National Aeronautics and Space Administration

NASA

EXPLORE SCIENCE

Exploration Update

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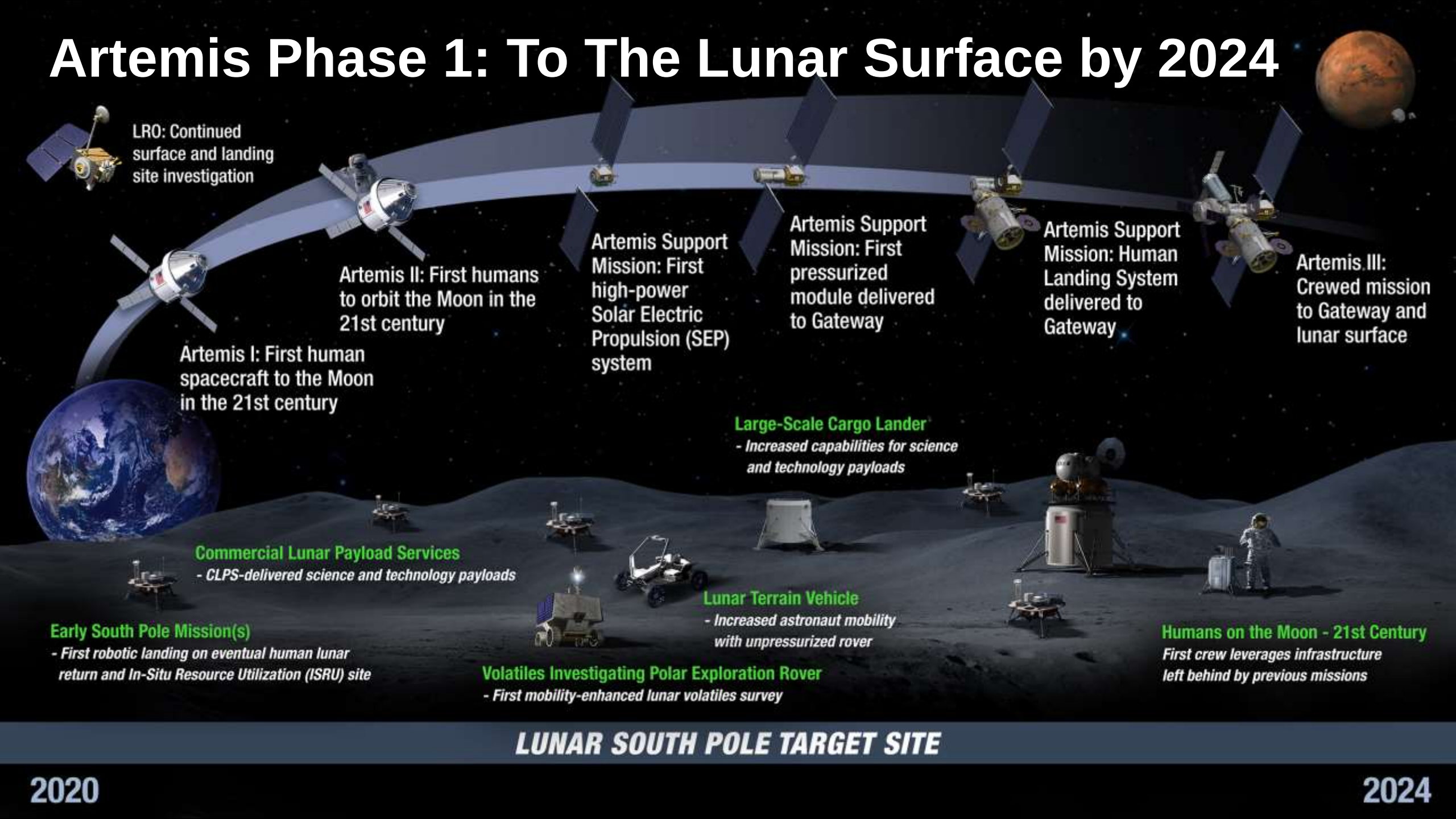
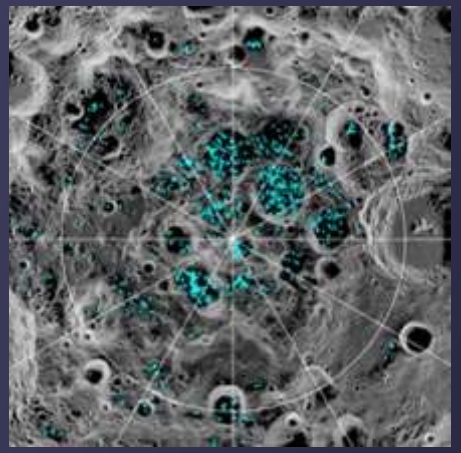
FY21 Budget Highlights

