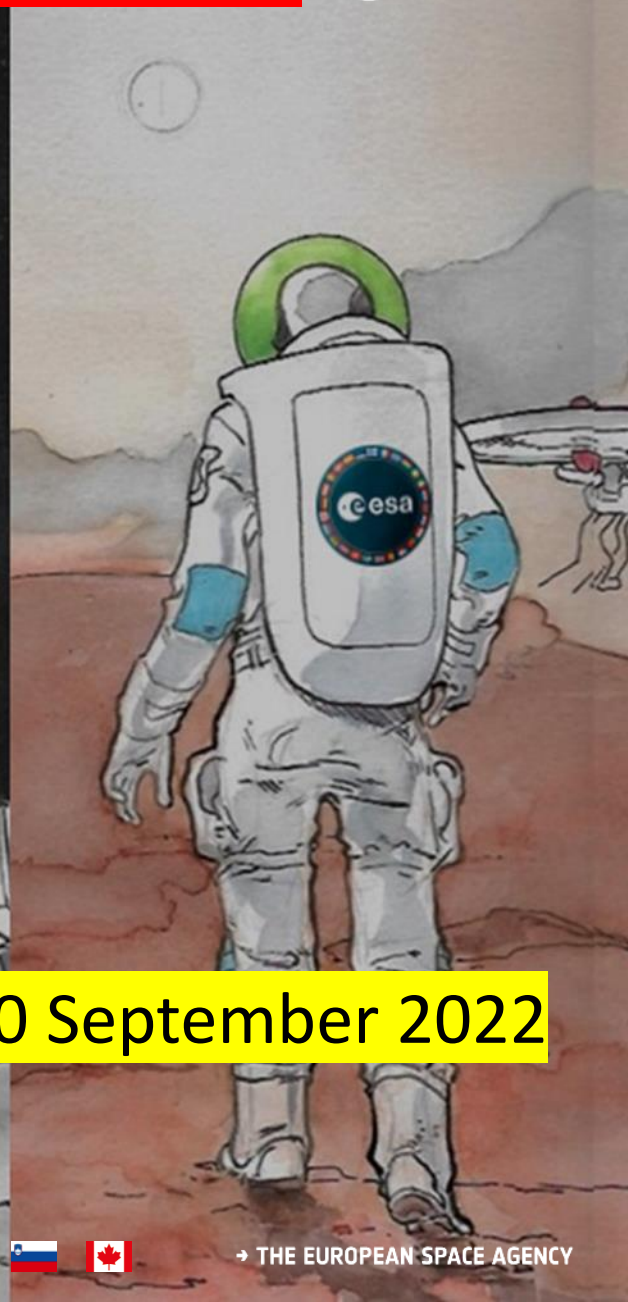
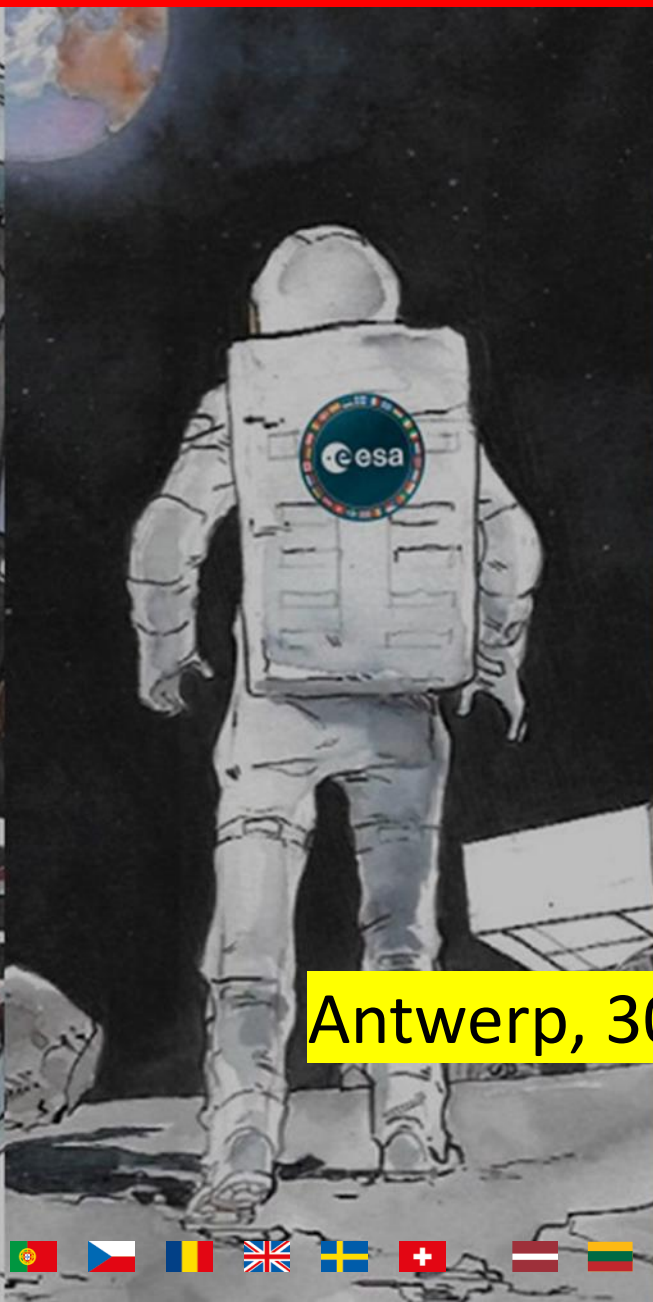


Terrae Novae is Europe's programme of human and robotic exploration



Antwerp, 30 September 2022



TERRAE NOVAE 2030+



Continuity

Sustained presence in, and utilisation of

Low Earth Orbit

Strategic resilience

End-to-end and capabilities provider

Inspiration and leadership

Science, technology, and commercial enabler

Reliable partner

Ambition

Europeans on the **Moon** surface by 2030

Vision

Europeans to **Mars** by 2040

European autonomy

Inspiration

Cargo and crew transportation



Europe's New Era Of Space Exploration



Extend ISS operations until 2030

New science benefits

New generation of astronauts

First astronaut with disability

Promote commercial exploration services

Prepare future science, missions & technology

ExoMars Trace Gas Orbiter

Deliver Mars science & communications

Argonaut (EL3)

