
National Aeronautics and Space Administration
NASA
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SPACE LAUNCH SYSTEM
DEEP-SPACE DEPLOYMENT FOR SMALLSATS
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NASA Space Launch System
FISO Telecton 07-12-17
www.nasa.gov/sls
SLS

SLS CAPABILITY AVAILABILITY

SLS Block 1
As Early As 2019

Provides

Initial Heavy-Lift Capability

Enables

Orion Test

SmallSats to Deep Space

SLS Block 1B Crew
As Early As 2022

Provides

105 t lift capability via Exploration Upper Stage

Co-manifested payload capability in Universal Stage Adapter

Enables

Deep Space Gateway

Larger CubeSat- and ESPA-Class Payloads

SLS Block 1B Cargo
As Early As 2023

Provides

8.4-meter fairings for primary payloads

Regular flight cadence for additional launches

Enables

Europa Clipper/Lander

Deep Space Transport

Large-Aperture Space Telescopes

Ice or Ocean Worlds Missions

Interstellar Medium

SLS Block 2
As Early As 2028

Provides

130 t lift capability via advanced boosters

10-meter fairings for primary payloads

Enables

Crewed Mars Orbit Missions

Crewed Mars Surface Missions

SLS SPACE LAUNCH SYSTEM

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SLS BLOCK 1 CONFIGURATION

OVERVIEW

- Initial configuration of vehicle optimized for near-term heavy-lift capability
- Completed Critical Design Review in July 2015

SLS Block 1

Capability: >70 metric tons

Height: 322 feet

Weight: 5.75 million pounds

Thrust: 8.8 million pounds

Available: 2019

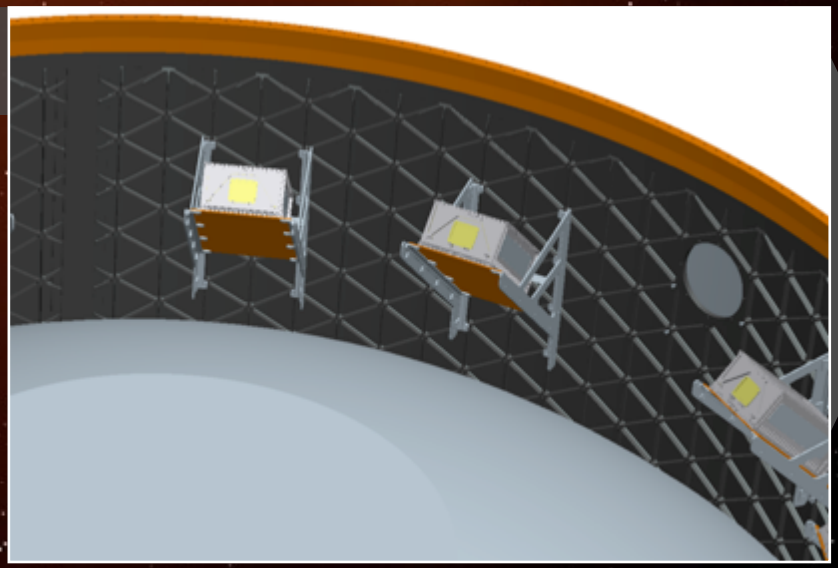
UTILIZATION

- Initial demonstration of Space Launch System and Orion capabilities
- Supports launch of Orion into distant retrograde orbit around the moon

EM-1 SECONDARY PAYLOAD CAPABILITY

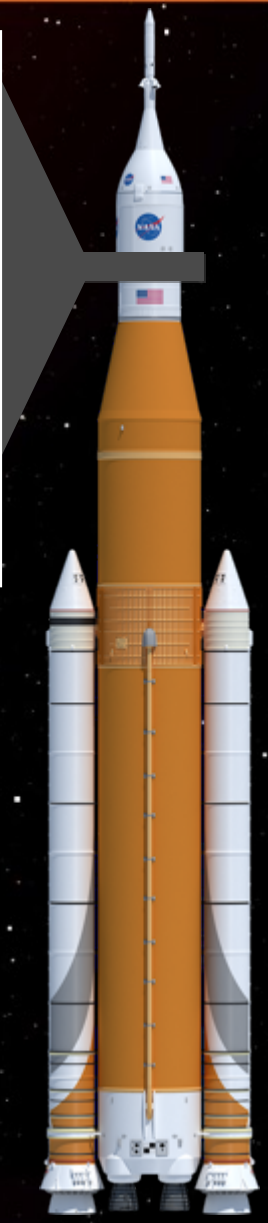
Accommodations

- SLS for Exploration Mission-1 will include thirteen 6U payload locations of up to 14kg per CubeSat



