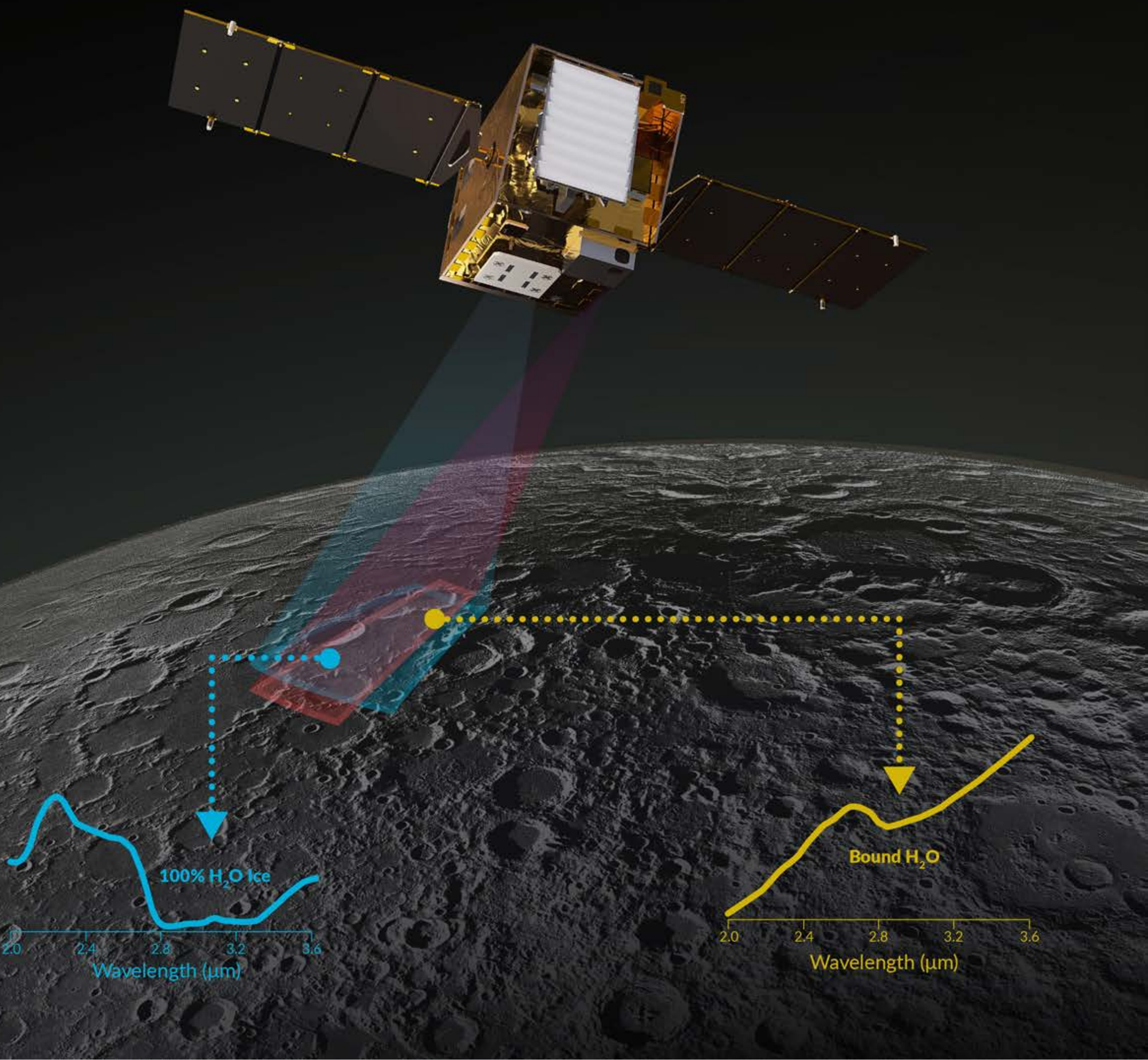
LUNAR TRAILBLAZER

A PIONEERING SMALLSAT FOR LUNAR WATER AND LUNAR GEOLOGY

Launch Press Kit



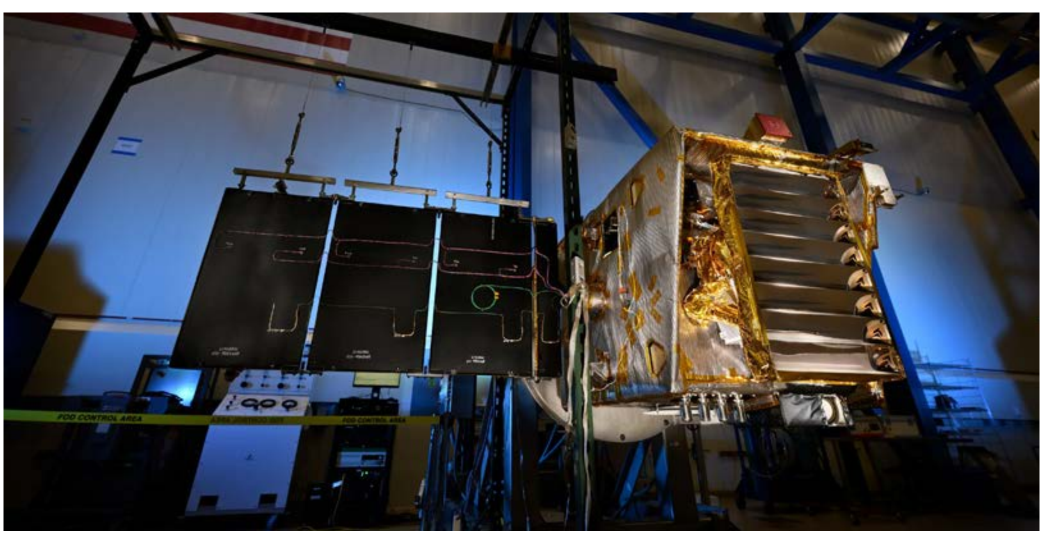
NASA's Lunar Trailblazer is a small satellite ('SmallSat') that will orbit the Moon to detect and map water on the lunar surface. The mission goal is to determine the form, abundance, and distribution of water on the Moon and to understand the lunar water cycle. Selected by NASA in 2019, Lunar Trailblazer is a SIMPLEx (Small, Innovative Mission for Planetary Exploration) selection, which provides opportunities for lower-cost, higher-risk planetary science missions. Lunar Trailblazer will provide the highest ever spatial resolution maps of water, composition, and thermophysical properties on the Moon to help guide future exploration.

INSTITUTIONS

NASA
Caltech
NASA's Jet Propulsion Laboratory
Lockheed Martin Space
United Kingdom Space Agency
University of Oxford
Maverick Space Systems
Johns Hopkins University Applied Physics Laboratory
Brown University
Northern Arizona University
University of Central Florida
Pasadena City College

Cover Image Credit: Lockheed Martin/Caltech/Jay Dickson/Jasper Miura

Table of Contents



Lunar Trailblazer in a clean room after undergoing environmental testing at Lockheed Martin Space. One of two solar panels deployed.

Credit: Lockheed Martin

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Engineers install the JPL-developed High-resolution Volatiles and Minerals Moon Mapper (HVM^3) for NASA's Lunar Trailblazer spacecraft in a clean room at Lockheed Martin Space in Littleton, Colorado, in December 2022.

