



horizons
2018

"Seen from a distance our planet is just a blue dot, a fragile spaceship for humankind. We need to understand the Universe we live in to protect our home."

Alexander Gerst

ALEXANDER GERST

A scientist back to space

Alexander Gerst became an astronaut by working hard to be a good scientist. His passion for understanding the world around him set his career on the path of science. He studied geophysics and Earth sciences.

Volcanology fascinates him. Alexander travelled to remote locations to study what happens during the first seconds of a volcanic eruption. Just like in space, setting foot in hostile environments and unexplored territories was the only way to collect data that could not be found anywhere else.

During his first stay in orbit he carried out over 50 science experiments. Highlights of the 'Blue Dot' mission included a spacewalk and the docking of Europe's last Automated Transfer Vehicle, a resupply vehicle for the International Space Station.



Alexander during an Antarctic expedition to study volcanoes up close (A. Gerst)

Horizons

Alexander is eager to return to the Space Station in June 2018. 'Horizons' is the name of his second mission, which comes packed with science.

He will share the ride in the Soyuz capsule with Russian cosmonaut Sergei Prokopyev and US astronaut Serena Auñón-Chancellor. Alexander will fulfil the role of Station commander in September.

This is the second time a European astronaut takes up this leading position on the Space Station. Alexander's main responsibilities are to maintain morale among the crew, look after safety and operations, and follow the instructions dictated by the flight director on the ground.

NAME

Alexander Gerst

BORN

3 May 1976, Künzelsau, Germany

OCCUPATION

Astronaut, geophysicist

STUDIES

Geophysics and Earth sciences

MISSIONS

Blue Dot (2014), Horizons (2018)

TIME IN SPACE

165 days

SPACEWALKS

1 > 6 hours 13 minutes

HOBBIES

Mountaineering, skydiving, snowboarding



"I am humbled and honoured to command the Space Station. This international sign of trust reflects Europe's reliability in space."



Winter survival training in Russia (GCTC)

TRAINING FOR SUCCESS

On the road to space

Since he got back to Earth in 2014, Alexander has been preparing for his next mission.

The astronaut's refresher courses include scientific, engineering and medical skills, as well as orbital mechanics and Russian language, plus survival training in prolonged isolation and under psychological stress.

Continuous training helps astronauts to be mentally prepared to handle emergencies, such as spacecraft depressurisation, fire or toxic spills.

The road to space requires going under water. Alexander was immersed into 12-m deep pools in the United States and Russia to practise spacewalking on submerged mockups of the Space Station. If the opportunity for a spacewalk arises, he is ready to go back out into space.



Spacewalk training underwater to simulate weightlessness (NASA)

"The key to success for my previous campaigns as geophysicist was to prepare as perfectly and meticulously as possible, but then switch to 'MacGyver' mode during the expedition itself. This strategy is applicable to many tasks on the Space Station."



Emergency training with NASA crewmate Serena Auñón-Chancellor (NASA)



Suited for outer space (NASA)

RESEARCH FOR THE BENEFIT OF HUMANKIND

European science in space

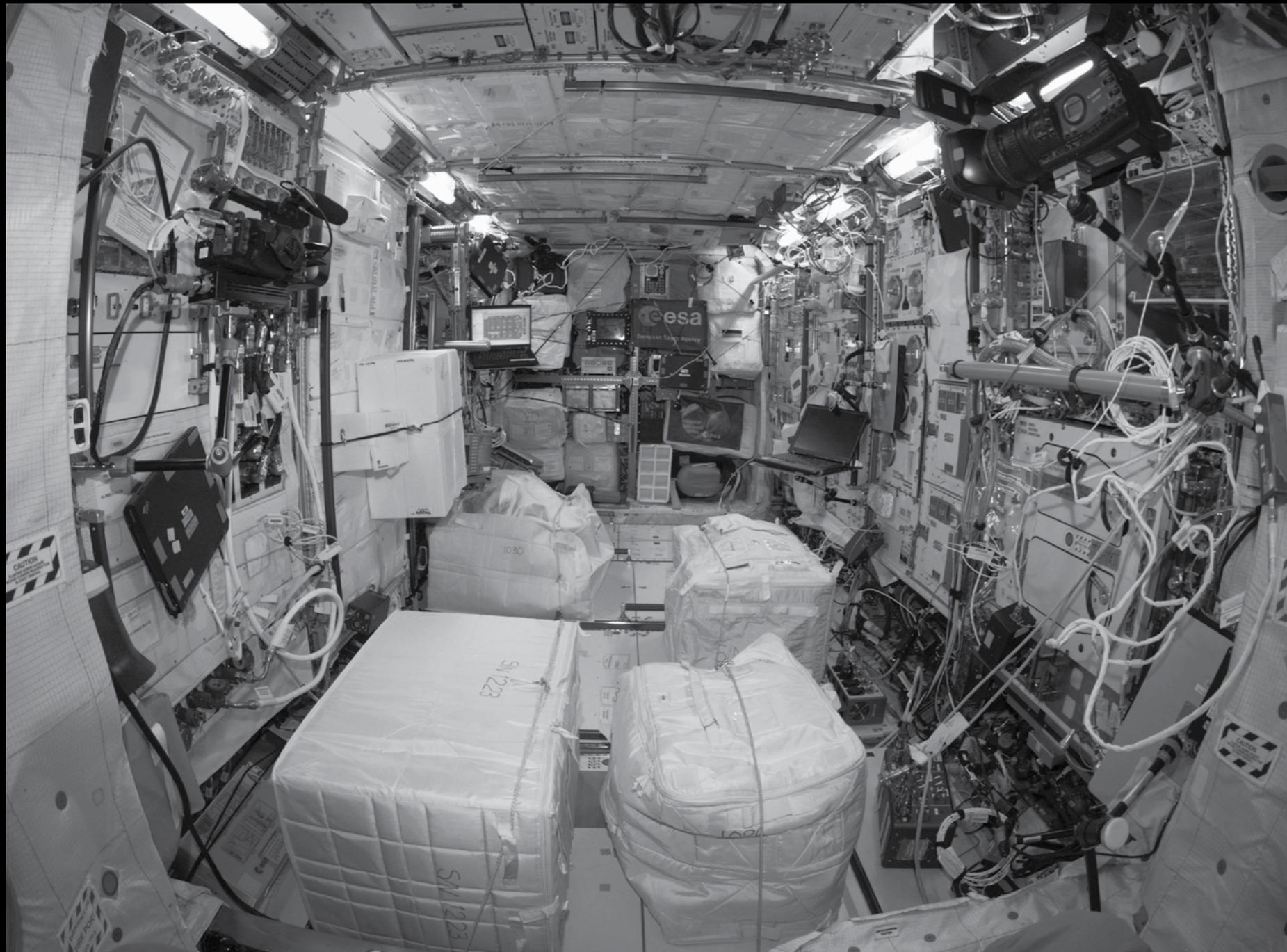
Gravity affects almost everything we do. Remove it from the equation and we can improve our understanding of natural phenomena. The International Space Station is a place where the rules governing sedimentation, buoyancy and convection do not apply.

