

**SPACE LAUNCH SYSTEM PAYLOAD TRANSPORTATION BEYOND LEO.** S. D. Creech<sup>1</sup>, J. D. Baker<sup>2</sup>, A. L. Jackman<sup>3</sup> and G. Vane<sup>4</sup>, <sup>1</sup>NASA/MSFC Huntsville, AL 35812, [steve.creech@nasa.gov](mailto:steve.creech@nasa.gov), <sup>2</sup>Jet Propulsion Laboratory, Pasadena, CA 91109, [john.d.baker@jpl.nasa.gov](mailto:john.d.baker@jpl.nasa.gov), <sup>3</sup>NASA/MSFC Huntsville, AL 35812, [angie.jackman@nasa.gov](mailto:angie.jackman@nasa.gov), and <sup>4</sup>Jet Propulsion Laboratory, Pasadena, CA 91109, [gregg.vane@jpl.nasa.gov](mailto:gregg.vane@jpl.nasa.gov)

**Introduction:** NASA has successfully completed the Critical Design Review (CDR) of the heavy lift Space Launch System (SLS) and is working towards the first flight of the vehicle in 2018. SLS will begin flying crewed missions with an Orion capsule to the lunar vicinity every year after the first 2 flights starting in the early 2020's. As early as 2021, in addition to delivering an Orion capsule to a cislunar destination, SLS will also deliver ancillary payload, termed "Co-manifested Payload (CPL)", with a mass of at least 5.5 mT and volume up to 280 m<sup>3</sup> simultaneously to that same destination. Later SLS flights have a goal of delivering as much as 10 mT of CPL to cislunar destinations.

In addition to cislunar destinations, SLS flights may deliver non-crewed, science-driven missions with Primary Payload (PPL) to more distant destinations. SLS PPL missions will utilize a unique payload fairing offering payload volume (ranging from 320 m<sup>3</sup> to 540 m<sup>3</sup>) that greatly exceeds the largest existing Expendable Launch Vehicle (ELV) fairing available. The Characteristic Energy (C3) offered by the SLS system will generate opportunities to deliver up to 40 mT to cislunar space, and deliver double PPL mass or decrease flight time by half for some outer planet destinations when compared to existing capabilities. For example, SLS flights may deliver the Europa Clipper to a Jovian destination in under 3 years by the mid 2020's, compared to the 7+ years cruise time required for current launch capabilities.

This presentation will describe ground and flight accommodations, interfaces, resources, and performance planned to be made available to potential CPL and PPL science users of SLS. In addition, this presentation should promote a dialogue between vehicle developers, potential payload users, and funding sources in order to most efficiently evolve required SLS capabilities to meet diverse payload needs as they are identified over the next 35 years and beyond.



5...4...3...2...1...

