

HUMAN SPACEFLIGHT AND ROBOTIC EXPLORATION UPDATE

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Directorate of Human & Robotic Exploration Programmes

55th ESSC Plenary Meeting - 22-24/05/2018

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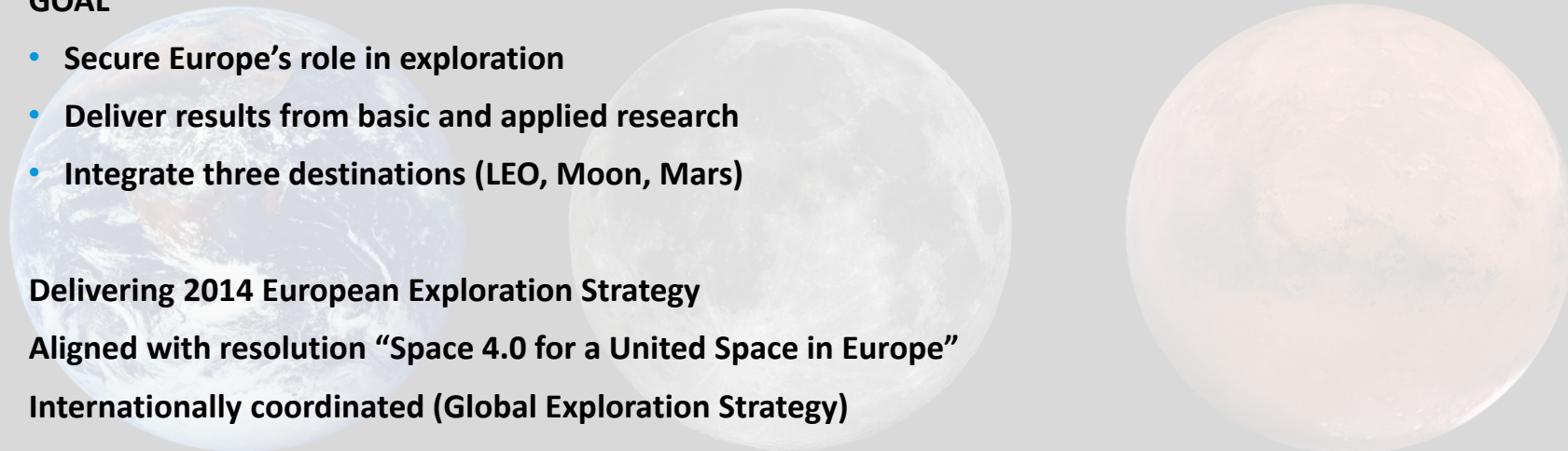
- E3P Programme Overview
 - Goals/CMIN 16 recap
 - Future Mission Roadmap Concept
 - Candidate Elements up to 2030
 - Future Programme Structure
- E3P Element Status
 - SciSpace
 - ISS Exploitation
 - Lunar Activities
 - Mars Activities
 - Commercial Partnerships



EUROPEAN EXPLORATION ENVELOPE PROGRAMME (E3P)



- **GOAL**
 - **Secure Europe's role in exploration**
 - **Deliver results from basic and applied research**
 - **Integrate three destinations (LEO, Moon, Mars)**
- **Delivering 2014 European Exploration Strategy**
- **Aligned with resolution "Space 4.0 for a United Space in Europe"**
- **Internationally coordinated (Global Exploration Strategy)**



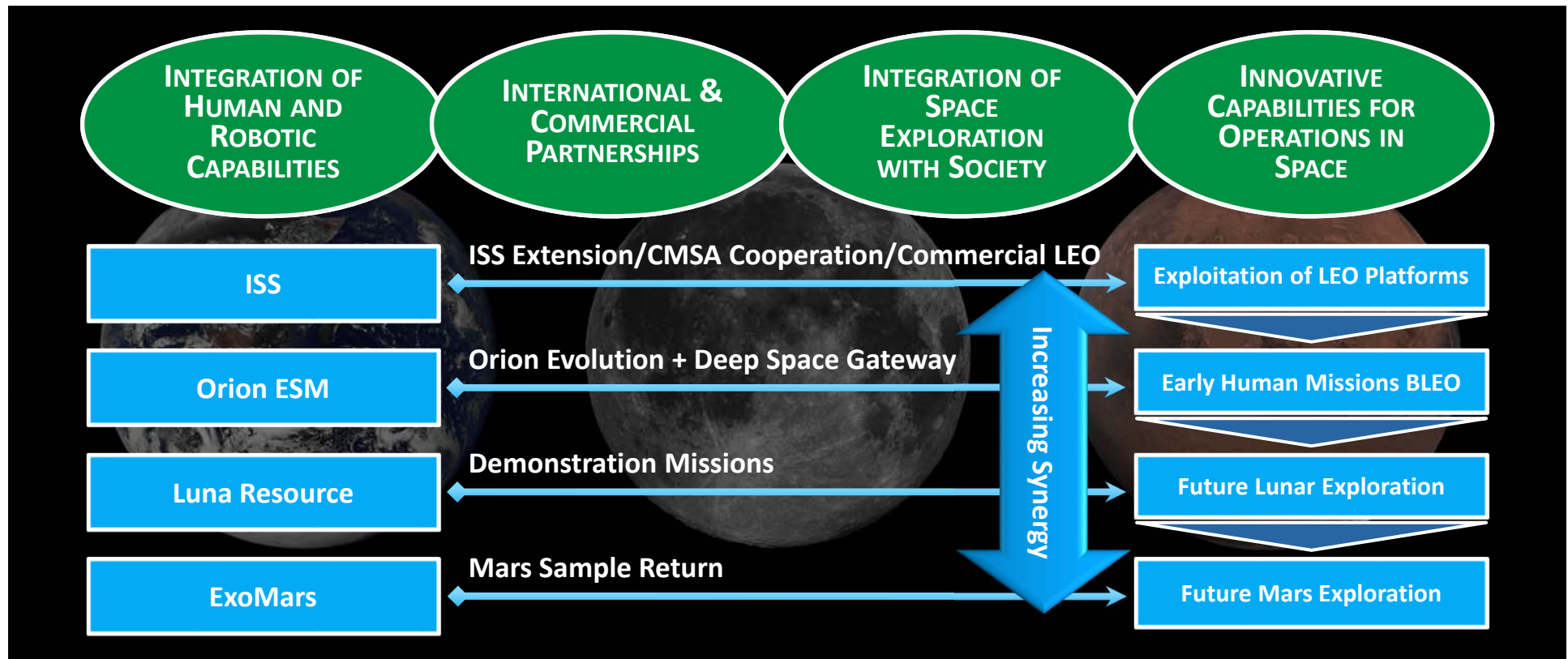
EUROPEAN EXPLORATION ENVELOPE PROGRAMME (E3P)