In 'freefall' around the planet, astronauts on the Space Station live in microgravity. This 'weightless' laboratory offers the possibility to perform experiments that are just not possible on Earth.

Up there, the crew carries out pioneering research, tests new technologies and pushes the boundaries of our knowledge. Alexander will devote a lot of time to scientific activities in this unique environment, covering human research, physical science, biology and radiation, as well as demonstrating technology. This is a showcase of European experiments bringing benefits back to people on our planet.



"We run scientific experiments on the Space Station to broaden our horizons as humankind."



Europe's laboratory in space is packed with high-technology scientific equipment, video and communications links, as well as cables, ducts and piping (ESA/NASA)

"The European Columbus laboratory became like a second home to me. We must never forget what a precious gem we have up there."

THE COLUMBUS LABORATORY

Where science happens

Europe's laboratory in space houses a wide range of scientific disciplines, from astrobiology to solar science through metallurgy and psychology. Inside and out, this complex and powerful module offers microgravity to unmask phenomena that cannot be observed on Earth. Columbus is the first and only European lab dedicated to long-term research in weightlessness.

Alexander's work station is a high place of science where 16 telephone-booth-sized experiment facilities run 24/7. After 10 years in orbit circling our planet at 28 800 km/h, more than 225 experiments have been carried out in this remarkable experiment facility. Columbus delivers over 500 gigabytes of science data a month.

Intensive use of this laboratory leads to new applications and benefits for people on Earth, from space to your doorstep.



Exercising on the International Space Station's fitness bike to fight muscle weakness in orbit (ESA/NASA)

LIVE BETTER

Muscle tone

Astronauts experience muscle weakening in space. Alexander's back and neck will be sore, and his feet will be more tender than normal. Back to the effects of Earth's gravity after his mission, it will take him a few months to recover his muscle tone.

The **Myotones** experiment will monitor the tone, stiffness and elasticity of Alexander's muscles with a non-invasive, portable device on the Space Station. Results from the back, arms and legs will be compared with measurements before and after the spaceflight to help identify critical risks and the best countermeasures.

This research could improve the lives of many people affected by strained muscles. Elbow and back pain are common aches for office workers and those handling big loads. Patients going through long periods of inactivity could also benefit from it. The device is already used on Earth as an alternative to muscle biopsies.

Elastic time

Time perception is elastic – it stretches and bends. To your brain, a minute is relative. Sometimes it takes forever for a minute to be over; sometimes it flies. Scientists believe that astronauts underestimate time in orbit, just as they have an altered perception of distance in space. Mental representations of space and time are believed to share the same neural networks.

Alexander will judge how fast time flies in space. He will provide duration estimates and reaction times throughout his mission for the **TIME** experiment. This is important because a misperception of time may cause delayed responses that could create a risk for crew safety.

Learning more about the subjective perception of time and how to deal with it could have a positive impact among the elderly and incapacitated patients. Now that teleworking is becoming more popular, this research could help people experiencing isolation through work.



On the watch in the Space Station's Cupola (ESA/NASA)



ESA astronaut Tim Peake breathes in to probe lung health on the Station (ESA/NASA)

BREATHE EASIER

Understanding asthma from space

For the millions of people suffering from asthma around the world, pioneering research in orbit is uncovering new ways of understanding what goes wrong in patients with airway inflammation. The results are helping to develop quick and ultra-sensitive lung tests for an improved quality of life – both on Earth and in space.

With each lungful of air, our bodies absorb oxygen and exhale waste-product molecules. In people with asthma, inflammation in the lungs adds nitric oxide to exhaled air. Doctors measure the amount of nitric oxide exhaled by patients to diagnose inflamed lungs and asthma.