# SPACE LAUNCH SYSTEM

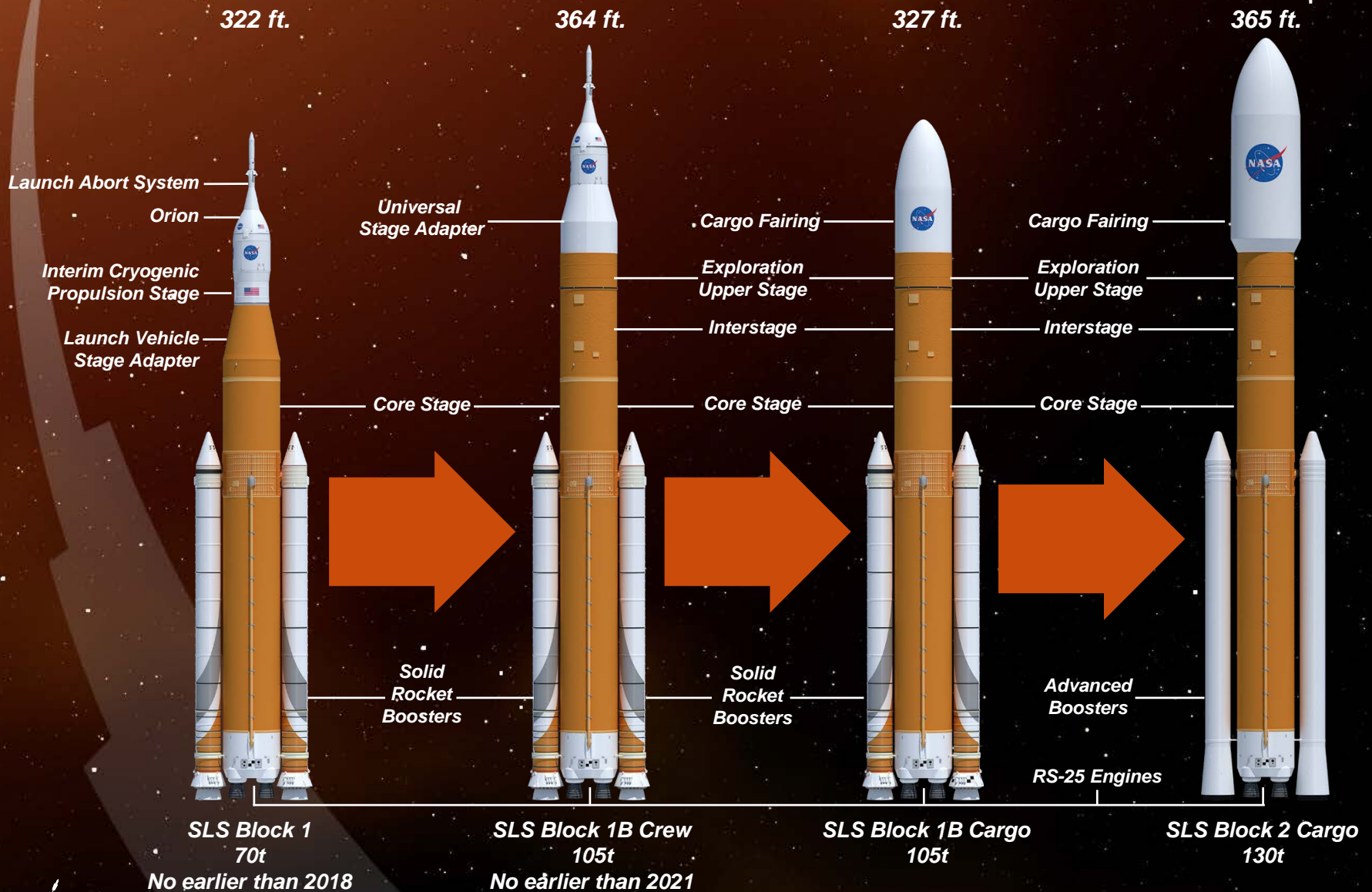
SLS Payload Transportation Beyond LEO

**Angie L. Jackman**  
*1 March 2017*

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# SLS Evolution Overview



No earlier than 2018

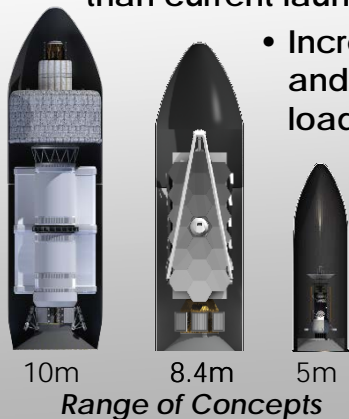
[www.nasa.gov/sls](http://www.nasa.gov/sls)

No earlier than 2021

# Benefits of SLS Performance

## Increased Mass/Volume Payload to Orbit

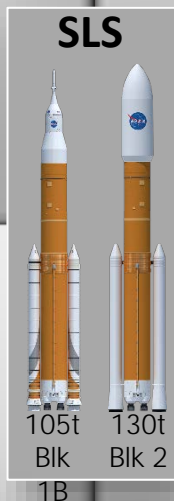
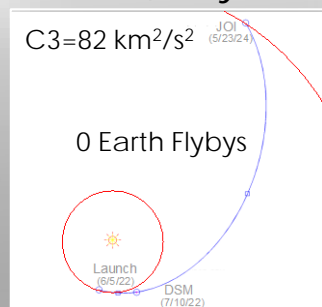
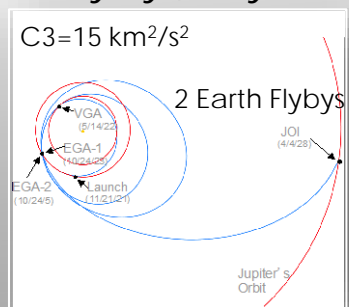
- Up to 5 times greater mass to orbit capability than current launch systems



- Increases payload mass margins and offers greater propellant loads
- Accommodates a range of (5m-10m) fairing sizes
- Up to 6 times greater payload volume

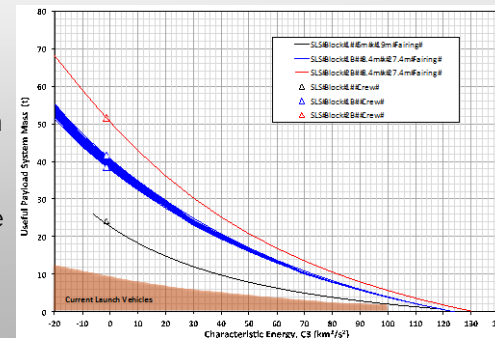
## Shorter Transit Times to Destination

- Jovian system transit time reduced up to 70%
  - Longer launch window provides more mission margin
  - Reduced mission operations cost over time
- With fly-bys, 6.4 years      SLS Direct, 1.9 years



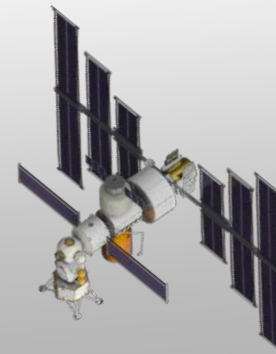
## Larger Interplanetary Mass to Destination

- 3 to 4 times the mass to destination
- Single launch of larger payload reduces payload complexity
  - Human Cis-lunar
  - Human Mars
  - Asteroid Redirect Mission
  - Mars Sample Return
  - Jupiter Europa Orbiter
  - Saturn/Titan Sample Return
  - Ice Giant Exploration
  - Outer Planet Sample Return
  - Large Telescopes