Credit: Lockheed Martin

NEWS RELEASES, FEATURES AND STATUS REPORTS

News, updates and feature stories about the Lunar Trailblazer mission are available at **https://science.nasa.gov/mission/lunar-trailblazer/** and **https://blogs.nasa.gov/trailblazer/**

VIDEO AND IMAGES

A collection of videos, animation, images and infographics can be found on the mission website's gallery: **https://trailblazer.caltech.edu/**

The NASA image use policy is available at **https://www.nasa.gov/multimedia/guidelines/index.html**

MEDIA EVENTS

The most up-to-date information about Lunar Trailblazer mission media events and where to watch them is available at **https://www.nasa.gov/live/**

HOW TO WATCH

News briefings and launch commentary for Lunar Trailblazer will be streamed on NASA+, **https://www.nasa.gov/live/**, and **https://www.youtube.com/NASA/**. On-demand recordings will also be available on YouTube after the live events have finished.

ADDITIONAL RESOURCES ON THE WEB

The Lunar Trailblazer website is **https://science.nasa.gov/mission/lunar-trailblazer/**. Additional information about the Lunar Trailblazer mission, including a digital version of this press kit, can be found on Caltech's mission website: **https://trailblazer.caltech.edu/**

NASA's Lunar Trailblazer fact sheet is available at: **https://science.nasa.gov/mission/lunar-trailblazer-fact-sheet/**

NASA's Eyes has trajectory and position information for Lunar Trailblazer at: **https://eyes.nasa.gov/apps/solar-system/#/sc_lunar_trailblazer/**

Bethany Ehlmann's Caltech Watson Lecture about Lunar Trailblazer can be watched at: **https://www.youtube.com/watch?v=XGNNxd_o98s/**

SOCIAL MEDIA

Join the conversation and follow Lunar Trailblazer on its various social media platforms.

The following NASA accounts provide mission information:

X: **@NASA**, **@NASASolarSystem**, **@NASAMoon**

Facebook: **/NASA**, **/NASASolarSystem**, **/NASAMoon**

Instagram: **@nasa**, **@nasasolarsystem**

Hashtags: #LunarTrailblazer

Quick Facts: Five Key Takeaways from the Lunar Trailblazer Mission

1. Lunar Trailblazer maps water, minerals, and temperature simultaneously with two science instruments, HVM^3 and LTM.

2. Lunar Trailblazer's high-resolution maps of the form and amount of water on the Moon will help determine where to send future robotic and human missions for measurements of ice and possible extraction of water as a resource.

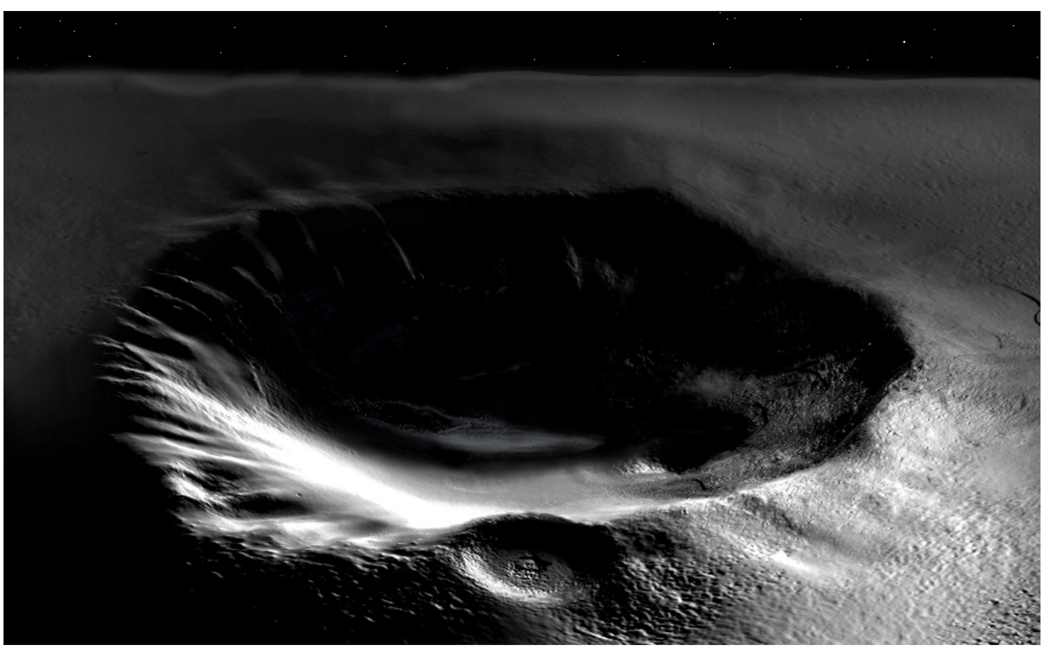
3. Lunar Trailblazer is a NASA's SIMPLEx (Small Innovative Missions for Planetary Exploration) selection, which provides opportunities for low-cost science missions to rideshare with selected primary missions. To maintain a lower overall mission cost, SIMPLEx missions have a higher risk posture and lighter requirements for oversight and management.

4. Lunar Trailblazer is a university-led mission and undergraduate students from Pasadena City College and Caltech have trained to work alongside professional staff in mission operations.

5. Lunar Trailblazer's team includes the United Kingdom as a partner and mission members in more than seven states

QUICK MISSION FACTS:

LAUNCH PERIOD OPENS	February 26, 2025 (ET)
LAUNCH SITE	NASA's Kennedy Space Center, Florida
LAUNCH VEHICLE	SpaceX Falcon 9
RIDESHARE	Launches with Intuitive Machines' IM-2 lunar lander and two other spacecraft
OPERATIONS PHASE	24 months
SPACECRAFT MASS	440 lbs (200 kg) when fully fueled
NAVIGATION	NASA JPL
SPACECRAFT DESIGN & BUILD	Lockheed Martin
OPERATIONS	Caltech IPAC
SCIENCE TEAM	9 Institutions in the US and UK, Caltech-led
NUMBER OF UNDERGRADUATE INTERNS	52 to date



Artist's depiction of water ice in a permanently shadowed crater at one of the poles of the Moon.

Credit: NASA/Caltech/PCC/Joni Cui

Mission Profile

Lunar Trailblazer is a pioneering smallsat which will detect and map water on the lunar surface. Lunar Trailblazer will enable a better understanding of the Moon's water and geology by determining the form, abundance, and distribution of water across the lunar surface.

To accomplish these science goals, Lunar Trailblazer will collect data using two science instruments:

- The **High Resolution Volatiles and Minerals Moon Mapper (HVM^3)**, provided by NASA JPL and funded by NASA, is optimized to collect information about lunar water by measuring visible and infrared light that is reflected off of the lunar surface from the Sun.
- The **Lunar Thermal Mapper (LTM)**, provided by the University of Oxford and funded by the UK Space Agency, will provide simultaneous information about the thermophysical properties of the lunar surface.

Lunar Trailblazer's two instruments will be carried to the Moon on a box-shaped spacecraft with two solar arrays. With these solar arrays deployed, the length of the spacecraft is about 11.5 feet (3.5 meters). The total mass of Lunar Trailblazer is 463 lbs (210 kg), with a 44 lbs (20 kg) science payload.

LAUNCH

Lunar Trailblazer is a "rideshare mission," taking advantage of the extra mass capacity aboard the SpaceX Falcon 9 rocket launching the larger Intuitive Machines' IM-2 lunar lander mission.