EM-1 Trajectory

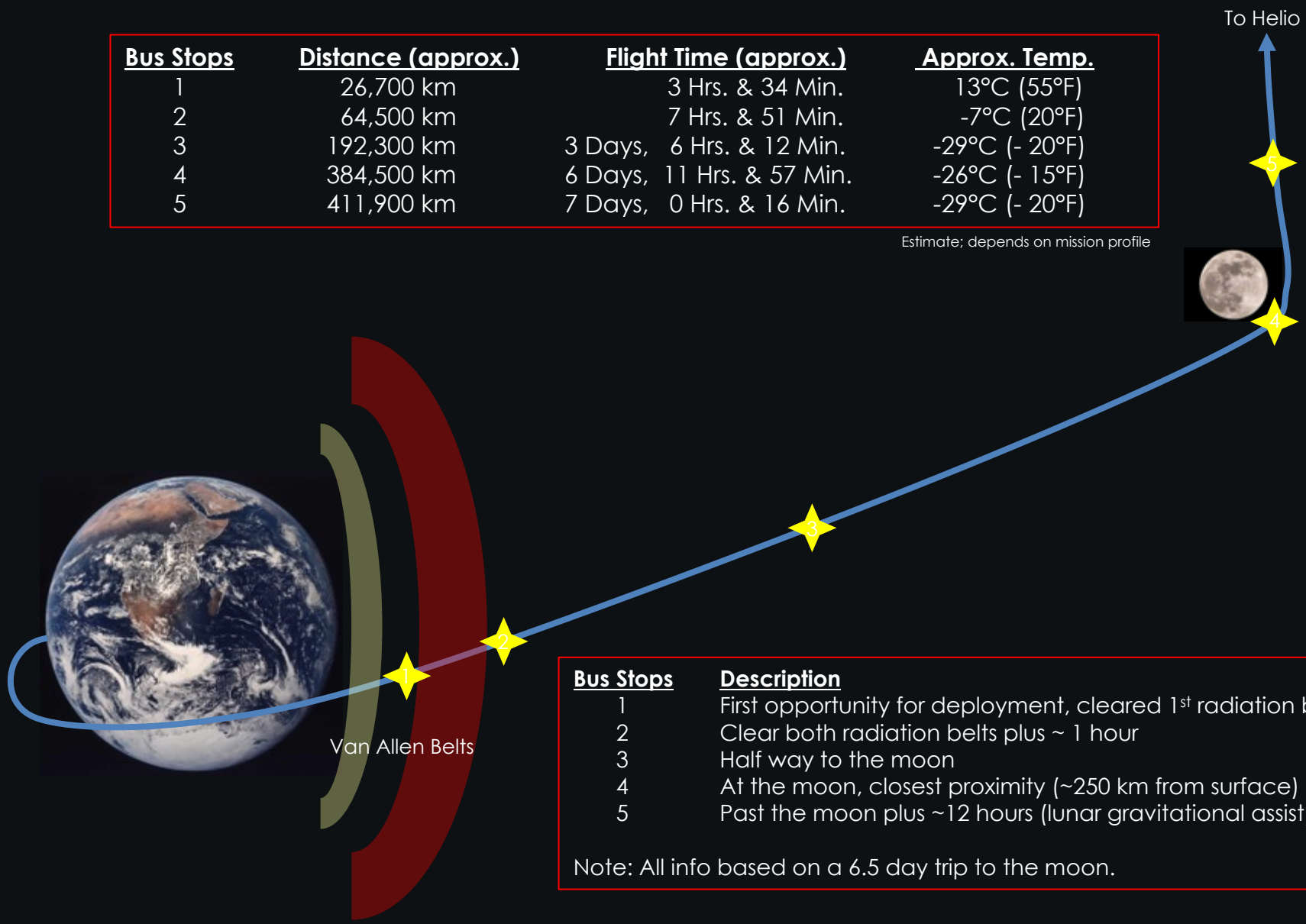
- Orion will enter Distant Retrograde Orbit around the moon
- Additional cislunar trajectories being studied for future missions



EM-1 CUBESAT BUS STOPS

Bus Stops	Distance (approx.)	Flight Time (approx.)	Approx. Temp.
1	26,700 km	3 Hrs. & 34 Min.	13°C (55°F)
2	64,500 km	7 Hrs. & 51 Min.	-7°C (20°F)
3	192,300 km	3 Days, 6 Hrs. & 12 Min.	-29°C (- 20°F)
4	384,500 km	6 Days, 11 Hrs. & 57 Min.	-26°C (- 15°F)
5	411,900 km	7 Days, 0 Hrs. & 16 Min.	-29°C (- 20°F)

Estimate; depends on mission profile



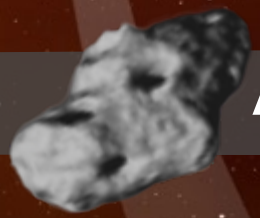
Bus Stops	Description
1	First opportunity for deployment, cleared 1st radiation belt
2	Clear both radiation belts plus ~ 1 hour
3	Half way to the moon
4	At the moon, closest proximity (~250 km from surface)
5	Past the moon plus ~12 hours (lunar gravitational assist)

Note: All info based on a 6.5 day trip to the moon.

ONE LAUNCH, MULTIPLE DISCIPLINES

Moon

- Lunar Flashlight (NASA)
- Lunar IceCube (Morehead State University)
- LunaH-Map (Arizona State University)
- OMOTENASHI (JAXA)



Asteroid

- NEA Scout (NASA)

Sun

- CuSP (Southwest Research Institute)

Earth

- EQUULEUS (JAXA)
- Skyfire (Lockheed Martin)

And Beyond

- Biosentinel (NASA)
- ArgoMoon (ESA/ASI)
- Cislunar Explorers (Cornell University)
- CU-E3 (University of Colorado Boulder)
- Team Miles (Fluid & Reason)

