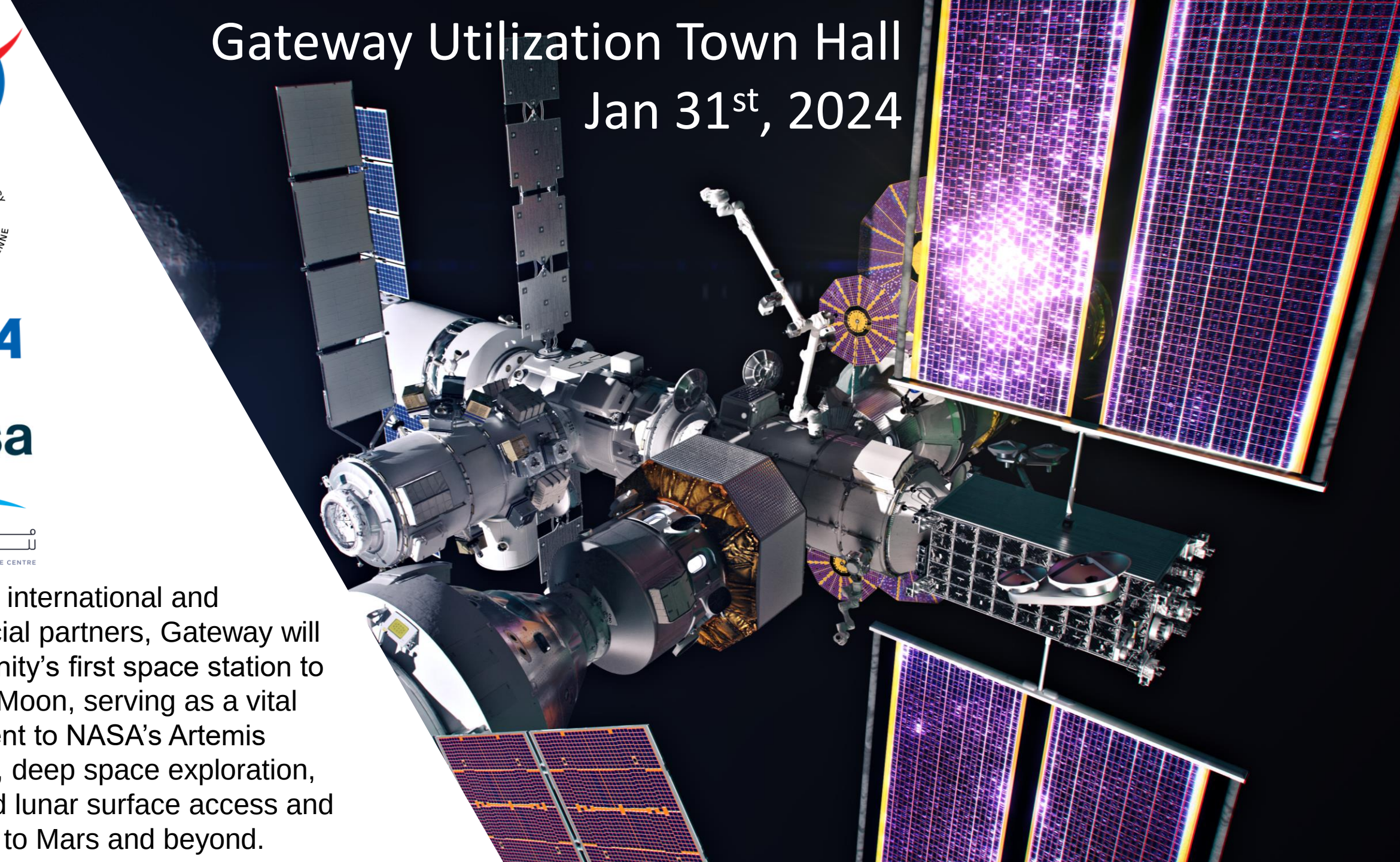
Gateway Utilization Town Hall
Jan 31st, 2024



Built with international and commercial partners, Gateway will be humanity's first space station to orbit the Moon, serving as a vital component to NASA's Artemis missions, deep space exploration, sustained lunar surface access and missions to Mars and beyond.

National Aeronautics and Space Administration

Artemis and Gateway Overview

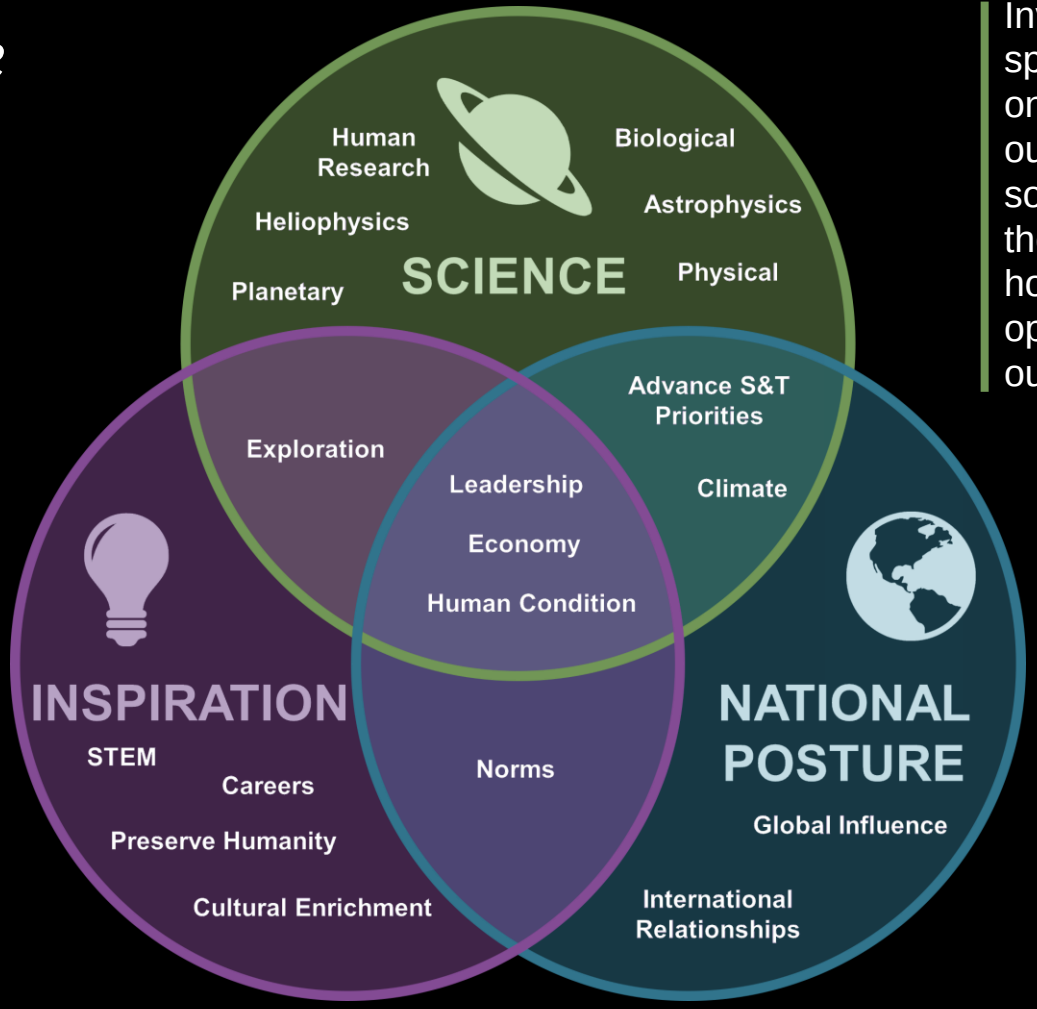
Stephanie Dudley, NASA Manager,
Gateway Mission Integration and Utilization

Tim Horvath, NASA Deputy Manager,
Gateway Mission Integration and Utilization

31st January 2024

Benefits to Humanity

Why We Explore



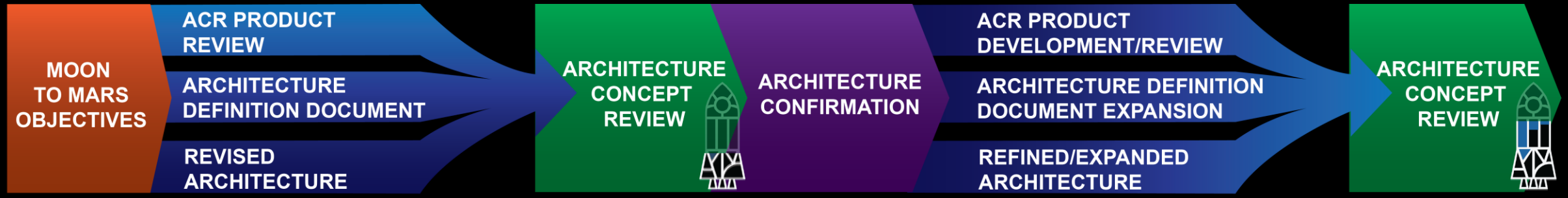
Investigations in deep space, on the Moon, and on Mars will enhance our understanding of the solar system, the Earth, the human body, and how to perform new operations while we are out there exploring.

Accepting audacious challenges and succeeding through perseverance and tenacity in the face of adversity motivates current and future generations to dare mighty things.

