huginn

2023

"Astronauts are explorers that travel into space to gather information and expand our knowledge of our world, much like Huginn the mythical raven, which was sent out each day to fly around the world and bring back information to the Nordic god Odin."

Andreas Mogensen

ANDREAS MOGENSEN

Space Viking

Andreas Mogensen joined the ESA astronaut class of 2009 and became the first Dane in space on a 10-day mission, 'iriss', that launched to the International Space Station in 2015. His next mission is called Huginn, Andreas's first long-duration mission on Earth's free-falling laboratory in space, set to launch this year.

Andreas has a master's degree in Aeronautical Engineering from Imperial College London, UK, and a PhD in Aerospace Engineering from the University of Texas, USA, where his research focused on guidance, navigation and control of spacecraft during entry, descent and landing. Once he completed the iriss mission, Andreas worked as the European astronaut liaison officer to NASA's Johnson Space Center, communicating with the astronauts on the Space Station as Capcom from Mission Control Center in Houston, USA.

Huginn

This name, chosen by Andreas, originates in Norse mythology with Huginn and Muninn – the two raven accomplices of the god Odin. The two symbolise the human mind, with Huginn representing thought and Muninn, memory.

The two ravens flew into the world at dawn and gathered information from the farthest corners of the world to bring back news to Odin. The Huginn mission will see Andreas fly to Earth's orbiting outpost to run experiments at the edge of our planet and bring knowledge to humankind back on Earth.

The Huginn mission patch captures several details, with the raven Huginn in front and the silhouette of Denmark embedded in its wings. The white line in Huginn's wing symbolises the flight path from Copenhagen, Denmark, to the International Space Station.

ESA/NASA

"Just like Huginn told Odin the knowledge he had collected after flying into the world, we try to further the knowledge by telling others on Earth what we have learned through our work on the Space Station."

Andreas Mogensen

NAME
Andreas Enevold Mogensen

BORN
2 November 1976,
Copenhagen, Denmark

OCCUPATION
Astronaut

EDUCATION
PhD in Aerospace Engineering
from the University of Texas, USA

MISSIONS
iriss (2015)

TIME IN SPACE
9 days, 20 hours and 14 minutes

HOBBIES
Rugby, mountaineering, diving

THE EUROPEAN SPACE AGENCY

Space for everyone

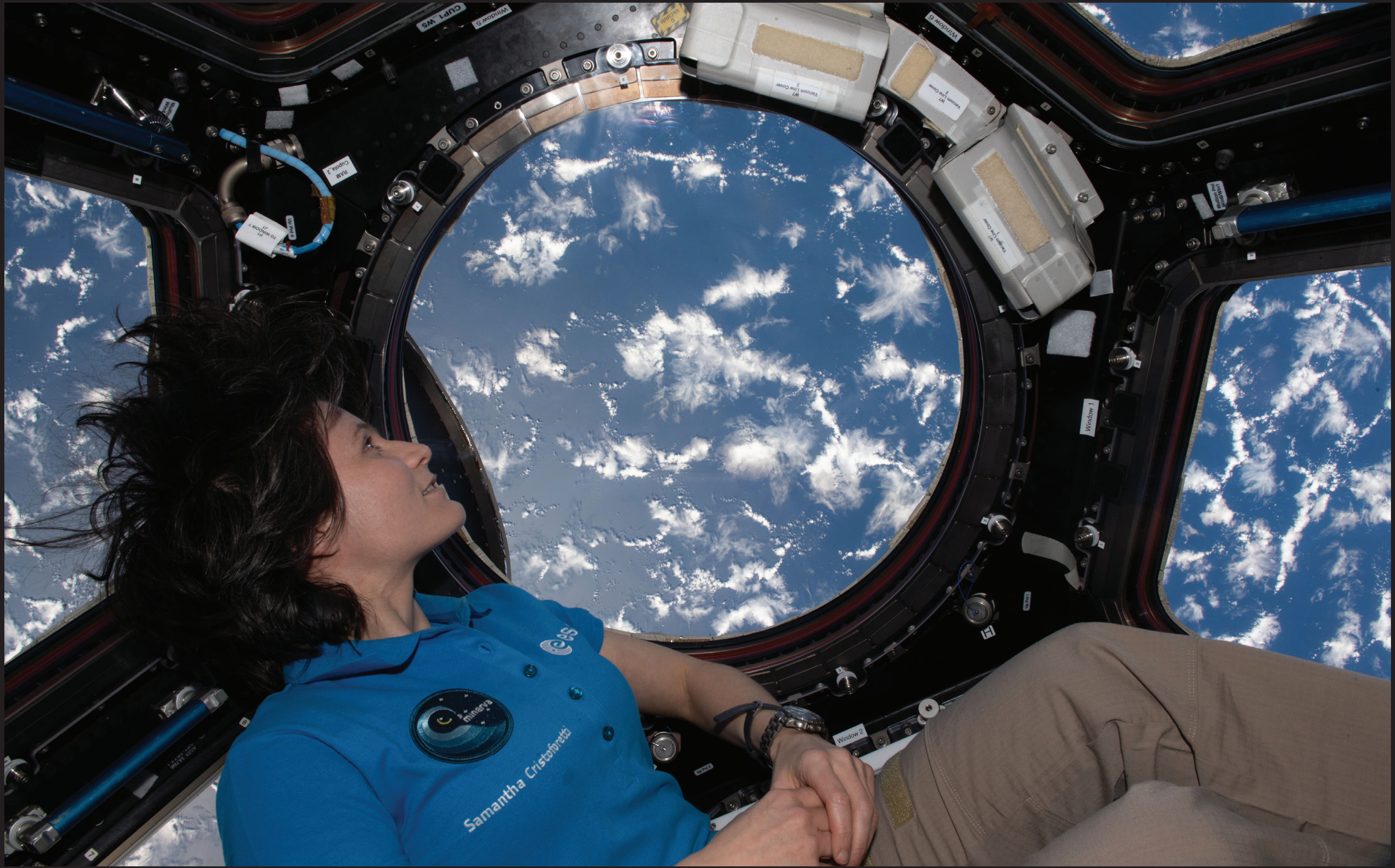
Established in 1975, ESA now has 22 Member States and cooperates with many others. These countries are home to more than 500 million European citizens. If you are one of these citizens, then your support plays a vital role as we explore farther in space.

ESA's mission is the peaceful exploration and use of space for the benefit of everyone. Our family of scientists, engineers and business professionals from all over Europe watch over Earth, develop and launch inspiring and unique space projects, fly astronauts and push the boundaries of science and technology, seeking answers to the big questions about the Universe.

ESA is a partner in the International Space Station programme along with the United States, Russia, Japan and Canada. The first ESA astronaut flew to space in 1983, and the European Astronaut Centre in Germany has been training men and women for missions since 1998.

Participation in the International Space Station project allows thousands of Europe's brightest people at hundreds of universities and companies in ESA's Member States to work at the leading edge of science and engineering.

Knowledge developed through our work on the Space Station makes it possible to send humans farther into space than ever before and improve the quality of life here on Earth.



Samantha Cristoforetti floating in the International Space Station's European-built Cupola observatory (ESA/NASA)

Denmark from the International Space Station during 'iriss' mission (NASA/ESA)

THE DANISH SPACE DIVISION

Established in 2016, the Danish space division, Kontoret for Rum, regulates and implements the Danish Space Strategy and cooperates with the space sector in Denmark through the initiative "Space Exploration Danmark" to coordinate how the country can move forward in the global space sector.

