Towards *Terrae Novae*

BVS-ABR Scientific meeting
Radiation protection in space

Directorate of Human and Robotic Exploration
Frank De Winne

18 June 2021

Agenda 2025 and Exploration

Expansion for 2025

Ambition for 2030

Vision for 2040

Proof of space race

Credit: House Appropriations Committee webcast

NASA Administrator Bill Nelson shows an image of China’s Zhurong Mars rover, during a May 19 House appropriations hearing.

International developments: accelerating US v China race

Europe/ ESA?

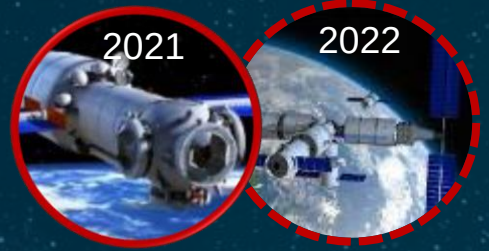
"Commercial" **NASA** "in-house"

CNSA-CMSA

Done

Under way

PERMANENT PRESENCE



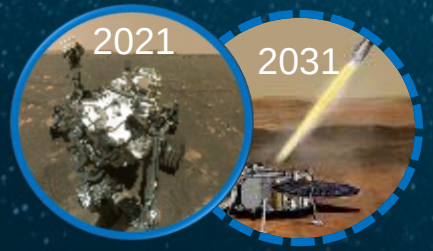
Tianhe

PERMANENT PRESENCE

Chang'e series

Deep space human-rated

FIRST HUMAN MISSION



Zhurong

Sample return

Continuing the European exploration heritage

1980 > 2000
"Foot-in-the-door"

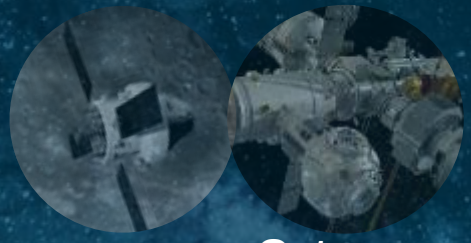
Spacelab

2000 > 2020
Non-critical partner

ISS *contribution*

2020 > 2030
Mutual inter-dependence

ISS *Cont'd*



Orion/ESM
System critical

Gateway
> 50% contribution

ExoMars 2016 **ExoMars 2022**
(ESA- Roscosmos)

Mars Sample Return
> 20% of the partnership

2030 > 2040
European-led capabilities

Post-ISS
Commercial

European-lead
New partnerships

Evolved cooperation

European-lead
New partnerships

Evolved cooperation

Towards a more autonomous exploration programme

1980 > 2000
"Foot-in-the-door"

Spacelab

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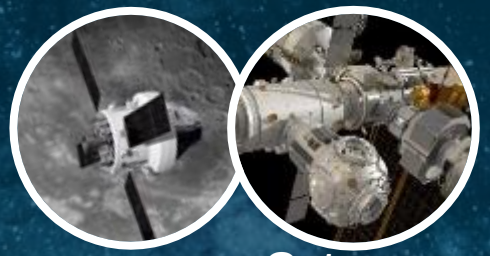
ISS ***contribution***

2020 > 2030
Mutual inter-dependence

ISS ***Cont'd***



Orion/ESM
System critical

Gateway
> 50% modules

ExoMars 2016 **ExoMars 2022**
(ESA- Roscosmos)

Mars Sample Return
> 20% of the partnership

2030 > 2040?
European-led capabilities

European identity
Strategic autonomy
Thematic leadership

Cost implications for E3P

New benefits

Multi-domain projects
Evolved cooperation/barters
New international partnerships

Benefits

Uninterrupted access to LEO, new lunar (RFI:300 replies) & Mars science

Knowledge

Economy

Leverage hard-won capabilities & growing European industrial excellence (space & non-space)

Strategic autonomy/European identity

"We want Europe to benefit from space as much as the US and China"

