




# NASA's Space Launch System: *Exploration Beyond Earth's Orbit*

*Todd A. May, Program Manager  
Garry M. Lyles, Chief Engineer  
Joan (Jody) A. Singer, Deputy Program Manager  
David E. Beaman, Spacecraft and Payload Integration Manager  
Stephen D. Creech, Strategic Development Manager*

May 2012

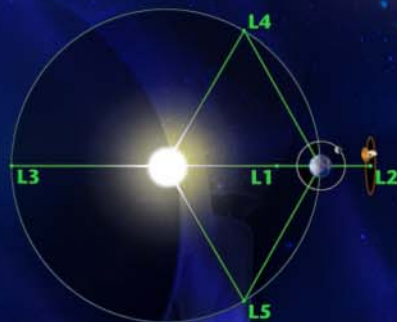
A composite image of the solar system. In the upper left, a bright yellow Sun glows. To its right, Earth is shown with blue oceans and white clouds. Further right is Mars, a reddish-orange planet with dark surface features. Several grey, irregularly shaped asteroids are scattered throughout the scene, some appearing to orbit or pass near the planets. The background is a deep blue space filled with numerous small, distant stars.

Todd May, Program Manager  
*NASA's Vision and Mission*



“To reach for new heights...  
and reveal the unknown so that what we do and learn  
will benefit all humankind.”

National Aeronautics and  
Space Administration

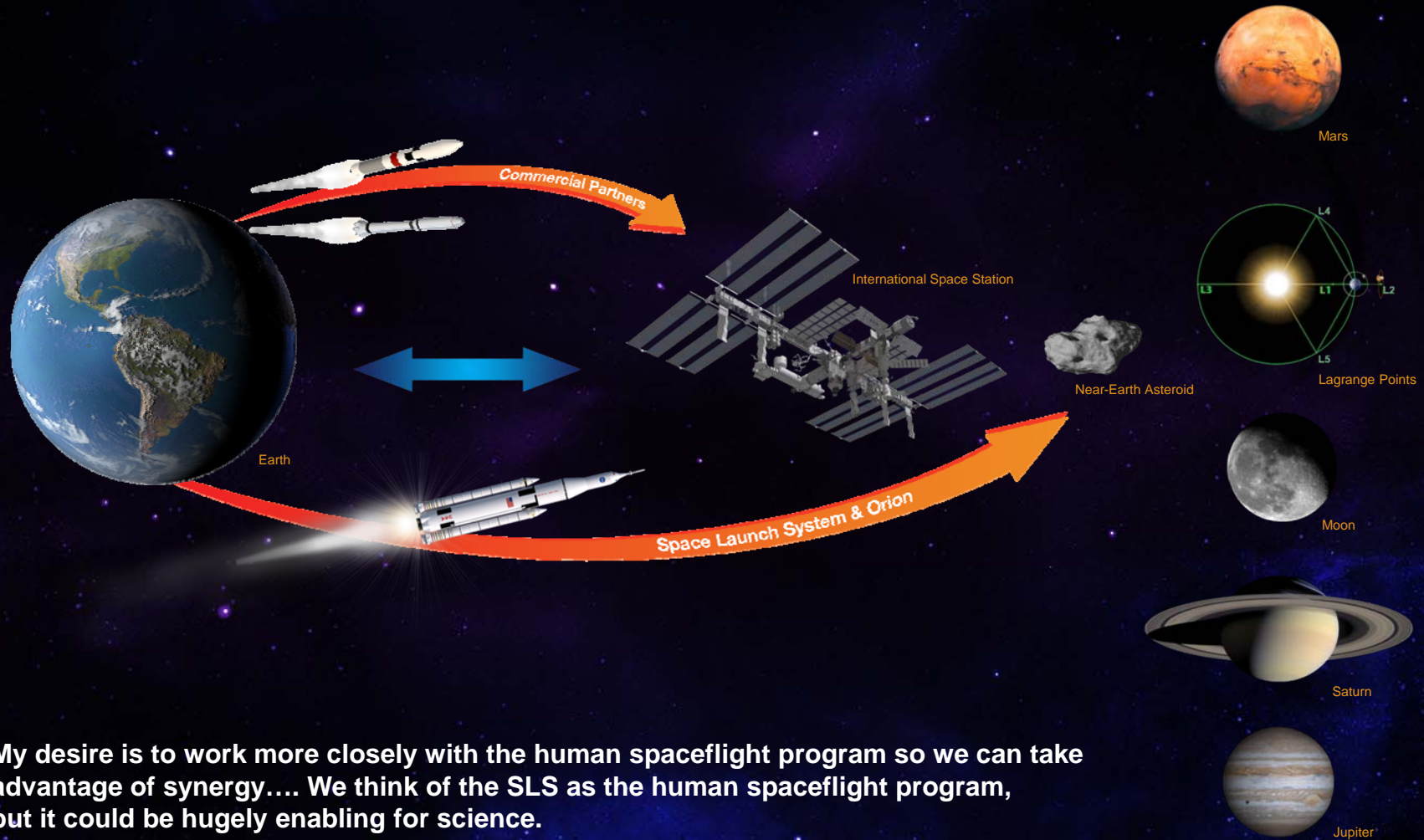


# *SLS Launches in 2017*

“Extend and sustain human activities  
across the solar system.”  
NASA 2011 Strategic Plan



# The Future of Exploration



My desire is to work more closely with the human spaceflight program so we can take advantage of synergy.... We think of the SLS as the human spaceflight program, but it could be hugely enabling for science.

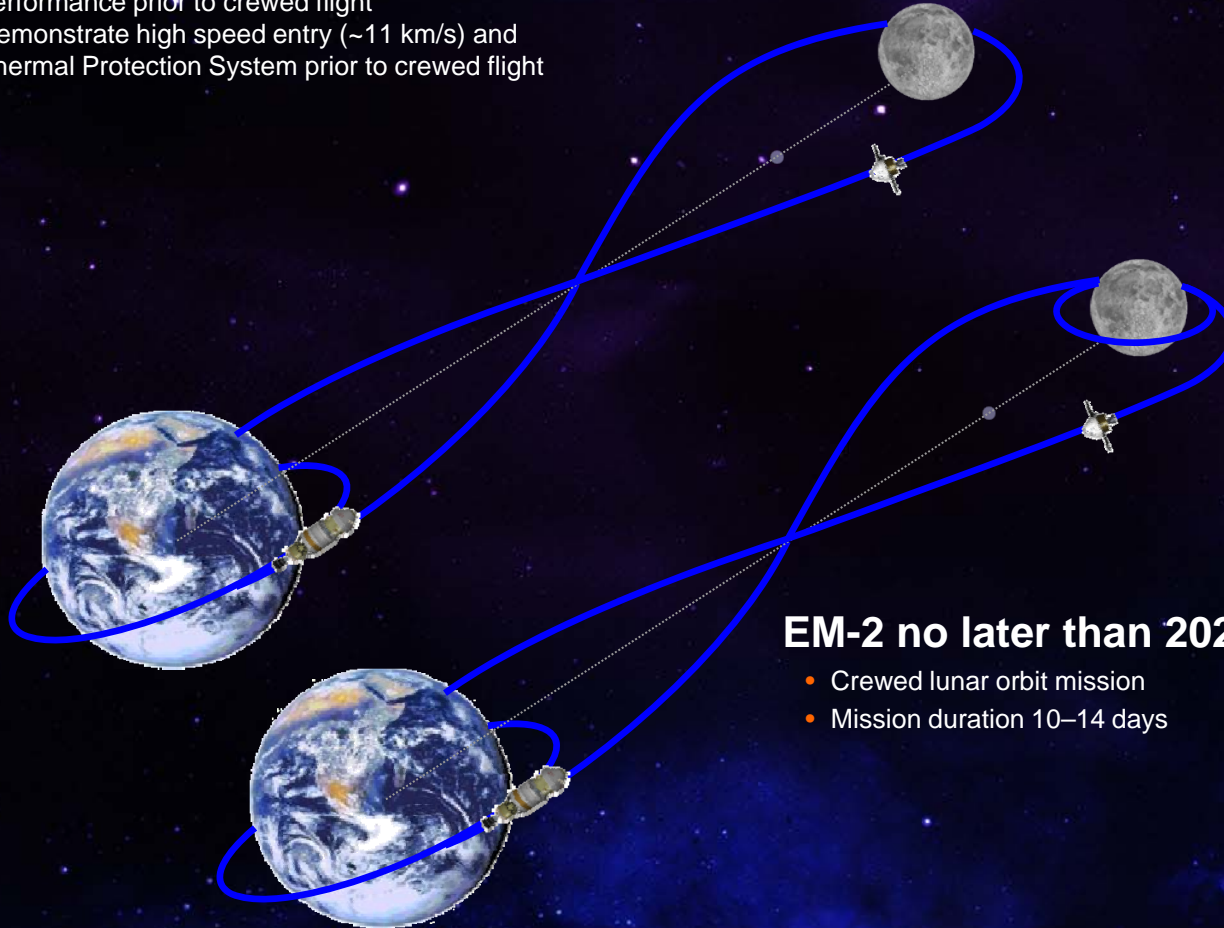
— John Grunsfeld, Associate Administrator  
NASA Science Mission Directorate  
*Nature*, Jan 19, 2012



