(Human) Space Research in LEO

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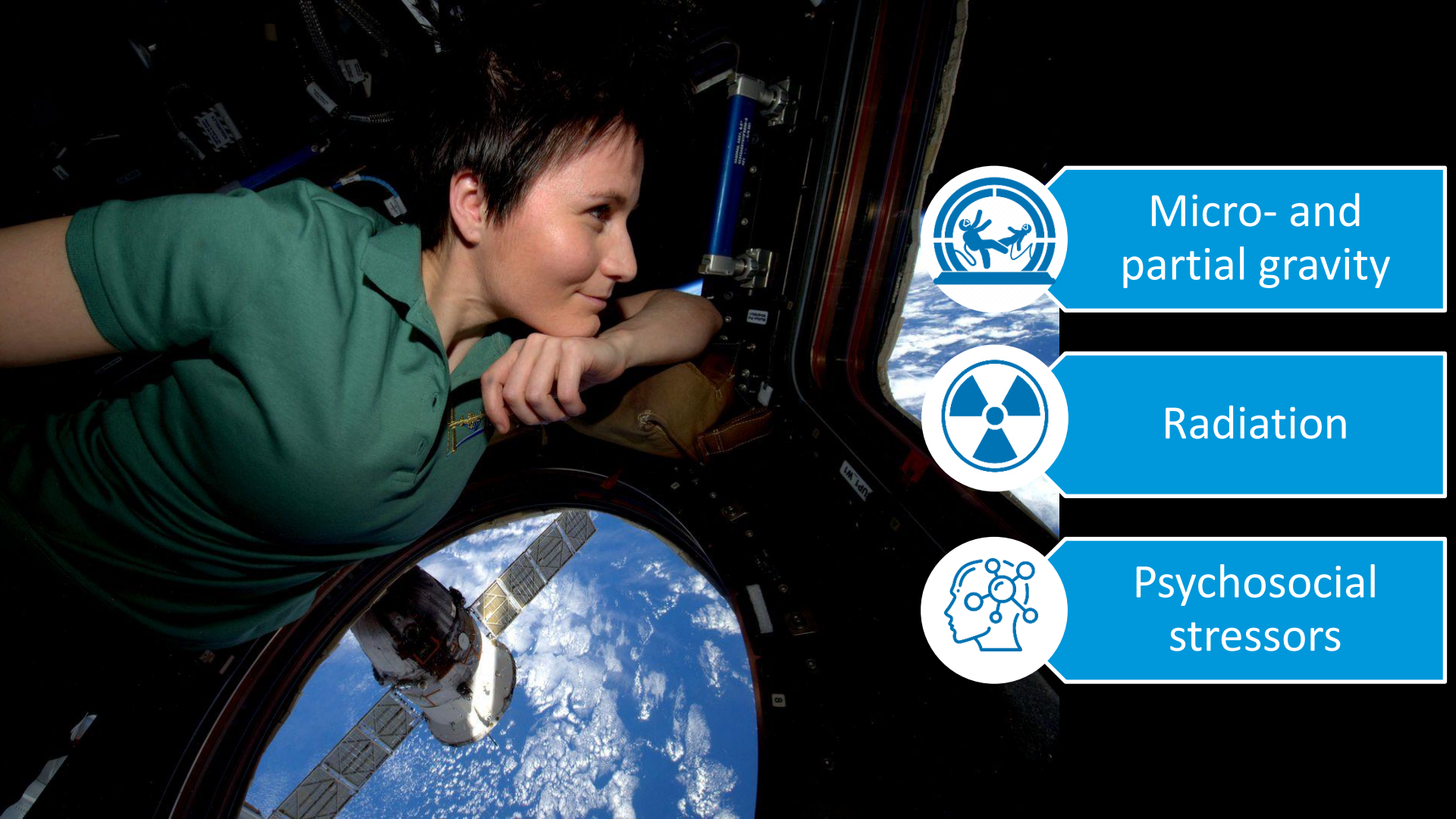
Discipline Lead for Life Sciences

SciSpacE team (HRE-RS)

