Rymdstyrelsen
Swedish National Space Agency

esa

muninn
MARCUS WANDT
Launch kit

ABOUT THIS LAUNCH KIT

This is an interactive media kit. Navigate between pages from the contents page or with the arrows at the bottom of each page.

Explore the Muninn mission through the series of infographics. Roll over the graphic elements to discover hyperlinks to more information on related webpages.

Click on the symbol to directly access the infographic download page. Links to recommended images, videos and animations are provided towards the end of this media kit.

An internet connection is required to access the external webpages.

> I want to be part of building the foundation from which humankind can reach further.
>
> Marcus Wandt

CONTENTS

MUNINN IN A NUTSHELL

Mission

Name:
Axiom Mission 3 (Ax-3)

Duration:
Up to 14 days

Destination:
International Space Station

Astronaut

Name:
Marcus Wandt

Occupation:
ESA project astronaut

Born:
Dalarna, Sweden
22 September 1980

Education:
Electrical engineering

Experience:
Fighter and test pilot

Key data

Launch site:
Launch pad 39A,
NASA's Kennedy Space Center,
Florida, USA

Launch date:
18 January 2024
21:49 GMT/22:49 CET
(16:49 local time)

Spacecraft:
Dragon

Launcher:
Falcon 9

The crew

Michael López-Alegría
Spain and USA, Commander

Walter Villadei
Italy, Pilot

Alper Gezeravcı
Türkiye, Mission Specialist

Marcus Wandt
Sweden, Mission Specialist

Facts and figures

1st space mission
for Marcus Wandt

1st ESA astronaut
on a commercial spaceflight

3rd Swedish
to travel to space

3rd Axiom
Space commercial mission

5th European astronaut
to fly on a Dragon capsule

MARCUS WANDT

Born in 1980, Marcus Wandt grew up in Hammarö, at the shoreline of the biggest lake in Sweden. He also has Norwegian roots on his mother's side.

Becoming an astronaut was never his master plan. While the idea was unlikely, it remained a captivating dream that took root and grew stronger.

Creating, building, repairing, and fixing things have always been a big interest for Marcus. He combined his studies in electrical engineering with a promising career as a pilot.

Marcus has flown as a military fighter and test pilot over the last two decades. Lieutenant Colonel in the Swedish Air Force and head of flight operations at Saab Aeronautics, he defines himself as an action-oriented thinker able to adapt quickly to different missions.

Marcus was one of the 17 new astronaut candidates chosen from over 22 500 applicants from across ESA Member States in November 2022. He became an ESA project astronaut and started intensive training for his spaceflight in June 2023.

As a project astronaut, his job at ESA is linked to this specific flight opportunity on a fixed-term contract.

Marcus is the first of a new generation of European astronauts to go on a commercial manned space flight with Axiom Space, and the second Swedish astronaut employed by ESA to fly in space. He follows in the footsteps of Christer Fuglesang, who flew two Space Shuttle missions in 2006 and 2009. Swedish-American astronaut Jessica Meir has also been in space, but as a NASA astronaut. All three have Swedish citizenship.

TT

THE MISSION

ESA project astronaut Marcus Wandt from Sweden will travel to the International Space Station on Axiom Mission 3 (Ax-3). He will spend up to 14 days in orbit conducting microgravity research and educational activities.

A SpaceX Falcon 9 rocket will launch Ax-3 on a SpaceX Dragon spacecraft to the Space Station from NASA's Kennedy Space Center in Florida, USA.

Europe is teaming up with a commercial space company to show how fast-track, short-duration missions with flexible access to microgravity can generate good science, outreach and education for a better life on Earth.

Ax-3 will be the first commercial human spaceflight mission with an ESA-sponsored astronaut, redefining the pathway to low Earth orbit to advance space exploration and research. Marcus's mission, supported by ESA and the Swedish National Space Agency, is called Muninn.

Axiom Space

THE PARTNERS

The European Space Agency

Established in 1975, ESA has 22 Member States and cooperates with many others. These countries are home to more than 500 million European citizens. 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.

ESA is a partner in the International Space Station programme along with the United States, Russia, Japan and Canada. Participation in the International Space Station allows thousands of Europe's brightest people to work at the leading edge of science and engineering.

The Swedish National Space Agency

The Swedish National Space Agency, SNSA, is a central governmental agency under the Ministry of Education and Research.

SNSA is responsible for space and remote sensing activities, mainly in research and development. The Swedish space programme is carried out with extensive international cooperation.

Muninn will be a unique mission for Sweden. It is the first time that several Swedish stakeholders are involved in funding an astronaut flight through an increased contribution to ESA. Besides the Ministry of Education and SNSA, there are contributions from the Swedish Armed Forces, the Swedish Space Corporation, Saab and the industrial group FAM.

Rymdstyrelsen
Swedish National Space Agency

Axiom Space

Axiom Space operates end-to-end missions to the International Space Station as the leading commercial provider of human spaceflight services and developer of human-rated space infrastructure.

ESA and Axiom Space signed a Memorandum of Understanding on 1 October 2023 to explore collaborative opportunities in human spaceflight, science, technology, and commercialisation.

The US company makes low Earth orbit more accessible to visionary governments, researchers, manufacturers, and individuals.

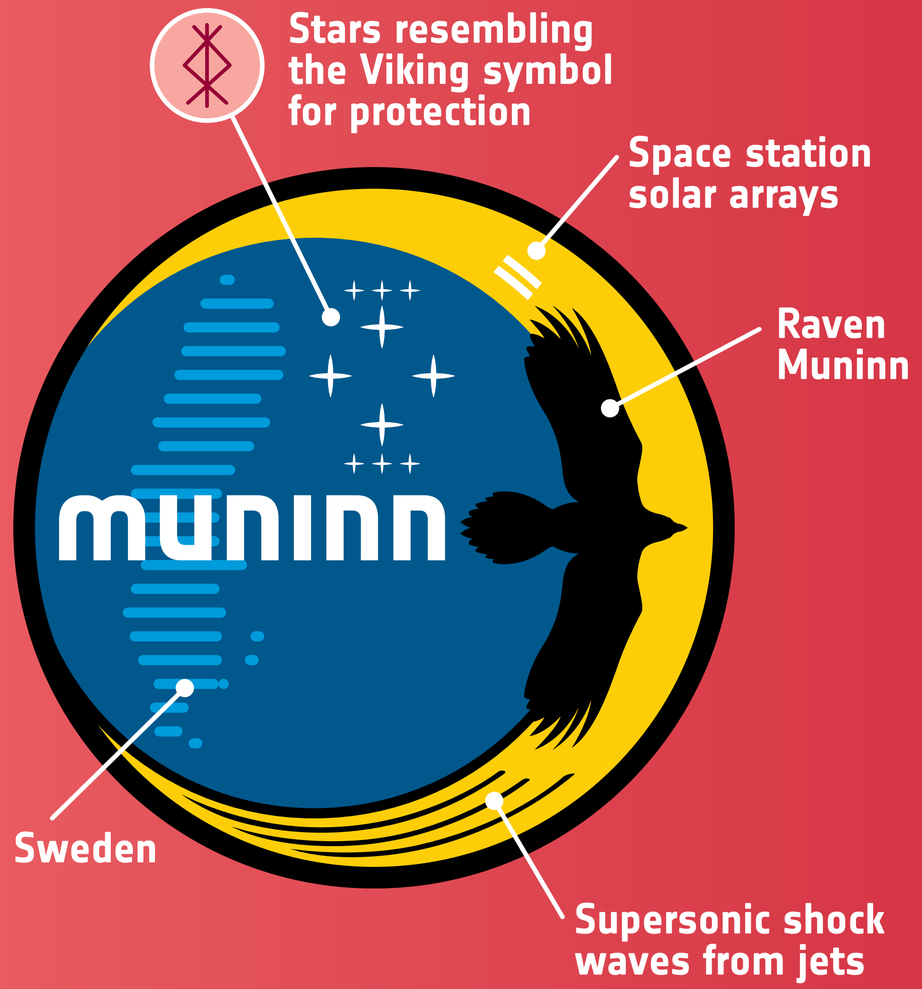
AXIOM SPACE

MISSION NAME AND PATCH

Marcus's first mission to space takes its name from Norse mythology and the two raven accomplices of the god Odin – Muninn and Huginn. Together, the two symbolise the human mind.