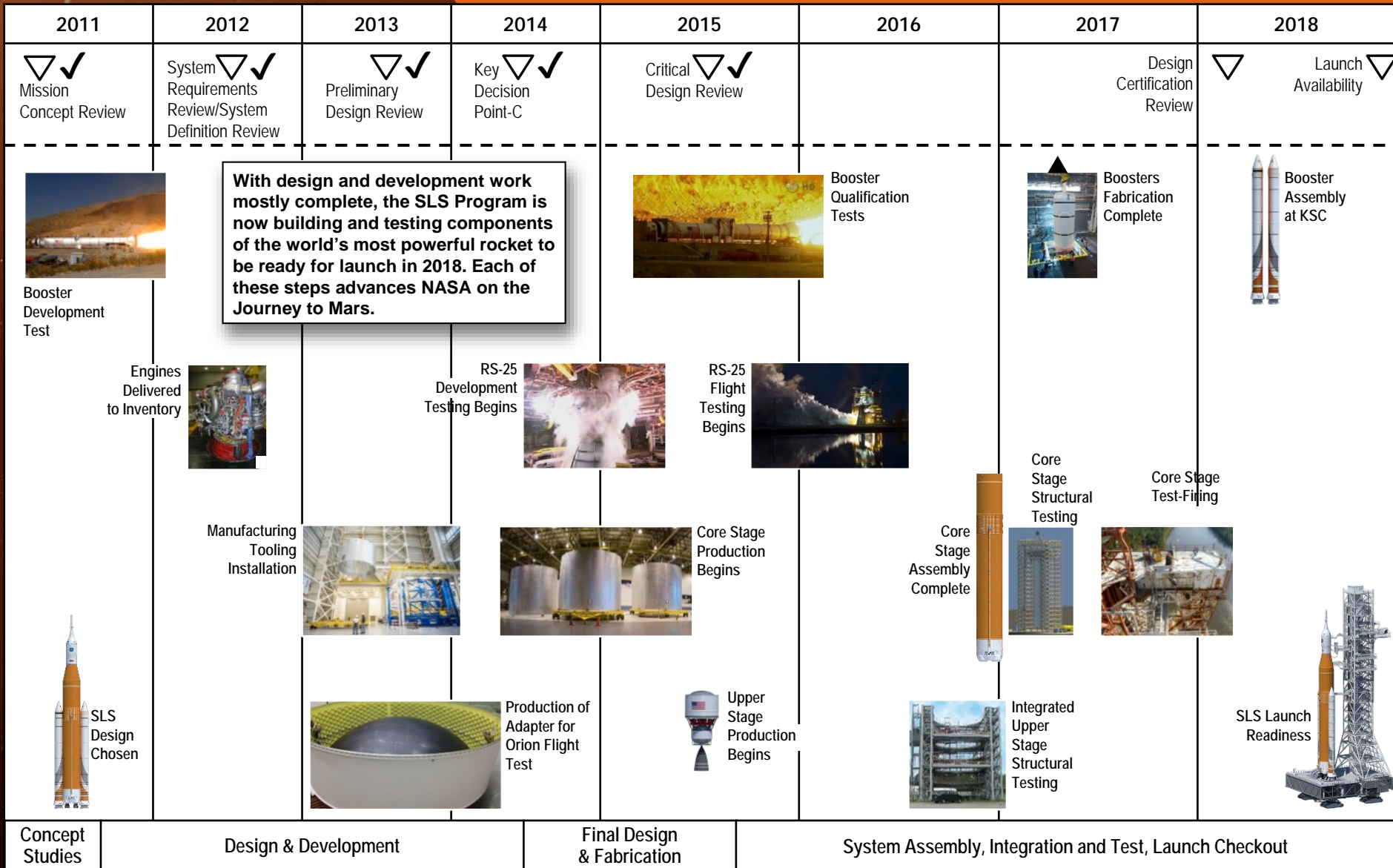


## Enhanced Reliability and Safety

- Fewer deployments simplifies orbital operations (less orbital assembly for large spacecraft)
- Significantly less time in Earth Orbit reduces propellant boil-off
- Reduces need for Earth flyby minimizing nuclear safety



