NASA's Space Launch System:
A Flagship for Exploration Beyond Earth's Orbit

Todd A. May, Program Manager
Stephen D. Creech
Space Launch System Program
NASA Marshall Space Flight Center, Alabama 35812
U.S.A.

Abstract

The National Aeronautics and Space Administration's (NASA's) Space Launch System (SLS) Program, managed at the Marshall Space Flight Center, is making measurable progress toward delivering a new capability for human and scientific exploration. To arrive at the current plan, government and industry experts carefully analyzed hundreds of architecture options and selected the one clear solution to stringent requirements for safety, affordability, and sustainability over the decades that the rocket will be in operation. Slated for its maiden voyage in 2017, the SLS will provide a platform for further cooperation in space based on the International Space Station model. This briefing will focus on specific progress that has been made by the SLS team in its first year, as well as provide a framework for evolving the vehicle for far-reaching missions to destinations such as near-Earth asteroids, Lagrange Points, and Mars. As this briefing will show, the SLS will serve as an infrastructure asset for robotic and human scouts of all nations by harnessing business and technological innovations to deliver sustainable solutions for space exploration.

National Aeronautics and Space Administration

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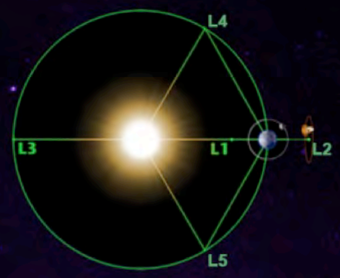
September 2012

The Future of Exploration

"This expanded role for the private sector will free up more of NASA's resources to do what NASA does best — tackle the most demanding technological challenges in space, including those of *human space flight beyond low-Earth orbit.*"

— John P. Holdren, Science and Technology Assistant to the President
The White House, May 22, 2012

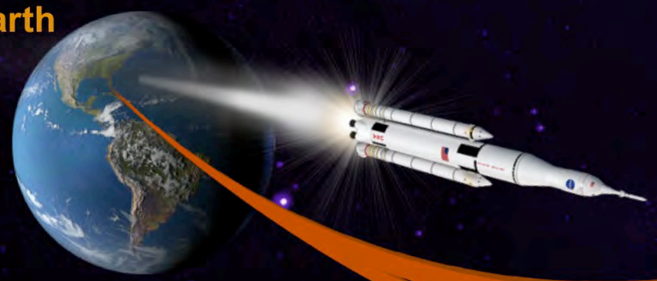
International Space Station
286 mi / 460 km



Lagrangian Point L2
274,000 mi / 440,960 km

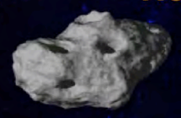
Mars
34,600,000 mi / 55,700,000 km

Earth



Moon
238,855 mi / 384,400 km

Near-Earth Asteroid
3,106,866 mi / 5,000,000 km



"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

NASA's Capability-Driven Framework

Mars: Ultimate human destination in the next decades

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

Planetary Exploration
- Mars
- Solar System

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

Into the Solar System
- Lunar Surface
- Initial Near-Earth Asteroid Missions
- Interplanetary Space

Extending Reach Beyond LEO
- Cis-Lunar Space
- Lunar Flyby & Orbit
- High-Earth Orbit / Geostationary Orbit
- Lunar Flyby & Orbit

