Artemis Human Landing System Overview

NASA 2025 International SPACE APPS Challenge

Luis Ortiz | NASA Johnson Space Langley Center | October 4, 2025

National Aeronautics and
Space Administration

Artemis Human Landing System Overview

Alicia Dwyer Cianciolo | NASA Langley Research Center | August 1, 2024

“The United States will Maintain its Leadership in Space Exploration and Space Science”

“Remain a global leader in science and engineering by pioneering space research and technology that propels exploration of the Moon, Mars, and beyond.”

“U.S. human and robotic space exploration missions will land the first woman and person of color on the Moon, advance a robust cislunar ecosystem, continue to leverage human presence in low-Earth orbit to enable people to live and work safely in space, and prepare for future missions to Mars and beyond.”

— The White House U.S Space Priorities Framework, Dec 2021

United States Space Priorities Framework
NASA 2022 Strategic Plan
2023 NASA Budget Request

“Los Estados Unidos mantendrá su liderazgo en la exploración espacial y la ciencia espacial”

Seguir siendo un líder mundial en ciencia e ingeniería, siendo los pioneros de la investigación y la tecnología espacial que impulsan la exploración de la Luna, Marte y más allá.

Las misiones estadounidenses de exploración espacial, tanto humanas como robóticas, llevarán a la primera mujer y persona de color a la Luna, impulsarán un sólido ecosistema cislunar, seguirán aprovechando la presencia humana en la órbita baja para que las personas puedan vivir y trabajar de forma segura en el espacio, y prepararán futuras misiones a Marte y más allá.

— The White House U.S Space Priorities Framework, Dec 2021

United States Space Priorities Framework
NASA 2022 Strategic Plan
2023 NASA Budget Request

What is Artemis?

Space Launch System

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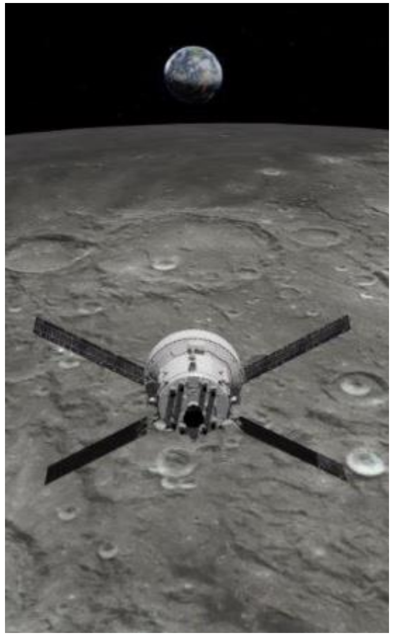
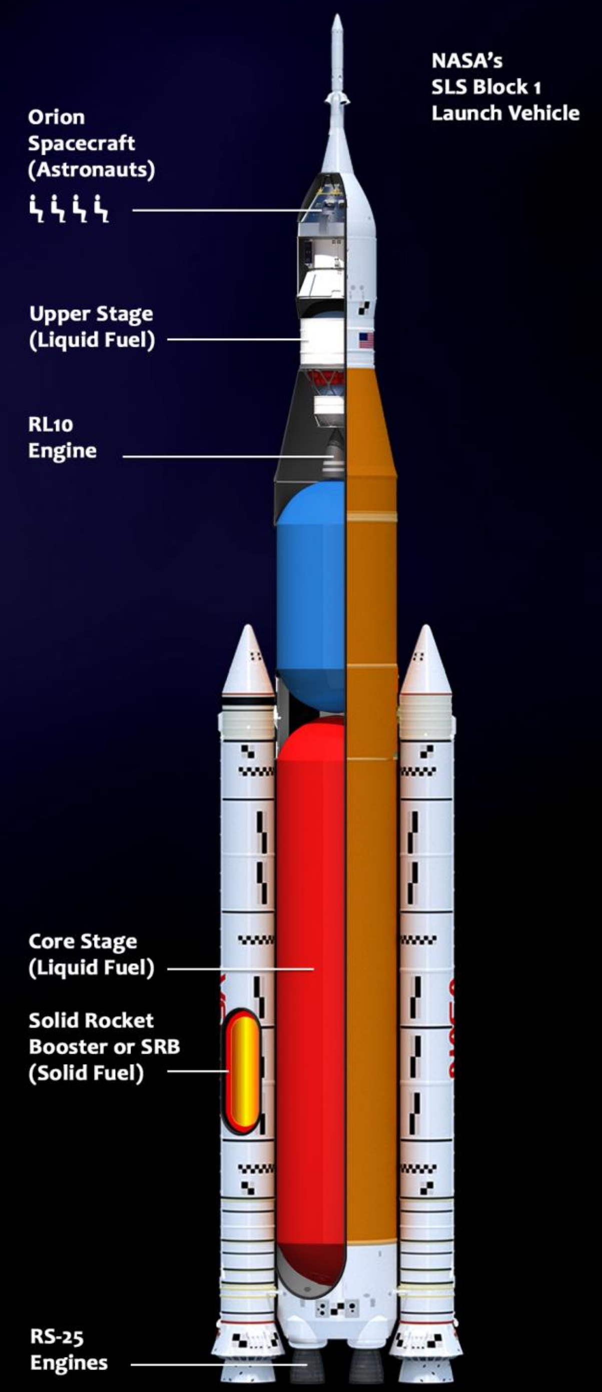


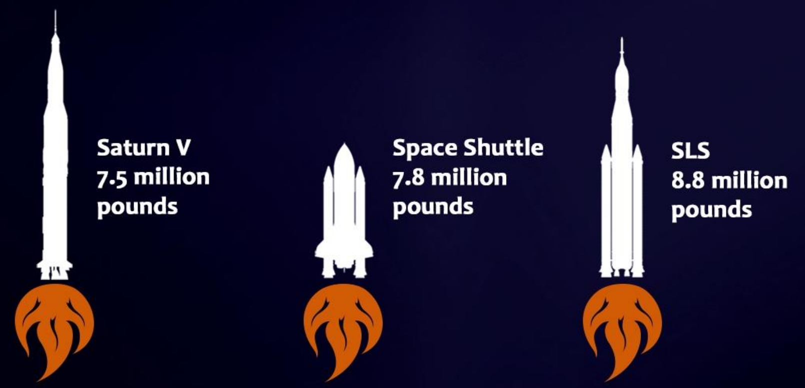
*Extravehicular Activity and Human Surface Mobility Program

Combines programs into missions

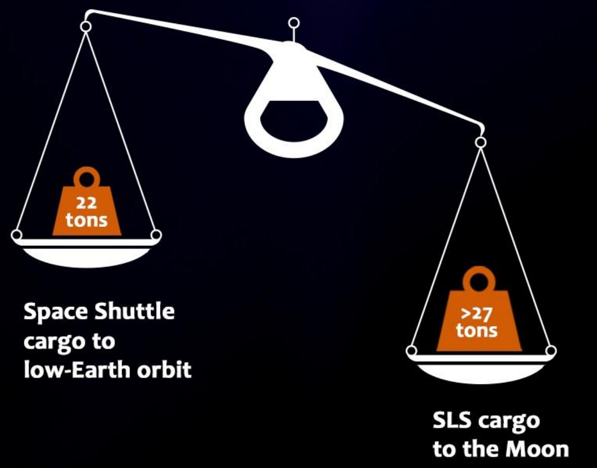
Space Launch System



SLS will produce 13% more thrust at launch than the space shuttle and 15% more than Saturn V during liftoff and ascent.

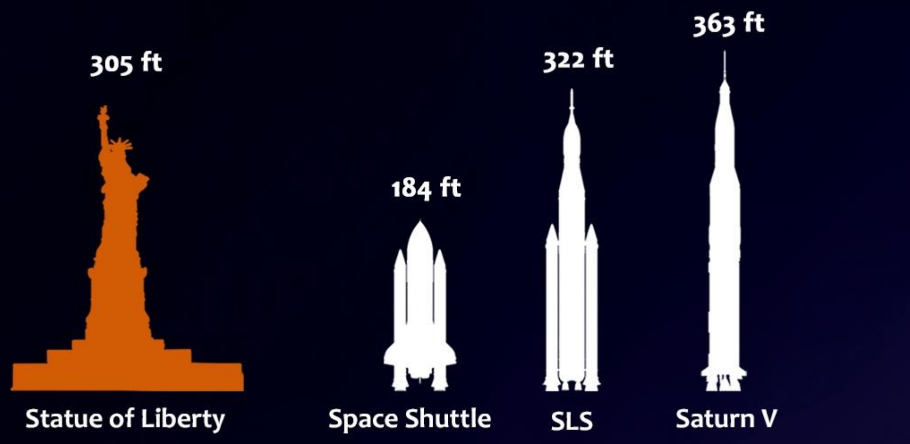


SLS will launch more cargo to the Moon than the space shuttle could send to low-Earth orbit.



www.nasa.gov/sls

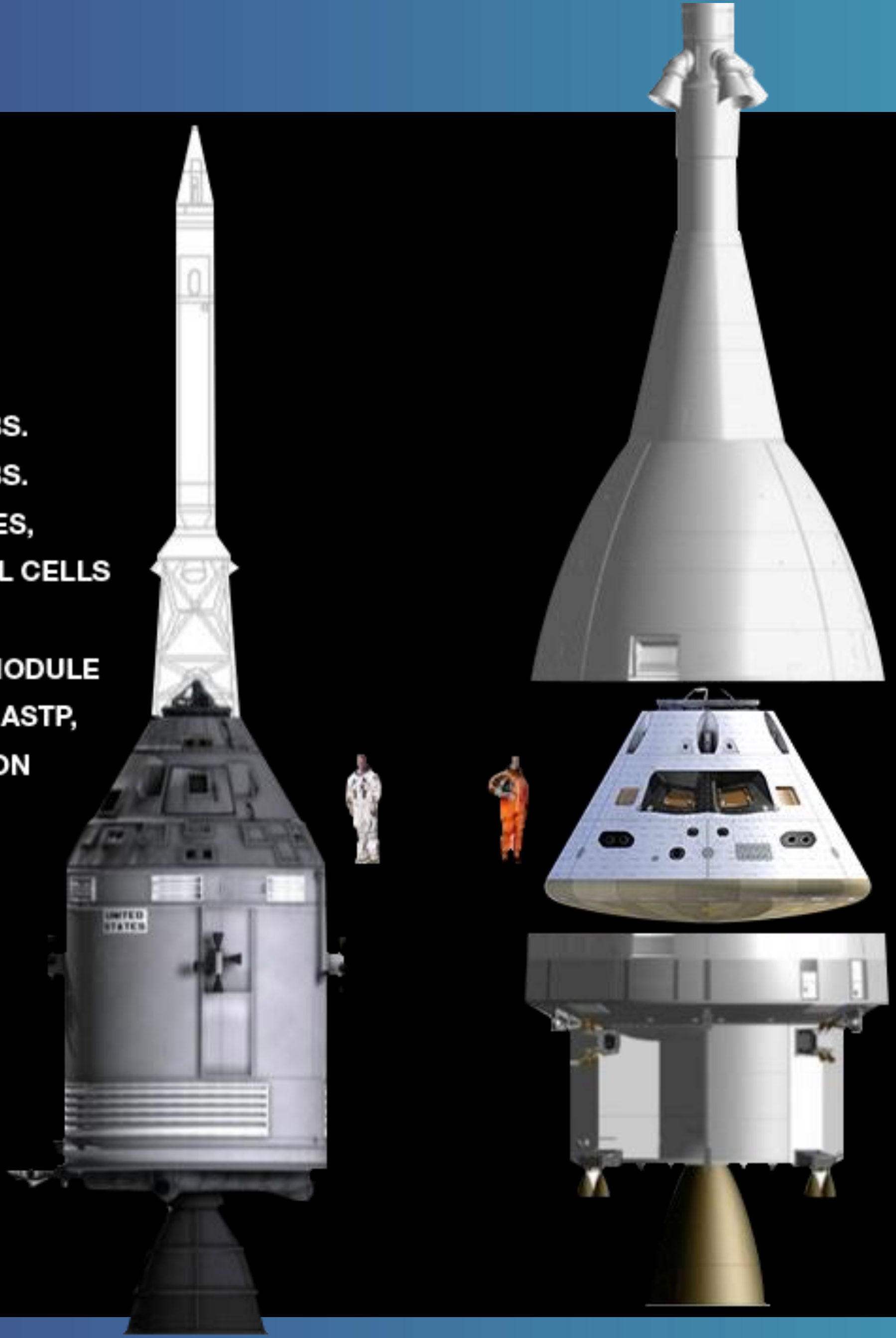
If you wonder how NASA's Space Launch System, or SLS, compares to earlier generations of NASA launch vehicles:



Orion

APOLLO

CREW MODULE DIAMETER:	12.8 FT.
CREW SIZE:	3
SERVICE MODULE DIAMETER:	13 FT.
SERVICE MODULE LENGTH:	24.5 FT.
SERVICE MODULE MASS:	54,000 LBS.
SERVICE MODULE THRUST:	20,500 LBS.
POWER:	BATTERIES, FUEL CELLS
LANDING:	WATER
DOCKING:	LUNAR MODULE
DESTINATION:	SKYLAB, ASTP, MOON



ORION

CREW MODULE DIAMETER:	16.5 FT.
CREW SIZE:	4 (6 TO ISS)
SERVICE MODULE DIAMETER:	16.5 FT.
SERVICE MODULE LENGTH:	15.7 FT.
SERVICE MODULE MASS:	27,500 LBS.
SERVICE MODULE THRUST:	7,500 LBS.
POWER:	SOLAR ARRAYS, BATTERIES
LANDING:	WATER
DOCKING:	MULTI PURPOSE
DESTINATION:	MARS, ASTEROIDS

Human Landing System

Single Stage Landers

For Reference:
Apollo 11
5.5 m tall

Image: NASA

Artemis III

SpaceX Starship

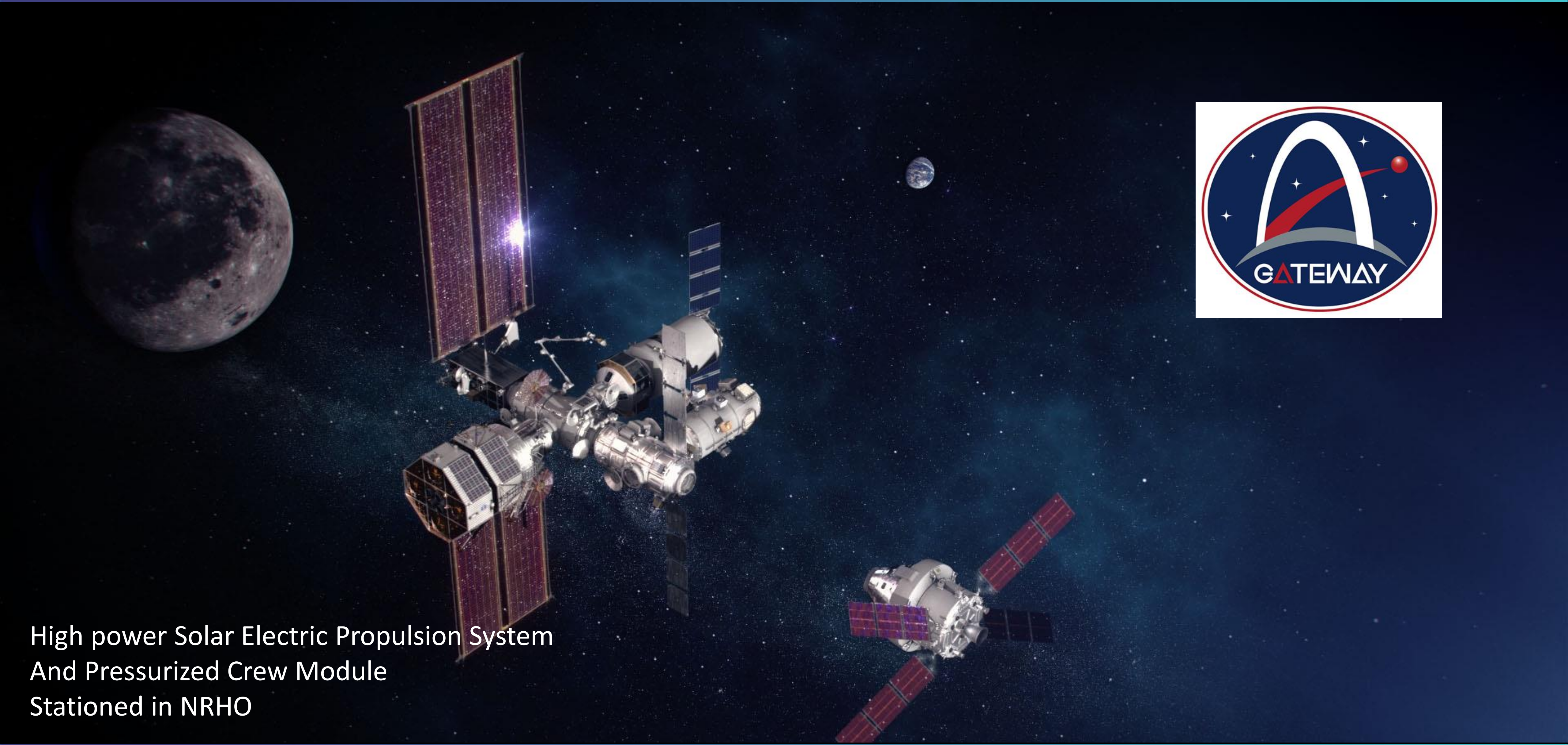
Artemis IV

SpaceX Starship

Artemis V

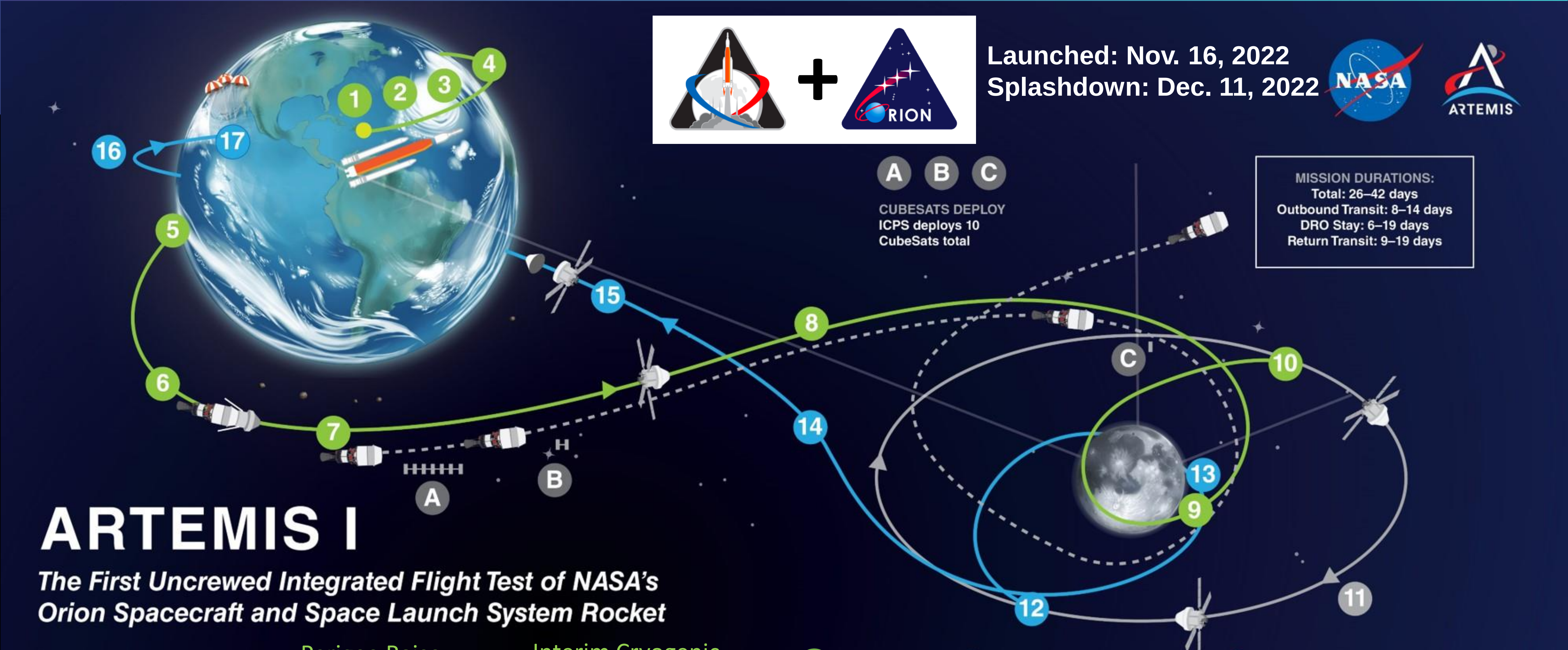
Blue Origin
Blue Moon

Gateway



High power Solar Electric Propulsion System
And Pressurized Crew Module
Stationed in NRHO