According to the myth, the ravens serve as messengers and advisors to their god, sharing all they see and hear. Muninn comes from the Old Norse word *munr*, that can be translated as mind and passion. Huginn is the name of ESA astronaut Andreas Mogensen's mission.

Patches are an integral part of every astronaut mission. Space agencies print out a cloth reproduction that astronauts wear during their flight, a tradition that started six decades ago. These emblems tend to reflect the space flyer's personality, the mission goals and the creativity of an artist.



TRAINING FOR THE MISSION

Many long hours of training transform today's potential astronauts into the spacefarer of tomorrow. Marcus Wandt started intensive training for his mission in June 2023. Since Marcus will fly a 14-day mission, his schedule combined basic and mission training.

Across the globe

Lessons on payloads and simulators take place in training facilities and space centres around the world. Each of the partners is in charge of training astronauts on the elements that they contribute to the International Space Station.

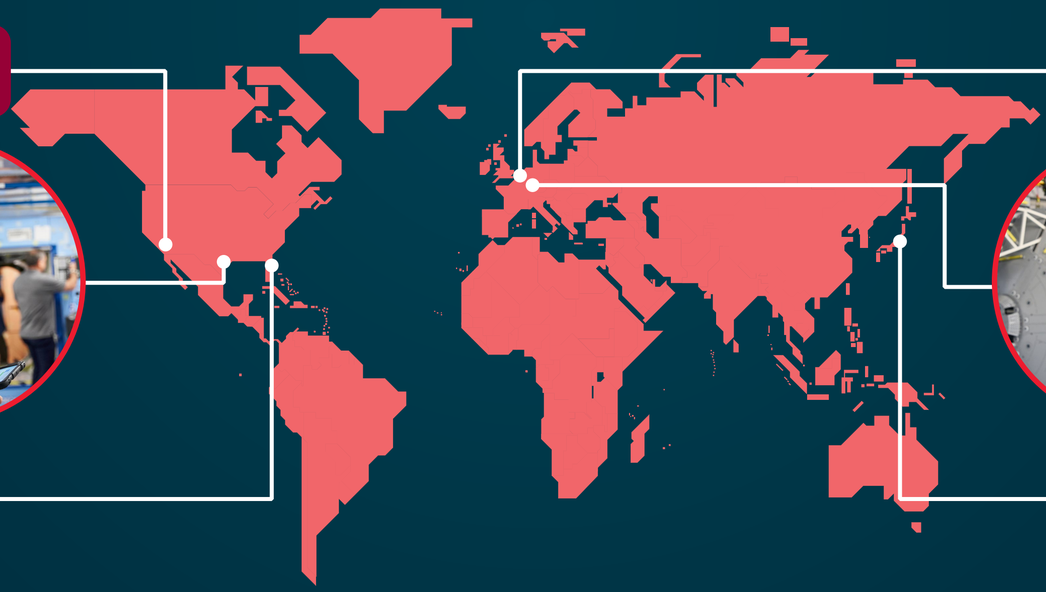
Marcus's training in Europe focuses on the Columbus module systems and the experiments he will conduct during his Muninn mission. Spaceflight instructors adjusted their lessons to his level and sped up the training.

SpaceX headquarters, California

NASA Johnson Space Center, Texas

NASA Kennedy Space Center, Florida

Training sites



ESTEC, The Netherlands

European Astronaut Centre, Germany

Tsukuba Space Center, Japan

TRAINING FOR THE MISSION

Space knowledge

Marcus studied the elements of the International Space Station in depth, immersing himself in 'hands-on' training and using realistic mock-ups and simulators. He learnt how to operate the different modules, systems and subsystems of the Station. The Swedish astronaut also got to know every corner of ESA's Columbus laboratory in more detail, and how to use its scientific facilities. Apart from introducing the big picture of spaceflight, the training gave him a solid background of all the scientific disciplines he will have to deal with during his spaceflight.

Emergency training

All astronauts are trained to deal with emergency situations. In space, training for the unexpected becomes even more crucial. A large part of the training is geared towards emergency procedures and safety measures.

Astronauts train to handle potentially life-threatening situations in orbit. They must be mentally prepared to deal with spacecraft depressurisation, fire or a toxic atmosphere.

Space doctor

Where no ambulance can reach, the crew must be able to handle medical emergencies in space. Marcus practised through highly realistic simulations and real-life emergency cases to help him diagnose sick or injured crewmates, from stitching wounds to blood draws. Medical procedures can differ in weightlessness – floating needles are a hazard, for example.

Living out of this world

While most of the systems in the Dragon spacecraft work in automatic mode, astronauts need to be able to operate it manually in all possible scenarios.

Marcus and his crew studied every system of the spacecraft, re-enacted the stages of flight and learned the best response to off-nominal situations, from a communications glitch to a full-blown emergency.

Like any house, the International Space Station needs constant maintenance. Marcus was trained to solve technical problems and became proficient in the use and repair of all equipment.

Living in space requires versatility and multitasking. Astronauts must work as a team and learn how to best communicate with their crew mates.

INTERNATIONAL SPACE STATION

A collaboration between five space agencies, the International Space Station has become a symbol of peaceful international cooperation. It represents the best of our engineering capabilities as well as humankind's pursuit of scientific knowledge and exploration.

The Space Station is an incredible piece of spacecraft engineering. The football-pitch-sized spacecraft travels about 400 km above our heads at 28 000 km per hour, circling Earth approximately 16 times every day.

