
esa
E3P Period 2
Update
September 2019
David Parker & HRE team
Space19
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European Space Agency

# European Exploration Envelope Programme

## E3P Period 1 (2016-2019)

*Recent update*

# BEYOND Mission - Launch

- Successful launch on July 20th, 2019 from Baikonur

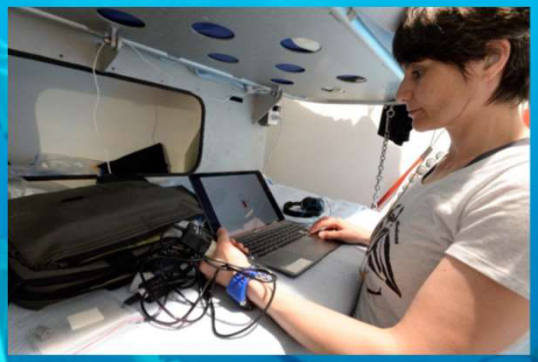
# BEYOND Mission - AMS

- The Alpha Magnetic Spectrometer (AMS) will be repaired over 5 EVAs in November 2019.
- Luca is planned to participate in all EVAs.

# Training for first United Arab Emirates Astronaut

- UAE Prime and Back-Up Astronauts trained at EAC on
  - Columbus Systems
  - Payloads
  - Education
- ESA support to UAE mission implementation and Flight Controllers training
- 4 ESA experiments selected for implementation

# NEEMO 2019



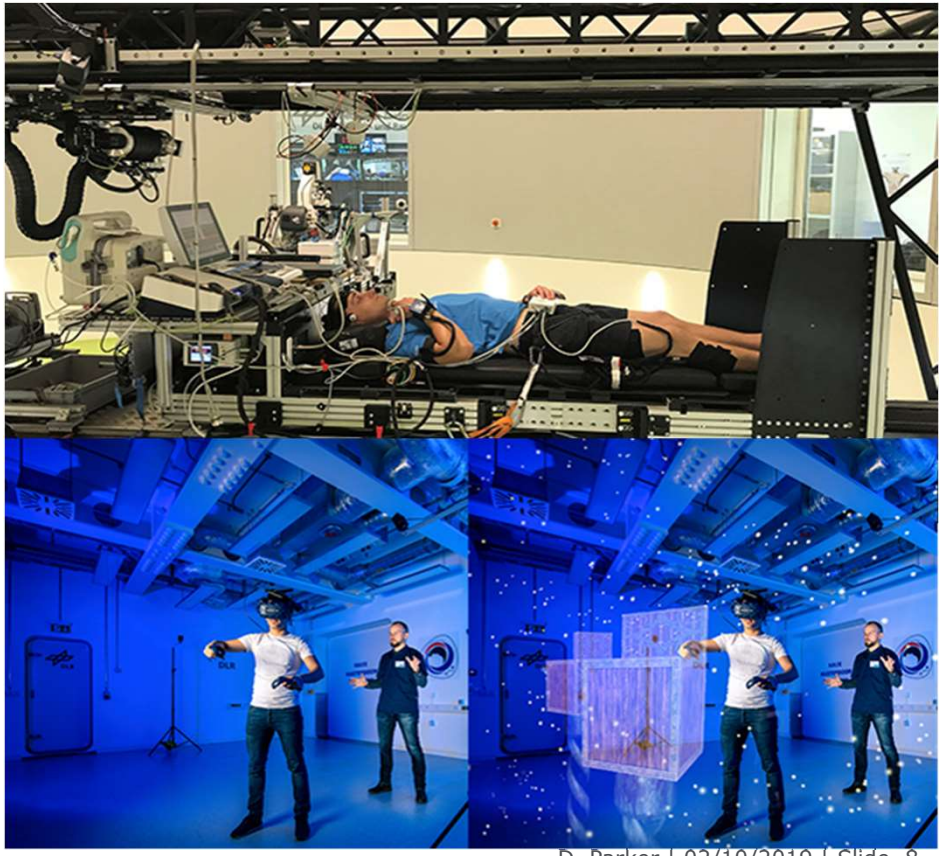
- ESA Astronaut S. Cristoforetti was NEEMO 23 Commander
- Scientific experiments
- Technology testing:
  - ESA Lunar Evacuation System
  - Geological tools & support trolley

# PANGAEA Norway

- Dry runs for a new session of PANGAEA, focusing on Moon highland rocks, at Lofoten, Norway, one of few & best locations in the world for visible outcrops of anorthosites
- PANGAEA offers a planetary geology course for astronauts
- Online course for engineers & ops personnel being developed

# ESA Research using bedrest model

- First campaign of ESA/NASA Bedrest “AGBRESA” study successfully completed in June 2019
- Second campaign started in September 2019



# ESA Research using Sounding Rockets

MASER-14:

- Launched successfully on June 24, 2019
- Two ESA Physical Sciences payloads:
  - XRMON-GF
  - ARLES

# ESM-1 in KSC

Orion vehicle for Artemis 1 mission

ESM1 mated to US Crew Module

Ready for system functional tests

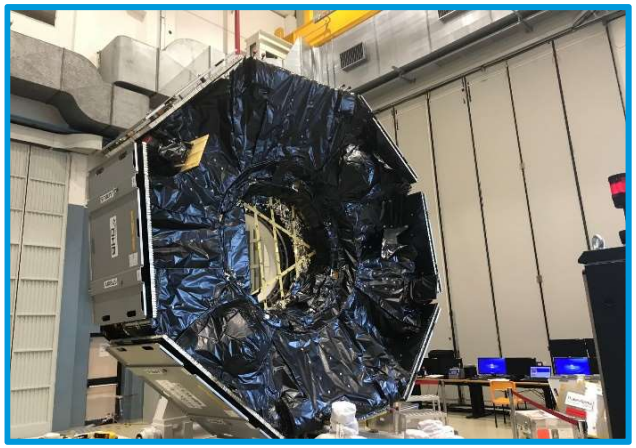
Engines test firings

# Status of ExoMars-2020: progress (1/2)

- ✓ Carrier and Descent Modules mated in TASinI
- ✓ The flight rover completed assembly at Airbus-UK and shipped for its environmental test campaign at Airbus-FR
- ✓ Integrated flight spacecraft was shipped to TASinF for environment test campaign.

