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space:uk

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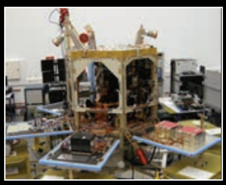

UK SPACE AGENCY

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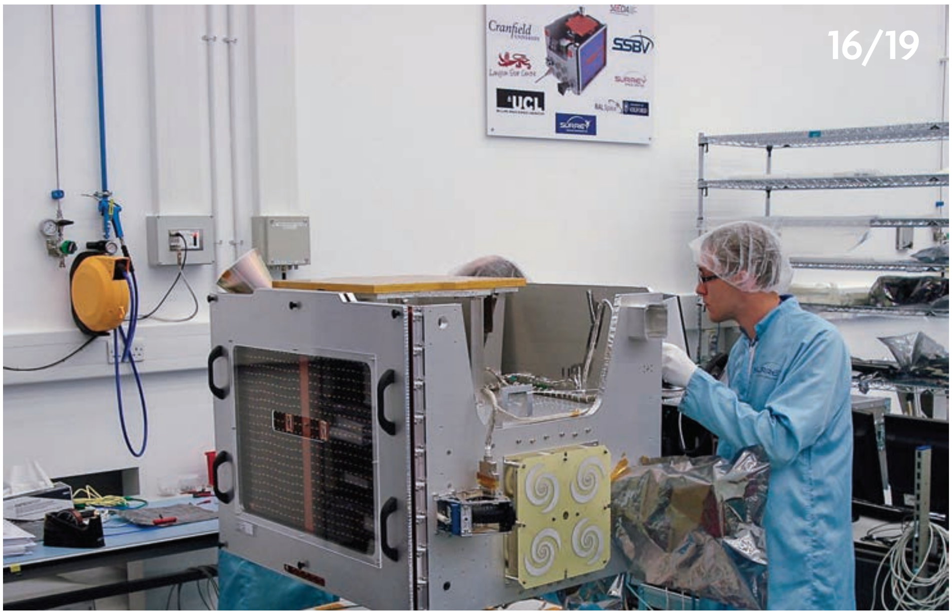

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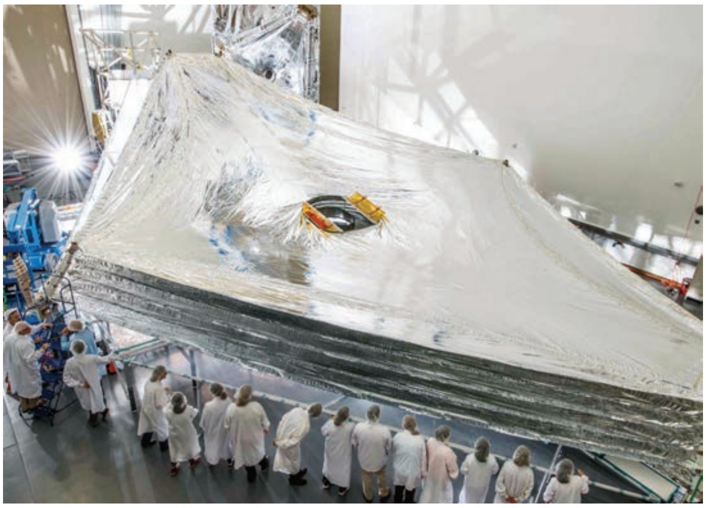
Front cover image Rosetta took this close up of comet 67P in preparation for landing **Credit:** ESA

UK space success



The UK is involved in several major international missions, including the massive new James Webb Space Telescope **Credit:** NASA

The space industry contributes £11.3 billion to the UK economy each year, according to the latest report on the health of the sector.

The Government unveiled the latest growth figures for the UK space sector at the Farnborough International Air Show in July. The independent study, commissioned by the UK Space Agency, concludes that the industry employs more than 34,000 people and has been growing at an average rate of 7.2 per cent, making space one of the fastest growing sectors of the UK economy.

"We're at the dawn of nothing less than a new space revolution," said Aviation Minister Robert Goodwill. "The space industry in Britain is once again confident and flourishing."

Spaceport UK

The Minister also set out plans for Britain's first spaceport and revealed eight potential locations, shortlisted by the Civil Aviation Authority, for the site. The Government's ambition is to open the spaceport in 2018 to help position the UK as a leader in the expanding commercial space market.

A British spaceport could host Virgin Galactic's spaceplane **Credit:** Virgin Galactic

"In order to lead the way on commercial spaceflight, we need to establish a spaceport that enables us to operate regular flights," said the Minister. "The work published today has got the ball rolling – now we want to work with others to take forward this exciting project."

The spaceport could be designed in partnership with a commercial operator, such as Virgin Galactic or XCOR. Both companies are currently developing spaceplanes.

The CAA report estimates that the economic benefits of a spaceport could be worth up to £4 billion to the UK by 2030. The Government has identified space as a key sector for investment and the UK has set that date as a target to capture 10% of the global space business.

Vince Cable and UK Space Agency Chief Executive, David Parker, in the Mars Yard at Airbus Defence and Space in Stevenage where ESA's new Mars rover is being developed
Credit: UK Space Agency

Place for space

Business Secretary, Vince Cable, said: "Exploring the opportunities that commercial spaceflight presents will support the growth of this thriving industry and underpin the economy of tomorrow, making the UK the place for space."

As a major funder of the European Space Agency (ESA), the UK is already a world leader in satellite and space technology. British scientists and engineers are currently involved in missions to investigate the Earth, explore the Solar System and understand the Universe. British ESA astronaut, Tim Peake, will launch to the International Space Station next year, while UK space companies continue to win new business.

"There's a buzz around the industry at the moment," Chair of Industry body UK Space and Chief Executive of Surrey Satellite Technology Limited, Matt Perkins, told *space:uk*. "There are more companies, more people, more interest."

For more on Spaceport:UK see our feature on page 10.

J marks the spot for Rosetta

The countdown is underway to land on a comet:

Rosetta mission scientists are preparing to land a probe on comet 67P Churyumov Gerasimenko after selecting a landing site: "We're flying at 55,000 km per hour, 30 km away from the comet," said Rosetta Mission Manager Fred Jansen during a press conference at the European Space Agency's (ESA) headquarters in Paris on September 15. "The next stage is landing."

The announcement revealed that J – not X – would mark the spot for the planned 12 November landing by the Rosetta spacecraft's Philae lander. Located on the top of the head of the 'space duck' shaped comet, site J offers the best mix of scientific potential and the least risk.

"None of the landing sites met all of the operational criteria 100 per cent," said Stephan Ulamec, the Philae Lander Manager. "But site J is clearly the best solution."

Double structure

The compromise resulted from the unexpected shape of the comet, which appears to be two objects connected together. "Originally we were all thinking that we would get to some kind of rounded potato-shaped comet with rough and structured terrain," said Jansen. "The double structure of the comet really complicates things and has had an impact on the number of viable landing sites we could target."

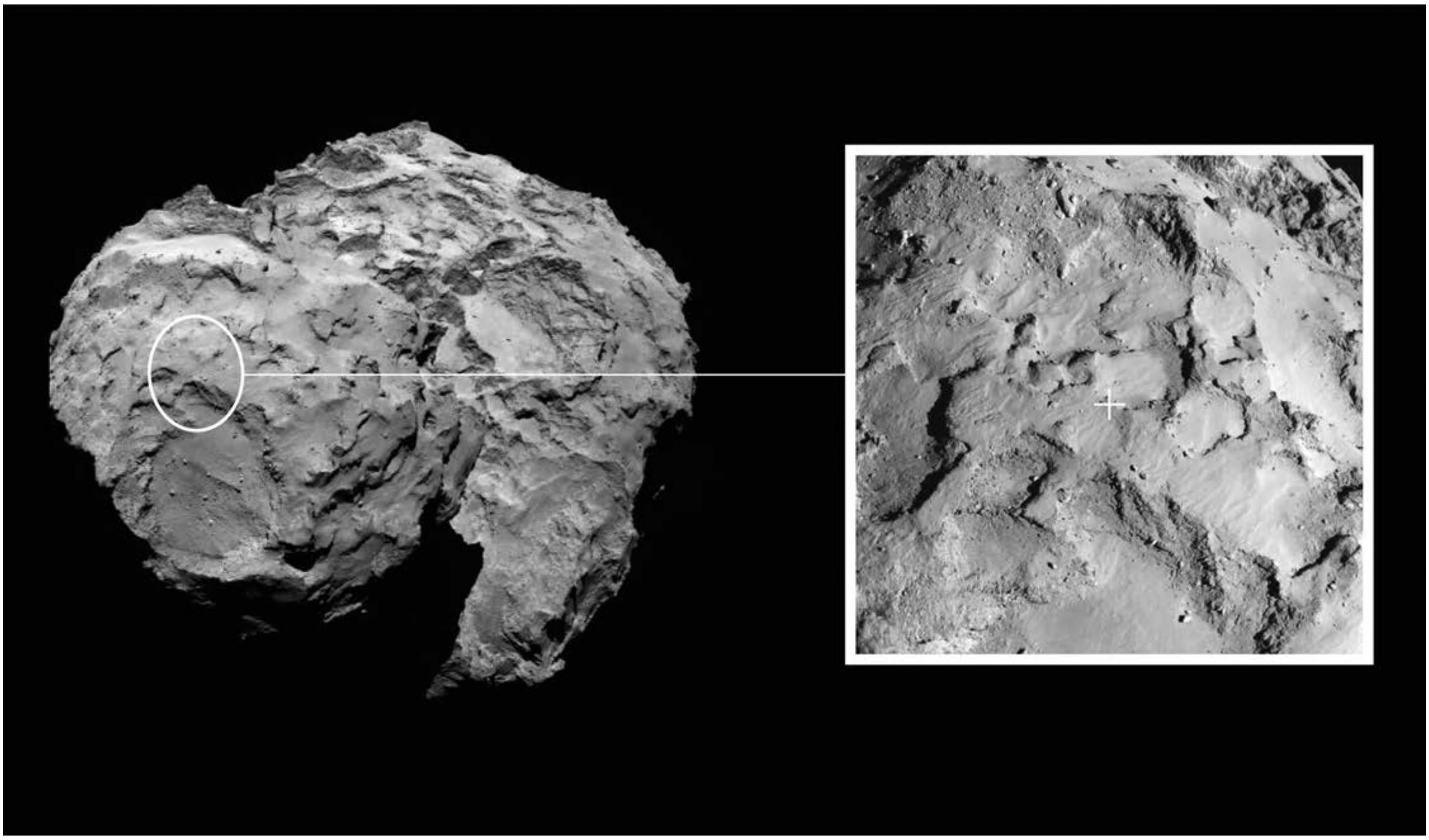
The Rosetta spacecraft arrived at comet 67P in August after a decade long journey. Images revealed the comet's unexpected shape and, from a distance of 100 km, five potential landing sites – A, B, C, J and I – were identified on the 'head' and 'body' of the comet.

Scientists from ESA, Philae's Science, Operations and Navigation Centre at France's CNES space agency, the Lander Control Centre in Germany, and those representing the lander and the orbiter's instruments made the final decision. For two days they assessed each shortlisted site before revealing J as the primary site, with C as back up.

Considerations included a smooth terrain relatively free from boulders, the flight dynamics and orbital manoeuvres necessary to perform the landing, the site's visibility and illumination (the lander needs sunlight to recharge), and the scientific potential.

UK science teams

The main scientific investigation of comet 67P is being done by the Rosetta orbiter, much of which was built at Airbus Defence and Space in Stevenage. After ten years in space, it reached the comet in May and will remain in orbit until the end of 2015. The landing, however, will offer unprecedented insight into a comet as well as providing a 360 degree stereoscopic panoramic view from the surface. As the comet nears the Sun, it will warm up and release material and there are already hints that gas will be released near the chosen site.