CRUISE

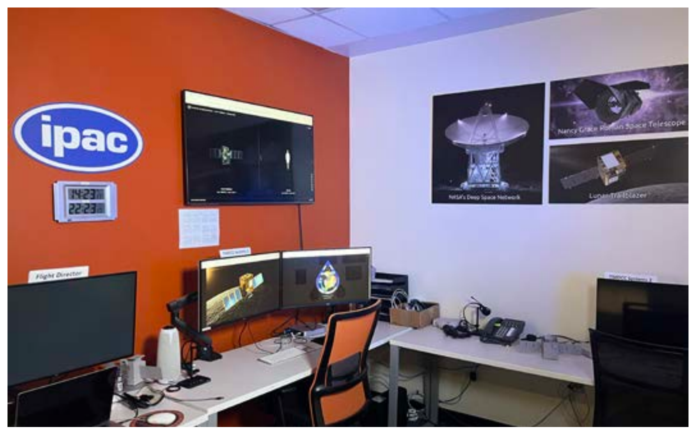
Lunar Trailblazer will use a low-energy transfer trajectory to get to the Moon. Lunar Trailblazer's trajectory is distinct for each and every launch date, and Lunar Trailblazer may take between four to seven months to arrive at the Moon.

LUNAR ORBIT

Once Lunar Trailblazer completes its cruise period to the Moon, it will enter a 100±30 km orbit (43 to 80 mile) polar orbit. This orbit will enable Lunar Trailblazer to collect high-resolution spectral data for targets across the surface and at both poles. The combined cruise and science mapping phases will last 24 months.

MISSION OPERATIONS

Lunar Trailblazer uses NASA's Deep Space Network (DSN) to communicate and bring data back to Earth. NASA JPL provides navigation and mission design. Mission operations—including communication with and commanding of the spacecraft, managing resources on board, and processing data—is conducted on the Caltech campus. In an innovative, university-based approach for space missions, Caltech IPAC staff and undergraduate students from Caltech and Pasadena City College will be on console communicating with the spacecraft, assisting with ground software, and processing data. Lockheed Martin assists with engineering products.



Caltech IPAC operations center.

Credit: Caltech IPAC

STUDENT COLLABORATION

A distinctive feature of the Lunar Trailblazer mission is that undergraduate students are infused in all aspects of science and operations. Students work on console during operations, communicating with spacecraft and the DSN. They make graphics to communicate Lunar Trailblazer science. They design ground software for telemetry parsing and visualization and science image processing. They create webpages explaining the mission and profiling team members. They test procedures for spacecraft commanding and vet contingency scenarios. Funded by a NASA "Student Collaboration" option, Pasadena City College and Caltech students enhance the mission by their efforts and receive training for future space careers.

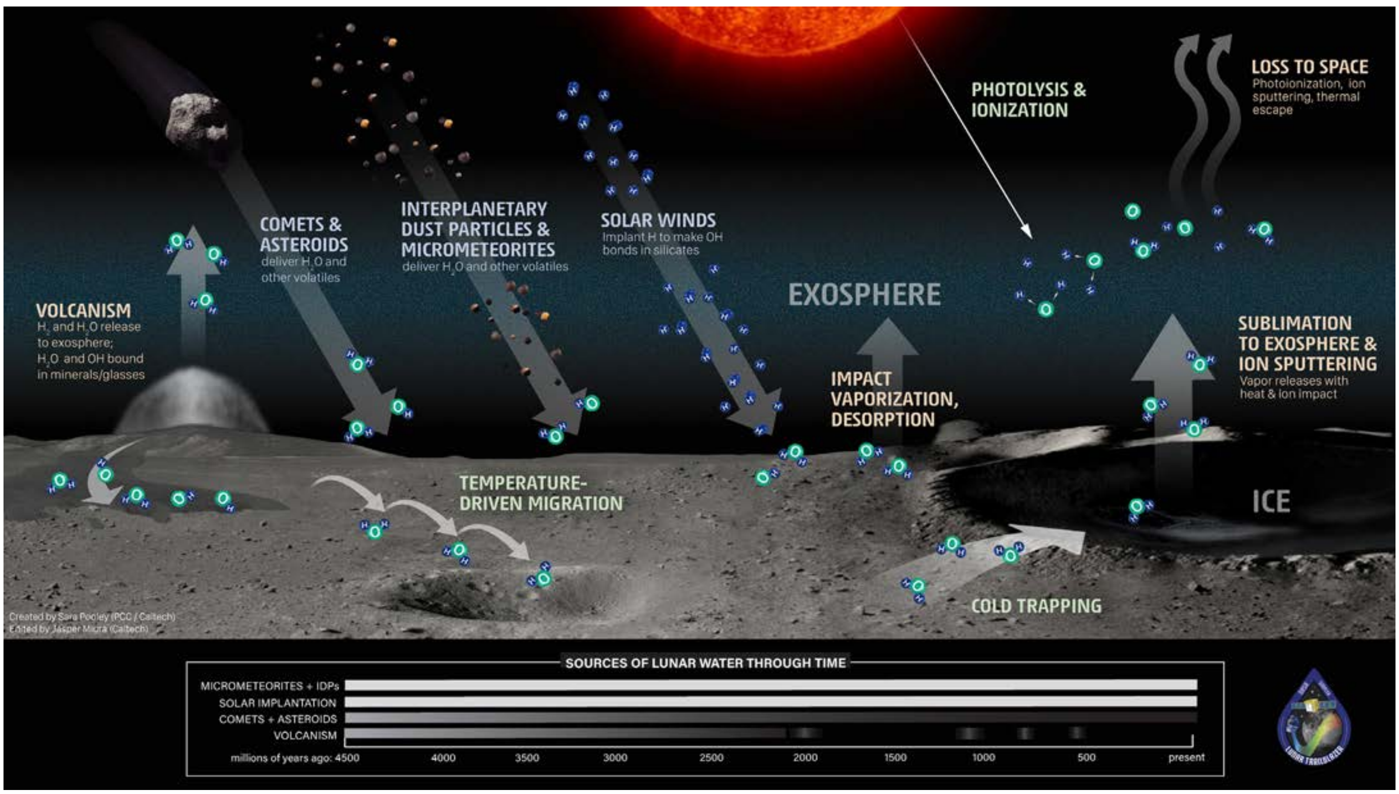
KEY QUESTIONS ABOUT THE LUNAR WATER CYCLE

How much water is on the Moon?

While we know there is water on the Moon, we do not know how much. Some data collected by prior missions suggest that there may be up to 1.3 trillion pounds (600 million metric tons) of ice in the permanently shadowed regions of the lunar poles. Finding and quantifying these deposits of water is important for future exploration.

Where does lunar water come from?

Current evidence suggests that comets and asteroids may have brought some water to the Moon. Interplanetary dust particles and micrometeorites may also deliver water to the lunar surface. In addition, some water may have been sourced from the lunar interior by ancient volcanism. The Sun may also play a role—a stream of hydrogen from the Sun, called the solar wind, may combine with oxygen on the Moon to form lunar water directly on the surface.



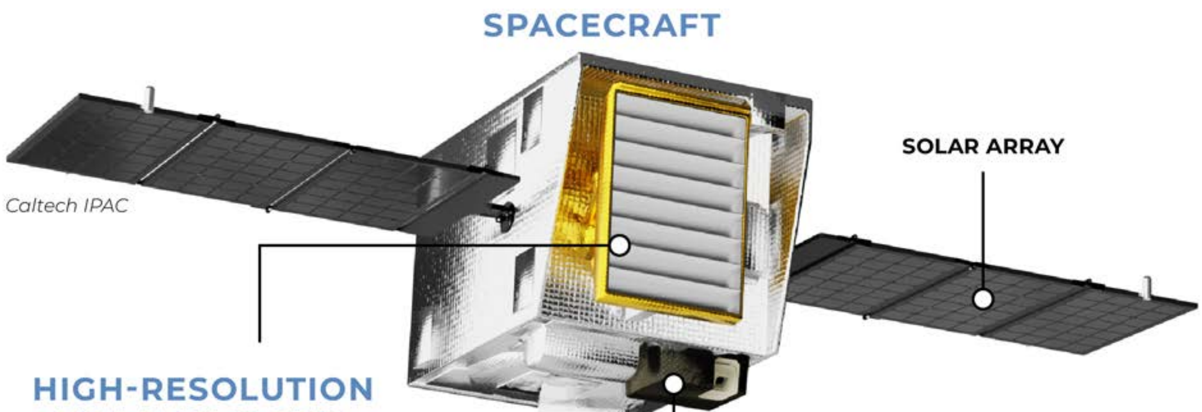
Some hypothesized processes that may contribute to the lunar water cycle.

