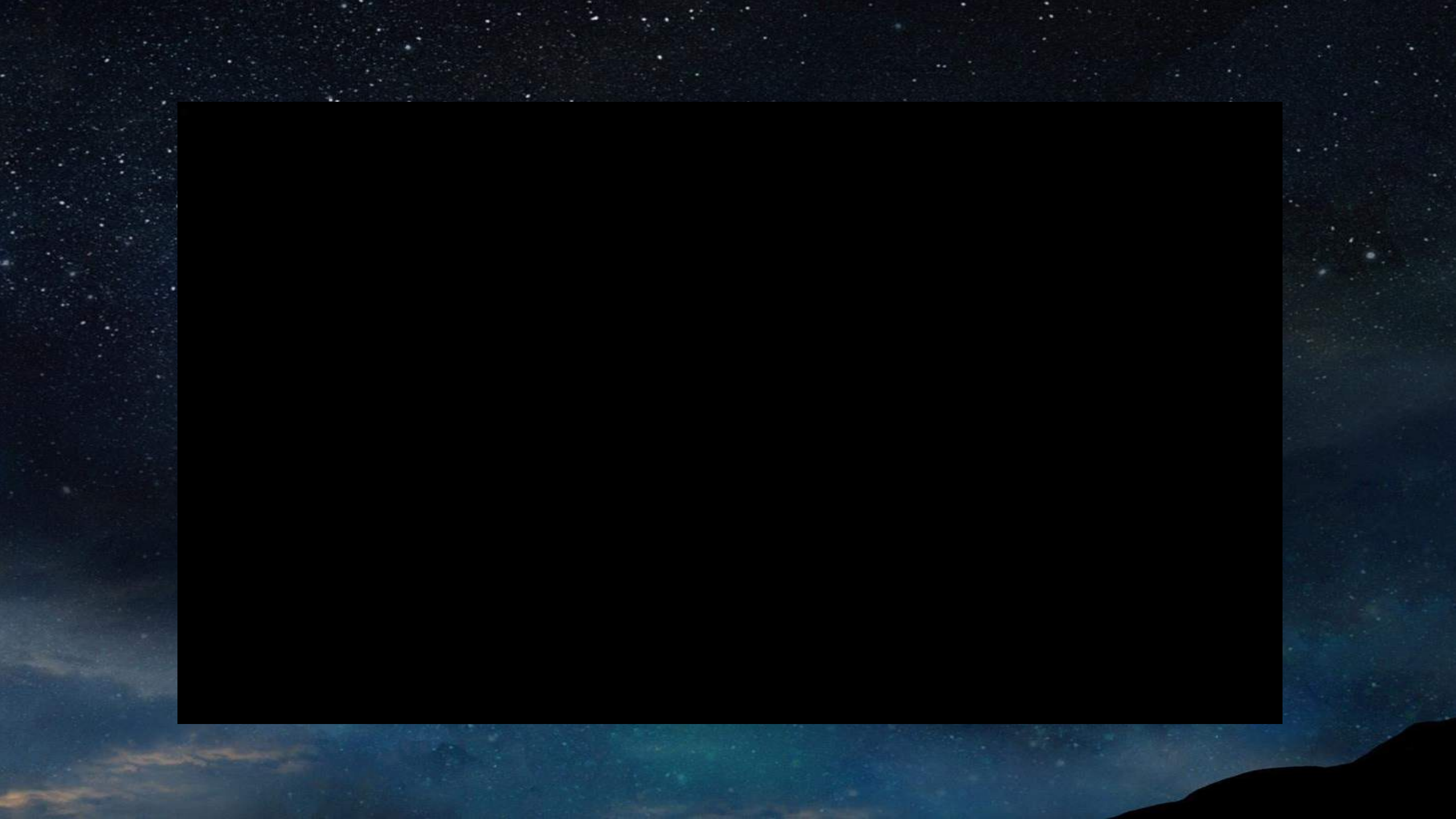


National Aeronautics and  
Space Administration



# EXPLORE *as* ONE

Bob Cabana, Director  
Kennedy Space Center



# Premier Multi-User Spaceport



**BOEING**



**SPACEX**



**NORTHROP GRUMMAN**



**LOCKHEED MARTIN**

**BLUE ORIGIN**

**FIREFLY AEROSPACE**

**OneWeb Satellites**

**SPACE FLORIDA**



**BLUE ORIGIN**



# KSC Programs and Projects



Commercial Crew Program



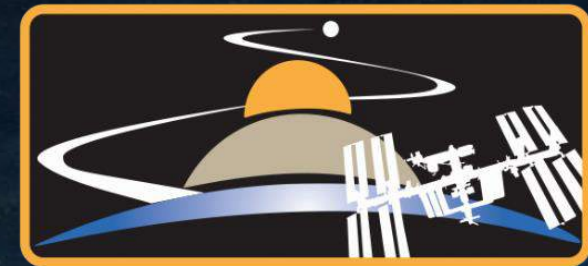
Launch Services Program



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
✓ November 4	Boeing Pad Abort Test	White Sands

---

## Remaining Milestones Planned in 2019

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

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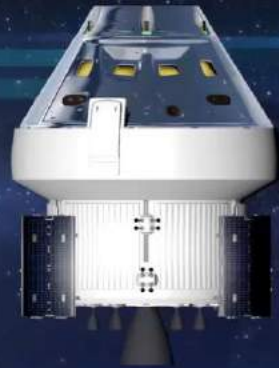
# EXPLORE HUMANS *in* SPACE

