CAPSTONE™ LUNAR MISSION

PRESS KIT | NET 28 JUNE 2022

Rocket Lab USA, Inc.
rocketlabusa.com

TO THE

MOON

CAPSTONE™ MISSION INFORMATION

LAUNCH VEHICLE

ELECTRON

and Photon Spacecraft

LAUNCH SITE

LC-1 B

Mahia, New Zealand

ORBIT

NEAR RECTILINEAR HALO ORBIT OF EARTH'S MOON

MISSION PARTNERS

NASA, ADVANCED SPACE, TERRAN ORBITAL

PAYLOAD MASS

CAPSTONE SPACECRAFT:

55 LBS
(~25 KG)

TOTAL LIFT MASS WITH LUNAR PHOTON:

661 LBS
(~300 KG)

SATELLITES

1

LAUNCH WINDOW

June 28 – July 27

The target lift-off time will shift several minutes earlier on each day of the launch window.

DAILY TARGET T-0 TIMES

NZST	
Jun-28	21:55
Jun-29	21:50
Jun-30	21:45
Jul-01	21:40
Jul-02	21:35
Jul-03	21:10
Jul-04	21:10
Jul-05	21:05
Jul-06	21:00
Jul-07	21:00
Jul-08	21:00
Jul-09	20:55
Jul-10	20:50
Jul-11	20:50
Jul-12	20:45
Jul-13	20:45
Jul-14	20:40
Jul-15	20:40
Jul-16	20:35
Jul-17	20:30
Jul-18	20:15
Jul-19	19:55
Jul-20	19:50
Jul-21	20:00
Jul-22	20:00
Jul-23	20:00
Jul-24	19:55
Jul-25	19:50
Jul-26	19:50
Jul-27	19:45

UTC	
Jun-28	9:55
Jun-29	9:50
Jun-30	9:45
Jul-01	9:40
Jul-02	9:35
Jul-03	9:10
Jul-04	9:10
Jul-05	9:05
Jul-06	9:00
Jul-07	9:00
Jul-08	9:00
Jul-09	8:55
Jul-10	8:50
Jul-11	8:50
Jul-12	8:45
Jul-13	8:45
Jul-14	8:40
Jul-15	8:40
Jul-16	8:35
Jul-17	8:30
Jul-18	8:15
Jul-19	7:55
Jul-20	7:50
Jul-21	8:00
Jul-22	8:00
Jul-23	8:00
Jul-24	7:55
Jul-25	7:50
Jul-26	7:50
Jul-27	7:45

PDT	
Jun-28	2:55
Jun-29	2:50
Jun-30	2:45
Jul-01	2:40
Jul-02	2:35
Jul-03	2:10
Jul-04	2:10
Jul-05	2:05
Jul-06	2:00
Jul-07	2:00
Jul-08	2:00
Jul-09	1:55
Jul-10	1:50
Jul-11	1:50
Jul-12	1:45
Jul-13	1:45
Jul-14	1:40
Jul-15	1:40
Jul-16	1:35
Jul-17	1:30
Jul-18	1:15
Jul-19	12:55
Jul-20	12:50
Jul-21	1:00
Jul-22	1:00
Jul-23	1:00
Jul-24	12:55
Jul-25	12:50
Jul-26	12:50
Jul-27	12:45

EDT	
Jun-28	5:55
Jun-29	5:50
Jun-30	5:45
Jul-01	5:40
Jul-02	5:35
Jul-03	5:10
Jul-04	5:10
Jul-05	5:05
Jul-06	5:00
Jul-07	5:00
Jul-08	5:00
Jul-09	4:55
Jul-10	4:50
Jul-11	4:50
Jul-12	4:45
Jul-13	4:45
Jul-14	4:40
Jul-15	4:40
Jul-16	4:35
Jul-17	4:30
Jul-18	4:15
Jul-19	3:55
Jul-20	3:50
Jul-21	4:00
Jul-22	4:00
Jul-23	4:00
Jul-24	3:55
Jul-25	3:50
Jul-26	3:50
Jul-27	3:45

OVERVIEW

CHARTING A NEW PATH TO THE MOON

Rocket Lab is launching the Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment, also known as CAPSTONE.