Support Artemis

- **Support the Artemis program with enhanced lunar science and technology demos, and a strengthened collaboration between science and human exploration**
- **Enable development of more than 15 missions (including lunar, Mars, and heliophysics) that inform Artemis work**
- **Bolster crucial lunar science with Commercial Lunar Payload Services (CLPS) initiative, leveraging commercial partnerships to deliver science and tech payloads beginning in 2021 to virtually anywhere on the Moon, including the poles and far side**
- **Begin investigating polar water ice by 2023 with Volatiles Investigating Polar Exploration Rover (VIPER)**
- **Provide valuable precursor experience for human exploration of Mars with bold new missions such as Mars Sample Return and Mars Ice Mapper**

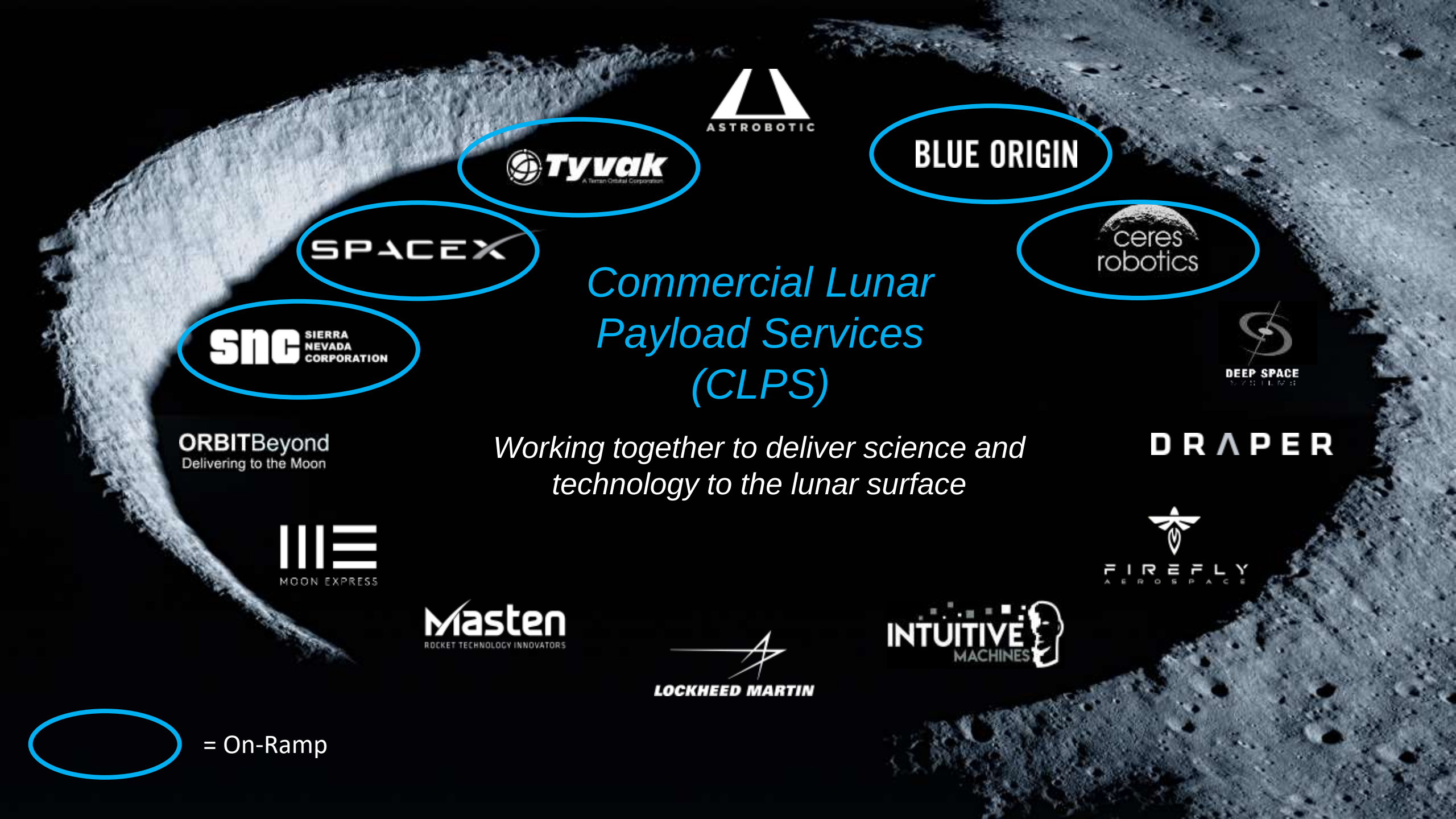
Artemis Phase 1: To The Lunar Surface by 2024