Philae's primary landing site on Comet 67P **Credit:** ESA

UK scientists can be found throughout the mission, such as ESA Project Scientist Matt Taylor. He chairs the Rosetta mission's science working team of Principal Investigators (PIs) and interdisciplinary scientists who examine the overall science of the mission.

"The UK has Rosetta involvement at Imperial College London, in the same group where I got my PhD," said Taylor. "Chris Carr is the PI of the Plasma Interface Unit (PIU) of the Rosetta Plasma Consortium, a group of instruments looking to study and measure the plasma interactions at the comet."

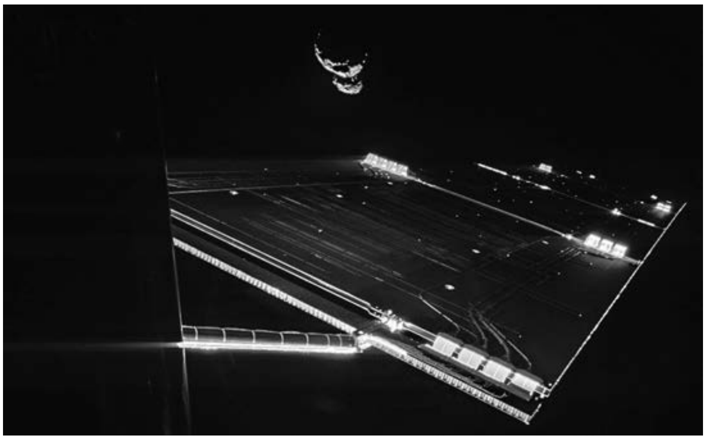
Plasma, a charged gas, is known as the fourth state of matter and can be found in a comet's tail extending up to millions of kilometres away from the surface. "Some of the very first space-based observations of comets were made by plasma detectors investigating plasma interactions," said Taylor. "It's cool stuff."

Ian Wright at the Open University in Milton Keynes is PI of the Ptolemy gas analyser on the Philae lander. "They are going to scratch and sniff the comet nucleus and look at the volatile components, ices and light elements, that are ejected into space to form the coma," said Taylor. The coma is a fuzzy halo of gas and dust surrounding the main body of the comet.

The team at Milton Keynes can only begin work in earnest, however, once Philae touches down on the comet's surface and it is by no means a done deal.

High risk

Any landing is full of uncertainties and risk – risk that involves descending from an orbiting spacecraft onto a comet shaped like a duck with craters, boulders and mountains littered upon



A Rosetta selfie showing the comet **Credit:** ESA

its surface. It could also be a soft or hard landing as the surface composition is not yet known. But then Rosetta always was an audacious mission and the science collected so far by the orbiter is extraordinary.

"We have fully characterised two asteroids, Lutetia and Steins. We have journeyed over ten years to rendezvous with a comet - and that's never been done," Taylor said. "We will continue to ride alongside the comet for over a year, watching it grow in activity to a maximum next year in August 2015 when it gets closest to the Sun."

A successful landing would be the cherry on the cake and Taylor – whose commitment to the mission is reflected by the Rosetta landing tattoo on his leg – is feeling confident.

"We are now on our way to deliver a lander on the surface of the comet. It's not easy. That's why its never been done before. But we have chosen the best place to land and we have the best teams to make this happen."

Artist's impression of the Rosetta orbiter deploying the Philae lander **Credit:** ESA

Small satellite success

The launch of TechDemoSat-1 and Ukube-1 on a Soyuz from Baikonur in Kazakhstan **Credit:** Roscosmos

Two small UK satellites, packed with innovative technology, have been successfully launched from Baikonur in Kazakhstan. The first, UKube-1, was co-funded by the UK Space Agency and built by Clyde Space in Glasgow.

"We've got a stable orbit and we're getting lots of power from the spacecraft," said Clyde Space CEO Craig Clark, speaking after the July launch. "We expect to get more data over the next few weeks."

UKube-1 was launched on the same Soyuz rocket as TechDemoSat-1, which was built by Surrey Satellite Technology Limited and part-funded by InnovateUK. Both small satellites are carrying a number of payloads from UK universities and industry, helping to prove new space technologies.

At 157 kg, TechDemoSat-1 is the larger of the two satellites and contains four 'suites' including one on the space environment. This will be used to study space weather. This harmful solar activity can damage spacecraft and affect power grids and electricity supplies on Earth.

See feature on page 16

Some like it hot

UK scientists will play a key role in the Advanced Telescope for High Energy Astrophysics (Athena) X-ray observatory mission. Athena, selected by ESA in July, will study the hot and energetic parts of the Universe to help unravel its mysteries. These include trying to understand why ordinary matter assembles into galaxies and how black holes grow.

Athena will help scientists understand how galaxies form **Credit:** ESA, NASA

Members of the University of Leicester's X-ray and Observational Astronomy Group contributed to the mission proposal, which will be the largest X-ray telescope ever built, as part of a worldwide consortium.

"We are all thrilled with ESA's decision and look forward to participating in building this great telescope," said Dick Willingale.

UK engineers will help design, build and test the 3 metre X-ray mirror and build detectors for the focal plane of the telescope, which is due to be launched in 2028.

Gaia detects distant detonation

Europe's Gaia mission has spotted its first supernova, less than two months after the spacecraft began its extensive survey of the night sky in July. The cosmic event, named Gaia14aaa, occurred in a galaxy around 500 million light years away. The exploding star revealed itself as an increase in brightness between two measurements made a month apart.

Gaia, launched in December 2013, is the largest digital camera ever flown in space and is designed to produce a detailed three-dimensional map of our galaxy. The spacecraft employs a unique ten-metre diameter 'skirt' to shade two optical telescopes and three scientific instruments. With key systems built in the UK, the mission involves several British science teams.

Gaia is positioned in the Sun's shadow, 1.5 million km from Earth, orbiting a special point in space called L2 where it can maintain the same position relative to both the Sun and the Earth. Here it rotates once every six hours, its sensors recording brightness, position and spectral data for the brightest stars in the Milky Way.

During its five-year mission, Gaia will chart the position, distance, movement and changes in brightness of stars in our galaxy. It will also spot small alterations in more distant objects. "These transient sources can be signposts to some of the most powerful phenomena in the Universe, like this supernova," said Simon Hodgkin, from Gaia's Science Alert Scheme.

Gaia is fitted with a ten-metre diameter Sunshield **Credit:** ESA

Tim Peake mission named

With just over a year to go to launch, Tim Peake, the European Space Agency's (ESA) first British astronaut, is busy training for his long duration space mission in November 2015. After a public competition, the mission now also has an official name.

In July, ESA announced that expedition 46/47 will be known as Principia, after the British scientist Sir Isaac Newton's *Naturalis Principia Mathematica*, a three part text describing the principal laws of motion and gravity.

The name, a popular choice from more than 4000 entries, is definitely appropriate since Peake will spend six months on board the International Space Station (ISS) in conditions of weightlessness.

"I hope it will also encourage people to observe the World as if for the first time," said Peake, "just as Isaac Newton did."

Once the name was decided, the UK Space Agency teamed up with ESA and BBC children's programme Blue Peter to get viewers to design Peake's mission patch. The winning design will be announced in November, exactly one year before Peake is launched from Russia's Baikonur cosmodrome in Kazakhstan.

Gooey gypsum

Peake, a helicopter pilot and test pilot, was selected from 8000 hopeful candidates in 2009 to become an ESA astronaut. Based at the Agency's European Astronaut Centre in Cologne, Germany, he was assigned his mission in 2013.

During the past few months he has been working in the replica of the space station's Columbus science laboratory in

Tim Peake with Sir Issac Newton at the Royal Society **Credit:** UK Space Agency

Germany, learning how to clean its smoke detectors, and has also joined NASA astronauts Jeff Williams and Tim Kopra in a simulator at NASA's Johnson Space Center in Houston.

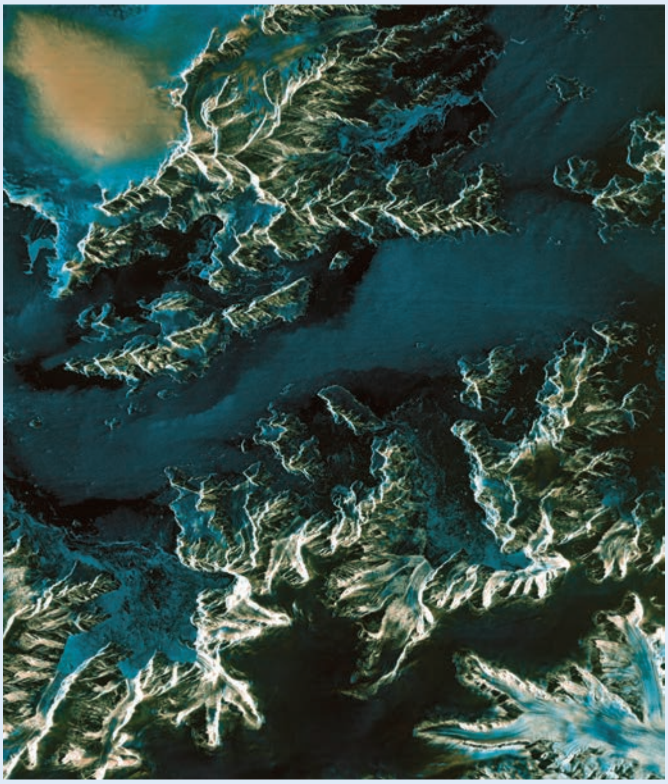
Training in the United States included preparing for a spacewalk. "We pre-breathe oxygen to reduce risk of decompression sickness," said Peake.

Sometimes mission preparation can be unexpected, such as lying in a bath of gooey gypsum, which is used to make plaster of Paris. "This will be the mould for my Soyuz seat liner," said Peake, "which ensures a snug fit on launch and reentry."

Once on board the ISS, Peake – who has described being selected as an astronaut as "a huge privilege" – will spend most of his time working on microgravity experiments that cannot be done on Earth. He is also hoping to inspire children during his stay in space by promoting healthy eating (see page 20).

Survival training in Russia **Credit:** ESA

Cryosat confirms Antarctic ice loss



Sentinel 1A view of the Antarctic Peninsular showing several glaciers **Credit:** ESA

Observations made by ESA's Cryosat mission reveal that Antarctica is losing ice much faster than thought, a finding with worrying implications for future changes in sea level.

According to the UK's Centre for Polar Observation and Modelling, between 2010 and 2013, the Antarctic ice sheet lost a total of 159 billion tonnes of ice per year. The loss is especially pronounced along glaciers bordering the Amundsen Sea.

Malcolm McMillan from the University of Leeds, the study's lead author, said: "This area has long been identified as the most vulnerable to changes in climate and recent assessments say its glaciers may have passed a point of irreversible retreat."

Cryosat, launched in 2010, uses a precision stereo radar system to measure changes in the volume of ice. This latest study is in line with German research published earlier this year, also based on Cryosat data, that showed accelerating ice loss in Antarctica and Greenland.

British satellite for Algeria

Surrey Satellite Technology Limited has signed a contract with the Algerian Space Agency (ASAL) to build a new medium resolution Earth observation satellite, Alsat-1B. Like its predecessor, Alsat-1A, the new satellite will monitor natural resources and form part of the Disaster Monitoring Constellation.

As part of the deal, 18 engineers from ASAL will complete the assembly, integration and test phases of the mission at Algeria's new Centre for Satellite Design in Oran. 18 Algerian students will also study for Higher Degrees at the University of Surrey.

The arrangement is part of long-term plans for enhanced collaboration between ASAL and the UK Space Agency following the signing of a Memorandum of Understanding in March this year.