Directorate for Human and Robotic Exploration Programmes


Micro- and partial gravity
Radiation
Psychosocial stressors

ESA SciSpacE research

Micro-/Partial Gravity	Radiation	Isolation/Confinement	Other
Bedrest Dry Immersion Parabolic Flight Drop Tower Sounding Rockets Ground-based facilities	Ground-based Radiation GSI Radiation	Isolation studies Concordia (Antarctica)	Ground-based facilities

LEO: International Space Station (ISS)

BLEO: Gateway

GAINING KNOWLEDGE AND CLOSING GAPS

SciSpacE

Ground analogues

Low gravity platforms

Moon Mars

SciSpacE main goal is to understand how space affects fundamental physical and biological processes, and to find ways to explore and live sustainably in space while bringing back benefits for Earth.

SciSpacE objectives

Physical Sciences

- Use space to understand the fundamental laws governing matter
- Use Space platforms to understand Climate and Earth atmosphere
- Characterise new materials and complex fluids to support space exploration and earth applications
- Enabling sustainable solution for space and earth

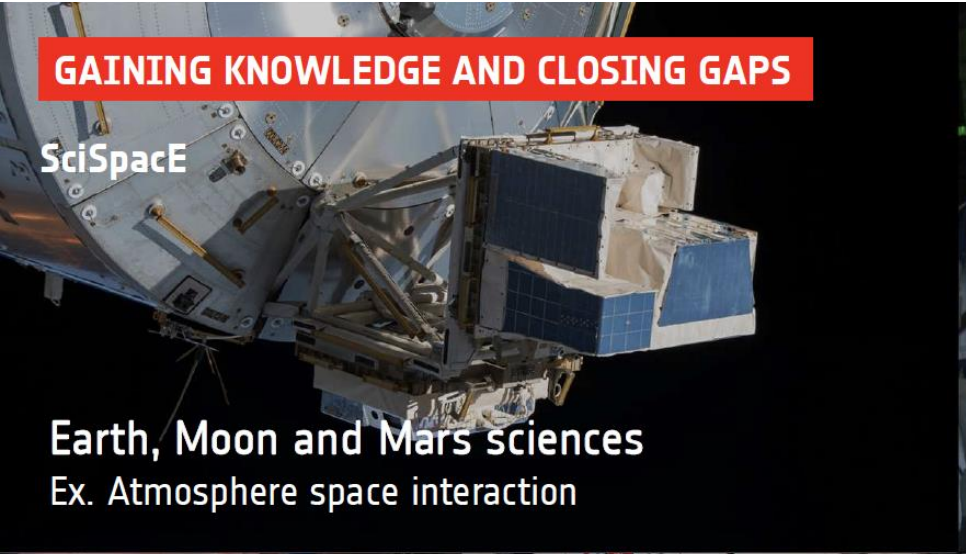
Life Sciences

- Better understand fundamental mechanisms and responses to different space stressors on biological and physiological processes
- Optimize and personalize countermeasures to mitigate the deep space risks
- Push the frontiers of habitability to advance sustainable human exploration in deep space
- Foster and inspire translation of space-acquired scientific knowledge to address terrestrial challenges.

Moon & Mars

- Deepen our understanding of the Solar System's history and the origins, formation and evolution of the Earth-Moon System and Mars
- Characterise planetary environments at and around the Earth, Moon and Mars, expand our understanding of their properties and dynamics with their implications for exploration
- Determine the Solar System conditions under which life emerged and evolved and search for extinct and extant life beyond Earth
- Identify and quantify potential resources at the Moon and Mars and explore approaches to responsible utilisation