On the Moon and Mars, an astronaut's lungs may become easily irritated or inflamed by dust particles. The reduced gravity on those celestial bodies makes the dust floating around a real threat for humans. The **Airway Monitoring** experiment looks at the amount of nitric oxide expelled by the astronauts in a microgravity environment and reduced pressure.

An easy-to-use and accurate device is used in clinics and hospitals today, helping asthmatics and offering a cheaper way to diagnose lung problems around the world.

WORK SMARTER

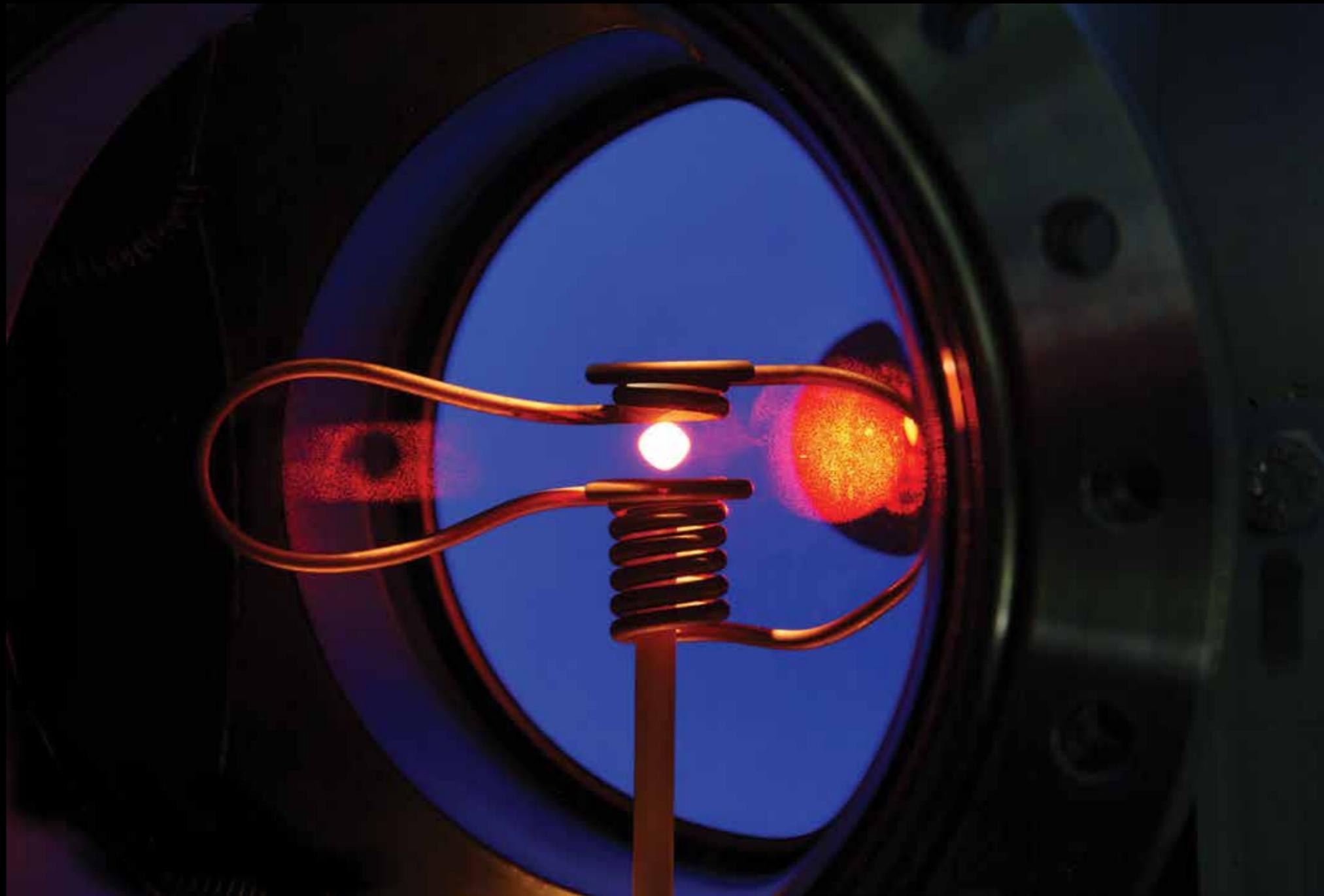
Space workshop for super materials

Most metals used today are mixtures – alloys – developed for specific uses. Improving our knowledge of what influences solidification in different alloys will help in the creation of high-performance materials that are lighter in weight, stronger and more resistant to fatigue.

