Mars Sample Return (MSR)

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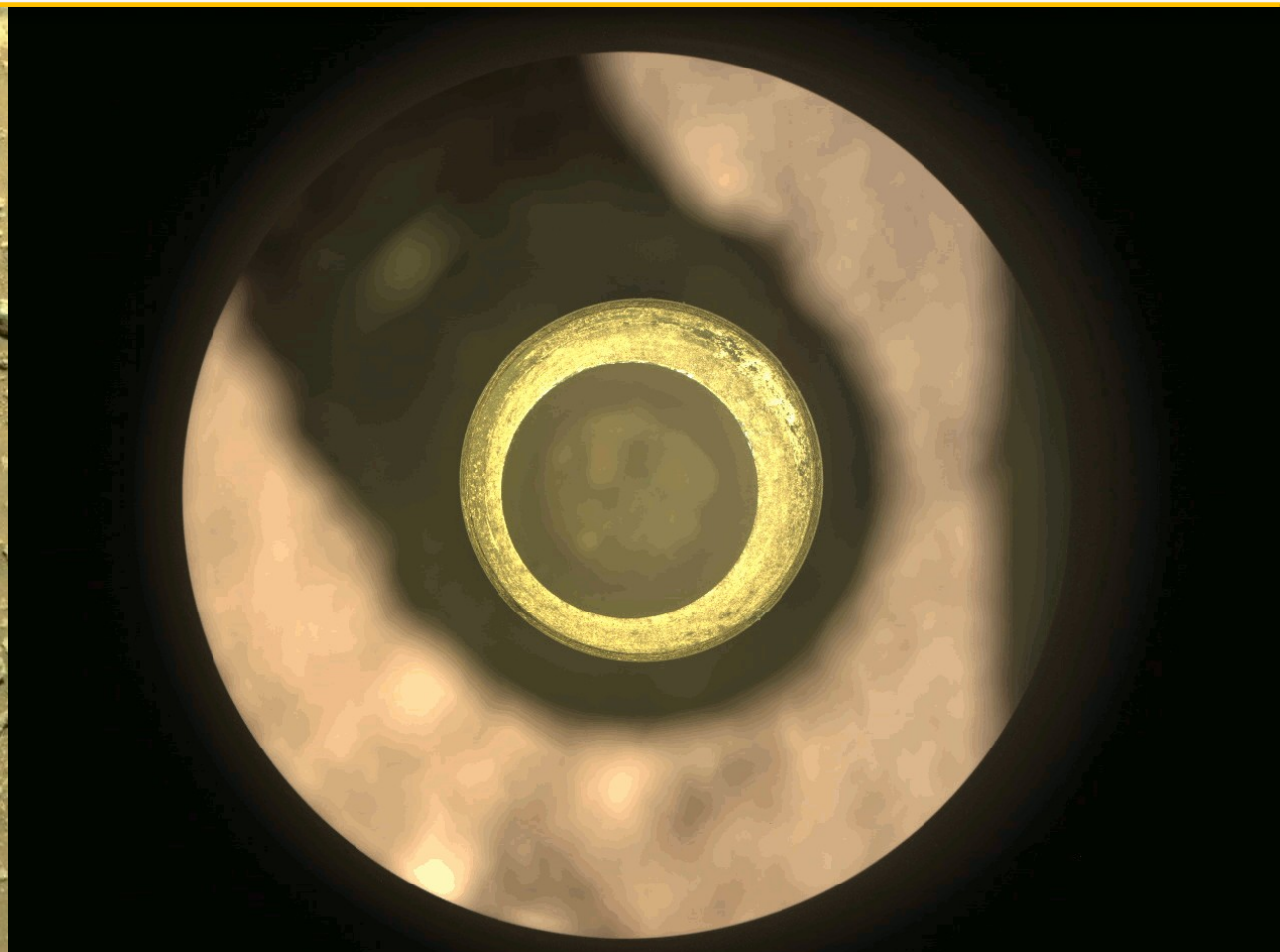
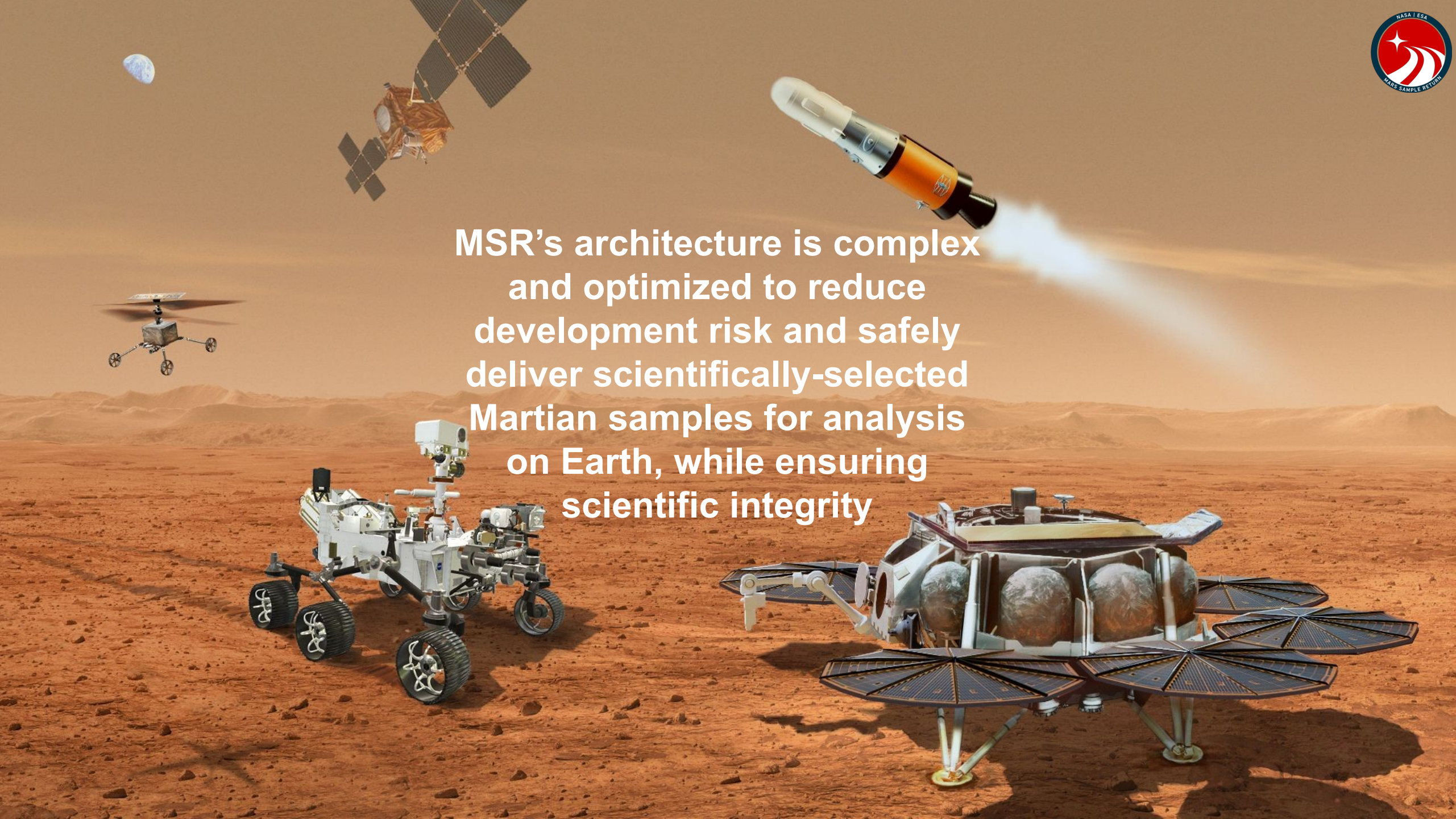
IAC, September 2022

The decision to implement Mars Sample Return will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process. This presentation is being made available for information purposes only.

