

TAKING SILICON VALLEY TO THE MOON

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Vice President Announces Human Return to the Moon by 2024

Vice President Mike Pence, chair of the National Space Council, on March 26, 2018, called for a landing of American astronauts at the south pole of the Moon by 2024.

“We need to clearly articulate the reasons for going to the Moon, so Congress and the public will embrace this goal,” Burns told the council, also emphasizing that adequate funding to NASA will be critical to meeting the ambitious agenda set by the White House.



Why Go to the Moon?

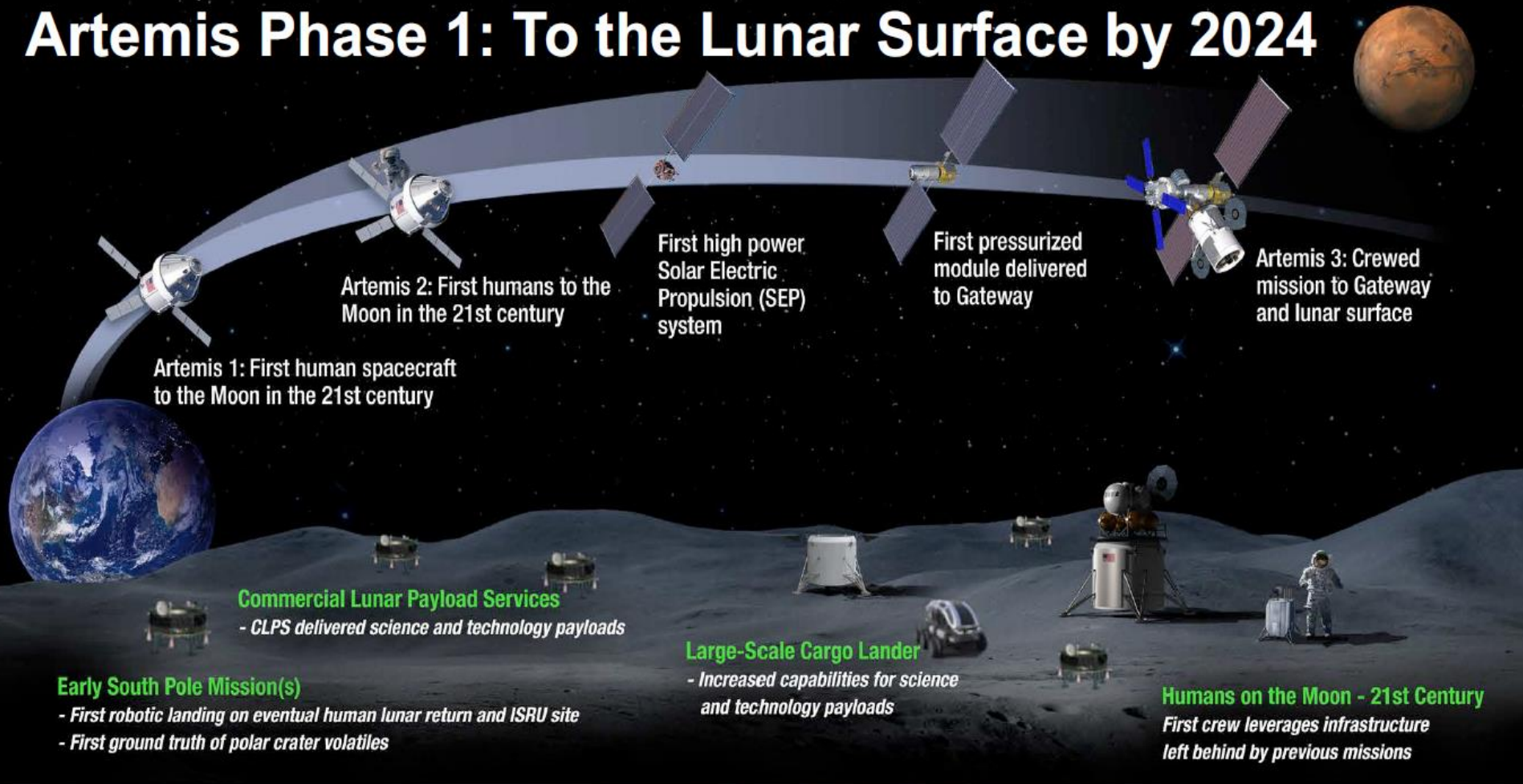


- Establishes American leadership and strategic presence
- Proves technologies and capabilities for sending humans to Mars
- Inspires a new generation and encourages careers in STEM
- Leads civilization changing science and technology
- Expands the U.S. global economic impact
- Broadens U.S. industry & international partnerships in deep space



