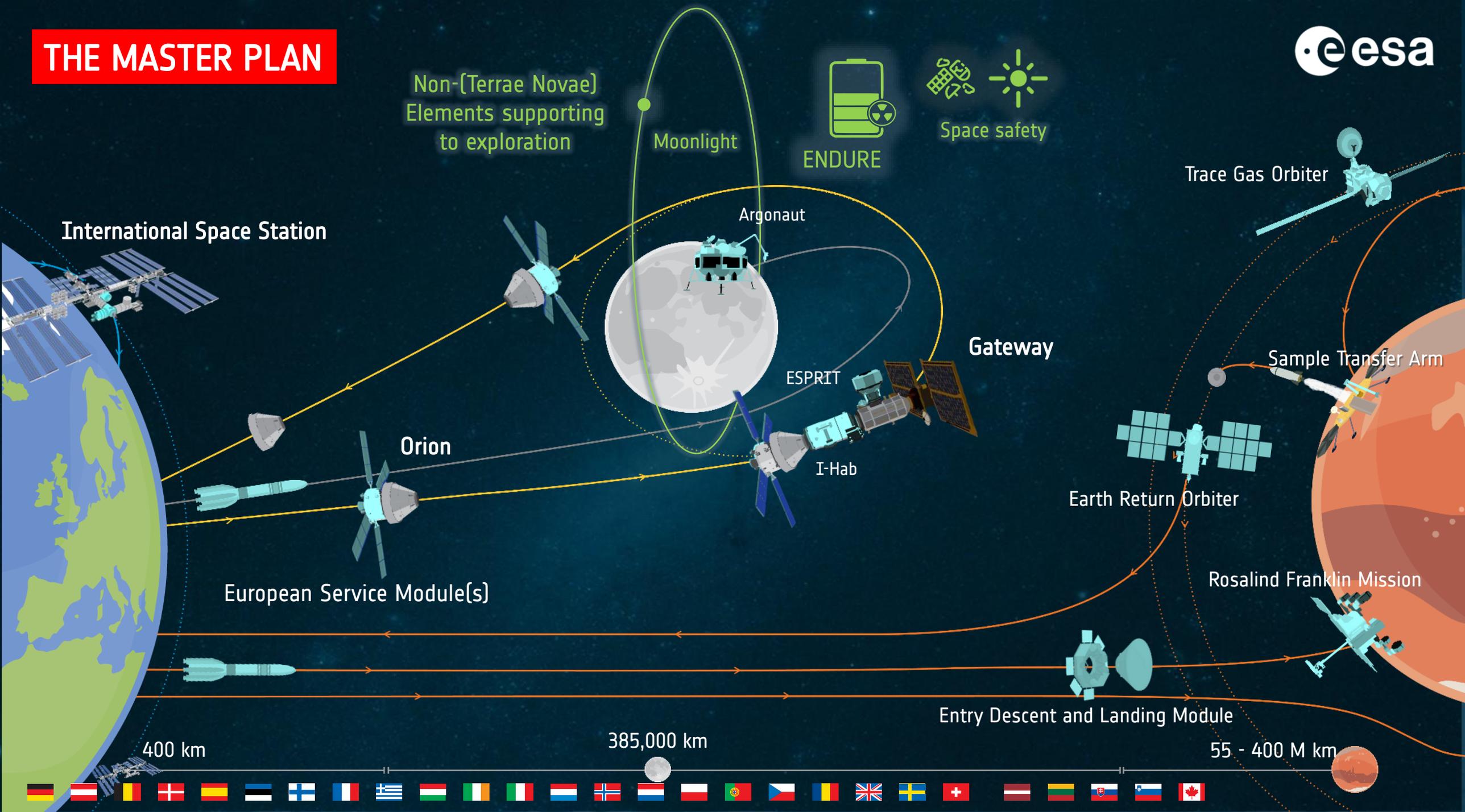


ESA's HRE SciSpaceE research opportunities

Sebastien Vincent-Bonnieu (HRE-RS)
ESA Days Slovenia
Ljubljana, 11/10/2023

THE MASTER PLAN



Non-(Terra Novae)
Elements supporting
to exploration

ENDURE

Space safety

International Space Station

Moonlight

Argonaut

Trace Gas Orbiter

Gateway

ESPRIT

I-Hab

Sample Transfer Arm

Orion

Earth Return Orbiter

European Service Module(s)

Rosalind Franklin Mission

Entry Descent and Landing Module

400 km

385,000 km

55 - 400 M km



OUR NEXT GENERATION EXPLORERS



5

Career Astronauts

1

Parastronaut
Feasibility Study
Member

11

Members of the
Astronaut Reserve



TERRAE NOVAE 2030+



- Create new opportunities in low Earth Orbit for a sustained European presence after the International Space Station,
- Enable the first European to explore the Moon's surface by 2030 as a step towards sustainable lunar exploration in the 2030's,
- to prepare the horizon goal of Europe being part of the first human mission to Mars.

E3P Period 3 (2022-2025)