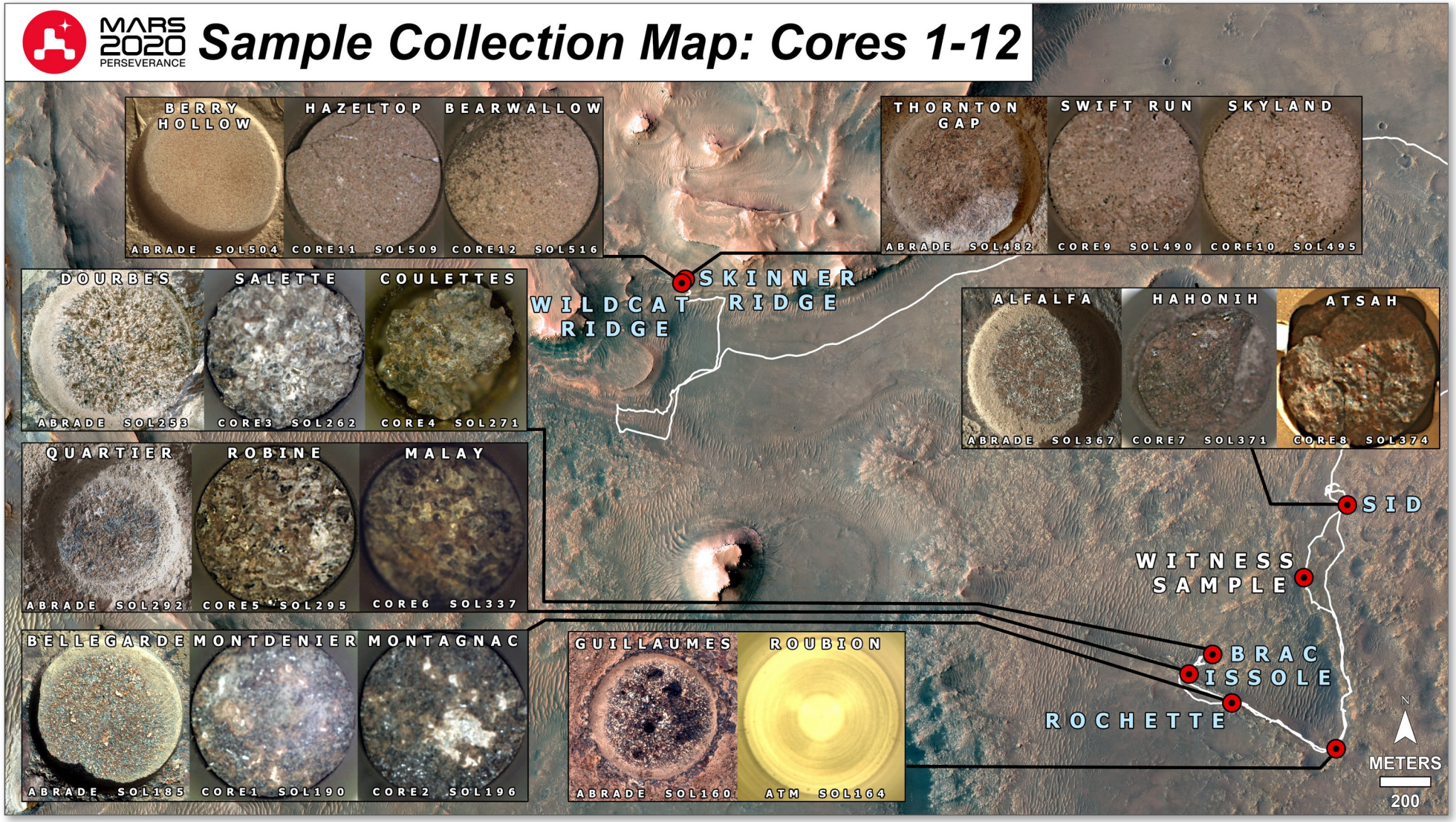
“The highest scientific priority of NASA’s robotic exploration efforts this decade should be completion of Mars Sample Return as soon as is practicably possible with no increase or decrease in its current scope”

Origins, Worlds, and Life- A Decadal Strategy for Planetary Science and Astrobiology 2023-2032

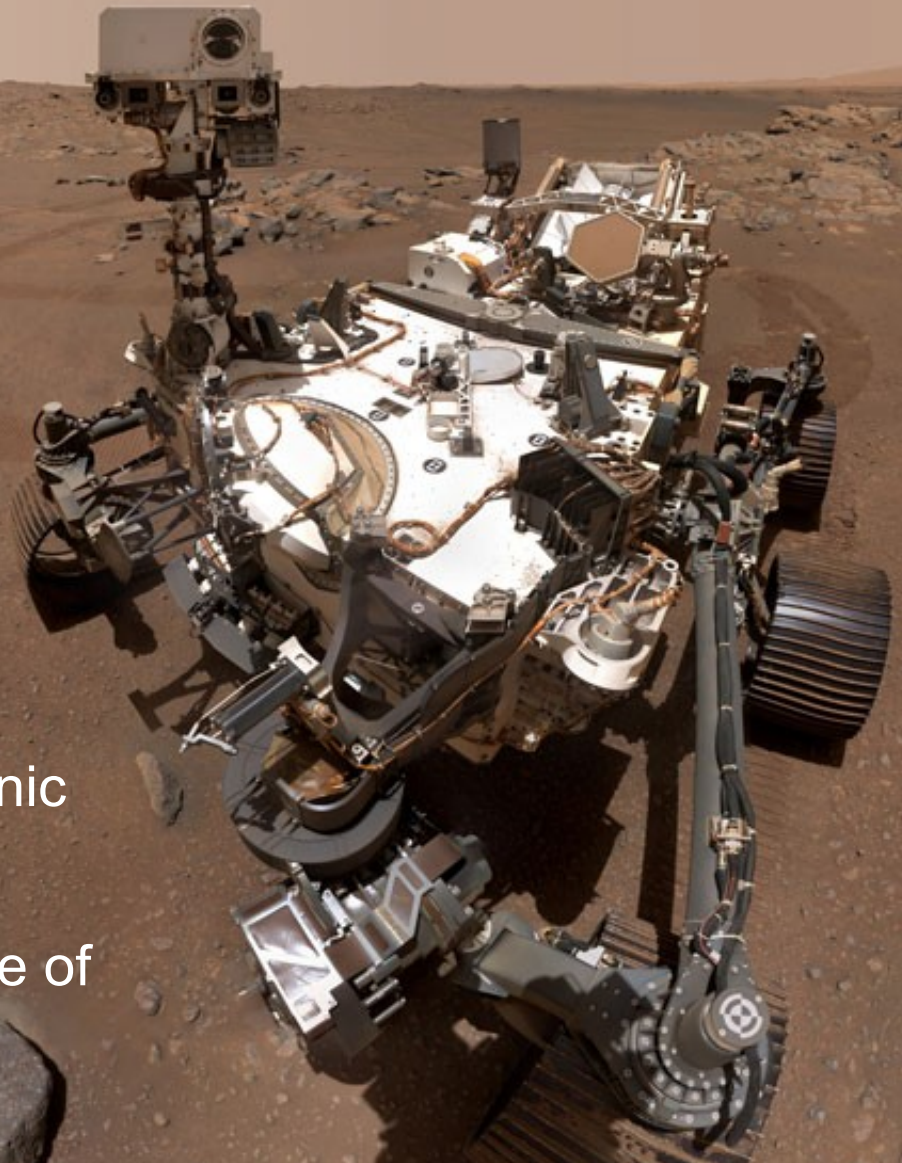



MSR’s architecture is complex and optimized to reduce development risk and safely deliver scientifically-selected Martian samples for analysis on Earth, while ensuring scientific integrity

The MSR Campaign is underway with successful landing and collection of 12 scientifically-selected samples



All of the science objectives* for MSR could be addressed by the samples already cached



Examples:

- ✓ Igneous rocks: absolute ages of units in Jezero crater and anchor the ages of Martian epochs
- ✓ Detrital sedimentary rocks from the delta front, a target for the search for evidence of life
- ✓ Evidence of aqueous alteration: insights into the history of water in this region of Mars
- ✓ Organic compounds: deduce their origins (biogenic vs. abiogenic).
- ✓ Samples to address major gaps in our knowledge of concern to future human exploration.

