

National Aeronautics and  
Space Administration



# EXPLORE MOON *to* MARS

NASA Status Report

James L. Green

October 20, 2021

COSPAR Planetary Protection Panel



# Outline

Status of NASA's Science Missions – J. Green

- Lunar Missions
- Mars Mission Sampling
- Sample Return Activities
- Venus missions – Present Later

NASA Planetary Protections Activities – J. Nick Benardini NASA PPO

# LUNAR EXPLORATION—ORBITAL

2021–2024

## PAYLOAD THEMES

- Measure and characterize radiation exposure levels
- Capture high-resolution photography of mission milestones
- Search for and characterize lunar surface volatiles
- Demonstrate novel trajectory, propulsion, and landing techniques
- Measure launch through landing acceleration and vibration loads on anatomical human models
- Scout potential landing sites for human and robotic missions

**ARTEMIS I**  
UNCREWED FLIGHT TEST  
+ CUBESATS

**THEMIS-ARTEMIS**

**LUNAR  
PATHFINDER**

**KPLO**

**LRO**

**ARTEMIS III**  
CREW

**GATEWAY**  
PPE & HALO

**ARTEMIS II**  
CREWED  
FLIGHT TEST

**CAPSTONE**

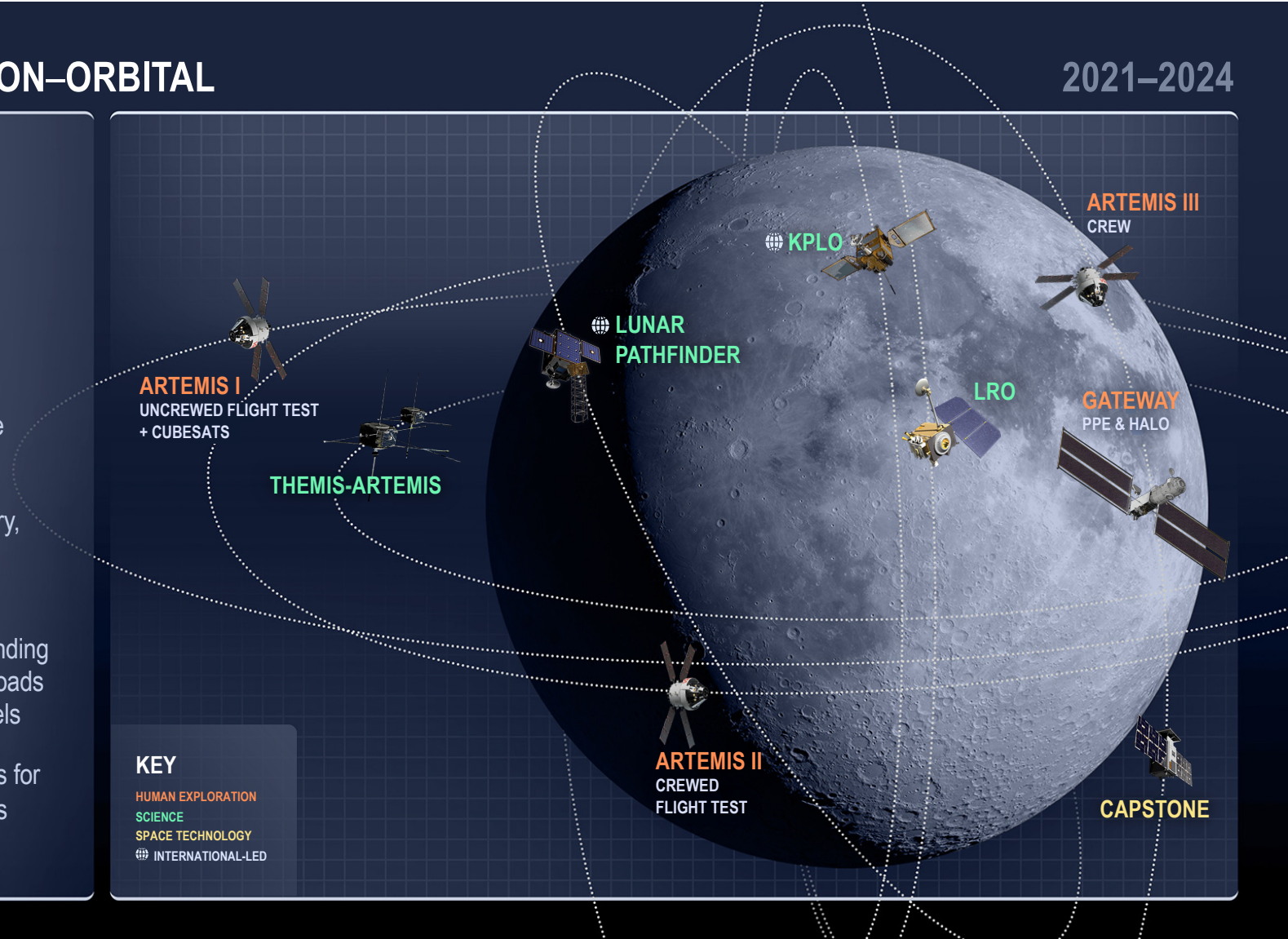
## KEY

HUMAN EXPLORATION

SCIENCE

SPACE TECHNOLOGY

INTERNATIONAL-LED





# LUNAR EXPLORATION—SURFACE

2021–2024

## NASA CLPS DELIVERY GOALS



### 1ST NOVA-C / INTUITIVE MACHINES / 2022

- Plume/surface interactions, charged particles near surface
- Lander prop tank gauge test



### PEREGRINE-1 / ASTROBOTIC / 2022

- Regolith volatiles composition
- Local radiation environment



### 2ND NOVA-C / INTUITIVE MACHINES / 2022

- Drilling for volatiles



### BLUE GHOST / FIREFLY / 2023

- Characterize Earth's magnetosphere and Moon's interior



### GRIFFIN / ASTROBOTIC / 2023

### VIPER / NASA / 2023

- Search for volatiles, below surface & in permanently shadowed regions



### XL-1 / MASTEN / 2023

- Regolith volatiles composition
- Surface terrain & mineralogy

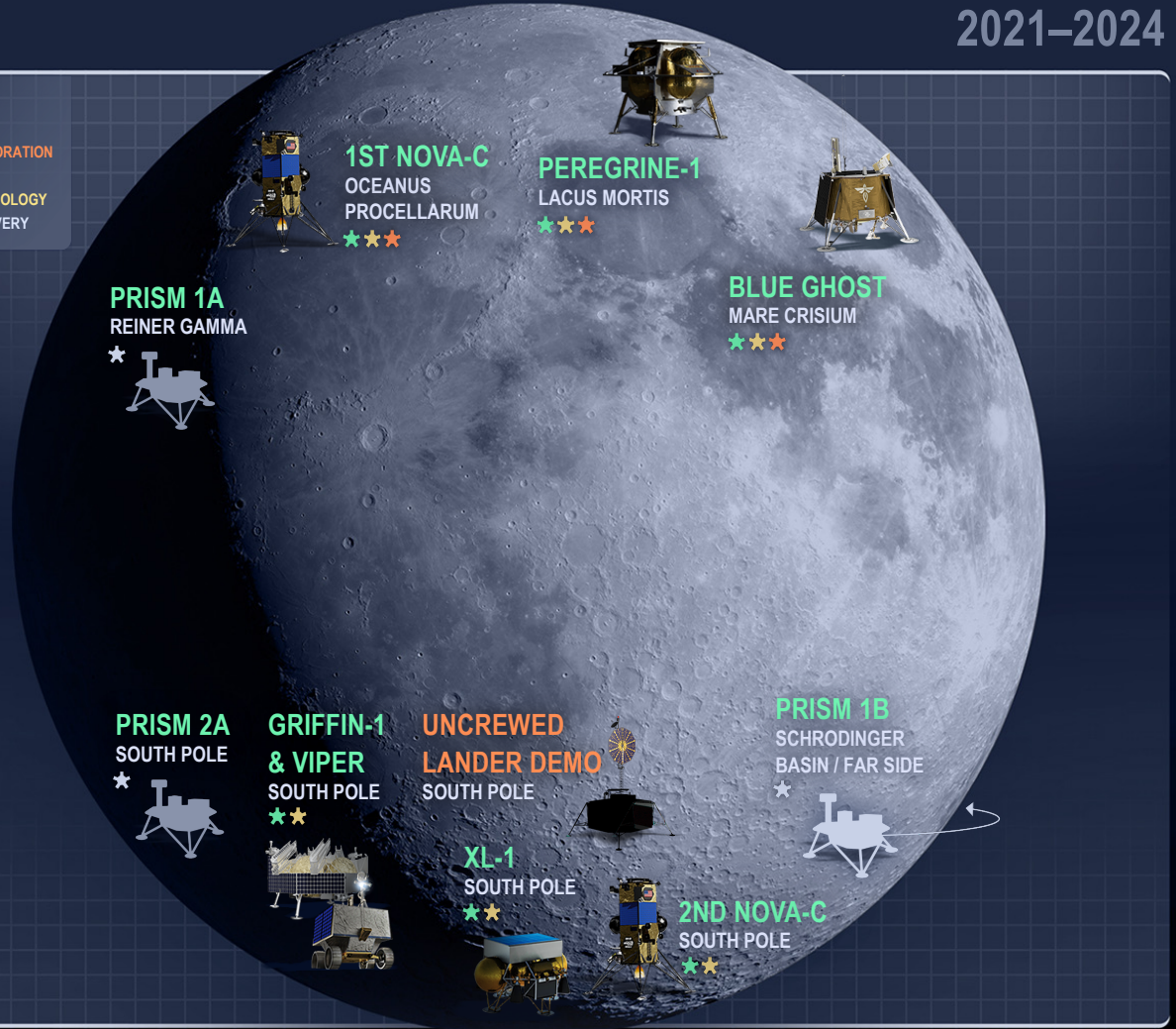
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SCIENCE