Build Europe's ride to the Moon

Mars Sample Return

Make science history back on Earth

European Service Modules 4-9 for Orion

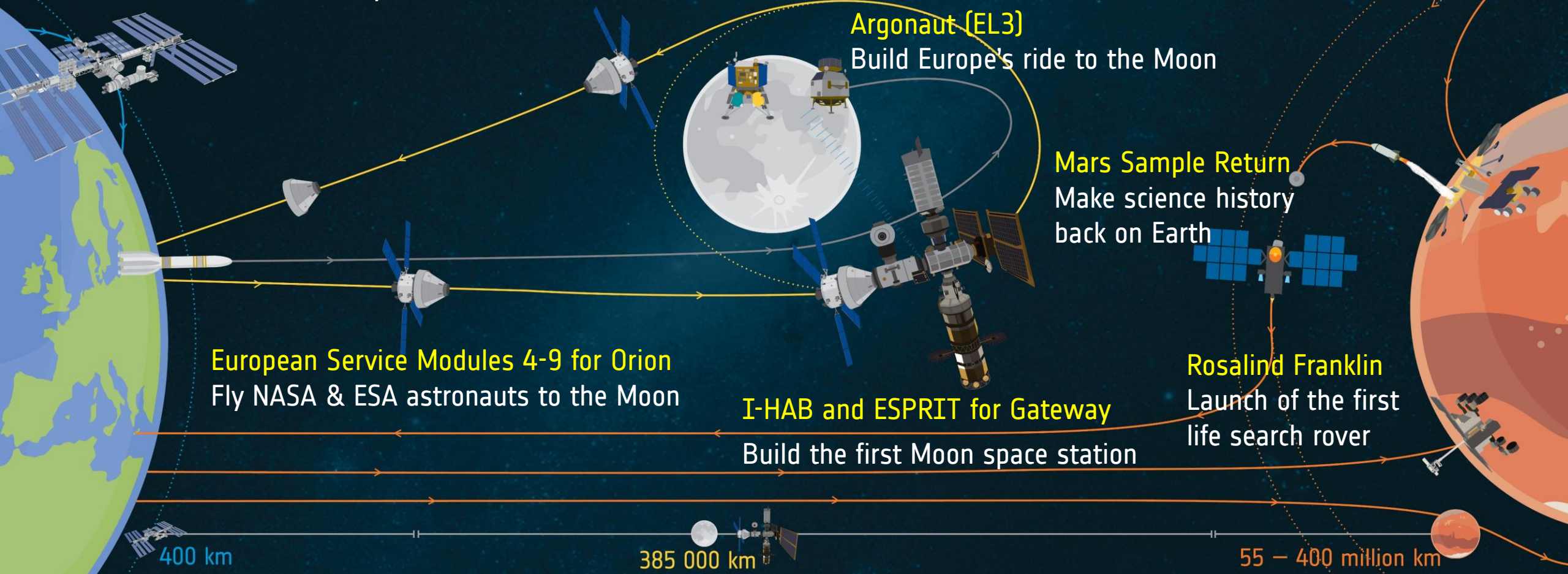
Fly NASA & ESA astronauts to the Moon

I-HAB and ESPRIT for Gateway

Build the first Moon space station

Rosalind Franklin

Launch of the first life search rover



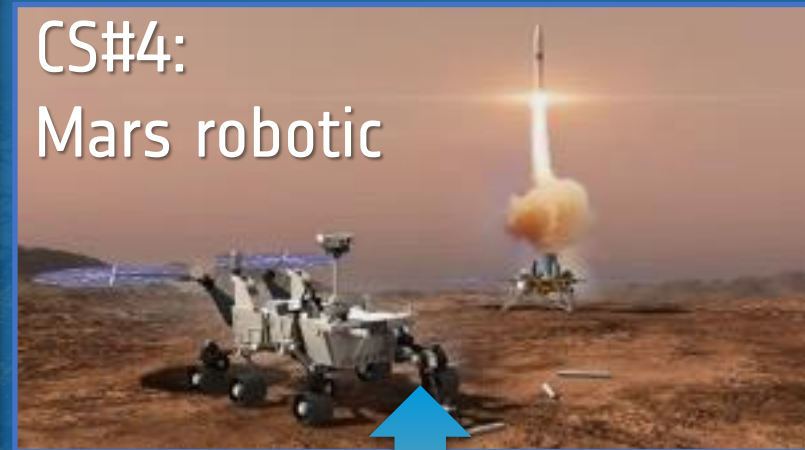
Commercialisation as a cross-cutting theme