# Initial Exploration Missions (EM)

## EM-1 in 2017

- Un-crewed circumlunar flight – free return trajectory
- Mission duration ~7 days
- Demonstrate integrated spacecraft systems performance prior to crewed flight
- Demonstrate high speed entry (~11 km/s) and Thermal Protection System prior to crewed flight



## EM-2 no later than 2021

- Crewed lunar orbit mission
- Mission duration 10–14 days



# NASA's Space Launch System

- ◆ *Vital to NASA's exploration strategy and the Nation's space agenda.*
- ◆ Key tenets: safety, affordability, and sustainability
- ◆ System Requirements Review/ System Definition Review in progress
- ◆ Partnerships with NASA Exploration Systems Development (Headquarters), Orion and Ground Operations Programs, and Centers
- ◆ Prime contractors on board, engaging the U.S. aerospace workforce and specialized infrastructure
- ◆ Turning plans into progress: Design and development work moving forward today, to deliver an unsurpassed capability that launches in 2017



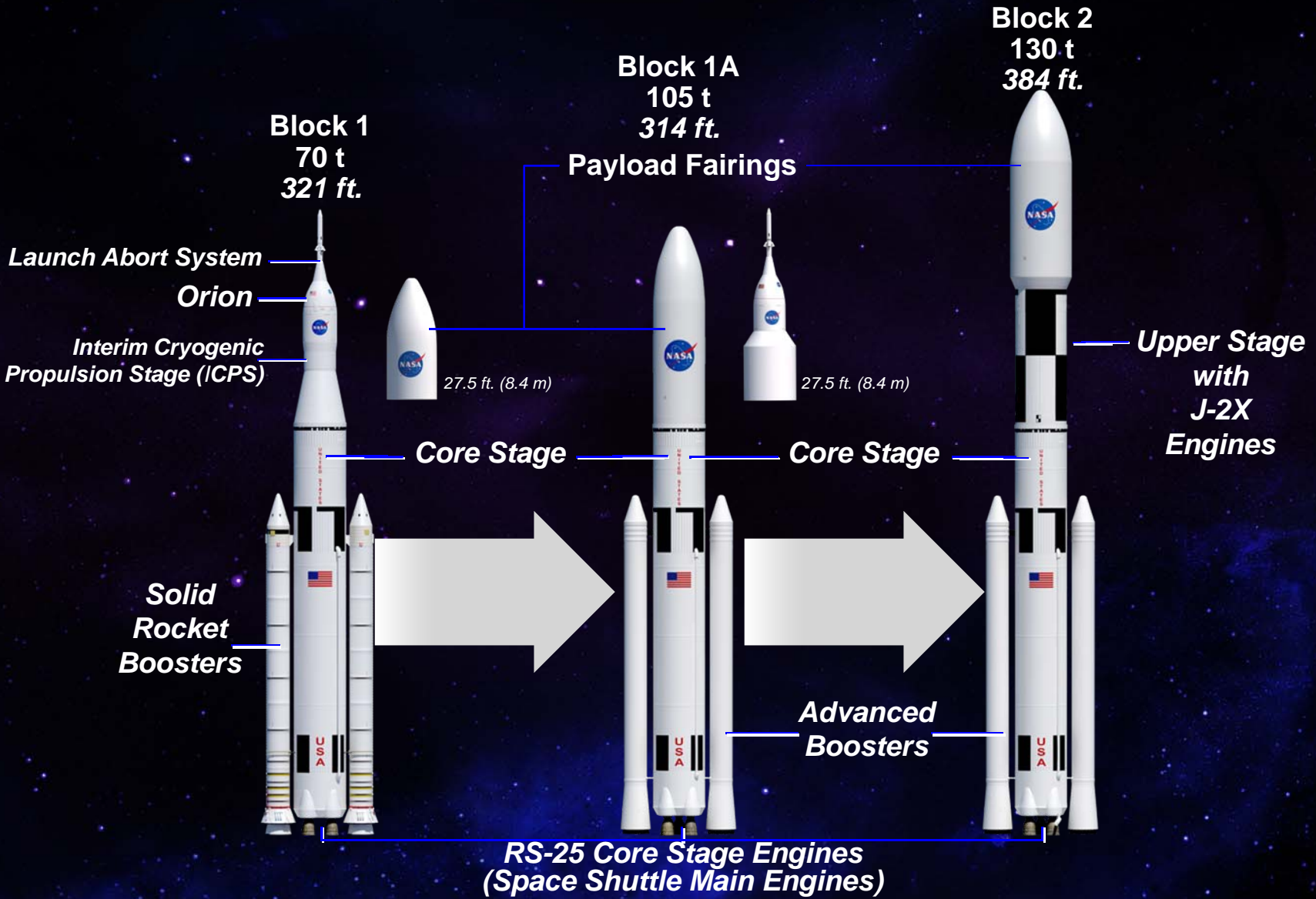
*On Track for First Flight in 2017*



A composite image of the solar system. In the upper left, a bright yellow Sun glows. To its right, Earth is shown with blue oceans and white clouds, with a small satellite in orbit. Further right is Mars, a reddish-orange planet with dark surface features, and its two moons. The foreground is filled with numerous brown, rocky asteroids of various sizes. The background is a deep blue space filled with stars.