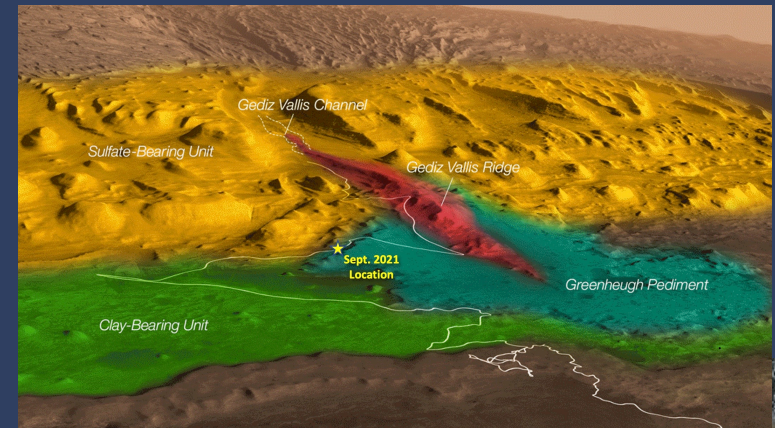
SPACE TECHNOLOGY

★ CLPS DELIVERY

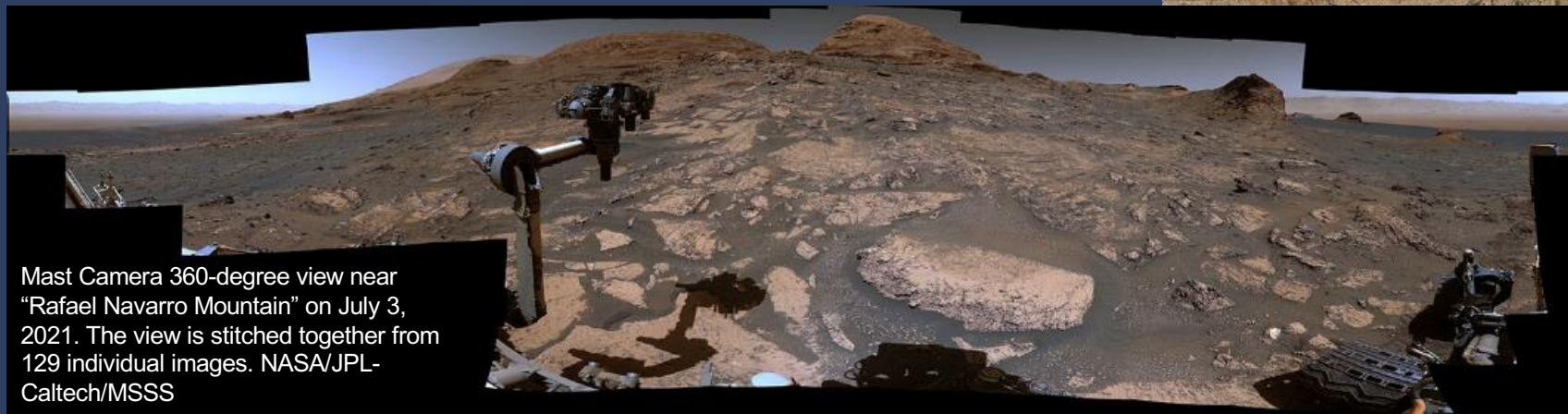


# Mars Science Laboratory

- Curiosity continues its climb up Mt Sharp near Rafael Navarro Mountain - moving out of the clay unit and towards the sulfate unit
- Curiosity has used the drill on its robotic arm to take 33 rock samples to date
