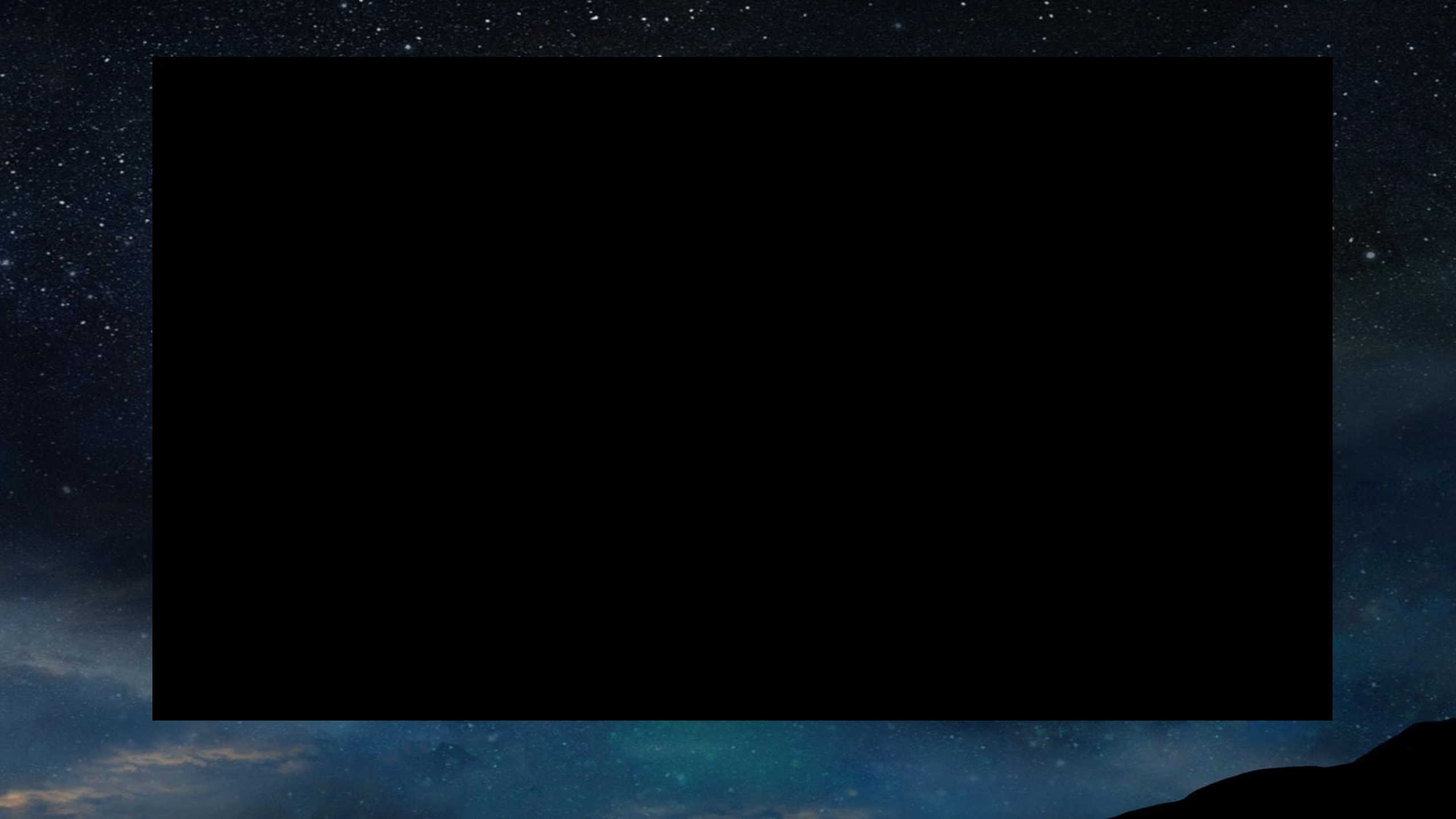

National Aeronautics and
Space Administration
NASA
EXPLORE as ONE
Bob Cabana, Director
Kennedy Space Center



Premier Multi-User Spaceport

BOEING

SPACE FLORIDA

SPACEX

NORTHROP GRUMMAN

LOCKHEED MARTIN

BLUE ORIGIN

FIREFLY AEROSPACE

OneWeb Satellites

SPACE FLORIDA

BLUE ORIGIN

KSC Programs and Projects

Commercial Crew Program

Launch Services Program

Exploration Ground Systems

Gateway — A spaceport for human and robotic exploration to the Moon and beyond

Exploration Research & Technology Programs

2019 KSC Key Milestones

✓ March 2	SpaceX Demo-1	LC 39A
✓ June 27	Mobile Launcher rolls testing to SLC 39B	
✓ July 2	Orion Launch Abort System Test	SLC-46
✓ October 10	ICON Mission	CCAFS

Remaining Milestones Planned in 2019

Boeing Pad Abort Test – Target date 11/4/19
Boeing Orbital Flight Test – Target date mid December
SpaceX In-Flight Abort Test – Target date early December
Gateway Logistics Contract Award

2020 KSC Key Milestones

Orion Mass Simulator on dock KSC – 1/24/20
SpaceX Demo-2
Boeing Crewed Flight Test
Solar Orbiter – 2/5/20
SLS Boosters arrive and processing begins – 3/18/20
Orion turnover to EGS – 5/16/20
MARS 2020 – 7/17/20
Sentinel 6A – 11/15/20
Landsat-9 – 12/15/20


