ORBITBeyond

#ThinkingTomorrow

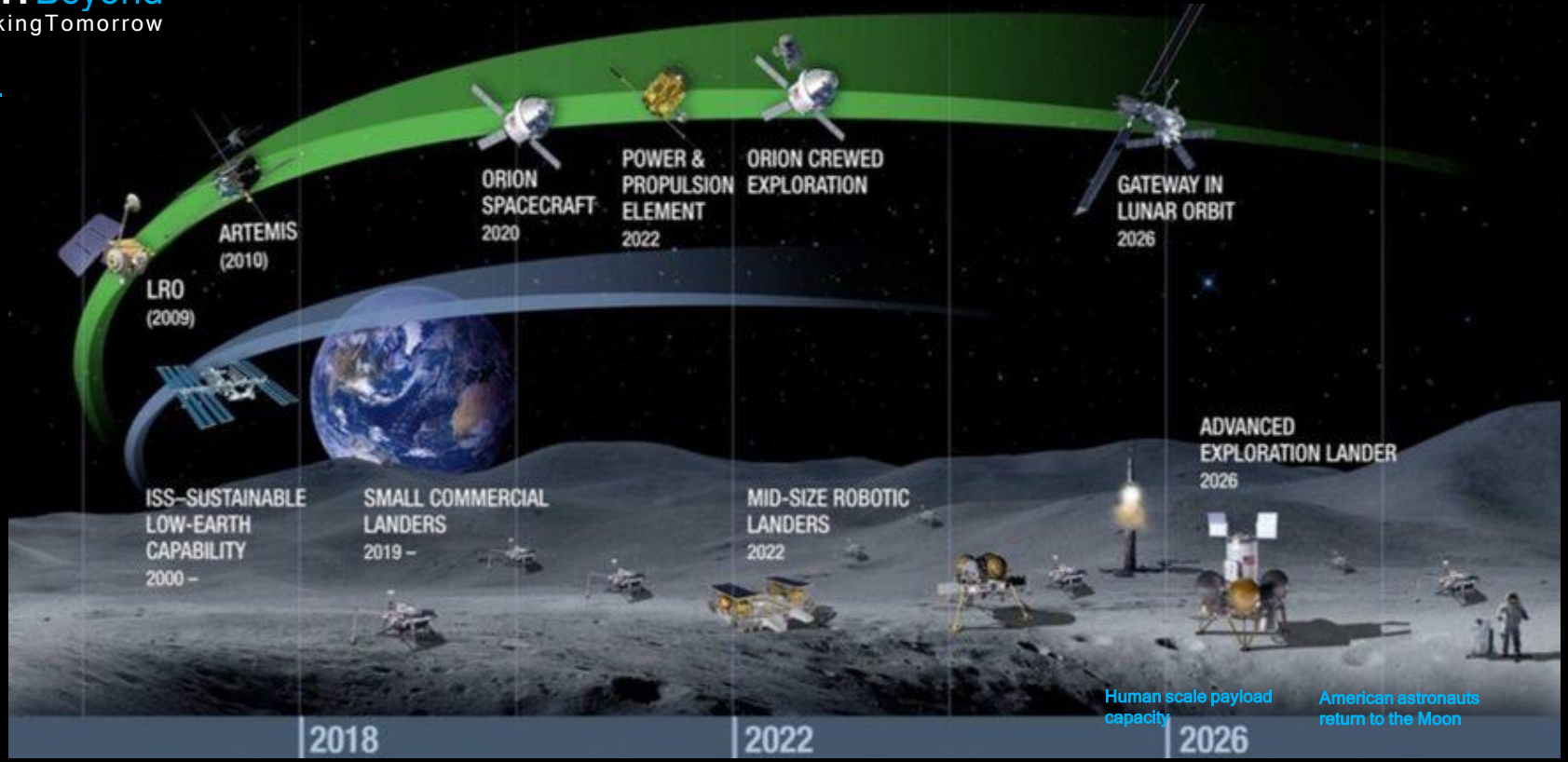
Supporting space exploration through

- low-cost
- reliable
- frequent

access to the cis-lunar ecosystem
(lunar orbit, lunar surface)