Flight rover completed

Landing Platform completed



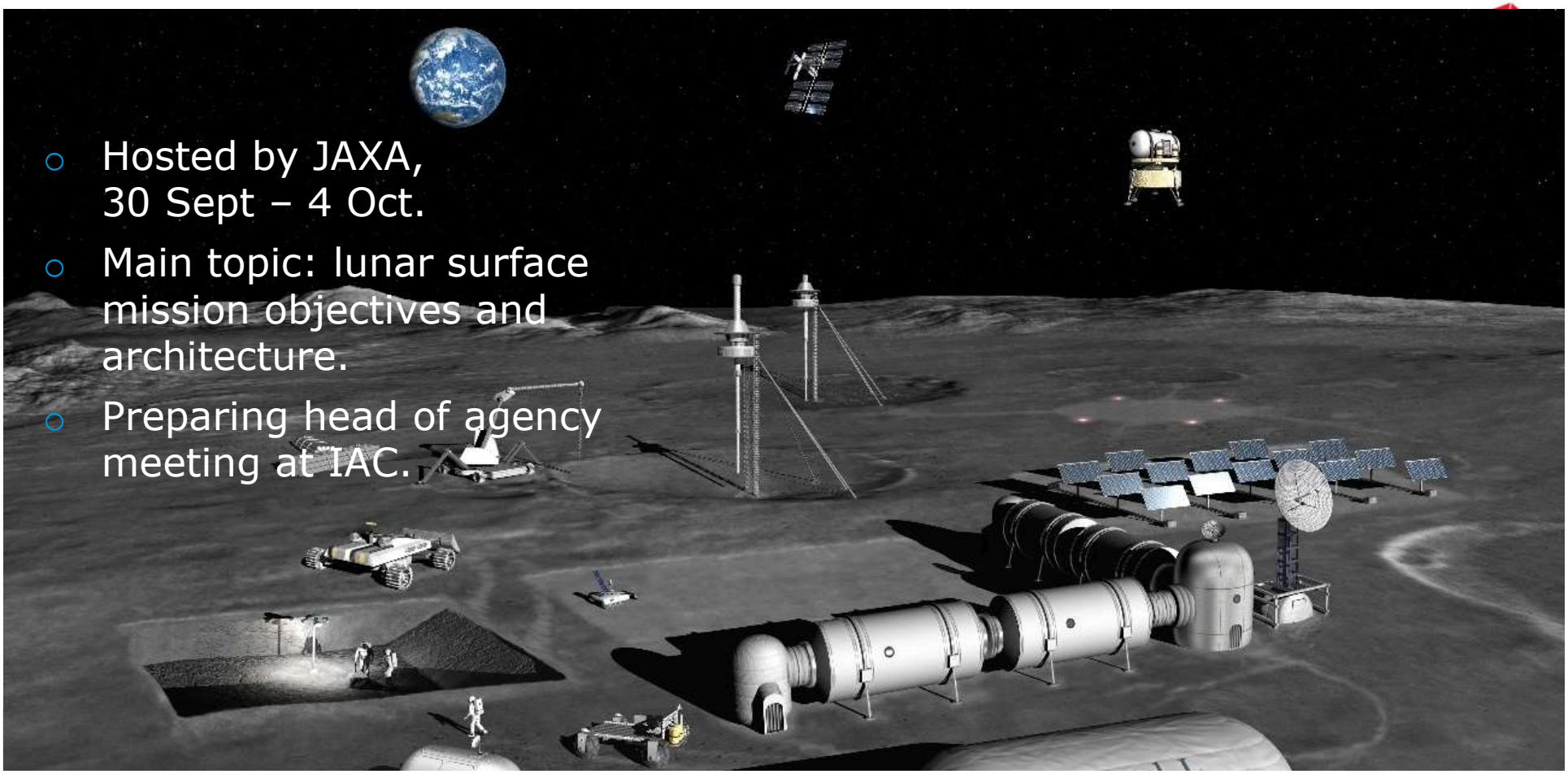
Carrier Module completed

# Status of Exomars-2020:progress (2/2)

Proto-Flight Model of the Descent Module (w/t heat shield) in ISO8 test facility

(TASinI)

# ISECG workshop & senior agency managers meeting

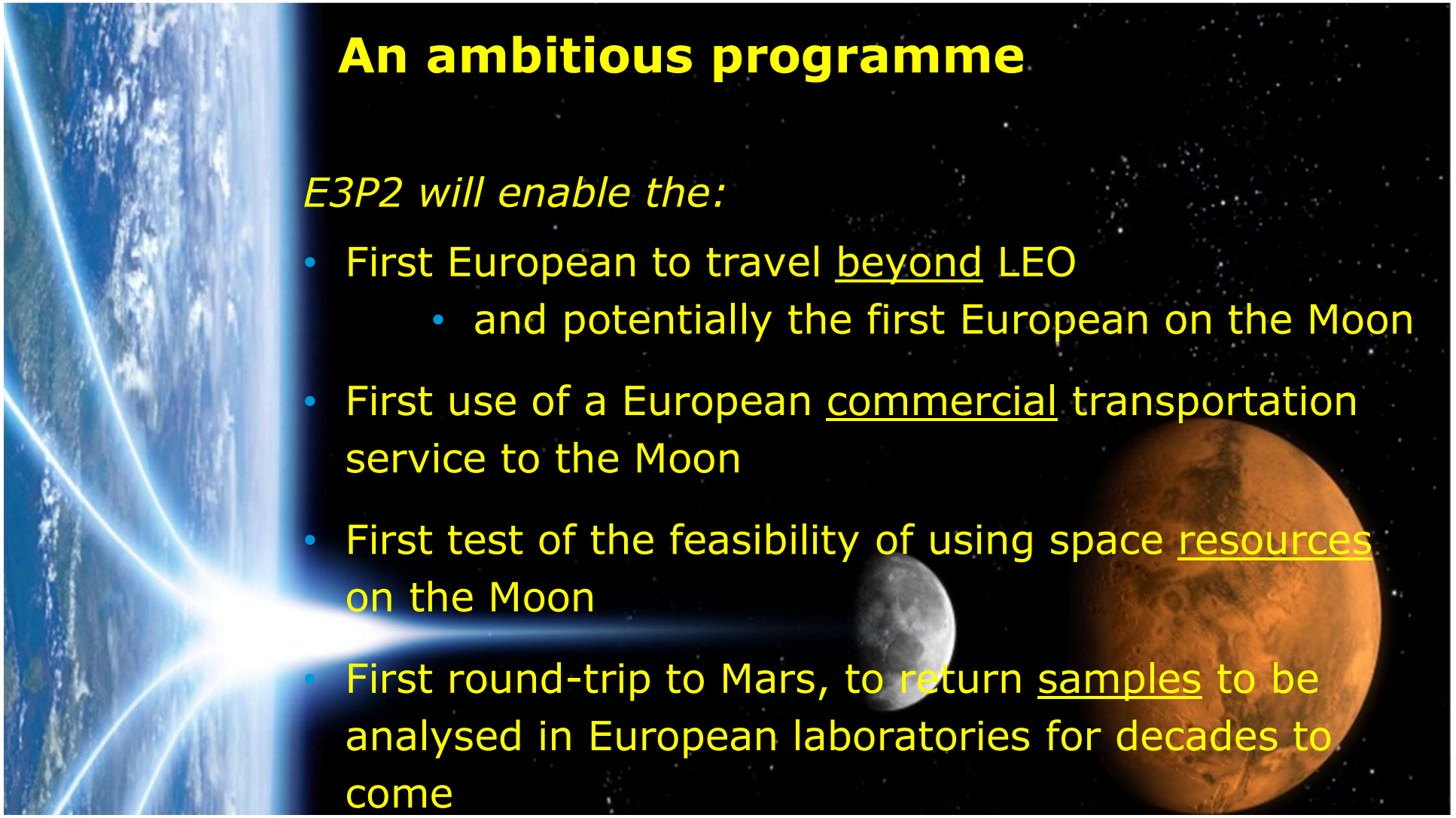


- Hosted by JAXA, 30 Sept – 4 Oct.
- Main topic: lunar surface mission objectives and architecture.
- Preparing head of agency meeting at IAC.