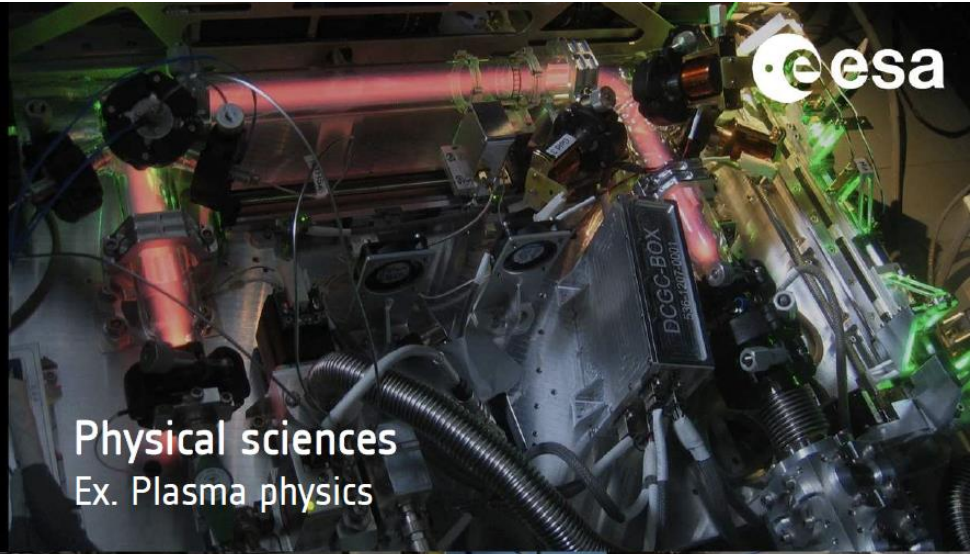
GAINING KNOWLEDGE AND CLOSING GAPS



SciSpacE

Earth, Moon and Mars sciences

Ex. Atmosphere space interaction



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Physical sciences

Ex. Plasma physics

Physical sciences

Ex. Fluids

Life sciences

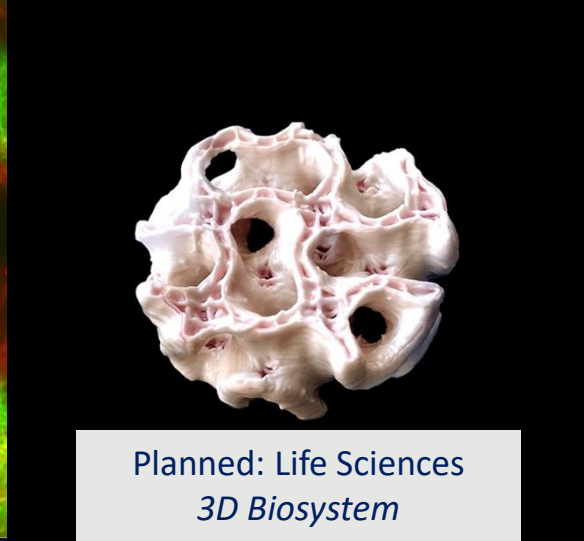
Ex. Human physiology

GAINING KNOWLEDGE AND CLOSING GAPS

SciSpacE

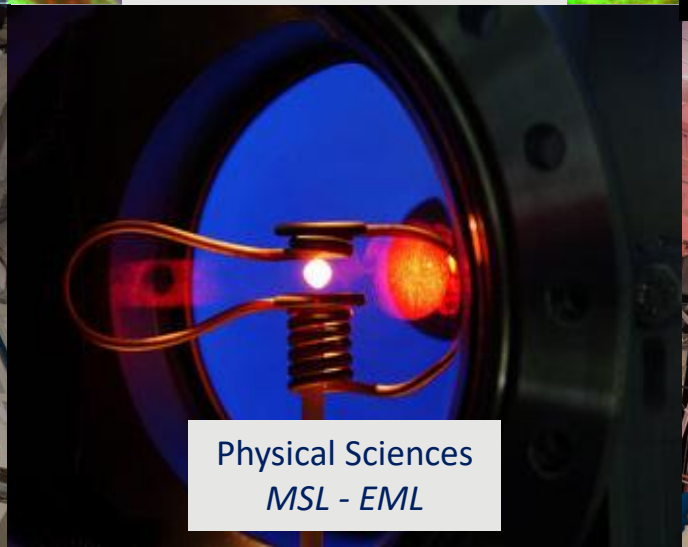
Planned: Life Sciences
Exobiology facility