New pollution satellite takes shape

In the Hercules clean room at Airbus Defence and Space in Stevenage, a new European air monitoring satellite is nearing completion.

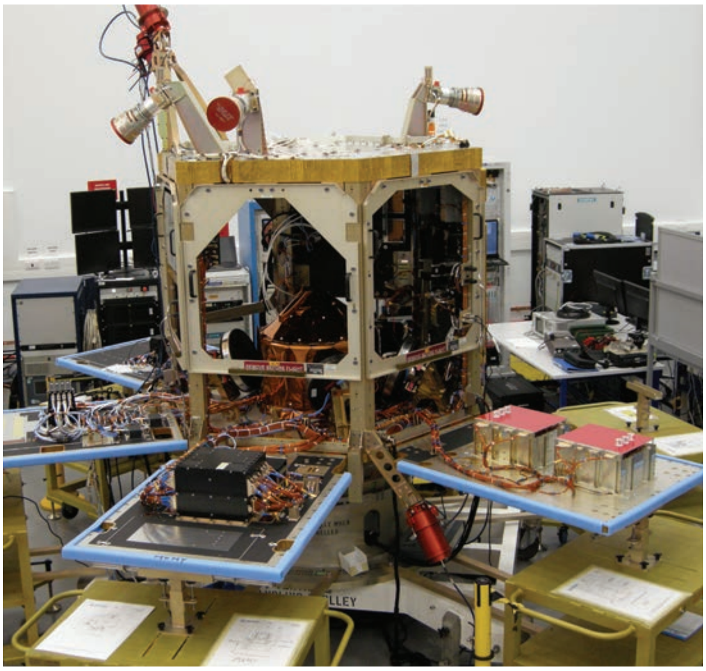
The hexagonal-shaped Sentinel-5 Precursor (Sentinel-5P) satellite is being built to monitor the chemistry of the air in the Earth's troposphere – the lowest 10 km of the atmosphere.

"This new ESA satellite is designed to measure the abundance of trace gases in the troposphere, this is the part of the atmosphere where we live and breathe," said Ralph Cordey, Head of Business Development for Earth Observation at Airbus Defence and Space. "Monitoring these trace gases is important for both understanding long-term climatic processes but also for monitoring air quality today."

Chemicals that will be measured by the imaging instrument on the satellite include pollutants such as sulphur dioxide, carbon monoxide and low-level ozone. "Gases absorb sunlight at very particular wavelengths," explained Cordey. "By using data from this satellite we will be able to calculate the number of molecules of particular gases per cubic litre."

Sentinel-5P was commissioned by ESA following the untimely demise of the giant Envisat Earth observation satellite in 2012. The new satellite will help minimise the gap in data between Envisat and the future Sentinel 5 satellite.

Due for launch in late 2015, Sentinel-5P forms part of ESA's Copernicus programme. This will eventually employ a fleet of satellites, as well as airborne and ground sensors, to supply an unprecedented quality and range of environmental data to European governments, agencies and businesses.



Sentinel-5P in the Hercules clean room in Stevenage **Credit:** Airbus Defence and Space

Final farewell for Venus Express

Europe's Venus Express is making final science observations before descending into the planet's atmosphere at the end of the year. The successful mission lasted double its planned lifetime with British involvement in five of the seven instruments from University College London, Imperial College London and the universities of Oxford and Sheffield.

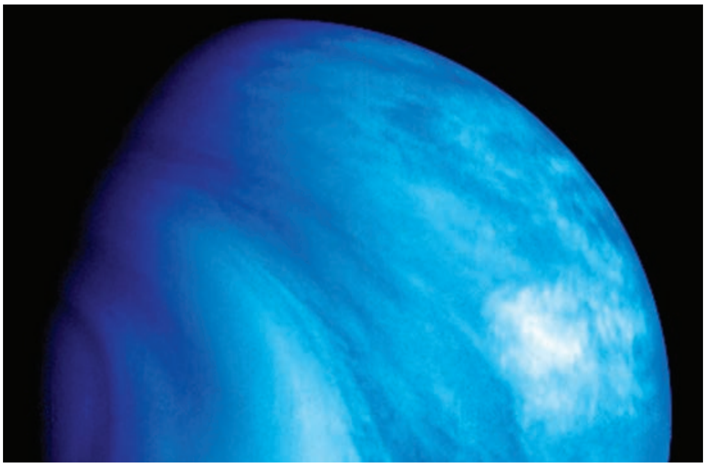
Scientists from the University of Sheffield have been analysing how particles from the Sun, known as the solar wind, react with Venus' ionosphere. "Venus doesn't have its own magnetic field like the Earth so the interaction with the solar wind is very different," said Simon Pope. "We've got an insight into how these interactions happen and how the atmosphere of Venus is lost into space."

They also designed the calculations needed to separate measurements of the spacecraft's own magnetic field from the field naturally present in space. "This had never been done before," said Pope, who developed the algorithms during his PhD and is now co-investigator for the magnetic field experiment. "Without this post-measurement cleaning, a lot of the science couldn't be done."

Launched in November 2005, the ESA spacecraft arrived at Venus in 2006. Since then it has provided a comprehensive study of the planet's surface, atmosphere and ionosphere. Routine science operations ended in May followed by some daring experimental aerobraking manoeuvres in June and July, where the spacecraft used the planet's atmosphere to reduce its speed. Venus Express surfed in and out of the atmosphere exploring previously uncharted areas.

The mission team observed both the drag and rapid heating experienced by the spacecraft. "Analysing the spacecraft's response will be useful for planning future spacecraft systems," said Adam Williams, ESA's Venus Express spacecraft operations manager.

Thousands of planetary features were recorded during the mission, from lightning bursts in clouds of sulphuric acid to a vortex at the planet's south pole.



Ultraviolet image from Venus Express of the planet's southern hemisphere **Credit:** ESA

Agency update

Funding for the ISS will be discussed at the ESA Council of Ministers **Credit:** ESA

With the Farnborough International Airshow in July, it was always going to be a busy summer for the UK Space Agency. However, a reshuffle of Ministerial posts on the day of the Farnborough Space Conference wasn't part of the plans!

Greg Clark was appointed as the new Minister for Universities, Science and Cities on 15 July, and the Agency has been working to support him over the summer.

Meanwhile, the Space Zone at the Farnborough Airshow was an unqualified success. The Agency coordinated an exhibition for twenty companies and organisations from around the British space sector, showcasing their world-class technology, science, applications and services, alongside ESA and multinational companies.

The UK Space Agency was at the centre of it all, making announcements on the future of commercial spaceflight in the UK with partners from the Department for Transport, Civil Aviation Authority and the Ministry of Defence.

The autumn has got off to a busy start as well.

From 29 September to 3 October, the UK Space Agency visited the 65th International Astronautical Congress in Toronto, Canada. This was the first time since Glasgow 2008 that the Agency has exhibited at this international gathering of the space community. Our presence was again in partnership with other members of the UK space sector, coordinated by the British Interplanetary Society.

With a number of major scientific events and industry announcements on the horizon, the UK Space Agency is preparing for discussions at the upcoming ESA Council of Ministers in December. On the table are the next generation of Ariane launchers, funding for the International Space Station (ISS) and the future of the ESA-European Union relationship.

With a busy last few months of 2014 ahead, there will certainly be more to report in the next issue of *space:uk*.

Farnborough 2014

The Space Zone at this year's Farnborough International Airshow was bigger and more popular than ever. Highlights of the show included a giant model of ESA's Alphasat spacecraft, the unveiling of sites for a UK spaceport (see page 10) and a visit from British ESA astronaut, Tim Peake.

The 2014 air show is officially opened by the RAF Red Arrows **Credit:** ESA

Tim Peake visiting during Futures Day with some of the UK students who took part in the Mission-X challenge. Mission-X involves schoolchildren learning what it takes to be an astronaut **Credit:** ESA

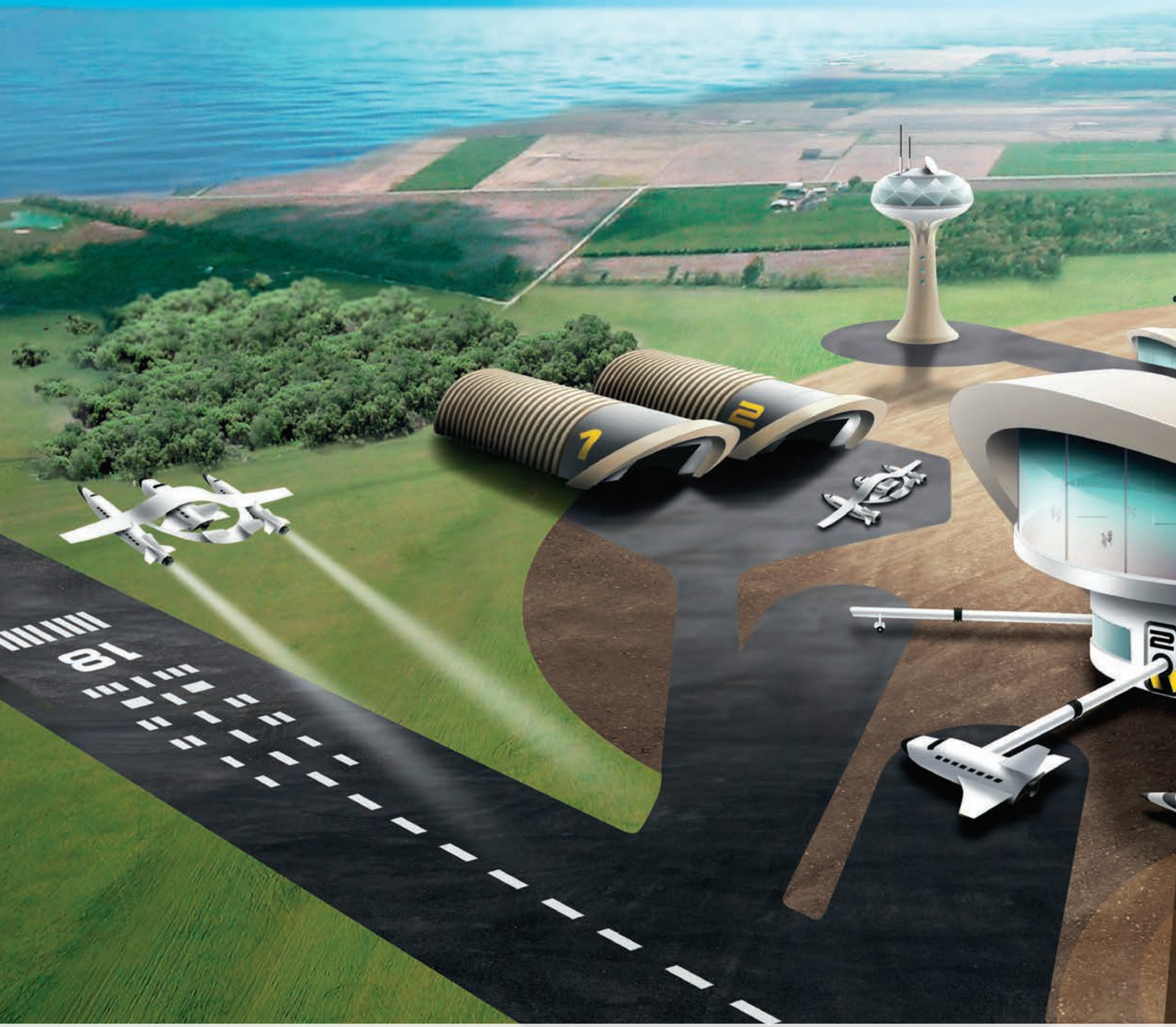
Red Arrow pilot Mike Child meets astronaut Tim Peake for the first time. Both aviators were pupils at Chichester High School for Boys **Credit:** UK Space Agency

ESA Director General Jean-Jacques Dordain, Aviation Minister Robert Goodwill and Chief Executive of the UK Space Agency David Parker in the ESA exhibition area **Credit:** ESA

A full-sized model of Alphasat towers above the space pavilion. Launched last year, and built partly in the UK, Alphasat is one of the world's most sophisticated communications satellites **Credit:** ESA

Dozens of UK space companies and scientific institutions were represented in the Space Zone, including UK satellite manufacturer SSTL. The industry is worth some £11.3 billion to the British economy **Credit:** SSTL

Spaceport:UK



space:uk editor Richard Hollingham reports on the spacecraft that might one day fly from a UK spaceport and examines why Britain wants to get into the launching business:

On July 15, in a packed conference room at the Farnborough International Air Show, Aviation Minister Robert Goodwill unveiled a report that lays the foundations for commercial spaceflight from the UK. The CAA (Civil Aviation Authority) study identifies eight possible sites for a spaceport and the economic opportunities the development could bring to Britain.