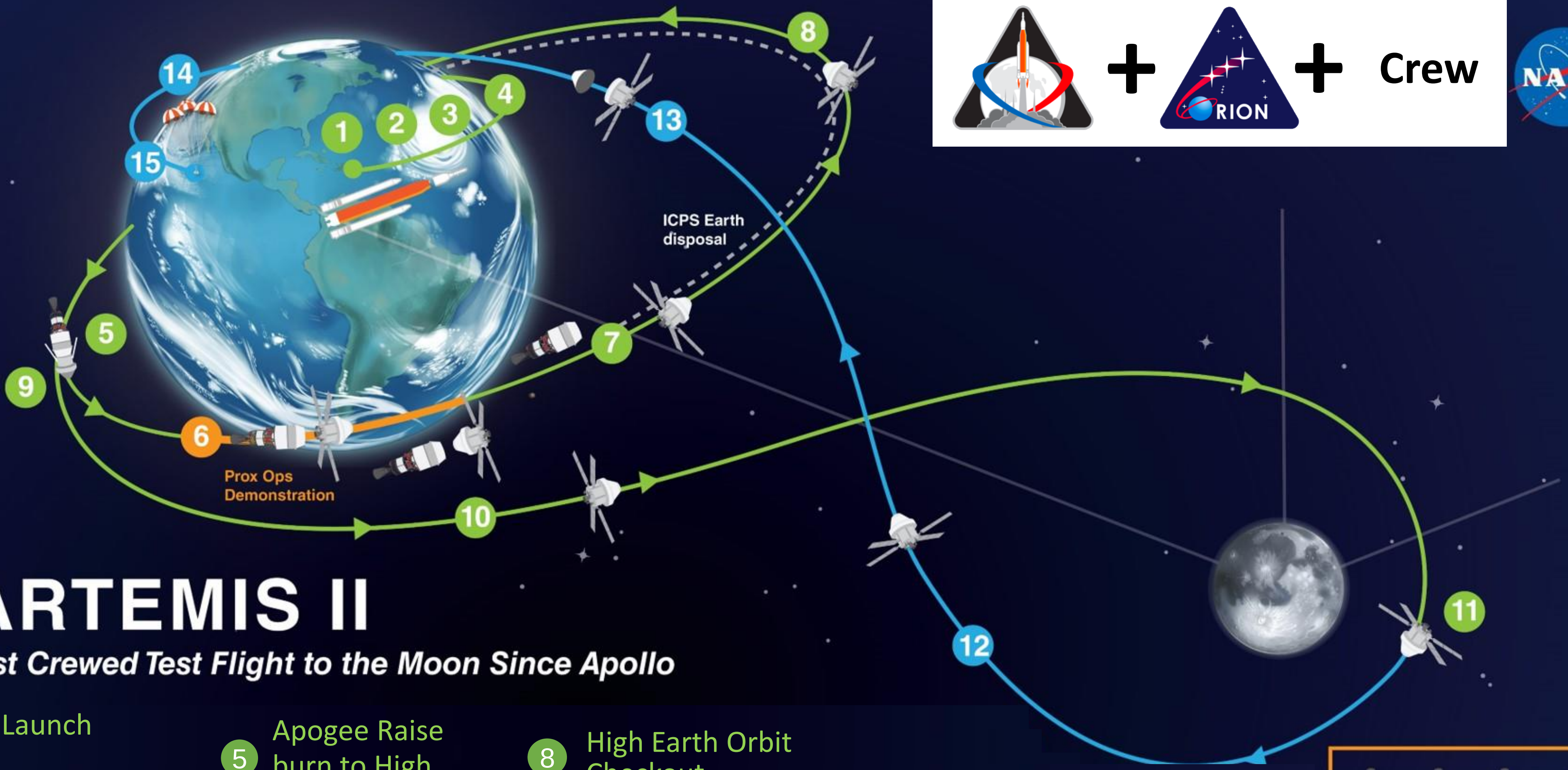
Combine programs into missions.



1 Launch	10 Lunar Orbit Insertion
2 Jettison Rocket Boosters	11 Distant Retrograde Orbit (DRO)
3 Main Engine Cut Off	12 DRO Departure
4 Perigee Raise Maneuver	13 Return Powered Flyby
5 Earth Orbit	14 Return Transit
6 Trans Lunar Injection Burn	15 Crew Module Separation
7 Interim Cryogenic Prop Stage Separation	16 Entry Interface
8 Outbound Trajectory Correction Burn	17 Splashdown
9 Outbound Powered Flyby	

https://appel.nasa.gov/wp-content/uploads/2021/11/artemis_1_map_october_2021.jpg

+ + Crew



ARTEMIS II

First Crewed Test Flight to the Moon Since Apollo

1. Launch
2. Jettison Rocket Boosters
3. Main Engine Cut Off
4. Perigee Raise Maneuver
5. Apogee Raise burn to High Earth Orbit
6. Prox Ops Demonstration
7. Interim Cryogenic Prop Stage Separation
8. High Earth Orbit Checkout
9. Trans-Lunar Injection
10. Outbound Transit to the Moon
11. Lunar Flyby
12. Trans-Earth Return
13. Crew Module Separation
14. Entry Interface
15. Splashdown