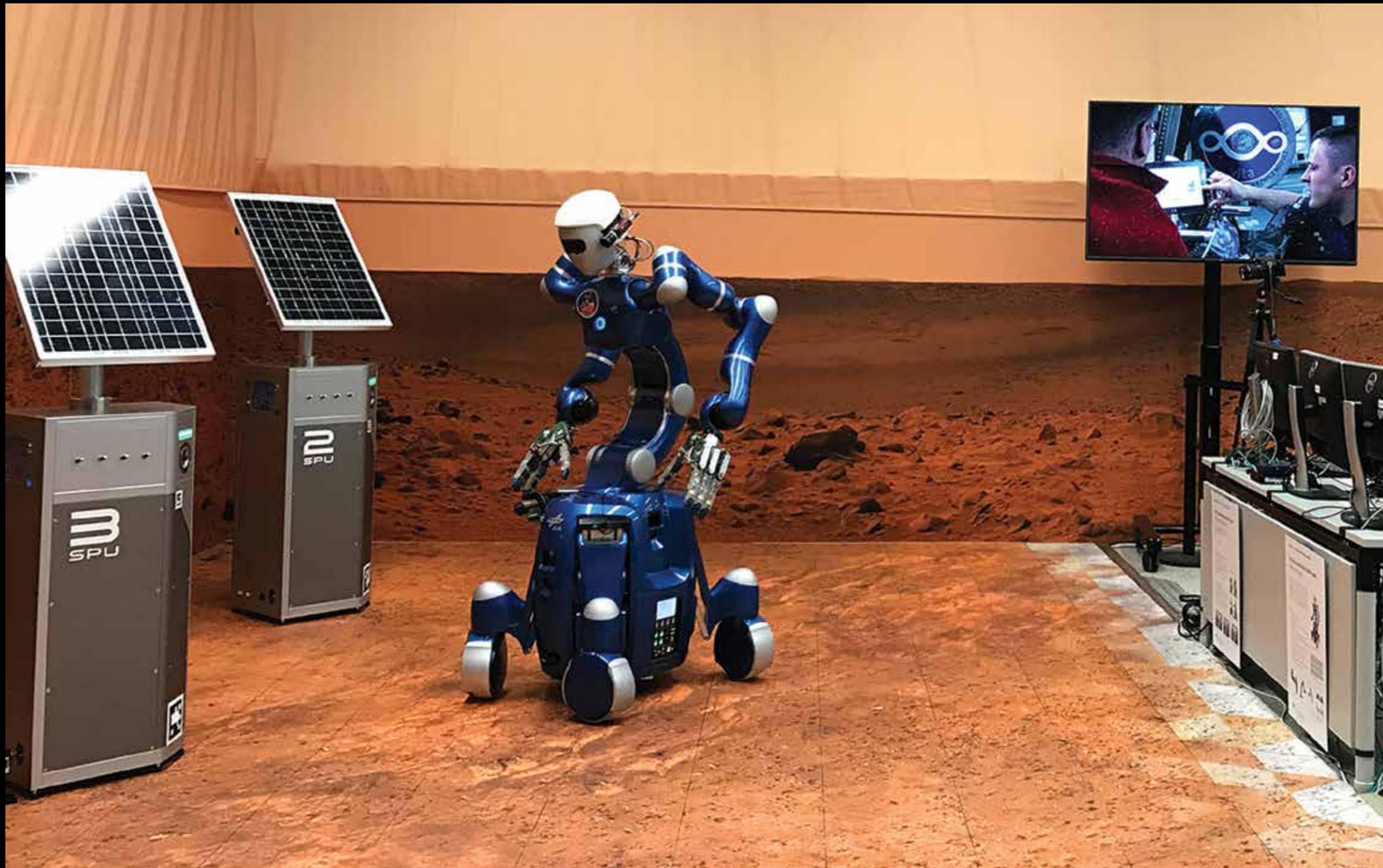
Space research is enabling the way forward, providing the means to determine how phenomena, normally masked by gravity on Earth, influence solidification.

Alexander will be using the **Electromagnetic Levitator** to help improve the quality, reliability and reproducibility of products made on Earth. This furnace can heat metals up to 2100°C and then cool them rapidly. It allows the melting and solidifying of metallic samples suspended in a magnetic field with no need for a container.

Super-alloy metals are in high demand to optimise industrial casting processes. The end products from space research can range from lightweight turbine blades used in jet engines to computer chips found in almost all smartphones.



A free-floating molten metal suspended by electromagnetic force in weightlessness (DLR)



Artificial intelligence by your side

Alexander will operate humanoid robot called 'Rollin' Justin' from space using a tablet. The experiment **METERON SUPVIS Justin** enacts future scenarios in which astronauts orbiting planets or moons can instruct robots to do difficult or dangerous tasks before setting up a human base.

The humanoid robot will be commanded perform a range of tasks, such as navigating on a simulated martian terrain or adjusting solar panels. Justin's local intelligence will execute detailed movements under supervision from orbit, with added time delays to simulate communication from Mars.

More automation can reduce ground operations, costs and eventually risks. Robotic teleoperations also allow us to explore remote places even on Earth. This technology could help to provide humanitarian aid after earthquakes or other natural disasters, and allow robots to carry out delicate tasks in the extreme conditions found in nuclear reactors or offshore drilling operations.