Artist's impressions suggest this futuristic spaceport would be in a coastal location surrounded by countryside. It would have a large curved terminal building, cylindrical hangers and bulbous control tower. On the taxiway, multiple space vehicles of varying designs would carry passengers to and from space.

The design looks similar to Virgin Galactic's Spaceport America that has been built in New Mexico. It also chimes with how rival space company XCOR sees the industry developing.

"We envision up to 40 of our Lynx spacecraft flying from different places around the world," says XCOR Aerospace President, Andrew Nelson. "Certain sites will have two or three, because the demand is there for science missions or space tourism."

The artist's impression of how a UK spaceport might look **Credit:** CAA

"Eventually," says Nelson, "we're going to go to the next step, to fully reuseable orbital systems that you can land anywhere in the world and, 30 years from now, it'll turn into point to point travel." This means that, instead of flying through the air, passengers will be able to travel from one country to the next via space, shortening international flights from hours to minutes. "Far-thinking countries are deciding that if they get into the game now, then they'll have that opportunity in the future," Nelson adds.

If the industry evolves as he suggests, then any spaceport is likely to become a hub for hi-tech jobs. As all the potential sites are in rural areas this would be good news for local economies.

"You're going to have microgravity and atmospheric research, composite material and hi-precision machine shops," says Nelson. "It's going to become an economic engine for the whole economy. I believe the school kids in these areas are going to have greater access to fly experiments in space than students at Oxford or Cambridge, because they're right next door."

"Space is going places at the moment, and industry, government and academia are responding to the challenge."
Matt Perkins, SSTL

continues >

An aerial shot of Virgin Galactic's spaceport in New Mexico
Credit: Virgin Galactic

Thrill ride

But there is a long way to go before this vision becomes a reality. To witness the beginning of this new space industry, you have to travel to Los Angeles and then drive two hours north into the desolate scrub of the Mojave Desert. Here, at the Mojave Air and Space Port, a collection of utilitarian buildings and hangars strung out along a runway, Virgin Galactic's and XCOR's spacecraft are taking shape.

Virgin's spaceplane, SpaceShipTwo, is inside one of the larger hangars. Driving past, you can glimpse the black and white spacecraft slung beneath its twin-hulled carrier aircraft. For $200,000 Virgin is offering passengers a sub-orbital flight, including at least five minutes of weightlessness, with the opportunity to float around the cabin and look out of the rocket's large round windows at the Earth below.

Virgin's spaceplane and its carrier aircraft in Mojave
Credit: Virgin Galactic

The interior of XCOR's Lynx spaceplane, on the other hand, is not much bigger than the front seats of a small family car. It will carry just two people, a pilot and a single passenger. A suborbital flight will set customers back $95,000 but for that they will get the ultimate thrill ride, reaching Mach 1 in under 50 seconds.

I have visited the Mojave Air and Space Port twice, most recently in February this year, to follow the progress of these innovative space companies. All being well – within the next twelve months – either Virgin Galactic, XCOR or both will make it into space and, shortly afterwards, carry their first fare-paying passengers.

These companies promise to transform the economics of space to help create an estimated global market for commercial spaceflight of £40 billion by 2030. No wonder the Government and UK space industry are backing plans for a UK spaceport.

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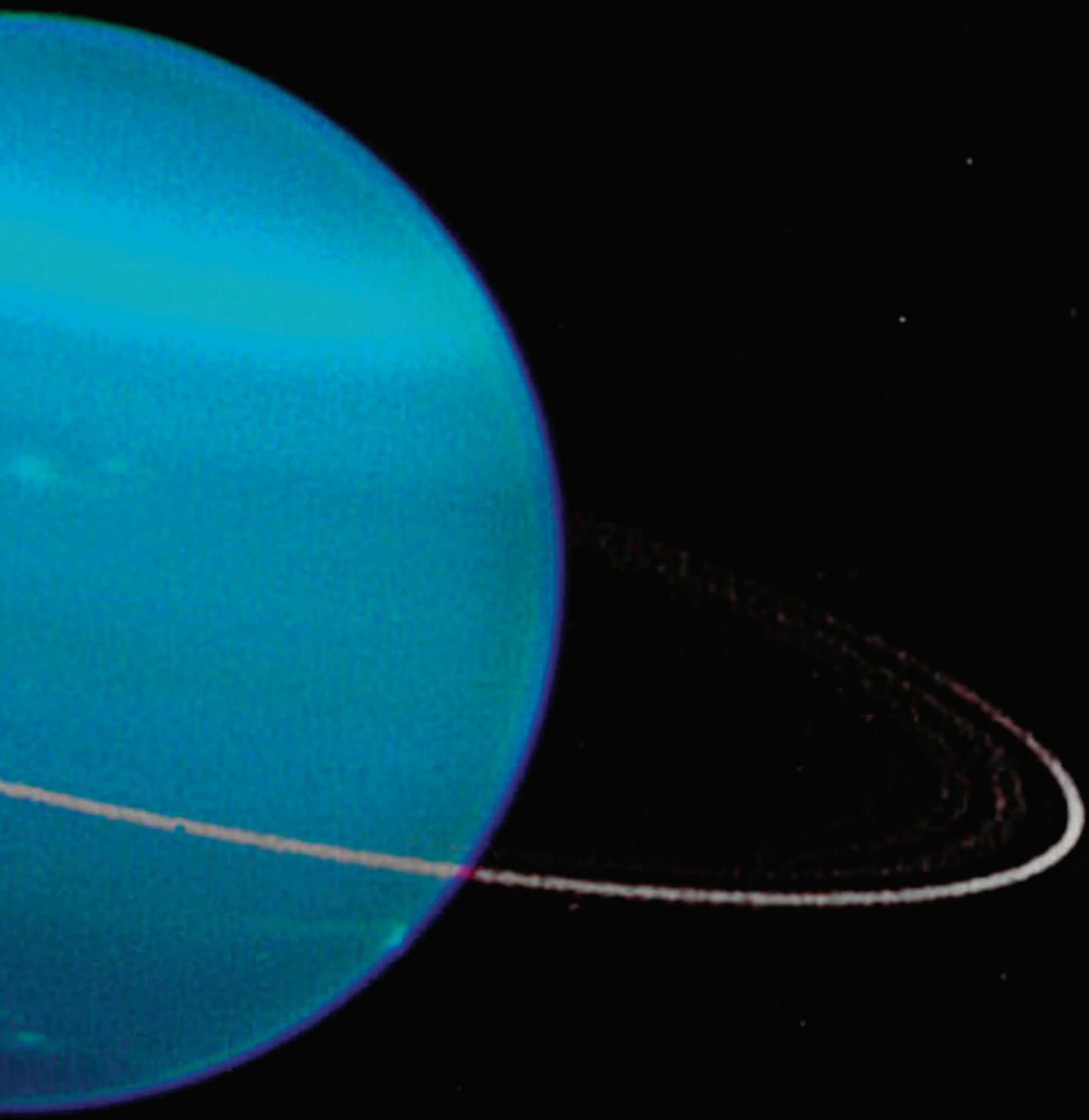


UK SPACE AGENCY

Unique

The seventh planet from the Sun is one of the most unusual in the Solar System. Uranus is named after the Greek god of the sky, Ouranos.

Uranus was the first planet to be discovered by telescope when it was spotted by British astronomer William Herschel in 1781. Although the planet is 60 times the volume of Earth, Herschel only saw it as a tiny blue-green disc.

Since its discovery, space scientists have found that Uranus is surrounded by 11 faint rings, 26 small moons and a weak magnetic field.

Uranus has no solid surface but is made up of a mass of compressed gas including water, methane, ammonia and hydrogen sulphide. These chemicals form a continuous progression from gas to liquid towards, what is likely to be, a small rocky core.

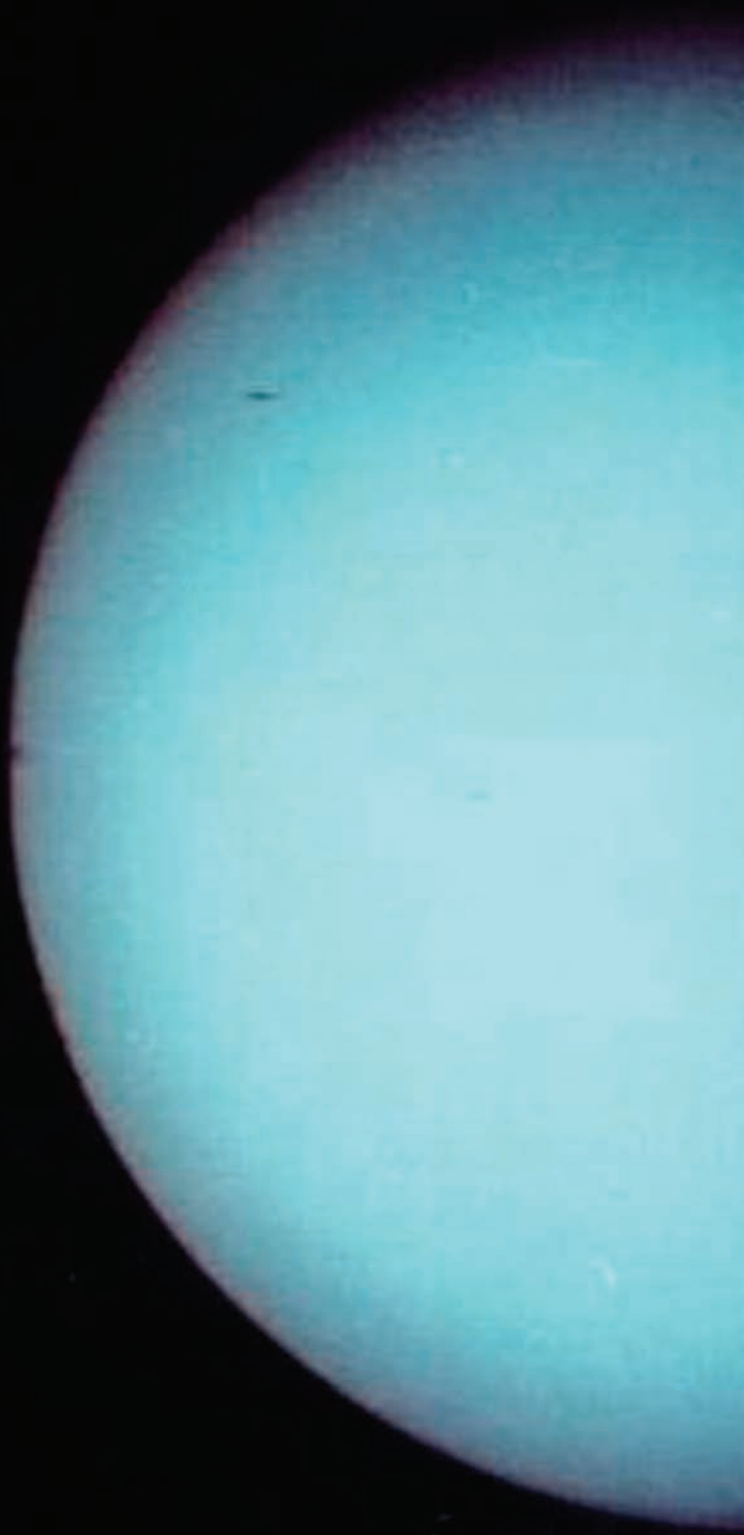
Unlike every other planet in the Solar System, Uranus rotates on an axis that is almost at right angles to its 84-year orbit around the Sun. This means that its atmosphere is subjected to extremes of climate not found elsewhere, with winter darkness lasting for decades.