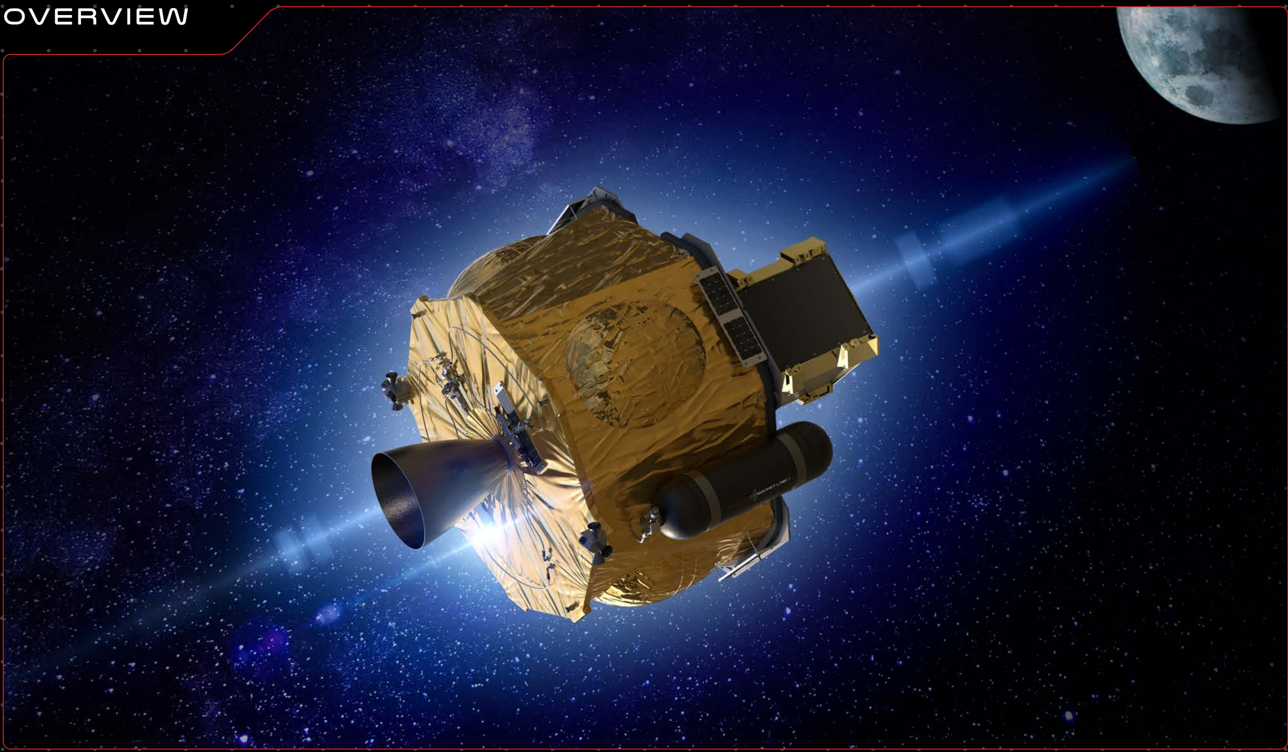
This pathfinding 55-pound CubeSat, designed and built by Tyvak Nano-Satellite Systems, Inc., a Terran Orbital Corporation, and owned and operated by Advanced Space, will be the first spacecraft to test the Near Rectilinear Halo Orbit (NRHO) around the Moon, paving the way for future exploration of the lunar surface.

Researchers expect this orbit to be a gravitational sweet spot in space – where the pull of gravity from Earth and the Moon interact to allow for a nearly-stable orbit – allowing physics to do most of the work of keeping a spacecraft in lunar orbit. NASA has big plans for this orbit. The agency hopes to park bigger spacecraft – including the lunar-orbiting space station Gateway – in a NRHO around the Moon, providing astronauts with a base from which to descend to the lunar surface as part of the Artemis program.

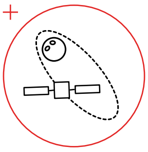
> **The orbit will bring CAPSTONE within 1,000 miles of one lunar pole on its near pass and 43,500 miles from the other pole at its peak every seven days, requiring less propulsion capability for spacecraft flying to and from the Moon's surface than other circular orbits.**

CAPSTONE is expected to orbit this area around the Moon for at least six months to understand the characteristics of the orbit. Specifically, it will validate the propulsion requirements for maintaining its orbit as predicted by NASA's models and gain operational experience, reducing logistical uncertainties. It will also demonstrate innovative navigation solutions including spacecraft-to-spacecraft navigation and one-way ranging capabilities with Earth ground stations. For future lunar mission communications needs, the NRHO provides the advantage of an unobstructed view of Earth in addition to coverage of the lunar South Pole.

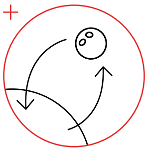
→ NASA.gov/capstone



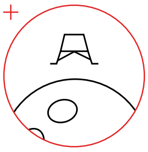
MISSION OBJECTIVES



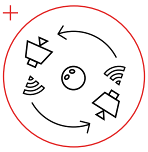
Verify the characteristics of a cis-lunar Near Rectilinear Halo Orbit for future spacecraft



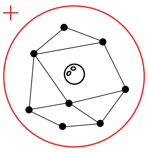
Demonstrate entering and maintaining this unique orbit that provides a highly efficient path to the Moon's surface and back



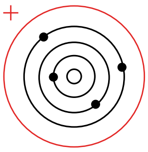
Lay a foundation for commercial support of future lunar operations



Demonstrate spacecraft-to-spacecraft navigation services that allow future spacecraft to determine their location relative to the Moon without relying exclusively on tracking from Earth



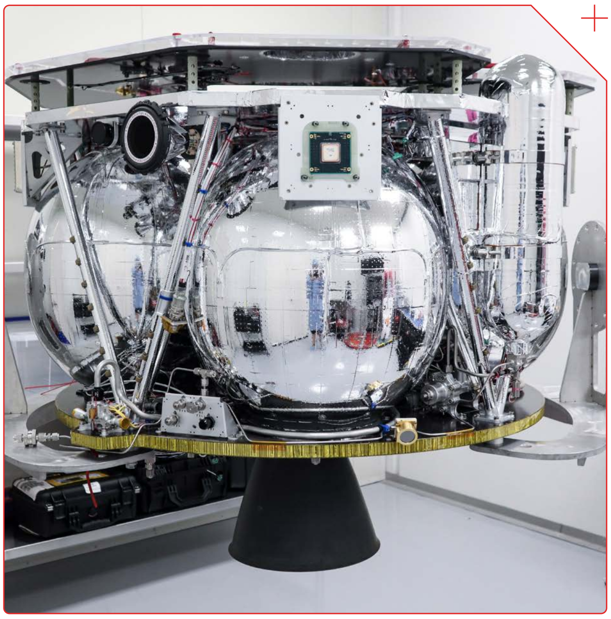
Demonstrate one-way ranging technique using Deep Space Network (DSN) signals and a Chip Scale Atomic Clock, which allows many users around the the Moon to determine position and navigation.