EXPLORE
HUMANS in SPACE
FOR ALL HUMANITY
NASA

A Tale of **Three** Capsules

EXPLORE

NASA
Orion

BEYOND EARTH ORBIT

SpaceX
Crew Dragon

Boeing
CST-100 Starliner

LOW-EARTH ORBIT

National Aeronautics and Space Administration

NASA

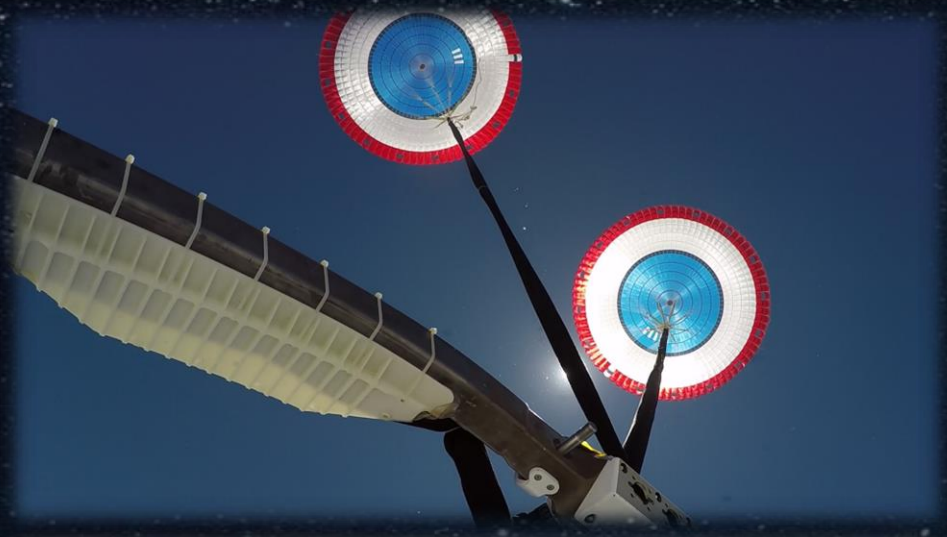
COMMERCIAL CREW

SpaceX Demo-1

March 2, 2019

Boeing Hotfire & Parachute Tests

May 22, 2019




NASA
ARTEMIS
PHASE ONE:
Lunar South Pole by 2024

Moon Before Mars

On the Moon, we can take reasonable risks while astronauts are just three days away from home.

There we will prove technologies and mature systems necessary to live and work on another world before embarking on what could be a 2-3 year mission to Mars.

The Artemis Program

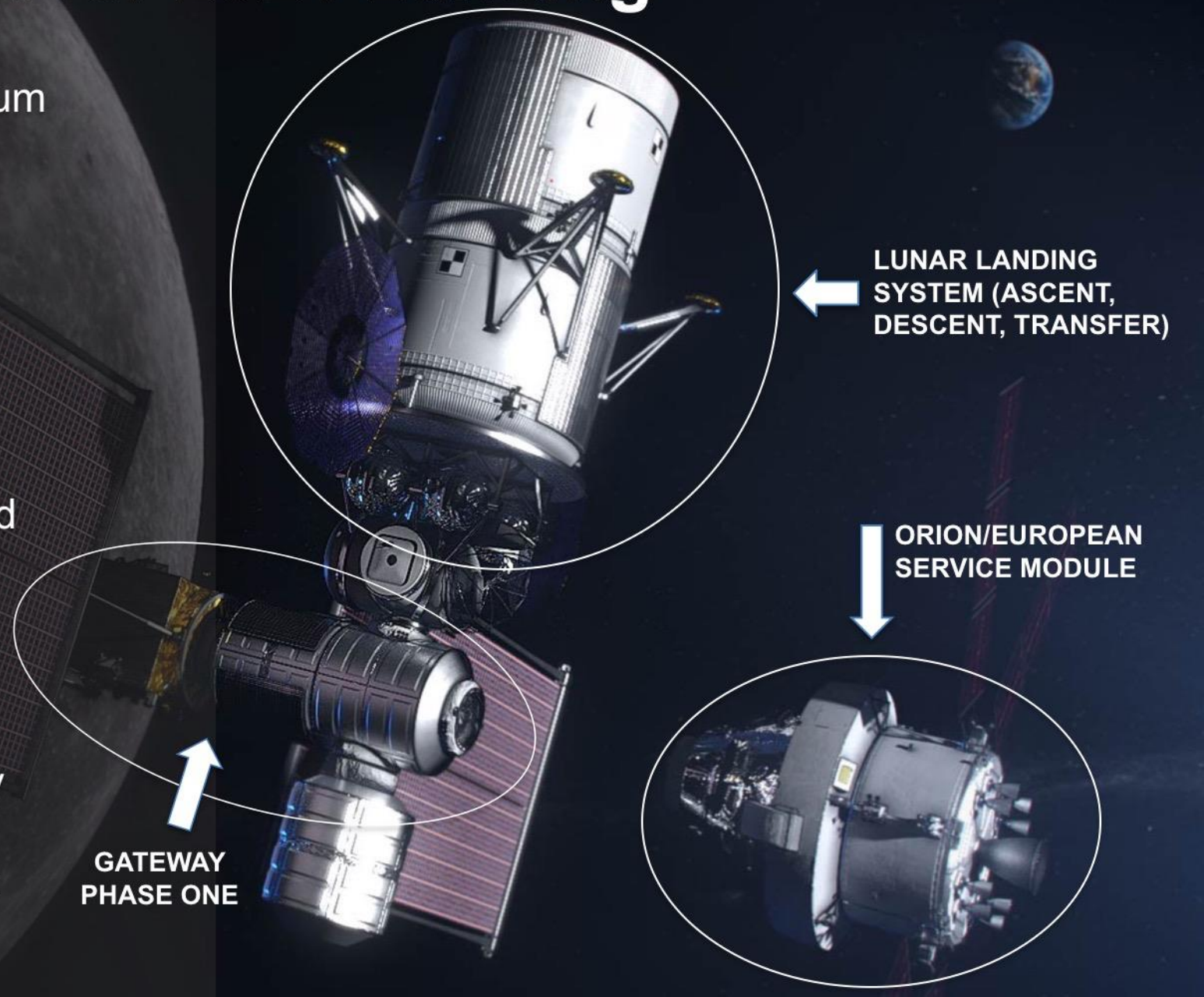
Artemis is the twin sister of Apollo and goddess of the Moon in Greek mythology. Now, she personifies our path to the Moon as the name of NASA's program to return astronauts to the lunar surface by 2024.