NASA's Human Mission to the Moon: Project Artemis

Artemis Phase 1: To the Lunar Surface by 2024



LUNAR SOUTH POLE TARGET SITE

2019

2024

Lunar Science by 2024



Polar Landers and Rovers

- First direct measurement of polar volatiles, improving understanding of lateral and vertical distribution, physical state, and chemical composition
- Provide geology of the South-Pole Aitken basin, largest impact in the solar system

Non-Polar Landers and Rovers

- Explore scientifically valuable terrains not investigated by Apollo, including landing at a lunar swirl and making first surface magnetic measurement
- Using PI-led instruments to generate Discovery-class science, like establishing a geophysical network and visiting a lunar volcanic region to understand volcanic evolution

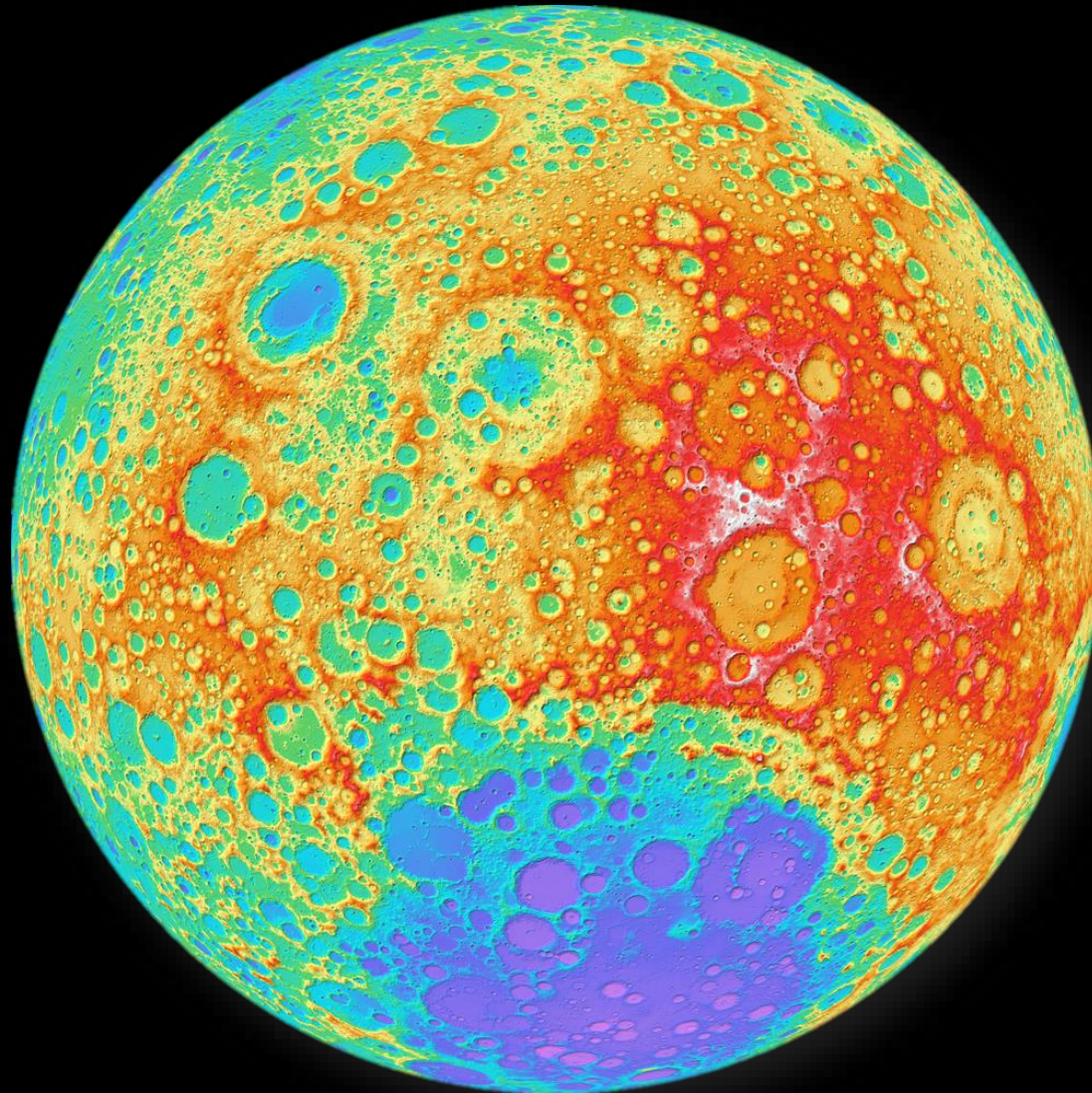
Orbital Data

- Deploy multiple CubeSats with Artemis 1
