



NASA'S SPACE LAUNCH SYSTEM: DEEP-SPACE OPPORTUNITIES FOR SMALLSATS

4S Symposium

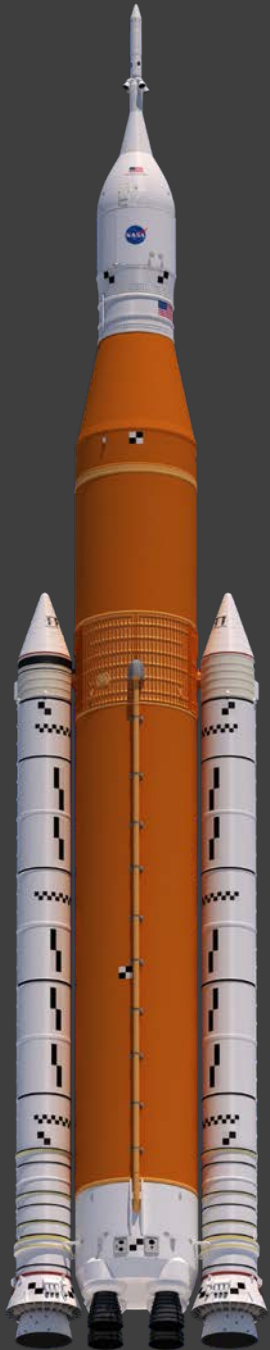
Kimberly Robinson, Ph.D.
Payloads Manager

Carole McLemore, Ph.D.

Secondary Payloads Integration Manager
Space Launch System Program

May 29, 2018

NASA'S EXPLORATION PLANS



Earth

Notional Commercial Platform



ISS

Commercial launch Vehicles

In LEO

Commercial & International partnerships

Moon



Orion



SLS



Commercial Lunar Lander

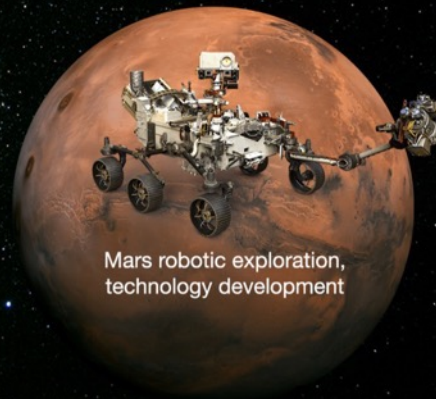
In Cislunar Space

A return to the moon for long-term exploration

Mars



Robotic Surface Missions



Mars robotic exploration, technology development



Lunar Orbital Platform - Gateway
PPE- Habitat - Airlock - Logistics

On Mars

Research to inform future crewed missions

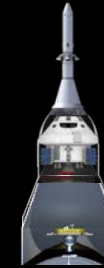
SLS – ENABLING HUMAN EXPLORATION

EXPLORATION CLASS: DEEP SPACE CAPABILITIES



VOLUME

- **Five times more volume** than any contemporary heavy lift vehicle
- **Only vehicle** that can carry the Orion and a co-manifested payload to the Moon



Orion with Science Missions



8m fairing with large aperture telescope

MASS

- Block 1: Can launch **60% more mass** than any contemporary launch vehicle
- Block 2: Mars-enabling capability of **greater than 45 metric tons** to Trans Lunar Injection



