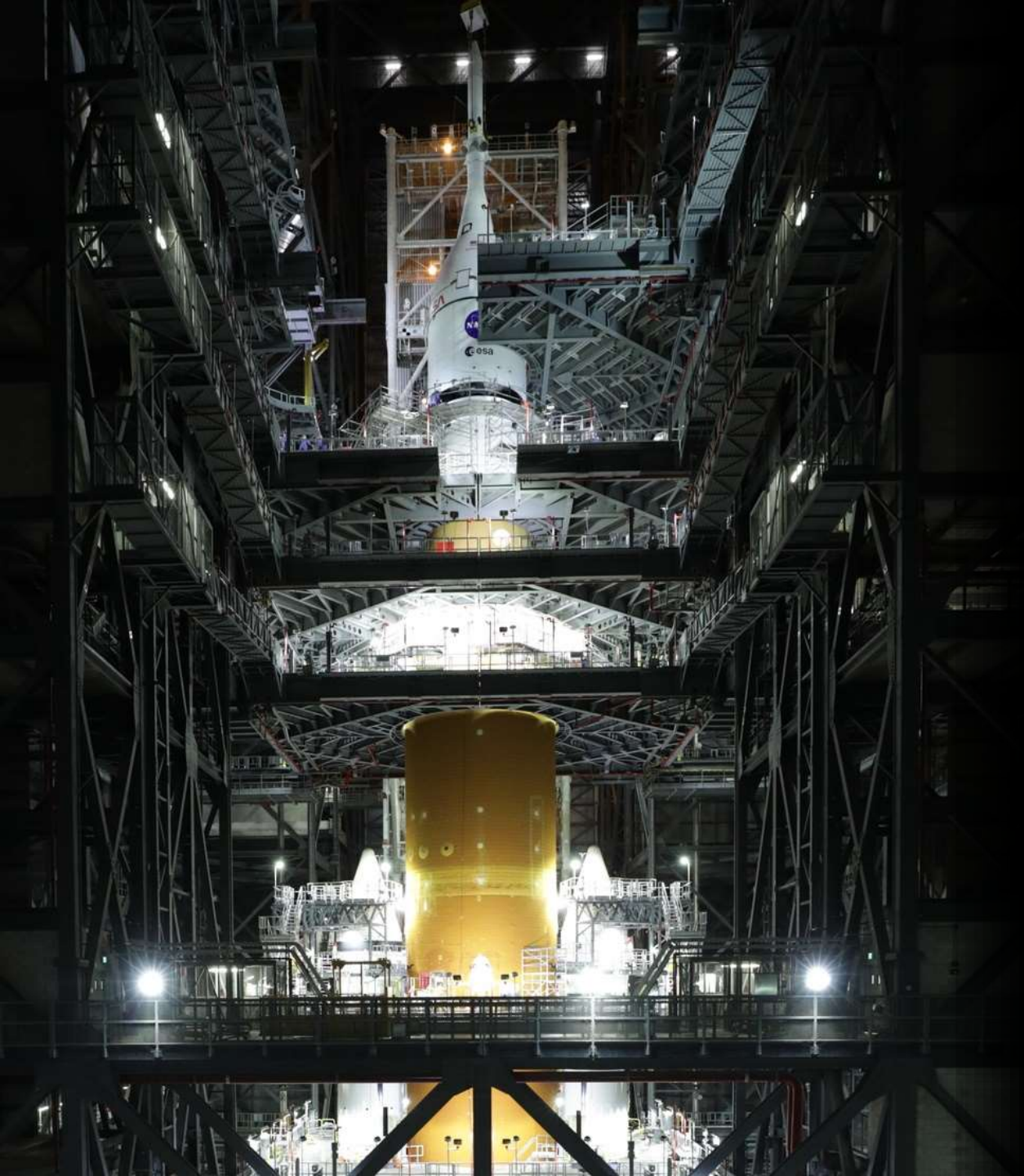


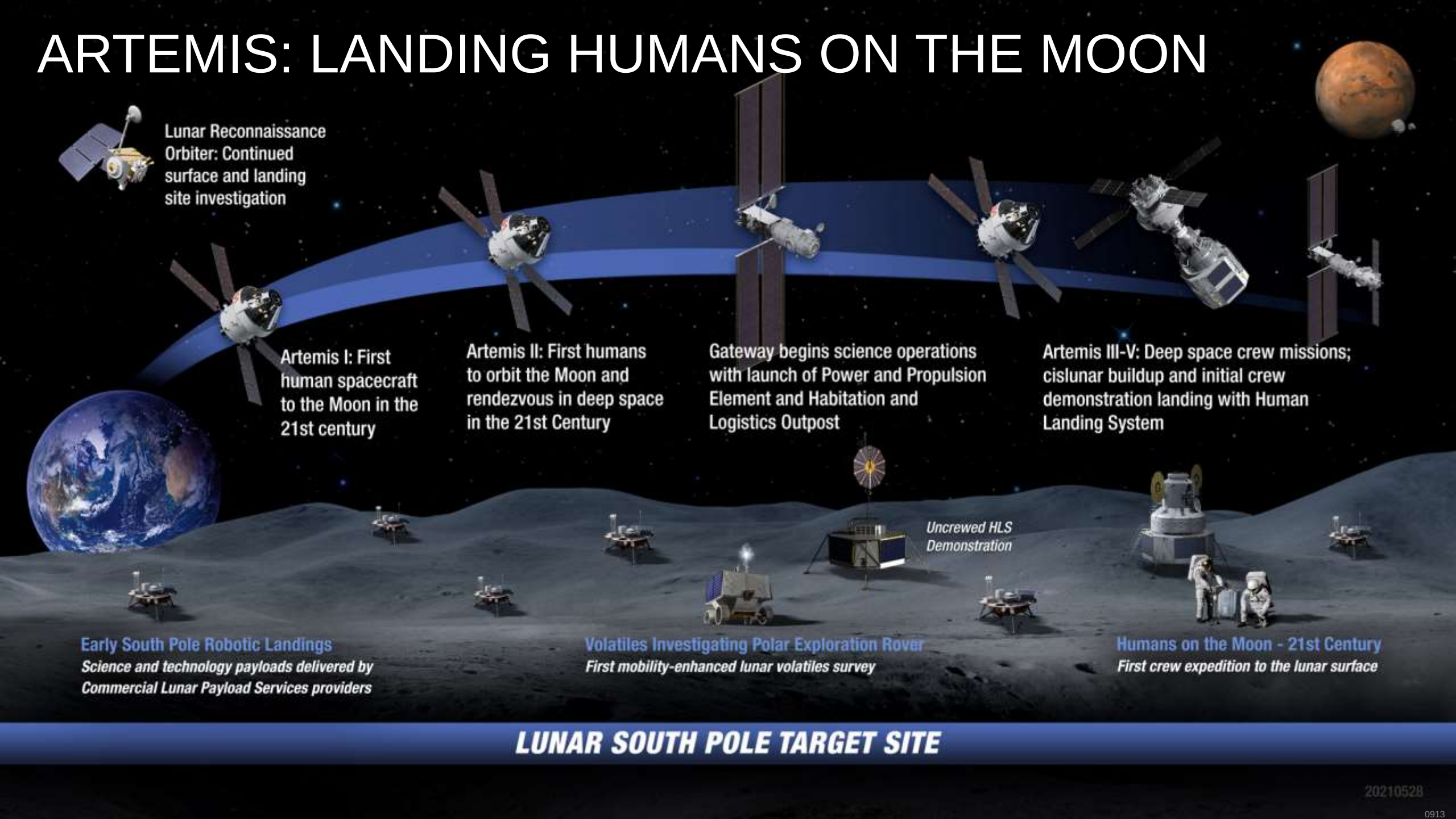
SPACE LAUNCH SYSTEM

Countdown to Launch

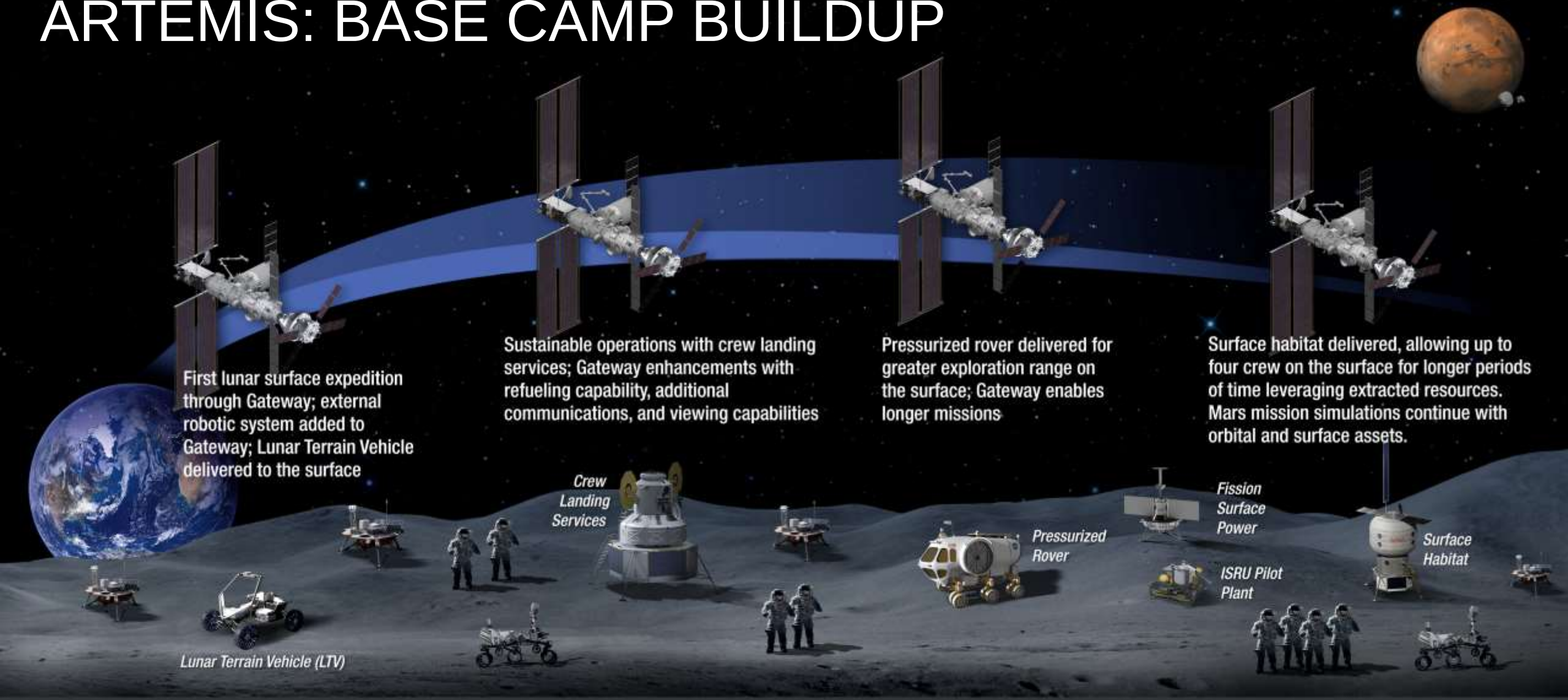
January 11, 2022

Brian Matisak
Block 1 Deputy Manager
Systems Engineering & Integration Office
SLS Program

ARTEMIS: LANDING HUMANS ON THE MOON



ARTEMIS: BASE CAMP BUILDUP



SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

MULTIPLE SCIENCE AND CARGO PAYLOADS | U.S. GOVERNMENT, INDUSTRY, AND INTERNATIONAL PARTNERSHIP OPPORTUNITIES | TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

20210528

0913

LUNAR MISSIONS PREPARE US FOR MARS

IN ORBIT

DEEP SPACE AGGREGATION
Assembling a complex ship in deep space

MARS TRANSIT HABITAT
Round the clock, years-long operations of a Mars-class habitat and life support system

ORBIT TO SURFACE OPERATIONS
Operating an orbiting outpost that deploys a lander and its crew to a planetary surface

COMMERCIAL RESUPPLY AND REFUELING
Leveraging the space logistics supply chain for industry provided cargo deliveries

CREW HEALTH & PERFORMANCE
Studying how the human body and mind adapt to deep space hazards

A roundtrip mission to Mars will take about two years—and once the ship's course is set, there's no turning back.

As much as is possible, lunar systems will be designed for dual Moon-Mars operations.

Integrated missions in the lunar vicinity prepare us for successful Mars missions.

ON THE SURFACE

SPACESUIT ADVANCEMENTS