FOR ALL HUMANITY



# A Tale of **Three** Capsules

EXPLORE



**NASA**  
Orion

BEYOND EARTH ORBIT



**SpaceX**  
Crew Dragon

LOW-EARTH ORBIT

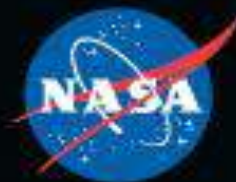


**Boeing**  
CST-100 Starliner

LOW-EARTH ORBIT



National Aeronautics and  
Space Administration



# COMMERCIAL CREW





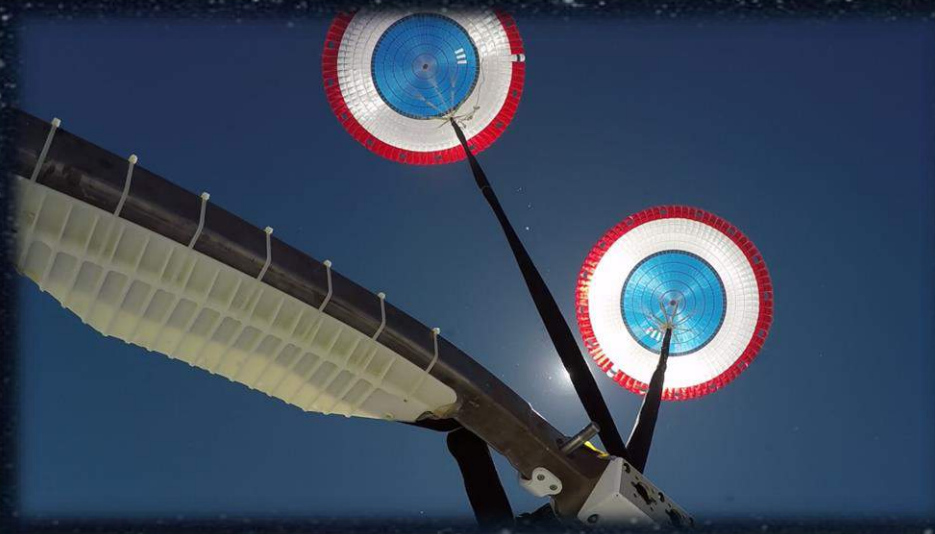
# SpaceX Demo-1

March 2, 2019



# Boeing Hotfire & Parachute Tests

May 22, 2019





# 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.

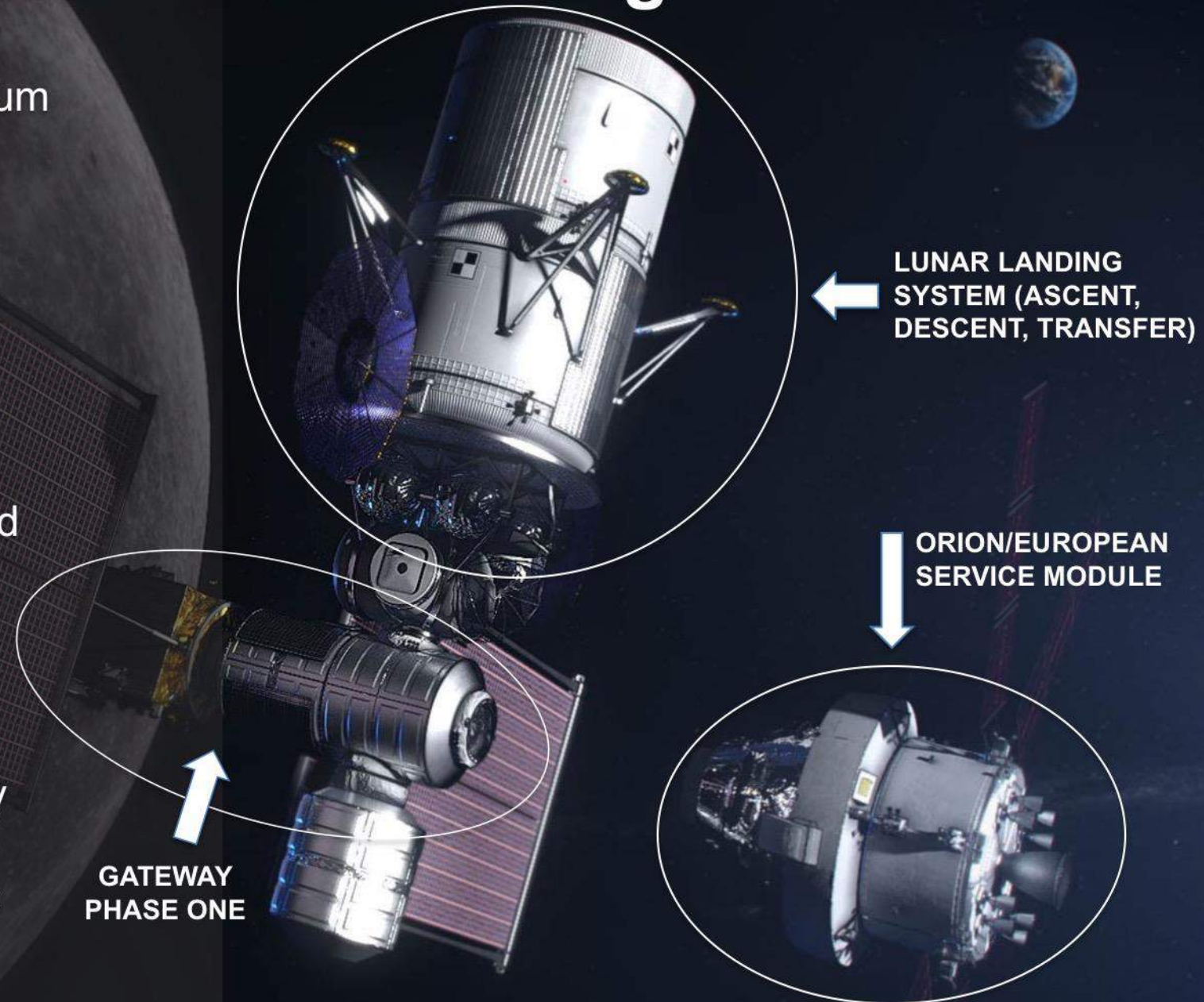
When they land, Artemis astronauts will step foot where no human has ever been before: the Moon's South Pole.