Missions to Uranus

Voyager 2 is the only mission to have ever visited Uranus and that was during a fly-by in 1986. At its closest approach, the spacecraft came within 81,500 km of the planet's cloud-tops to send back thousands of images and a wealth of scientific data.

The spacecraft revealed details of the planet's five largest moons – Oberon, Titania, Umbriel, Ariel and Miranda – and detected ten more that were previously unseen.

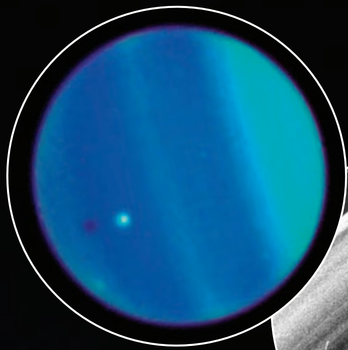
Voyager 2 also confirmed that the planet's rings are made up of rocky fragments and investigated its unusual magnetic field. This field is not aligned with the planet's centre of rotation, suggesting it may be generated in the liquid mantle rather than the core.

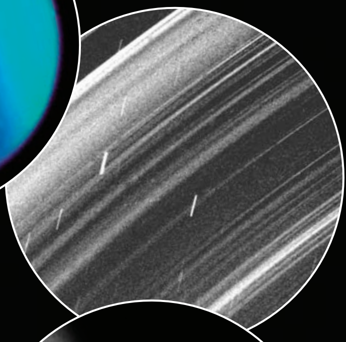


Voyager 2 captured this image when it passed Uranus in 1986 Credit: NASA

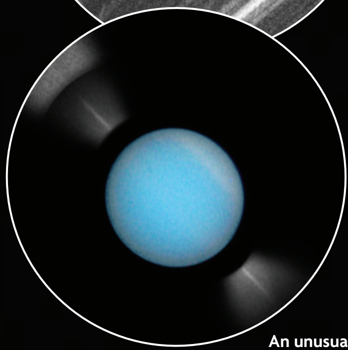
Uranus

Uranus' moon, Ariel, passes in front of the planet in this Hubble image





A close-up view of Uranus' rings captured by Voyager 2. The long exposure required to take this picture resulted in background stars appearing as smears across the image



An unusual edge-on view of Uranus' rings, taken by Hubble

Future missions

Uranus is almost three billion kilometres from the Sun, which makes any mission to the planet extremely challenging.

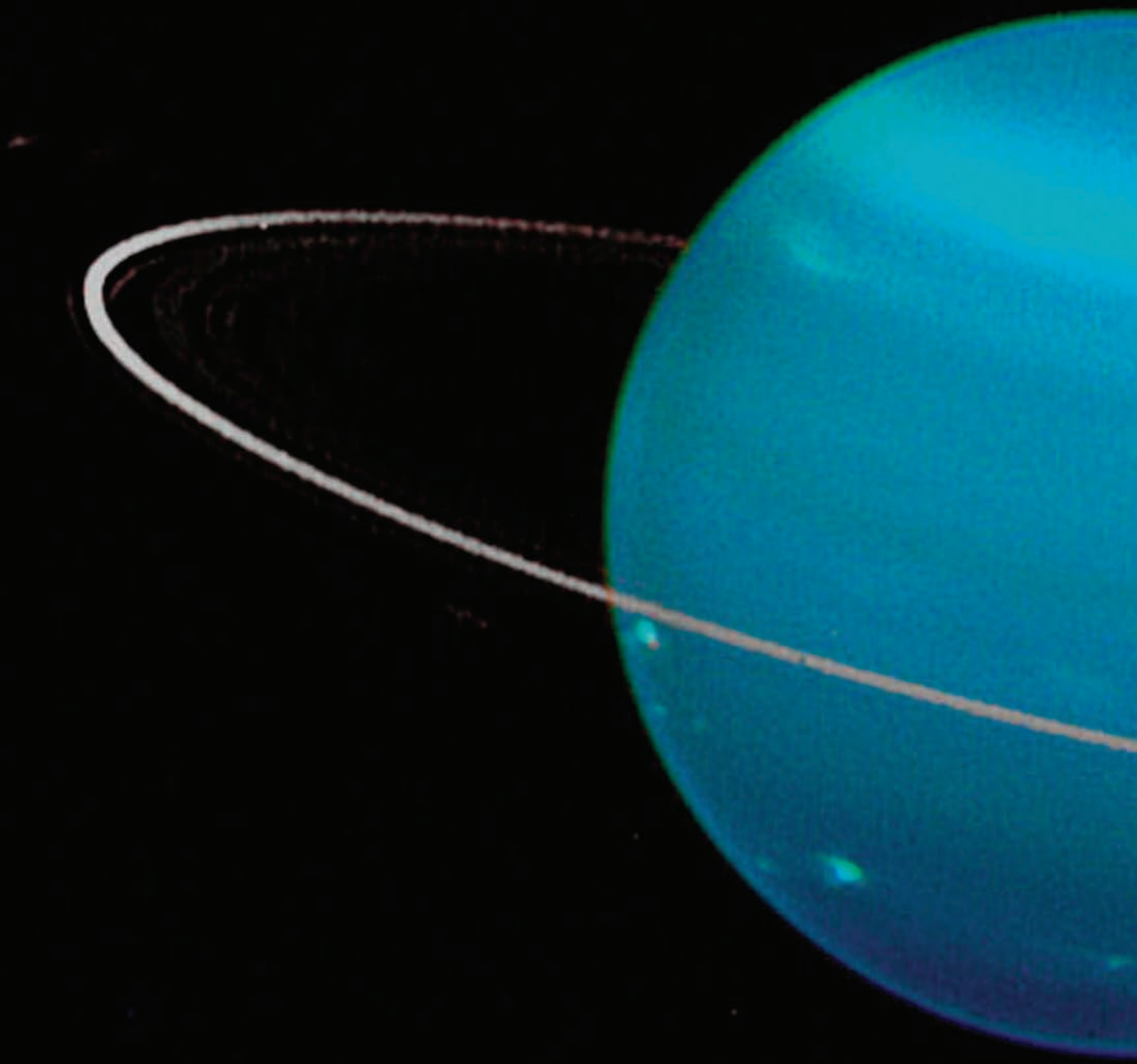
Using conventional propulsion systems, any space probe will take at least fifteen years to reach the planet. The spacecraft will need to be fitted with a nuclear power source, as sunlight will be too weak for solar panels to be effective. It will also need to be equipped with a powerful transmitter, to relay data back to Earth over such a vast distance.

However, because Uranus is so interesting, a mission to the planet is considered a priority by space agencies and an international team of scientists and engineers is currently developing a detailed mission proposal. Jointly led by UK scientists, the group hopes to have a spacecraft in orbit around Uranus within the next 30 years.

Produced by RCUK's Internal Service Provider on sustainable forestry paper, October 2014. www.gov.uk/government/organisations/uk-space-agency

Ura

The Seventh planet consists of a compressed mass of gas surrounding a solid core. Uranus is encircled by faint rings and 26 Moons and spins at right angles to its orbit around the Sun.



An image taken by the Keck Observatory in Hawaii, showing the planet's tenuous rings Credit: W. M. Keck Observatory

British benefits

"The rigour in which the UK government has approached the issue of commercial spaceflight is to be applauded," says CEO of Virgin Galactic George Whitesides. "The prospect of commercial spaceflight from the UK is exciting and the working group that has been examining this issue has produced a great report."

This study, complied by the CAA, summarises the legal, regulatory, safety and economic arguments for a UK spaceport. It was commissioned following a recommendation of the Space Growth Action Plan, which identified 15 priority space markets that would create the largest value for the UK.

The CAA report suggests that, if work were to begin immediately, then it would be possible for spaceplane operations to start from one of the eight shortlisted sites in 2018 with economic benefits of up to £20 billion by 2030. This would make a significant contribution to the UK's ambitious target to capture 10% of the global space market by then.

"This is part of a long-term vision for the UK space sector," says Catherine Mealing-Jones, Director for Growth at the UK Space Agency. "We are in the very early days of this industry – it's like the early days of rail or aviation."

These spaceplanes are not only for the wealthy with a few hundred thousand dollars to spare. They are also capable of carrying scientific microgravity experiments and both Virgin and XCOR have ambitions for orbital flights to launch satellites.

The cost of accessing space in one of these new spaceplanes is a fraction of the price of using conventional rockets. In time, as the next generation of spaceplanes is developed, more companies are likely to enter the market, such as the UK's Reaction Engines or Europe's Airbus – both developing spaceplanes of their own.

"We're at an exploratory stage of trying to unlock a major new market, which could be a major growth opportunity for the UK," says Mealing-Jones. "Low cost access to space brings down the cost of everything but any location that's selected would have to meet all the relevant environmental laws and would only be built after local consultation."

continues >

Virgin's SpaceShipTwo during a test flight
Credit: Virgin Galactic

The entrance to the Mojave Air and Space Port in California
Credit: Watkins, Boffin Media

No borders

It is easy to get carried away by these visions of how glorious a spaceport might be. It is worth remembering that neither Virgin Galactic nor XCOR have yet flown their spaceplanes in space and there are several challenges to overcome before spacecraft flying passengers or even research experiments become a reality. Quite apart from the technical issues of building safe, reliable and reusable spaceplanes, one of the major hurdles is regulation.

Aircraft are regulated by national authorities and through international agreements. In the UK, the Civil Aviation Authority (CAA) ensures that pilots, aircraft and air traffic controllers operate safely. It works with other nations to make sure that aircraft regulations and movements are coordinated. But who controls what happens when a spaceplane leaves the Earth?

“Space doesn’t have lots of borders and each country has its own laws when it comes to launching into space,” says George Nield, Associate Administrator for Commercial Space Transportation for the United State’s Federal Aviation Administration (FAA). “We need to have a common understanding of safety, cooperation and how these space operations will work.”

To this end, the UK has signed a Memorandum of Cooperation with the FAA, which has developed regulations for the US space industry. “We hope to learn from the expertise they’ve built up,” says Mealing-Jones. “What we’re trying to do is learn from best practice to help make this industry a success and ensure the safety of those flying in spaceplanes and living near any spaceport.”

A coastal location might also be suitable for rocket launches, using rockets from companies like SpaceX
Credit: SpaceX

“We envision up to 40 of our Lynx spacecraft flying from different places around the world. Certain sites will have two or three, because the demand is there for science missions or space tourism.”
Andrew Nelson, XCOR

US rocket

But it might not only be spaceplanes taking off from Spaceport:UK. Depending on the site selected, the spaceport could also be used for traditional launch vehicles. This would mean that satellites built in the UK could be blasted into orbit from the UK. With the UK satellite industry thriving, Chief Executive of satellite manufacturer SSTL, Matt Perkins, believes this would be a definite advantage.