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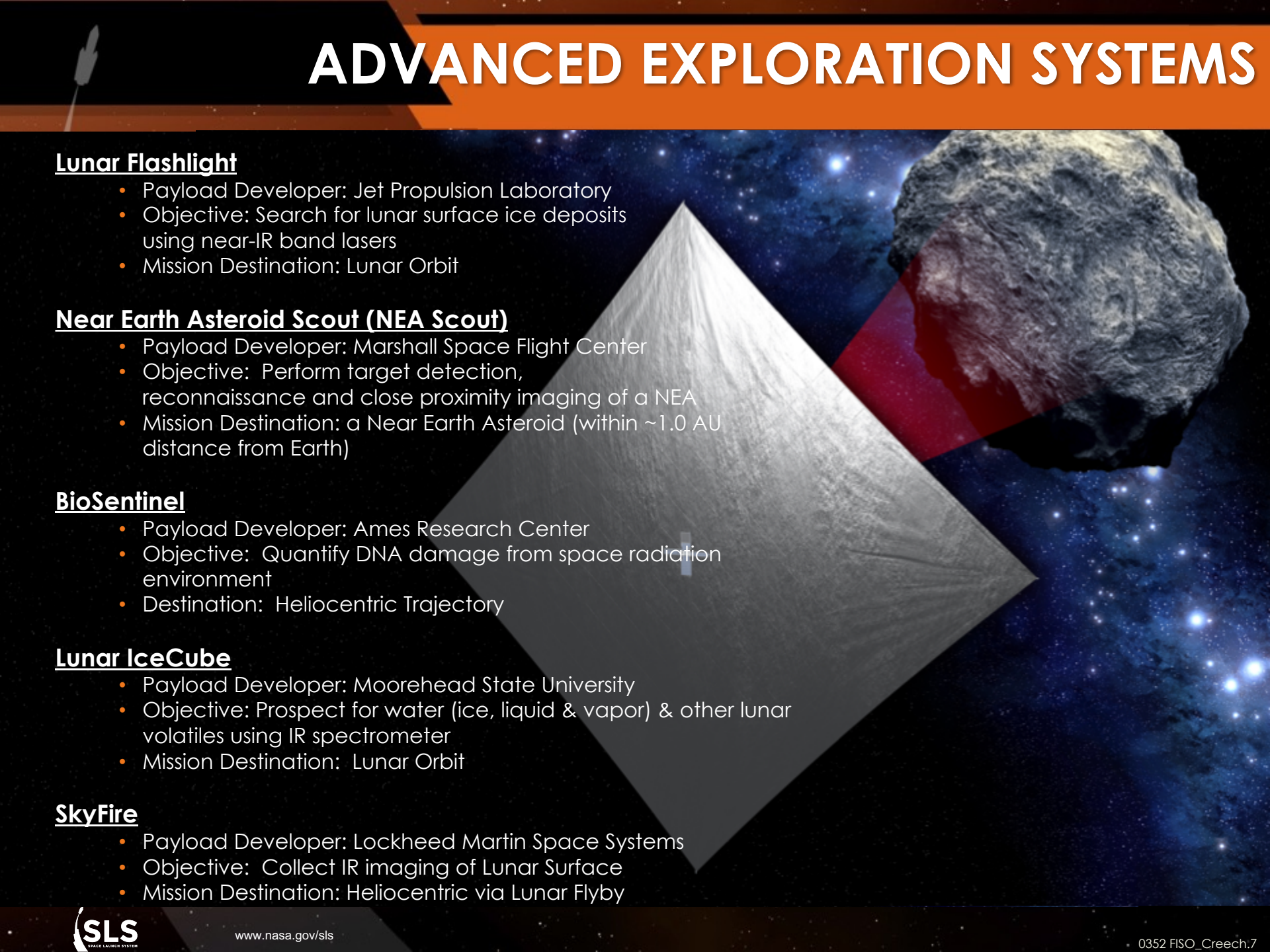
ADVANCED EXPLORATION SYSTEMS



Lunar Flashlight

- Payload Developer: Jet Propulsion Laboratory
- Objective: Search for lunar surface ice deposits using near-IR band lasers
- Mission Destination: Lunar Orbit

Near Earth Asteroid Scout (NEA Scout)

- Payload Developer: Marshall Space Flight Center
- Objective: Perform target detection, reconnaissance and close proximity imaging of a NEA
- Mission Destination: a Near Earth Asteroid (within ~1.0 AU distance from Earth)

BioSentinel

- Payload Developer: Ames Research Center
- Objective: Quantify DNA damage from space radiation environment
- Destination: Heliocentric Trajectory

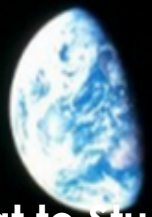
Lunar IceCube

- Payload Developer: Moorehead State University
- Objective: Prospect for water (ice, liquid & vapor) & other lunar volatiles using IR spectrometer
- Mission Destination: Lunar Orbit

SkyFire

- Payload Developer: Lockheed Martin Space Systems
- Objective: Collect IR imaging of Lunar Surface
- Mission Destination: Heliocentric via Lunar Flyby