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

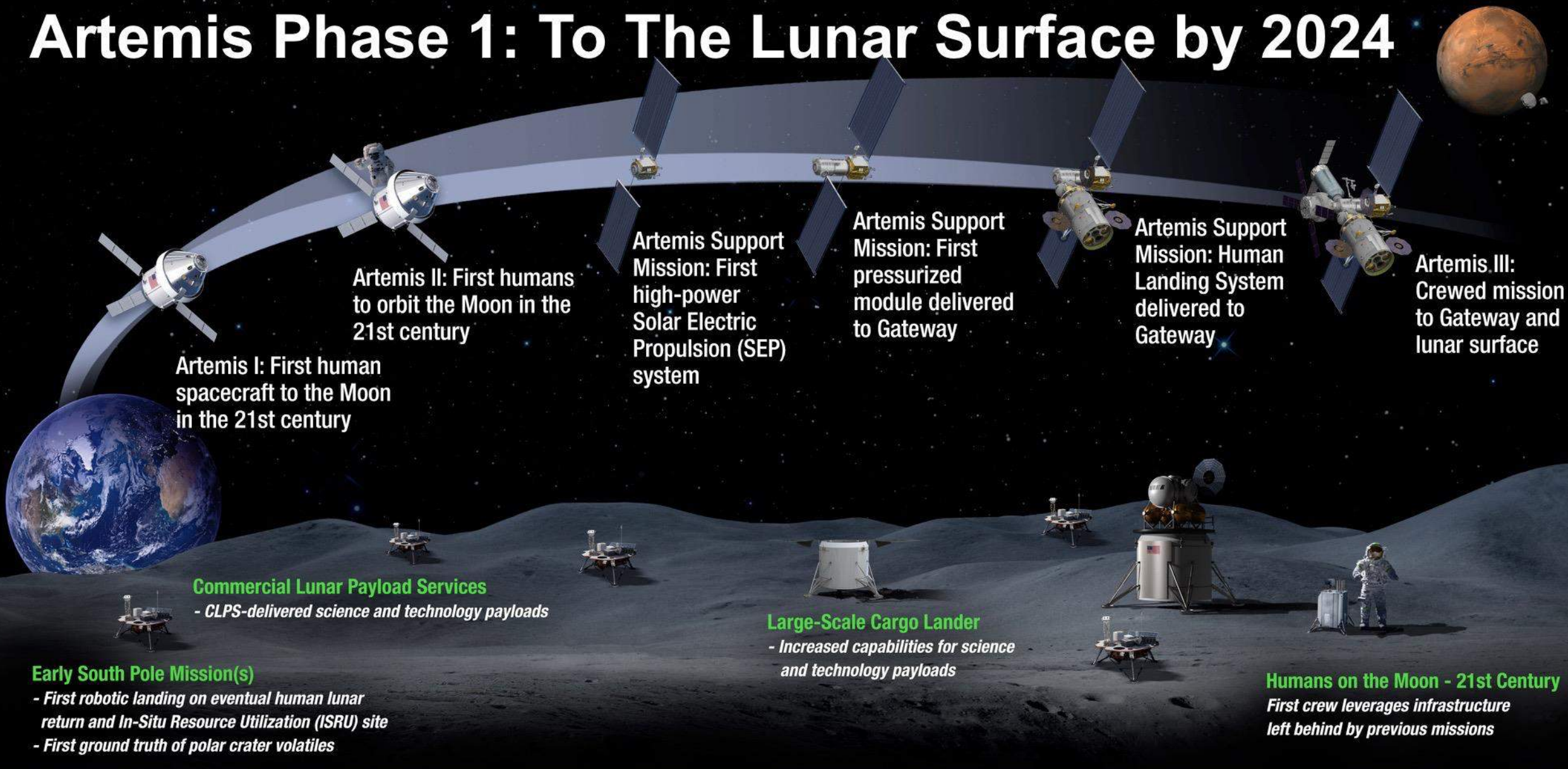


# Gateway is Essential for 2024 Landing

- 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:** First human spacecraft to the Moon in the 21st century

**Artemis II:** First humans to orbit the Moon in the 21st century

**Artemis Support Mission:** First high-power Solar Electric Propulsion (SEP) system

**Artemis Support Mission:** First pressurized module delivered to Gateway

**Artemis Support Mission:** Human Landing System delivered to Gateway

**Artemis III:** Crewed mission to Gateway and lunar surface

### Commercial Lunar Payload Services

- CLPS-delivered science and technology payloads

### Early South Pole Mission(s)

- First robotic landing on eventual human lunar return and In-Situ Resource Utilization (ISRU) site
- First ground truth of polar crater volatiles

