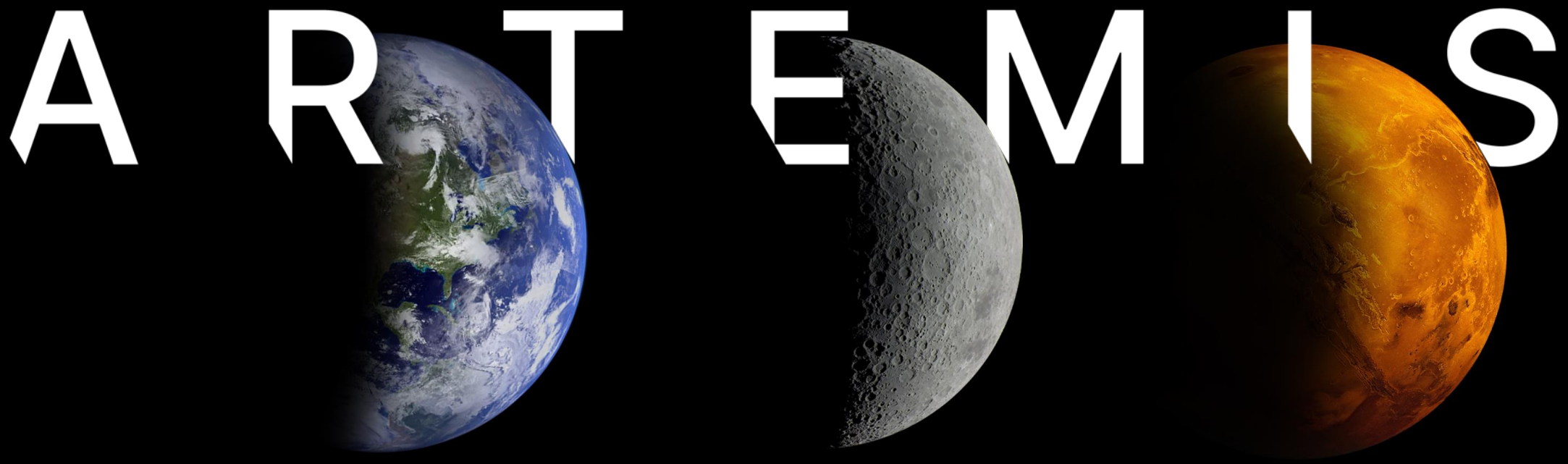
Korean Space Health Summit

September, 2024

National Aeronautics and Space Administration

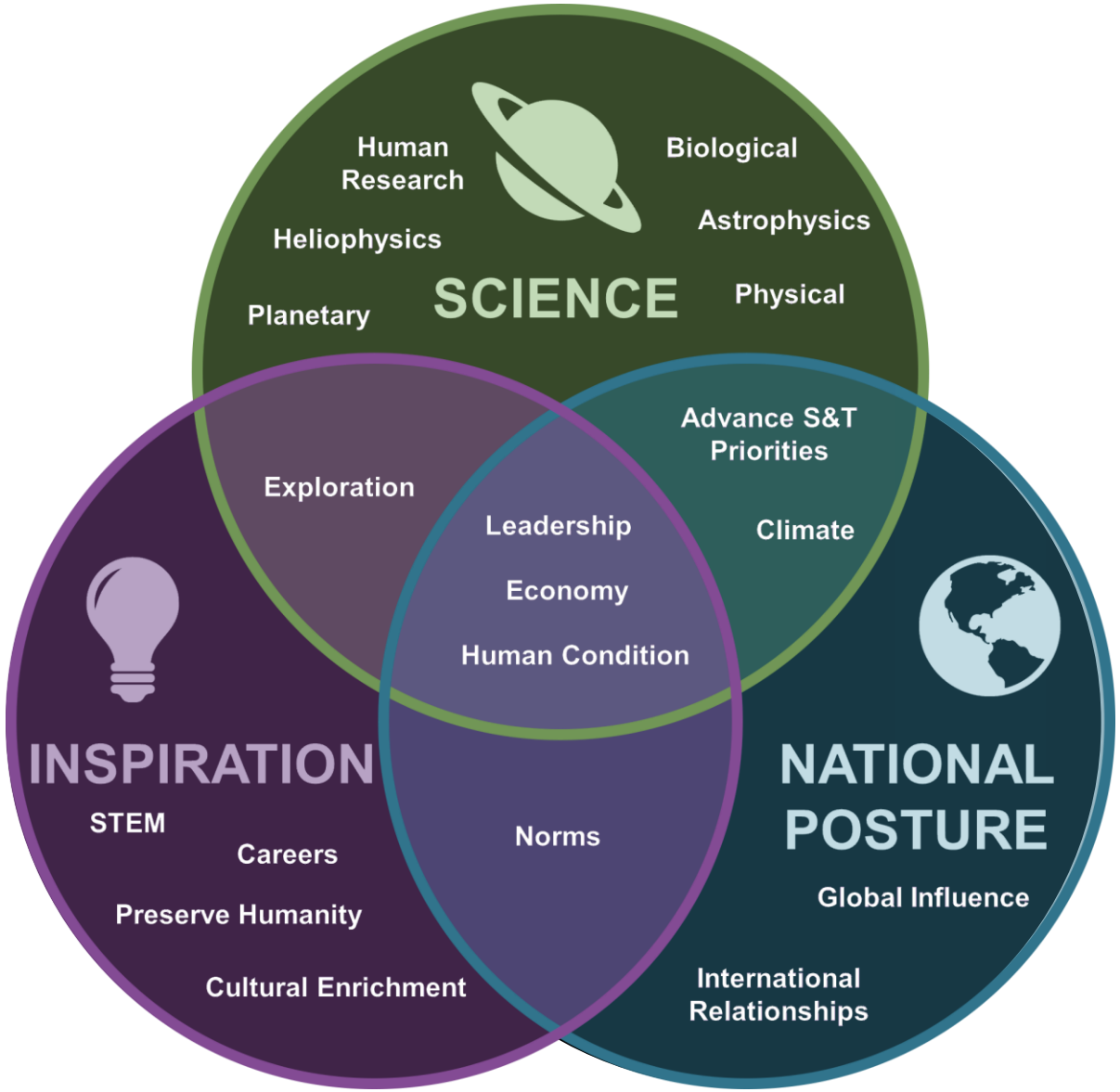
NASA



Jancy McPhee
Associate Chief Scientist
NASA Human Research Program

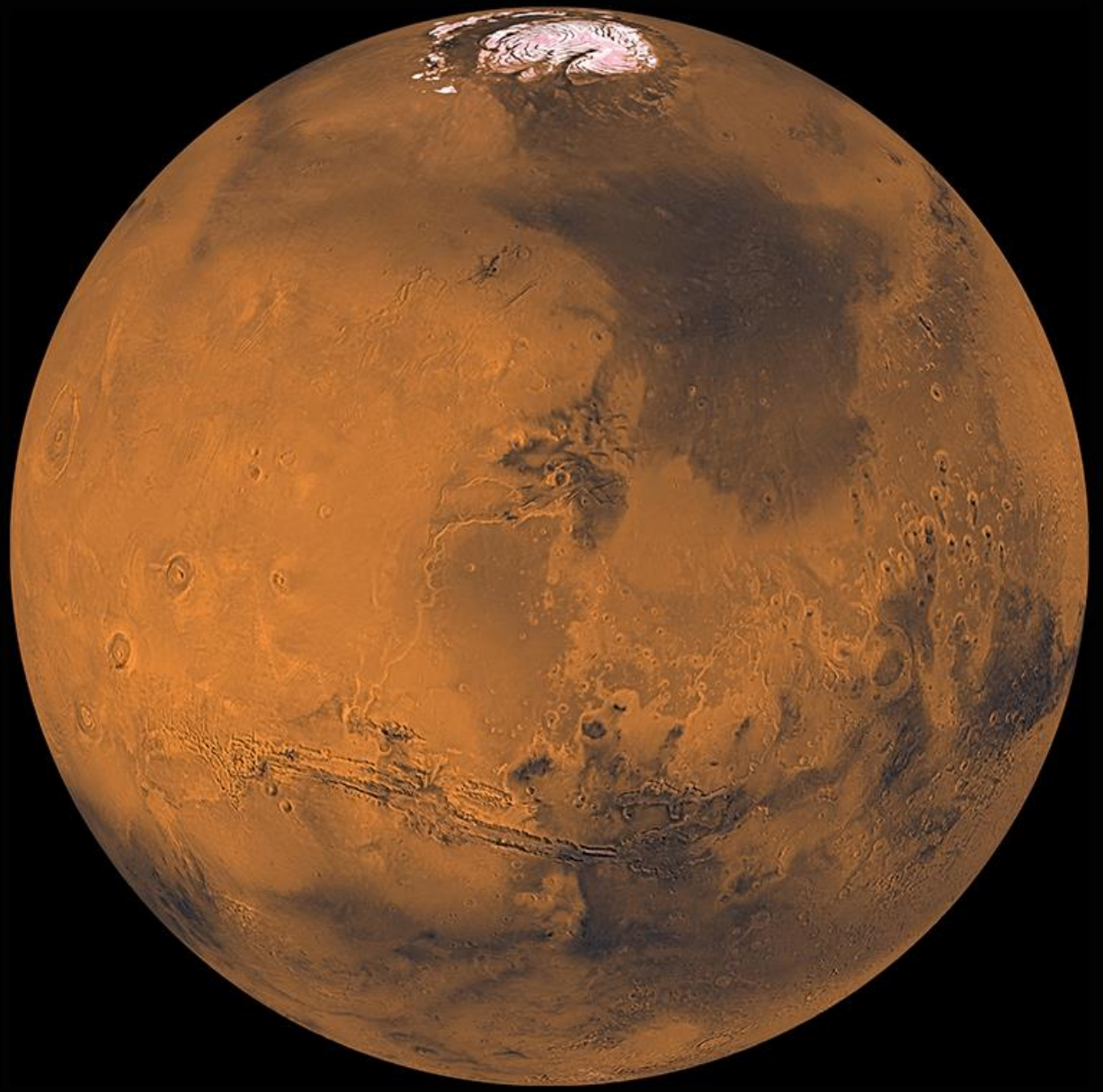
www.nasa.gov

Why Go? Benefits to Humanity




Vast
scientific
potential


Living On The Moon



ARTEMIS ACCORDS


Angola


Argentina


Armenia


Australia


Bahrain


Belgium


Brazil


Bulgaria


Canada


Colombia


Czech Republic


Ecuador


France


Germany


Greece


Iceland


India


Israel


Italy


Japan


Lithuania


Luxembourg


Mexico


Netherlands


New Zealand


Nigeria


Peru


Poland


Republic of Korea


Romania


Rwanda


Saudi Arabia


Singapore


Slovakia


Slovenia


Spain


Sweden


Switzerland


Ukraine


United Arab Emirates


United Kingdom


United States of America


Uruguay

United for Peaceful Exploration of Deep Space

AA–12.12.48

International Collaboration: People

Crew of Artemis II

50 attendees representing 18 countries attended the Moon to Mars Architecture Workshop on Feb. 20, 2024.