- Mast Camera captured the below panoramic view of a craggy hump that reaches 450 feet tall located on Mt Sharp in northwest Gale Crater



Mars Hand Lens Imager (MAHLI), a camera on the end of the robotic arm, provided the images in this collage



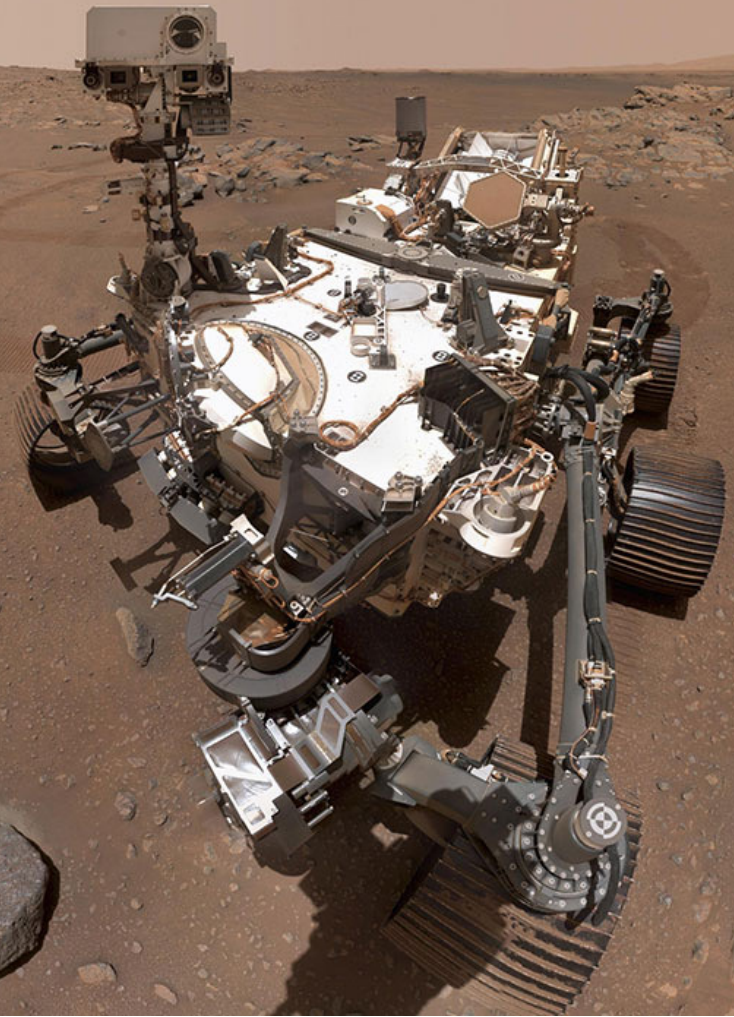
Mast Camera 360-degree view near "Rafael Navarro Mountain" on July 3, 2021. The view is stitched together from 129 individual images. NASA/JPL-Caltech/MSSS