Contemporary Heavy Lift



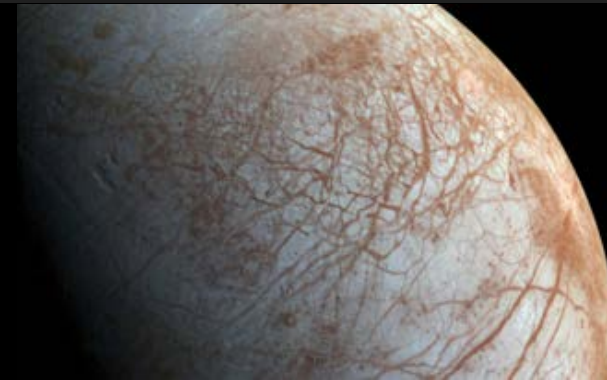
SLS Block 1 Exploration Class



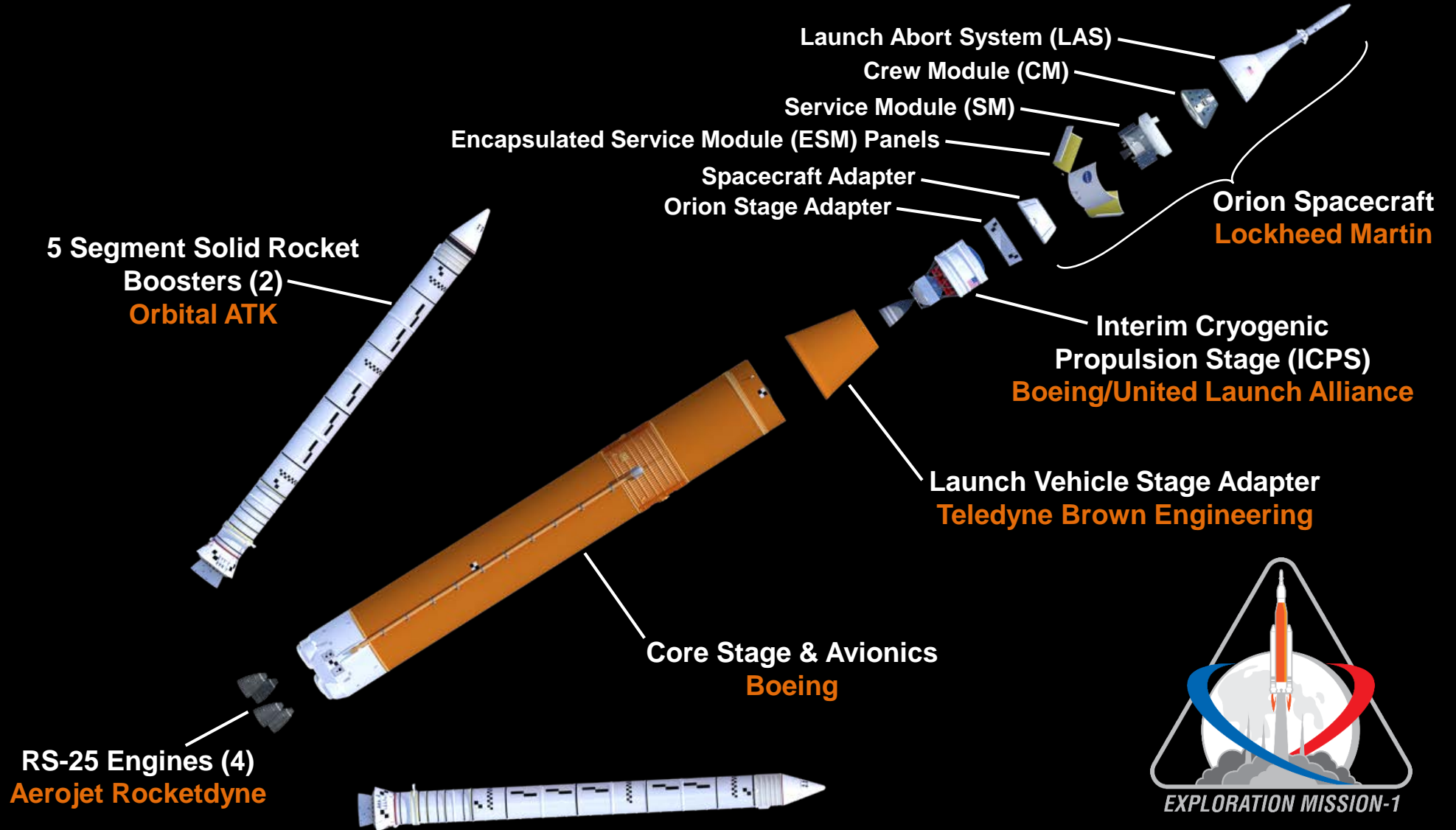
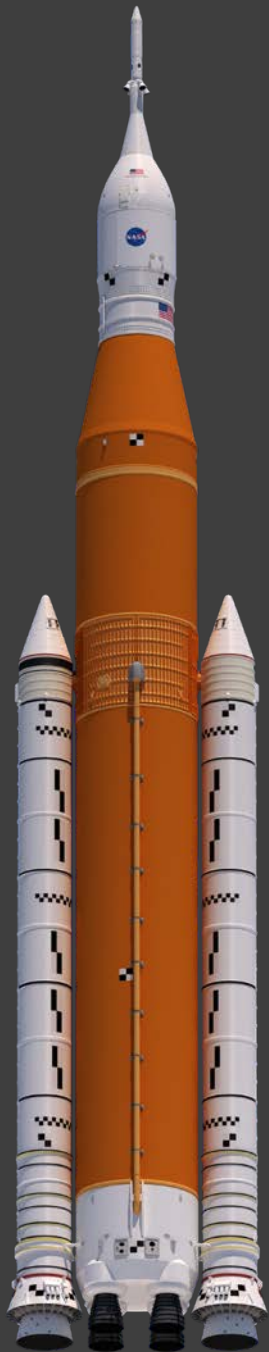
SLS Block 2 Exploration Class

DEPARTURE ENERGY

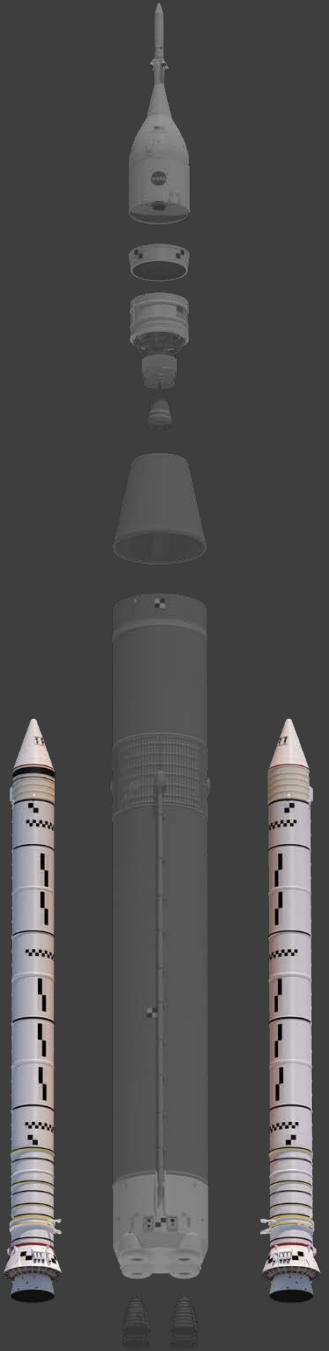
- **Reduce transit times by half or greater** to the outer solar system