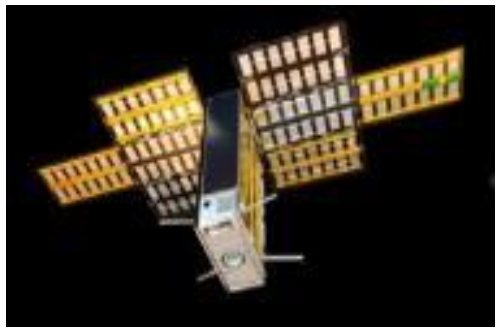
International Collaboration: Hardware

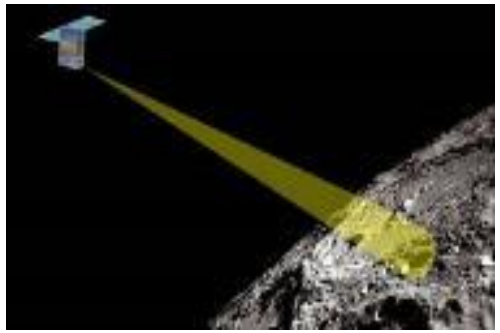
Artist's concept of Gateway

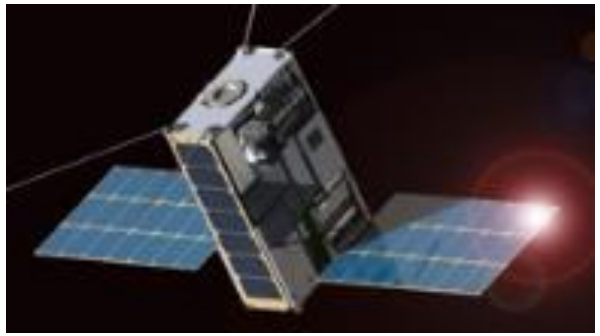
European Service Module for the Orion spacecraft, provided by the European Space Agency.

International Collaboration: Payloads

Artemis I: Several international partners provided payloads to research key knowledge gaps for deep space exploration.

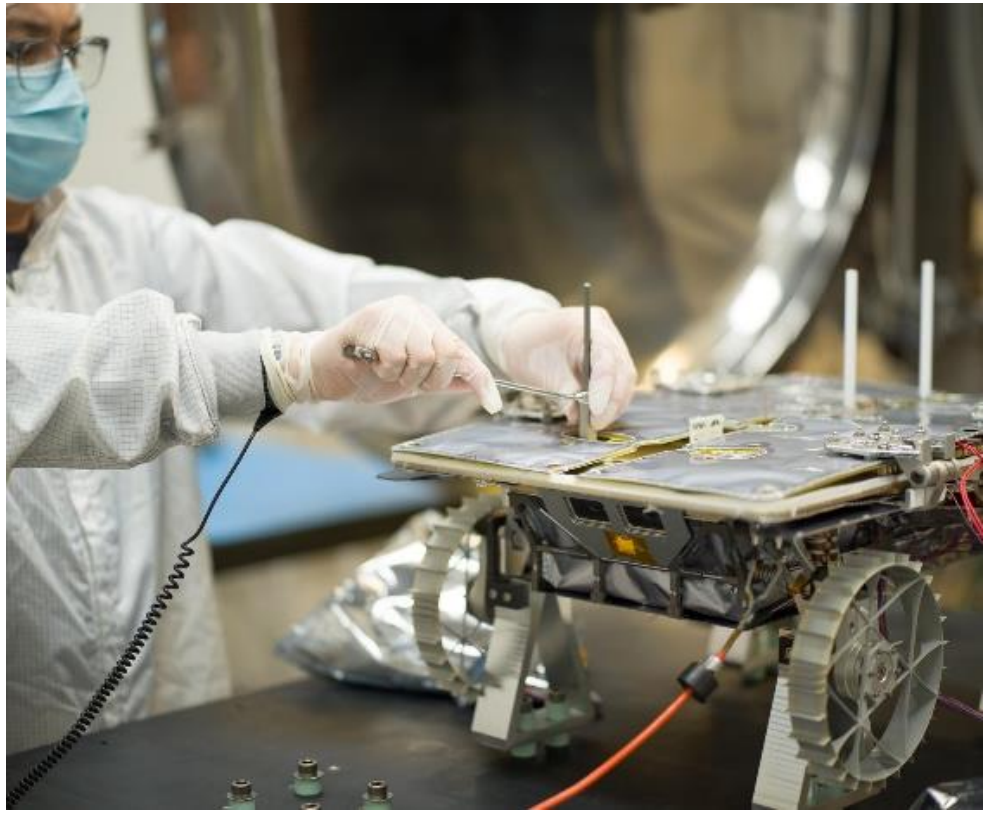






International Collaboration

Lunar Science



An engineer prepares a small rover—part of NASA's CADRE (Cooperative Autonomous Distributed Robotic Exploration) technology demonstration that will be headed to the Moon.

Space Communications and Navigation

Deep Space Station 53 is a new waveguide antenna that went online in February 2022 at NASA's Deep Space Network's ground station in Madrid.

ARTEMIS I

First Mission
(Uncrewed Flight Test)