Danish companies and universities have supported several ESA missions over the years, in space science, Earth observation and human and robotic exploration as well as collaborations with NASA, delivering components for robotic exploration on Mars.

During the Huginn mission, Andreas will carry out several Danish experiments from both Danish universities and companies, ranging from climate science and materials science to water filtration, human physiology and many more.

Uddannelses- og Forskningsministeriet

SPACE EXPLORATION DANMARK

GROUND CONTROL

User support and operations centres

In 1998, ESA created the User Support and Operations Centres (USOCs) to assist Space Station users. Centres around Europe are responsible for the use and implementation of European hardware on the Space Station. The operation centres conduct tasks needed to prepare and operate experiments. They act as the link between science teams on the ground and the Space Station.

The Columbus Control Centre distributes data to the USOCs and receives information from them. This information is used to generate mission plans and timelines for the flight controllers and astronauts.

Columbus Control Centre

ESA's Columbus Control Centre, known by its call sign Col-CC, supports the European Columbus laboratory on the Space Station. It is located at the German Aerospace Center DLR in Oberpfaffenhofen, near Munich, Germany.

Col-CC is the direct link to Columbus in orbit. Its main functions are to command and control the European space laboratory's systems, coordinate operations of European payloads on the Space Station and to operate the European ground communications network.

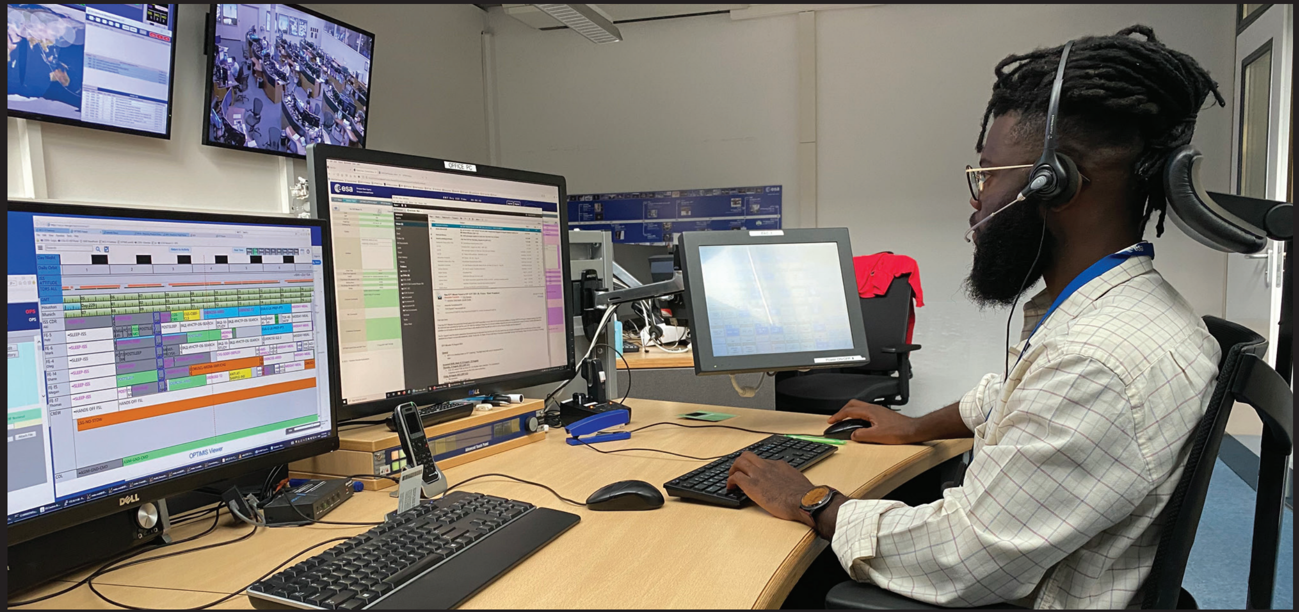
Col-CC's operational teams focus on aspects of Columbus from the flight director to safety, equipment, ground systems and configuration, and provide assistance 24 hours a day, seven days a week.

The voice of Earth

The European Communicator and Medical Operations (EUROCOM) console is based at ESA's European Astronaut Centre (EAC) in Cologne, Germany, and is the interface between astronauts, the Columbus flight control team, User Support and Operation Centres and space medicine experts.

EUROCOMs are selected from EAC's crew support, crew instructors and biomedical engineers to perform and manage communication between ESA's Columbus control centre, USOCs all over Europe and astronauts from all countries working on ESA activities in orbit.

Columbus control centre (ESA/DLR)



European spacecraft communicator preparing the daily planning conference between the Columbus flight control team and the crew on the International Space Station, at the European Astronaut Centre (ESA)

Astronauts Andreas Mogensen and Kate Rubins during ESA's PANGAEA geology training (ESA)

TRAINING FOR THE MISSION

Leading the way

In his position as the European astronaut liaison, Andreas communicated with the astronauts on the International Space Station as Capcom from Houston, USA. Here he was the lead communications for the SpaceX-12 and SpaceX-14 supply missions where he supported the crew on the Station to capture the incoming spacecraft with the robotic arm, Canadarm2. He also supported three spacewalks from mission control.

In 2021 and 2022, Andreas embarked on ESA's Pangaea training course in Germany, Italy, Spain, and Norway. He was joined by NASA astronaut Kate Rubins to gain practical skills in the field of geology and astrobiology, and prepare for future human space exploration as humankind goes back to the Moon and farther to Mars.

"Knowing more about Earth is helping me understand the geology on the Moon and Mars and gain a better insight into our entire Solar System. An arid island like Lanzarote is teaching us how crucial the smallest amount of water can be for life."

Andreas Mogensen

Andreas Mogensen during training (NASA)

Andreas Mogensen training with a spacewalk suit with Jasmin Moghbeli (NASA)

Andreas Mogensen training in the Columbus mockup at the European Astronaut Centre (ESA–S. Corvaja)

Andreas's first mission, iriss, launched from Baikonur Cosmodrome, Kazakhstan on a Soyuz launch vehicle. He will be flying on a SpaceX Crew Dragon for the Huginn mission. Andreas will be the first non-US pilot for this spacecraft, where he will be second in command, like a co-pilot in aviation, to NASA astronaut and Crew-7's commander Jasmin Moghbeli. He will oversee the spacecraft's systems and performance while flying to the International Space Station.

Andreas has been training at the European Astronaut Centre in Cologne, Germany, on the ESA experiments he will conduct during his Huginn mission ranging from materials science and water filtration to human physiology and climate science.