Planned: Life Sciences
ESA-DLR Live Cell Imaging

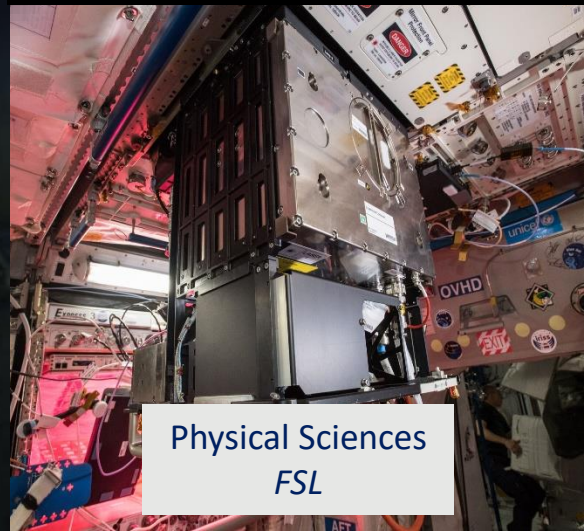


Planned: Life Sciences
3D Biosystem

Life Sciences
KUBIK

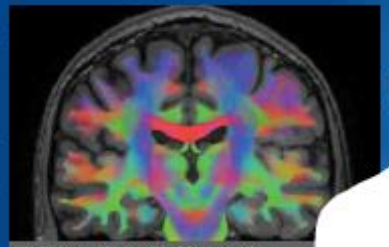


Physical Sciences
MSL - EML



Physical Sciences
FSL

ESA's Human Health Research Programme On Board the ISS



↑ Brain scan (University of Antwerpen)

↑ Testing GRIP prototype on weightless parabolic flight

↑ Space food for the Energy experiment

↑ ESA astronaut Alexander Gerst with a thermometer on his forehead to measure his temperature continuously (ESA/NASA)

Ageing

Cardiovascular

Immunology

Muscle and bone

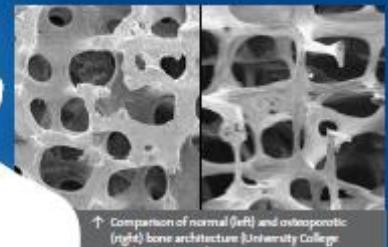
Neurophysiology

Nutrition

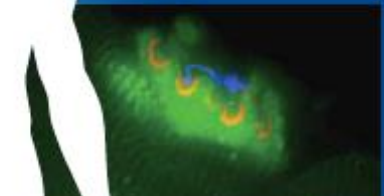
Respiratory system

Thermoregulation

…



↑ Comparison of normal (left) and osteoporotic (right) bone architecture (University College London – T. Arnett)



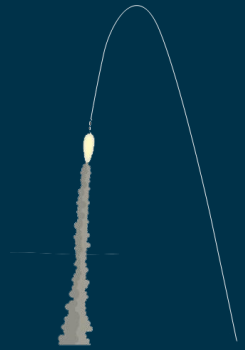
↑ Laser image of a calf muscle (Charité)

↑ ESA astronaut Samantha Cristoforetti running the Skin-B experiment (ESA/NASA)

SciSpacE - Research Ground Platforms

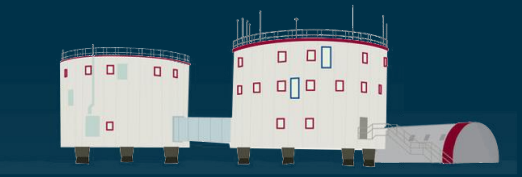
Bedrest

Dry Immersion



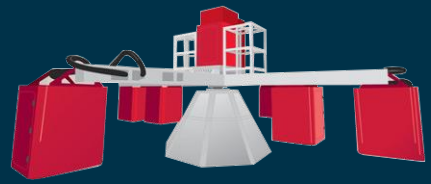
Sounding Rocket

Drop Tower

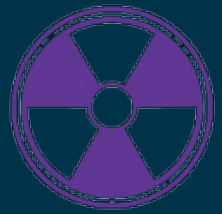


Concordia, Antarctica Isolation and Confinement

Parabolic Flight



Ground-based facilities



Radiation

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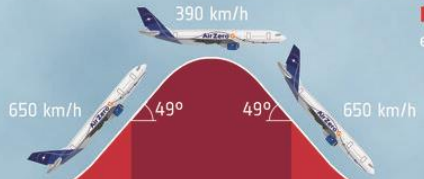
→ SCIENCE WITH(OUT) GRAVITY

Parabolic flights

A refitted aircraft flies for three hours in repeated **rollercoaster parabolas.**

The climb can be changed to **simulate lunar or martian gravity.**

30 parabolas a day offer **20 seconds of microgravity** each time.