COMPLETE

ARTEMIS II

First Crew

ARTEMIS III

First Human Surface Landing

Artist's Concept

ARTEMIS IV

First Lunar Space Station
Assembly Mission

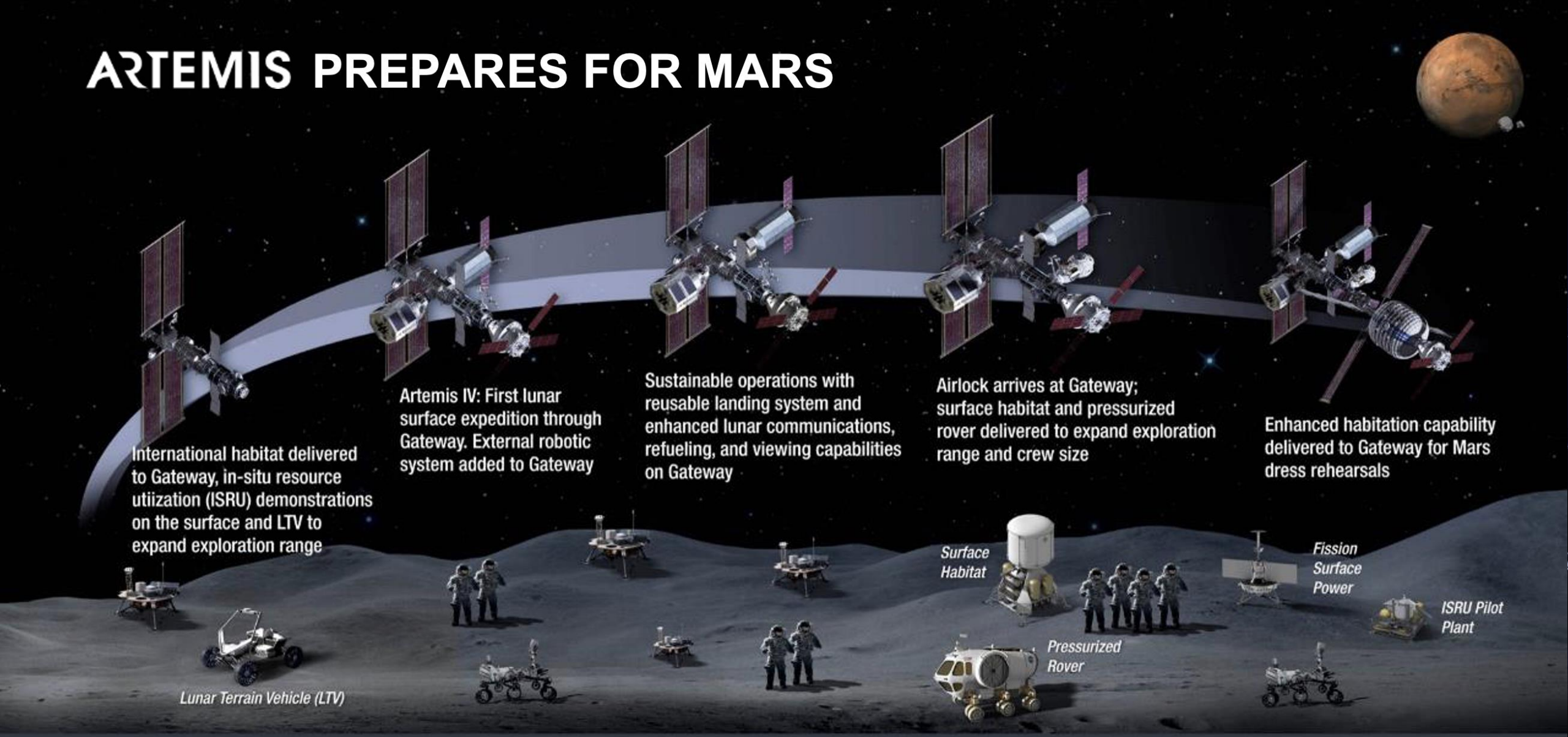
Artist's Concept

ARTEMIS V

Crewed Mobile Surface Exploration,
Gateway Expansion

Artist's Concept

ARTEMIS PREPARES FOR MARS



SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

MULTIPLE SCIENCE AND CARGO PAYLOADS | U.S. GOVERNMENT, INDUSTRY, AND INTERNATIONAL PARTNERSHIP OPPORTUNITIES | TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

ARTEMIS II

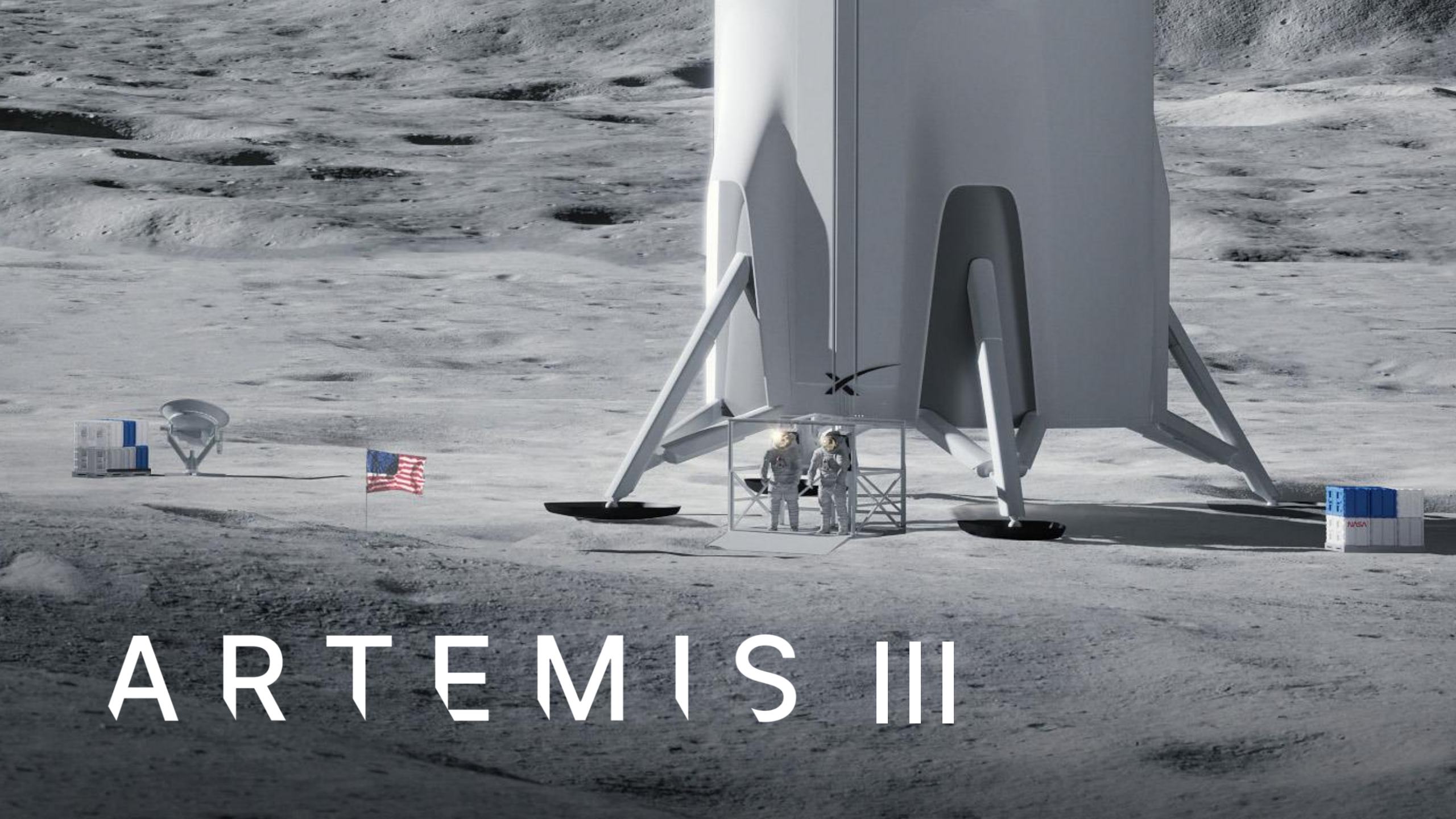
Artemis II HRP Payloads

Artemis Research for Crew Health & Readiness ARCHeR:

- Wearable device for crewmembers.
- Study sleep-wake patterns & activity levels in Orion.
- Collect performance data on crew and team operational tasks during the mission.
- Audio and video between operations teams will also be collected for analysis after the mission.