### Large-Scale Cargo Lander

- Increased capabilities for science and technology payloads

### Humans on the Moon - 21st Century

First crew leverages infrastructure left behind by previous missions

## LUNAR SOUTH POLE TARGET SITE

2020

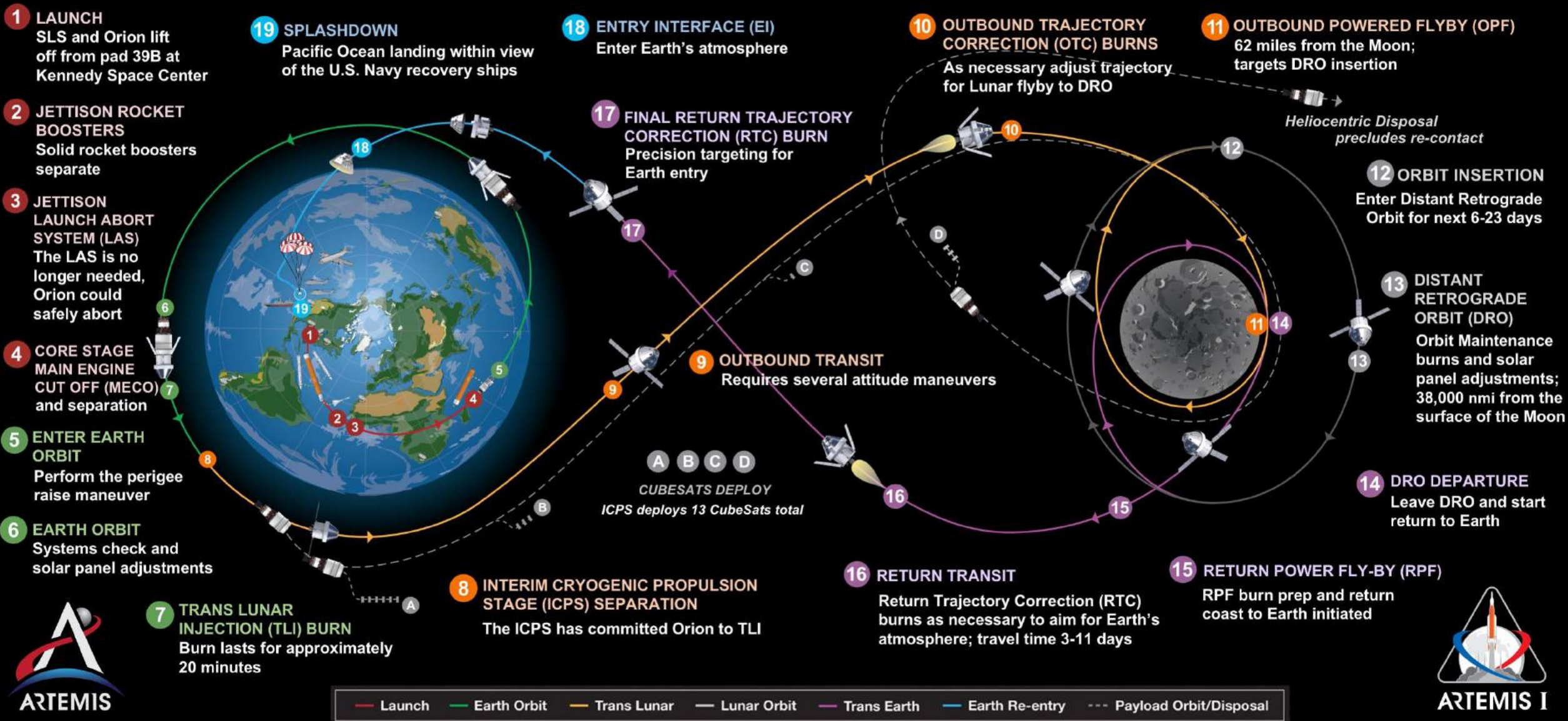
2024



# ARTEMIS I



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



ARTEMIS I

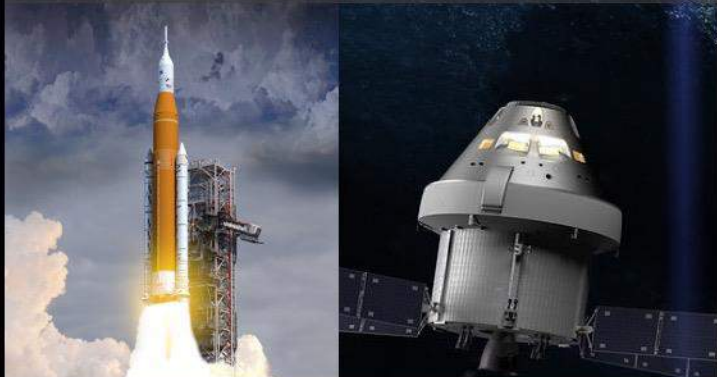
Total distance traveled: 1.3 million miles – Mission duration: 26-42 days – Re-entry speed: 24,500 mph (Mach 32) – 13 CubeSats deployed