Parabolic flights are often used to conduct research with humans and **validate experiments** before they fly to the International Space Station.

#Space19plus #ScienceAtESA

Space19+

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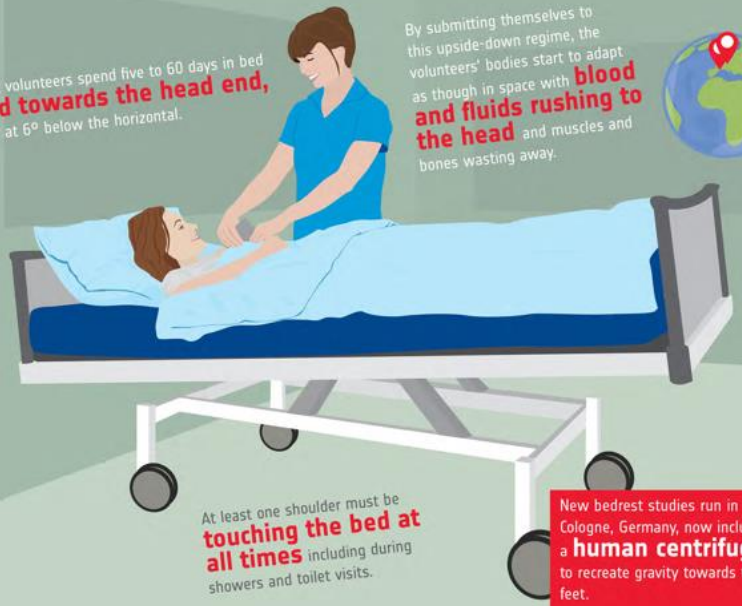
→ SCIENCE WITH(OUT) GRAVITY

Bedrest

Bedrest volunteers spend five to 60 days in bed **tilted towards the head end,** usually at 6° below the horizontal.

By submitting themselves to this upside-down regime, the volunteers' bodies start to adapt as though in space with **blood and fluids rushing to the head** and muscles and bones wasting away.



At least one shoulder must be **touching the bed at all times** including during showers and toilet visits.

New bedrest studies run in Cologne, Germany, now include a **human centrifuge** to recreate gravity towards the feet.

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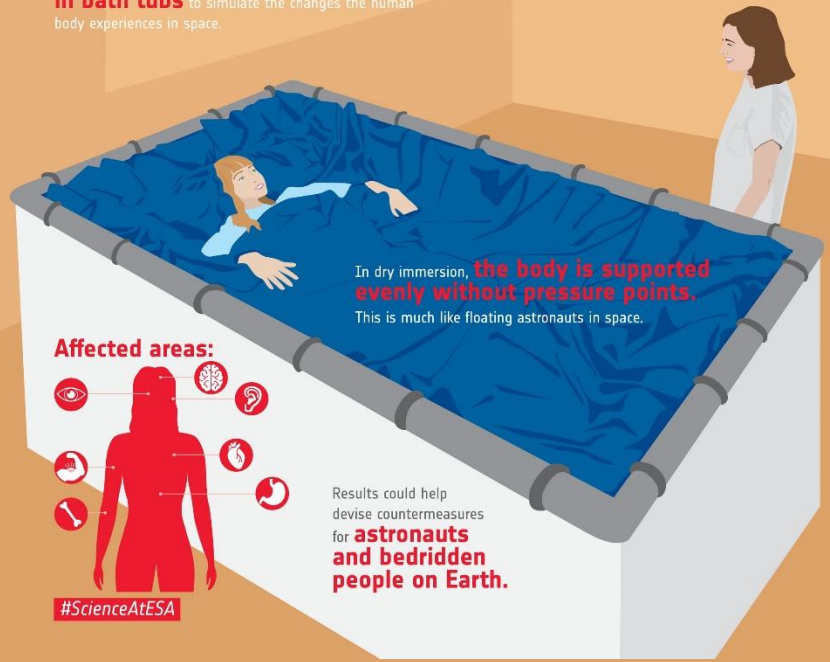
→ SCIENCE WITH(OUT) GRAVITY

Dry immersion

Volunteers spend **3 to 21 days immersed in bath tubs** to simulate the changes the human body experiences in space.