43 Sample tubes  
(~15 g each)

Three Samples Taken  
- 2 Rock Cores  
- 1 Atmospheric



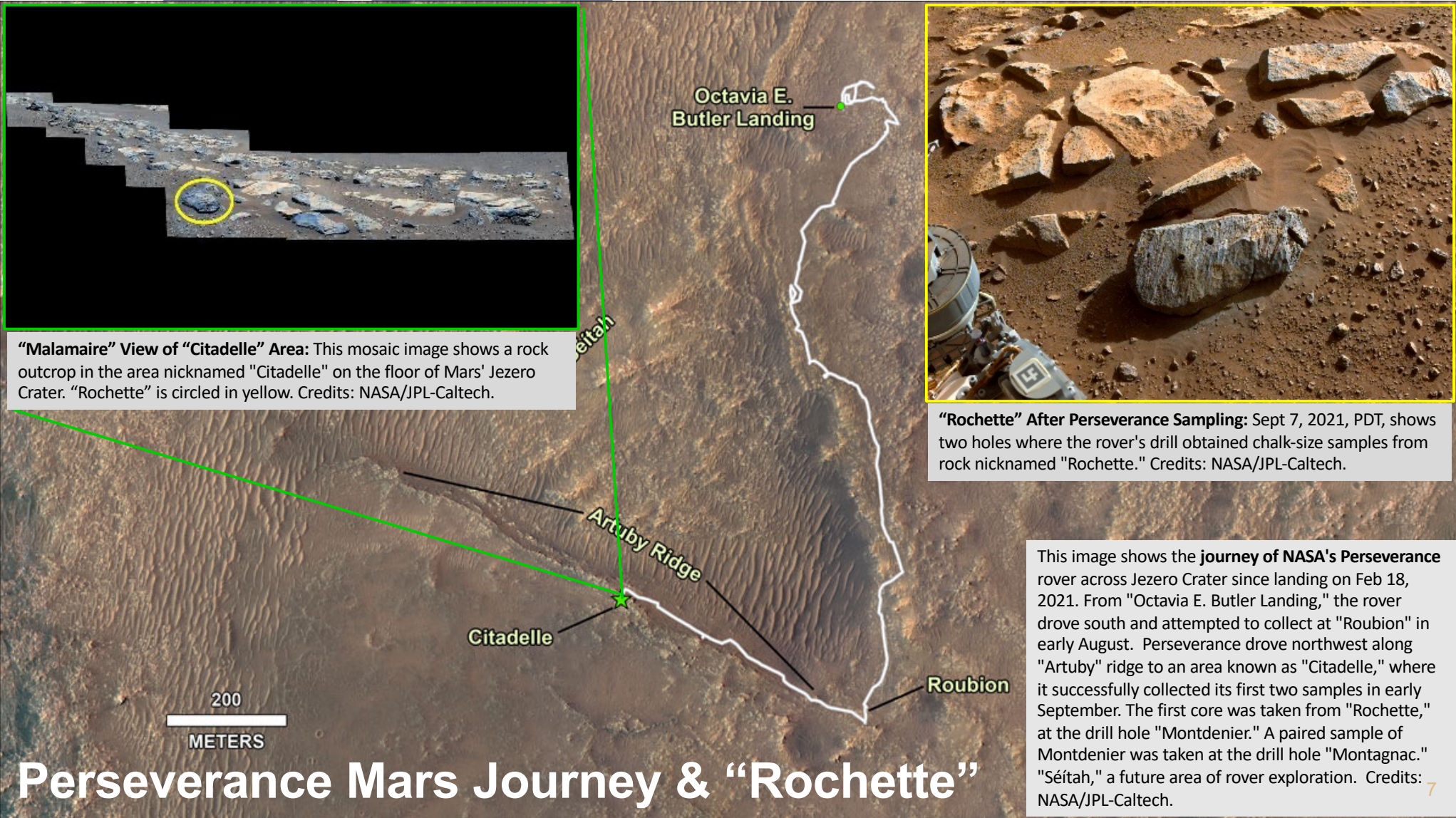




**"Malamaire" View of "Citadelle" Area:** This mosaic image shows a rock outcrop in the area nicknamed "Citadelle" on the floor of Mars' Jezero Crater. "Rochette" is circled in yellow. Credits: NASA/JPL-Caltech.



**"Rochette" After Perseverance Sampling:** Sept 7, 2021, PDT, shows two holes where the rover's drill obtained chalk-size samples from rock nicknamed "Rochette." Credits: NASA/JPL-Caltech.