ESA – Agenda 2025

Inspire European children to dream of walking on the Moon today & Mars tomorrow

Inspiration

Cooperation

Evolved/new partnerships, global challenges & space diplomacy

E3P3 commitments & new projects - Technology portfolio - Long term strategy

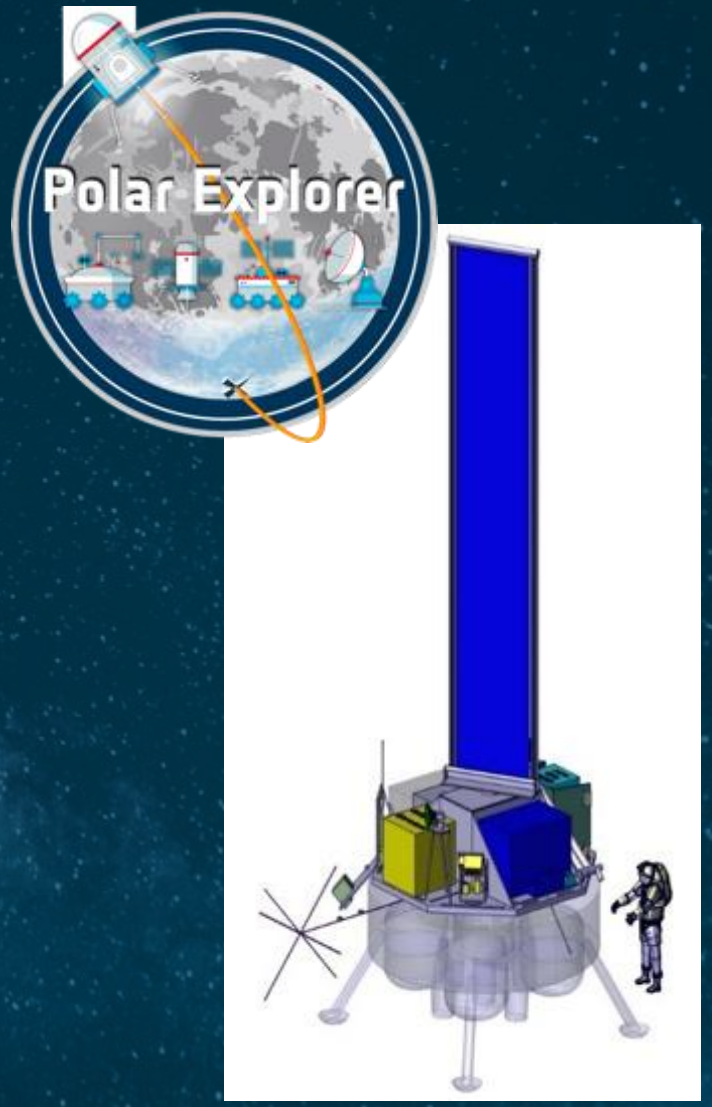
European Large Logistic Lander (EL3)

- 1.5 tonnes of payload to lunar surface
  - 2 x Phase A/B1 studies on-going - ADS (D) and TAS (I)

  → *Game changing technologies: main engine + night survival + precision GNC for landing*
- Consultations with NASA started
- Goal for proposal of full development by end of 2022, allowing full go-ahead in early 2023
- Could enable major science activities on lunar surface:

  → 300 responses to 2020 RFI, consolidated into small number of focused science mission concepts

