Spring 2014 Issue 40

space:uk

Destination Mars:
the UK goes to the red planet

UK SPACE AGENCY

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Front cover image The Curiosity rover's view of Mars **Credit:** NASA

Alien world in Stevenage

A new simulated Martian landscape in the Hertfordshire town of Stevenage will be used to test the autonomous navigation systems on Europe's first Mars rover.

The Mars Yard at Airbus Defence and Space, which is building the European Space Agency (ESA) ExoMars rover, is 30m by 13m, contains 300 tonnes of sand, a convincingly painted backdrop and is strewn with rocks to represent a realistic Martian environment.

"You have to remember roving on Mars is not easy," said ESA's Director of Science and Robotic Exploration, Alvaro Giménez. "The sand that you see here is real and gets into any mechanism so you have to make sure that you know how this will affect your design and work. For people here, developing the rover for ExoMars, it's essential."

Eight sites on Mars have been longlisted for the 300kg rover, which will launch in 2018 and land in January 2019. The rover will contain a suite of instruments, including the UK-led camera PanCam and a drill that will search for evidence of past or present life, up to two metres underground.

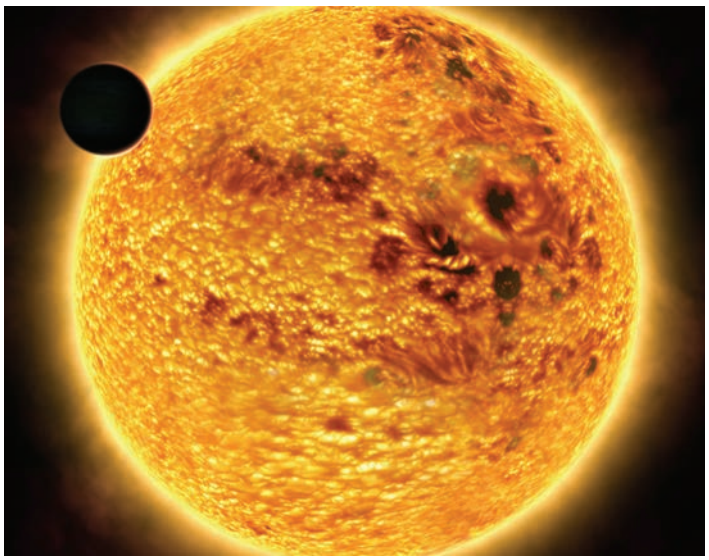
"The first Mars mission to try to explore below the surface with a drill that gets below the irradiated bits of the soil is a real landmark for the whole European Space Agency and therefore for the UK as well," said UK Space Agency Chief Executive David Parker.

The state of the art facility in Stevenage replaced a much smaller Mars Yard and was opened in March by the Secretary of State for Business, Innovation and Skills, Vince Cable. "Not only is it hugely exciting that Europe's next mission to Mars will be British built," he said, "but it is incredibly rewarding to see the benefits of our investment in the European Space Agency creating jobs here in the UK."

For more on the Mars rover, see feature on page 10

Vince Cable and David Parker walk on Mars **Credit:** UK Space Agency

UK joins planet hunters



PLATO will seek out alien worlds around distant stars **Credit:** ESA

The UK is investing £25 million in a European Space Agency (ESA) mission to seek out habitable planets around alien stars. Due for launch in 2024, the PLATO planet-hunting mission is likely to use British-built technology and involve several UK science teams.

ESA's Science Programme Committee selected PLATO – which stands for Planetary Transits and Oscillations of stars – as the Agency's latest medium-class mission.

Fitted with 34 separate telescopes, PLATO will monitor stars to search for any tiny regular dips in brightness. These small changes in light level correspond to when orbiting planets pass in front of the stars. The spacecraft will be able to measure the size, mass and ages of the planetary systems it discovers, allowing scientists to make detailed comparisons with our own solar system.

"PLATO is the next logical step in our search for extrasolar planets," said Don Pollacco from the University of Warwick, who is leading the mission's science consortium. "It will revolutionise our knowledge of rocky planets and will enable the first directed search for life around Sun-like stars."

Essex company e2v is expected to develop the CCD detectors for PLATO and other UK firms are well placed to be involved in building the spacecraft systems and instruments.

"This is an important mission for the UK," said Chris Castelli, Acting Director of Technology, Science and Exploration at the UK Space Agency. "It's also a very exciting mission – this is the first time we've been involved in a spacecraft designed to seek out habitable planets like our own."

Training for space

Tim Peake during spacewalk training at NASA **Credit:** NASA

In November 2015, British astronaut Major Tim Peake will join a six-month mission to the International Space Station (ISS). *Space:uk* is following the ESA astronaut's progress and we spoke to Tim shortly after he arrived in Star City near Moscow for his latest training:

Why are you in Star city?
I'm here to do more training on the Russian segment of the ISS. We have to get qualified to use the systems, so we know how they operate, how the Soyuz and Progress dock and how to use the computers and fire extinguishers.

How different is the Russian segment?
It's completely different – that's one of the funny things that surprised me when I first started training. Coming from a test pilot background I expected everything to be cutting-edge. Looking at the space station, you realise it dates back to the 1990s. It's essentially a Russian space station bolted to an American space station with European and Japanese modules bolted onto those two. There are lots of compromises and there's a real mix of old and new technology.

Getting to grips with the workings of the Canadian robotic arm **Credit:** Canadian Space Agency

You've also been doing survival training in case the Soyuz capsule lands in a remote area
There's a disused Soyuz capsule in the woods near Star City, which they put you into dressed in your space suit. Then you have to put on your survival gear inside the capsule – which is one of the hardest things you have to do because it's such a tiny space. Once you've got changed, you hike to an area where you practice building a shelter and going through some survival skills. It was a lot of fun really and the cold wasn't an issue – it was minus 24 on both nights.

Survival training in the Russian winter **Credit:** ESA

Apart from the experiments you will be conducting on the ISS, you're planning a lot of educational projects
We've got a really exciting programme that the UK Space Agency is working on and we're really going to be engaging people in terms of competitions, designing the mission patch, looking at exercise and nutrition and science for the whole spectrum of ages.

Are you getting excited about the mission?
At the moment time is absolutely flying by and I know that the next year and a half will go just as quick. It's a case of being able to enjoy the moment as much as possible.

Rosetta targets comet

All of the scientific instruments on board the Rosetta spacecraft – including the UK's Ptolemy experiment on the Philae lander – have successfully re-activated after a three-year hibernation in deep space.

The OSIRIS imaging system, the spacecraft's scientific eye, was the first remote sensing instrument to be switched on. It consists of two cameras, including a narrow angled camera that will focus on the structure of the comet's nucleus.

Images from OSIRIS (Optical, Spectrocopic and Infrared Remote Imaging System) will become more detailed the closer it gets to the comet and will gradually become full frame, high-resolution images by July. These images will help scientists reconstruct the comet's rotation and shape. They will also play an important role in the navigational corrections that are sent to the spacecraft in May.

"We are currently approaching the comet on trajectory but we have a bit of uncertainly as to the comet's exact position," said Andrea Accomazzo, ESA's Spacecraft Operations Manager at the European Space Operations Centre in Darmstadt, Germany. "So to resolve this uncertainly we need to take optical images and we use images produced by OSIRIS to resolve exactly where the comet is so we can approach it."

Ten years in space

ESA's comet chasing mission made headlines around the world in January when it successfully woke up on its long journey to comet 67P/Churyumov-Gerasimenko. In March, Rosetta celebrated its tenth year since launch. Over the coming months, the spacecraft will fly alongside and orbit its target and, in November, its Philae lander will attempt the first ever, controlled landing on a comet.

Artist's impression of Rosetta approaching its final destination **Credit:** ESA

The Open University's Ptolemy instrument – an 'electronic nose' – is onboard the lander. "We are really pleased that Philae has come back online," said Ptolemy principal investigator, Ian Wright, "and feel a debt of gratitude to the lander engineers in Cologne and Toulouse who are working tirelessly to make this all happen."

There is also significant UK involvement from industry and science in ten of the 21 instruments. AEA Batteries Systems provided innovative batteries for the spacecraft and lander, and SciSys UK developed the mission control system. SSTL designed a wheel to stabilise the probe as it descends and lands on the comet and Polyflex Space provided the lander's helium storage tanks.

UK universities are also playing a role. A team from Imperial College London and University College London will study the comet's plasma. Scientists from Armagh Observatory will help analyse results from OSIRIS and Oxford University is part of the science team for the VIRTIS instrument.

Celebrations in mission control when, after 31 months in deep space hibernation, Rosetta sent its first signal back to Earth **Credit:** ESA

Ball of fire

Students at the launch of the new iBook **Credit:** B

UK space scientists joined teenagers at London's Science Museum in March for explosions, solar physics and cake to celebrate the launch of A Big Ball of Fire: a free interactive iBook about the Sun.

Students from Eastlea Community School in east London created the iBook with expert help from Cambridge University and University College London's Mullard Space Science Laboratory. The UK Space Agency funded the project, which included a visit to the Institute of Astronomy in Cambridge to meet astronomy and astrophysics students and to observe sunspots.

"I was very happy to share my passion for the Sun with the students at Eastlea School," said Helen Mason, from the University of Cambridge. "They have taken this iBook project on with great enthusiasm and imagination, reaching levels way beyond my expectations."

The iBook can be downloaded for free from the iTunes store.

Sweeping up cosmic dust

Data gathered by ESA's Herschel space observatory has been used to compile the largest-ever census of dust in nearby galaxies. Cosmic dust grains are a fundamental ingredient in the recipe for creating stars and planets. But despite their importance, there is an incomplete picture of the properties of dust in galaxies beyond the Milky Way.

Herschel image of the Crab Nebula: a cloud of cosmic gas and dust **Credit:** ESA

30 years in orbit

One of the first satellites ever built by Surrey Satellite Technology Limited (SSTL) and the Surrey Space Centre, has celebrated 30 years of operations. UoSAT-2, launched in March 1984, has remained a constant in SSTL's evolution from university spin-off to world-leading small satellite manufacturer.

Today, UoSAT-2 still transmits its VHF signal on a regular 11-day cycle and the on-board clock still tells the time – although engineers report that it is running somewhat late. Telemetry from the spacecraft continues to be tracked by amateur radio satellite enthusiasts around the world.

Earth's first Sentinel launched

Sentinel 1A, the first satellite in Europe's Copernicus environmental monitoring programme, has been successfully launched from ESA's spaceport in French Guiana. The satellite's synthetic-aperture radar is designed to 'see' the Earth's surface through rain and cloud, day or night, providing a reliable and real-time source of information about our planet.