# Space Launch System Path to the Pad



# Recent Progress Toward Launch



Core Stage production at Michoud



Booster testing at Orbital ATK



Engine testing at Stennis Space Center



Test stand construction at Marshall

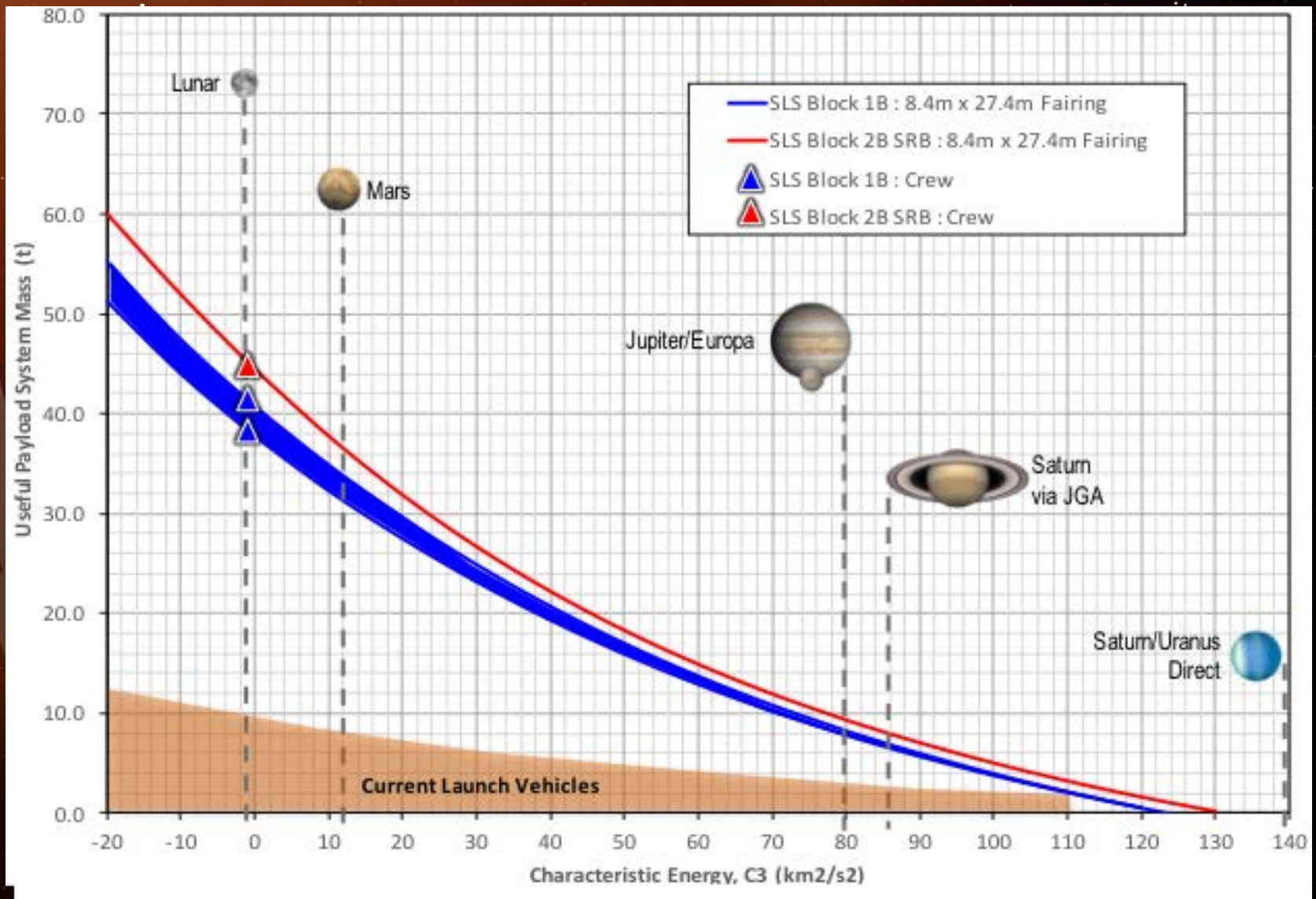


Stage adapter welding at Marshall

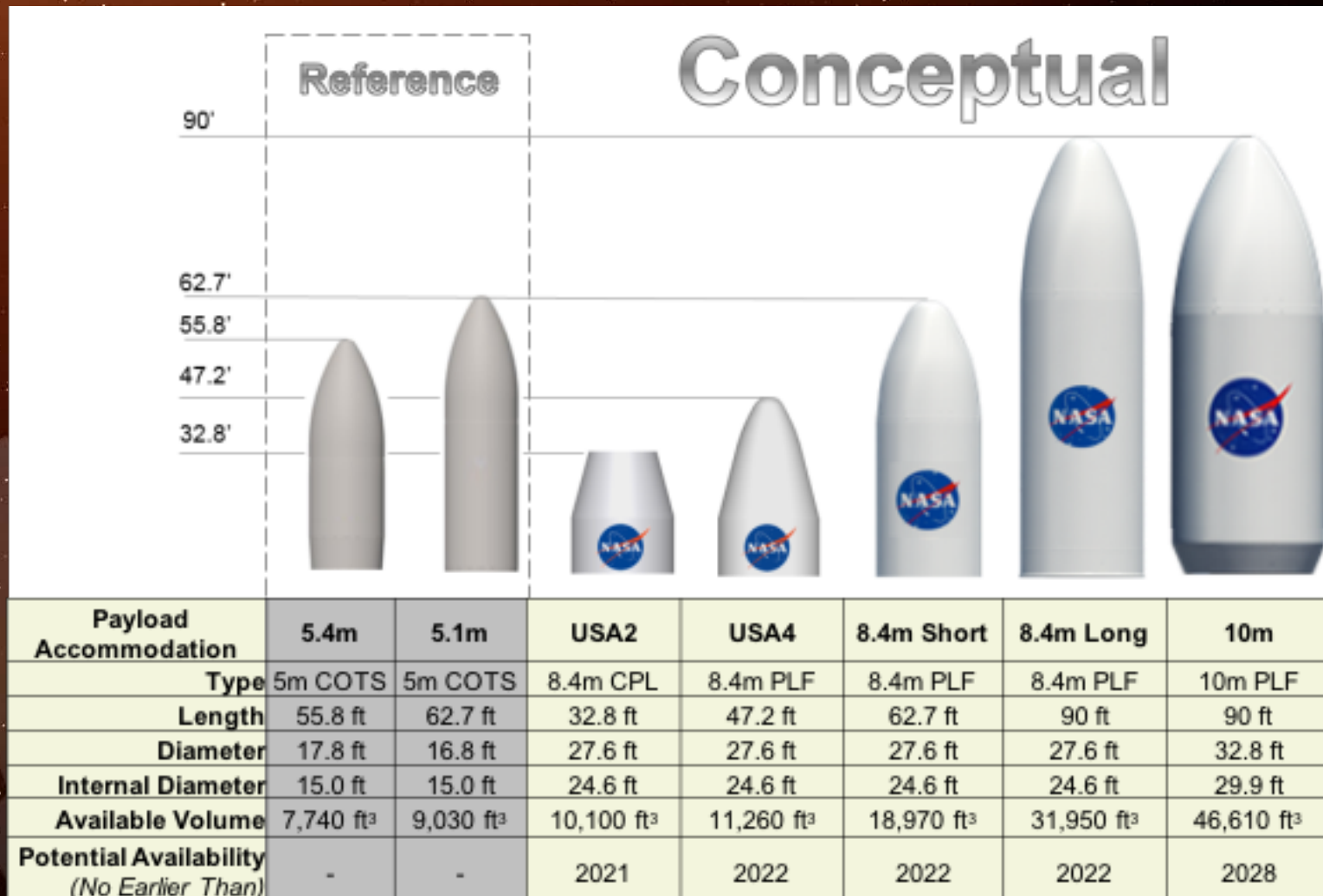


Upper stage production at ULA

# SLS Payload Mission Capture



# Range of Payload Encapsulation



Bik 18

COTS: Commercial Off-the-shelf

PLF: Payload Launcher Adapter CPL: Commercial





# Range of SLS Spacecraft/Payload Types

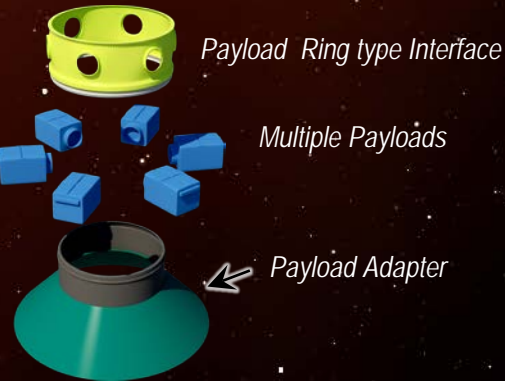
## Orion Spacecraft



## Orion Co-Manifested Payload (CPL)

### Smaller CPL

Mounted to ring adapter between Spacecraft and Payload Adapter



Payload Ring type Interface

Multiple Payloads

Payload Adapter

Orion

Universal Stage Adapter

Larger CPL

## Secondary Payloads (SPL)

≤ 27U Cubesat type Secondary Payloads  
Mounted to Payload Adapter PAF

Payload Separation System

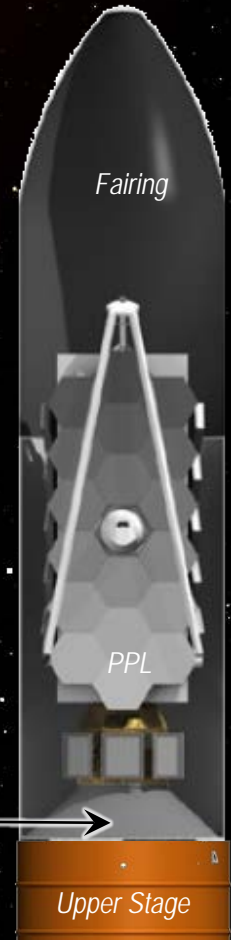
27U Secondary Payload & Deployment System

Payload Interface Adapter

12U Secondary Payload & Deployment System

Payload Attach Fitting

## Primary Payload (PPL)



Fairing

PPL

Upper Stage