# 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

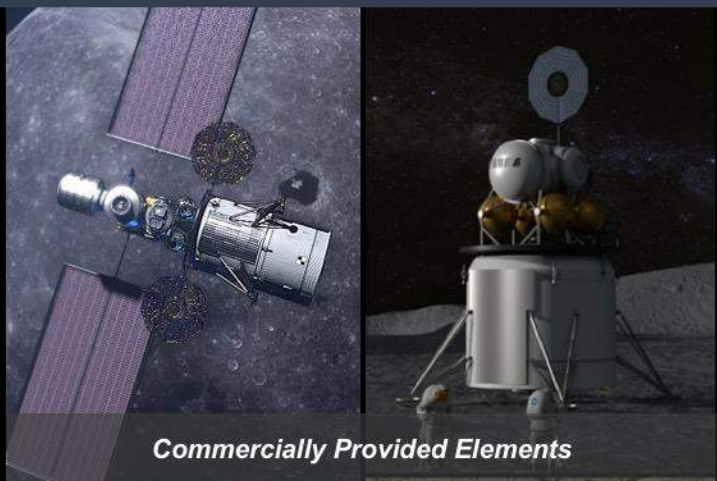
### Artemis II

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*

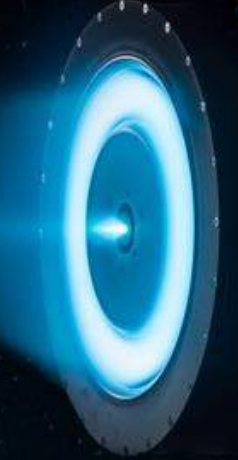


High  
Performance  
Spaceflight  
Computing



Precision  
Landing

Solar  
Electric  
Propulsion



# Space Technology for 2024 and Beyond



Cryofluid  
Management

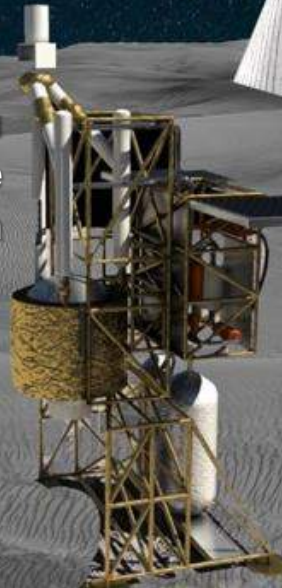


Lunar Dust  
Mitigation



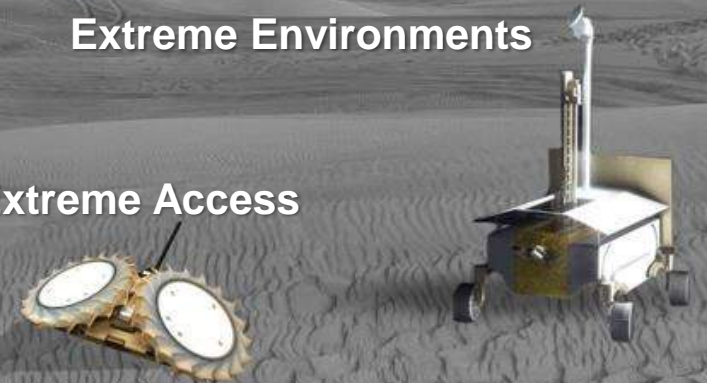
Surface  
Excavation/Construction

In Situ  
Resource  
Utilization



Extreme Environments

Extreme Access



Lunar Surface  
Power



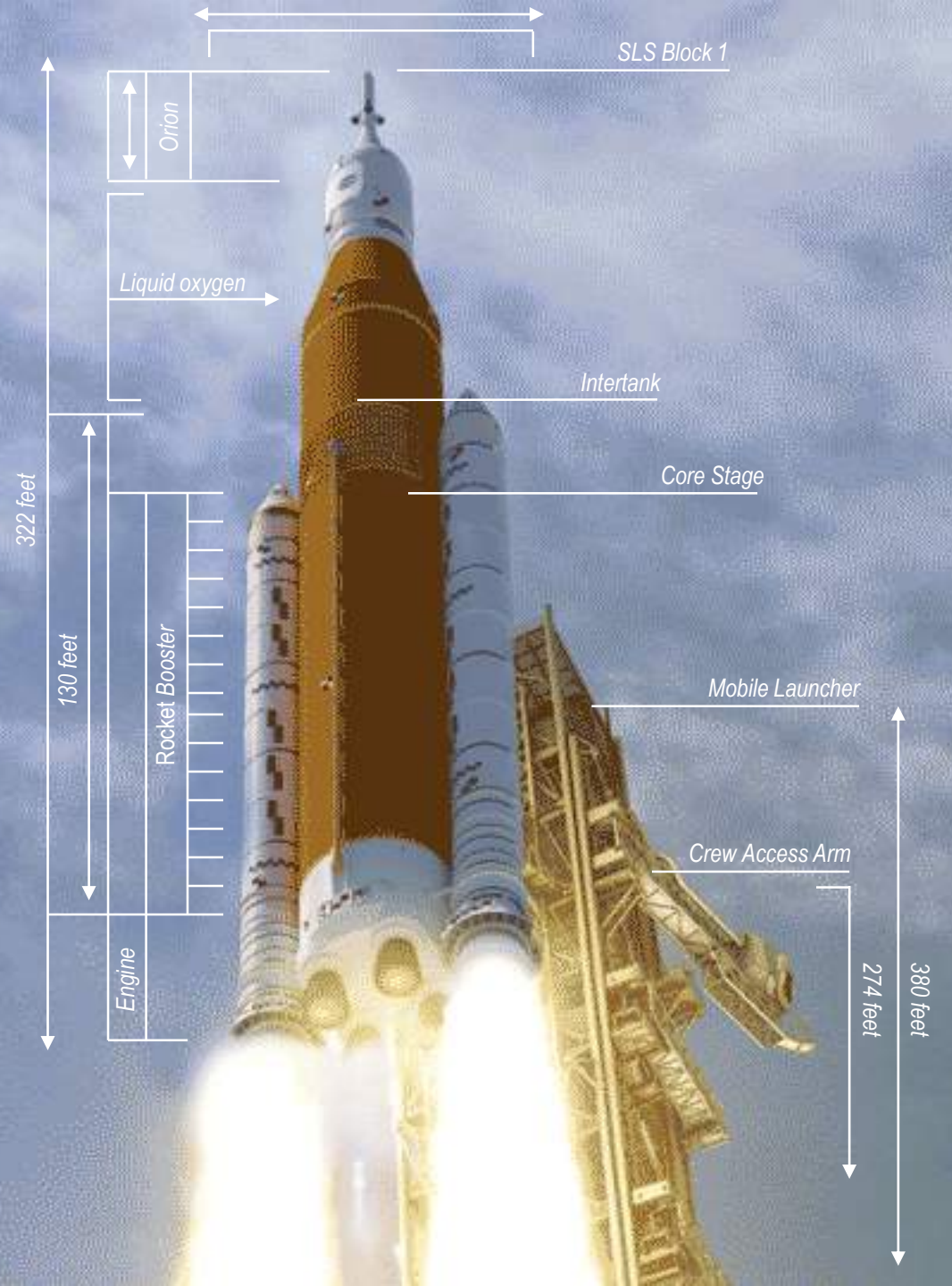
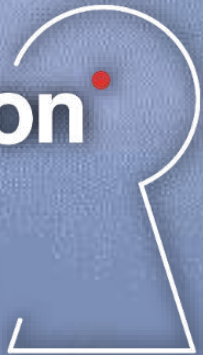
Lunar Surface Innovation Initiative