Proximity Operations Demonstration Sequence

https://www.nasa.gov/missions/artemis/artemis-ii-map/

Meet the Artemis II Crew

Reid Wiseman
Commander

Victor Glover
Pilot

Christina Hammock Koch
Mission Specialist

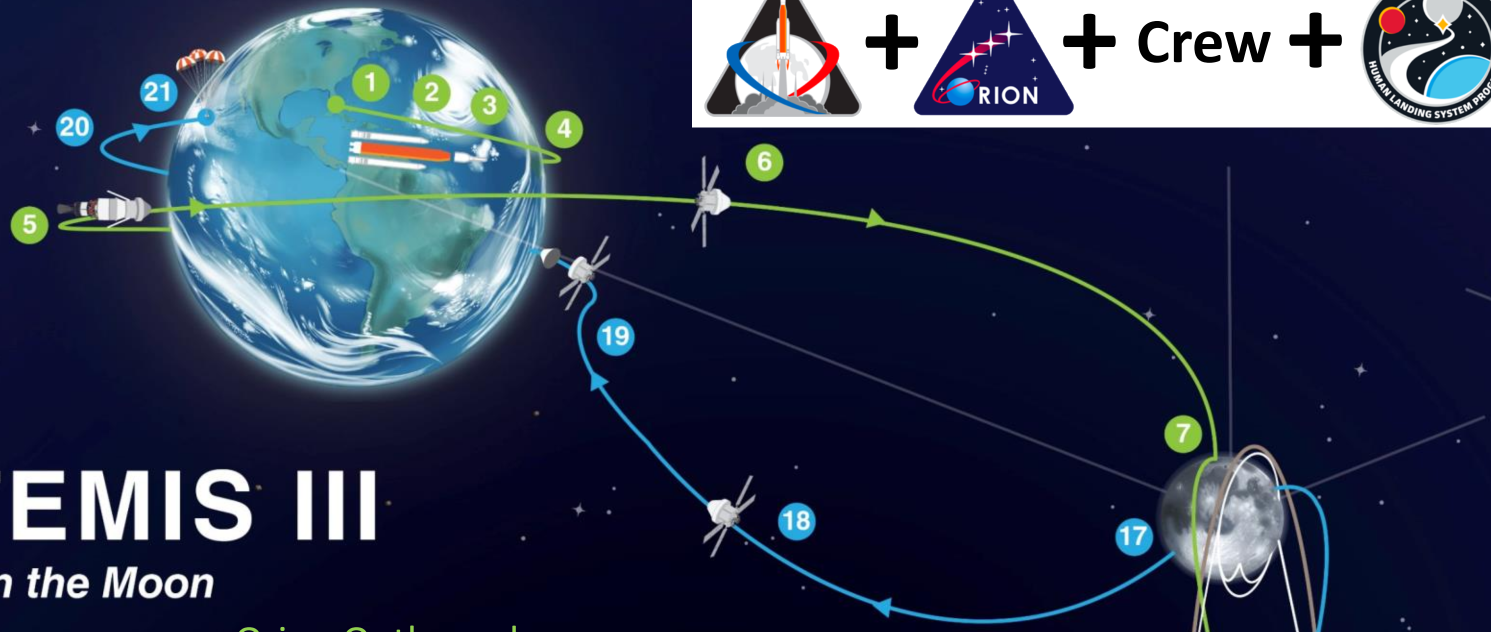
Jeremy Hansen
Mission Specialist

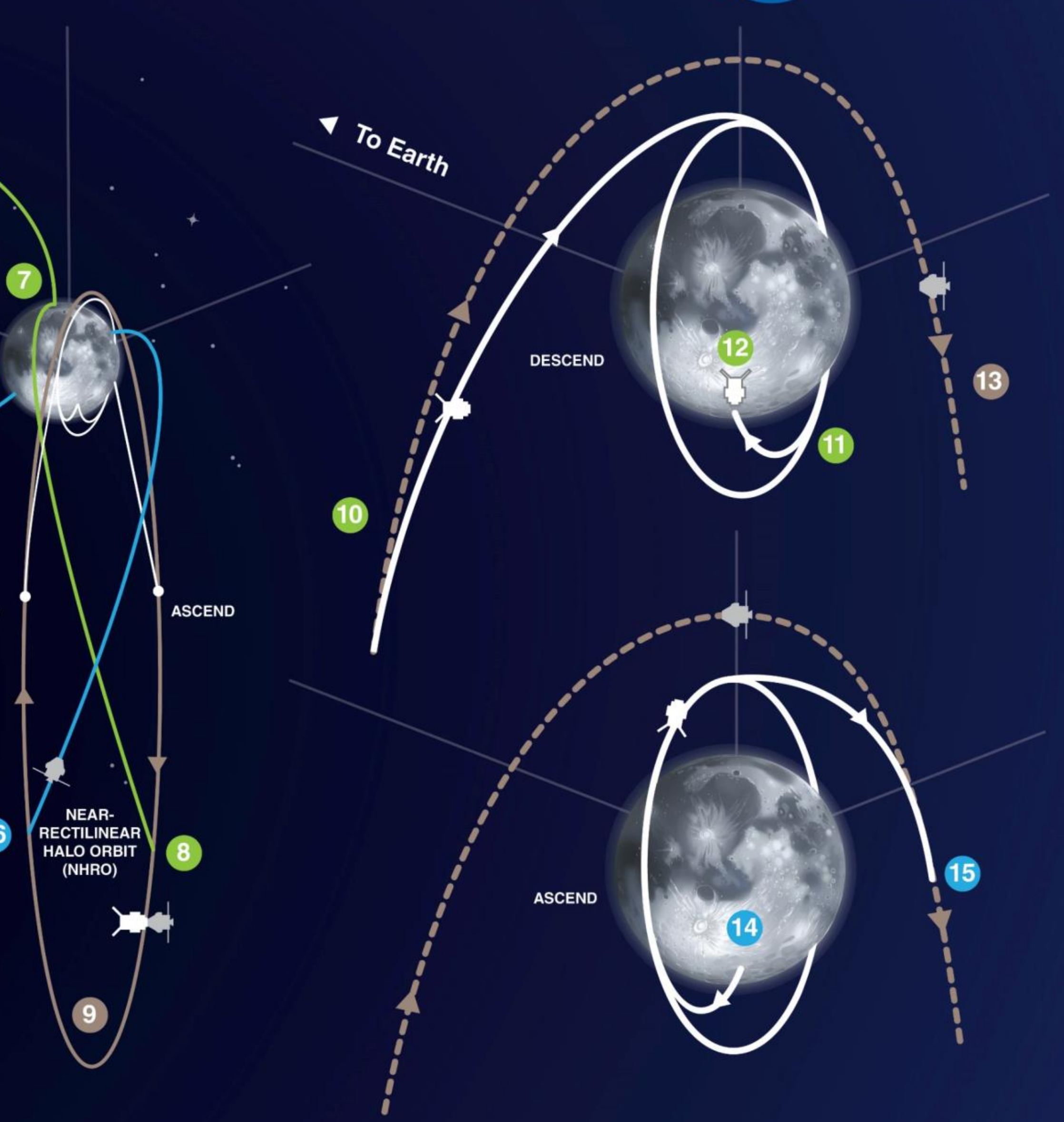
Credit: NASA

ARTEMIS III

Landing on the Moon

\+ \+ Crew \+ \+

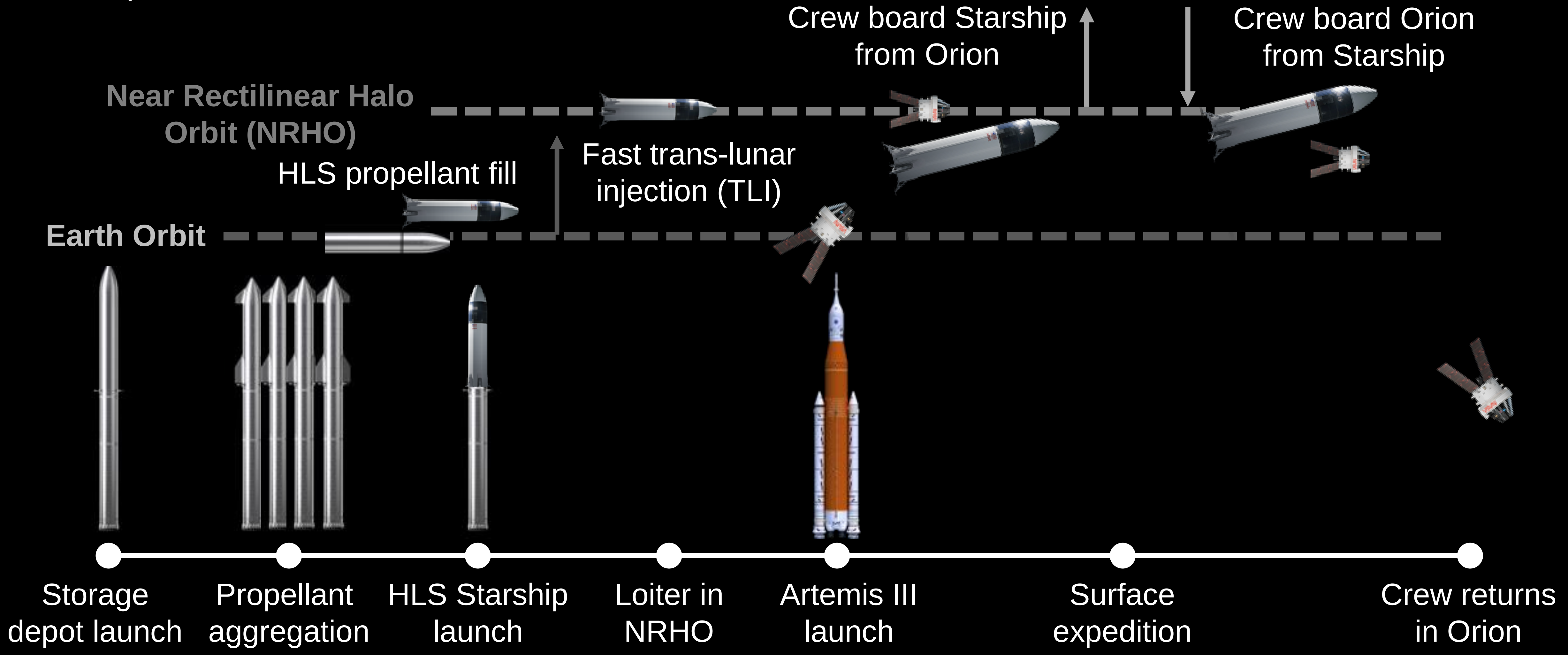




1. Launch
2. Jettison Rocket Boosters
3. Main Engine Cut Off
4. Enter Earth Orbit
5. Trans Lunar Injection Burn
6. Orion Outbound Transit to Moon
7. Orion Outbound Powered Flyby
8. NRHO Insertion Burn
9. Lunar Landing Preparation
10. Lander Undocking and Separation
11. Lander Enters Low Lunar Orbit
12. Lunar Surface Exploration
13. Orion Remains in NRHO
14. Lander Ascends to Low Lunar Orbit
15. Lander Performs Rendezvous and Docking
16. Crew Returns to Orion
17. Orion Performs Return Powered Flyby
18. Final Return Trajectory Correction Burn
19. Crew Module Separation
20. Entry Interface
21. Splashdown

Human Landing System (HLS) Starship
Artemis III Concept of Operations

NASA has awarded SpaceX a contract to develop its HLS Starship for use on Artemis III



Challenges of Landing at the Lunar South Pole for Artemis III

Apollo Landing Sites

Apollo 11 JUL 69
Mare Tranquillitatis
0.67416°N 23.47314°E
LM: 21.6 hours EVA: 2.5 hours

Apollo 12 NOV 69
Oceanus Procellarum
3.0128°S 23.4219°W
LM: 31.5 hours EVA: 7.8 hours

Apollo 14 FEB 71
Fra Mauro Highlands
3.64589°S 17.47194°W
LM: 33.5 hours EVA: 9.4 hours

Apollo 15 AUG 71
Hadley Rille
26.13239°N 3.63330°E
LM: 66.9 hours EVA: 19.1 hours

Apollo 16 APR 72
Descartes Highlands
8.9734°S 15.5011°E
LM: 71.0 hours EVA: 20.2 hours

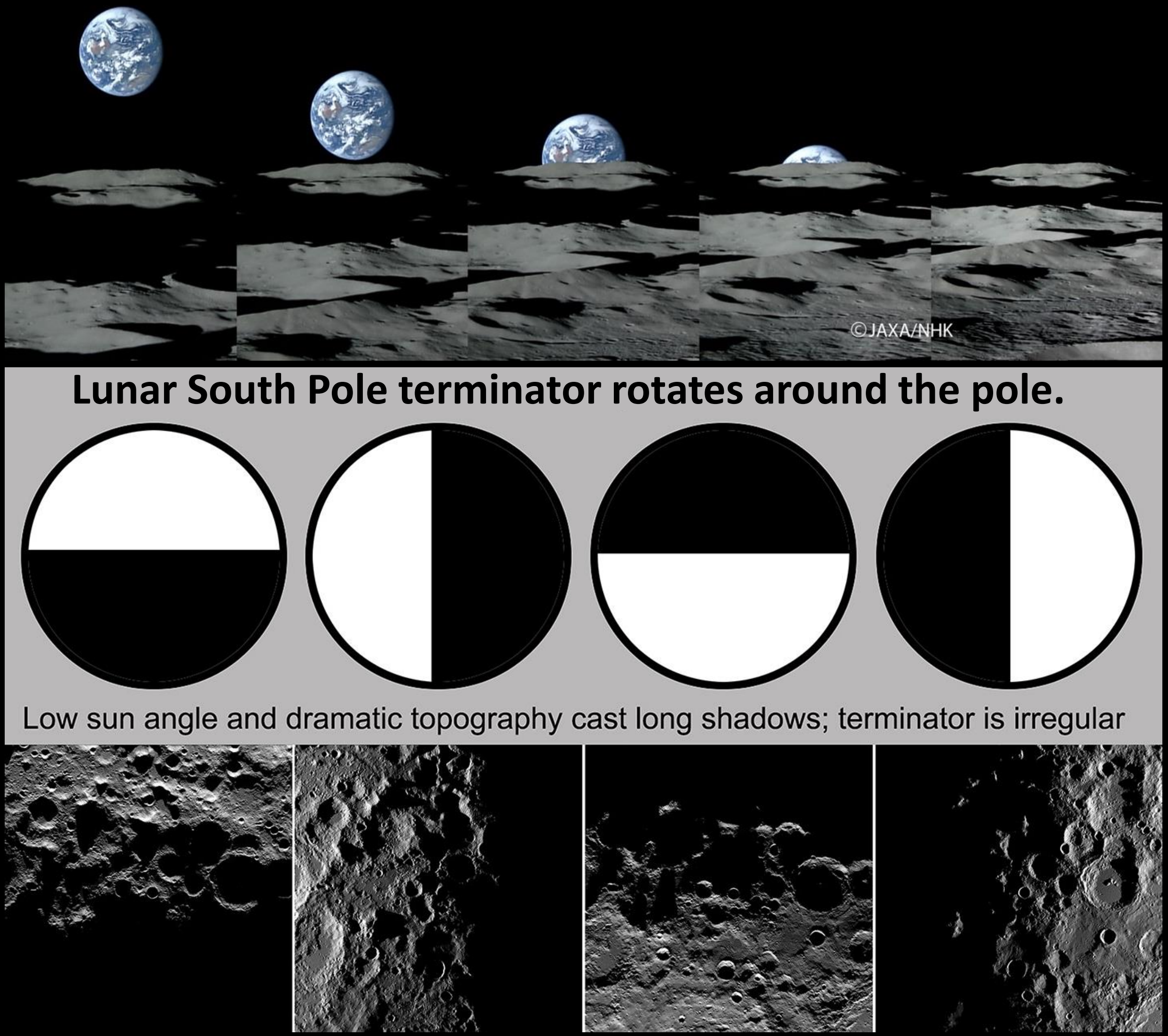
Apollo 17 DEC 72
Taurus-Littrow Valley
20.1911°N 30.7655°E
LM: 75.0 hours EVA: 22.1 hours

Time: 01 Jul 1969 00:00 UT
Phase: 97.8% (16d 00h 51m)
Diameter: 2002.2 arcseconds
Distance: 357960 km (28.09 Earths)
Position: 19h 56m 00s, 25° 08' 12"S
Subsolar: 1.479°N 14.482°W
Sub-Earth: 5.585°N 2.246°E
Pos. Angle: 349.630°