Improving spacesuit design across Artemis missions with astronaut input and private sector innovation

MOBILE OPERATIONS
Living and working 'on the go' inside a mobile habitat for weeks at a time

PLANETARY PROTECTION
Mitigating dust transfer and establishing pristine sample curation protocols

HUMAN ROBOTIC EXPLORATION
Robots pre-positioning surface assets and conducting reconnaissance for astronauts

HUMAN RESILIENCE
Learning how humans can survive and thrive in a partial gravity environment

THE POWER OF SLS

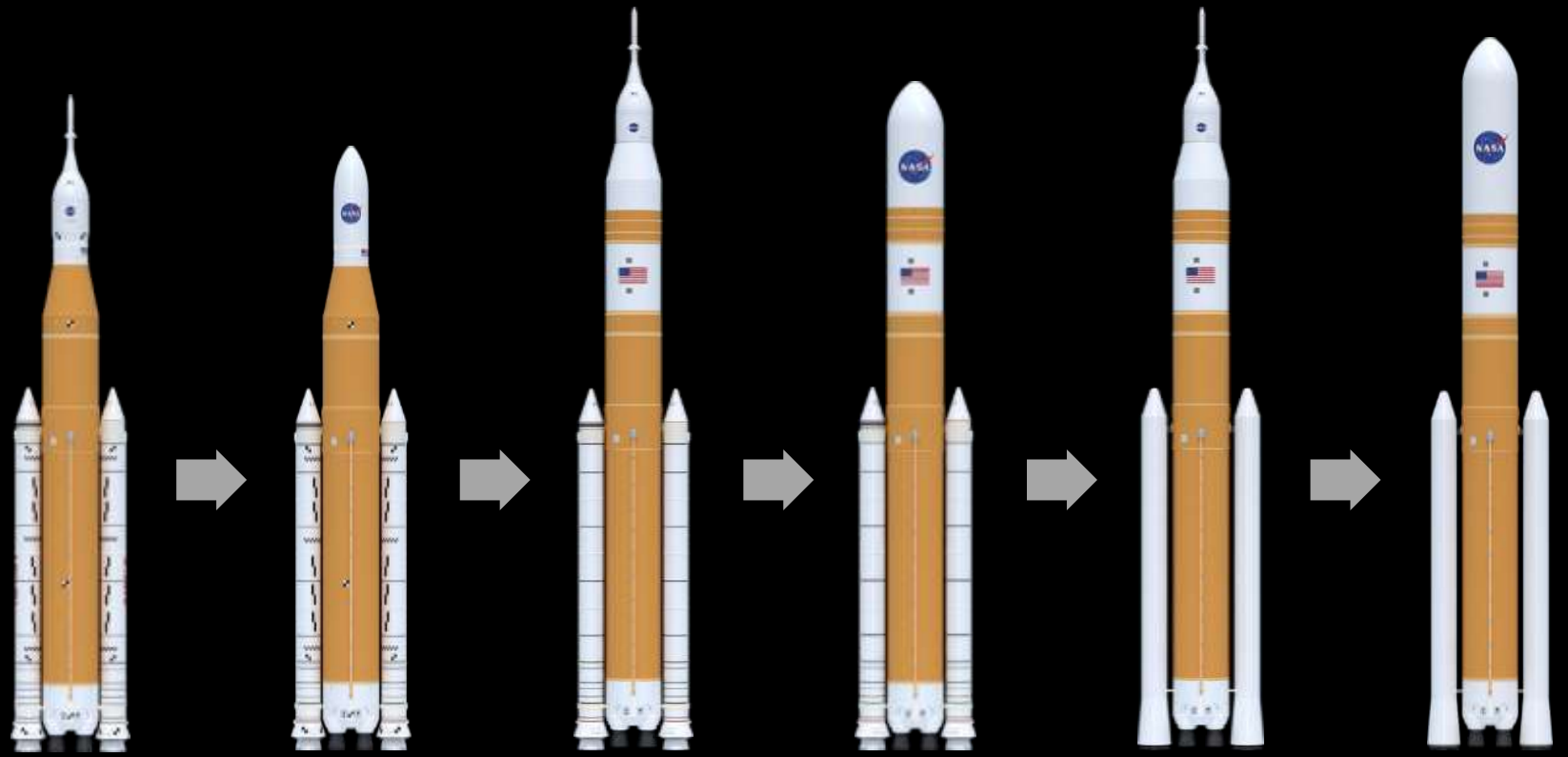
FOUNDATION FOR A GENERATION OF DEEP SPACE EXPLORATION

	SLS Block 1 Crew	SLS Block 1 Cargo	SLS Block 1B Crew	SLS Block 1B Cargo	SLS Block 2 Crew	SLS Block 2 Cargo
Payload to LEO	95 t (209.4k lbs)	95 t (209.4k lbs)	105 t (231.4k lbs)	105 t (231.4k lbs)	130 t (286.6k lbs)	130 t (286.6k lbs)
Payload to TLI/Moon	> 27 t (59.5k lbs)	> 27 t (59.5k lbs)	38 t (83.7k lbs)	42 t (92.5k lbs)	> 43 t (94.7k lbs)	> 46 t (101.4k lbs)
Payload Volume	516 ft^3 (14.6 m^3)	8,118 ft^3 (229.9 m^3)	10,100 ft^3 (286 m^3)**	21,930 ft^3 (621.1 m^3)	10,100 ft^3 (286 m^3)**	34,910 ft^3 (988 m^3)

Low Earth Orbit **(LEO)** represents a typical 200 km circular orbit at 28.5 degrees inclination

Trans Lunar **Injection (TLI)** is a propulsive maneuver used to set a spacecraft on a trajectory that will cause it to arrive at the Moon. A spacecraft performs **TLI** to begin a lunar transfer from a low circular parking orbit around Earth.