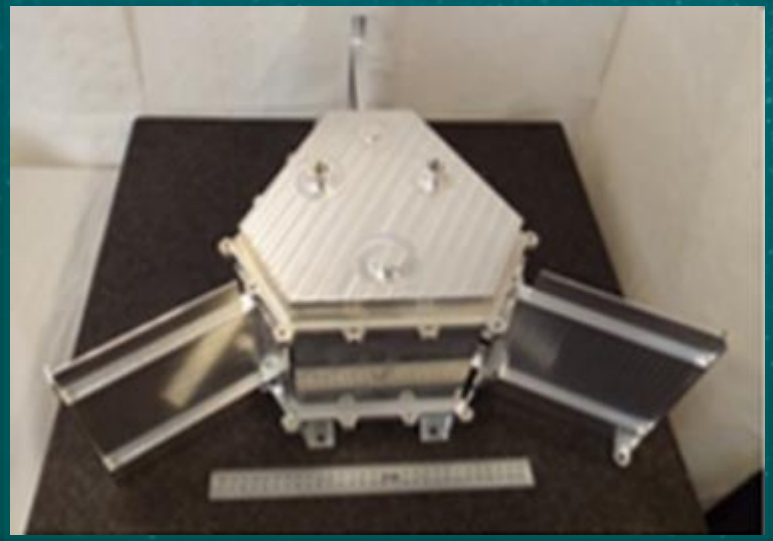
Cooperation opportunity with national agencies for payloads?



Science and technology for lunar exploration 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 ROS, NASA, JAXA, ISRO – 4 missions by 2025

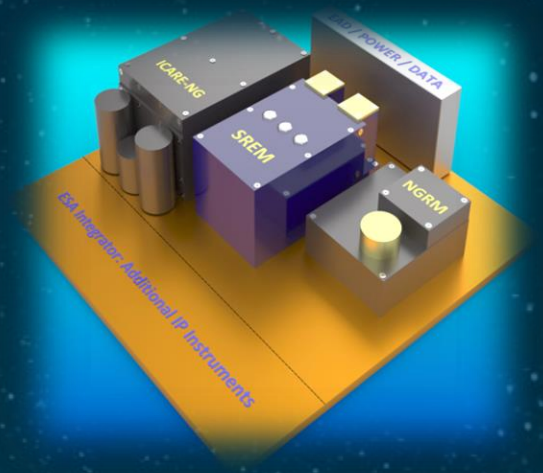


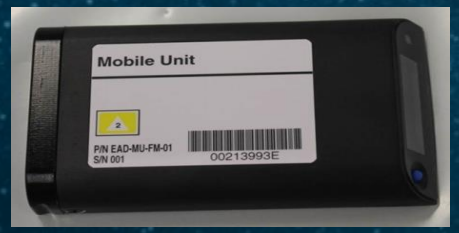
- European radioisotope technology based on americium-241: Radioisotope Heater Unit, European Large Heat Source, Radioisotope Thermoelectric Generator

- Tempus Pro supporting EVA science, medical operations

European Radiation Package on Gateway overview

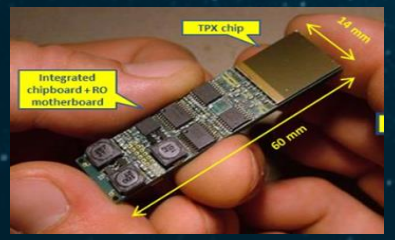
- ERSA : European Radiation Sensor Array
  - 2 ESA Active Dosimeter (EAD) boards
  - Standard Radiation Environment Monitor
  - Influence of Space Radiation on Advanced Components – New Generation
  - Next Generation Radiation Monitor
  - 2 MediPix units
  - 2 Magnetometer sensors





EAD

TRITEL DU



MediPix

PADLES + D-SPACE

- IDA : Internal Dosimeter Array
  - 1x EAD (active)
  - 1x TRITEL Detector Unit (DU) (active)
  - 1x MediPix (active)
  - 1x PADLES + D-Space dosimeters (passive) (JAXA)

Multi-domain projects (Multiple ESA Directorates)

Coms and Nav functions on and around the Moon **as a set of Services**

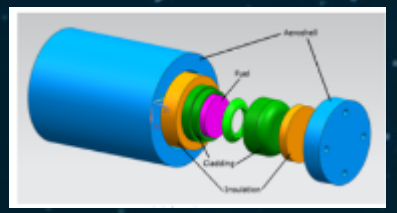
Enabling the emergence of a private European Service provider

for ESA and any other public or private entities worldwide, incl. as barters

UNDER CONSIDERATION

Cis-lunar Transfer Vehicle as a modular and **versatile in-space transportation system** compatible with Ariane 64 and supporting LEO, MEO, GEO and Moon missions, based on ATV and ESM expertise