Characteristics of the South Pole

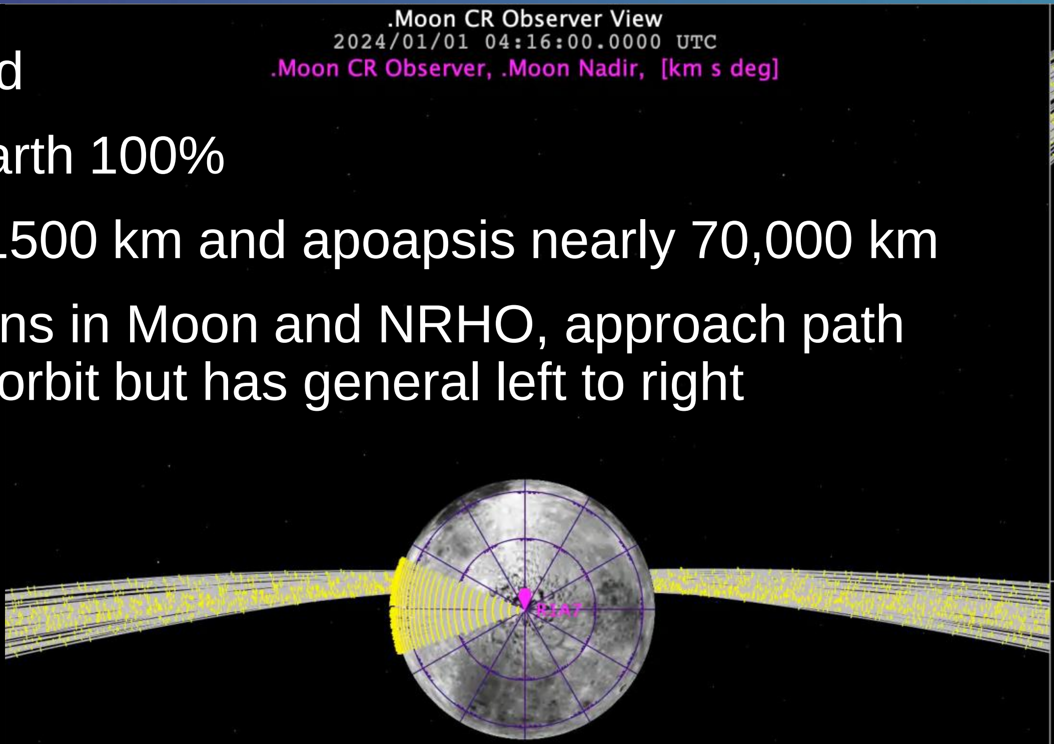
Characteristics of the South Pole

- Earth is upside down and spins backwards
- Same side of the moon always faces the Earth
- Sun and Earth only rise above the horizon ~2 to 7 deg
- Sun casts long shadows
- Earth is in a 2-week cycle: visible two weeks, not visible two weeks
- Terminator, where light meets darkness, is not smooth
- Constantly changing lighting effects at the pole

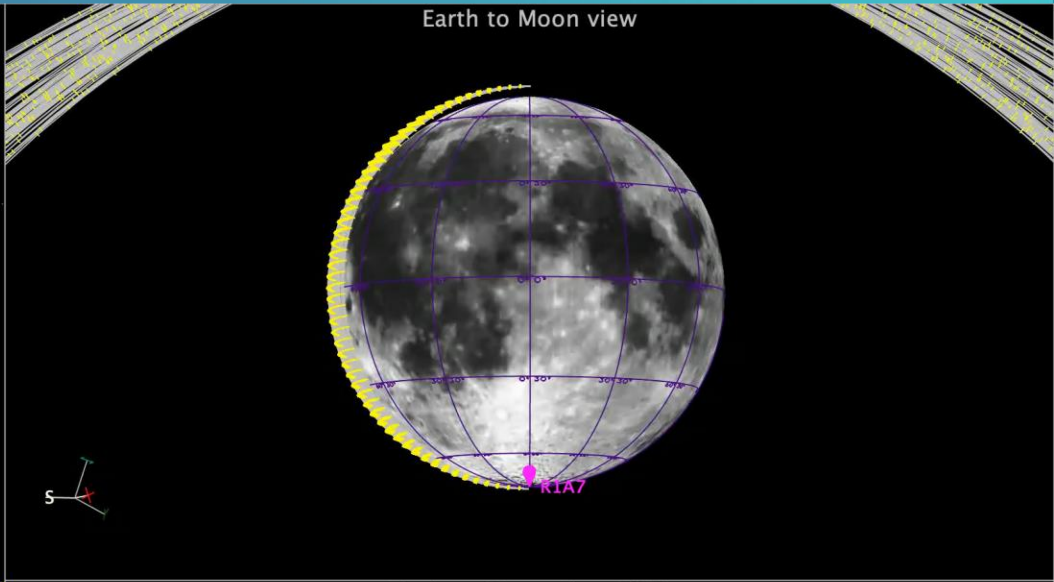


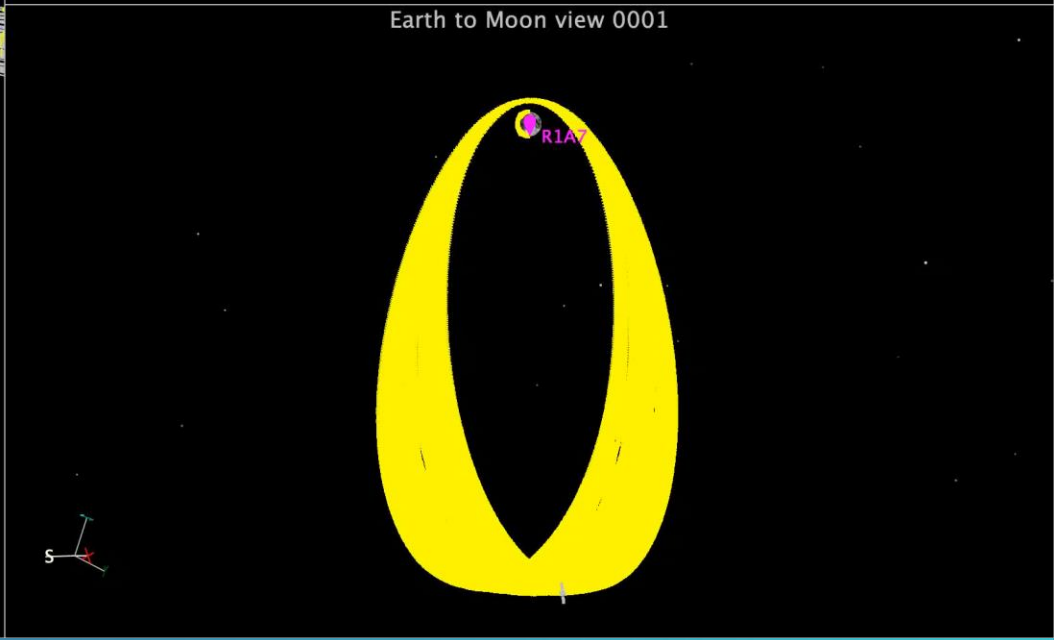
Characteristics of Near Rectilinear Halo Orbit

- ~6.5 day period
- Visible from Earth 100%
- Periapsis of ~1500 km and apoapsis nearly 70,000 km
- Due to variations in Moon and NRHO, approach path varies orbit-to-orbit but has general left to right direction



- Other Considerations:
  - Assumes Gateway fixed NRHO, so can only descend to the surface once every 6.5 days (~55 opportunities to land per year)
  - Earth/Moon orbital mechanics and SLS/Orion limitations reduce ability to get to NRHO to ~28 NRHO departure opportunities per year



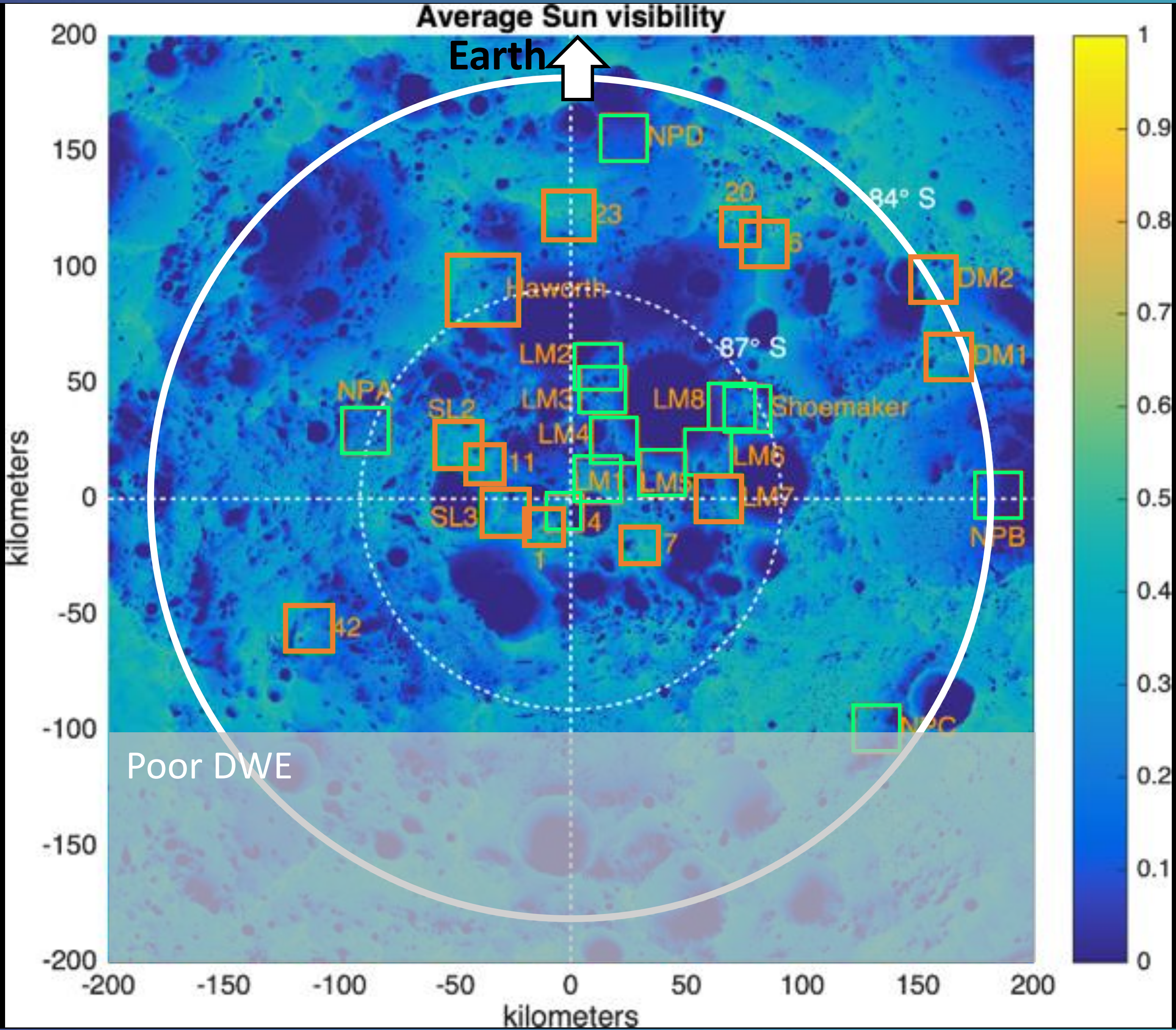


Key Artemis III Landing Requirements

1. Land within 6 deg latitude of the South Pole
2. Surface slope for landing (100m): <10 deg
3. Surface slope limit for EVA (2km): <20 deg
4. Direct with Earth (DWE) communication; assume no comm relay is available
5. Lighting
    a. Surface Lighting
    b. Approach lighting
6. Land within 100 m of a target

Objective: Identify locations that are viable for landing and meet all requirements and constraints