Presentation to: Space Resources Roundtable 2019
Colorado School of Mines, Golden, CO
June 12, 2019

by Dr. Jon Morse
Chief Science Officer



** Image courtesy NASA Image archives

MOTIVATION

NASA’s MOON2MARS FY20 PBR ROADMAP

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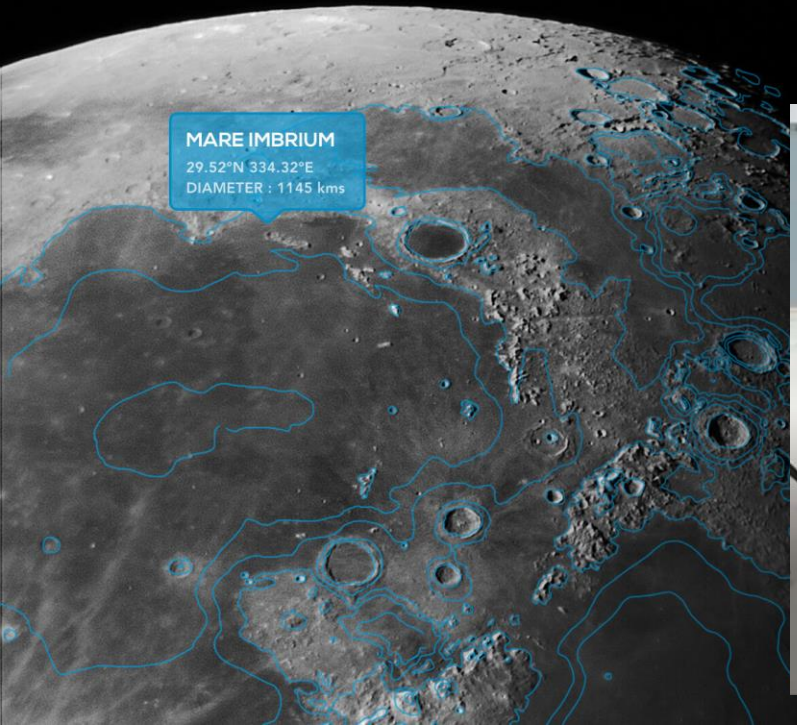
Z-01 Lander Mission

- Launch: Targeting Q3 2020
- 40 kg capacity to lunar surface
- Possible capacity to lunar orbit



CLPS Lander announcement at GSFC – 5/31/19

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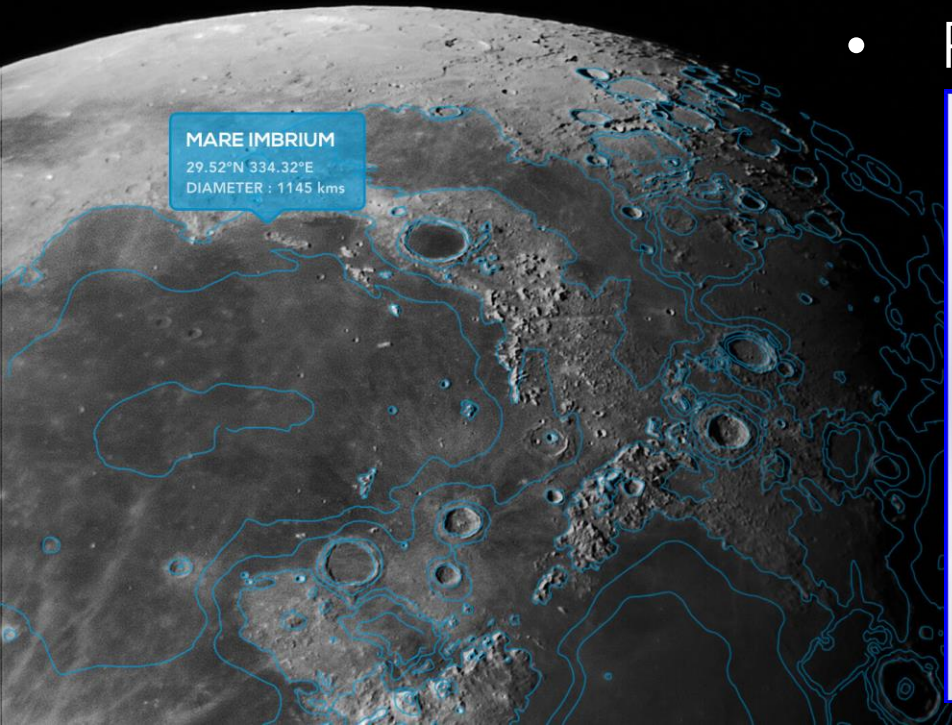