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

Moon

ISS

Commercial Crew & Cargo

Space Launch System:
130t configuration

Surface Capabilities Needed

Advanced Propulsion Needed

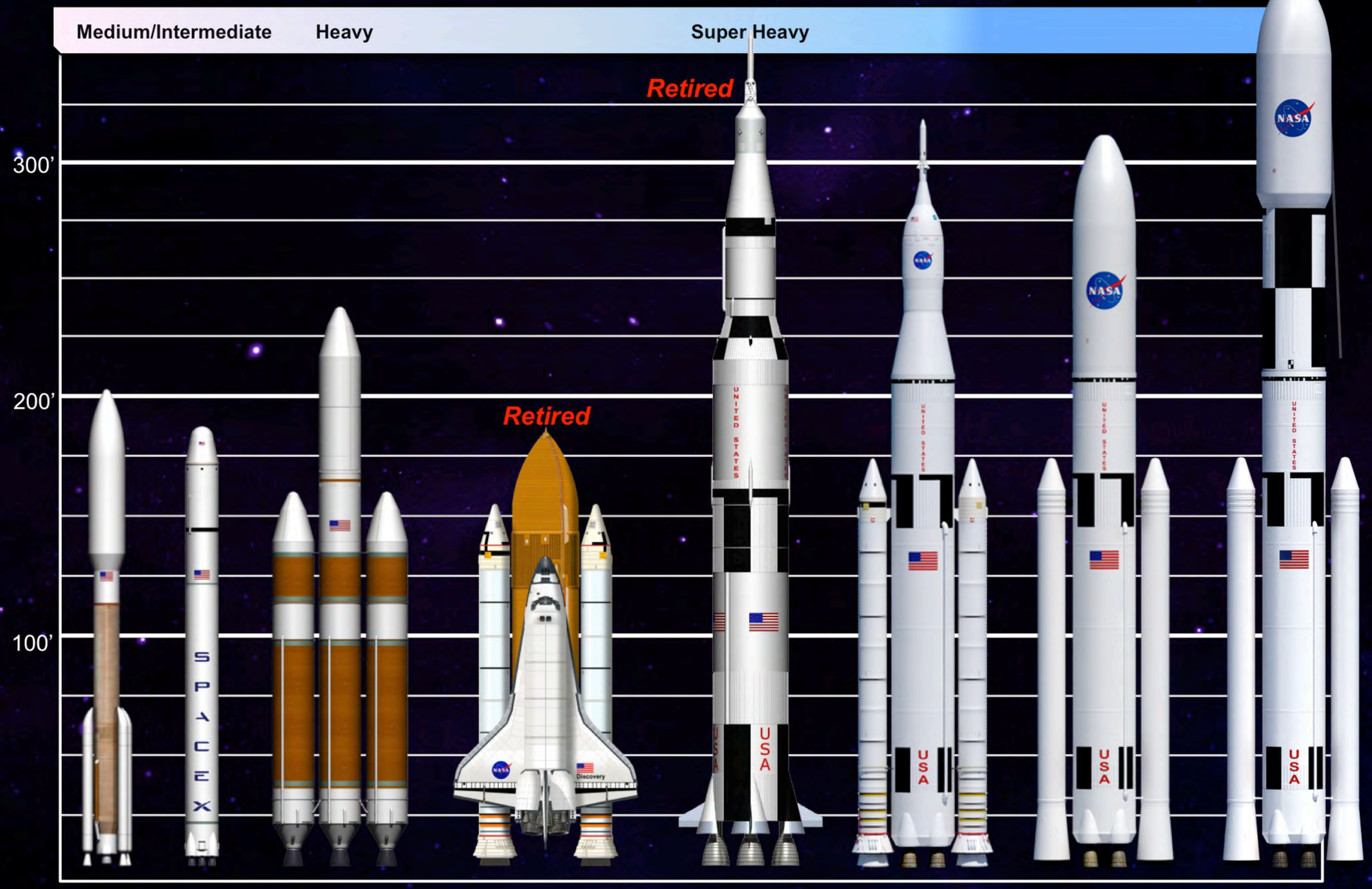
