Sample Return

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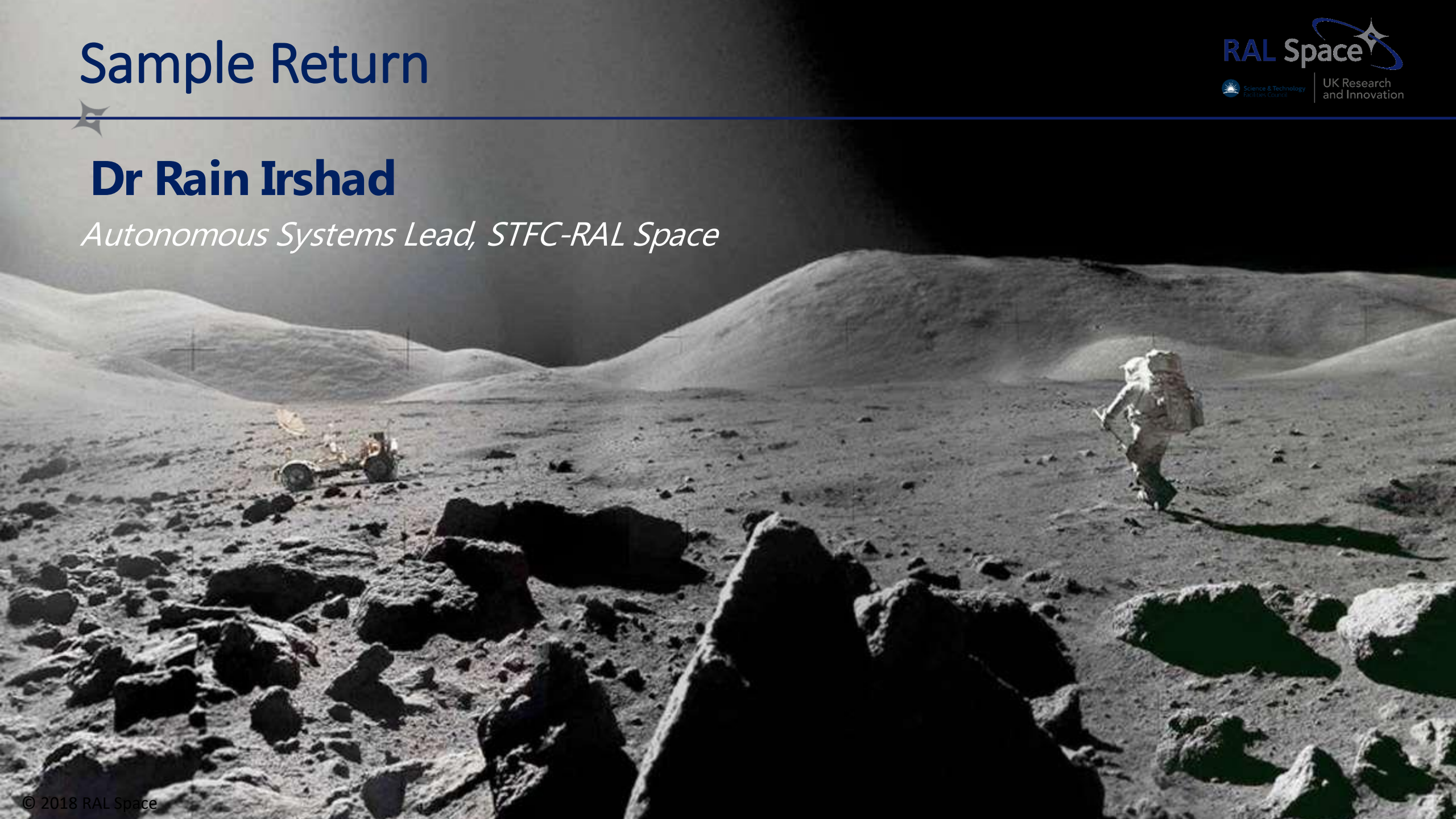

Sample Return – what and why?