Gain experience with small dedicated launches of CubeSats beyond low-Earth orbit, to the Moon, and beyond

NASA.gov/capstone

FLY ME TO THE MOON, AS EFFICIENTLY AS POSSIBLE

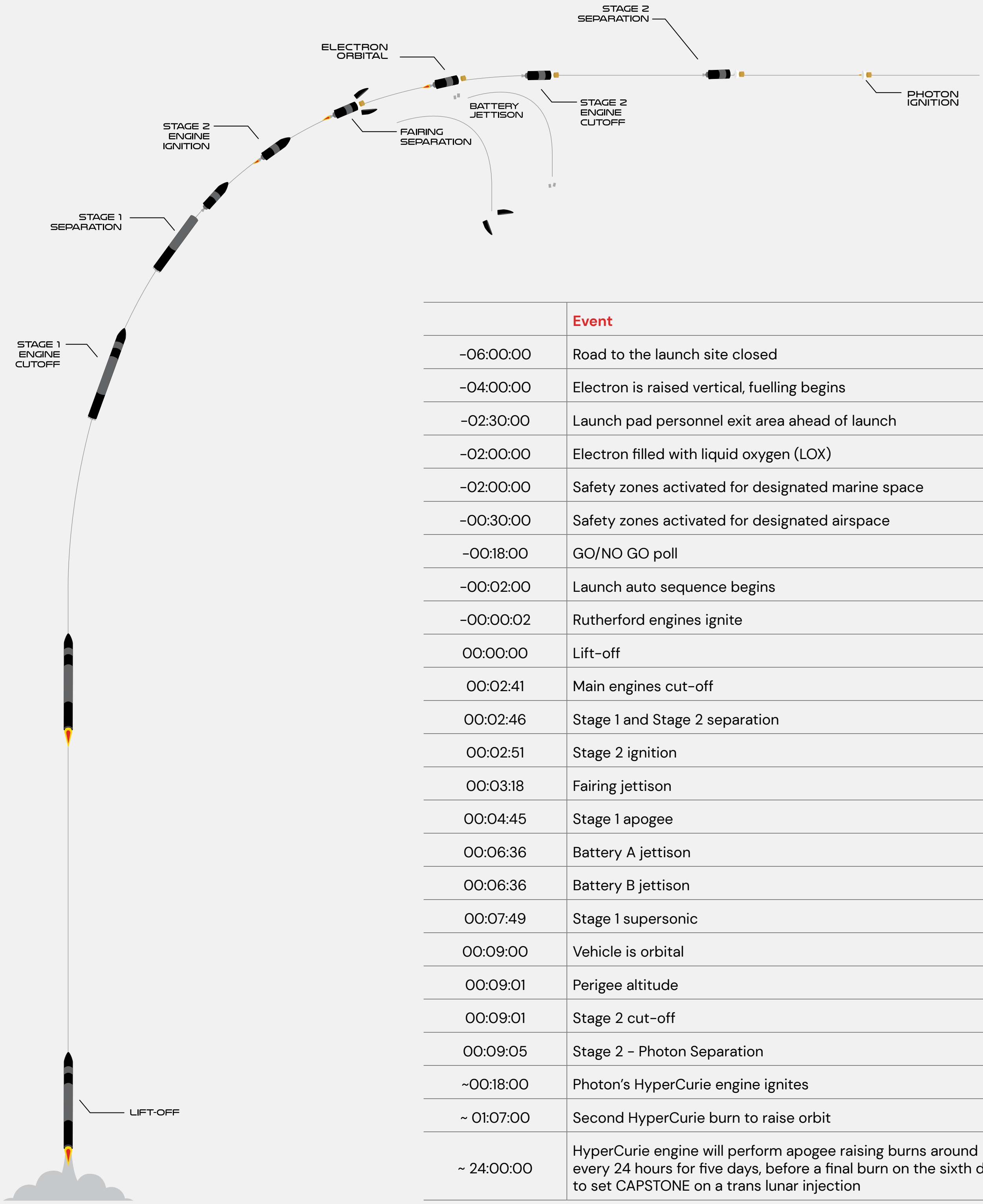


Rocket Lab launches typically deploy spacecraft to orbits between 500 – 1,200 km altitude above Earth's surface. This time, we're combining Electron and Photon to send a spacecraft a little bit further than usual. Some 1.3 million km further.

CAPSTONE will be launched to an initial low Earth orbit by Rocket Lab's Electron launch vehicle and then placed on a ballistic lunar transfer by Rocket Lab's Lunar Photon spacecraft bus. Unlike the Apollo lunar missions of the 1960s and 70s, which took a free return trajectory to the Moon, this fuel efficient ballistic lunar transfer makes it possible to send CAPSTONE on its way to such a distant orbit using a small launch vehicle.

THE LAUNCH

TIMELINE OF LAUNCH EVENTS



	Event
-06:00:00	Road to the launch site closed
-04:00:00	Electron is raised vertical, fuelling begins
-02:30:00	Launch pad personnel exit area ahead of launch
-02:00:00	Electron filled with liquid oxygen (LOX)
-02:00:00	Safety zones activated for designated marine space
-00:30:00	Safety zones activated for designated airspace
-00:18:00	GO/NO GO poll
-00:02:00	Launch auto sequence begins
-00:00:02	Rutherford engines ignite
00:00:00	Lift-off
00:02:41	Main engines cut-off
00:02:46	Stage 1 and Stage 2 separation
00:02:51	Stage 2 ignition
00:03:18	Fairing jettison
00:04:45	Stage 1 apogee
00:06:36	Battery A jettison
00:06:36	Battery B jettison
00:07:49	Stage 1 supersonic
00:09:00	Vehicle is orbital
00:09:01	Perigee altitude
00:09:01	Stage 2 cut-off
00:09:05	Stage 2 - Photon Separation
~00:18:00	Photon's HyperCurie engine ignites
~ 01:07:00	Second HyperCurie burn to raise orbit
~ 24:00:00	HyperCurie engine will perform apogee raising burns around every 24 hours for five days, before a final burn on the sixth day to set CAPSTONE on a trans lunar injection