Commercialisation as a cross-cutting theme

space robotics

ExPeRT

ESA

- Orbit
- Control
- Life Support and Power
- Navigation
- Thermal

Cornerstone #1:
Humans in LEO

Cornerstone #4:
Mars robotic exploration

SciSpace

Cornerstone #2:
Humans beyond LEO

Cornerstone #3:
Moon robotic exploration

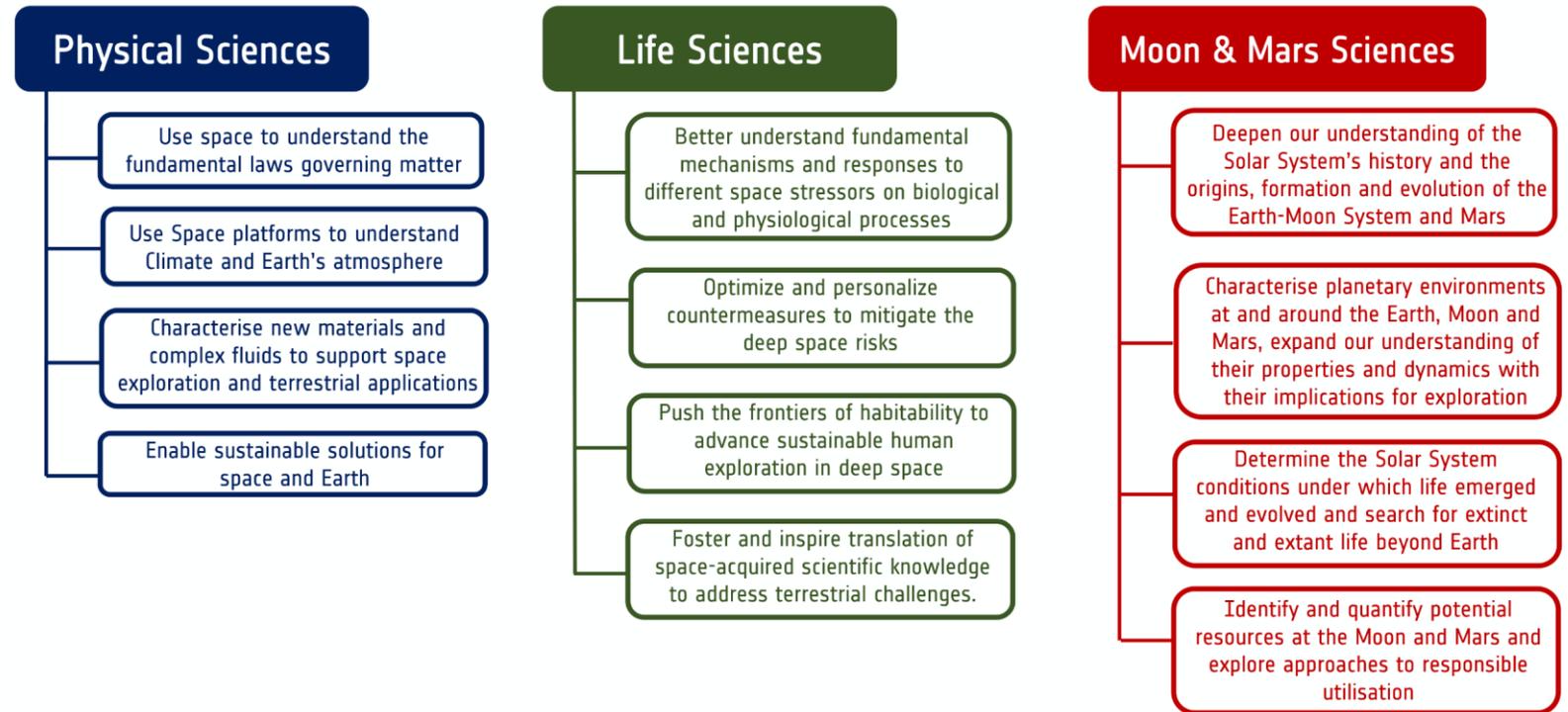
ExPeRT = Mission studies and mid-TRL technology

SciSpace = Science in the Space Environment

SciSpacE structure

SciSpacE prepares and delivers multidisciplinary science activities utilising varied research platforms including ground-based analogues; micro-gravity and LEO facilities, and is expanding to Moon and Mars destinations

- Fosters innovative, world-class, science research
- Helps to deliver solutions to challenges on Earth
- Supports European economy
- Prepares responsible sustained human and robotic exploration



Science recommendations and HRE Strategy

SciSpacE White papers* : science community's recommendations on future research focus 16 areas, February 2021. Published in *npj Microgravity* collection.

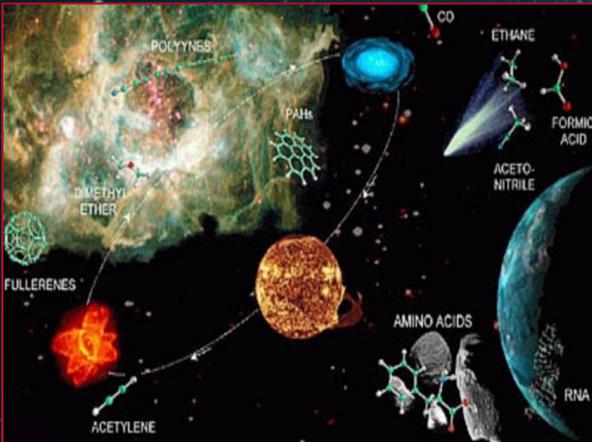
SciSpacE Retreat, 54 scientists, December 2022, in ESTEC about SciSpacE strategy

HRE strategy has been defined in Terrae Novae roadmap for the CM 2022.



*https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Research/The_SciSpacE_White_Papers

HUMANS LIVING ON MOON & MARS



EXTRATERRESTIAL LIFE

ASTRONAUT 2.0



FUNDAMENTALS OF NATURE

SPACE TRAVEL AND TRANSPORT

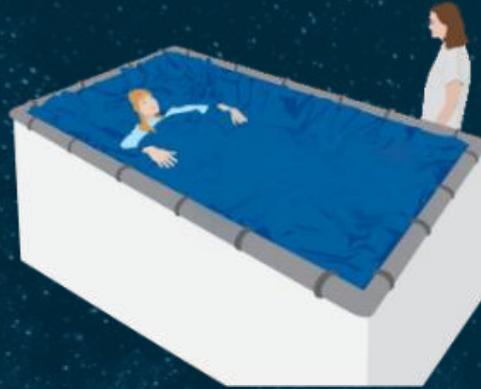


NATURE OF EXPLORATION DESTINATIONS

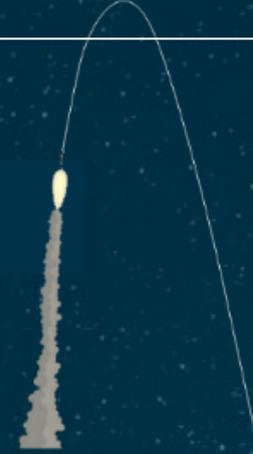
RESEARCH USING Ground and Sub-Orbital PLATFORMS