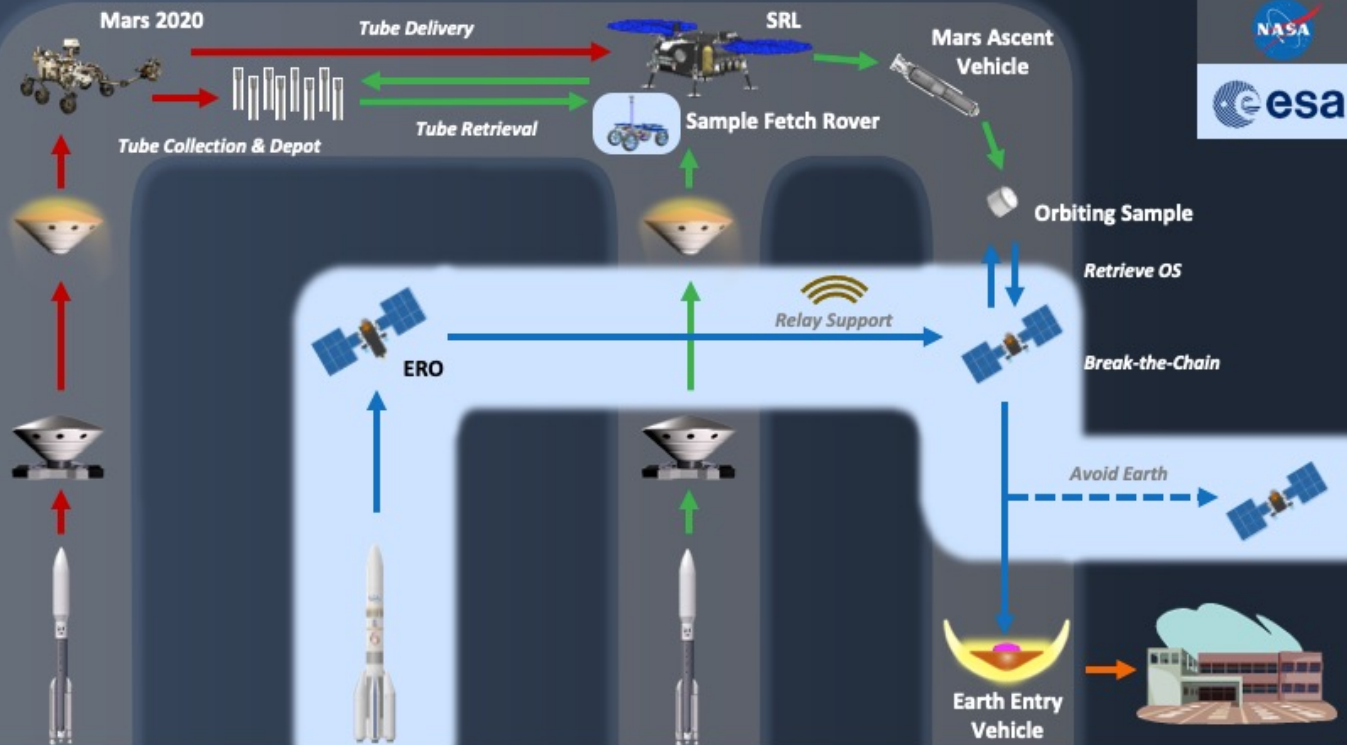
This image shows the **journey of NASA's Perseverance** rover across Jezero Crater since landing on Feb 18, 2021. From "Octavia E. Butler Landing," the rover drove south and attempted to collect at "Roubion" in early August. Perseverance drove northwest along "Artuby" ridge to an area known as "Citadelle," where it successfully collected its first two samples in early September. The first core was taken from "Rochette," at the drill hole "Montdenier." A paired sample of Montdenier was taken at the drill hole "Montagnac." "Séítah," a future area of rover exploration. Credits: NASA/JPL-Caltech.

# Perseverance Mars Journey & "Rochette"

# MRSR Architecture Overview



Mars



Mars2020

Earth Return Orbiter

Sample Retrieval Lander

Sample Return and Science

Earth

Status of NASA's Current Plan





A photograph of a Mars landscape, showing a reddish-brown terrain with some rocks and a hazy horizon under a pale sky. The image is partially obscured by a dark blue circular graphic element on the right side of the slide.