Credit: NASA/Caltech/PCC/Sara Pooley

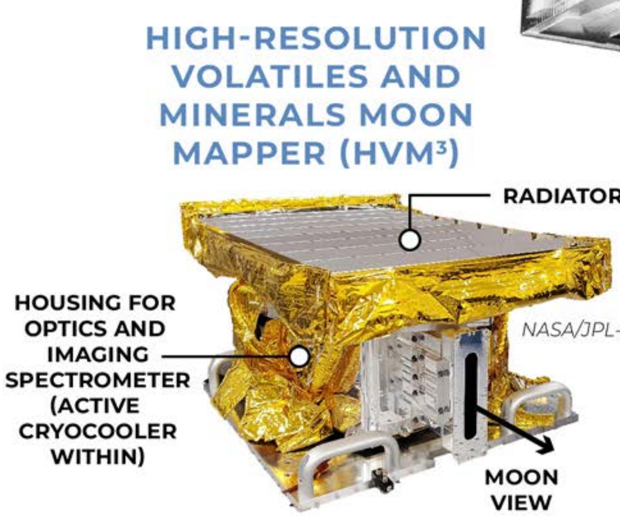
Spacecraft

In keeping with the SIMPLEx approach, the Lunar Trailblazer spacecraft was built by Lockheed Martin using a single string spacecraft architecture, built for cost efficiency without redundancy in computers or other flight system parts. For most subsystems, Lunar Trailblazer uses commercially available parts and systems, which are then rigorously tested once they are built into their respective subsystems, rather than custom-designed parts.

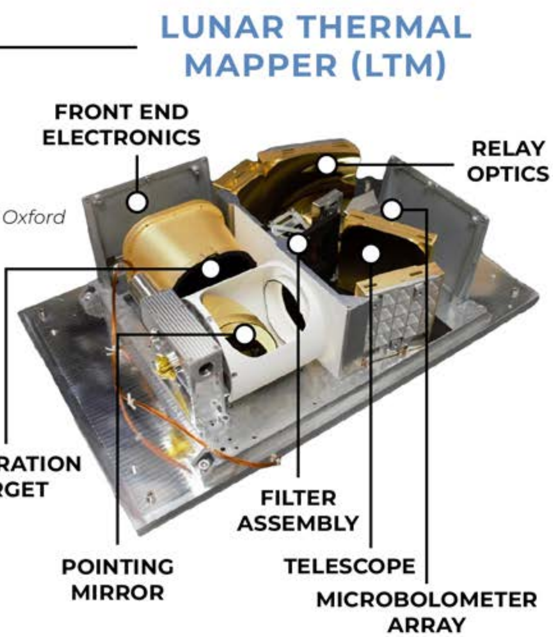
Lunar Trailblazer has a box-shaped body with two solar arrays. With these solar arrays deployed, the length of the spacecraft is about 11.5 feet (3.5 meters). The solar panels will provide 280 W of power. The total mass is 440 lbs (200 kg), with 44 lbs (20 kg) of science instrument payload.



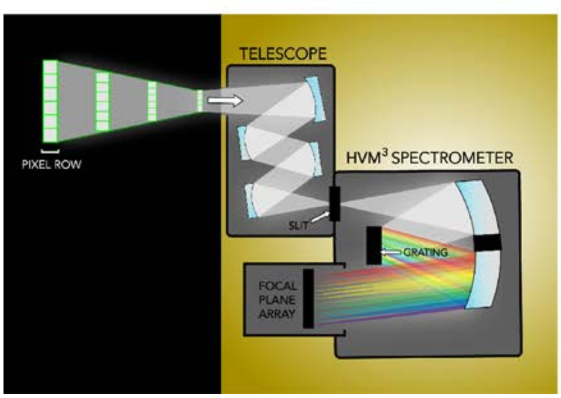
Caltech IPAC



NASA/JPL-Caltech



University of Oxford



HVM³ Interior Schematic
Credit: NASA/ Caltech/Emily Felder

Instruments

Lunar Trailblazer carries two instruments to achieve its science objectives: the High-resolution Volatiles and Minerals Moon Mapper (HVM³) built by NASA JPL and funded by NASA, and the Lunar Thermal Mapper (LTM) built by the University of Oxford and funded by the UK Space Agency. The two instruments are used simultaneously to collect two nested "data cubes" that provide the ability to concurrently identify the various forms of water on the Moon, mineralogy, and temperature.

HIGH-RESOLUTION VOLATILES AND MINERALS MOON MAPPER

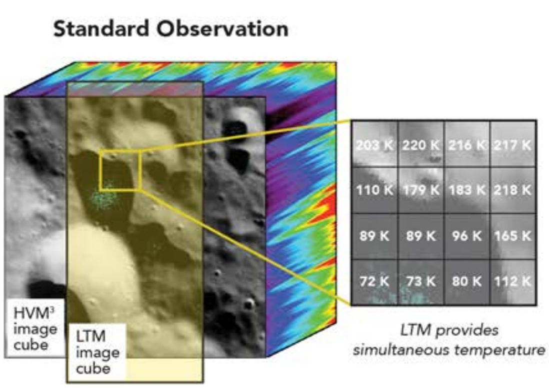
HVM³ is a pushbroom shortwave infrared (SWIR) imaging spectrometer that is optimized for the detection of volatiles to map OH, bound H_2O, and water ice.

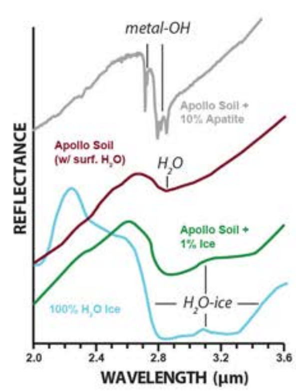
SPATIAL SAMPLING	165 – 295 ft/pixel (50 – 90 m/pixel)
SWATH WIDTH	98 – 180 ft (30 – 55 km)
SPECTRAL RANGE	0.6 – 3.6 μm
SPECTRAL SAMPLING	10 nm
SNR	>100 at reference
UNIFORMITY	>90% cross track
# DATA CUBES	≥1000

LUNAR THERMAL MAPPER

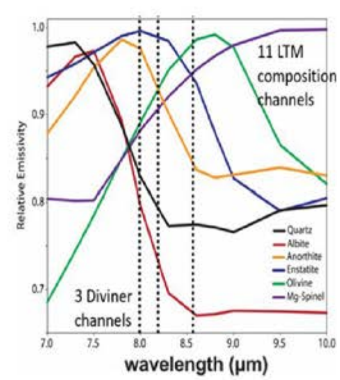
LTM is a pushbroom multichannel imaging thermal radiometer that simultaneously maps temperature, physical properties, and composition of water-bearing areas in HVM³ pixels.