Bedrest



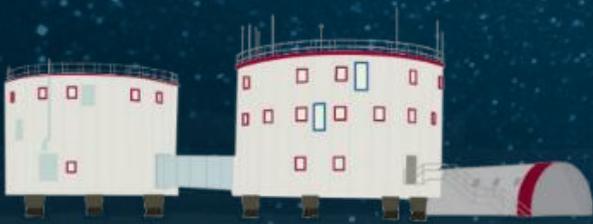
Dry Immersion



Sounding Rockets



Drop Tower



Concordia, Antarctica
Isolation and Confinement



Parabolic Flight



Ground-based
facilities

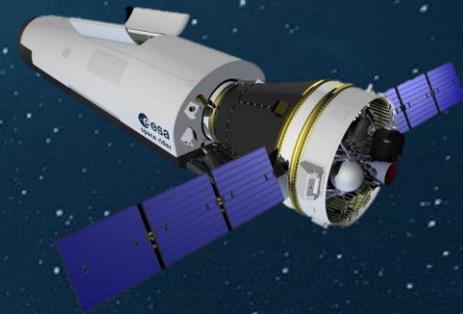


Radiation

RESEARCH USING SPACE PLATFORMS



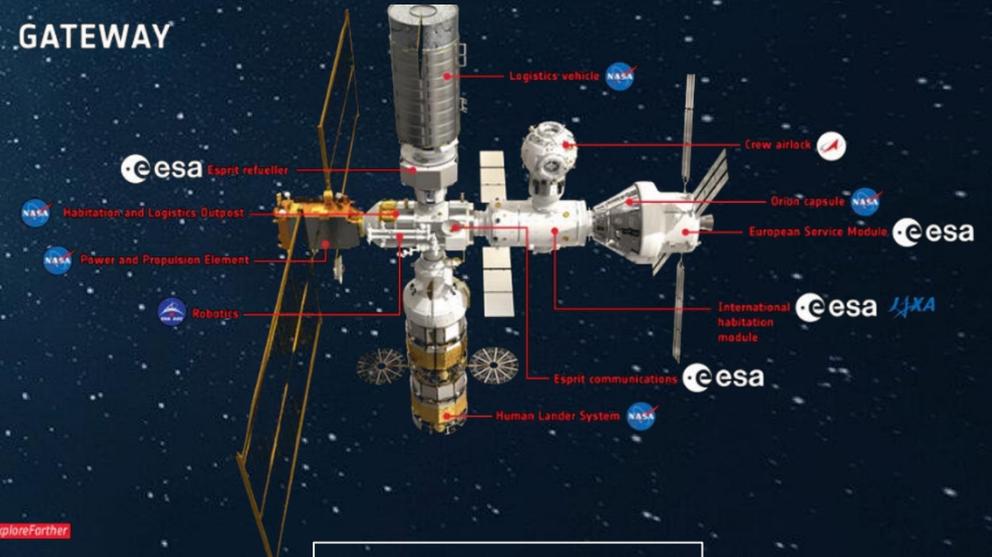
International Space Station (ISS)



Space Rider



Argonaut



Gateway

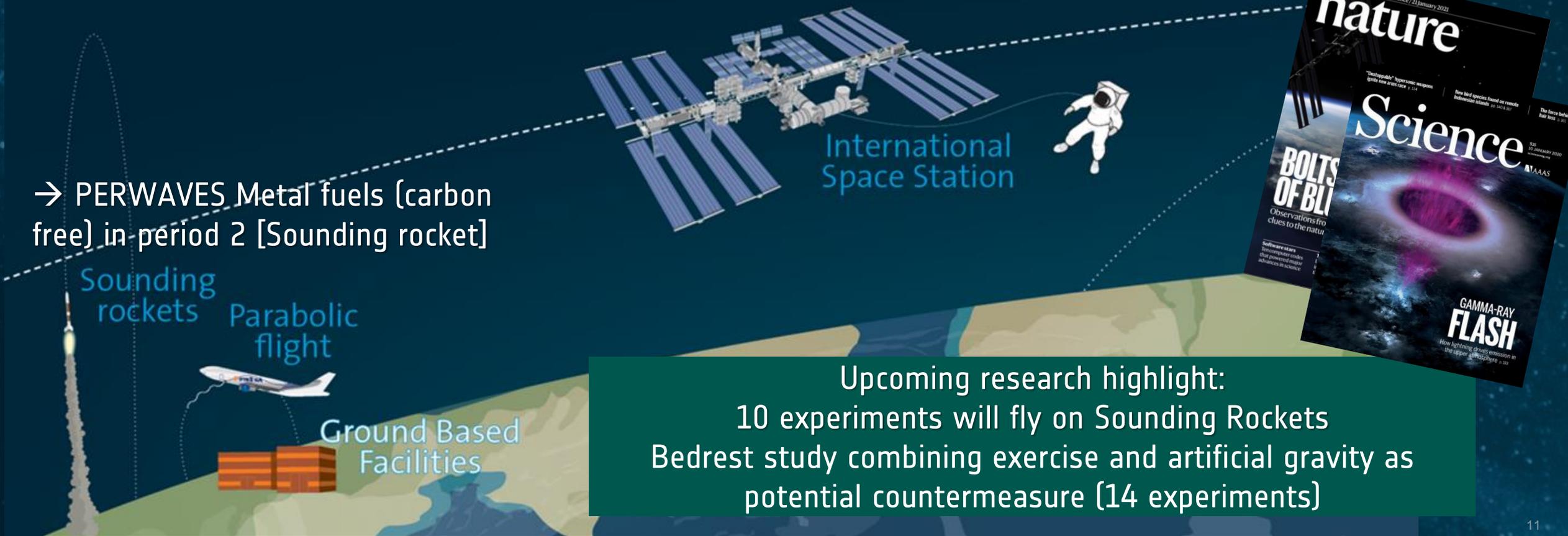


RESEARCH HIGHLIGHTS

- Understanding of cell ageing - DNAmAge
- Musculoskeletal deconditioning in long spaceflight
- Complex Plasmas effect on ISS
- Metallic alloys properties measurements EML and MSL

→ ASIM observed the genesis of blue lightning into the stratosphere

→ PERWAVES Metal fuels (carbon free) in period 2 [Sounding rocket]



Upcoming research highlight:
10 experiments will fly on Sounding Rockets
Bedrest study combining exercise and artificial gravity as potential countermeasure (14 experiments)