Immune Biomarkers:

- Samples of crew saliva taken during the mission to determine how space travel affects the immune system.
- Potentially involving stress hormones, protective proteins, and latent viruses that could be reactivated.


ARTEMIS III

Artemis III and IV
Human Landing System (HLS)

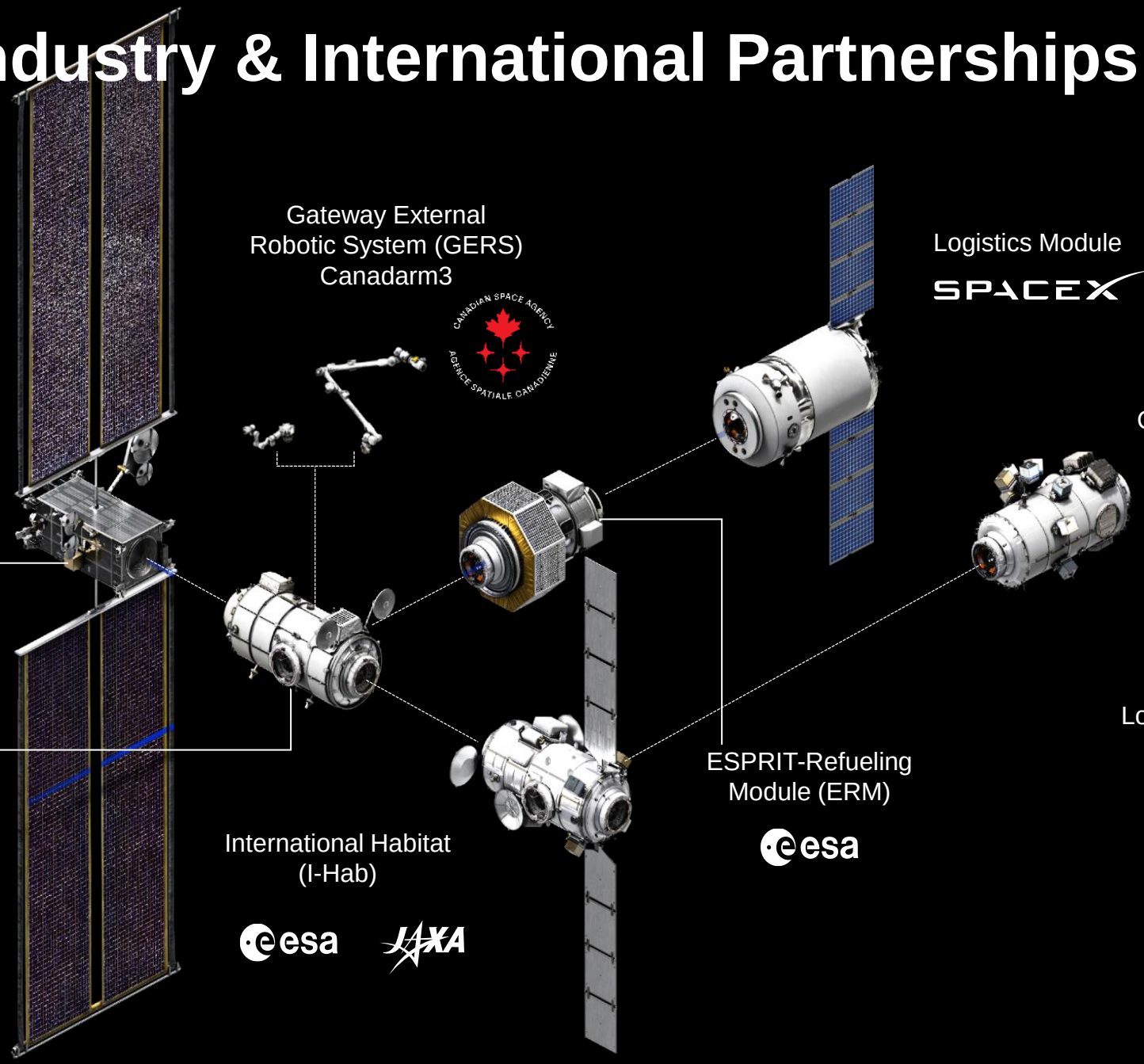
Image Credit: SpaceX

Image Credit: Axiom Space

Dark mode … activated!


ARTEMIS IV
NASA
ARTEMIS

Gateway Industry & International Partnerships



Power and Propulsion Element (PPE)

MAXAR

Habitation and Logistics Outpost (HALO)

NORTHROP GRUMMAN

JAXA esa

Gateway External Robotic System (GERS) Canadarm3

CANADIAN SPACE AGENCY / AGENCE SPATIALE CANADIENNE

International Habitat (I-Hab)

esa JAXA

Logistics Module

SPACEX

Crew and Science Airlock*

مركز محمد بن راشد للفضاء
MOHAMMED BIN RASHID SPACE CENTRE

ESPRIT-Refueling Module (ERM)