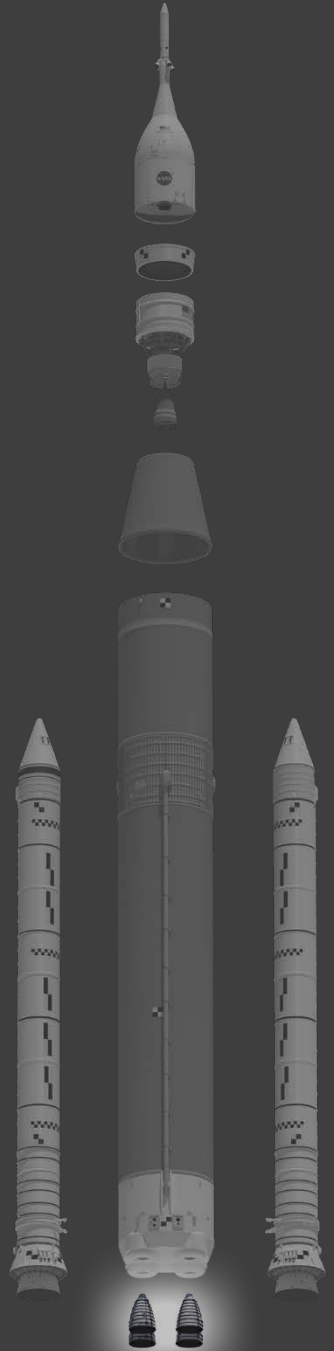
SLS BLOCK 1 CONFIGURATION FOR EM-1



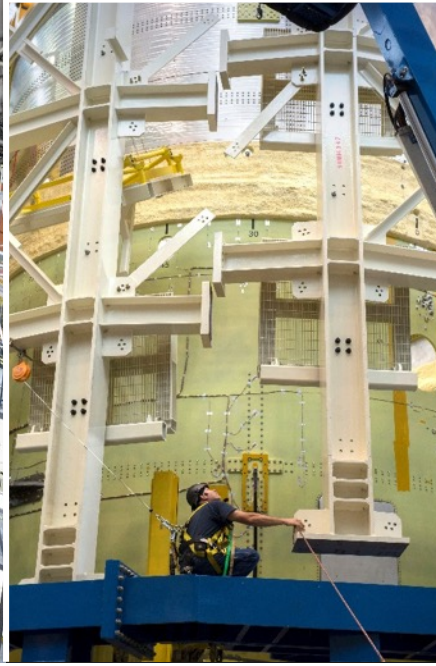
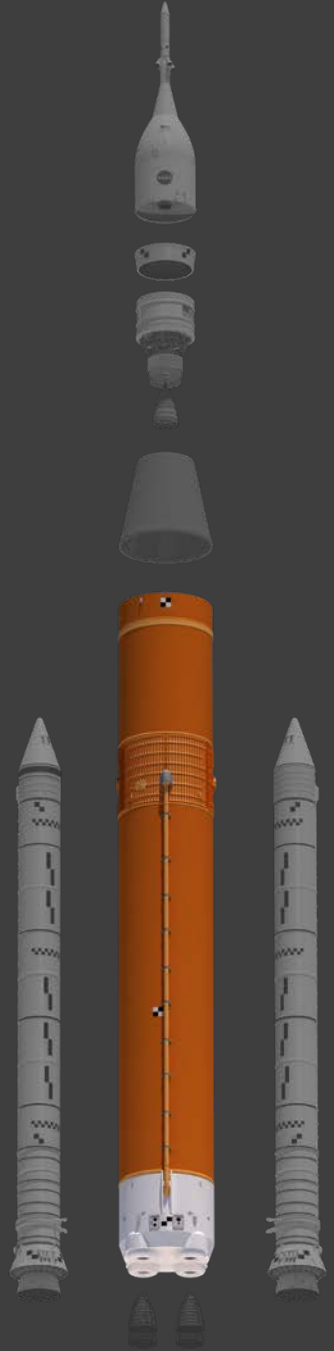
SOLID ROCKET BOOSTERS



ENGINES



CORE STAGE



IN-SPACE STAGE AND ADAPTERS





EXPLORATION MISSION-1

FULL SYSTEMS CHECKOUT PRIOR TO CREWED MISSIONS

SAMPLE DEPLOYMENT LOCATIONS



Bus Stops

- | <u>Bus Stops</u> | <u>Description</u> |
|------------------|--|
| 1 | First opportunity for deployment, cleared 1 st radiation belt |
| 2 | Clear both radiation belts plus ~ 1 hour |
| 3 | Half way to the moon |
| 4 | At the moon, closest proximity (~240 km from surface) |
| 5 | Past the moon plus ~12 hours (lunar gravitational assist) |