*Beaty, et al, 2019, *Meteorit Planet Sci* 54:S3-S152

A Joint ESA-NASA Science Team has been established and a Science MOU is in development

Co-Chairs


Michael Meyer


Gerhard Kminek

Joint Science Office


Dave Beaty


Elliot Sefton-Nash


Brandi Carrier


Fiona Thiessen


Tim Haltigin

Selected Members


Audrey Bouvier


Andy Czaja


Nicholas Dauphas


Kate French


Lydia Hallis


Rachel Harris


Ernst Hauber


Laura Rodriguez


Susanne Schwenzer


Andrew Steele


Kim Tait


Michael Thorpe


Tomo Usui


Jessica Vanhomwegen


Michael Velbel


Maria-Paz Zorzano

Ex Officio


Sam Edwin


Ken Farley


Danny Glavin


Andi Harrington


Lindsay Hays

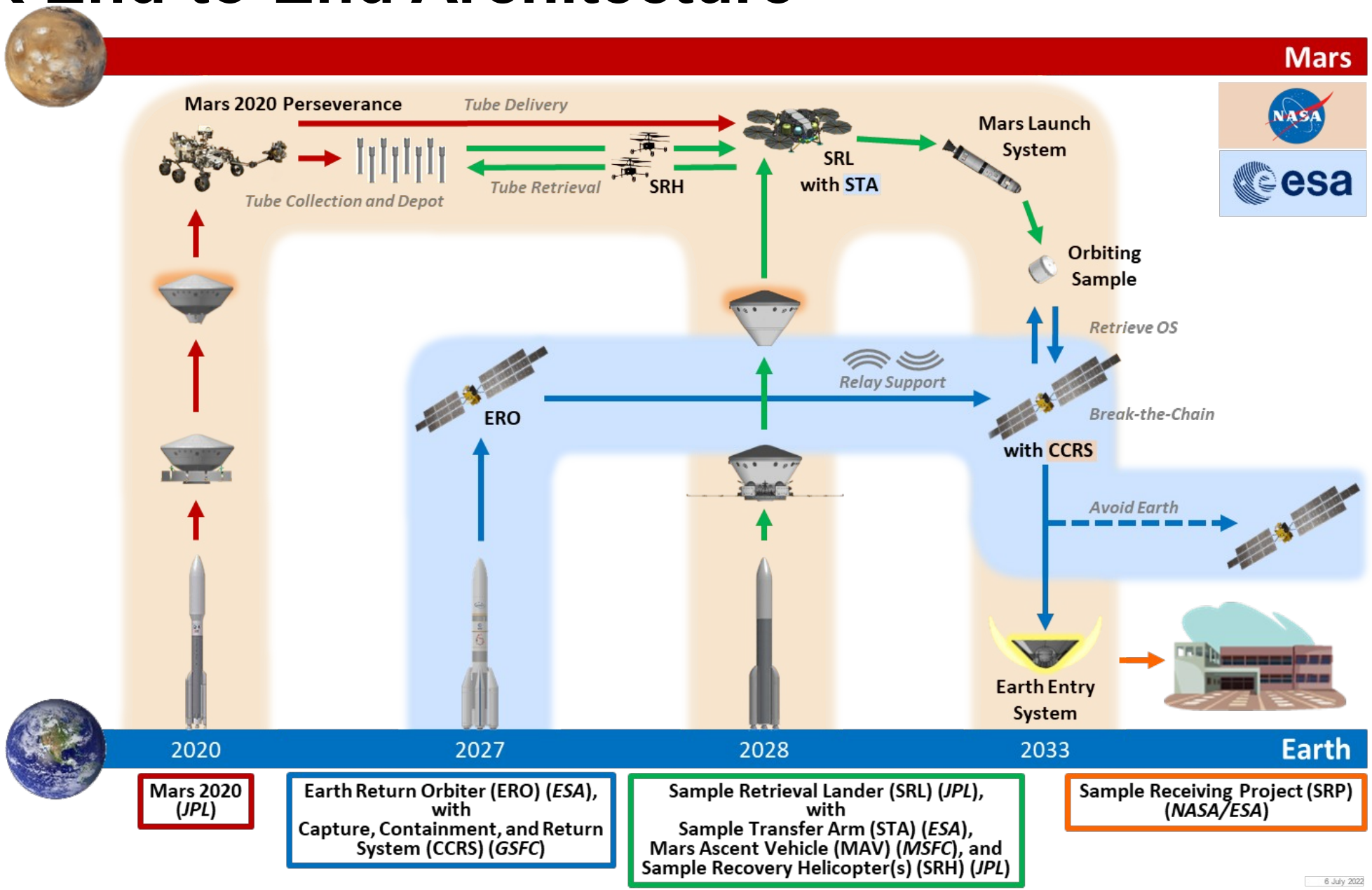

Aurore Hutzler


Mini Wadhwa

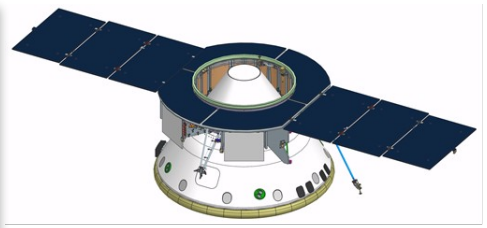
The **MSR Campaign Science Group** was openly competed and jointly selected. They will ensure the science potential of the returned samples will be realized through science community involvement

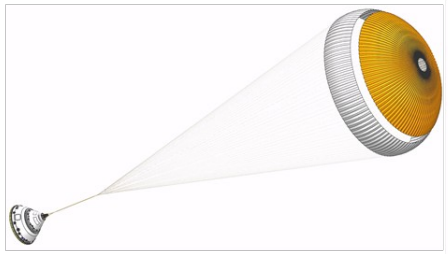
The **Science Memorandum of Understanding (MOU)** is an agreement between agencies codifying our intended science collaboration

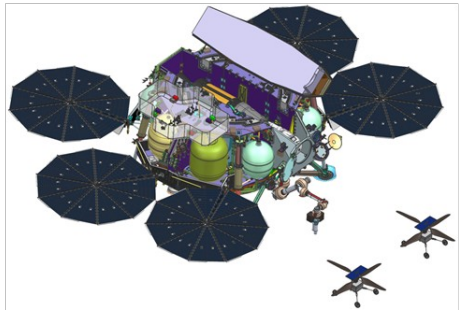
MSR End-to-End Architecture

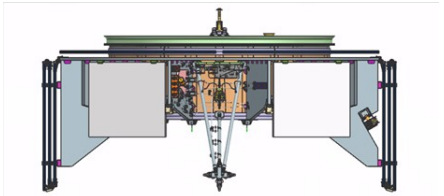


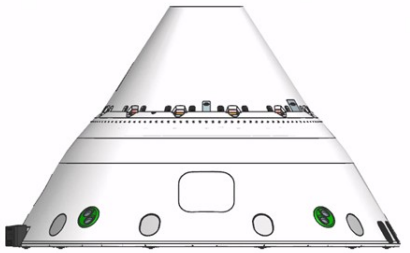
Bringing Mars samples to Earth for future study will require several steps with multiple spacecraft, in a synchronized manner

