



National Aeronautics and  
Space Administration

# NASA SCIENCE

Lunar and Planetary Science  
Conference

Lori S. Glaze, Ph.D.

NASA Planetary Science Division Director

March 11, 2024



1 HISTORICAL PHOTOS THAT WILL IMPACT YOU



6. A truck flees the pyroclastic clouds of an erupting Mt. Pinatubo, Philippines, June 17th, 1991.

# PSD Personnel Updates



*Michael Meyer (Retired)*



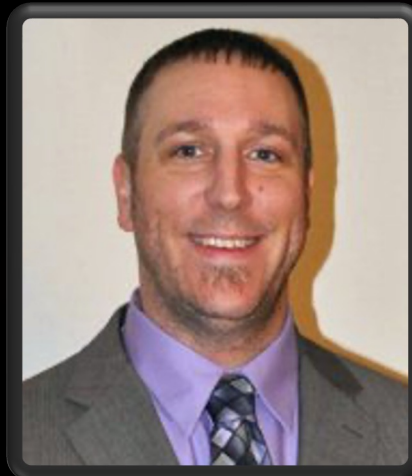
*Tom Statler, Lead Scientist for  
Solar System Small Bodies*



*Nick Lang, Program Scientist*



*Jeff Grossman (Retired)*



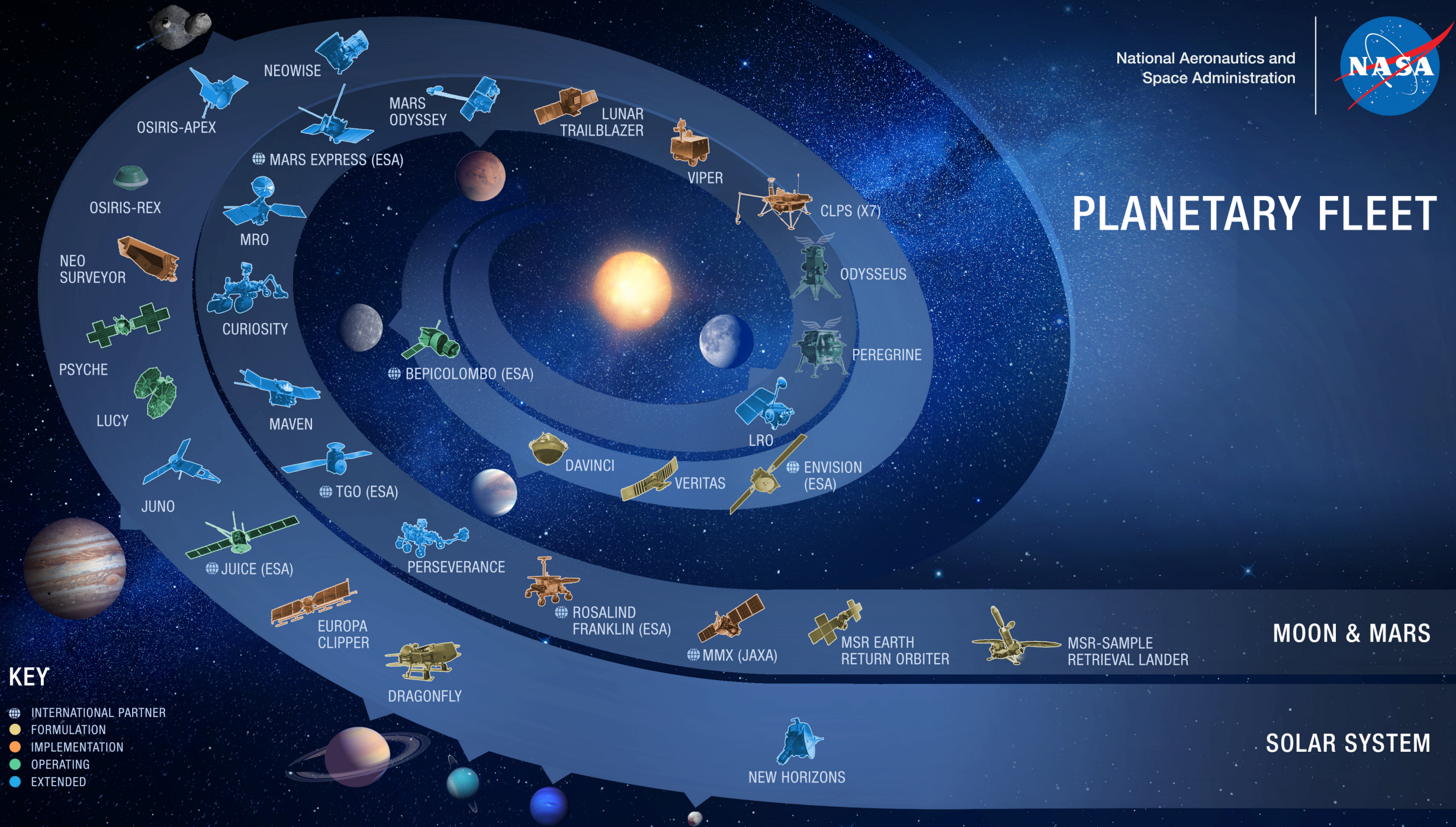
*Aaron Burton, Program Scientist*



*Katie Robinson, Program Scientist*



# PLANETARY FLEET



## KEY

- INTERNATIONAL PARTNER
- FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED

MOON & MARS

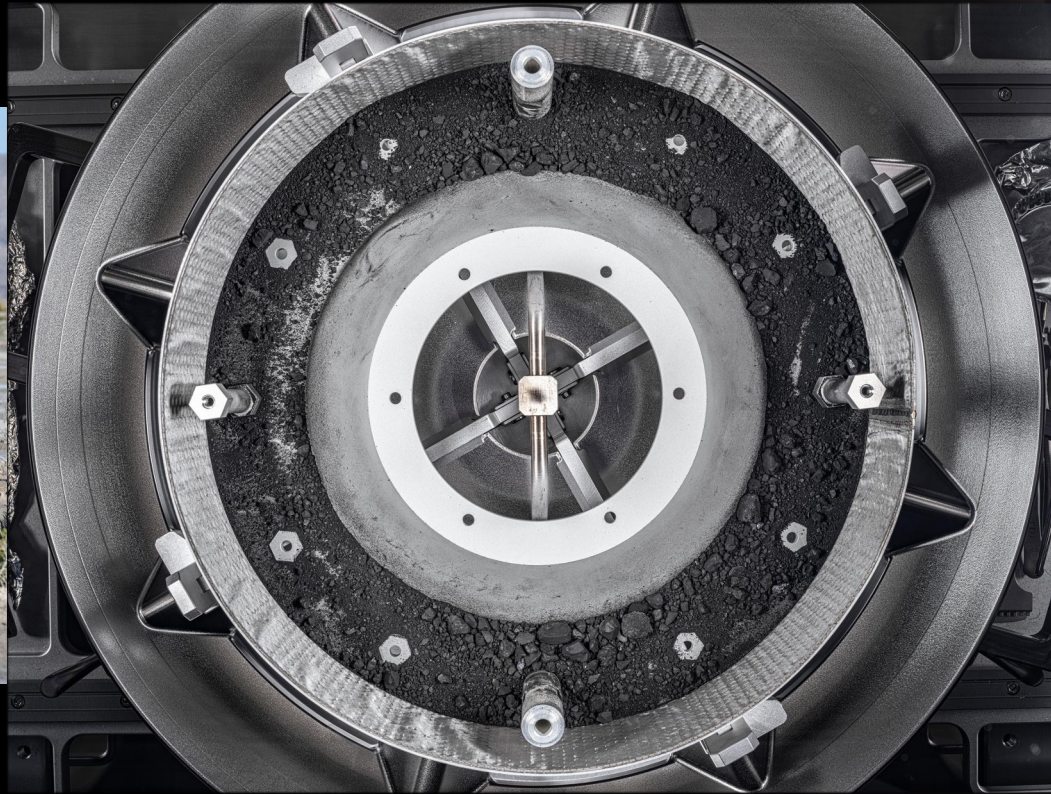
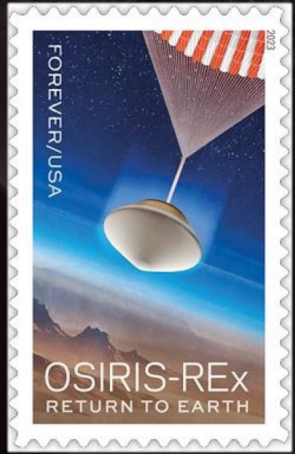
SOLAR SYSTEM