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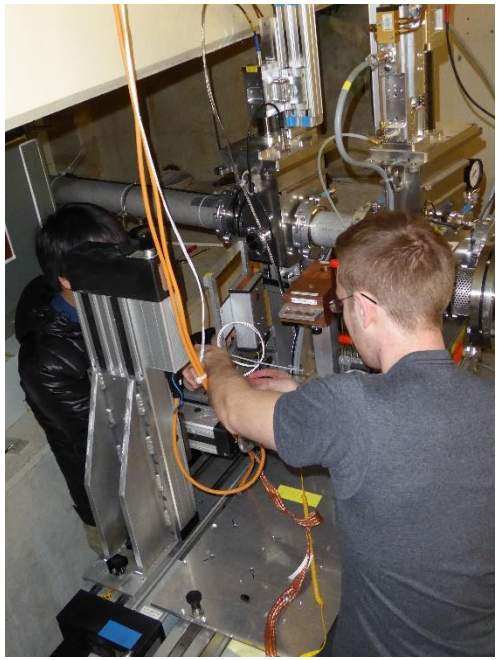
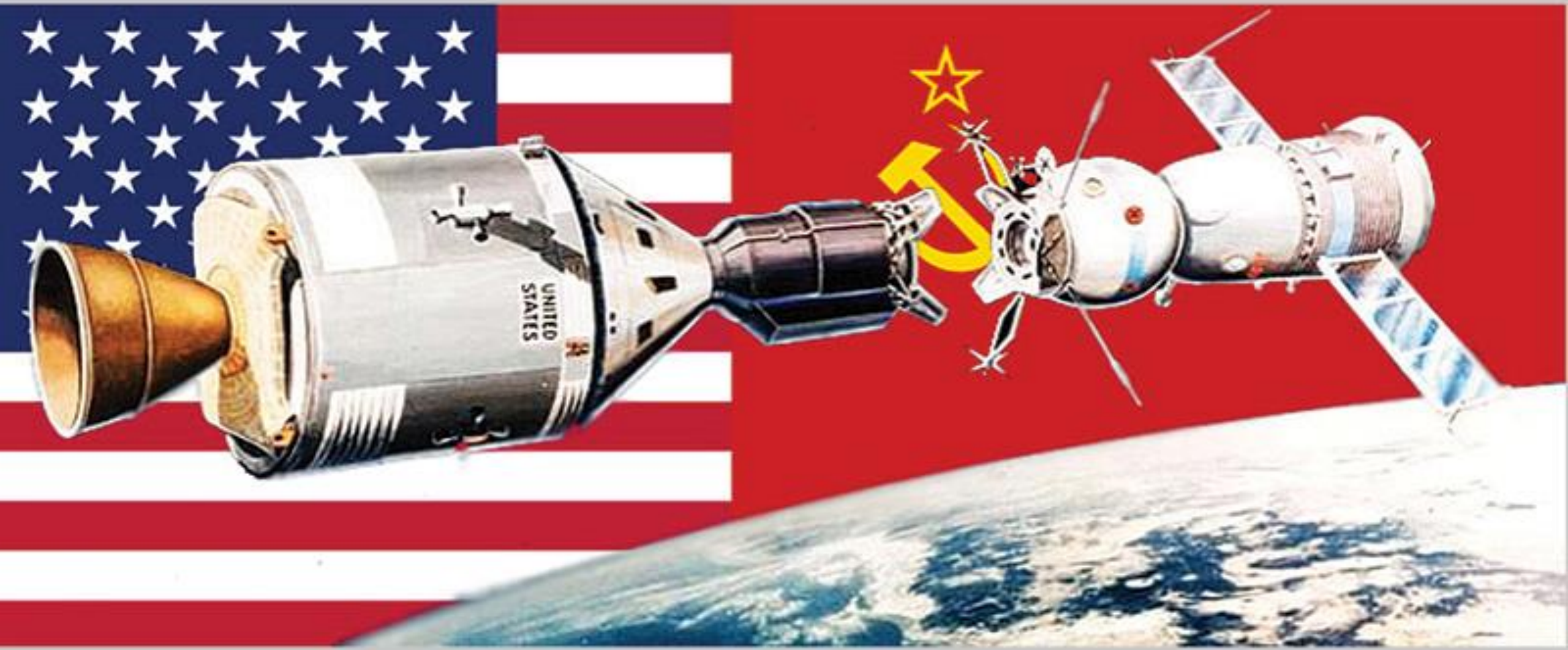
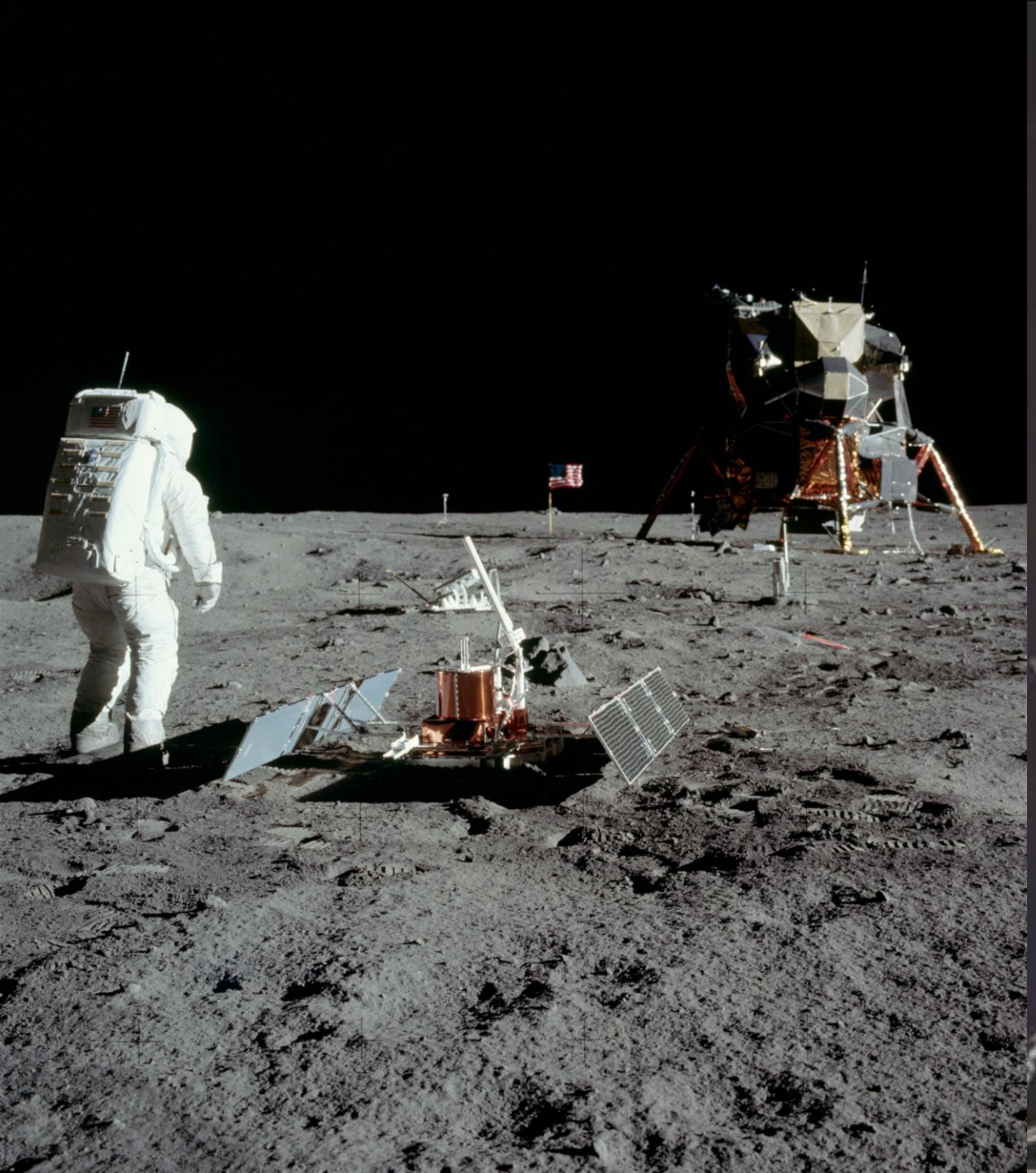
The return of extra-terrestrial material to Earth