Sentinel 1A will be used to map sea ice, track and direct shipping, and examine land use. It is one of the first satellites equipped with a laser terminal for data transfer. This means it can send the information it collects to satellites in high geostationary orbits, which can then be beamed back down to Earth.

The Copernicus programme, previously known as Global Monitoring for Environment and Security (GMES), will eventually supply an unprecedented quality and range of environmental data to European governments, agencies and businesses. It will gather its data from a fleet of satellites, as well as airborne and ground sensors. Other Sentinel satellites will be launched to gather high-resolution optical images and data on the behaviour of the sea and atmosphere.

A second Sentinel, 1B, will be launched in 2015 to complete a mini-constellation of two satellites. On every orbit each satellite can take pictures in a swathe from 80 to 400km wide, covering every part of the Earth's surface over a 12-day period. The second satellite will reduce this to once every six days.

Sentinel 1A was built by a group of around 60 companies from across Europe, led by Thales Alenia Space and Airbus Defence and Space. The 2.3 tonne satellite was carried aboard a Soyuz launcher into orbit some 700km above the Earth.

Launch of the Sentinel 1A satellite **Credit:** ESA

Floods: response from space

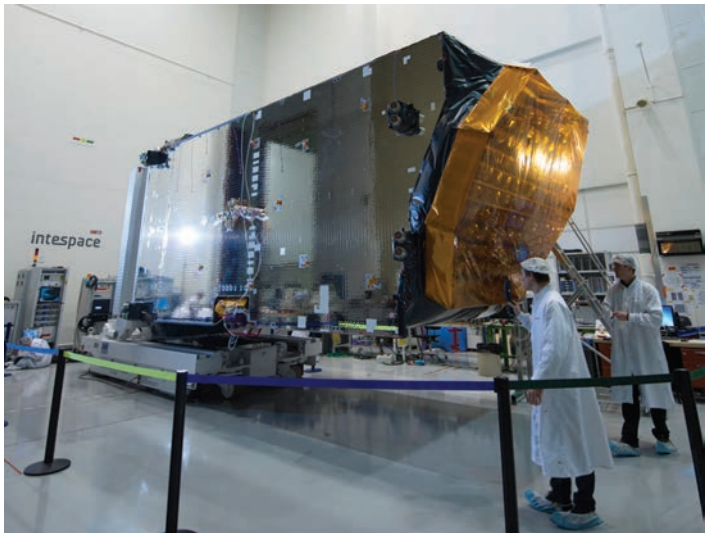
Satellites have been used to help agencies respond to this year's severe winter flooding.

In February, the Environment Agency activated the International Charter Space and Major Disasters – an international effort to provide free satellite data during emergencies. With storms battering the country and with thousands of properties flooded, satellite images and data were used by government agencies to assess the extent of damage. Pictures from satellites can be combined with maps and other infrastructure information to identify areas most at risk.

Since it was set up in 1999, the Charter has helped emergency workers after more than 400 disasters worldwide but it is rare for the UK to activate the Charter on its own behalf. Images provided under the Charter included pictures from the UK's disaster monitoring satellite, UK-DMC2, operated by DMC International Imaging Limited as part of the international Disaster Monitoring Constellation.

The images below were captured by Airbus Defence and Space's Spot 6 Earth observation satellite. They show the River Parrett near Bridgewater in Somerset on 8 June 2013 and on 11 February 2014, after the river had breached its banks.

Satcoms: the next generation



Alphasat prior to its 2013 launch, this sophisticated communications satellite was built in a partnership between ESA and UK satellite operator Inmarsat. Much of the satellite was built in the UK **Credit:** ESA

ESA has taken the first step towards the development of a new generation of communications satellites, a move that is certain to benefit UK industry.

Contracts for Phase-B of ESA's Neosat project have been signed between the Agency and representatives of Airbus Defence and Space and Thales Alenia Space. The two companies will be responsible for developing the technology for new communication satellites. The process is expected to take around 13 months, with a view to the first launches within five years.

Neosat will feature innovations in several key technical areas, including electrical propulsion, new methods for temperature control and battery technology. The contract follows the UK Space Agency's increased investment, to more than €200 million, in ESA's telecommunications programme at the last ESA Council of Ministers.

Minister for Universities and Science, David Willetts, said that Neosat, "provides a significant opportunity for the UK space industry and will not only help to create as many as 100,000 new jobs by 2030 but also deliver future orders and exports for the industry."

ESA aims to help European satellite companies win the lion's share of the world satellite communications market, a prize worth an estimated €25 billion in sales between 2018-2030. Europe's space industry already has a good track record in communication satellites. The Eurostar platform, originally developed in the mid-80s, has formed the basis for more than 45 satellites.

British companies – not just Airbus Defence and Space but also smaller firms who will be sub-contractors for Neosat – are expected to receive around a third of the project's €18 million budget.

Happy birthday Hubble

The team behind the international Hubble Space Telescope marked its 24th anniversary with the release of this spectacular image of the Monkey Head Nebula. Otherwise known as NGC 2174, this cloud of gas and dust lies about 6400 light-years away in the constellation of Orion. Hubble is a joint project between NASA and ESA, and involves several UK science teams.

Together in space

The UK Space Agency and the French space agency, CNES, have agreed to work even closer together in space. The deal includes £15 million of UK investment in instruments for the next generation of European weather satellites.

The agreement paves the way for joint work on Earth observation, telecommunications, space weather and the development of new space technologies. It was witnessed by the Prime Minister and President Hollande at the recent UK-France Summit in Oxfordshire.

Swarm moves into place

The three Swarm satellites ready for launch
Credit: ESA

The three Swarm satellites, designed to map the Earth's magnetic field with unprecedented accuracy, are being moved towards their operating orbits. The ESA spacecraft were launched in November last year and have been undergoing a complex commissioning process ever since.

Once fully operational, the satellites will investigate the Earth's magnetic field from the core to the crust and out into space. The structures for the constellation of identical spacecraft were built in Stevenage and several UK science teams are involved in the mission.

Postcard from deep space

Europe's Gaia space observatory is making final preparations for its ambitious billion-star survey and has sent back its first image. The test picture, taken as part of the process of focusing, aligning and calibrating its instruments, represents less than 1% of Gaia's field of view.

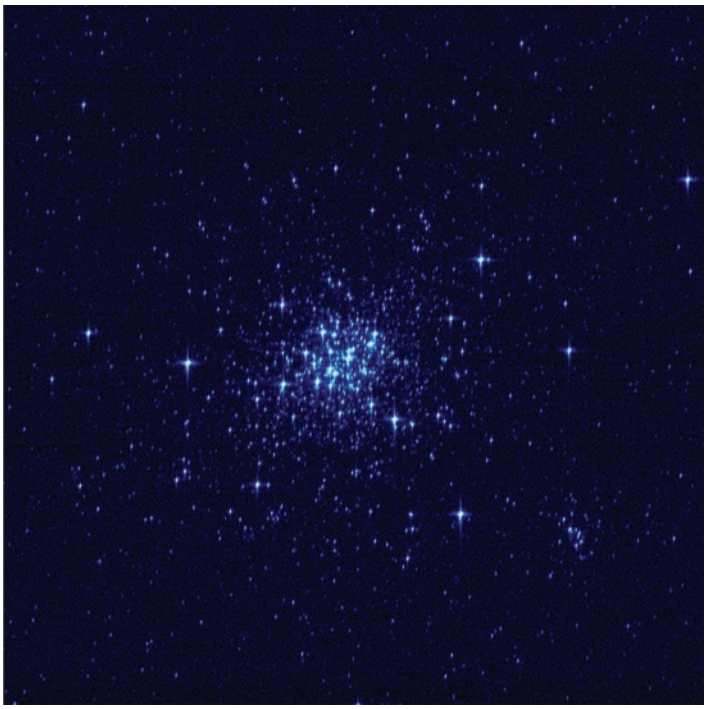
Gaia, launched on 19 December 2013, orbits a point in space called L2. This position, 1.5 million kilometres from the Earth and on the opposite side to the Sun, is always in the Earth's shadow. This makes it a good location for a space observatory.

Gaia's objective is to create the most detailed map ever made of our Milky Way, a survey that will pinpoint around 1% of its 100 billion stars. To do so the spacecraft will spin slowly, continuously scanning the whole sky with its two telescopes.

The spacecraft is fitted with two optical telescopes and instruments that will measure and analyse the light from stars, planets and supernovae. The powerful detectors it uses were supplied by Chemsford company, e2v, with other UK teams involved in the manufacture and science of this ambitious mission.

Gaia will have recorded all of its target stars in the first six months of operation, and for the remainder of its five-year mission will examine tiny changes in their positions. This will reveal not only the stars' motion but also their distance. Gaia will also measure physical properties of each star, including their brightness, temperature and chemical composition.

The test snap is one of the last full-frame images that Gaia will ever send. In order to limit the amount of data produced, it will send back only small portions of whole images, centred on each star it detects.



The first test image from Gaia **Credit:** ESA

Galileo works

The core of Europe's new satellite navigation system, Galileo, is fully operational after an intensive phase of testing of the first four orbiting satellites and the ground network to support them.

The UK has made a significant investment in the European project and UK industry has built and designed key technology for these next generation navigation satellites. The navigation payloads for the four In-Orbit Validation (IOV) satellites were developed and built by Airbus Defence and Space (previously Astrium) in the UK. Surrey Satellite Technology is building the payloads for 22 of the 30 satellites in the final constellation.

Four satellites is the minimum number needed to fix a position on Earth and the IOV satellites have proved that the Galileo system works well. The testing process involved teams across Europe. "More than 10,000 kilometres were driven by test vehicles in the process of picking up signals, along with pedestrian and fixed receiver testing," said Marco Falcone, ESA's Galileo System Manager. "Many terabytes of IOV data were gathered in all."

Developed by ESA on behalf of the European Union, Galileo is the first civilian owned and operated satellite navigation system. When Galileo is complete, it will be able to position objects down to a metre or less – much more accurate than the navigation signals available today.

Galileo will operate alongside the US Global Positioning System (GPS) and the Russian Glonass system, using new, and some existing, receivers. The satellites will also provide a search and rescue signal and a secured signal, similar to a military GPS. However, this will also be available for civilian applications.

For the views of the Minister for Universities and Science on Galileo, see feature on page 16

Testing the Galileo satellites involved making helicopter flights **Credit:** ESA

Agency update

The Government has ambitious targets for the UK space sector **Credit:** ESA, NASA

Following more than a year of preparations, the UK Space Agency announced a reorganisation taking effect on 1 April 2014. The aim of the reorganisation – called the Arrow Programme – is to set a structure for the Agency that is a better fit for delivery of the Government's growth ambitions for the UK space sector.