What we choose to do, how we do those things, and who we do them with greatly impacts our place in the world today, our quality of life, and our possibilities for the future.

Architecture Concept Reviews

The purpose of the yearly Architecture Concept Review (ACR) is to help unify the agency, promote advocacy for the architecture, and generate inputs from across NASA.



Goal of Architecture Concept Review 22

ACR22 reached concurrence on…

- Newly established ACR process
- Disposition of key issues for Moon to Mars Architecture Definition Document
- Priority tasks for ACR23

ACR 23 Future Architecture Concept Reviews

Further refinements will align with budget cycle to accommodate for evolving…

- Detail and definition of objective needs and efforts to enable Mars missions
- Partner Contributions
- Technology and innovations
- Humans to Mars

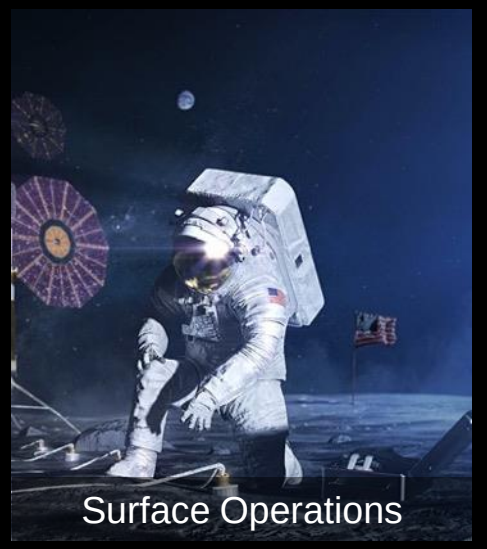
GATEWAY SCIENCE

EXPANDED CAPABILITIES THROUGH GLOBAL PARTNERSHIPS

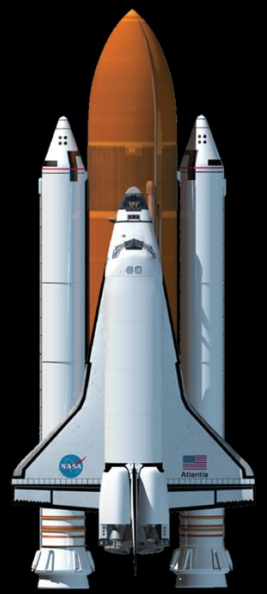
Gateway and its unique orbit will provide opportunities for scientific investigations with extended views of the Earth, Sun, Moon, and space not possible from Earth's surface or from low-Earth orbit.

- EARTH SCIENCE
- HELIOPHYSICS
- LUNAR AND PLANETARY SCIENCES
- LIFE SCIENCES
- ASTROPHYSICS
- FUNDAMENTAL PHYSICS

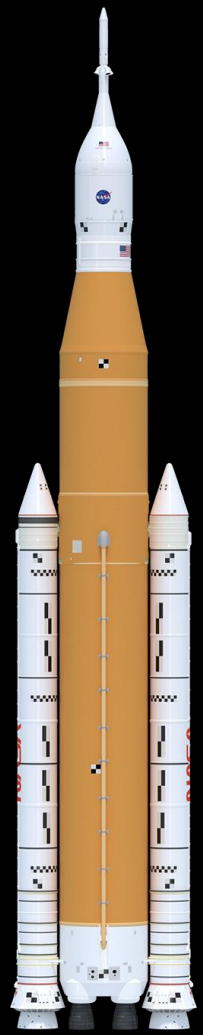
Artemis: A Foundation for Deep Space Exploration



STATUE OF LIBERTY
305 ft



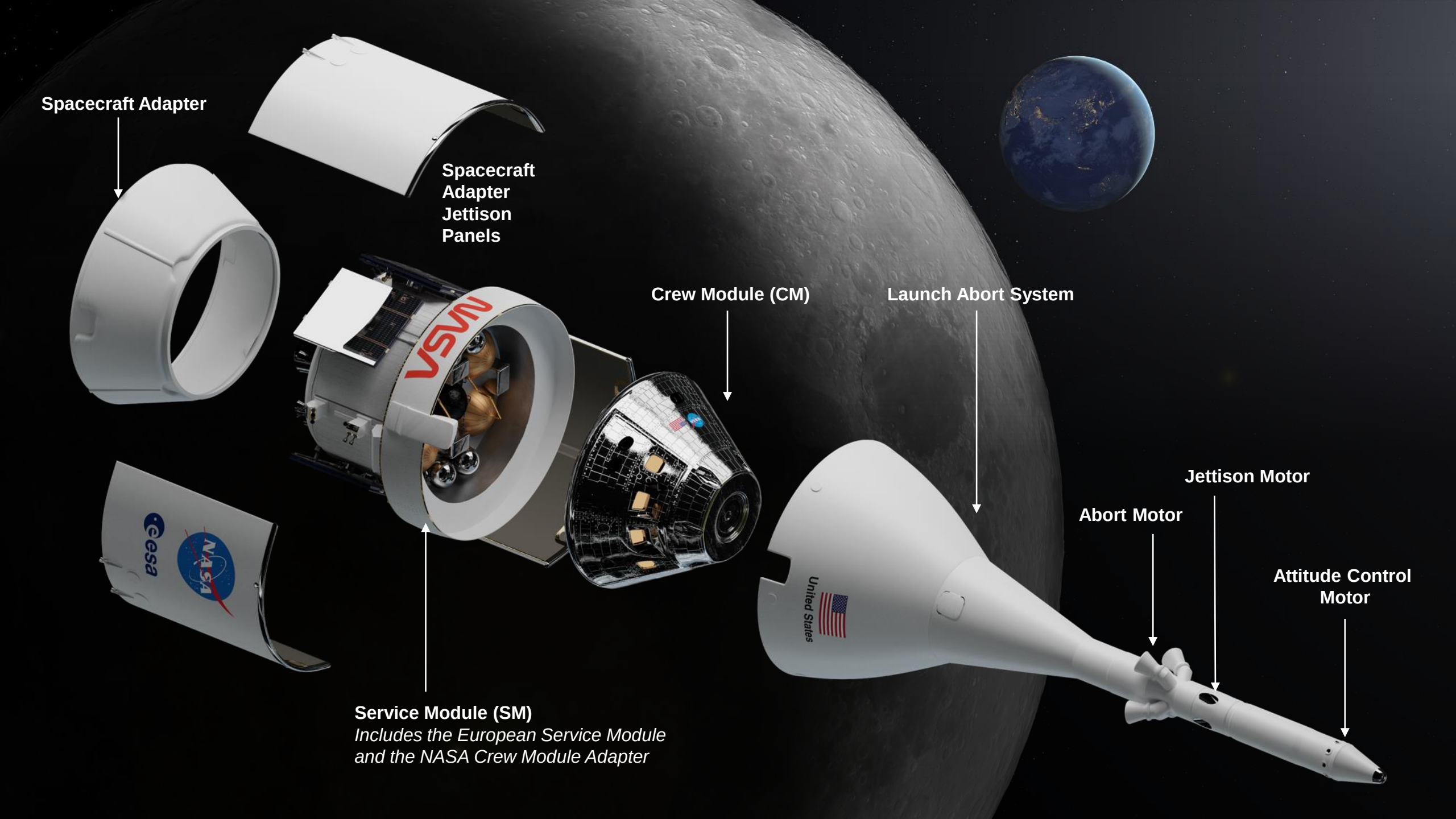
SPACE SHUTTLE
184 ft



SLS/ORION Block I
322 ft

SLS/ORION Block II
364 ft

SATURN V
363 ft


Spacecraft Adapter
Spacecraft Adapter Jettison Panels
Crew Module (CM)
Launch Abort System
Jettison Motor
Abort Motor
Attitude Control Motor
Service Module (SM)
Includes the European Service Module and the NASA Crew Module Adapter

ARTEMIS

I

COMPLETE

II

CREW SELECTED

III

CREWED LANDING

Artist's Concept

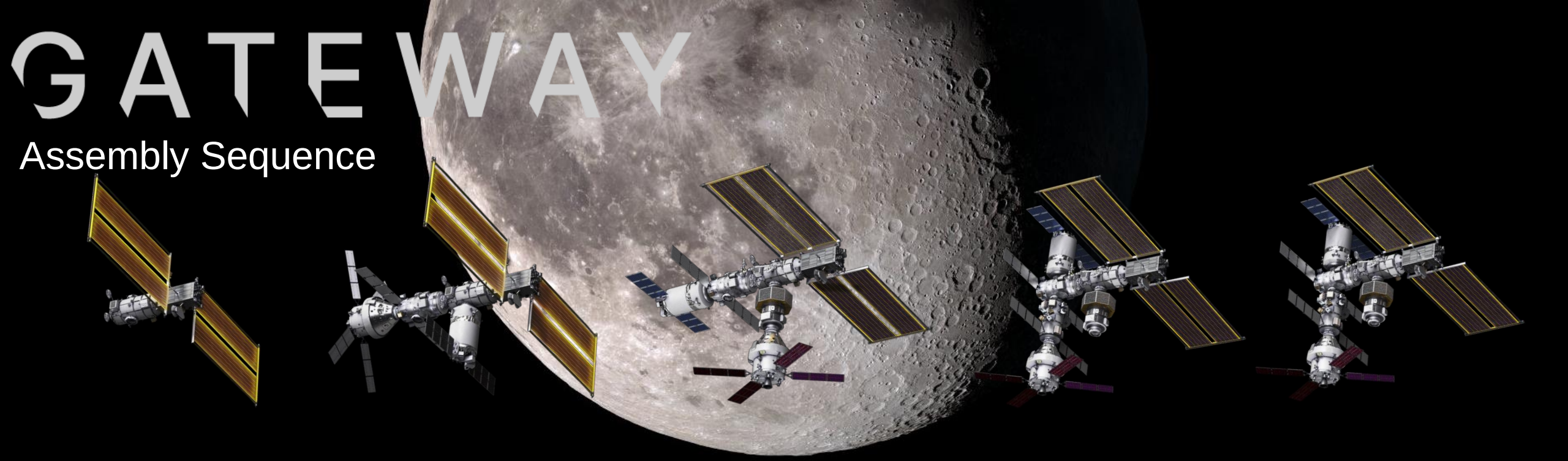
IV

CREWED GATEWAY

Artist's Concept

GATEWAY

Assembly Sequence



LAUNCH

Gateway's two foundational elements, Power and Propulsion Element (PPE) and Habitation and Logistics Outpost (HALO) launch on a SpaceX Falcon Heavy rocket to pre-stage in lunar orbit

