first six weeks of 2011. The rest of the list makes equally sombre reading: floods in Brazil and Mozambique, an earthquake in Pakistan, landslides in Turkey, the worst snow in a century in Korea and, after the floods, a cyclone in Australia. Space technology can't prevent these disasters but satellites can help the authorities and rescue agencies get help to where it's needed most.

"We have achieved a great deal during the past ten years,"
Dave Hodgson

International Charter

When a country is affected by disaster it can call on the combined resources of most of the World's space agencies to provide, for free, images of the affected area. This is done through the International Charter, Space and Major Disasters. Since it was set up in 1999, the Charter has helped in more than 300 disasters for more than 100 countries.

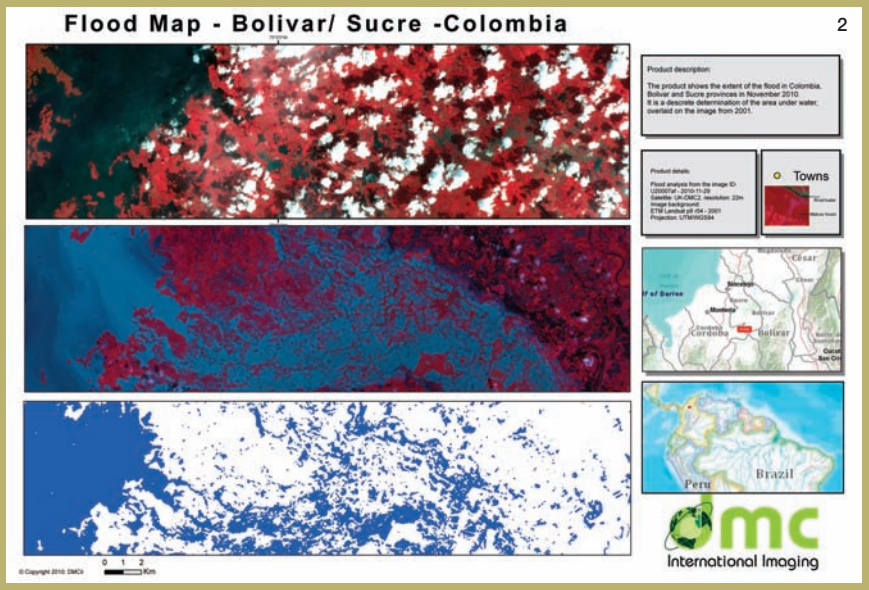
"Satellite images can make a tremendous difference in the immediate aftermath of an emergency," says Alice Bunn, Assistant Director of Earth Observation for the UK Space Agency. "Without the Charter it could have been many days before a satellite was able to provide the images you need but by using the Charter you have access to a vast range of satellite resources."

Pictures taken from satellites can be used by governments to assess the extent of damage or by aid agencies to decide where to target their resources. Radar images can see through fire or smoke, and other sensors can even monitor the spread of pollution. When the information from satellites is combined into charts and maps, it becomes even more useful to rescue teams on the ground.

Disaster satellites

Although the Charter can call on images from a wide range of satellites, six countries in particular have together created a system specifically designed to respond to disasters. Built in the UK by Surrey Satellite Technology Limited, the Disaster Monitoring Constellation (DMC) can acquire detailed images of anywhere on Earth at least once a day. The constellation celebrates its tenth anniversary this year and currently comprises satellites operated by the UK, Algeria, China, Nigeria and Spain. The DMC satellite operated by the sixth member of the consortium, Turkey, is no longer operational.