Four years on from its creation, the UK Space Agency continues to work towards delivering the target of a £40 billion space sector by 2030. As the Agency's work has expanded, the Government has recognised the challenge of delivering this ambitious target, committing more resources to the Agency and increasing the staff by 50% over the past year. The addition of new staff will help strengthen an Agency that is working across the country and around the world on behalf of the UK space industry and academic community.

In addition to providing leadership for ESA's world class science missions, staff at the Agency are helping industry compete for new European contracts. They are working to attract inward investment to the UK and to export UK excellence in technology and services overseas. The UK Space Agency is also strengthening its support for the development of the UK Space Gateway at Harwell, Oxford with a dedicated team.

The new structure sees four Directors working with the Chief Executive to form the senior management team. Catherine Mealing-Jones is Director of Growth and Peter Finn is Chief Operating and Finance Officer, with the Director of Policy and Director of Programmes yet to be appointed.

Space with a bang!

The UK Space Agency joined forces with RAL Space and ESA to demonstrate the wonders of space, and careers in space, to students at this year's Big Bang Fair.

The challenge: to use dried spaghetti and marshmallows to protect an egg on a vibration table. Similar tables are used to test instruments and satellites to see if they are up to being blasted into space.

A bicycle wheel is used to demonstrate how spinning satellites can give them stability in orbit.

One of the perks of being an engineer in the space industry is you get to dress up in clean room gear. Hands-on activities on the space stand were used to demonstrate how engineers work to get their satellite into space.

Back at the vibration table, the UK Space Agency's Jeremy Curtis tries to reassure a student that he won't get splattered in egg.

This event is the largest celebration of science, technology, engineering and maths for young people in the UK. The fair, at Birmingham's NEC in March, was attended by more than 75,000 young people, teachers and parents.

Credit for Big Bang Fair images: UK Space Agency, Max Alexander

ESA, RAL Space and the UK Space Agency support events like the Big Bang Fair to encourage young people to consider careers in the space sector. Some of these students may end up working on missions like Gaia, seen here being blasted into space in December 2013.

Destination Mars

Sue Nelson meets the UK science and engineering teams preparing for Europe's first mission to the Martian surface:

"The whole thing is a thrill, being able to build a camera that will take pictures of Mars and help explore a region of Mars we've never seen before"

Craig Leff
MSSL

There's a touch of ET about the ExoMars rover for Europe's first mission to Mars. Like Stephen Spielberg's extraterrestrial creation, it has a long neck in the form of a mast and large eyes spaced wide apart. The eyes are two wide-angle cameras, designed to take panoramic pictures of the Martian surface. Together with a high-resolution colour camera, they form the UK-led PanCam system: the most powerful scientific camera ever to be sent to Mars.

The launch date is 2018, with an ExoMars orbiter and landing demonstrator module called Schiaparelli setting the stage two years earlier. The rover will perform geology, geochemistry and exobiology – searching for evidence of environments that may have once supported life. The UK is the second largest contributor to the ExoMars mission, which is part of ESA's Aurora programme.

ESA's Mars Express captured this image, which appears to show an area of volcanic ash on the surface of the red planet **Credit:** ESA

"It's a really fantastic mission," exclaims PanCam's principal investigator Andrew Coates, from University College London's Mullard Space Science Laboratory (MSSL). "NASA's Curiosity rover can only drill 5cm under the surface of a rock. We're going to be able to drill two metres under the surface of Mars. It's a big advance."

The PanCam camera will play a key role in assessing the Martian terrain before drilling. "The wide-angled cameras are situated 50cm apart at the top of the rover's mast," says Coates. "They have wider separation than human eyes and are about at the height of a human on the surface, so we can get better stereo reconstruction than humans do." The result will be detailed three-dimensional images of Mars.

Each wide-angle camera will sample a different wavelength, to examine the spectra of sunlight reflected off rocks on the Martian surface. "These give you mineral identification," Coates explains. "We're looking for the geological context on the surface for example, where we're going to be drilling and what are the important rocks to look at. We've packed as much science as we can into the PanCam design."

Artist's impression of the ExoMars rover on the Martian surface **Credit:** ESA

continues >

Made in Wales

Coates and his international team are working on PanCam with UK scientists at Aberystwyth University, Birkbeck College, Edinburgh University, Imperial College London, Surrey University, Leicester University, the Open University and the Natural History Museum.

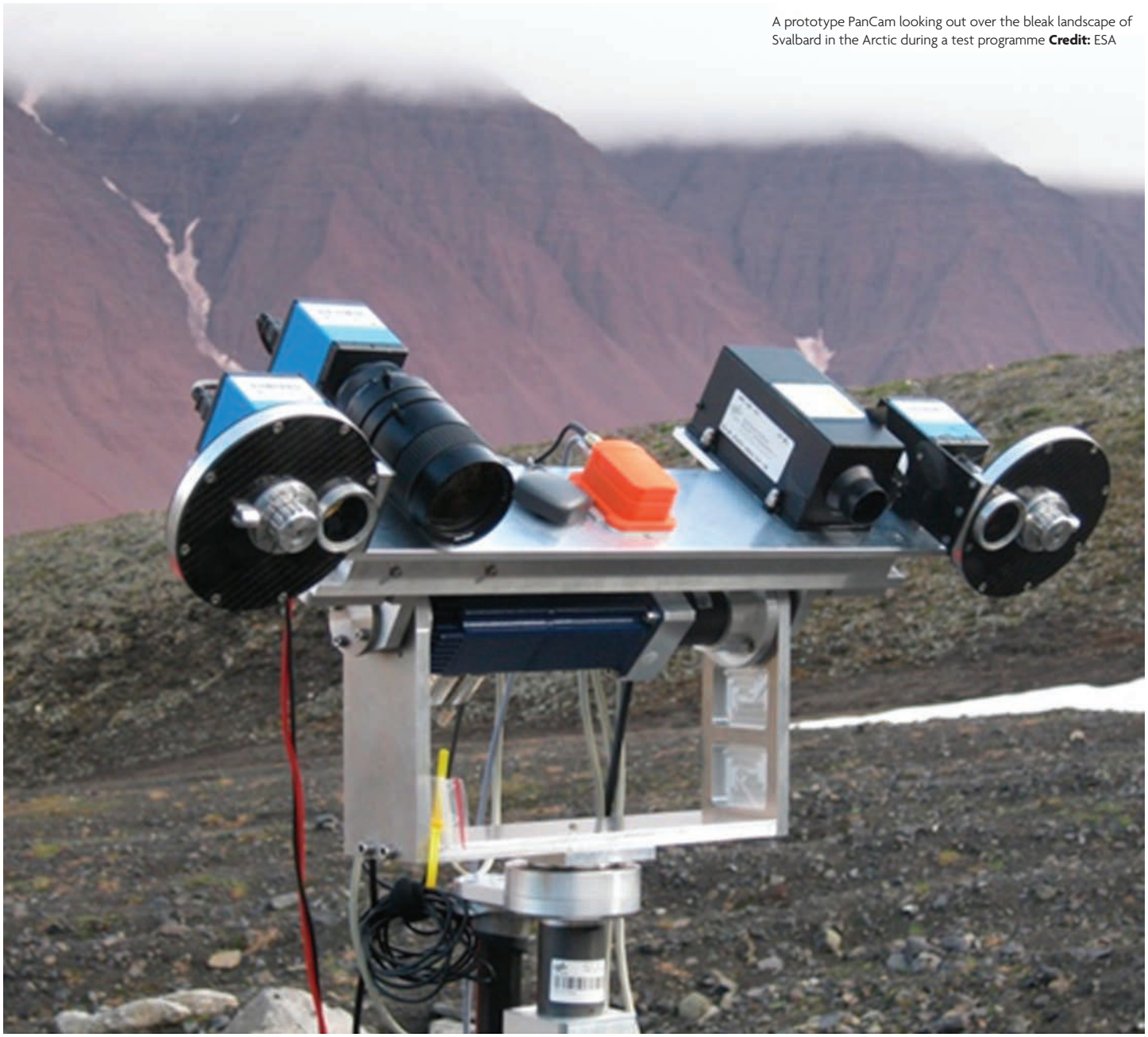
"We're involved in two of the instruments," says Dave Barnes, Professor of Space and Planetary Robotics at Aberystwyth University and PanCam co-investigator. "First of all with PanCam and also with the close-up imager, CLUPI. In both cases one of our major contributions is providing the calibration target for each instrument."

These calibration targets will be fitted to the rover to compare the reflected light from the surface of Mars against what is expected in the laboratory on Earth. This will ensure that each instrument produces accurate science data.

"It's similar to a professional photographer doing a white balance correction so the colours are correct," he says. "The Martian atmosphere, because of dust particles, casts a yellowy brown hue over everything and it allows us to compensate for that. It's as if a human was standing on the surface of Mars."

These calibration targets are also completely different to previous ones flown by NASA. "Our colour target is made out of stained glass," says Barnes. "Mars has very high UV irradiation, due to very little ozone, and UV bleaches colours, which is why the surface is very sterile. We know that by using stained glass, if you go to a medieval church, the colours are as good today as they were hundreds of years ago."

These unique designs are being built in Wales. "This is made in Wales going to Mars," says Barnes proudly. "I'm trying to figure out how to get a Welsh dragon on there."



A prototype PanCam looking out over the bleak landscape of Svalbard in the Arctic during a test programme **Credit:** ESA

urn

by rings made up of millions of particles of rock and ice.
a hydrocarbon smog, and Enceladus, which spews out plumes of water.

UK SPACE AGENCY

Saturn: Lord

Galileo discovered the second largest planet in the Solar System in 1610 and, a few years later, Dutch astronomer Christiaan Huygens deduced that it had rings.

The gas giant does not have a solid surface but is made up of hydrogen and helium with traces of methane, ammonia and ice. More than 700 Earths would fit inside the volume of Saturn. However, the planet's density is so low that it would float if you could put it in a giant bathtub of water.

Saturn's seven groups of rings are made up of billions of pieces of ice and rock. They circle around the planet at high speed and range in size from a grain of sugar to a large house. They are thought to be remnants from comets, asteroids and shattered moons.