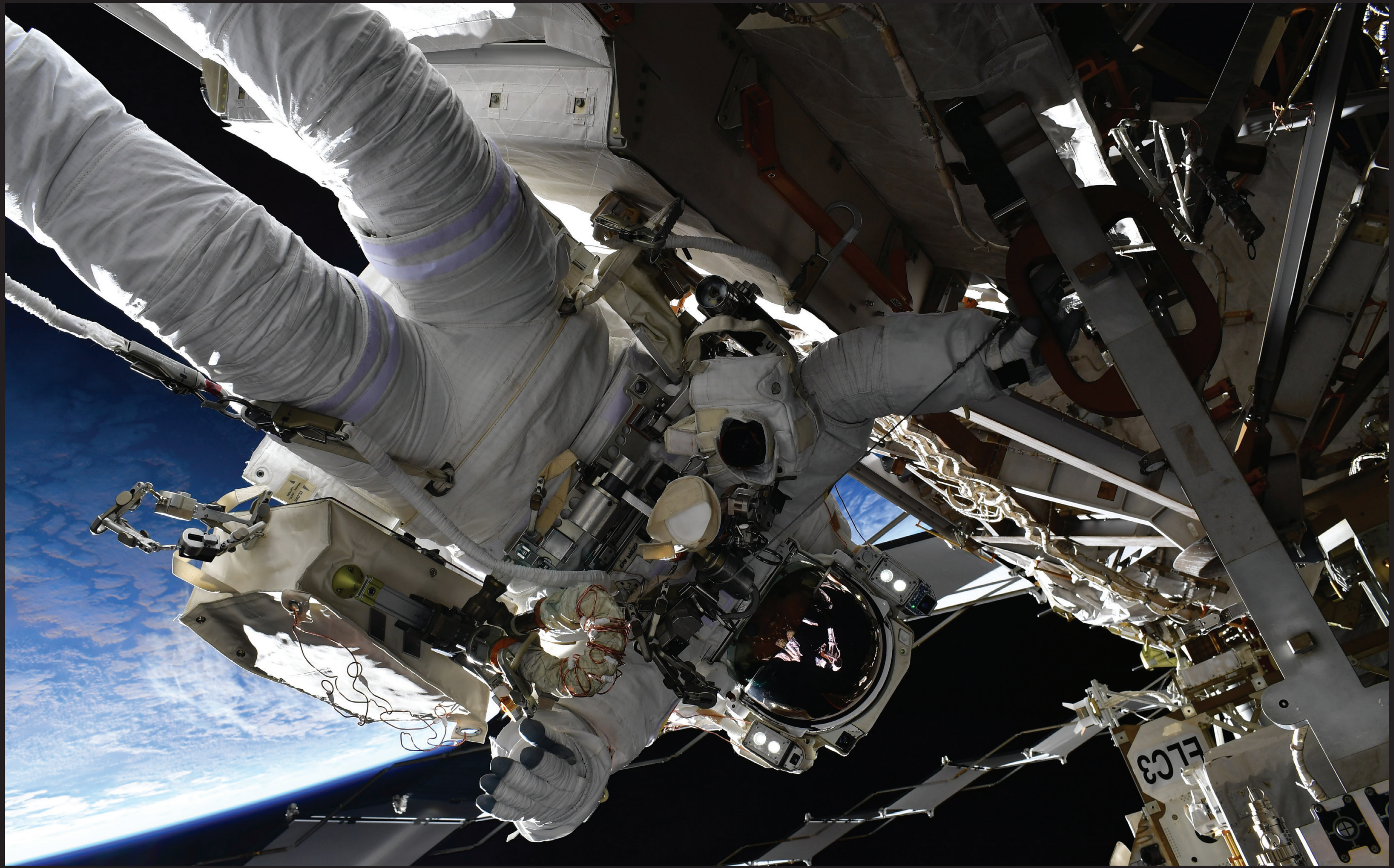
"While here at EAC, I have been training on ESA experiments for my mission, which I'm looking forward to conducting on the Space Station. On top of that, I've been doing some of my medical assessments, as astronauts have to be healthy and fit before launch."

Andreas Mogensen

RESEARCH FOR THE BENEFIT OF HUMANKIND

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 – making it a fantastic resource for enhancing scientific knowledge.

In constant freefall around the planet, astronauts on the Space Station live and work in microgravity. This weightless laboratory allows them to perform experiments that are not possible on Earth. Up there, crews run pioneering research, test new technologies and push the boundaries of knowledge. Andreas will devote much of his time to scientific activities, covering climate research, fundamental science, and health, as well as demonstrating technologies that could shape the way we live and work on Earth.



Mathias Maurer on a spacewalk during his Cosmic Kiss mission (ESA/NASA)

Andreas Mogensen in the Columbus module, Europe's laboratory in space, packed with scientific equipment (NASA)

"The Space Station is first and foremost a laboratory, so while we are up there, we conduct experiments that are used to improve life back on Earth."

Andreas Mogensen

THE COLUMBUS LABORATORY

Home of European science in orbit

Columbus is Europe's laboratory on the International Space Station. This laboratory accommodates a wide range of scientific research in space, from astrobiology and solar science to metallurgy and psychology. Inside and out, it provides the microgravity environment and capabilities needed for researchers to test technology and observe phenomena that cannot be observed on Earth.

This laboratory will be Andreas's main workstation throughout Huginn and includes 16 experiment facilities that operate continuously. Each unit functions independently, with its own power and cooling systems and communications links to scientists on Earth. After more than a decade in orbit, circling our planet at 28 800 km/h, Columbus is a versatile laboratory that is constantly breaking new scientific ground. Over 250 experiments have been carried out in this remarkable facility, with many more to come. In this section you will find a snapshot of some of the science activities and technology demonstrations taking place throughout Andreas's Huginn mission. Stay tuned to Andreas's social media accounts, the ESA website and ESA's Huginn page for regular updates on the science in orbit.

SCIENCE ON THE HUGINN MISSION

The Huginn mission has varied scientific experiments ranging from understanding and improving sleep in orbit, to the science of alloys and investigating how rocky planets are formed. Three pillars set the stage for the science experiments of the Huginn mission: health, space for Earth, and climate. Each pillar is aligned with Andreas's vision of the Huginn mission and the science he will be performing on the Space Station.

Health

- Circadian Light
- SpaceWear
- Sleep in Orbit
- Immunity Assay
- VR for Mental Care

Space for Earth

- VR for Exercise
- Metal 3D Printer
- Surface Avatar
- ASI EVOO
- LaPlace

Climate

- EarthShine
- Multi-Needle Langmuir Probe
- Thor-Davis
- Aquamembrane
- CNES MatISS

In-ear device for measuring brain activity during sleep, similar to the one Andreas will wear (AU Foto)

Health

Understanding a good night's sleep

Our sleep cycle is a complex process that plays a vital role in maintaining good physical and mental health. Sleep in Orbit will investigate Andreas's brain activity and sleep stages as he rests on the Space Station by using in-ear measurement devices.