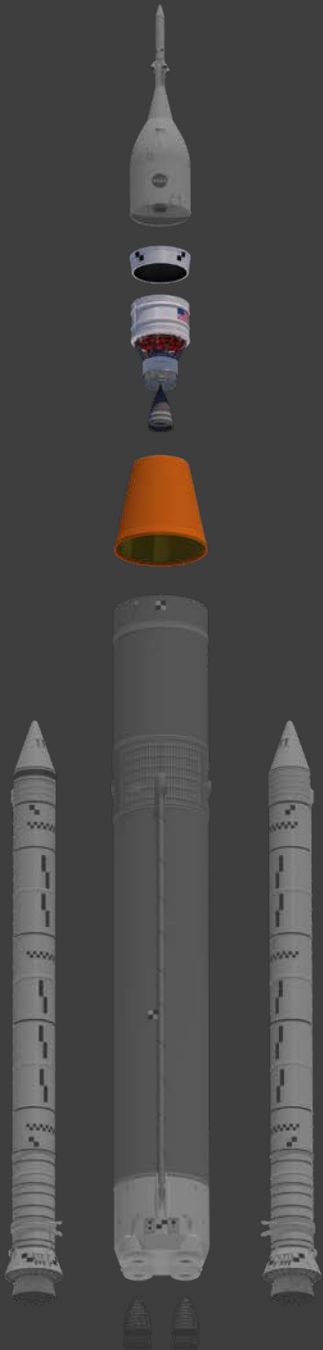
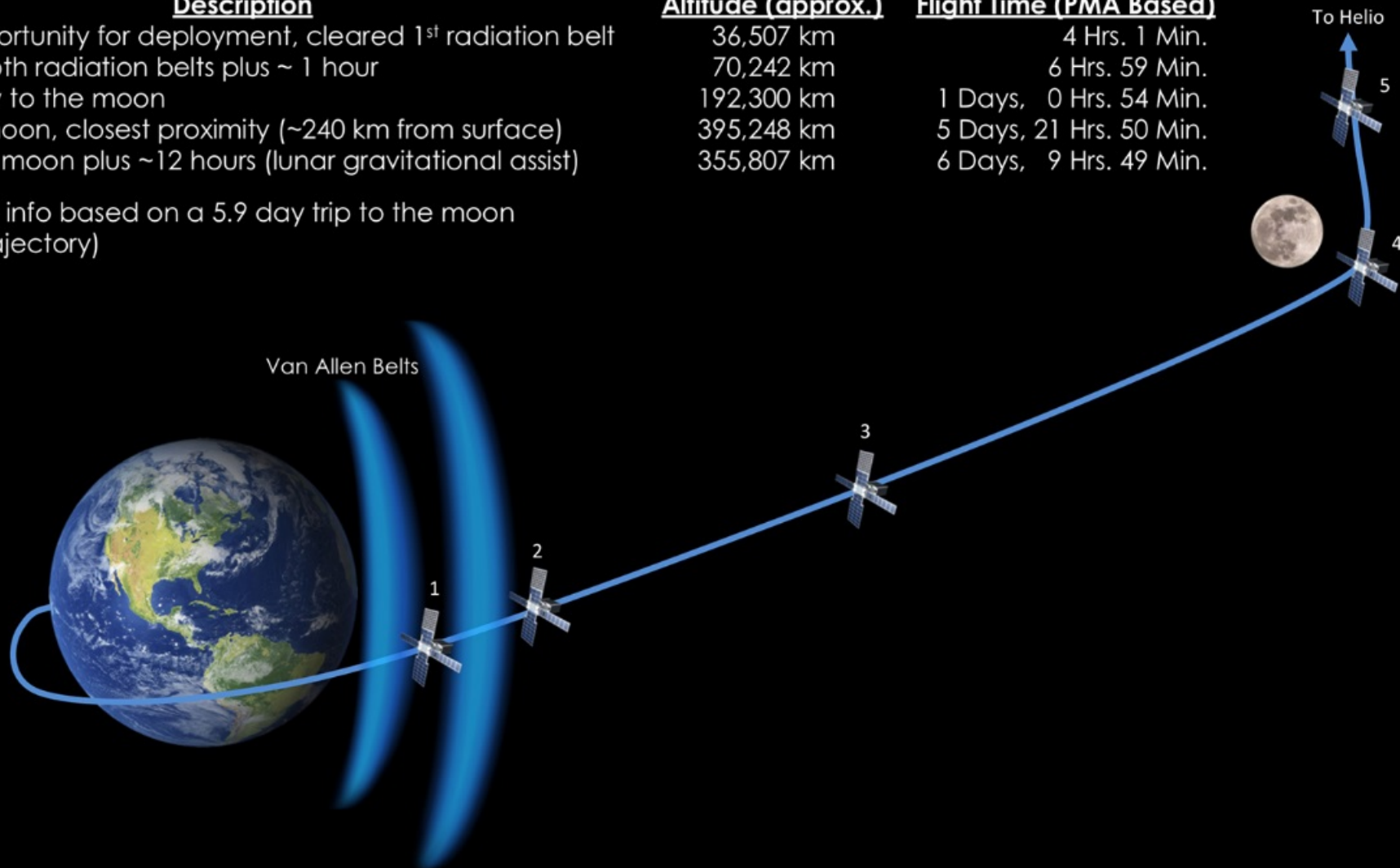
Altitude (approx.)