- Provides fundamental ground truth
- We are limited in the technology we can send into space
  - Instruments must be small and lightweight
  - Robust enough to survive launch, radiation, temperature extremes
- Facilities on Earth are have greater capability
  - Global facilities may be employed for analysis
  - Provides greater resolution, more accurate, higher quality data
- Analysis of returned samples provides information on:
  - Origins of Solar System
  - Formation of planets
  - Identification of resources
  - Origins of life



The History of Sample Return






СССР

Apollo Programme

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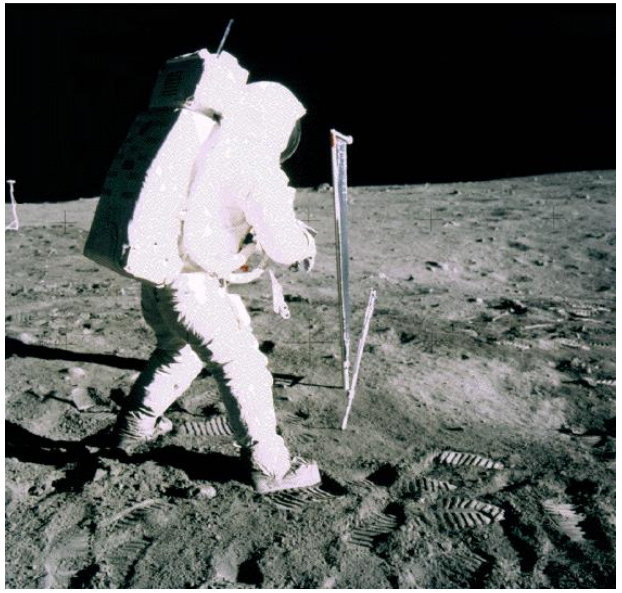
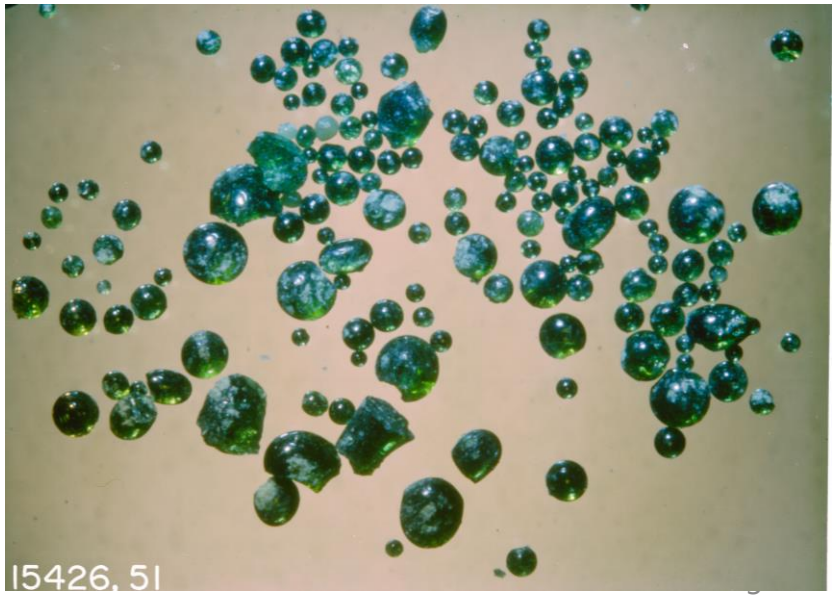
Returned over 382kg of Lunar rock and soil

- Provided valuable scientific knowledge on the moon
- Demonstrated the importance of curation for future scientists
  - In 2008 water was discovered in lunar volcanic glass samples
  - In 2013 chemical traces of water were discovered in the Genesis rock, challenging long-standing theories on how the moon formed