## Mars Sample Return (MSR) Updates

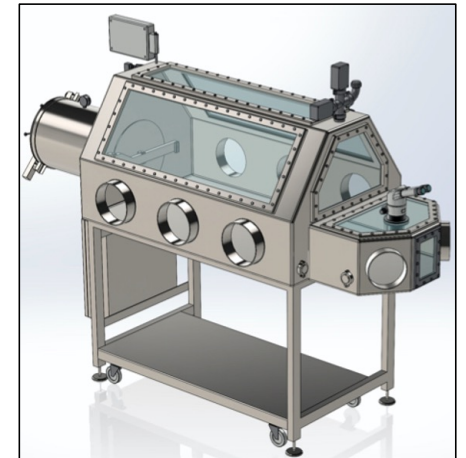
- Program is in Phase A, maturing technical/programmatic baseline for KDP-B
- Making progress on multiple technology and engineering developments including orbiting sample sealing technique, MAV thrust vector control, and Earth Entry System impact structure
- Initiated numerous procurement efforts
  - ESA Earth Return Orbiter (ERO) now in Phase B2/C/D
  - Sample Retrieval Lander (SRL) Aeroshell, Landing Engines, etc
  - Capture, Containment and Return System (CCRS) Spin Eject Mechanism Request for Proposal (RFP) released
  - Earth Entry System (EES) Aeroshell study contract to be released in late September
  - Mars Ascent Vehicle (MAV) System Integration RFP released

# NASA Hayabusa-2 Sample Allocation from JAXA

- As part of a Sample Exchange agreement between JAXA (H-2) and NASA (ORex)
- NASA will receive 500 mg of H2, which is 10% of returned sample
  - 220 mg of individual particles
  - 280 mg of particle aggregates
  - 10 % of samples from first and second touchdowns
- Cleanroom construction is complete at JSC, undergoing final certification
- Sample transfer is scheduled in December 2021

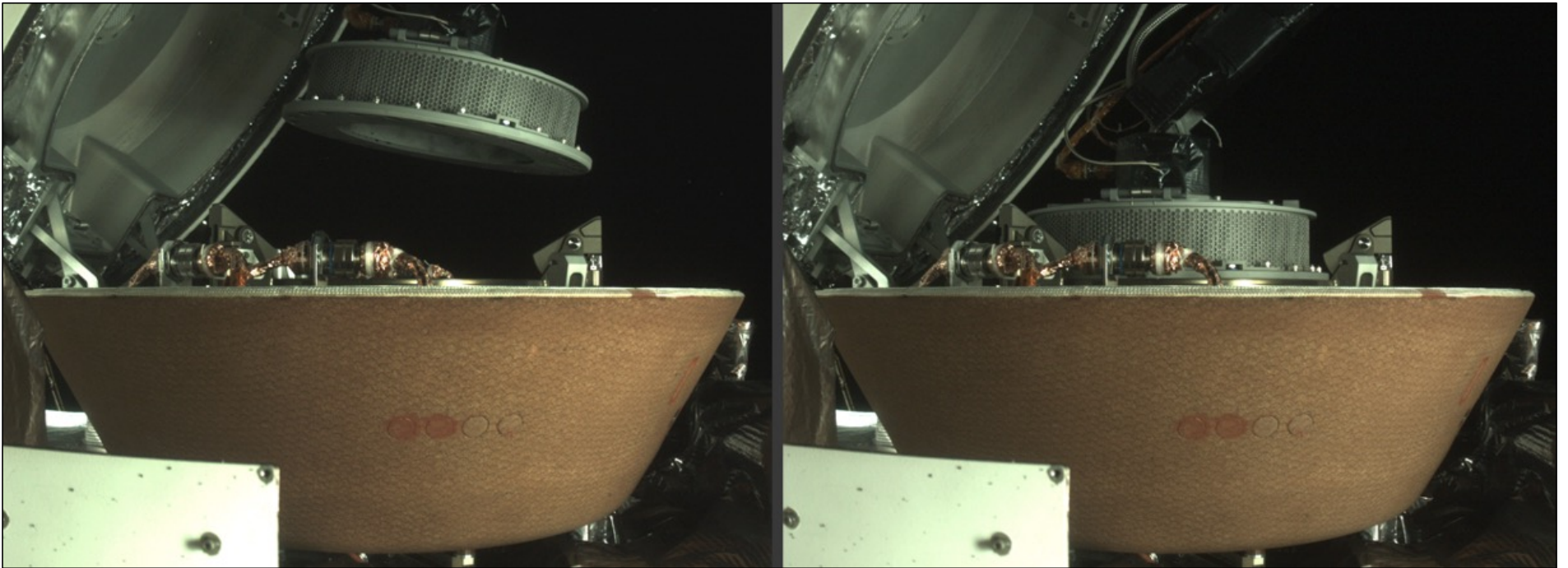


Thank You JAXA for this excellent cooperation!!!