When they land, Artemis astronauts will step foot where no human has ever been before: the Moon's South Pole.

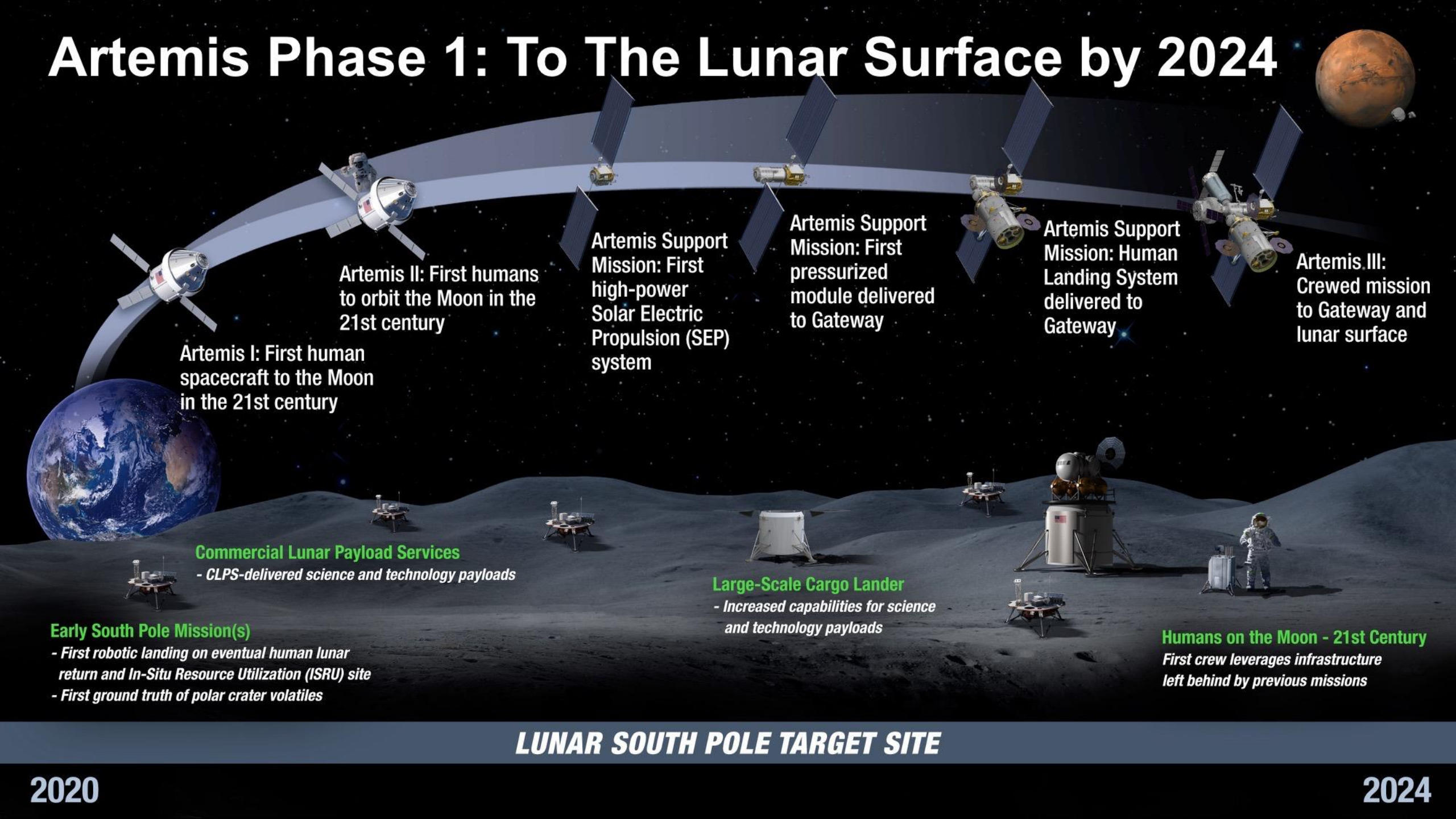
With the horizon goal of sending humans to Mars, Artemis begins the next era of exploration.

Gateway is Essential for 2024 Landing

- Initial Gateway focuses on the minimum systems required to support a 2024 human lunar landing while also supporting Phase 2
- Provides command center and aggregation point for 2024 human landing
- Establishes strategic presence around the Moon – US in the leadership role
- Creates resilience and robustness in the lunar architecture
- Open architecture and interoperability standards provides building blocks for partnerships and future expansion



Artemis Phase 1: To The Lunar Surface by 2024



ARTEMIS I

The first uncrewed, integrated flight test of NASA's Orion spacecraft and Space Launch System rocket, launching from a modernized Kennedy spaceport

1 LAUNCH
SLS and Orion lift off from pad 39B at Kennedy Space Center

2 JETTISON ROCKET BOOSTERS
Solid rocket boosters separate

3 JETTISON LAUNCH ABORT SYSTEM (LAS)
The LAS is no longer needed, Orion could safely abort

4 CORE STAGE MAIN ENGINE CUT OFF (MECO) and separation

5 ENTER EARTH ORBIT
Perform the perigee raise maneuver

6 EARTH ORBIT
Systems check and solar panel adjustments

7 TRANS LUNAR INJECTION (TLI) BURN
Burn lasts for approximately 20 minutes

8 INTERIM CRYOGENIC PROPULSION STAGE (ICPS) SEPARATION
The ICPS has committed Orion to TLI

9 OUTBOUND TRANSIT
Requires several attitude maneuvers

A B C D
CUBESATS DEPLOY
ICPS deploys 13 CubeSats total

10 OUTBOUND TRAJECTORY CORRECTION (OTC) BURNS
As necessary adjust trajectory for Lunar flyby to DRO

11 OUTBOUND POWERED FLYBY (OPF)
62 miles from the Moon; targets DRO insertion

Heliocentric Disposal precludes re-contact

12 ORBIT INSERTION
Enter Distant Retrograde Orbit for next 6-23 days

13 DISTANT RETROGRADE ORBIT (DRO)
Orbit Maintenance burns and solar panel adjustments; 38,000 nmi from the surface of the Moon