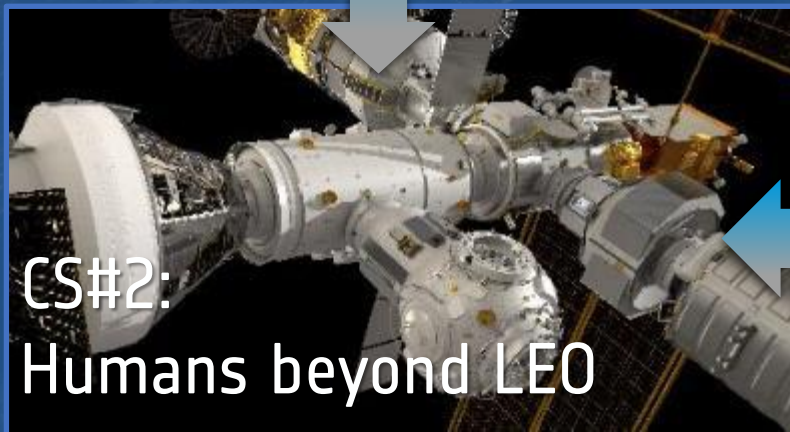
ExPeRT



CS#1:
Humans in LEO



CS#4:
Mars robotic



CS#2:
Humans beyond LEO



CS#3:
Moon robotic



SciSpace

ExPeRT = mid TRL technology and mission studies

SciSpace = Science in the Space Environment

SciSpacE Offers Unique Science Facilities To Europe



ISS



Parabolic flights



Antarctic missions



Analogue studies



Sounding rockets



Drop tower

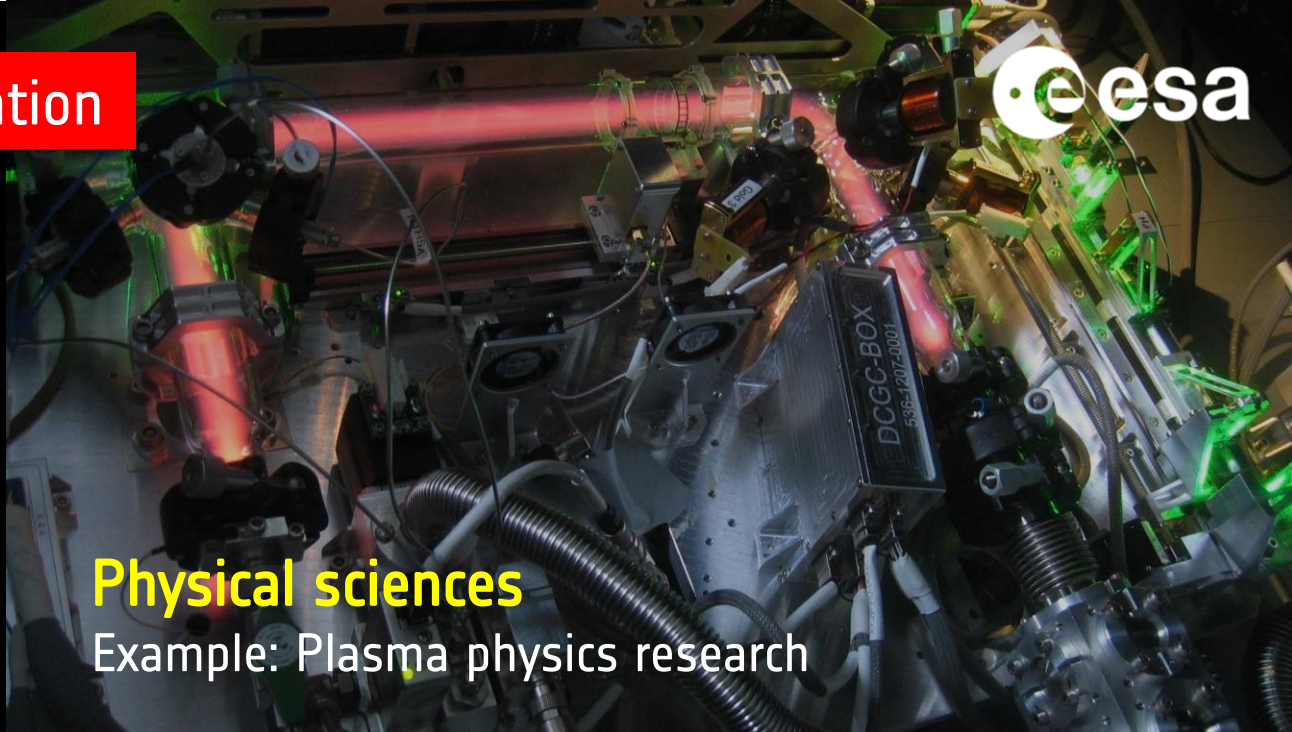


ESA science aboard the International Space Station



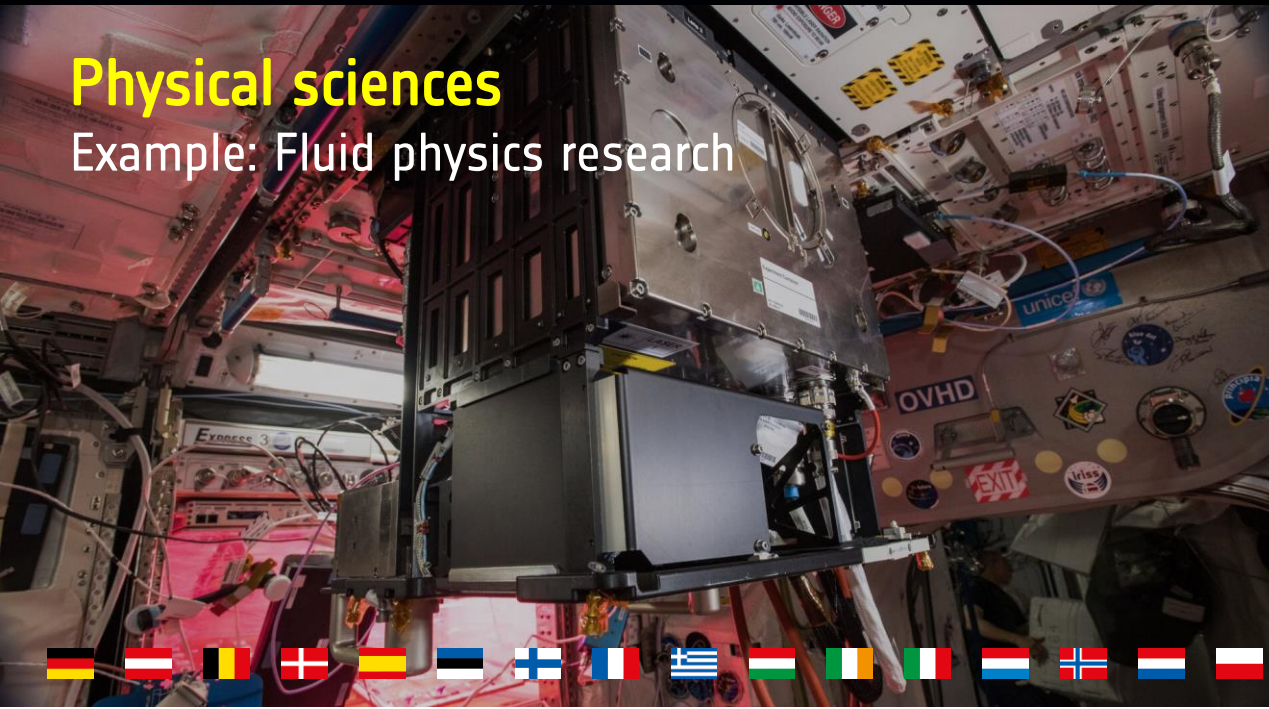
Earth, Moon and Mars sciences

Example: Atmosphere Space Interaction Monitor



Physical sciences

Example: Plasma physics research



Physical sciences

Example: Fluid physics research



Life sciences

Example: Human physiology research



EUROPEAN ASTRONAUT CORPS AND TRAINING CENTRE



ISS Long-duration Missions



Thomas Pesquet

Mathias Maurer

Samantha Cristoforetti

Andreas Mogensen



2021

2021

2022

2023



The New Generation Explorers



Astronaut selection



New ESA astronauts and the first parastronaut



Low Earth Orbit

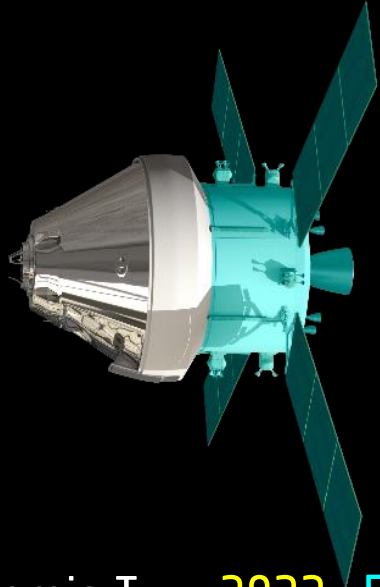
- Europe needs LEO for utilisation and exploration preparation, post-ISS
- Preparing the post-ISS era has already started with trend of commercialisation
- Agency owned platforms unlikely, instead buying services
- Transportation model is fundamental
- The *SciHab* concept enables a role for European industry & service providers



Europe at the Heart Of Moon Exploration



Orion and the lunar Gateway



European Service Module
ESM

European System Providing Refuelling, Infrastructure and Telecommunications

ESPRIT



International Habitation Module
I-HAB

YOU ARE HERE



Artemis I	2022	ESM-1	Uncrewed flight test
Artemis II	2024	ESM-2	Crewed flight test
Artemis III	2025	ESM-3	Moon landing
Artemis IV	2027	ESM-4	I-HAB delivered to Gateway
Artemis V	2028	ESM-5	ESPRIT delivered to Gateway
Artemis VI	2029	ESM-6	

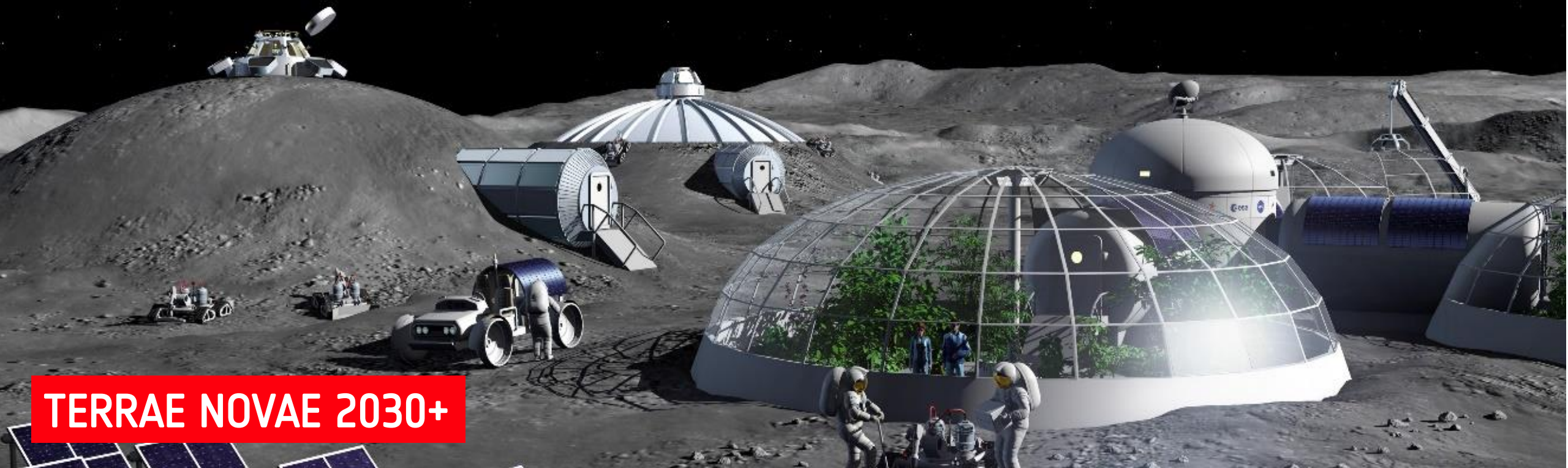
... ..