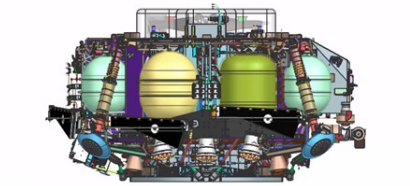


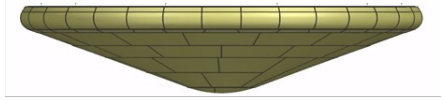


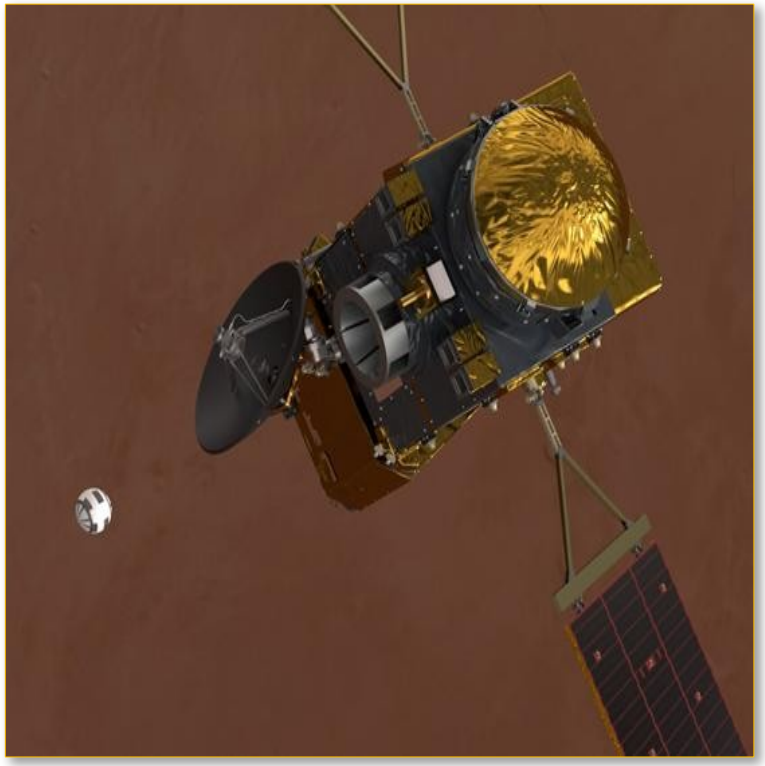




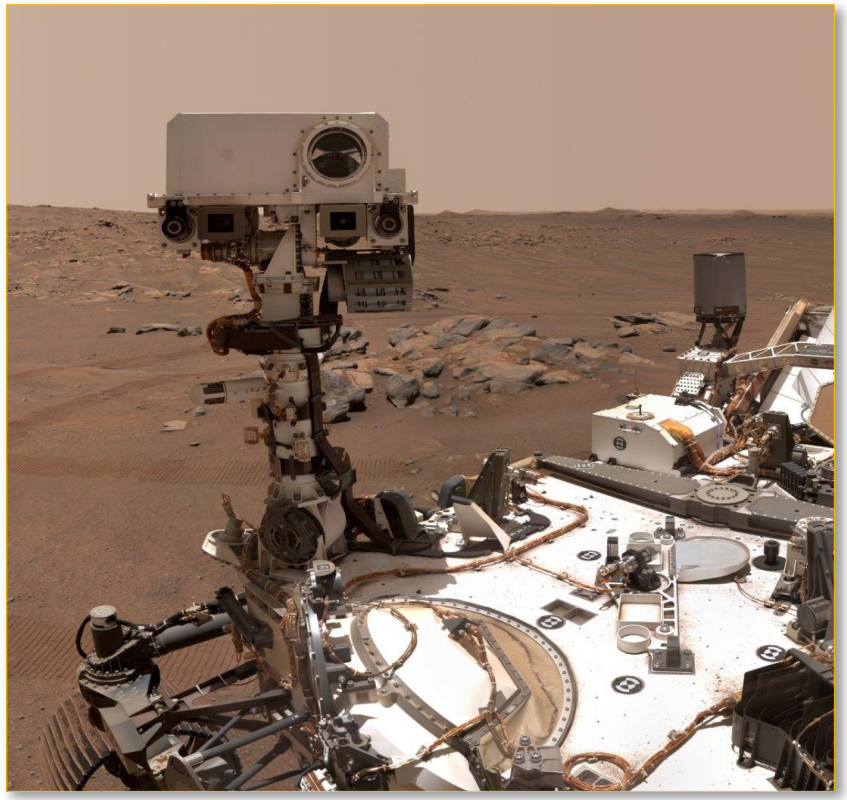


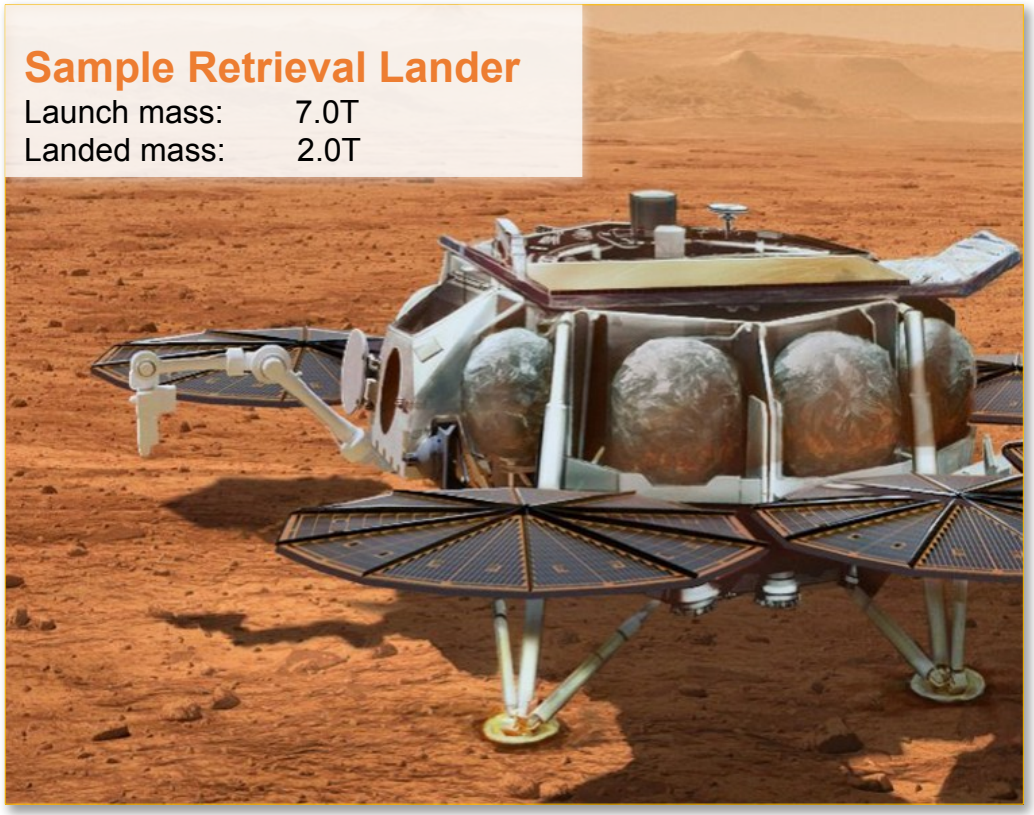


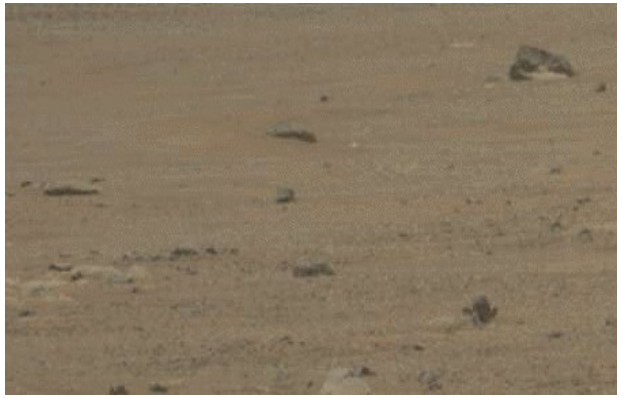




NASA's Sample Retrieval Lander (SRL) with the Mars Ascent Vehicle (MAV), two Sample Recovery Helicopters (SRH), and ESA's Sample Transfer Arm (STA) will join the Perseverance rover near Jezero Crater.