1. Land within 6 deg latitude of the pole

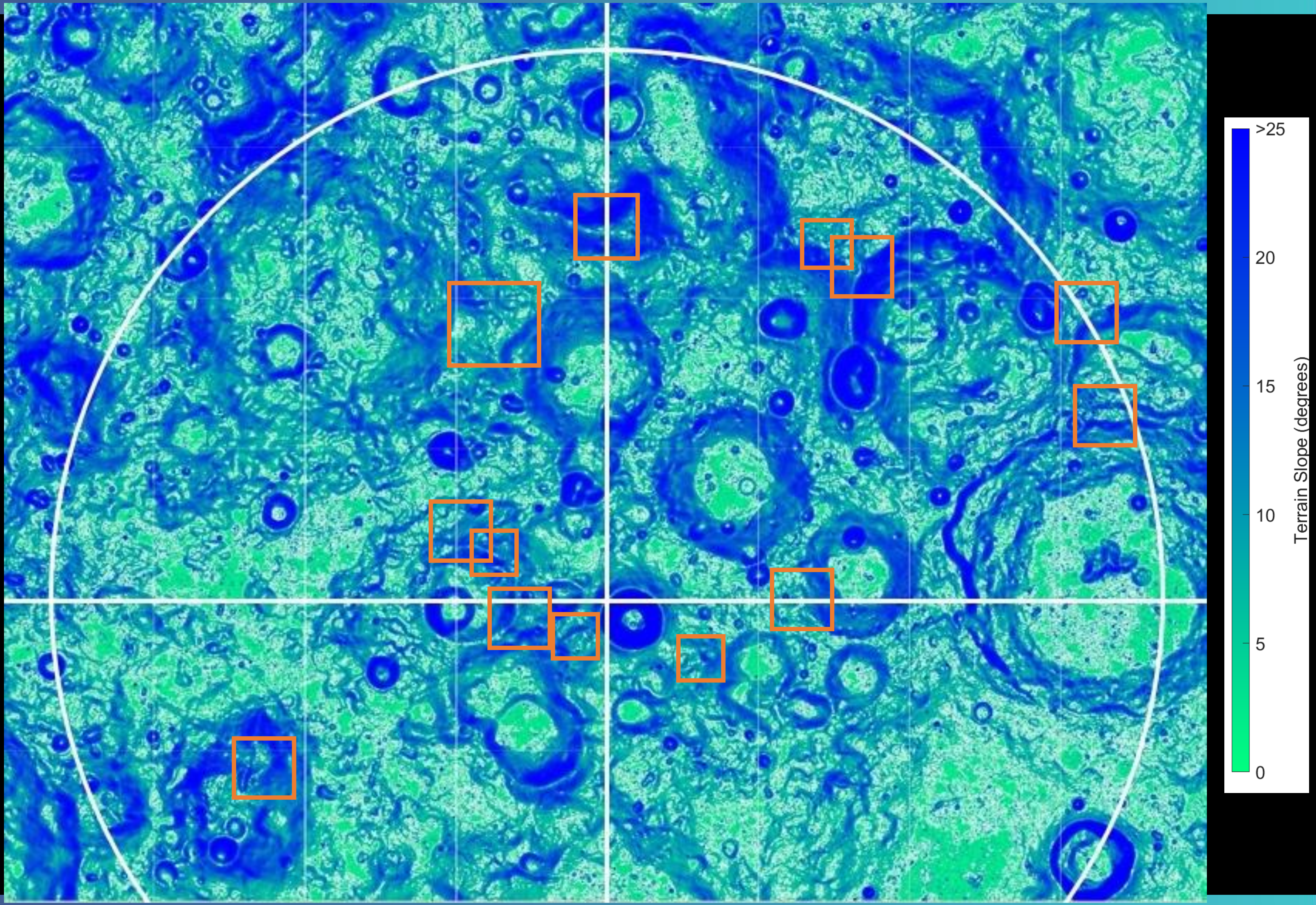


2. Surface slope for landing: <10 deg

Slopes for landing must be less than 10 deg

Green areas show slopes less than 10 deg

White contours show regions of continuous 8 deg slope

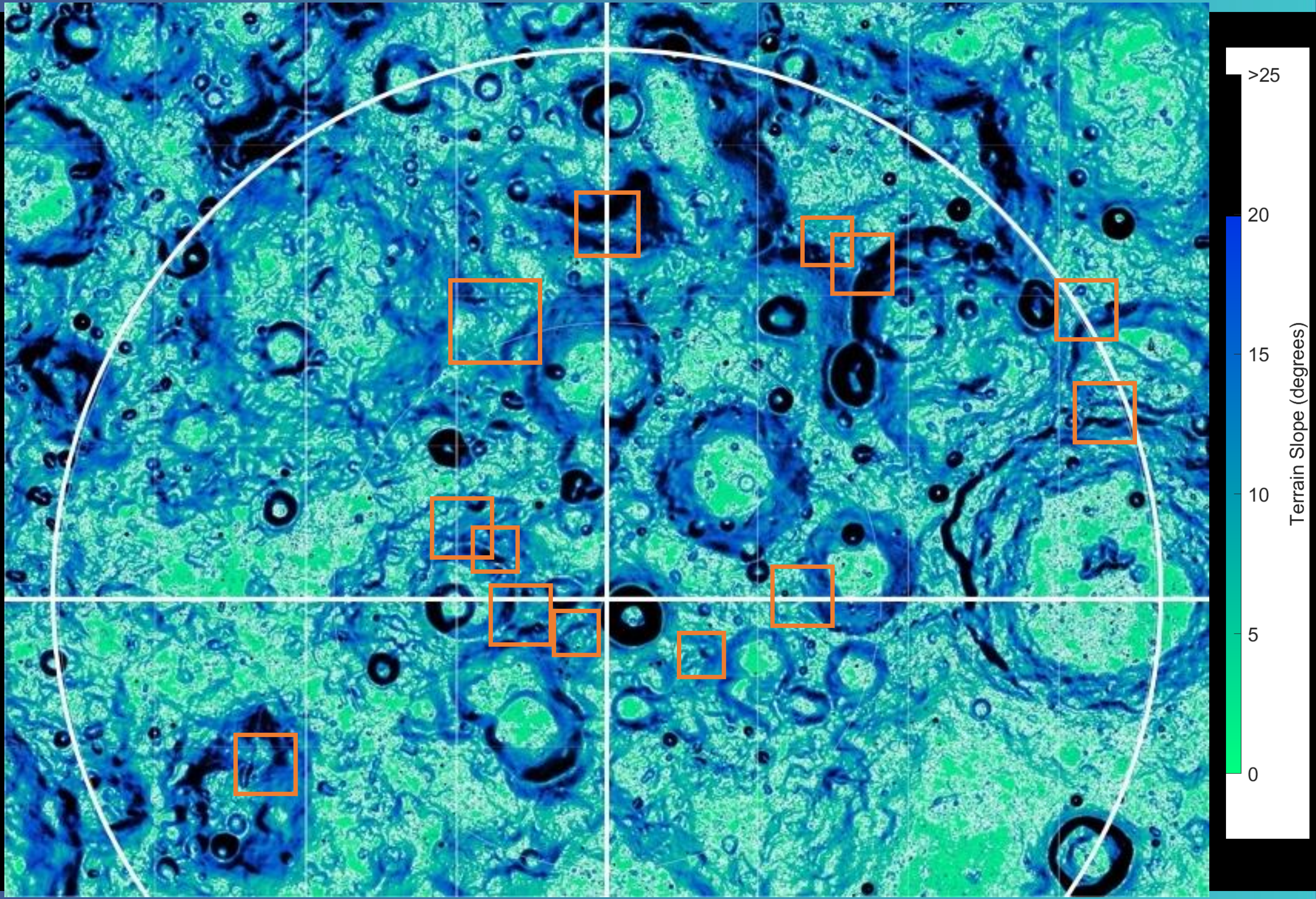


3. Surface slope for EVA: <20 deg

Slopes for Extravehicular Activity (EVA) must be less than 20 deg

Black designates areas of slope > 20 deg

No EVAs can occur in black areas

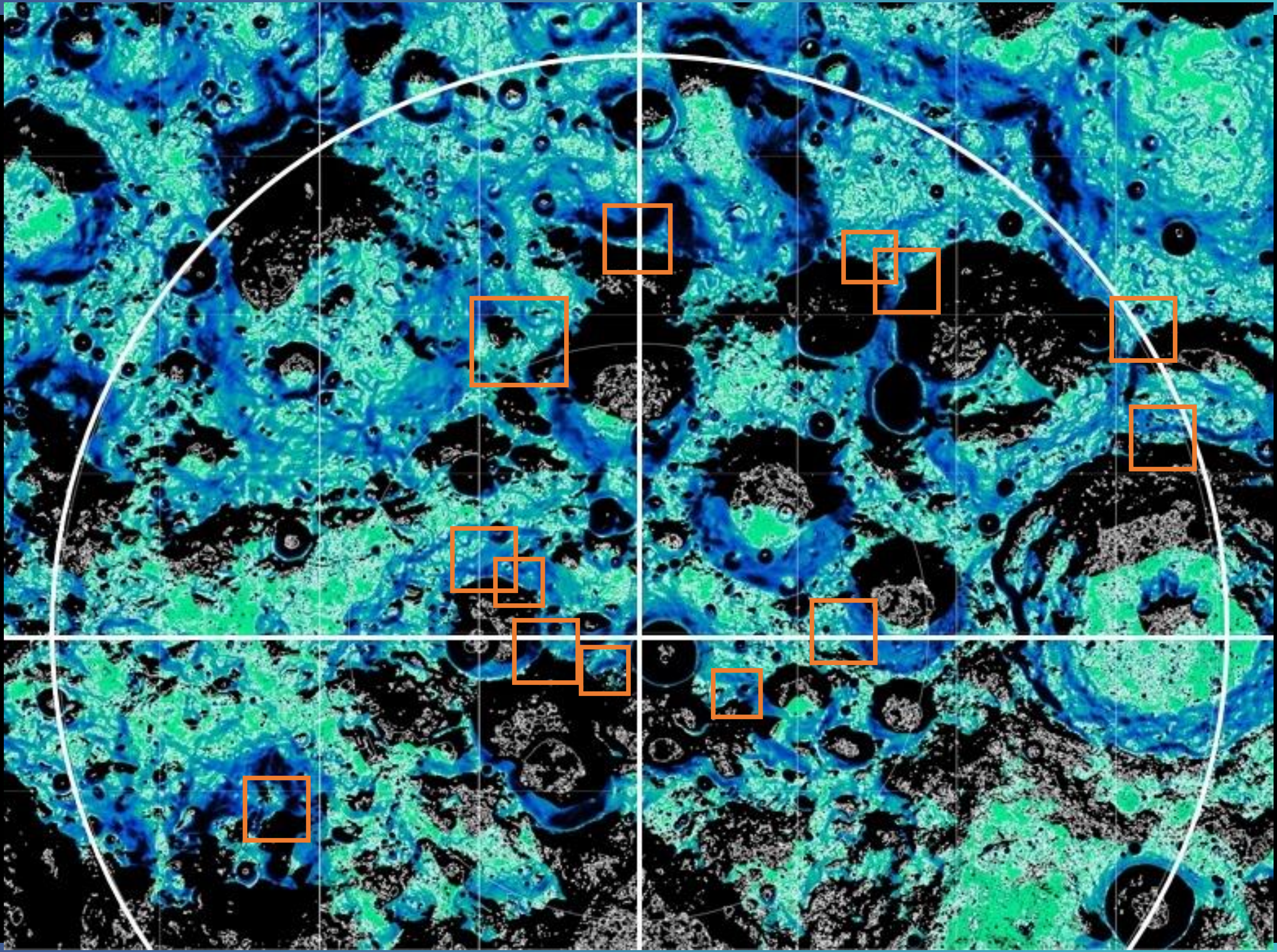


4. Direct with Earth Communication

Artemis III will require Earth to be visible for communications

Black designates areas of slope > 20 deg
+
Earth visibility < 25%

Reduces areas suitable for landing.