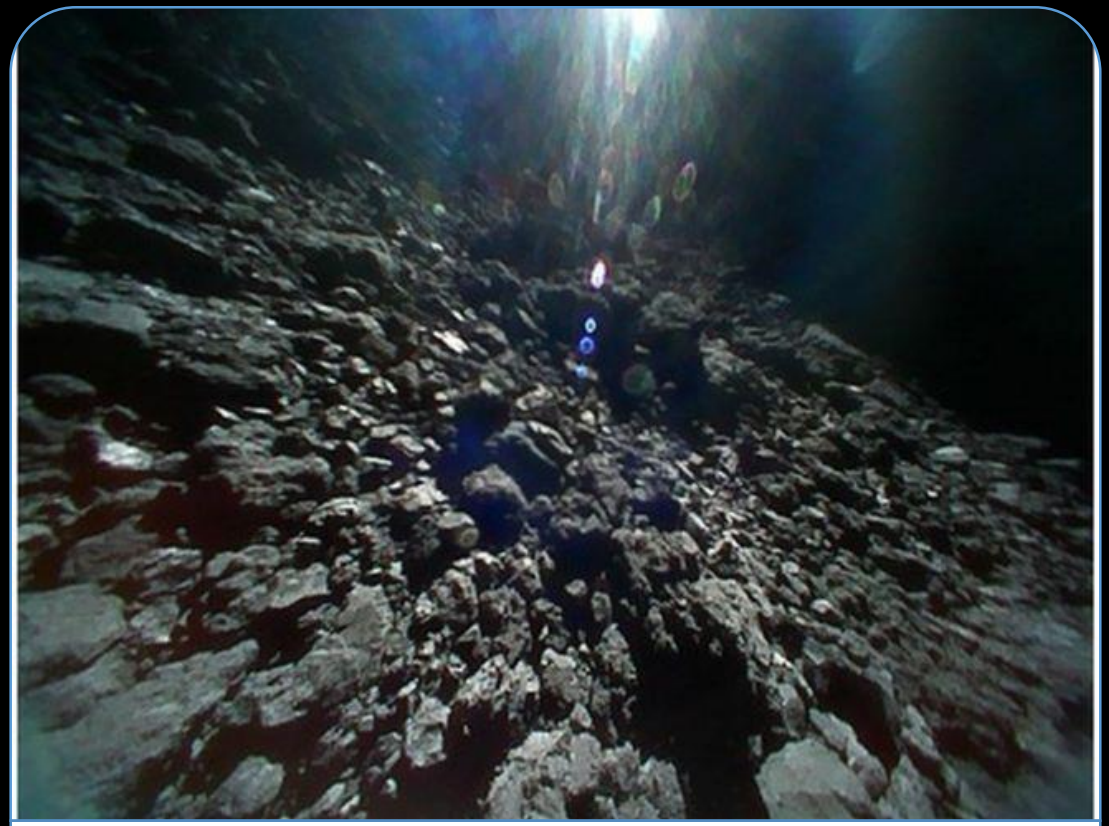
List of Sample Return Missions

Successful Missions

• Earth-Orbital Debris	LEO
• Tanpopo	LEO
• Luna 16	Moon
• Luna 20	Moon
• Luna 24	Moon
• Stardust	Comet
• Genesis	Solar wind
• Hayabusa	Asteroid

Failed Missions

• Luna E-8-5 402, 405, 412	Moon
• Cosmos 300	Moon
• Cosmos 305	Moon
• Luna 15, 18, 23	Moon
• Fobos-Grunt	Phobos



