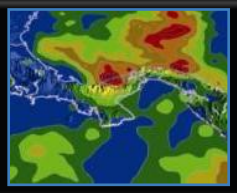
National Aeronautics and Space Administration

Status of NASA's Space Launch System

Jody Singer, Deputy Manager
Space Launch System (SLS) Program
NASA Marshall Space Flight Center
April 25, 2012







Space Launch System

NASA Vision

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

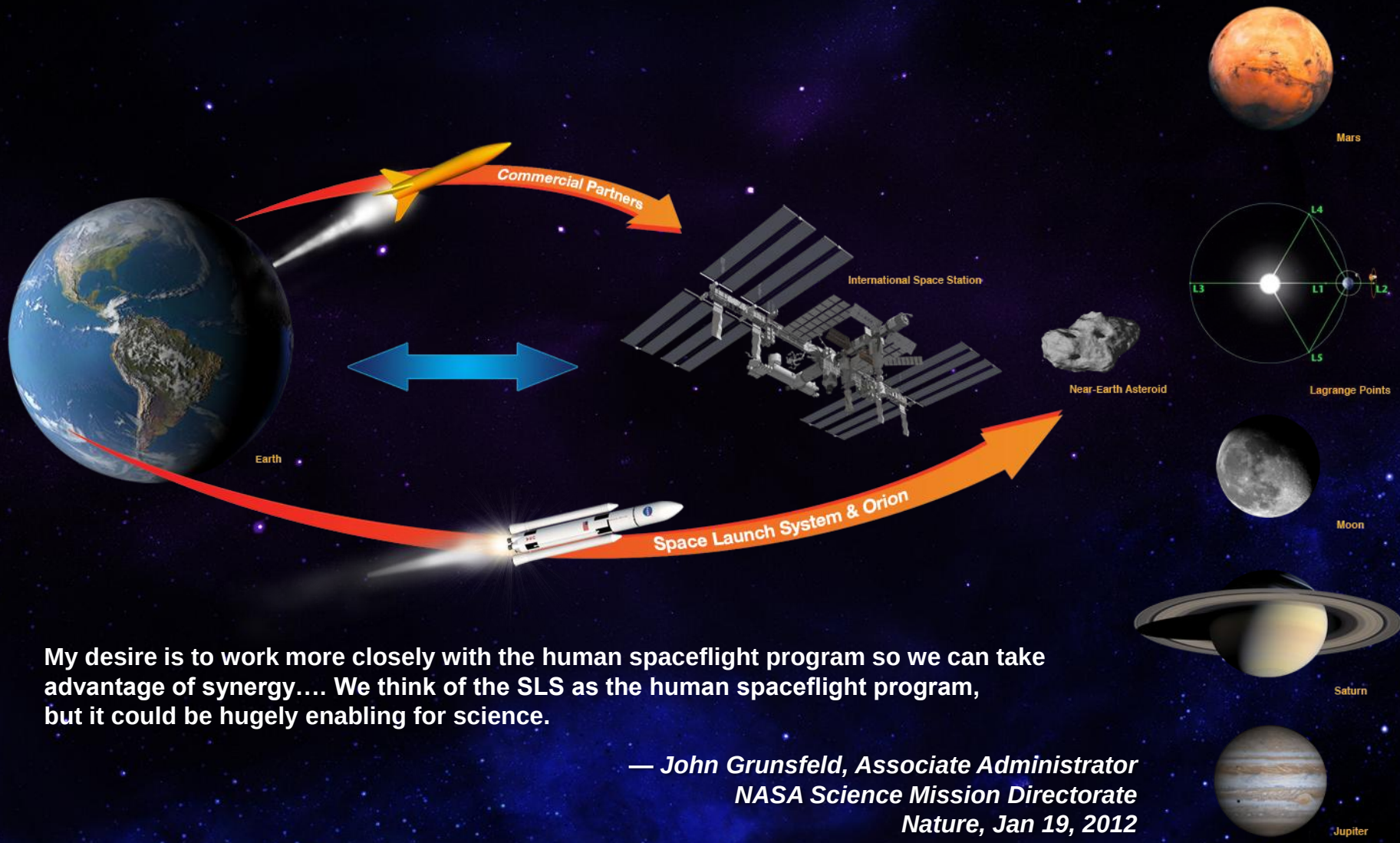
NASA Strategic Goals

- ✔ ***Extend and sustain human activities across the solar system.***
- ✓ Expand scientific understanding of the Earth and the universe in which we live.
- ✓ Create the innovative new space technologies for our exploration, science, and economic future.

  Advance aeronautics research for societal benefit.
- ✓ Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.
- ✓ Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation, and contribute to a strong national economy.