"We have some great launch providers but we often have no control over the launch date," says Perkins, who is also Chair of industry body UK Space. "We are quite used to delays of 12 or even 18 months and having the capability here would mean we have much more control. We need to get more spacecraft into orbit and we've got to reduce the cost of access."

Initially, Perkins suggests, Spaceport:UK could launch rockets that are already available on the market, such as SpaceX's Falcon. "However," he says, "the best combination would be for the UK to design our own rocket to do what we need it to do. We've got plenty of capability in the UK for this to happen."

Despite the progress that is being made with the Skylon spaceplane, there is a long way to go before a UK launcher blasts off from a UK spaceport with a UK satellite on board. Nevertheless, these are serious proposals from an industry that is seeing massive growth (see page 1) and is optimistic for the future.

With eight spaceport sites shortlisted, a consultation is now underway to refine the shortlist of locations. "We're at an exploratory phase, trying to unlock a major new market and growth opportunity for the UK," says Mealing-Jones cautiously. "We're taking things one step at a time and, ultimately, any decision about whether to go ahead would be made by Ministers."

Only a few years ago, the idea of a Government-backed UK spaceport would have seemed extraordinary. The fact that it is now under serious consideration shows just how far the UK space industry has come.

"Space is going places at the moment," exclaims Perkins, "and industry, government and academia are responding to the challenge."

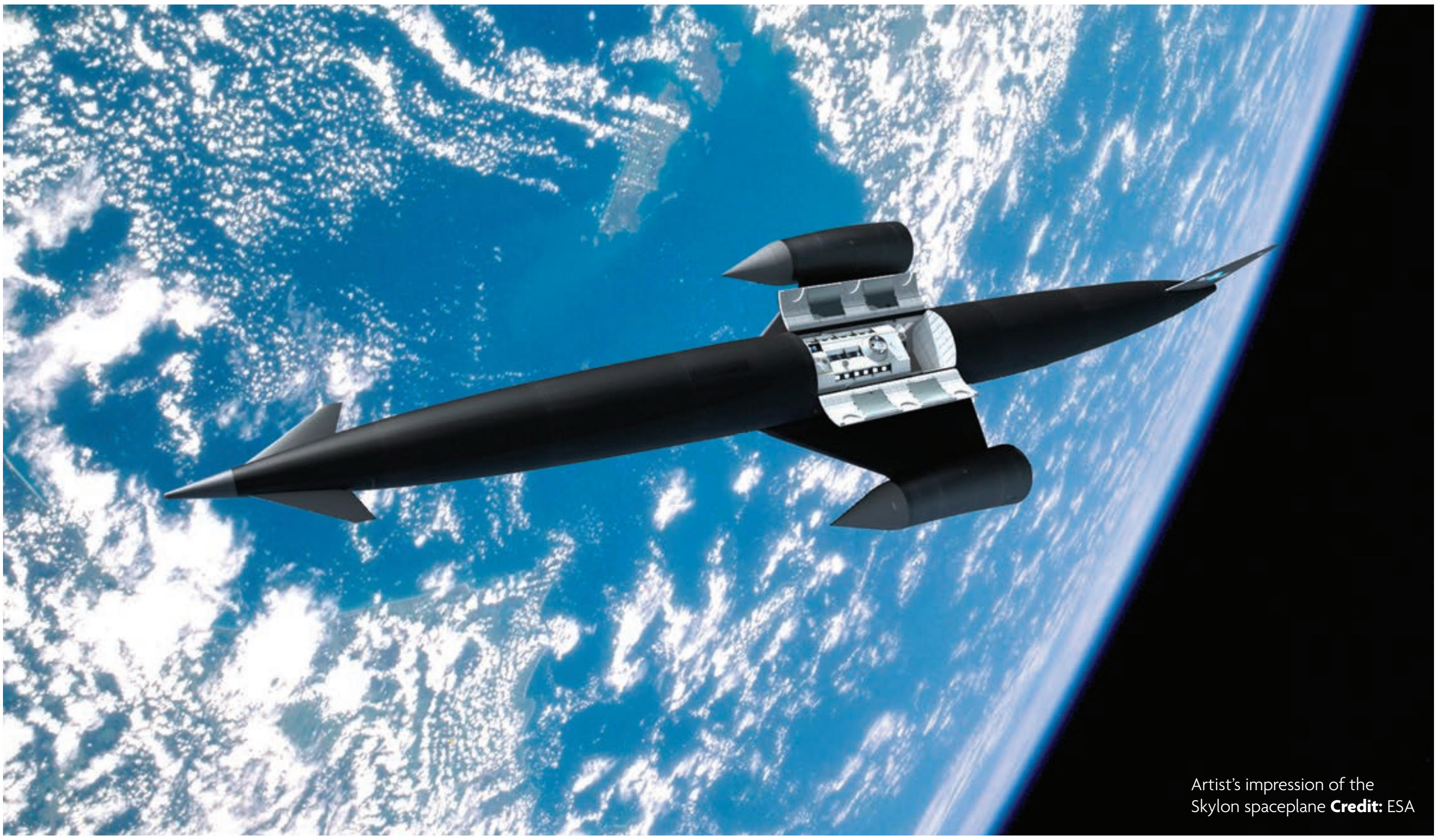
Potential spaceports

In its report (available on the UK Space Agency Website) the CAA shortlisted eight coastal locations that could be used for a spaceport:

Campbeltown Airport (Scotland)
Glasgow Prestwick Airport (Scotland)
Llanbedr Airport (Wales)
Newquay Cornwall Airport (England)
Kinloss Barracks (Scotland)
RAF Leuchars (Scotland)
RAF Lossiemouth (Scotland)
Stornoway Airport (Scotland)

In addition to weather, environmental and economic factors, any potential spaceport must also have:

- ★ **A runway that is (or could be extended to) over 3000 m**
- ★ **The ability to accommodate dedicated airspace to manage spaceflights safely**
- ★ **A reasonable distance from densely populated areas**



Artist's impression of the Skylon spaceplane **Credit:** ESA

Small but Perfectly Formed

TechDemoSat-1 under construction at SSTL **Credit:** SSTL

The successful launch of two UK satellites proves that good things definitely come in small packages. Sue Nelson reports on the increasingly big market for small satellites:

On 8 July 2014, a Soyuz rocket launched two UK technology demonstration satellites, TechDemoSat-1 and Ukube-1. One of them made history.

Clyde Space in Glasgow assembled UKube-1 and, in doing so, produced Scotland's first satellite. "Nobody had ever done that before," says Clyde Space CEO Craig Clark. "We're proud of that."

UKube-1 – funded in a collaboration between Clyde Space, the UK Space Agency, InnovateUK and STFC – certainly puts the small into small satellites. Its body weighs just 3.5 kg and consists of three 'cubesats' – 10 cm cubed boxes – connected together. "Small satellites are getting smaller," says Clark. "They're much smaller than the ones produced ten years ago in the UK."

Cubesats are a new departure for a company more used to making parts for ESA and NASA space missions. But Clark believes producing spacecraft with the combination of low cost and improved technology is an expanding market and a desirable one.

"We can now supply platforms to the rest of the world as well as parts," says Clark. "Satellites that are less than 5 kgs are doing some amazing things, such as catching live images of the Earth, processing data on board and doing attitude control to a very fine degree. We're already making another two and will soon be making a lot more of them."

"It's what you do with the satellite that counts."
Steve Young, SSTL

Global coverage

The low weight also reduces the cost of the launch, allowing several satellites to be launched at once. Ukube-1, for instance, was one of eight satellites onboard the Soyuz rocket. Despite being the size of a shoebox, it also contains several different payloads from across the UK.

These include two next generation cameras from the Open University that, as well as taking images, can test the effect of radiation on space hardware. There is also a GPS device, called TOPCAT, from the University of Bath to measure space weather; an experiment that generates random numbers with an application for secure telecoms from Airbus Defence and Space; and the outreach experiment FUNcube-2 from AMSAT, the UK organisation for amateur satellites, which allows schools to hear the satellite as it passes.

Apart from the innovative science that can be done with such small satellites, there is also a huge advantage when it comes to cost.

"Because the spacecraft are so small, using ones less than 5 kg means you can have 100 for less than the cost of a large satellite," Clark explains. "So you can have global coverage and effectively have spacecraft overhead all the time in low Earth orbit, which has never been possible before because it is just too expensive to do that with larger satellites."

It is also providing opportunities for other space-related companies, contributing to the continued growth of the UK satellite industry. Clyde Space itself is moving to larger premises in Glasgow at the end of 2014 after growing by 100% in the last year. It is also constructing what Clark regards as "the most advanced cubesat ever built".

This contains a hyper spectral imager that generates vast amounts of data in a short period of time and this data is processed on board. "This has now become an ESA mission called Picasso, so we'll be providing the spacecraft and performing the operations for our first ESA mission," says Clark proudly. "It's quite exciting for us. We need to have that launched by end of next year."

If Clyde Space is the new kid on the block for small satellites, Surrey Satellite Technology Limited (SSTL), is the experienced veteran. "Over the last 30 years we've delivered 43 satellites and the majority of this is export revenue to the UK, which is obviously very valuable," says SSTL's head of business development and sales, Steve Young.

Since the UK's space industry already supports 34,000 full time jobs and generates an annual £11.3 billion for the economy, it is easy to see why space was included as one of eight great technologies with the potential to propel UK growth. "Five years ago, in 2008, we were at 250 people as permanent staff," says Young. "We're now near 600 and in that time we've quadrupled our turnover from £36 million to £120 million."

The Space Innovation and Growth Strategy has set out a 20-year plan to make the most out of this potential and the Government aims to achieve a UK space industry worth £40 billion by 2030.

UKube-1 and the Clyde Space team **Credit:** Clyde Space, Archibald Photography

continues >

TechDemoSat-1's selfie taken shortly after launch
Credit: SSTL

Space selfie

SSTL, the UK's small satellite pioneer, built the other UK satellite launched alongside Ukube-1: the 157 kg, washing machine sized TechDemoSat-1. InnovateUK part funded SSTL's TechDemoSat as a way to help companies demonstrate key technologies, such as sensors and instruments, to help get them to market.

"TechDemoSat has eight different payloads from UK academia and industry as well as 25 new developments from SSTL," says Young.

The payloads are divided among four 'suites' covering maritime, air and land monitoring, space environment and platform technology. The space environment suite, for example, carries instruments to study space weather and the solar particles that can damage spacecraft and affect power grids on Earth.

University College London's Mullard Space Science Laboratory supplied a prototype compact Charged Particle Spectrometer to detect electrons and ions. Imperial College London and the Rutherford Appleton Laboratory also provided a Highly Miniaturised Radiation Monitor and UK space competition winners – sixth form college The Langton Star Centre – developed the onboard LUCID payload (Langton Ultimate Cosmic ray Intensity Detector).

By the time *space:uk* goes to press, all the payloads are due to be up and running but one of TechDemoSat's first operations has already gained widespread coverage. "We took a selfie from space!" Young exclaims.

The satellite selfie, taken just a few minutes after the spacecraft separated from the Soyuz launcher, shows Earth from space and the spacecraft's antenna pointing mechanism. When a minute-long video of planet Earth was released – the first images captured by a UK-built spacecraft and filmed by an inspection camera mounted on the outside of the craft – one news outlet pronounced: Blighty in Space!

These fun 'windows' into space certainly capture people's imagination – as did the launch last year of STRaND-1, the first smartphone in space, from Surrey Space Centre – but the small satellite industry is first and foremost a serious business.

"Satellites that are less than 5 kgs are doing some amazing things, such as catching live images of the Earth, processing data on board and doing attitude control to a very fine degree."

Craig Clark, Clyde Space

Global competition

SSTL is currently manufacturing three high-resolution optical satellites that will form a constellation data service called DMC3, which will launch from India in early 2015. DMC will produce 1 m resolution images that can be used for, among other things, precision agriculture, disaster monitoring and response.