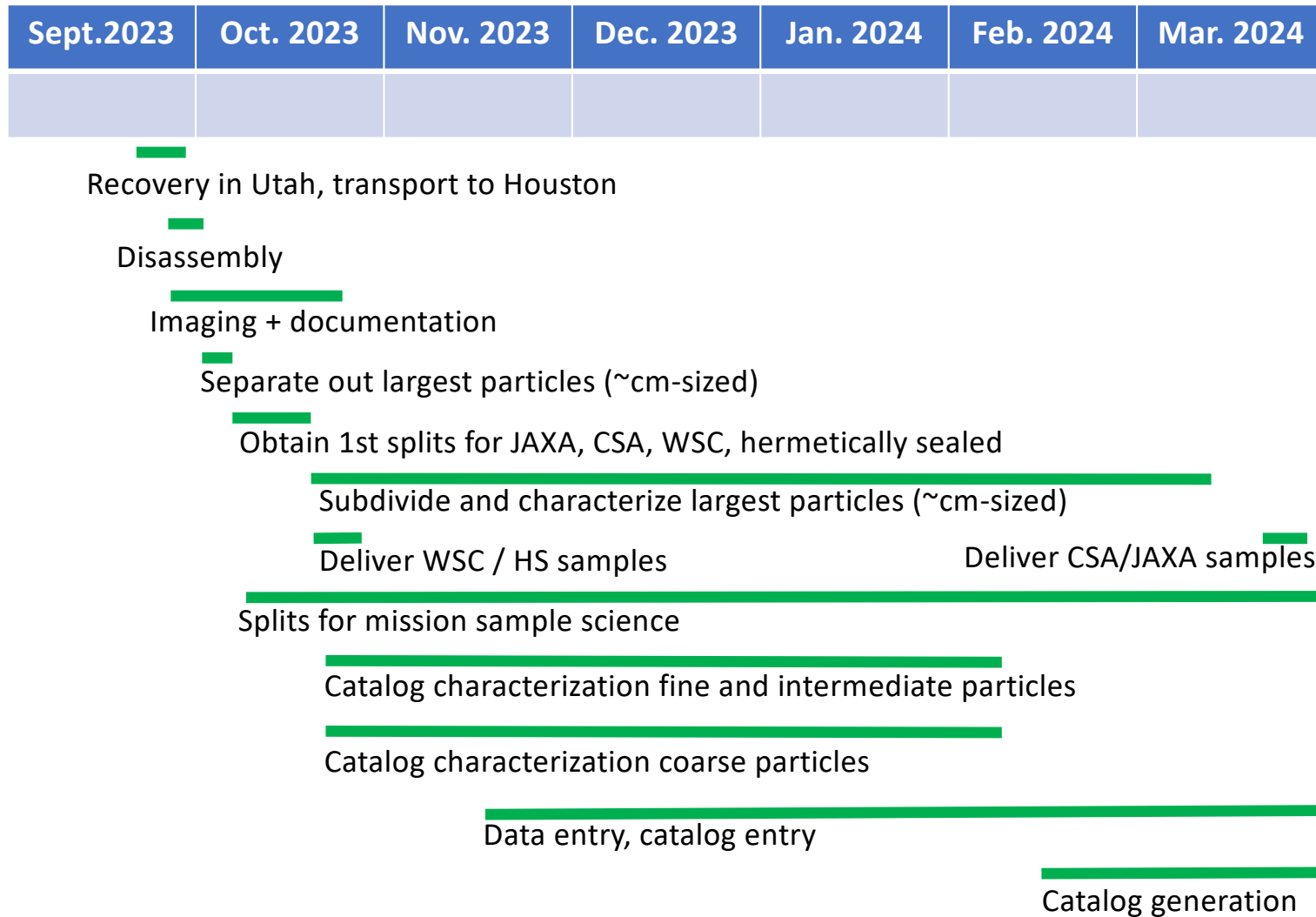


# Sample Stowage on October 27, 2020



Plan is for OSIRIS-REx to have samples return to Earth on September 24, 2023

# OSIRIS-REx Sample Timeline





A composite image featuring a mountain valley at night. A large, bright full moon hangs in a starry sky above a valley with green hills and a river. The scene is reflected in a calm lake. In the foreground of the lake, a reddish-orange sphere representing Mars is also reflected. The overall color palette is dominated by blues, greens, and the warm tones of Mars.

**QUESTIONS?**

**EXPLORE**  
with us