ARTEMIS IV

Orion and the International Habitat (I-Hab) module launch on the Space Launch System (SLS) Block 1B (B1B) rocket

Integration of I-Hab with Gateway

ARTEMIS V

Orion and the ESPRIT Refueling Module (ERM) launch on the SLS B1B rocket and a logistics spacecraft delivers Canadarm3

Integration of ERM and Canadarm3 with Gateway

ARTEMIS VI

Orion and an airlock module launch on the SLS B1B rocket

Integration of the airlock with Gateway

ARTEMIS VII+

Crew to live and work on Gateway in a regular cadence of missions

All Artemis missions: crew transfer to the human landing system for surface expedition, unique science while in a polar orbit, deep space logistics flights

THE ARTEMIS II CREW

The Artemis II crew represents thousands of people working tirelessly to bring us to the stars.
This is their crew. This is our crew. This is humanity's crew.

Reid Wiseman
Commander
NASA

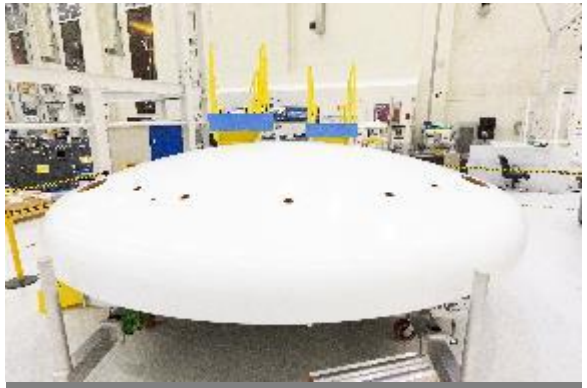
Victor Glover
Pilot
NASA

Christina Hammock Koch
Mission Specialist
NASA

Jeremy Hansen
Mission Specialist
Canadian Space Agency

Artemis II Progress

Crew Module ECLSS Bay Components Installed



Heatshield Thermal Test Complete

Crew Module Adapter and European Space Module Mate

Crew Module Prop and ECLSS Tanks Installed and Welded

Artemis II Slide Hatch in Acceptance Testing

Artemis II Launch Abort System 0 Degree Ogive in Protoqual Testing

Artemis II Launch Abort System Hatch Completing Production

Forward Bay Cover Tile and FRSI Bonding Complete

Integration of Crew and Service Modules for the Artemis II Orion Spacecraft Complete

Human Landing System (HLS)

STARSHIP

NASA has awarded SpaceX contracts to develop its HLS Starship for use on Artemis III and IV. Each contract includes two surface missions.

- SpaceX Uncrewed Lunar Demo-A
- SpaceX Crewed Lunar Demo-A – Artemis III
- SpaceX Crewed Lunar Demo-B – Artemis IV

There is an active procurement open to select an additional HLS provider for missions after Artemis V.

Image Credit: SpaceX

ARTEMIS III

STARSHIP TEST FLIGHT SN8 LAUNCH (*Image: SpaceX)*

STARSHIP TEST FLIGHT SN15 LANDING (*Image: SpaceX)*

PRESSURE TESTING OF NASA’S FULLY ASSEMBLED EXPLORATION SPACESUIT

Advanced SUITS

- Increased flexibility for exploring new regions and advanced sample collection
- Increased size range and modular design accommodate a wider range of crew members
- Rechargeable systems enable more spacewalks and longer stays on surface
- Specialized tools to collect quality samples and returned them safely to Earth
- NASA has selected Axiom Space and Collins Aerospace to build the next generation of spacesuit and spacewalk systems

Pictured left: Artist's render of an astronaut inspecting potential locations to collect samples on the lunar surface.

Exploration Extravehicular Activity (xEVA) Systems Development: Not Just Spacesuits

Advanced suits (Exploration Extravehicular Mobility Units or xEMUs)

- Portable Life Support Subsystem (xPLSS) which contains CO_2 removal and thermal control
- Pressure garment subsystem (xPGS)

Vehicle interfaces (VISE)

- Physical interfaces and support equipment such as don/doff fixtures, launch enclosures, umbilicals, battery chargers, and maintenance equipment

Tools and equipment

- Geology equipment for sample collection
- Construction tools for maintenance activities
- Translation support like handrails

Pictured left: xEVA Geology Tools
Pictured right: NASA Astronaut Jessica Meir in an xEMU

Artist's Concept

HUMANS

in lunar orbit

In the unique lunar environment, new truths of our solar system can be unlocked. For the first time, humans will establish a long-term outpost in lunar orbit where they can live and work: Gateway.

FOUNDATIONAL SYSTEMS

ENABLING SCIENCE & EXPLORATION

GATEWAY

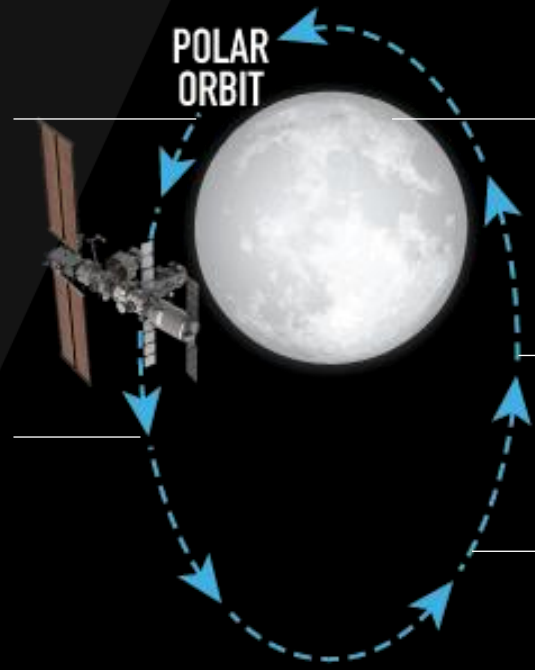
HUMAN LANDING SYSTEMS

CREW TRANSPORTATION SYSTEMS TO AND FROM EARTH

SURFACE MOBILITY SYSTEMS

GATEWAY'S Unique Orbit

There are many ways to orbit the Moon. Gateway will travel in a **Polar Orbit** to support missions to the lunar surface and serve as a staging point for exploration farther into the solar system, including Mars.



ACCESS
Easy to access from Earth orbit with many Current launch vehicles; Staging point for both lunar surface and deep space destinations

ENVIRONMENT
The deep space environment is useful for radiation testing and experiments in preparation for missions to the lunar surface and Mars

SURFACE OPERATIONS
Supports surface telerobotics, Including lunar farside; provides A staging point for planetary sample return missions

SCIENCE
Favorable vantage point for Earth, Sun and deep space observations

COMMUNICATIONS
Provides continuous view of Earth and communication relay for lunar farside

GATEWAY Integrated Spacecraft Configuration

Co-manifested (PPE/HALO)
Launch Vehicle
SPACEX

Gateway External
Robotic System (GERS)
Canadarm3

Logistics Module
Dragon XL
SPACEX

Power and Propulsion
Element (PPE)
MAXAR

ESPRIT-Refueler
esa

Airlock *
مركز محمد بن راشد للفضاء
MOHAMMED BIN RASHID SPACE CENTRE

Co-manifested
Artemis IV, V and VI
Launch Vehicle
BOEING
NORTHROP GRUMMAN
AEROJET ROCKETDYNE

Human Landing
System (HLS) *

Habitation and Logistics
Outpost (HALO)
NORTHROP GRUMMAN
JAXA esa

International Habitat
(I-Hab)
esa JAXA

Orion
NASA
esa
LOCKHEED MARTIN

Logistics Module
HTV-XG
JAXA

*government reference concept shown

GATEWAY

Launch

The first Gateway elements will launch together, establishing a platform where astronauts can live and work in lunar orbit.