THE LAUNCH

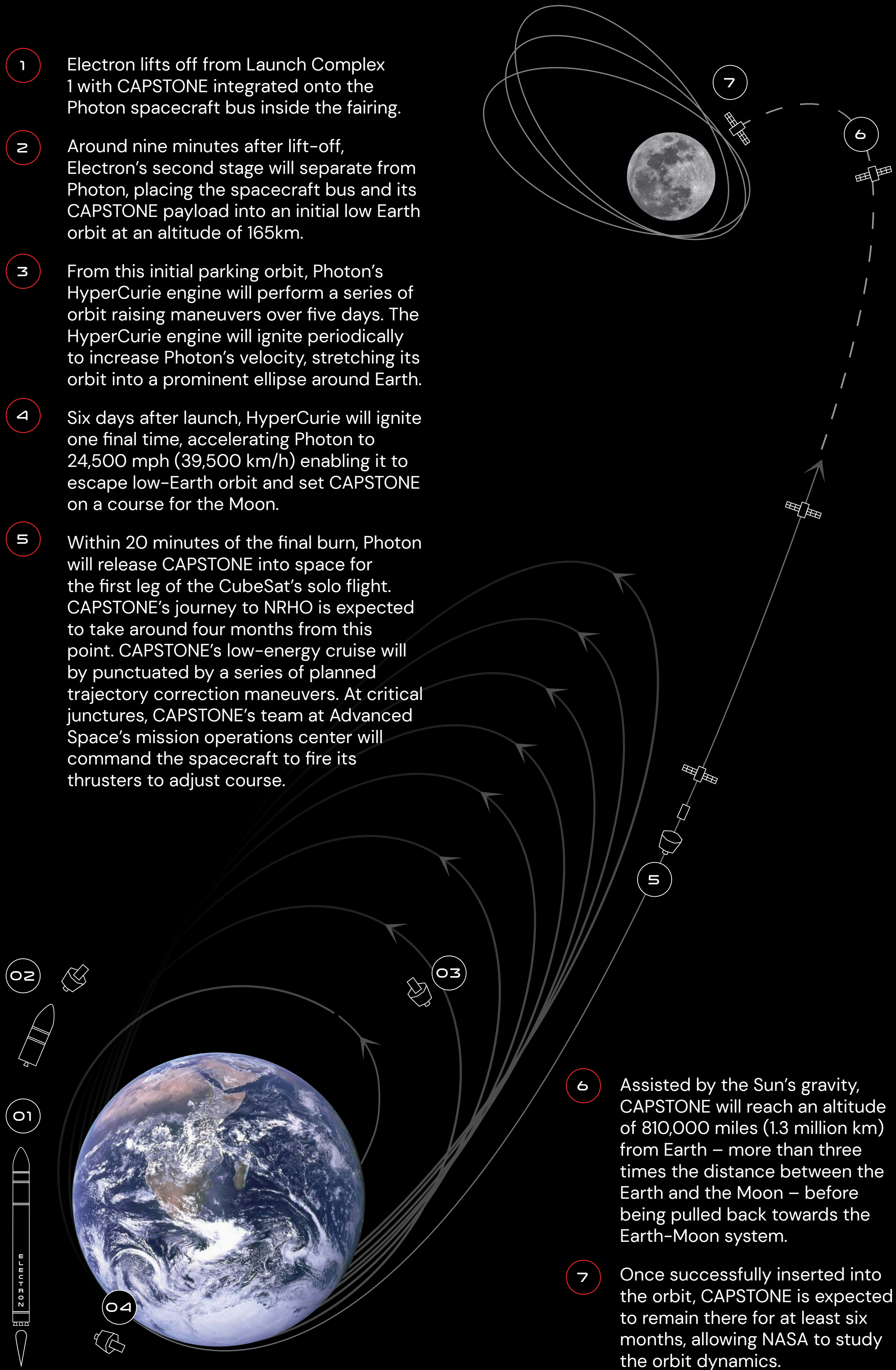
1. Electron lifts off from Launch Complex 1 with CAPSTONE integrated onto the Photon spacecraft bus inside the fairing.

2. Around nine minutes after lift-off, Electron's second stage will separate from Photon, placing the spacecraft bus and its CAPSTONE payload into an initial low Earth orbit at an altitude of 165km.

3. From this initial parking orbit, Photon's HyperCurie engine will perform a series of orbit raising maneuvers over five days. The HyperCurie engine will ignite periodically to increase Photon's velocity, stretching its orbit into a prominent ellipse around Earth.

4. Six days after launch, HyperCurie will ignite one final time, accelerating Photon to 24,500 mph (39,500 km/h) enabling it to escape low-Earth orbit and set CAPSTONE on a course for the Moon.

5. Within 20 minutes of the final burn, Photon will release CAPSTONE into space for the first leg of the CubeSat's solo flight. CAPSTONE's journey to NRHO is expected to take around four months from this point. CAPSTONE's low-energy cruise will by punctuated by a series of planned trajectory correction maneuvers. At critical junctures, CAPSTONE's team at Advanced Space's mission operations center will command the spacecraft to fire its thrusters to adjust course.



6. Assisted by the Sun's gravity, CAPSTONE will reach an altitude of 810,000 miles (1.3 million km) from Earth – more than three times the distance between the Earth and the Moon – before being pulled back towards the Earth-Moon system.

7. Once successfully inserted into the orbit, CAPSTONE is expected to remain there for at least six months, allowing NASA to study the orbit dynamics.