ESA astronauts



Vision: European astronauts, science and technology at future international station for research on the Moon



TERRAE NOVAE 2030+



From vision to action

- Step-wise scientific utilisation
- European lunar transportation
- Communications and navigation services
- Enabling surface power technology
- Space resources
- Develop crew skills and capabilities
- International partnerships
- Partnerships with business

TERRAE NOVAE 2030+



PROSPECT on NASA CLPS

Package for Resource Observation and in-Situ Prospecting for Exploration,

Exploration Mass Spectrometer

- EMS launch on NASA/Astrobotics Peregrine lander
- EMS LUPEX MOU signed with JAXA

LANDCAM-X on NASA CLPS

Camera for future vision based navigation

Negative Ions at the Lunar Surface (NILS)

for the Chinese Chang'e 6 lunar sample return mission

Laser Retroreflector

New For CM22 – the European Large Logistic Lander



one launch every 2-3 years starting in 2029



Lunar Pathfinder - a precursor for Moonlight constellation

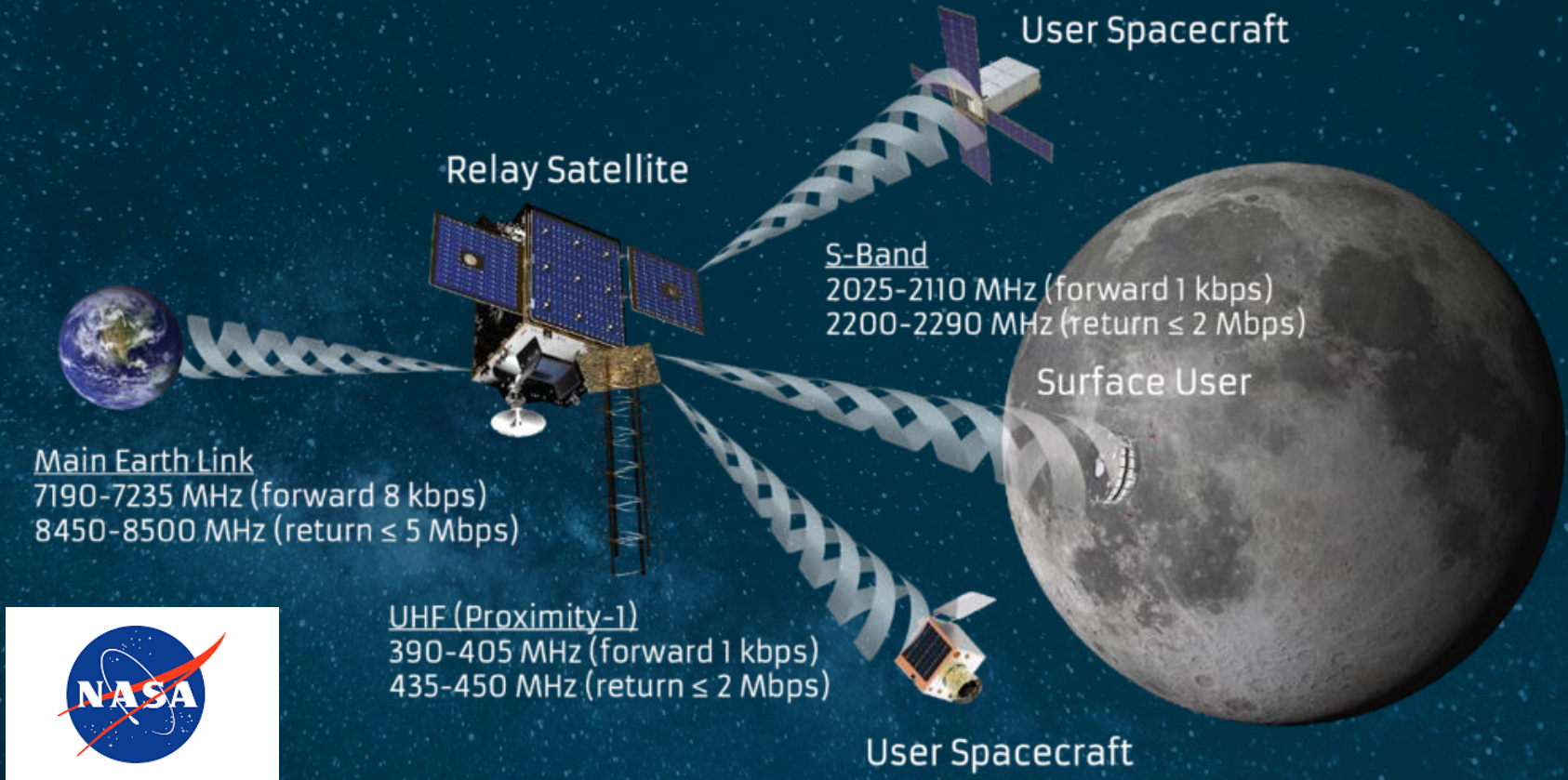
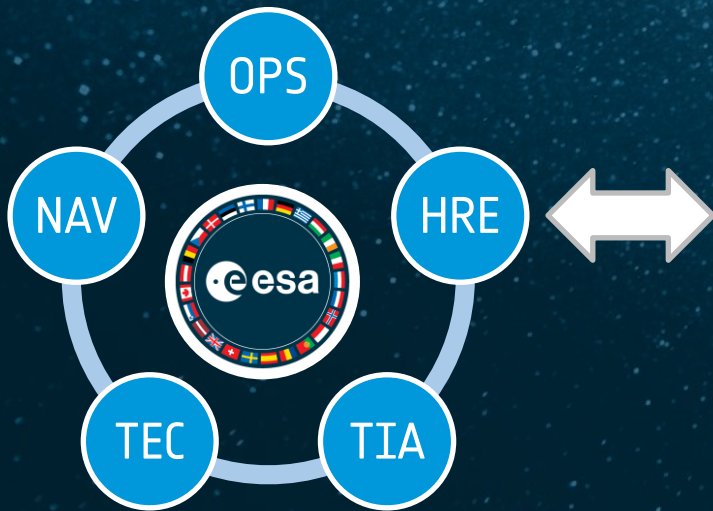
- Providing commercial lunar communications services and for testing lunar navigation for a future constellation

- Data service procurement (ESA - HRE)
- Moonlink telecoms payload (ESA - TEC)






Hosted Payloads

- ✓ GNSS receiver and antenna (ESA - NAV)
- ✓ Radiation Monitor (ESA - OPS)
- ✓ Laser retroreflector (NASA)

NASA provision of ride-share launch



ESA + DLR LUNA facility: Preparing for the Moon

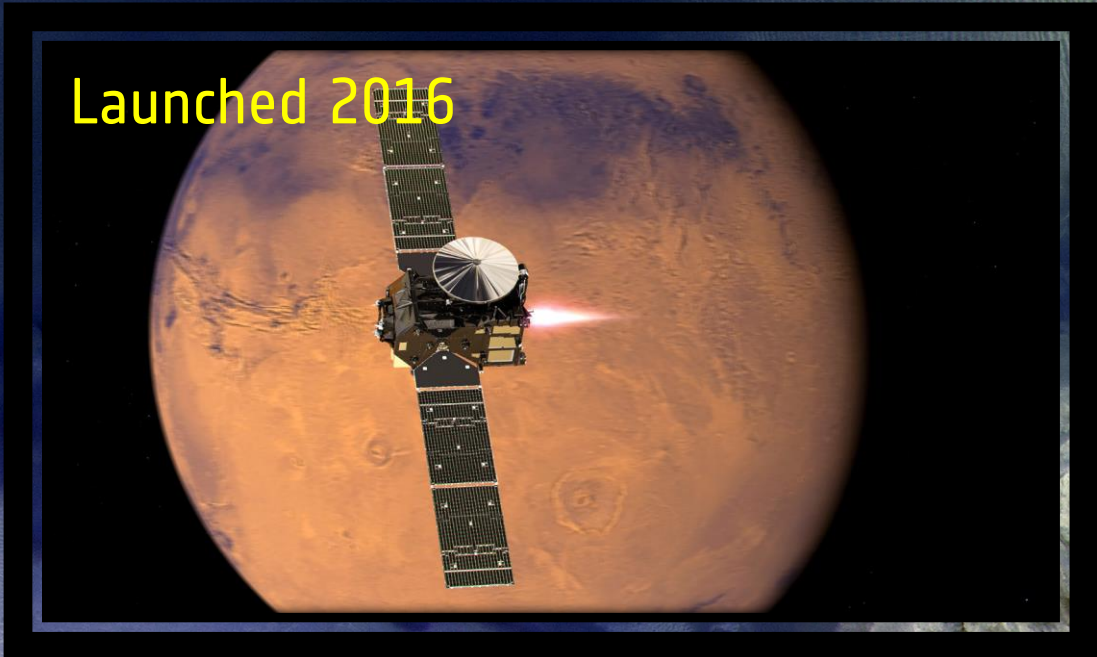
-  ISS Operations & Training
-  Field Training
-  EVA tools
-  Future Systems & Technologies
-  Science & research, incl. space medicine, life sciences, ISRU, etc.