# European Exploration Envelope Programme

# Period 2 (2020-2022)

# Programme proposal update

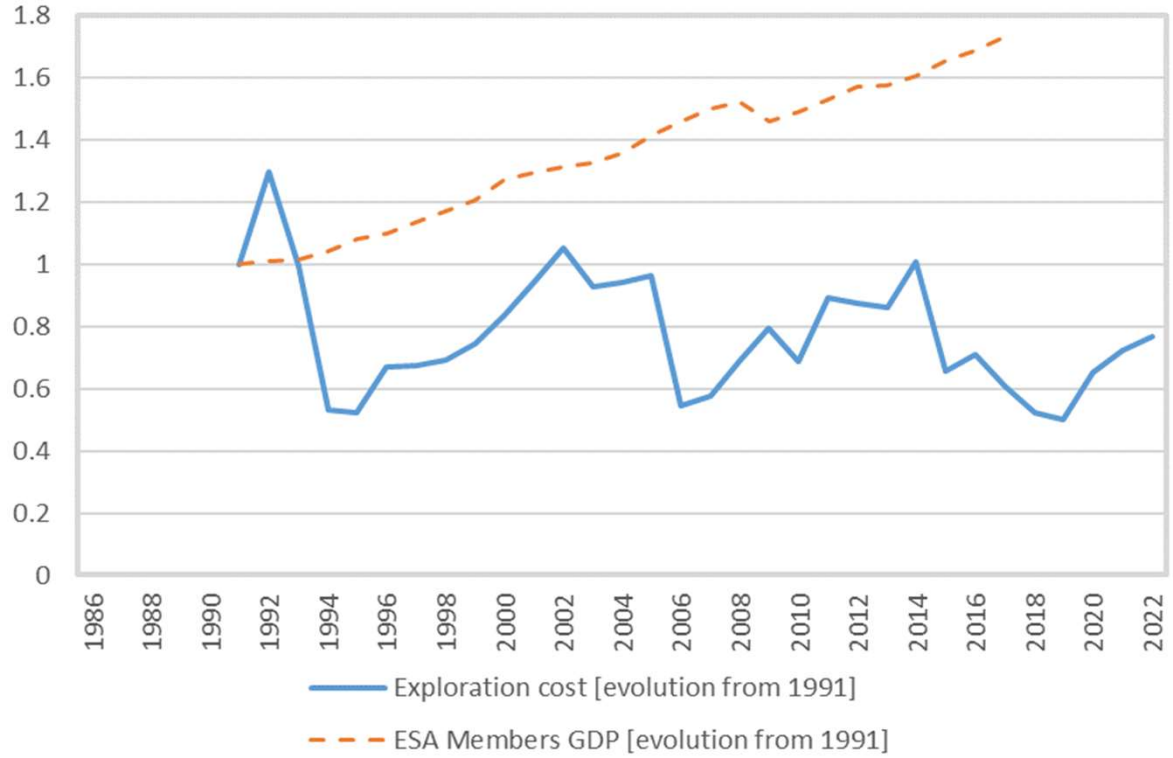


# An ambitious programme

*E3P2 will enable the:*

- First European to travel beyond LEO
  - and potentially the first European on the Moon
- First use of a European commercial transportation service to the Moon
- First test of the feasibility of using space resources on the Moon
- First round-trip to Mars, to return samples to be analysed in European laboratories for decades to come

# ESA Exploration Programme Cost versus GDP
## (2019 e.c.)

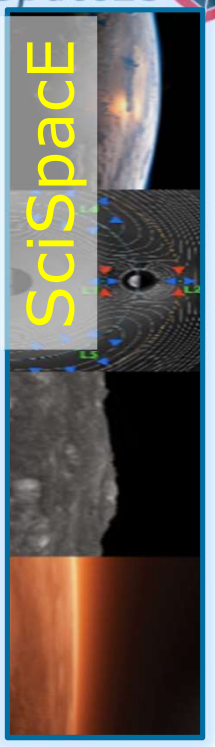


# Proposed programme is result of 2 year dialogue

## *6 Activities; 4 Cornerstone campaigns; 1 Programme*





# → HUMAN AND ROBOTIC EXPLORATION ECONOMIC IMPACT

esa

## E3P Period 2 projected 2020–2025

**Cornerstone 1**
Humans in Low Earth Orbit
- Budget invested in industry: 790
- GDP impact: 2460
- Total tax revenue for ESA countries: 640

**Cornerstone 2**
Humans Beyond Low Earth Orbit
- Budget invested in industry: 350
- GDP impact: 1100
- Total tax revenue for ESA countries: 280

**Cornerstone 3**
Lunar robotic
- Budget invested in industry: 150
- GDP impact: 450
- Total tax revenue for ESA countries: 120

**Cornerstone 4**
Mars robotic
- Budget invested in industry: 440
- GDP impact: 1370
- Total tax revenue for ESA countries: 350

Source: Open University

Figures in M€

**Each €1 ESA invests in industry creates €0.8 in tax revenue for ESA countries**


**Each €1 ESA invests in industry creates €3 in immediate economic impact**


#Space19plus

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# SciSpacE
# Expected experiments in E3P Period 2 and 3

| | Research in LEO (permanent ongoing) | | Deep Space and Moon Science | | Mars Science | |
|---|---|---|---|---|---|---|
| | Ground-based | On ISS | At the Gateway | At the Moon | On ExoMars | From MSR |
| **E3P2** | 200 | 110 | 1 | 1-2 | 500 scientists | None* |
| **2023-25** | 200 | 110 | 3-5 | 5-10 | --- | None* |

*European experiments on NASA Mars 2020, not funded via ESA

# Cornerstone 1: Humans in LEO

## Research in Low Earth Orbit benefiting Earth

# Main deliverables in CS#1 – Humans in LEO

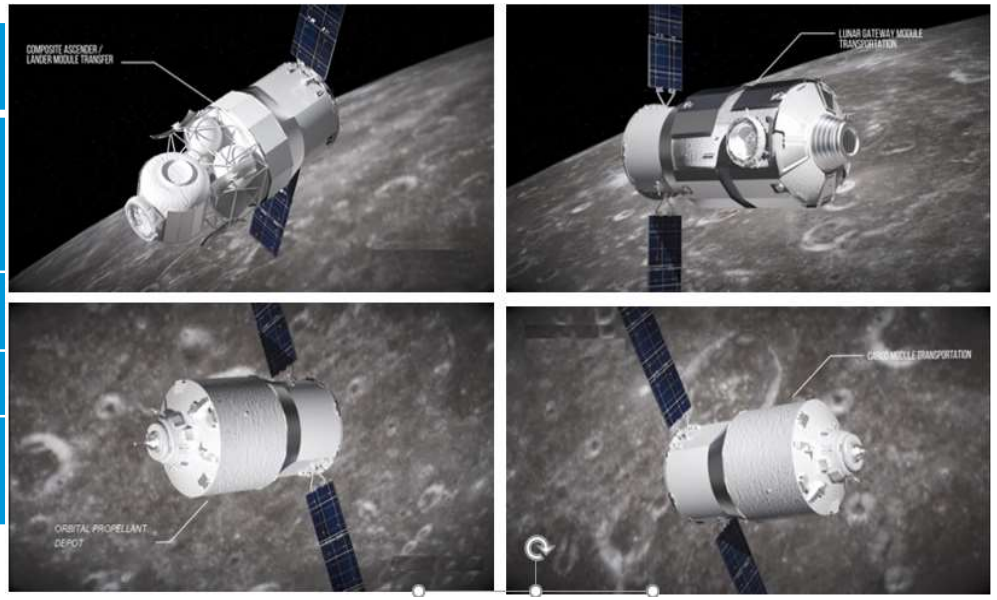
| Activity | Expected deliverable |
|---|---|
| **Columbus 2030** | Inflight and ground infrastructure upgrades<br>Continued operations |
| **Astronauts flights** | Three astronaut flights<br>(medium to long duration) |
| **Resources acquisition/utilisation on ISS** | upload mass<br>download mass<br>crew time |
| **Commercial utilisation** | Delivery and installation of Bartolomeo<br>First experiments of Bioreactor Express<br>First use of Teldasat services<br>Additional ICE Cubes |