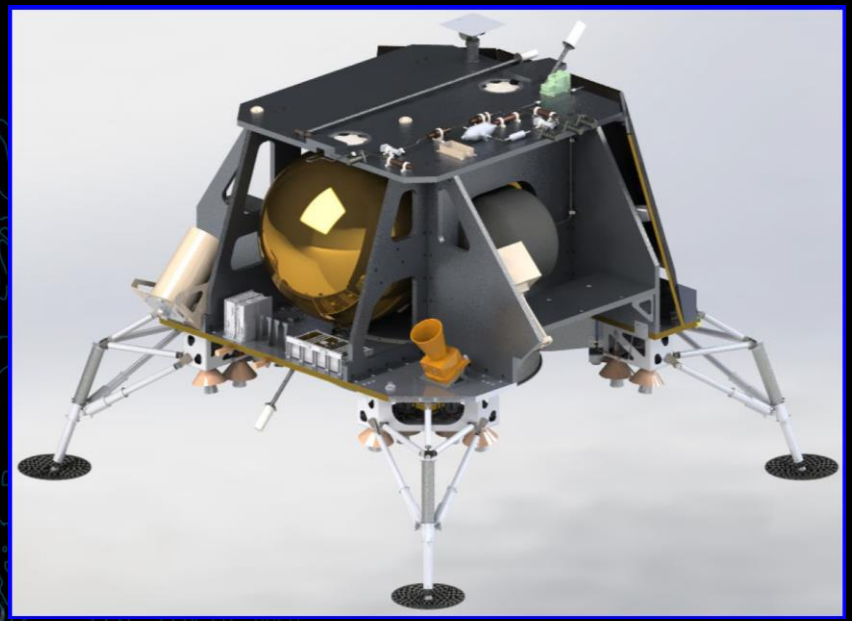

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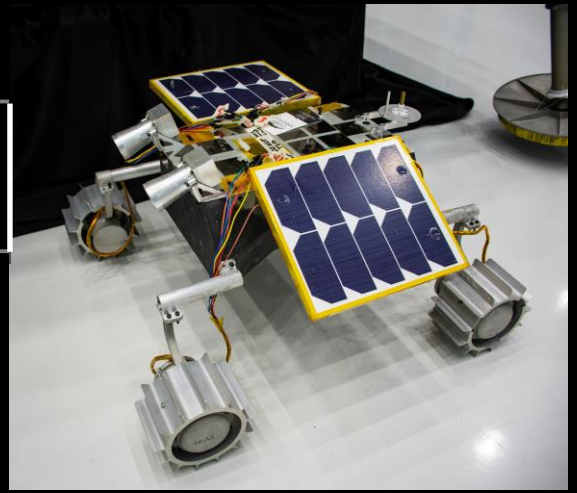
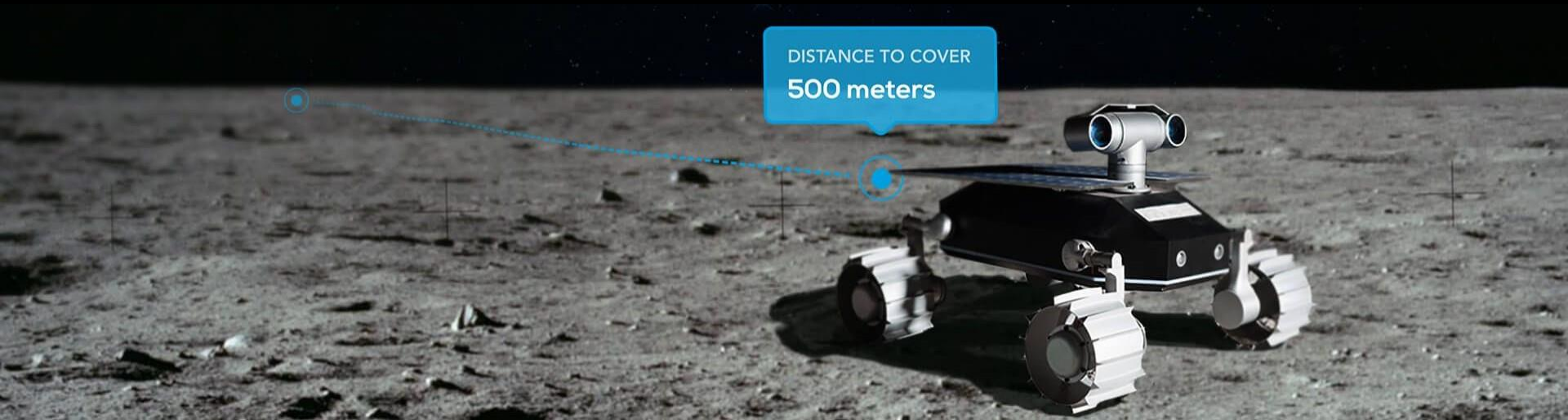
ECA Rover – Surface Mobility

- ✶ Rover qualification model complete
- ✶ 5 kg payload capacity
- ✶ High-res stereoscopic imaging





Mission decoded

- Trajectories
- Autonomous descent & landing
- Hazard avoidance
- Surface operations