The numbers depicted here indicate the mass capability at the Trans-Lunar Injection point.



** Not including Orion/Service Module volume

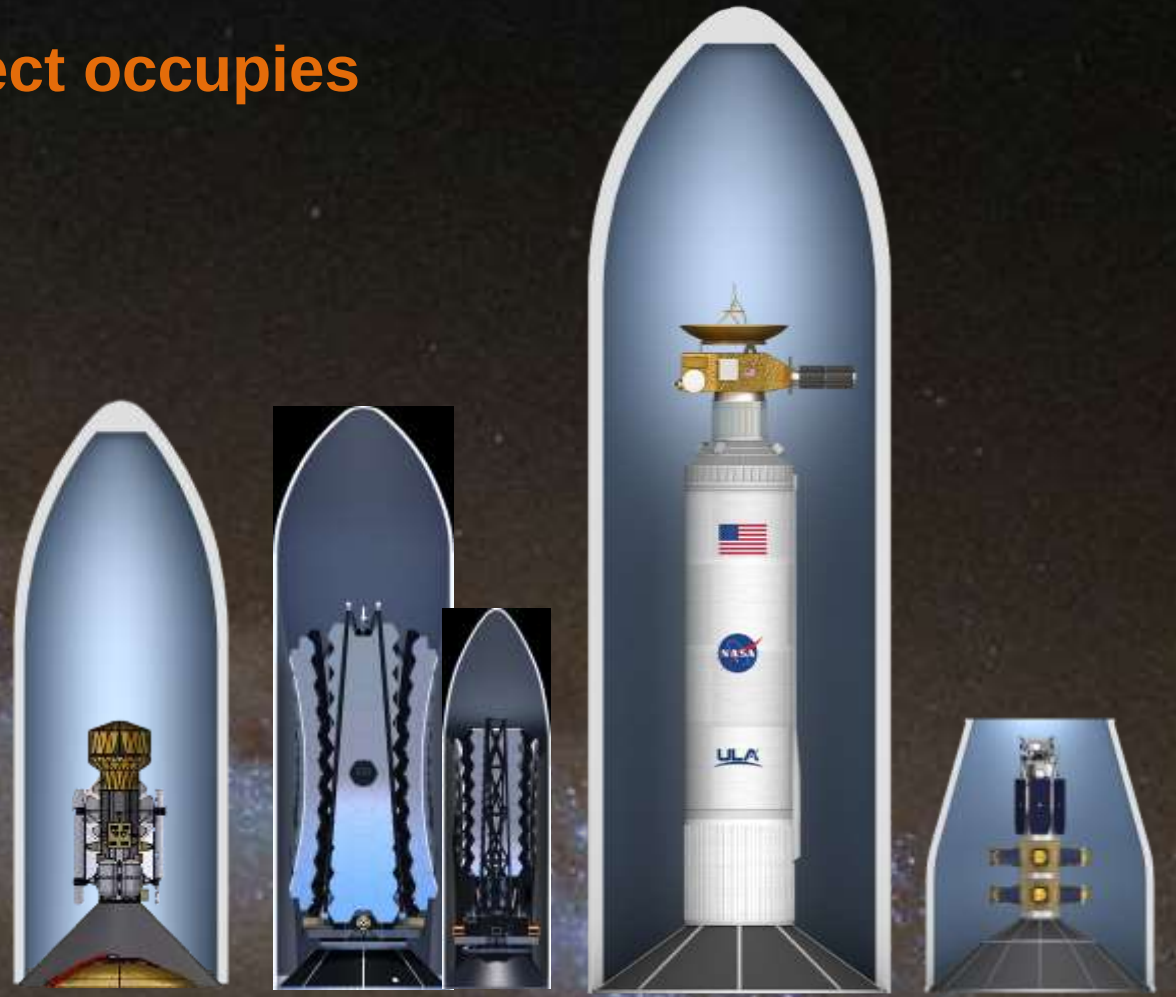
	SLS Block 1 Crew	SLS Block 1 Cargo	SLS Block 1B Crew	SLS Block 1B Cargo	SLS Block 2 Crew	SLS Block 2 Cargo
Maximum Thrust	8.8 M lbs	8.8 M lbs	8.9 M lbs	8.9 M lbs	9.5 M lbs	9.5 M lbs

SLS ENABLES CARRYING MORE

UNIQUE CAPABILITY FOR EXPLORATION

VOLUME: the amount of space that an object occupies

- SLS is the only vehicle that can carry the Orion and a co-manifested payload to the Moon
- Later versions of SLS will carry more than double the volume of any contemporary heavy lift vehicle, enabling large habitats, telescopes, and more
- SLS in Block 1B configuration with an 8.4 m long fairing:
  - Could take two Hubble Telescopes to Mars
  - Could hold 87 standard Sedans

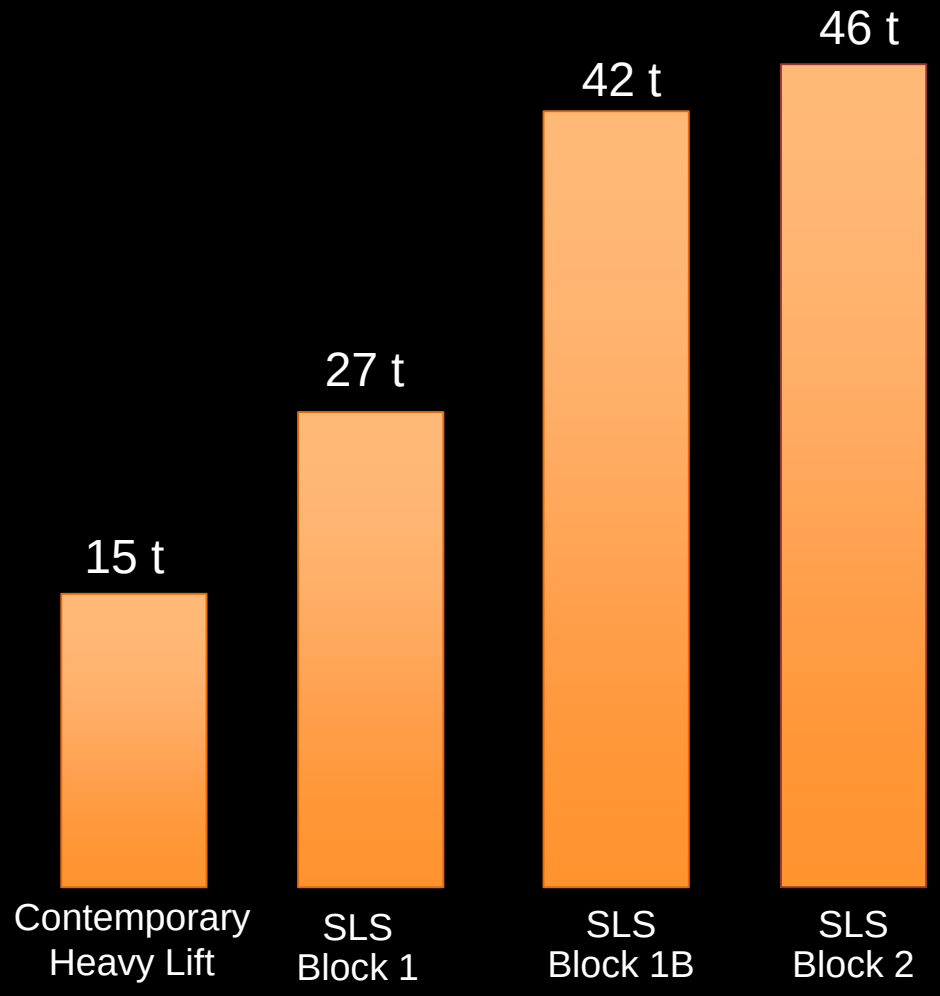


SLS can carry more using the large fairing (or nose cone) in its cargo configuration for deep space science missions

SLS ENABLES CARRYING MORE

UNIQUE CAPABILITY FOR EXPLORATION

MASS: the measure of the matter in an object



- Artemis I has the capability of carrying greater than 26 metric tons to Trans-Lunar Injection
- Later versions of SLS have the capability of carrying 46 metric tons
- Block 1B: Can launch 50% more mass than any contemporary launch vehicle
- Block 2: Mars-enabling capability of greater than 45 metric tons to Trans Lunar Injection
- SLS enables carrying more to the Moon… paving the way to Mars and beyond

