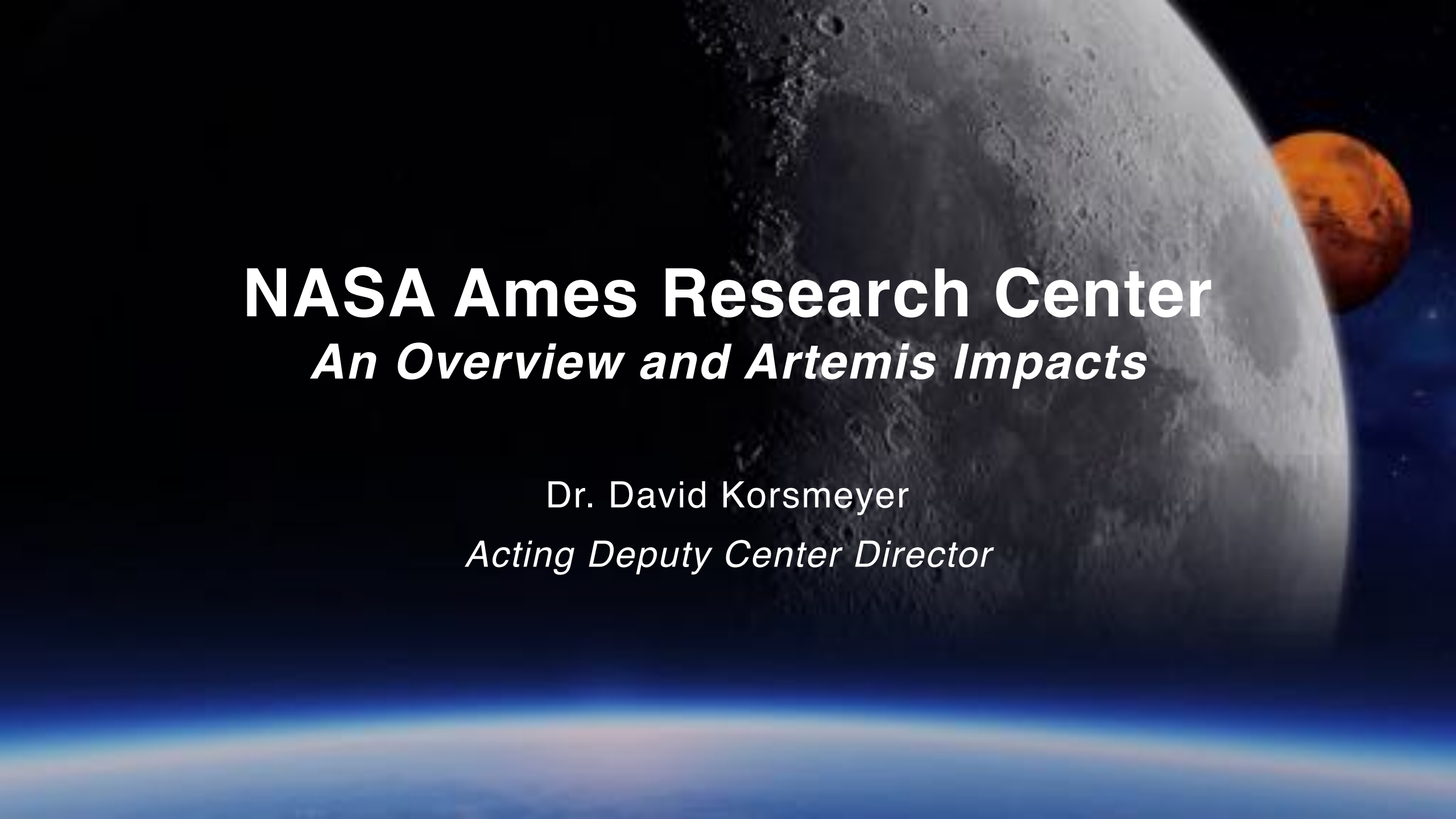


NASA Ames Research Center

An Overview and Artemis Impacts

Dr. David Korsmeyer

Acting Deputy Center Director

NASA Centers

Ames Research Center

Glenn Research Center

HQ

Goddard Space Flight Center

Langley Research Center

Marshall Space Flight Center

Armstrong Flight Research Center

Jet Propulsion Laboratory

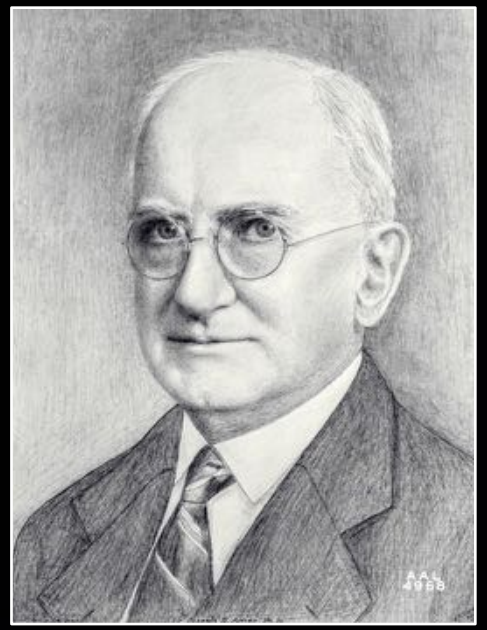
Johnson Space Center

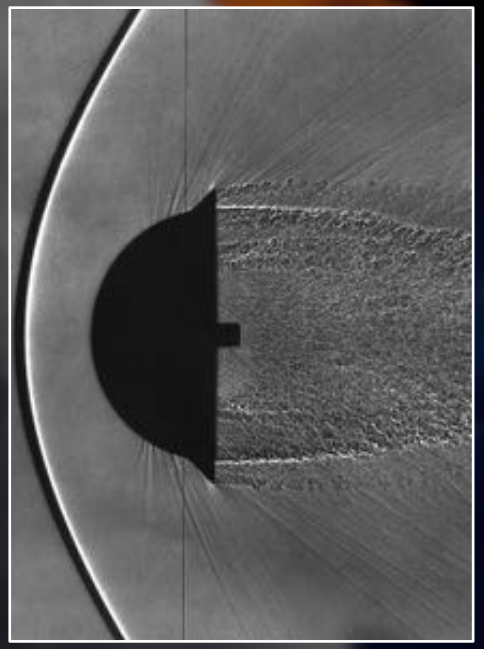
Stennis Space Center

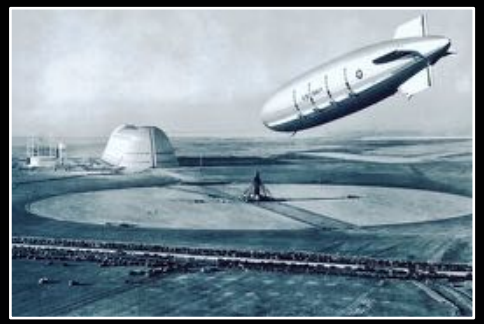
Kennedy Space Center

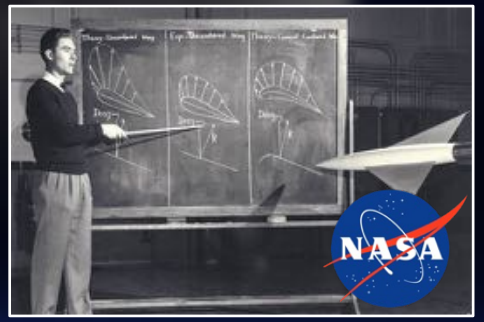
Ames Aeronautical Laboratory

NACA's Second Laboratory









1915 1917 1939 1941 1946 1958

"Langley Memorial Aeronautical Laboratory"
Langley Research Center (LaRC)

"Ames Aeronautical Laboratory"
Ames Research Center (ARC)

"Aircraft Engine Research Laboratory"
Glenn Research Center (GRC)

"Muroc Flight Test Unit"
Armstrong Flight Research Center (AFRC)