Lunar Discovery & Exploration Program

- **Foundational to Artemis missions, leads the Nation's return to the lunar surface in 2021, leveraging an innovative and rapid acquisition approach to commercial lunar delivery services, building to a cadence of two deliveries per year**
- **Implements an integrated science strategy of the Moon through robotic and human exploration collaboration, and interagency and international participation**
- **Leverages future platforms including SmallSats, the Gateway, and Human Landing System to enable interdisciplinary science and technology development opportunities**
- **Develops and delivers the first lunar south pole rover to investigate water ice in advance of Artemis Mission III, landing the first woman and next man to the lunar surface**


ASTROBOTIC
Tyvak
A Terran Orbital Corporation
BLUE ORIGIN
SPACEX
ceres robotics
SNC
SIERRA NEVADA CORPORATION
DEEP SPACE
Commercial Lunar Payload Services (CLPS)
ORBITBeyond
Delivering to the Moon
Working together to deliver science and technology to the lunar surface
DRAPER
MOON EXPRESS
FIREFLY
AEROSPACE
Masten
ROCKET TECHNOLOGY INNOVATORS
INTUITIVE MACHINES
LOCKHEED MARTIN
= On-Ramp

Commercial Lunar Payload Services (CLPS) Summary

- **Task Order 2 - Astrobotic (NPLP + HEO/STMD in-line tech demos)**
  - Lunar delivery September 2021
- **Task Order 2 – Intuitive Machines (NPLP + STMD in-line tech demo + STMD data buy)**
  - Lunar delivery October 2021
- **Task Order 19C (LSITP + NPLP 2nd's)**
  - Will deliver LSITP payloads and some NPLP second copies to a lunar pole in late 2022.
  - Request for Task Order Proposal (RFTOP) proposals received March 4; award in early April.
- **Task Order 20A (VIPER)**
  - RFTOP released February 25 with proposals due April 10 and award late mid/late May.
    - Delivery lunar surface delivery to late-2023 with a mid-2023 accelerated option.
- **Task Order 19D (Second LSITP)**
  - Will deliver additional payloads from LSITP and tech demos to a non-polar location in early 2023.
  - RFTOP release planned for June/July 2020 timeframe.

2021 CLPS Delivery Manifests

Payloads largely selected from NASA Provided Lunar Payloads (NPLP)

Astrobotics Lander

- Surface Exosphere Alterations by Landers (SEAL)
- Photovoltac Investigation on Lunar Surface (PILS)
- Near-Infrared Volatile Spectrometer System (NIRVSS)
- Mass Spectrometer Observing Lunar Operations (Msolo)
- PROSPECT Ion-Trap Mass Spectrometer for Lunar Surface Volatiles (PITMS)
- Linear Energy Transfer Spectrometer (LETS)
- Neutron Spectrometer System (NSS)
- Neutron Measurements at the Lunar Surface (NMLS)
- Fluxgate Magnetometer (MAG)
- Navigation Doppler Lidar for Precise Velocity and Range Sensing (NDL)

Key

- Science
- Technology
- Exploration
- HEOMD/STMD

Intuitive Machines Lander

- Lunar Node 1 Navigation Demonstrator (LN-1)
- Stereo Cameras for Lunar Plume-Surface Studies (SCALPSS)
- Low-frequency Radio Observations from the Near Side Lunar Surface (ROLSES)
- Navigation Doppler Lidar for Precise Velocity and Range Sensing (NDL)
- Radio Frequency Mass Gauge (RFMG)

CLPS COVID-19 Impacts

Task Order 2

- Both providers are in full telework mode; no touch labor due to local closures
- Impact to schedules under assessment