Celebrating  
Success



# OSIRIS-REx: To Bennu – and Back!





# Psyche Launched!

Mars flyby: March–May 2026

Psyche Orbit Insertion: August 2029

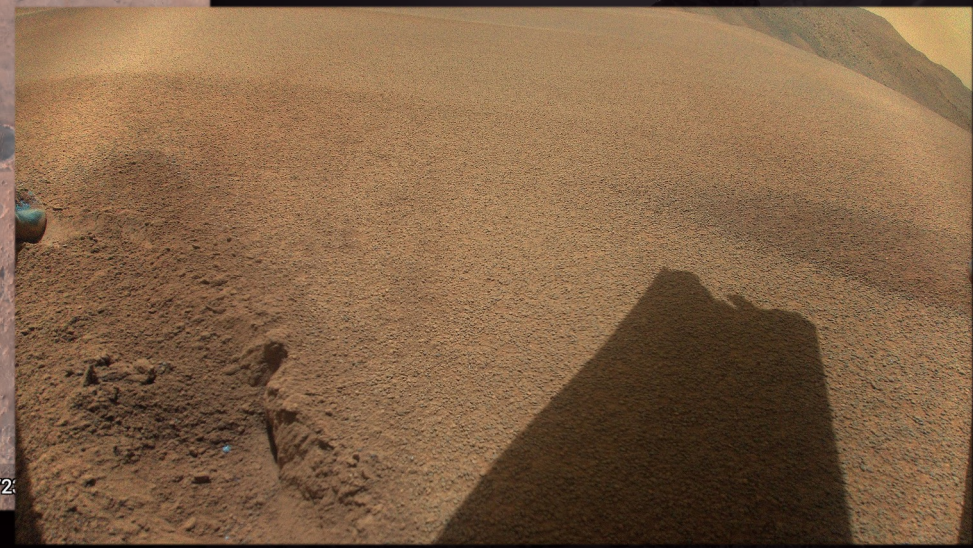
Orbital mission: ~26 months





# Perseverance & Ingenuity

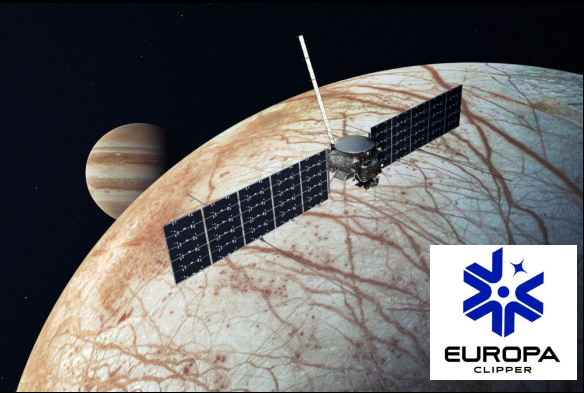
NASA Perseverance's Location Latest Drive: Sol 1066 | Total Distance 15.47 miles / 24.89 km



Location as of February 20, 2024



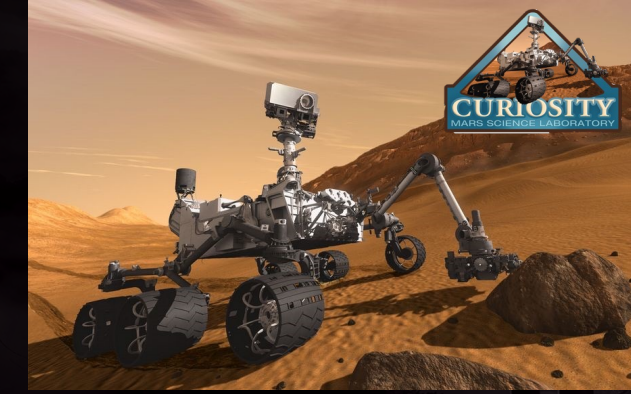
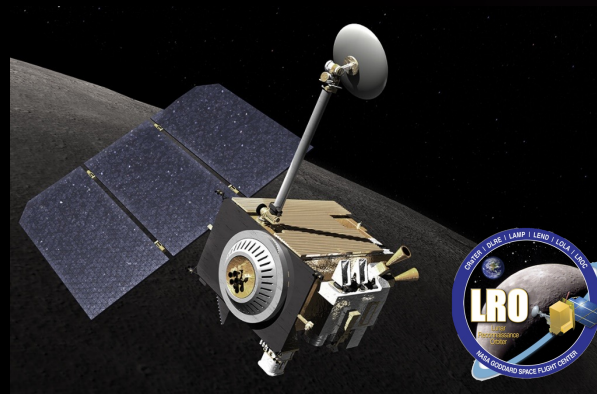
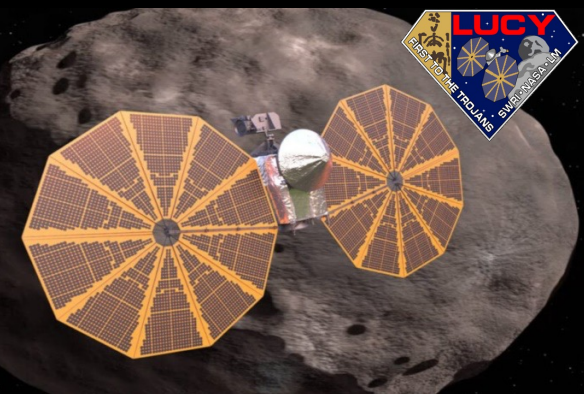
# Here to Observe (H2O) Program



Ohio & Puerto Rico Space Grant Consortia  
 Robert Romero (Ohio Aerospace Institute)  
 Prof. Gerardo Morell (U. of Puerto Rico)  
 Dr. Rachel Klima (Europa Clipper Mission Liaison)

Kingsborough Community College  
 Prof. Steven Jaret (KBCC)  
 Dr. Alexandra Pontefract (Dragonfly Mission Liaison)

New Mexico State University  
 Prof. Nancy Chanover (NMSU)  
 Dr. Erika Kohler (DAVINCI Mission Liaison)



Univ. of Arkansas at Pine Bluff  
 Prof. Miah Adel (UAPB)  
 Dr. Katherine Kretke (Lucy Mission Liaison)

New Mexico Institute of Mining & Technology  
 Prof. Raúl Morales-Juberías (NMT)  
 John Van Eepoel (LRO Mission Liaison)

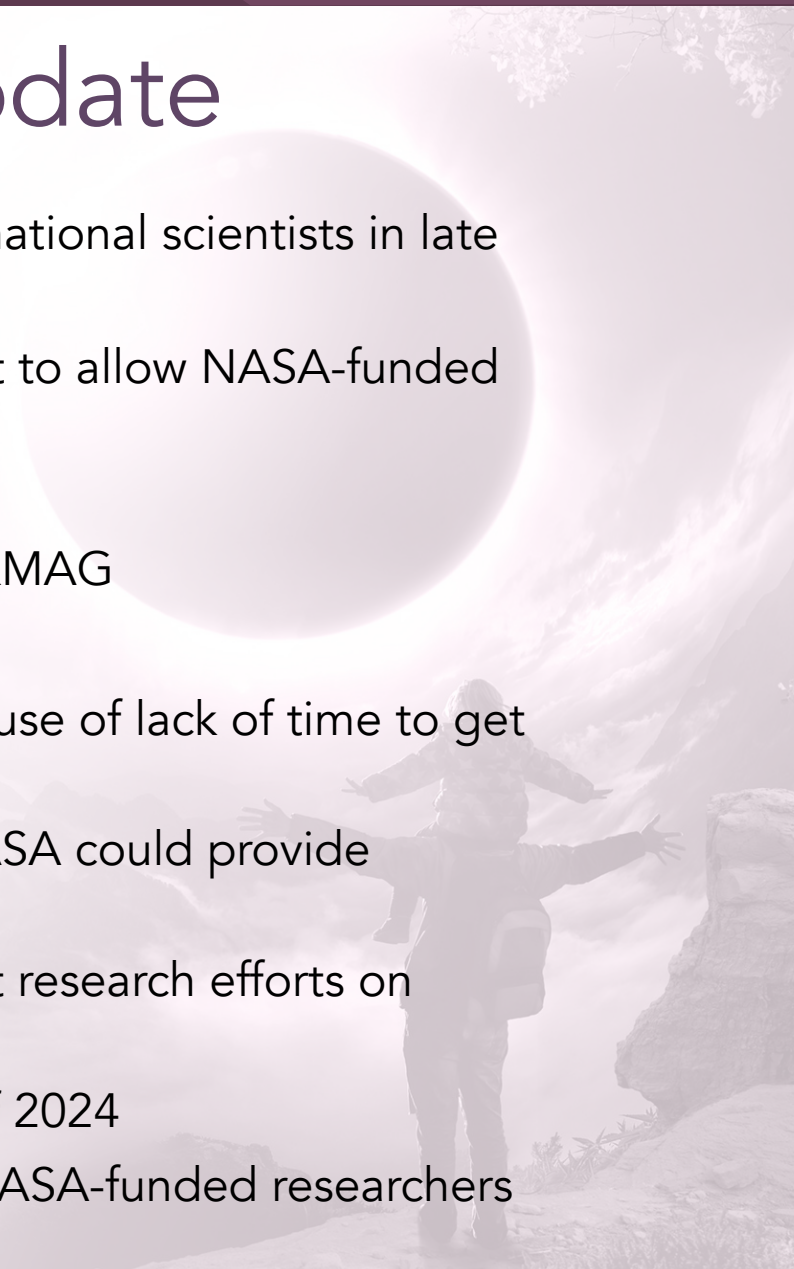
Virginia State University  
 Prof. Dawit Haile (VSU)  
 Dr. Ashwin Vasavada (Curiosity Mission Liaison)



# Community Announcements

# CNSA Chang'e-5 Lunar Samples Update

- CNSA opened applications for access to Chang'e-5 lunar samples to international scientists in late 2023
- November 2023, Administrator Nelson certified to Congress NASA's intent to allow NASA-funded researchers to apply to CNSA for access to these samples
  - A limited exemption under the Wolf Amendment
- NSPIRES notification released on November 29, amplified by LEAG and ExMAG
- CNSA received nearly a dozen applications from US proposers
  - NASA civil servant applications will not be considered this round because of lack of time to get an appropriate international loan agreement in place
  - In February NASA requested a status update from all proposers so NASA could provide guidance on next steps
  - Guidance will be given on how NASA funding may be used to support research efforts on Chang'e 5 samples
- A second opportunity for international proposers is expected in summer of 2024
  - NASA intends to certify negotiations with CNSA to allow NASA and NASA-funded researchers to apply to CNSA in this second round of applications