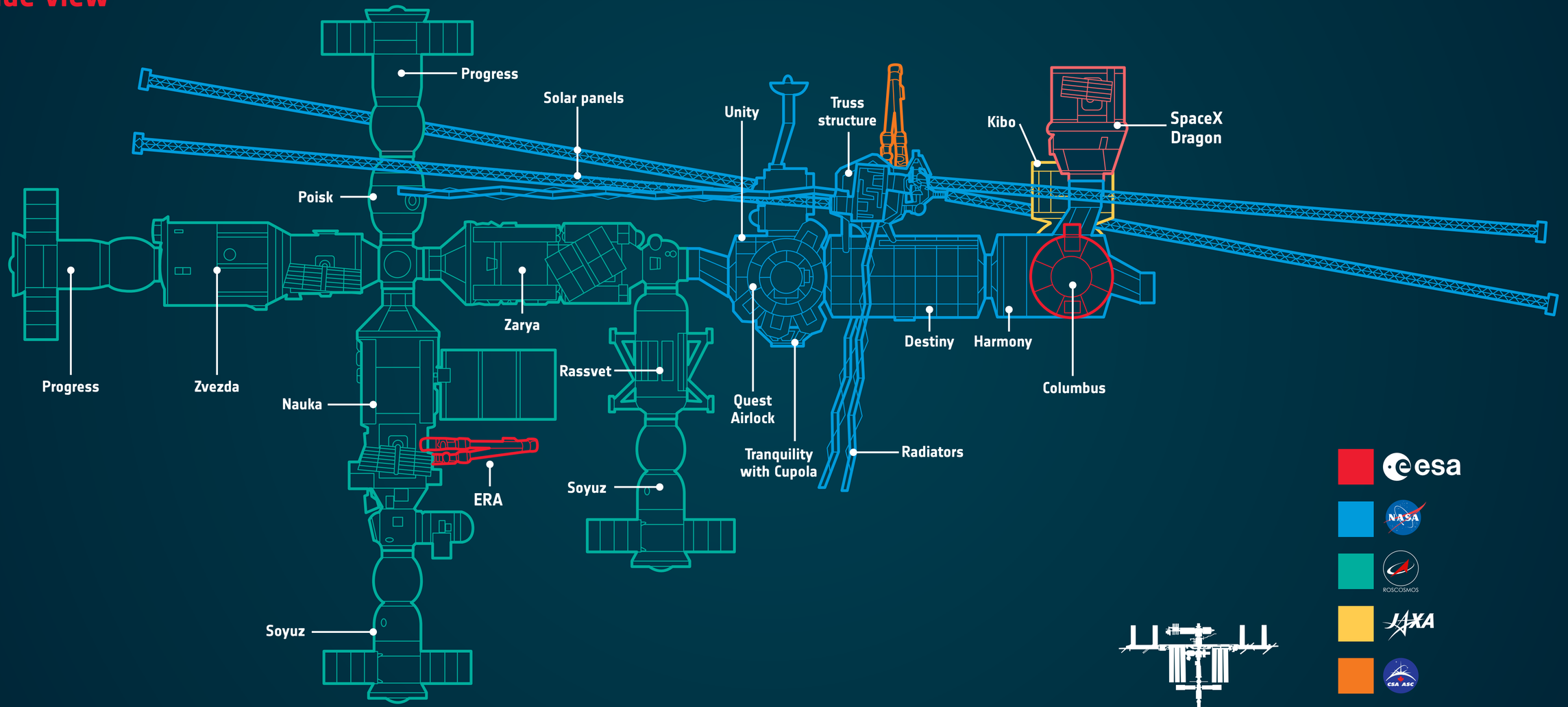
This jewel of human cooperation and ingenuity has brought humankind together to live and work in space continuously for more than two decades. The largest object ever built in orbit is the first stepping-stone as we venture beyond our home planet.

Knowledge developed through our work on the Space Station helps manage the risks of future human missions farther out in space and improve the quality of life here on Earth.

ESA/NASA

INTERNATIONAL SPACE STATION

Side view



Top view

esa
NASA
ROSCOSMOS
JAXA
CSA ASC
Visiting vehicles

ESA/NASA

The Columbus laboratory

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

This Europe-built laboratory in space will be Marcus's main workstation throughout Muninn. The module has 16 experiment facilities that operate continuously and independently.

After more than a decade in orbit, 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.

JOURNEY TO SPACE

Marcus Wandt will be the fifth ESA astronaut to fly on a Dragon spacecraft. The Axiom-3 crew of four astronauts will be launched into space on a SpaceX Falcon 9 rocket. Nearly nine minutes after liftoff, the astronauts will reach orbit and continue their way to the International Space Station.

The trip to their new home and place of work in space will take around 36 hours. The spacecraft will fly autonomously but it will be monitored and could be controlled by the crew if necessary. The Dragon will stay docked with the Space Station for the duration of the mission, acting as a lifeboat for the crew in case of an emergency.

Marcus's Muninn mission will begin once he enters the Space Station.

SpaceX

THE CREW

Marcus Wandt
Mission Specialist

Michael López-Alegría
Commander

Walter Villadei
Pilot

Alper Gezeravcı
Mission Specialist

Axiom Space

PRE-LAUNCH TRADITIONS: DRAGON

ESA astronauts launching into space on a Dragon spacecraft from the US have a few pre-launch traditions:

1 **Plant a tree** at ESA's European Astronaut Centre (EAC) in Cologne, Germany.

2 Visit **reused rocket booster** in the US.

3 Last meal before launch. Astronauts choose a **special meal to eat** before they are launched to space.

4 Crew **waves to their families** for the last time before the launch.

5 Drive a designated **vehicle** from the Falcon Support Building to launchpad 39A at NASA's Kennedy Space Center.

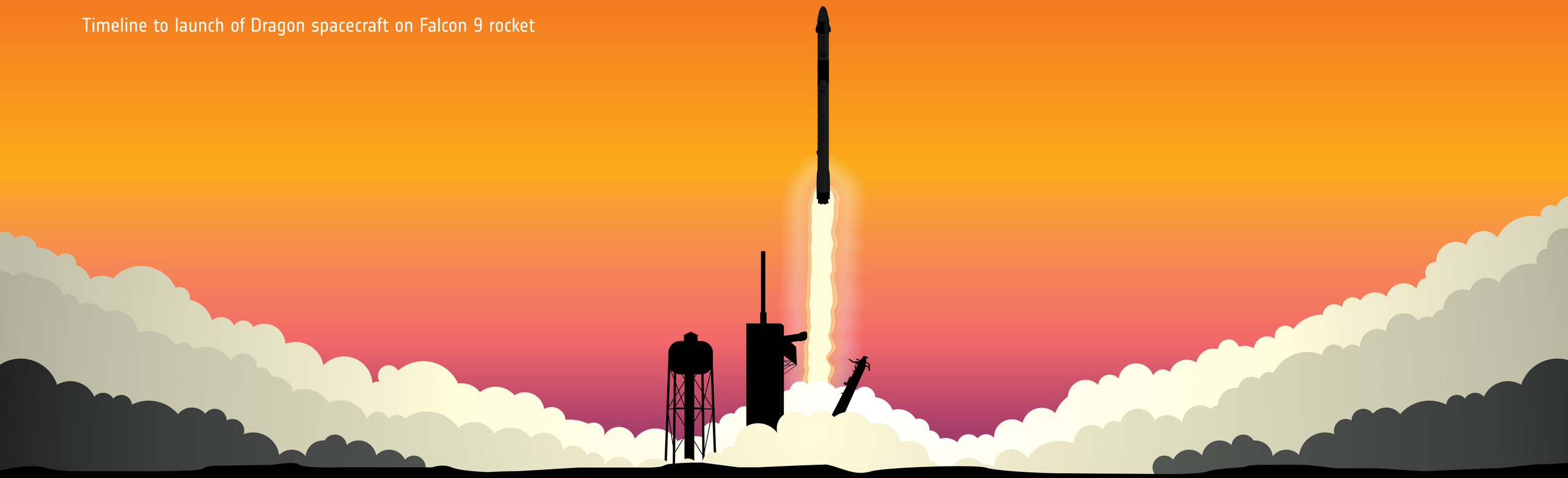
6 **Look up** at the spacecraft one more time.

7 **Sign name** on White Room wall before entering the capsule.