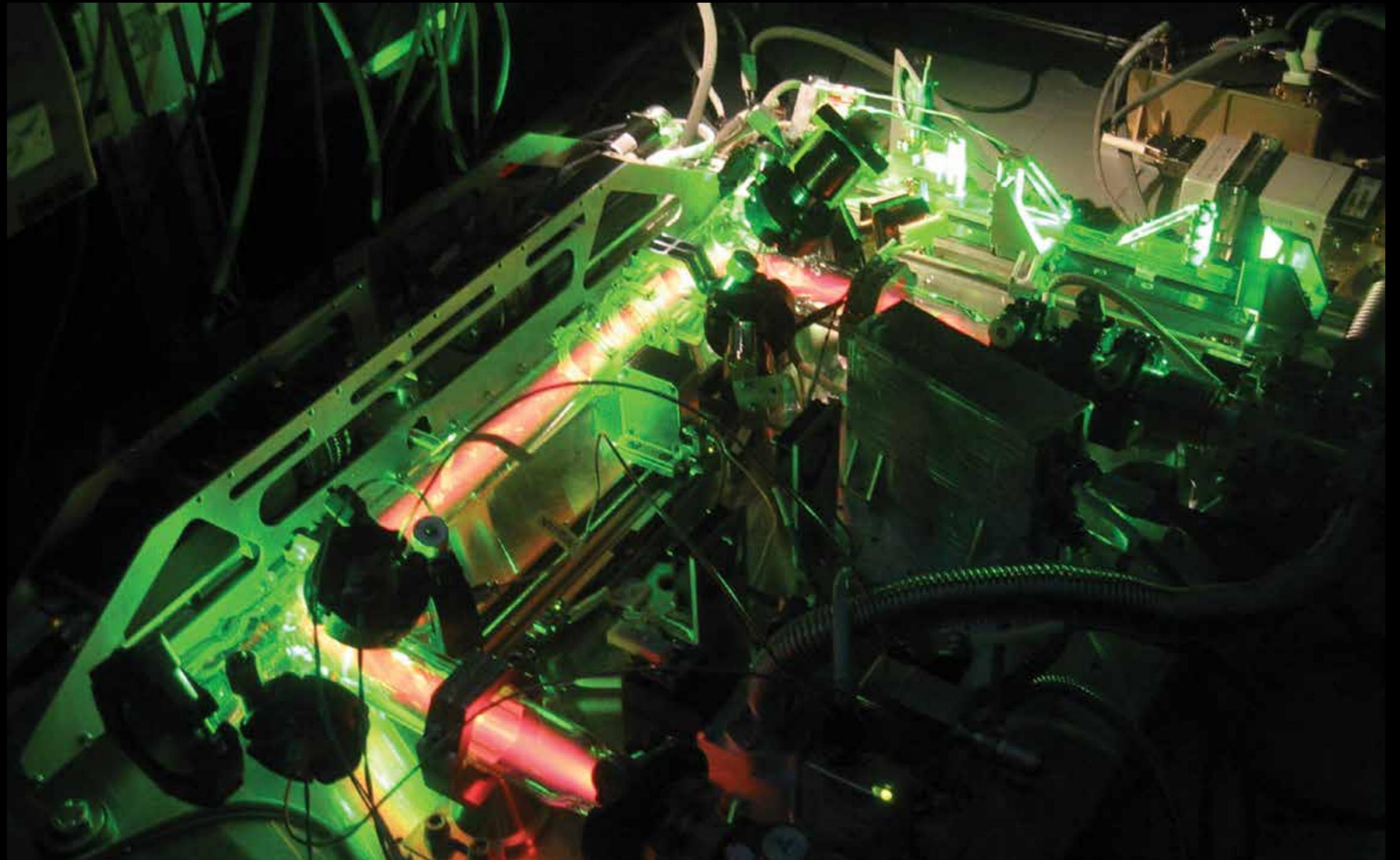
EXPLORE FARTHER

Plasma for a safer world

In recent years, health experts have seen a dramatic rise in super-strains of bacteria that can survive the strongest antibiotics in medicine's arsenal. More than a decade of fundamental research on 'dusty plasmas' – plasma is an electrically charged gas – has generated a precious technological knowhow for the design of miniature plasma devices.

A team of scientists made use of this knowledge to design efficient plasma devices for the disinfection of wounds at room temperature. This revolution in healthcare has many practical applications, from food hygiene to treatment of different kinds of skin diseases, purification of water and odour management.

The inspiration for these technical innovations comes from the Russian-European **Plasma Kristall** experiments – the longest-running series of space experiments in the history of human spaceflight. Fundamental research in space involves injecting microscopic dust into neon or argon plasmas and trying to understand how these particles interact and bond to form atomic structures similar to solids, liquids or gases. Weightlessness offers the possibility to gain new insight into the interaction between atoms.



Glowing plasma on Earth. The space experiment recreates atomic interactions in a fluid on a larger scale (MPE–M. Kretschmer)

DESTINATION: INTERNATIONAL SPACE STATION

The International Space Station is a shining example of broad cooperation, uniting Europe, USA, Russia, Japan and Canada in one of the largest partnerships in the history of science.

The Station is one of the greatest engineering works ever achieved by mankind, and the proof that it is possible to sustain life off-planet. Results about the effects of long stays in orbit teach us how to manage the risks of future human missions further out in space.

The endeavour has brought humanity together to live and work in space uninterrupted for close to two decades.



DID YOU KNOW?

The International Space Station

- flies about **400 km** above Earth
- orbits the planet once **every 90 minutes**, 30 times faster than the speed of a Jumbo jet
- can be seen as **a bright moving star** with the naked eye from most places on Earth
- is larger than a **six-bedroom house** with two toilets and fitness facilities
- has required **200 space missions** for building and maintenance
- has been inhabited **since 2000**

"Looking back on Earth helps you gain a new perspective. The view is beautiful, the feeling – overwhelming. Our planet is a really special place."