In discussion with STS



UNDER CONSIDERATION

Radio-isotopic heat and power sources to **enhance European autonomy**

e.g. for EL3, barter possibly with existing and new International Partners and potentially other **scientific missions** within the Science programme

Discussions ongoing

E3P Period 3 – 3 key deliverables

ISS extension until 2030

- More science
- ~6 long duration astronaut flights

Europe(an) on the Moon before 2030

- European identity
- Strategic autonomy
- Thematic leadership

Prepare Europe beyond 2030

- Europeans in LEO
- Europeans on the Moon
- Europeans on Mars

Implementing Agenda 2025

Expansion for 2025

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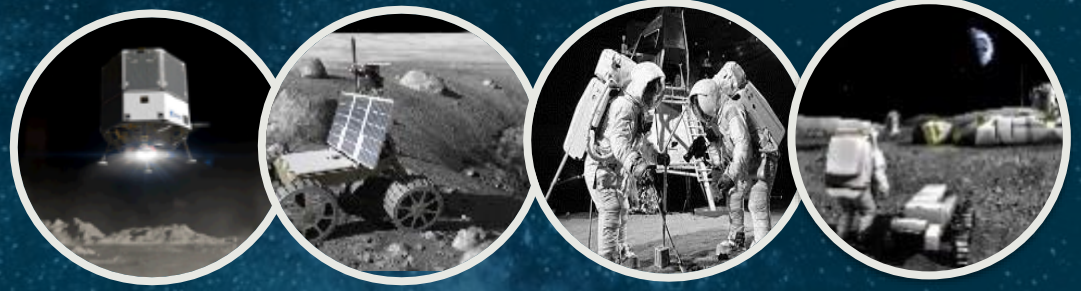
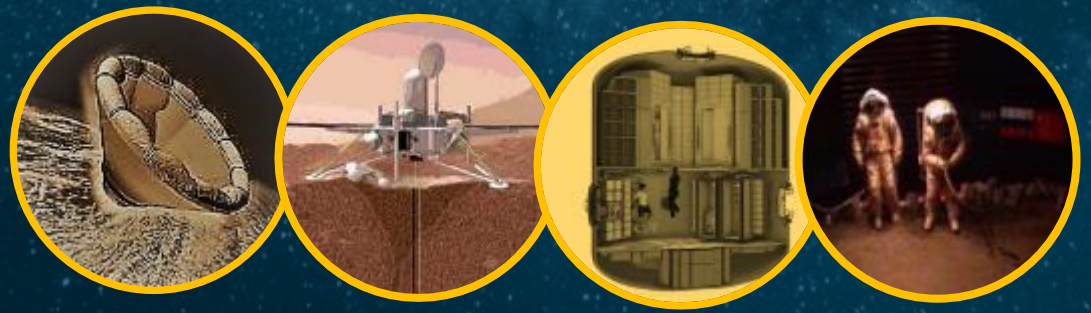
Realistic and affordable in E3PX

Commercial-based



European leadership | Mostly in cooperation



European leadership | Mostly in cooperation

Realistic but not within E3P

Not affordable

Terrae Novae - Executive Summary of E3P Period 3

Continue Implementation of Projects, Science, & Operations agreed at Space19+

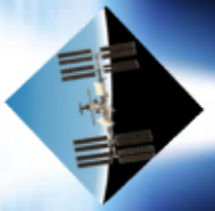
Implement new robotic lunar projects

Prepare activities to implement in Period 4/5+

Autonomous capabilities … and enable European boots on the Moon by 2030 → additional investment

Top priority – meet international commitments

Grow the LEO economy



CM16
E3P created

Space19+
Cornerstones established

CM22
Moon surface + LEO economy