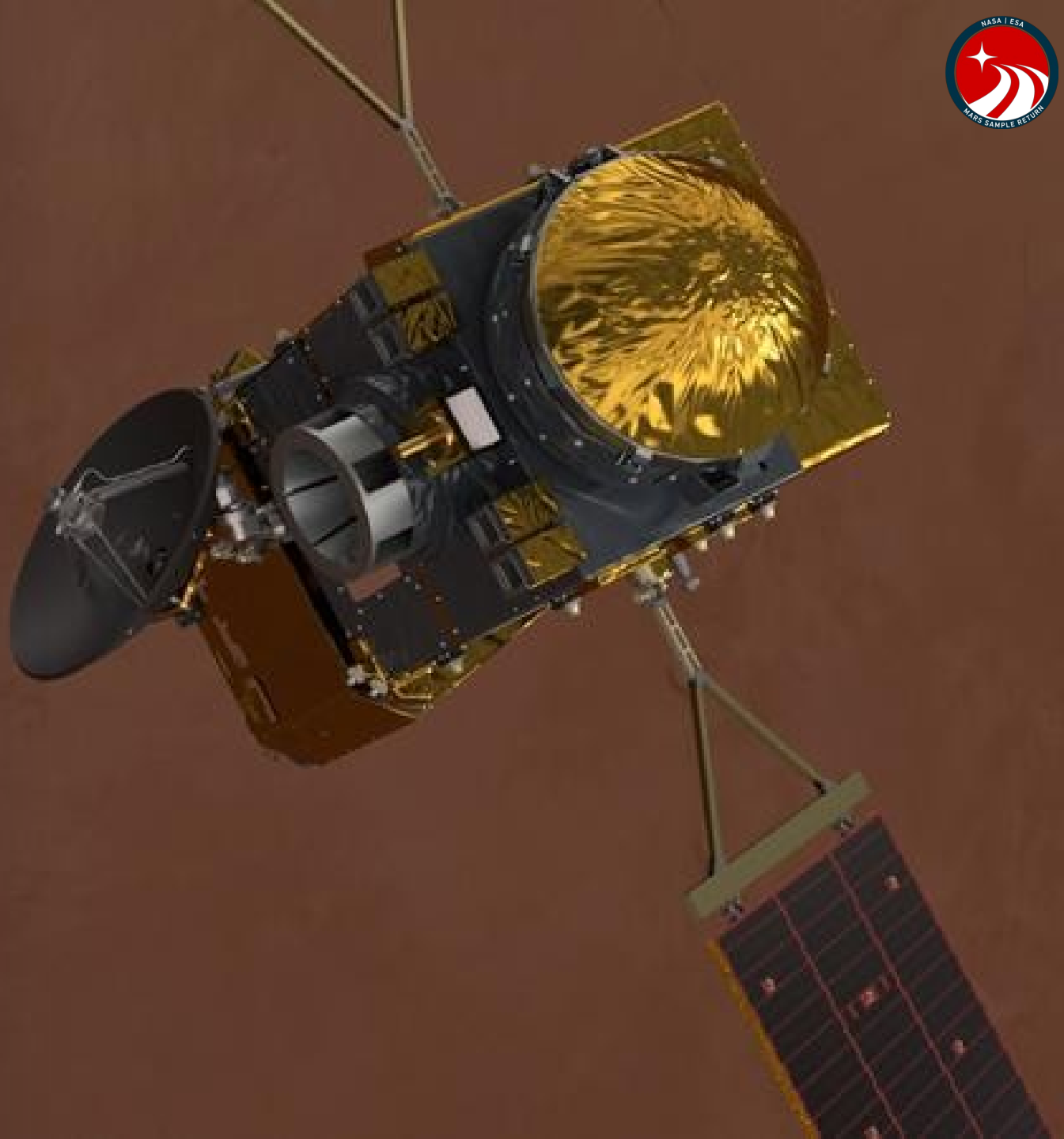






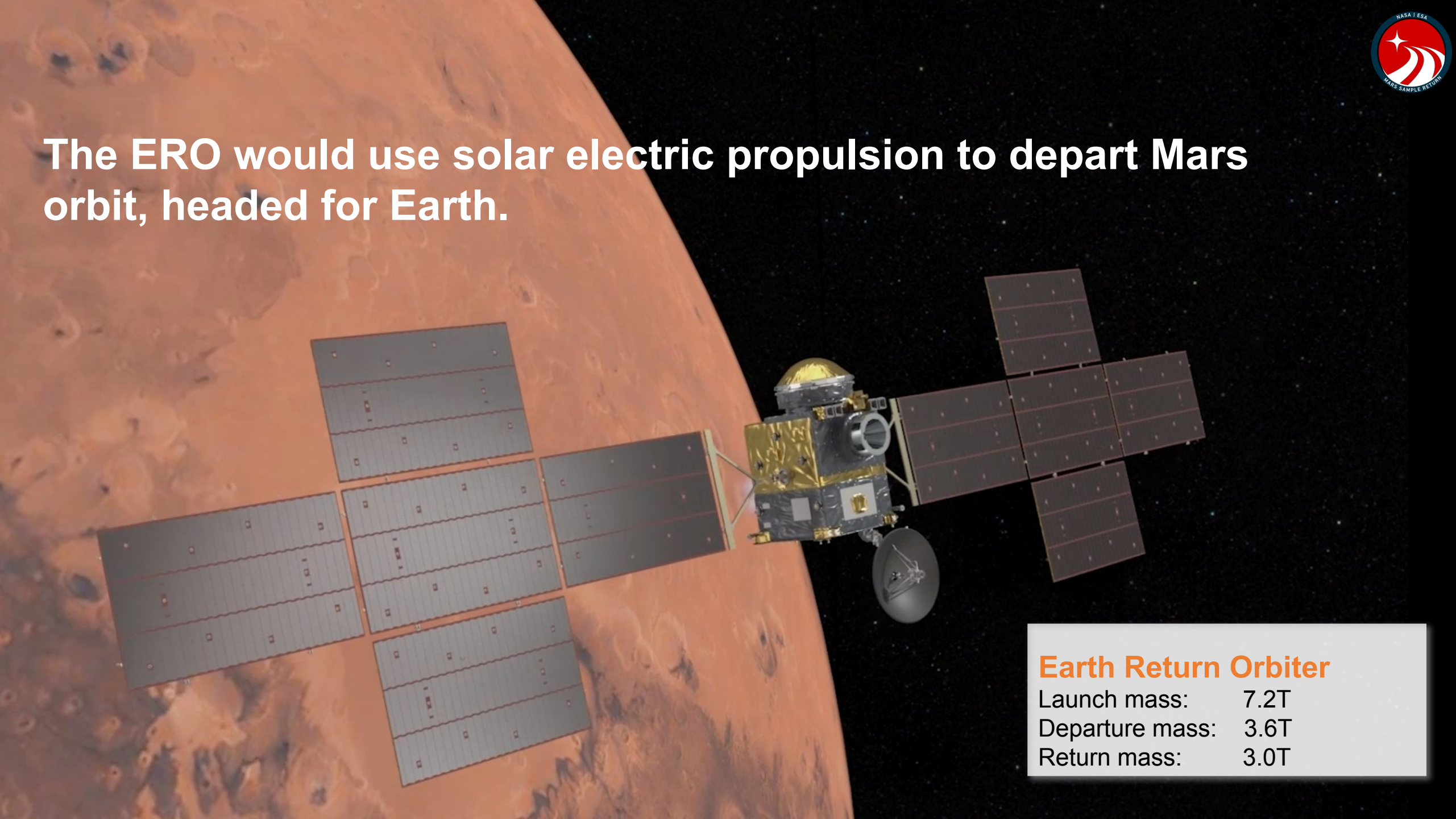
With samples in hand, the MAV would be the first rocket ever to launch from the surface of another planet.

Another spacecraft, the ESA Earth Return Orbiter (ERO) will travel to Mars, carry the Capture, Containment, and Return System (CCRS), provide data relay services during lander descent and surface phase operations through MAV launch, while waiting in orbit to collect the samples and return them safely to Earth.