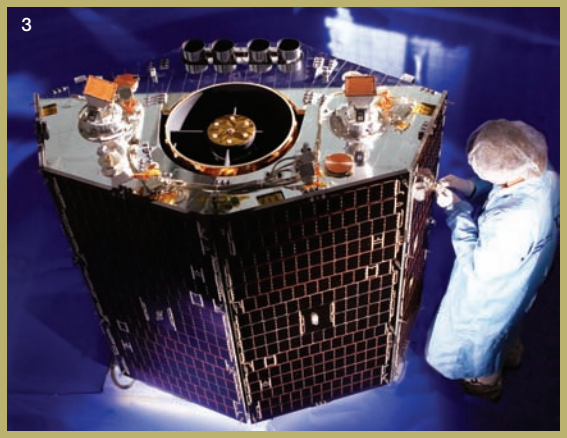
"We have achieved a great deal during the past ten years," says Dave Hodgson, Managing Director of DMC International Imaging – the company set up to manage disaster response and distribute images. "By coordinating multiple satellites we have been able to respond to disasters more rapidly and detect fast changing phenomena with daily images of anywhere on Earth."



Events where the constellation has played an important role during the past decade include the aftermath of Hurricane Katrina (2005), the Asian Tsunami (2004) and the UK floods of 2008, amongst others. The latest satellites to be launched into the DMC are UK-DMC2 and Spanish-owned Deimos-1. Both these new generation satellites feature improved cameras, enhanced memory capacity and faster communications. They can take pictures of much larger areas in a single pass than previous satellites.

Fortunately, there aren't enough disasters to keep the DMC occupied full-time and its humanitarian mission is supported by other commercial applications. In recent years these have included high resolution mapping of the Amazon rainforest to monitor illegal logging, and a project to provide high definition images and maps of sub-Saharan Africa in a shorter time period than ever before. Pictures from the satellites are even good enough to be used to monitor the growth of crops on the regular basis needed for efficient, modern agriculture.

The international nature of the constellation has proved to be one of its strengths with countries able to use it as a springboard to establish their space capabilities. Director General of the Nigerian Space Agency, S.O. Mohammed said: "In joining the DMC we have not only developed our knowledge of Nigeria's resources but also formed the foundations for our growing national space programme."



Future plans

Later this year, the Nigerian Space Agency will launch two new satellites: NigeriaSat-2 and NigeriaSat-X. Built by SSTL, NigeriaSat-2 will be one of the most advanced small satellites ever launched. NigeriaSat-X has been built by the West African country's engineers as part of a training programme. Both will join the DMC. "As new satellites and new members join the constellation we look forward to expanding its capabilities long into the future," says Hodgson.

As well as leading the development of the DMC, later this year the UK will take its turn (once again) to chair the International Charter. Alice Bunn from the UK Space Agency sees this as an opportunity to improve access to the World's satellite resources. "The UK would like to see more countries benefiting from the Charter," says Bunn. "For instance, some of the British Overseas Territories are particularly prone to disasters as they lie near fault lines or hurricane paths. There is tremendous potential for them to benefit from the Charter but we have to do more to ensure the right links are in place."

From tracking the path of extreme weather, floodwater or pollution to dealing with the aftermath of earthquakes, tsunamis, oil spills or hurricanes, information from space has made a crucial difference in responding to disasters. Although it's impossible to put a figure on it, satellites have undoubtedly helped to save many lives.

1. More than two million people were affected by flooding in Columbia in November 2010. UK-DMC2 captured this image of the disaster area
Credit: DMCii

2. DMCii used the satellite images to put together these maps to help rescue efforts
Credit: DMCii

3. NigeriaSat-2 nears completion
Credit: SSTL

Antarctica: Life on Mars

Credit: Tim Miall

The hostile environment of Antarctica is an ideal testing ground for equipment and technology that will be used for future missions to Mars. Physics teacher Tim Miall has just returned from the frozen wilderness where he found out what it might be like to be an astronaut.

Here I was, completely alone, in a tent surrounded by a cold and barren landscape. I had no watch, books, iPod or other entertainment. All I was allowed was a small amount of food, a sleeping bag and a 2-way radio in case of emergencies. Astronauts exploring the Solar System may have to spend months, if not years, on their own on their way to distant planets. Because of this, students from Twyford School and Ellen Wilkinson School wanted to see what it would feel like to spend twenty-four hours in remote isolation.

This isolation experiment was part of the 'Antarctica: Mars on Earth' science competition – funded by the UK Space Agency (through its 'Space for All' programme) and the Science and Technology Facilities Council. It was the culmination of four gruelling but exhilarating weeks, where I swapped the classroom for the glaciers of Antarctica to carry out a variety of space related experiments designed by students from across the UK.