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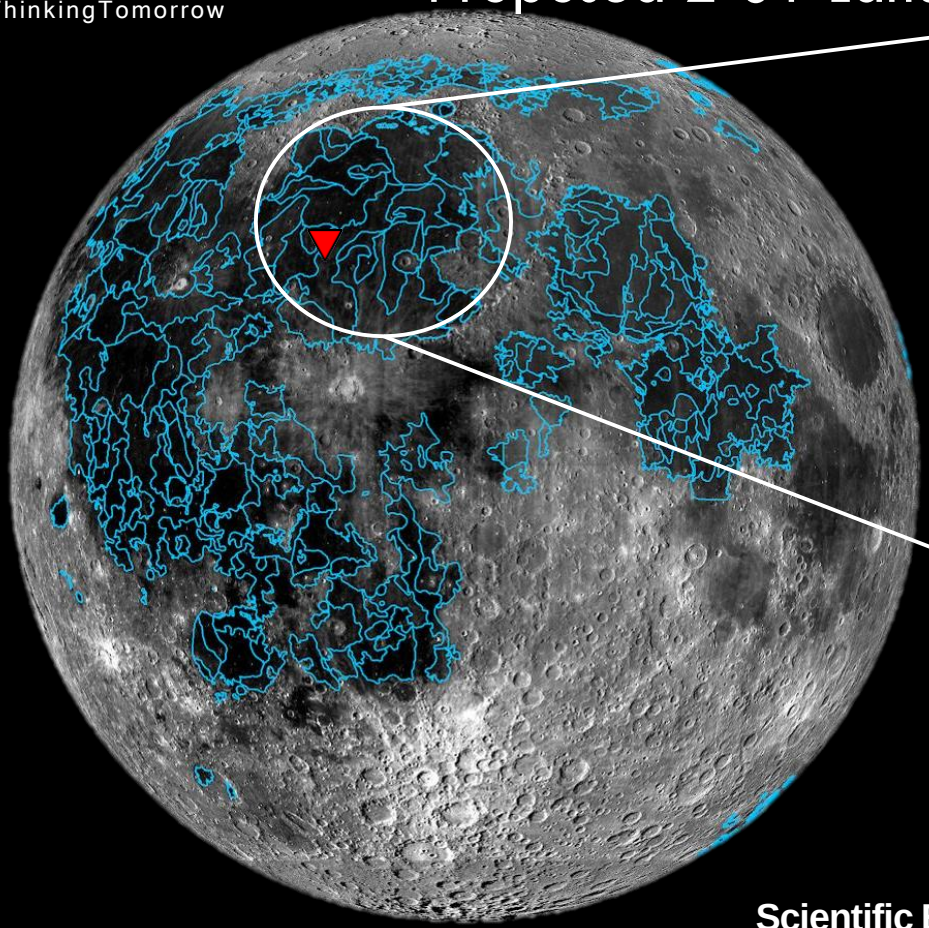
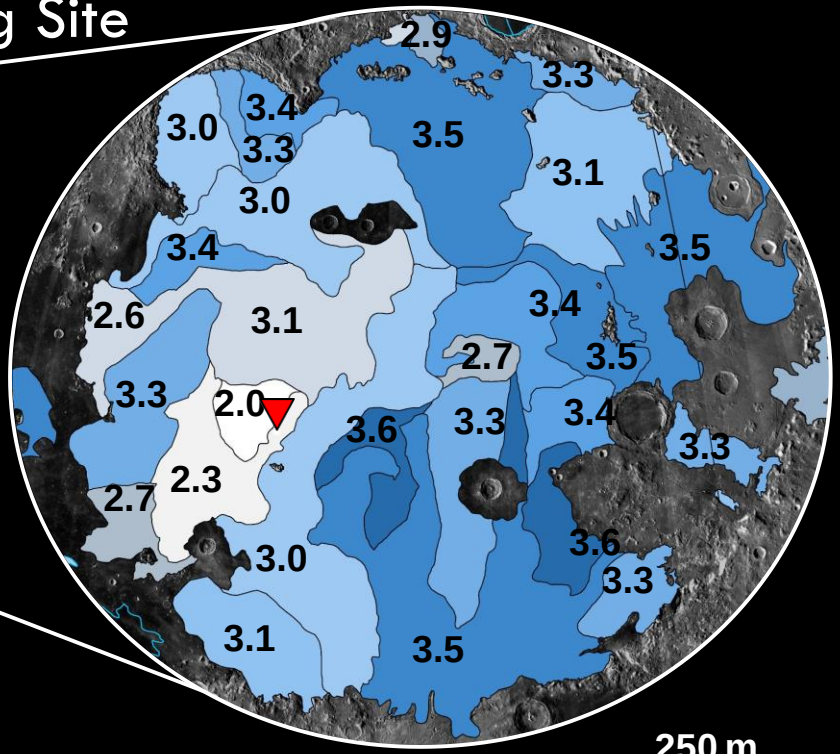
Proposed Z-01 Landing Site





Mare ages (Ga)

250 m

Landing point
29.5212°N, -25.6801°E

Mare outlines (*Hiesinger et al., 2010*)

Scientific Exploration of Mare Imbrium

Exploration of **Mare Imbrium** can improve our understanding of

1. The generation, ascent, and eruption of magma on the Moon
2. Thermal evolution of the Moon
3. Regional geologic variations

KEY SCIENTIFIC OBJECTIVES

- Characterize the sequence of flows.
- Characterize the properties of erupted magma through time.
- Characterize extent, topography, and geometry of the flows.