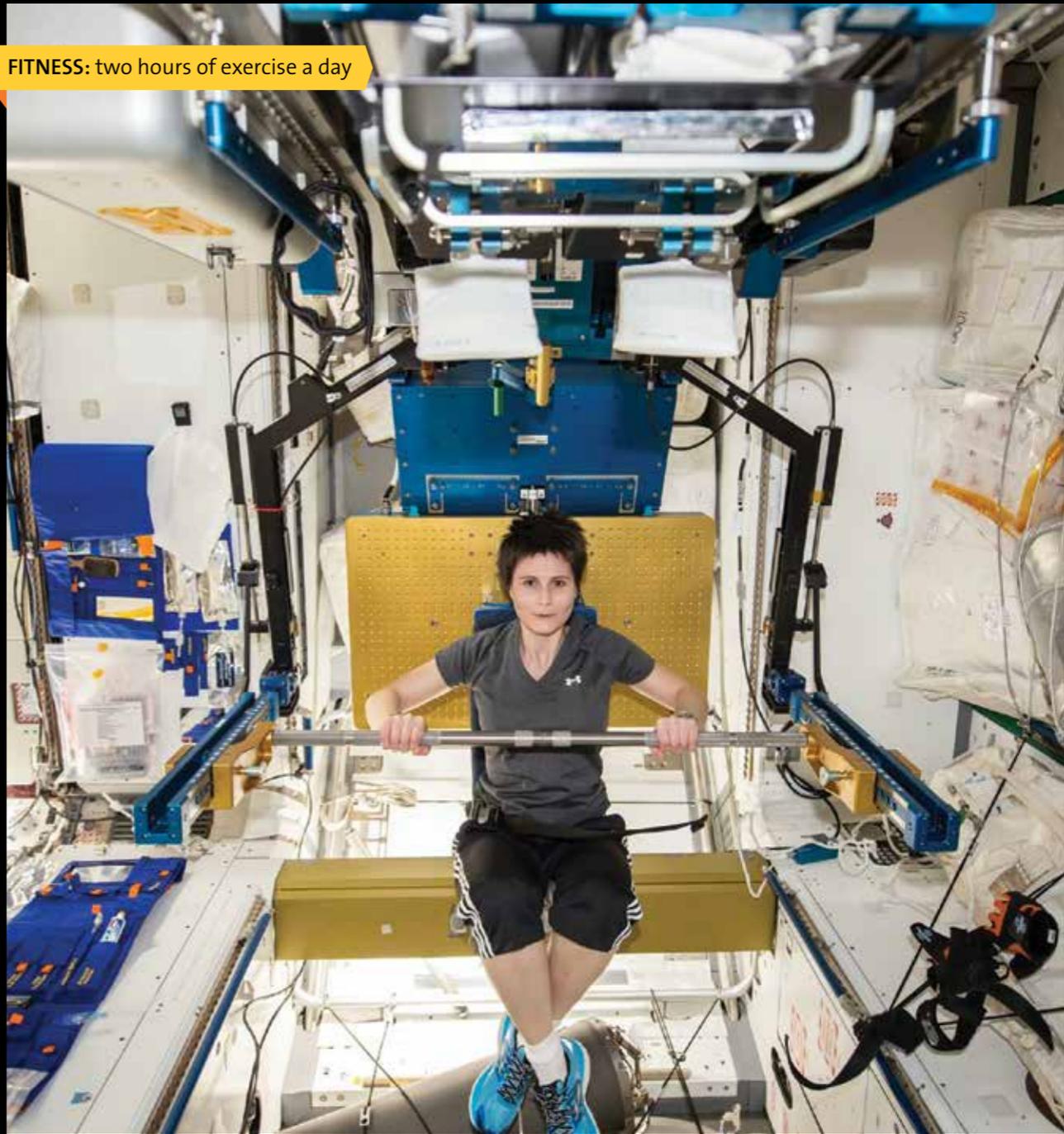
THE HUMAN FACTOR

A day in the life



FIRST TWO WEEKS: adapting to microgravity and Space Station routine

Luca Parmitano dedicated some of his free time to taking pictures from the Station's Cupola, an observation module made in Europe (ESA/NASA)



FITNESS: two hours of exercise a day

Samantha Cristoforetti exercises in the space gym to prevent muscle and bone loss during long-duration spaceflight (ESA/NASA)

SLEEP: eight and a half hours per day



Paolo Nespoli rests in his free-floating sleeping bag (ESA/NASA)

SOCIAL: daily phone calls with family and friends



FACTS AND FIGURES

- Over **550 people** have been to space, of which around **230** have stayed on the International Space Station
- Astronauts have performed over **200 spacewalks** to build and maintain the Station
- Cosmonaut Gennady Padalka has spent a record **879 days** in space over five missions
- Cosmonaut Valeri Polyakov holds the record for the longest single stay in space, **437 days** on Mir in 1994/5
- **6 months:** typical astronaut stay on the Station

Thomas Pesquet contacts amateur radio stations on Earth (ESA/NASA)

HEALTH CHECK: weekly conferences with doctors



Blood draw for health and science research in space (ESA/NASA)

WEEKENDS: housekeeping, voluntary tasks and spare time



Cleaning duties on the Station involve a space hoover and disinfectant wet-wipes (ESA/NASA)



The 51-m high Soyuz FG rocket launches from the same pad used for the world's first human spaceflight made by Yuri Gagarin in 1961 (NASA)