# SLS Payload Accommodations

## Adapter/Fairing Availability

- ◆ Universal Stage Adapter offers opportunity for co-manifested payloads with Orion spacecraft or near-term 8.4-meter lower-height accommodations.
- ◆ Universal Stage Adapter accommodations available as soon as 2021
- ◆ 8.4- and 10-meter fairings available in the mid- and late-2020s, respectively.



total mission volume = ~

400m<sup>3</sup>

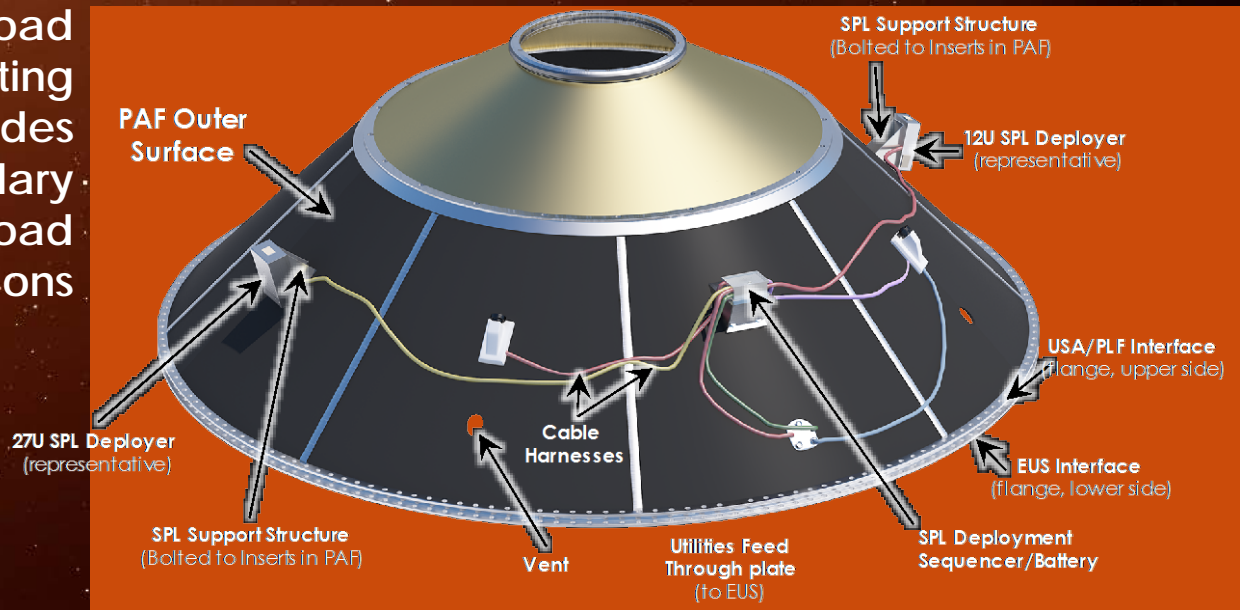
400m<sup>3</sup>

1200m<sup>3</sup>

1800m<sup>3</sup>

# SLS Secondary Payload Capability

SLS Payload Attach Fitting (PAF) provides Secondary Payload accommodations



- Block 1B vehicle offers up to seven 12U to 27U payload locations (or their volume equivalent) on the PAF outer face
- Payloads will be “off” from roll-out through Orion separation and payload deployment
- Payload Deployment System Sequencer; payload deployment will begin with pre-loaded sequence following Orion separation and Upper Stage disposal burn
- Payload requirements captured in a Interface Definition and Requirements Document



# One Launch, Multiple Disciplines

The first SLS launch will carry 13 6U smallsats, representing multiple disciplines and partners. The smallsats will be deployed from the Orion Stage Adapter.