LOW EARTH ORBIT



Europe needs LEO for utilisation and exploration preparation, also post-ISS

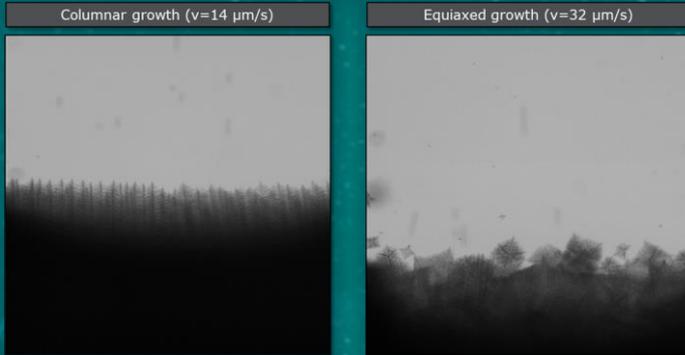
Preparing the post-ISS era has already started with international trend of commercialisation

No Agency owned platforms, instead buying services

Transportation model is fundamental

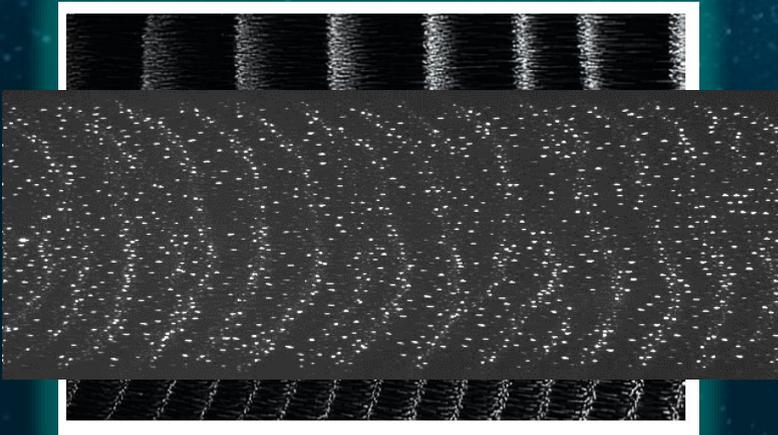
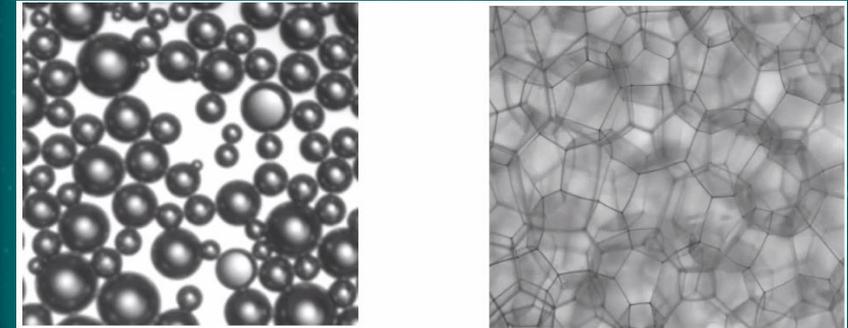
TERRAE NOVAE 2030+





► **Soft Matter:** New insights on Foam coarsening and Granular matter in Fluid Science Laboratory [SMD-FOAM]

◀ **Materials science:** observation of the columnar-to-equiaxed transition [CETSOL]



► **Atmosphere Physics:** ASIM: observing mysterious blue lightning jets in the high atmosphere (Nature, 2021)

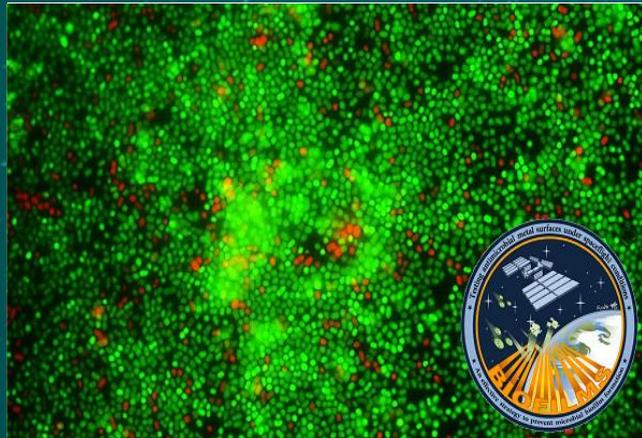
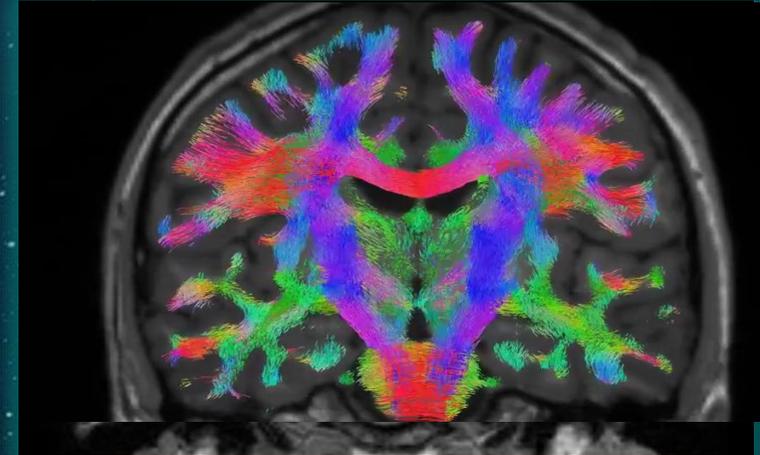
◀ **Soft Matter:** Plasma Kristall-4 successful campaign, spatiotemporal wave in complex plasma





▶ **Biology:** understanding wound healing processes in microgravity [Suture in Space]

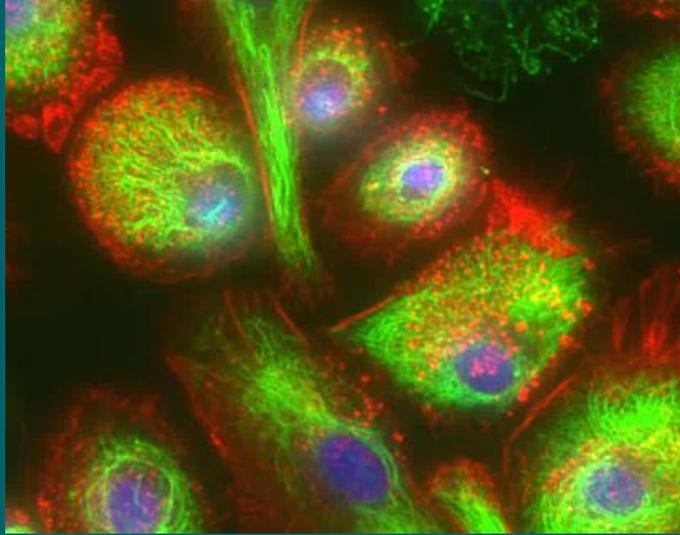
▶ **Human health:** New insights in changes in brain structure and function after long-duration brain spaceflight [BRAIN DTI]