# Cornerstone 2: Humans Beyond LEO

## We are already in the game

# Main deliverables in CS#2 – Humans beyond LEO

| Activity |
| --- |
| ESMs |
| ESPRIT |
| I-HAB |
| Cis-Lunar transfer vehicle (CLTV) |



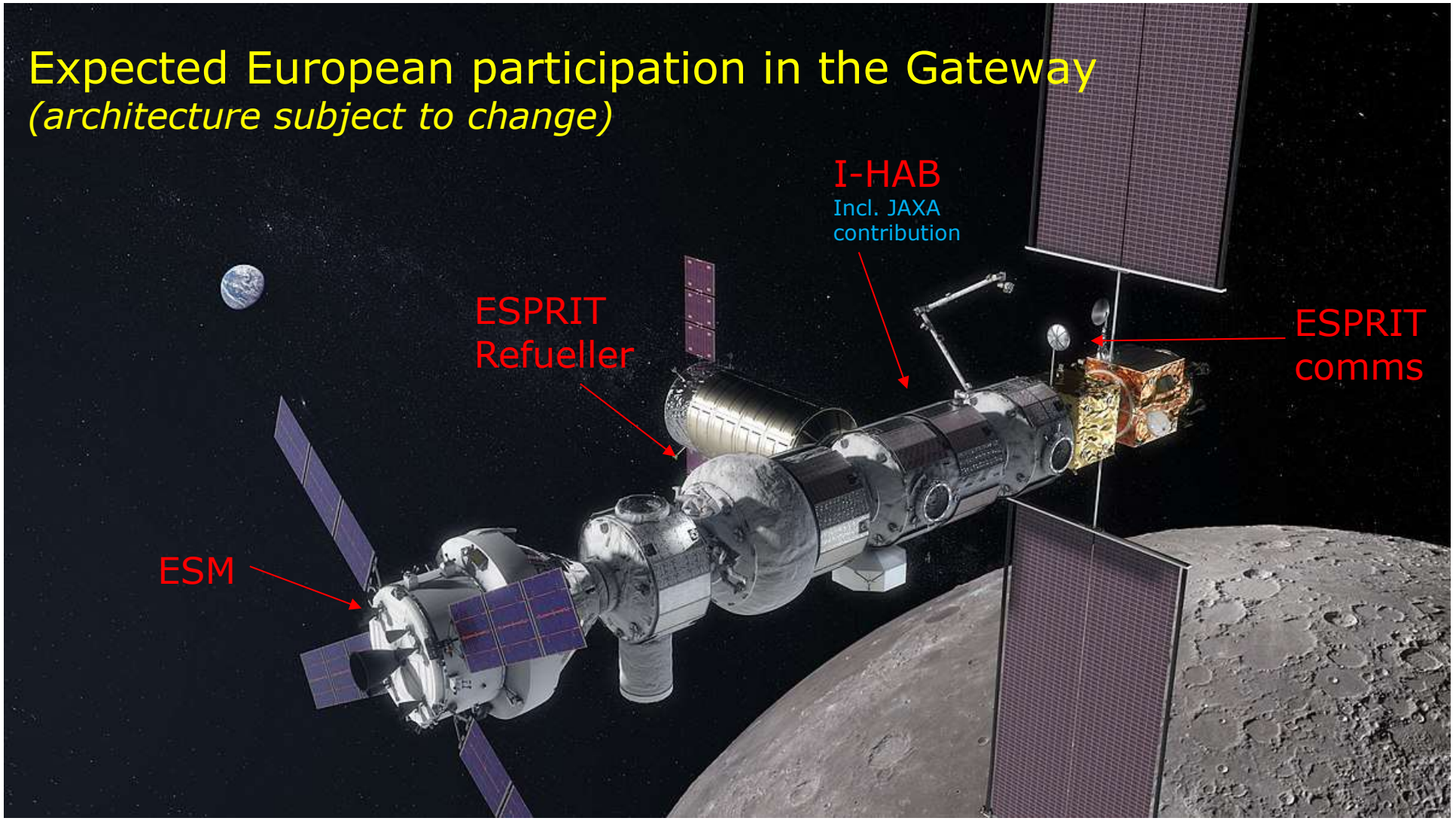

Courtesy ADS

# Tentative ESM delivery timeline

| ESMs | ESM1 | ESM2 | ESM3 | ESM4 | ESM5 | ESM6 |
|---|---|---|---|---|---|---|
| **Delivery date to NASA/KSC** | 2018 | 2020 | 2022 | 2023 | 2024 | 2025 |
| **Launch date** | 2021 | 2022 | 2024 | 2025 | 2026 | 2027 |
| **Orion mission objectives** | 1st uncrewed mission | 1st crewed mission | First Artemis landing | Second Artemis landing | TBD | TBD |