- | |
|------------|
| 36,507 km |
| 70,242 km |
| 192,300 km |
| 395,248 km |
| 355,807 km |

Flight Time (PMA Based)

- | |
|-------------------------|
| 4 Hrs. 1 Min. |
| 6 Hrs. 59 Min. |
| 1 Days, 0 Hrs. 54 Min. |
| 5 Days, 21 Hrs. 50 Min. |
| 6 Days, 9 Hrs. 49 Min. |

Note: All info based on a 5.9 day trip to the moon
(PMA Trajectory)



ONE LAUNCH, MULTIPLE DISCIPLINES

SMALLSATS TO BE DEPLOYED FROM THE ORION STAGE ADAPTER

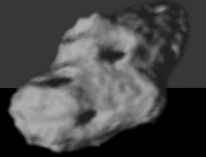


MOON

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

ASTEROID

- NEA Scout (NASA)



EARTH

- EQUULEUS (JAXA)



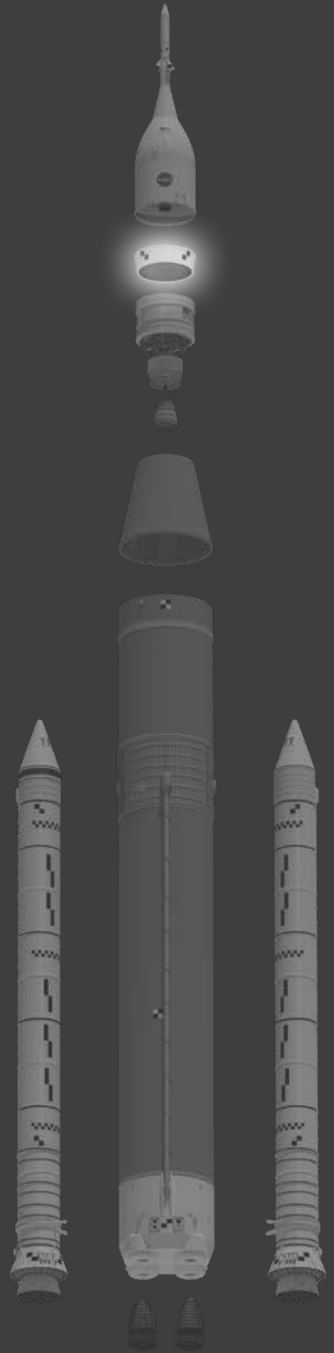
AND BEYOND

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



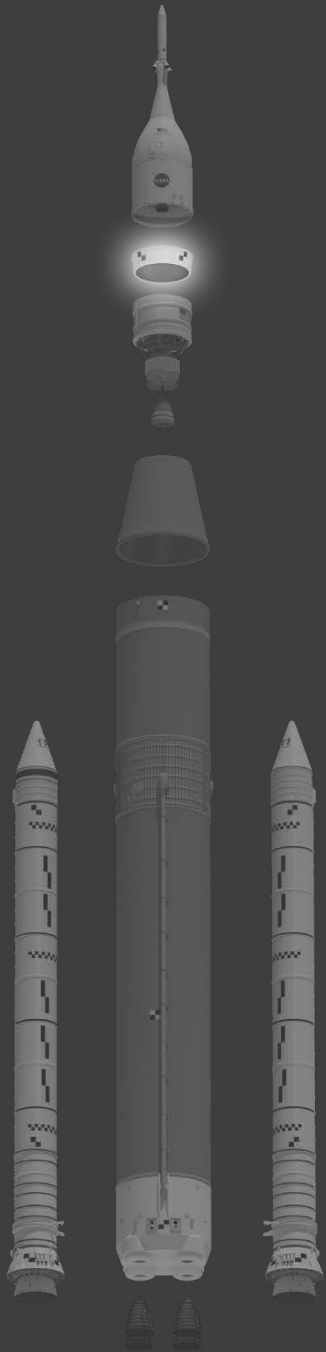
SUN

- CuSP (Southwest Research Institute)