▶ **Biology:** Investigating the antimicrobial properties of laser-structured metal surfaces under microgravity conditions to combat microbial growth [BIOFILMS]

▶ **Human health:** Monitoring biomechanical properties of skeletal muscle with a non-invasive, portable device [Myotones]





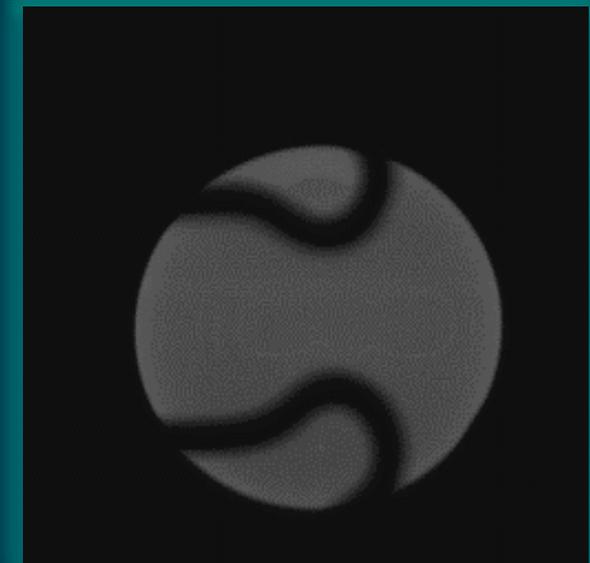
◀ **Biology research:** Live Cell Imaging (DLR/ESA) about biology and complex matter experiments.

▶ **Fundamental Physics:** Atomic clock ACES, Measurement of the gravitational red shift, Search for time drifts of fundamental constants, violations of special relativity



◀ **Exobiology and Material Research:** Exobiology facility and Euro Materials Ageing (EMA-CNES/ESA) outside the ISS.

▶ **Materials Science:** New campaign of EML and Transparent alloy, X-Ray Facility



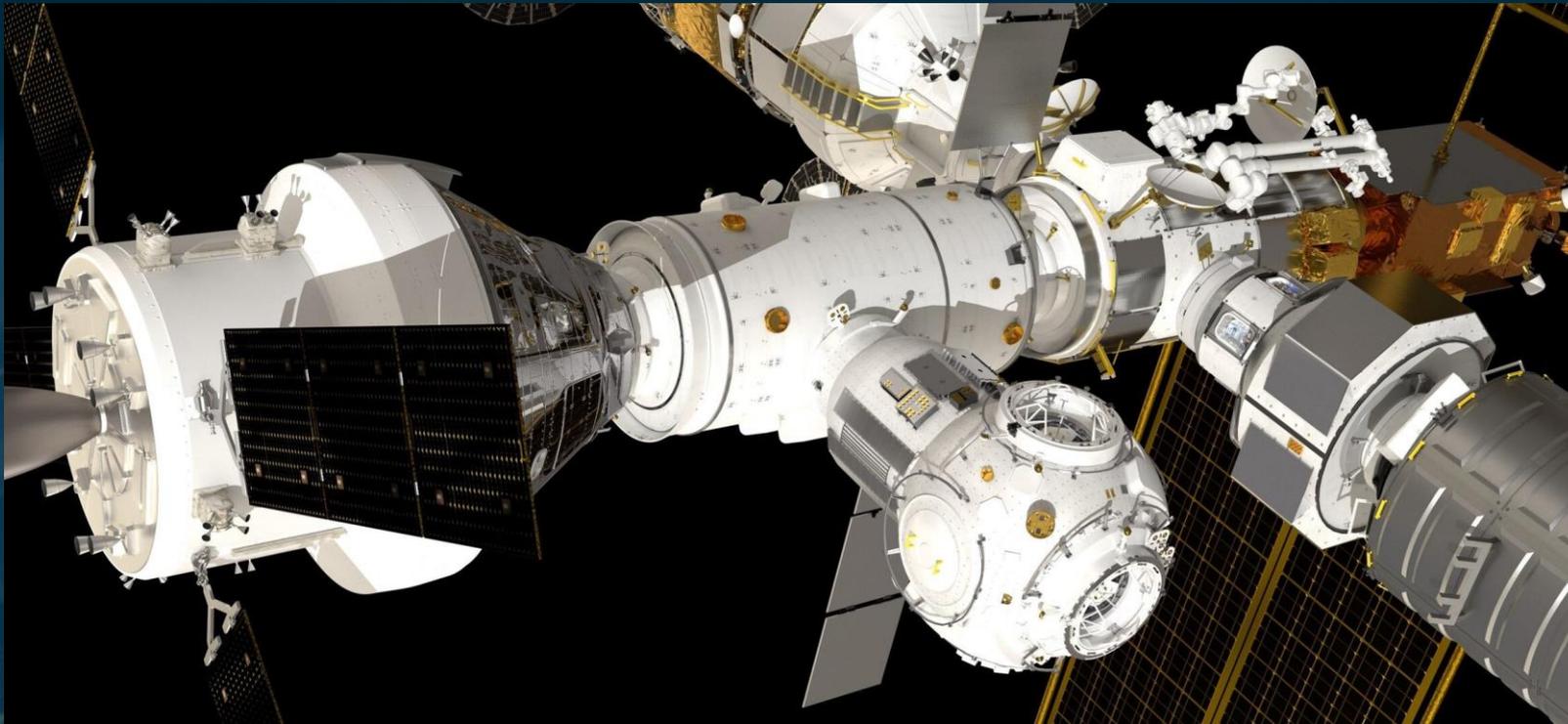
Regular and substantial robotic access during the 2030s enabling European-led scientific and logistic activities

Reliable and visible partner for sustainable exploration of the Moon

Ambition of the first European on the surface by 2030

TERRAE NOVAE 2030+





Future prospects :