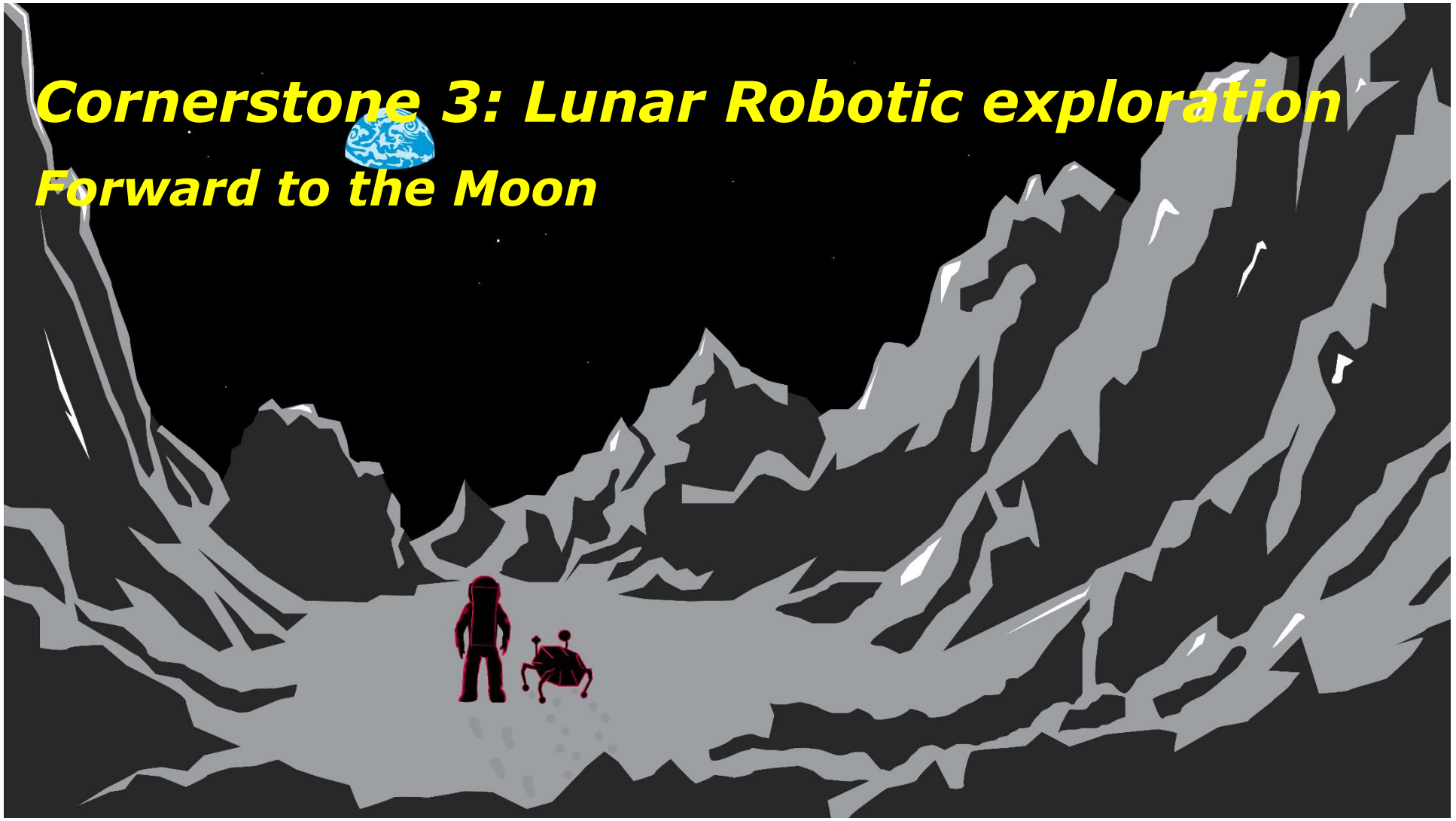
# Expected European participation in the Gateway

*(architecture subject to change)*



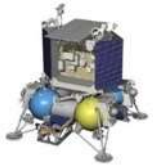
# Cornerstone 3: Lunar Robotic exploration

## Forward to the Moon



# CS #3 - Four Theme Robotic Lunar Campaign

*CLPS Lander*



*Lunar Resource Lander*

Opportunity science & technology missions

*Mission Phase A/B1/B2*

European Large Logistics Lander

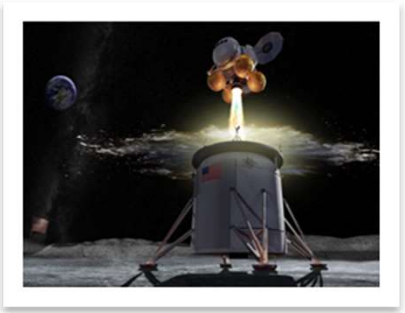
*Lunar Pathfinder comsat*

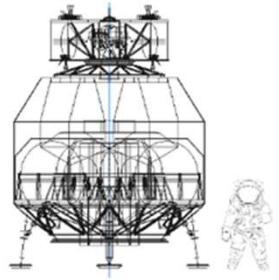
Commercial Lunar products and services

*Payload Phase B1/B2*

Space Resources Campaign

Period 2 (2020-22) | Period 3 (2023-25) | Period 4 (2026-28)





# Main activities in CS#3 (1/2)

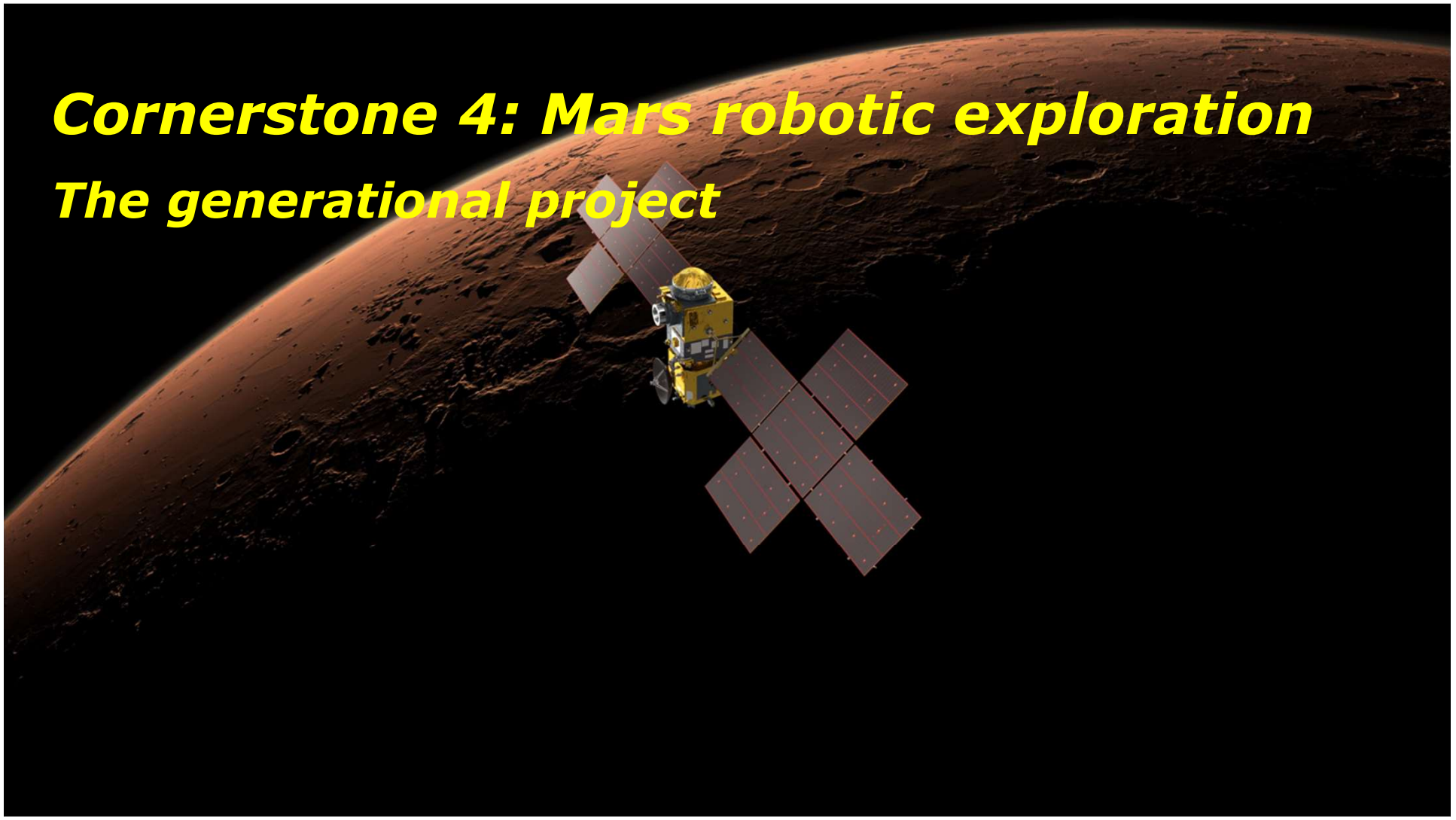
| Activity | Sub-activity |
|---|---|
| **PILOT/ PROSPECT** | Completion & operation of PILOT and PROSPECT for Luna-27 |
| **Lunar Science & technology missions of opportunity** | Build, fly, operate payloads selected in 2019, and for Chang'e 6; Build future payloads for Period 3 implementation |
| | International Lunar Science and Research Team; Support to ground-based sample analysis |
| | International Lunar Research Station Study (CNSA) |
| | Small lunar science mission Phase A/B1 x 2 |
| **Commercial Lunar Products and Services** | Implementation of Lunar Pathfinder Mission Service |
| | Lunar Communication and Navigation Service Phase B |
| | Maturation of critical payload technologies up to TRL 5 |