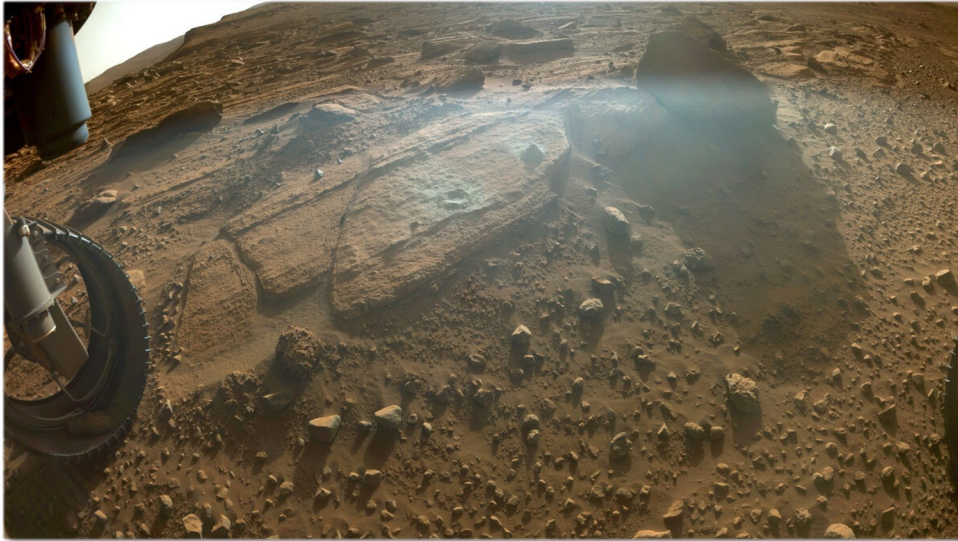


# NASA Events at LPSC

Citizen Science in the Era of Big Data	Tuesday, 11:00 am
Open Science Data Management Plans & Community Resources	Tuesday, 11:30 am
NASA HQ R&A Townhall (Plenary)	Tuesday, 1:00 pm
NASA PSD Meet and Greet	Tuesday, 5:30 pm
Ask Your Program Officers Anything (for early-career researchers)	Wednesday, 11:30 am
NASA HQ Technology Development Plan (Plenary)	Wednesday, 1:00 pm
Planetary Data Ecosystem Update	Thursday, 11:30 am
Early-Career Award Proposal Workshop	Thursday, 11:30 am
Future Science: NASA's Early Career Award Winners (Plenary)	Thursday, 1:00 pm



# Mars Sample Return



*Mars Perseverance rover collecting a rock core sample from an outcrop called "Berea"*

## Mars Sample Return (MSR)

- In response to the findings of the second Independent Review Board (IRB; completed in September 2023) and expected budget constraints in FY24, NASA initiated a slow-down of MSR program activities in Fiscal Year (FY) 2024
  - Cease activities on Capture, Containment, and Return System (CCRS) after Preliminary Design Review (PDR)
  - Reduced JPL budget allocation for Sample Return Lander (SRL) work
- SMD MSR IRB response team is developing options for a sustainable MSR program that is part of a balanced Planetary Science portfolio



Jeff Gramling, Program Director



Donya Douglas-Bradshaw, Deputy Program Director



Rich Ryan, Deputy Program Director – Business



Chris Carson, Program Executive



Megan Ansel, Program Scientist



Leo Gomez, Executive Officer



Lindsay Hays, Lead Scientist



Steve Thibault, Chief Engineer



Michaela Munoz Fernandez, Program Executive



Megan Gorham, Systems Engineer



George Tahu, Program Executive



Budget



# FY 2024 Budget: NASA & SMD

NASA's budget for FY2024 was included in the minibus bill passed by Congress last week

(\$M)	FY23 Enacted	FY24 PBR	FY24 Minibus Bill	Delta from PBR	Delta from FY23
Science	7,795.0	8,260.8	7,334.2	-926.6	-460.8
Earth	2,195.0	2,472.8	2,195.0	-277.8	0.0
Planetary	3,200.0	3,383.2	2,716.7	-666.5	-483.3
Astrophysics	1,510.0	1,557.4	1,530.0	-27.4	20.0
Heliophysics	805.0	750.9	805.0	54.1	0.0
Biological & Physical Sciences	85.0	96.5	87.5	-9.0	2.5

# FY 2024 Budget: PSD

- NASA's FY 2024 Appropriations for PSD: \$2.7B
  - \$483M lower than FY 2023 (15% reduction of FY2023 budget)
  - \$666.6M (~20%) lower than FY 2024 President's Budget Request (PBR)
- Reduction is mostly accounted for by reduced support for Mars Sample Return
  - MSR to be funded at \$300M (or more)
  - Although appropriation allows **up to** the President's FY24 request (\$949.3M) for MSR, portfolio balance and Decadal Survey guidelines within the fixed top line are a high priority
- Special interest language:
  - ~\$210M for NEO Surveyor
  - Up to FY 2023 level (~488M) for New Frontiers, including not less than \$360M for Dragonfly
- Operating plan will be worked over the coming months

(\$M)	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
PSD	1,342.3	1,446.7	1,628.0	1,827.5	2,217.9	2,746.7	2,712.6	2,693.2	3,120.4	3,200.0	2,716.7

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\*From FY25 PBR

# Planetary Science Budget Priorities

## Explore/Innovate/Partner/Inspire

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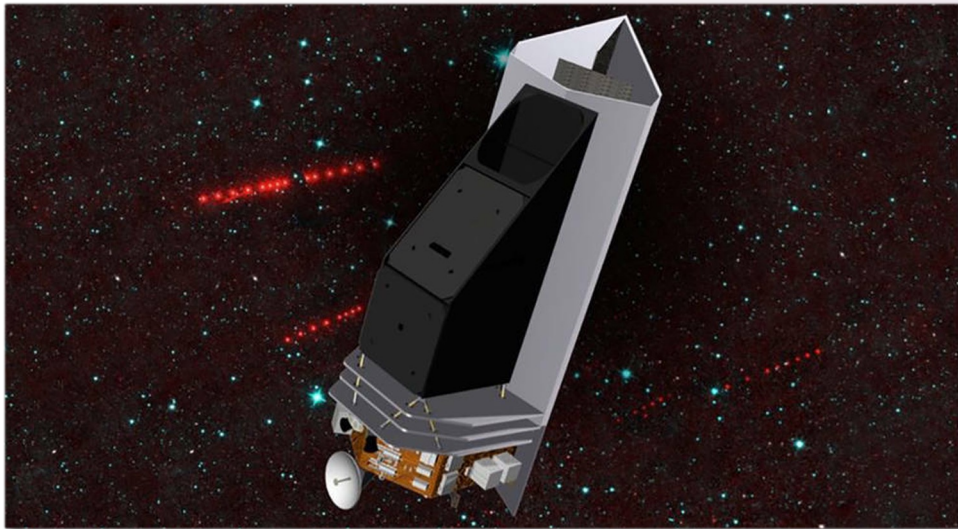
Successfully complete confirmed high-priority missions including **Europa Clipper**, **NEO Surveyor**

Support **international partnerships**: JUICE, MEGANE/MMX, Rosalind Franklin Mission, EnVision

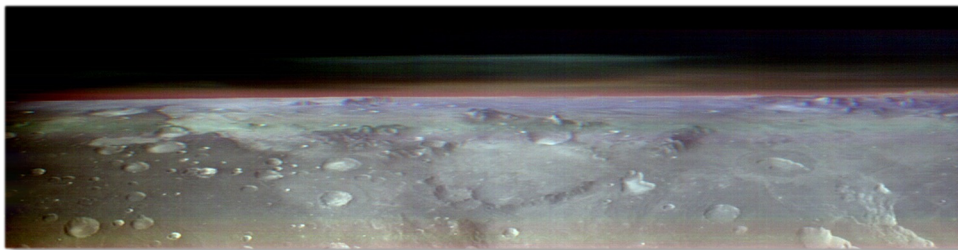
Ensure Decadal-recommended science investigations are included in **Artemis** campaign; support stable cadence of future CLPS deliveries to the lunar surface

Support Planetary Science **research** community to ensure continued scientific discovery from NASA mission data