- **Ratified at CMIN 2016**
 - **ISS operations/astronaut missions until 2024**
 - **Orion Service Modules**
 - **SciSpacE**
 - **ExoMars**
 - **Luna-Resource Lander**



E3P FUTURE MISSION ROADMAP CONCEPT

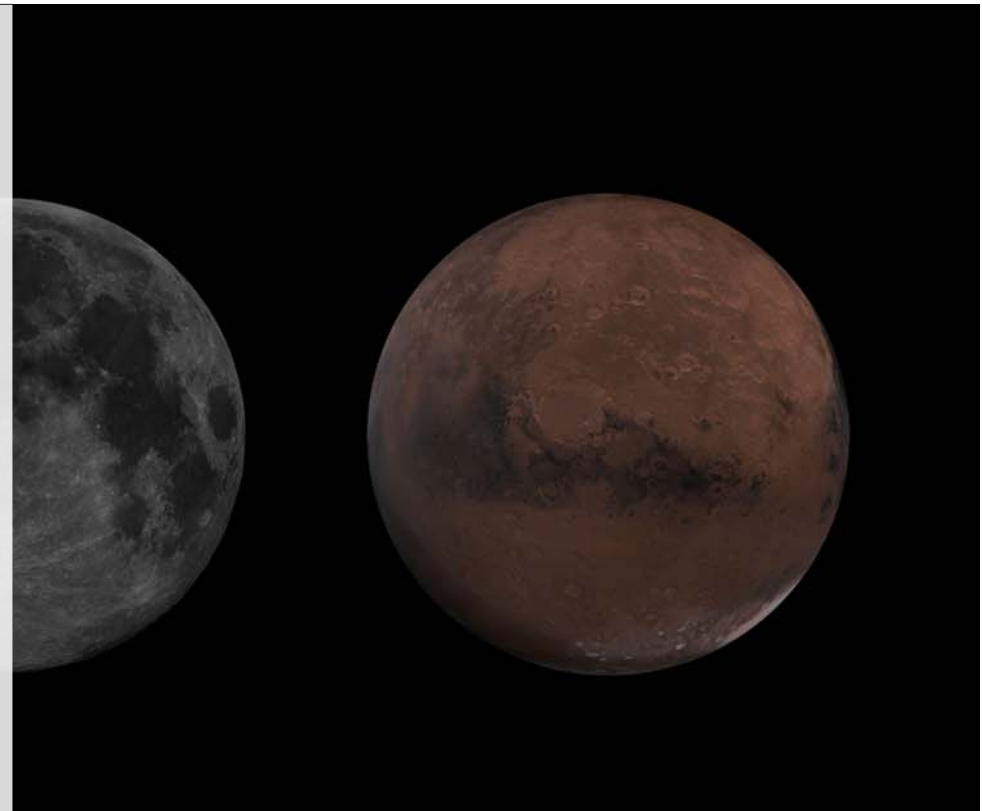


CANDIDATE E3P ELEMENTS UP TO 2030



○ CORNERSTONES

- LEO exploitation >2024 (ISS and transitioning to post-ISS commercial partnerships)
- Early Human mission beyond LEO (ESM + Deep Space Gateway)
- Sample return (Moon, Phobos, Mars)
- Long term lunar surface exploration, initiated with robotic precursor mission



CANDIDATE E3P ELEMENTS UP TO 2030



- **TECHNOLOGY DEMONSTRATORS**

- Rendezvous/docking demonstrator
- ISRU demonstrator
- Life support systems
- Robotics