Hayabusa2

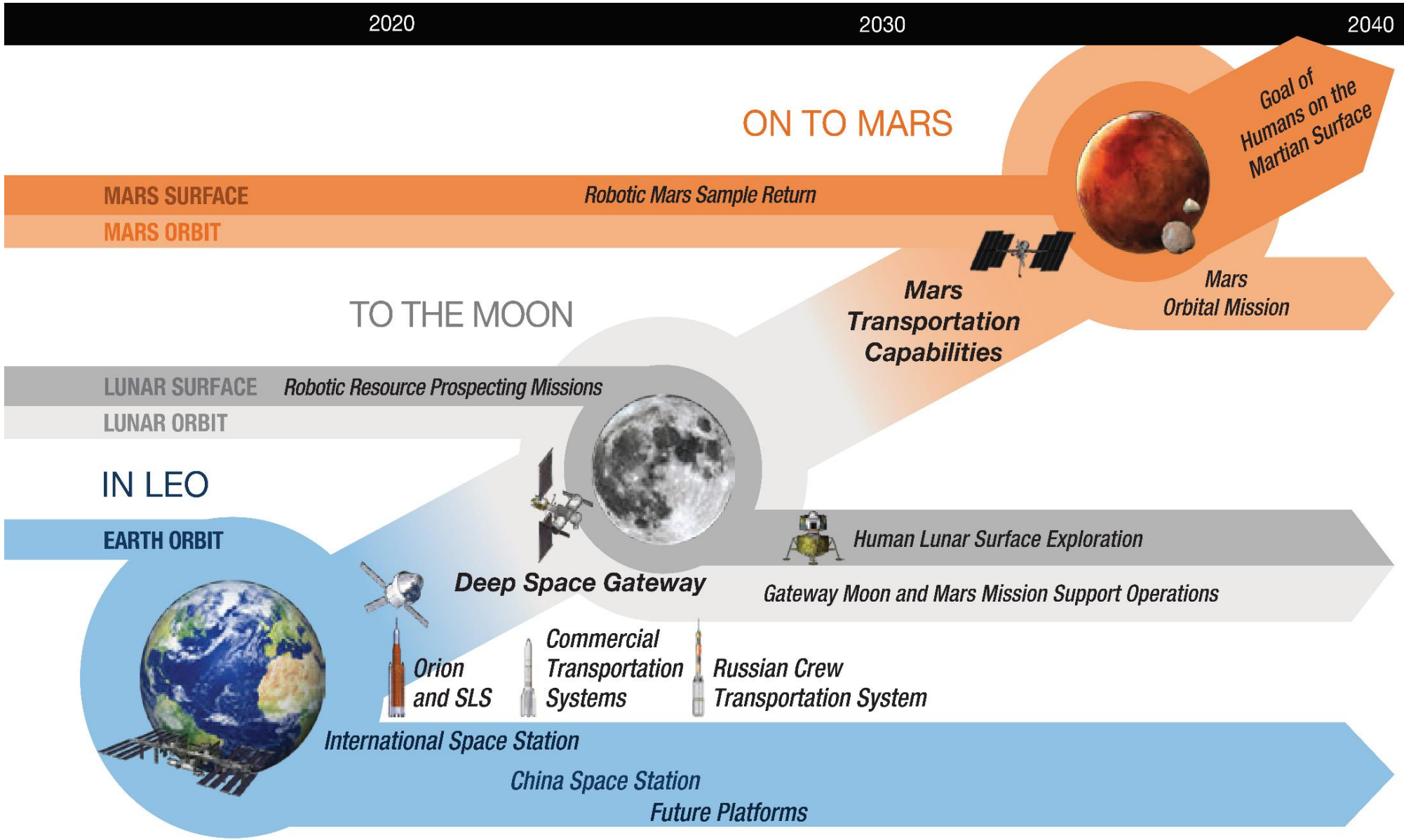
Osiris-Rex

Global Space Exploration Strategy

International Space Exploration Coordination Group

- Established by the 14 Space Agencies:
  - CSIRO – Australia
  - CSA – Canada
  - ESA – European Space Agency
  - CNES – France
  - ISRO – India
  - ASI – Italy
  - JAXA – Japan
  - KIRI – Republic of Korea
  - ROSCOSMOS – Russia
  - Star Space Agency – Ukraine
  - UAE Space Agency – United Arab Emirates
  - UK Space Agency – United Kingdom
  - NASA – United States