- Meteoroids, lunar dust and interstellar matter
- Environmental effects on biology and materials
- Next generation radiation platforms
- Enhanced human health research

◀ **Radiation** European Radiation Sensor Array (ERSA) – External deep space radiation environment and space weather

◀ **Radiation** Internal Dosimeter Array (IDA) – Internal radiation as experienced by crew

◀ **Human Health**

- In-situ assessment of immune parameters
- Retinal camera
- Cardiorespiratory and Cardiovascular response to Gateway environment
- AI guidance for Ultrasound measurements



◀ Lunar environment

Negative Ions at the Lunar Surface (NILS) on Chang'e 6 examining the interaction of the solar with airless bodies

Geophysics ▶

MoonLIGHT laser retroreflector on Intuitive Machines mission IM3, ranging from Earth to probe the interior of the Moon and relativistic physics

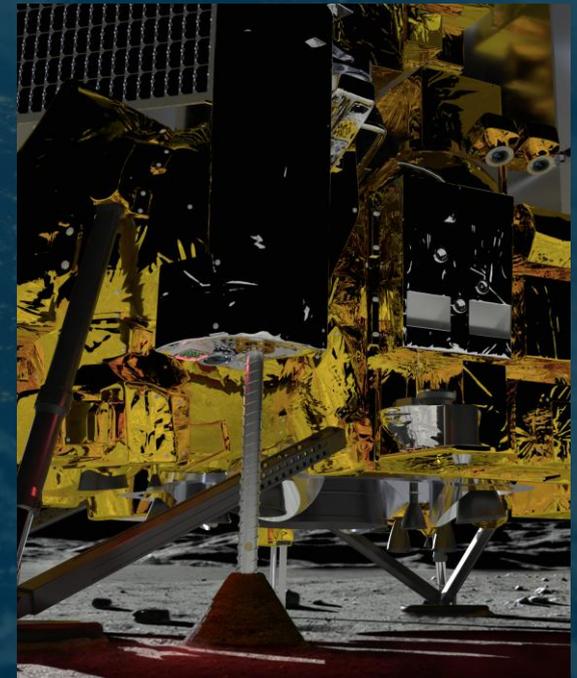


◀ Resources exploration

Exploration Mass spectrometer (EMS) on Astrobotic mission 1 and JAXA LUPEX rover looking for water ice near the surface

Resources exploration ▶

PROSPECT drill and chemical laboratory: drilling at the lunar South Pole for ice and volatile chemistry. Resource extraction experiments



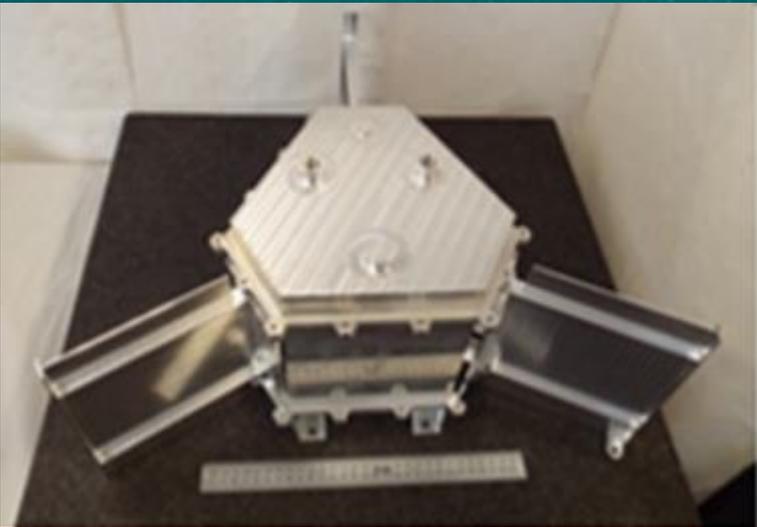
Future prospects: environment characterisation, resources exploration, sample selection and return, space biology, human health research, physics and astrophysics

Lunar science and technology highlights



◀ **Space Resources:** 'before and after' demonstration of oxygen and titanium extraction from lunar regolith simulant using Metalysis process

▶ **Lunar science** missions of opportunity with NASA, JAXA/ ISRO, CNSA – up to 6 missions by 2025



◀ European **radioisotope** technology based on americium-241 for heat and electrical power generation: essential for future science and exploration

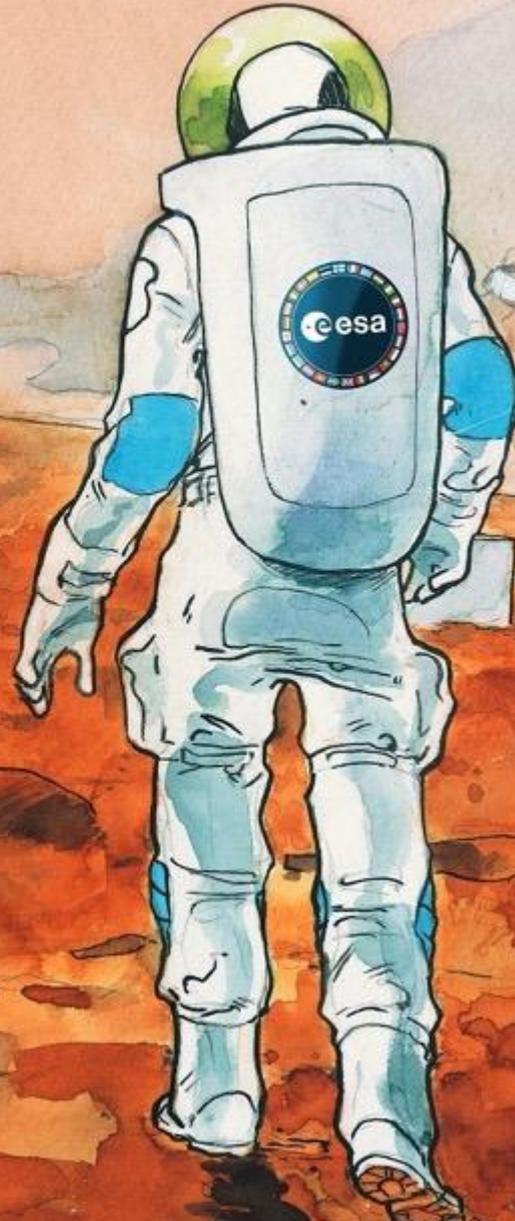
▶ ESA technology in the hands of astronauts for **science, medical and operations support**