8 Each crew has their own **gravity indicator,** usually a plush toy.

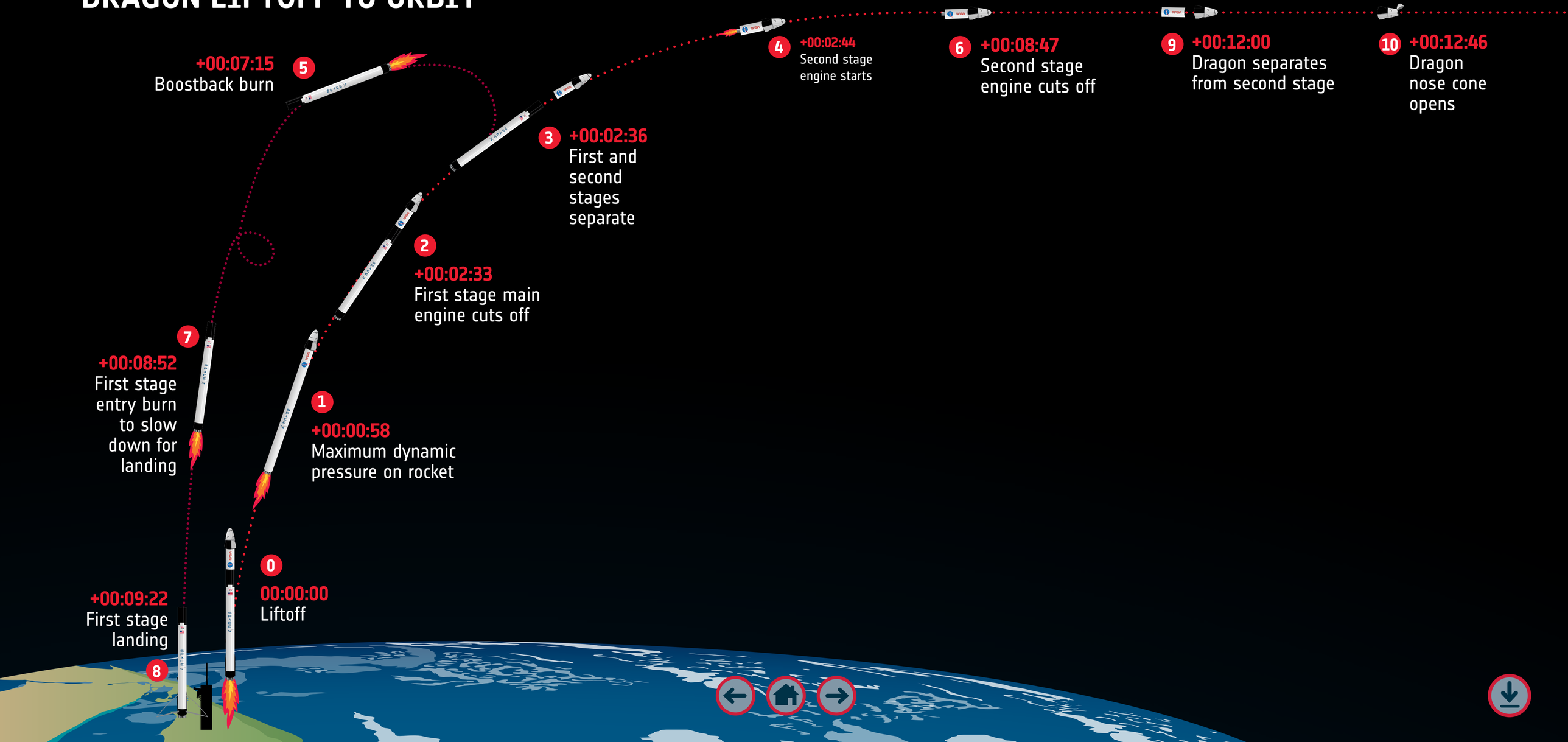
DRAGON LIFTOFF

Timeline to launch of Dragon spacecraft on Falcon 9 rocket



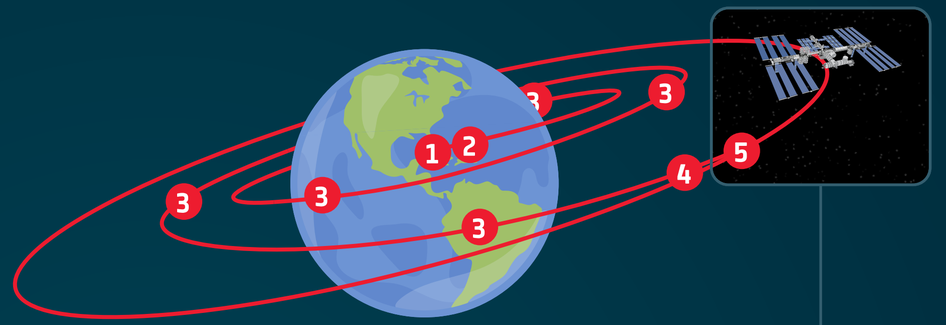
−00:45:00	−00:42:00	−00:37:00	−00:35:00	−00:35:00	−00:16:00	−00:07:00	−00:05:00	−00:01:00	−00:00:45	−00:00:03	−00:00:00
Go for propellant loading	Access arm retracts	Dragon launch escape system armed	Kerosene fuelling begins	First stage liquid oxygen fuelling begins	Second stage liquid oxygen fuelling begins	Falcon 9 engines cool before launch	Dragon goes to internal power	Tank pressurisation begins	Go for launch	Engine ignition sequence to start	Falcon 9 liftoff