14 DRO DEPARTURE
Leave DRO and start return to Earth

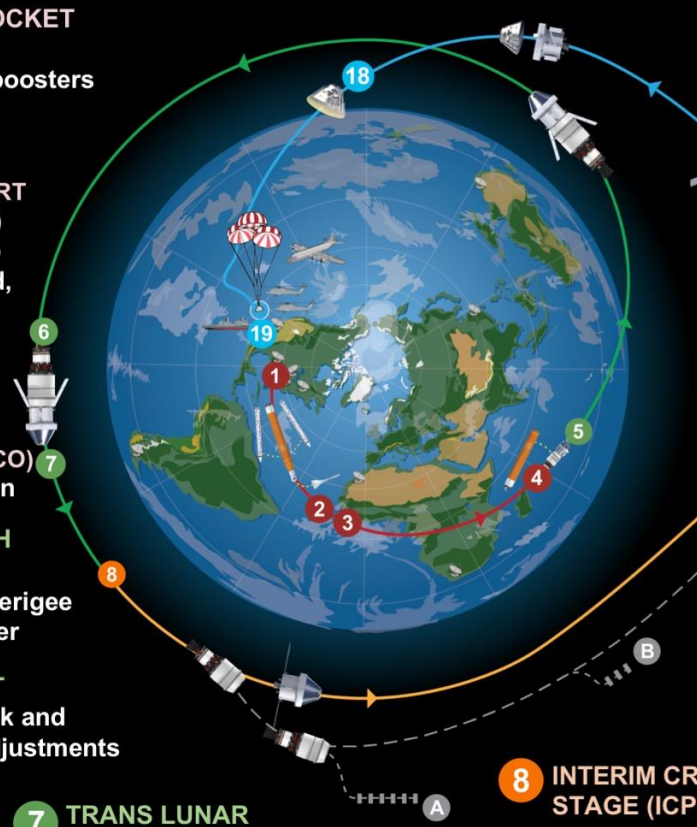
15 RETURN POWER FLY-BY (RPF)
RPF burn prep and return coast to Earth initiated

16 RETURN TRANSIT
Return Trajectory Correction (RTC) burns as necessary to aim for Earth's atmosphere; travel time 3-11 days

17 FINAL RETURN TRAJECTORY CORRECTION (RTC) BURN
Precision targeting for Earth entry

18 ENTRY INTERFACE (EI)
Enter Earth's atmosphere

19 SPLASHDOWN
Pacific Ocean landing within view of the U.S. Navy recovery ships



Launch | Earth Orbit | Trans Lunar | Lunar Orbit | Trans Earth | Earth Re-entry | Payload Orbit/Disposal

ARTEMIS

ARTEMIS I

Total distance traveled: 1.3 million miles – Mission duration: 26-42 days – Re-entry speed: 24,500 mph (Mach 32) – 13 CubeSats deployed

Achieving 2024 – A Parallel Path to Success

Artemis will see government and commercial systems moving in parallel to complete the architecture and deliver crew

CREW

NASA Programs SLS and Orion

Artemis I

First flight test of SLS and Orion as an integrated system

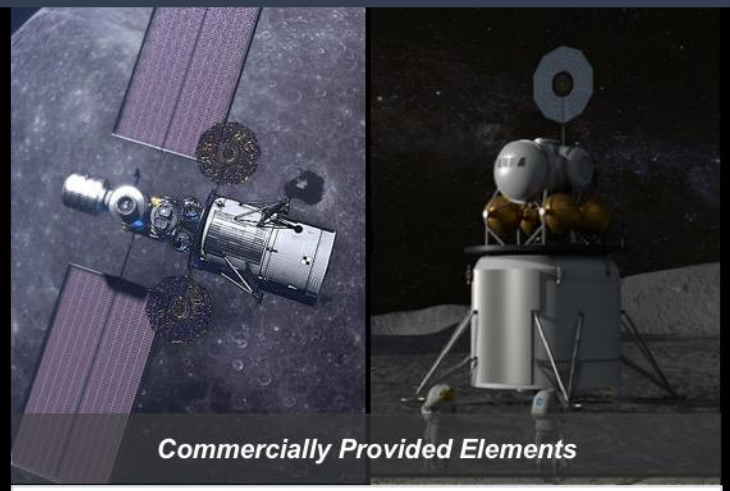
Artemis II

First flight of crew to the Moon aboard SLS and Orion

Artemis III

First crew to the lunar surface; Logistics delivered for 2024 surface mission

Between now and 2024, U.S. industry delivers the launches and human landing system necessary for a faster return to the Moon and sustainability through Gateway.



Commercially Provided Elements

CARGO

PPE

Power and Propulsion Element arrives at NRHO via commercial rocket

Pressurized Module

Small area for crew to check out systems prior to lunar transfer and decent

Human Landing System

Transfer

Transfers lander from Gateway to low lunar orbit

Descent

Descends from Transfer Vehicle to lunar surface

Ascent

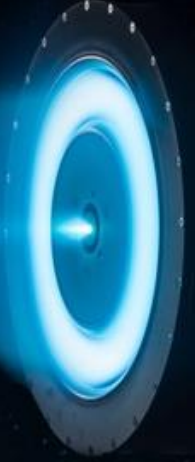
Ascends from lunar surface to Gateway

Up to three commercial rocket launches, depending on distribution of the Transfer, Descent, and Ascent functions