RETURN TICKET TO SPACE

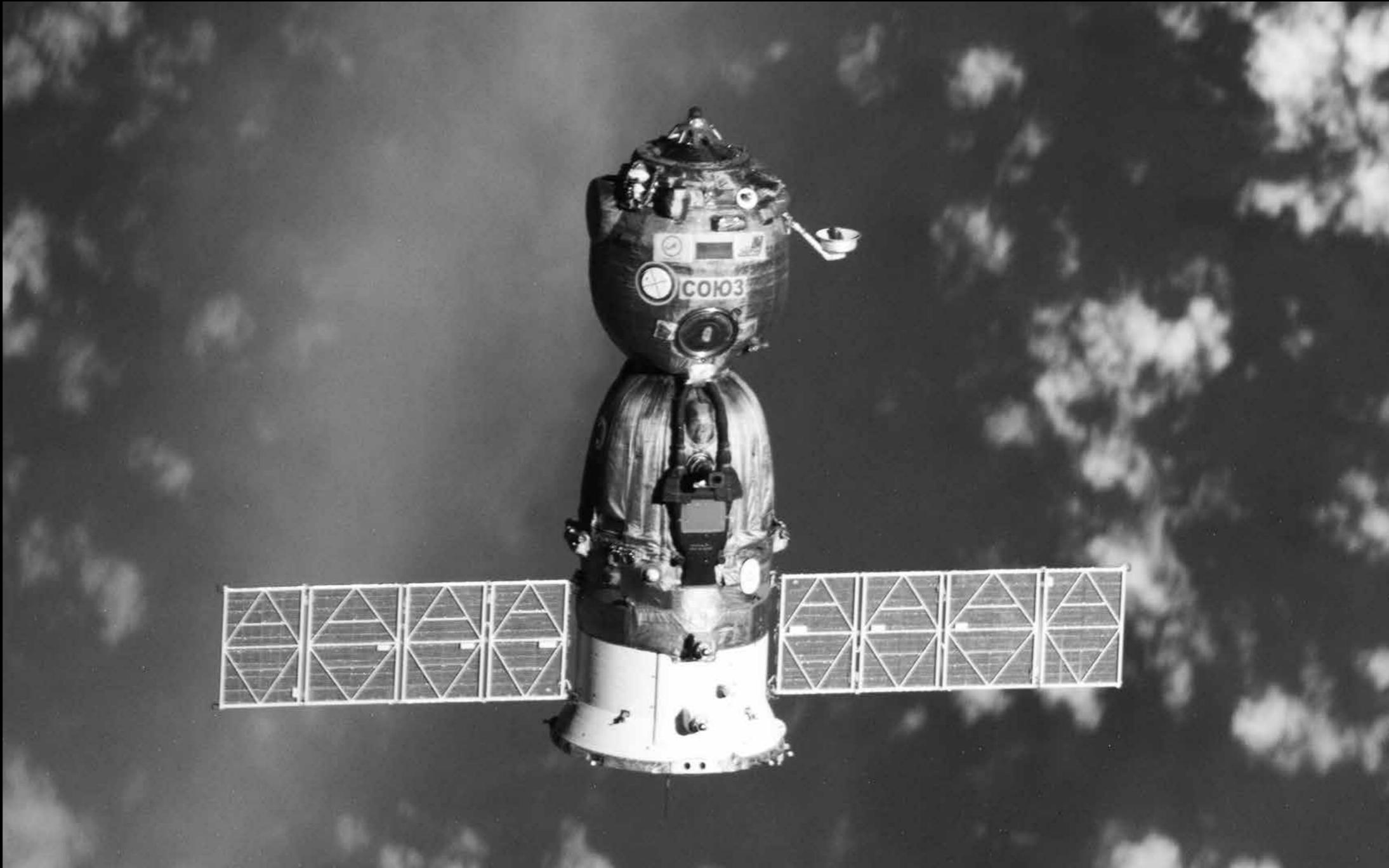
A voyage with Soyuz

Four boosters, each about 20 m in length loaded with 225 tonnes of fuel and liquid oxygen, will propel Alexander Gerst into space from the steppes of Kazakhstan. In less than ten minutes into the flight and at speeds of about 25 000 km/h, he will enter Earth orbit and float 'weightless'.

Soyuz rockets have launched crewed spacecraft and satellites into orbit for over half a century – they are the most-used launch vehicles in the world. The Soyuz spacecraft shares the same name as its launcher – Soyuz means 'union' – and it is currently the only transport system for astronauts to reach and leave the International Space Station.

KEY DATA

Launch site	Baikonur, Kazakhstan
Launch	6 June 2018
Landing	10 December 2018
Spacecraft	Soyuz MS-09
Launcher	Soyuz FG



The Soyuz spacecraft can manoeuvre, rendezvous and dock in orbit in an automated or manual control mode. Alexander will support the Soyuz commander as copilot during launch and return to Earth.

The Soyuz spacecraft is capable of transporting up to three people to and from the International Space Station (NASA)



Three hours after leaving the Station, the Soyuz descent module deploys a series of parachutes to allow a stable descent at a speed of around 7 m/s (NASA)

After living and working on the Space Station for six months, Alexander will return to Earth in the Soyuz capsule with his two crewmates. Only one of the three modules of the Soyuz survives the reentry into Earth's atmosphere – the descent module. Reentry begins at an altitude of about 100 km, when the speed at which the capsule travels is reduced dramatically and the crew is pushed back into their seats with a deceleration of up to 5 g, feeling the equivalent of five times their body weight.

Less than four hours after leaving the Station, the Soyuz touchdown will signal the end of his 'Horizons' mission. Alexander will fly directly to Cologne, Germany, where all medical checks, rehabilitation activities and post-flight science will take place.