A mockup of the Circadian Light experiment (SAGA)

Health

Helping your inner clock

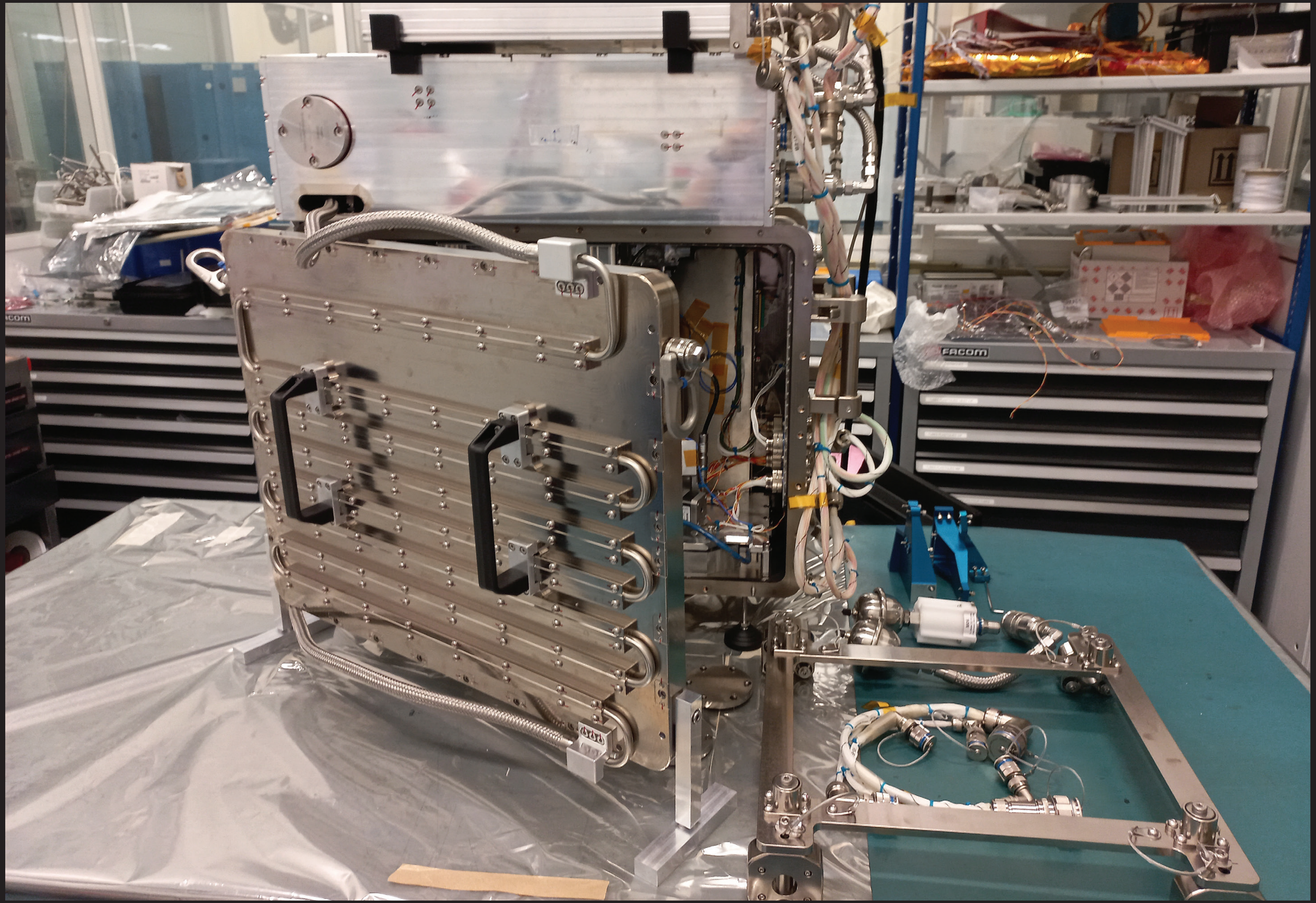
Circadian rhythms describe the changes our bodies undergo in a full day. This internal clock is regulated by our core temperature, which tells our bodies when it is day or night and triggers the metabolic system and the sleep cycle. This daily rhythm is connected to many factors, and light exposure is one of them. This is the focus of the Circadian Light experiment. Using LED lights with specific wavelengths in Andreas's sleeping quarters, set to follow the natural sunrise and sunset, will help researchers understand how Andreas's sleep patterns are affected from living in space.

Health

Exercising with immersive VR

Exercise is a regular part of an astronaut's day in space. Astronauts on the International Space Station live in microgravity and have less load on their muscles, bones and cardiovascular system compared to on Earth. Andreas will test VR for Exercise with virtual reality (VR) videos of mountain bike tracks in nature. Different environments can help create a more engaging experience while cycling on the Space Station's exercise bike.

Scenery similar to what Andreas will see during the VR for Exercise experiment (ESA–H. Hansen)



Flight model of the Metal 3D printer (ESA/Airbus SAS)

Space for Earth

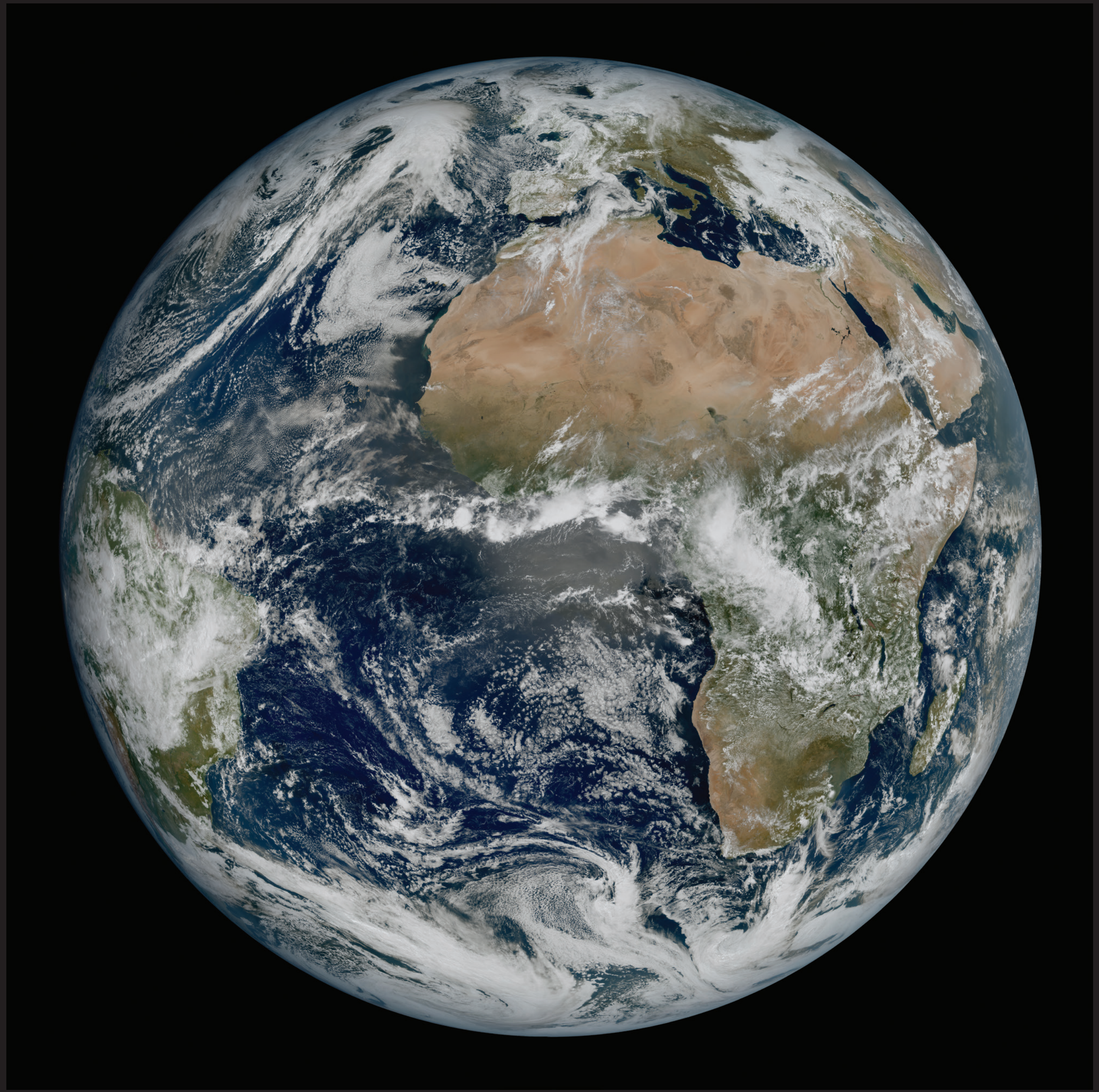
Printing metal in space

3D printing has skyrocketed over the last decade, bringing rapid manufacturing to consumers while allowing for complex shapes and intricate details. Metal 3D Print will use a new metal 3D printer on the Space Station to study how printing metal objects is affected by microgravity, especially how shapes expand and shrink compared to a model printed on Earth.