MORE ABOUT CAPSTONE

Visualize CAPSTONE's Flight in Real Time

NASA invites the public to follow CAPSTONE's journey live using NASA's Eyes on the Solar System interactive real-time 3D data visualization. Starting about one week after launch and throughout CAPSTONE's mission, you can virtually ride along with the CubeSat with NASA's Eyes.

The simulated view of our solar system runs on real data in the app. The positions of solar system objects – planets, moons and spacecraft – are shown where they are right now. This visualization is a mobile-friendly version of NASA's Eyes software that runs directly through a web browsers.

Learn More About CAPSTONE:

NASA.gov/capstone

CAPSTONE Charts a New Path for NASA's Moon-Orbiting Space Station | NASA

NASA — CAPSTONE: Testing a Path to the Moon (tumblr.com)

MISSION PARTNERS

NASA

NASA: CAPSTONE's development is supported by the Space Technology Mission Directorate via the Small Spacecraft Technology and Small Business Innovation Research programs at NASA's Ames Research Center in California's Silicon Valley. The Artemis Campaign Development Division within NASA's Exploration Systems Development Mission Directorate supports the launch and mission operations. NASA's Launch Services Program at Kennedy Space Center in Florida is responsible for launch management. NASA's Jet Propulsion Laboratory supported the communication, tracking, and telemetry downlink via NASA's Deep Space Network, Iris radio design and groundbreaking 1-way navigation algorithms.

Tyvak Nano-Satellite Systems, Inc., a Terran Orbital Corporation: Spacecraft design, development and implementation, hardware manufacturing, assembly, testing and mission operations support.

Orion Space Solutions (formerly Astra): Chip Scale Atomic Clock (CSAC) hardware provider necessary for the 1-way ranging experiment.

Rocket Lab USA, Inc.: Launch provider launching CAPSTONE on the Electron launch vehicle and Photon spacecraft bus.

Advanced Space: Owner and operator of the CAPSTONE mission. Developers of the proprietary CAPS, Cislunar Autonomous Positioning System, technology being demonstrated using peer-to-peer navigation.

Stellar Exploration: Propulsion subsystem provider.

Space Dynamics Lab (SDL): Iris radio and navigation firmware provider.

Tethers Unlimited, Inc.: Cross Link radio provider.

The mission is also supported by Space Exploration Engineering (mission design and flight dynamics expertise), Swedish Space Corporation (ground station support), and KSAT (ground station support).