LUNA as leading lunar analogue facility and operational ecosystem
Project Kickoff on 13 Sept. 2022

At The Red Planet

ExoMars Trace Gas Orbiter



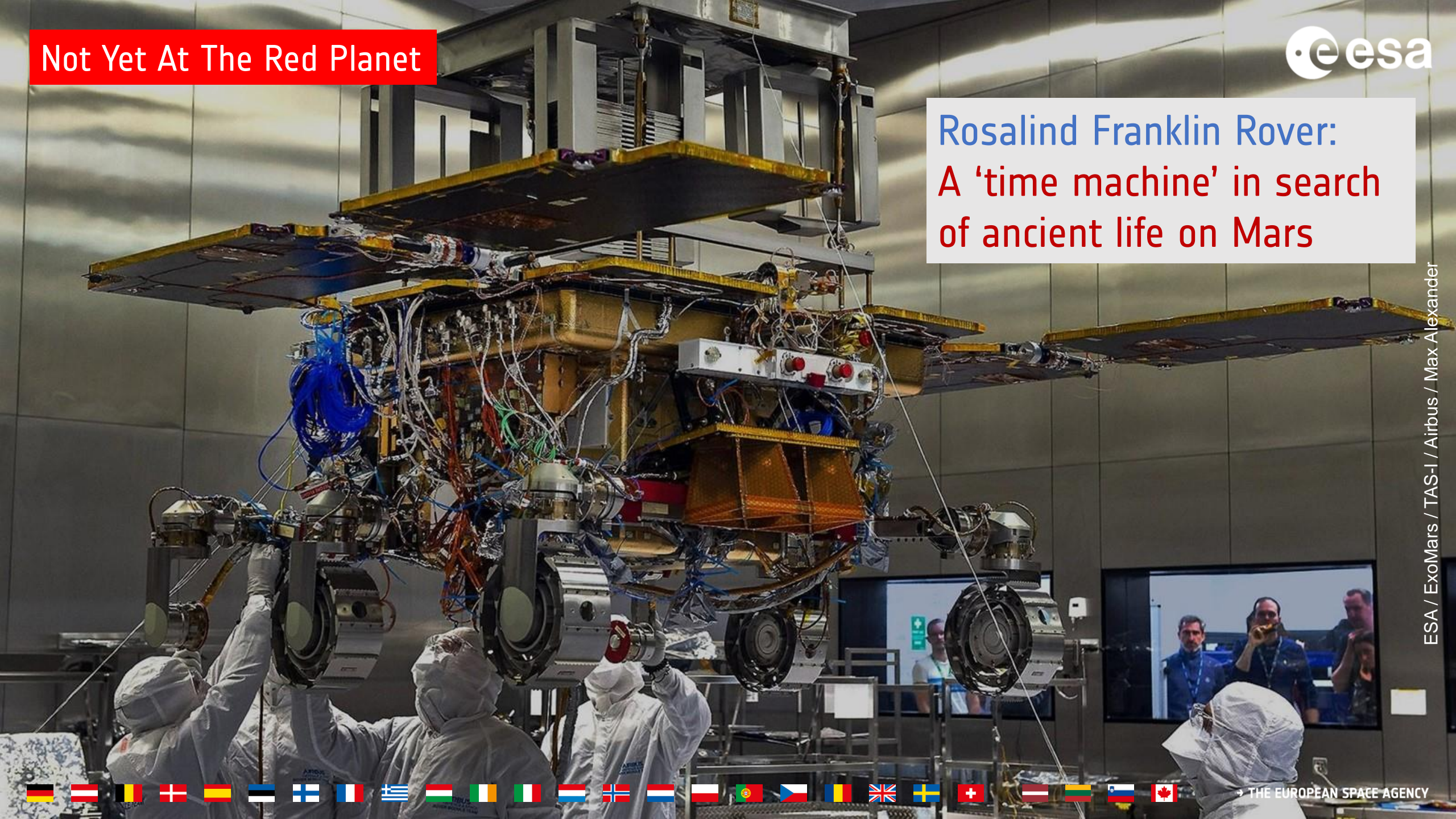
ESA / Roscosmos / TGO / CaSSIS



Not Yet At The Red Planet



Rosalind Franklin Rover: A 'time machine' in search of ancient life on Mars

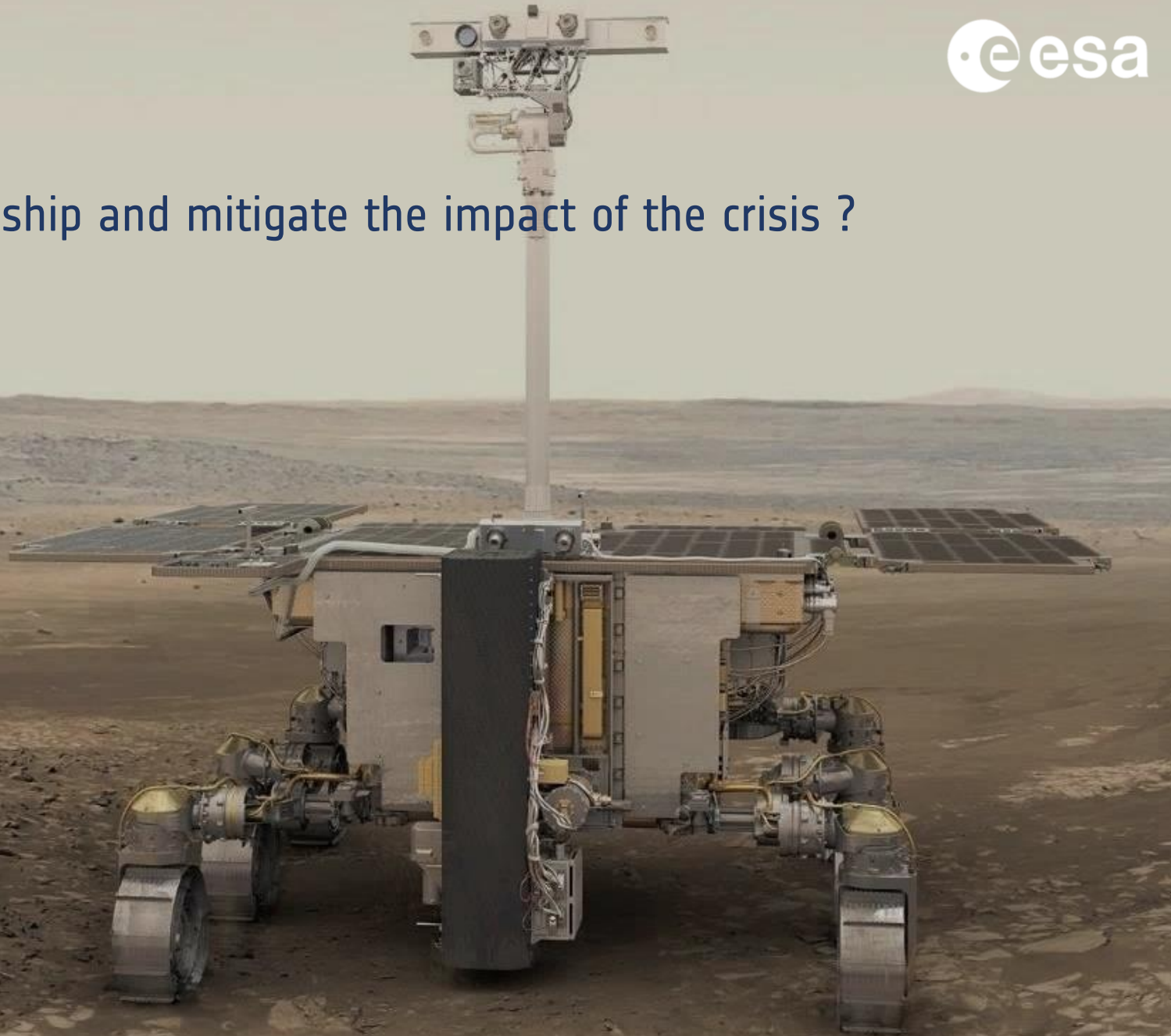
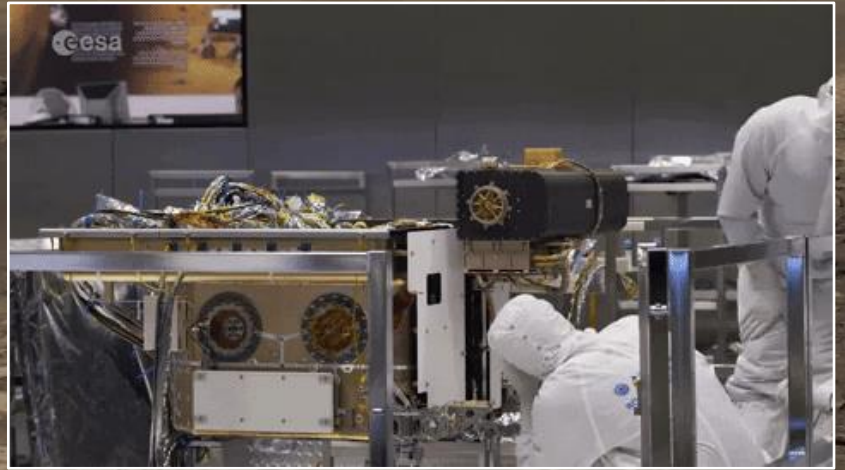