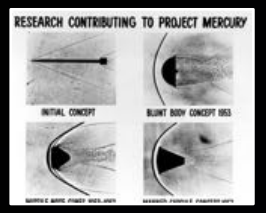
83 Years of Innovation

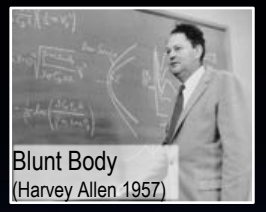

1955


Launch Escape System (1963)

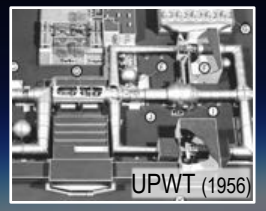

1957


Lifting Body (M2F1 1965)




Blunt Body (Harvey Allen 1957)


Free flight Ablation Test (Apollo Pgm. 1963)


UPWT (1956)


Steerable parachute (1963)

1940 2020

83 Years of Innovation


1955


Launch Escape System (1963)


Pioneer (1972)

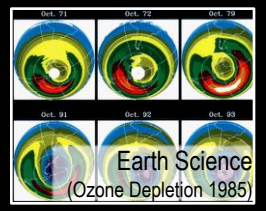

Viking (1975)


Galileo (1989)

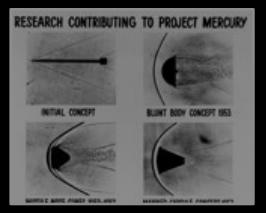

1957


Lifting Body (M2F1 1965)

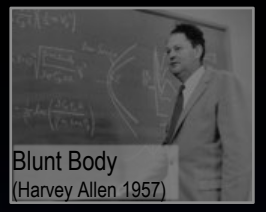

Airborne Science (ER2 1970)


Earth Science (Ozone Depletion 1985)


Earth Science Project Office (1987-)




XV-15 (1980)

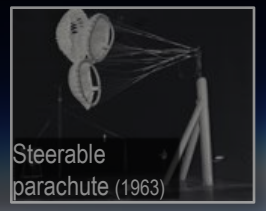

Blunt Body (Harvey Allen 1957)


Free flight Ablation Test (Apollo Pgm. 1963)


Reusable Surface Insulation Lost Tile Test (Shuttle Pgm. 1976)


PICA (1980s)


UPWT (1956)

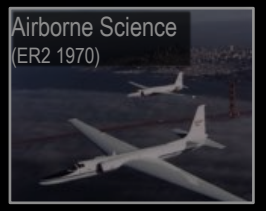

Steerable parachute (1963)

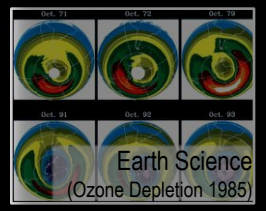

Life Science Research (Cyril Ponnamperuma, 1969)

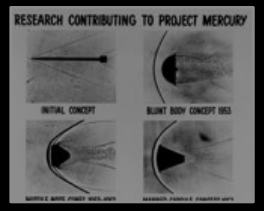

Cray-2 (1987)

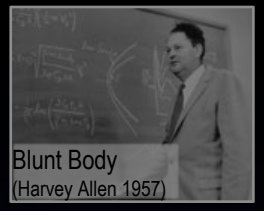
1940 2020

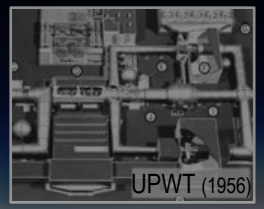
83 Years of Innovation

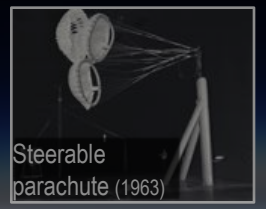


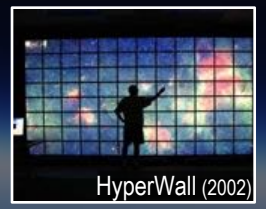


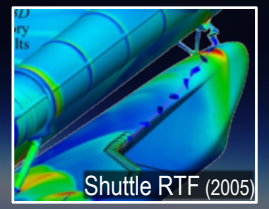












1940 2020

Ames Today

Occupants

- *~1,200 civil servants*
- *~1,900 on-site contractors*
- *~2,500 NRP workforce*
- *~700 summer students in 2019*

FY20 Budget

- *~$1B (includes reimbursable/EUL)*

Real Property

- *~1,900 acres*
- *400 acres security perimeter*
- *5M building ft²*
- *Airfield with ~9,000 and 8,000 ft. runways*

Ames Today (NASA Research Park)

Occupants

~1,200 civil servants
~1,900 on-site contractors
~2,500 NRP workforce
~700 summer students in 2019

FY20 Budget

~$1B (includes reimbursable/EUL)

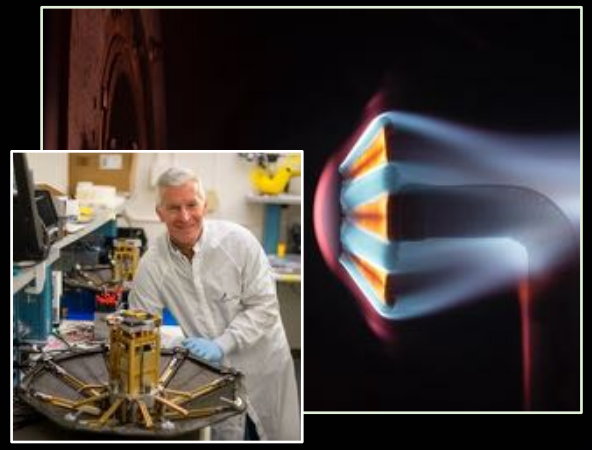
Real Property

~1,900 acres
400 acres security perimeter
5M building ft²
Airfield with ~9,000 and 8,000 ft. runways