Garry Lyles, Chief Engineer  
*The SLS Design*

# SLS Architecture Block Upgrade Approach

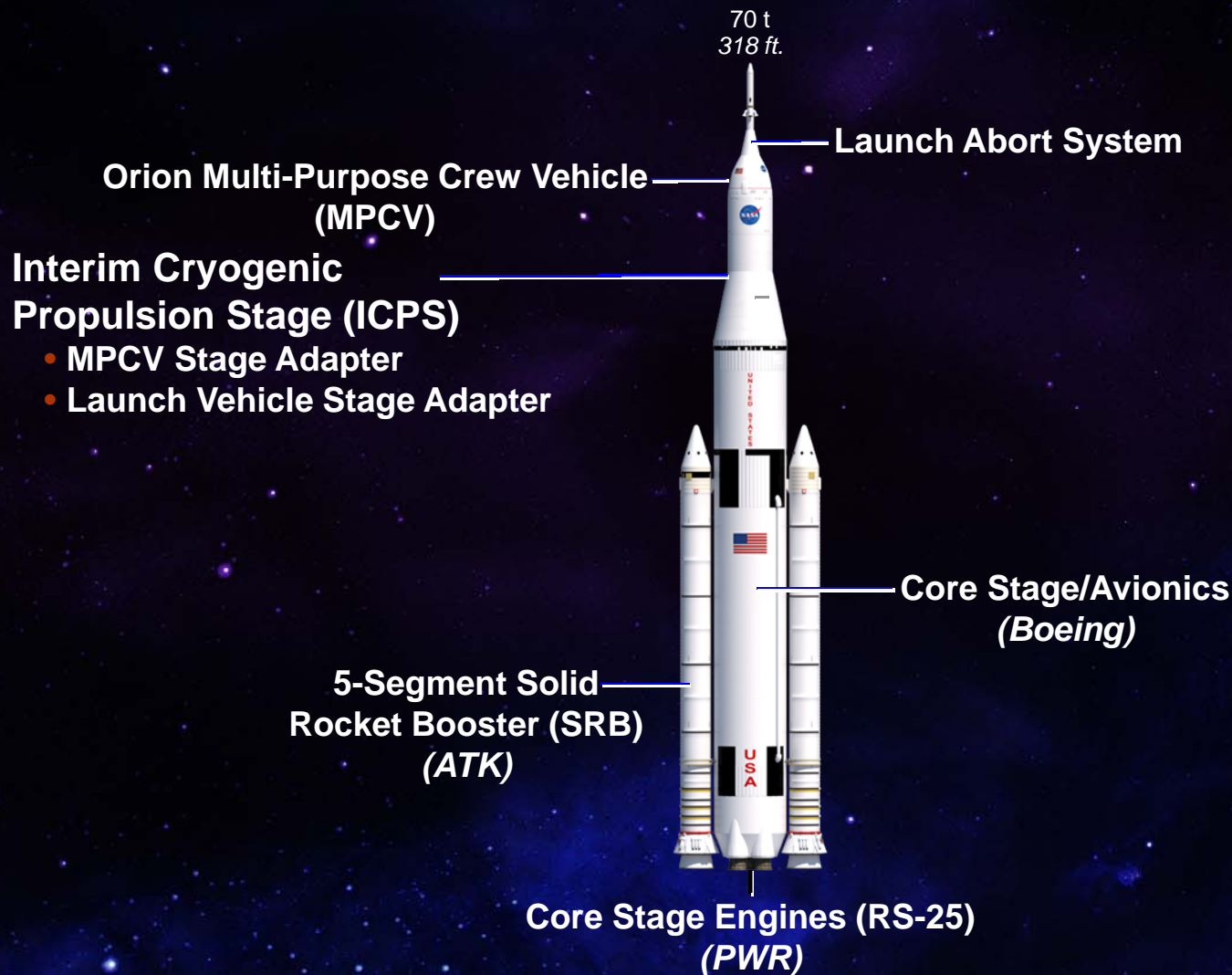


*Starting with Available Assets and Evolving the Design*



# SLS 70 Metric Tons: *First Flight 2017*

INITIAL CAPABILITY, 2017-21

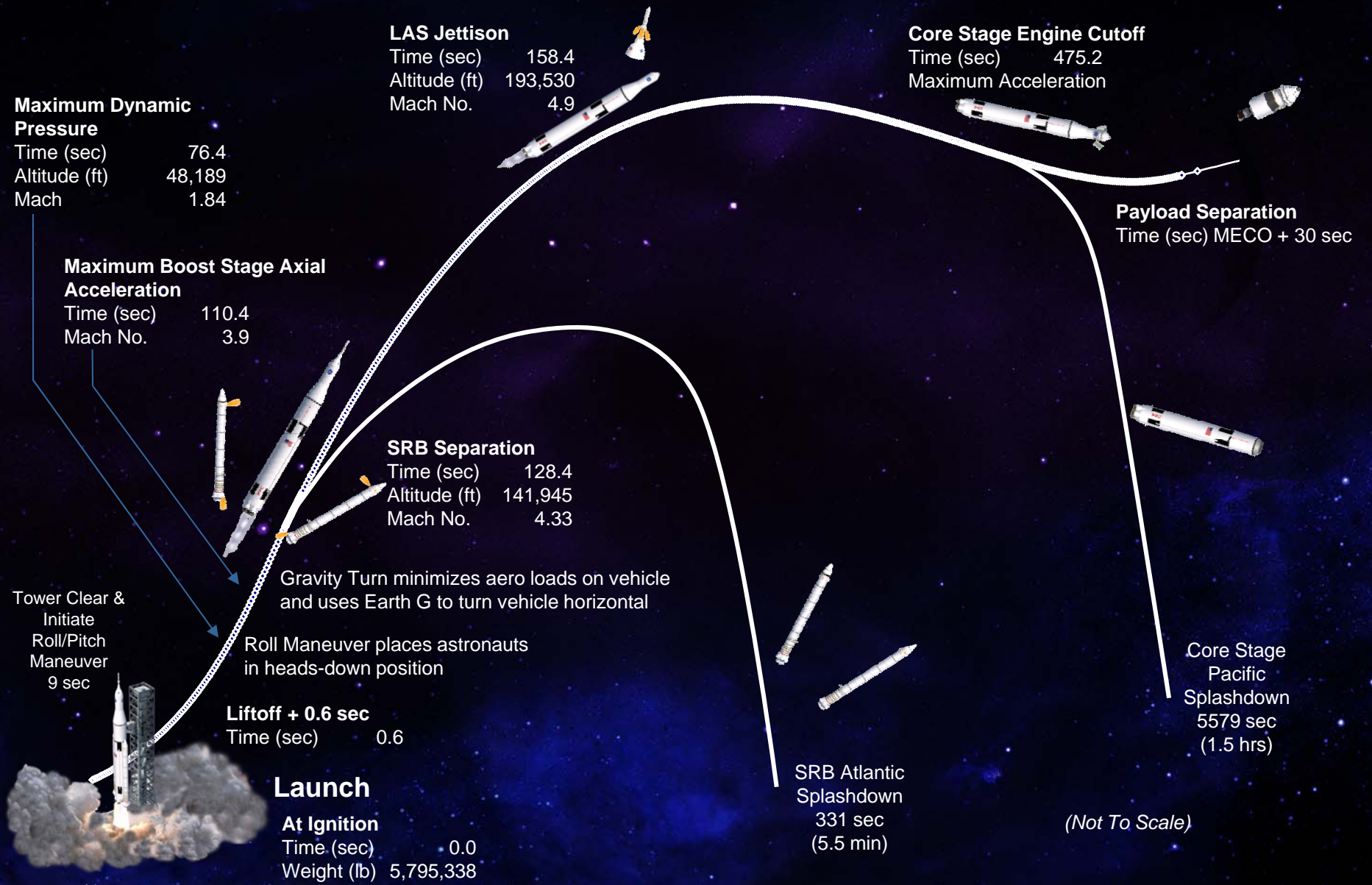




***SLS will launch from  
Kennedy Space Center  
in 2017***



# Ascent Mission Profile: SLS/Orion



# SLS: Being Built Today



First ring forging prepared for Orion Stage Adapter, Cudahy, WI, April 2012.



Stages Industry Day at Michoud Assembly Facility, New Orleans, Nov 2011.



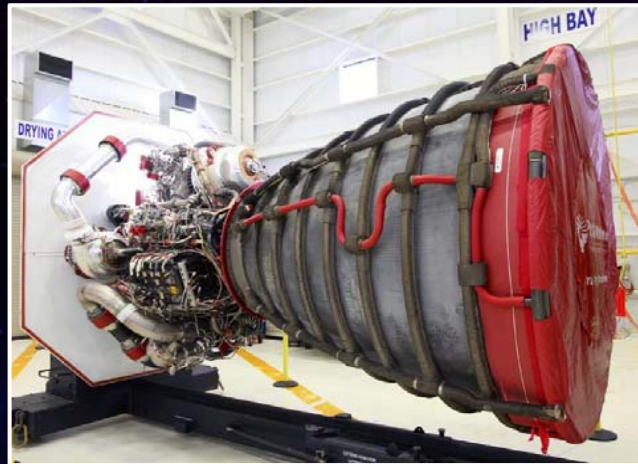
Solid Rocket Booster development motor test, Promontory, Utah, Sep 2011.



KSC is preparing Launch Complex 39B for SLS/Orion operations, 2012.



Installing the J-2X powerpack in test stand at SSC.



RS-25 Core Stage Engine in the KSC Engine Processing Facility, 2011.




J-2X Upper Stage Engine powerpack test, Stennis Space Center (SSC), MS, Feb 2012.



Meeting with Space Campers at U.S. Space & Rocket Center, Huntsville, AL, Feb 2012.



A composite image of space featuring a bright sun in the upper left, Earth and Mars in the center, a satellite, and a field of asteroids in the foreground.

Jody Singer, Deputy Program Manager  
*Hardware Progress*





*RS-25 Engines  
received at  
Stennis Space Center  
April 2012*



A large rocket engine is suspended vertically in a dark industrial test chamber. A bright, intense plume of fire and white smoke is being emitted from the engine's nozzle, directed downwards. The surrounding environment is filled with structural beams, pipes, and various pieces of equipment, all dimly lit. The overall scene conveys a sense of high-pressure engineering and testing.