Lying in the tent, the first thing that struck me was how quickly I lost my perception of time. Twenty-four hours of sunlight and the overcast conditions gave no hints as to how much time had passed. Each hour I radioed what I thought the time was to base camp

but was soon totally out of sync. It was clear that my body clock wasn't working properly; what I thought was 5pm was in fact 7pm and when I phoned in at 7pm, it was actually 9.30pm. The first couple of hours I kept myself occupied by sorting out equipment and adjusting the tent but time soon started to drag and my mind began to wander. It is amazing how hard it is not to think about loved ones at home, with thoughts of reunions upon my return coming to the front of my mind.

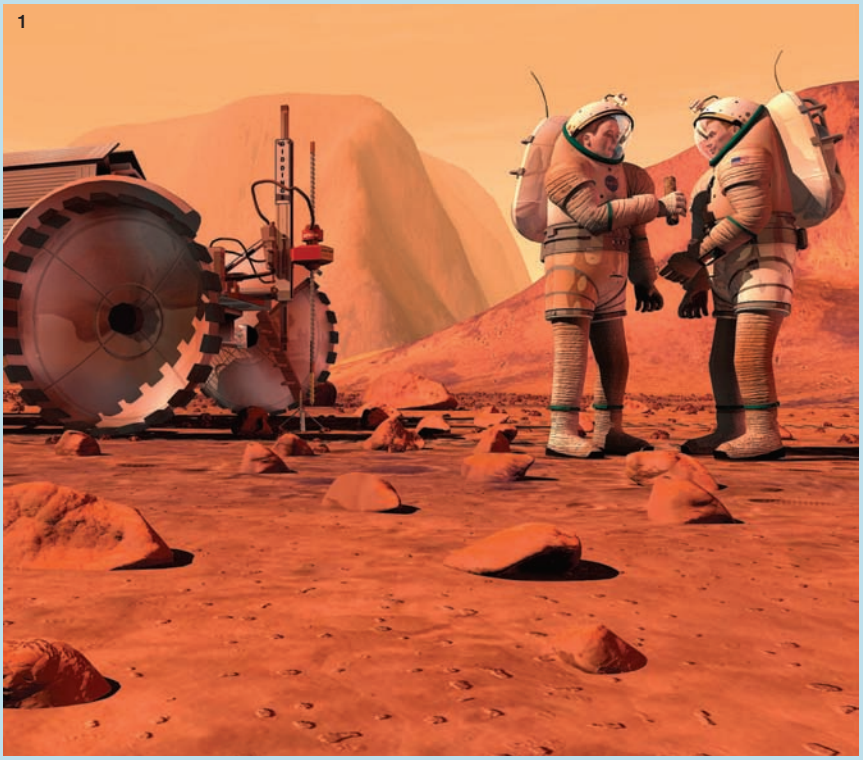
Mars on Earth

When I was at school the most exciting physics experiments involved rolling small trolleys down ramps, or circuits that never quite worked as they should. Fortunately, this has now changed and it's in this vein of change that the Fuchs Foundation Antarctica Expedition was organised. The Foundation was set up in the memory of Antarctic Explorer Sir Vivian Fuchs who inspired a generation of young people into science and adventure and the organisation aims to do the same by sending teachers to harsh environments. A month on the stunning glaciers of a largely unexplored part of the continent, called the Ellsworth Mountains, really gave me a taste of what it would be like to experience life on Mars.

Camping at temperatures as low as -40˚C and hauling tents and equipment across the frozen wilderness was a major challenge, especially when you have to do these activities in a huge protective suit and survive on freeze-dried food. However, it is these harsh and challenging conditions that make Antarctica a great double for an inhospitable planet like Mars, where the average temperature is -133 degrees celsius.