Future Task Orders

- 19C (polar) – Award early April
- 20A – VIPER delivery proposals due April 10; award late May/early June

NPLP COVID-19 Impacts

Lunar Payload	COVID-19 Assessment
SEAL	No Impact: Payload development is complete.
PITMS	No Impact: Majority of payload development currently being performed in Europe.
ROLSES	Minimal Impact: The electronics boards are presently being assembled by non-NASA personnel and the project is currently awaiting delivery of long-lead procurement items.
MSolo	Day-for-Day Slip starting 23 March: Thermal vacuum test is on hold pending personnel return to MSFC. All other environmental testing is complete.
SCALPSS	Day-for-Day Slip starting 18 March: Digital Storage Unit assembly is on hold pending personnel safe return to LaRC.
NIRVSS	Day-for-Day Slip started 12 March: Environmental test campaign is on hold pending personnel return to ARC.
LN-1	Day-for-Day Slip started 16 March: Assembly activities (FPGA, flight controller and power regulator boards, etc…) are on hold pending personnel return to MSFC.
NDL	Day-for-Day Slip started 16 March: Synthesizer electronics module board assembly was put on hold pending personnel return to LaRC.
PILS	Day-for-Day Slip started 18 March: PCB integration/wiring and assembly of solar cell front plate to honeycomb support panel suspended pending personnel return to GRC.
LETS	Day-for-Day Slip starting 6 April: LETS housing is scheduled for fabrication starting and will be delayed pending safe return to JSC.
NMLS	Day-for-Day Slip started 12 March: Flight hardware build put on hold pending personnel return to MSFC.
MAG	Day-for-Day Slip starting 9 April: FPGA and flexiharness is scheduled for assembly and will be delayed pending safe return to GSFC.
NSS	Day-for-Day Slip started 17 March: Flight hardware environmental testing was put on hold pending personnel return to ARC.

Test Facility Scheduling and Availability is the Primary Concern Upon Return to Development

Other COVID-19 Impacts

- Lunar Surface Instrument and Technology Payload (LSITP)
  - No immediate impacts
  - Schedule slips likely, however, instruments have margin

- Lunar Reconnaissance Orbiter (LRO)
  - All instruments have implemented remote operations from their host institutions.
  - Mission Operations Team has begun minimizing the number of people in the room at any one time with the remainder of the team working remotely.
  - The team is also implementing more telework capabilities and planning reduced-staff contingency responses.