SCIENCE MISSION DIRECTORATE

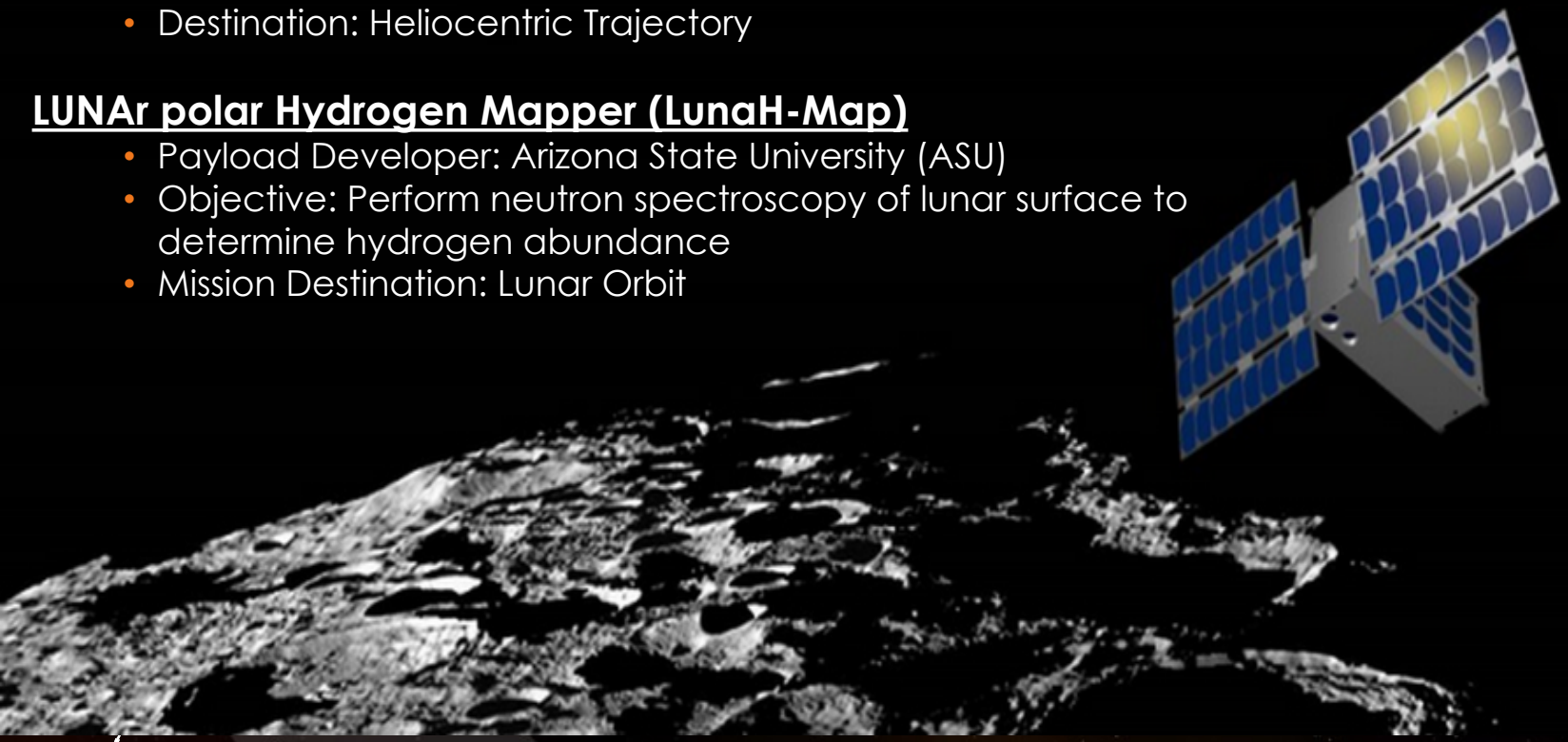


Cubesat to Study Solar Particles (CuSP)

- Payload Developer: Southwest Research Institute (SwRI)
- Objective: Observations of Interplanetary Space environment to gain insight into space weather
- Destination: Heliocentric Trajectory

LUNAr polar Hydrogen Mapper (LunaH-Map)

- Payload Developer: Arizona State University (ASU)
- Objective: Perform neutron spectroscopy of lunar surface to determine hydrogen abundance
- Mission Destination: Lunar Orbit



INTERNATIONAL PARTNERS

ArgoMoon

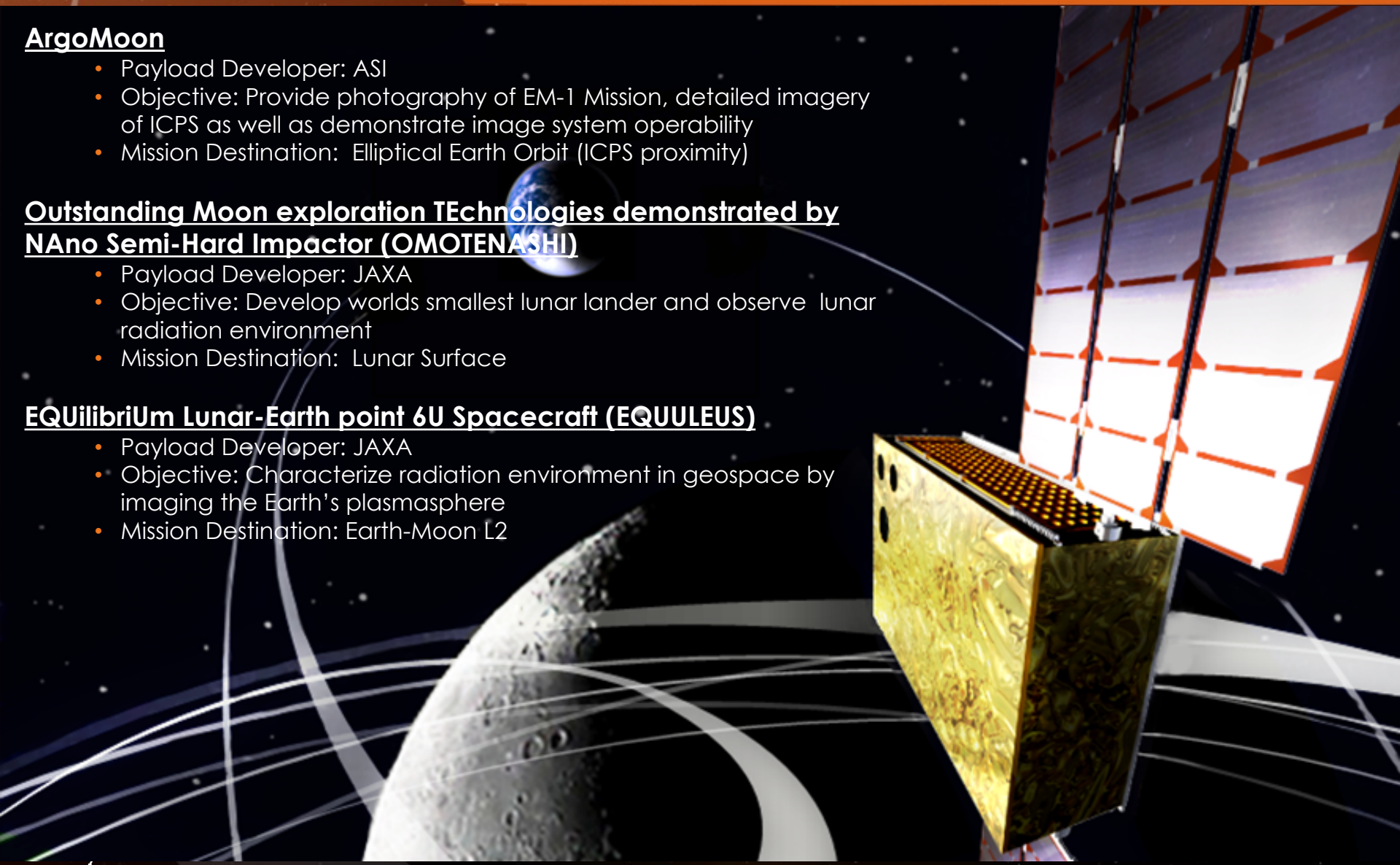
- Payload Developer: ASI
- Objective: Provide photography of EM-1 Mission, detailed imagery of ICPS as well as demonstrate image system operability
- Mission Destination: Elliptical Earth Orbit (ICPS proximity)