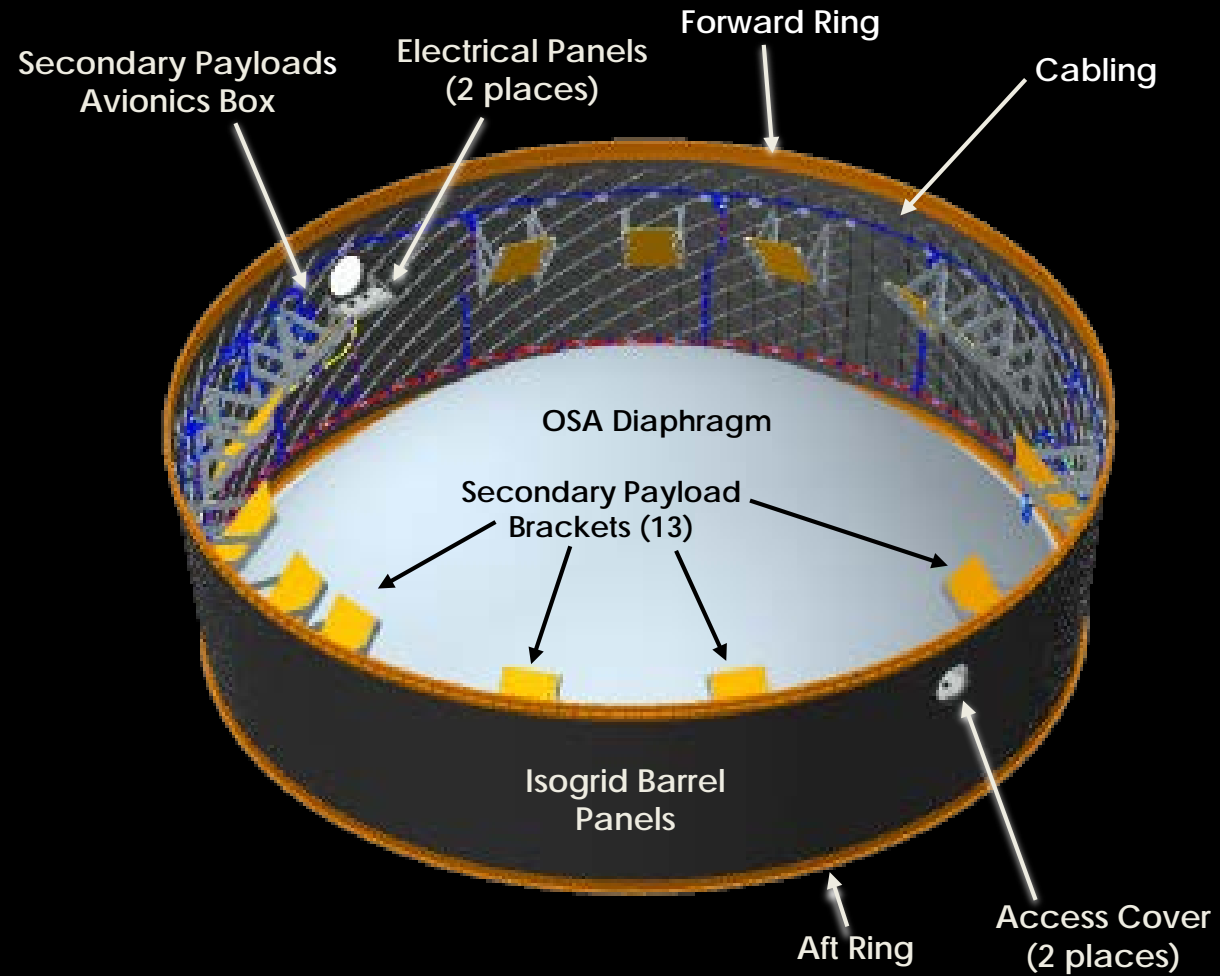
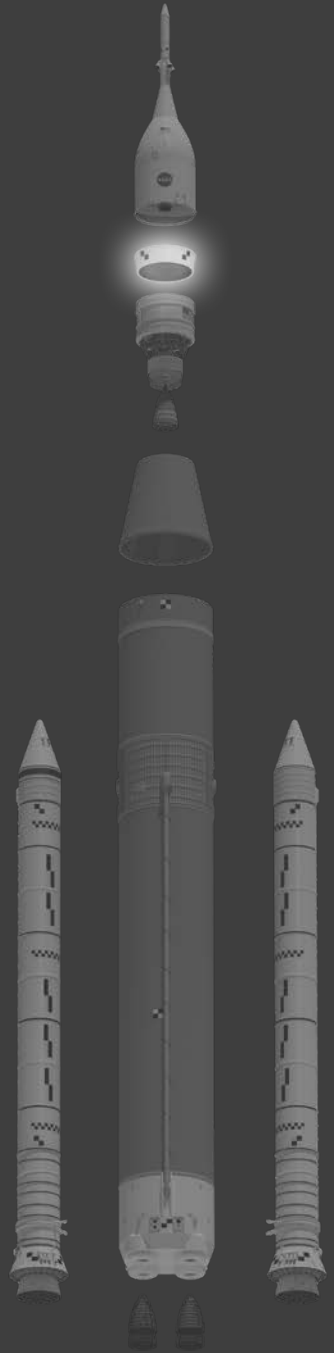