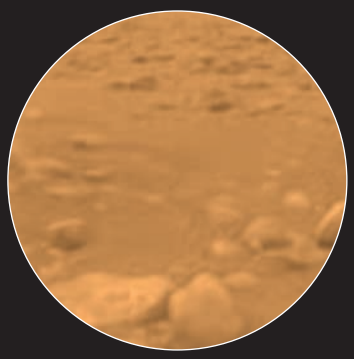
Missions

Saturn was first explored by NASA's Voyager 1 and Voyager 2 space probes, which flew past in 1980 and 1981 on their way to the outer solar system. In July 2004, the international Cassini-Huygens mission became the first spacecraft to orbit the ringed planet.

A joint mission of NASA, ESA and the Italian Space Agency, the spacecraft continues to send back spectacular images and these have transformed our understanding of Saturn and its moons. The mission has proved so successful that it was recently extended until 2017.

The UK has been at the forefront of the design, engineering and science of Cassini-Huygens. In January 2005, the Huygens probe descended by parachute through Titan's atmosphere and survived for several hours on the surface. The first part to touch the ground of this alien world was made in the UK.

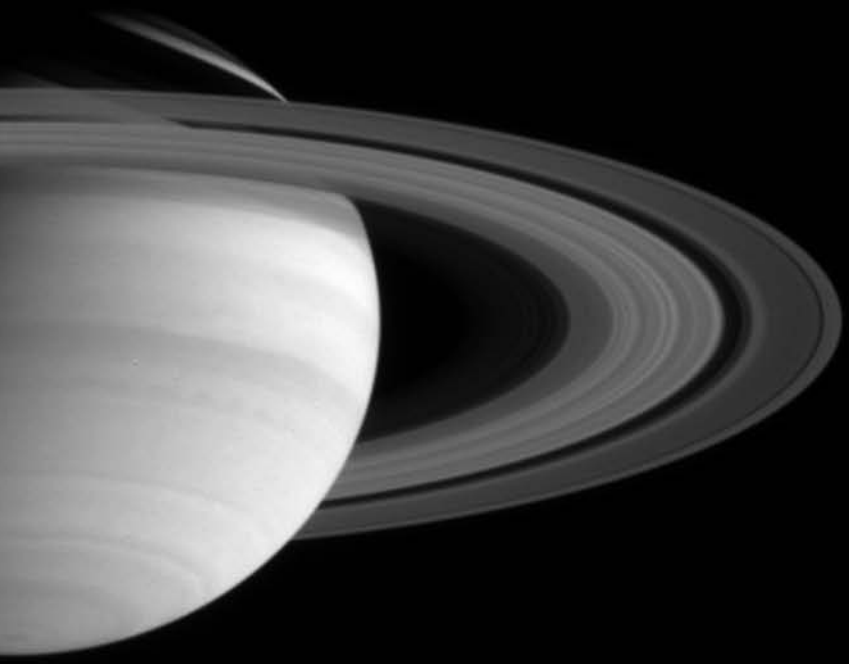
Other achievements of the mission include the discovery of new rings and several new moons. Cassini has also witnessed a massive hurricane-like storm in Saturn's atmosphere and found evidence that the planet's rotation appears to be slowing.

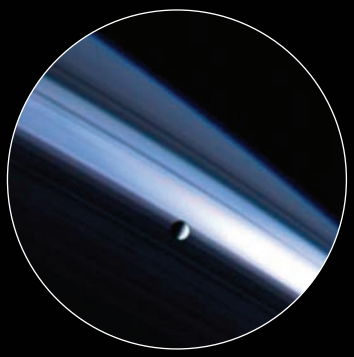


The inhospitable surface of Titan
Credit: ESA, NASA

Main image: Cassini-Huygens was more than 66 million kilometres away when it took this image Credit: ESA, NASA

of the Rings





Saturn's lonely moon Mimas is seen against the cool, blue-streaked backdrop of Saturn's northern hemisphere
Credit: NASA/JPL/Space Science Institute

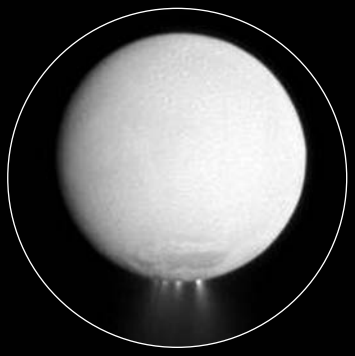
Moons

Saturn has more than 60 moons and new ones are being discovered every year. They vary dramatically in age, appearance and size. Some moons – including Enceladus and Dione – are active, flinging streams of material into space. Others are little more than lumps of ice.

Titan is of particular interest because it is thought to be similar to Earth when it was a young planet. Titan is surrounded by a thick atmosphere and is rich in organic molecules. By studying the moon, scientists hope to gain an insight into how life might have become established on our own world.

Evidence from the Cassini-Huygens mission suggests that Titan has hydrocarbon seas, methane rain, erosion, stream-like drainage channels and dry lakebeds. The surface of the moon where the Huygens probe landed shows it has a consistency of soft, damp sand.

One of the most curious recent discoveries has been made by a UK-led team who used instruments on Cassini to investigate a mysterious atmosphere around Saturn's icy moon Enceladus. Further investigation has revealed that this tiny moon expels around 250 kg of water every second through a collection of jets at its south polar region. UK scientists were also surprised to discover charged particles within this remarkable plume.



Water plumes shoot from Enceladus
Credit: NASA/JPL/Space Science Institute

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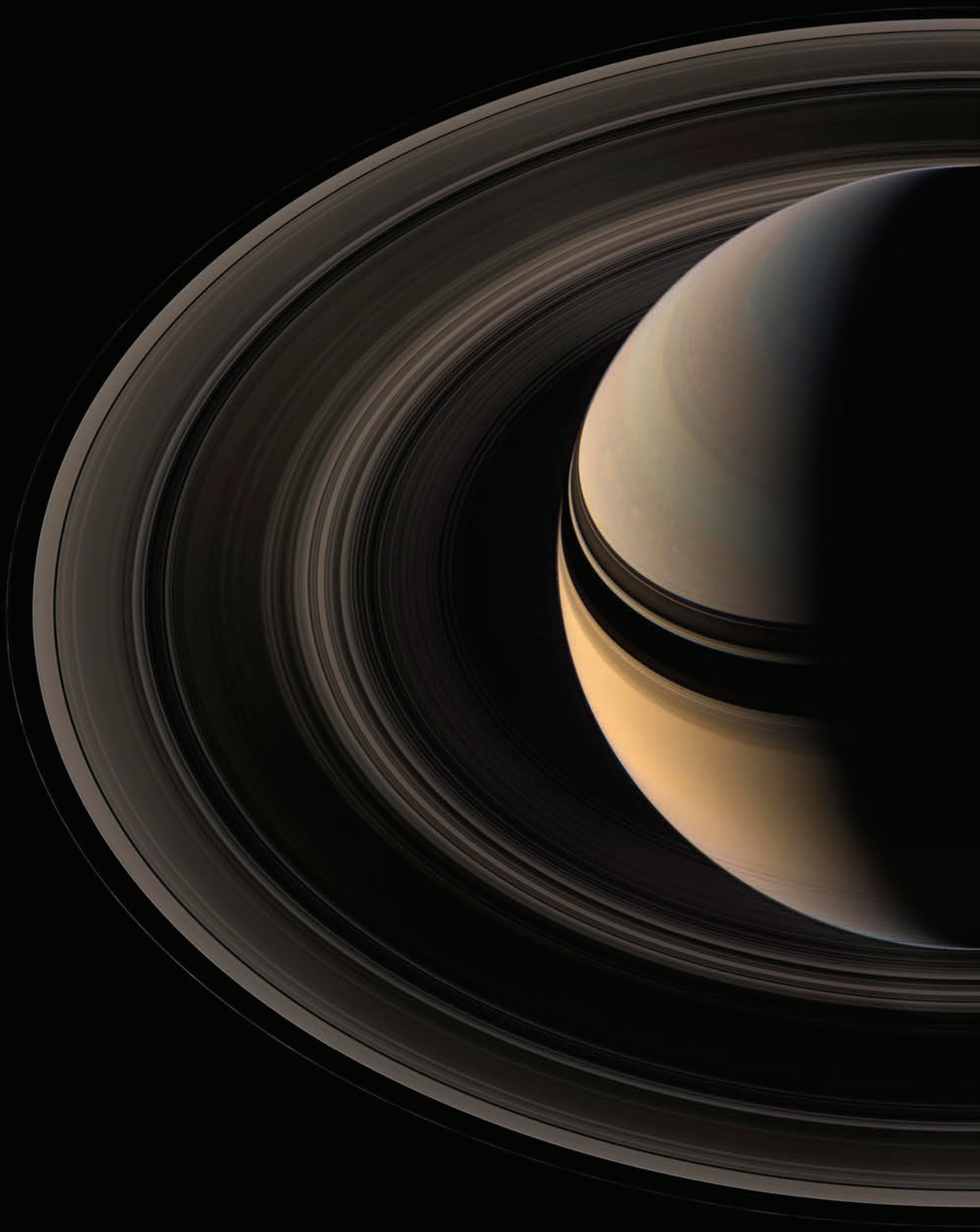
Sat

The sixth planet from the Sun is a gas giant surrounded
Saturn has more than fifty moons including Titan, which is enveloped in



45 different images went into making-up this picture of Saturn captured by the international Cassini-Huygens spacecraft Credit: ESA, NASA

Life on Mars

The high-resolution camera (HRC) on PanCam, which is provided by Germany, will provide zoomed colour images to add the texture of the rocks and soil. "In addition to that, the close up imager CLUPI can look in even more detail," says Coates, "and then both our HRC camera and CLUPI will be able to look at a sample before it's ingested into the analysis system on board.

"So we will not only be able to take images of the scene and play a key role in mission planning," he says, "but we will also get detailed geology and an understanding of the sample which we can analyse to look for signs of life."

Establishing if there is life elsewhere in the Solar System is an important scientific endeavour, with both ExoMars missions paving the way for a future mission to return a sample of soil from Mars.

Previous missions to Mars have already established that there are polar ice caps mostly made of frozen carbon dioxide. There are also clouds of water in the atmosphere, seasonal weather patterns and features ranging from canyons and craters to dusty plains and mountainous volcanoes.

The planet may be dry and rocky, but PanCam's wide-angle cameras also contain filters that will allow scientists to examine water in the Martian atmosphere. "Imagine being on Mars looking at the sunset," says Coates. "We expect to be able to see the amount of radiation absorbed by the atmosphere attenuated by the atmosphere at a particular wavelength, which is a tell tale sign of water."

The ExoMars rover will be able to drill two metres beneath the surface **Credit:** ESA

UK science can also be found on the rover's Raman Laser Spectrometer with Leicester University, Bradford University and RAL Space helping to develop its CCD camera.