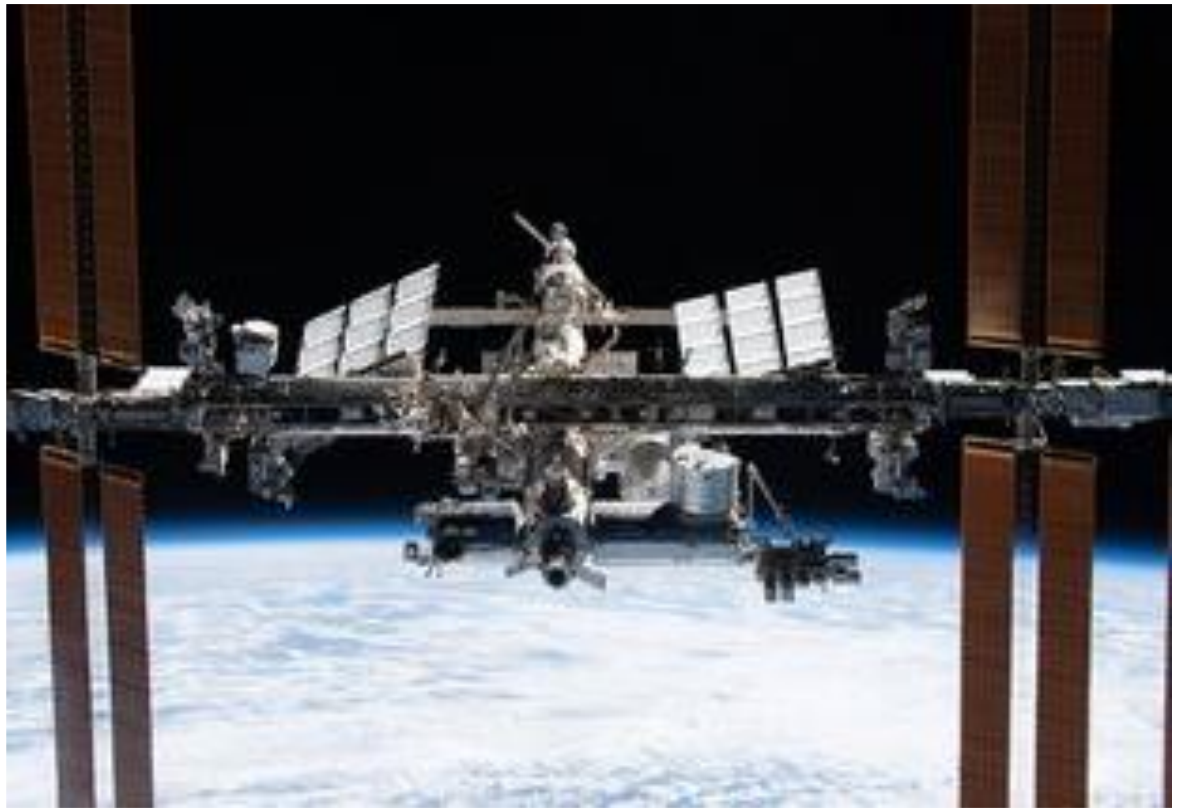
esa

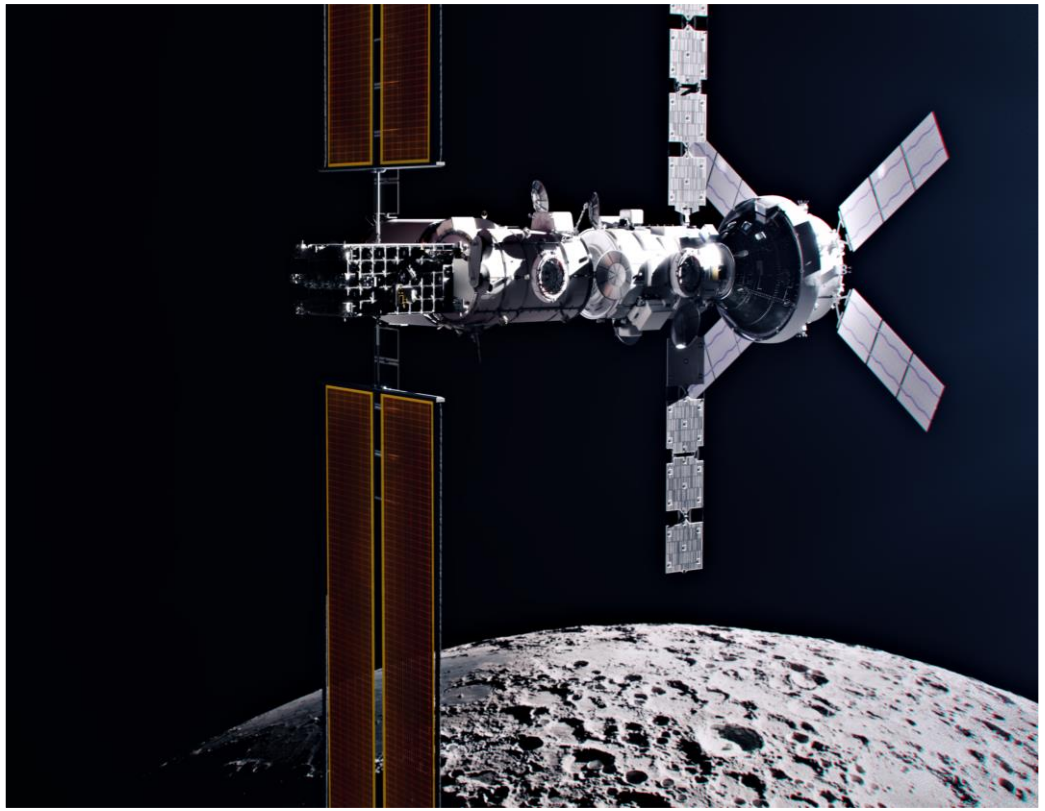
Logistics Module HTV-XG

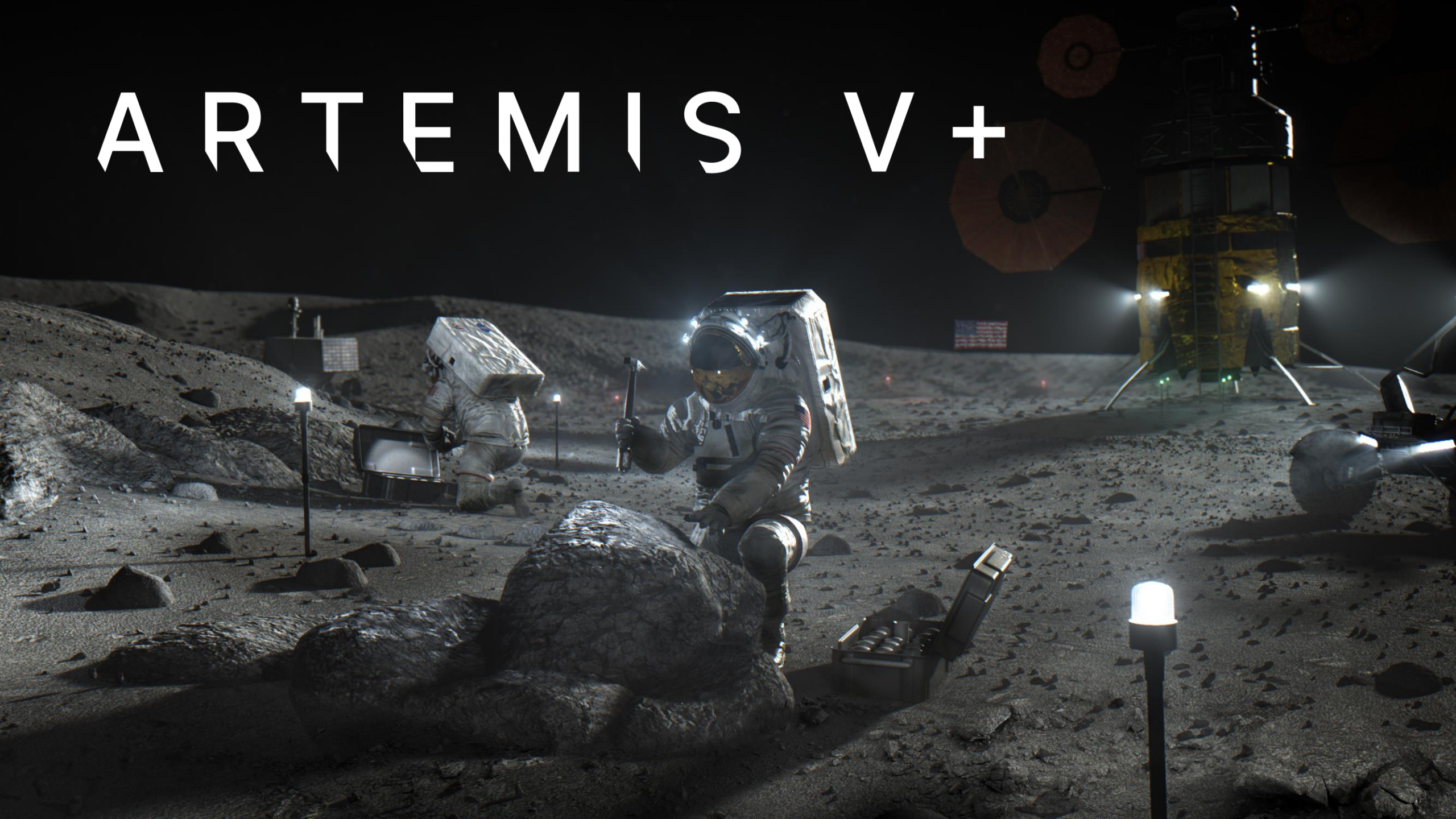
JAXA

*Government reference concept shown

International Space Station & Gateway






ARTEMIS V+

Artemis V: Human Landing System (HLS)

BLUE MOON LANDER

MISSION SUMMARY:

In preparation for the launch of the Artemis V crew aboard Orion on SLS, Blue Origin will launch its Blue Moon Human Landing System (HLS) and fuel it in the selected Near Rectilinear Halo Orbit (NRHO).

Image Credit: Blue Origin

ARTEMIS FIRSTS:

- Lunar lander fueled in NRHO for a crewed mission

NEW ELEMENTS:

- Blue Moon lander
- Cislunar transporter

Credit: Intuitive Machines

Lunar Terrain Vehicle (LTV)

- NASA has selected Intuitive Machines, Lunar Outpost, and Venturi Astrolab to advance the unpressurized, unenclosed LTV


Credit: Lunar Outpost


Credit: Astrolab

Artist's Concept

Artemis VI

ARTEMIS FIRSTS:

- Gateway assembly complete
- Conducting science and demonstrating technology in orbit and on the surface

NEW ELEMENTS:

- Human landing system via services contract
- Gateway module: airlock

COMMON ELEMENTS:

- Space Launch System rocket Block 1B configuration
- Orion crew spacecraft
- Mobile Launcher 2 with supporting ground systems
- Spacesuits and support systems
- Gateway space station and Deep Space Logistics
- Lunar Terrain Vehicle (LTV)