*100%  
Success  
Rate*

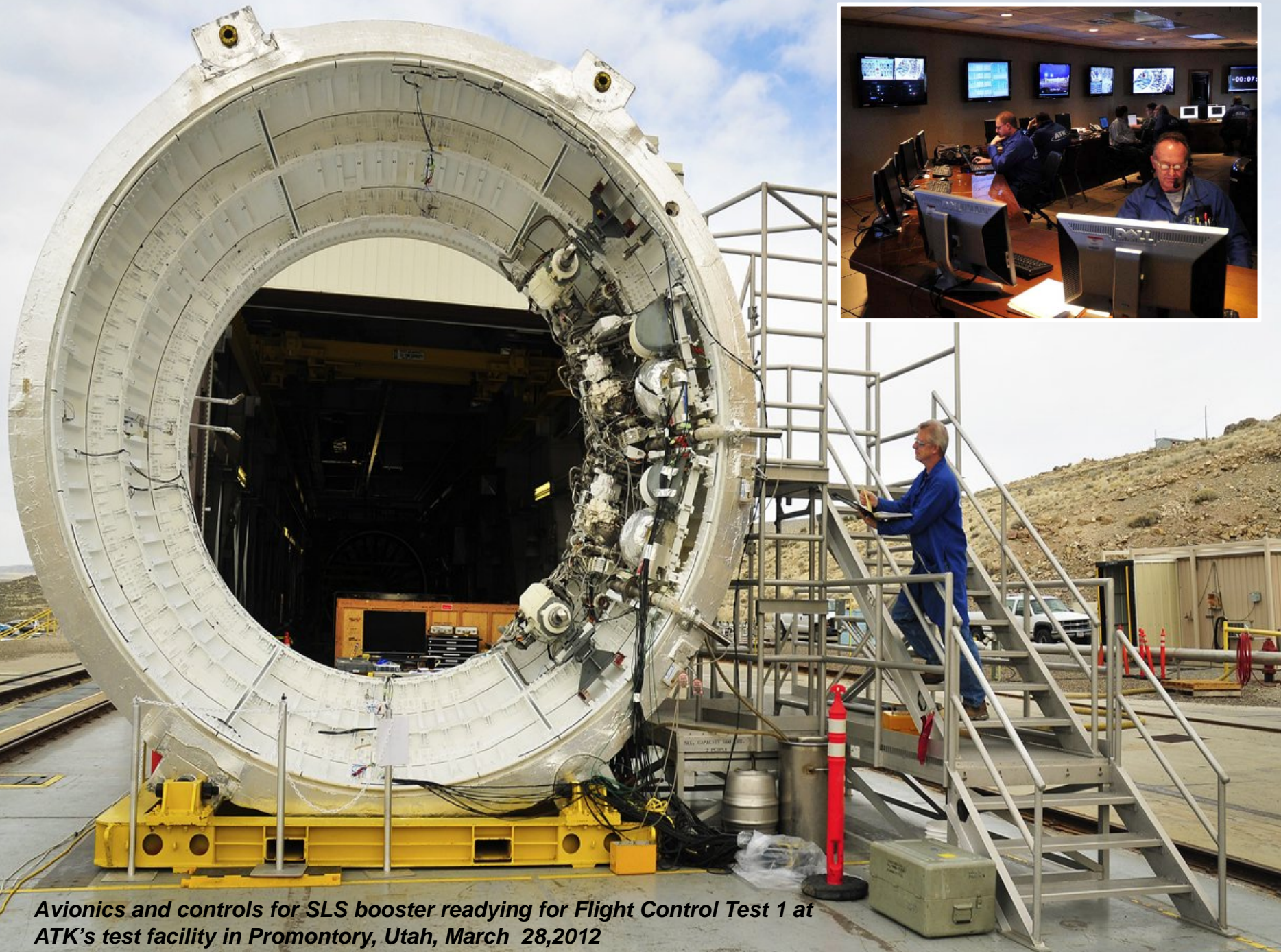


# 5-Segment Solid Rocket Booster



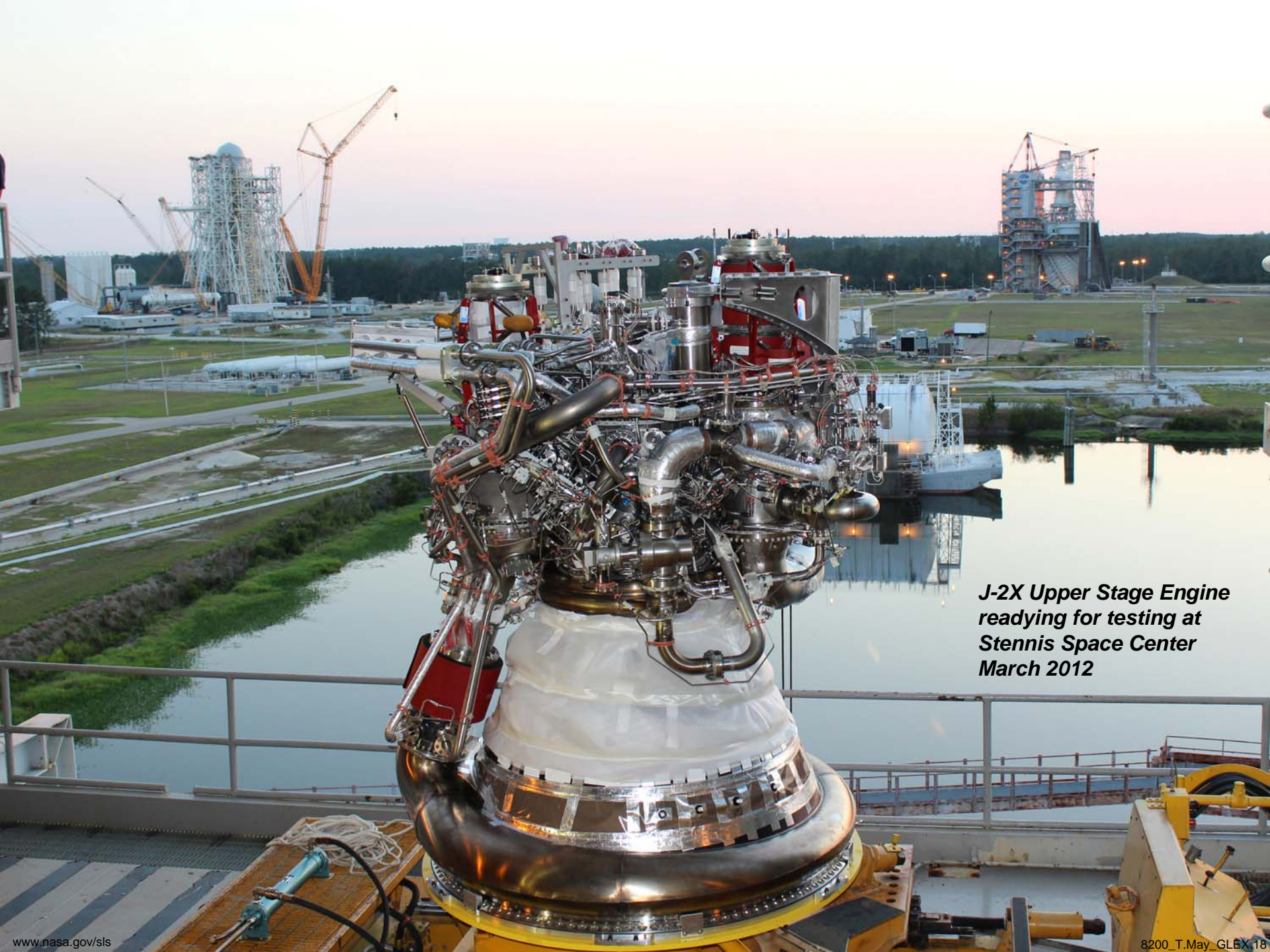
Development Motor Test 3  
ATK Promontory, Utah  
Test Site, September 8, 2011





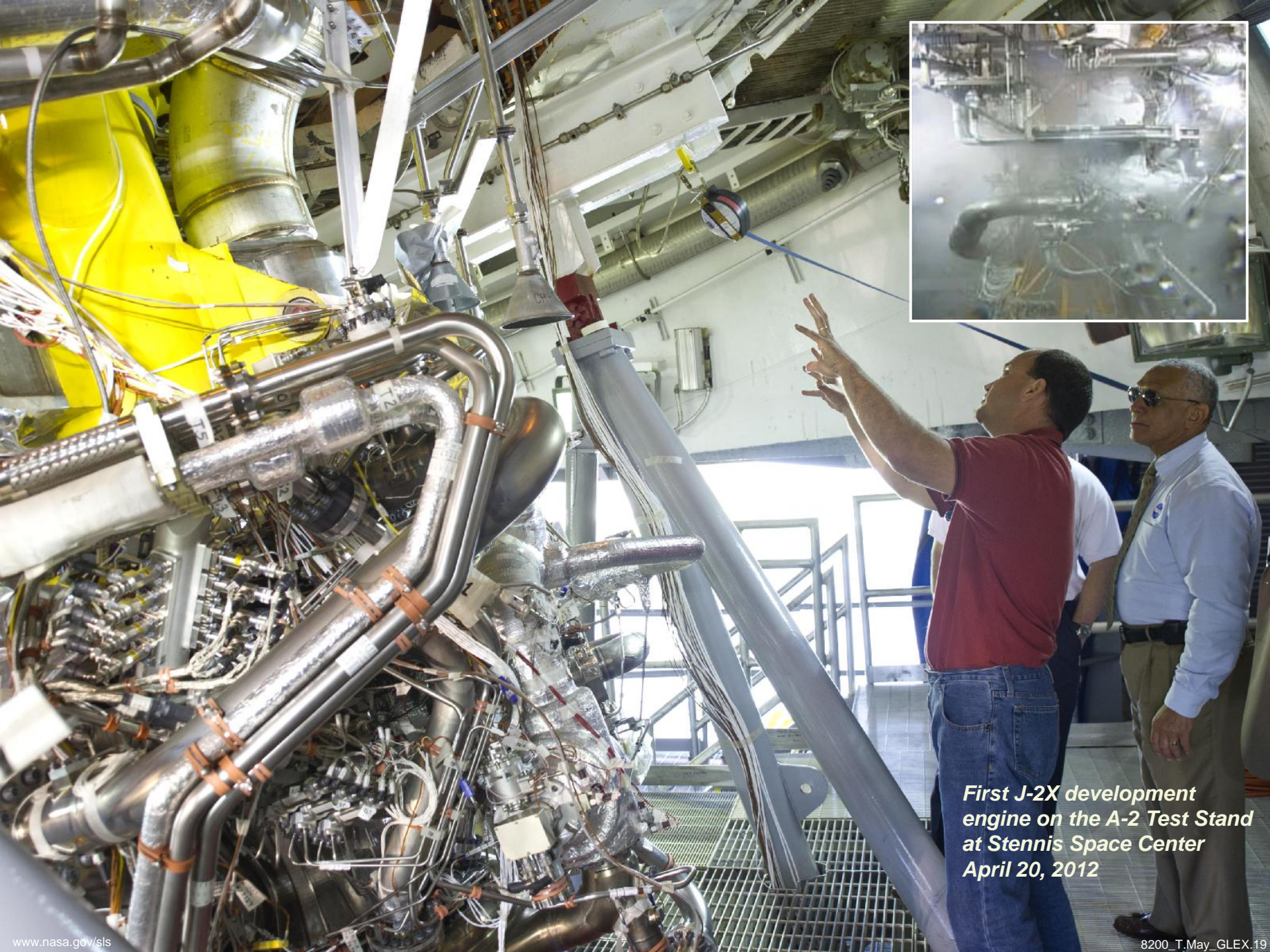
**Avionics and controls for SLS booster readying for Flight Control Test 1 at ATK's test facility in Promontory, Utah, March 28, 2012**