Ames Core Competencies

Air Traffic Management

Entry Systems

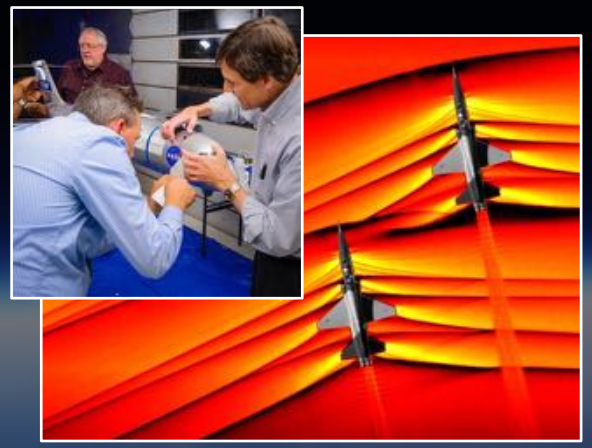


Advanced Computing & IT

Intelligent / Adaptive Systems

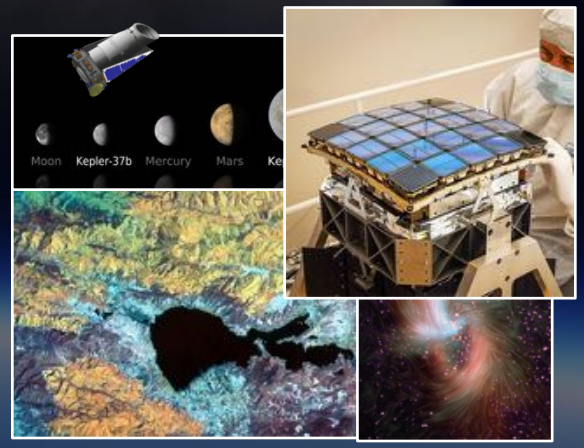
Cost-Effective Space Missions

Aerosciences



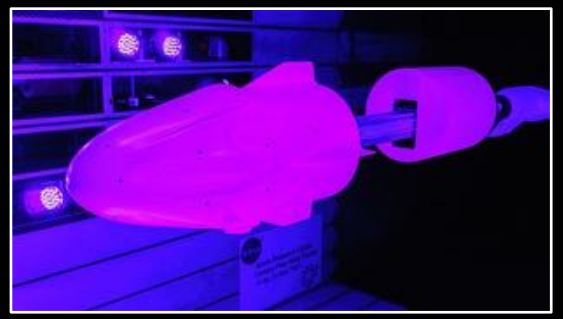
Astrobiology & Life Science

Space & Earth Sciences



Major Research Facilities

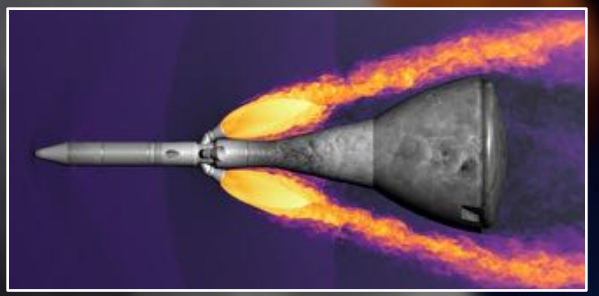
Wind Tunnels

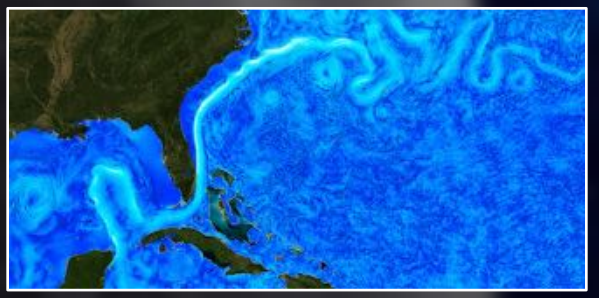


Arc Jet Complex

Simulators

Supercomputing





What Does NASA Do?

Aeronautics Research

Transform Aviation through R&D

Science

Understand the Sun, Earth, and Universe

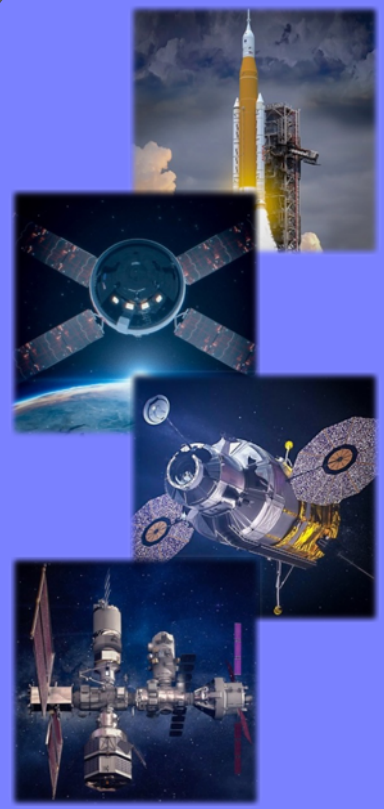
Space Technology

Develop and Transfer Revolutionary Technologies

Space Operations

Launch and Space Operations

Deep Space Exploration Sys.



Moon to Mars Exploration

Space Operations

Launch and space operations, including the International Space Station, the commercialization of low-Earth orbit, and eventually, sustaining operations on and around the Moon

International Space Station: Automation& Flight Projects


Astrobee + ISAAC


Playbook

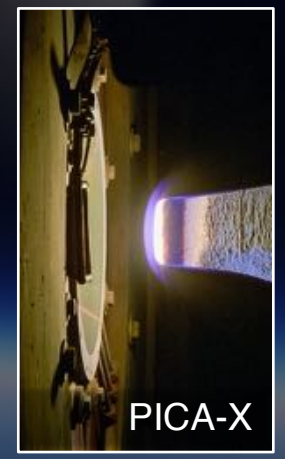
Commercial Space

Pilot Training


Rodent Research


Cell Science / BioCulture System


Wind-Tunnel Testing


PICA-X

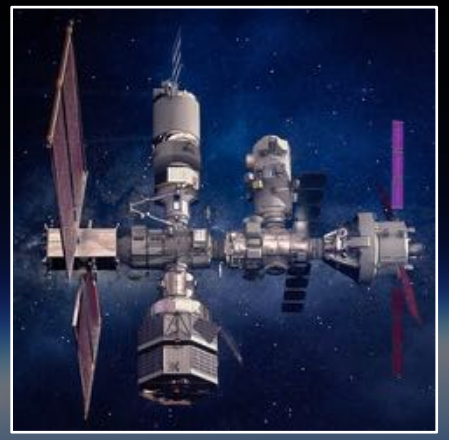
Exploration Systems Development

Define and manage systems development for programs critical to Artemis and plan the Moon to Mars exploration approach in an integrated manner

Orion Space Craft

Space Launch System

Exploration Ground Systems



Gateway

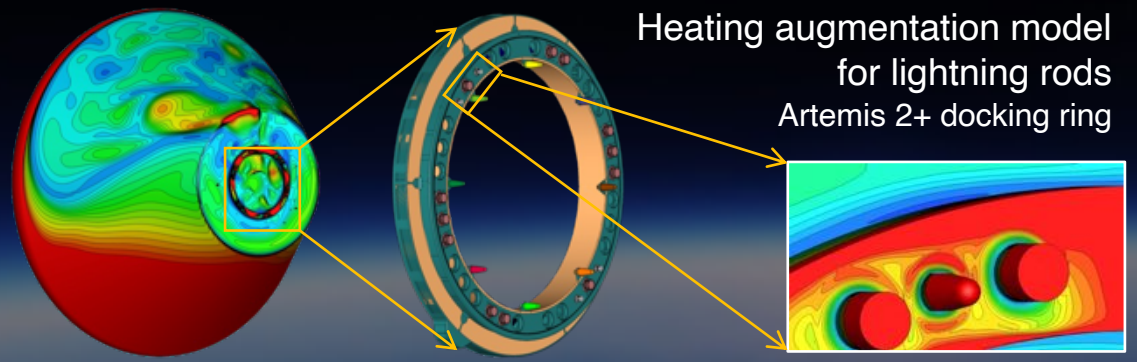
Human Landing System

Artemis Base Camp

Artemis: Aerodynamics and Thermal Modeling

Launch Abort Orion

Passive particles seeded at nozzle exit and vehicle surface colored by pressure for a simulation of the Orion launch abort system during a low altitude high angle of attack transonic abort scenario.



Heating augmentation model for lightning rods

Artemis 2+ docking ring

Multiphase launch environment simulation of SLS during take-off at KSC Pad 39-A.

Launch Environment

Space Launch Vehicle

Particle traces colored in time during SLS Stage Separation even

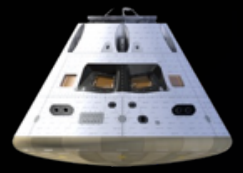
SRB Separation

Space Launch Vehicle

Arc Jet Complex

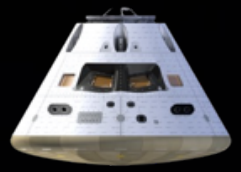
Thermal Protection Systems (TPS) Development and Testing

2005 — 2010 — 2020 — 2028

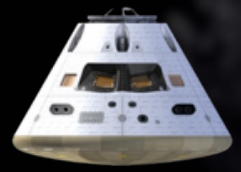


The CEV TPS ADP (2005-2009) advanced both tiled Avcoat and PICA heatshield TPS architectures with Ames TPS and arc jet testing expertise.