Credit: JAXA/Toyota

Artist's Concept

Artemis VII

ARTEMIS FIRSTS:

- Use of a pressurized rover by crew to access more of the lunar surface and collect diverse scientific samples
- Conducting science and demonstrating technology in orbit and on the surface

NEW ELEMENTS:

- Pressurized rover

COMMON ELEMENTS:

- Space Launch System rocket Block 1B configuration
- Orion crew spacecraft
- Mobile Launcher 2 with supporting ground systems
- Spacesuits and support systems
- Gateway space station and Deep Space Logistics
- Lunar Terrain Vehicle (LTV)

HRP Research: Sustainable Human Presence

CHAPEA MISSIONS

HERA MISSIONS

HRP Products Informing Artemis Vehicle Development

Artemis Challenge	HRP Deliverable
New verification methodologies	Best practices for using tools (virtual reality) and methods (human in the loop testing) to verify requirements and assess human-system performance during the development, verification, and validation of vehicle and mission.
Food/Medication Safety	Food and Medication acceptability testing after exposure to new environments (temperature/pressure).
New Medical Conditions	Computational tools that better predict Loss of Crew risk metrics.
Hardware in Radiation Environment	Coordinating with commercial partners to help qualify flight systems by exposing hardware to simulated Galactic Cosmic Radiation (GCR) in the NASA Space Radiation Laboratory (NSRL).