Outstanding Moon exploration TEchnologies demonstrated by NAno Semi-Hard Impactor (OMOTENASHI)

- Payload Developer: JAXA
- Objective: Develop worlds smallest lunar lander and observe lunar radiation environment
- Mission Destination: Lunar Surface

EQUilibriUm Lunar-Earth point 6U Spacecraft (EQUULEUS)

- Payload Developer: JAXA
- Objective: Characterize radiation environment in geospace by imaging the Earth's plasmasphere
- Mission Destination: Earth-Moon L2



CUBE QUEST CHALLENGE

Goal: Foster innovation in small spacecraft navigation, operations, and communications techniques for deep space.

- CubeSat design limited to 6U and 14kg. Participants may qualify for EM-1 launch or provide their own ride. $5 million prize money available.

Lunar Derby
While in lunar orbit

Achieve Lunar Orbit-
$1.5M/shared, $1M max per team

Error-free Communication
Burst Rate- $225k/25k
Total Volume- $675k/75k

Longevity
$450k/50k

Deep Space Derby
While range ≥4M km

Farthest Distance
$225k/25k

Error-free Communication
Burst Rate- $225k/25k
Total Volume- $675k/75k

Longevity
$225k/25k

Ground Tournaments (GT)

4 Rounds

Approx every 6 months

Top 5 teams receive incremental funding (max $100k per team)

Top 3 teams launch free on EM-1

CUBE QUEST CHALLENGE

Team Miles

- Payload Developer: Fluid & Reason, LLC
- Objective: Compete in the Deep Space Derby for Furthest Communication Distance from Earth prize
- Mission Destination: Deep Space

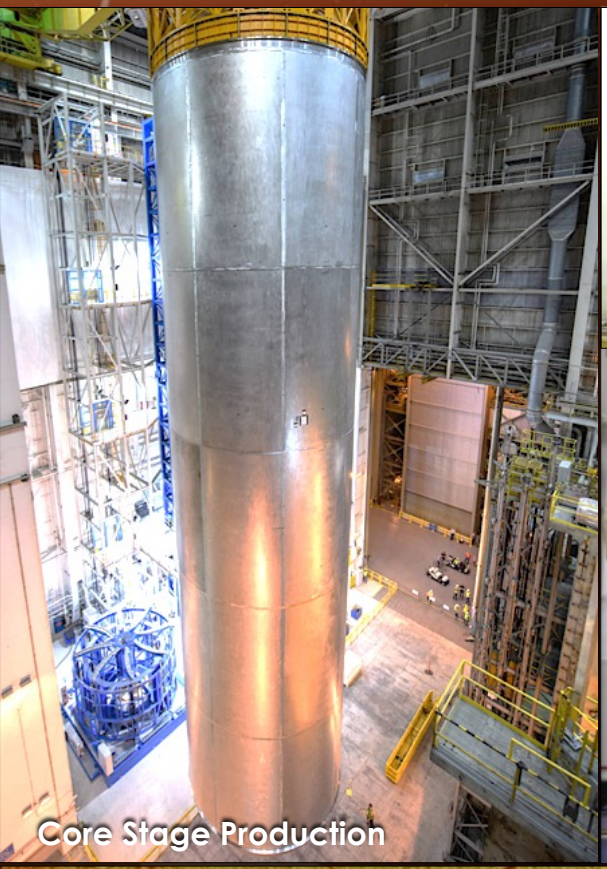
Cislunar Explorers

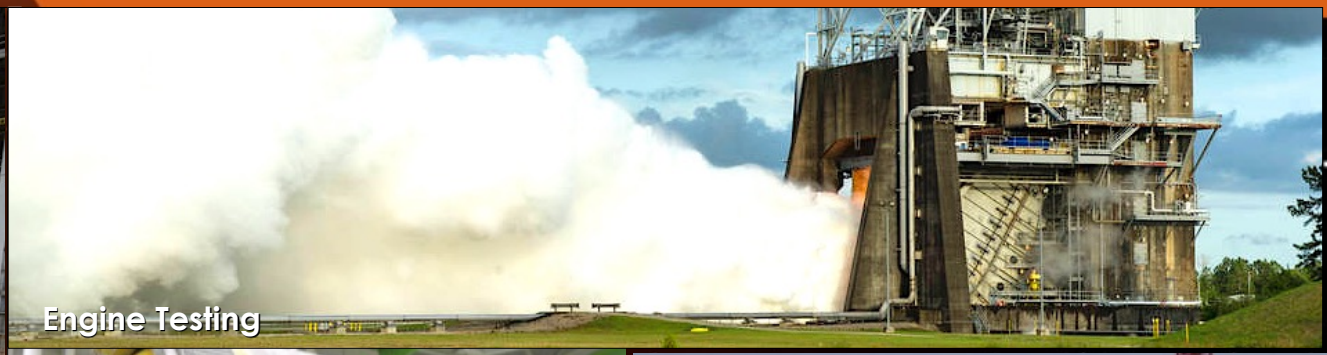
- Payload Developer: Cornell University
- Objective: Compete in the Lunar Derby for Achieving Lunar Orbit and Spacecraft Longevity prizes
- Mission Destination: Lunar Orbit