ONE LAUNCH, MULTIPLE DISCIPLINES

13 SMALLSATS TO BE DEPLOYED FROM THE ORION STAGE ADAPTER



EM-1 SECONDARY PAYLOAD CAPABILITY

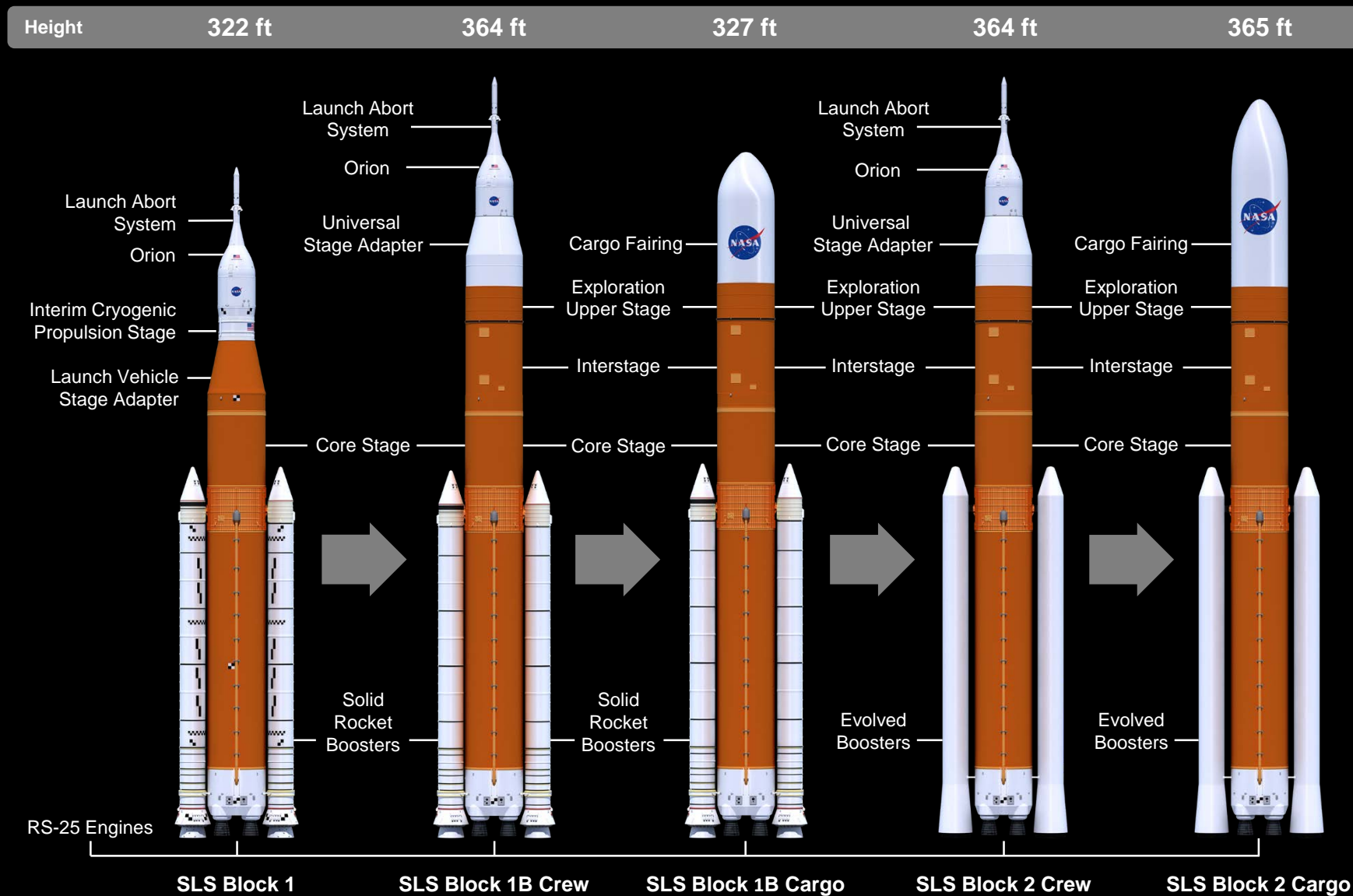


Orion Stage Adapter (OSA)

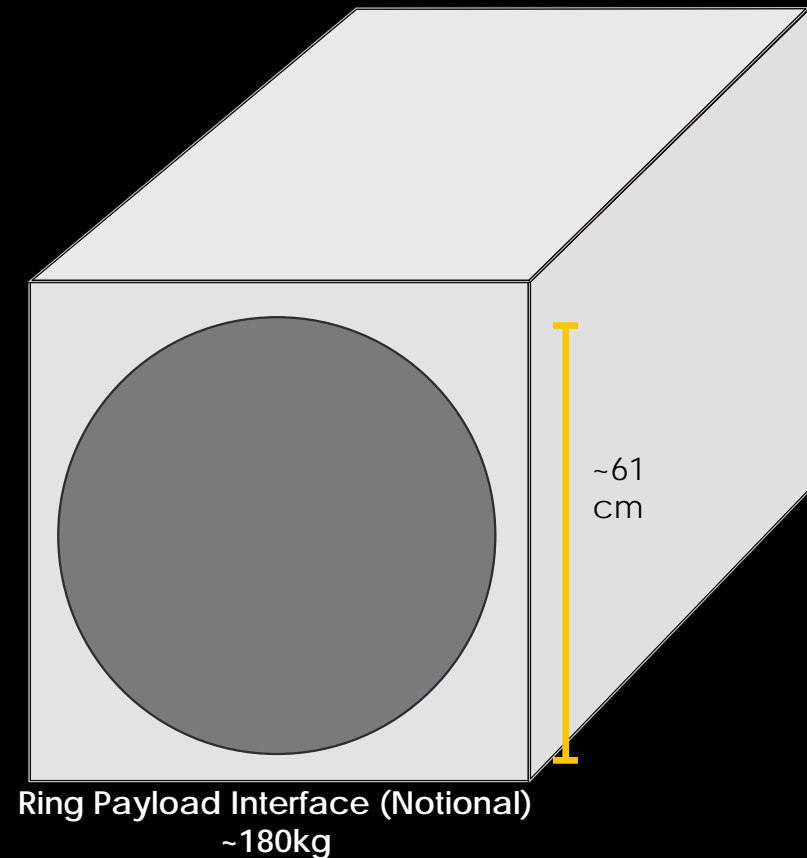
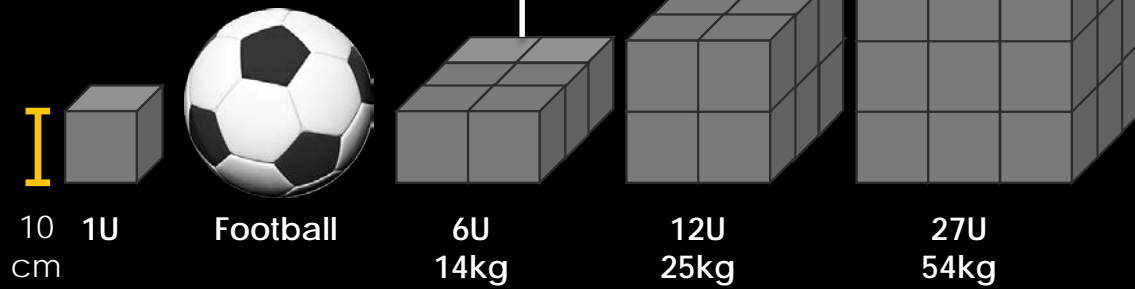
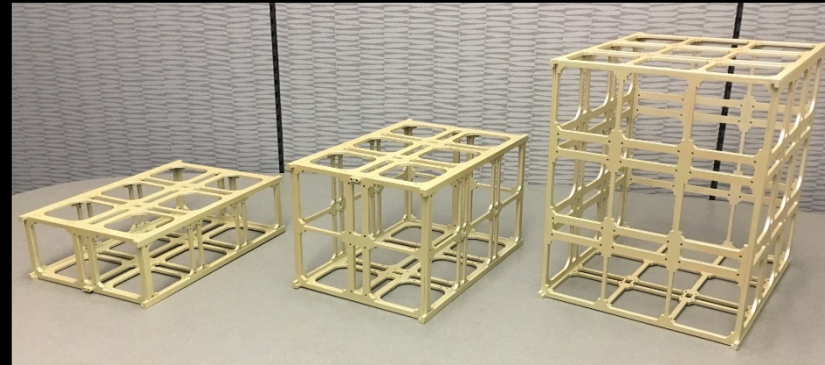
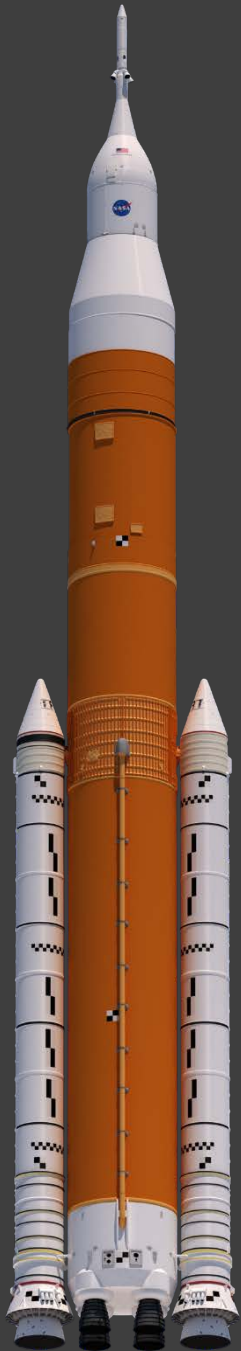
SLS EVOLVABILITY