# Planetary Science Highlights



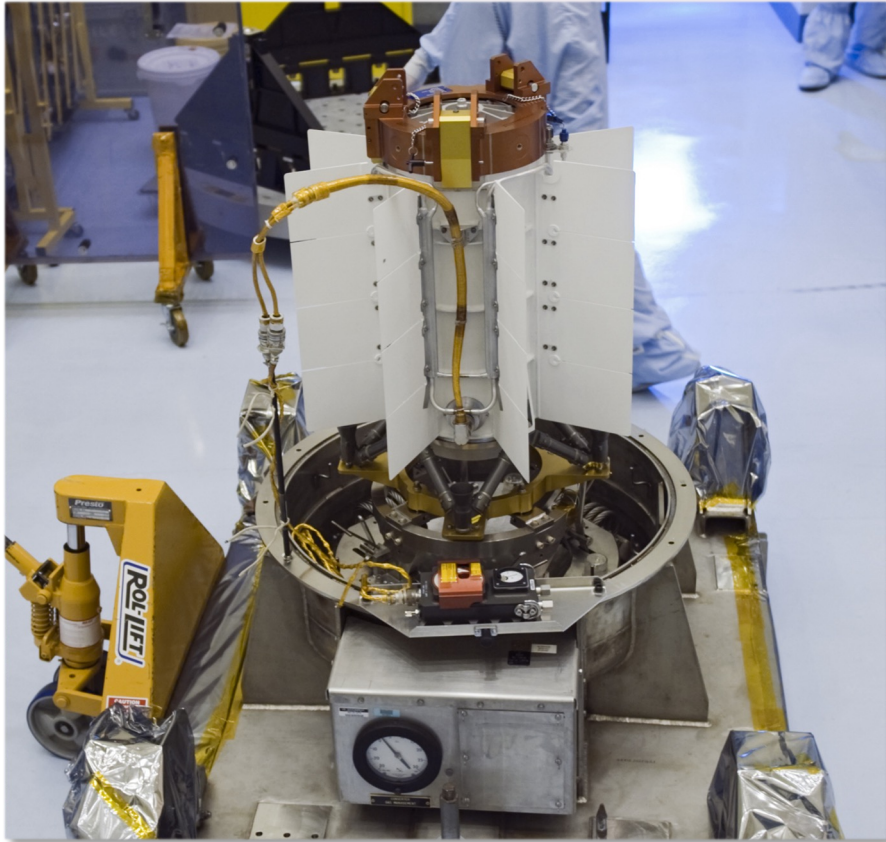
Artist conception of the NEO Surveyor spacecraft. Image credit: NASA/JPL-Caltech



This view of Mars was captured by NASA's Odyssey orbiter using its THEMIS camera. It combines three channels of infrared data that highlight water-ice clouds and dust in the atmosphere. Image credit: NASA/JPL-Caltech/ASU

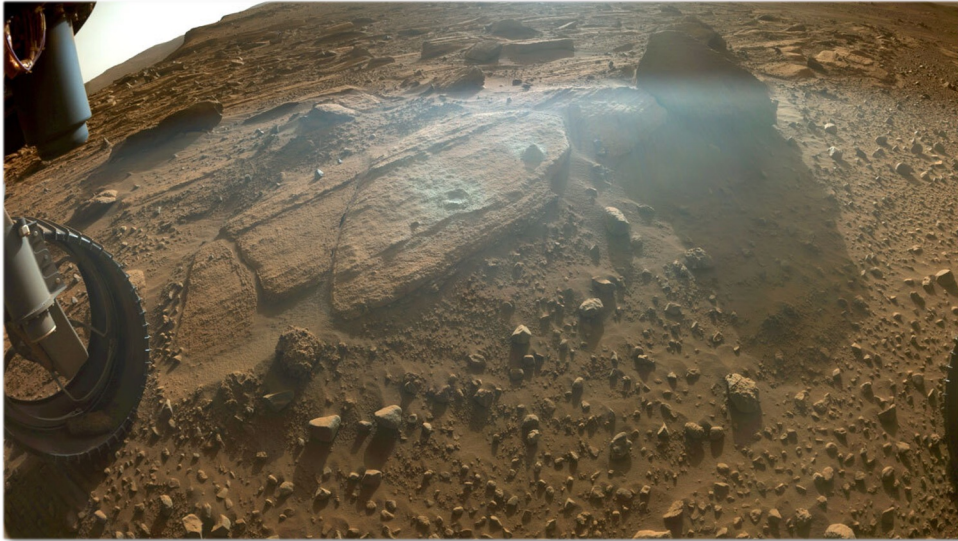
- **Mars Sample Return** paused in FY24 while architecture studies are completed; FY25 budget request is TBD (see later slide)
- Supports launches of **Europa Clipper** (Oct 2024) and **NEO Surveyor** (2028)
- Supports **Dragonfly** mission for 2028 LRD in anticipation of confirmation decision in 2024
- Three missions to study Venus: **DAVINCI**, **VERITAS** (both to launch in 2031–32 timeframe) and contributions to ESA **EnVision**
- **Mars Exploration Program** supports ongoing operation of 5 missions at Mars, including Perseverance and MSL, and new investments in technology to enable future Mars missions
- **Robust Lunar Discovery and Exploration Program** which includes:
  - Two **CLPS** awards per year in most years
  - Annual **PRISM** calls for instruments
  - Artemis Science instruments, including handheld instruments for astronauts and the lunar terrain rover
  - Lunar Reconnaissance Orbiter operations
  - Support for **VIPER** and **Lunar Trailblazer** for planned launches in FY 2025

# Planetary Science Highlights



An RPS MMRTG. This unit is currently installed and operating on the Curiosity Rover. Image Credit: NASA/DOE

- The next **New Frontiers, Discovery, and SIMPLEx** AOs expected to be released no earlier than 2026
- New **Planetary Technology** strategy and project, to provide integrated technology development for future planetary science missions
- Pre-formulation studies of the Decadal-Survey-recommended Uranus Orbiter and Probe mission will begin in the current budget horizon
- Investments in **Open Source Science** to enhance transparency, inclusivity, accessibility, and reproducibility in publicly funded scientific research.
  - This project also supports SMD's transition to cloud computing services
- **Radioisotope Power Systems** program investments in technology, to enable successful trips to distant solar system destinations with harsh environments; includes development of the Dragonfly MMRTG
- **Planetary Data System** data archives, which now span more than 50 years of NASA-funded research, and will expand to include ground-based observations of Near-Earth objects



*Mars Perseverance rover collecting a rock core sample from an outcrop called "Berea"*

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  - Cease activities on Capture, Containment, and Return System (CCRS) after Preliminary Design Review (PDR)
  - Reduced JPL budget allocation for Sample Return Lander (SRL) work
- SMD MSR IRB response team is developing options for a sustainable MSR program that is part of a balanced Planetary Science portfolio
- Given that the Mars Sample Return mission is a major part of NASA's Planetary Science budget, the Budget enables NASA's internal assessment of mission architecture options to be completed to address increases in mission cost estimates before providing final details for the \$2.7 billion Planetary Science budget
- NASA expects to provide an FY25 budget amendment for MSR this spring



Looking  
Ahead





# Future Mission AOs

- Next New Frontiers (NF) AO final release will be no earlier than 2026
  - NASEM Committee on Astrobiology and Planetary Sciences (CAPS) have been tasked with assessing the target list for the next NF AO (considering the lists for NF5 and NF6)
- Unlikely to be solicitations for Discovery or SIMPLEx in the next two years

*The National Academies of*  
SCIENCES • ENGINEERING • MEDICINE

# ORIGINS, WORLDS, AND LIFE

A Decadal Strategy for Planetary Science & Astrobiology  
2023–2032

# The Moon's Moment in the Sun



First CLPS Landings  
*February and beyond*



Firefly  
*Blue Ghost Mission 1*



Total Solar Eclipse  
*April 8*



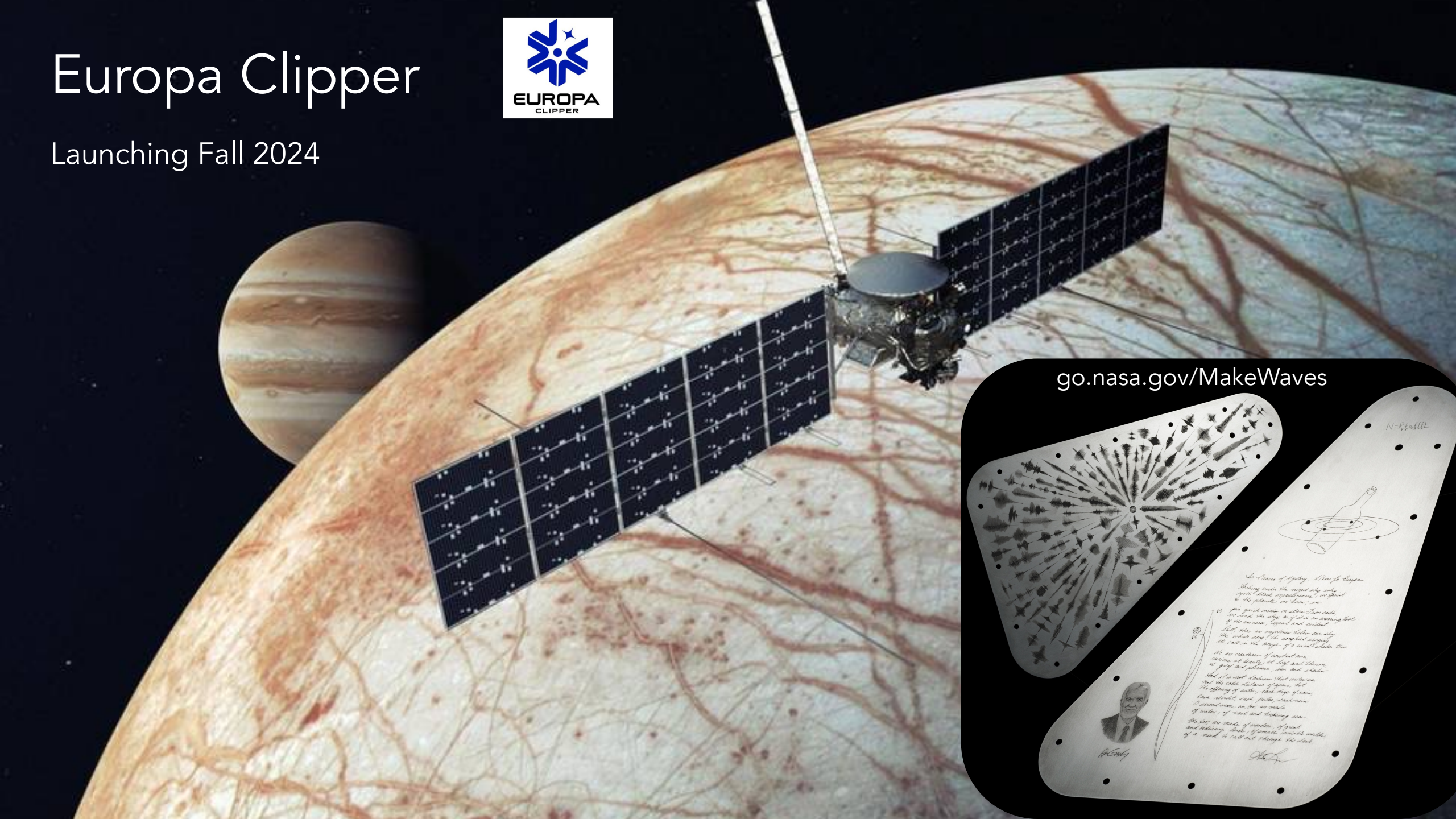
Lunar Trailblazer  
*Launching with IM-2*