High Thrust In-Space Propulsion Needed

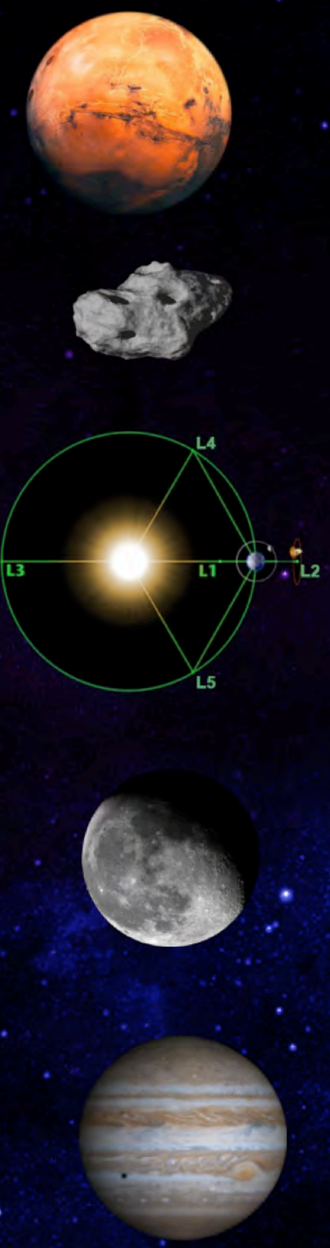
Long Duration Habitat Needed

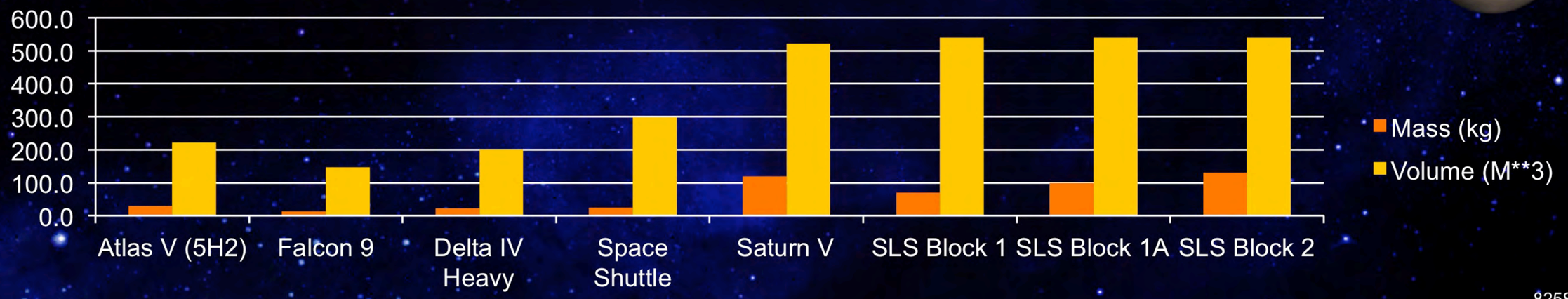
SLS — Going Beyond Earth's Orbit In 2017