LAUNCH VEHICLE: ELECTRON

OVERALL

LENGTH
18m

DIAMETER (MAX)
1.2m

STAGES
2 + Photon Lunar

VEHICLE MASS (LIFT-OFF)
13,000kg

MATERIAL/STRUCTURE
Carbon Fiber Composite/Monocoque

PROPELLANT
LOX/Kerosene

PAYLOAD

NOMINAL PAYLOAD
200kg / 440lbm To 500km SSO

FAIRING DIAMETER
1.2m

FAIRING HEIGHT
2.5m

FAIRING SEP SYSTEM
Pneumatic Unlocking, Springs

STAGE 2

PROPULSION
1x Rutherford Vacuum Engine

THRUST
5800 LBF Vacuum

ISP
343 Sec

INTERSTAGE

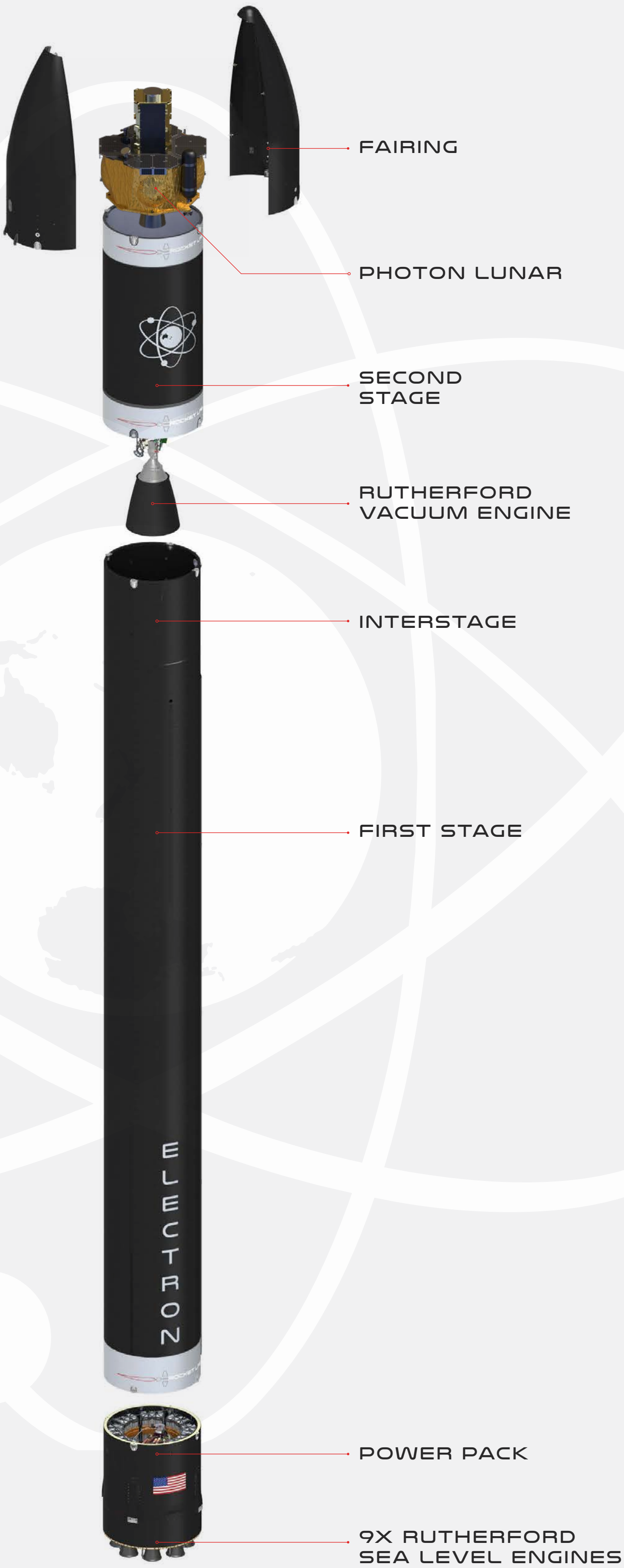
SEPARATION SYSTEM
Pneumatic Pusher

STAGE 1

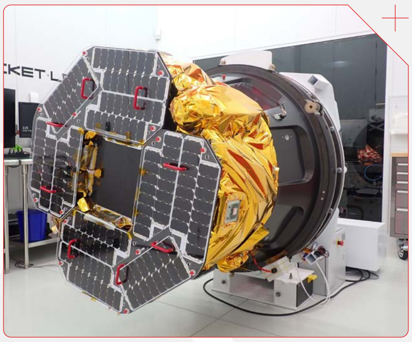
PROPULSION
9x Rutherford Sea Level Engines

THRUST
5600 LBF Sea Level (Per Engine)

ISP
311 Sec

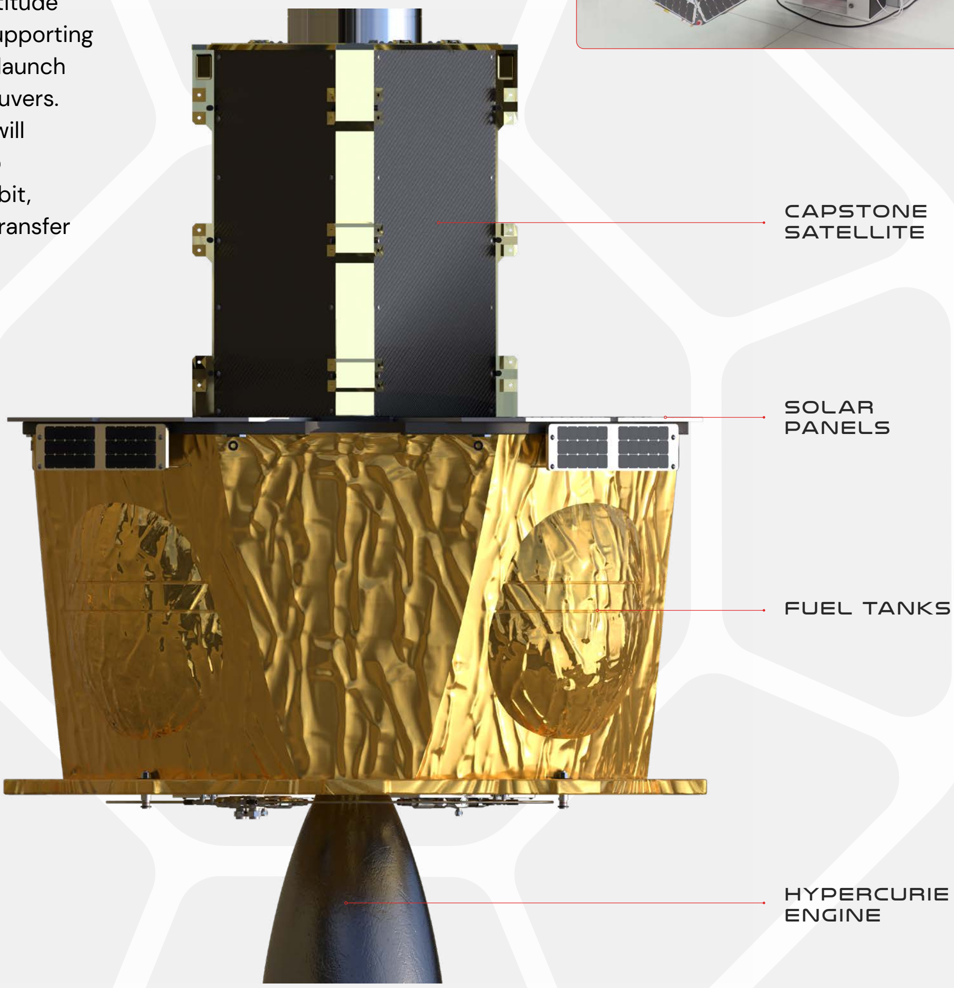


SPACECRAFT: PHOTON



After Electron launches CAPSTONE to an initial low Earth orbit, the Photon spacecraft bus takes over.

CAPSTONE will be integrated onto Photon, a highly capable spacecraft based on the heritage Electron Kick Stage. Photon provides in-space propulsion, communications, power, and high-accuracy attitude determination and control, supporting CAPSTONE for six days after launch during the orbit raising maneuvers. Photon's HyperCurie engine will provide the final push to help CAPSTONE escape Earth's orbit, setting it on a ballistic lunar transfer to achieve the NRHO.