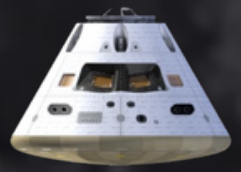
ESDMD



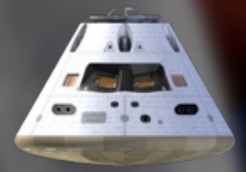
EFT-1 (2014) Avcoat



Artemis I (2022) Avcoat



Artemis II (2024) Avcoat



Artemis III (2025) Avcoat

SOMD

SpaceX CRS-1 (2010) PICA

SpaceX Crew Demo-2 (2020) C-PICA

SpaceX Crew 4 (2022) C-PICA

SMD

MSL (2012) PICA

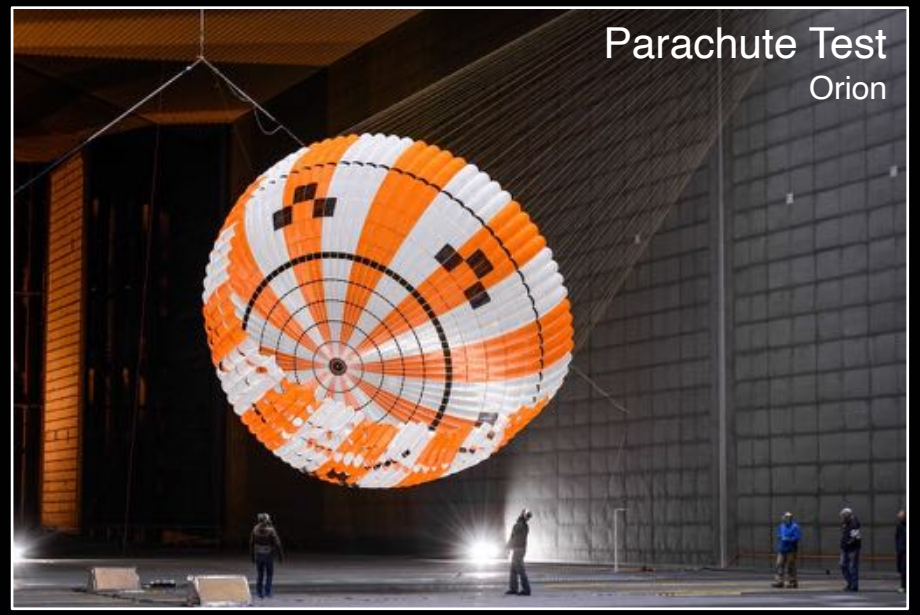
M2020 (2021) PICA

MSR SRL-MAV (2028) PICA

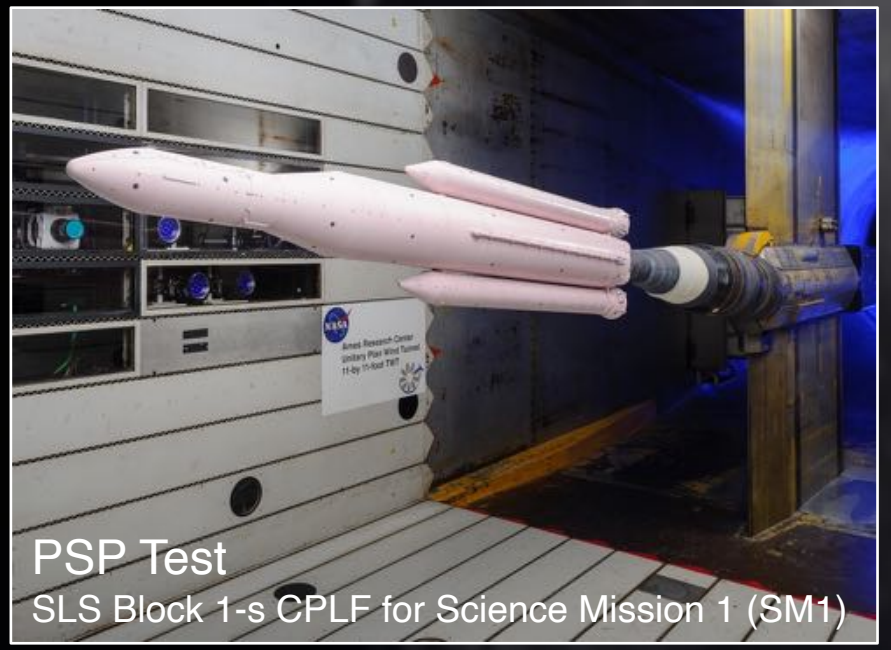
MSR SRL-SFR (2028) PICA

Exploration Systems Development

Wind Tunnel Testing



Parachute Test
Orion



PSP Test
SLS Block 1-s CPLF for Science Mission 1 (SM1)

Hot Helium Testing
Orion

Wind Tunnel Model and Instrumentation
SLS Block 1B

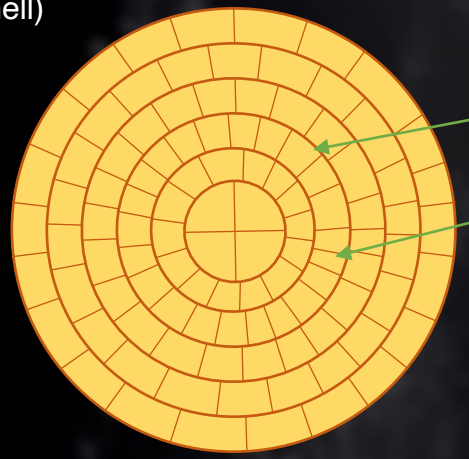
Pressure Sensitive Paint Test
Space Launch System

Exploration Systems Development

Heatshield and Backshell Development

Orion 3DMAT Material Response in IHF/LEAF for combined convective and radiative test

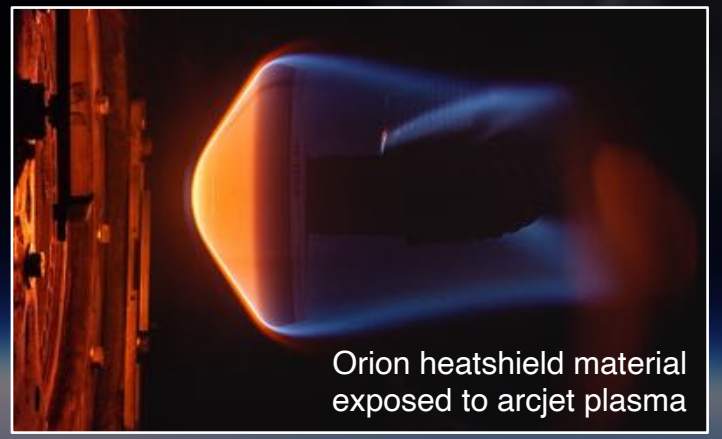
Artemis 1&2 Instrumentation Hardware (Heatshield And Backshell)



DFI Sensors
Artemis-1

Thermocouple plug

Radiometer sub-assembly prior to installation into heat shield



Orion heatshield material exposed to arcjet plasma

Engineers from Ames Research Center and Marshall Space Flight Center remove Avcoat segments from the surface of the Orion heat shield.

NASA's Deep Space Human Exploration Plans

Human Exploration Focus

SCIENCE

Connects all elements
The “why”

Enables architecture
Ex: In-situ Resource Utilization

Incorporation of Decadal Level Science

ANNUAL LUNAR SURFACE MISSIONS

2025-2031
2 Crew | 6.5-14 days

2031+
4 Crew | 30 days

MARS

Analogs
Space Station | Moon

Robotic Sample Return
Volatiles

EXPANDING PARTNERSHIPS

International
Existing and New Partners

Industry
Economic Development

Other Government
Agency Partners (DOE, NSF, NIH)

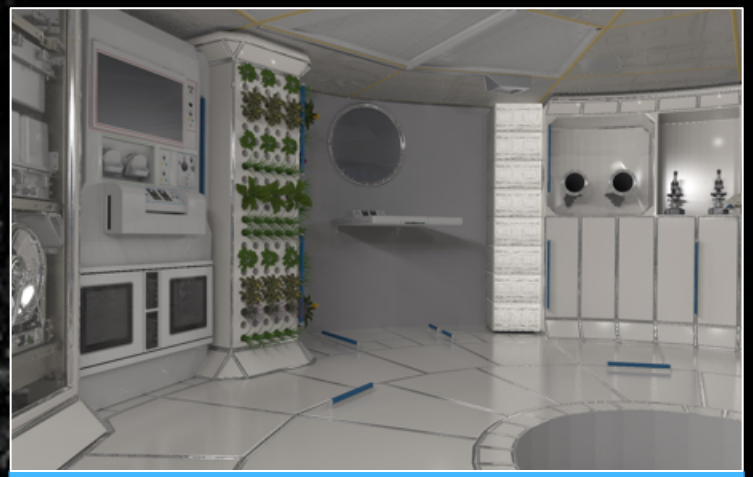
Exploration Architecture

A set of functional capabilities, their translation into elements, their interrelations and operations. The architecture enables the implementation of various mission scenarios that achieve a set of given scientific and exploration systems goals and objectives.