HRP Products Informing Artemis Dynamic Operations

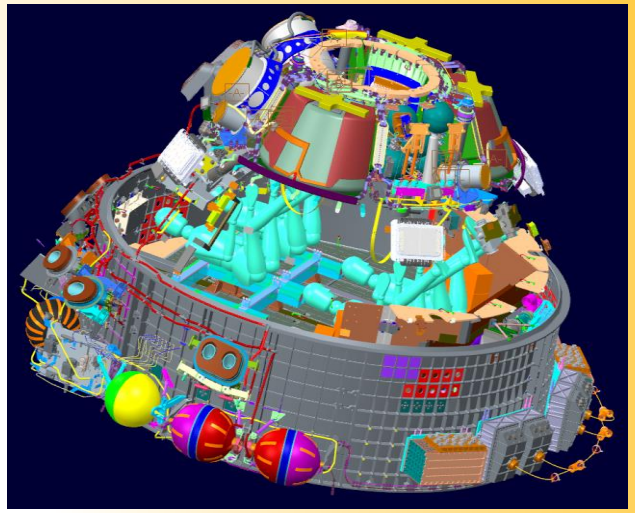
Artemis Challenge	HRP Deliverable
Launch/Landing Loads	Computational tools to predict injury risks in spaceflight resulting from new launch/landing loads (seated vs standing).
Space Adaptation	Developing piloting and sensory motor training plans to better prepare our crew by using the KRAKEN spatial disorientation training device, provided by the United States Military.

HRP Products Informing Artemis Vehicle Development

Artemis Challenge	HRP Deliverable
High Tempo EVA	Improving Decompression Sickness (DCS) risk prediction tools to better respond to various vehicle, habitat and suit atmospheres that may be encountered in upcoming Artemis missions.
	Food Acceptability testing in Lunar-like conditions (high caloric demands, compressed mealtimes, no food warmer, and no fresh food).
	Evidence-based recommendations for the timing and implementation of countermeasures (caffeine, lighting) to help offset fatigue.

M2M Progress: Radiation Protection

- Updated health standards:
  - All crew have same career limit
  - Long-duration habitats must factor GCR
- Developed zero-mass impact solution for radiation protection in Orion storm shelter (OLTARIS)
- Characterized Mars radiation surface environment over a solar cycle
- Tested next gen dosimetry systems (ARES, HERA) on ISS, Artemis I
- Built integrated SPE scoreboard models to inform Artemis operations
- Developed compact on-board space weather observation packages for launch to Gateway (HERMES/ERSA)



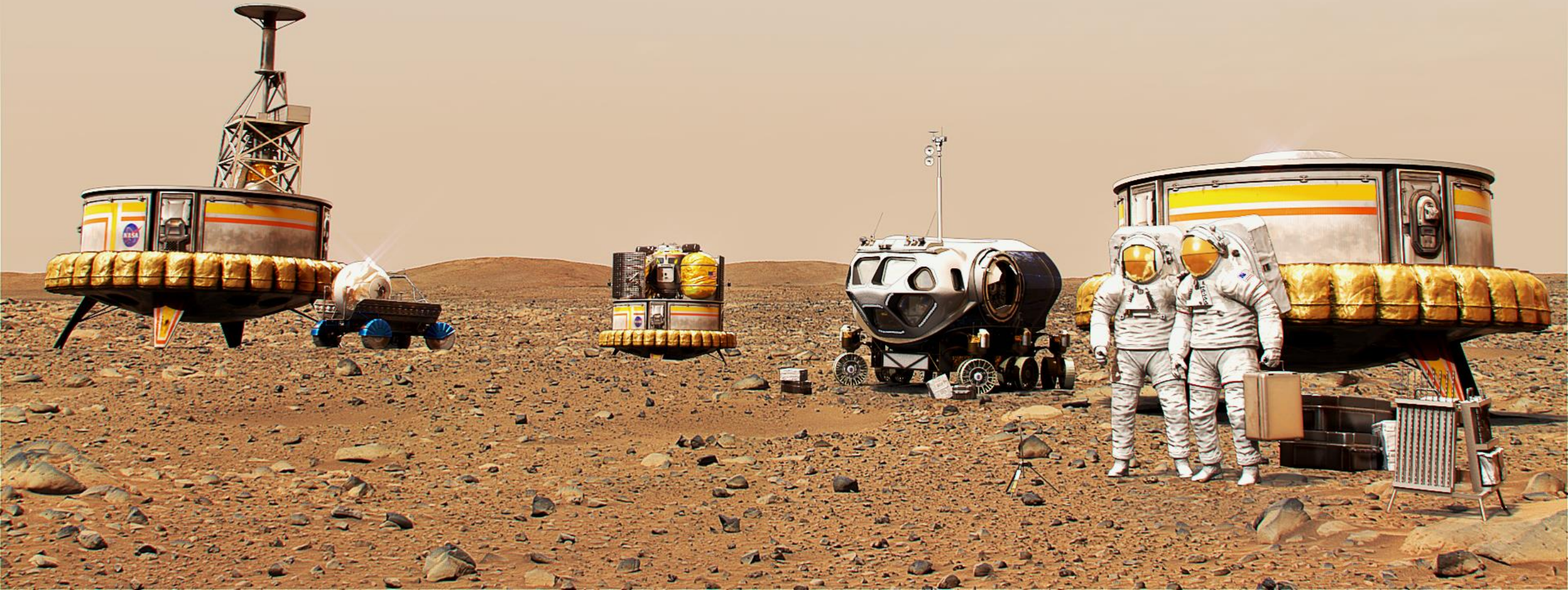
Orion Shield Design

Artemis-I HERA

Working On The Moon

Artist's Illustration

Working On Mars



We came in peace.

We return for all humanity.

Image credit: Andrew McCarthy


National Aeronautics and
Space Administration
NASA
Thank you!