CANDIDATE E3P ELEMENTS UP TO 2030

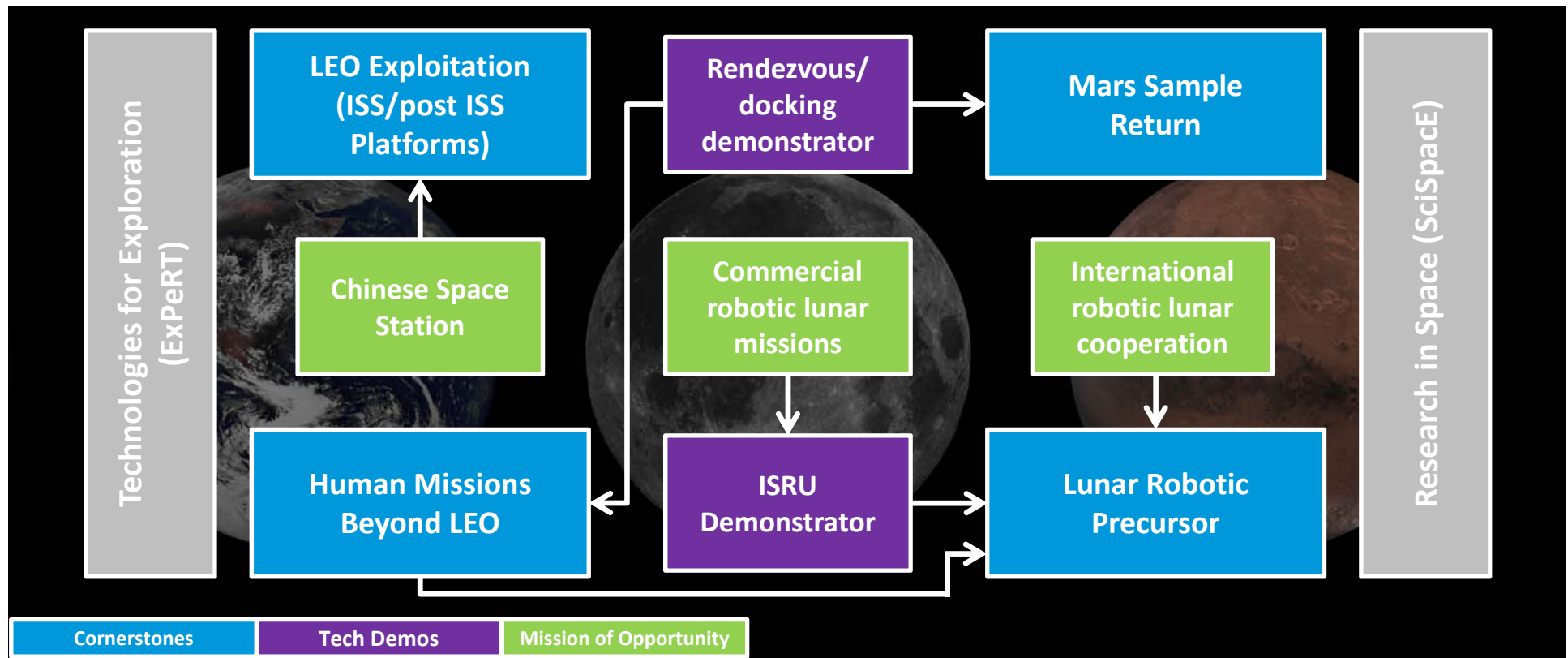


MISSIONS OF OPPORTUNITY

- Cooperation with CMSA on Chinese Space Station (CSS)
- Commercialised lunar missions (communication, logistic services)
- Cooperation with international partners on robotic lunar exploration



FUTURE E3P PROGRAMME STRUCTURE



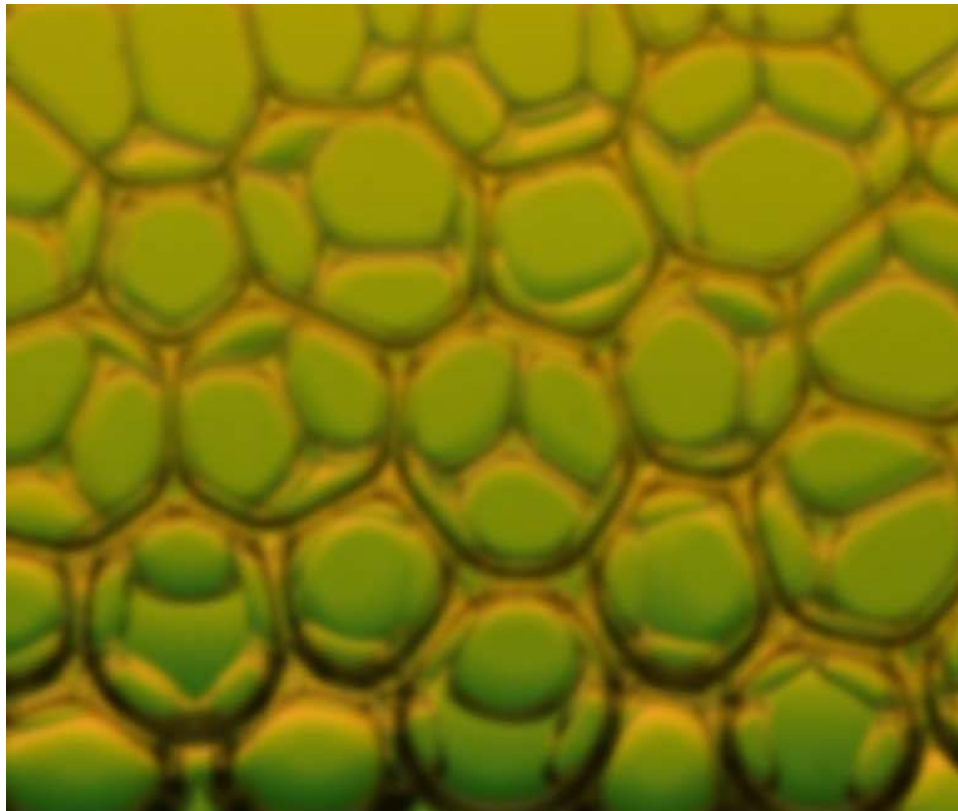
ISS EXPLOITATION



- **Continuation of ESA's participation in ISS at least until 2024 covering**
 - Engineering support, Logistics and Operations, USOC's
 - EAC support of astronauts
 - Regular ESA Astronaut flights (Horizons)
 - Orion European Service Modules
 - Phase A/B studies to support decision at CM19
 - ISS Technology Demonstrators



SCIENCE IN THE SPACE ENVIRONMENT (SciSPACE)



- **SciSpace**
 - Objectives
 - Roadmaps
 - Implementation
 - Defining Research: MAP/Topical Teams
 - Prioritisation
 - Producing Results



LINKS TO SUSTAINABLE DEVELOPMENT GOALS



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European Space Agency

SCIENCE ROADMAPS



PHYSICAL SCIENCES

Fundamental Physics in Space
Soft or Complex Matter
Boiling, Evaporation and Heat Transfer
Advanced Materials Processing

BIOLOGY

Astrobiology
Biology Under non-Earth Gravity
Supporting Life in Hostile Environments

HUMAN RESEARCH

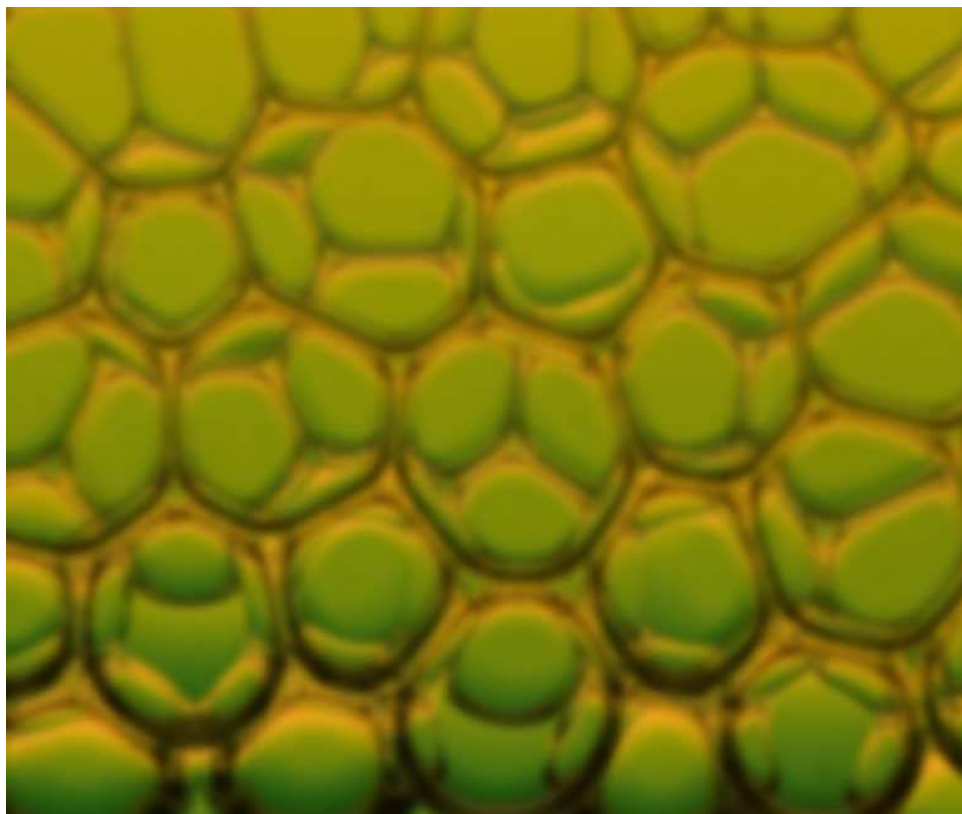
Human Body Under Space Conditions
Psychological/Neurosensory Adaptations