Landing Site Analysis & Design Reference Mission by Prof. Jim Head and students (Brown Univ)

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KEY SCIENTIFIC OBJECTIVES

- Measure distribution, shape, and size of vesicles.
- Constrain texture and grain size of solidified lavas.
- Measure differences in tonality within the visible spectrum

Apollo 15 "seatbelt basalt" 15016

Exploration of **Mare Imbrium** can improve our understanding of

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KEY SCIENTIFIC OBJECTIVES

- Analyze how lunar regolith changes through time as it is exposed to the space environment.
- Characterize physical properties of the regolith.
- Study meteorite bombardment environment.
- Compare geologic observations at the landing site with nearby heritage sites.

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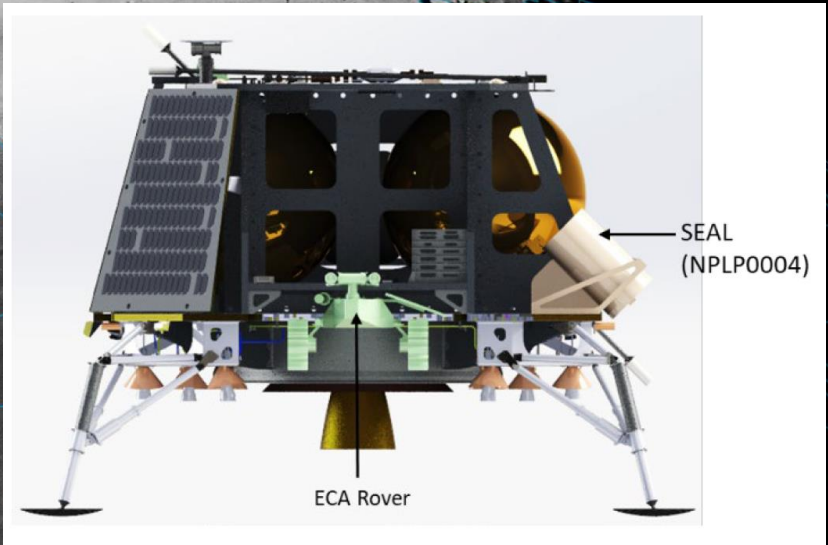
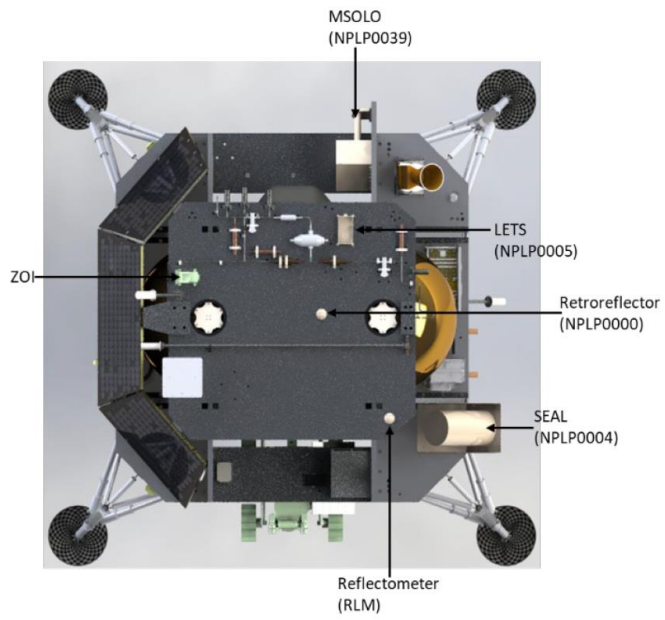
Z-01 Lander Mission

- Proposed Payloads





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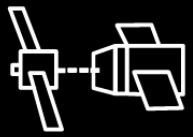
ROADMAP

2020

Versatile Landers



Autonomous Rendezvous

Lunar ISRU

Mars

2025

2030

Z-01 Heritage Flight

Advanced Mobile Platform

Sample Return

Asteroids

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Join the Journey

+ PARTNERS

Advanced SPACE

Axiom Research Labs

AGILE SPACE PROPULSION

HONEYBEE ROBOTICS

ceres robotics

ALTIUS

ils Integrated Launch Solutions