Foundation
for a
generation
of deep
space
exploration



FUTURE SLS EXPLORATION MISSION OPTIONS FOR SMALL PAYLOADS



VOLUME AND MASS RANGE

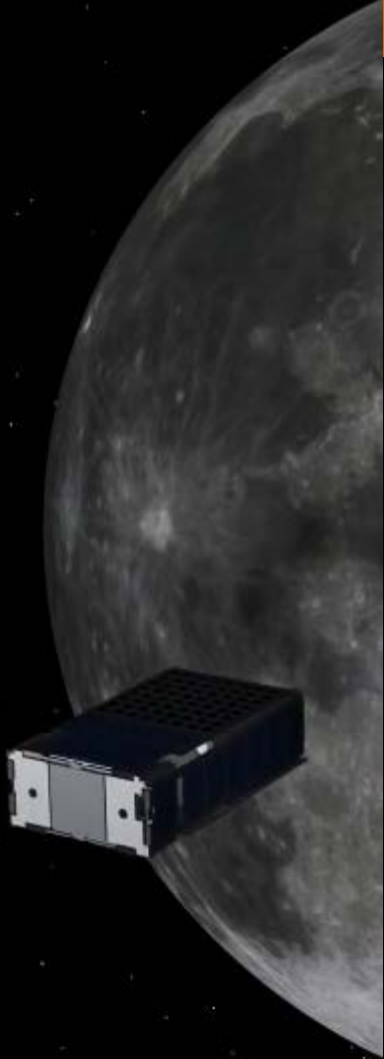


SUMMARY

- SLS provides unique opportunities for smallsats
 - Affordable access to the Moon and deep space
 - Payloads ranging from 6U/12U/27U to ESPA-class may be accommodated
- EM-1 launching in fiscal year 2020, with 13 CubeSats manifested
- Hardware for second mission in progress
- Call for next SLS CubeSat payloads planned for this summer
- Flexible architecture will meet demands of deep space exploration
 - Flight manifest may include multiple Block 1 flights

More Information

- SLS Mission Planner's Guide (ESD 30000)
 - Provides future payload developers/users with information to support preliminary SLS mission planning
 - Copies can be requested via email: NASA-slspayloads@mail.nasa.gov
 - www.nasa.gov/opportunities for CubeSat payload opportunities and announcements



IT'S HAPPENING NOW!



www.nasa.gov



[@NASA_SLS](https://twitter.com/NASA_SLS)



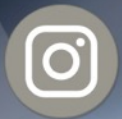
[NASASLS](https://www.facebook.com/NASASLS)



google.com/+nasa



youtube.com/nasa



[@explorenasa](https://www.instagram.com/explorenasa)





EXPLORATION MISSION-1

DEEP-SPACE OPPORTUNITIES FOR SMALLSATS