Space Technology for 2024 and Beyond

High Performance Spaceflight Computing

Precision Landing

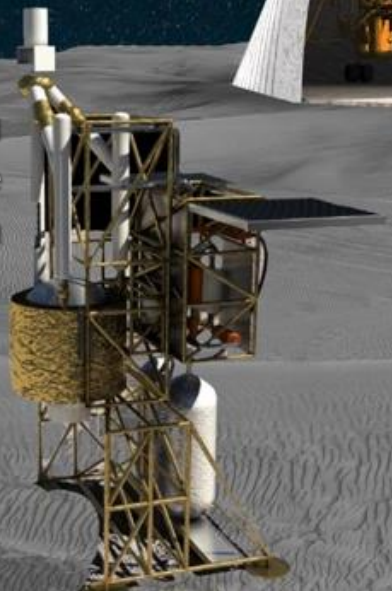


Solar Electric Propulsion

Cryofluid Management

Lunar Dust Mitigation

Surface Excavation/Construction



In Situ Resource Utilization

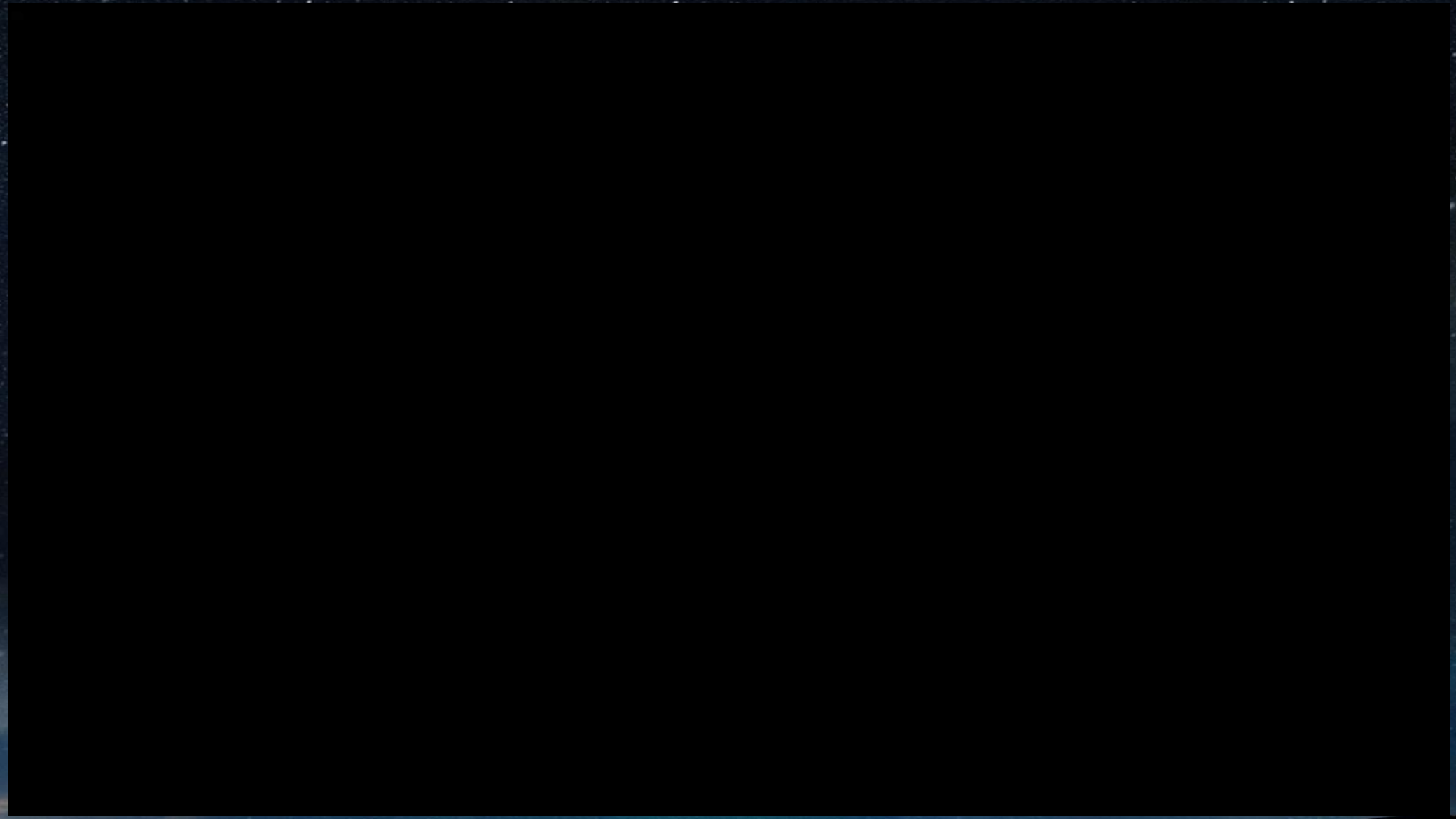
Lunar Surface Power

Extreme Environments

Extreme Access

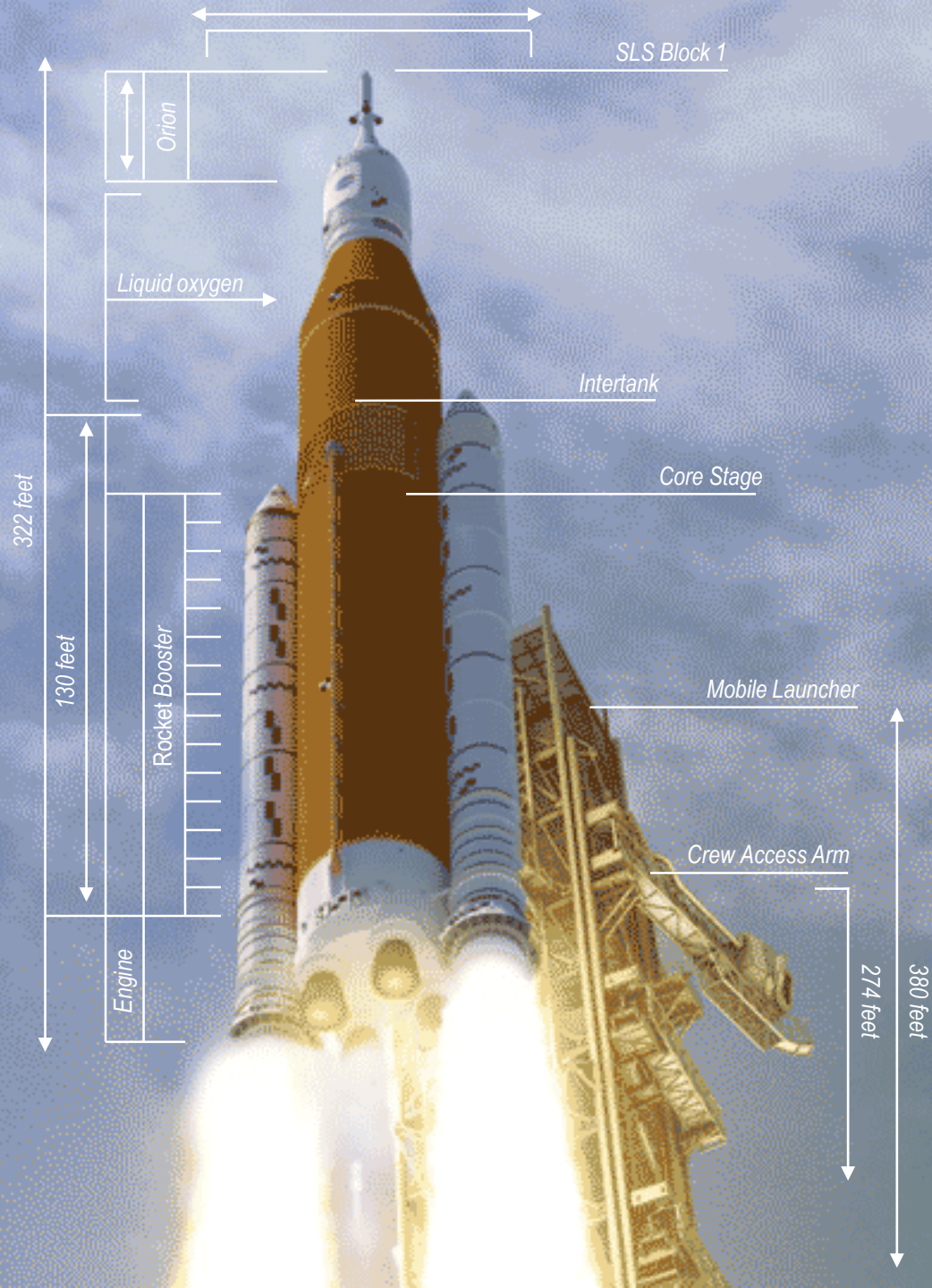