COSMIC RADIATION RISKS FOR HUMAN EXPLORATION:

Self-standing and Multidisciplinary Research:



SCIENCE ROADMAPS: PHYSICAL SCIENCES



PHYSICAL SCIENCES

Fundamental Physics in Space

- ACES, Outlook

Soft or Complex Matter

- Current/Upcoming Research/Future Outlook

Boiling, Evaporation, Condensation and Heat Transfer

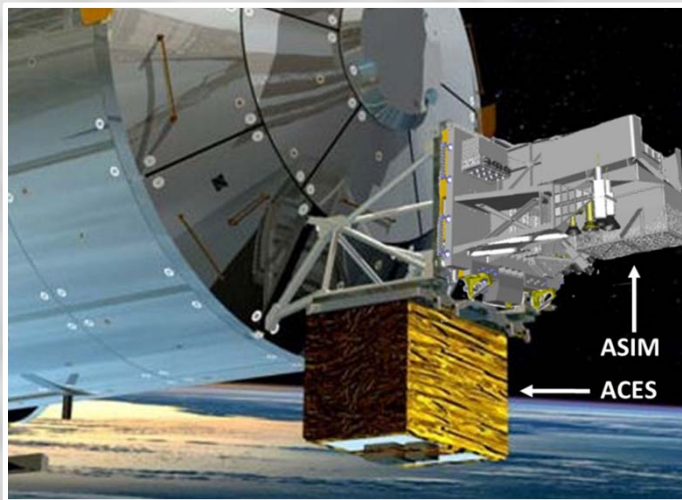
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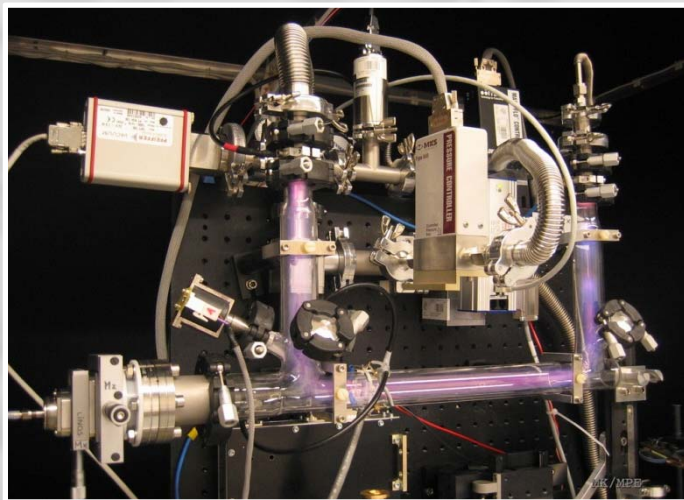
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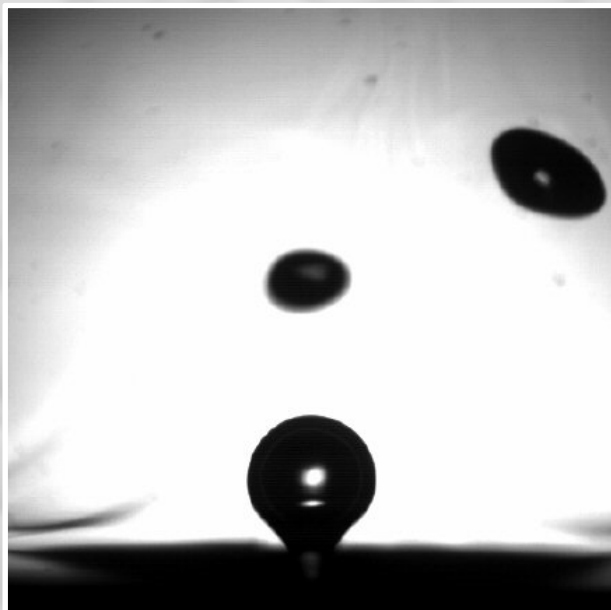
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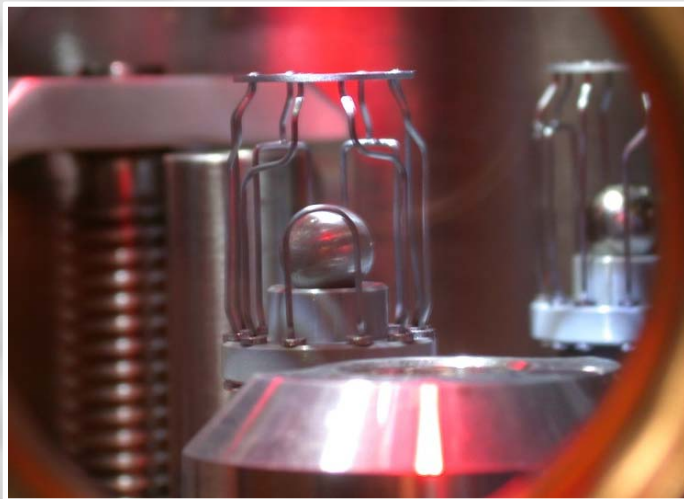
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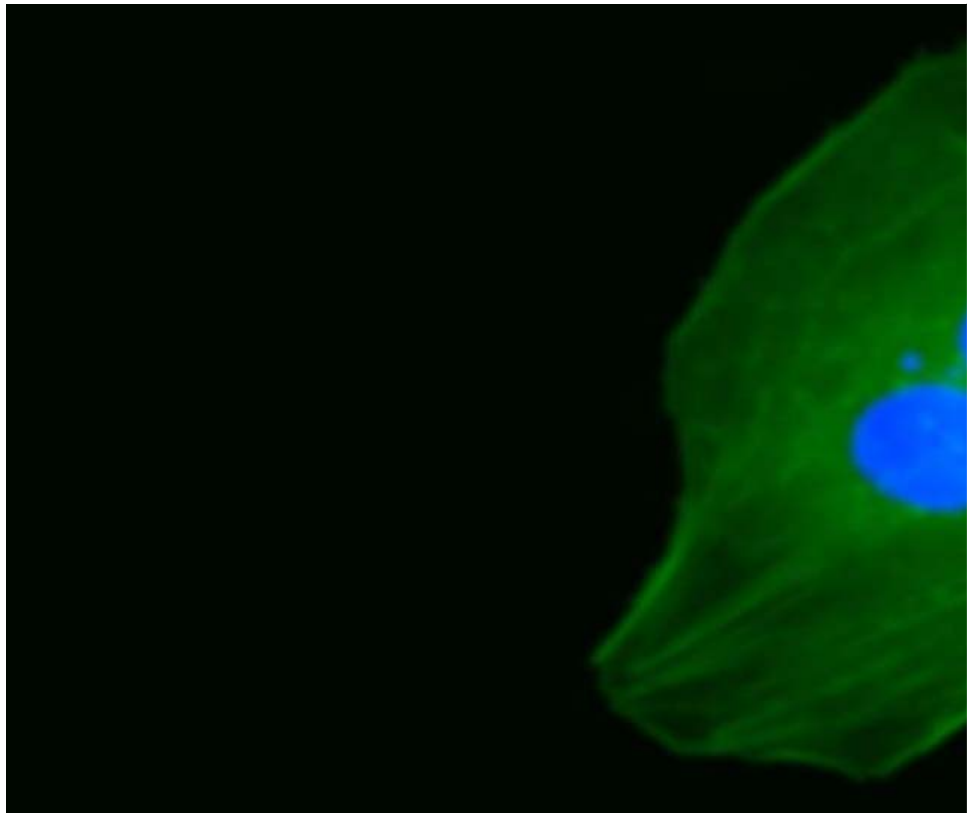
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BIOLOGY