Orion with Co-manifested payload

SLS GOES FASTER, FARTHER

UNIQUE CAPABILITY FOR EXPLORATION

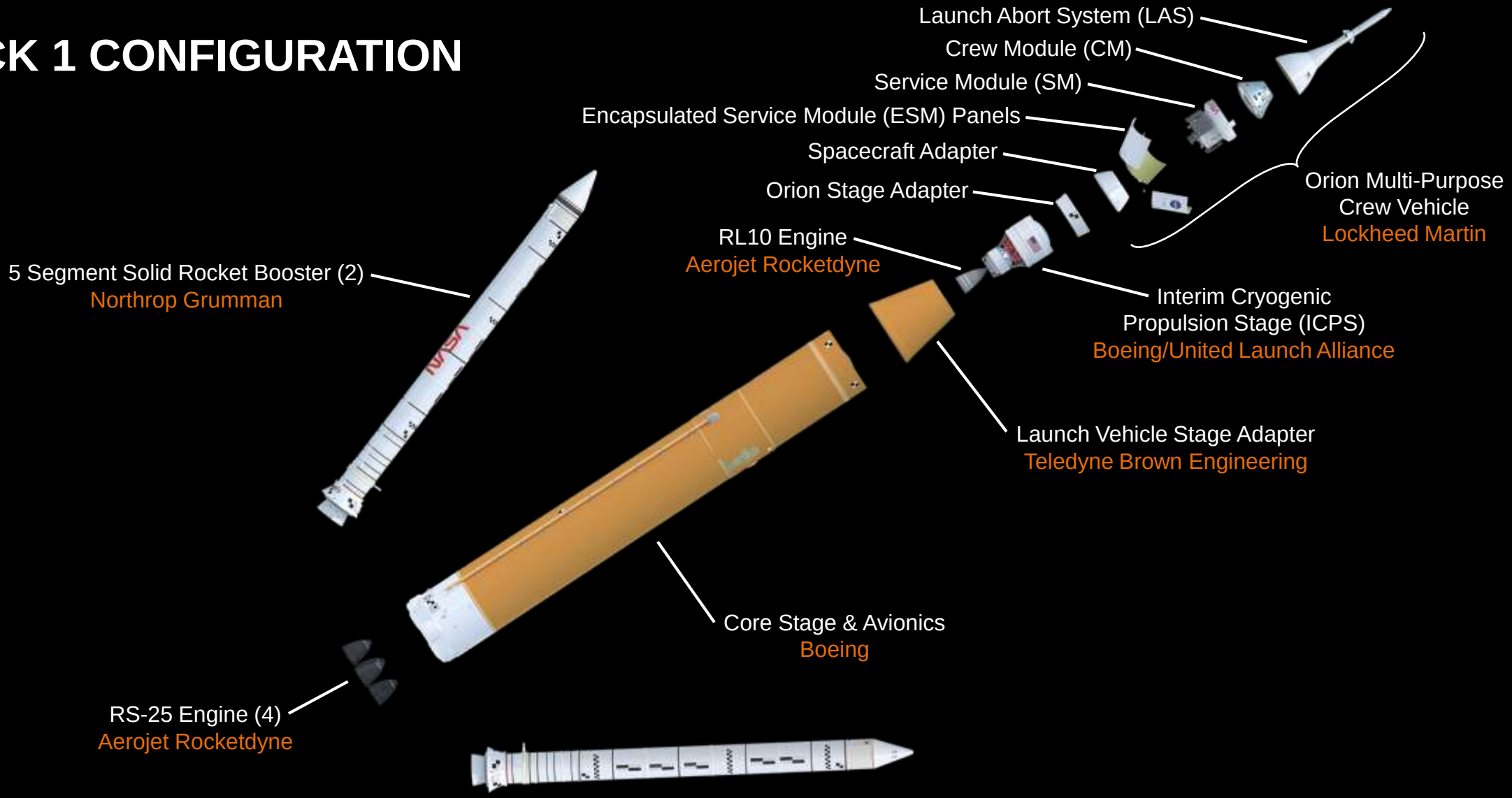
DEPARTURE ENERGY: The energy a mission requires after escaping Earth's gravitational influence

- SLS's unmatched departure energy benefits deep space exploration and science missions by allowing payload developers the flexibility to trade mass, volume and speed to match their mission preference
- SLS's departure energy can reduce transit times by half or greater to the outer solar system