- Potential to acquire new scientifically valuable datasets through CubeSats delivered by CLPS providers or comm/relay spacecraft
- Global mineral mapping, including resource identification, global elemental maps, and improved volatile mapping
- Low Radio Frequency Observations using SmallSat (DAPPER)

In-Situ Resource Initial Research

- Answering questions on composition and ability to use lunar ice for sustainment and fuel

We also need to explore & discover on the Lunar Farside



DAPPER

The **D**ark **A**ges **P**olarimeter **P**athfinder**E**R



Principal Investigator:

Dr. Jack Burns, University of Colorado Boulder

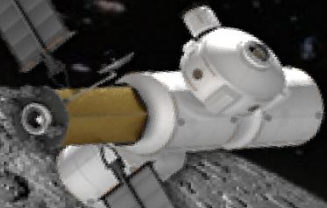
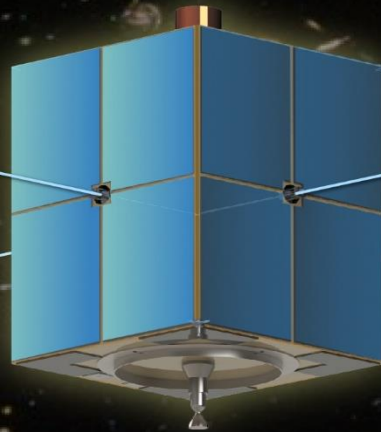
Co-Investigators:

Dr. Stuart Bale, University of California at Berkeley

Dr. Richard Bradley, National Radio Astronomy Observatory

NASA Lead Center:

NASA Ames Research Center



SCIENCE

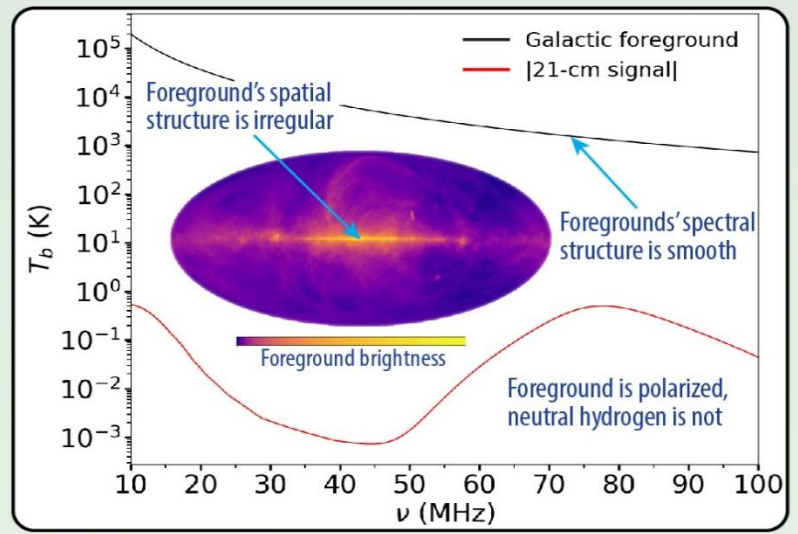
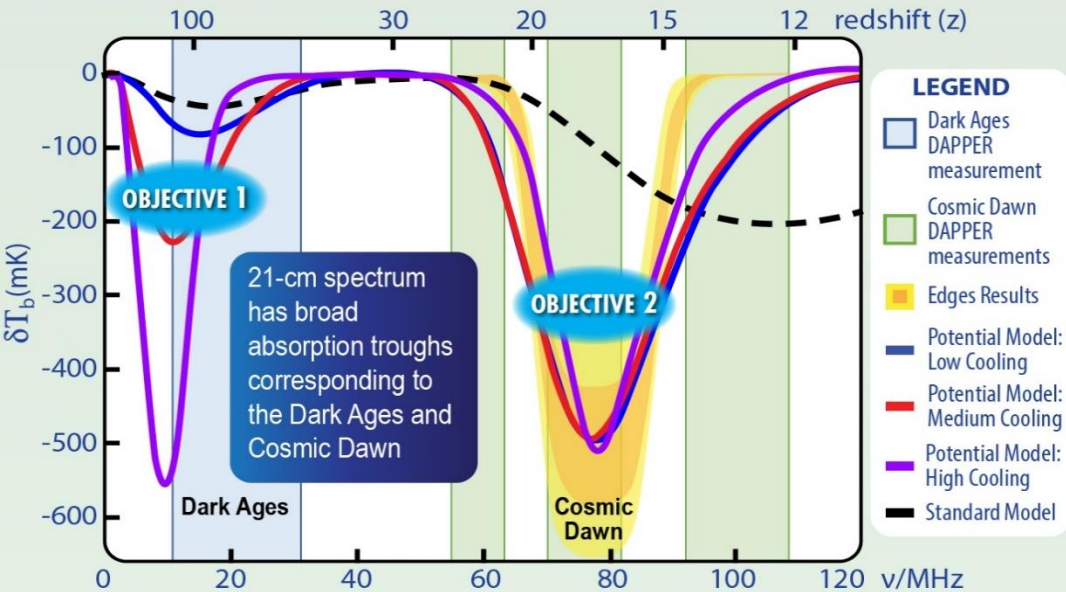
OBJECTIVE 1:

- Determine the level of (dis)agreement with the standard cosmological model caused by dark matter in the Dark Ages.

OBJECTIVE 2:

- Determine the level of excess cooling above the adiabatic limit for Cosmic Dawn.
- Determine when the first stars and black holes formed.

Will the observed behavior of redshifted neutral hydrogen redefine the standard cosmological model?



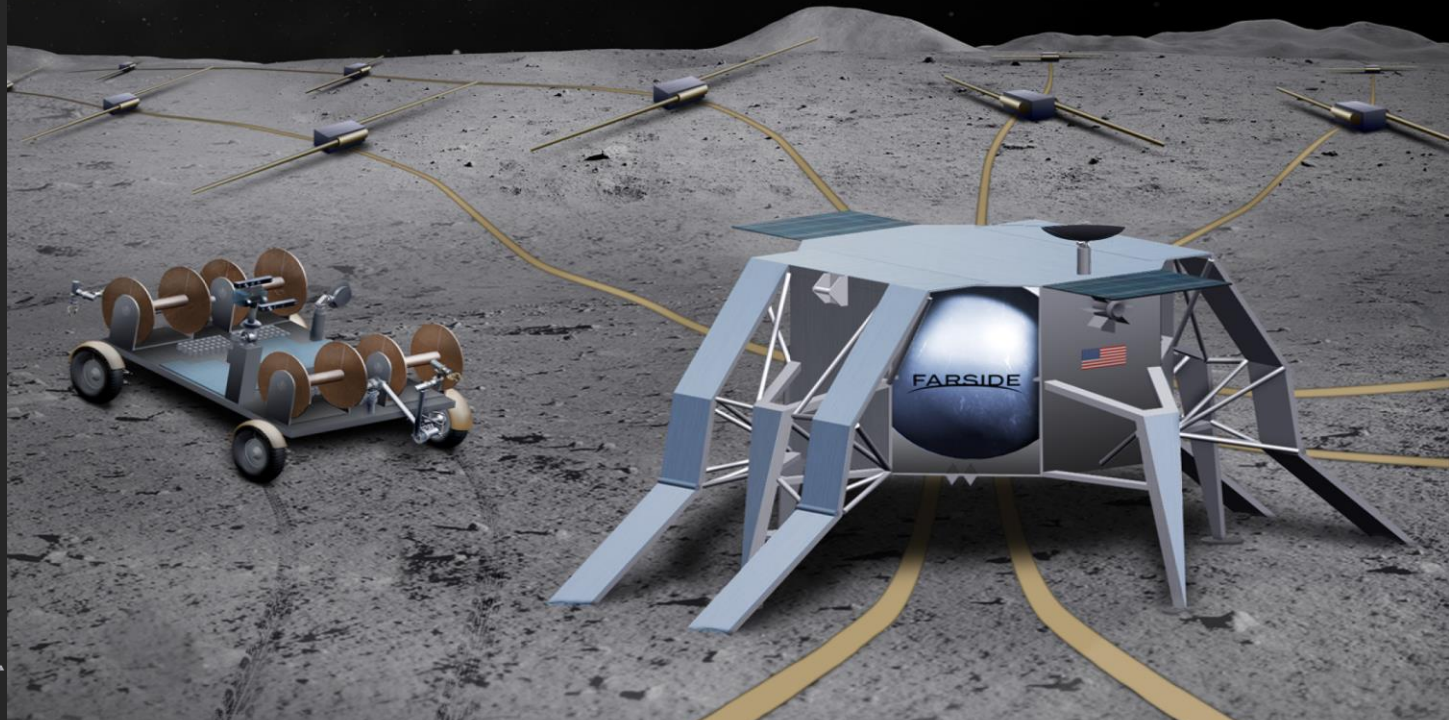
DAPPER uses the 21-cm all-sky signal to observe redshifts $z = 83-12$, associated with the Dark Ages and the Cosmic Dawn.