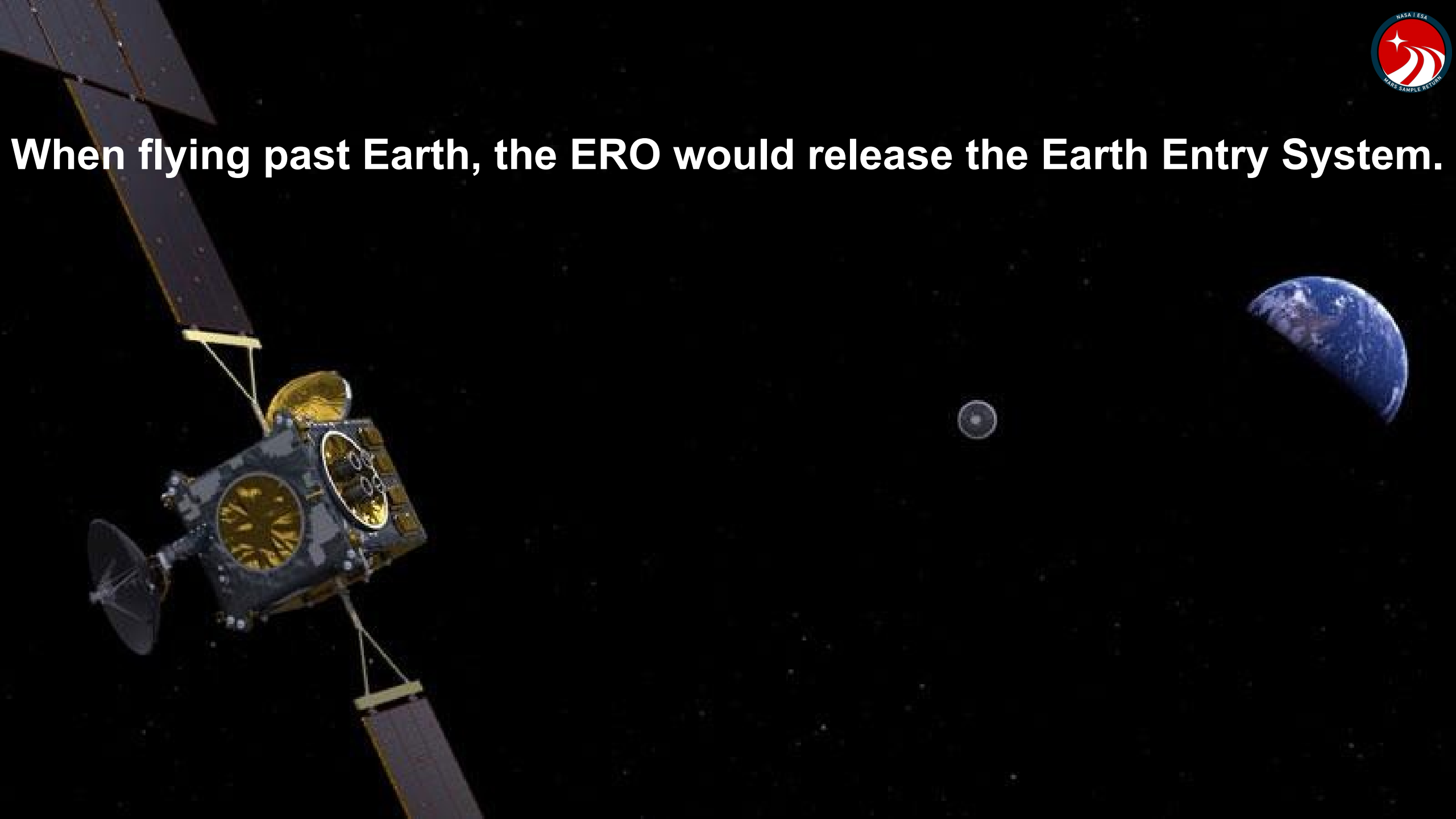
Inside the orbiter would be the NASA-provided CCRS, which would contain the sealed samples, then prepare them for the return to Earth inside the Earth Entry System.

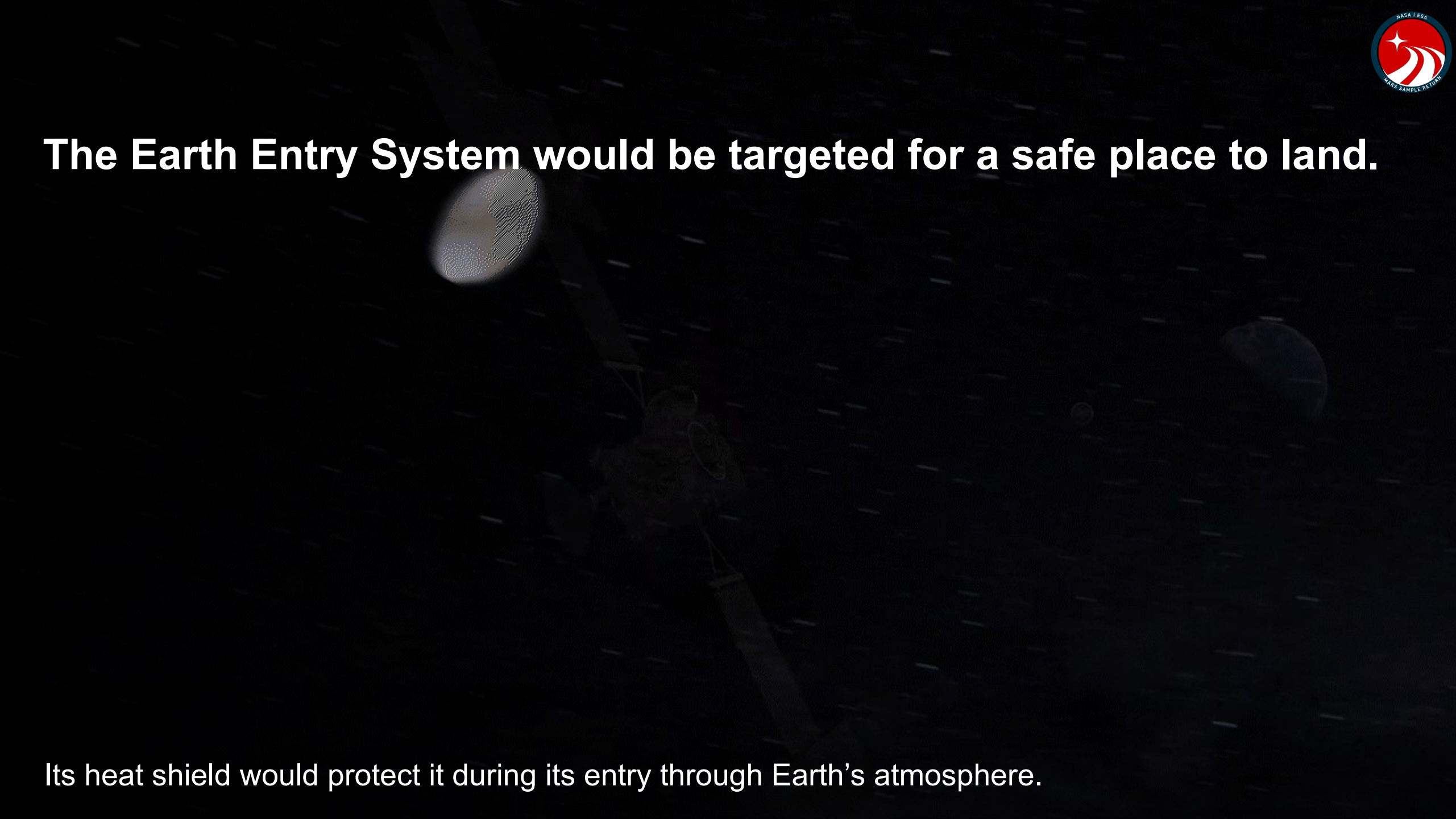
The ERO would use solar electric propulsion to depart Mars orbit, headed for Earth.