Power and Propulsion Element (PPE)

- High-power solar electric propulsion spacecraft
- Transit to lunar orbit
- Establishes a communications relay with Earth
- Maintains Gateway’s orbit

Habitation and Logistics Outpost (HALO)

- Houses up to 4 crew for up to 90 days (with Orion)
- Provides high-rate lunar communication relay to support lunar surface activities and command and control systems for Gateway
- Docking port for visiting spacecraft and future modules

GATEWAY

Expanded Capability through a Global Community

NASA and its international partners will add modules and capabilities, evolving into a robust orbiting laboratory and a home away from home for astronauts on their way to and from the lunar surface. Gateway will serve as a test bed and staging point for future human exploration into deep space.

Canadian Space Agency (CSA):
External robotics system, robotic interfaces, and end-to-end robotic operations

European Space Agency (ESA):
International Habitat (I-Hab) and refueling modules, along with enhanced lunar communications

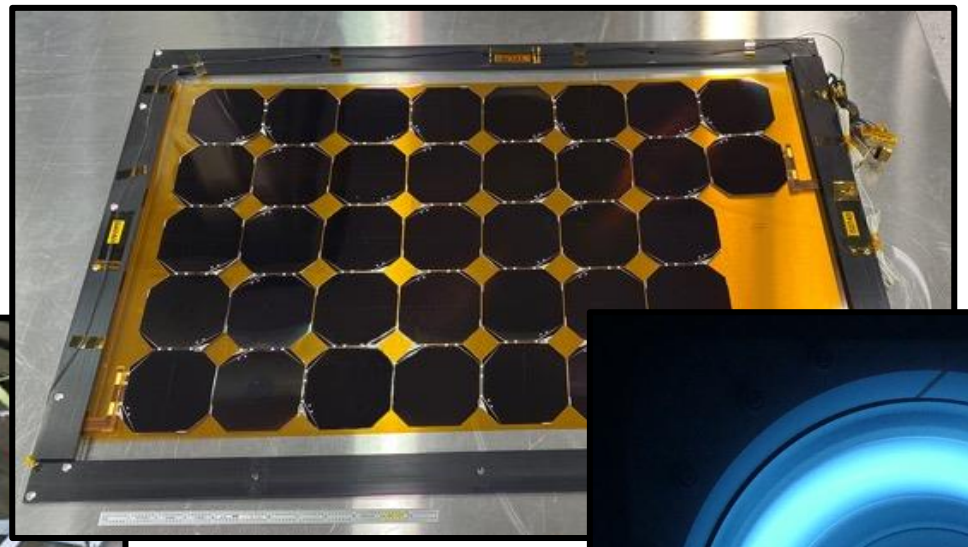
The Japan Aerospace Exploration Agency (JAXA):
I-Hab's environmental control and life support system, batteries, thermal control, and imagery components

United Arab Emirates-Mohammed Bin Rashid Space Centre (UAE-MBRSC): Crew and Science Airlock module to permit crew and science payload transfers

Gateway Hardware Progress

HALO primary structure assembly
at Thales Alenia Space Italy (TASI)

PPE Solar Array Power Module
750+ of these modules will comprise the arrays



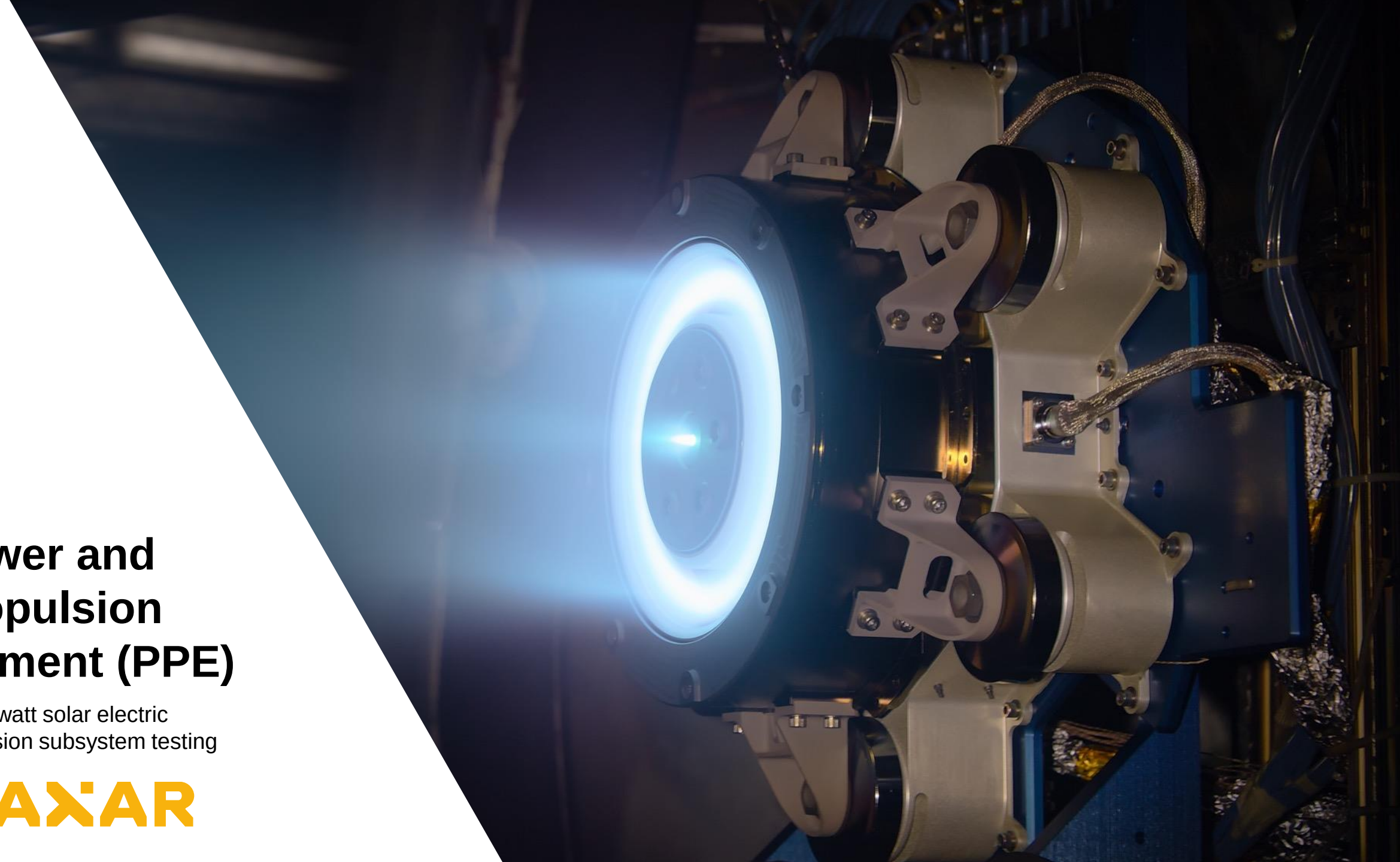
PPE Roll Out Solar Array (ROSA) Boom

PPE 6-kilowatt SEP subsystem test

Power and Propulsion Element (PPE)

12-kilowatt solar electric propulsion subsystem testing

MAXAR



Habitation and Logistics Outpost (HALO)

HALO, after completion of final friction welds in Turin, Italy

NORTHROP GRUMMAN

Gateway: An International Program

- Gateway is an international program collaborated across four primary international partners: NASA, ESA, CSA, and JAXA

- The four partners signed Memorandums of Understanding (MOUs) outlining how the program would be jointly governed

- Compared to International Space Station (ISS), Gateway is a small space station with limits on key resources for utilization

- To maximize the amount of science and research return with the most on-orbit efficiency, the MOUs specify that the utilization program shall be collaborative

Gateway: An International Program

- ”…promote cooperation in the exploration and the peaceful uses of outer space, enable scientific activities, stimulate the development of advanced technologies … and inspire the public”

- Specific to accomplishing science and research, “…minimize or eliminate redundancy in experiments and hardware among the Gateway partners, identify opportunities for efficiency and collaboration, and maximize available resources”

- Each partner has the right to use Gateway for its Agency’s high priority utilization objectives and has the obligation to promote collaboration across the partnership

- All science and research proposed for the Gateway must be advocated through and by one of the four international partners, and agreed by the partnership

National Aeronautics and Space Administration

Gateway Science Utilization Strategy

Jake Bleacher, NASA Research Coordinator

31st January 2024

The Gateway Utilization Coordination Panel (GUCP)

- **GUCP Purpose**
  - The GUCP is a multilateral management forum established under the authority of the Gateway MOUs, signed between NASA and each of the Gateway international Partners. The GUCP establishes a baseline for and controls subsequent changes to the Gateway Program utilization plans. Such plans are coordinated and integrated with each Gateway partner's high-priority utilization objectives, consistent with resource availability. The GUCP is responsible for developing the multilateral utilization priorities and strategic objectives for the utilization program for Gateway and provides payload manifesting recommendations.
- **GUCP Structure**
  - Chair and Co-Chair
    - NASA Manager and Deputy Manager, Mission Integration and Utilization Office, Gateway Program
  - Gateway Program Members
    - Representative, National Aeronautics and Space Administration (NASA) Research Coordinator
    - Representative, European Space Agency (ESA) Research Coordinator
    - Representative, Japan Aerospace Exploration Agency (JAXA) Research Coordinator
    - Representative, Canadian Space Agency (CSA) Research Coordinator

The Gateway Utilization Coordination Panel (GUCP)

- **Discipline Working Groups (DWGs) Purpose**
  - DWGs fulfill the crucial role of identifying potential research and technology objectives for future Gateway Missions. Comprising of representatives designated by GUCP Partners on behalf of their respective agencies, DWGs may choose to involve additional community input as needed. DWGs integrate external sources of Partner research objectives and priorities into a list of Gateway relevant research objectives.
    - Heliophysics
    - Dust
    - Astrophysics
    - Human Health
    - Space Biology and Life Science
    - Lunar & Planetary
    - Technology & Materials
    - Education
    - Public Outreach

- The GUCP identifies payload and research opportunities that align with the list of Gateway-relevant research objectives
- Each Partner identifies high priority Gateway research opportunities that they would participate in and/or lead.