Space for Earth

Understanding Earth's origin

Wondering where we all came from is a thought deeply rooted in being human. The origin of the planets in our Solar System is not exactly known. The Solar System was created from a cloud of gas and dust, but how did the dust grow from the first grain to rocky planets like Earth? This is the focus of LaPlace, an experiment that will examine how dust grains grow in gaseous environments into macroscopic bodies.



Earth as seen by Meteosat Third Generation (EUMETSAT/ESA)

ESA's two-armed rover that will be used for the Surface Avatar experiment (ESA)

Space for Earth

The next step in operating robots from space

Operating robots over vast distances allows humans to explore and perform complex tasks from the safety of a control room. The Surface Avatar experiment takes operating robots to the next level, allowing astronauts to operate multiple robots on Earth from the International Space Station, using force-feedback controls to sense the robot touching and handling objects on ground. Several robots will work together to complete complex tasks, which gives valuable insight on how humankind can work on the Moon and beyond.

Climate

A view of Earth's climate from the Moon

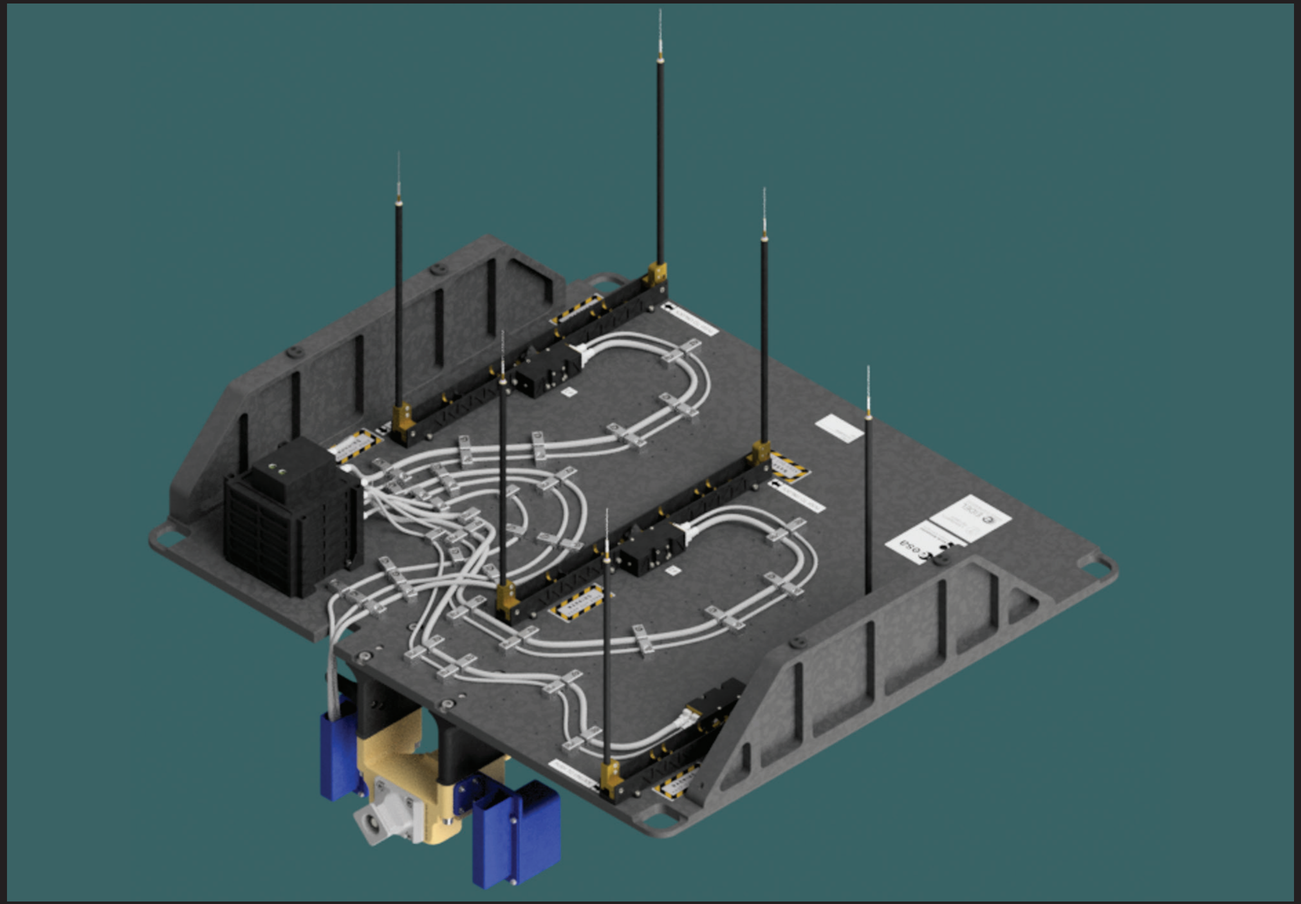
Earth's climate is changing. Understanding how much the Earth is reflecting sunlight, called the albedo, is a crucial parameter. Earthshine will have Andreas Mogensen take hundreds of photos of the new Moon phase from the Space Station's Cupola observatory to measure the amount of reflective Earth light hits the Moon to calculate the albedo of Earth and help scientists build better climate models.

A new Moon seen from the International Space Station (ESA–S. Cristoforetti)