OVERALL

Photon Lunar Dry Mass
55kg / 121 lbs

Vol/Dimension
1.4 m x 1.1 m x 1.0 m

Propulsion
Bipropellant, pump-fed
3D printed HyperCurie engine,
>3.2 km/sec delta-V

VIEWING A LAUNCH ONLINE

LIVE STREAM LINKS

The livestream is viewable at:

[rocketlabusa.com/live-stream]

Webcast will be live approx. T-20 minutes

LAUNCH FOOTAGE & IMAGES

Images and footage of the 'CAPSTONE' launch will be available shortly after a successful mission at:

rocketlabusa.com/about-us/updates/link-to-rocket-lab-imagery-and-video

flickr.com/photos/rocketlab

UPDATES

For information on launch day visit:

rocketlabusa.com/next-mission

FOLLOW ROCKET LAB

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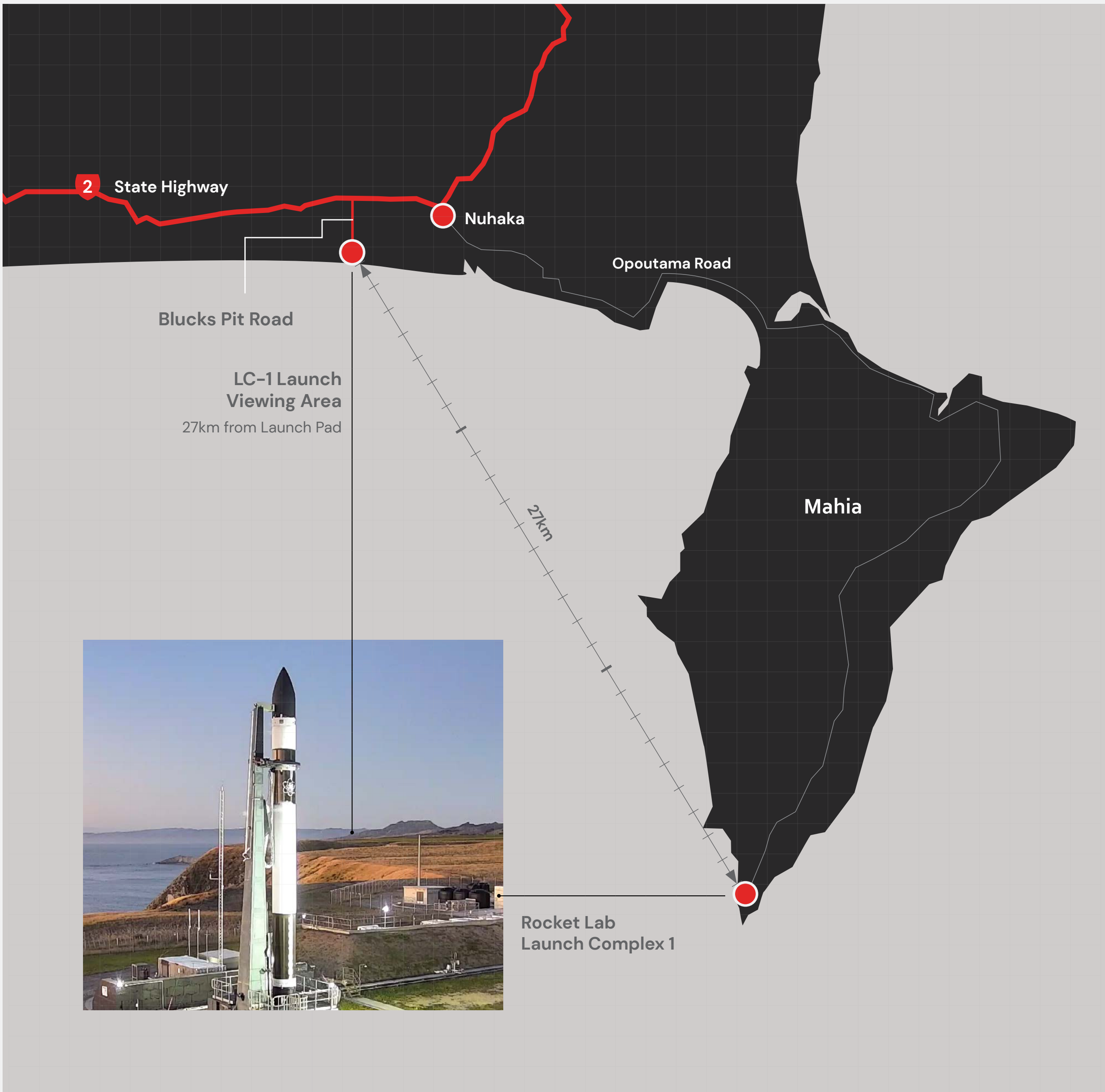
VIEWING A LAUNCH IN PERSON

LOCATION

Wairoa District Council has allocated a rocket launch viewing area for the public near Nuhaka, accessible via Blucks Pit Road. Scrubs and postponements are likely during launch windows, so visitors to the Blucks Pit viewing site should anticipate multiple postponements, sometimes across several days.

MORE INFORMATION VISIT

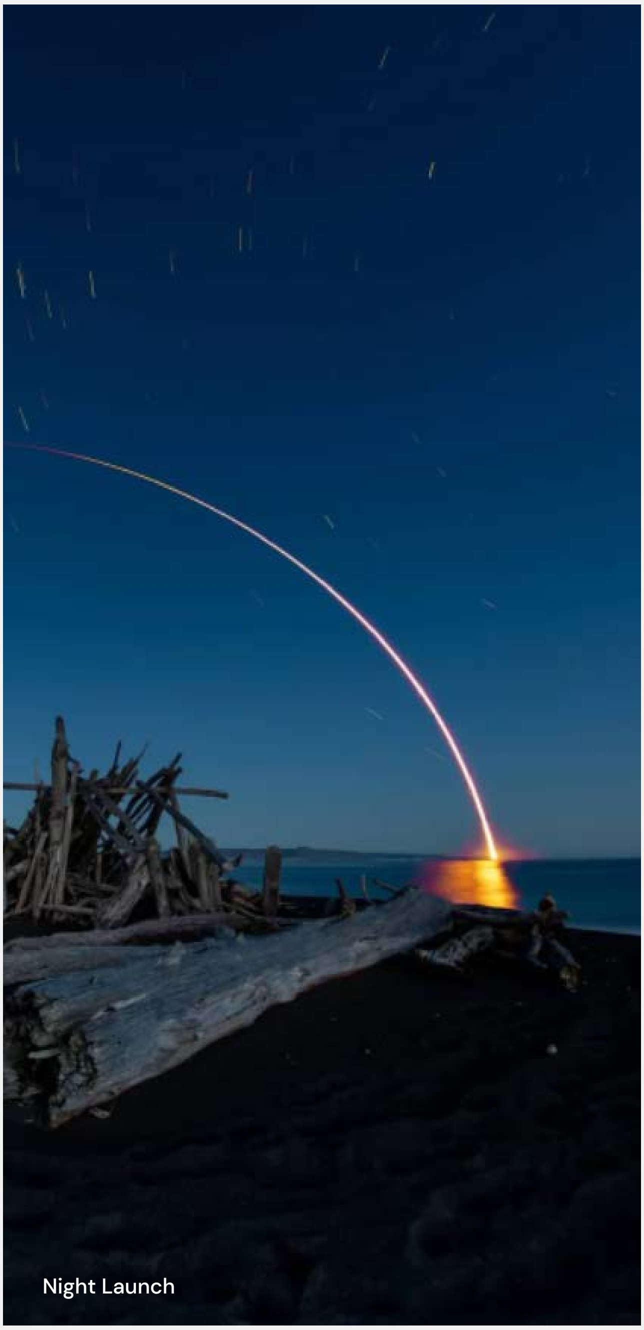
visitwairoa.co.nz/welcome-to-wairoa/space-coast-new-zealand