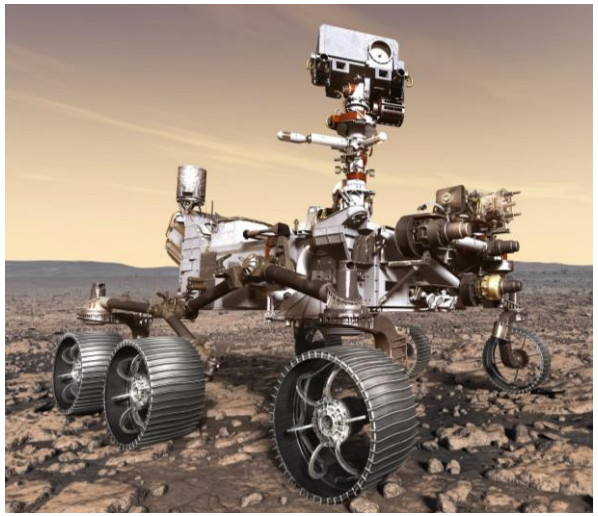
Space Exploration Roadmap

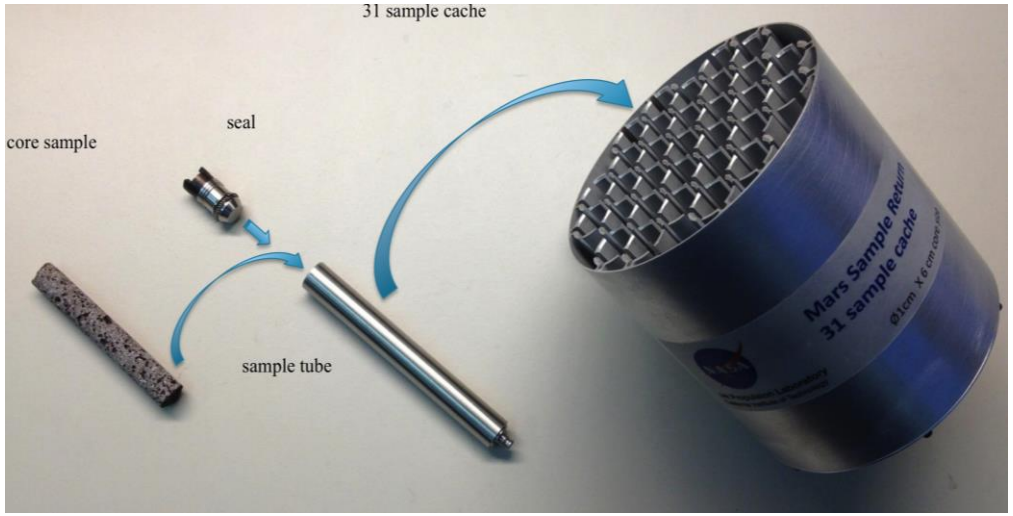


Mars Sample Return

Joint NASA/ESA Enterprise – 2 stage mission

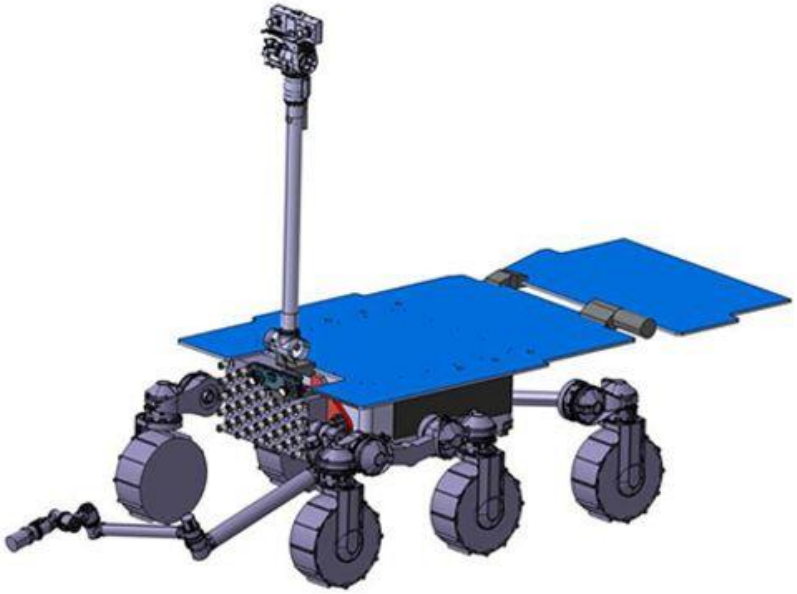
- MARS 2020
  - NASA rover mission with drill to collect core rock/soil samples to cache on Martian surface
  - Carries experiments to support future human exploration e.g. MOXIE – oxygen extraction
- MSR 2030
  - Sample Return Lander with Mars Ascent Vehicle and Sample Fetch Rover to collect samples
  - Earth Return Orbiter – capturing samples to return to Earth. May become a separate mission



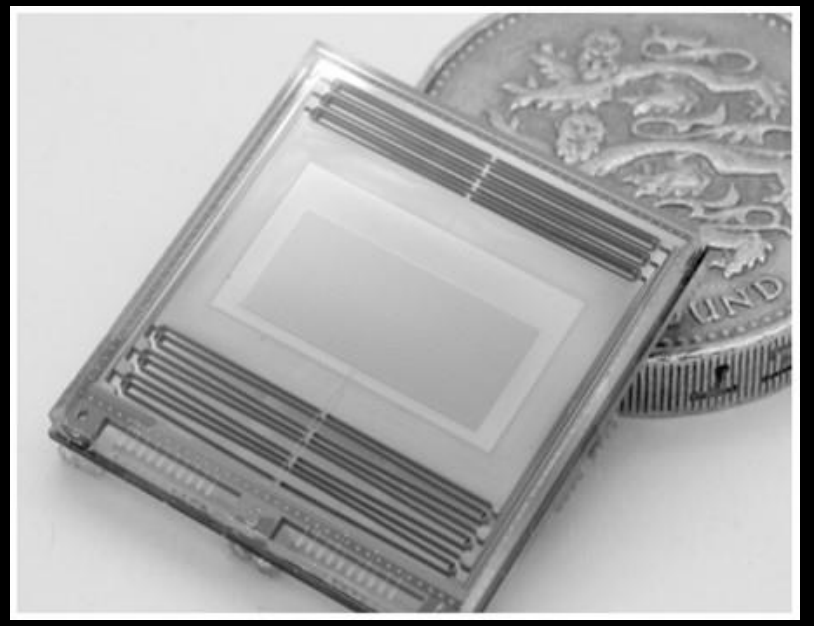


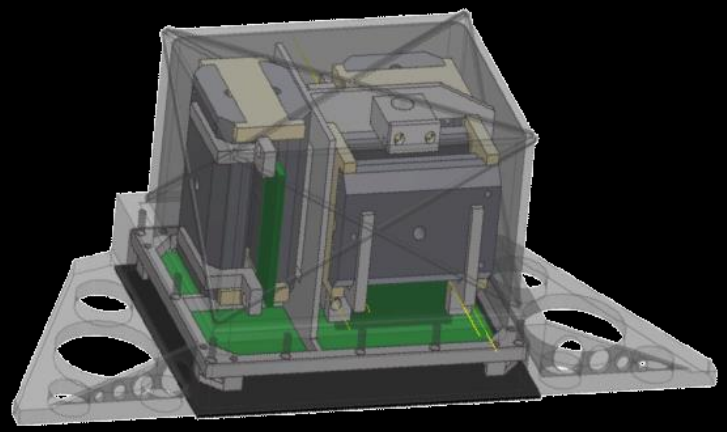
UK Involvement

- Airbus undertaking study for Sample Fetch Rover
- TAS-F undertaking similar study for aspects of rover design
- RAL Space supporting ESA in provision of field trials for robotic testing
  - Building on existing heritage from previous projects in support of ExoMars
  - Includes development of terrestrial analogue rover for testing