***J-2X Upper Stage Engine  
readying for testing at  
Stennis Space Center  
March 2012***





*First J-2X development engine on the A-2 Test Stand at Stennis Space Center April 20, 2012*



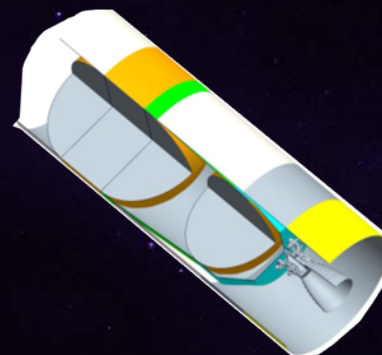
# Marshall Space Flight Center's Michoud Assembly Facility



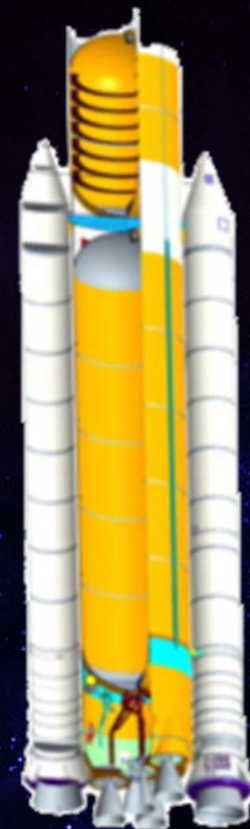
*One-of-a-Kind Infrastructure Asset*



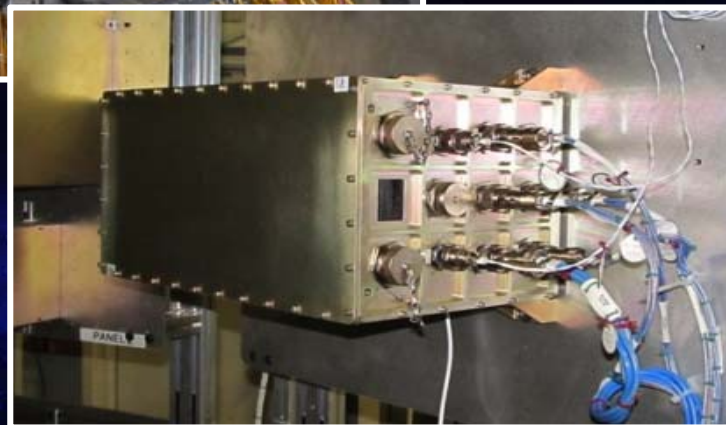
# Stages and Avionics



Upper Stage



Core Stage



# SLS Commonalities

## Core Stage work directly applies to Upper Stage:

- Same diameter (27.5 ft.) and basic design
- Manufacturing facilities, tooling, materials, and processes/practices
- Workforce
- Supply chain/industry base
- Transportation logistics
- Ground systems/launch infrastructure
- Propellants

70 ton Payload  
(Block 1)



## Payload Interfaces:

- Mechanical
- Avionics
- Software


130 ton Payload  
(Block 2)



Core Stage

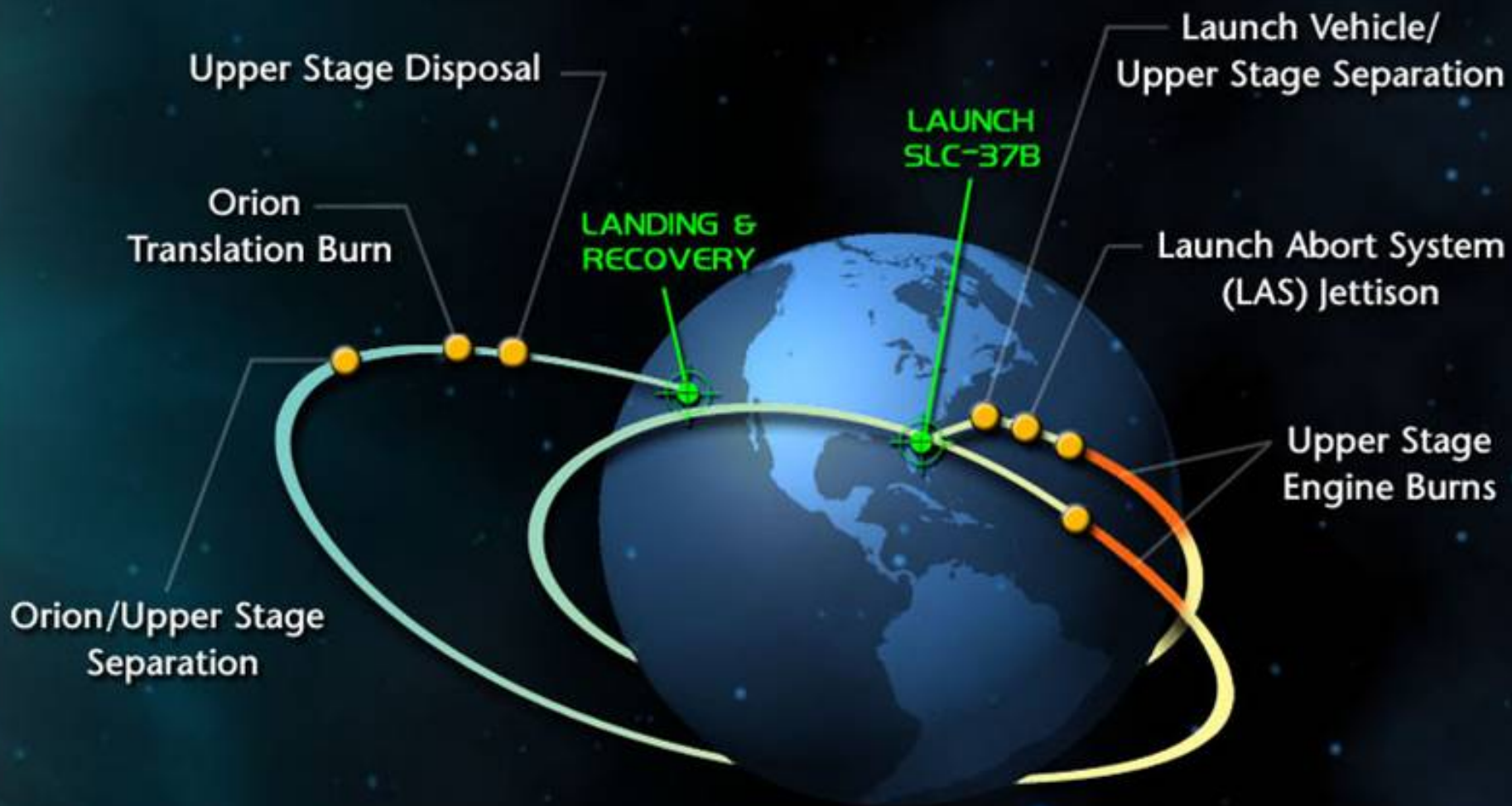
RS-25 Core Stage Engines



A composite space scene featuring the Sun, Earth, Mars, a satellite, and asteroids. The Sun is a large, bright yellow-orange sphere in the upper left. Earth is a blue and white sphere in the center. Mars is a reddish-orange sphere on the right. A satellite with solar panels is positioned between Earth and Mars. The foreground is filled with numerous brown, rocky asteroids of various sizes. The background is a dark blue space filled with stars and a faint, glowing nebula or galaxy structure in the upper right.