The Gateway Utilization Coordination Panel (GUCP)

- **Research Coordinators Role**
  - Primary liaison between Agencies and Gateway Program for utilization.
  - Working with GUCP Chair to identify research opportunities from DWGs inputs.
  - Responsible for identifying which research opportunities an Agency would take advantage of.
  - The Research Coordinators lead the entire payload coordination process through the GUCP.

- **Research Coordinators coordinate within each Agency to communicate opportunities to potential stakeholders**
  - Research Organizations independently fund research to match with opportunities

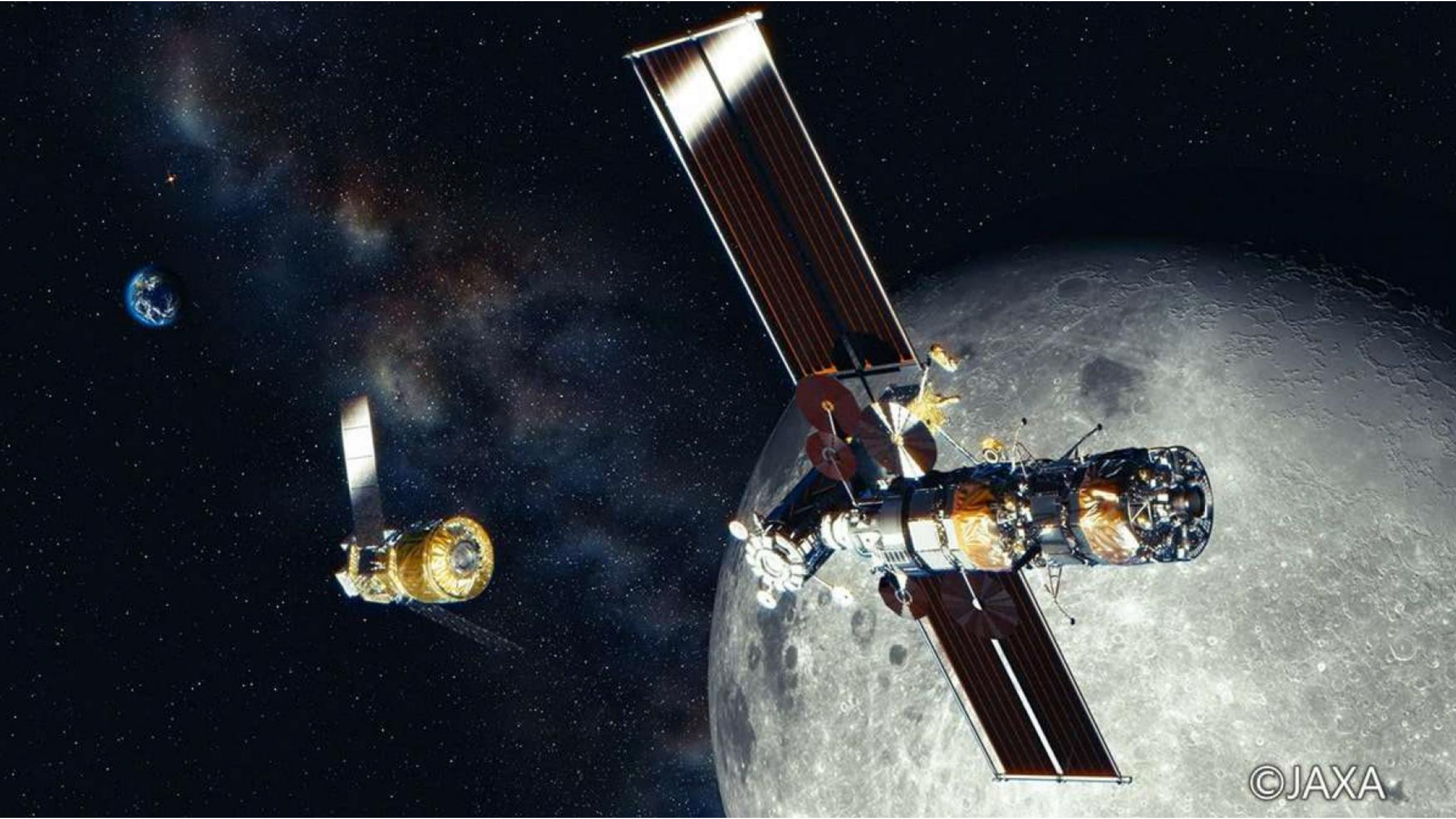
- **NASA Research Coordinator**
  - Integrates utilization across multiple directorates.
  - Directorate interest in Gateway research is communicated to the public by existing funding mechanisms.
    - Science Mission Directorate (SMD), Space Operations Mission Directorate (SOMD), Space Technology Mission Directorate (STMD), and Exploration Systems Development Mission Directorate (ESDMD).

JAXA Gateway Utilization

Japan Aerospace Exploration Agency (JAXA)
Sayaka Umemura

January 31, 2024

Gateway Utilization Town Hall for the International Science Community


©JAXA

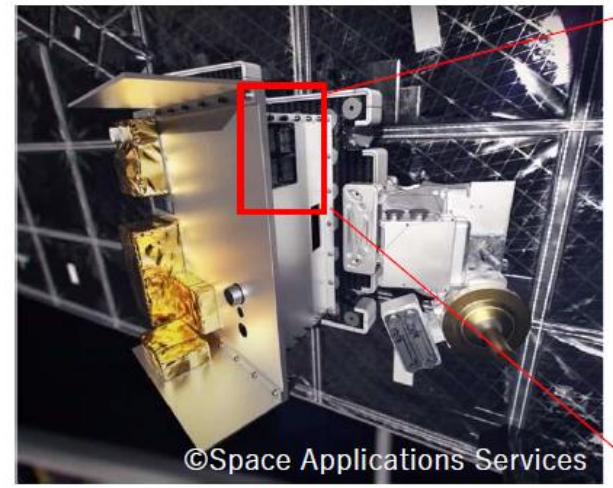
LVDM: Low Velocity Dust Monitor

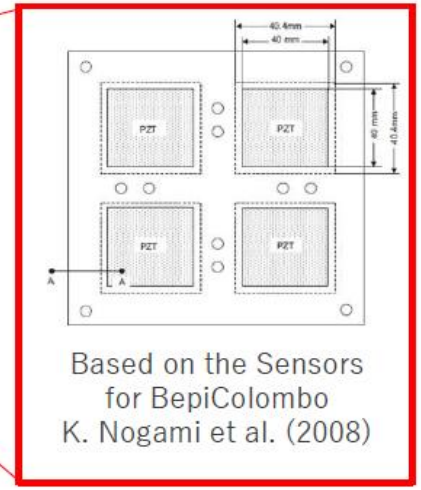
LVDM integrated into ERSA/ESA measures dust flux of the Gateway exterior and helps risk assessment of lunar dust transfer from HLS to Gateway modules.

Observations for the following types of dust:

- ✓ Hypervelocity dust that impacts the Gateway during the early stages of the construction
- ✓ Low velocity dust transferred by HLS

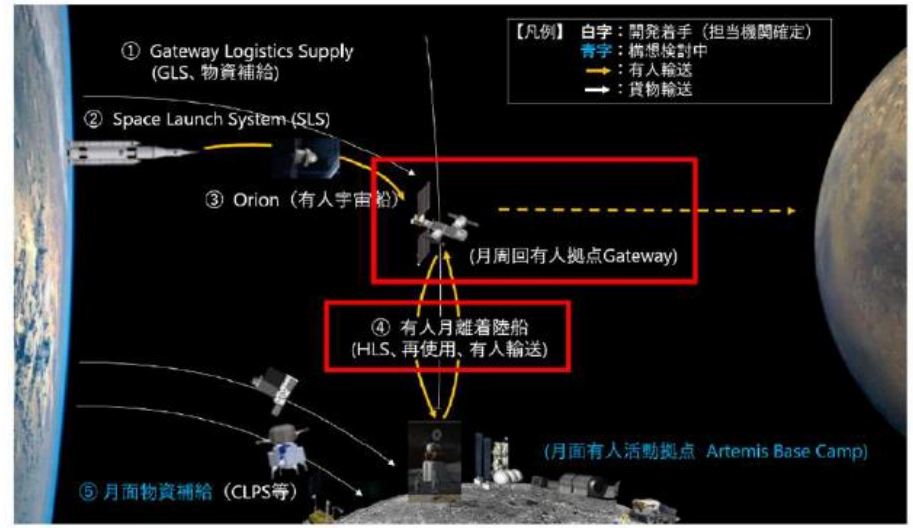
Acquired data will be utilized for risk assessment of system operation of Gateway.