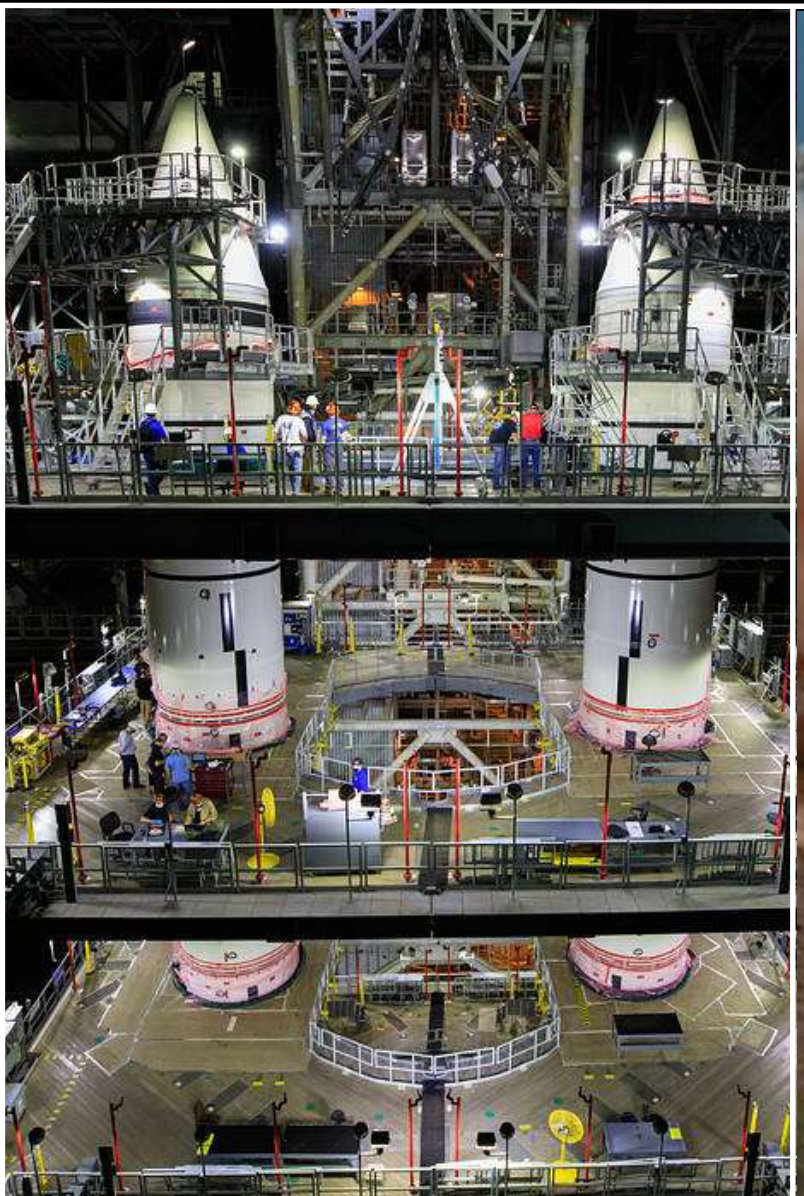
NASA'S SPACE LAUNCH SYSTEM

BACKBONE OF DEEP SPACE EXPLORATION

BLOCK 1 CONFIGURATION



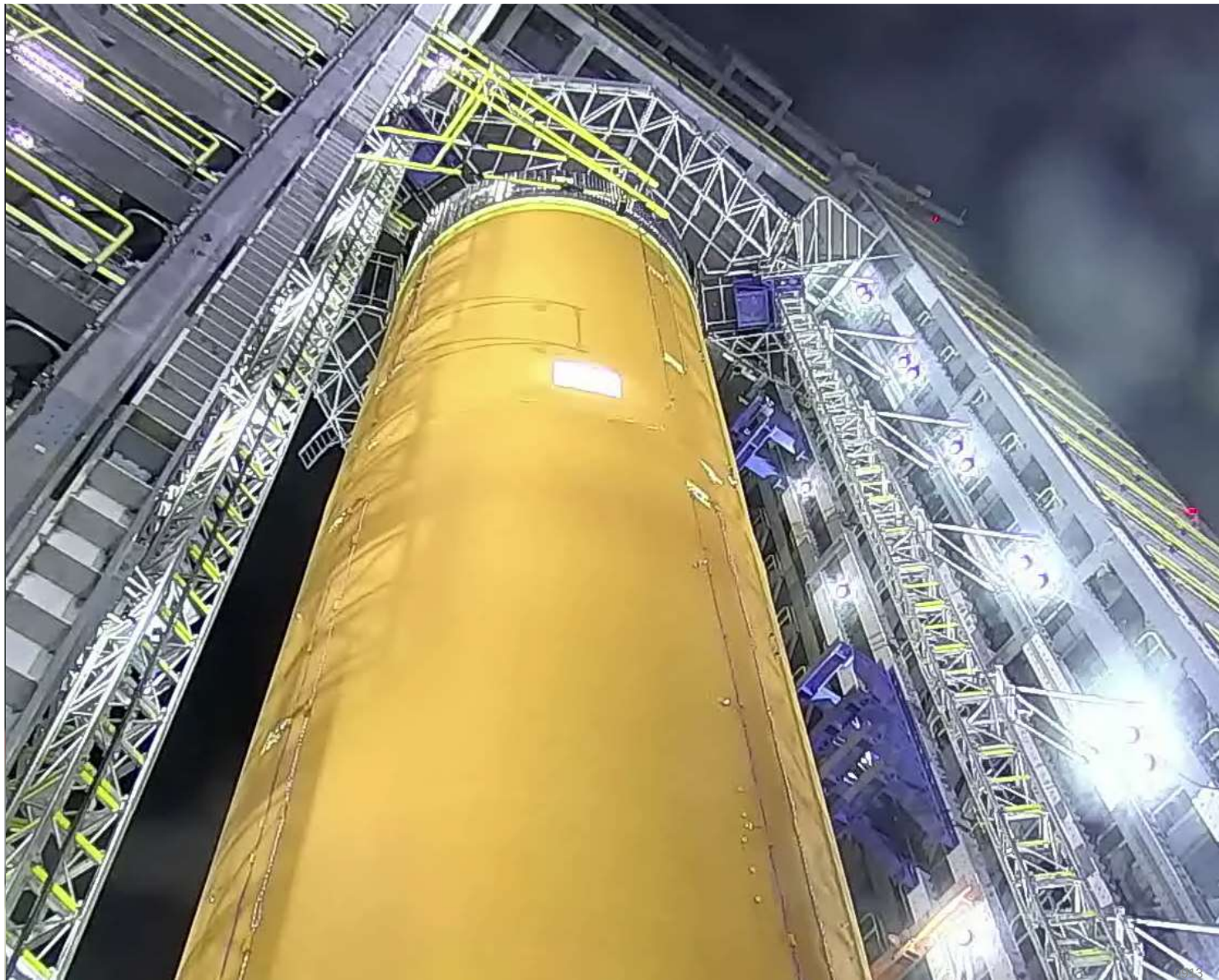
SLS SOLID ROCKET BOOSTERS



SLS RS-25 CORE STAGE ENGINES

SLS CORE STAGE

TESTING LOX AND LH2 TANKS



GREEN RUN TEST SERIES COMPLETE

SPACE LAUNCH SYSTEM

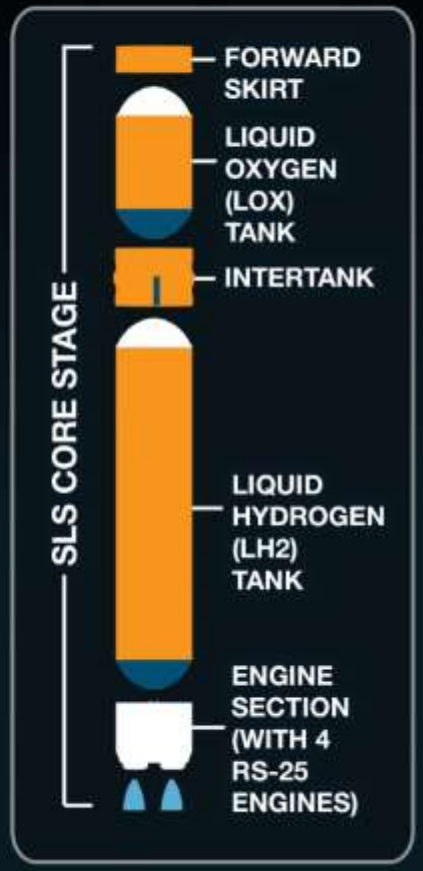
ARTEMIS TESTING: GREEN RUN CHECKLIST

National Aeronautics and Space Administration

TESTING THE WORLD'S LARGEST ROCKET STAGE

A total of eight Green Run tests minimize risk to the **ARTEMIS I** core stage and ensure the flight hardware satisfies design objectives and validates design models:

TEST 1	Apply forces simulating launch to the unpowered, suspended core stage.	✓
TEST 2	Turn on and check out core stage avionics.	✓
TEST 3	Simulate potential issues to test systems that shut down other systems if there's a problem.	✓
TEST 4	Test main propulsion system components that connect to the engines.	✓
TEST 5	Test thrust vector controls and check out all the related hydraulic systems.	✓
TEST 6	Simulate launch countdown to validate timeline and sequence of events.	✓
TEST 7	Load and drain more than 700,000 gallons of cryogenic propellants.	✓
TEST 8	Fire all four RS-25 engines for up to 8 minutes.	✓



#ARTEMIS

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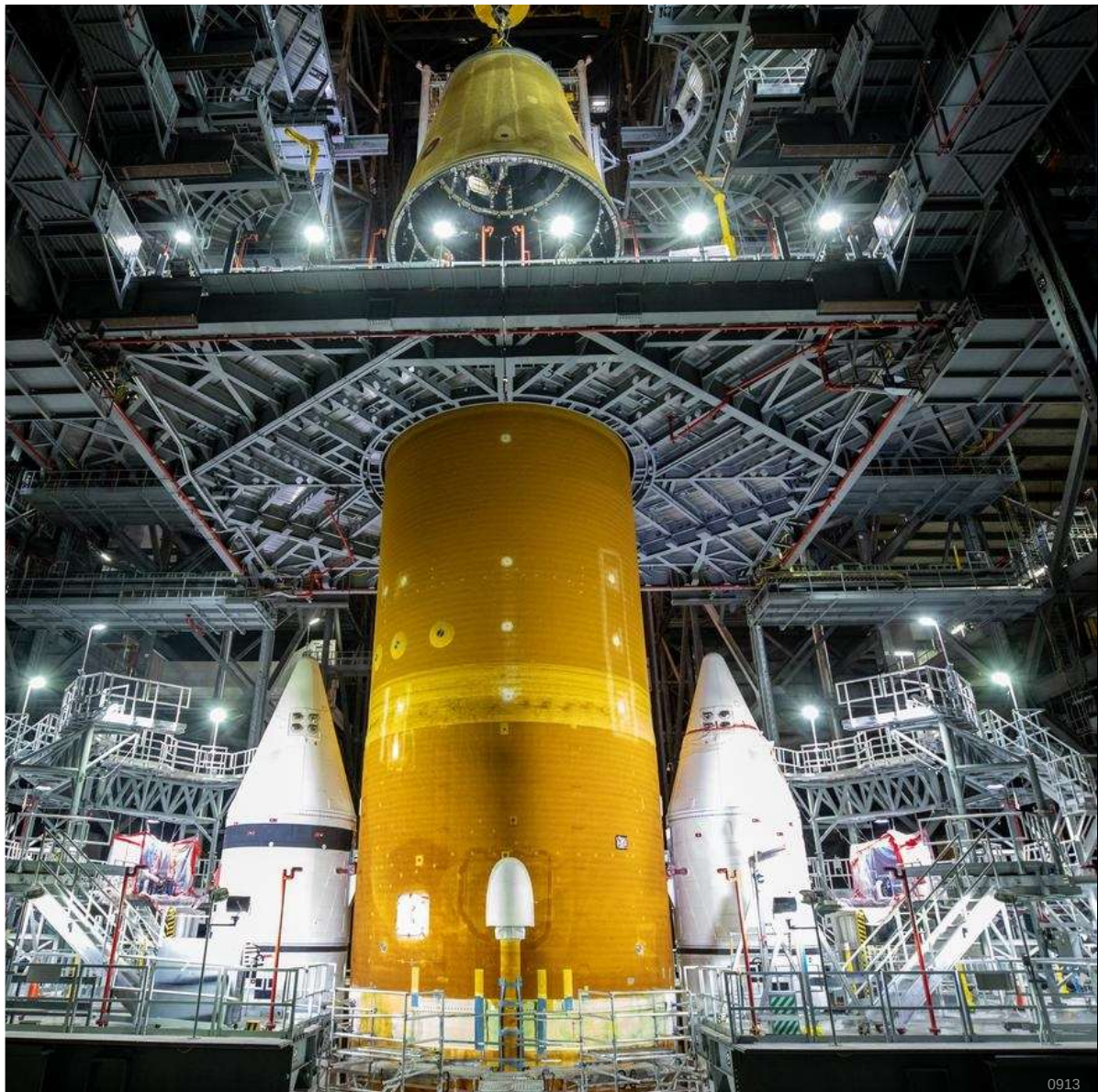
LVSA STACKED IN THE VAB