Antarctica has less rainfall than the Sahara desert and is often referred to as Mars on Earth because of its cold and dry conditions and its increased levels of ultraviolet radiation - a fact that scientists from NASA and ESA are taking advantage of in the planning stages for future missions. About a year before the robotic arm of NASA's Phoenix Mars Lander began digging into the red soil and subsurface ice of an arctic plain of Mars, six scientists travelled to Antarctica for soil and ice studies that would end up aiding analysis of the Mars data.

The experiments that I took to Antarctica fell into the categories of engineering, physiology, biology and psychology. As well as testing the effect of the harsh Mars-like conditions on the body, the mind, and man-made materials, I looked at the types of life that can survive in such an extreme environment. But my greatest challenge was one that both astronauts and Antarctic explorers have to face. As I settled in to my expedition, the extreme conditions and the vastness of the Antarctic landscape soon made me feel quite isolated. Just think what it will be like for future astronauts stuck in space capsules for months on end.



1. Working on Mars would be tough
Credit: NASA

2. Tim's isolated tent
Credit: Tim Miall

Tim's Antarctic diary can be found on the Fuchs Foundation website. He is now preparing teaching resources that will be freely available over the coming months.

Mission X

Train Like an Astronaut


2


1

As lessons go, it's refreshingly different. A class of 9-11 year-olds is designing space food for astronauts. The concentration is immense as children consider nutrition, container design and even the psychological aspects of feeding men and women in microgravity.

It's all part of Mission X: a pilot educational project for 8-12 year-olds focusing on fitness and nutrition and helping them become Fit Explorers.

Launched in December by British-born astronaut Piers Sellers and supported by the UK Space Agency, it involves close to 4,000 children from 40 cities around the world. Birchanger Primary School in Essex is one of the seven UK schools taking part.

"They're loving it," says teacher Nickie Williams. "It ties in with our Keeping Healthy project. Last week they recorded how their pulse rate increased and decreased during exercise - so there was a lot of maths involved as well." Nickie also introduced space history into literacy, and essays on the wall cover topics including the Apollo missions and the possibility of extraterrestrial life.

Visiting space food designer Chiara Bello, from ZeroGastronomy, had set today's space food topic. Mission X ambassador Richard Garriott, the British-born computer games entrepreneur and astronaut space tourist, is another former guest speaker. "It was a privilege to meet him," says Andrew Hewins, aged 11 and editor of the school newspaper Student Voice. "He talked about space and his life. It was really good."

Mountfitchet Mathematics and Computing College (MMCC) a few miles away in Stansted, is the UK's lead school during the pilot phase. "Mission X was too good an opportunity to miss," explains head teacher, Catherine Anderson, who saw it as a way to inspire the school's children. "It engages them in education and consolidates and complements the curriculum in an innovative way."

Project names range from 'Jump for the Moon' and the 'Astro-Agility course' to 'Crew strength training' and 'Let's climb a Martian mountain.' Related science modules cover bones, energy and gravity and, at MMCC, the Hydration Station seems to have been particularly popular.

Children had to keep a hydration log over 12 hours, monitoring what they drank, how often they went to the toilet and the colour of their urine. "It was different from any other homework we've had," says 11 year-old Marley Wright. For Rebecca Albiston, also 11, it changed her life. "I didn't used to drink lots and I got quite a few headaches before," she says. "Now I don't get them any more."

David Green, Mission X's UK science adviser, will be pleased. He runs the space physiology and health masters programme at King's College, London. "If we want to live a healthy and long life we have to take responsibility for ourselves just like an astronaut does," he says.

"An astronaut has to exercise two hours a day on the International Space Station because of the challenges that microgravity presents," Green adds. "You can't force them to do it but they know it's good for them. On Earth, if you don't look after yourself over your entire life, you'll pay the consequences for that."

Newly qualified British astronaut and Mission X supporter, Tim Peake, is well aware of the importance of exercise and diet. "Healthy eating plays an important role in maintaining the right balance of energy and nutrition for a physically and mentally demanding training regime," says Peake, "and keeping well hydrated is very important."

"In zero gravity bones and muscles that are not needed as much for support will degenerate. The heart does not need to work so hard as it is not fighting gravity and the blood volume reduces," he adds. "These changes can cause major problems when returning to Earth and so astronauts have to be completely fit and healthy before space flight."