Astrobiology

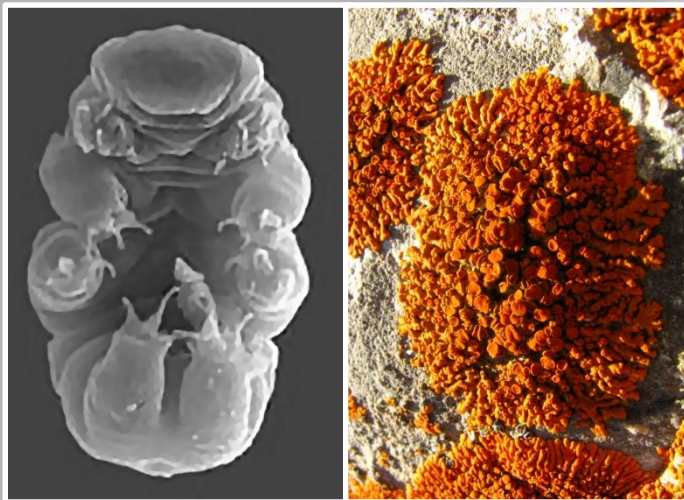
- Past/On-going (analysis), Future

Biology Under non-Earth Gravity

- Current/On-going research

Supporting Life in Hostile Environments

- Recent research



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Supporting Life in Hostile Environments

- **Recent Research Activities, Outlook**

SCIENCE ROADMAPS



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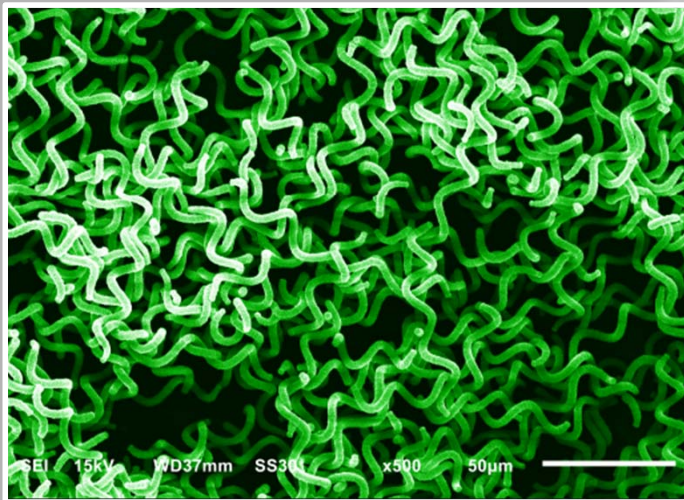
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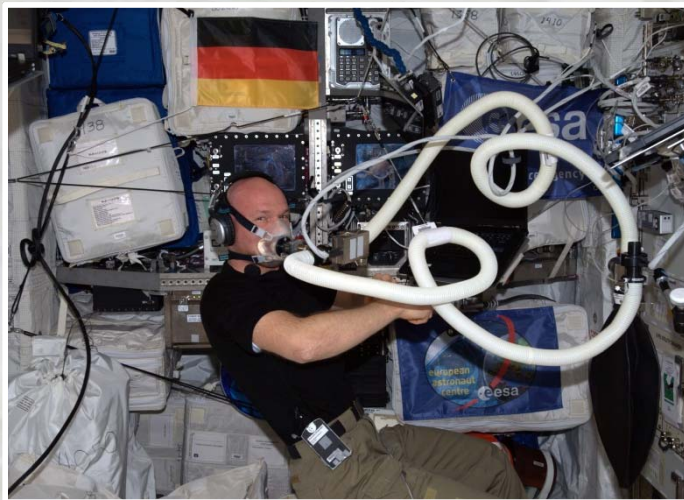
HUMAN RESEARCH