## Moon

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

## Asteroid

- NEA Scout

## Sun

- CuSP (Southwest Research Institute)



## Earth

- EQUULEUS (JAXA)
- Skyfire (Lockheed Martin)



## And Beyond

- Biosentinel (NASA)
- ArgoMoon (ESA/ASI)
- Three Centennial Challenge Winners (TBD)

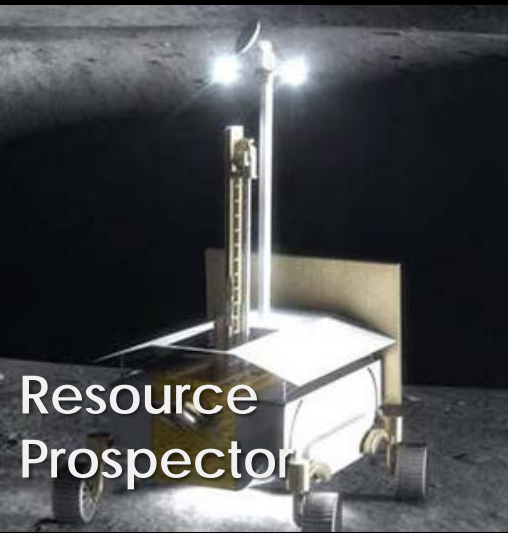




NextSTEP and  
Future Capacities Team (FCT)



Europa  
Clipper



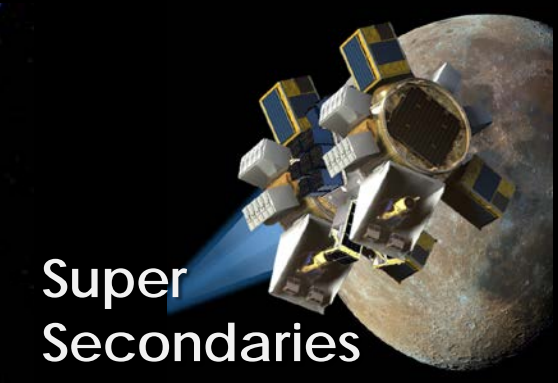
Resource  
Prospector

# Potential Near Term SLS Missions

Timeframe: 2021- 2025

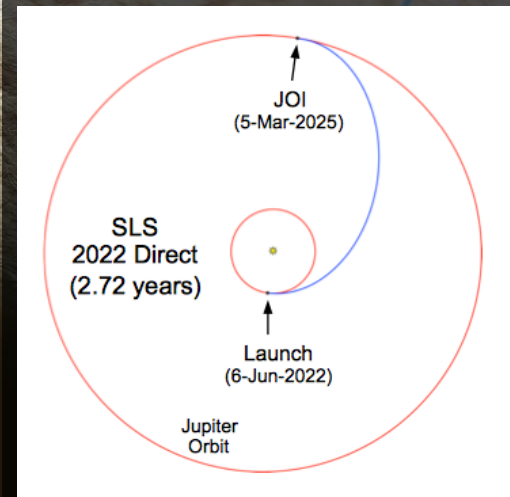
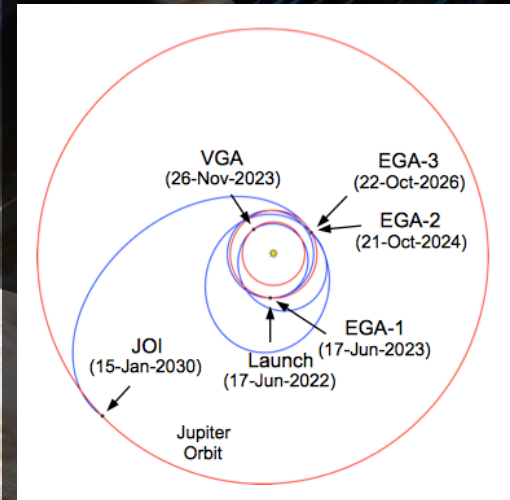
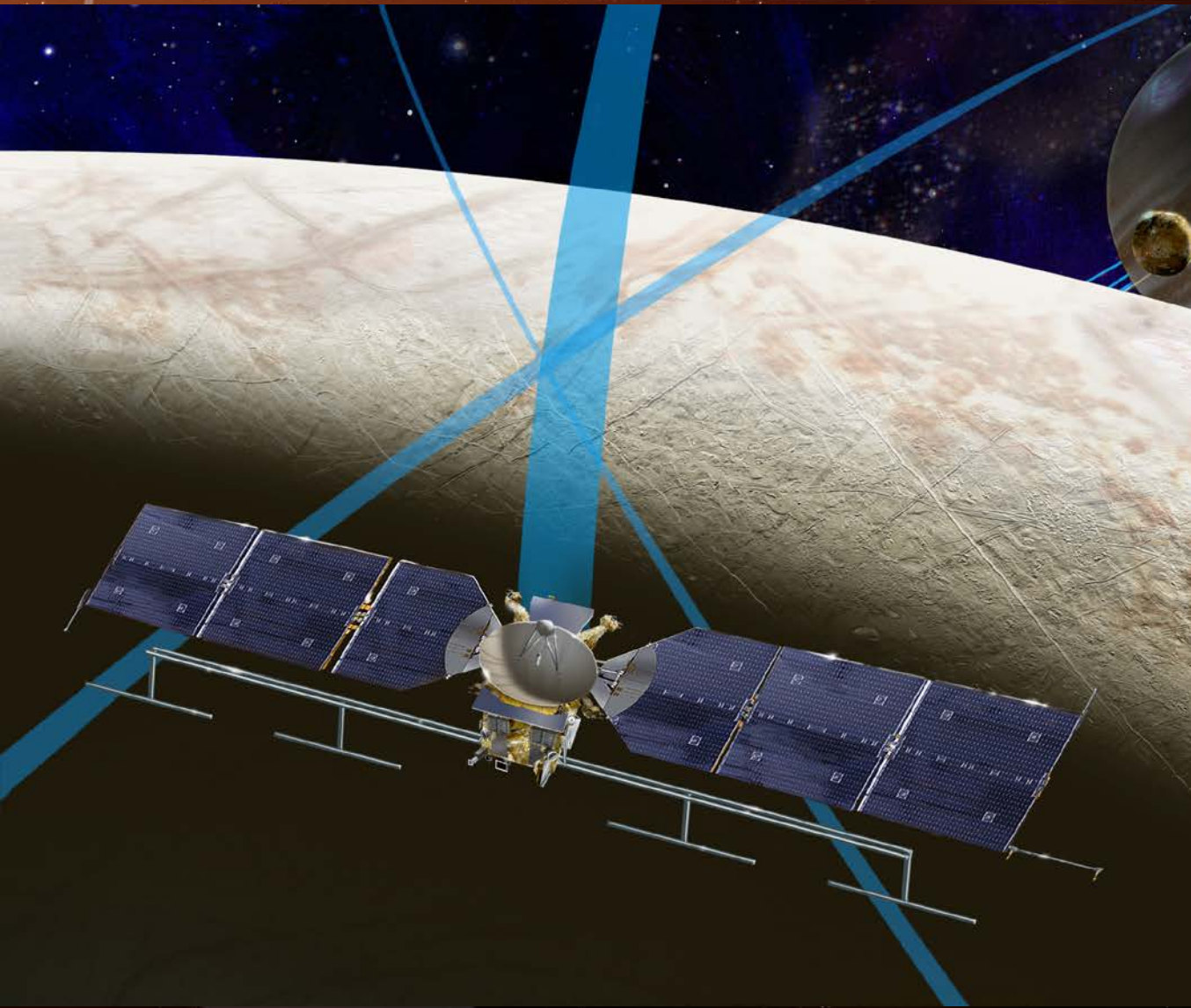