Each satellite is around 3 m tall and 300-400 kgs in weight (satellites tend to be deemed small if they are less than 500 kgs).

"We're also developing NovaSAR-S (Small satellite Synthetic Aperture Radar mission), which is half funded by the UK Space Agency," says Young. "Airbus Portsmouth is making the synthetic aperture radar and that will be ready to go towards the end of next year."

Three NovaSAR-S satellites, working together in a constellation, will be able to capture images of any point on the Earth every day, regardless of weather conditions.

SSTL is also working with smaller 50-100 kg satellites for disaster monitoring. "They can now do things that three to five years ago you needed a much bigger and heavier satellite for," says Young.

The company has also set up SST-US in Denver, Colorado, to service the US market. At Clyde Space, in Glasgow, a third of their business now comes from the States. "That's an indication that they look to UK companies," says Clark. "They don't see us as a threat. They want to work with us and that's great."

SSTL has led the world with its manufacture of small satellites and so, understandably, the rest of the world has been quick to follow. "The main competition comes from SATREC-I in South Korea. They're a company who've done two or three satellites to date of a similar size and capability. The Israelis can do it. The Russians can do it. The Chinese can do it."

Young believes SSTL still has the lead, however, because of their heritage. "We have so much experience and the risks are lower. We've got the substance behind what we do and the innovation that comes with us."

Young is in no doubt that applications are key. "It's what you do with the satellite that counts."

SSTL engineers working on DMC3 **Credit:** SSTL

Tim Peake and Heston Blumenthal sorting through the entries **Credit:** UK Space Agency

British space menu

space:uk meets a winner of the UK Space Agency's Great British Space Dinner competition:

Vacuum packed, dehydrated, powdered and dried, food in space is notoriously bland and boring. In fact, during their long duration missions to the International Space Station (ISS), the food is one of the few things that gets astronauts down.

But when British ESA astronaut Tim Peake arrives at the ISS in November 2015, his meals will include a variety of new space foods in a uniquely British menu concocted by students from across the UK.

"We wanted to give him traditional British food, so he remembers where he comes from and that we're all behind him," explains 14 year old Aminah Hussan, a member of the Astro Foodies team from Plashet School in East Ham in London.

Hussan's team was selected by Peake and celebrated chef Heston Blumenthal as one of the winners (see box) of the Great British Space Dinner. The competition, open to individuals and groups of young people across the UK, was conceived by the UK Space Agency as part of the extensive education programme around Peake's mission to the ISS.

(l-r) Nilum, Aminah and Iram in Heston Blumenthal's experimental kitchen **Credit:** Plashet School

Tim's space menu will be inspired by:

Space Fuel by Astro Foodies
The Astro Foodie's menu was conceived by 14 year olds Aminah Hussan, Nilum Khaliq and Iram Farooqui. It includes a Spaceshoup B4R, with tomato soup encased in a crispy shell of bread; a Sunday roast adapted into a helmet-shaped pie; and bite-sized desserts resembling planets.

Rocket Lolly by KFSPACEGIRLS
These pupils at Emmanuel College in Gateshead came up with a mouth-watering three-course meal contained in a lolly, featuring a soup starter, curry main course and Eton mess dessert.

Nova Tiffin Capsule by Chloe Cockshull
The Hreod Academy pupil in Swindon designed an Anglo-Indian meal of spicy main course, followed by rhubarb and custard, conveyed into space in a tiffin carrier.

Big Breakfast Launch by Archie Luckett
Archie, a pupil at Abberley Parochial VC Primary School in Worcestershire, has devised an entire full English breakfast in the guise of a big square burger.

Space Menu by Joseph Drennan
Joseph, a pupil at Wray Common Primary School in Reigate, has invented a cosmic menu including tomato and rocket soup, best of British stew and asteroid dumplings with a chocolate mousse and space dust dessert.

:British space menu

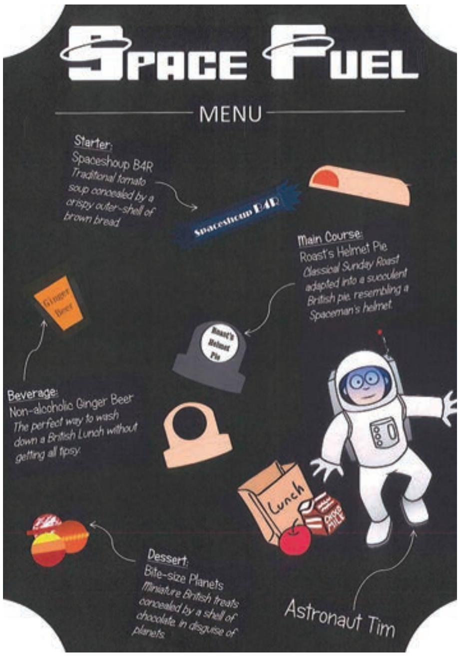
"Our aim was to make space food interesting and tasty," says Hussan. "We knew we couldn't take soup into space and have it in a bowl, so we came up with the idea of the Spaceshoup B4R, where we encased the soup inside the bread – that way it'll work in the space environment without losing the texture."

Since the winners were announced in July, they have been developing their ideas alongside professional chefs in Blumenthal's experimental kitchen at the Fat Duck restaurant at Bray in Oxfordshire.

"On the day we went to the Fat Duck, I realised the scale of what we were doing," says fellow Astro Foodie, Iram Farooqui. "It was fantastic to see our creations come to life, we realised it was an amazing opportunity."

After talking through their ideas they discovered, for instance, that taking liquid soup into space was not going to be practical. "The chefs explained there may be an issue with microbes developing in the soup if we took it up in that form," says Hussan. "So they came up with the idea of a belt of the flavours of tomato soup laid in the bread."

"It was really interesting to see our idea come alive," Hussan says, "they'd been inspired by what we'd designed, to come up with a realistic alternative to tomato soup in space."



The Astro Foodies' menu **Credit:** Plashet School

"We tried the bite-sized planets and they were really amazing," adds Farooqui. "The chefs had made a golden shell and piped in flavourings of Eton mess and sticky toffee pudding and when you bit into them they were bursting with flavour."

For the third member of the Astro Foodies, Nilum Khaliq, getting the right flavour was key: "Our food was inspired by different cultures, with a kick to remind Tim Peake of home."

Meeting the students, you cannot help but be impressed by the thought and effort they have put into their creations.

These are foods that, after further development, could eventually be eaten by Peake when he is orbiting 400 km above the UK. So what does their teacher, STEM (Science, Technology, Engineering, Mathematics) co-ordinator at Plashet School, Ann English, think about their achievement?

"Initially they were a bit timid," English admits, "but once they got going, the end achievement was fantastic."

"When I saw the entry, I knew this was a winner," English says. It has also enabled the students to learn about a range of subjects. "STEM is a cross between science and technology and this project involved physics and biology as well as design and presentation."

English says this could be the start of something even bigger. "This project has shown the students how far they can end up and, just think, one of our girls could become an astronaut as well."

Teaching resources

Resources for key stages 2 and 3 are available for free at: www.nationalstemcentre.org.uk/spacedinner

Educational resources linked to Tim Peake's mission are available for free at: www.esero.org.uk/timpeake

Meal time on the ISS **Credit:** ESA

Ask the experts

In this issue our questions come from @spacegovuk and @spaceboffins followers on Twitter and Space Boffins Podcast followers on Facebook.

Stephanie Yardley
PhD Student
Mullard Space Science Laboratory

What constellation is the Sun in and is it unique?

When asking an astronomer to describe our Sun they will say it is an ordinary yellow dwarf star that is just one of hundreds of billions of stars in our galaxy.

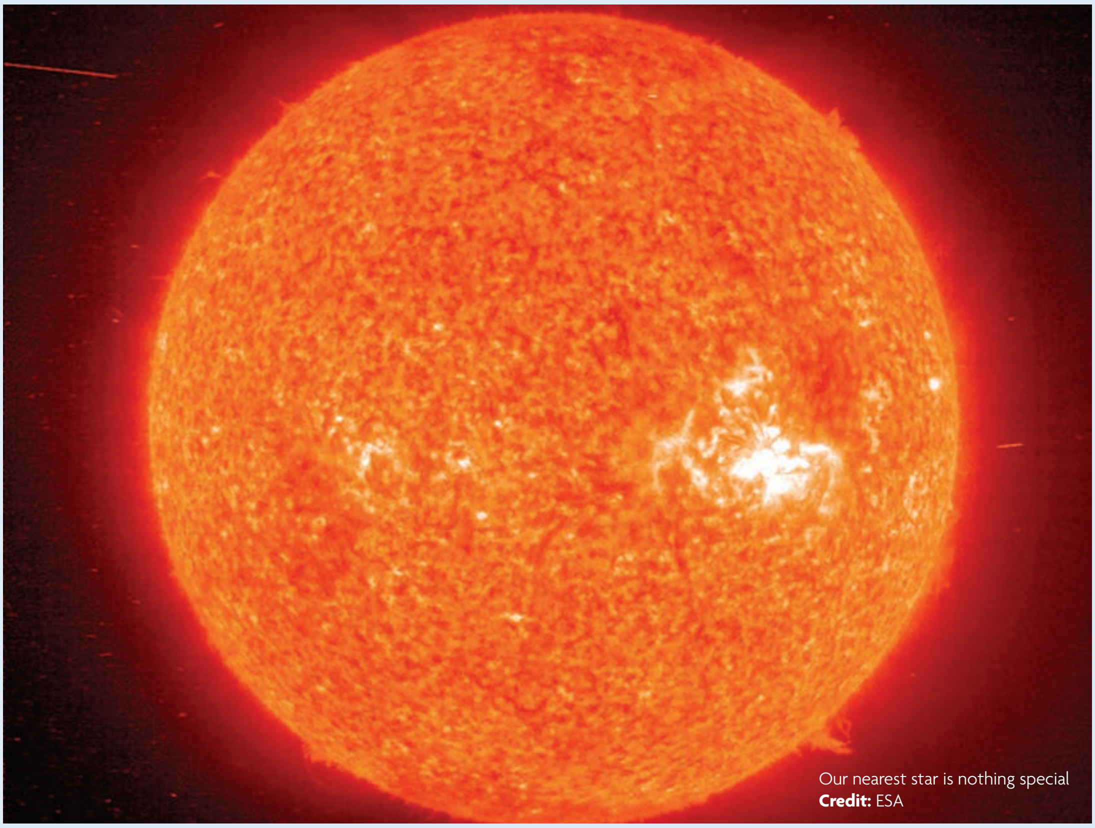
Although it is currently in the main stage of its life it is over four billion years old, has a surface temperature of 5700 Celsius and is more than a million times larger than the Earth. However, this ordinary star is a giant ball of hot gas and regularly throws out huge eruptions which race across the Solar System and can hugely impact the Earth.

It was originally thought that the Sun, and hence the Solar System, was located at the centre of the Milky Way galaxy. However, our galaxy has a spiral structure and we are in fact located near the outer edge on what is known as the Orion Arm. Despite the Sun's colossal orbital speed around the centre of the Milky Way, it still takes 230 million years to make one complete orbit.

The question of what constellation the Sun belongs to is a bit of a trick one. In fact the Sun does not belong to any constellation. Because the Earth orbits around the Sun, the Sun moves in the sky relative to the other stars. So a better question might be: what constellation does our Sun belong to today? Depending upon the time of year, the Sun passes through each of the constellations of the Zodiac. Your astrological sign is the constellation that the Sun was in on the day you were born.

Is our Sun unique or is it a 'sibling star' made of the same material as another? This is found by looking at the light coming from the star, which shows its chemical composition.