# Europa Clipper



Launching Fall 2024



[go.nasa.gov/MakeWaves](https://go.nasa.gov/MakeWaves)

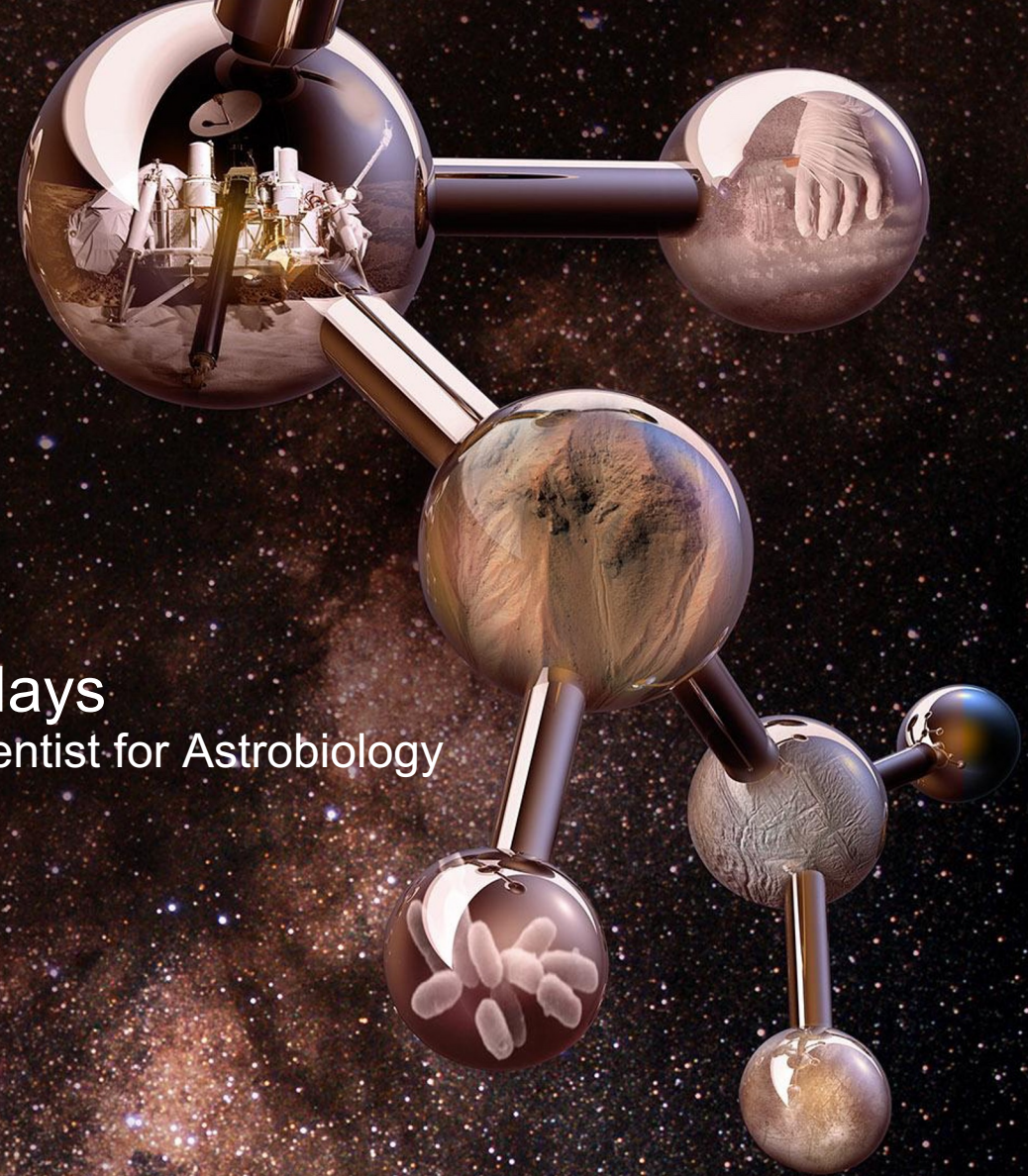


# NASA Astrobiology Program Update

David Grinspoon  
Senior Scientist for Astrobiology Strategy

Lindsay Hays  
Program Scientist for Astrobiology

NASA Town Hall  
LPSC  
March 11, 2024





# New AB program leadership

Senior Scientist for Astrobiology Strategy  
(David Grinspoon):

“Up and out”

Expand the astrobiology program within NASA and beyond



Program Scientist for Astrobiology  
(Lindsay Hays)

“Down and in”

Manage existing Astrobiology research and coordination programs



Deputy Program Scientist for Astrobiology  
(Becky McCauley Rench)





# Astrobiology Research Programs

- C.5 Exobiology (PO: Lindsay Hays)
  - Aim is to understand the origin, evolution, distribution, and future of life in the Universe. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere.
- C.14 Planetary Science and Technology Through Analog Research (PSTAR) (PO: Becky McCauley Rench)
  - This program solicits proposals for investigations focused on exploring the relevant environments on Earth in order to develop a sound technical and scientific basis to conduct astrobiological research on other Solar System bodies.
- C.20 Interdisciplinary Consortia for Astrobiology Research (ICAR) (PO: Lindsay Hays)
  - Proposals that describe a multi-million dollar, five-year project with an interdisciplinary approach to a single, compelling question in astrobiology. For projects larger than the scope of the individual research programs, but within the scope of the Research Coordination Networks.
- F.4 Habitable Worlds (HW) (PO: Becky McCauley Rench)
  - Aim is to use knowledge of the history of the Earth and the life upon it as a guide for determining the processes and conditions that create and maintain habitable environments and to search for ancient and contemporary habitable environments and explore the possibility of extant life beyond the Earth.

# Research Coordination Networks



The Nexus for Exoplanet  
System Science  
*nexss.info*

## From Early Cells to Multicellularity

*lifercn.org*



To understand how life and the Earth coevolved, focused on key innovations in the transition from early cells to multicellularity.

To investigate the diversity of exoplanets and to learn how their history, geology, and climate interact to create the conditions for life, dedicated to the study of planetary habitability.

## The Network for Life Detection

*nfold.org*

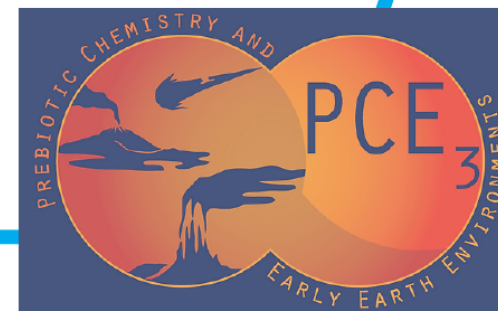


To advance life detection strategy and capability and catalyze interdisciplinary collaborations for research and technology objectives.

## The Network for Ocean Worlds

*oceanworlds.space*

To advance comparative studies to characterize Earth and other ocean worlds across their interiors, oceans, and cryospheres; to investigate their habitability; to search for biosignatures; and to understand life—in relevant ocean world analogues and beyond.



## Prebiotic Chemistry and Early Earth Environments

*prebioticchem.org*

Investigate the delivery, synthesis, and fate of small molecules under the conditions of the Early Earth, and the subsequent formation of proto-biological molecules and pathways that lead to systems harboring the potential for life.





# Expand the astrobiology program within NASA and beyond.

- Increased cross-divisional & cross-directorate activity in Astrobiology at NASA. (Remedy “siloing”)
- Interagency programs. (NSF, USGS, NIH...)
- Revitalized international connections & collaborations.
- Public/private partnerships.
- Role in missions.
- Post discovery planning: communication strategy, science strategy.



## Year 1 Goal: Increased cross-divisional & cross-directorate activity in Astrobiology at NASA.

We are in the process of planning several interdisciplinary community activities designed to explore and catalyze new interdivisional collaborations and the potential for possible new interdivisional programs.