INTERIM CRYOGENIC PROPULSION STAGE - STACKED

MODAL TESTING

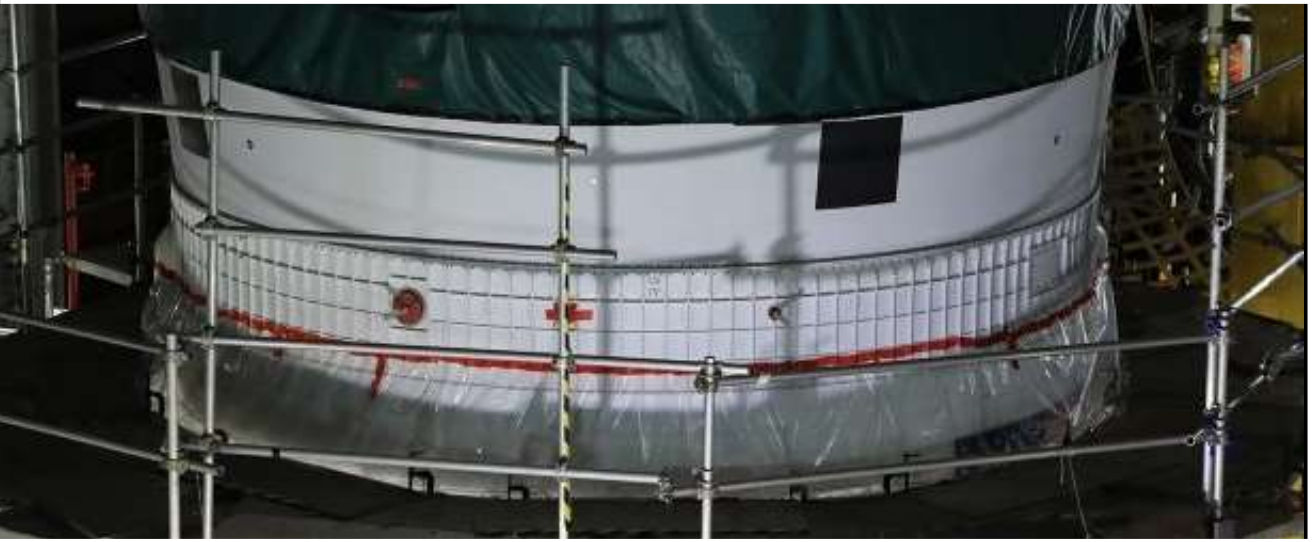
Orion mass simulator for modal testing

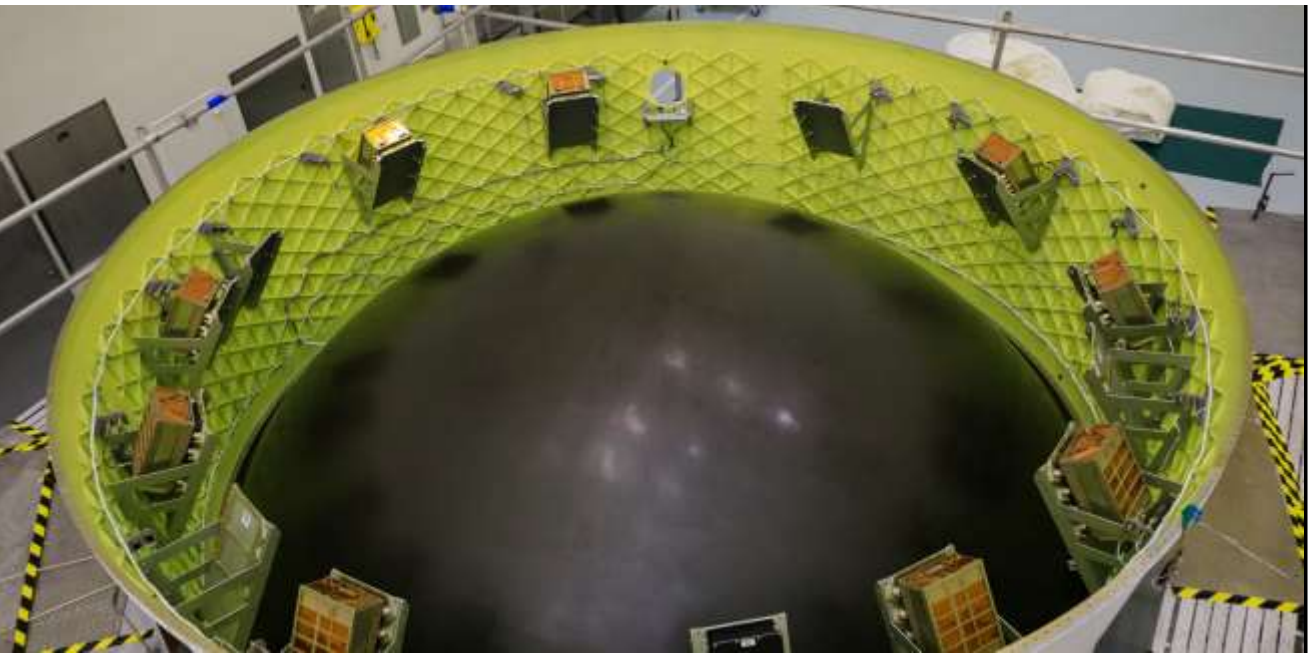
Integrated modal testing stack

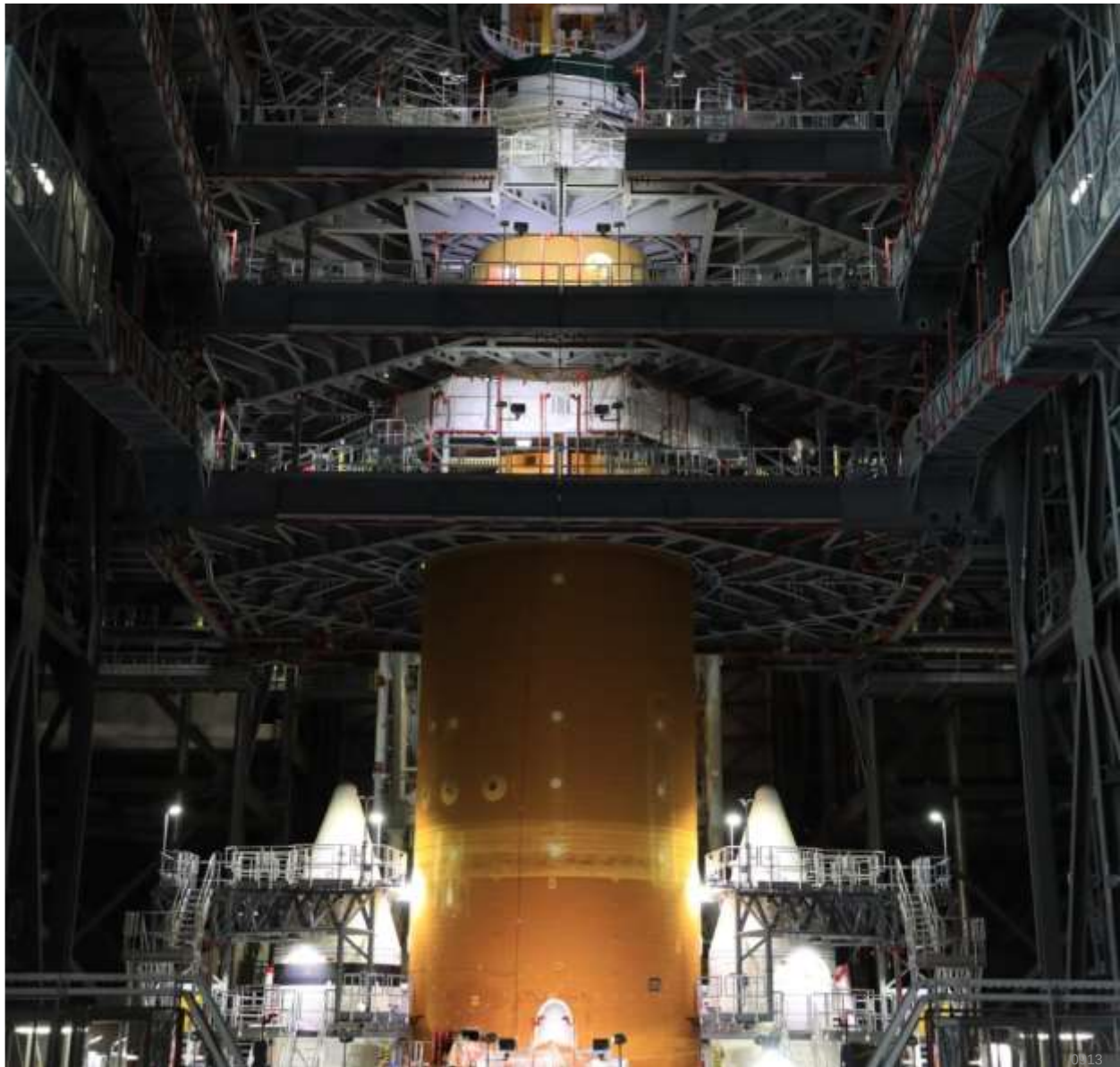
Mission simulations in progress

SLS Engineering Support Center

ORION STAGE ADAPTER STACKED

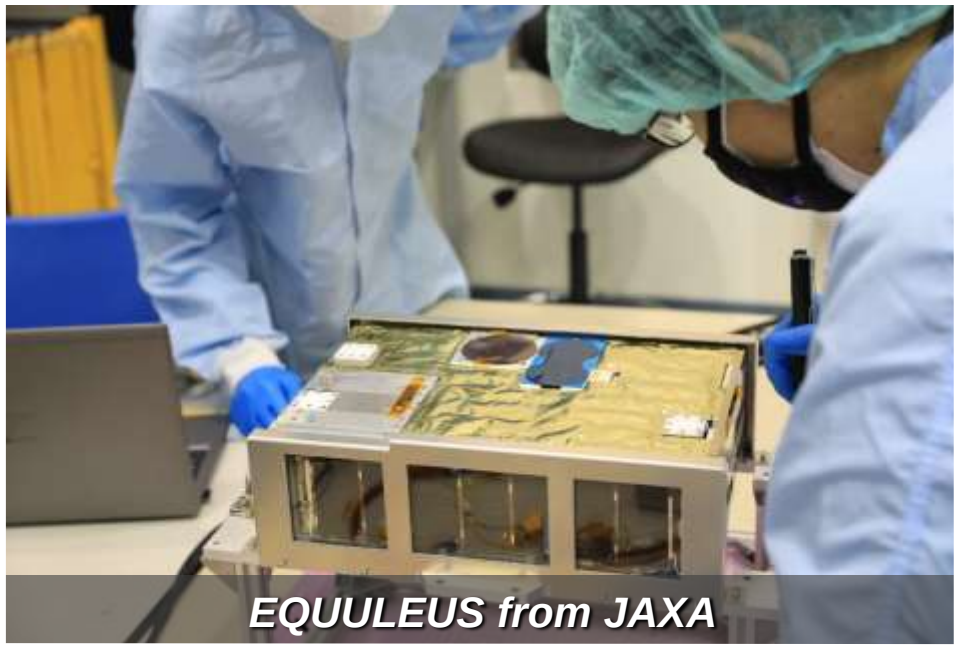






ARTEMIS I CUBESAT PAYLOAD INTEGRATION

Team Miles



EQUULEUS from JAXA

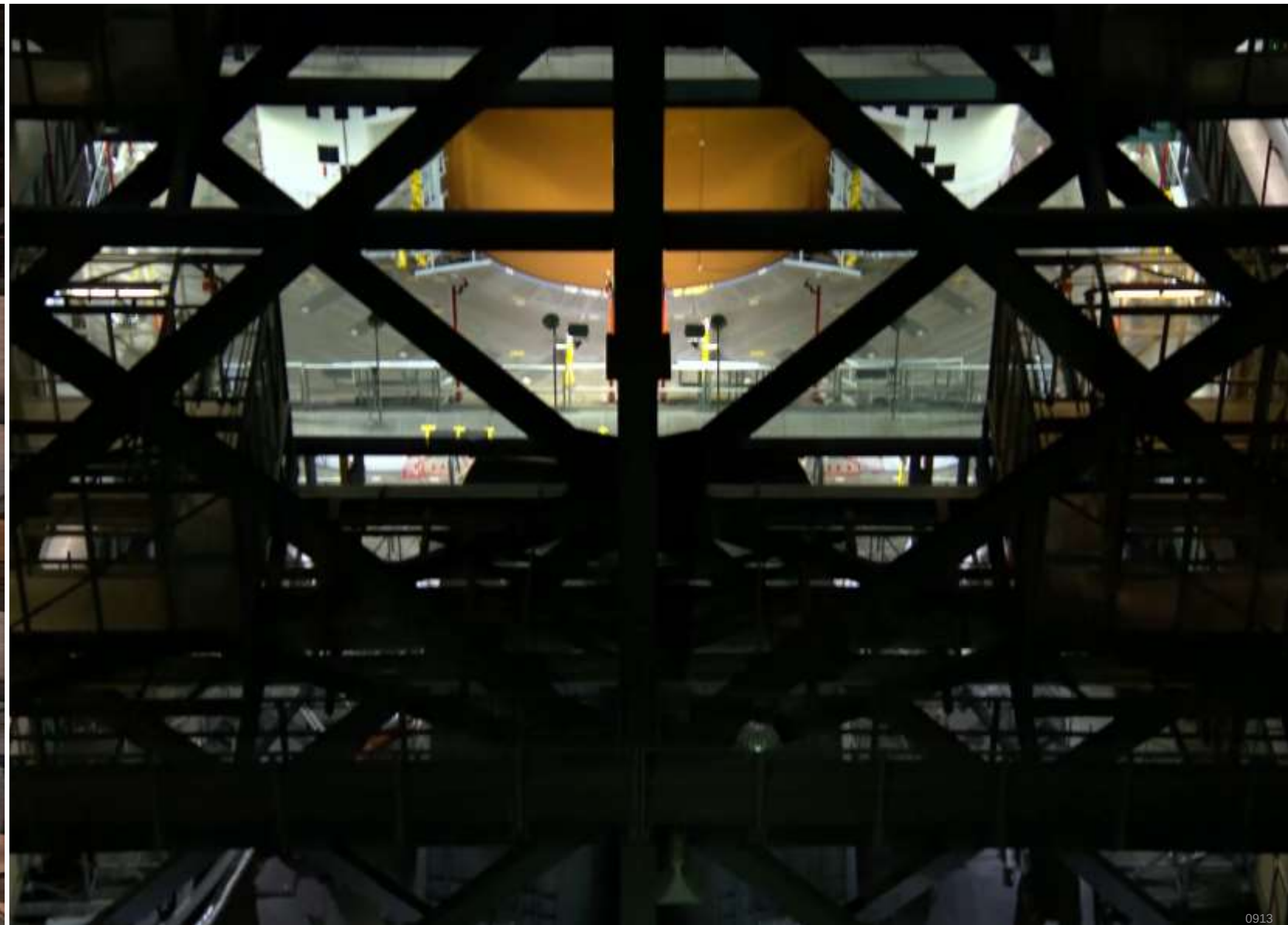
Lunar IceCube from Morehead State University

NEA Scout from Marshall Space Flight Center

OMOTENASHI from JAXA

OSA

ORION SPACECRAFT STACKED



ARTEMIS I: COUNTDOWN TO LAUNCH

Mission simulations in progress

SLS Engineering Support Center

- More testing, joint simulations to come
- Wet dress rehearsal
- Rollout to Pad B for launch of Artemis I

ARTEMIS I

The First Uncrewed Integrated Flight Test of NASA's Orion Spacecraft and Space Launch System Rocket

1. **LAUNCH**
   SLS and Orion lift off from pad 39B at Kennedy Space Center.
2. **JETTISON ROCKET BOOSTERS, FAIRINGS, AND LAUNCH ABORT SYSTEM**
3. **CORE STAGE MAIN ENGINE CUT OFF**
   With separation.