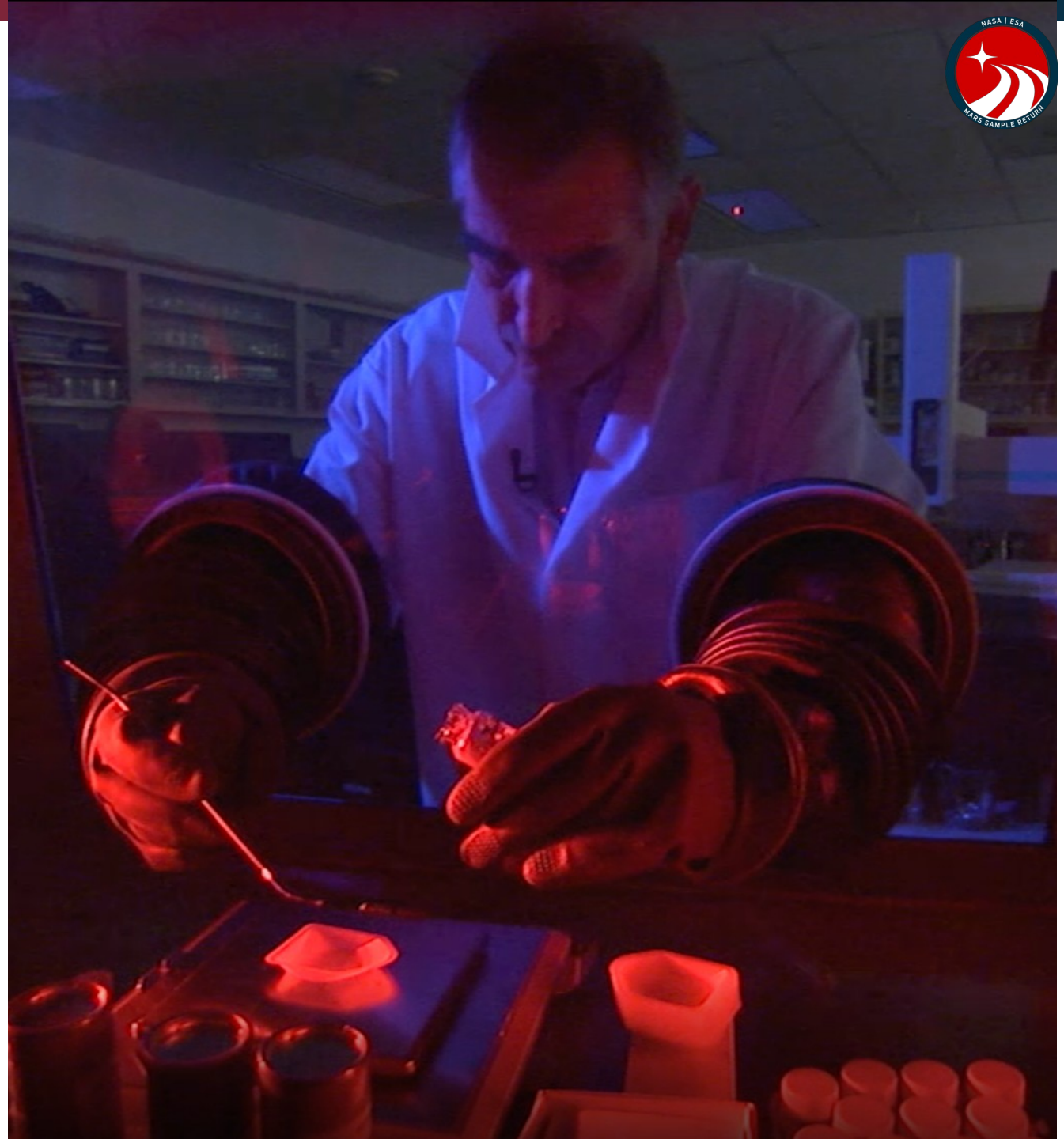
Earth Return Orbiter

Launch mass:	7.2T
Departure mass:	3.6T
Return mass:	3.0T


When flying past Earth, the ERO would release the Earth Entry System.


The Earth Entry System would be targeted for a safe place to land.
Its heat shield would protect it during its entry through Earth’s atmosphere.

On Earth, we can apply the full breadth of terrestrial science laboratories to study samples, including many instruments too large and complex to send to Mars, and including instruments yet to be invented.



The architecture was externally reviewed by an independent ESA-NASA Review Board at the Mission Definition Review (July 12-15, 2022)

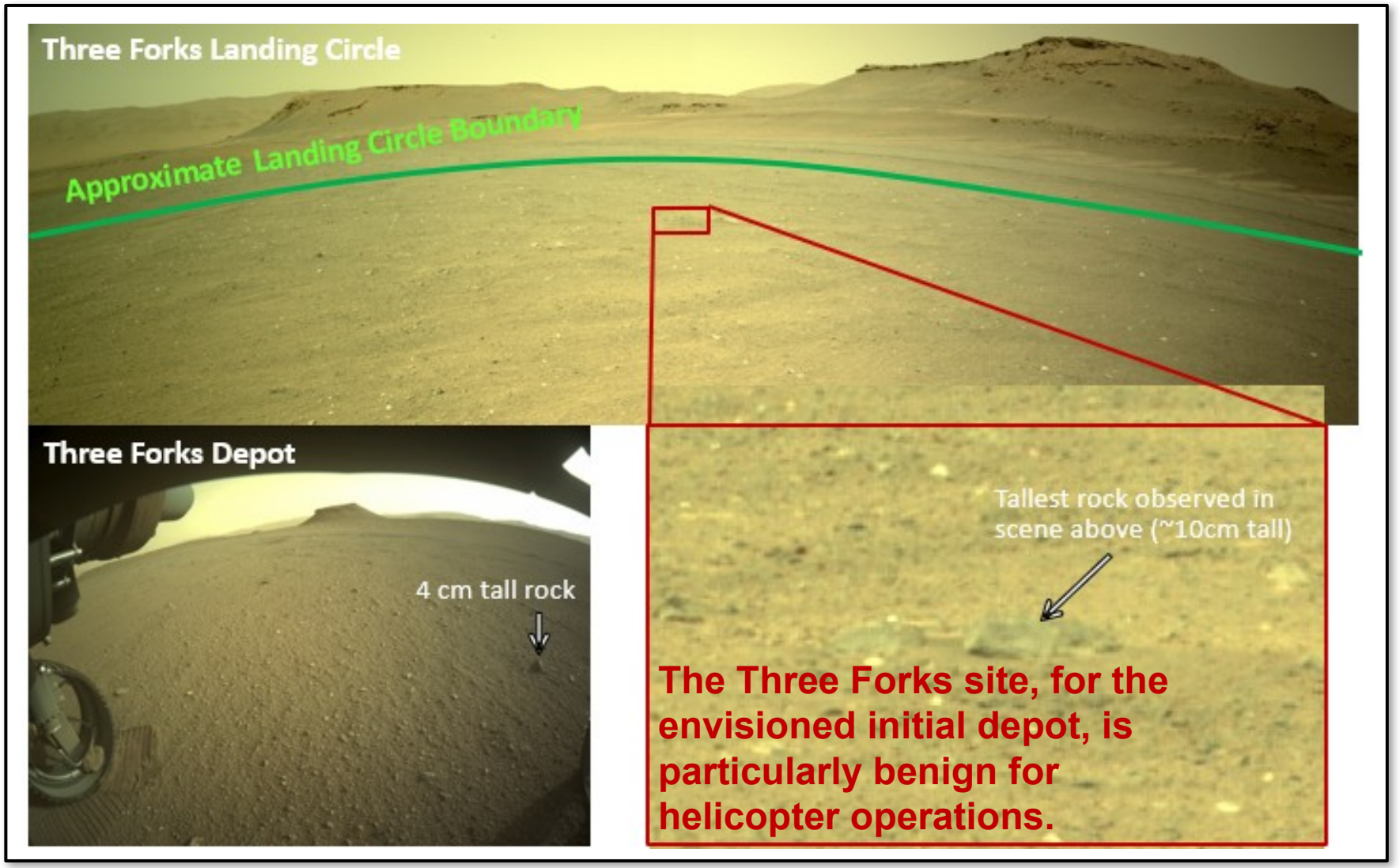
NASA KDP-B Expected By End of September 2022

Planning is underway to establish an initial surface depot at Three Forks

Establishment of the initial depot will be preceded by a Science Team workshop to review caching plans.