DRAGON LIFTOFF TO ORBIT

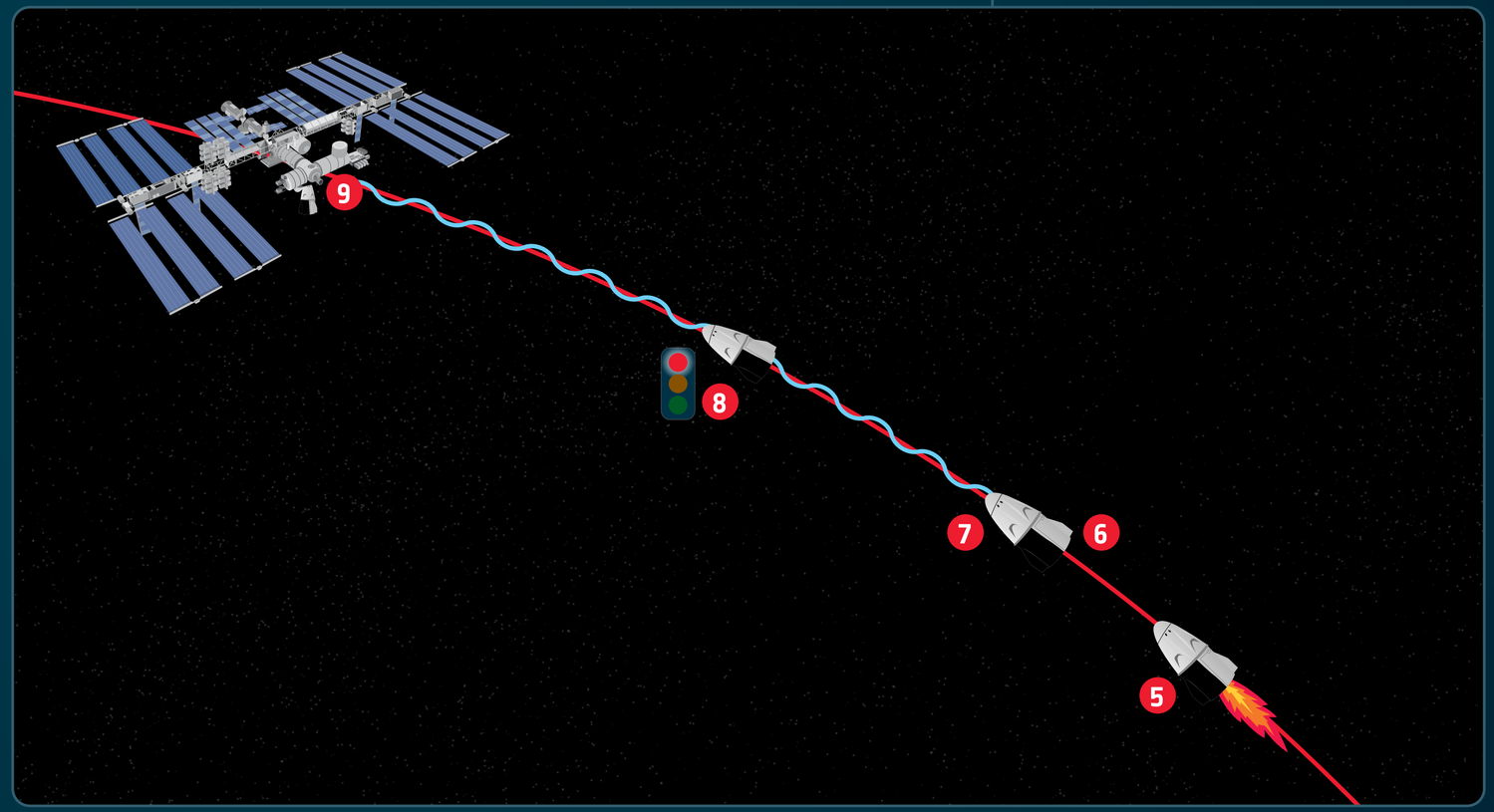


DRAGON RENDEZVOUS AND DOCKING

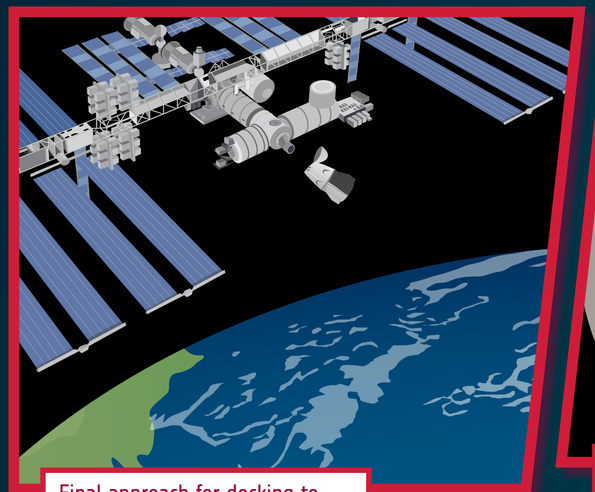
The Dragon takes around a day to reach the International Space Station while orbiting Earth.



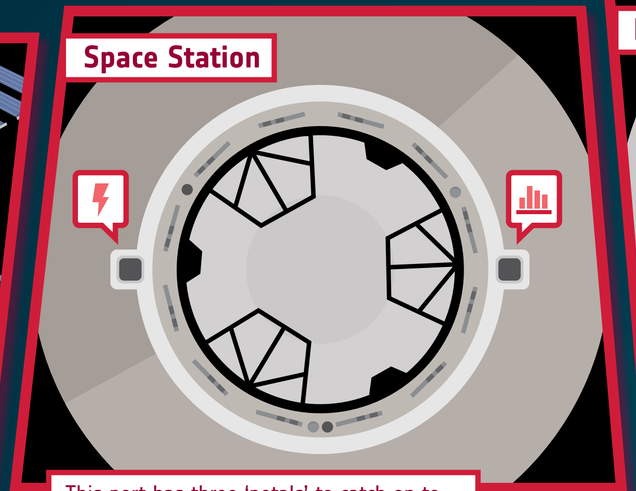
1. Liftoff from Kennedy Space Center.
2. Separation of Dragon capsule from launcher rocket.
3. Engines fire to keep capsule on course to International Space Station.
4. Dragon establishes communication link.
5. 7.5 km behind and below the Space Station, Dragon fires engines for final approach.
6. 200 m from the Space Station, Dragon establishes relative navigation.
7. The final approach is autonomous from 200 m out.
8. Dragon holds position at 20 m from the Space Station and awaits go from Mission Control.
9. Dragon docks with a free International Docking Adapter port on the Space Station.



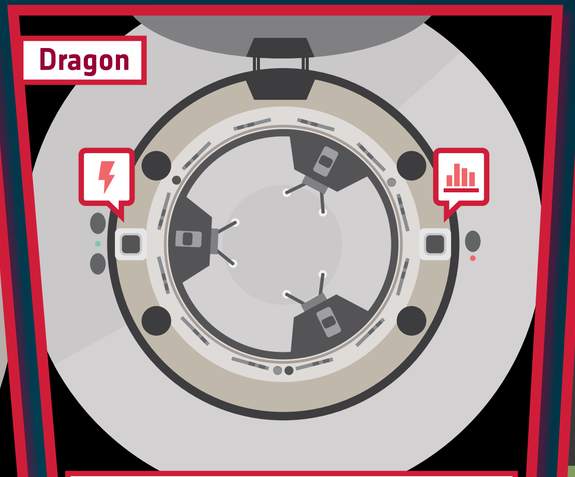
DRAGON DOCKING TO THE INTERNATIONAL SPACE STATION



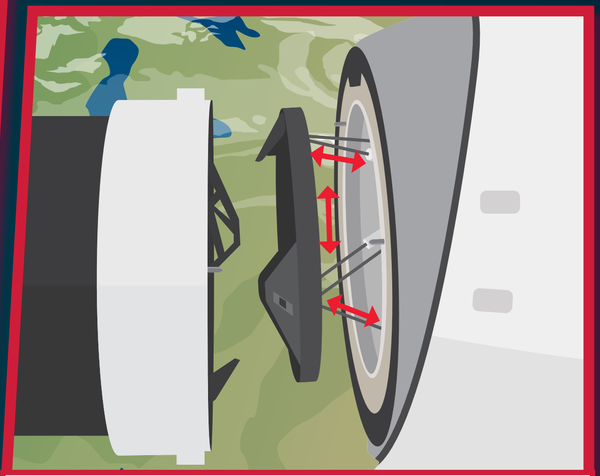
Final approach for docking to the International Space Station.



This port has three ‘petals’ to catch on to. Square connectors transfer power and data.



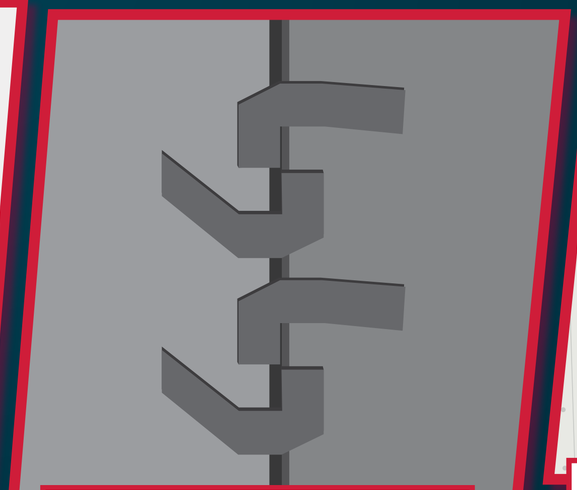
The Dragon has three petals, each with two rods, that move to align the docking system.