### Earth Science:

EPSCoR on Ocean Worlds

Ocean Drilling Workshop (joint with NSF). April 2-4, Washington DC

### Astrophysics:

Possible Ideas Lab: Exoplanet biosignatures (late 2024)

Supporting HWO working group on exoplanet biosignatures.

Joint communication efforts with Astrophysics on potential biosignature discoveries.

### Biological and Physical Sciences:

Exploring Workshop on Metagenomics in Astrobiology, Space Biology and Planetary Protection.

# Astrobiology Strategy 2025

We are starting to plan an activity to formulate a new Astrobiology Strategy

A decade since the previous one.

**Much has happened:**

- New Decadal Survey.
- Concrete evidence of habitable early environments on Mars.
- Dragonfly selection.
- Exoplanets (discovery that Trappist-1 has multiple planets in potentially HZ).
- Tremendous progress in understanding biology and environmental evolution of early Earth.

**Include post-discovery science strategy?**

**Worth looking more than 10 years ahead?**

20 years from now: Hopefully, samples back from many targets, HWO will be operating, perhaps we'll be planning a fleet of next generation telescopes, perhaps we'll have found multiple biosignatures (or not).

What laboratory & analytical techniques might we have access to?

What will our science look like?





National Aeronautics and  
Space Administration

# NASA SCIENCE

**Joel Kearns**

Deputy Associate Administrator for Exploration  
NASA Science Mission Directorate

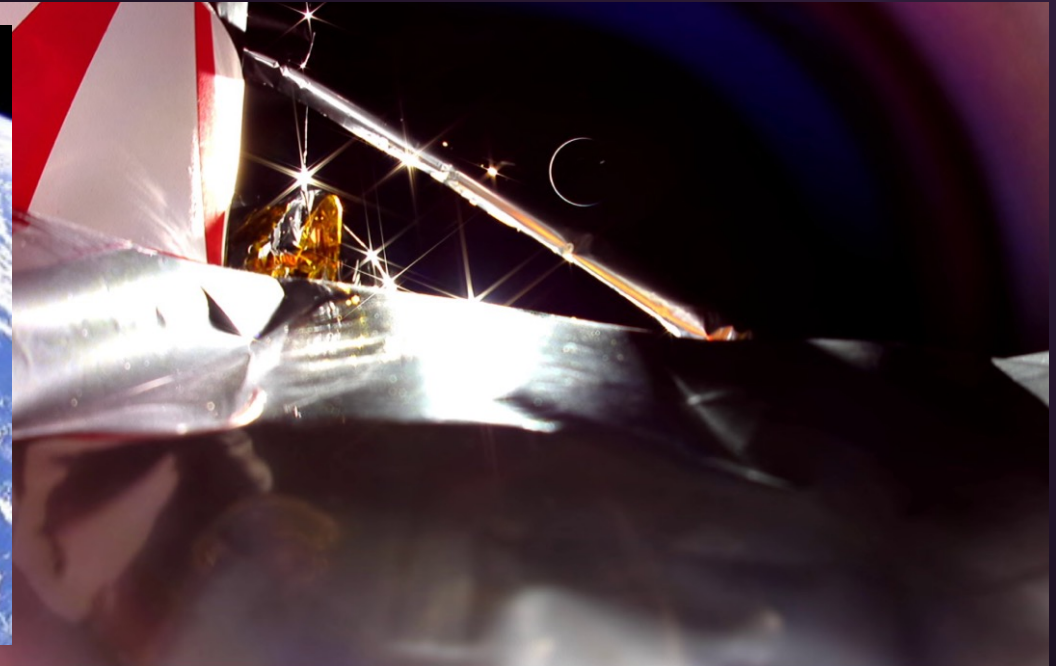
**Lunar Discovery and Exploration Program  
Update**



## Competitive Solicitations:

- Artemis III Deployed Instruments call (A3DI)
  - selections spring 2024
- PRISM-SALSA (Stand Alone Site Agnostic) instruments call
  - Draft call for community comment spring 2024
- Planning: A4DI call (Artemis IV: FY28 Launch)
- Planning: LTV instruments call
- Planning: A4 Hand-Held Instruments call

PM-1



 **ASTROBOTIC**

Moon Location  
1/12/24

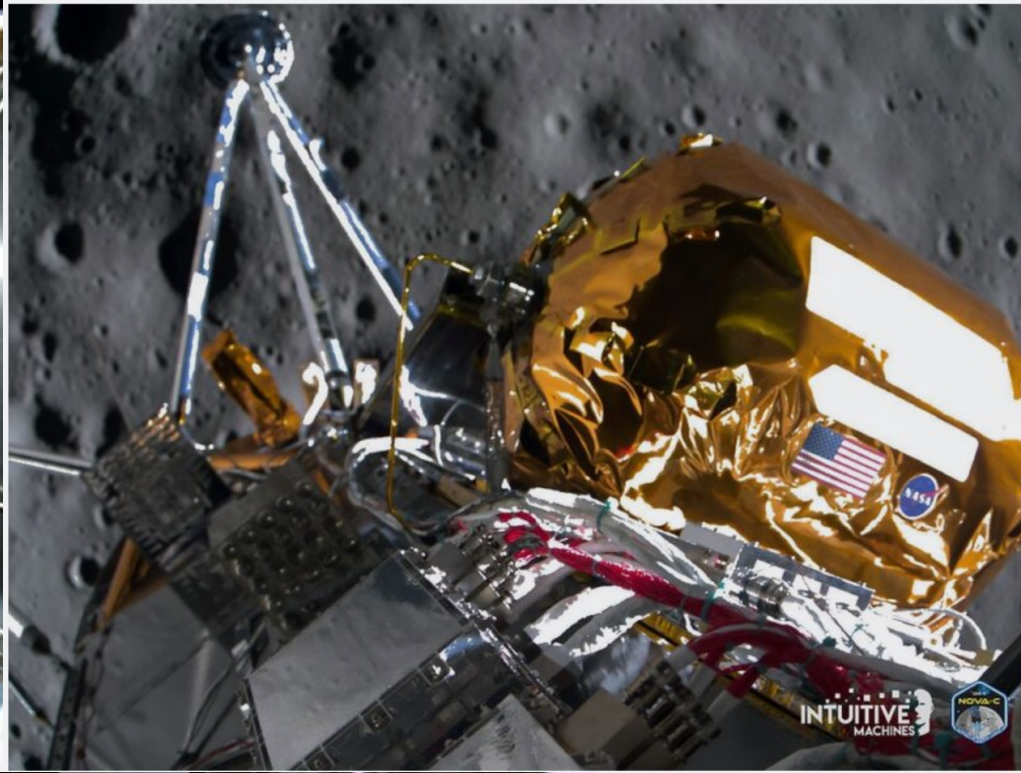
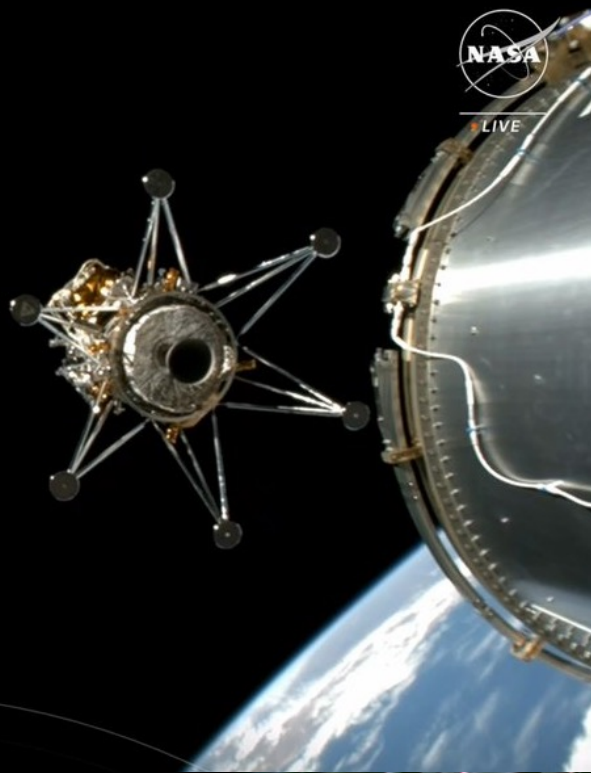