In dry immersion, **the body is supported evenly without pressure points.** This is much like floating astronauts in space.

Affected areas:

Results could help devise countermeasures for **astronauts and bedridden people on Earth.**

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→ ISOLATION STUDIES

Sirius

The Sirius programme simulates space missions on Earth to better understand human behaviour, health and performance in **isolation** and **confinement.**

Sensory and social deprivation

Six volunteers live and work without natural daylight, no fresh air and limited human interaction.

Challenges

The crew has to cope with limited communications, emergency scenarios and simulated spacecraft manoeuvres – all while being cut off from the world.

Why

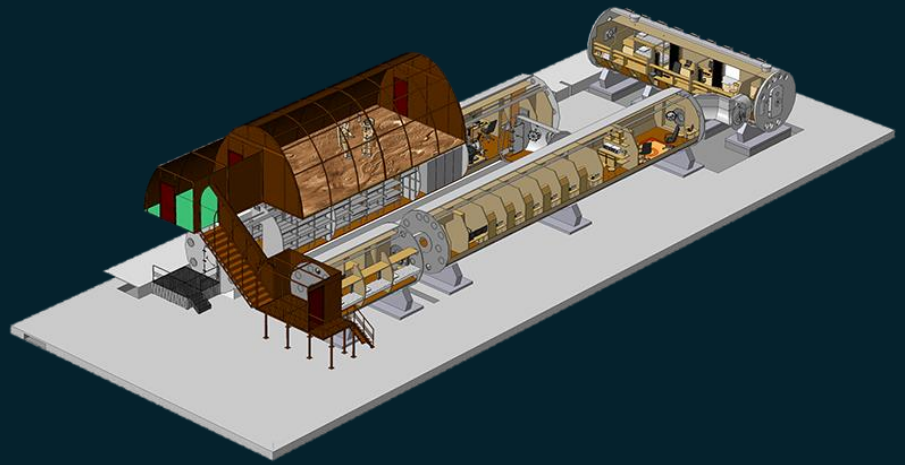
To learn how to prevent conflicts, and keep optimal crew performance while avoiding social isolation and stress among space travelers.

Go green

The crew grows vegetables under artificial light in a greenhouse. This source of food will be crucial for future long-duration missions away from Earth.

#Space19plus #ScienceAtESA #ExploreFarther

Space19



ESA SciSpacE Research Opportunities

Announcements of Opportunity (AO)	Continuously Open Research Announcements (CORA)	Other
Bedrest Dry Immersion Concordia and Isolation [Sounding Rockets] IBER at GSI ISS (Human Health + Biology)	Parabolic Flight [Drop Tower] Ground-based facilities, incl. radiation via IBER	Topical Team

ESA's Open Space Innovation Platform (OSIP) at ideas.esa.int

ESA SciSpacE Research Opportunities - Current

Continuously Open Research Announcements (Parabolic Flight, Drop Tower, Ground-based Facilities, Radiation)

- *2022 Sounding Rocket AO – closed*
- *2022 IBPER (Radiation) AO - closed*
- *2022 Ground 3D Bioprinting in Space AO – closed*

- 2022 Reserve Pool for ISS – deadline: 16 Sep 2022
- 2022 Reserve Pool for Moon – deadline: 16 Sep 2022

ESA SciSpacE Research Opportunities - Planned

- AO for ESA's isolation studies
- AO for ESA dry immersion study (with countermeasures)
- AO for ESA bedrest study (with countermeasures)
- AO for data mining of standard measures (bedrest, dry immersion, isolation)
- AO for Space Biology on ISS (KUBIK, ICECUBES, 3D Biosystem)

THANK YOU! – QUESTIONS?

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