After a recent study of nearby stars we have in fact discovered that the Sun does have a non-identical twin. It has the same composition as the Sun and it appears to be moving in an orbit in the same part of space. This star is named HD 162826 and is 15% more massive than the Sun. It is fairly bright and so, with a good telescope, you may be able to find it in the constellation of Hercules.



Our nearest star is nothing special
Credit: ESA

What is the future of the ISS?

Currently the only way to reach the ISS is in the cramped Russian Soyuz spacecraft **Credit:** ESA

Sophie Allan
Physics Teacher
National Space Academy

A joint endeavour between the American, Russian, European, Japanese and Canadian space agencies, the International Space Station (ISS) has provided us with a permanently inhabited research laboratory in low Earth orbit since November 2000.

Despite the fact that the opportunity to conduct experiments in the unique conditions of microgravity and the technology necessary to keep people alive in space are great catalysts for science and technology applications on Earth, the future of the ISS is somewhat uncertain.

We do know it will operate until at least 2020. Beyond this it is unclear exactly what will happen and there are many factors that will affect its future. Although many people see the ISS as a beacon of international cooperation, current events are potentially impacting the path that its future will take.

With the retirement of the Space Shuttle program in 2011, the Russian Soyuz spacecraft has been the only way of ferrying astronauts and cosmonauts to the ISS. The Russian space agency is contracted to fly astronauts until a replacement for the Space Shuttle can be found.

However, there have been suggestions by some Russian politicians that beyond 2020 they will seek to part ways from the collaboration and focus on their own, independent, options. This might involve using some of the Russian ISS modules as the basis for a new station.

NASA is also working on new transport to the ISS. Rather than develop its own spacecraft for station missions, NASA has offered private companies the chance to provide a craft capable of transporting astronauts to low Earth orbit. With Boeing's CST-100 and SpaceX's Dragon 2 capsule being developed, it is expected that astronauts will be less reliant on Russia within the next three years.

Even then, the ISS will not last forever. By 2020 it will have been operational for 20 years, with the earliest modules having spent 22 years in orbit. The first priority will be to evaluate the safety and stability of the structure. If this proves to be positive, the next step will be to answer the question of whether it can provide a meaningful contribution in the future. After all, there is only so much space inside for instruments and crew, and the technology on board is getting older by the day.

Whether it gets a refit, or is sent into a controlled re-entry to burn up in Earth's atmosphere, for now we must be content that this incredible football field sized orbital science laboratory is carrying out research 400 km above our heads. Regardless of the decisions made in its future, it truly is a shining example of what humans can achieve when they collaborate in the name of science.

Rosetta in the classroom

After a ten-year journey through deep space, ESA's Rosetta has become the first spacecraft to rendezvous with a comet. As the World waits excitedly for the landing of Rosetta's Philae craft on comet 67P, ESERO-UK is also hot on the tail of the comet putting the finishing touches to a set of eight exciting lessons ready for use in UK primary schools.

The lessons are designed to help children from ages 4-11 learn more about our Solar System and beyond, generate enthusiasm for science and perhaps give them a taste of the excitement a career in space using STEM subjects could bring. The investigative activities and images have clear links with the Rosetta mission and provide a sequence that helps children to explore the secrets of the Universe in practical ways, involving the use of key skills.

The pack has something to appeal to everyone, with numerous opportunities for practising cross-curricular skills, including maths, literacy, IT, art, design technology, PE and music. The resources introduce the children – through story, video, photographs and demonstrations – to a range of challenges requiring the use of enquiry, discussion, teamwork and problem solving consistent with UK curricula requirements. These include 'Working Scientifically' from the newly revised English Science curriculum.

So, what can teachers and children experience from this resource?

The first lesson offers younger pupils a fast and furious journey into the Solar System. They can also discover what causes shooting stars, maybe handle a real meteorite and discover a link between the size of a meteorite and the crater it produces.

They will get a feel for the huge distances in the Solar System by using relative distances to draw and walk around the orbits of the planets and they can practise their maths skills by calculating their weights on different celestial bodies. Even more challenging for 9-11 year olds would be researching key events in the history of the Universe and plotting those events on a timeline. They could also design and build a solar-powered rover, or work as a team of engineers designing a craft to successfully land an egg without damage!

Although each lesson consists of a self-contained unit showing clearly the learning objectives, resources and materials required for a class of primary children, the eight sessions could easily provide a whole school project. This would help create the excitement of this real life mission that is venturing where none has dared to go before.

You can find the resources here:
http://stem.org.uk/cx3y4

Meet the team:

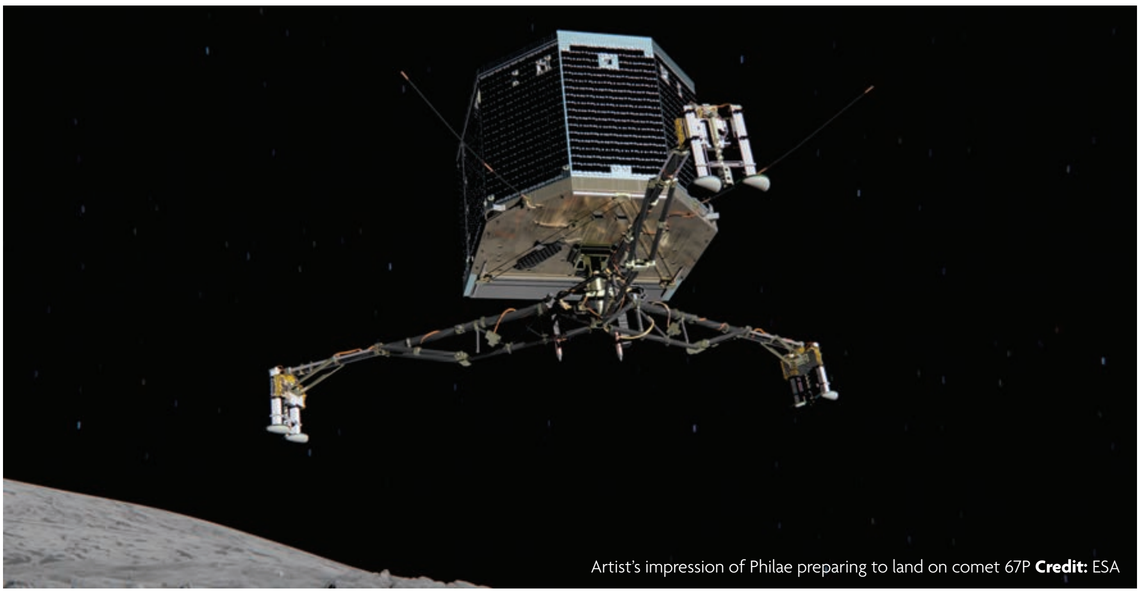
Allan Clements
ESERO-UK Manager

Sue Andrews
ESERO
Space Ambassador

Alice Coates
STEM Project Officer

Rachel Jackson
Primary Specialist

Tom Lyons
ESERO-UK Teacher
Fellow



Artist's impression of Philae preparing to land on comet 67P **Credit:** ESA

European Space Propulsion is a new company, based in Northern Ireland, producing rocket propulsion systems. Its Managing Director is Paul Sinton:

Paul Sinton

Image top right: European Space Propulsion's parent company made the main engines for the Space Shuttle
Credit: NASA

Bottom image: The Curiosity Rover on Mars
Credit: NASA

What does European Space Propulsion do?

We're a wholly-owned subsidiary of Aerojet Rocketdyne, an American company that's a major player in the business of making propulsion systems for a range of applications including spacecraft. In Northern Ireland we're going to be specialising in propulsion systems that are used by orbiting satellites and for deep space missions.

Your parent company has a long history in the space sector?

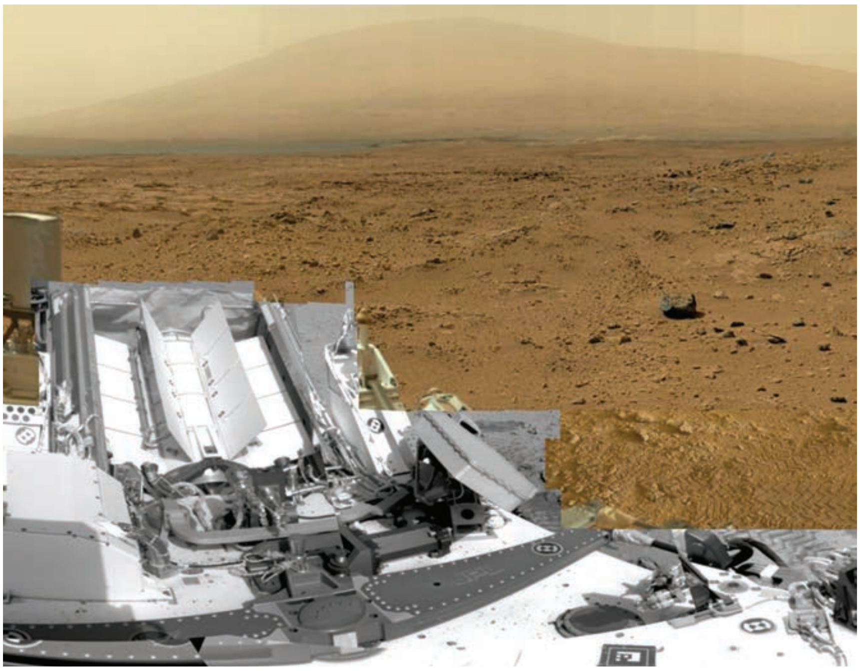
Yes, it's worked on numerous missions, including the main engines for the Space Shuttle and the thrusters that enabled the Curiosity rover to land on Mars. It's also developing the engines that will power NASA's next generation rocket, which will be capable of taking astronauts into deep space.

Why set up in Northern Ireland?

Aerojet Rocketdyne spent some time looking round Europe for business partners and got introduced to Thales Air Defence, based in Belfast. There are a lot of synergies between their product range and ours. They also have a similar focus on quality and reliability. So they're going to be our primary sub-contractor in undertaking the majority of manufacturing.

What will this bring to the area?

Initially it will secure jobs in the precision engineering sector and the plan is to grow employment levels in the whole space arena in Northern Ireland. There's a lot of potential here. This is really the nucleus of a new space hub in Northern Ireland and we're working with Invest Northern Ireland, the UK Space Agency and European Space Agency to make this a success.



What would be your advice to young people in Northern Ireland considering a career in space?

There're lots of opportunities here both in manufacturing and the applications of space technology, many more than there were even five years ago. There's a definite need for skilled workers in the space sector.

Europe in space: part 2

ESRO-1 being tested in July 1968 at the recently opened ESTEC
Credit: ESA

Fifty years ago, the UK became a founding member of a European effort to pursue scientific research in space.

The European Space Research Organisation (ESRO) was formed in 1964 to bring together European nations working in space science research. Funded by member nations, it oversaw the production of the first joint European scientific satellites and led to the formation of the European Space Agency (ESA).

The UK was represented on the first ESRO leadership council by Harrie Massey from University College London. Massey was a key figure in the development of the UK's space programme and had worked in partnership with NASA on the UK's first satellite, Ariel-1.

ESRO launched its first satellite in May 1968. ESRO 2B was designed to study cosmic rays and X-rays from the Sun. A second satellite, ESRO 1, was launched later that year to investigate the Earth's ionosphere and aurorae.

The organisation also flew sounding rockets. These suborbital craft were used to carry scientific experiments into space and back, allowing the payload to experience a few minutes of microgravity.

In 1975, ESRO became part of ESA and the UK continued to play a leading role. Many of the space institutions now run by ESA were created under ESRO. These include the European Space Research and Technology Centre (ESTEC) in the Netherlands and the European mission control centre at Darmstadt in Germany.

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