Lunar  
Orbit

Peregrine  
1/12/24

\*Not to scale





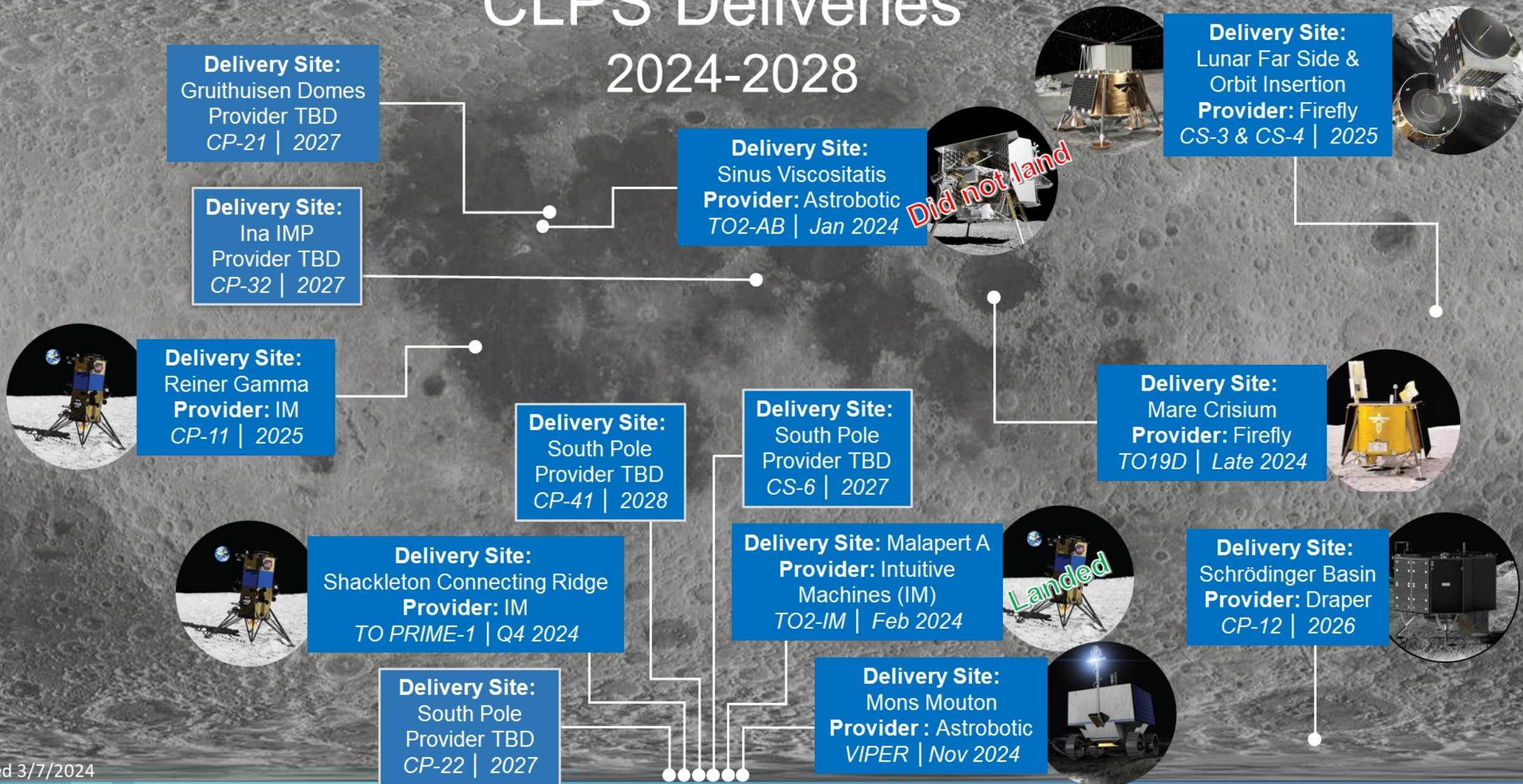
DEPLOY  
T+ 00:48:47  
IM-1

IM-1



# CLPS Deliveries

## 2024-2028







# Exploration Systems Development Mission Directorate Updates

**Dr. Jacob Bleacher**  
Chief Exploration Scientist  
Exploration Systems Development Mission Directorate



**Lunar & Planetary Science Conference**  
*March 11, 2024*

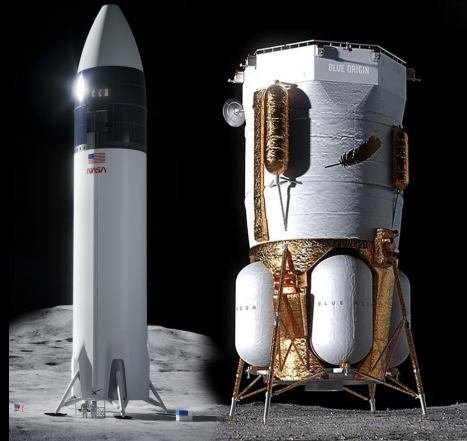
# Artemis: A Foundation for Deep Space Exploration



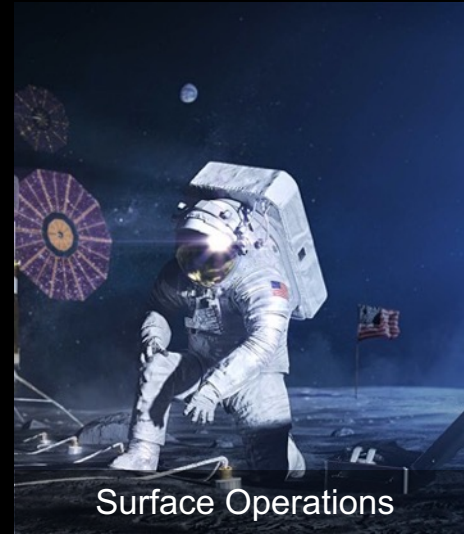
Space Launch System



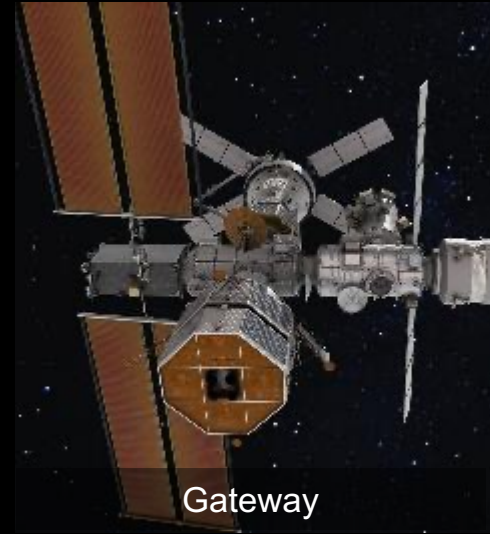
Orion Spacecraft



Human Landing System



Surface Operations



Gateway



Exploration Ground Systems



Space Communications and Navigation



Surface Mobility



Spacesuits



Surface Infrastructure



# Artemis II

## ARTEMIS FIRSTS:

- Crewed integrated flight test of the Space Launch System (SLS) rocket, Orion spacecraft, and Exploration Ground Systems (EGS) at KSC
- Active Orion Launch Abort System (LAS)
- Demonstration of Orion life support systems
- Proximity operations demonstrations
- Human data collection in transit to and from the Moon, in lunar orbit, and through reentry and splashdown
- Conducting new science and technology demonstrations in orbit

## NEW ELEMENTS:

- Orion life support systems
- Launch Complex 39B emergency egress system for crew and new liquid hydrogen system

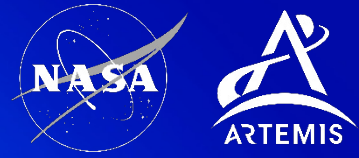
## COMMON ELEMENTS:

- SLS rocket Block 1 configuration
- Orion crew spacecraft
- Mobile Launcher 1

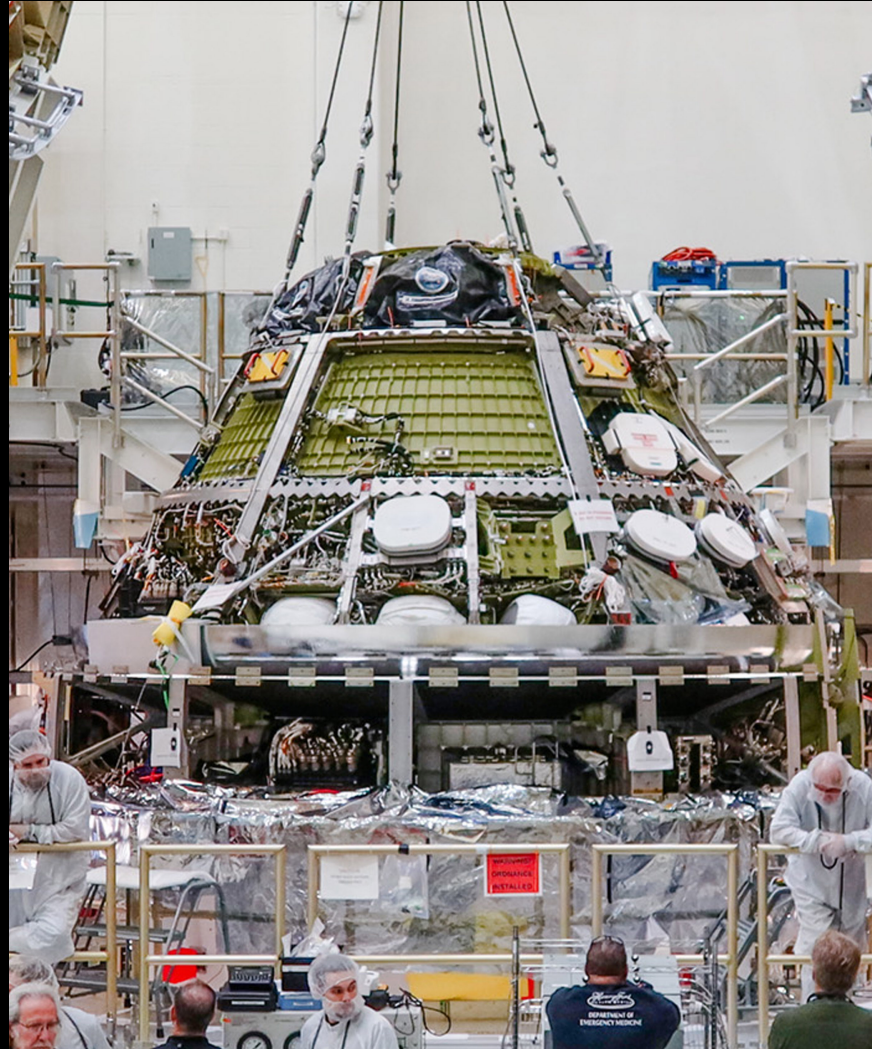
**ENSURING CREW SAFETY IS OUR TOP PRIORITY!**