SPATIAL RESOLUTION	131 – 230 ft/pixel (40 – 70 m/pixel)
SWATH WIDTH	46 – 89 ft (14 – 27 km)
THERMAL TEMPERATURE RETRIEVAL	-262 – 260 °F (110 – 400 K; ± <2 K) 4 broad bands, 6-100 μm
COMPOSITION	7 – 10 μm, 11 channels; <0.5 μm
# DATA CUBES	≥1000





HVM³ spectra directly detect and determine the form of water



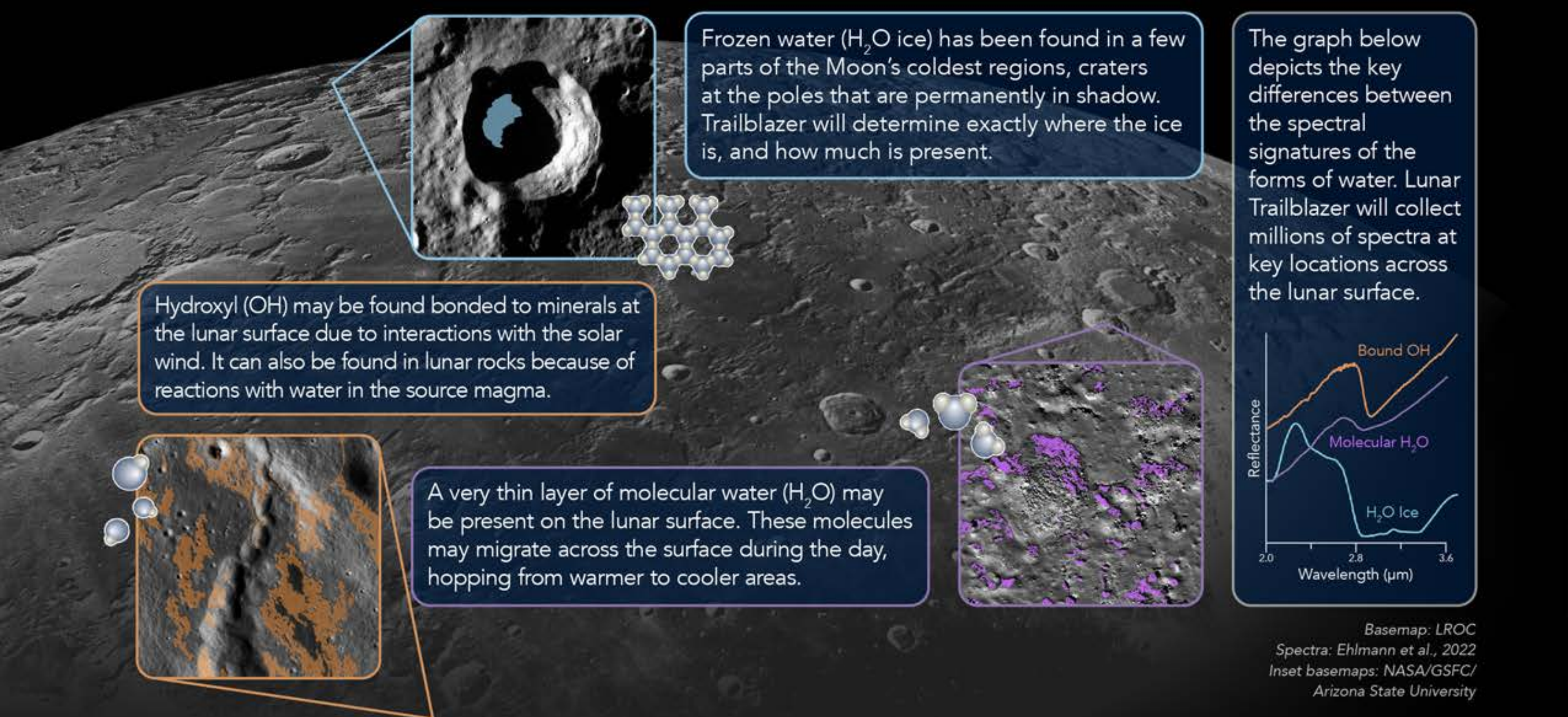
LTM compositional channels measure rocks and minerals on the lunar surface

Credit: Caltech/UCF

Science Objectives

LUNAR TRAILBLAZER OBJECTIVE 1

Determine form, abundance, and distribution of H_2O/OH across targeted areas of sunlit lunar surface, including variability by latitude, soil maturity, and lithology.

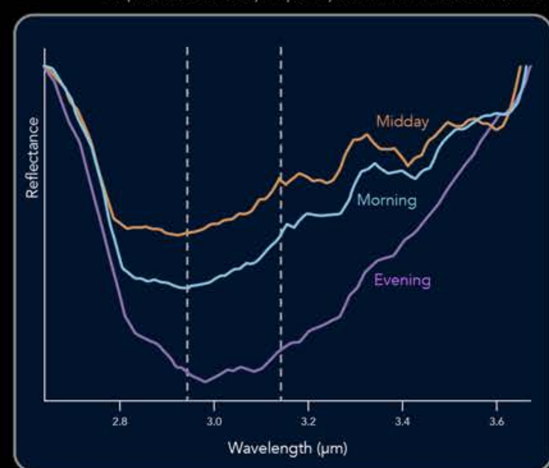


Basemap: LROC
Spectra: Ehlmann et al., 2022
Inset basemaps: NASA/GSFC/ Arizona State University

LUNAR TRAILBLAZER OBJECTIVE 2

Test for and measure the possible temporal variations of H_2O/OH across targeted areas of sunlit portions of the lunar surface.

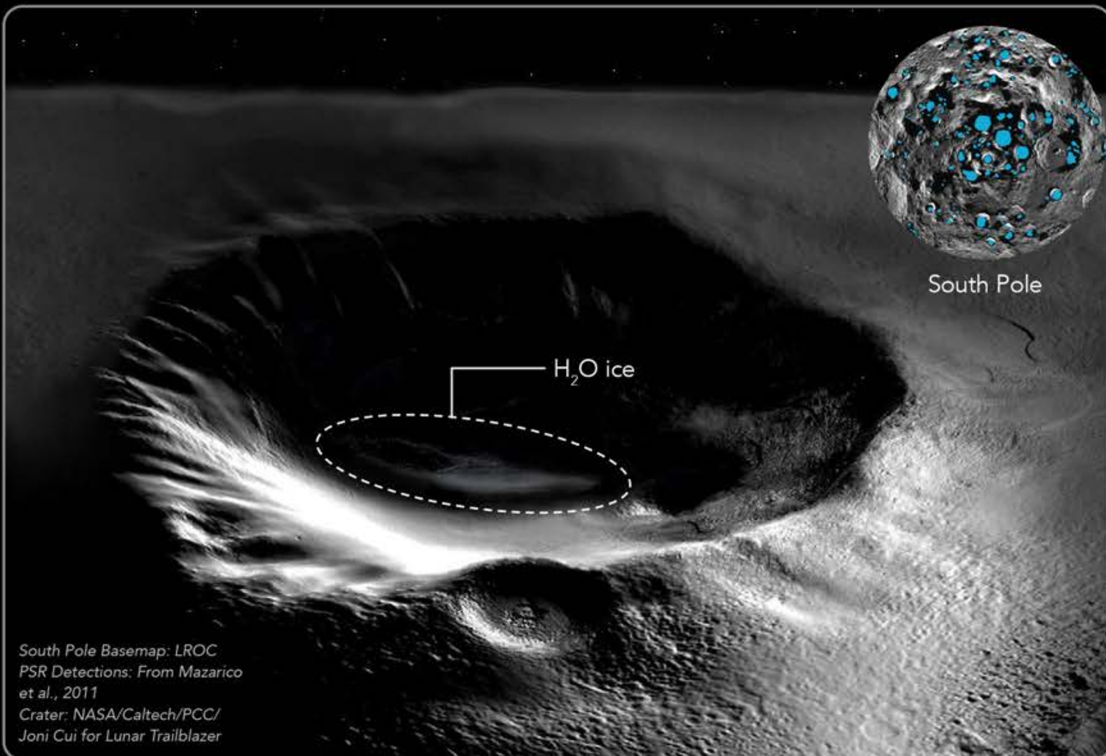
Basemap: LROC/ACT
Graph: Based on Deep Impact spectra in Laferriere et al., 2022



These simulated maps and spectra show how the amount and distribution of water detected on the lunar surface could change during the day. Water molecules may condense in cold shadowed regions and then evaporate or sublimate when warmed by sunlight. Lunar Trailblazer will determine whether the abundance of water changes by measuring the lunar surface at multiple times of day.