The Dragon docking system extends and aligns to the Space Station port with the rods compensating for any offset.

The Dragon latches on to the International Space Station and pulls them together.

The hard capture system now takes over.

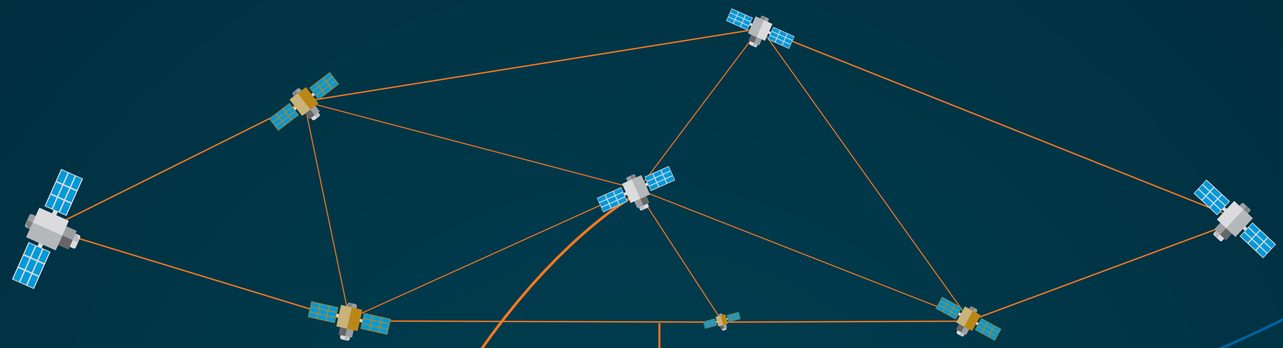


24 hooks connect to create an airtight seal.

After leak checks the astronauts open the hatches and are welcomed to the International Space Station.

COMMUNICATIONS

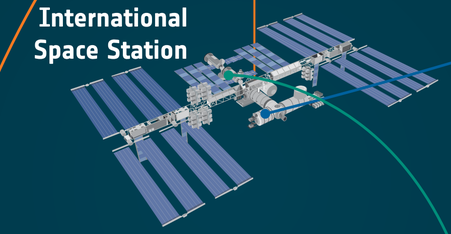
International Space Station



European Data Relay Satellite

Columbus Control Centre

- **Controls** Columbus laboratory systems
- **Coordinates** European payload operations
- **Runs** the European ground communications network
- **Relays** communication services such as voice, video and data



International Space Station

Space network

The International Space Station communicates to the world through US, Russian and European systems, ensuring almost a **constant connection** for researchers on Earth.

Russian Mission Control Centre
Moscow, Russia

White Sands Complex
New Mexico, USA

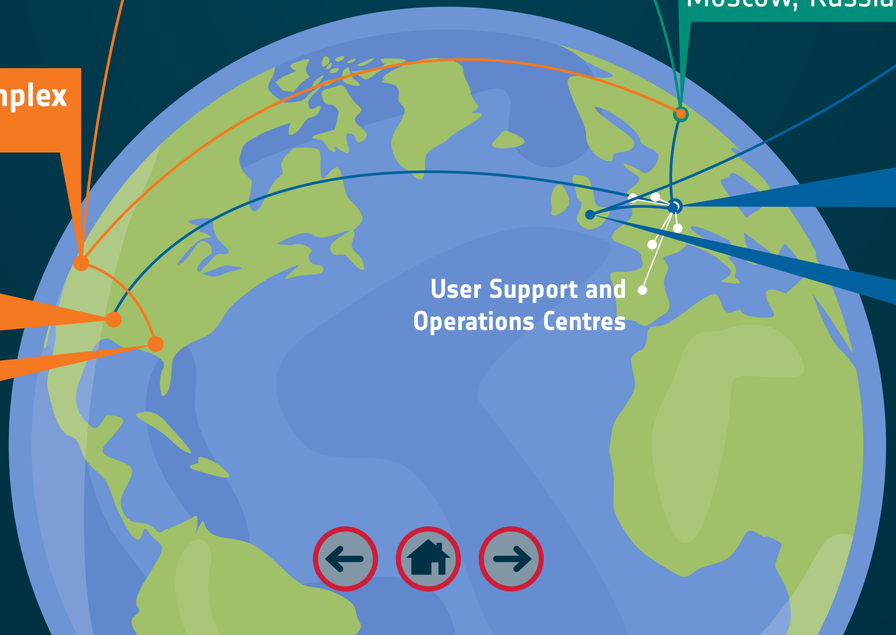
Columbus Control Centre
Oberpfaffenhofen, Germany

Space Station Mission Control Center
Houston, USA

Space Cluster
Harwell, UK

User Support and Operations Centres

Huntsville Operations Support Center
Alabama, USA



- US communications systems
- Russian communications systems
- European communications systems

MUNINN SCIENCE

European 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. The weightless laboratory allows astronauts to conduct pioneering research, test new technologies and push the boundaries of knowledge.

Marcus will devote much of his time to scientific activities and technology demonstrations that could shape the way we live and work on Earth. In total, he will run around 20 experiments. Here is our top 5.

ESA/NASA

Bone health

What is it?

The Bone Health experiment looks at changes in Marcus's bone density after his two-week stay in space, and especially how long it takes for his bones to start recovering upon return to Earth. Will bone loss halt or continue after the mission?

Why is this important?

Bone loss from the lower extremities is a well-known consequence of life in orbit. It starts very soon after leaving Earth, and astronauts lose up to 1% of their bone mass each month spent in space. Loss of bone density can increase the risk of bone breakage and injury.

How do you benefit from it?

Looking at astronauts in space could unveil the mechanisms of bone loss. This research has the potential to help patients on Earth with osteoporosis and spinal cord injury, as well as people who spend prolonged periods in hospital beds.

ESA/NASA

Orbital architecture

What is it?

This study explores how the design of space habitats affects the astronaut's thinking and stress levels. Researchers will monitor Marcus's heart rate, brain activity, sleep quality, diet and exercise routine to see how he copes with the new environment. To assess the cognitive impact of life on the Space Station, Marcus will carry out tasks on a computer to test his working memory, reaction time, attention, and organisation.

Why is this important?

The design of buildings and spaces can greatly affect how people feel and perform. In confined places like space habitats where astronauts live and work, architecture is important for their well-being and mission success. As we plan for longer space missions and more diverse crews, creating habitats that help them think clearly and handle stress is key.

How do you benefit from it?

By understanding how architecture influences astronauts, we can create spaces that support their thinking and emotions for mission success. Results from this research in space can be applied in the design of extreme and isolated environments on Earth.

MEMO BC

What is it?