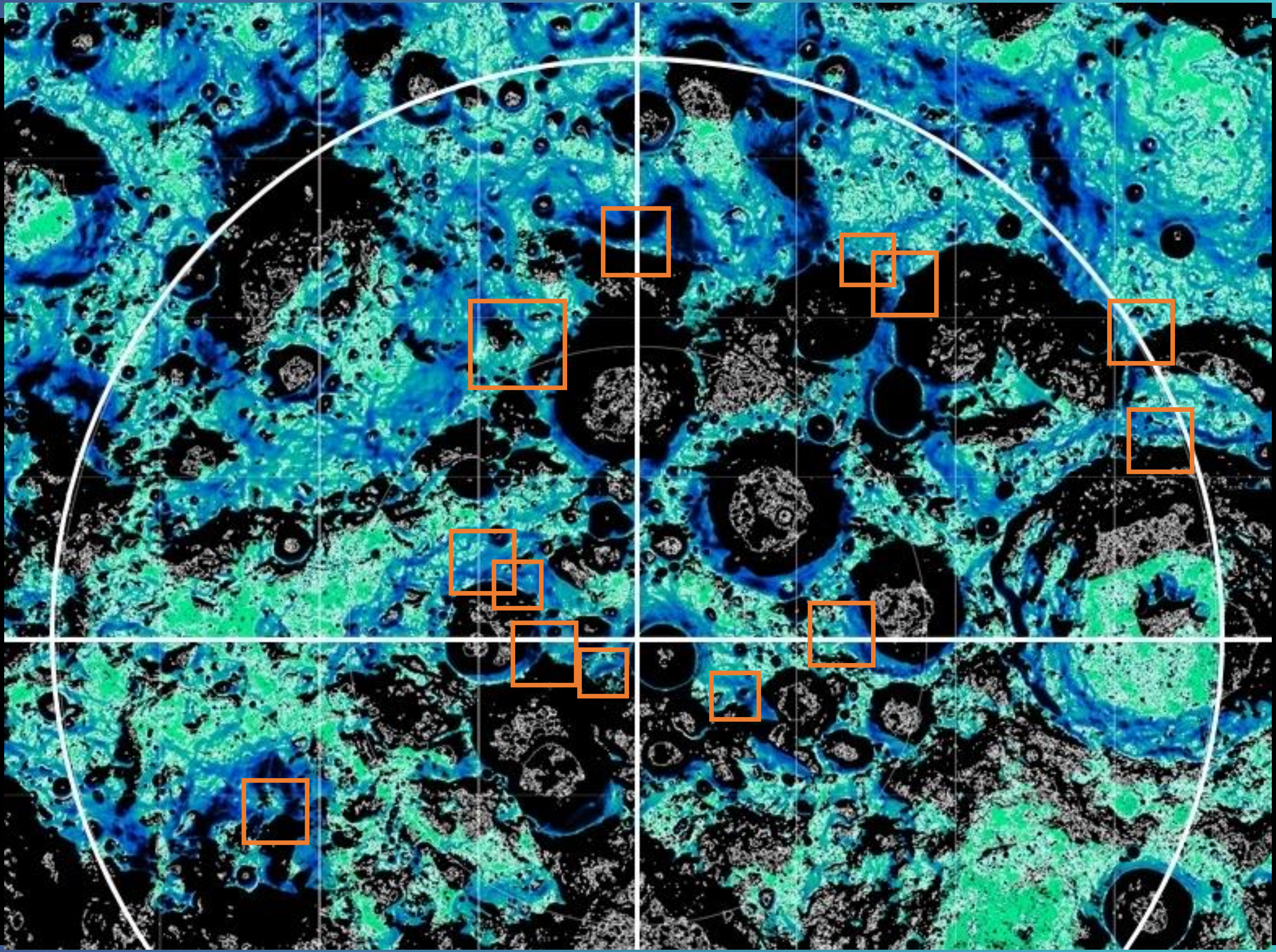


5a. Surface Lighting

Artemis III will require the surface to be lit for the duration of the surface stay

Black designates areas of slope > 20 deg
+
Earth visibility < 25%
+
Solar visibility less 5%

Reduces areas suitable for landing.

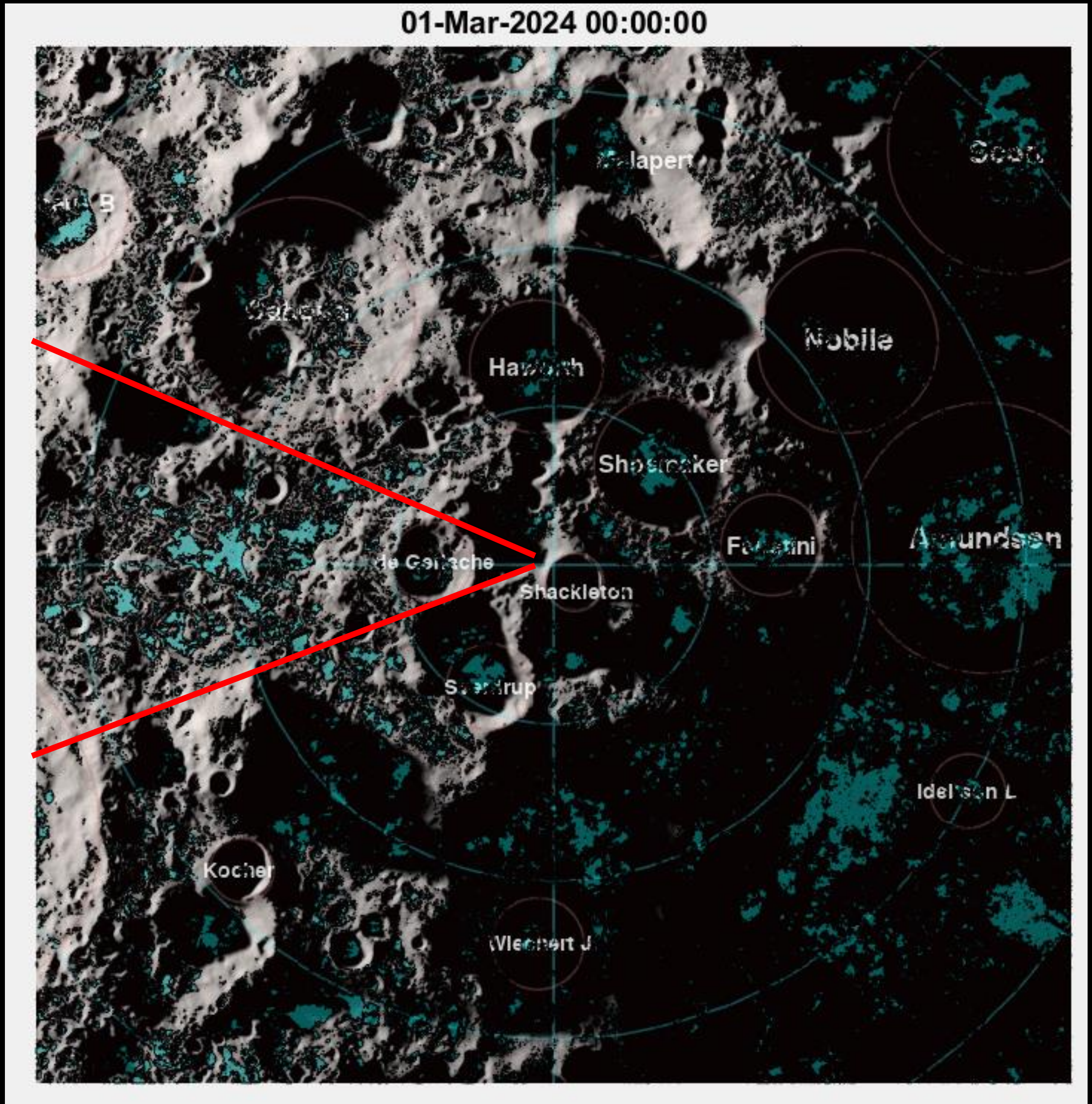


5b. Approach Lighting

Illumination along the approach trajectory is beneficial.

The approach trajectory is different for each landing opportunity.

Notional range designated in red



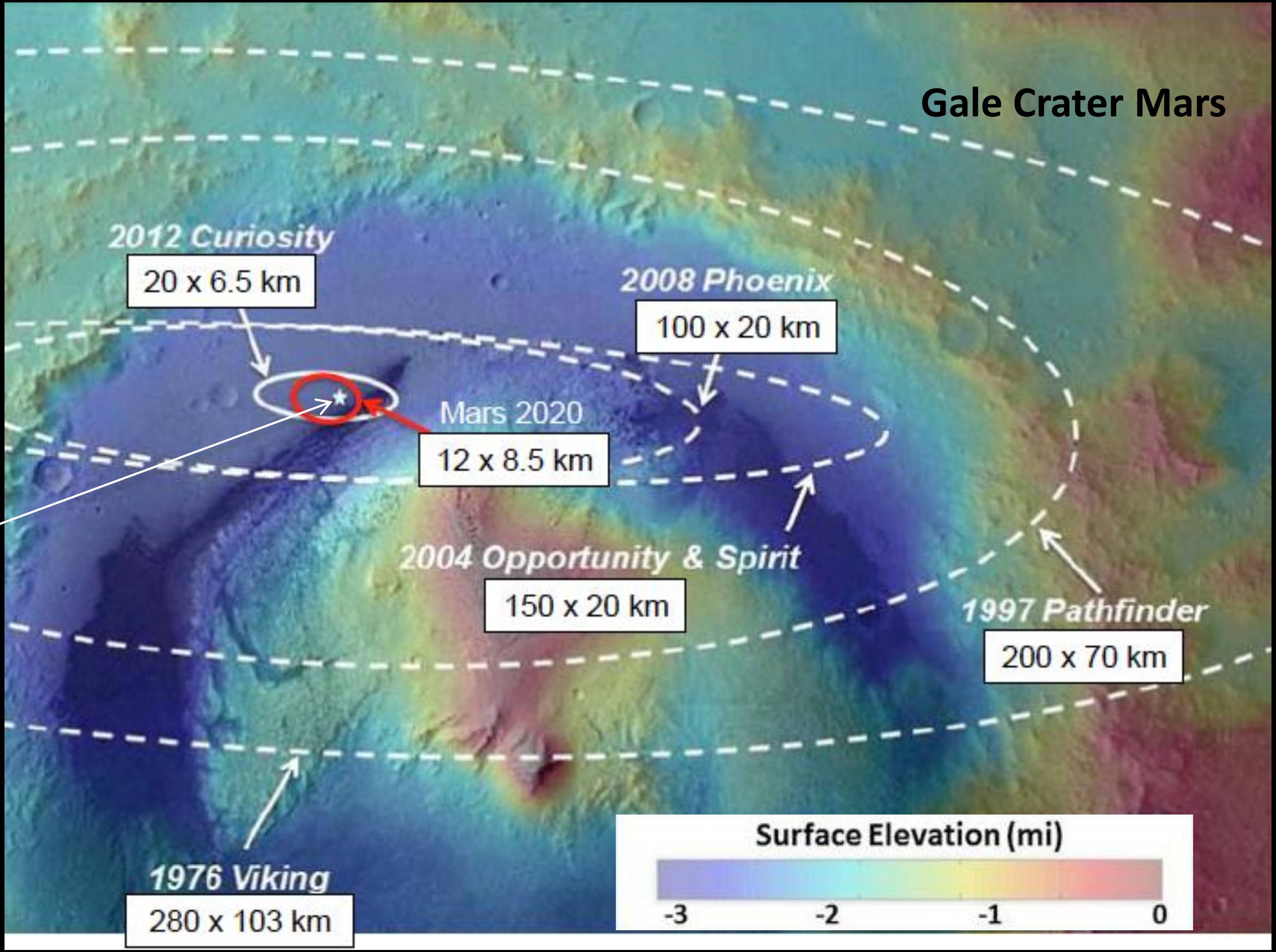
Peak lighting conditions are periodic and shift 2-3 weeks earlier each year, where by 2030, peak solar illumination occurs around the month of August