"I didn't like science before but now I've come here I like it a lot," admits Marley Wright. Mountfitchet's head of science, Charmain Dunham, believes it has helped capture children's imagination and interest. "It fits in with physics, biology and chemistry," she says, "and the materials are excellent."

American space agency NASA, who originated the project, also produced the materials. The international aspect of Mission X highlights "the excitement of space exploration," according to NASA's Alicia Llewellyn, who coordinates the schools taking part. "The curriculum easily tied in space exploration with the urgent issue of childhood obesity, a problem facing all the partner nations."

The World Health Organisation designated childhood obesity one of the most serious public health challenges of the 21st century. By promoting an awareness of diet, health and physical activity, Mission X addresses this problem while opening children's eyes to the science and skills required for space travel.

The six-week pilot project runs until the end of March. "Mission X is still in its launch phase," explains coordinator of the UK Lead project, Heather MacRae. "We hope that it will take off and that more schools might be interested in the project in the future."

For a recommendation ask Marley Wright. "I thought it would be rubbish," he admits, "but it turned out to be really good." From an eleven year old, that's praise indeed.

Mission X materials are freely available on www.trainlikeanastronaut.org
For more information contact heather@venturethinking.com

1. Students at Mountfitchet Mathematics and Computing College look through some of the mission patches designed in class
Credit: Boffin Media/UK Space Agency

2. Richard Garriott (right) poses with flight engineer Greg Chamitoff on the International Space Station
Credit: NASA

3. Training like an astronaut means working in demanding environments
Credit: ESA

4. One of the mission patches designed by students
Credit: Boffin Media/UK space Agency

education & careers

Ask the experts

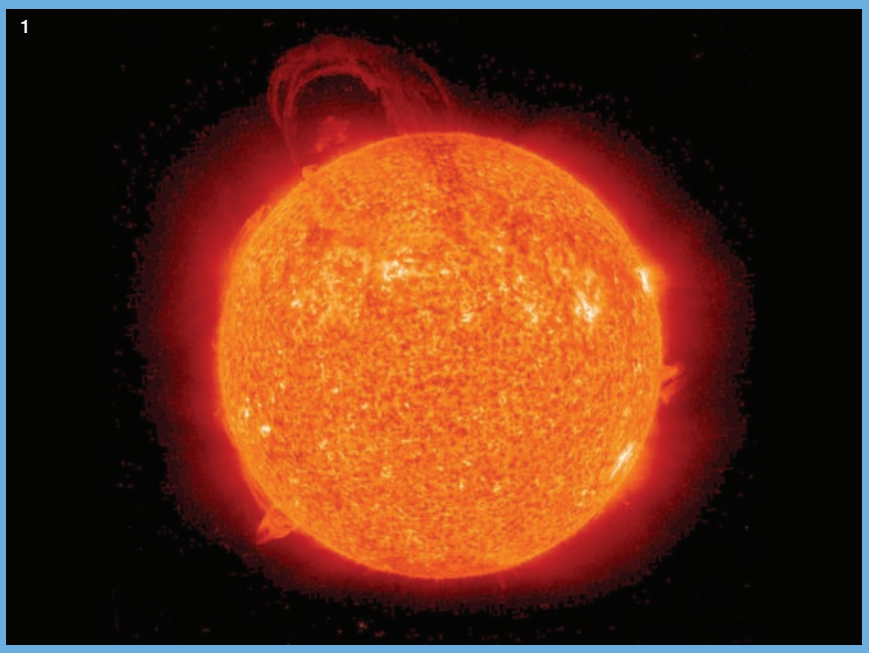
If you have a question about space, we'll track down the right person to answer it.

This time our questions come from Mission X pupils at Birchanger Primary School in Essex.

Becky Parker
Director, Langton Star Centre, Kent

Ed Brown
Head of Mechanical, Thermal & Propulsion Systems,
Astrium UK

Anu Ojha
Director, Space Academy
National Space Centre



How many suns are there and how big are they?