TRANSPORTATION

In Space:
SLS
Orion
Commercial Launch Providers

To/On the Surface:
Human Landing System
Lunar Terrain Vehicle
Pressurized Rover



HABITATION & LIFE SUPPORT

In Space:
Orion
Gateway HALO
Gateway I-Hab

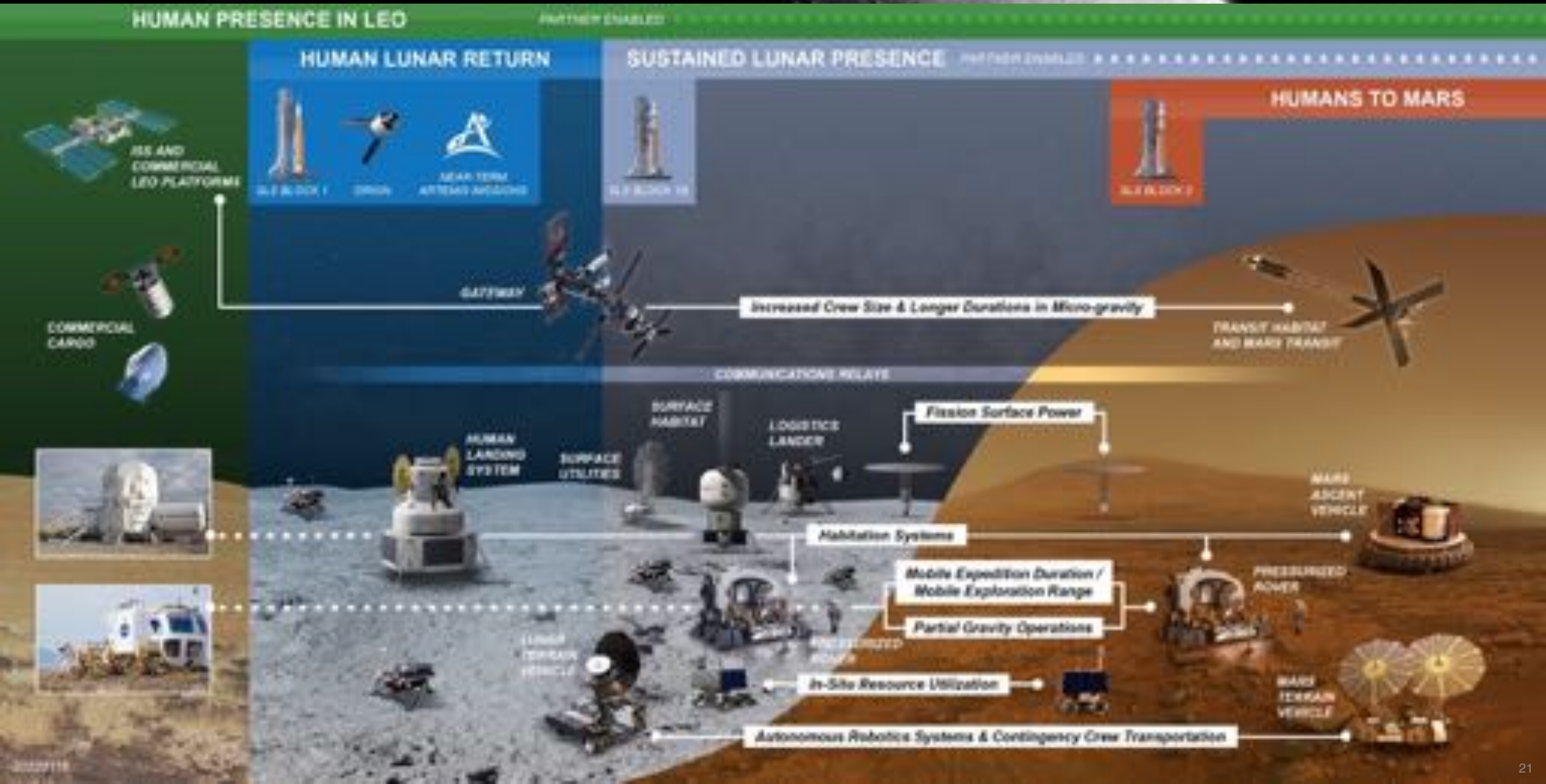
On the Surface:
Human Landing System
Spacesuits
Surface Habitat
Pressurized Rover

INFRASTRUCTURE

In Space:
PPE: Comm and Power
Deep Space Logistics
Deliveries
LunaNet

On the Surface:
Fission Surface Power
Logistics and Science
Deliveries

Exploration Campaign & Segments



Artemis I: 2022

Uncrewed Flight Test

Space Launch System & Orion Spacecraft

VIPER: 2024

Robotic Rover

Ice Exploration and Prospecting

Artemis II: 2024+

Crewed Flight Test

Space Launch System & Orion Spacecraft

SpaceX Uncrewed Demo

Starship Demonstration to the lunar surface

Gateway: 2025+

A lunar orbiting Crewed outpost

ARTEMIS I

Uncrewed Flight Test

- Demonstrate Orion heatshield at lunar entry conditions
- Operate Systems in Flight Environment
- Retrieve Spacecraft
- Complete Remaining Objectives: Perform residual mission in the absence of system failures and conduct all mission content as planned.

Status Update: Started rolling back to VAB last night. No new launch date yet, but expect late October/November

VIPER Rover: Exploring Ice Region at Lunar Poles

VIPER will spend 20-30 days (over two lunar days) exploring and mapping the lunar Ice Deposits for Science, and future Human Exploration and use