DAPPER separates Galaxy foreground from 21-cm signal using differences in spectral shapes, spatial structure, and polarization.

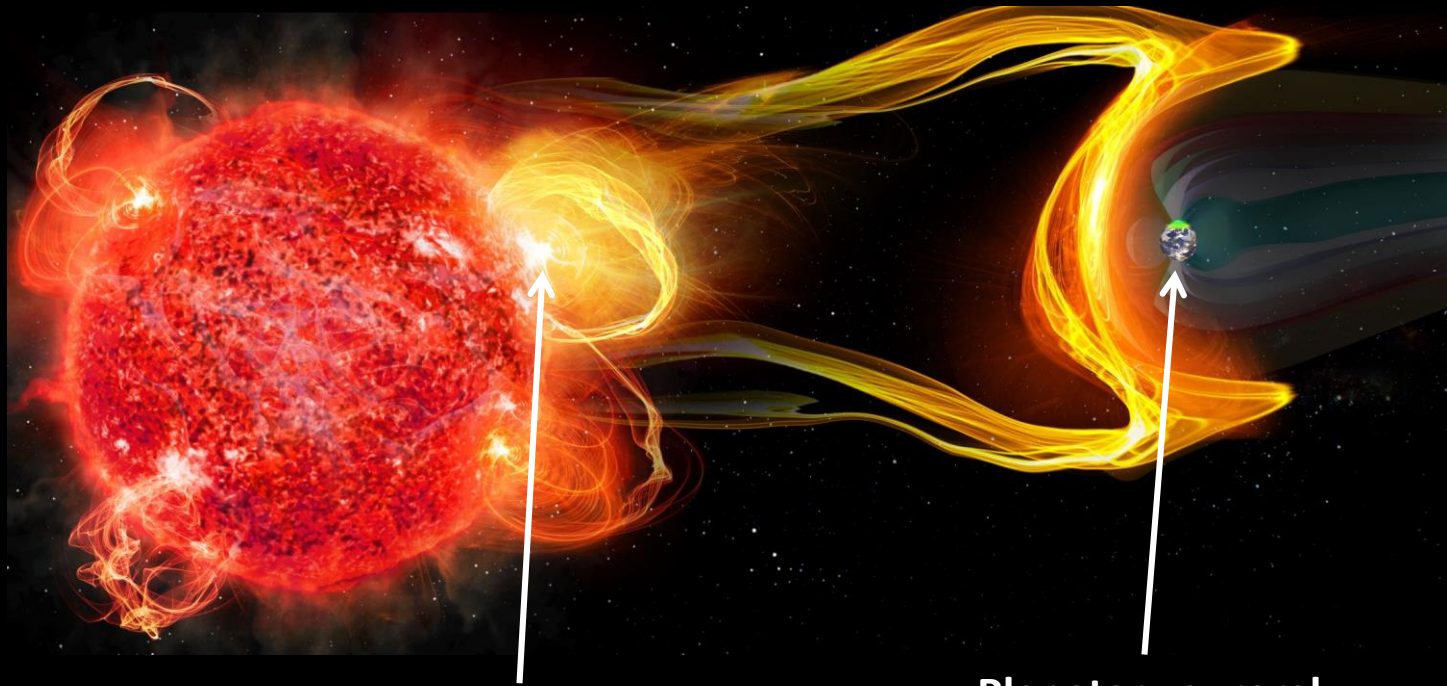
Jack Burns, U. Colorado, P.I.
Gregg Hallinan, Caltech, Co-PI
JPL, lead organization