LUNAR TRAILBLAZER OBJECTIVE 3

Determine the form and abundance of H_2O ice and bound H_2O/OH in targeted permanently shadowed regions (PSRs).

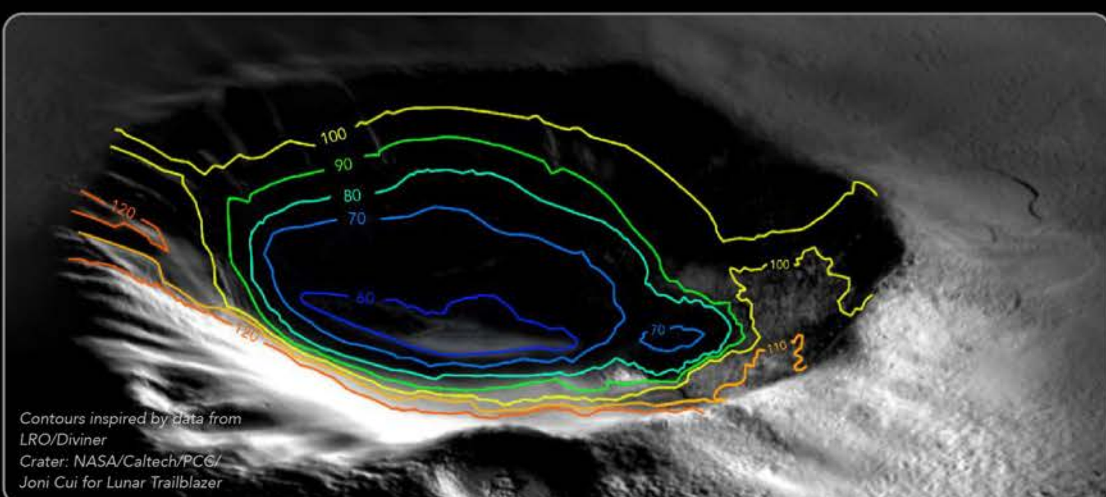


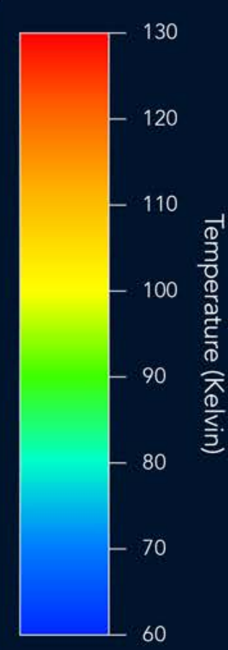
Permanetnly shadowed regions (PSRs)

Most craters on the Moon get sunlight during the day, but due to the geometry of the lunar orbit, some craters at the poles never receive direct sunlight. These permanently shadowed regions (PSRs) stay far colder than the surrounding area, trapping water and other volatiles. Lunar Trailblazer will identify water inside these PSRs using reflected light scattered from nearby sunlit surfaces.

LUNAR TRAILBLAZER OBJECTIVE 4

Understand how localized gradients in albedo and surface temperature affect ice and OH/H_2O concentration, including the potential identification of new, small cold traps.