Lunar Surface Innovation Initiative

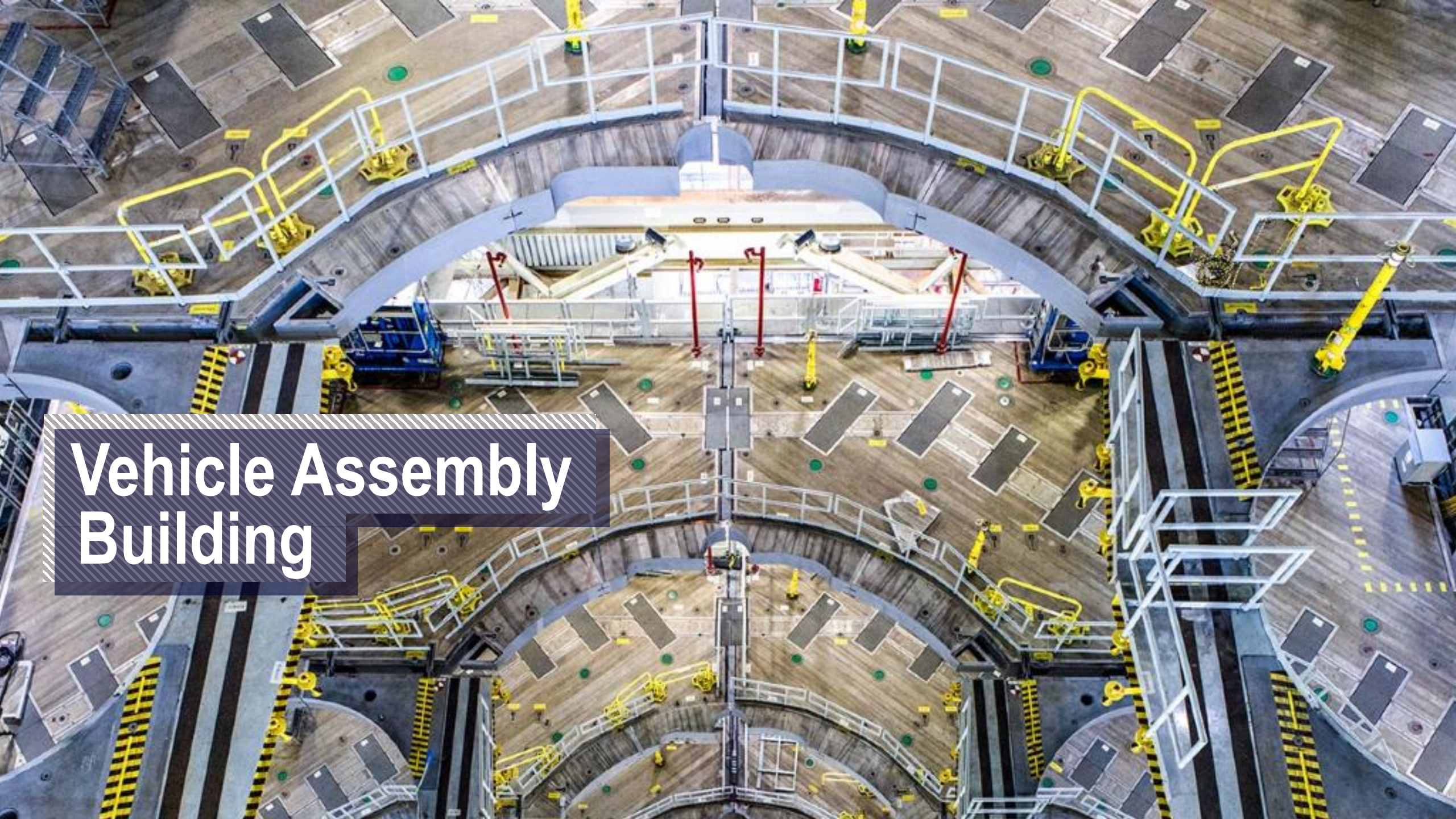
EGS Striving Toward Launch of Artemis I



Artemis I

Exploration Ground Systems





Vehicle Assembly Building

Mobile Launcher

Launch Pad 39B

Landing and Recovery

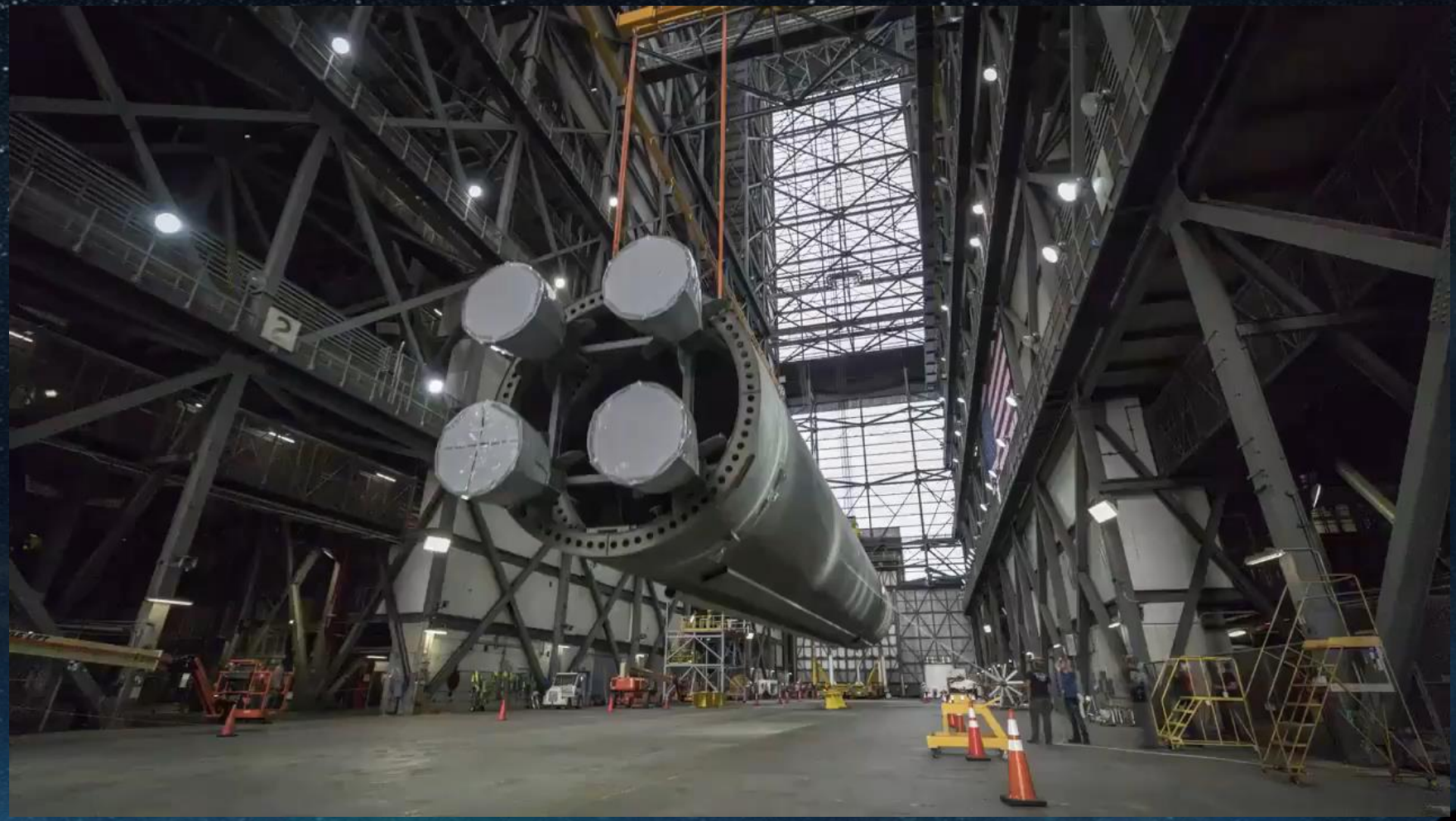
Orion Ascent Abort-2 Flight Test

July 2, 2019

Firing Rooms and Launch Control

SLS Core Stage Pathfinder

October 15-16, 2019