FARSIDE

Farside Array for Radio Science Investigations
of the Dark Ages and Exoplanets



Low Radio Frequency Emission

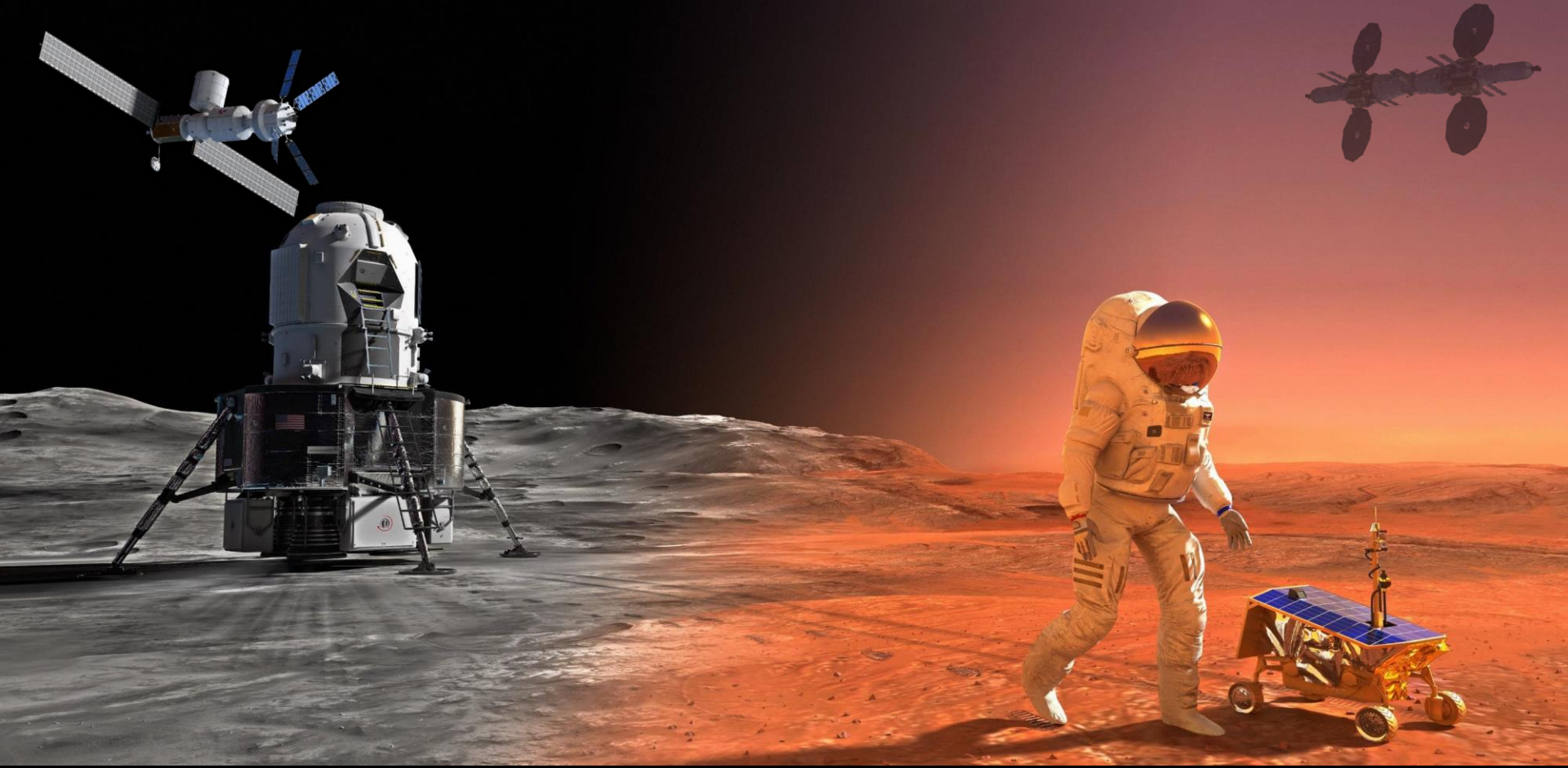


Type III radio
emission associated
with CMEs

Planetary auroral
radio emission

The Path to Mars...