CU-E3

- Payload Developer: University of Colorado Boulder
- Objective: Compete in the Deep Space Derby for Best Burst Data Rate, Largest Aggregate Data Volume Sustained over time, Spacecraft Longevity and Furthest Communication Distance from Earth prizes
- Mission Destination: Deep Space

PROGRESS TOWARD FIRST LAUNCH


Core Stage Production


Engine Testing


Second Stage Preparation


Structural Testing


Booster Testing

SLS BLOCK 1B CONFIGURATION

OVERVIEW

- Replaces Interim Cryogenic Propulsion Stage with human-rated Exploration Upper Stage
- EUS has completed checkpoint prior to Preliminary Design Review

SLS Block 1B

Capability: >105 metric tons

Height: 364 feet

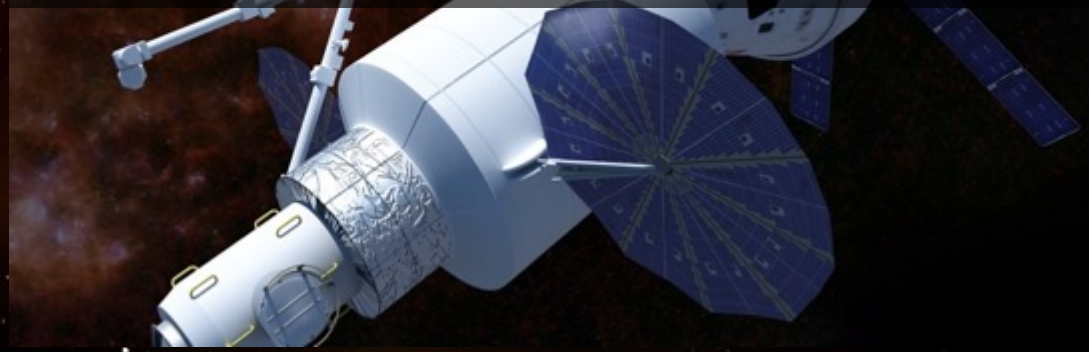
Weight: 6 million pounds

Thrust: 8.8 million pounds

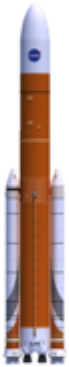
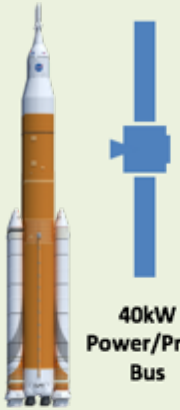
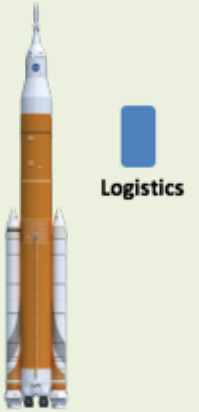
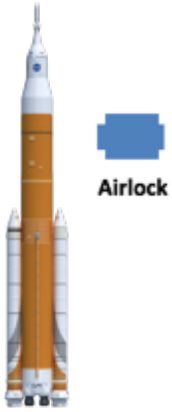
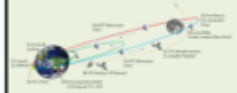
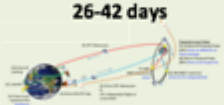
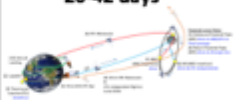
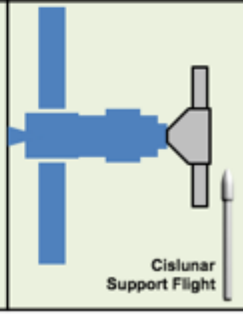
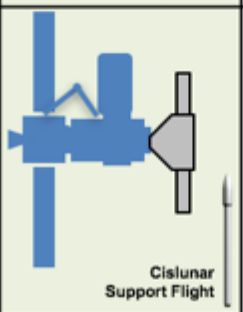
Available: No earlier than 2021

UTILIZATION

- Supports launch of Orion and co-manifested exploration systems in "Proving Ground" of cislunar space
- With large 8.4-meter fairing, can launch game-changing science missions and other high-priority payloads



PHASE 1 DEVELOPMENT

		Deep Space Gateway Buildup			
EM-1	**Europa Clipper**	**EM-2**	**EM-3**	**EM-4**	**EM-5**
2018 - 2025					**2026**
SLS Block 1 Crew: 0	SLS Block 1B Cargo	SLS Block 1B Crew: 4 CMP Capability: 8-9T	SLS Block 1B Crew: 4 CMP Capability: 10mT	SLS Block 1B Crew: 4 CMP Capability: 10mT	SLS Block 1B Crew: 4 CPL Capability: 10mT
	 Europa Clipper (subject to approval)	 40kW Power/Prop Bus	 Habitation	 Logistics	 Airlock
Distant Retrograde Orbit (DRO) 26-40 days	Jupiter Direct	Multi-TLI Lunar Free Return 8-21 days	Near Rectilinear Halo Orbit (NRHO) 16-26 days	NRHO, w/ ability to translate to/from other cislunar orbits 26-42 days	NRHO, w/ ability to translate to/from other cislunar orbits 26-42 days
					
Gateway (blue) Configuration (Orion in grey)			 Cislunar Support Flight	 Cislunar Support Flight	

These essential Gateway elements can support multiple U.S. and international partner objectives in Phase 1 and beyond

Known Parameters:

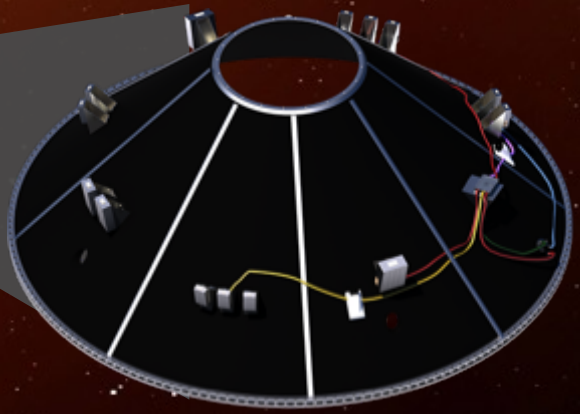
- Gateway to architecture supports Phase 2 and beyond activities
- International and U.S. commercial development of elements and systems
- Gateway will translate uncrewed between cislunar orbits
- Ability to support science objectives in cislunar space

Open Opportunities:

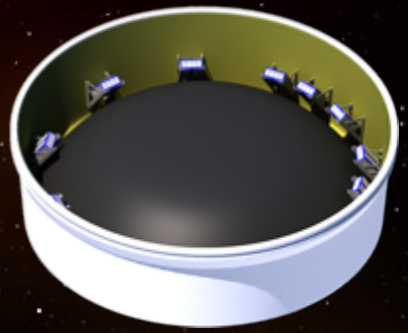
- Order of logistics flights and logistics providers
- Use of logistics modules for available volume
- Ability to support lunar surface missions

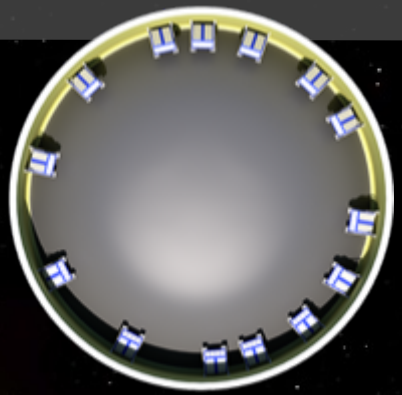
BLOCK 1 & BLOCK 1B COMPARISON

BLOCK 1B



BLOCK 1





SLS SPACE LAUNCH SYSTEM

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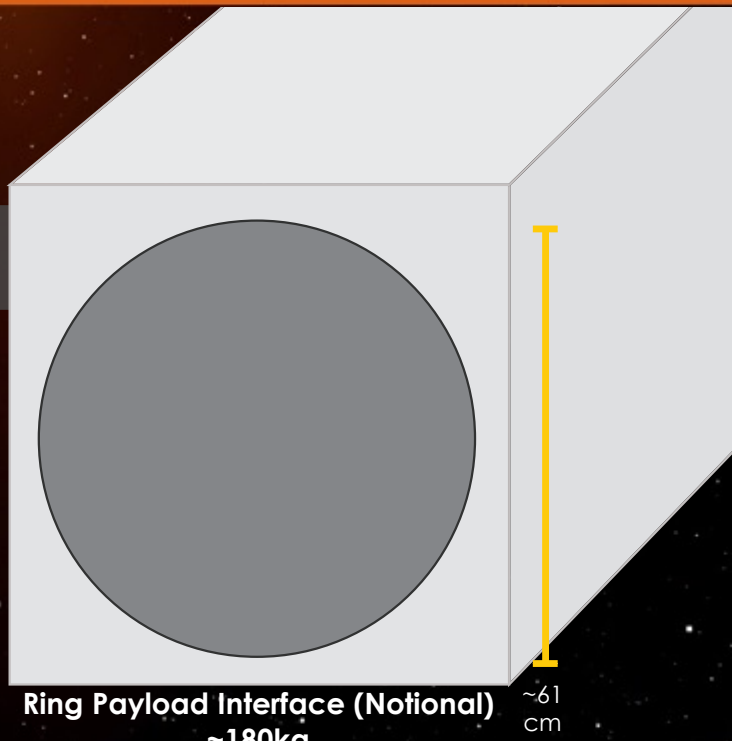
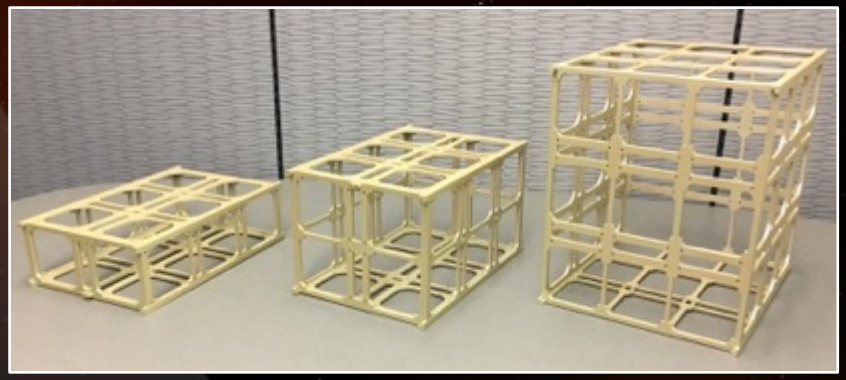
BLOCK 1B SMALL PAYLOAD OPTIONS

VOLUME AND MASS RANGE





PROGRESS TOWARD EM-2/BLOCK 1B


EM-2 Core Stage Welding


EM-2 Booster Insulation Installation


EM-2 Flight Engine Testing


EUS Development Panel Forming


Universal Stage Adapter Contract

Summary

- SLS provides a unique opportunity for the CubeSat/smallsat community
  - Enables access to Earth, Moon, Sun & Deep Space
  - Opportunity to manifest payloads from 6U/12U/27U to ESPA-Class
- First Flight (EM-1) hardware production in-progress
  - Block 1B initiating procurement/production activities