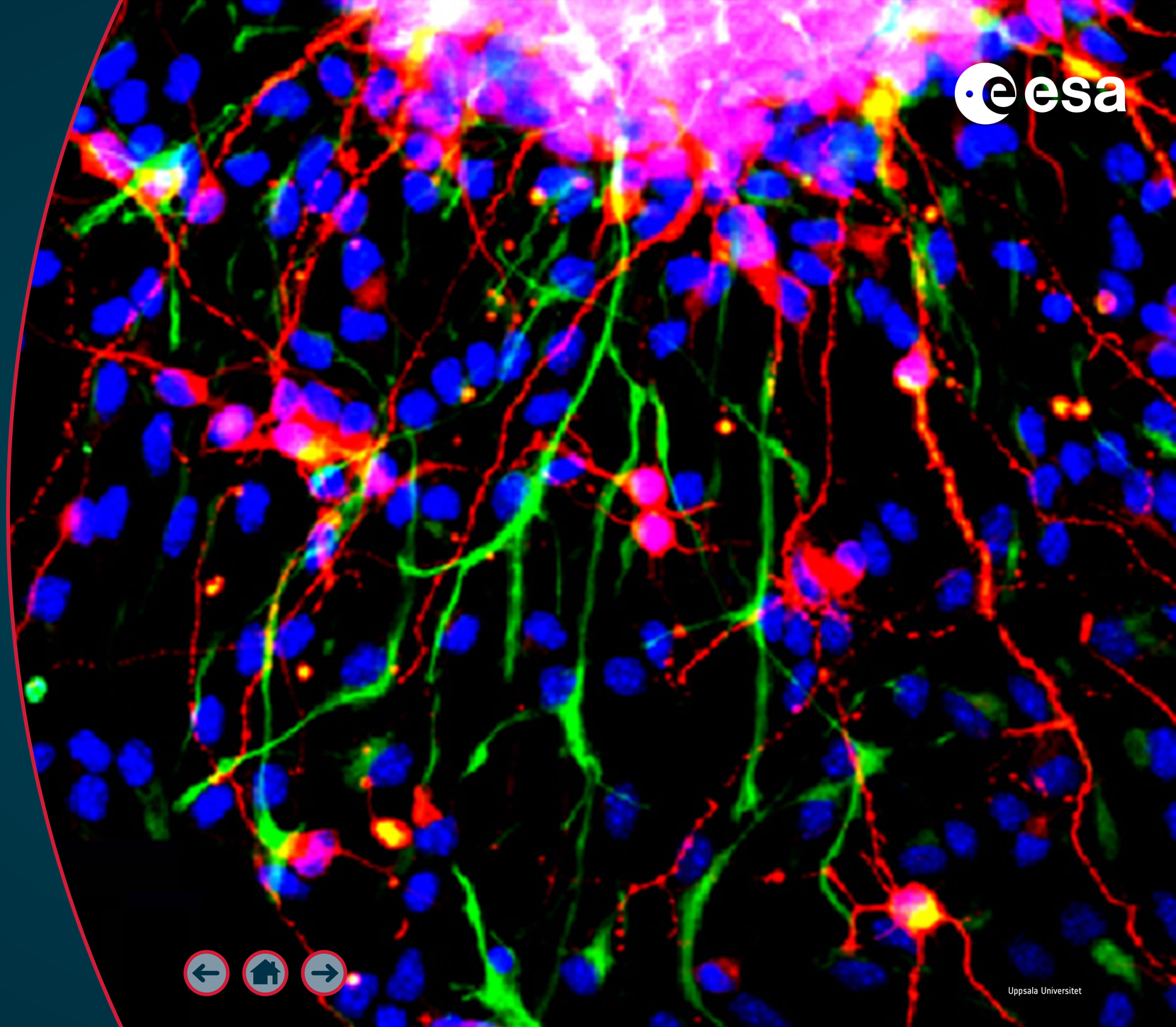
Microgravity triggers changes in cellular structures and gene expression, sometimes with unexpected benefits. Marcus will monitor boundary cap neural stem cells (BC) on the Space Station for up to two weeks.

Why is this important?

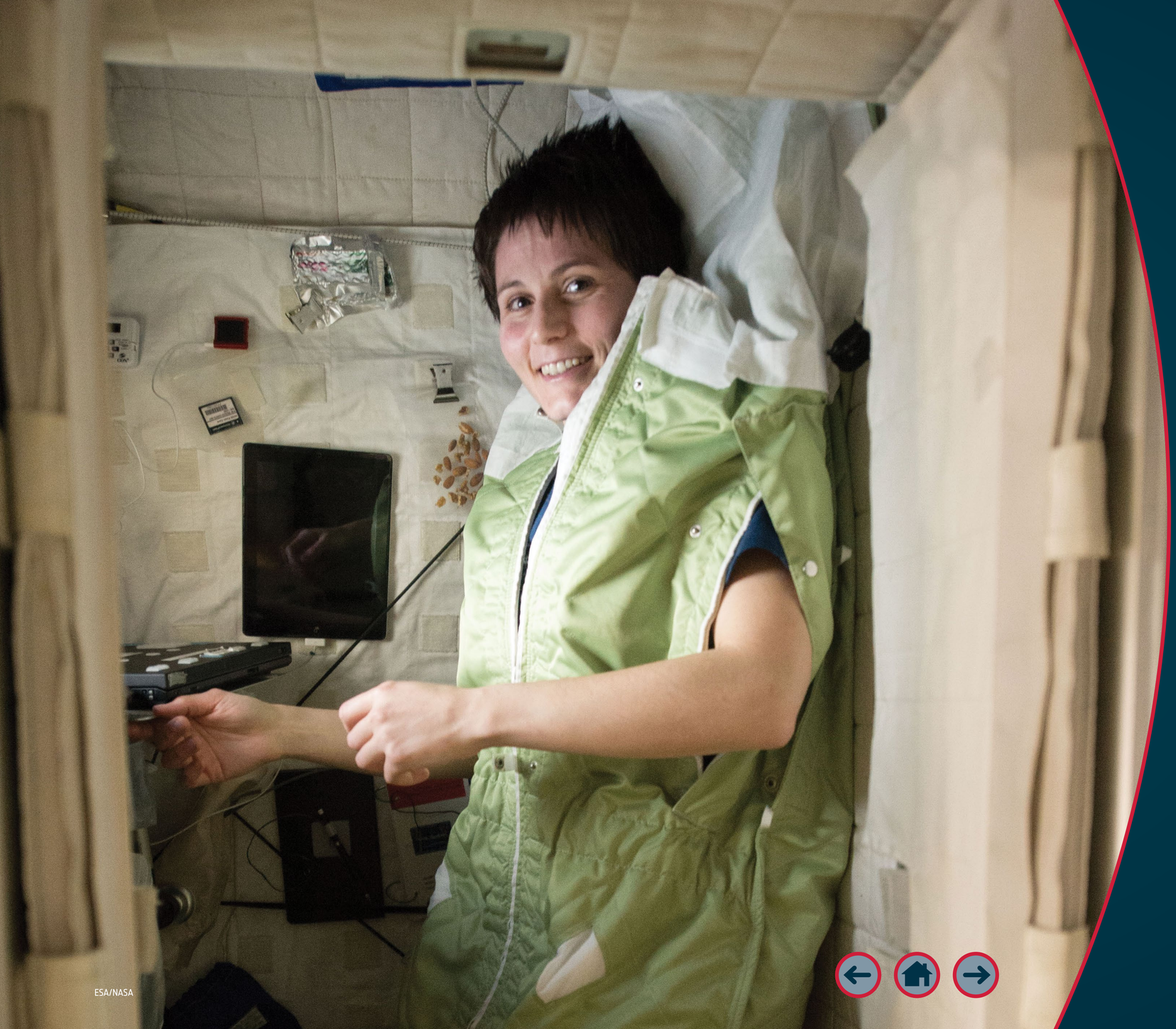
Studies on boundary cap neural cells revealed their great capacity to survive in microgravity and a higher rate of cell division on Earth after being exposed to weightlessness on sounding rocket flights. These cells play a critical role in the early development of the peripheral nervous system. Recent experiments show that this type of cell supports the function and survival of other cells from the nervous and endocrine systems.