www.nasa.gov/sls

Most Capable U.S. Launch Vehicle

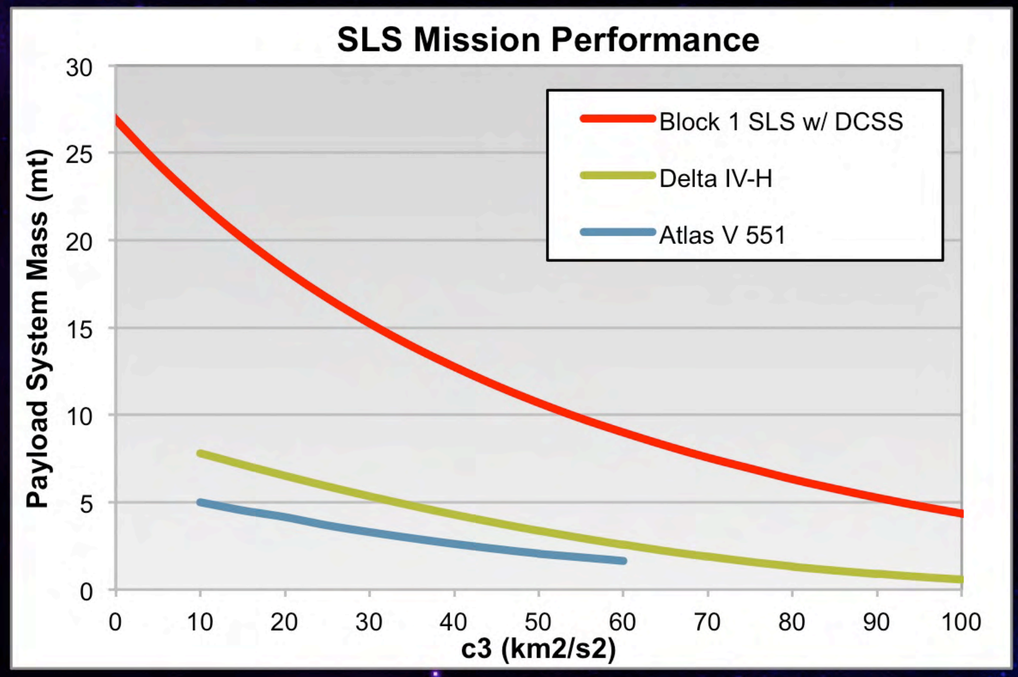






SLS Benefits

Attributes	Outcomes
• Greater volume and mass capability/margin	• Increased design simplicity • Fewer origami-type payload designs needed to fit in the fairing
• Single launch of multiple elements • Fewer launches and deployments • Fewer critical operations	• Increased mission reliability and confidence • Less risk
• High-energy orbit • Shorter trip times	• Less expensive mission operations
• Increased lift capacity • Increased payload margin	• Less Risk



SLS: Safe, Affordable, and Sustainable

INITIAL CAPABILITY, 2017–21

70 t
321 ft

Orion Multi-Purpose Crew Vehicle (MPCV)
- ***Lockheed Martin***

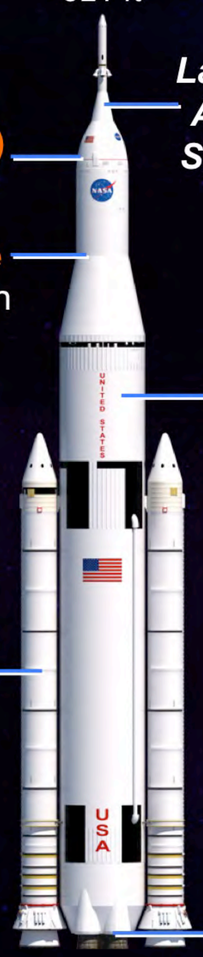
Launch Abort System

Interim Cryogenic Propulsion Stage
- Allows early flight certification for Orion
- Flexible for a range of payloads
- *Boeing*

Core/Upper Stage
- Common design, materials, & manufacturing
- *Boeing*

Avionics
- Builds on proven EELV software
- *Boeing*

5-Segment Solid Rocket Boosters
- Upgrading Shuttle heritage hardware
- *ATK*



Evolutionary Path to Future Capabilities
- **Minimizes unique configurations**
- **Allows incremental development**
- ***Advanced Development contracts to be awarded in FY13***

EVOLVED CAPABILITY, Post-2021

130 t
384 ft

Fairings (27.5’ or 33’)
- Right-sized for the payload
- In-house design
- *Full-and-open competition FY13*

J-2X Upper Stage Engine
- Builds on Apollo Saturn J-2 heritage
- *Pratt & Whitney Rocketdyne*

Advanced Boosters
- Competitive opportunities for affordable upgrades
- *Risk-reduction contracts to be awarded in FY13*

RS-25

Core Stage Engines
- Using Space Shuttle Main Engine inventory assets
- Building on the U.S. state of the art in liquid oxygen/hydrogen
- ***Initial missions: Pratt & Whitney Rocketdyne***
- ***Future missions: Agency is determining acquisition strategy***