# Artemis II Progress



The crew stand on the crew access arm of the mobile launcher at Launch Pad 39B as part of an integrated ground systems test



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



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



Artemis II Service Module



# Artemis III

## ARTEMIS FIRSTS:

- Human landing in South Pole region and return
- Orion to human landing system direct mission including crew docking activity
- Use of Near Rectilinear Halo Orbit (NRHO)
- Four astronauts to lunar orbit
- Two astronauts to lunar surface to collect scientific samples and data
- Conducting new science and technology demonstrations

## NEW ELEMENTS:

- Orion full up rendezvous, proximity operations, and docking systems
- Starship human landing system
- Advanced spacesuits and tools to explore the surface and collect samples

## COMMON ELEMENTS:

- SLS rocket Block 1 configuration
- Orion crew spacecraft
- Mobile Launcher 1

# Artemis III Progress

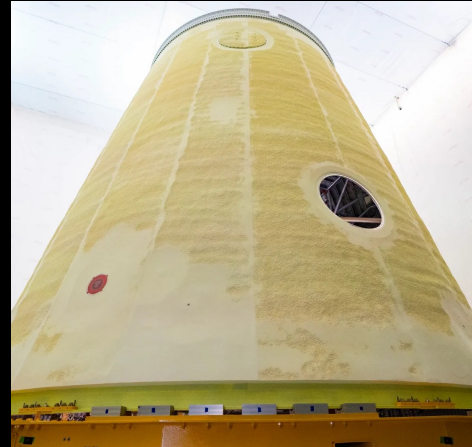


Image: SpaceX

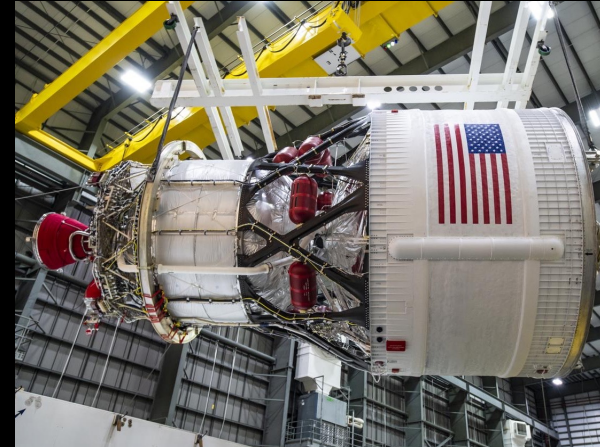
Starship second integrated flight test



Starship Human Landing System elevator astronaut testing



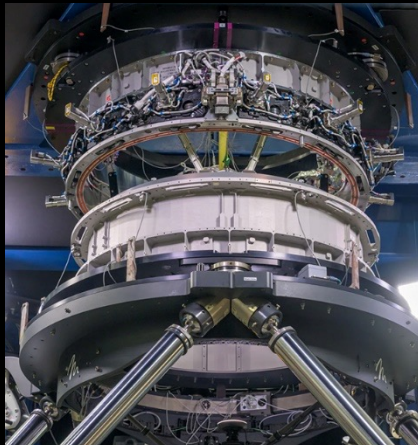
Frangible joint assembly installed onto the Launch Vehicle Stage Adapter



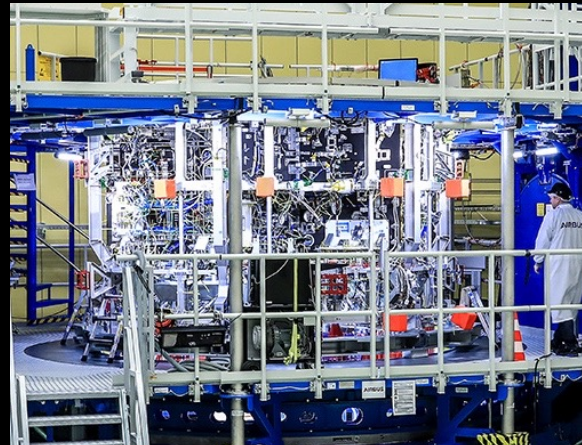
Artemis III Interim Cryogenic Propulsion Stage being processed



Artemis III Space Launch System Core Stage Liquid Oxygen Aft Dome



Starship Human Landing System docking system



European Service Module-3 integration in Bremen cleanroom



Crew Module-3 integration



Artemis III booster segments

# Architecture Strategy



*A blueprint for future human exploration,  
architecting from the right.*

## ARCHITECTURE

*Iterate and evolve  
through annual  
Architecture  
Concept Reviews*

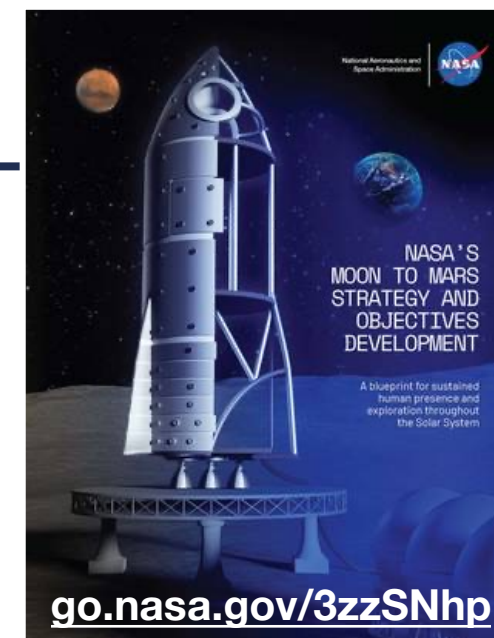
### Goals and Objectives

SCIENCE

TRANSPORTATION  
AND HABITATION

LUNAR AND MARS  
INFRASTRUCTURE

OPERATIONS



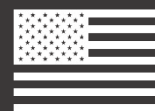
Requested feedback on these objectives in summer 2022 from the following key stakeholders:



NASA workforce:  
our greatest asset



International partners: our key  
current and future, anticipated  
collaborators



U.S. industry, academia, DOE, NIH,  
NSF, etc.: our national leaders in  
space research and capabilities

# Architecture Segments



## Human Lunar Return

Initial capabilities, systems, and operations necessary to re-establish human presence and initial utilization on and around the Moon.



## Foundational Exploration

Expansion of lunar capabilities, systems, and operations supporting complex orbital and surface missions to conduct utilization and Mars forward precursor missions.



## Sustained Lunar Evolution

Enabling capabilities, systems, and operations to support regional and global utilization, economic opportunity, and a steady cadence of human presence on and around the Moon.



## Future Segments

## Humans to Mars

Initial capabilities, systems, and operations necessary to establish human presence and initial utilization on Mars and continued exploration.





**Moon to Mars Architecture, White Papers and More**





# Artemis Science



**Sarah Noble**  
Artemis Lunar Science Lead  
Science Mission Directorate



# Update on the “Implementation Plan for a NASA Integrated Lunar Science Strategy in the Artemis Era”

Draft released for public comment on November 14th

- Received 21 individual responses through the Google Form (plus 1 additional individual response through email), plus a compiled group response from GSFC and a compiled response from LEAG
- We appreciate the feedback and are working on edits with a final version expected to be released later this Spring

# Artemis II – September 2025

- Artemis 2 lunar science objective definition underway for mission integration (includes inputs from the community gathered during December 2023 Orbital Observations LSSW)
- Science Evaluation Room in development and will be ready for Artemis 2
- Artemis 2 Science Officers (Flight Control Team representatives for lunar and geological sciences) have started training
- Early science training completed for Artemis II crew and more mission-specific training anticipated in the next year
- Artemis 2 as a pathfinder for Artemis 3+: SER development, lunar science integration into Artemis missions and operation, understanding orbital observations in Artemis



# 1<sup>st</sup> Artemis III Science Team meeting

The Artemis Internal Science Team (AIST) and the Artemis Geology Team (A3GT) held their first formal joint training activity at JSC Feb 26-Mar 1



# Get Involved in Artemis!

## Upcoming Artemis-related calls:

- Lunar Mapping Program – proposals due 6/12
- Analog Activities Program – proposals due 12/6
- Artemis 3 Participating Scientist Program
- Artemis 4 Deployed Instruments
- Artemis Handheld Instruments
- Lunar Terrain Vehicle Instruments

These two calls are open to  
“senior” graduate students

## Opportunities to provide input:

- LSSWs
- LEAG and ExMAG
  - Joint SAT on samples
- Upcoming NAS study

# Lunar Surface Science Workshops (LSSWs)



## Last year:

- Candidate Artemis III Landing Sites (Apr)
- Updates from HQ (May)
- Geologic Maps for Artemis Strategic Decisions (Aug)
- Artemis Orbital Observation Science (Dec)

## This year:

- Science Enabled by the Artemis Base Camp – April 3<sup>rd</sup>
- Updates from HQ – May 23<sup>rd</sup>
- Plume-Surface Interactions – July 9<sup>th</sup>-10<sup>th</sup>
- BPS Decadal Discussion – TBD Summer

# Through the Eyes of NASA