Upcoming – Cis-Lunar and Lunar Surface

- Utilisation studies: Exploration of polar resources, radio astronomy, geology, life sciences lab, ISRU...
- Argonaut lander to support the NASA Artemis lunar surface programme, including candidate payloads (science and technology demonstrations)
- Gateway: Payloads implemented by ESA to support health research, Potential development of an Exobiology facility with accompanying AO for science selection European Radiation Sensor Array (ERSA),
- Moon surface: Reserve pool of science activities (AO launched in 2022)
Coordination of access to new samples from Artemis missions for scientific utilisation for the European science community and build curation community in Europe





Robotic missions to consolidate key capabilities to

- Continue the search for life
- Secure Europe's independence of action at Mars

Future possible missions studies as part of ExPeRT

In synergy with LEO and Moon, position Europe for a strong contribution to the Human journey in the 2040s

TERRAE NOVAE 2030+

Cornerstone 4: Ambitious decade of Mars exploration

Trace Gas Orbiter

- TGO science continuing
- Data relay for Curiosity, Insight, Perseverance continues

→ ERO is in phase C development (readiness for launch is 2027)

ExoMars Rover

- Mission to land Rosalind Franklin proposal in cooperation with NASA decided at CM22

Earth Return Orbiter

→ **Discontinued**

→ STA Contract signed in July 2022

Sample Fetch Rover

Sample Transfer Arm



ESA's SciSpacE Research Opportunities



Announcements of Opportunity
(AO)

Bedrest
Dry Immersion
Concordia and
Isolation
Sounding Rockets
Radiation experiments (IBPER) at GSI
ISS
...

Continuously Open Research Announcements
(CORA)