4. **PERIGEE RAISE MANEUVER**
5. **EARTH ORBIT**
   Systems check with solar panel adjustments.
6. **TRANS LUNAR INJECTION (TLI) BURN**
   Maneuver lasts for approximately 20 minutes.
7. **INTERIM CRYOGENIC PROPULSION STAGE (ICPS) SEPARATION AND DISPOSAL**
   ICPS commits Orion to moon at TLI.
8. **OUTBOUND TRAJECTORY CORRECTION (OTC) BURNS**
   As necessary adjust trajectory for lunar flyby to Distant Retrograde Orbit (DRO).
9. **OUTBOUND POWERED FLYBY (OPF)**
   60 nmi from the Moon; targets DRO insertion.
10. **LUNAR ORBIT INSERTION**
    Enter Distant Retrograde Orbit.
11. **DISTANT RETROGRADE ORBIT**
    Perform half or one and a half revolutions in the orbit period 38,000 nmi from the surface of the Moon.
12. **DRO DEPARTURE**
    Leave DRO and start return to Earth.
13. **RETURN POWERED FLYBY (RPF)**
    RPF burn prep and return coast to Earth initiated.
14. **RETURN TRANSIT**
    Return Trajectory Correction (RTC) burns as necessary to aim for Earth's atmosphere.
15. **CREW MODULE SEPARATION FROM SERVICE MODULE**
16. **ENTRY INTERFACE (EI)**
    Enter Earth's atmosphere.
17. **SPLASHDOWN**
    Pacific Ocean landing within view of the U.S. Navy recovery ship.