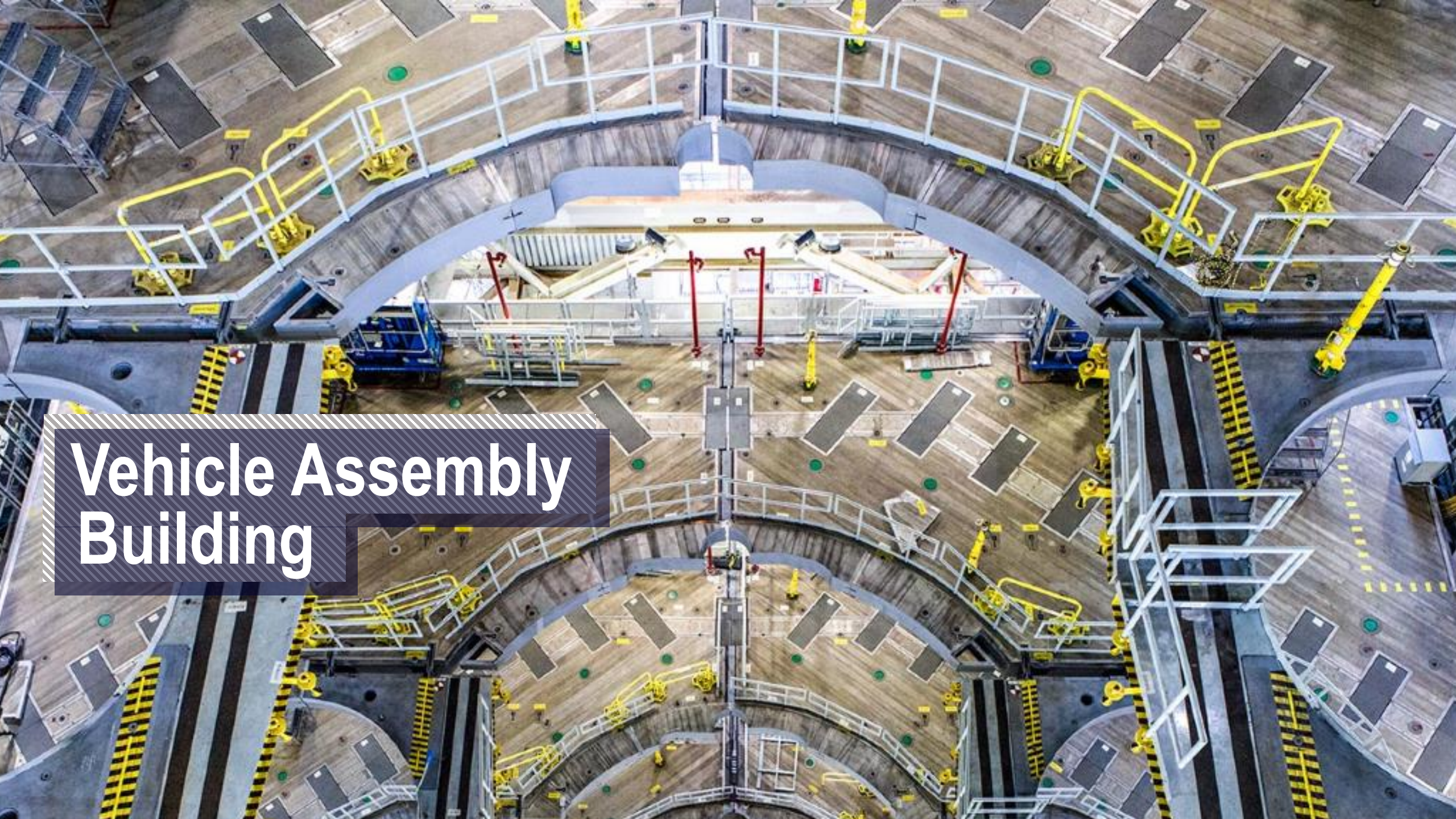
# EGS Striving Toward Launch of Artemis I