Human Body Under Space Conditions

- Current/Recent Research

Psychological/Neurosensory Adaptations

- On-going/Recent Research
- Upcoming Research



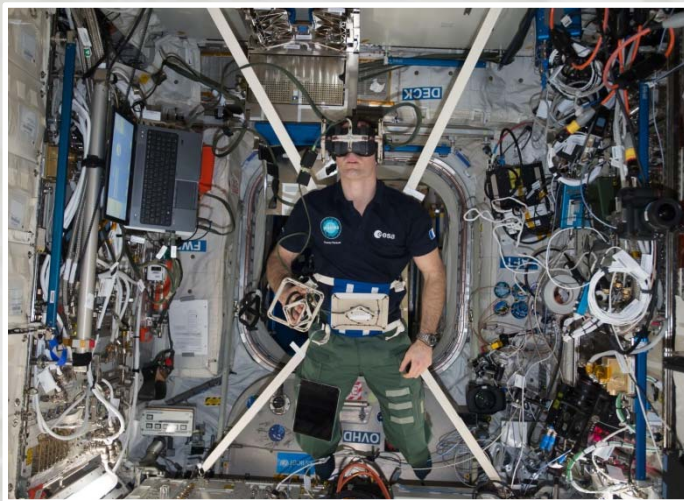
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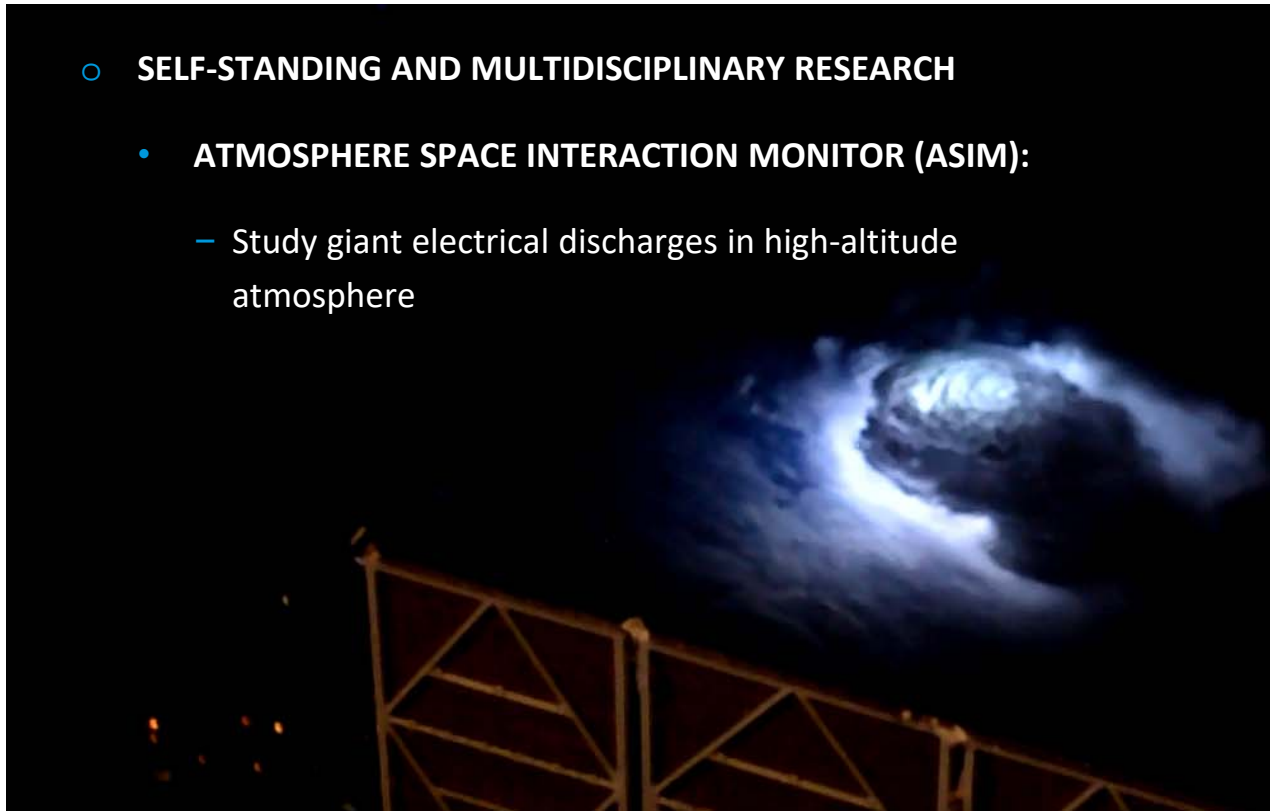
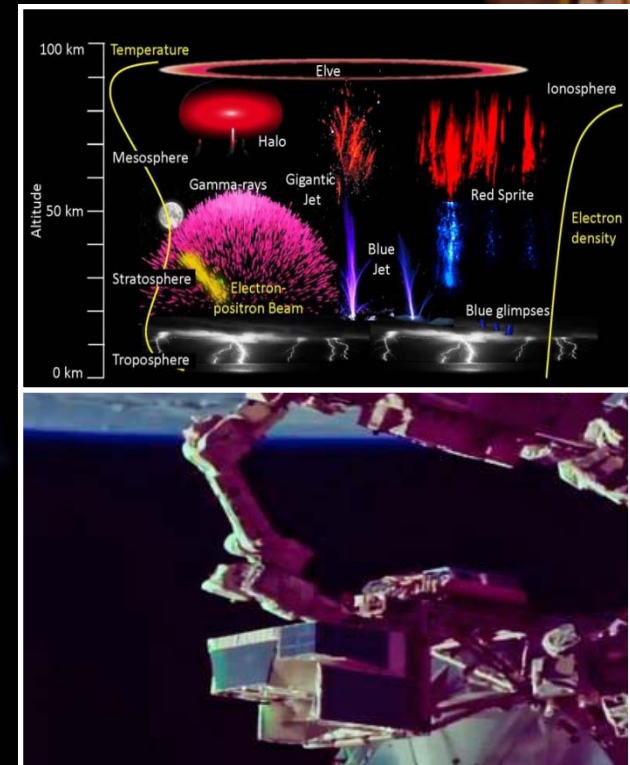