Based on the Sensors for BepiColombo
K. Nogami et al. (2008)

Image of installation in ERSA



Artemis Architecture
(Transportation Elements)

D-Space/PADLES

D-Space and PADLES are one of components for the IDA, which is the International cooperation mission of space radiation environment measurement.

- D-Space is an active dosimeter to monitor internal radiation doses.
- PADLES is a passive and integrating detector, can measure absorbed doses, LET distributions, dose equivalents with high accuracy.

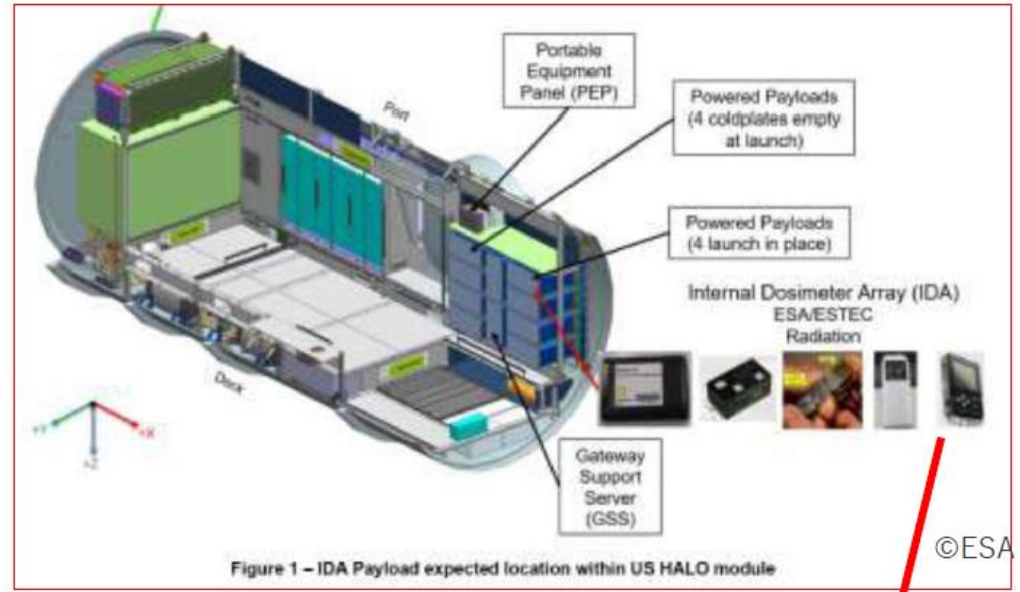


Figure 1 – IDA Payload expected location within US HALO module

Gateway HALO module inside drawing
(As of 2023)

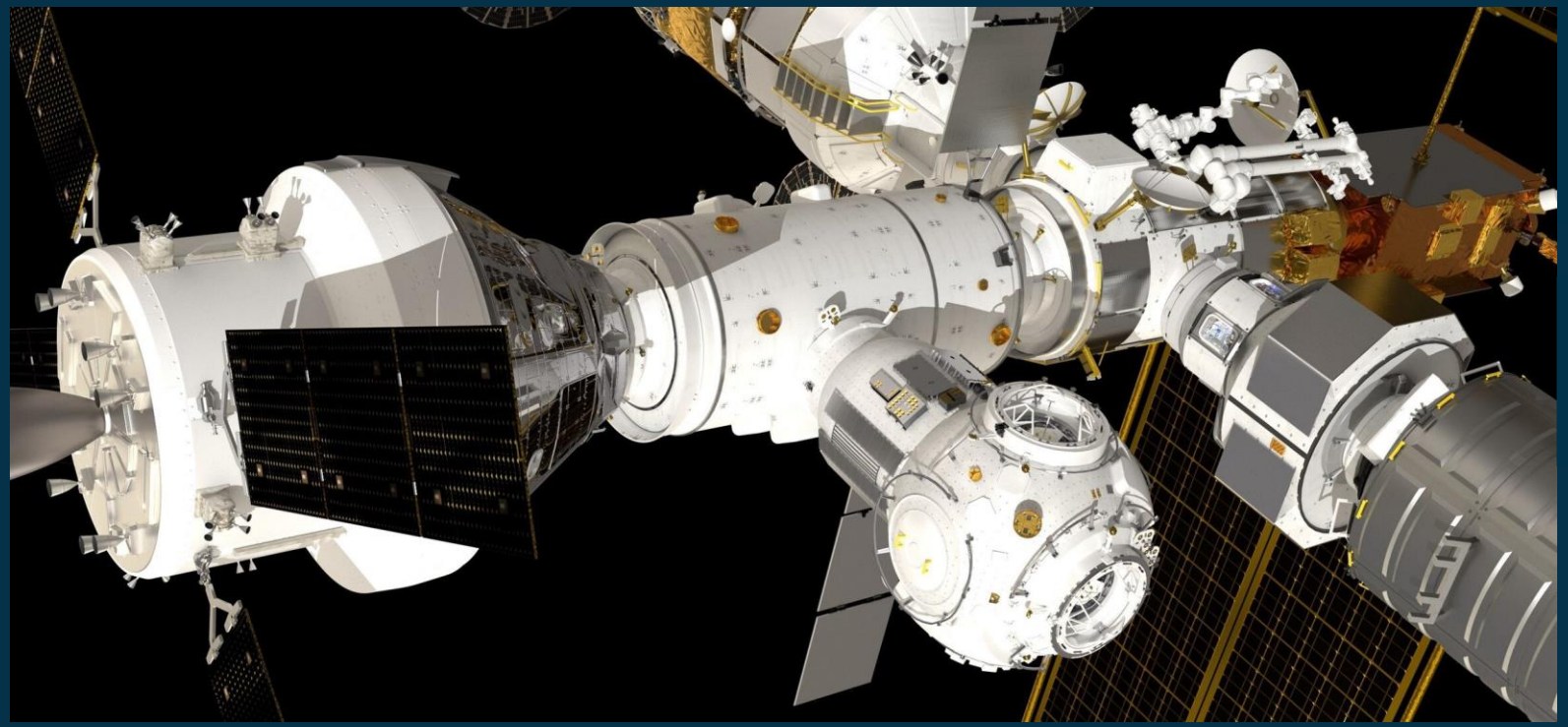
(Left) D-Space
(Right) PADLES

D-Space/PADLES(EM)
in IDA tray(EM)

Participation Opportunities

James David Carpenter

ESA Science on Gateway



◄ Radiation European Radiation Sensor Array (ERSA) – External deep space radiation environment and space weather

◄ Radiation Internal Dosimeter Array (IDA) – Internal radiation as experienced by crew

◄ **Human Health**
In-situ assessment of immune parameters, Health…

Future prospects :

- Definition ongoing for:
  - Active Sensors for Telemetry of Extraterrestrial Impactors At Gateway (ASTERIA) – Meteoroids and dust
  - Multifunctional Exposure Testbed in deep Space (METIS) – biology and materials exposure
- Future prospects for life science and next generation radiation and heliophysics measurements

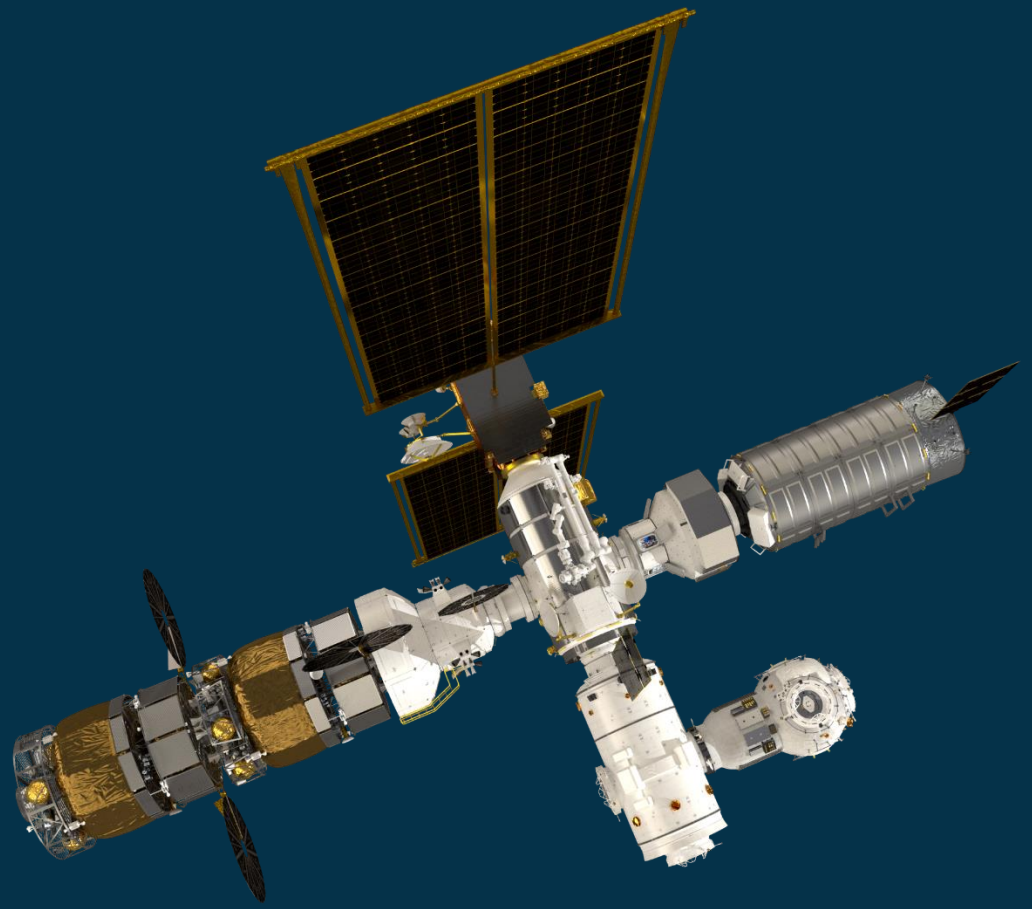
Participation Opportunities

Definition Teams:
Open calls released for definition team membership to prepare study phase prior to science selection.