# Artemis I

Exploration  
Ground  
Systems





# Vehicle Assembly Building

# Mobile Launcher



- 10.5 million lbs.
- Tower about 355 ft. tall







# Launch Pad 39B



# Landing and Recovery



U.S. Navy

Orion Test Article

# Orion Ascent Abort-2 Flight Test

July 2, 2019



0:39:39  
UNIVERSAL TIME

HOLD TIME REMAINING

1:09:39  
LOCAL TIME

# 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



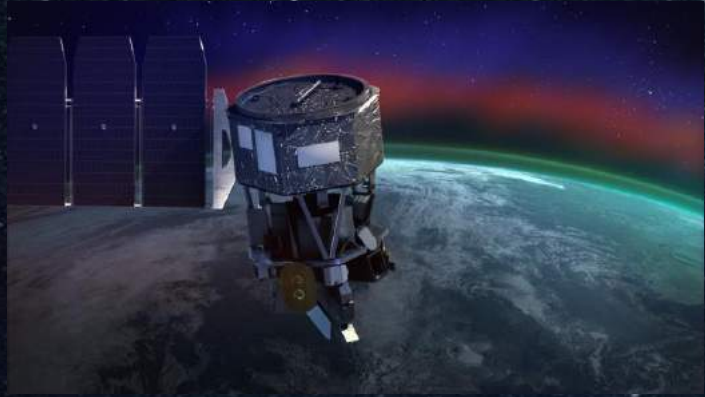
Commercial  
Resupply Services



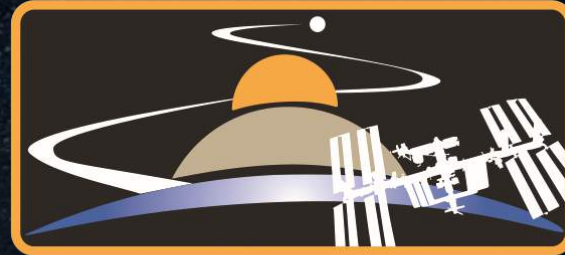
Gateway Logistics

# Ionospheric Connection Explorer (ICON)

October 10, 2019



# Exploration Research and Technology Programs

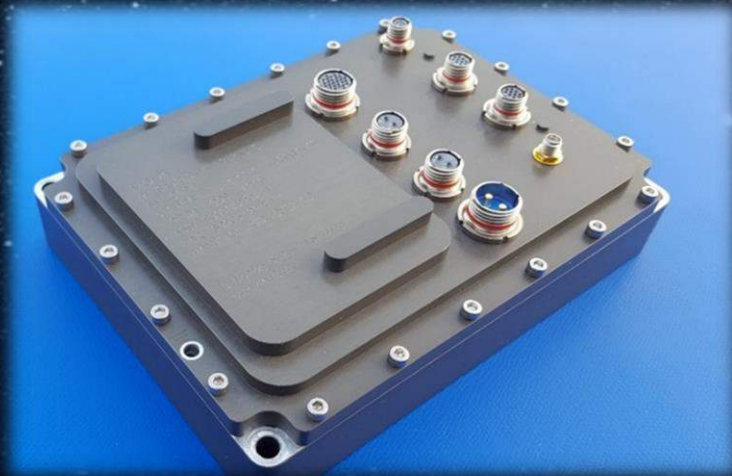


## Exploration Research and Technology Programs





# 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

2019

2020

2021

2022

2023

2024

## Exploration

**~ 65 NASA launches, 10+ NASA launches/year**

MSolo, Observing Lunar Operations, Mass Spectrometer, Lunar Syngas/Commodity Augmentation Reactor, Restore-L, Robotic spacecraft servicing

## International Space Station

**~ 22 ISS launches**

SpX-22, SpX-23, HTV-X4, HTV-X3, CRS 2-12, CRS 2-13

**~ 14 crewed launches**

**~ 16 CCP launches**

## Launch Services

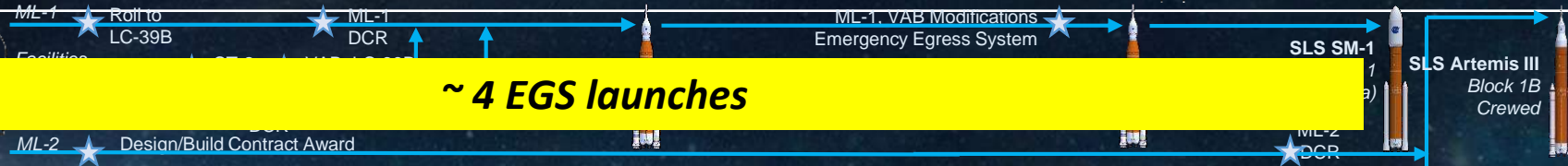
**~ 17 LSP launches**

VCLS-E, IXPE, DART, IPSS-2, GOES-U, IMAP, REX

## Lunar Gateway

**~ 5 Gateway launches**

Power/Propulsion Element, MiniHab, Payload Services



**~ 4 EGS launches**

**103 CoF Projects at >\$1B value**

Phase 1, Solar Plant, Upgrades, Restoration, Competition, Complex 48, Annex Upgrades, LH2 Upgrades, LN2 System, CCHQ Phase 2 (2026)

**~ 7+ launch vehicle fleets**

# KSC's Economic Impact

## 2017 IMPACTS OF SPACEPORT OPERATIONS IN FLORIDA



23,753

FLORIDA JOBS



\$1.6B

TOTAL INCOME  
GENERATED



\$2.2B

VALUE ADDED TO  
FLORIDA'S GDP



\$3.9B

TOTAL ECONOMIC  
IMPACT IN FLORIDA

### SPACEPORT WORKFORCE



1,964

NASA CIVIL SERVANTS



5,488

NASA CONTRACTOR  
EMPLOYEES



1,314

COMMERCIAL LAUNCH  
PROVIDER EMPLOYEES



544

OTHER SPACEPORT  
TENANT EMPLOYEES



884

KSC VISITOR COMPLEX  
EMPLOYEES

EVERY \$1 SPENT AT KSC RESULTS IN  
FOR FLORIDA'S ECONOMY \$1.92



SPACEPORT  
AVERAGE  
INCOME

\$99,000

GROWTH OF THE MULTI-USER SPACEPORT  
NON-NASA JOBS AT KSC: 2010, 2017

10% 2010 → 27% 2017

### VISITORS



1.693M

TOTAL VISITORS TO  
THE KSC VISITORS  
COMPLEX



1.4M

OUT-OF-STATE  
VISITORS



\$110.1M

OUT-OF-STATE  
VISITOR SPENDING

10,194 + 13,559

TOTAL SPACEPORT  
EMPLOYMENT

ADDITIONAL FLORIDA  
JOBS CREATED

EVERY

10

JOBS  
AT KSC



CREATES  
APPOX.  
13.3  
JOBS IN FLORIDA

## KENNEDY SPACE CENTER WORKFORCE PROFILE (through 9/30/18)

Civil Servants	1,909*
NASA Pathways Interns	82
<b>Total Civil Servants</b>	<b>1,991</b>