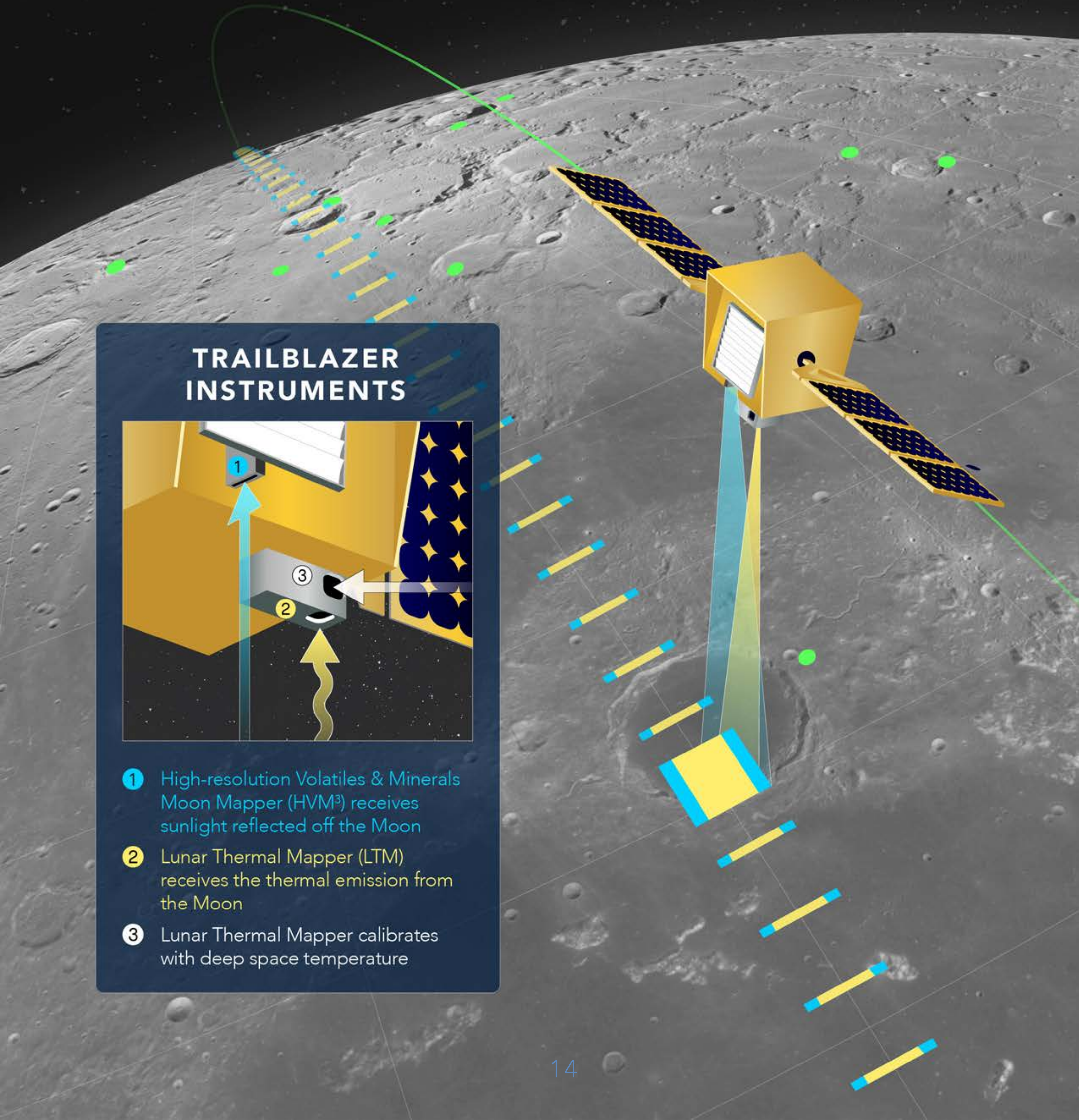


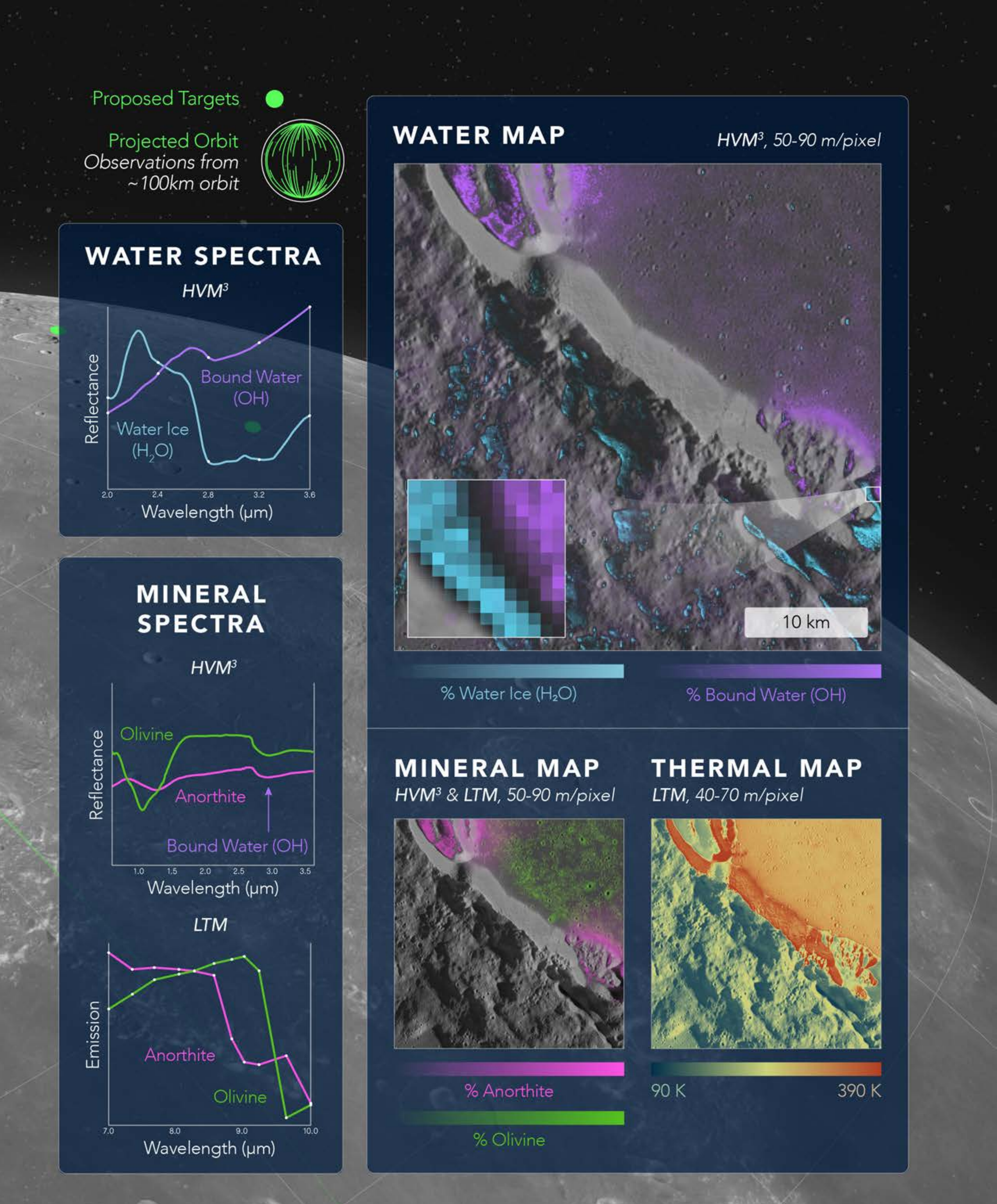
The presence of water ice on the Moon is dependent on temperature. Due to the sparse atmosphere of the Moon, the lunar surface is surrounded by vacuum. In a vacuum, water ice normally sublimates from a solid state to gas. But at temperatures below 110K (-163°C, -262°F) like this crater, water will only sublimate about one millimeter per billion years. Lunar Trailblazer will map the relationship between water and temperature.

Credit: NASA/Caltech/PCC/Isabelle Adamczewski

Science Data

With its two instruments (HVM³ and LTM), Lunar Trailblazer will collect data for targeted locations across the lunar surface. Each pixel in an image represents a spectrum, which can provide information about the presence of different forms of water and lunar mineralogy. This information is used to create maps of the lunar surface.





Created by Filo Merid (PCC/Caltech)
Edited by Jasper Miura (Caltech)

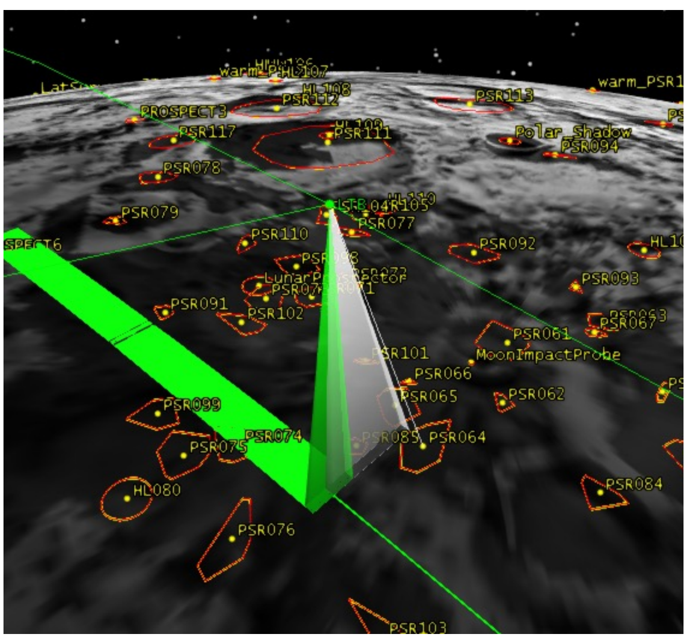
Getting to the Moon – Trajectory and Orbit

Lunar Trailblazer launches with the Intuitive Machines IM-2 mission on an ESPA ring, a standard add-on located below the primary payload. Even though Lunar Trailblazer's fuel tank makes up around two-thirds of its volume, the spacecraft does not have enough propellant to directly insert into orbit about the Moon after a few-day transfer like the Apollo spacecraft. Instead, Lunar Trailblazer uses a low-energy transfer trajectory to get to the Moon. This approach follows a path made possible by the gravity of the Earth, the Moon, and the Sun. Lunar Trailblazer will fire its hydrazine chemical propulsion system for short periods of time at gravitationally favorable points to maximize fuel efficiency.

To minimize its propellant consumption, Lunar Trailblazer has different routes to the Moon available for different days during its launch period. Depending on which day Lunar Trailblazer launches, it can take between four and seven months before insertion into orbit about the Moon.