David Beaman, Spacecraft and  
Payload Integration Manager  
*Adapters and Fairings*

# Exploration Flight Test-1 Mission Overview





# Orion MPCV Stage Adapter



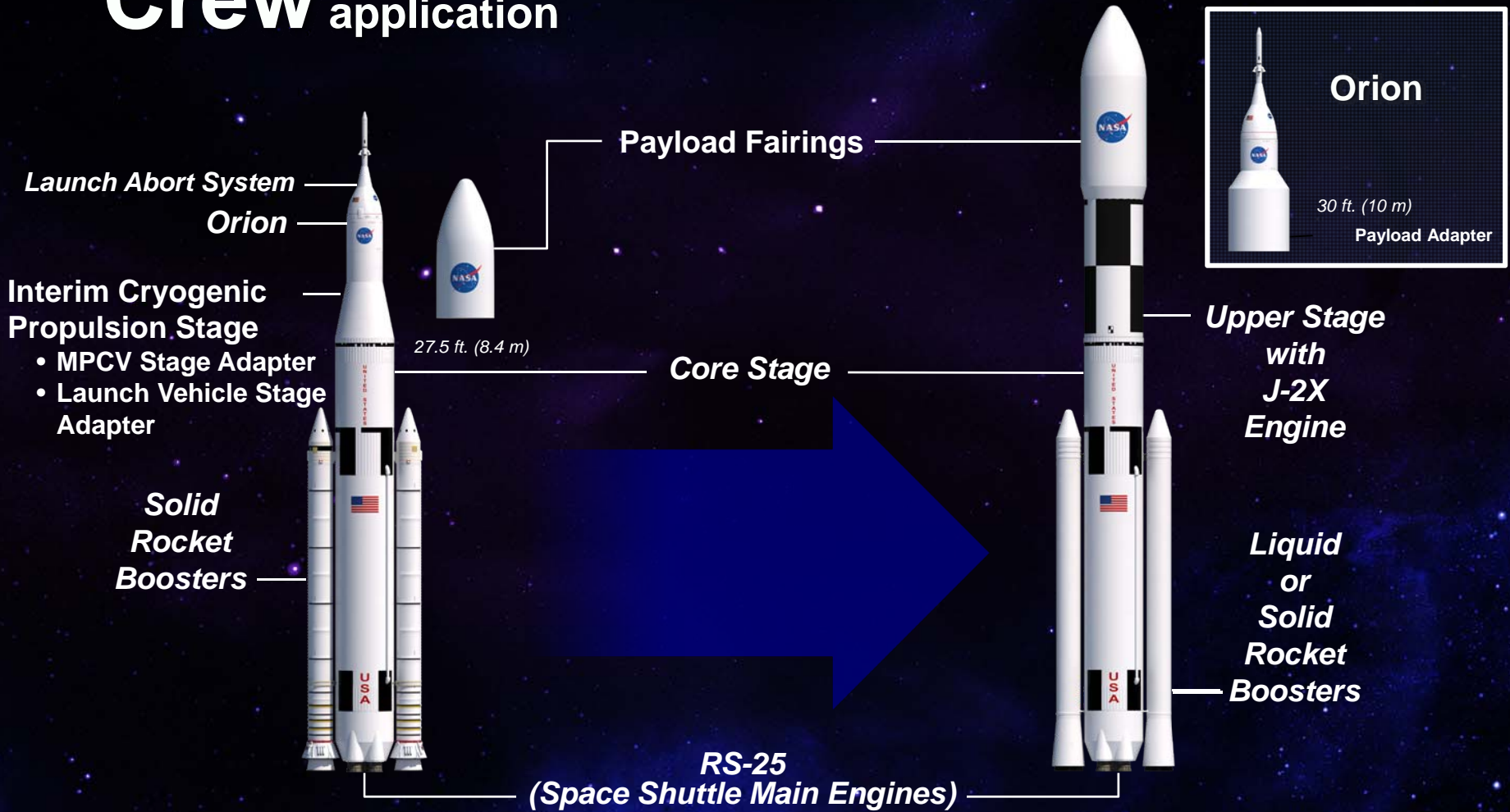


*First ring forging preparation by  
ATI/Ladish Forging, Cudahy,  
Wisconsin, April 2012*



# Cargo application

## Crew application



**INITIAL CAPABILITY, 2017-21**

**EVOLVED CAPABILITY, Post-2021**

A composite image of space featuring the sun, Earth, Mars, a satellite, and asteroids. The sun is a large, bright yellow-orange sphere in the upper left. Earth is a blue and white sphere in the center. Mars is a reddish-orange sphere on the right. A satellite is visible near Earth. Numerous brown, rocky asteroids are scattered in the foreground and middle ground. The background is a dark blue space filled with stars.

Steve Creech, Strategic Development Manager  
*Mission Capabilities*



# A National Asset for Stakeholders and Partners

Incremental steps to steadily build, test, refine, and qualify capabilities that lead to affordable flight elements and a deep space capability.

Moon: 237K mi / 381K km

Mars: 33,900,000 mi  
54,556,000 km

## Initial Exploration Missions

- International Space Station
- Space Launch System
- Orion Multi-Purpose Crew Vehicle
- Ground Systems Development & Operations
- Commercial Spaceflight Development

## Into the Solar System

- Interplanetary Space
- Initial Near-Earth Asteroid Missions
- Lunar Surface

## Extending Reach Beyond LEO

- Cis-Lunar Space
- Geostationary Orbit
- High-Earth Orbit
- Lunar Flyby & Orbit

## Exploring Other Worlds

- Low-Gravity Bodies
- Full-Capability Near-Earth Asteroid Missions
- Phobos/Deimos