Parabolic Flight
Drop Tower
Ground-based facilities, incl. radiation via IBPER

Other

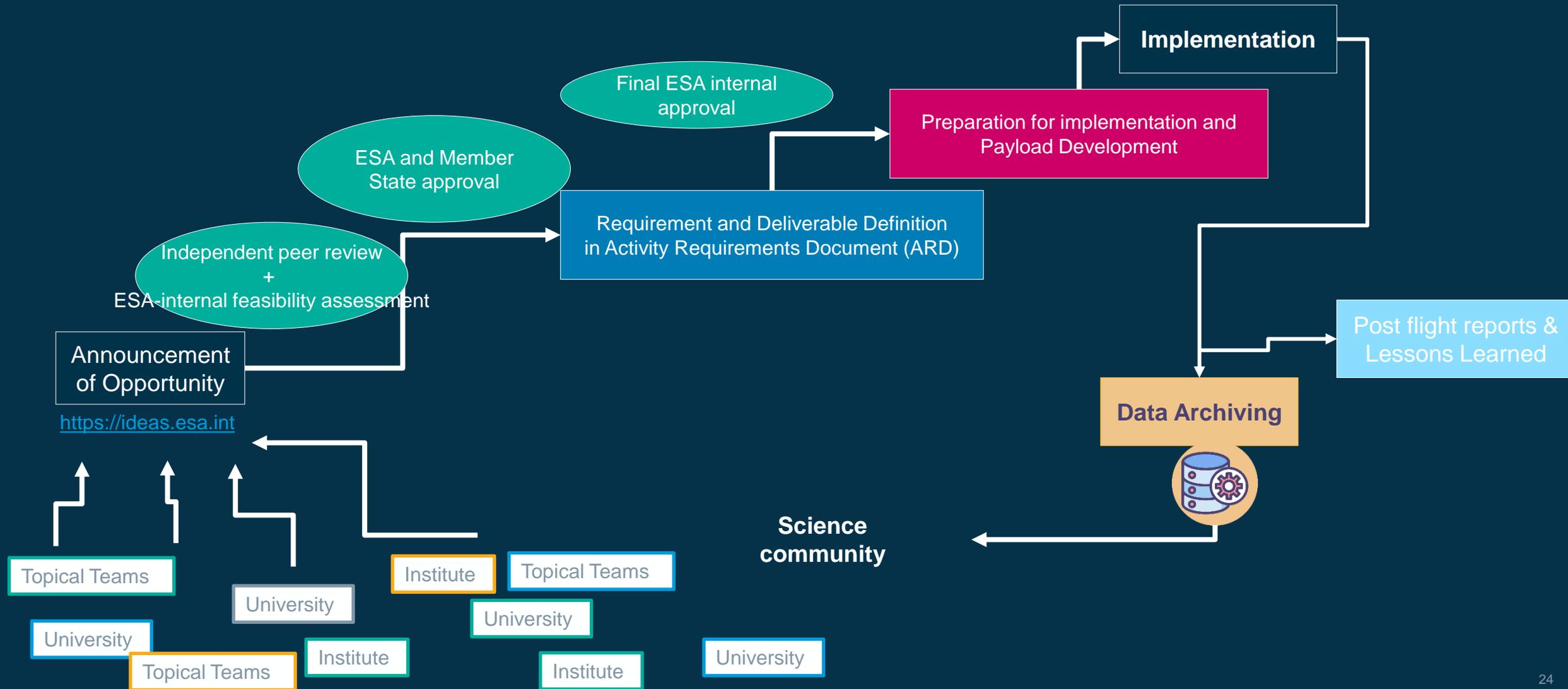
Topical Team

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

SciSpacE website at scispace.esa.int



FROM OPPORTUNITY TO IMPLEMENTATION



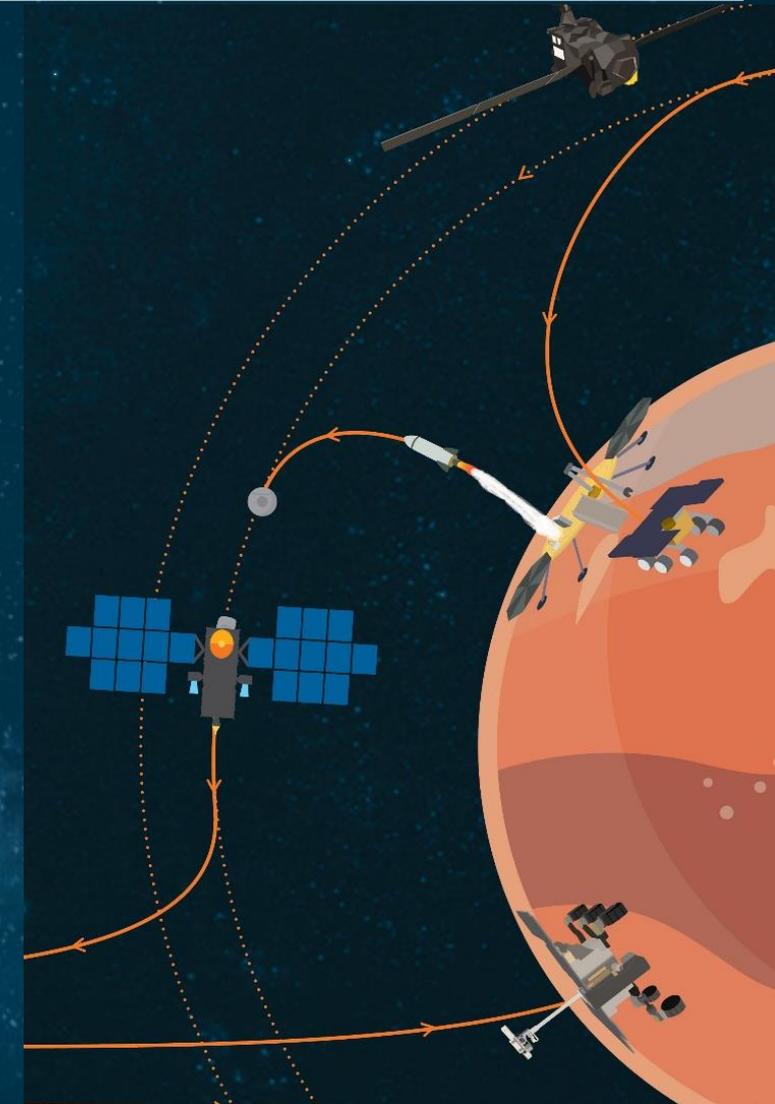
Earth Return Orbiter

- Development of flight instrument, Space Dosimetry Telescope, for integration on ERO

AO for science for Mars payloads to select science instrumentation for future Moon mission candidate studies

Preparation for Mars sample return

- Prepare for return of Mars samples through NASA collaboration and build an effective and competitive curation community in Europe



Upcoming Announcements of Opportunities

Ground and Sub-Orbital Platforms

- [Parabolic Flight](#) (2 campaigns per year) continuously open
- [Drop Tower](#) (120 drops/annually) continuously open
- [Ground-Based Facilities](#), incl. radiation via IBPER [Radiation](#) continuously open
- ESA Isolation Study at :envihab end of 2023/early 2024
- Dry Immersion study end of 2023/early 2024
- Bedrest Core Data (data mining) recently closed

ISS

- 3D BioSystem early 2024
- [ISS Human research](#) flexible experiments end of 2023
- Soft Matter on ISS (Soft Matter Dynamics payload) recently closed
- Materials science on ISS (EML Batch) recently closed
- Call for Low Earth Orbit Facility Definition Teams (FDTs) Membership recently closed

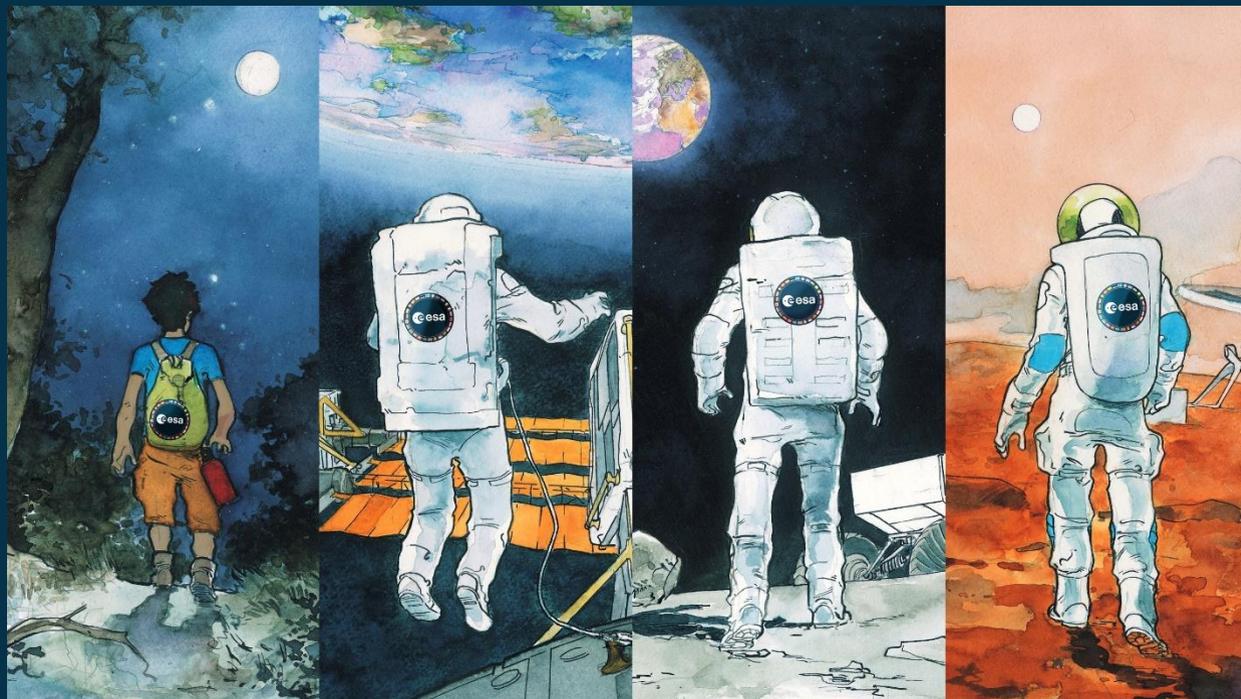
Moon

- Call for Lunar Gateway and Moon Surface Facility Definition Teams (FDTs) Membership recently closed

Gateway

- AO for health science payloads 2024 (TBC)

Check out SciSpacE opportunities on <https://scispace.esa.int/>
ESA's Open Space Innovation Platform (OSIP) at ideas.esa.int



THANK YOU! – QUESTIONS?



SciSpacE@esa.int



<https://scispace.esa.int>

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the
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