Alexander back on Earth in 2014 (ESA)

THE SPACE GENERATION

Calling all innovators

Alexander invites youngsters to shape the future, to be bold and creative on and beyond Earth. Europe's ambassador in space will perform a set of experiments in orbit with the help of the next generation of engineers and scientists.

European Astro Pi Challenge

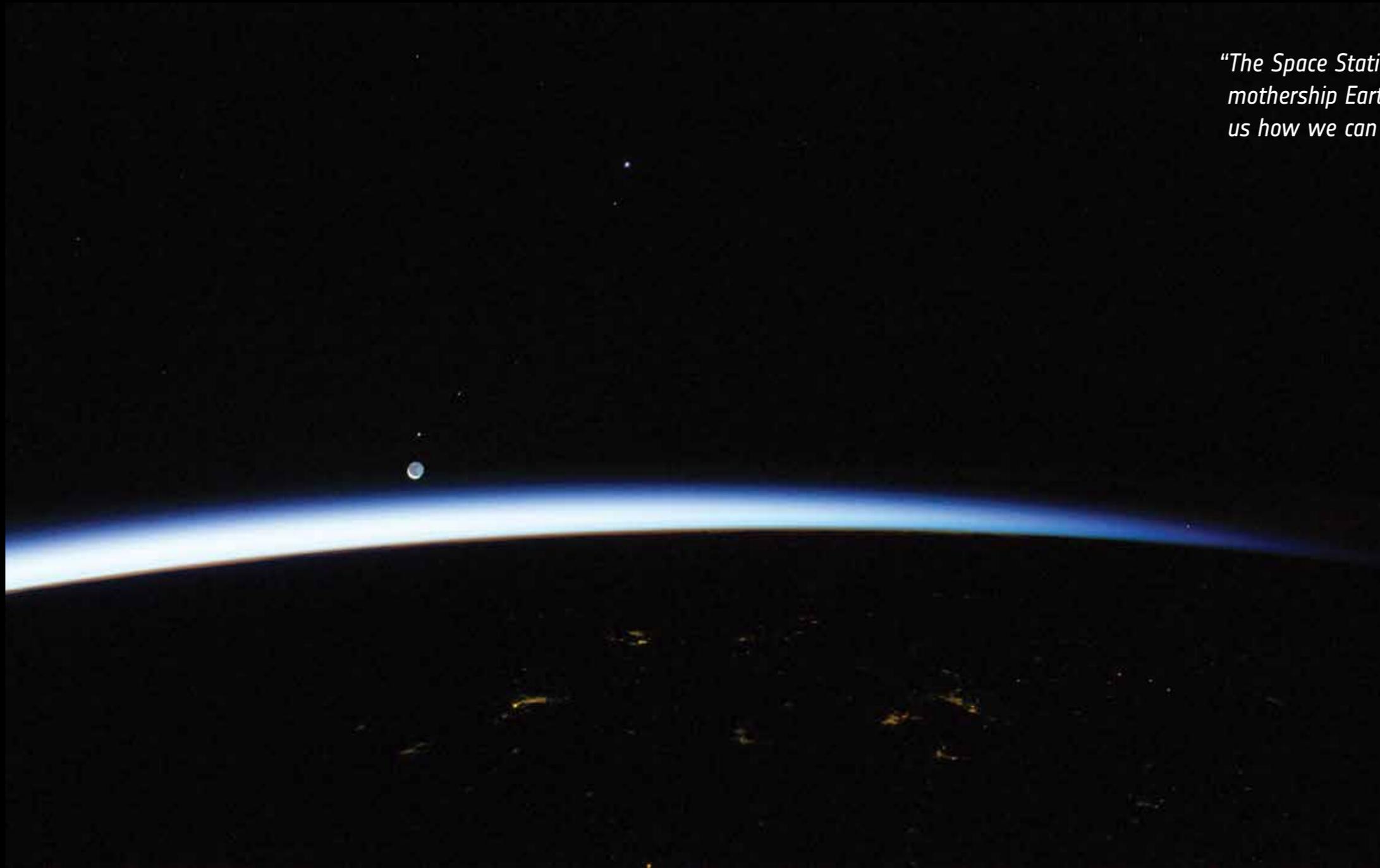
Astro Pi are credit card-sized computers equipped with a host of sensors and gadgets onboard the Space Station. Students all over Europe have the opportunity to run their own codes in space. Alexander will promote this challenge with different levels of complexity: from sending greetings to the crew with the ambient temperature to scientific investigations about life on Earth and in space.

Flying Classroom 2.0

Alexander will use small items to visually demonstrate on the Space Station several principles of physics to students. Acceleration, propulsion, electrostatic charging and collisions will be put to the test to better understand microgravity and its effects.



Astro Pi mini computers running students' code on the Space Station (ESA/NASA)



"The Space Station gives us the opportunity to leave our mothership Earth. After all, it is the first spaceship to show us how we can live beyond the terrestrial boundaries."

New horizons

The same curiosity and fascination that inspired him to take on the challenge of space is directing Alexander's gaze at new horizons from the International Space Station. Science and technology research continuously running on the Station for two decades shows a future where humans and robots work together, understanding health in space becomes part of the journey and international cooperation is always a driver.

This gateway to space exploration is paving the way to the Moon, Mars and beyond.

Alexander's trip continues the legacy of bravely going onward and upward into the unknown. As a good scientist, he keeps asking himself what lies beyond.

The Moon rising above Earth's horizon together with Mercury, Mars, the star Regulus and Venus as seen from the International Space Station (ESA)

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