A Platform for Global Cooperation

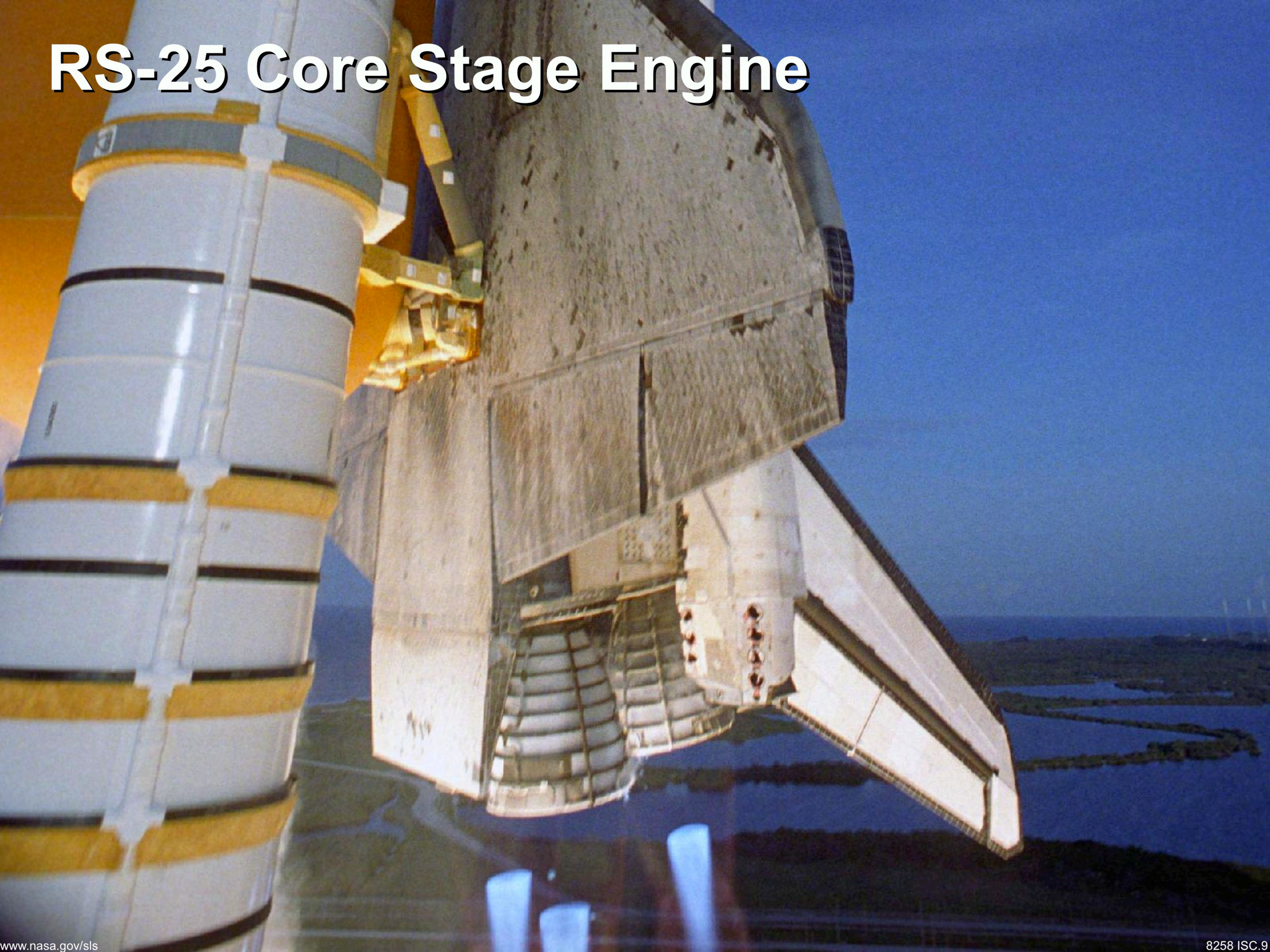
SLS 70t Expanded View

Launch Abort System
Crew Module
Service Module
Encapsulated Service Module Panels
Spacecraft Adapter
MPCV/Stage Adapter
Interim Cryogenic Propulsion Stage
Solid Rocket Boosters (2)
Orion Multi-Purpose Crew Vehicle (MPCV)
Launch Vehicle/ Stage Adapter
Core Stage
RS-25 Engines (4)

5-Segment Solid Rocket Booster