Science Teams:
Science teams / investigations for approved projects through open calls. All science on Gateway should be accessible to scientists from all partner countries

Data access and analysis:
All science data will be open access.

Questions and comments: james.carpenter@esa.int



Gateway Capabilities for Science Utilization

Raymond Echols, NASA Gateway Integration
Daniel Shafer, NASA Gateway Integration

31st January 2024

Last updated: Jan. 2024

GATEWAY

Initial Science Payloads

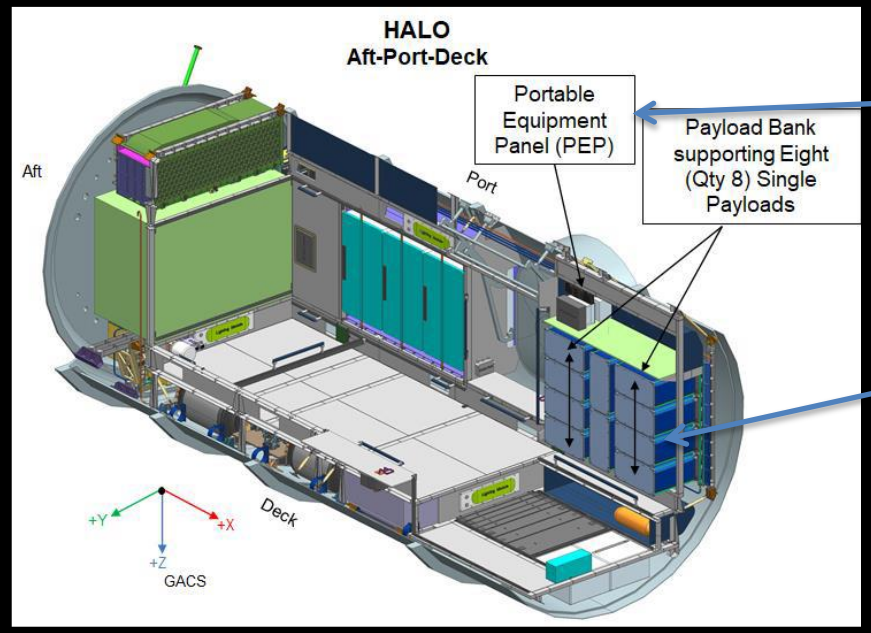
European Radiation Sensors Array (ERSA): The European Space Agency's (ESA's) radiation instrument package will help provide an understanding of how to keep astronauts and hardware safe by monitoring the radiation at higher energies with a focus on space weather

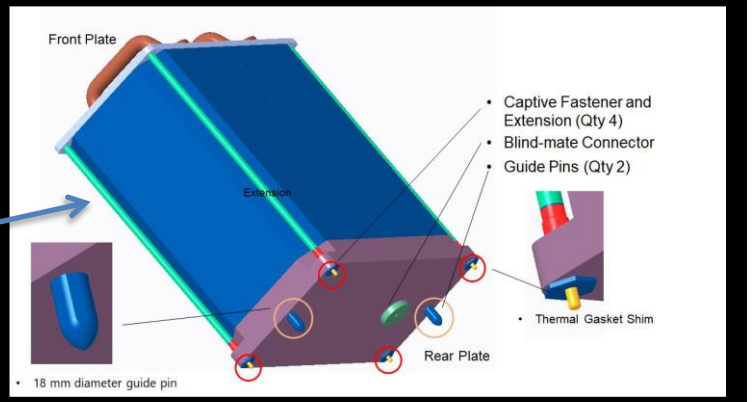
ESA's Internal Dosimeter Array (IDA): Instruments including those provided by Japan Aerospace Exploration Agency (JAXA) will inform for improvements in radiation physics models for cancer, cardiovascular, and central nervous system effects, helping assess crew and hardware risk on exploration missions

Heliophysics Environmental Radiation Measurement Experiment Suite (HERMES) pictured left: NASA's space weather instrument suite will observe lower energy solar particles critical to scientific investigations of the Sun including the solar winds

Gateway's polar orbit will offer unique opportunities for heliophysics, human health research, space biology and life sciences, astrophysics, and fundamental physics investigations. As new modules are added, science capability will increase.

INTERNAL UTILIZATION CAPABILITIES





Gateway Portable Equipment Panel Concept

- **The Payload Bank is a module mounted "rack" that provides standard mechanical, thermal, power, and data interfaces configuration.**
  - Payloads bolt to rear surface coldplate
  - Blind-mate connectors
  - No fans or ducts for rear air cooling
  - Enclosures may be GFE or supplied by the Payload Developer

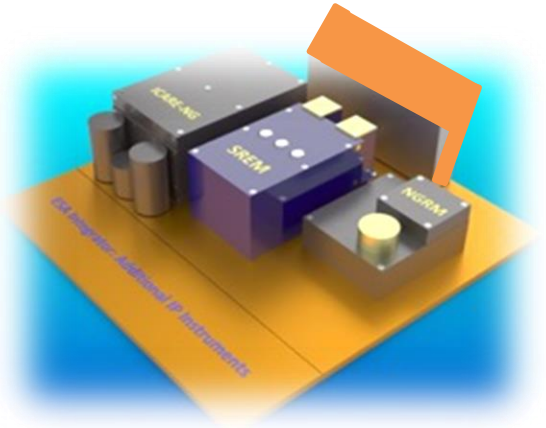
- **All power available may be 120Vdc or Variable 3-28Vdc**
- **Autonomous Research**
  - Gateway has capability to conduct research when uncrewed
  - Systems built to respond to anomalies without ground operator input

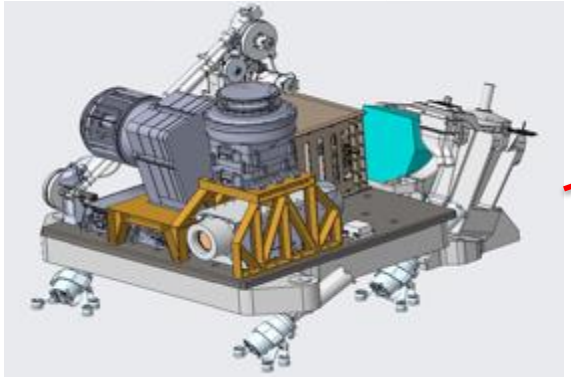
- **Portable Equipment Panel**
  - Supports Aisle-deployed payloads
    - Limited availability
  - Power & Data Connections
  - Thermal via Cabin air

GFE Payload Enclosure (Mockup)

EXTERNAL UTILIZATION CAPABILITIES

European Radiation Sensors Array (ERSA)
ESA/ESTEC
Space Weather
(Includes JAXA Low-Velocity Dust Monitor)





Heliophysics Environmental & Radiation Measurement Experiment Suite (HERMES)
NASA/GSFC
Heliophysics

PPE SORI Payload
(not visible, empty at launch)