COSMIC RADIATION RISKS FOR HUMAN EXPLORATION

SCIENCE ROADMAPS: ADDITIONAL



- SELF-STANDING AND MULTIDISCIPLINARY RESEARCH
 - **ATMOSPHERE SPACE INTERACTION MONITOR (ASIM):**
 - Study giant electrical discharges in high-altitude atmosphere



NON-ISS RESEARCH PLATFORMS



- **Drop towers**
- **Flight Campaigns:**
- **Sounding Rockets:**
- **Orbital Capsules**
- **Isolation Studies:**
- **Bedrest Studies:**
- **IBER**



INTEGRATING/NATIONAL COMMERCIAL ELEMENTS



- **Integrating/National Commercial Elements:**
 - Optimising resources/Maximising return
 - Societal stimulus
 - Aligned with national missions
 - Broader research perspectives
 - Stimulating STEM subjects
 - Recent activities



COMMERCIAL PARTNERSHIPS



- **Commercial Partnerships:**

- Initiative started in spring 2015
- ICECUBES
- BARTOLOMEO
- Lunar Pathfinder

SPACE EXPLORATION AS DRIVER
FOR GROWTH AND COMPETITIVENESS

Call for ideas



ORION ESM



- **Orion European Service Module (ESM):**
 - Complimentary barter elements.
 - **ESM-1**
 - Delivery no later than Aug 2018.
 - Launch with EM1 in 2019
 - **ESM-2**
 - Delivery in Sept. 2019
 - Target launch in 2021.
 - Will carry astronauts on Moon fly-by (EM2)
 - First European spacecraft element to carry humans.
 - **Future developments (ESM3 & beyond)**



LUNAR ORBIT PLATFORM – GATEWAY



- **Lunar Orbit Platform – Gateway :**
 - NASA-ESA Umbrella Understanding signed 12 April 2018
 - Call for Ideas/Workshop
 - Competitive phase A/B1 proposals received, for potential ESA elements (ESPRIT, I-HAB).
 - IBDM selected for European elements on LOP-G

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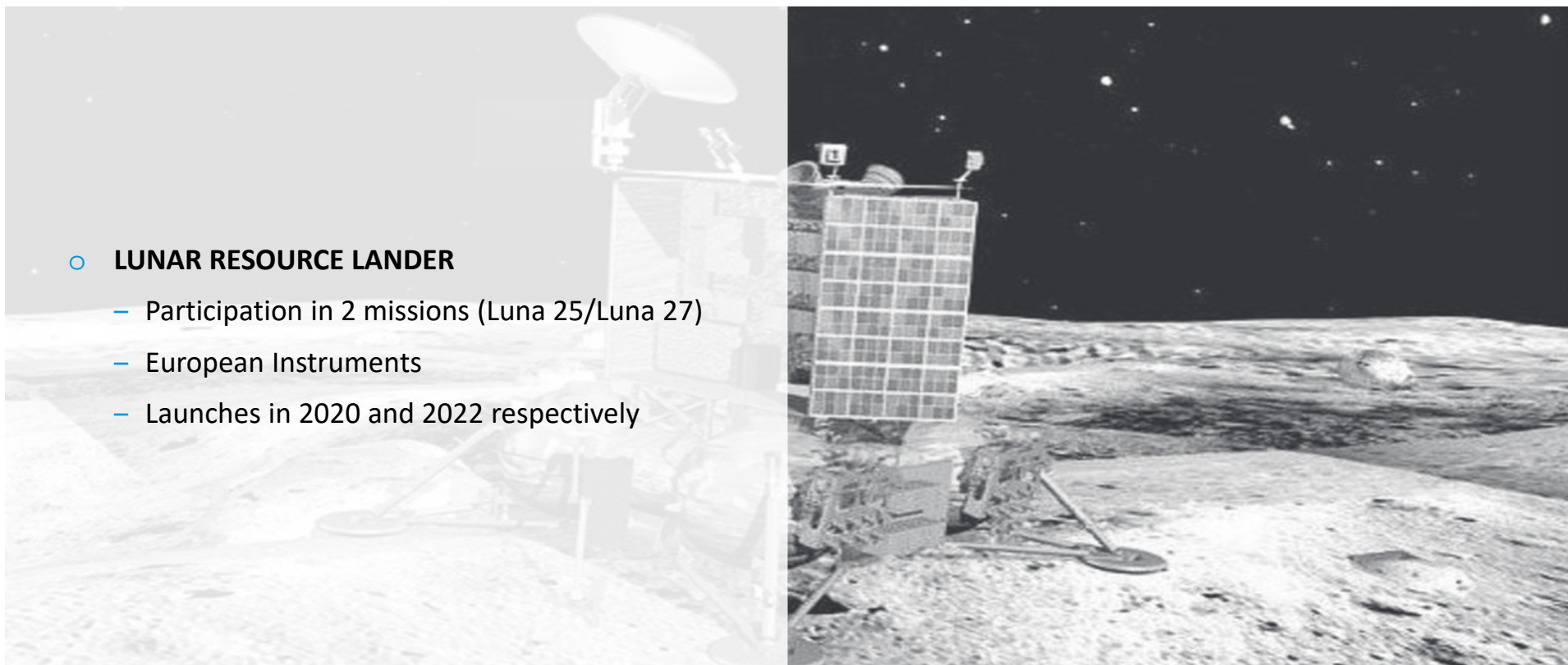