Launch Services Program Manifest

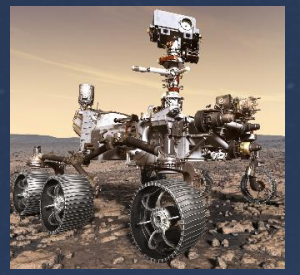
2019

ICON
Ionospheric Connection Explorer

Venture Class
Launch Services

2020

Solar Orbiter



Mars 2020

Sentinel 6A
(Jason-CS)

Landsat-9

Providing Advisory Services

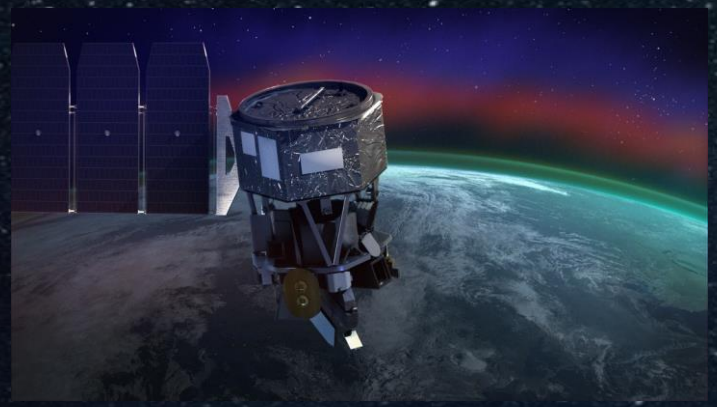
Commercial Crew
Program

Commercial
Resupply Services

Gateway Logistics

Ionospheric Connection Explorer (ICON)