## Planetary Exploration

- Mars
- Solar System

ISS: 237 mi / 381 km

Surface Capabilities Needed

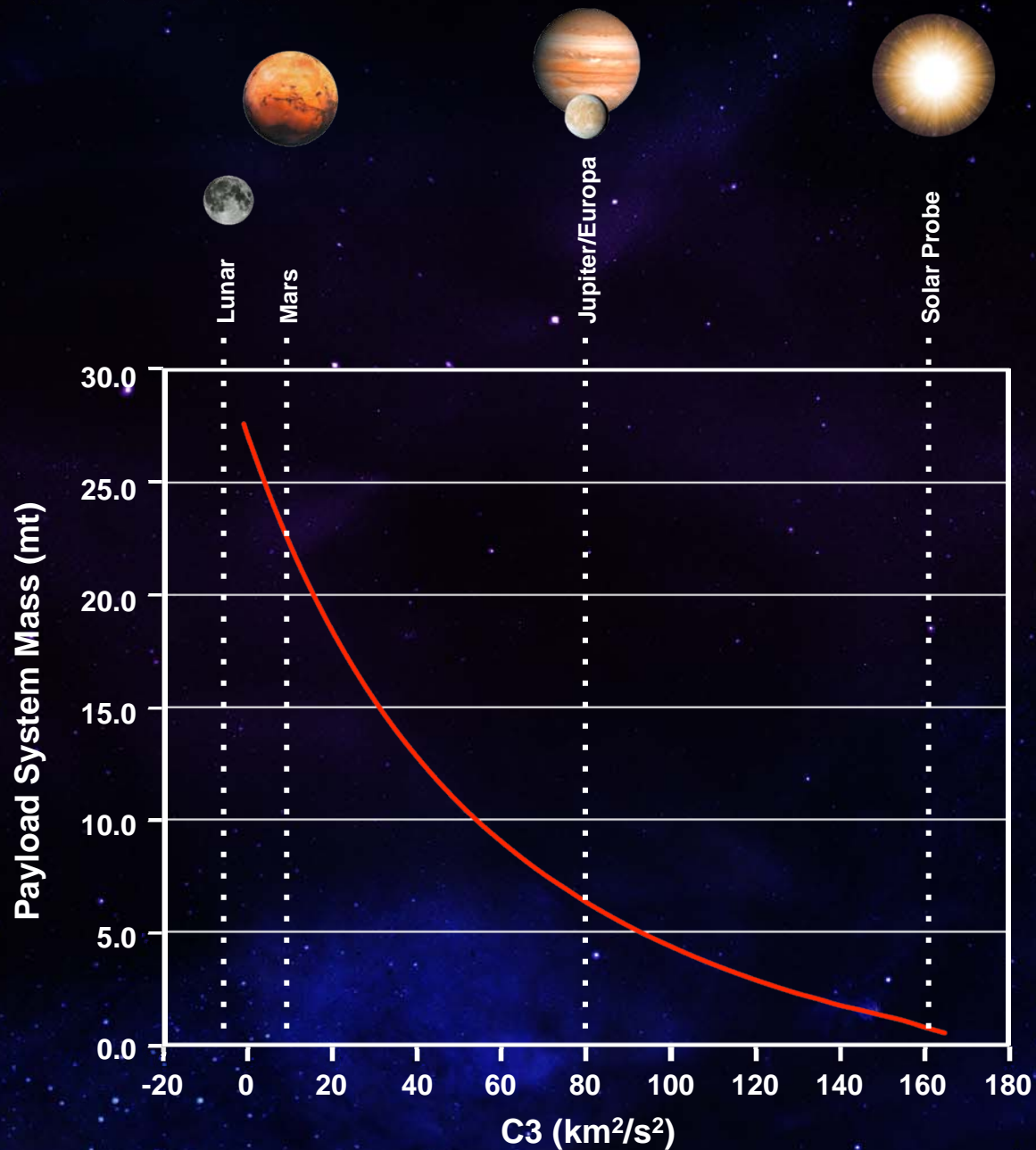
Advanced Propulsion Needed

High Thrust In-Space Propulsion Needed

Long Duration Habitat Needed

# SLS — Going Beyond Earth's Orbit

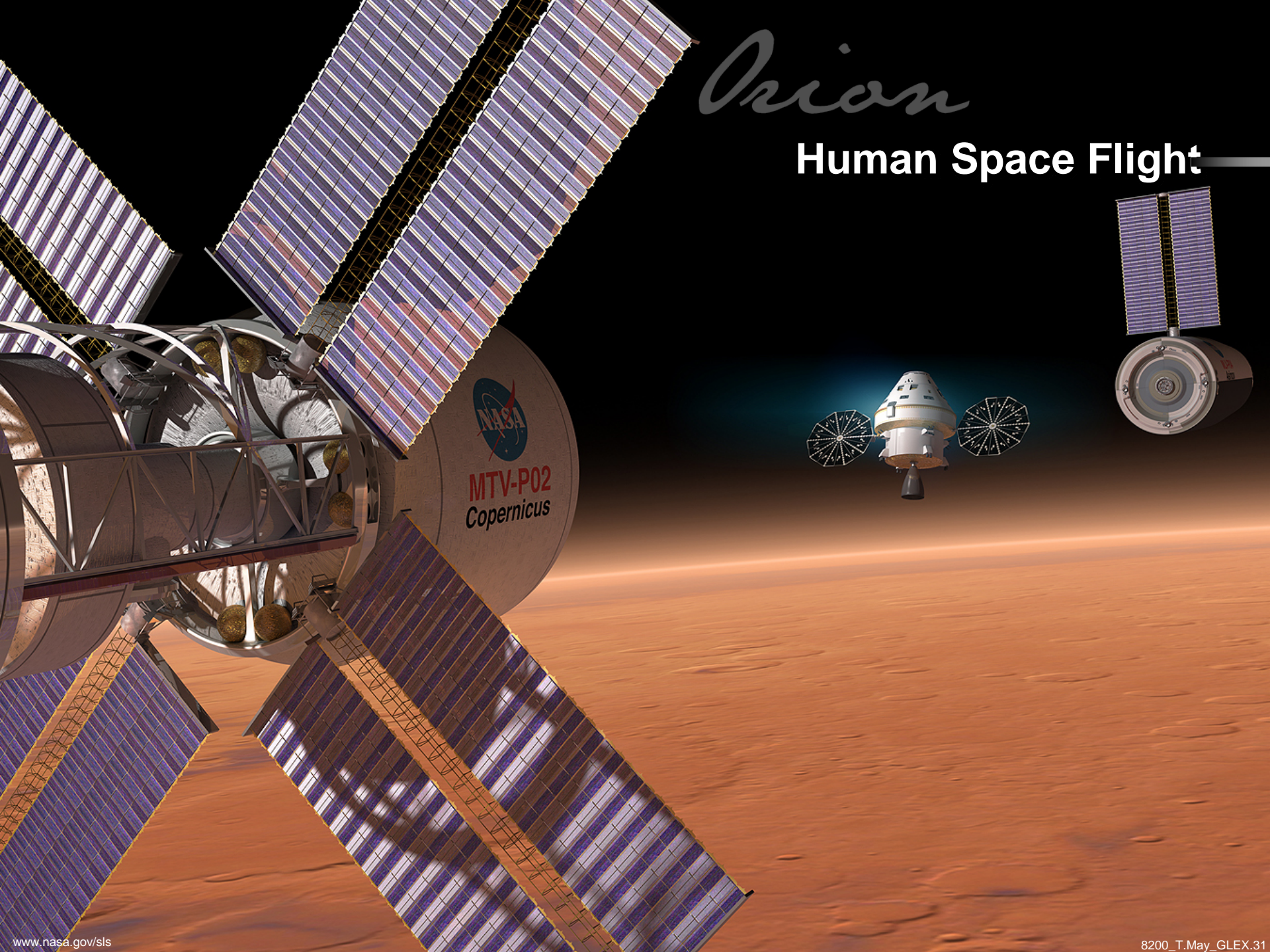
# Block 1 ICPS





*Orion*

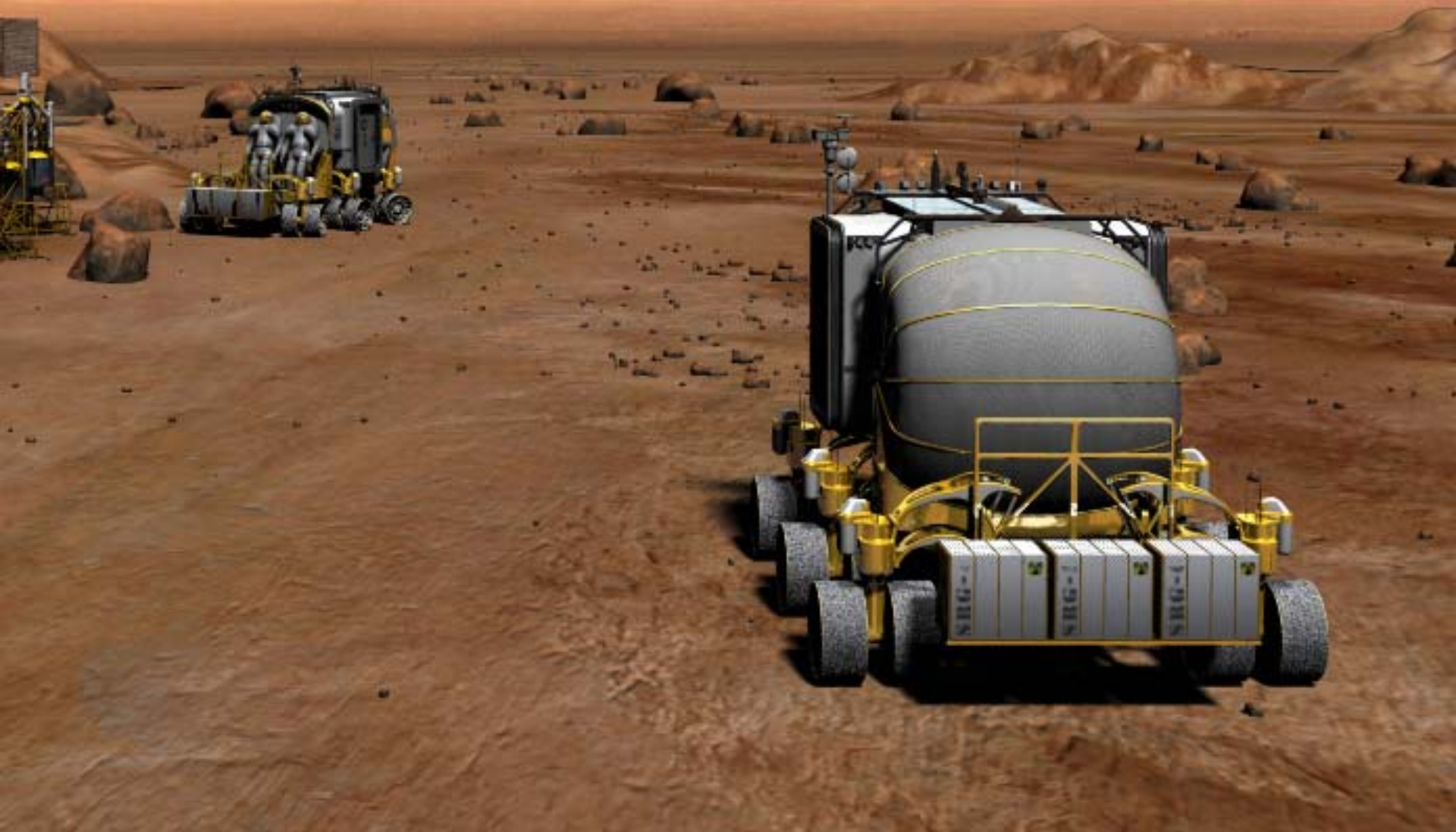
# Human Space Flight





# Mars

## Human Mission to Mars





# SLS Performance = Affordability

*Less Risk*



Increased lift capacity

Increased payload margin

*Less Expensive Mission Operations*



High energy orbit

Shorter trip times

*Increased Design Simplicity*



Volume and mass capability

Increased design simplicity

*Increased Mission Reliability and Confidence*