...Leads Past the Moon

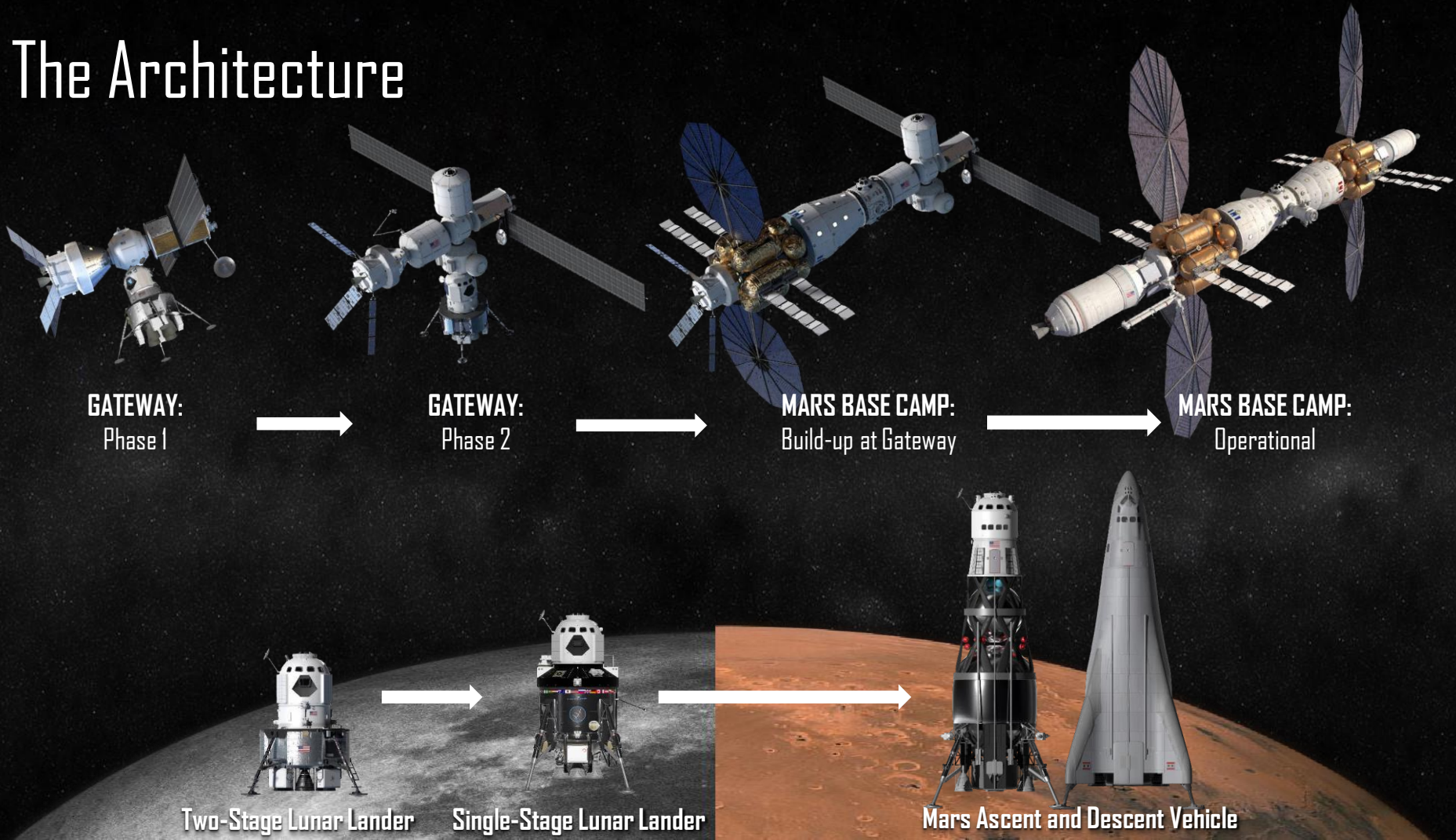




Key Messages

- Artemis systems and operations **directly translate** to Mars human orbital and surface missions
- 2024 lunar landing **is achievable** given appropriate funding and use of existing systems
- 2024 lunar landing is critical to drive **mission cadence** and to focus development on the **specific technologies** required for Mars such as long-duration cryogenic systems
- Inclusion of the **Phase 1 Gateway** in Artemis enables Mars exploration vehicle buildup while simplifying cislunar exploration programmatic and allowing for affordable, reusable systems from the outset