Screenshot from the VIPER Traverse Planning tool /M. Shirley

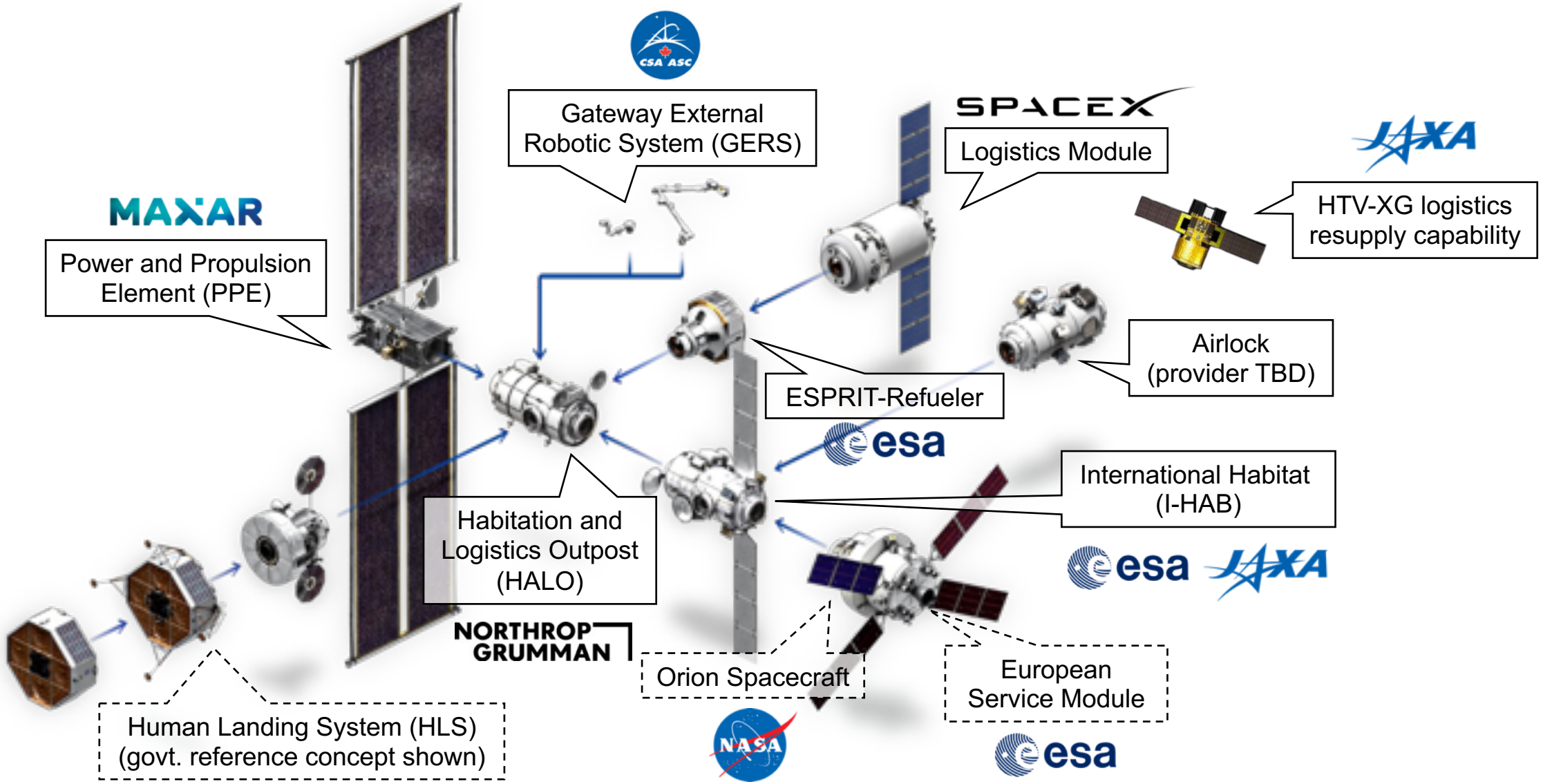
ARTEMIS II

First Crewed Flight Test to the Moon Since Apollo

- Proximity Operations Demonstration in high-Earth orbit
- Four days outbound transit, free return trajectory
- Lunar flyby 4,000 nmi lunar farside altitude


GATEWAY
NASA
CSA ASC
esa
JAXA

Gateway Integrated Spacecraft



ARTEMIS III

First Crew Return to the Lunar Surface

- Demonstrate Crewed SpaceX Starship Human Landing System
- Conduct field science in new spacesuits
- Deploy instruments
- Collect a variety of samples to return to Earth for later research
- Capture real-time human response measures and environmental characterizations

Artemis III Candidate Landing Regions

KEY LANDING REGION CONSIDERATIONS

Proximity to the South Pole

Gentle slope for landing and moonwalks

Constant view to Earth for communications

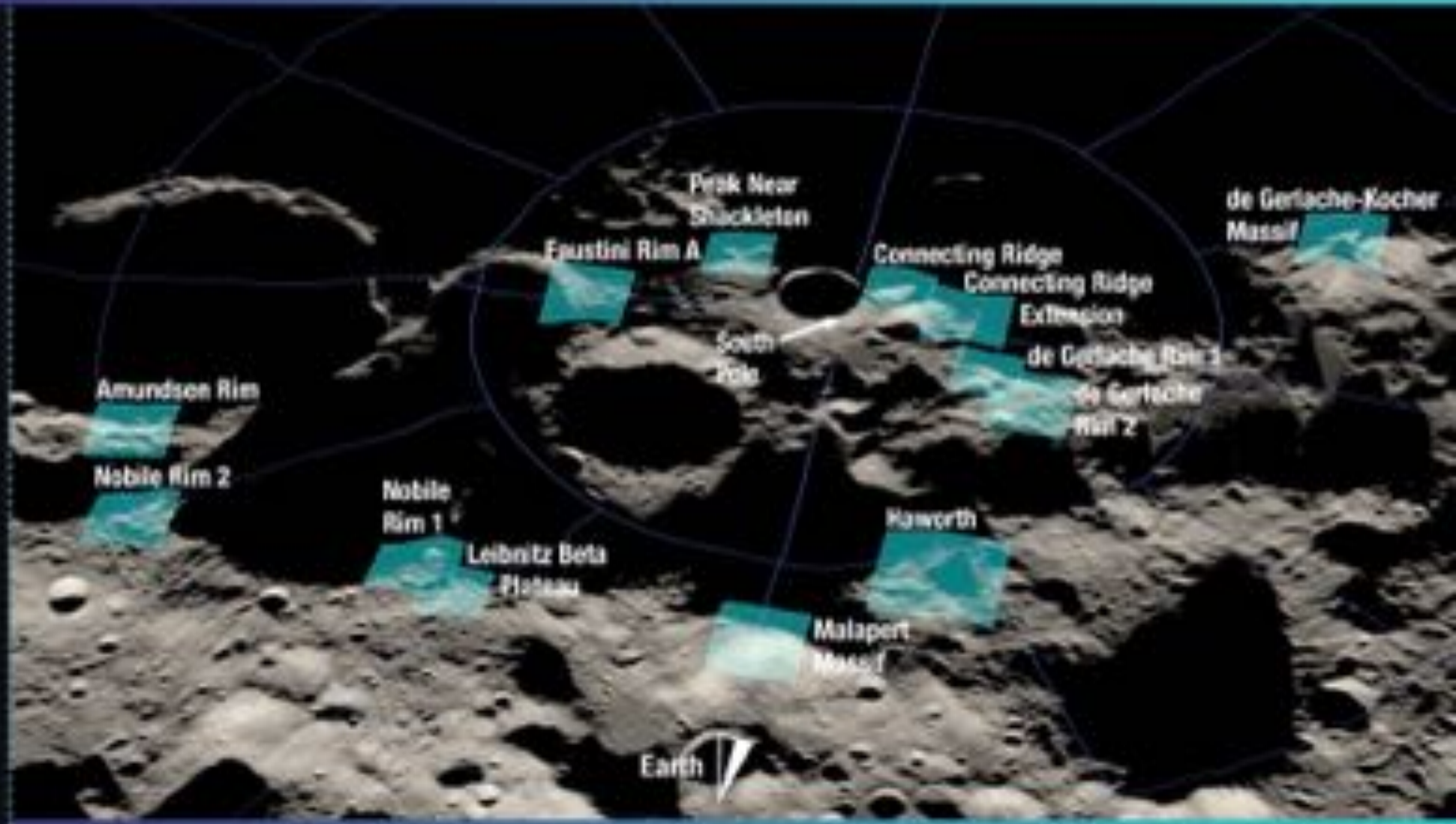
Continuous sunlight throughout the surface expedition of about 6.5 days

Landing Accuracy

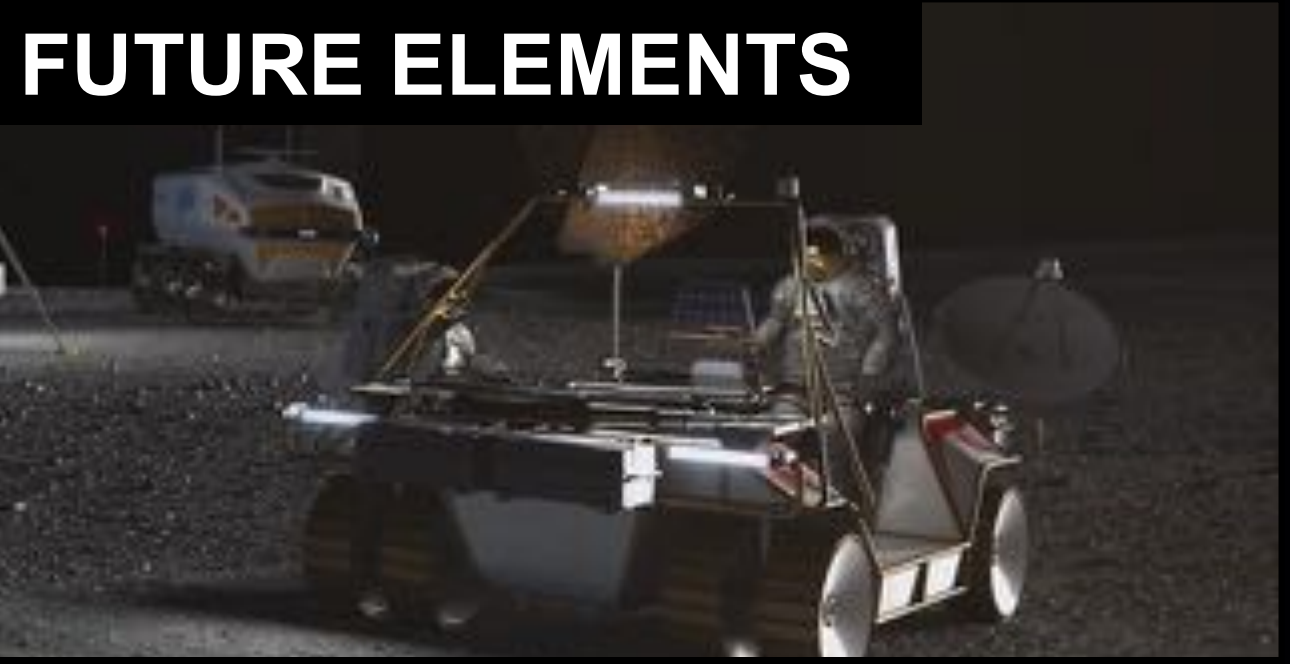
Surface data resolution

Combined mission vehicle capabilities: Space Launch System, Orion spacecraft, Starship Human Landing System

A landing *region* is approximately 15 km^2. Each landing region includes multiple potential landing sites.