Our Sun is a star and the planets rotate round it. In the night sky nearly all the objects you see twinkling are stars, bodies like our Sun. In our galaxy, the Milky Way, there are about a 100 billion stars. If every star in the Milky Way was a grain of salt, they would fill an Olympic sized swimming pool. Now this is the number of stars in our galaxy. How many galaxies are there? If you put your thumb up to the night sky the area of sky you will block out with your thumbnail will contain about 50 million galaxies. There are billions of galaxies in the Universe, each one with billions of stars.

The sizes of the stars vary. The largest known star is VY Canis Majoris in the constellation Canis Major, which has a radius about two thousand times the size of our Sun. Wolf 359, in the constellation Leo, is one of the faintest and lowest mass stars known at about 0.16 times the radius of the Sun. Sirius, the brightest star in the night sky located in Canis Major, is nearly twice the size of our Sun. There's so much more to find out about stars.

Becky Parker

How long does it take to make a satellite?

It all depends on the type of satellite. At Astrium we build a number of communications satellites every year, which beam television, radio and broadband internet signals worldwide from a distance of 36,000 km above the Earth's surface. These six tonne spacecraft take about two and a half years for us to build from design to launch.

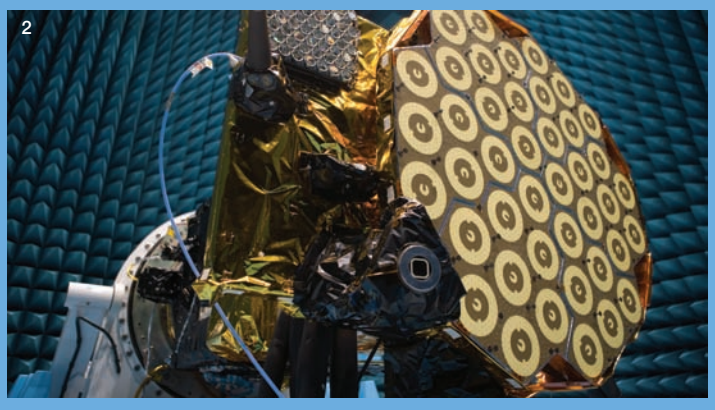
The design phase is where we work out what is required from the satellite in order to meet our customers' requirements. This could include delivering on-demand TV programmes to homes across South America or providing broadband internet access to remote parts of Europe. This phase usually takes about a year to complete.

Once the design has been agreed, we then have to actually build the satellite. We do this by manufacturing and bringing together the satellite's overall structure, life support systems and most importantly its payload – the satellite's brain. This process takes around one year.

Before a satellite is launched, we have to put it through a rigorous test campaign to make sure it can survive in the harsh environment of space. Testing takes about six months and during this phase we vibrate the satellite and expose it to loud noises to simulate a rocket launch; we put it into a thermal vacuum chamber, where we simulate the temperature extremes and vacuum of space; and expose the satellite to a series of radio-frequency tests to ensure all systems are working correctly.

Scientific or Earth observation satellites are a bit trickier. This is due to the fact that each mission is often completely different, whether it is imaging the stars in our galaxy, exploring Mars or mapping the Earth's polar ice caps - each spacecraft needs to be designed from scratch. For something like this it can take us anything from five to 15 years from design to launch.

Ed Brown



What type of food do they eat in space – and why?

Just like on Earth, the food that people eat in space needs to provide all of the necessary proteins, fats, carbohydrates, vitamins and minerals necessary for a balanced diet. In the early days of the human space programme, most food was pretty unappetizing and either squeezed out of tubes or in small bite-sized chunks. These days, astronauts get the opportunity to select from a pretty varied menu – and although some of the food is dehydrated (think of eating a pot noodle!) or tinned, advances in food technology mean that pre-packaged 'thermostabilised' meals (like those in military ration packs) can be pretty tasty – especially when you think about how supermarket 'ready meals' have developed over the years.

astronauts report that one interesting effect of being in a weightless or 'microgravity' environment is that food tastes pretty bland (perhaps due to fluid-induced congestion in their head) – and so there is a real demand for spicy extras such as chilli sauces, horseradish, garlic and pepper (which is dissolved in liquid so that granules don't float all over the place). A Space Shuttle astronaut reported that on one mission a colleague had such a craving for spices that he even added taco sauce to his breakfast cereal!