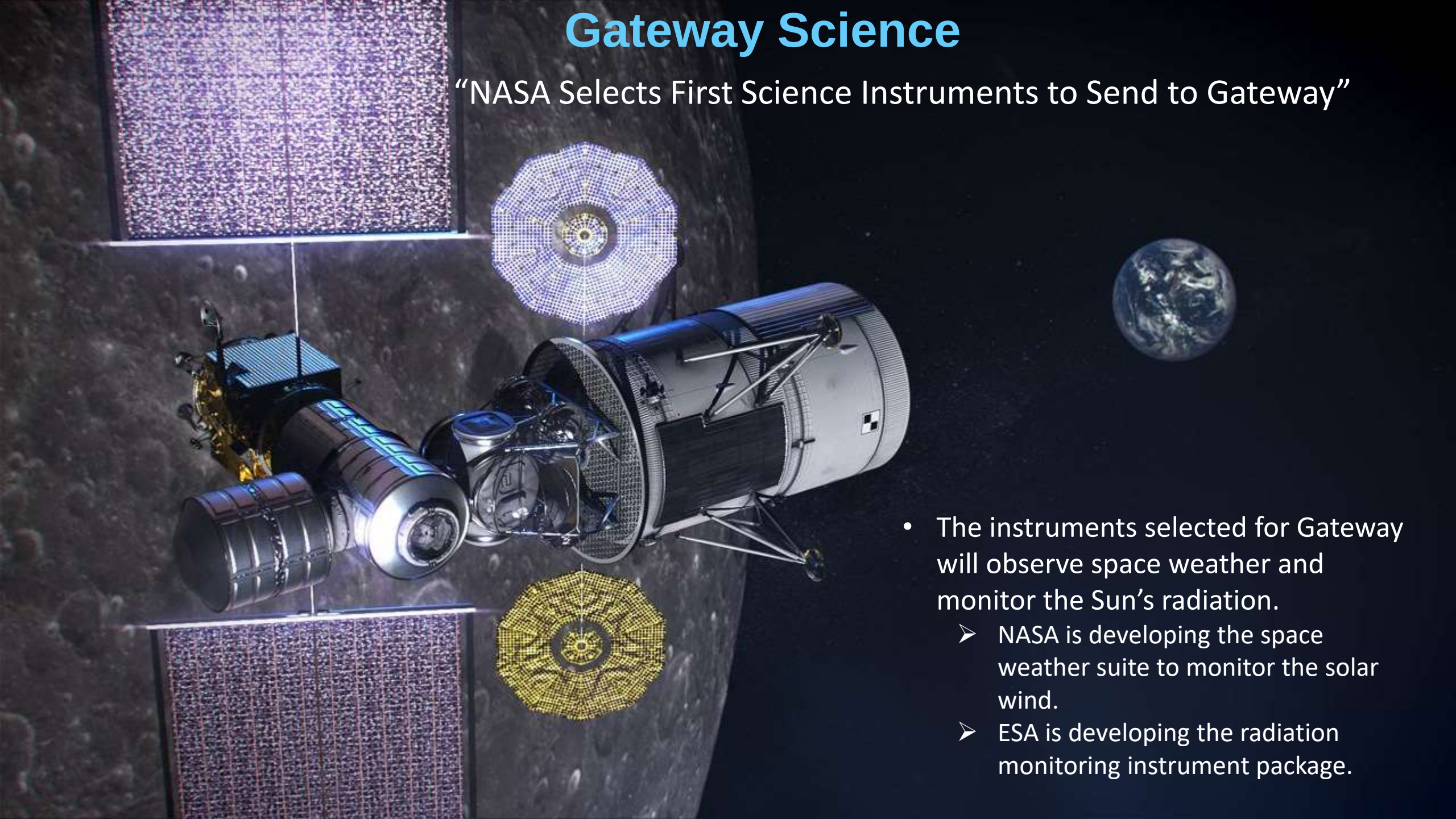
- Lunar Surface Science Workshop Postponed
  - SMD-led with HEOMD and STMD
  - Over 170 abstracts received
  - Purpose: To discuss the science enabled by crews going to the south polar region
  - Smaller virtual workshops under assessment

PRISM Overview

- Future Payloads and Research Investigations on the Surface of the Moon (PRISM) solicitation planned approximately annually with a 2-stage process
  - Stage 1 - Open RFI expected in March 2020
  - Stage 2 – NRA solicitations will state the location for each delivery, allowing PIs to propose science optimized for those locations
- PRISM Open RFI will result in a catalog of available instruments that will aid in determining future landing sites for CLPS deliveries.
- Initial priority is to solicit suites of instruments that can work together
  - High-value ‘location agnostic’ instruments also welcome
- Selected PRISM instruments will feed the CLPS manifests from 2023 onwards
  - International payloads, and payloads from other NASA mission directorates also could be incorporated into the Task Order
- The PRISM Open RFI also will create a catalog of instruments from which we can choose to fill out other flight opportunities, either commercial or international
- Expect to have Participating Scientist Programs for each flight
- Future PRISM calls will ask for destination agnostic and stand-alone instruments, in addition to instruments for network science on a campaign of landers

Gateway Science

"NASA Selects First Science Instruments to Send to Gateway"



- The instruments selected for Gateway will observe space weather and monitor the Sun's radiation.
  - NASA is developing the space weather suite to monitor the solar wind.
  - ESA is developing the radiation monitoring instrument package.

Science Strategy at the Moon: A Bold New Era of Human Discovery

- The Moon is:
  - A cornerstone for Solar System science and for exoplanet studies
  - A natural laboratory to study planetary processes and evolution, and a platform from which to observe the Universe
  - A critical location to understand volatiles cycles and study impact history of the Earth-Moon system
  - A record of the ancient Sun
- Conducting scientific exploration synergistically with crew and robotic explorers teaches us effective techniques that can be applied as we push the boundaries of exploration to Mars and other locations in our Solar System
- An opportunity to use emplaced infrastructure and resources
- The infrastructure associated with human exploration can be leveraged to support autonomous scientific investigations.
- Science mission planning for human lunar missions continue
  - A joint SMD/HEOMD/STMD workshop was planned for April 2020 to discuss the science enabled by crews going to the south polar region; postponed due to travel restrictions implemented with continuing coronavirus spread


NASA
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MOON LIGHTS THE WAY