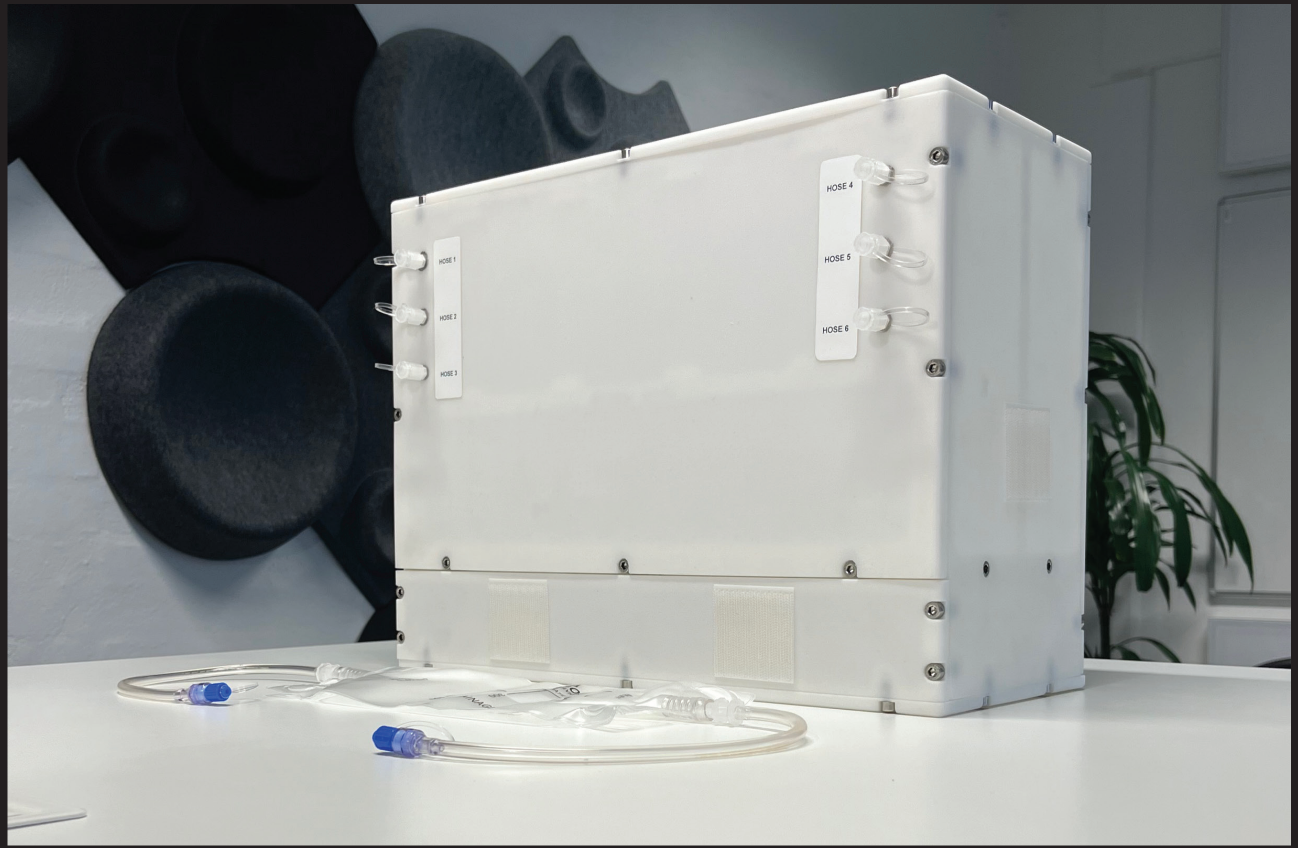
Climate

Forecasting space weather

Particles from the Sun affect Earth's atmosphere and magnetic field, causing auroras. How these particles interact with the atmosphere is called space weather. Understanding how space weather interacts with the uppermost regions of our atmosphere is what the multi-Needle Langmuir Probe (m-NLP) experiment focuses on, and will assist in better space weather forecasts and predict when satellite navigation services could be interrupted. The m-NLP will be one of the first payloads installed on the Bartolomeo platform outside the Columbus module.



The multi-Needle Langmuir Probe with its six probes and platform (Eidsvoll Electronics)



Model of the Aquamembrane experiment (Danish Aerospace Company)

Climate

Mimicking nature to clean water

Having access to clean water is important, both on Earth and on the Space Station. The Aquamembrane experiment is designed to test filtration of water using a membrane made of proteins found in nature, such as plant roots and in our kidneys. Building on the first model that flew on Andreas's first mission, the filtration system will use mechanical pumps to push Space Station wastewater past the membrane, to evaluate its efficiency in microgravity.

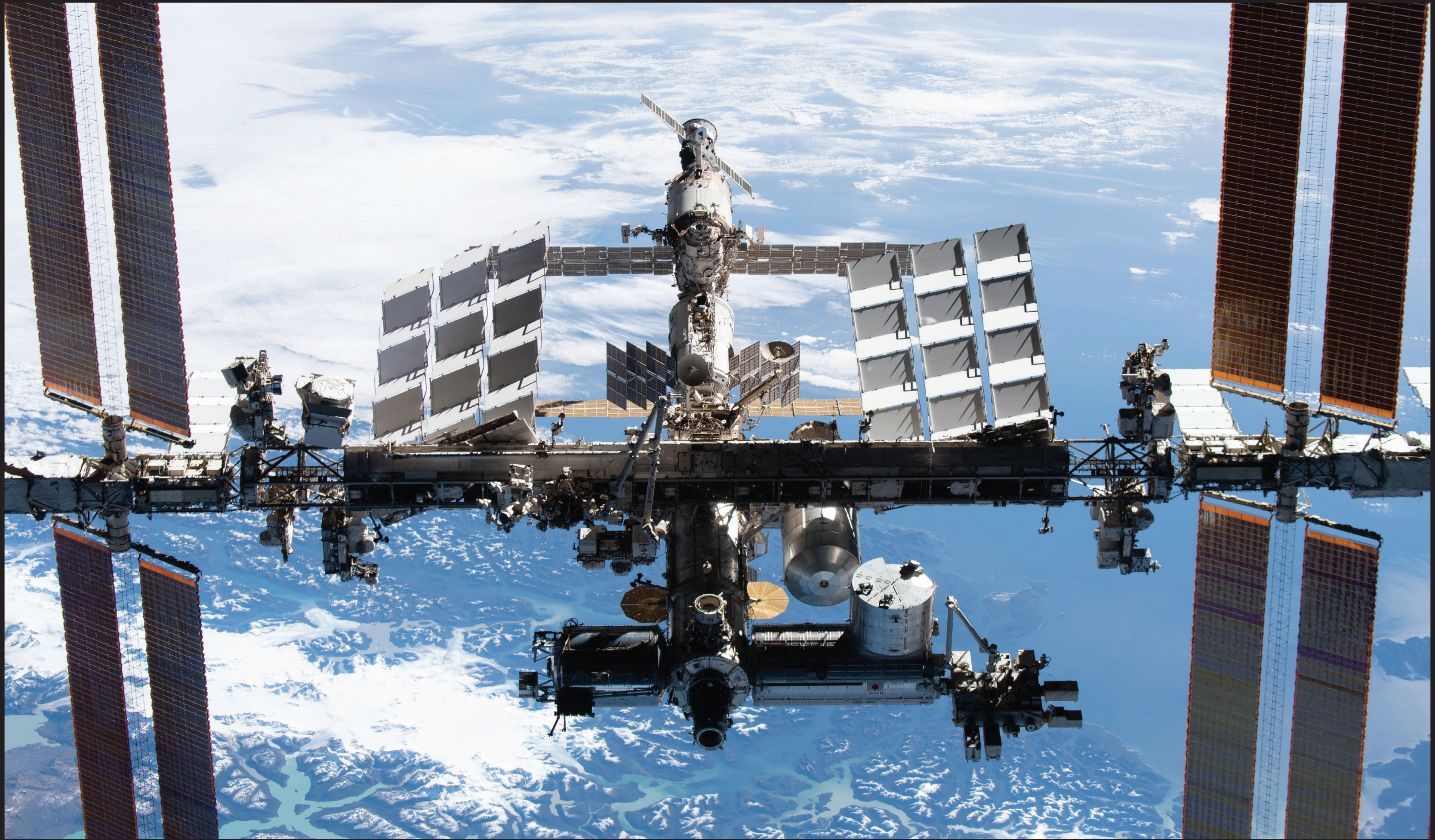
DESTINATION: INTERNATIONAL SPACE STATION