ESA / ExoMars / TAS-I / Airbus / Max Alexander



Not Yet At The Red Planet

A challenge:
should we recover Europe's science flagship and mitigate the impact of the crisis ?

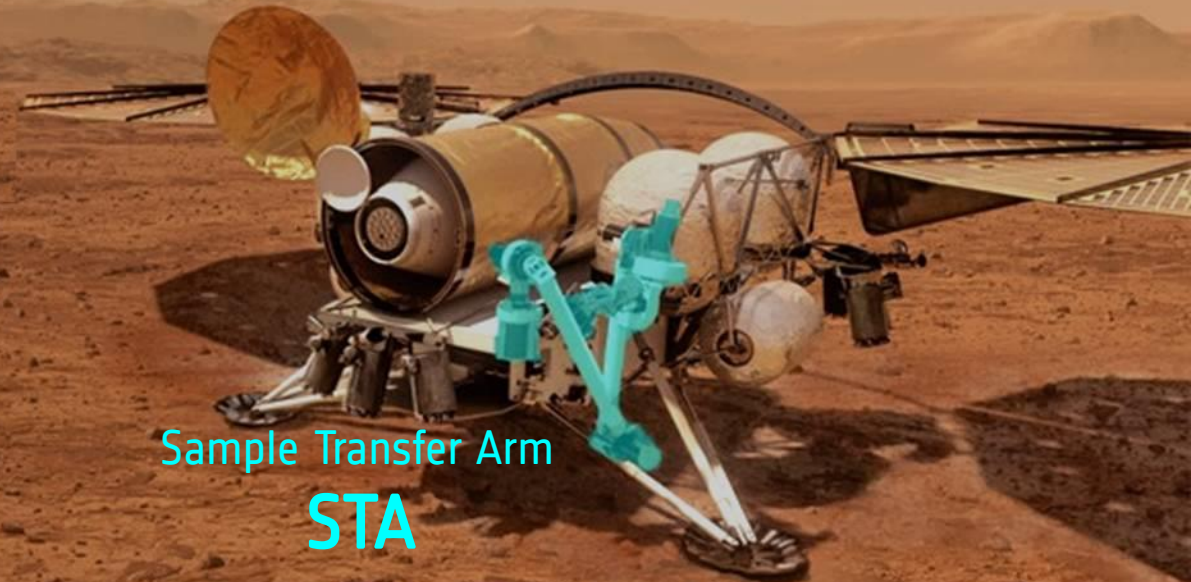
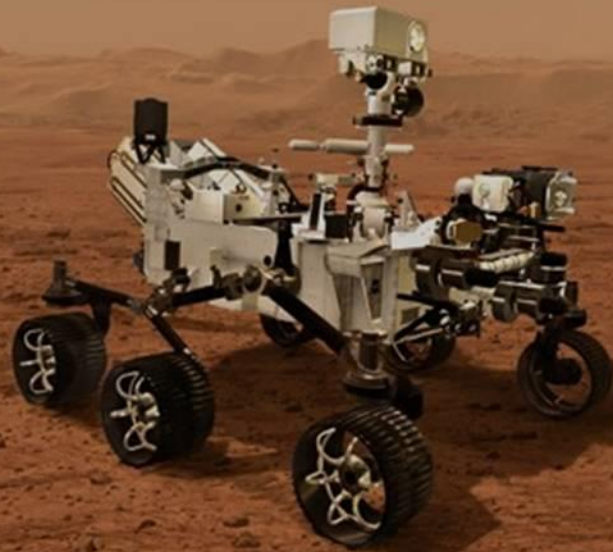