October 10, 2019



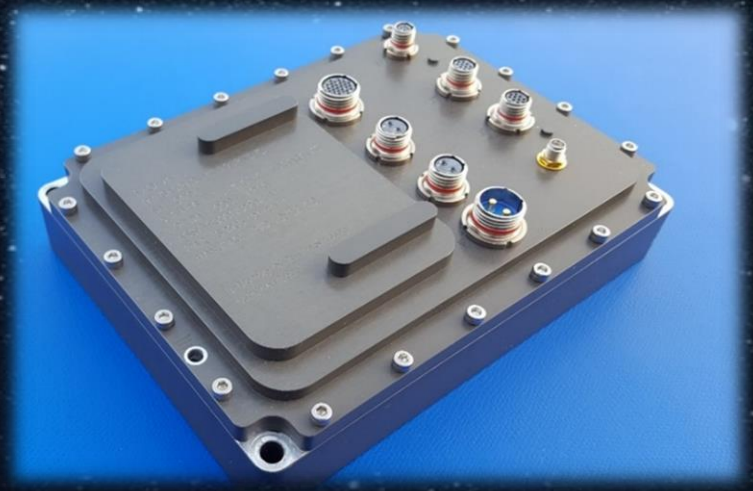
Exploration Research and Technology Programs

Exploration Research and Technology Programs

SPACE PLANT BIOLOGY
Veggie
Food Production and Astronaut Nutrition

SPACE PLANT BIOLOGY
APH
ADVANCED PLANT HABITAT
Large Plant Research Facility

Exploration Research and Technology - 2019 Awards



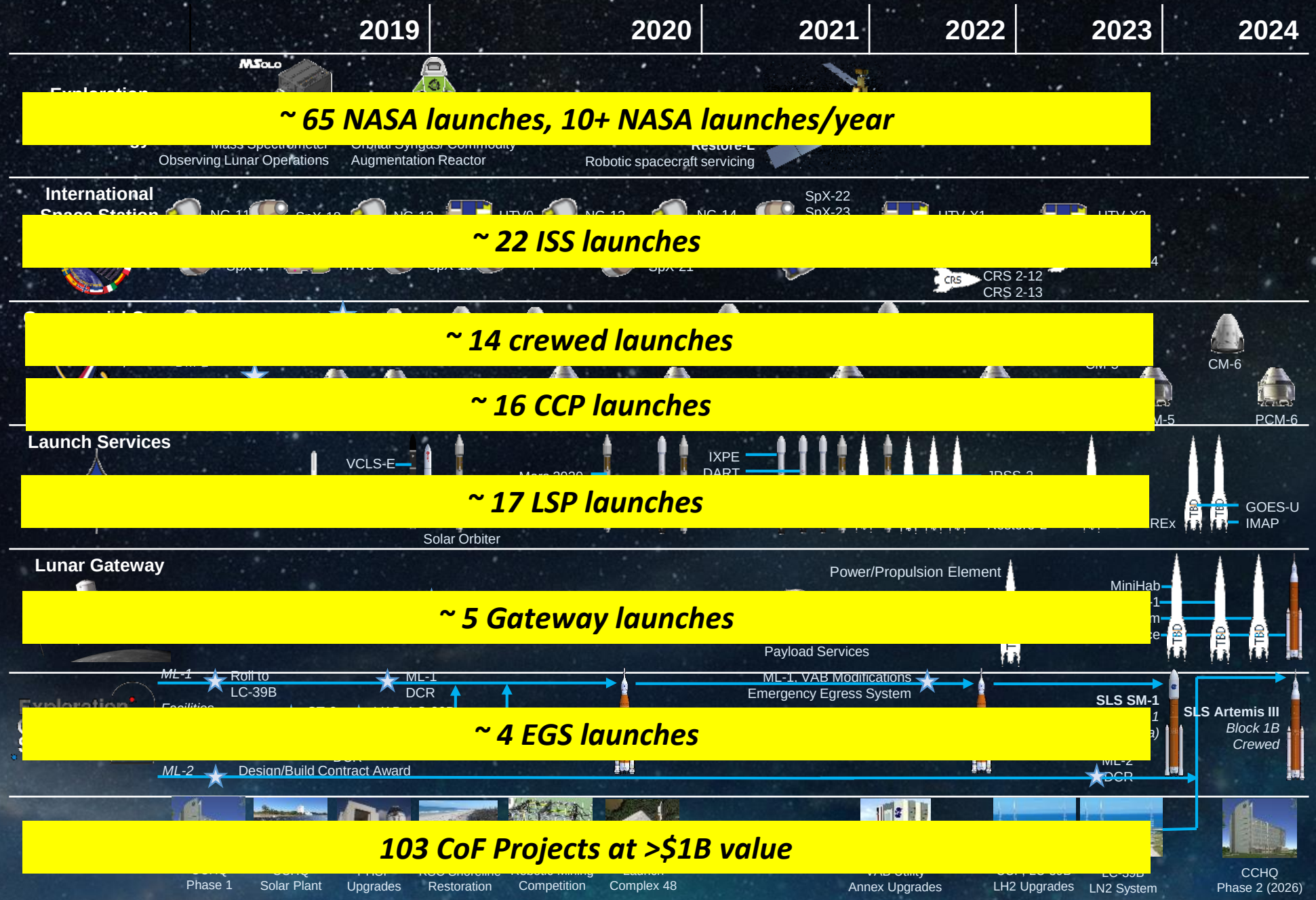
FLC Interagency Partnership Award for Technology Transfer

- KSC is the only NASA center to win award in 2019
- The Autonomous Flight Termination System (AFTS) augments or replaces the functions of the traditional human-in-the-loop system
- Allows multiple vehicles to be launched and tracked at the same time
- AFTS transferred to 30+ commercial space companies and other government organizations

NASA's Technology Transfer Licensing Award

- KSC won with 18 patent licenses in FY18
- Patent licensing is one of the ways we transfer NASA technologies to industry

KSC Roadmap – September 2019



~ 7+ launch vehicle fleets


NASA