Development Motor Test 3
Sep 8, 2011
ATK Promontory, UT

RS-25 Core Stage Engine



SLS 130t Expanded View

Payload Fairing

Cargo Payload Adapter

Upper Stage with
J-2X Engines (2)

Interstage

Advanced
Boosters (2)

Core Stage

RS-25
Engines

J-2X Upper Stage Engine

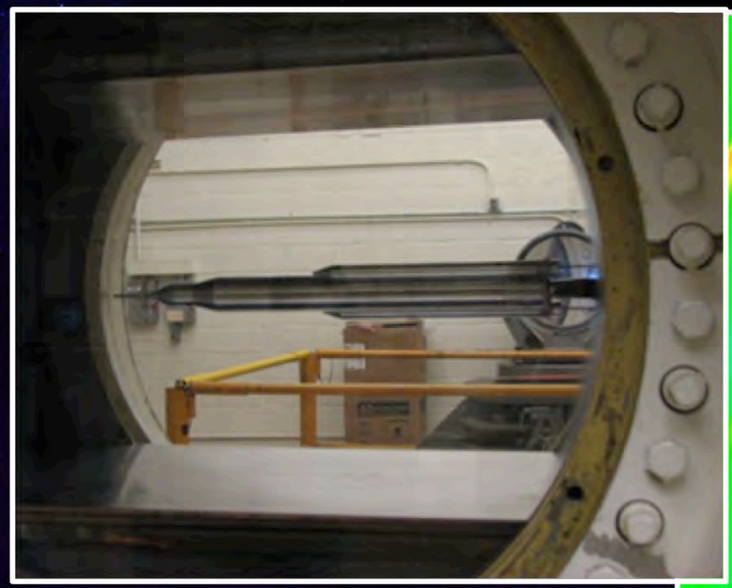
First J-2X development engine on the A-2 Test Stand at Stennis Space Center April 20, 2012