"We've packed as much science as we can into the PanCam design"

Andrew Coates, MSSL

continues >

ExoMars builds on the work being done by NASA's Curiosity rover, which captured this panorama of the surface of Mars **Credit:** NASA

Testing the Bridget rover in the Atacama Desert **Credit:** Airbus DS

Mars in Hertfordshire

Even the rover itself will be built on British soil. Construction will begin this year by engineers and space scientists at the Stevenage site of Airbus Defence and Space (Airbus DS – formerly known as Astrium UK) in Hertfordshire. Airbus DS is well prepared, as it has already built a number of prototype Mars rovers. "We've Bridget, Bruno and another one called Bryan," says Ralph Cordey, head of science business development at the company.

The site's simulated Martian surface, where the prototype rovers are tested, has now made way for a much larger Mars Yard Test Area. This was officially opened in March (see page 1).

It is now a 30 metre by 13 metre plot of simulated Martian terrain, using 300 tonnes of sand. Space scientist Cordey is standing in the middle of Mars when I speak to him.

"It's bigger, shinier and more representative of Mars," says Cordey. "It's intended to allow the visual system to operate as it would do in Mars and also to allow us a greater range of traverse on the simulated surface."

The most recent prototype rover, Bryan, represents the geometry and the physical behaviour of the final flight rover on Mars. "It doesn't look like the final rover will look," explains Cordey, "because it's not carrying the instruments but it's intended for a specific purpose in the Mars Yard."

Bryan is, however, the closest in design to the final flight ready ExoMars rover. "It has the same layout of wheels and bogies, and it has the same height of camera mast and the same centre of gravity as the rover will have on Mars. It's actually a lighter weight because the gravity on Mars is about a third of that on Earth."

The prototype will help verify the performance of the autonomy, the navigation systems, and the dynamics of the locomotion system. "It's to verify the navigation for autonomously avoiding objects and the performance of the system to make sure it's able to drive where it needs to go."

Airbus DS is also building a new clean room to assemble and test the ExoMars rover. "That one can't be tested in the Mars Yard because of the dust and dirt so it will sit in the clean room," says Cordey. "The clean room is also an investment for the future of the Stevenage site for other missions both scientific and commercial."

Human exploration

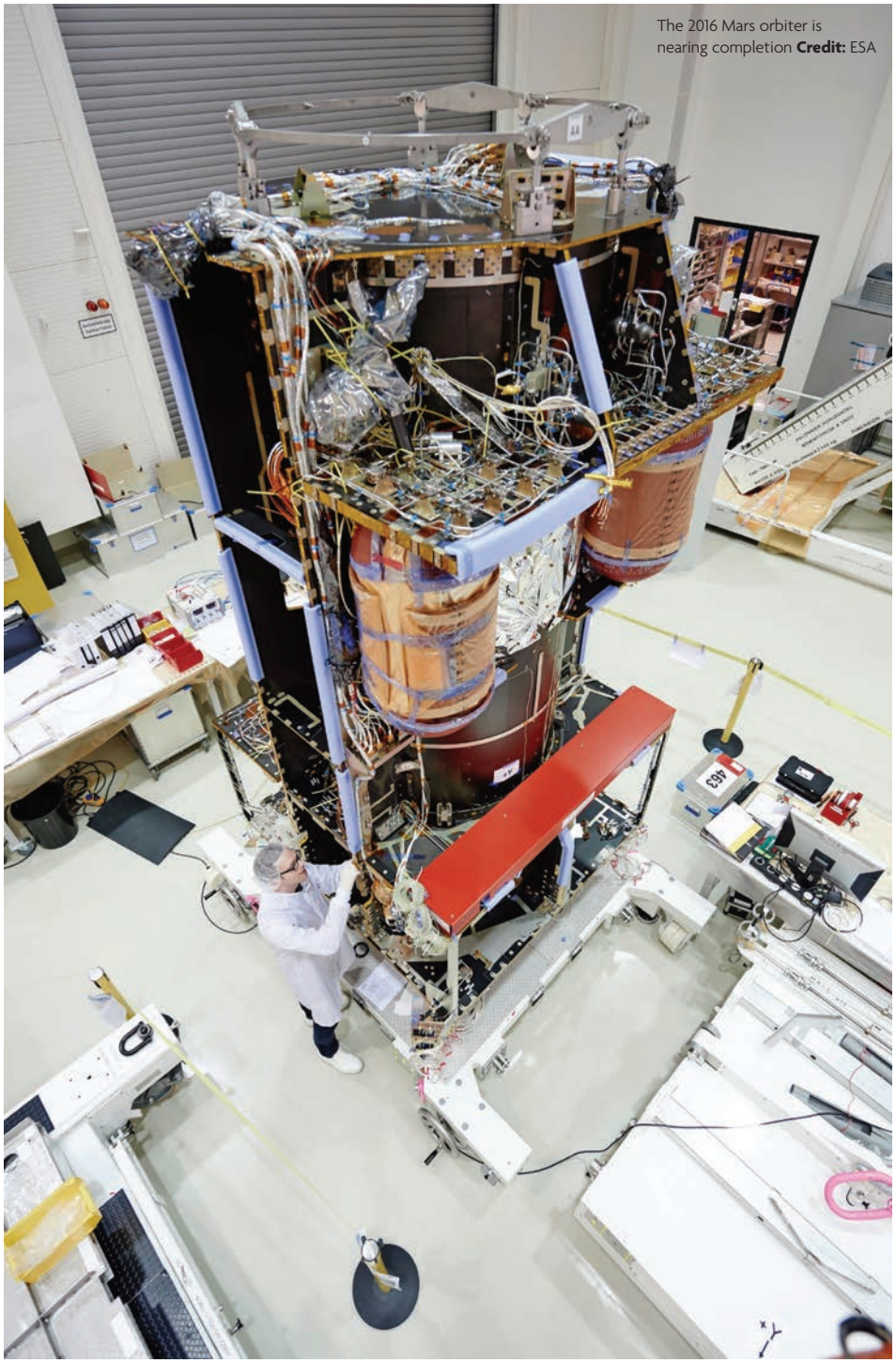
Airbus DS has decades of experience building and delivering spacecraft, as does MSSL with scientific space instruments. The project manager at MSSL, in charge of ensuring PanCam all goes to plan, is also a seasoned pair of hands. Craig Leff worked at NASA's Jet Propulsion Laboratory (JPL) in California for almost 20 years, including five years on the Spirit and Opportunity rovers. He's also worked on the Curiosity rover in Madrid. While this is his third Mars rover project, Leff remains enthusiastic.

"The whole thing is a thrill, being able to build a camera that will take pictures of Mars and help explore a region of Mars we've never seen before," he says. "It's a great opportunity that doesn't come up very often and I've been very lucky."

So how does working at MSSL in the UK compare to working at NASA?

"MSSL is NASA JPL in a microcosm," he says. "It's a concentrated set of specialised people building space instruments and helping design space missions. PanCam is the first big international team I've managed. It's the most responsibility I've been landed with too. It keeps me up at nights but it makes me want to get up in the morning."

At one stage ExoMars was a joint mission between ESA and NASA. After funding issues, NASA pulled out and ESA is now working with the Russian Federal Space Agency, Roscosmos. Russia will provide the Proton rockets to launch both the ExoMars missions as well as building additional instruments. The Russian infrared spectrometer (ISEM) for ExoMars, for example, will complement PanCam in helping with mineral identification. "We're working together on this," says Coates. "We invited Russian scientists to join our team and vice versa."



The 2016 Mars orbiter is nearing completion **Credit:** ESA

The PanCam Calibration Target includes panels made of stained glass **Credit:** Aberystwyth University

UK scientists are also involved in the earlier 2016 ExoMars orbiter. This mission will pay particular attention to observing methane in Mars' atmosphere, a gas that was first detected by ESA's Mars Express in 2003. Together, the two missions lay the foundations for future human exploration of the Solar System. "The surface of Mars is not where you'd look for life," says Coates, "you have to go beneath the surface and this is the first mission to really do it."

"This is made in Wales going to Mars, I'm trying to figure out how to get a Welsh dragon on there"

Dave Barnes, Aberystwyth University

Meet the Minister for Space

Hubble image of spiral galaxy NGC 1084 **Credit:** NASA, ESA

Minister for Universities and Science, David Willetts, oversees the UK's space programme and the work of the UK Space Agency. *space:uk* editor, Richard Hollingham, has been talking to him about his ambitions for the future of Britain in space:

You are often known as the Minister for Space, is that a title you enjoy?
I enjoy the responsibilities that come with being 'Space Minister'. It's an incredible opportunity because my responsibilities at the Department for Business, Innovation and Skills are science, technology and innovation. Space is a crucial part of that.

In a recent speech you described this period as a new era for space in the UK. What do you mean by that?
First of all, we've had quite an unusual model of how we've done space for the past 20 years. We haven't had any launcher system and we haven't had a big central state technology organisation like NASA. That means we've ended up more nimble, more privately funded and less tied up in spending on big launchers than most other advanced economies.

I think now, as money is tight, as conventional space launcher technologies start seeing challenges from new arrivals, suddenly the British model looks quite well suited to the future of space. I have a lot of other ministers [from other countries] look at us and think they want a different balance between public and private activity. They don't want quite so much of their budget going on big conventional launchers.

:meet the minister for space

The second thing is that Britain can leverage the great history we've got and our high reputation, to be more active internationally. I was pleased we were able to play such a positive role at the European Space Agency (ESA) Ministerial [in December 2012]. I was also pleased we got the flight for British astronaut Tim Peake and, when I go round the world, space collaboration is high on the Government's list.

We can hold our heads up high, we can be proud of not only what we've done in space in the past 50 years but what we're going to do in the future.

When it comes to launchers, the Government is now putting money into development of the SABRE engine for the Skylon spaceplane, which is being built by Reaction Engines in the UK.