# Main activities in CS#3 (2/2)

| Activity | Sub-activity |
|---|---|
| **European Large Logistic Lander** | Phase A lunar cargo vehicle (2 parallel studies) |
| | Phase B1 definition (2 parallel studies) |
| | Critical technologies up to TRL 5 (GNC + propulsion) |
| | Phase B2 schedule protection |
| **Space Resources (ISRU)** | European Innovation Centre for Space Resources |
| | Study of ISRU applications to future missions |
| | Phase B1 of ISRU demonstration payload(s) |
| | Phase B2 of ISRU payload ; technology de-risking |

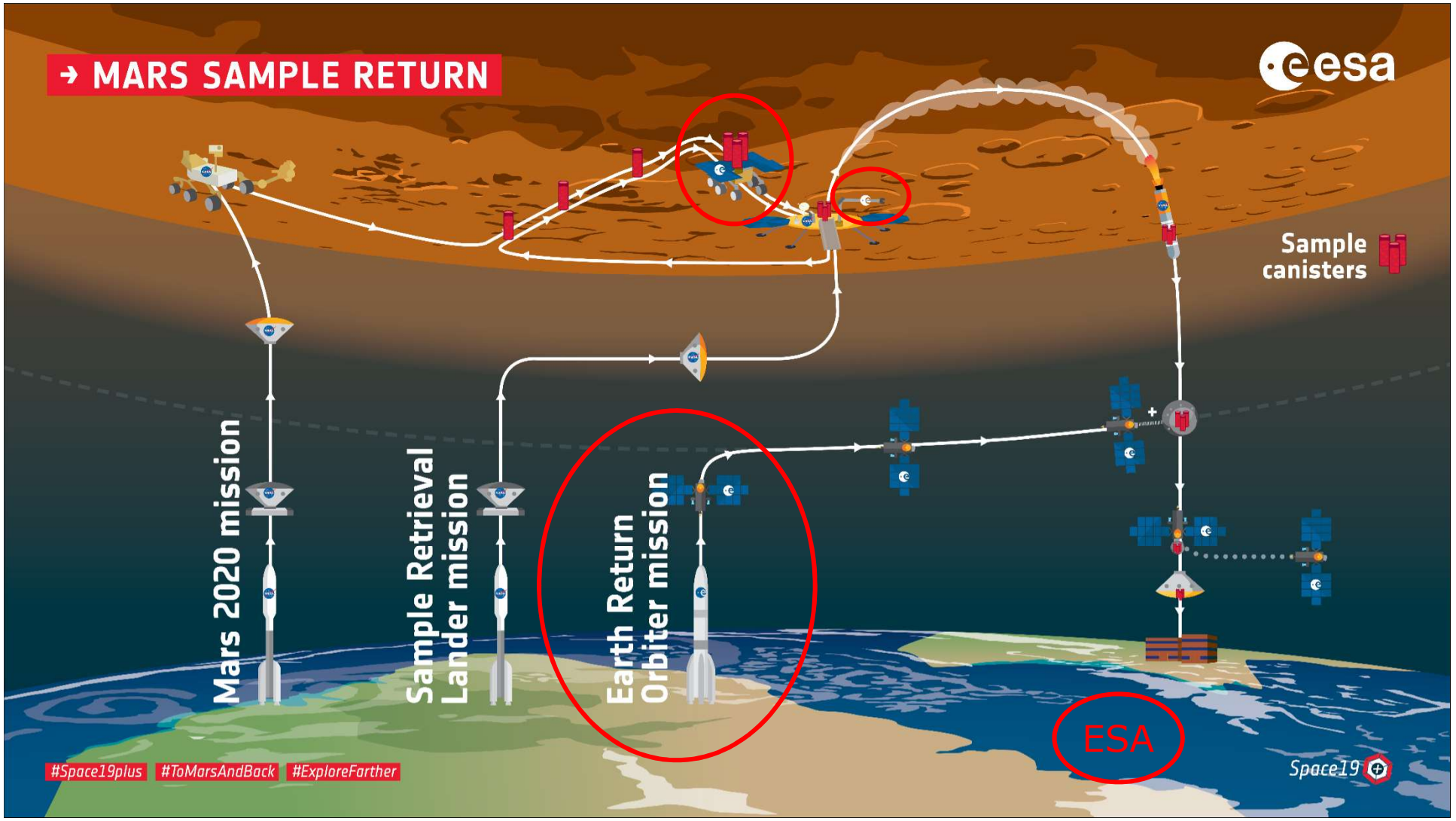
# Cornerstone 4: Mars robotic exploration