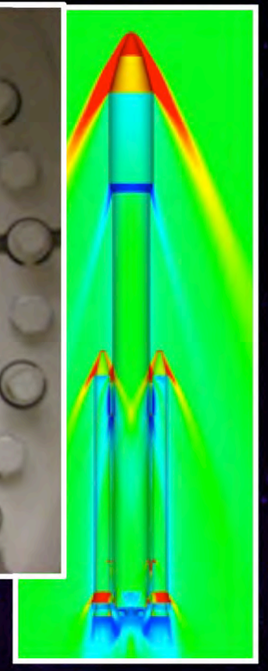
SLS: Preparing for First Flight in 2017

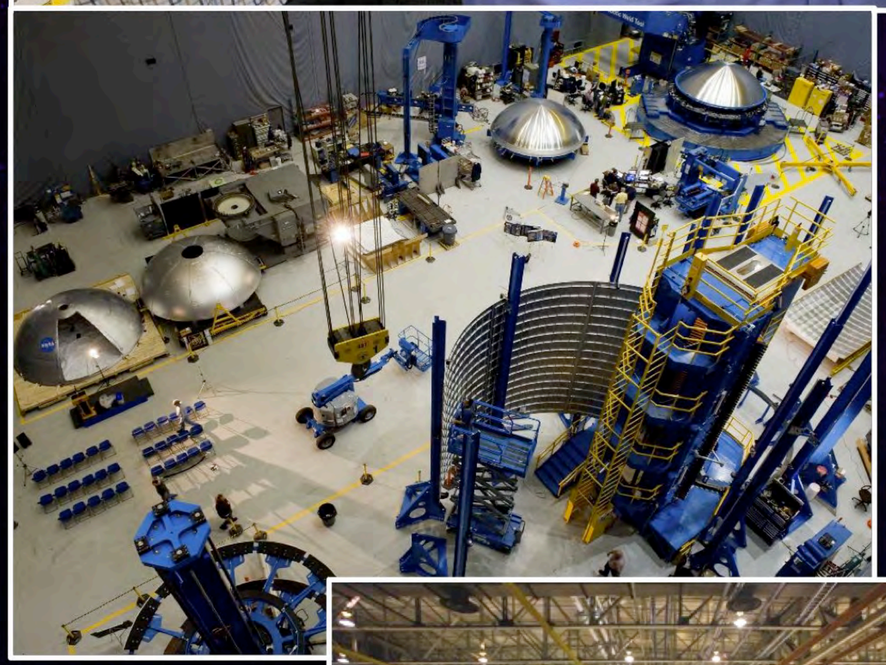
Avionics Test-Bed
May 2012

Systems Engineering & Integration

Force and moment wind tunnel testing
July 2012

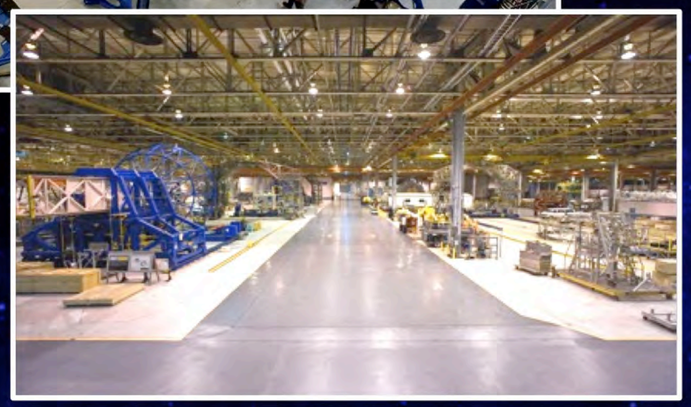






Ring Milling for Multi-Purpose Crew Vehicle-to-Stage Adapter (MSA) for 2014 Exploration Flight Test
June 2012

MSA Pathfinder hardware
June 2012



Stages manufacturing demos and tooling preparation for friction stir welding
April 2012

For More Information

www.nasa.gov/sls

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Somewhere, something incredible is waiting to be known.

— Carl Sagan

BACKUPS

SLS Program Life Cycle

NASA Life Cycle Phases	Approval for Formulation ▼	FORMULATION	▼ Approval for Implementation	IMPLEMENTATION			
Program Life Cycle Phases	**Pre-Phase A: Concept Studies**	**Phase A: Concept & Technology Development**	**Phase B: Preliminary Design & Technology Completion**	**Phase C: Final Design & Fabrication**	**Phase D: System Assembly, Int. & Test, Launch & Checkout**	**Phase E: Operations & Sustainment**	**Phase F: Closeout**
Program Life Cycle Gates and Major Events	KDP A ✔ FAD ✔ Draft Project Requirements ✔ Preliminary Program Plan ✔	KDP B ✔ Draft PCA ✔ Baseline Program Plan **We Are Here**	KDP C Final PCA	KDP D	KDP E Launch	KDP F End of Missions	Final Archival of Data
Agency Reviews	ASM ✔						
Human Space Flight Project Reviews	MCR ✔	SRR/SDR Steps 1 & 2 ✔	PDR	CDR	DCR	FRR PLAR	DR
	2011	**2012**	**2013**	**2015**	**2016**	**2017**	

First Flight 2017