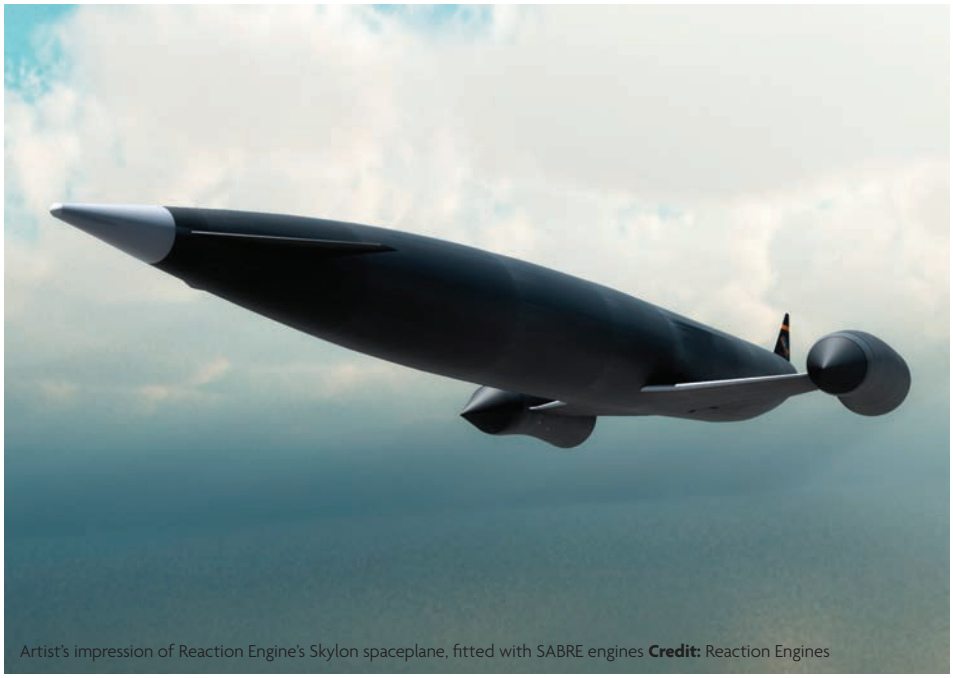
My impression is what is happening is the conventional, big, publically funded launch capability model is coming to the end of its life. And it's got at least two threats.

One is new technology, such as Virgin Galactic launching satellites or Reaction Engines. Secondly, there are new commercial models with providers such as SpaceX coming on the scene. You put those two together and I think the next 20 years are going to see much more radical change in launch systems than the previous 40 years.

David Willetts (l) with ESA Director General Jean-Jacques Dordain (m) and Roy Gibson (r) ESA's first DG, at the naming ceremony for the new European Centre for Space Applications and Telecommunications building at Harwell **Credit:** UK Space Agency/Max Alexander

That turning of the kaleidoscope is a great opportunity for Britain and it's one of the reasons that I, along with the Chancellor, took the decision to put funding into Reaction Engines. I think when there is a set of new challenger technologies coming along, and some great ones emerging in Britain, we should bloody well back them!

I can't guarantee they'll succeed but it's just possible that at the moment what is being hatched at Reaction Engines will be one of the main launch technologies of the next decade.


Artist's impression of Reaction Engine's Skylon spaceplane, fitted with SABRE engines **Credit:** Reaction Engines

You have also talked about having a UK spaceport.

The idea of the UK having a spaceport is on the cards and that is something we're looking at. No final decisions have been taken. There are quite tricky issues of which airspace is used, there are obviously strong arguments for having it on the coast and fortunately Britain has a lot of coast!

There are changes at a European level when it comes to space. As well as ESA, the European Union (EU) has started commissioning its own space systems: Galileo, the satellite navigation system, and Copernicus, a new Earth observation system. How do the two European institutions fit together?

This is a live topic and I hope it'll be finally resolved later this year when the ESA Ministerial happens. My view is we can use straightforward, pragmatic decisions here.

I think the European Space Agency works and collaboration is one of the key features with space, you can't just do it on your own. So, independent nation states coming together and signing a treaty and cooperating in the European Space Agency is an excellent model.

continues >

:meet the minister for space

The Minister and head of the UK Space Agency David Parker, examine a model of the UK's UKube-1 satellite **Credit:** UK Space Agency

ESA can do work for the EU, in particular it can do research and development work. After that it might well hand back the project for the EU to deliver in a way that is efficient.

For Galileo and Copernicus, it looks like it involves the EU setting up distinctive organisations to run them. But the European Space Agency can also do things that EU member states want to do that are completely independent of the EU.

There must be some way that we can make all this work, it's got a bit complicated since the Lisbon Treaty. I think with good will and some flexibility on both sides, it's a workable model.

Until the last few years, UK space policy was against funding astronauts – are you excited that Britian is backing human spaceflight now and that we have the first official British astronaut, Tim Peake, flying to the International Space Station (ISS) in 2015?

I'm very excited indeed and I'm very pleased to have been able to secure this. But my excitement is not the important thing. I want to see millions of British school kids being excited and, all the evidence is, having a British astronaut up there on the space station suddenly brings the space adventure to life and people realise what it's about.

The more schools that identify projects for Tim to carry out, the more he can communicate with them, the more online information about his training programme, I really want to harness that and Tim Peake wants to harness that. He's a great guy, he's got kids of his own and he absolutely sees the opportunity here.

There's a lot we can do to help people at school – at whatever age from primary to secondary, through to college and university to get young people in Britain more focussed on space.

Do you see this as the start of the UK backing human spaceflight or is this a one off?

There is a set of negotiating issues there and I don't want to reveal my negotiating position! But, look, I think human spaceflight does bring with it something special that you wouldn't otherwise get.

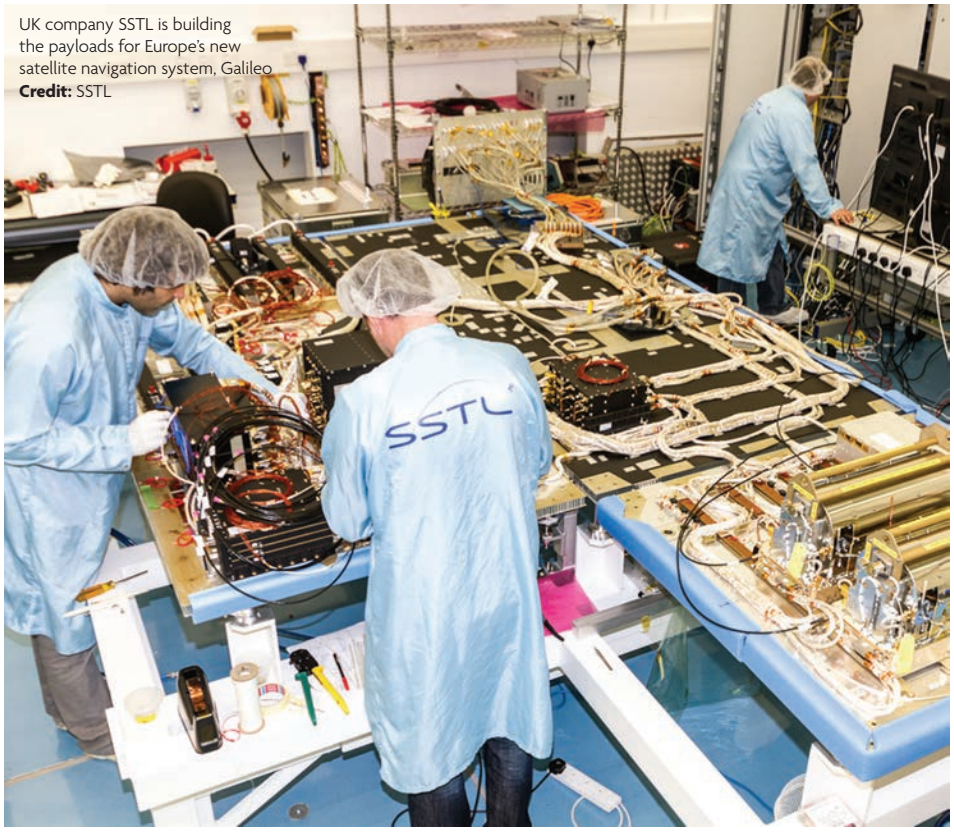
Tim up there will be doing serious research on phenomena such as human aging. A healthy astronaut in conditions of microgravity for weeks or months on end, goes through something rather like a speeded-up aging process. Their bones thin, their muscles are not as strong as they were. So you can help to understand aging if you track what's happening to a person in space.

:meet the minister for space

What's your feeling about the ISS – ten years ago, when I first started at *space:uk*, one of your predecessors in the Government described it as an orbiting white elephant?
I think the ISS is one of the world's great global science projects. I think it's up there with the Large Hadron Collider. The whole place is not just fascinating, it's worthwhile and it's great that Britain is participating in it.

Do you have any ambitions yourself to sign up as a space tourist?
I don't think I can quite afford Richard Branson's fare! I was offered one of those parabolic rides and, I must say, that didn't particularly grab me. Who knows? I'm now in my 50s...it would be good if the technology moves on. If getting into low Earth orbit becomes widely accessible then, yes, I would love to do that.

So what is your vision for the UK in space?
I can see the UK, first of all, nimble, enterprising and adventurous. I can see us doing really great science. I can see us moving more rapidly than almost anyone else into new technologies. And I can see the range of things that British science and British technology can do in space growing as we embrace some really good technologies, many of them being developed in research and development facilities across Britain as we speak. And if there's any young person reading this, I hope they'll want to be part of it.



UK company SSTL is building the payloads for Europe's new satellite navigation system, Galileo **Credit:** SSTL

You can listen to this interview, as an audio podcast, on the UK Space Agency website.


The UK has now given its backing to the ISS **Credit:** ESA, NASA

Landing on the beach at Barra **Credit:** Loganair

New horizons for UK space industry

Space funding from Europe will provide opportunities for UK businesses and researchers:

Flying into the Hebridean island of Barra is described on the airport website as a 'unique landing experience'. That is because it is not so much a runway, as a beach.

For pilots operating the daily scheduled flights to the island, this makes landing on the wet sand at this remote airport something of a challenge. It also means that if visibility is poor – as it can often be – flights have to be postponed or cancelled for safety, inconveniencing passengers. However, space technology could soon provide a solution.

Airline Loganair – which operates flights across the UK on behalf of Flybe – has been working with the national air traffic control company, NATS, to test a new European satellite navigation system. Known as EGNOS, this system augments the GPS navigation signal, making it accurate enough to navigate ships through narrow channels or land aircraft on remote runways.

"It will be something like eight or nine times safer," says Tim Kinvig, Flight Manager Technical for Loganair, who flies and tests the company's aircraft and landing procedures. "At the moment, to land at a typical regional airport, you might need two or three thousand metres visibility but with the EGNOS system that will probably reduce down to 1000 metres or less."

Money to trial EGNOS at small airports and remote airstrips was provided by NATS through a European Union research and development programme called FP7. Putting the EGNOS navigation system into practice is just one example of how this multi-billion Euro programme has benefited UK businesses and consumers.

New ideas

When it comes to space, money from FP7 has funded the development of navigation, communications, Earth observation and space science technologies. A project led by the University of Surrey, for instance, secured FP7 money to develop a 'deorbit sail' to help combat the problem of space debris. This sail can be deployed at the end of a satellite's life, increasing the drag on the spacecraft and pulling it out of orbit.