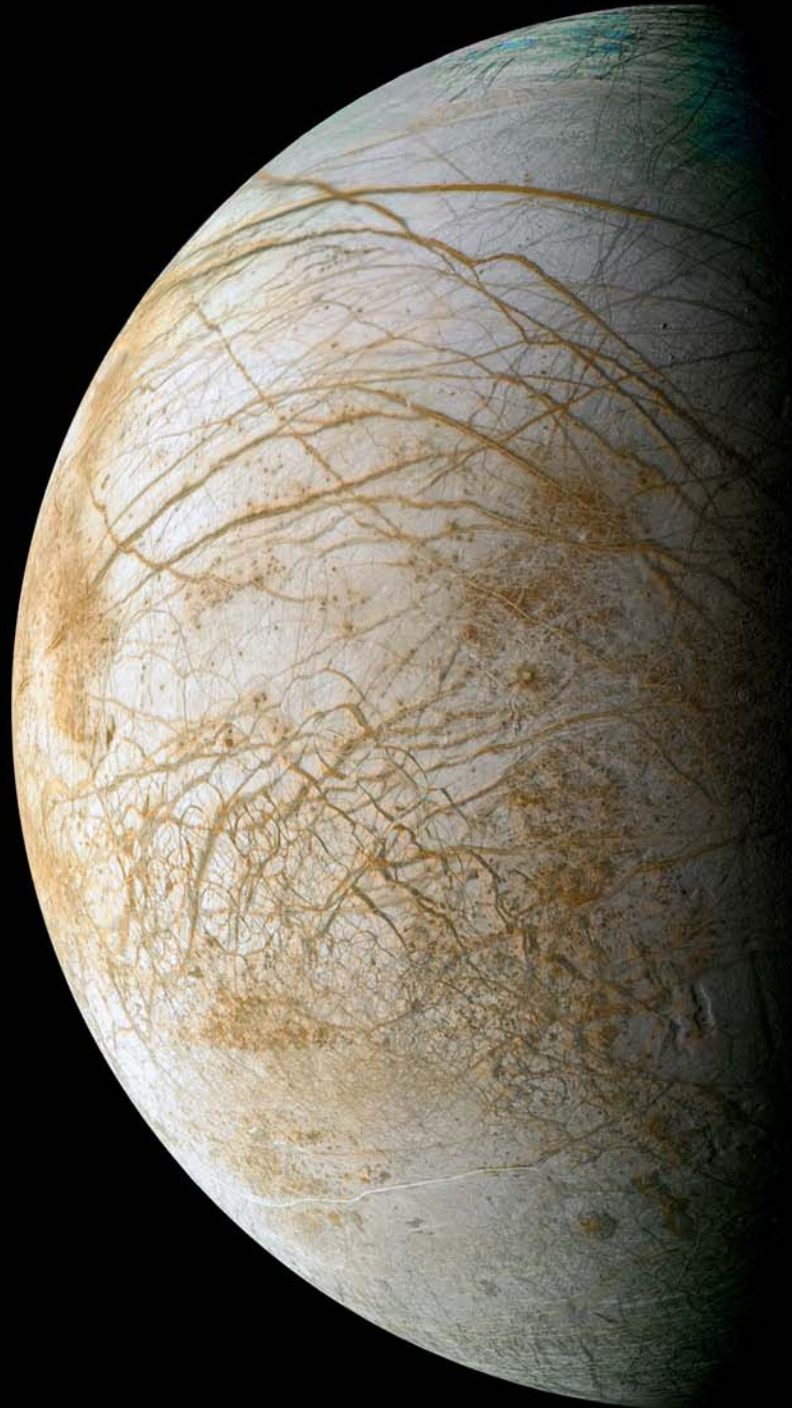
Volume and mass capability

Fewer deployments and critical operations

*Safe, Affordable, Sustainable*

# *Jupiter*

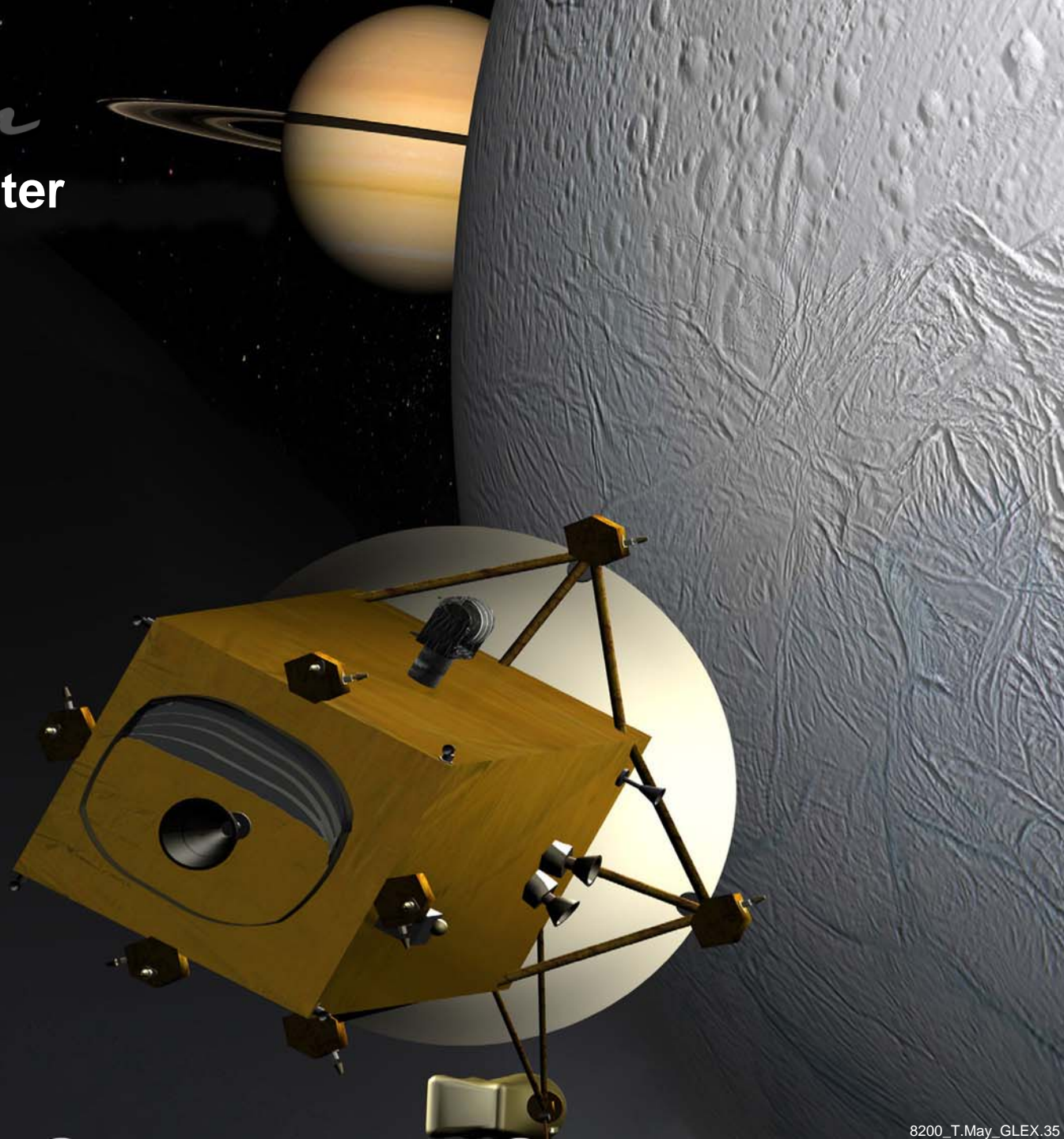
## The Ice of Europa





*Saturn*


**Enceladus Orbiter**









A composite image of the solar system. In the upper left, a bright yellow Sun glows. To its right, Earth is shown with blue oceans and white clouds, with a small satellite orbiting it. Further right, Mars is depicted in shades of orange and red, with a cratered surface. The foreground is filled with numerous brown, rocky asteroids of various sizes. The background is a deep blue space filled with stars.

*Somewhere, something incredible  
is waiting to be known.*

— Carl Sagan