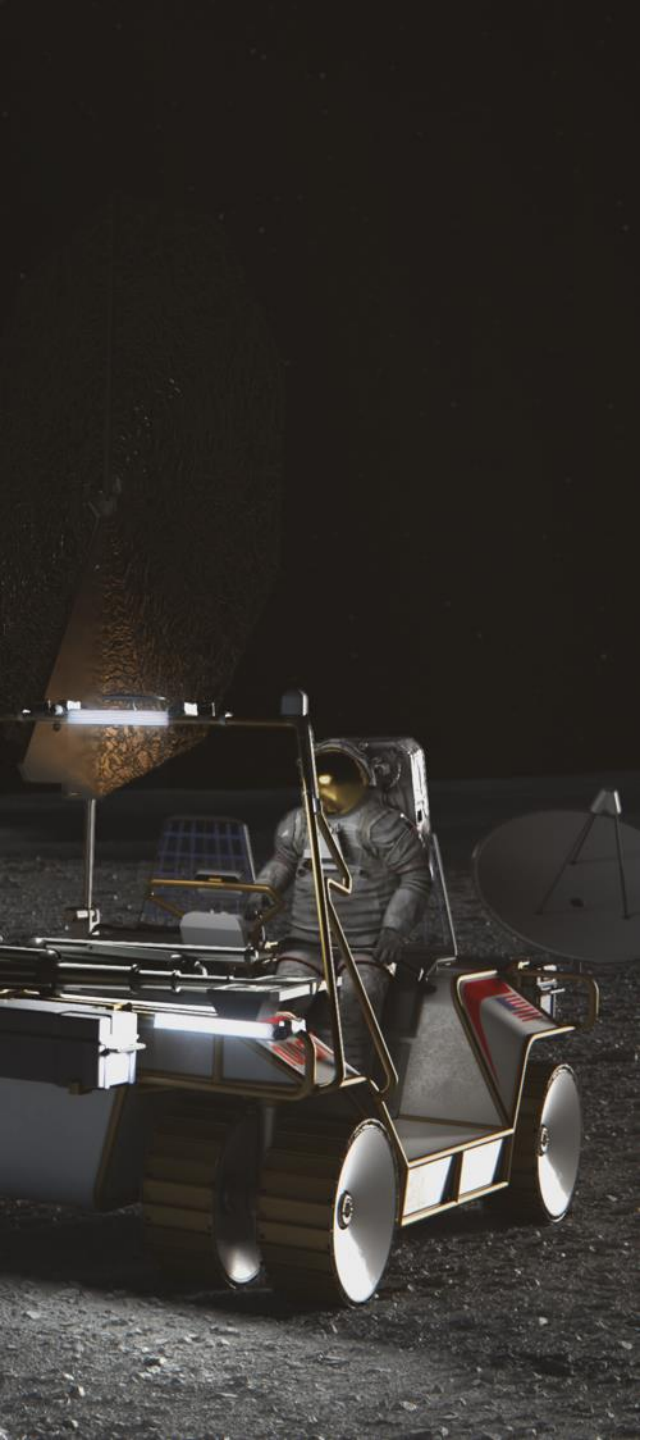
Airlock Module Payload Support TBD

- **Small, Medium, & Large ORU Robotics Interface (xORI)**
  - Modular Interface to Robotics (arm)
  - Two 120Vdc Sources each
  - Wired Ethernet
  - No Thermal I/F

I-Hab SORI Locations
(notional)

+Y +X +Z


ARTEMIS
Future Elements
A sustainable environment to live and work on the lunar surface
Artist's Concept



Lunar Terrain Vehicle

L T V

Requirements definition is currently in-work:

- Ability to traverse from one landing zone to another and increase exploration range beyond the maximum suited walking distance
- Reusable and rechargeable for approximate 10-year service life
- Remote operation from Human Landing System, the Gateway, Earth
- Interface with future science instruments and payloads for utilization or pre-deployment of assets
- Ability to survive eclipse periods

Pictured left: Artist's concept of LTV on the lunar surface.

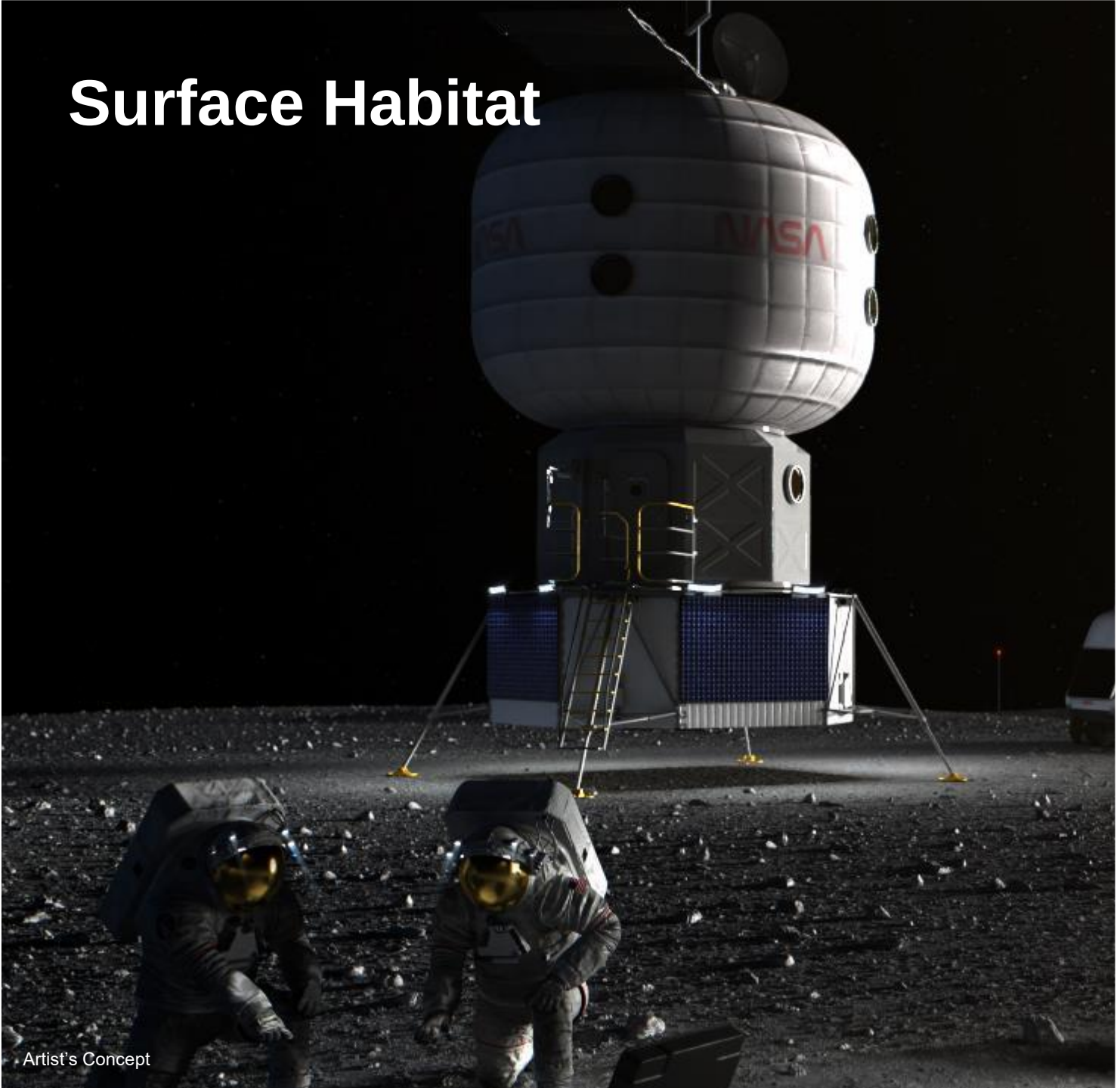
Pressurized Rover

Artist's Concept

Provides pressurized mobile habitation to enable long-range surface exploration in shirtsleeve environment and access to surface for exploration.

- Habitation for up to 30 days for two crew
- Allow astronauts to explore new locations outside the vehicle in their spacesuits
- Provides volume for spares and logistics
- Power generation and energy storage for lunar environment
- Dust and radiation protection
- Reuse for multiple missions of 10-year lifetime
- Capability also identified in current concepts for first human mission to Mars

Surface Habitat



Artist's Concept

Will be a primary asset to achieve a sustained lunar presence.

NASA is working with industry to develop conceptual designs for the Surface Habitat.

- Two to four crew – medical, exercise, galley, crew quarters, stowage
- Houses two crew for up to 30 days
- EVA capable via suitports and includes airlock for suit maintenance capability
- Power generation, recharge capability for surface assets
- Communication hub for surface assets
- Reuse for multiple missions of 15-year lifetime

A Global Community

International partnerships are critical to the next era of human exploration and expansion.

- Artemis Accords
- Gateway MOUs
- Scientific collaborations

These are just some examples of how we are collaborating. NASA is actively seeking opportunities to partner with other nations as Artemis grows.

Pictured left: Republic of Korea Minister of Science and ICT Lim Hyesook signs the Artemis Accords.

We came in peace.

We return for all humanity.

Image credit: Andrew McCarthy

For future participation

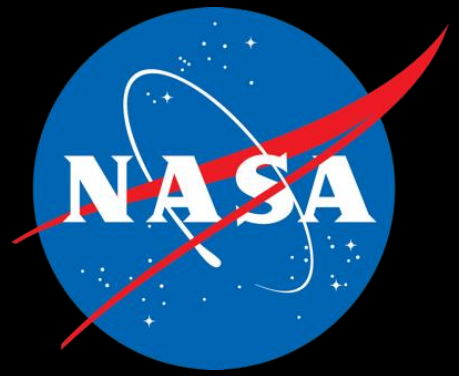
- From Europe
  1. European Lunar Symposium https://sservi.nasa.gov/els2024/ June 16-21 2024
- From Japan
  1. Information and Survey for Gateway utilization (in Japanese) https://humans-in-space.jaxa.jp/news/detail/003547.html
  2. Kibo Utilization Symposium 2024

     One of the sessions, “LEO as a foundation supporting exploration activities to the Moon and Mars” will cover the expectation for Gateway utilization.

     ✓ Date : February 22th, 2024

     ✓ Place: Tokyo Portcity Takeshiba (1-7-1 Kaigan, Minato-ku, Tokyo). The main hall will host a hybrid event with on-site and live streaming.

     ✓ Website (In Japanese): https://humans-inspace.jaxa.jp/kibouser/information/event/73820.html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GATEWAY


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