In fact the UK Space Agency estimates that investment into Britain from the final funding round of FP7, in the space sector alone, amounted to more than €30 million. This is in addition to any money from the European Space Agency.

Now, the seven-year successor programme to FP7, called Horizon 2020, is underway. This is specifically aimed at promoting scientific excellence as a means to economic growth. In this new round of funding, almost €1.5 billion of the total €79 billion budget is set aside specifically for European space research and development projects. On top of that, there is considerably more money potentially available for space projects from other Horizon 2020 programme areas, including climate change, transport and agriculture.

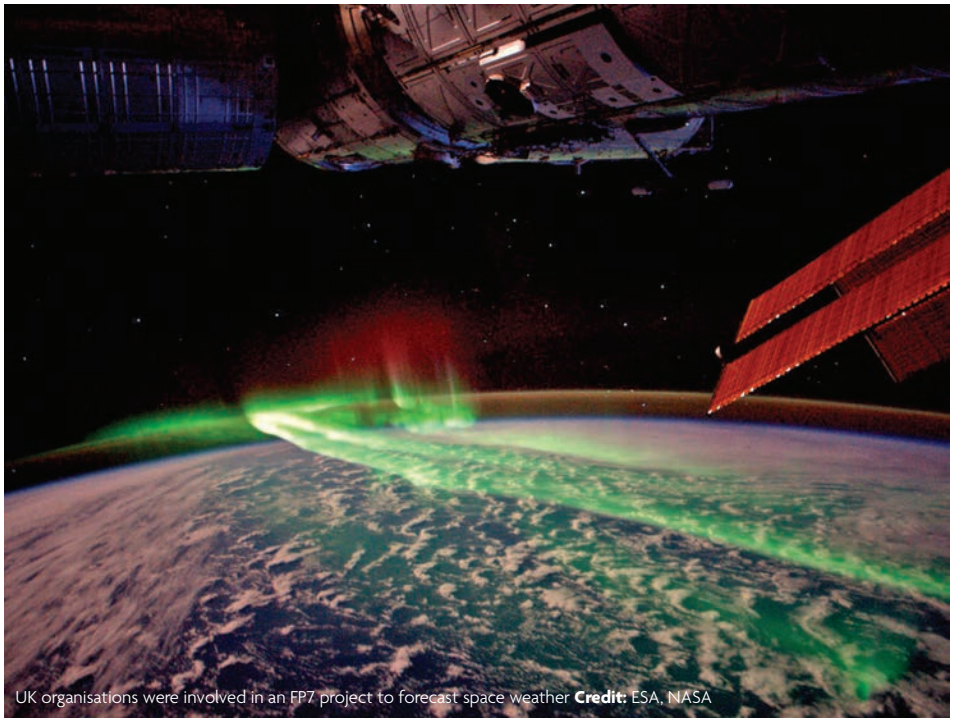
The UK Space Agency wants to see an increase in the number of proposals submitted by UK industry or research teams. It is part of the Government's ambition to significantly grow the UK's space business.

"There's a lot of money there and a lot of opportunity," says Lee Boland from

the UK Space Agency. "There's one and a half billion euros worth of direct funding and much more from other programmes. If the UK could access even part of that money that's a great investment in space research and development."

Horizon 2020 specifically targets collaborative projects, which typically bring together companies and academic institutions in different parts of the EU.

"What people should really be looking for is the chance to collaborate with other partners across Europe to get a project going," says Boland. "It's about more than the research and development funding itself, it's about positioning for new markets, it's about trying out new ideas with new partners." Ultimately, any projects funded through Horizon 2020 are designed to benefit EU science, economies and European citizens.



UK organisations were involved in an FP7 project to forecast space weather **Credit:** ESA, NASA

Good track record

However, applying for European funding – particularly with a new group of international partners – is often perceived as challenging, with long forms and independent evaluation of bids. The European Commission has recently streamlined procedures and UK teams have a good track record of success.

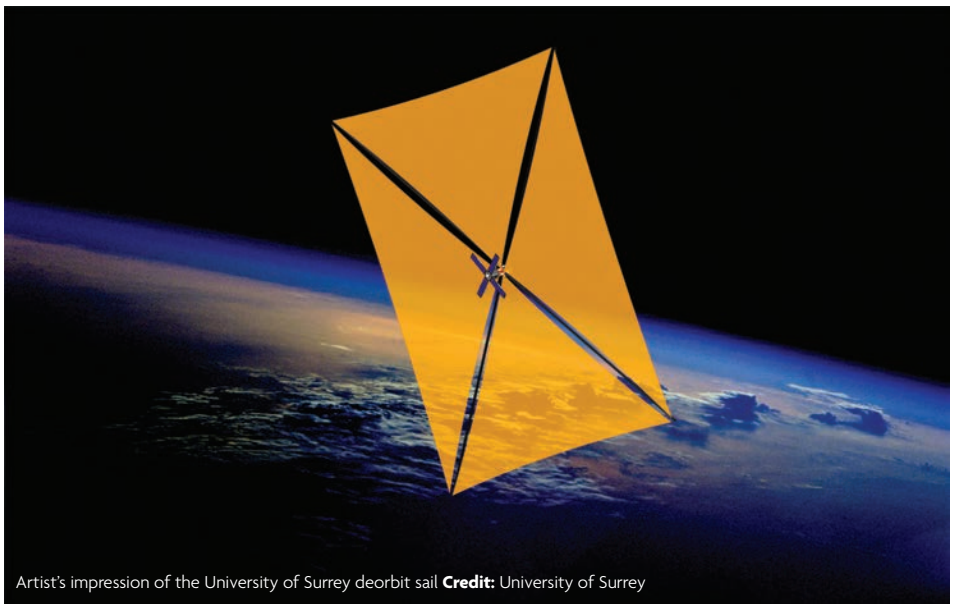
"We can put together excellent projects at an international level," says Robert Lowson, the UK's EU space national contact representative. Lowson provides support and advice to organisations seeking to access Horizon 2020 funds. "In the last round of FP7, Britain performed better than any other EU state with 12 of the 55 projects being led from the UK."

So how does it work in practice? "Each year there's a work programme; businesses and researchers look at the programme and set up or join a consortium," Lowson explains. "It's absolutely essential that the consortium is made up of partners from at least three different countries."

In the last round of FP7 funding, more than two thirds of the money went to academic institutions and the Government hopes to see greater involvement from business.

"I am very keen to stimulate more interest in the opportunities provided by Horizon 2020 outside the academic sector," says Lowson. "It would be good for business – particularly small businesses – to take more interest in the opportunities offered by Horizon 2020. I would also like to see the excellent work being done by the academic sector feeding through into industrial applications."

That view is echoed by Boland. "It's a very good mechanism for businesses to collaborate with universities," he says. "It would be good to see UK businesses – big, medium or small – being more involved."



Artist's impression of the University of Surrey deorbit sail **Credit:** University of Surrey

To find out more about Horizon 2020 visit: www.h2020uk.org

Deorbit sail: http://deorbitsail.com

Robert Lowson can be contacted via: robert.lowson@tsb.gov.uk

Ask the experts

Our questions in this issue, on mining the Moon and the achievements of the International Space Station, come from @spacegovuk followers on Twitter.

Richard Holdaway
Director RAL Space

What is your opinion on Moon mining and whether it will become a reality?

From @rhiannaspacelaw

Ever since man first looked up at the Moon, many thousands of years ago, people have wondered what it is made of and what might be lurking below the surface. Anyone over the age of 40 will know from TV that the only permanent inhabitants of the Moon are the Clangers, who live in lunar caves and eat green soup.

Today, we know a lot more: first the Apollo missions to the Moon told us a lot about the lunar surface and rock structure. The USA Clementine mission in the mid 1990s discovered the presence of water (in the form of ice) near the lunar south pole and ESA's SMART-1 discovered significant quantities of iron, magnesium and silicon. In recent years there has been speculation that there are also significant amounts of high-value minerals on the Moon, possibly including platinum.

There are two possible reasons for mining the Moon: financial and strategic. Neither NASA nor ESA has shown any particular interest in mining but China has recently demonstrated its interest by undertaking some preliminary surveying using radar on its Yutu (Jade Rabbit) lunar rover. A number of privately-backed consortia are also looking at the business case for mining.

So what is there of particular interest to mine? There is water, to enable humans to live on the Moon; helium to use as fuel to transport humans and equipment to other parts of the solar system; materials, such as iron, to build structures or spacecraft; and resources that can be brought back to Earth for commercial exploitation.

Perhaps the most interesting of these is the abundance of helium-3 on the Moon. We are facing a dire shortage of helium in general and helium-3 could have a variety of industrial uses, including fusion energy research. It is just possible that the Moon could provide that source of helium-3. It is said that a container lorry of helium could power Europe for a year.

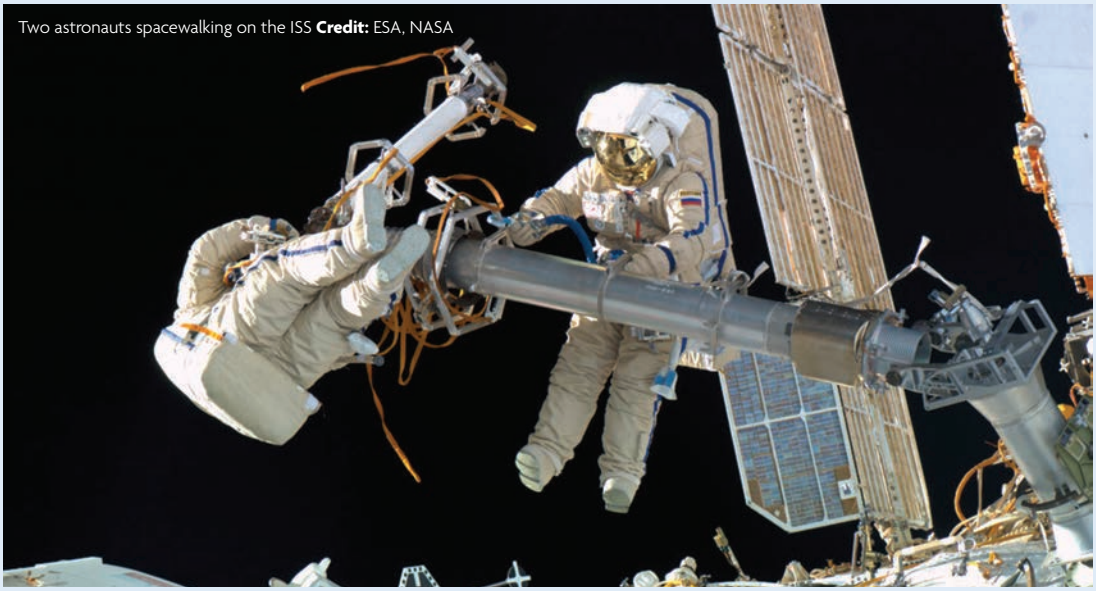
So, what is the timescale? The technology to mine the Moon in some form is already pretty close. The key issues right now are more likely to be cost and exploitation rights. My guess is that before 2020 (yes, less than six years away) some form of mining exploration may well be underway.