INSIGHT
REVEALING THE HEART OF MARS





M A R S

Planetary Protection

Protecting the Earth and Space from biological contamination

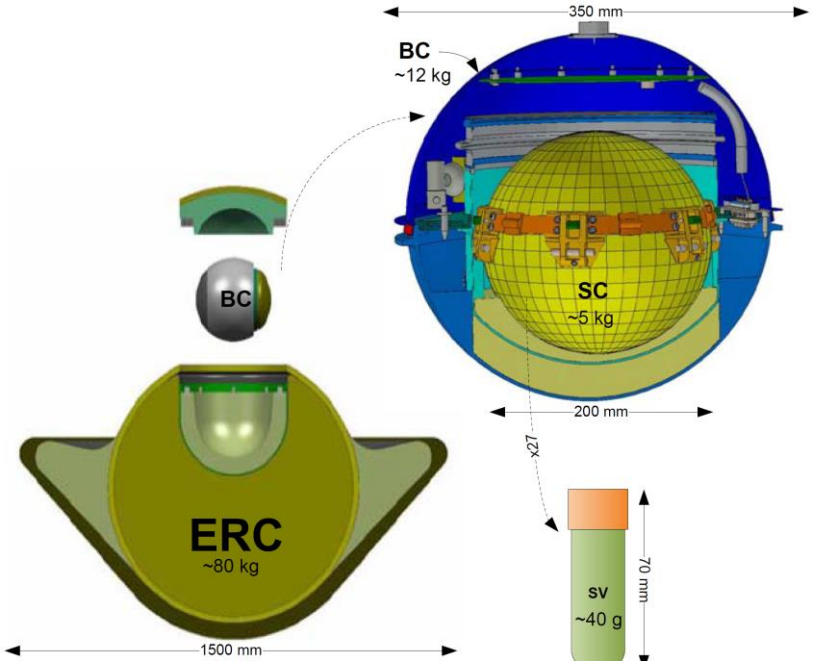
- Legal stipulation in UN Outer Space Treaty; recommendations defined by the Committee on Space Research (COSPAR)

Mission Category	Mission Type	Planetary Bodies
I	Any	No interest to the process of chemical evolution or the origin of life
II	Any	Significant interest to process of chemical evolution and/or the origin of life - only a remote chance that contamination could compromise future investigations
III	Flyby, Orbiter	Significant interest to process of chemical evolution and/or the origin of life - significant chance that contamination could compromise future work
IV	Lander, Probe	Significant interest to process of chemical evolution and/or the origin of life - significant chance that contamination could compromise future work
V (unrestricted)	Earth Return	Deemed to have no indigenous life-forms
V (restricted)	Earth Return	Significant interest to the process of chemical evolution and/or the origin of life

Returning Samples

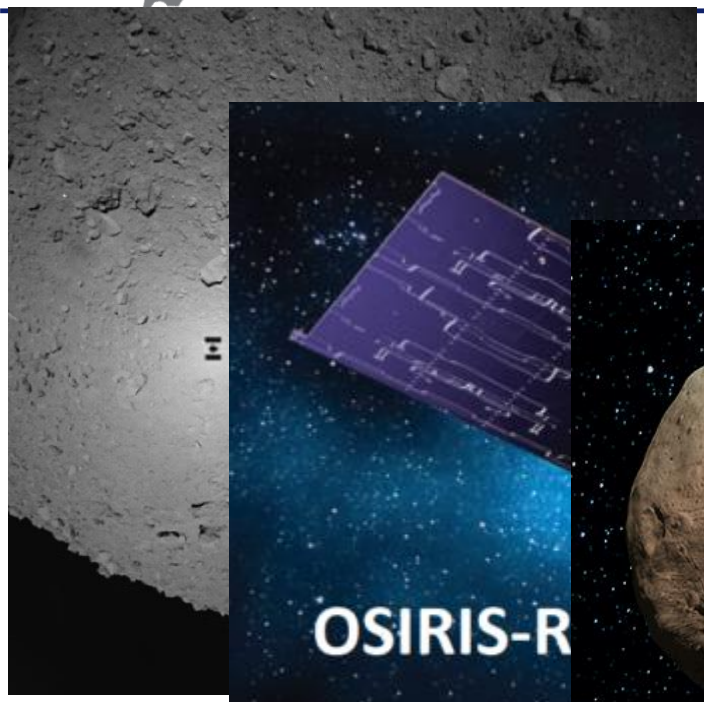
The need for a dedicated Return Facility

- Sample cores placed in layers of containers to survive transport to and re-entry into Earth's atmosphere



- Landing site for Earth Return Capsule identified in Utah Desert – Return Facility to be located here

Planned Missions



Sample Curation Facility

Scientific analysis

Hub for European Sample Science

Outreach & education

STFC Harwell Campus

European Sample Curation Facility

Establishing an international facility at Harwell Campus

- Sample Analogue Curation Facility established at Harwell Campus
  - Collection prepared by Natural History Museum
  - Facility set up and run by ESA
  - Location identified and supported by STFC
- Preparation of a Business Case
  - Collaborating with Natural History Museum
- Investigating sources of funding
- Environmental Impact feasibility study

Thank you