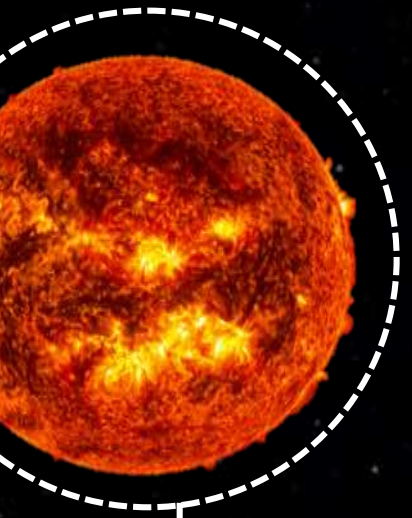
10/7/2021

ARTEMIS I TEST OBJECTIVES

Rigorous Checkout prior to Crewed Flights

- Test Orion's heat shield at lunar re-entry velocities
  - 24,500 mph or Mach 32
  - Re-entry will be as hot as 5,000°F – half as hot as the surface of the Sun!
- Test all SLS, Orion systems in deep space environment
- Test recovery systems and retrieve Orion
- Test all ground processing, launch facilities
- Deploy secondary payloads (CubeSats)

ARTEMIS I CUBESATS HITCH A RIDE TO SPACE



SUN
- CuSP (Southwest Research Institute)

MOON
- Lunar IceCube (Morehead State University)
- LunaH-Map (Arizona State University)
- OMOTENASHI (JAXA)
- LunIR (Lockheed Martin)
- EQUULEUS (JAXA)

ASTEROID
- NEA Scout (NASA)

…AND MORE
- BioSentinel (NASA)
- Team Miles (Miles Space)

EARTH-MOON
- ArgoMoon (ESA/ASI)

ARTEMIS II

SLS PROGRESS TOWARD ARTEMIS II

Orion Stage Adapter weldment complete

Booster motor segments complete

ICPS shipped to Cape Canaveral

Forward join complete

RS-25 engines complete

LVSA spray-on foam applied

Liquid Hydrogen Tank

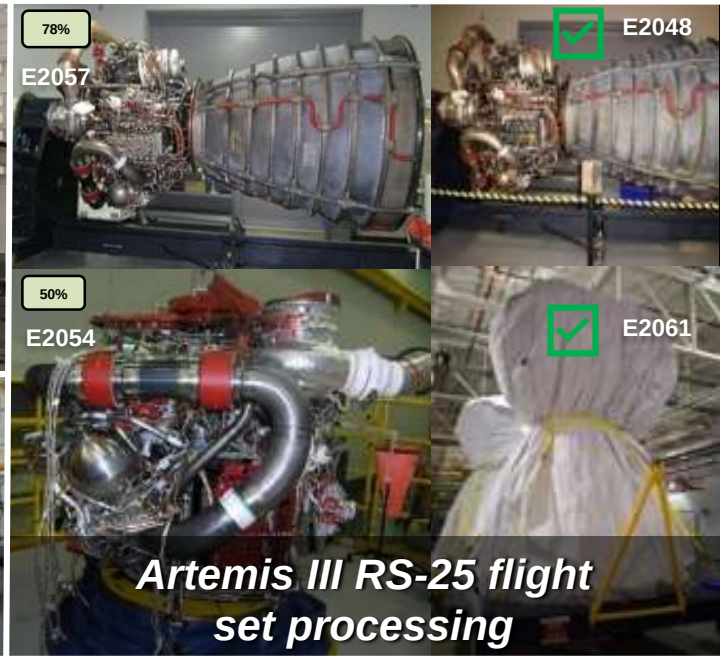
ARTEMIS III

SLS PROGRESS TOWARD ARTEMIS III AND BEYOND

Artemis IV booster segment

Universal stage adapter manufacturing demonstration article

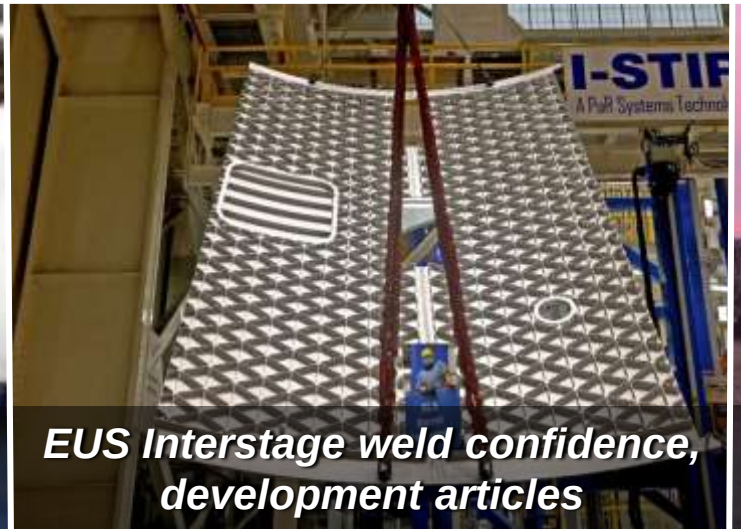
RL10 engines complete



Artemis III RS-25 flight set processing

Pathfinder composite case

Artemis III core stage LOX tank forward dome


EUS Interstage weld confidence, development articles

Exploration Upper Stage Umbilical

WATCH US MAKE HISTORY

We're returning to deep space and the Moon with the most powerful rocket in the world.

- Plan a watch party with friends (check Eventbrite.com for information!)
- Tell your friends about Artemis
- Follow our social media for updates
- Introduce kids to https://stem.nasa.gov/artemis/

ARTEMIS
nasa.gov
images.nasa.gov
@NASA_SLS
NASASLS
youtube.com/nasa
@NASAArtemis
NASA

Resources Shared in Chat

NASA Artemis: https://www.nasa.gov/artemisprogram

Space Launch System: https://www.nasa.gov/sls

Space Launch System Exploration Upper Stage: https://www.nasa.gov/exploration/systems/sls/multimedia/rocket-to-the-moon-what-is-the-exploration-upper-stage.html

Space Launch System Block 1 Expanded View: https://www.nasa.gov/exploration/systems/sls/multimedia/gallery/sls_config_70t.html

Orion: https://www.nasa.gov/exploration/systems/orion/index.html

Space Launch System Solid Rocket Boosters: https://www.nasa.gov/sites/default/files/atoms/files/sls_srb_fact_sheet_2018_pub_updated_02052020.pdf

Artemis I Booster Stacking: https://www.facebook.com/NASAGroundSystems/videos/artemis-i-booster-stacking-complete/877658436300169/

Vehicle Assembly Building (VAB) Infographic: https://www.nasa.gov/sites/default/files/files/GSDO_August2013_VABInfographicFINAL.pdf

Space Launch System RS-25 Engine: https://www.nasa.gov/sites/default/files/atoms/files/0080_rs-25_fact_sheet_12092020_3.pdf

Space Launch Systems Core Stage: https://www.nasa.gov/sites/default/files/atoms/files/sls_core_stage_fact_sheet_04262021_508.pdf

Space Launch System Liquid Oxygen Tank Test: https://www.youtube.com/watch?v=sSEh_oKLCAw

Space Launch System Liquid Hydrogen Tank Test: https://www.youtube.com/watch?v=-W5EXElmqC4

Space Launch System Green Run Hot Fire: https://www.youtube.com/watch?v=OvzeB1TI5qw&t=3s

Artemis Core Stage Activities at Kennedy Space Center: https://www.youtube.com/watch?v=ndb9Y_bREKg&t=73s

Resources Shared in Chat

Core Stage Stacking for Artemis I: https://www.youtube.com/watch?v=5n8AY-k-Su4

Space Launch System Modal Testing Infographic: https://www.nasa.gov/sites/default/files/thumbnails/image/modal_testing_infographic_final_flex.jpg

Artemis I CubeSat Payloads: https://www.nasa.gov/launching-science-and-technology.html

Artemis Mission Map: https://www.nasa.gov/image-feature/artemis-i-map

Orion Infographic: https://www.nasa.gov/image-feature/orion-capabilities-for-deep-space-enable-crewed-artemis-moon-missions

Subscribe to SLS in 3.2.1. (e-newsletter): https://visitor.constantcontact.com/manage/optin?v=001xttBXJn8QyZN_XhBfQEBAUzll8yyLHWL

Rocket Science in 60 Seconds (video series): https://www.nasa.gov/exploration/systems/sls/multimedia/rocket_science_in_60_seconds

Space Launch System Infographics: https://www.nasa.gov/exploration/systems/sls/multimedia/infographics.html

Space Launch System YouTube Playlist: https://www.youtube.com/playlist?list=PLBEXDPatoWBmX3yrpEObbUoNF5rbbNcgX

Why the Moon?: https://www.youtube.com/watch?v=bmC-FwibsZg

We Go as the Artemis Generation: https://www.youtube.com/watch?v=BfzPiEe-Aeg

Artemis I :https://www.youtube.com/watch?v=GgmRAV8HNKE

Do you want to share the excitement of Artemis I? Join NASA to participate online for NASA's Artemis I mission. All resources, participation, and registration are FREE. Registration will provide communications about launch related activities and access to curated STEM resources.
Are you ready to sign up? Click here to register to let NASA know that you're hosting a watch party, virtually participating, or would like to receive the Artemis I STEM Learning Pathway, an add-on the bottom of the registration page.