Bringing The Red Planet Back To Earth

Mars Sample Return

Returning scientific 'treasure' in partnership with NASA

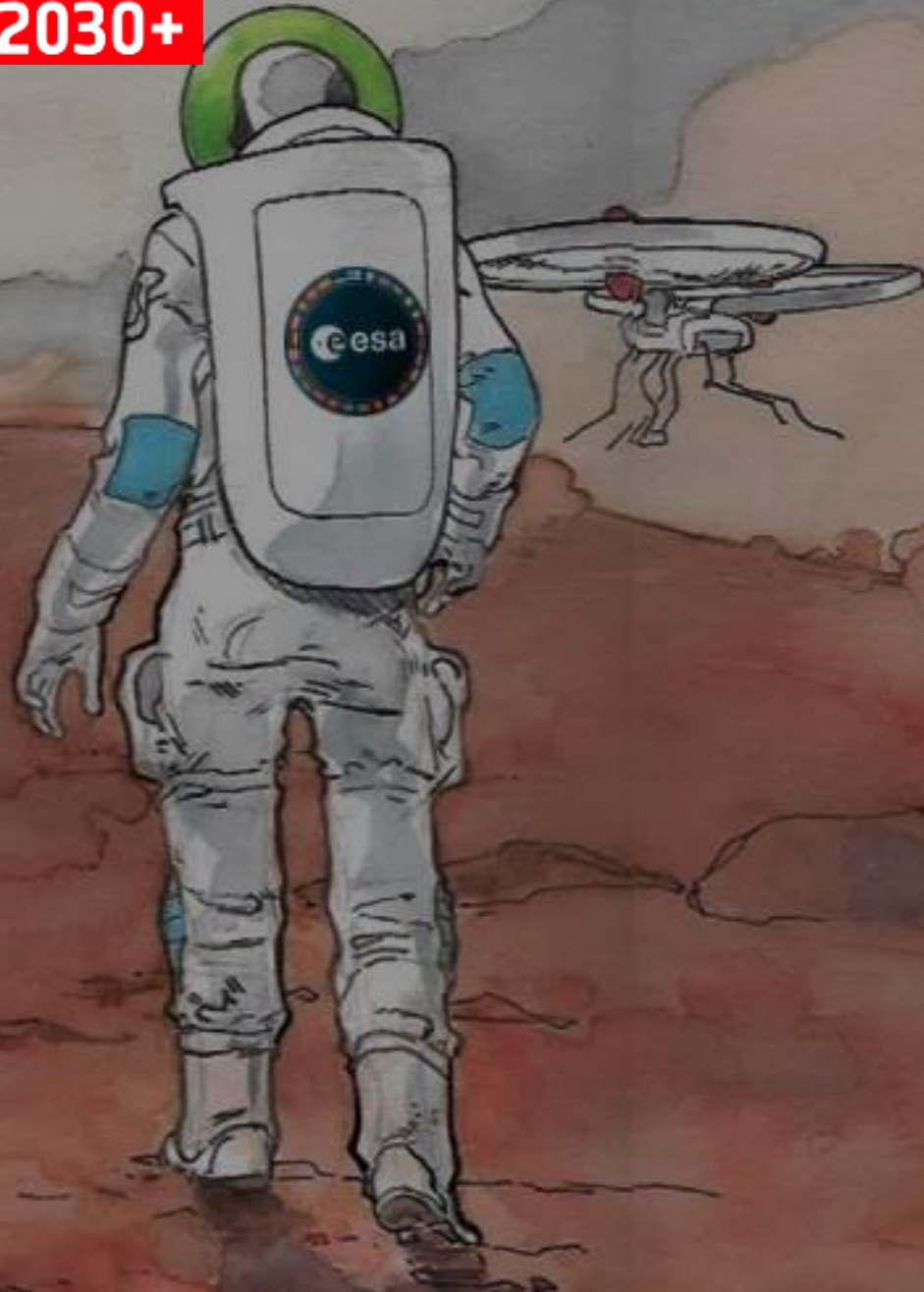
YOU ARE HERE



Sample Transfer Arm
STA

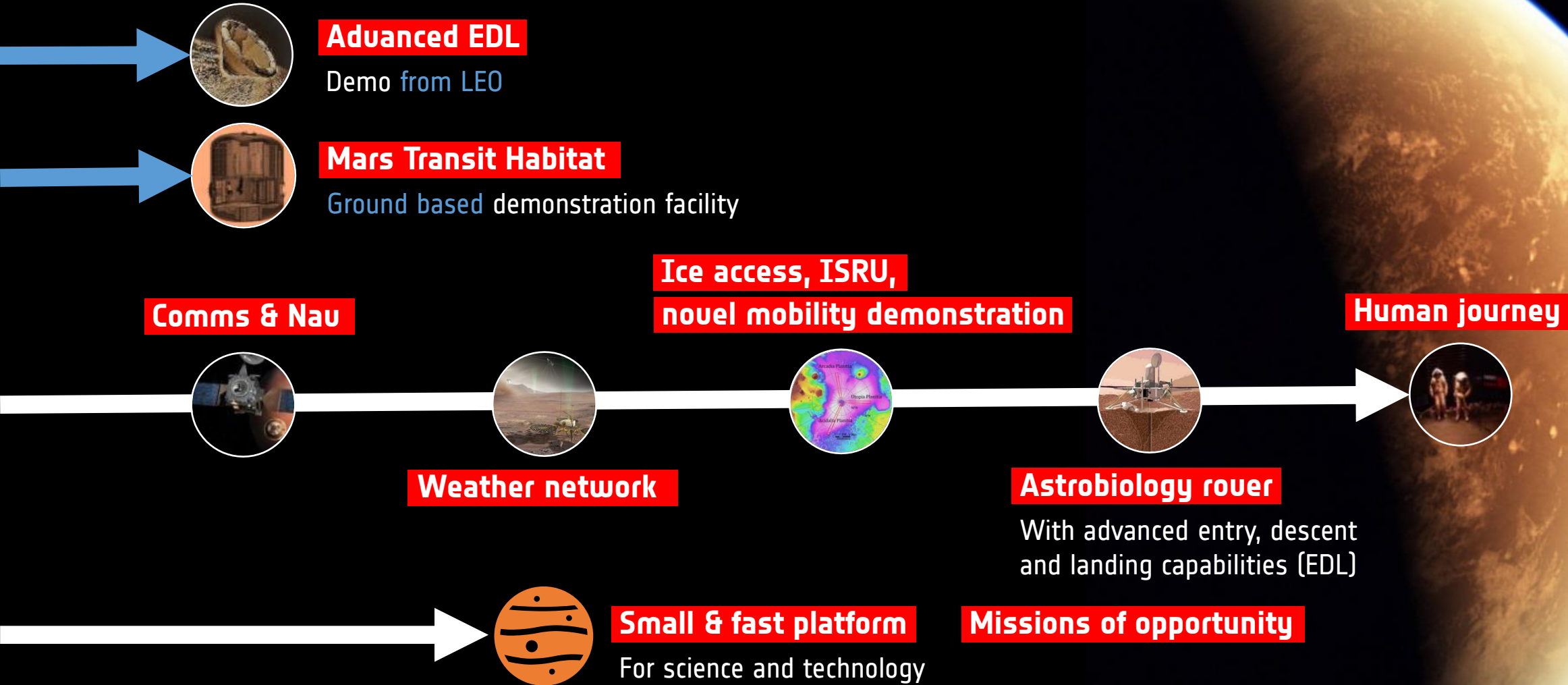


Mars



- Robotic missions to consolidate key capabilities:
 - Continue the search for life
 - Secure Europe's autonomous capabilities at Mars
- Possible campaign of small fast-track ESA-led missions
- In synergy with LEO and Moon, position Europe for a strong contribution to the Human journey in the 2040s

Long-term Strategy @Mars



TERRAE NOVAE 2030+



Fly Me To Mars

YOU ARE HERE —●



ESA astronauts ?

TERRAE NOVAE 2030+



ExPeRT: Preparing an exciting future



Exploration Preparation, Research and Technology: ExPeRT

ExPeRT prepares Europe's future exploration missions to low Earth orbit, Moon and Mars using visionary studies and pioneering technology



Zero-km Space Resources

True 'ground-breaking' research – can future lunar explorers use oxygen from lunar rock instead of bringing it from Earth ?



'ExPeRTs' at work



ESA Concurrent Design Session
Inventing the future through teamwork

ExPeRT technologies

Propulsion
In-Situ Manufacturing
Novel Energy Systems
Artificial Intelligence
Life Support Systems

Robotics & Mechanisms
Crew Health
Space Resources
Radiation Protection
Communications

Science instrumentation
Guidance, Navigation and Control
Avionics
Re-entry Technologies



Demonstrated Benefits At A Glance



Green and digital innovation and commercialisation

Investments fuelling economic activity & creating and supporting high-value jobs

Competitiveness maximising quality and global market share, strengthening European strategic autonomy in space

ISS cooling technologies used in maritime and energy sectors with 180 M€ in orders in two years, reducing CO₂ emissions

Terrae Novae direct economic impact of 5.4 B€ in E3P period 2

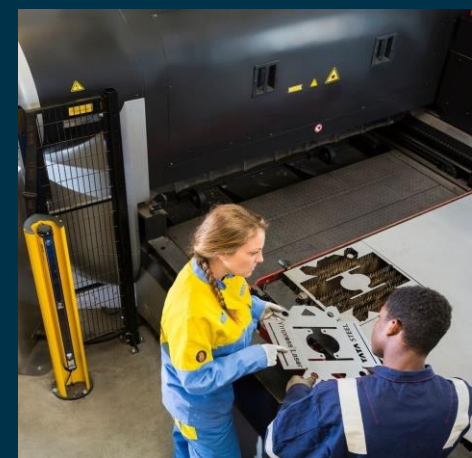
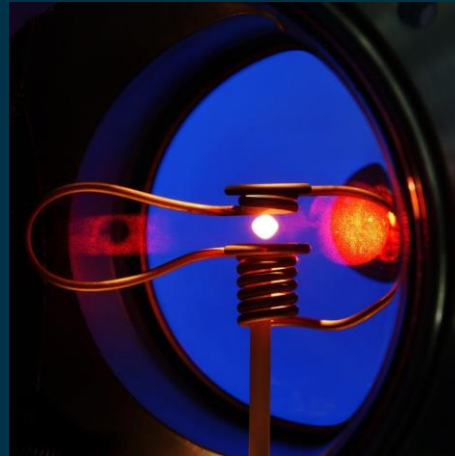
European technological leadership and unique capabilities in selected segments





Metallurgy Research in Microgravity

Reducing steel production scrap rates and manufacturing costs benefitting construction, automotive, white goods, food & canning





Biofacades in Paris

Closed-loop urban farming for the city of Amsterdam



CM22 Launches Europe's New Era Of Space Exploration



Extend ISS operations until 2030

New science benefits

New generation of astronauts

First astronaut with disability

Promote commercial exploration services

Prepare future science, missions & technology

ExoMars Trace Gas Orbiter

Deliver Mars science & communications

Argonaut (EL3)