6. Land within 100m of a target

Past Robotic mission landing performance at Mars

Apollo 11 landing ellipse: 17 x 5 km

Human Landing Accuracy Requirements 100 m x 100 m



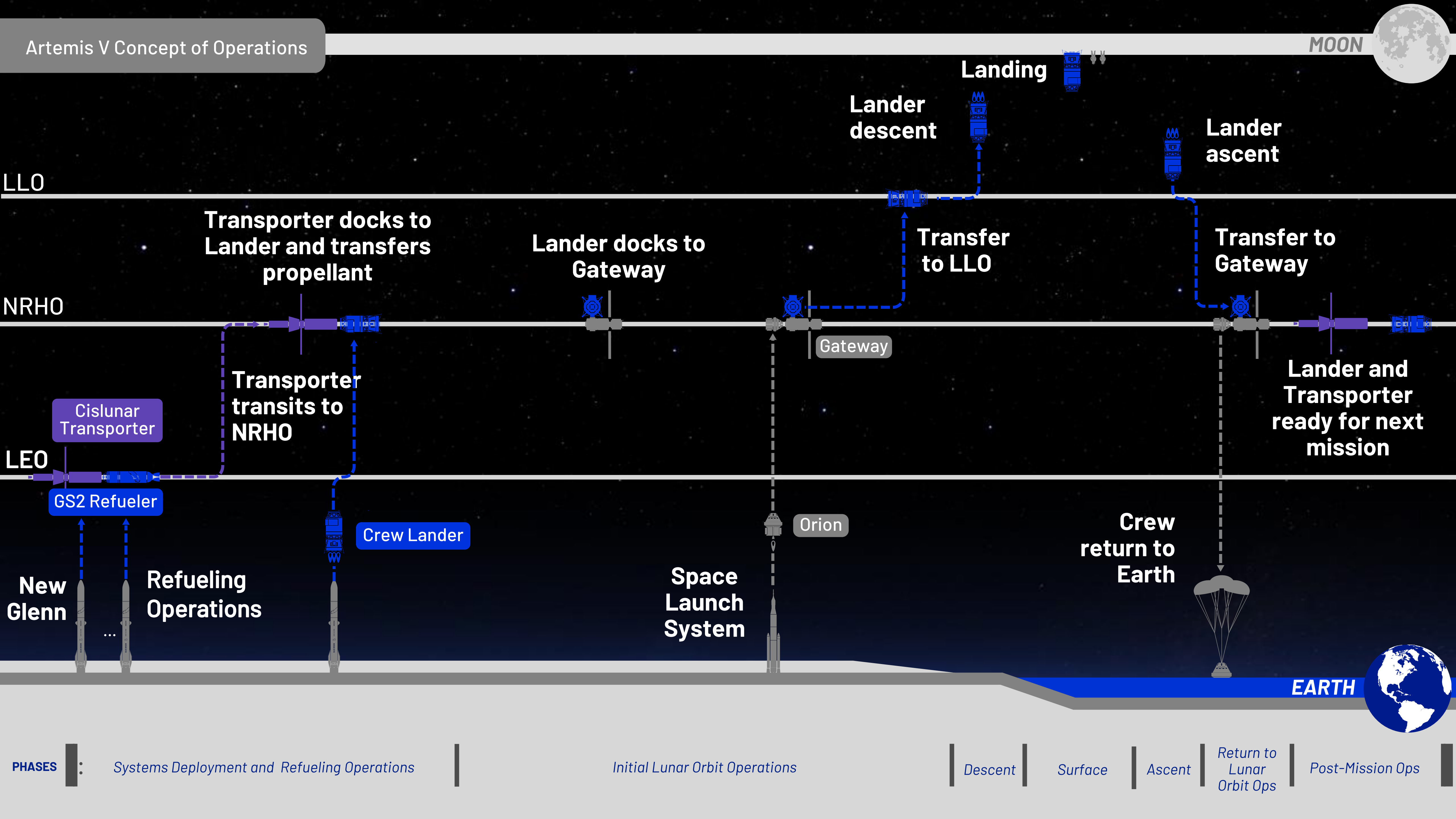
Looking Forward

ARTEMIS IV

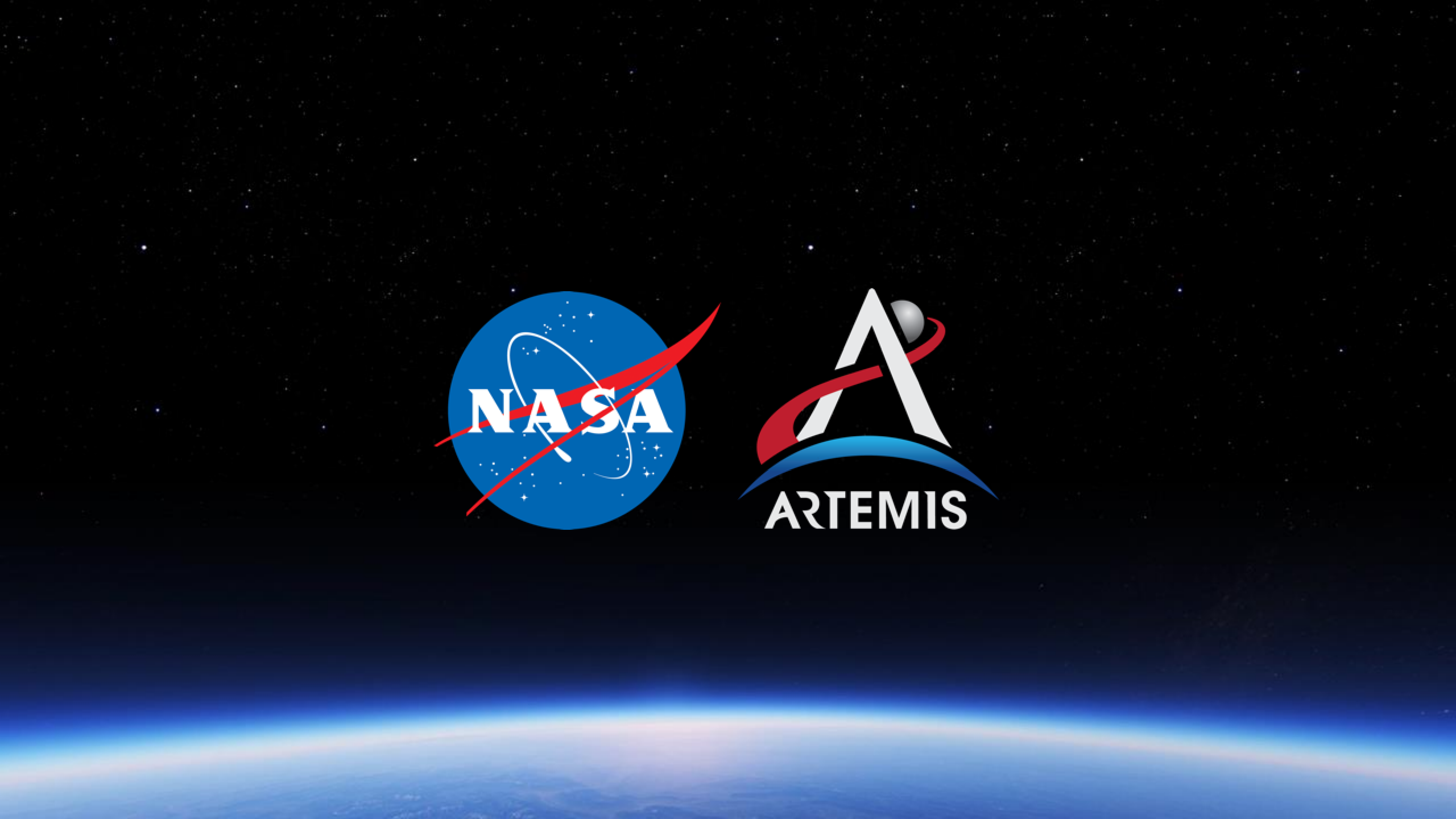
International Habitation Module delivery to Gateway followed by Crewed Lunar Landing

1. Launch
2. Jettison Rocket Boosters
3. Main Engine Cut Off
4. Enter Earth Orbit
5. Trans Lunar Injection Burn
6. Orion Tugs I-HAB to Moon
7. Orion Outbound Transit to Moon
8. Orion Outbound Powered Flyby
9. Gateway Orbit Insertion Burn
10. I-HAB Arrives at Gateway
11. I-HAB Activation and Crew Ingress
12. Lunar Landing Preparation
13. Lander Undock & Separation
14. Lander Enters Low Lunar Orbit
15. Lunar Surface Exploration
16. Orion Remains in Lunar GW Orbit
17. Lander Ascends to LLO
18. Lander Performs RPOD
19. Crew Returns to GW/Orion
20. Orion Performs Return Powered Flyby
21. Final Return Trajectory Correction Burn
22. Crew Module Separation
23. Entry Interface
24. Splashdown

+ + Crew + + +


Artemis V Concept of Operations
MOON
Landing
Lander descent
Lander ascent
LLO
Transporter docks to Lander and transfers propellant
Lander docks to Gateway
Transfer to LLO
Transfer to Gateway
NRHO
Gateway
Lander and Transporter ready for next mission
Cislunar Transporter
Transporter transits to NRHO
LEO
GS2 Refueler
Crew Lander
Orion
Crew return to Earth
New Glenn
...
Refueling Operations
Space Launch System
EARTH
PHASES
Systems Deployment and Refueling Operations
Initial Lunar Orbit Operations
Descent
Surface
Ascent
Return to Lunar Orbit Ops
Post-Mission Ops


ARTEMIS
WE GO


NASA
ARTEMIS