\*includes 8 part-time permanent and 1 full-time temporary employees

### Civil Servants Skill Mix

Scientific, Technology, Engineering and Mathematics	33%
Clerical and Professional Administrative	67%

On-site Contractor Employees	4,557
Off-site/Near-site Contractor Employees (Excludes construction workers)	85
<b>Total Contractor Employees</b>	<b>4,642</b>

Total Construction Workers	445
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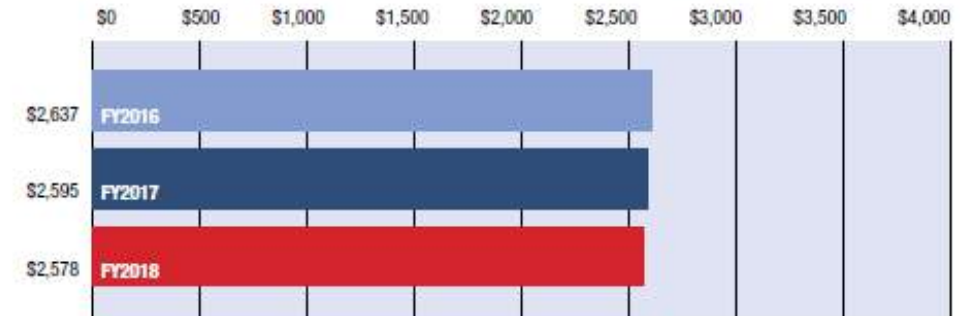
Total Tenants	2,146
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<b>TOTAL KSC POPULATION</b>	<b>9,224</b>
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## KENNEDY SPACE CENTER FY 2018 BUDGET AUTHORITY (\$ IN MILLIONS)

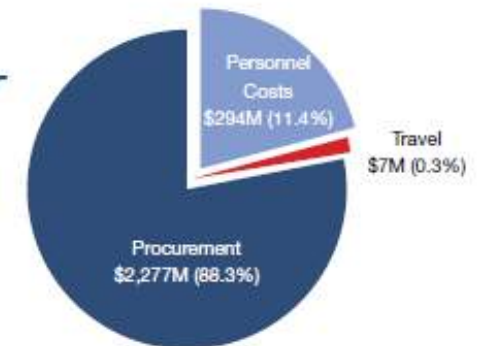
Commercial Crew Program	\$913
Launch Services/Science	\$492
Ground Systems Development and Operations	\$517
Space Station	\$57
Center Management & Operations	\$329
Other	\$270
<b>Total KSC</b>	<b>\$2,578</b>

## NASA/KSC BUDGET AUTHORITY SUMMARY FY 2016 THROUGH FY 2018 (\$ IN MILLIONS)



## FY 2018 KSC BUDGET BY ELEMENT (\$ IN MILLIONS)

TOTAL \$2,578M





<b>ALL</b>	\$10,530,146
Business	\$5,774,554
Large Business	\$3,453,087
Small Business	\$2,321,467
Small Business Innovative Research	\$871,056
Small Disadvantaged Business	\$167,990
Woman Owned Small Business	\$3,779
Educational	\$5,036,819
Non Profit Institutions	-\$281,227

#### LEADING STATE-BASED NASA BUSINESS CONTRACTORS

Contractor	Location	Investment
Honeywell International, Inc.	Minneapolis (Dist. 05)	\$1,842,181
Architecture Technology Corporation	Eden Prairie (Dist. 03)	\$1,471,056
MTS Systems Corporation	Eden Prairie (Dist. 03)	\$640,425

#### LEADING STATE-BASED NASA EDUCATION FUNDING

School	Location	Investment
Regents of the University of Minnesota	Minneapolis (Dist. 05)	\$4,933,754
Winona State University	Winona (Dist. 01)	\$20,000
Mayo Clinic	Rochester (Dist. 01)	\$83,065

# ELaNa 25A

Date: November 2, 2019

Mission: NG-12 – Antares II,  
Wallops Flight Facility, VA

7 CubeSat Missions scheduled to  
be deployed

SOCRATES – University of Minnesota, Minneapolis,  
Minnesota

SOCRATES will advance a Gamma Ray Incidence  
Detector (GRID) sensor from TRL 5 to 7. The sensor  
is being developed to make accurate positioning,  
navigation and timing measurements for CubeSats.



The graphic features a blue and orange color scheme. At the top, the text 'ELaNa 25' is written in large orange letters, with 'NASA NanoRacks' below it. The background shows a satellite in space with solar panels, a cluster of stars, and a view of Earth from space. A white launch rail is shown in the foreground. At the bottom, a list of CubeSat missions is provided in two columns. The quote 'Launching Education Into Space' is at the bottom center, and the vertical text 'Educational Launch of Nanosatellites' is on the right side.

**ELaNa 25**  
NASA NanoRacks

Argus-02	NEUTRON-1
AzTechSat-1	Phoenix
CAPSat	RadSat-u
CryoCube	SOCRATES
CySat-1	SORTIE
HARP	TJREVERB
HuskySat-I	SwampSat-II

“Launching Education Into Space”

Educational Launch of Nanosatellites



**NASA**