## The generational project



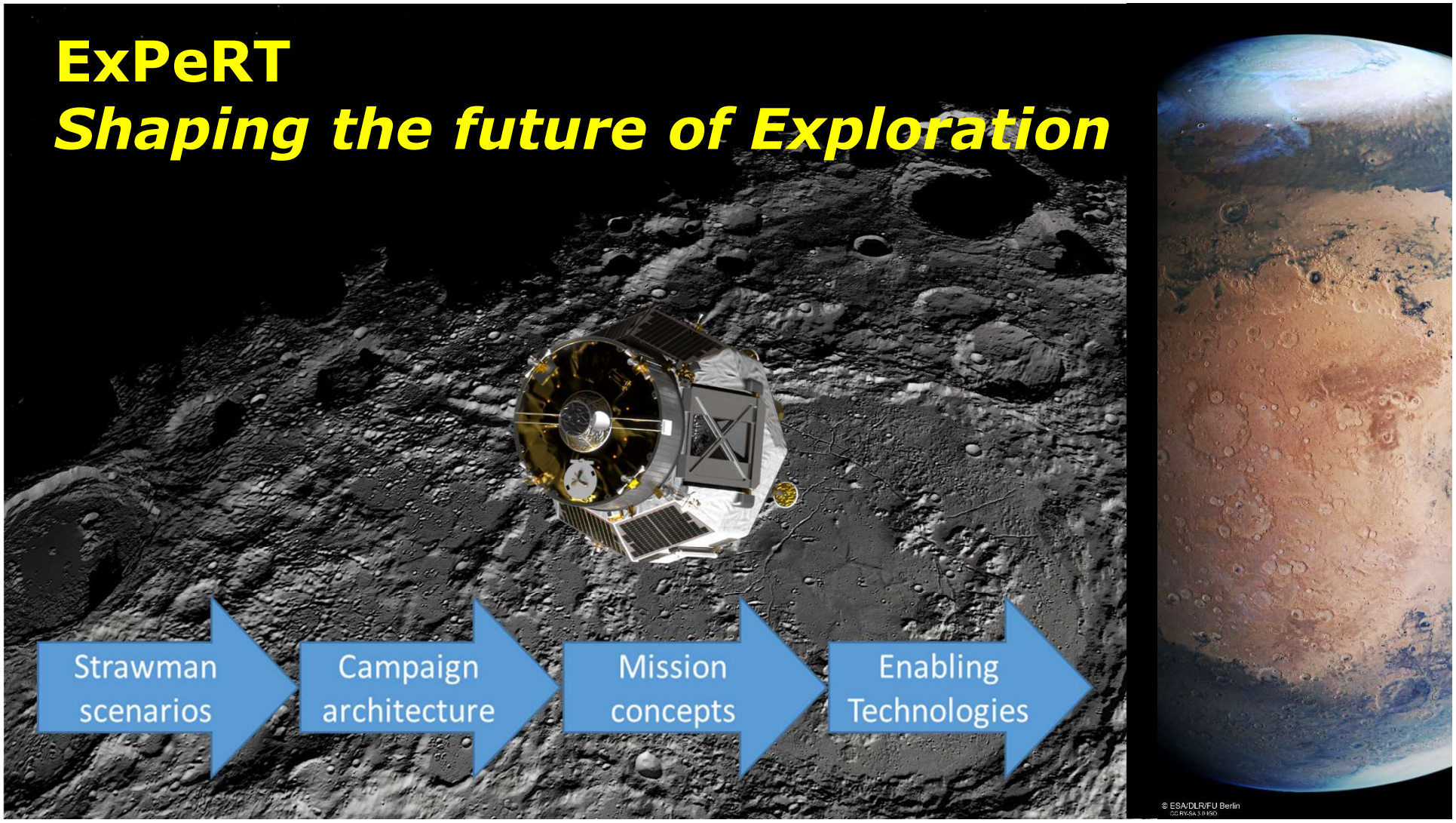
# Main deliverables in CS#4 – Mars robotic exploration

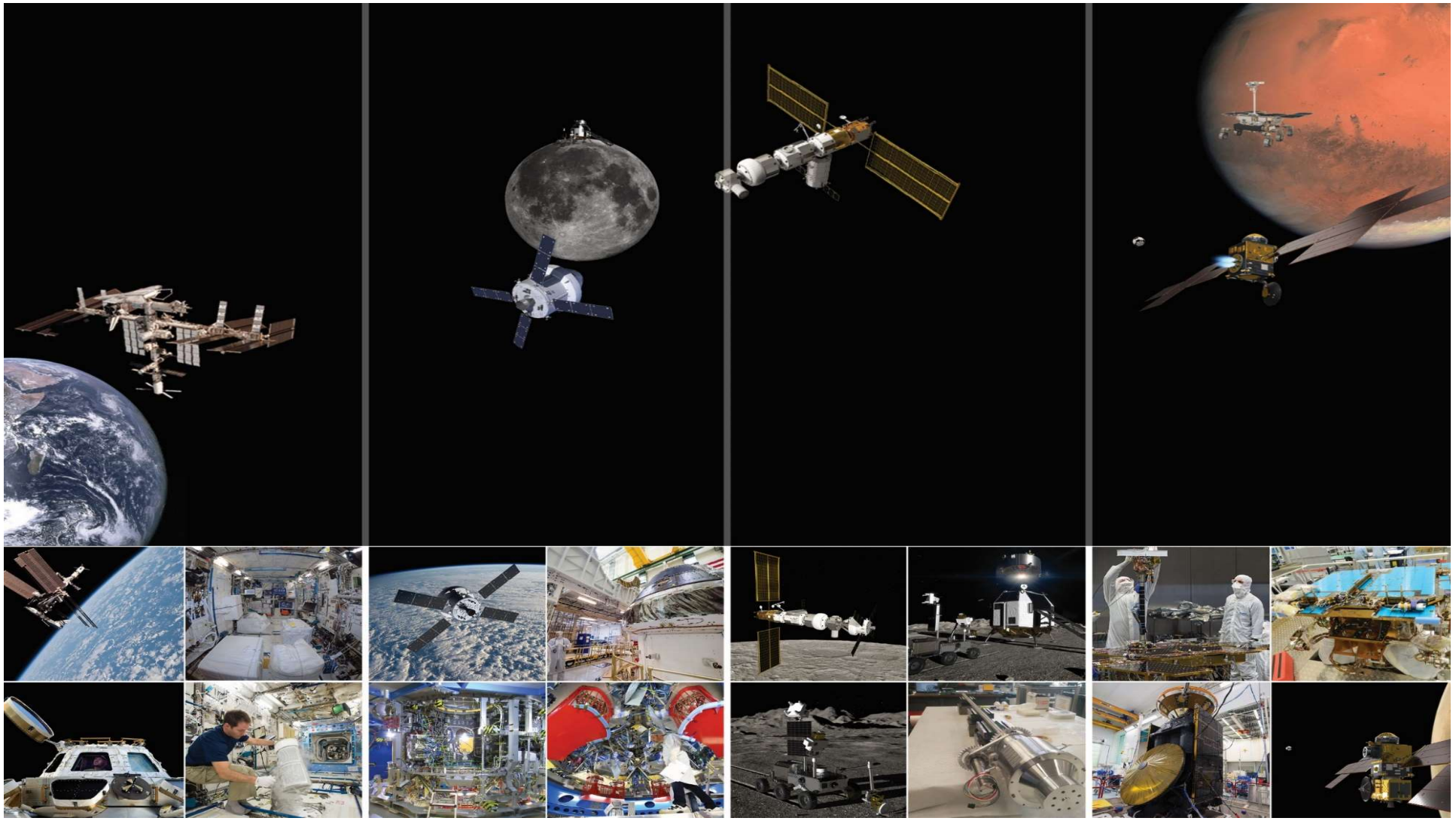
| Activity | Expected deliverable |
|---|---|
| **ExoMars 2016** | TGO mission extension |
| **ExoMars 2020** | Rover and landing systems |
| | Launch, landing and first scientific results |
| **Earth Return Orbiter ERO** | Breadboards and engineering models of critical units, e.g. ion propulsion system, solar arrays, rendezvous cameras |
| **Sample Fetch Rover SFR** | Key subsystem breadboards, e.g. locomotion system, integrated avionics, tube acquisition system. |
| **Sample Transfer Arm STA** | Breadboard of arm system<br>Engineering model |