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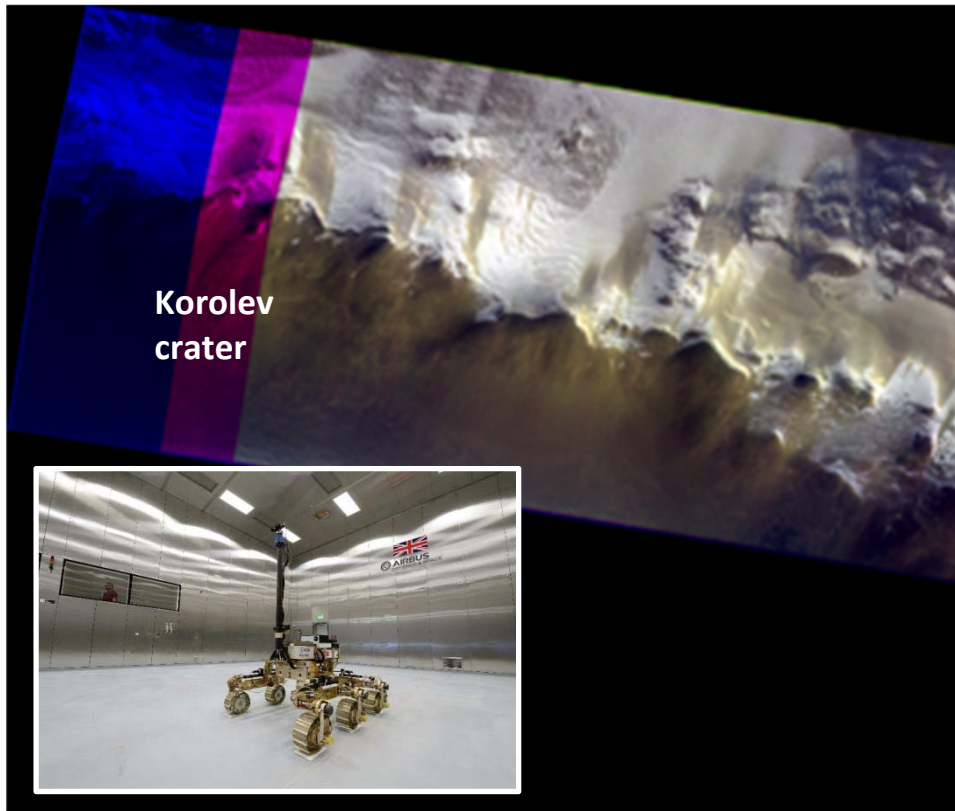
LUNAR RESOURCE LANDER



- **LUNAR RESOURCE LANDER**
 - Participation in 2 missions (Luna 25/Luna 27)
 - European Instruments
 - Launches in 2020 and 2022 respectively



EXOMARS



Korolev crater

- **ExoMars 2016/TGO Mission:**
 - Manoeuvres to reach final orbit completed
 - Science instruments activated.
 - First photos/data returned
- **ExoMars 2020 Mission:**
 - Testing and reviews on-going
 - Scheduled for July 2020 launch

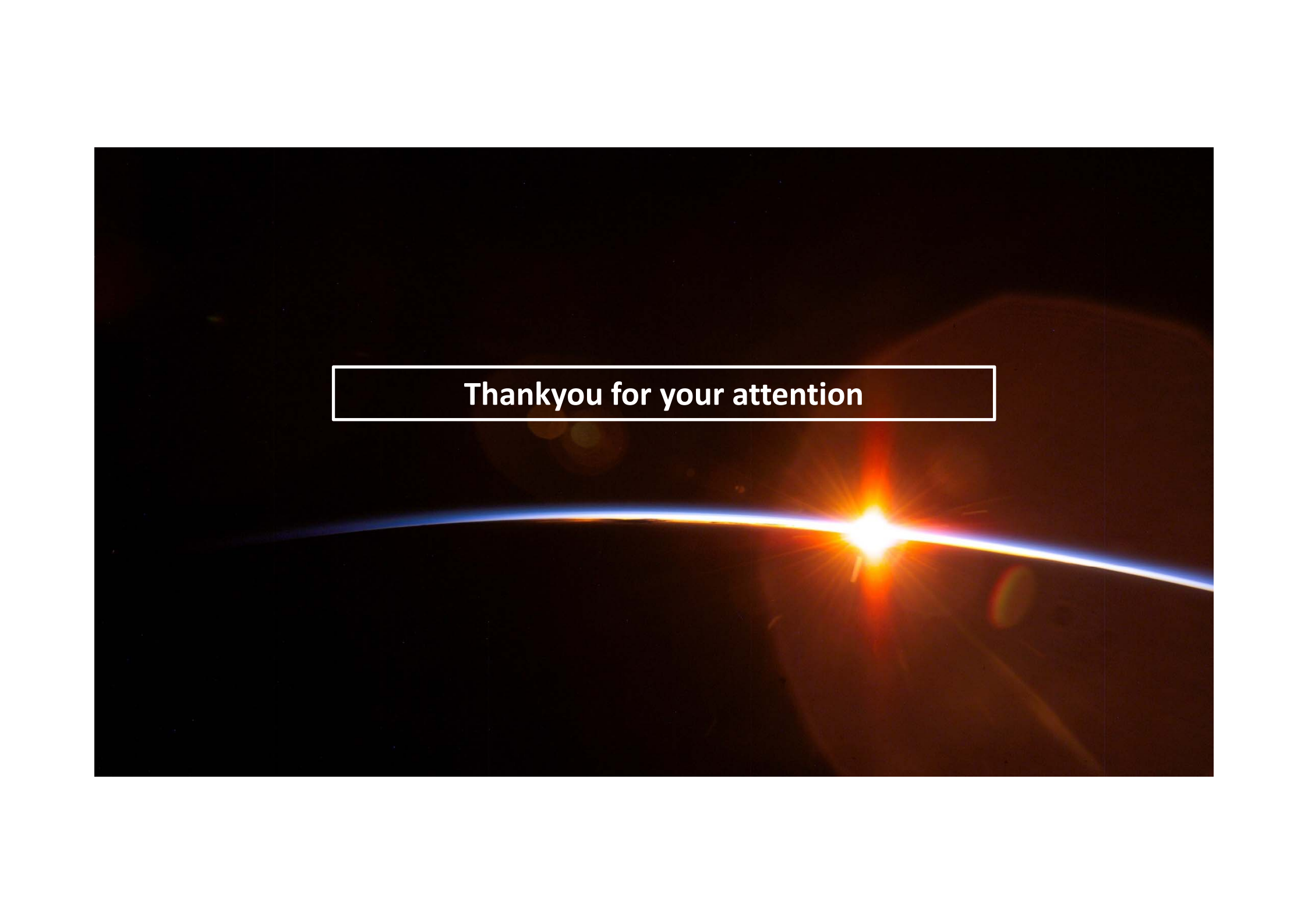


MARS SAMPLE RETURN



- **Mars Sample Return (MSR):**
 - Statement of Intent (Sol) signed 26 April (Berlin).
 - Competitive phase A/B1 proposals received, evaluation on going, May kick-off.



A photograph of Earth's horizon from space, showing a thin blue and white line of the atmosphere against the blackness of space. A bright sun or star is visible on the right side of the horizon, creating a lens flare effect. The text "Thankyou for your attention" is centered in a white box.

Thankyou for your attention

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