How do you benefit from it?

Unravelling the mechanisms behind the microgravity induced effects may help us understand the beneficial influence of boundary cap neural cells on other cells. The findings could have potential applications in clinical medicine.



Uppsala Universitet



ESA/NASA

Sleep in Orbit

What is it?

The Sleep in Orbit project will investigate differences between Marcus's sleep patterns on Earth and in space. Marcus will use in-ear electroencephalogram equipment to measure his brain activity during sleep.

Why is this important?

Living in zero gravity and in an artificial day-night cycle can influence Marcus's circadian rhythm and sleep patterns. Sleep has an impact on our health, well-being, and cognitive performance. Poor sleep could have immediate negative consequences on Marcus's attention, problem-solving, decision-making and emotions among others.

How do you benefit from it?

Results from this study could offer new insights into the physiology of the brain. Data from Marcus's mission have the potential to increase safety and reduce human errors in future space missions, as well as deepen our understanding on astronaut health and performance.

Thor-Davis

What is it?

Marcus will record thunderstorms and lightning shooting up towards space using a new camera capable of filming at up to 100 000 frames per second. The Davis camera is an event camera which works in a similar way to the human eye – it senses changes in contrast instead of capturing an image like a regular camera. Marcus will use the camera from the European-built Cupola windows.

Why is this important?

This technology will help Marcus capture severe electrical storms that extend into the stratosphere, giving accurate pictures of thunderstorms from above.

The upper part of clouds are difficult to see from the ground, and satellites in geostationary orbits are too far to give detailed observations. In contrast, the International Space Station's low orbit offers a vantage point to capture the fast lightning flashes across the regions with most thunderstorm activity on Earth.

How do you benefit from it?

Scientists hope to better understand the role of thunderstorms on upper-atmosphere dynamics and chemistry in a changing climate. Results could improve climate, atmosphere, and weather models. One of the goals of this project is to learn more about the effect of lightning on atmospheric greenhouse gas composition and circulation.

ESA/NASA

NASA

RETURN TO EARTH

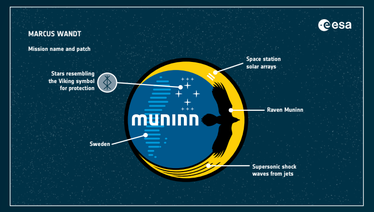
At the end of the mission, Marcus and his crew mates will return to Earth on the same Dragon spacecraft that brought them up to the Space Station.

The capsule will complete a series of burns to prepare for reentry into Earth's atmosphere and splashdown off the coast of Florida, USA.

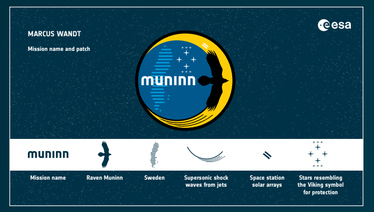
As the capsule enters Earth's atmosphere, the heat shield protects the crew from temperatures of up to 1600°C. When the capsule is around six kilometres above ground, two drogue parachutes will deploy, followed by the four main parachutes ensuring a safe landing off the coast of Florida, USA.

Boats will wait nearby and recover the capsule with the crew inside. The Dragon spacecraft is reusable and will fly again.

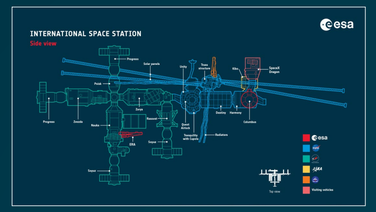
INFOGRAPHICS



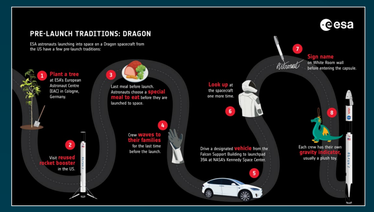
Mission name and patch



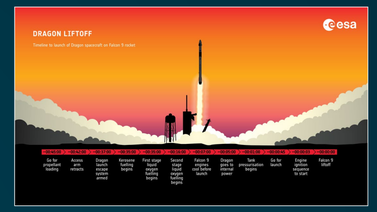
Mission name and patch



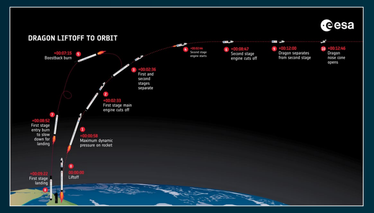
International Space Station



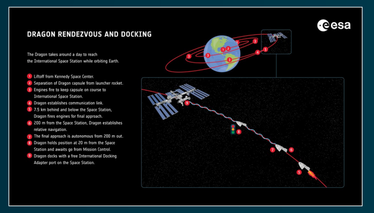
Pre-launch traditions: Dragon



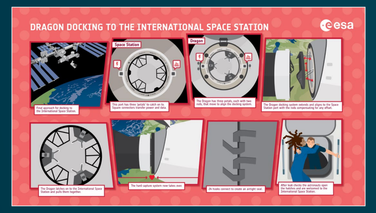
Dragon liftoff



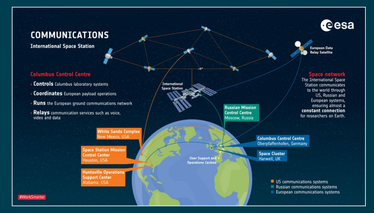
Dragon liftoff to orbit



Dragon rendezvous and docking

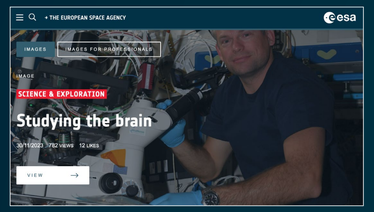


Dragon docking to the International Space Station

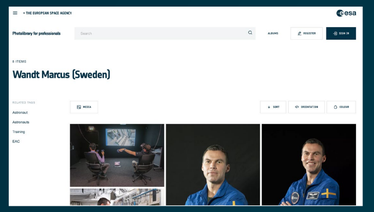


Communications International Space Station

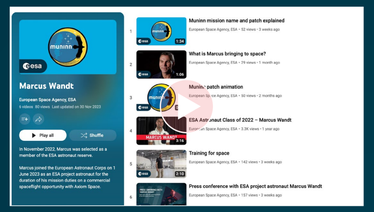
IMAGES AND VIDEOS



ESA images



ESA photolibrary



Muninn YouTube playlist

Training for space

What is Marcus bringing to space?

Muninn mission patch and name explained

Muninn patch animation

Press conference

ESA astronaut class of 2022 – Marcus Wandt

Marcus Wandt mission training

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MEDIA SERVICES

Contact

Newsroom and Media Relations
www.esa.int/Newsroom
media@esa.int

Ninja Menning
Head of Newsroom and Media Relations
ESA ESTEC, Netherlands

Daniel Scuka
Head of Contents Office
ESA ESOC, Germany

Rosita Suenson
Muninn Communication Programme Officer
ESA ESTEC, Netherlands

Johan Marcopoulos
SNSA Head of Communication
Stockholm, Sweden

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> I want to explore and open our world, to learn and create new things that bring progress back to Earth.
>
> Marcus Wandt

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