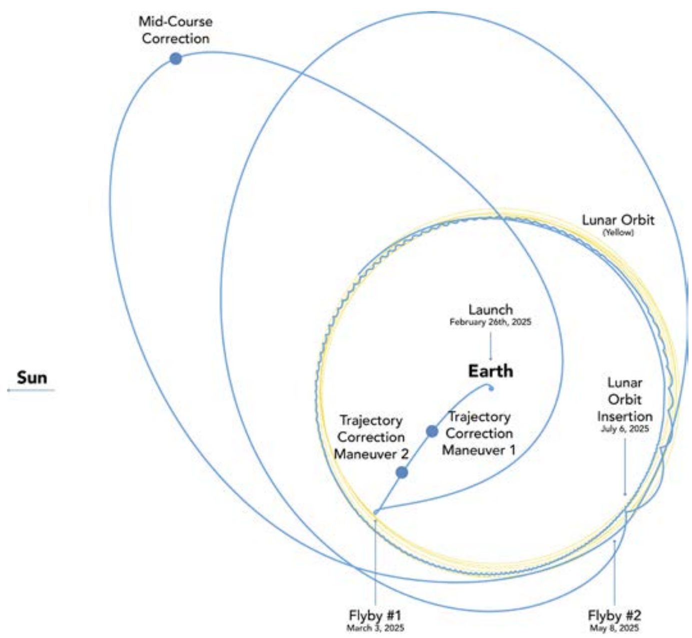
Once Lunar Trailblazer completes its cruise period to the Moon, it will spend a month and a half lowering its orbit to a polar science orbit at about a 62-mile (100-km) altitude. This near-circular orbit will enable Lunar Trailblazer to collect high-resolution spectral data for targets across the surface and at both poles. Lunar Trailblazer will revisit a target every 1 month and with the same viewing and lighting geometry every 6 months.

To communicate with the spacecraft, the Lunar Trailblazer operations team will use NASA's Deep Space Network (DSN). Mission operations are located at Caltech IPAC, while mission design and navigation are conducted at NASA JPL with engineering support from Lockheed Martin. Caltech staff, along with Caltech and Pasadena City College undergraduate students, command the spacecraft.



Simulation of Lunar Trailblazer's orbit around the Moon, with targets identified on the lunar surface.

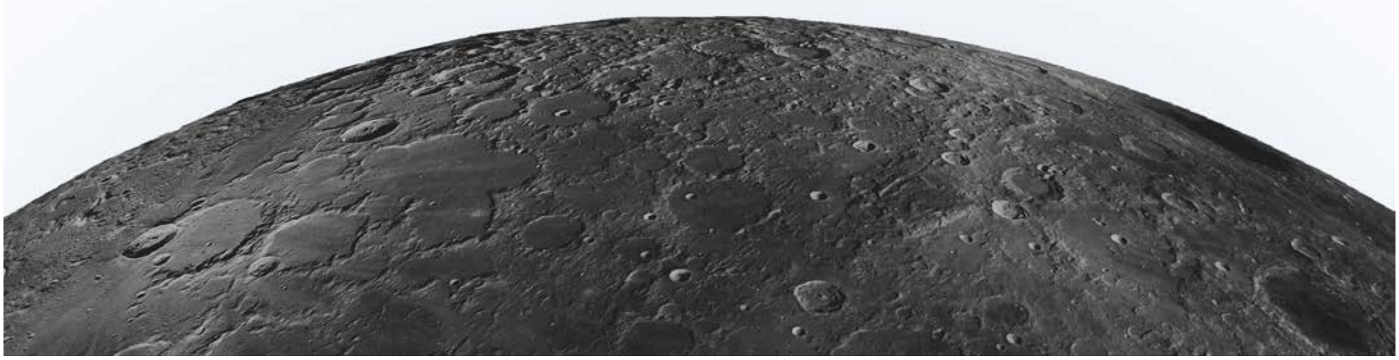
Credit: NASA/JPL-Caltech/Caltech



Sun-Earth rotating frame view of a trajectory for the February 26th, 2025 (ET) launch day.

Credit: NASA/JPL-Caltech

	0 Minutes	Launch
	LAUNCH + **48 Minutes**	Deployment of Lunar Trailblazer; Separation from ESPA Ring
	LAUNCH + **53 Minutes**	Power On and Autonomous Sequence Kickoff
AUTONOMOUS SEQUENCE	**35–45 Minutes**	Deploy Solar Arrays Propulsion System Configuration Instrument Initialization (Safe Mirrors, Turn On Survival Heaters, Start Overtemp Prevention) Initialize Attitude Control System Detumble First RF Transmission Propulsion System Initialization
	LAUNCH + **1 Hour 13 Minutes**	Nominal Time for DSN Initial Acquisition for Carrier Signal
	LAUNCH + **1 Hour 18 Minutes**	Possible First Signal Lock and First Telemetry Receipt
	LAUNCH + **2 Hours 54 Minutes**	Acquisition of 2-Way Signal Nominal Start Time for Commanding
	LAUNCH + **17 Hours**	Trajectory Correction Maneuver (TCM) 1
	LAUNCH + **41 Hours**	TCM-2
	LAUNCH + **68 Hours**	TCM-3
	LAUNCH + **91 Hours**	TCM-4
	LAUNCH + **4.5 Days**	First Lunar Flyby
	LAUNCH + **1 Week**	Begin Instrument Checkouts with LTM Commissioning. HVM^3 Heated for Decontamination; Partial Commissioning (Aliveness Check)
	LAUNCH + **1 Month**	Nominal End of HVM^3 Decontamination; Begin Full HVM^3 Commissioning and Star-Look Calibration
CRUISE	**4.3–7.1 Months**	Cruise Instrument Calibration, including Earth-looks, Moon-looks
	July 6/October 2, 2025 (ET)	Lunar Orbit Insertion
PERIOD REDUCTION	**43 Days**	Period Reduction Phase Transition to Science Orbit
	August 19/November 16, 2025 (ET)	Science Orbit Starts
	LAUNCH + **25 Months**	End of the Primary Mission & Decommissioning



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NASA's Jet
Propulsion Laboratory

Lunar Trailblazer engineers pose with the spacecraft inside the thermal vacuum chamber (TVAC) at Lockheed Martin.

Credit: Lockheed Martin

The Lunar Trailblazer operations team during an Operational Readiness Test in the "fishbowl" ops center.

Credit: Caltech IPAC

NASA Leadership

Program Executive
Karen Gelmis
NASA Headquarters

Program Scientist
Bobby Fogel
NASA Headquarters

Mission Manager
Kevin Sykes
NASA's Marshall Space
Flight Center

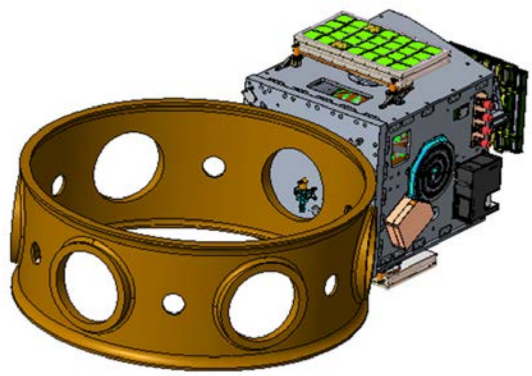
Launch Vehicle

ROCKET	SpaceX Falcon 9
LAUNCH SITE	NASA's Kennedy Space Center, Florida
MISSION	IM-2, Intuitive Machines lunar lander

Intuitive Machines' IM-2 separates from the SpaceX Falcon 9 rocket approximately 44 minutes after launch. Lunar Trailblazer is deployed from the ESPA ring about 48 minutes later. Lunar Trailblazer is launched off, turns on after separation, and executes autonomous sequencing to deploy the solar panels, detumble, and turn on its propulsion system to begin its journey to the Moon.

NASA's Lunar Trailblazer sits in a clean room at Lockheed Martin Space in Littleton, Colorado, as an engineer prepares the spacecraft for vibration testing.

Credit: Lockheed Martin



Lunar Trailblazer (right) attached to an ESPA ring (left).

Credit: Lockheed Martin

A SpaceX Falcon 9 rocket, similar to the one Lunar Trailblazer will be launching on with IM-2.

Credit: NASA

Launch press kit prepared by
Jasper Kenzo Miura, Caltech
NASA contract # 80NM0019F0079.