VIEWING A LAUNCH IN PERSON

Watching launch from Blucks Pit, you can expect launch views similar to the examples below.

Credit Joseph Baxter.

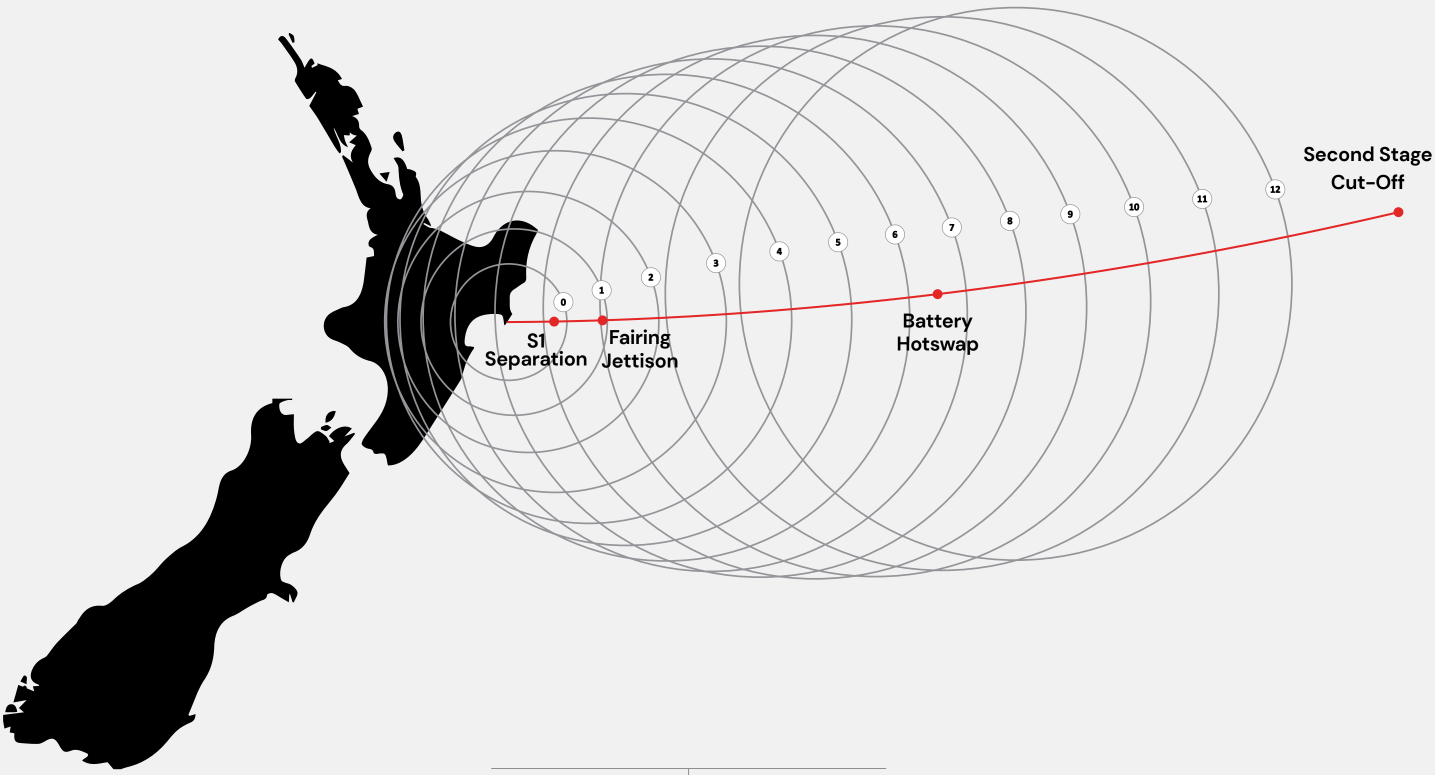


Night Launch

Day Launch

LAUNCH VISIBILITY MAP

WHEN AND WHERE TO SPOT THE LAUNCH



Marker	Mission Time
1	T+ 01:00
2	T+ 01:30
3	T+ 02:00
4	T+ 02:30
5	T+ 03:00
6	T+ 03:30
7	T+ 04:00
8	T+ 04:30
9	T+ 05:00
10	T+ 05:30
11	T+ 06:00
12	T+ 06:30
13	T+ 07:00

Note:
Visibility within circle specified by mission time

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