Anu Ojha

1. The international STEREO satellite took this spectacular image of the Sun – there are around 100 billion stars in our galaxy alone
Credit: NASA

2. A satellite under test at Astrium
Credit: Astrium UK

3. Space Shuttle astronaut Richard Searfoss grapples with his lunch
Credit: NASA

education & careers

Teaching resources

The UK space education office (ESERO-UK) promotes the use of space to enhance and support the teaching and learning of Science, Technology, Engineering and Mathematics (STEM) in schools and colleges throughout the UK. Funded by ESA and the Department for Education, the office has been established at the National STEM Centre at the University of York.

ESERO-UK aims to share good practice and become 'the place to go' for teaching and learning resources that use space as a context to enrich lessons. Key to this is the network of space education ambassadors that has been established throughout the UK. The ambassadors are all affiliated with space-related education offices, such as the National Space Centre in Leicester or the Armagh Planetarium in Northern Ireland.

The space ambassadors will engage with schools and colleges in their region, offering student events, continuing professional development for teachers and education resources. They will also facilitate a regional network of groups interested in promoting space in the classroom. Schools are encouraged to get in contact with their local space ambassador to find out how they can work together to improve their delivery of STEM education. Full contact details and biographies for the space ambassadors can be found on the ESERO-UK website (see below).

Credit: NASA

Resources include a virtual mission to the International Space Station

The UK space education office will also highlight top space education resources for teachers to use with their students. The resources are available online via an eLibrary accessible through the ESERO-UK website. The eLibrary has been tailor-made to be as useful as possible for teachers, allowing you to search by type of resource (eg video, quiz etc), age range, key stage, publisher, date of publication and much more. The eLibrary also contains resources for subjects such as biology, mathematics, engineering and physics. This treasure chest of resources provides great opportunities for cross-curricular subject development and lesson planning.

The ESERO-UK website also contains links to other useful space websites, and a list of activities and space education providers (such as planetaria, observatories, robotic telescopes etc) searchable by region to help give you inspiration for innovative approaches to lessons.

www.esero.org.uk

For more information, or to submit space education resources to the eLibrary, contact Dr Allan Clements: a.clements@nationalstemcentre.org.uk

Resource spotlight

Choosing a Telescope for a School is a video produced by ESERO-UK, working with colleagues at space ambassador Dan Hillier's Royal Observatory in Edinburgh. The video gives a brief demonstration on how to use a simple 70mm refractor telescope and is accompanied by a short factsheet written by space ambassador Paul Roche of the Faulkes Telescope Project in Wales (with support from the Institute of Physics) looking at some of the things to consider when purchasing a telescope. The resource is a great starting point for any teachers considering investing in a school telescope and can be found here: **http://stem.org.uk/rxtx**

CAREER FILE

Fancy a job in space? In every issue of *space:uk* we talk to someone who has a career in the UK space industry…

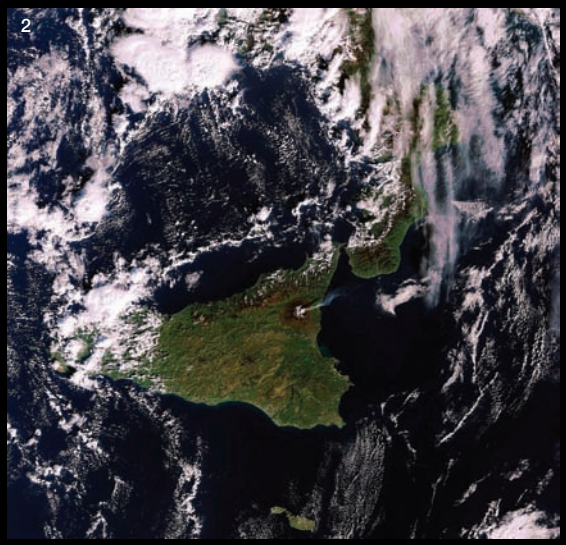
Phil Brown
is an Applications Engineer with UK company e2v.