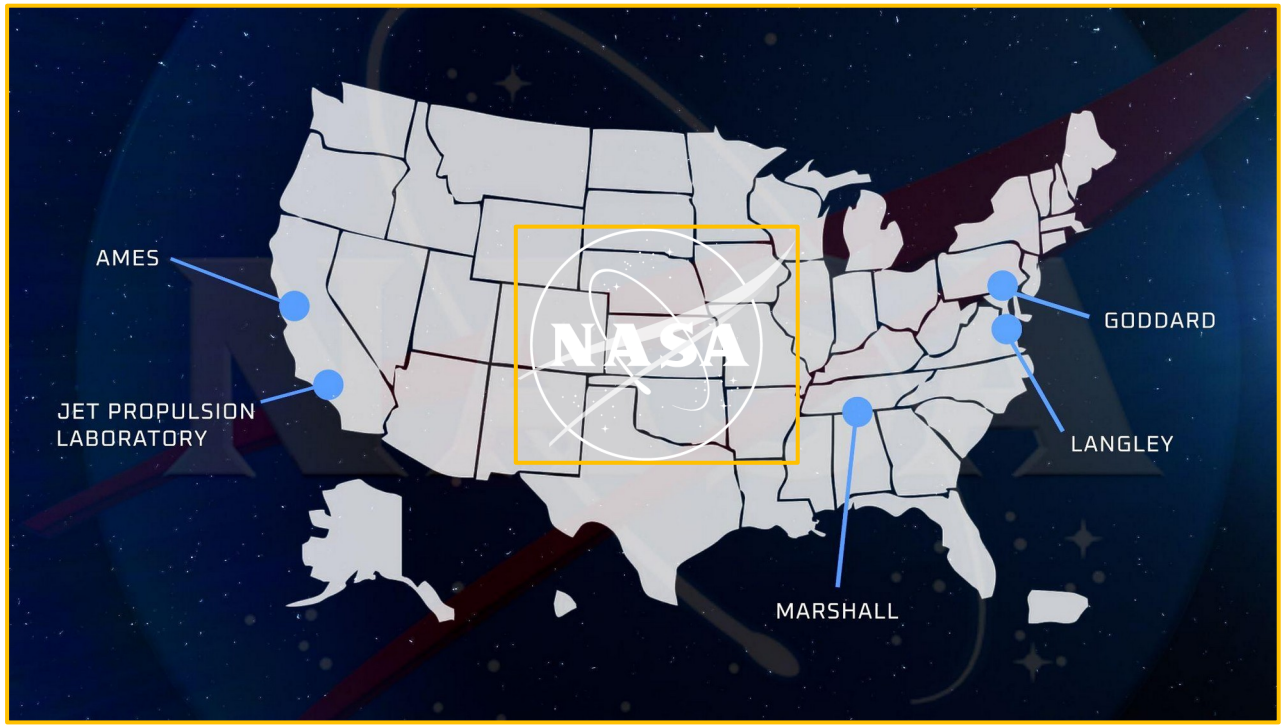
The open **Mars 2020/MSR Sample Depot Science Community Workshop** will solicit input from the science community on the potential for the samples in this proposed depot to meet MSR's science objectives.

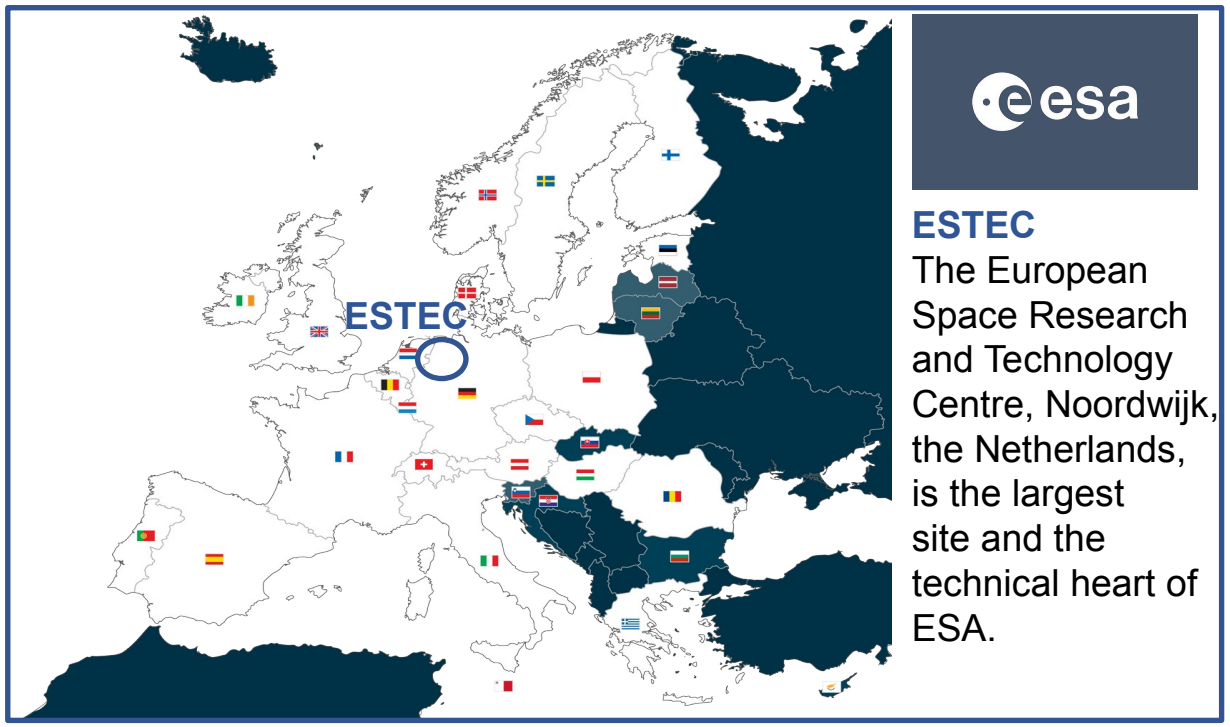
With a depot of scientifically exciting samples on the surface of Mars, and cached on the rover, two pathways to get samples to the lander exist



MSR is an ESA-NASA Partnership

- MSR is an ambitious, international science mission to collect and return rock and sediment samples from the Martian surface
- It is only possible today as a result of the substantial investments made through the formulation, technology and operational projects of the past decades, being realized through an international partnership





ESTEC
The European Space Research and Technology Centre, Noordwijk, the Netherlands, is the largest site and the technical heart of ESA.

MSR'S Responsibilities

Memorandum Of Understanding co-signed 5 October 2020 by NASA and ESA

NASA
- Manages Mars 2020 mission and sample caching/delivery of samples to SRL
- MSR campaign manager
- SRL mission lead, including the MAV and SRH
- Integrate and operate the ESA-delivered STA
- Launch SRL
- Deliver Orbiting Sample (OS) into Martian orbit
- Develop and deliver the to ERO the CCRS and Electra UHF radio payloads

ESA
- Supports MSR campaign activities
- Develop/operate the ERO mission
- Integrate CCRS onboard ERO
- Launch ERO with Ariane-64
- Identify/capture the OS around Mars
- Return the samples to Earth insertion orbit
- Data relay to Mars operations of SRL, Perseverance, SRH, and MAV
- Develop STA

NASA and ESA
- Coordinate biological planetary protection
- Develop a joint organization to draw maximum science benefit from the mission

Major developments are ongoing at NASA and ESA

- **SRL:** Managed by JPL with major developments from US and European industry
  - **MAV:** US consortium led by NASA's Marshall Space Flight Center
  - **STA:** European consortium led by Leonardo Spa Italy
  - **SRHs:** US consortium led by NASA's Jet Propulsion Laboratory
- **ERO:** European consortium led by Airbus Defense and Space France
  - **CCRS:** US consortium led by NASA's Goddard Space Flight Center
- The development of a **Sample Receiving Project** is also foreseen to recover, curate, and analyze the Martian samples.
  - Envisioned to be a US consortium led by NASA's Johnson Space Center

Now is the Time!

- Mars Sample Return has been a priority of the planetary science community for half a century
- Now is the time to complete the campaign to return scientifically selected samples for study using advanced instruments in laboratories around the world
- Breaking new Ground:
  - First precision landing
  - First launch from another planet
  - First in-orbit rendezvous at Mars
  - First round-trip mission to another planet
  - First return of samples from another planet

NASA/ESA Partnership is:

- Accomplishing the multi-decadal goal of returning samples from Mars
- Paving the way for future human exploration of Mars