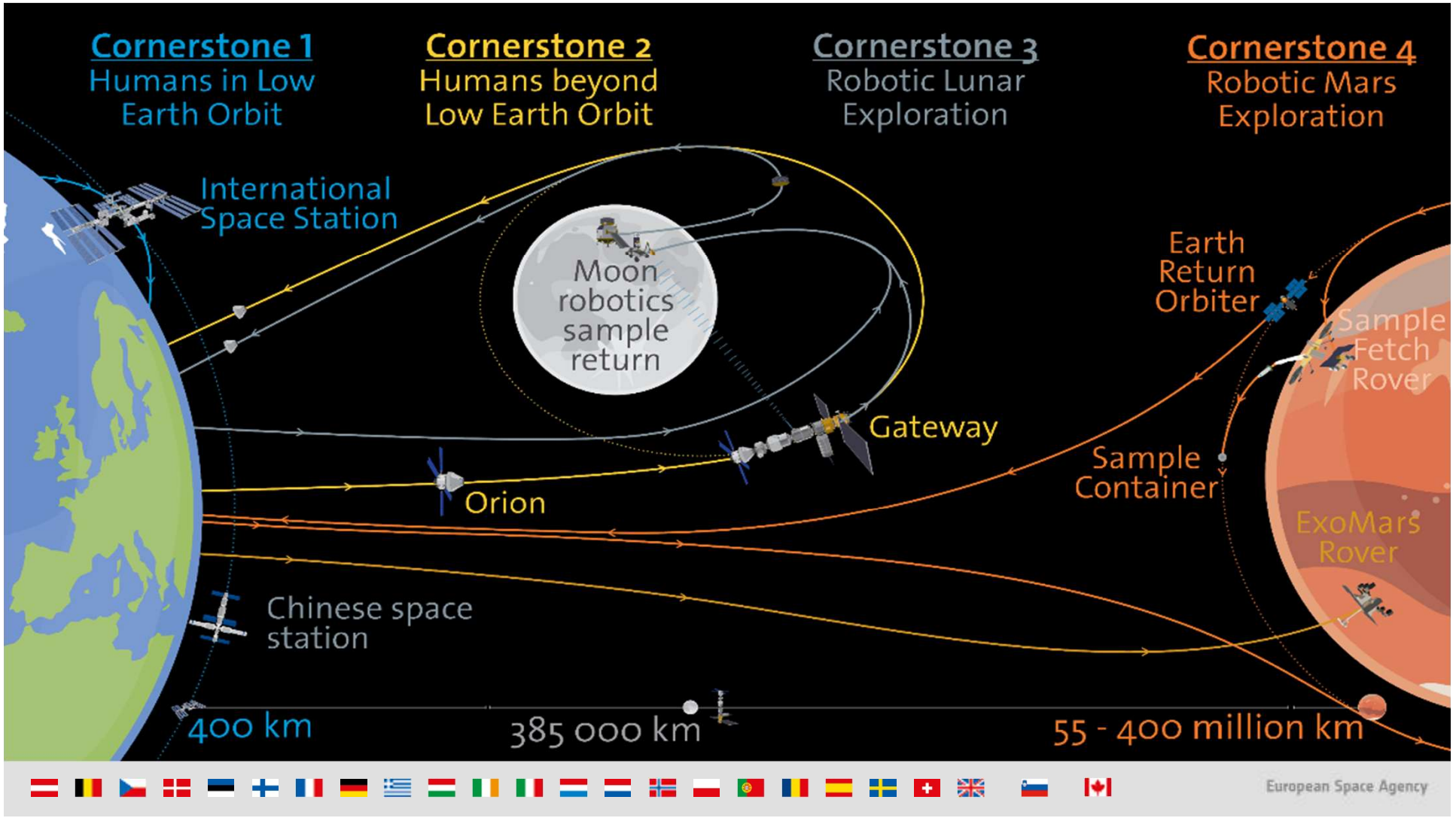

→ MARS SAMPLE RETURN
esa
Sample canisters
Mars 2020 mission
Sample Retrieval Lander mission
Earth Return Orbiter mission
ESA
#Space19plus
#ToMarsAndBack
#ExploreFarther
Space19+

# ExPeRT

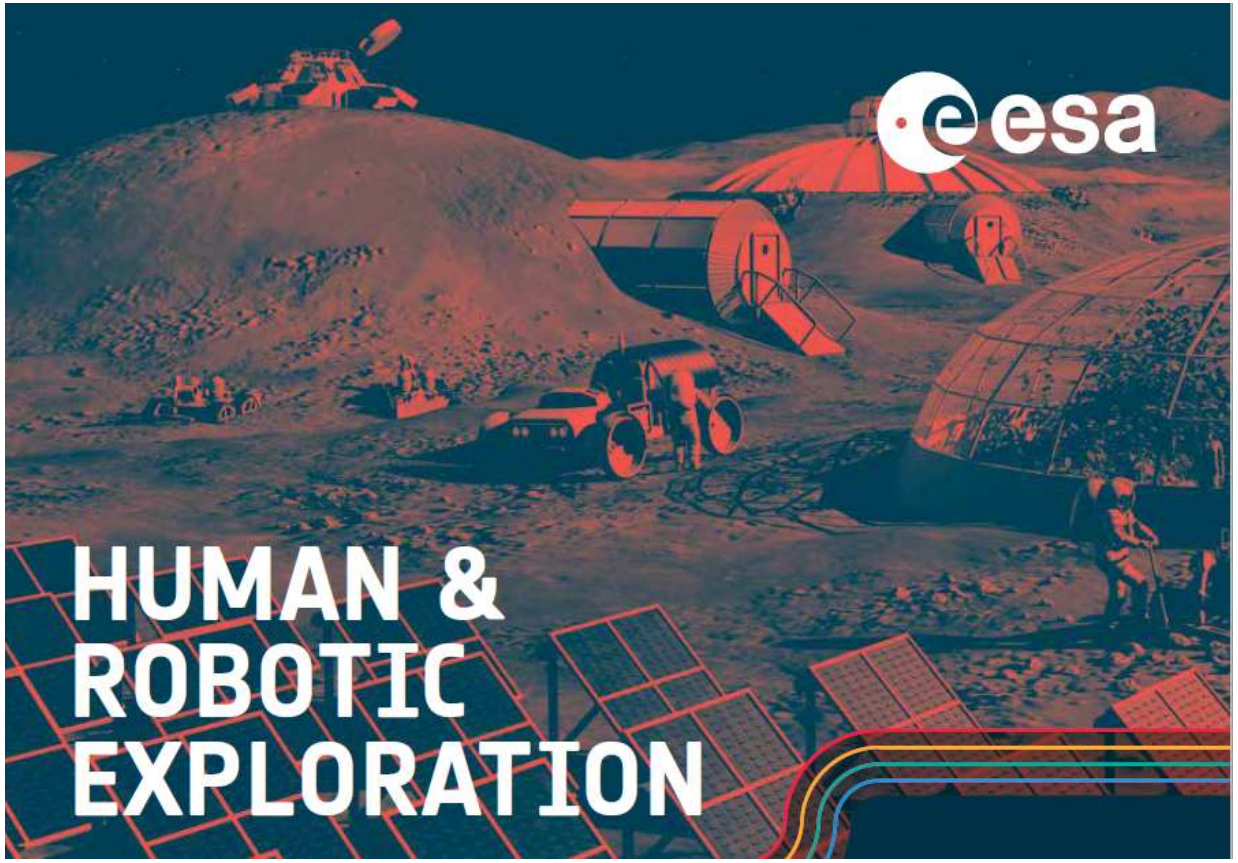
## *Shaping the future of Exploration*






Cornerstone 1
Humans in Low Earth Orbit
Cornerstone 2
Humans beyond Low Earth Orbit
Cornerstone 3
Robotic Lunar Exploration
Cornerstone 4
Robotic Mars Exploration
International Space Station
Moon robotics sample return
Earth Return Orbiter
Sample Fetch Rover
Gateway
Sample Container
Orion
ExoMars Rover
Chinese space station
400 km
385 000 km
55 - 400 million km
European Space Agency

# Brochure available

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