Asteroid Redirect Crew Mission  
(ARCM)

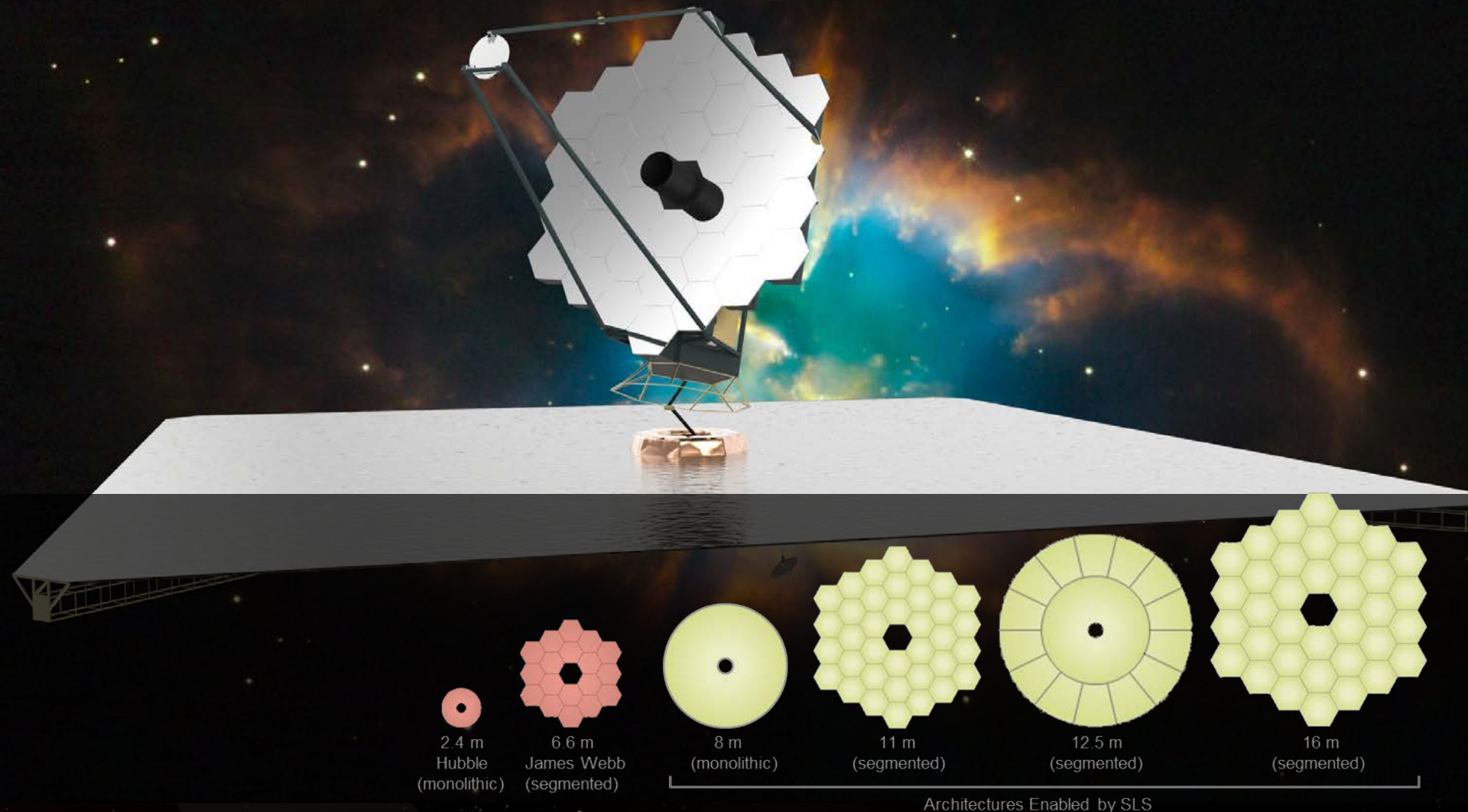


Super  
Secondaries

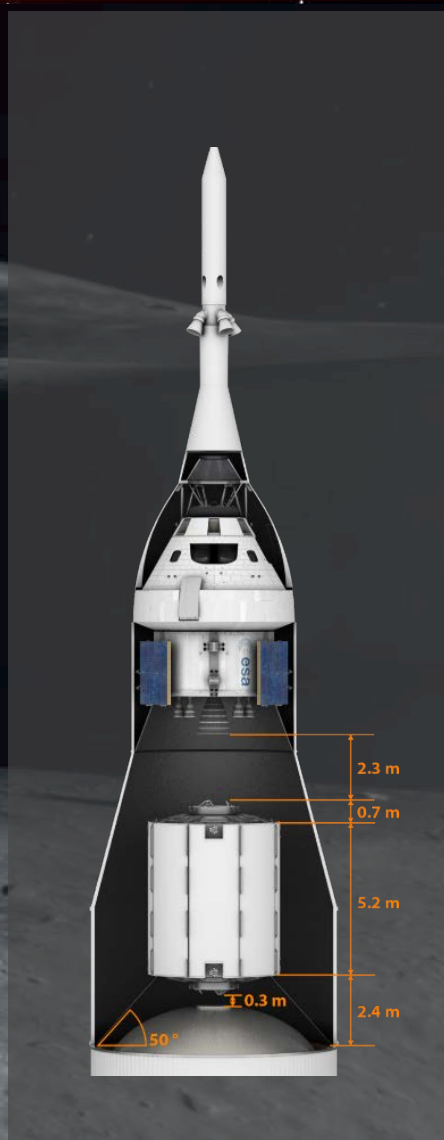
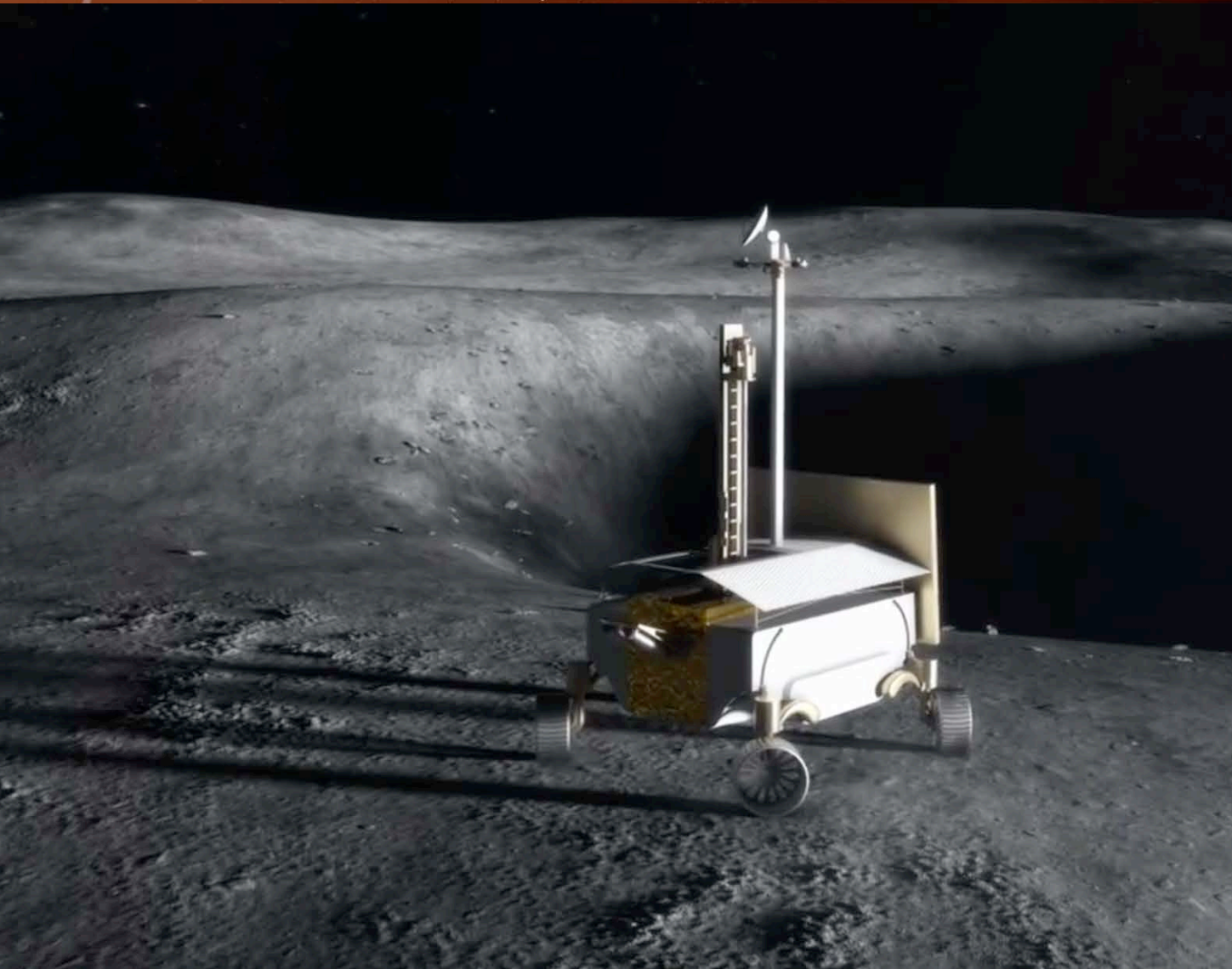
# Utilization of SLS Departure Energy



# Utilization of SLS Volume



# Utilization of SLS Co-Manifest Capabilities





***For More Information:***  
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#JOURNEYTOMARS



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