The Architecture





Science

TELEROBOTICS

Real-time robotic exploration

SAMPLE RETURN

Prospecting for resources

HUMAN BIOLOGY

Deep space survival outside Earth's protective magnetic field

FIELD GEOLOGY

Understanding Earth's origins

Gateway

Mars Base Camp

Power Station

CLPS Lander

Prospecting

ISRU Plant

ISRU Rover

Human Lander

Human Lander

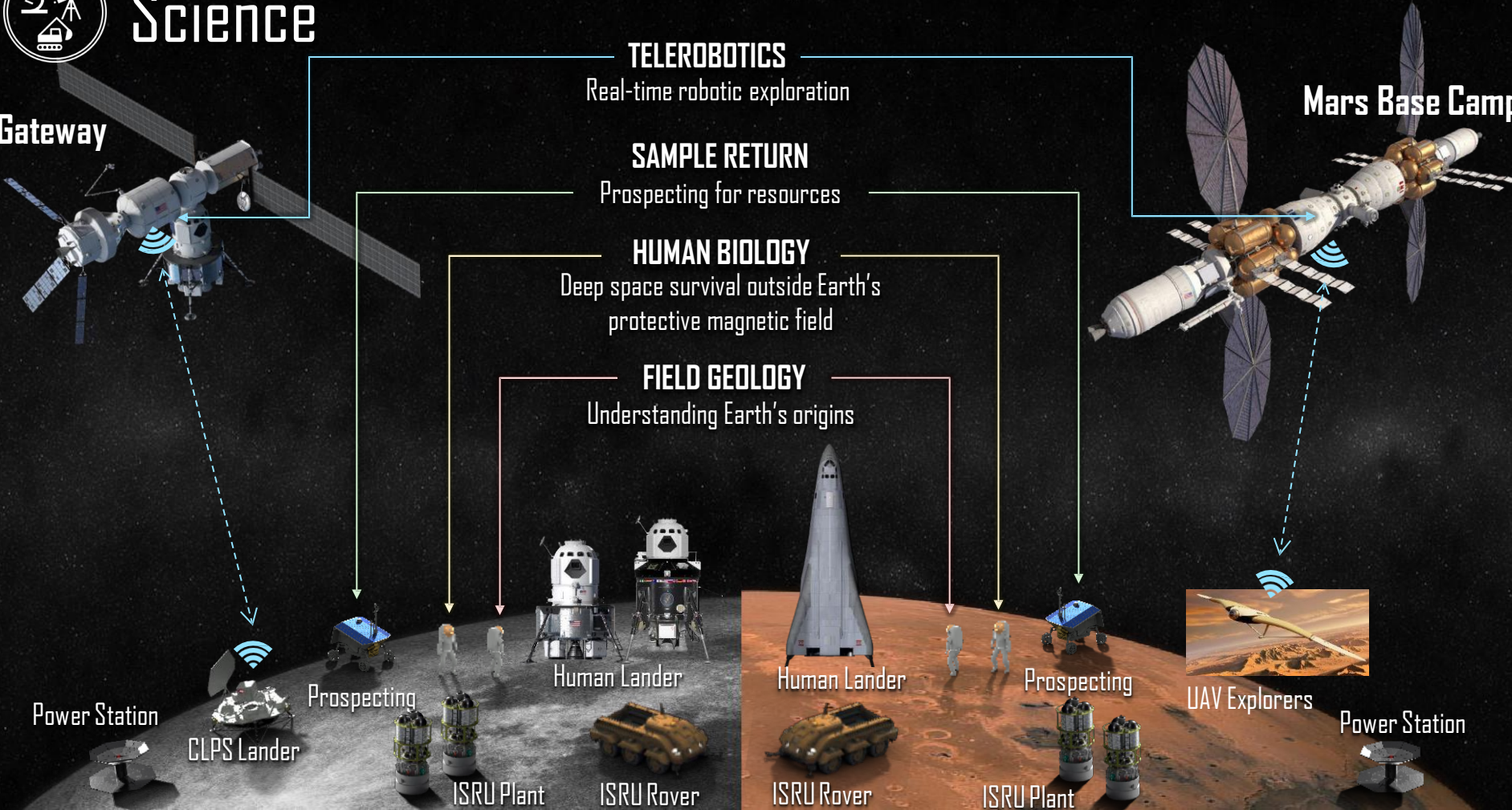
ISRU Rover

Prospecting

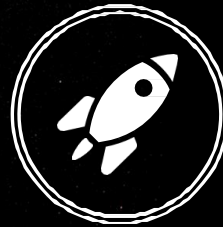
ISRU Plant

UAV Explorers

Power Station



Artemis Enables Mars



Propulsion



Habitability



Infrastructure
and
Operations



Science



Inspiring Future Space Explorers