The International Space Station is an example of cooperation beyond borders, with Europe, USA, Russia, Japan and Canada in one of the largest partnerships in the history of science. As one of the greatest engineering works ever achieved by humankind, the orbital outpost is proof that it is possible to sustain life away from Earth. Results relating to the effects of long stays in orbit teach us how to manage the risks of future human missions farther out in space. The endeavour has brought humankind together to live and work in space uninterrupted for more than 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 three toilets and fitness facilities
- required **200 space missions** to build and maintain
- has been inhabited **since 2000**



The International Space Station (ESA//NASA–T. Pesquet)

THE HUMAN FACTOR

A day in the life

FIRST TWO WEEKS: adapt to microgravity and Space Station working routine

Luca Parmitano ready to take some photos from the Station's Cupola, a European-made observation module (ESA/NASA)

FITNESS: exercise for approximately two hours per day, six days per week

Andreas Mogensen during his first mission, iriss, exercising to prevent bone and muscle loss during spaceflight (ESA/NASA)

Thomas Pesquet in his crew quarters during his Alpha mission (ESA//NASA–T. Pesquet)

FACTS AND FIGURES

- Over **600 people** have travelled to space
- Astronauts have performed over **260 spacewalks** to build and maintain the Station
- Cosmonaut Gennady Padalka 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 1994–1995
- Astronauts typically stay on the station for **6 months**

Andreas Mogensen and Expedition 45 crew at dinner time during the iriss mission (ESA/NASA)

HEALTH: participate in weekly medical conferences with flight surgeons

Samantha Cristoforetti setting up to record her body's fat and lean mass (ESA/NASA)

WEEKENDS: housekeeping, public relations and voluntary tasks, enjoy spare time, watch the world from the Cupola

Alexander Gerst carrying out cleaning duties on the Station (ESA/NASA)

Konstantin Borisov, Andreas Mogensen, Jasmin Moghbeli and Satoshi Furukawa in their SpaceX flight suits (SpaceX)

JOURNEY TO SPACE

Andreas will be the first non-US astronaut to pilot the SpaceX Crew Dragon and the fourth European astronaut to fly on Crew Dragon to the International Space Station.

In addition to commander of Crew-7 and NASA astronaut Jasmin Moghbeli, Japan Aerospace Exploration Agency (JAXA) astronaut Satoshi Furukawa and Roscosmos astronaut Konstantin Borisov will join Crew-7 and lift off from Kennedy Space Center in Florida, USA. Nearly nine minutes into the flight, Andreas, Jasmin, Satoshi, and Konstantin will reach orbital height and continue their way to the International Space Station. The first stage booster of the Falcon 9 rocket will then return to Earth for refurbishing for another flight.

"I'm very proud to be the pilot of Crew Dragon, and it is a great honour being the first pilot outside of the US, both for me, but also for ESA and it is a sign of the responsibility that ESA is not just a passenger in space exploration."

Andreas Mogensen

Dragon: up close

The Crew Dragon spacecraft is based on the uncrewed cargo version that SpaceX has been using to ferry supplies and equipment to the Space Station since 2010. The automated spacecraft is monitored and can be controlled from the inside if necessary, using touch screens.

The nose cone of the Crew Dragon will open 12 minutes after launch, revealing the docking port underneath. Once docked with the Space Station, the spacecraft will stay in place for the duration of the Huginn mission and act as a lifeboat for the crew in case of an emergency.

KEY DATA

Launch site	Kennedy Space Center, Florida, USA
Launch date	Late summer 2023
Duration	Approximately six months
Spacecraft	Crew Dragon
Launcher	Falcon 9

SpaceX Crew-3 on the launchpad (SpaceX)

Return to Earth

At the end of the Huginn mission, Andreas and his crew mates will go into the same Crew Dragon capsule that brought them up to the Space Station. After undocking, the Crew Dragon will complete a series of burns to prepare for reentry into Earth's atmosphere and splashdown off the coast of Florida, USA.

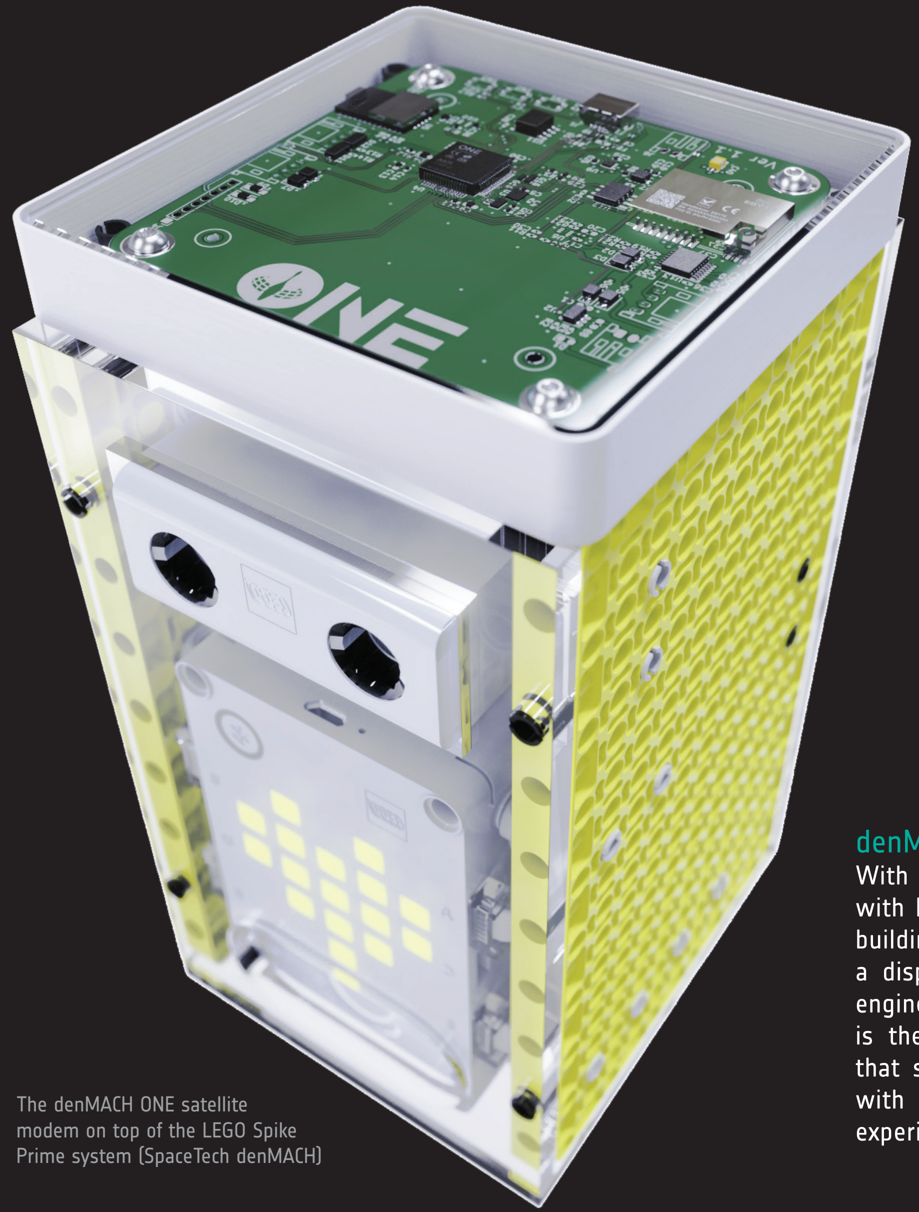
As the capsule enters Earth's atmosphere, the heat shield on the bottom of the Crew Dragon protects the crew from temperatures of up to 1600°C. After braking from the initial 27 000 km/h when the capsule enters our atmosphere at around six kilometres above ground, two drogue parachutes will deploy, followed by the four main parachutes ensuring a safe landing off the coast of Florida, USA. Boats will wait nearby and take the capsule and crew back for recovery and debriefing. The Crew Dragon is reusable and will fly again.