More Information

- SLS Mission Planner's Guide (ESD 30000)
  - Provides future payload developers/users with information to support preliminary SLS mission planning
  - Covers Block 1B (105mT*) & Block 2 (130mT*) configurations
  - Copies can be requested by email to: NASA-slspayloads@mail.nasa.gov

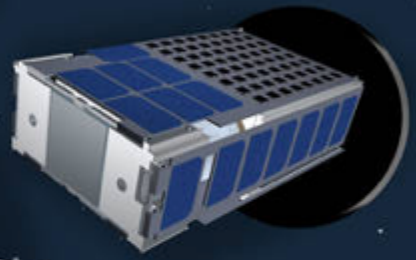
* Payload Mass to Low Earth Orbit

BACK UP

EXPLORATION MISSION-1: LAUNCHING SCIENCE & TECHNOLOGY SECONDARY PAYLOADS

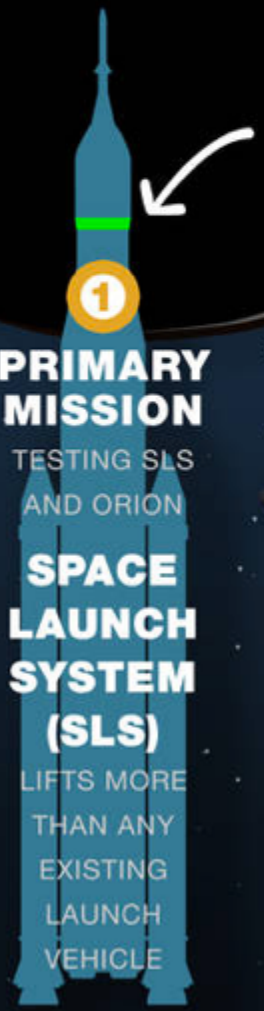
13 CUBESAT EXPLORERS

GOING TO DEEP SPACE WHERE FEW CUBESATS HAVE EVER GONE BEFORE.



ORION STAGE ADAPTER

SUPPORTS BOTH PRIMARY MISSION AND SECONDARY PAYLOADS



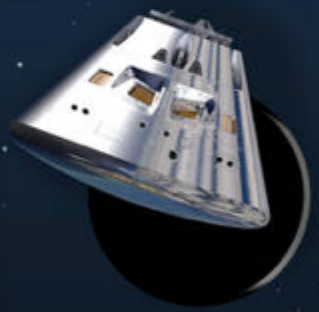
1

PRIMARY MISSION

TESTING SLS AND ORION

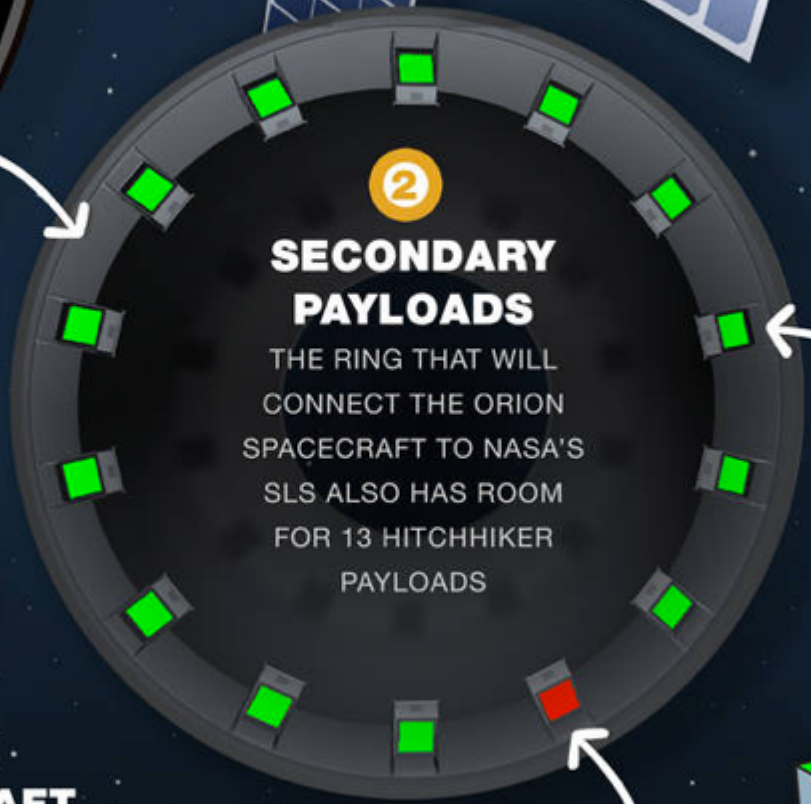
SPACE LAUNCH SYSTEM (SLS)

LIFTS MORE THAN ANY EXISTING LAUNCH VEHICLE



ORION SPACECRAFT

TRAVELING THOUSANDS OF MILES BEYOND THE MOON, WHERE NO CREW VEHICLE HAS GONE BEFORE



2

SECONDARY PAYLOADS

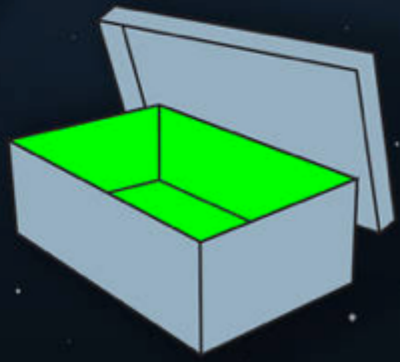
THE RING THAT WILL CONNECT THE ORION SPACECRAFT TO NASA'S SLS ALSO HAS ROOM FOR 13 HITCHHIKER PAYLOADS

SHOEBOX SIZE

PAYLOADS EXPAND OUR KNOWLEDGE FOR THE JOURNEY TO MARS

AVIONICS

(SELF-CONTAINED AND INDEPENDENT FROM THE PRIMARY MISSION) SEND CUBESATS ON THEIR WAY



#RIDEONSLS