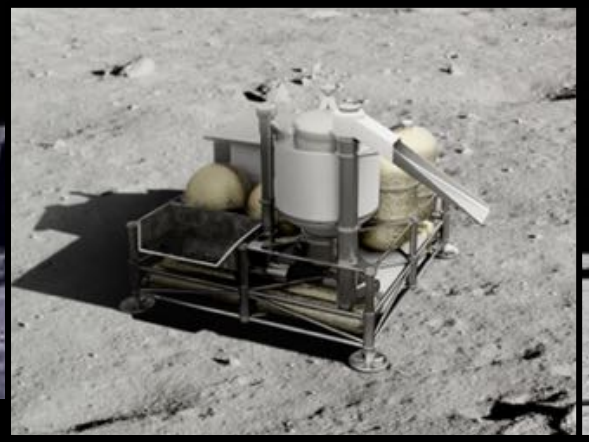
FUTURE ELEMENTS



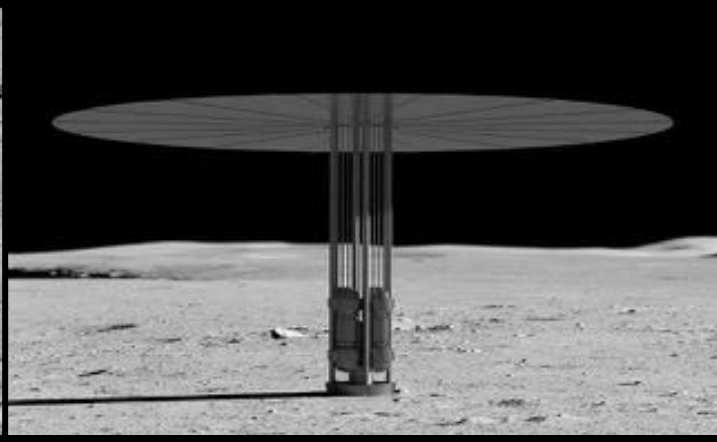
LUNAR TERRAIN VEHICLE (LTV)

PRESSURIZED ROVER

SURFACE HABITAT



IN-SITU RESOURCE UTILIZATION



FISSION SURFACE POWER

Base Camp

A truly sustainable infrastructure on the lunar surface

FIRST HUMAN MARS MISSION CONCEPT OVERVIEW

WHO

Current analysis includes 4 crew

Some could potentially remain in Mars orbit while others explore surface

WHAT

Mars Transit

Landing and Surface Exploration

Mars Ascent and Earth Return

WHERE

Cislunar, Deep Space and Mars orbit

Mars Surface

WHEN

As early as 2030s

Crew away from Earth ~2 years

~30 sols on Mars

WHY

Science, Exploration, and U.S. leadership

HOW

1 *Pre-Deployed Cargo Phase*

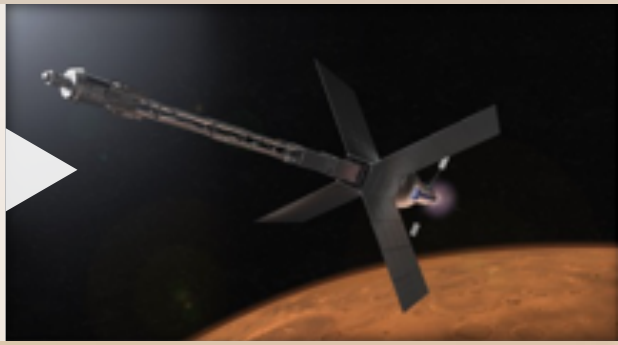
2 *Crewed Surface Exploration Phase*

First Conceptual Mars Mission

Reference architecture for *analysis purposes only.*

TRANSIT HABITAT AND PROPULSION STAGE

- Supports four crew on the long mission to Mars
- Two crew remain in orbit while two crew visit the Mars surface



1 PRE-DEPLOYED CARGO

- 25-ton class payload Mars lander
- Ascent vehicle propellant, Surface Power, and surface mobility/propellant transfer system

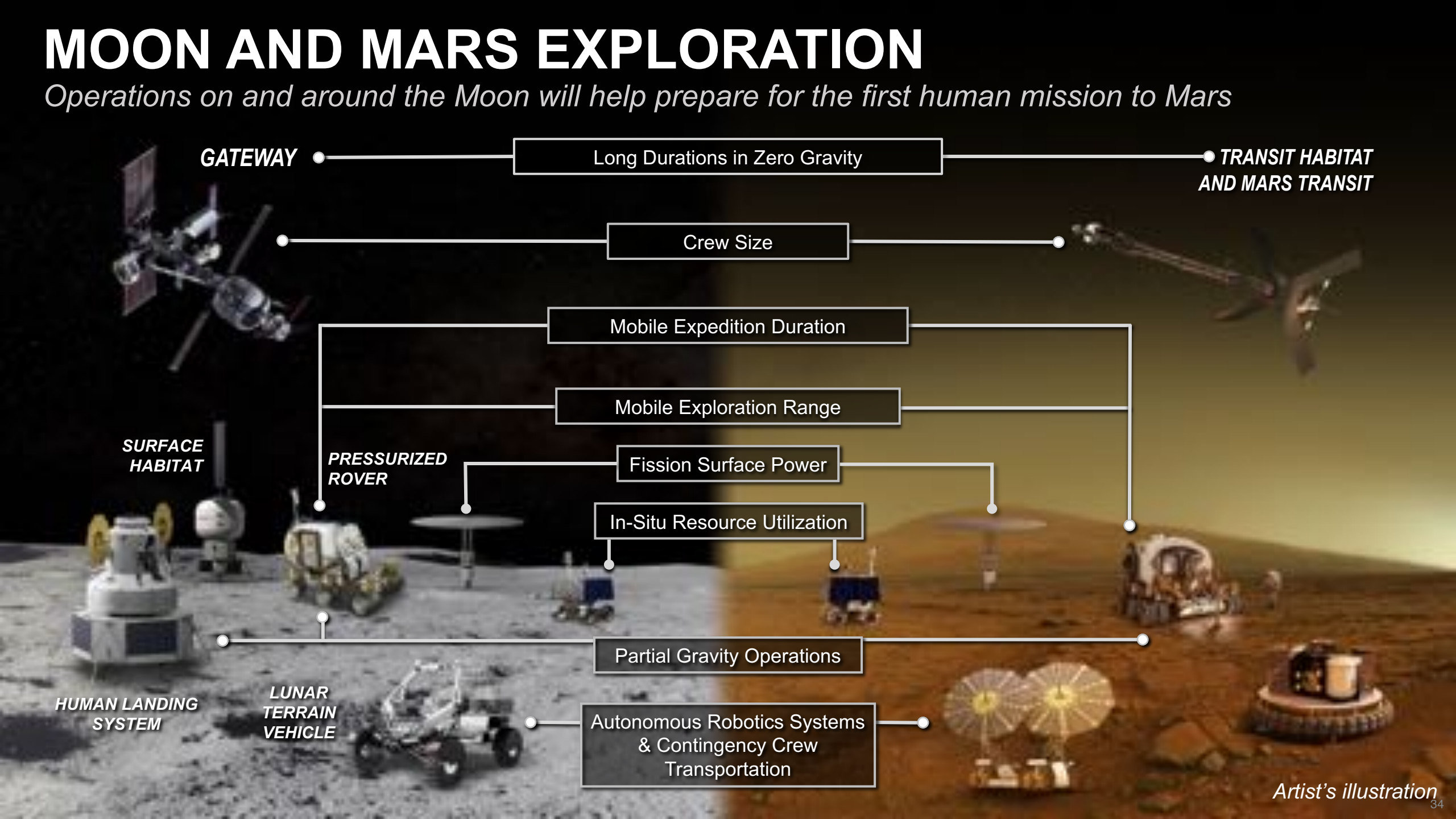
2 PRE-DEPLOYED CREW ASCENT VEHICLE

3 CREW

- Two crew land/live in pressurized rover
- Provides habitation and mobility for 30 days
- Supports science and exploration operations