What does your job involve?

I focus on winning imaging sensor business for e2v. This involves detailed discussions with space agencies and instrument manufacturers around the world to help them create the highest performance cameras and scientific instruments possible.

What do these sensors do?

Image sensors are the electronic equivalent of photographic film. They detect light and convert it into electrical signals. The largest cameras that use e2v image sensors are found in telescopes. One of the most prestigious cameras we've worked on is for is the Hubble Space Telescope, which has taken some of the most famous photographs in astronomy.



Closer to home, satellites use image sensors to take pictures of the Earth. They can also be used to monitor gas concentrations in our atmosphere, investigate Solar activity or even look for life on other planets. Technology we develop could help answer the big question: 'are we alone?'

What are you working on at the moment?

I am currently working with a team developing instruments for ExoMars, a billion-dollar ESA mission to land the next generation of rover on the surface of Mars. The ExoMars Rover will search for past and present signs of life by analysing samples taken from the surface.

Do you also get to travel a lot?

This year I've travelled to Russia, India, France and Ireland. I have visited several key government space and research facilities and I get to work with world class scientists and engineers from different cultures. I find it fascinating to see how science and technology has evolved in very different political climates.

What is it about space that so interests you?

Working on satellite instrumentation presents significant challenges, they have to be designed to survive the harsh launching conditions, work first time and be 100% reliable – once it is launched you can't make any changes!

How did you end up with this job?

I've always had an interest in how things work, I studied physics, chemistry and maths for A-Level before going on to study physics at university. I remember not having a clear idea of the career that I should follow but I enjoyed physics and it provided a very wide range of options.

What advice would you give someone considering a career in space?

Study core science and maths subjects. Choose a good university and be proactive in your search for the right job. You need to stand out from the crowd, so show initiative wherever possible.

1. ESA's ExoMars will look for signs of life
Credit: ESA

2. ESA's Envisat took this image of Mount Etna
Credit: ESA

3. Hubble image of the Sombrero Galaxy
Credit: ESA/NASA

UK SPACE PIONEERS

Skylark

Skylark was one of the most successful rockets ever built. Over a period of nearly fifty years, 441 Skylark rockets carried a total of some 1000 experiments into space.

Skylark was a sounding rocket, meaning the rocket 'sounded' the atmosphere – or tested it – as it rose towards space. It was built for ballistic flight, like a missile, and carried experiments to investigate astronomy, the atmosphere and the effects of microgravity. Each rocket experienced around six minutes of weightlessness. As it fell back towards the Earth, the capsule containing the experiments was released and landed using a parachute.

Skylark was conceived by British scientists in the mid-1950s and was first launched from Woomera in Australia, several months before Sputnik. The early single-stage rockets were around eight metres long and launched from a gantry made from leftover steel bridge panels. Over the years, Skylark became more sophisticated with multiple stages enabling the spacecraft to reach extremely high altitudes. A three-stage Skylark could fly to some 1000km – five times as high as the Space Shuttle. In 1965, a total of seven rockets was launched in a single day – this remains an unbeaten record.

Skylark's experiments range from observations of the upper atmosphere to X-ray astronomy, and from measurements of the Earth to the effects of weightlessness on muscle tissue. Many young scientists started their careers working on Skylark before going on to contribute to major international space missions.

The Government stopped funding the Skylark programme in 1977. However, UK companies continued to manufacture the rockets and they were sold to Germany and Sweden. Skylark flew for the final time in 2005, although sounding rockets are still used by researchers all over the World.

A podcast about Skylark is available on the UK Space Agency website, search for 'space 50 podcasts'.

Credit: Ken Pounds

Tests being carried out prior to launch on an early Skylark payload at Woomera

Credit for all images : Astrium

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March 2011. UK Space Agency www.bis.gov.uk/ukspaceagency