Finally, there is the tricky question of who actually owns or has rights to explore or mine the Moon. According to the 1967 Outer Space Treaty of the United Nations, countries are prohibited from laying claim to the Moon. The possibility of lunar mining and the emergence of private space companies has triggered a debate over lunar property rights. However, at the moment there is no clear way forward.

Artist concept drawing of a European Moon base
Credit: ESA, Foster and partners

Has the ISS achieved all it can expect to?

From @francissheridan


Two astronauts spacewalking on the ISS **Credit:** ESA, NASA

Construction of the International Space Station (ISS) began in 1998 with two main objectives in mind: to provide a permanent human presence in space, and to conduct scientific research. It has certainly excelled in the first, with uninterrupted habitation since November 2000, with 211 people (including seven tourists) spending time living aboard the station. However it is also arguably the single most expensive item ever constructed, with the total cost of the project running at over $150 billion. Have the achievements justified the cost?

If mankind is going to extend our natural curiosity to explore further into the Solar System, then the study of humans in long-term microgravity and relative isolation is vital. The ISS has revolutionised our understanding in these areas. We have also seen that it is possible to build, manage, maintain and manoeuvre a football field sized orbital science laboratory. The engineering developments will have consequences for future human spaceflight applications.

However critics argue that the secondary science objectives could have been achieved for far less cost using unmanned robotic spacecraft and that money that could have been spent on many smaller missions has been squandered.

Perhaps the greatest importance of the ISS has been as a focus for international collaboration. Following the fall of the Soviet Union, plans for another Mir space station and the suggested American station Freedom floundered due to cost and technical problems. There was also a very real fear that former Soviet space engineers might be tempted to go to work for rogue states. As a result, in 1993 the US and Russia agreed to combine their knowledge and technological strengths to collaborate on this joint space station.

With the Russians providing the bulk of the knowledge of pressurised habitation modules and the heavy lifting capacity, and the US providing the means to get people to the ISS and service the station with the space shuttle, a grand era of co-operation began.

Over time, further space agencies and countries have joined the programme to provide parts, expertise, funding and astronauts. In fact the ISS now has 23 contributing countries. It has been so successful in uniting so many countries through the medium of joint scientific exploration and advancement that there have been suggestions it should be nominated for a Nobel Peace Prize.

So the ISS has undoubtedly achieved much of what it set out to do, but one final effect is the awe and wonder generated in members of the public by knowing we have managed to overcome the dangers of living in space. And if you are lucky enough to look up and spy the ISS making a pass over your head at night, just remember, there are humans on that. And that is amazing.

Sophie Allan
Physics Teacher
National Space Academy

Meet the team:

Allan Clements
ESERO-UK Manager

Alice Coates
STEM Project Officer

Rachel Jackson
Primary Specialist

Tom Lyons
ESERO-UK Teacher Fellow

Teaching Earth and space

It is an exciting time for schools to engage students with space. In 2015, Tim Peake will become the first British ESA astronaut to visit the International Space Station (ISS), the Gaia spacecraft has set forth on an ambitious mission to chart a 3D map of the Milky Way and Rosetta has woken up from deep-space hibernation in order to rendezvous with a comet.

The UK branch of the European Space Education Resource Office (ESERO-UK) has been established to promote the use of space to enhance and support the teaching and learning of science, technology, engineering and mathematics (STEM) subjects. A vital part of the project is the ESERO-UK collection of space resources, which brings together materials to help teachers and lecturers use space as an engaging context for teaching and learning.

Resources for Primary Science

National STEM Centre Primary Specialist, Rachel Jackson, has put together a list of resources to support the new primary science curriculum. This consists of lesson plans, activities and video clips to support the teaching of Earth and Space in Year Five (Ages 9 to 10). It contains tips on using the resources, suggestions for further use and background subject knowledge. Possible misconceptions are highlighted so that teachers may plan lessons to facilitate correct conceptual understanding.

Designed to support the new curriculum programme of study in England, the resources aim to cover many of the requirements for knowledge, understanding and working scientifically.

www.nationalstemcentre.org.uk/earth-and-space

The resource *Is there anyone out there*? is very popular with primary teachers. It contains hands-on activities and uses the context of exploring Mars for the evidence of life. The activities are organised into three themes: life, landscape and landing. As well as science, the resource also covers mathematics, geography, literacy and ICT.

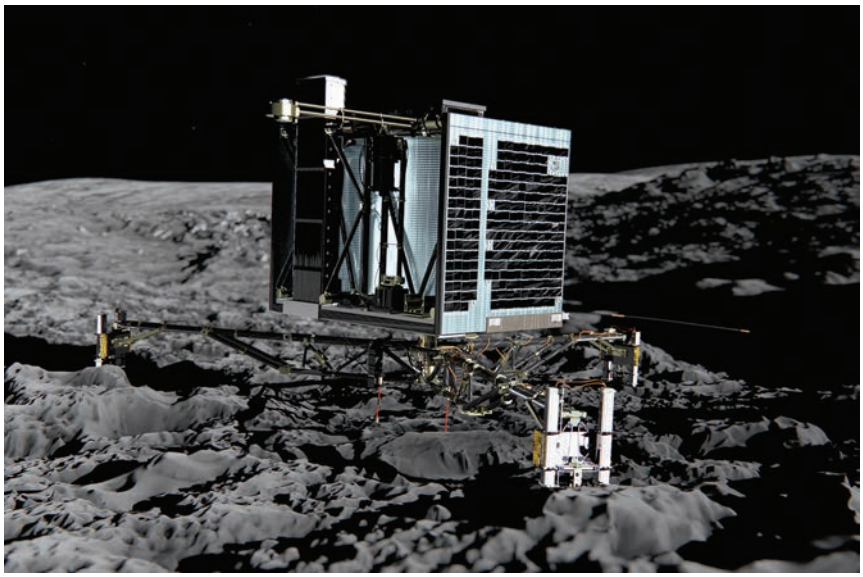
http://stem.org.uk/rx7kt

The ESA kids website also contains some great activities which pupils can use to research homework assignments or just have fun.

www.esa.int/esaKIDSen

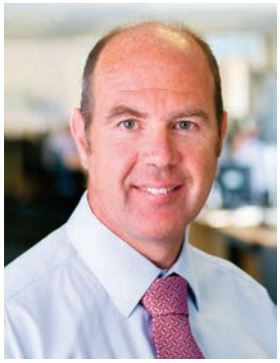
ESERO-UK is currently adapting space resources – produced by the ESERO in the Netherlands – for use by primary schools in the UK. The Dutch resources have been translated into English and will be made available to UK teachers at the start of the autumn term so that they can be used when Rosetta's lander makes contact with comet 67P.

The resources include the history and size of the Solar System, meteorites and how to make use of solar energy. There will be much media interest at the time of the landing on the comet, which will add to the excitement of the science lessons. This excitement will continue into 2015 as we prepare for Tim Peake's mission to the ISS.



Artist's impression of the Philae lander on comet 67P/Churyumov-Gerasimenko **Credit:** ESA

Fine Tubes is a medium sized manufacturing company, employing around 380 people, based in Plymouth. Its Business Development Manager for Aerospace is Paul Mallett:



Paul Mallett

What does your company do?

We manufacture small diameter, high quality metal tubes in stainless steel, titanium and nickel alloys. We aim at the high precision market where there are challenging applications. For example, we supply tubes to the aerospace, oil and gas, medical, nuclear power and space industries. In spacecraft our tubes tend to be used in the propulsion systems for moving fluids around.

What space missions have your products flown on?

Some are used in launch vehicles; others are used in deep space missions. We recently supplied tubes for ESA's Solar Orbiter mission, which is due for launch in 2017 to make a detailed study of the Sun.

What's it like to work in space?

Quite a lot of the applications we're involved with are prestigious and challenging but taking part in space missions is definitely one of the top ones. Personally I've always been a fan of space travel. I like science fiction and grew up with Star Trek, so it's something that's particularly exciting for me.

You didn't set out to work in space?

I was not technically or engineering inclined at school. My qualifications are in languages and sales. It shows you don't have to be an engineer to work in the space sector.

Is there a potential for growth in the space sector for your company?

Definitely. There are a host of companies out there – and we're working with several of them – trying to reduce the cost of access to space by developing economic, reusable launch vehicles such as the Skylon space plane. Not only will that make it cheaper to launch satellites or space probes, I believe it will bring high volume space tourism into reality. It's very exciting to be part of that.

Image top left: Artist's impression of the Solar Orbiter spacecraft
Credit: ESA

Image top right: Some very fine tubes
Credit: Fine Tubes

Bottom image: Fine Tubes supply tubes to Reaction Engines, the UK company developing the Skylon space plane
Credit: Reaction Engines

Europe in space: Part 1

A British-built rocket allowed the UK to participate in one of the first European space collaborations.

A Blue Streak missile being tested at the Spadeadam Rocket Establishment near Carlisle **Credit:** UK Space Agency

The European Space Vehicle Launcher Development Organisation (ELDO) was formed in 1964. The aim of ELDO was to develop a heavy launch vehicle to put European satellites into orbit without relying on American rockets.

The basis for this new three-stage launch vehicle was to be the British-built Blue Streak. This stainless steel rocket was originally developed in the 1950s as a nuclear missile but the Government cancelled the project in favour of Polaris submarines.

Rather than write-off all the money and effort that had been invested in Blue Streak, agreement was reached for it to be used for the first rocket stage of a new European launch vehicle, Europa. The second and third stages were to be provided by France and Germany, while Italy would build the satellite.

The firing range used for the project was Woomera in the Australian outback and in early tests the Blue Streak missiles performed flawlessly. However, when they were mated to the other stages of the Europa rocket, every launch attempt failed because of problems with the other sections.

Eventually, the UK pulled out of the project and the Europa rocket was abandoned. Lessons learned from the programme led to the development of Europe's highly successful Ariane launcher and, along with the European Space Research Organisation, ELDO became part of the European Space Agency (ESA). You can see a Blue Streak on display at the National Space Centre in Leicester.

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