Crew Dragon *Endurance* docked to the Station (NASA)

Andreas Mogensen and Satoshi Furukawa during water survival training (NASA)

Crew-4 splashdown in the Atlantic Ocean in 2022 (NASA)

INSPIRATION STATION



The denMACH ONE satellite modem on top of the LEGO Spike Prime system (SpaceTech denMACH)

denMACH

With denMACH, students will work with LEGO Spike Prime system: a LEGO building set with sensors, motors and a display to explore programming and engineering. Built onto the LEGO system is the denMACH ONE satellite modem that students can use to communicate with as they will carry out small experiments in space.

The micro:bit computer in its Astro Bit case, developed by ESA Education (ESA)

Ultra:space

Using a micro:bit computer, Danish students will write code and have it uploaded to a micro:bit on the Space Station for the ultra:space project. The micro:bit is the size of a credit card and has a built-in display made of 5 by 5 LEDs together with an array of sensors, which are all open to the students to work with as part of the ultra:space project.

Future Space Station

The National Center for Science Education, Astra, together with the European Space Education Resource Office (ESERO) Denmark will create a collaborative project for students, teachers, researchers, and companies to bring forward new ideas for a future space station: from how the astronaut can relax after a long day to how space missions could be more sustainable by recycling more.

Astro Pi challenge

Two Astro Pi computers on the International Space Station will host the Astro Pi challenge for students all over Europe. Equipped with a host of sensors and high-quality cameras, students can run their own computer programs in orbit. ‘Mission Zero’ teams will work to display a message and the Station’s temperature or humidity on the Astro Pi computers, whereas ‘Mission Space Lab’ teams will design a scientific experiment to investigate life in space or on Earth.

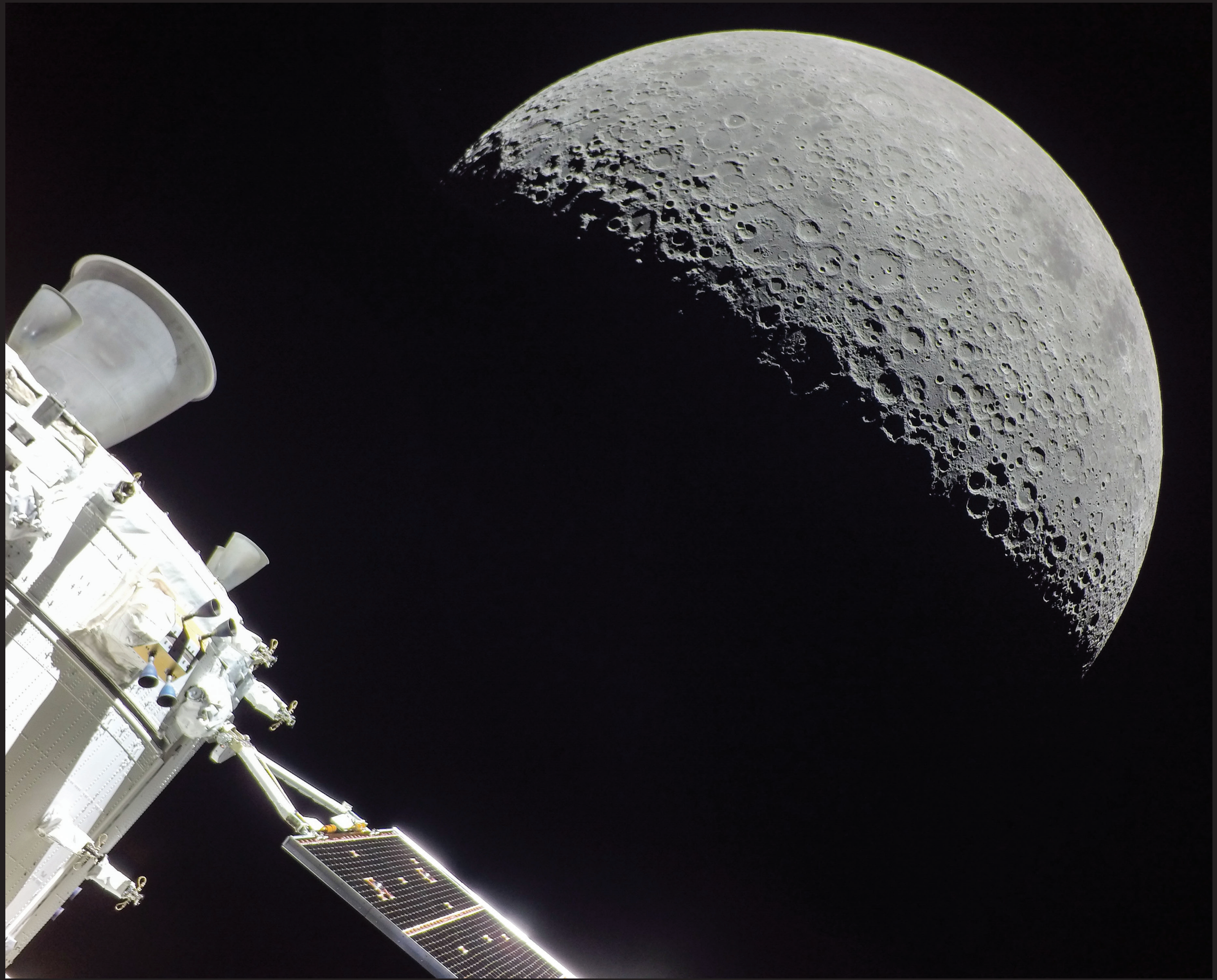
Two Astro Pi computers will take part in the Astro Pi challenge (Raspberry Pi Foundation)

Going to the Moon

The International Space Station is a stepping stone for future exploration. Lessons learned from our time on board have fed into technology that will take European explorers to the Moon and even farther.

Based on the success of Artemis I, where the Orion capsule powered by the European Service Module circled our Moon and returned to Earth, the Artemis II mission will see a crew of four fly to the Moon and back. European Service Modules will power all Orion capsules on their journey to the Moon and back, providing propulsion and consumables that the astronauts need to stay alive.

Modules for an outpost in lunar orbit known as the Gateway are already in development. The habitation module I-Hab and the communications and refuelling modules Esprit are being built in Europe, as we move away from one-shot orbital missions towards sustained presence – exploring together with robots, in international cooperation and with commercial partners.



The European Service Module and the Moon, taken during the Artemis I mission (NASA)

Follow Andreas's journey

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