Build Europe's ride to the Moon

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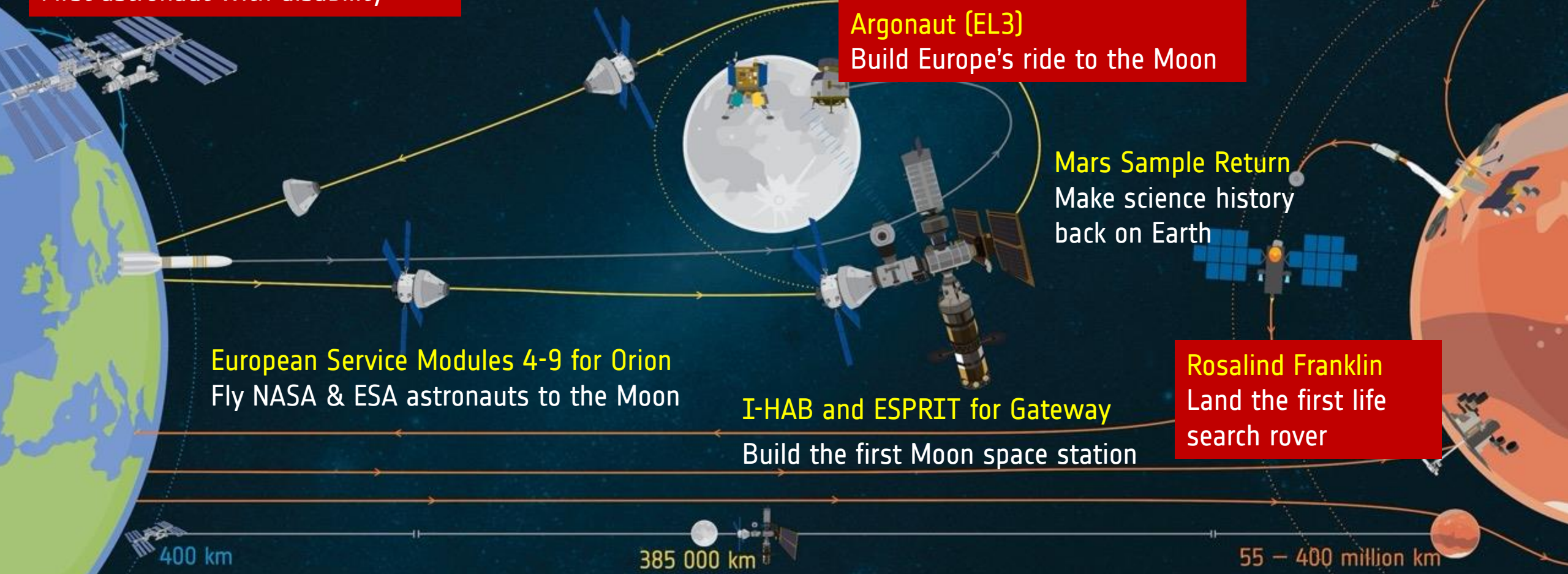
Fly NASA & ESA astronauts to the Moon

I-HAB and ESPRIT for Gateway

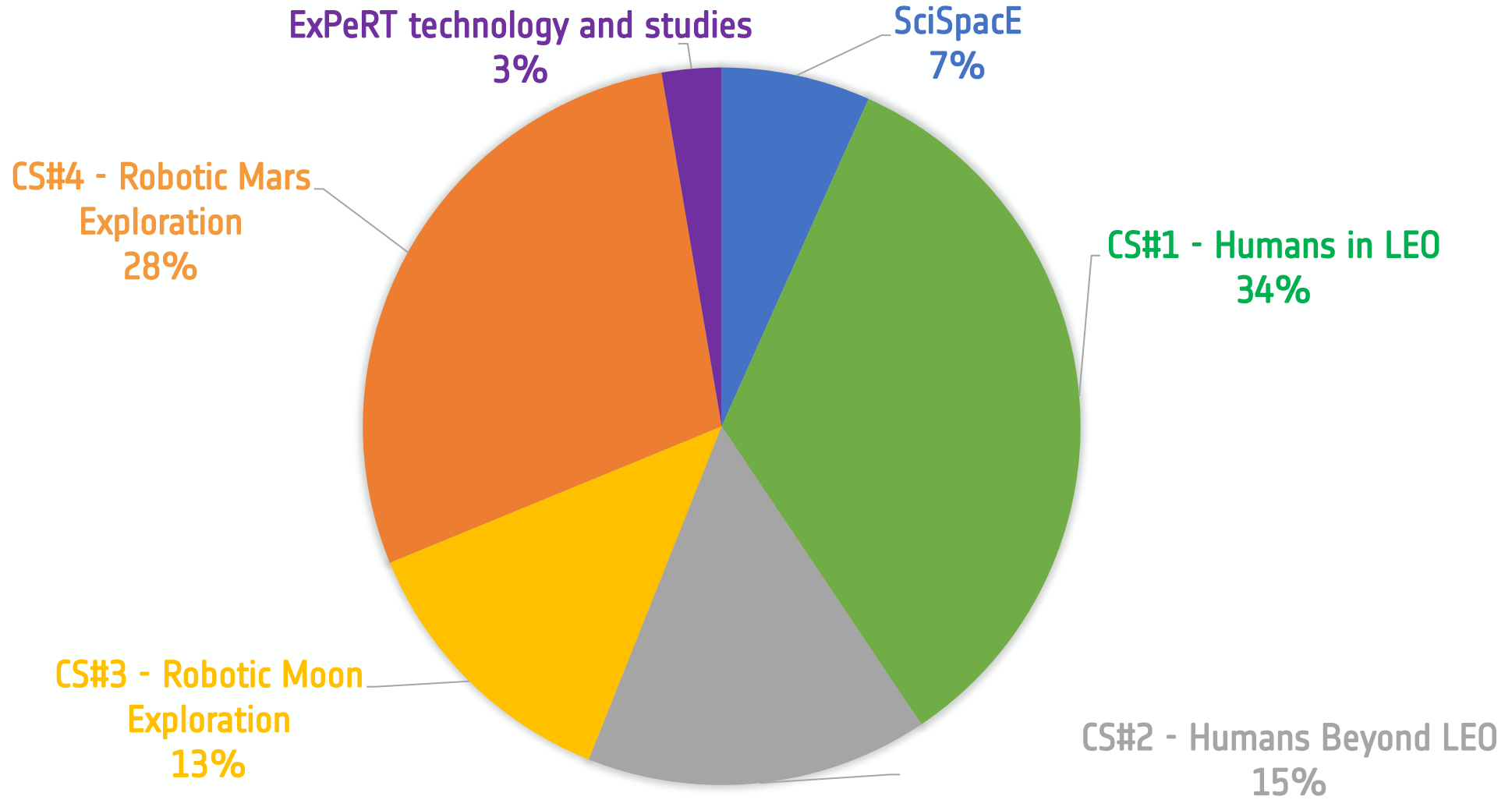
Build the first Moon space station

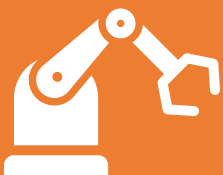
Rosalind Franklin

Land the first life search rover



Distribution of proposed funding of 2980 Meuro at CM22





TERRAE NOVAE

Benefits for Europe today



Terrae Novae actors (E3P period 2)



22
states



408
companies
contracted



95 research
organisations
contracted



4 commercial
services

ISS science and cooperation*



15 international partners
243 individuals from **19** countries visited the ISS
3000+ research investigations in **108** countries
4100+ ESA **SciSpacE** experiments
6400+ publications since '72
1900+ European researchers on ISS



*September 2021 status

E3P2 economic impact*



5.4B euro
direct
economic
impact



each **1 euro**
E3P invests
creates
3 euro impact



each **1 job sustained** by
E3P creates additional **2 jobs**
in the space and wider
economy

*Source: 2019 open university study

Terrae Novae inspiration

65K+ Mission X
participants/year*



22K+ astronaut
applications



410M+ ESA ISS
tracker views since '14

41K+ teachers trained/year*
& **1.4M+** pupils and
students reached/year* –
educational kits,



hands-on projects
& university lectures

2.8M+ Thomas
Pesquet followers on
facebook



*average 2018-2020



TERRAE NOVAE



Europe's journey into tomorrow ... begins at CM22



TERRAE NOVAE 2030+



An ambitious perspective
for the current and next generations