MOON AND MARS EXPLORATION

Operations on and around the Moon will help prepare for the first human mission to Mars

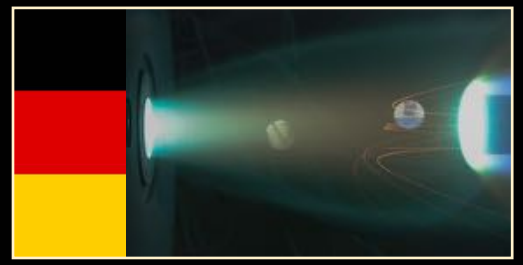


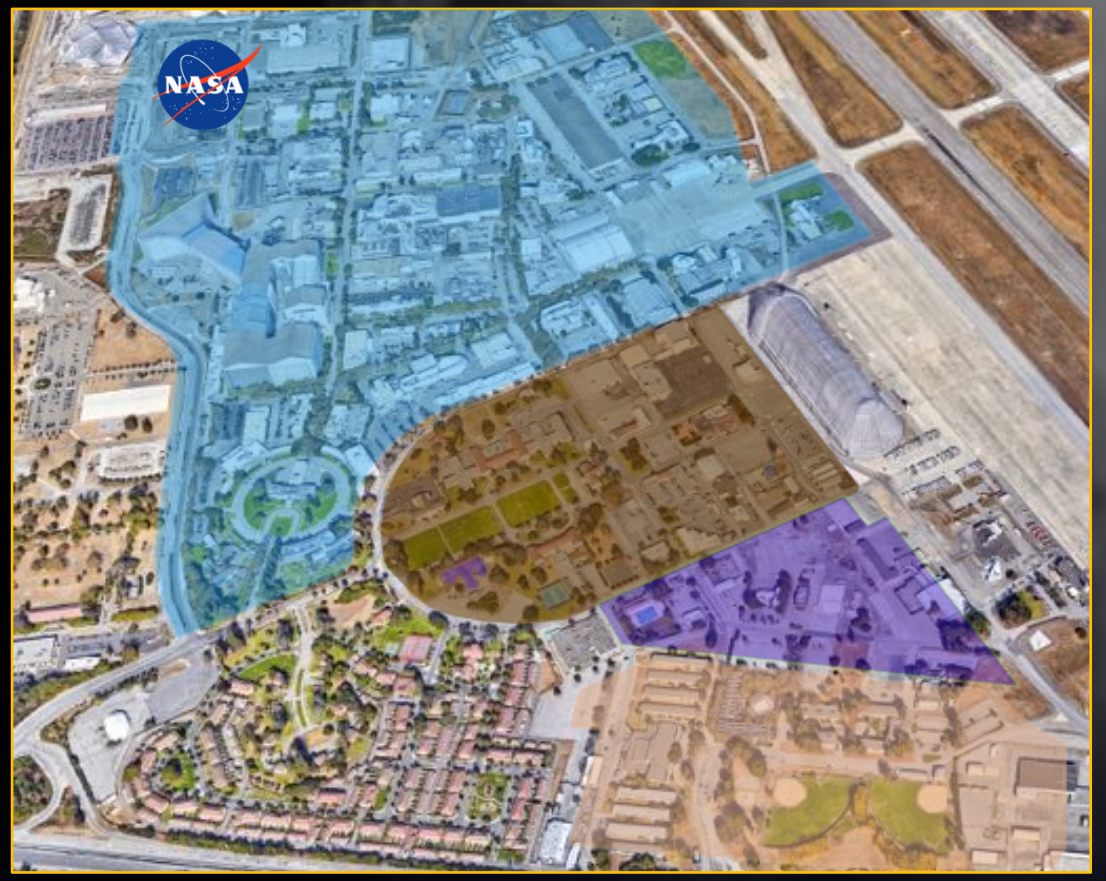
Artist's illustration


NASA

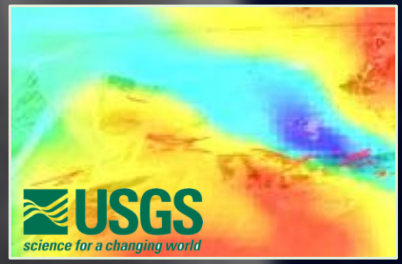
Ames' Partnerships

International





Inter-Agency

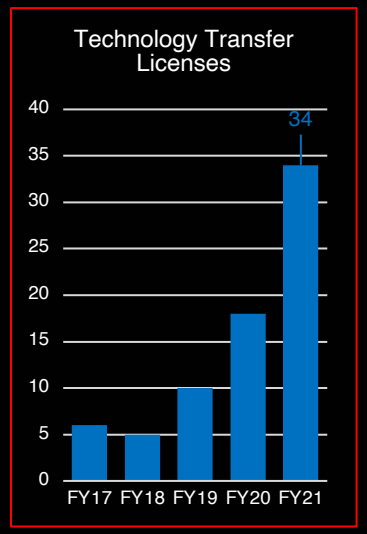


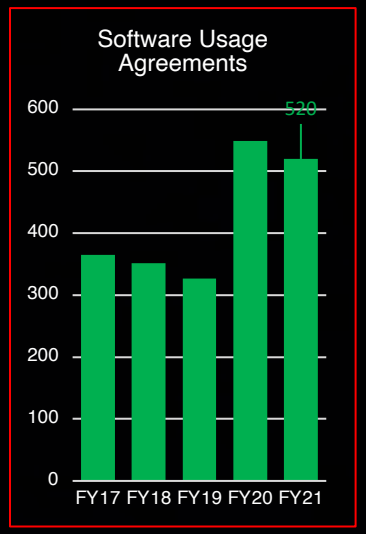
Commercial

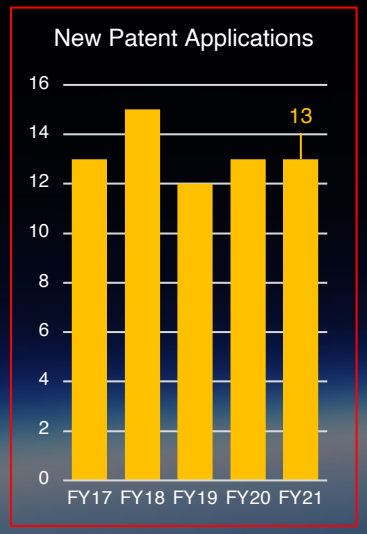
Academic

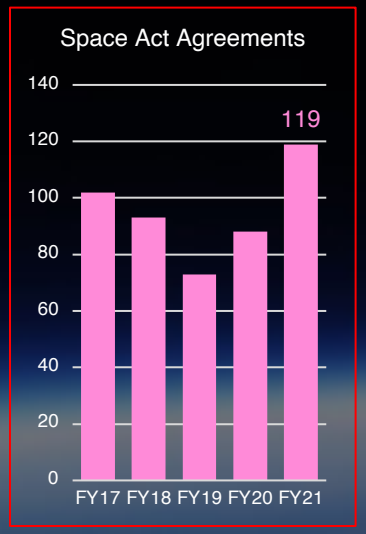
Technology Transfer

Metrics









Software of the Year

Past 10 years: 6 Winners, 3 Runner ups

Invention of the Year

Past 10 years: 4 Winners, 1 Co-winner, 1 Runner up

Patents