SLS — Safe, Affordable, and Sustainable

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

A National Asset for Stakeholders and Partners

NASA Authorization Act of 2010

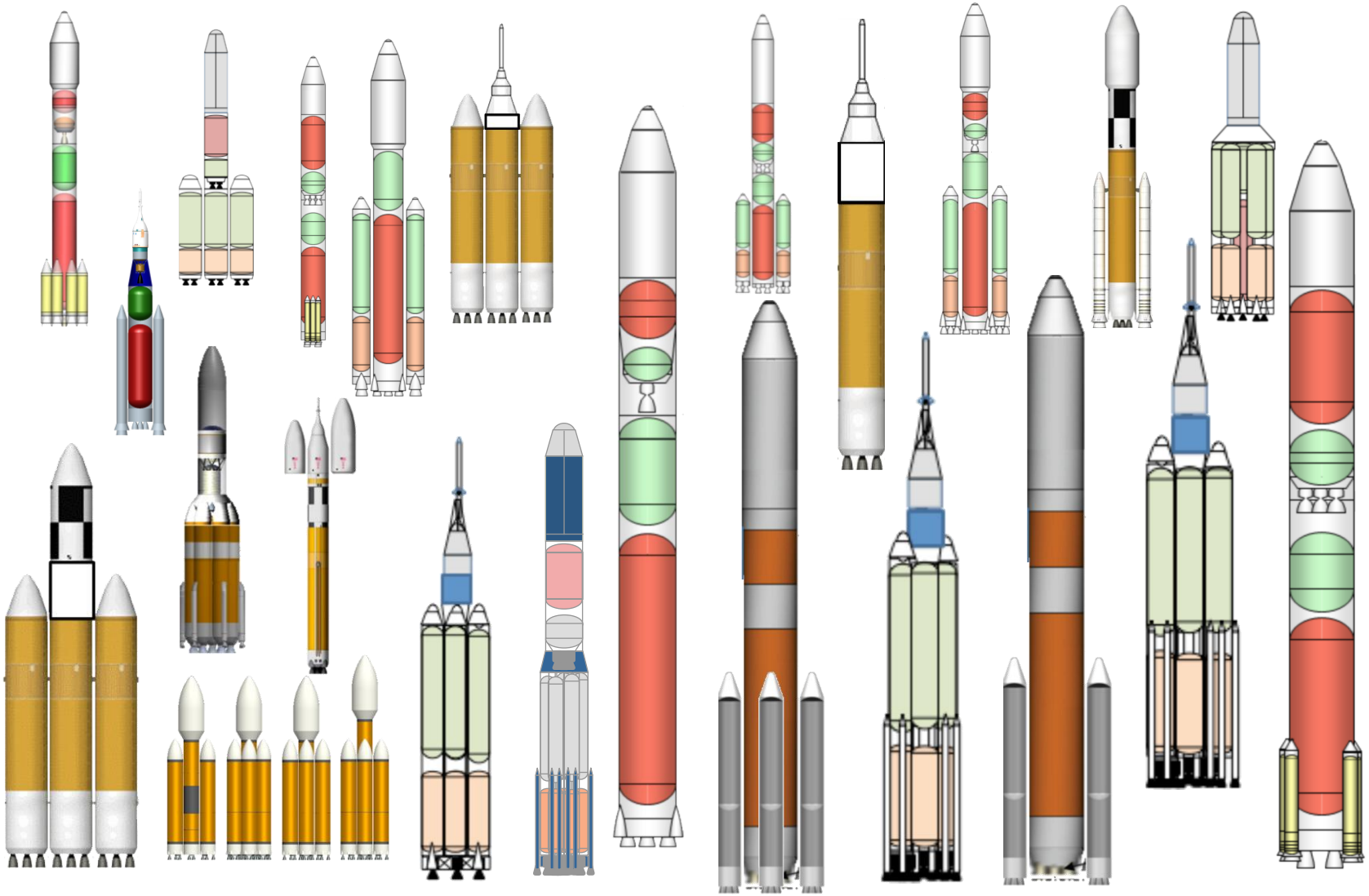
- **The Congress passed and the President signed the National Aeronautics and Space Administration Authorization Act of 2010.**
  - Bipartisan support for human exploration **beyond low-Earth orbit (LEO)**

- **The Law authorizes:**
  - Extension of the International Space Station (ISS) until at least 2020
  - Strong support for a commercial space transportation industry
  - **Development of Orion Multi-Purpose Crew Vehicle (MPCV) and heavy lift launch capabilities**
  - A "flexible path" approach to space exploration, opening up vast opportunities including near-Earth asteroids and Mars
  - New space technology investments to increase the **capabilities beyond Earth orbit (BEO)**

This rocket is key to implementing the plan laid out by President Obama and Congress in the bipartisan 2010 NASA Authorization Act.
— NASA Administrator Charles Bolden
September 14, 2011

Delivering on the Laws of the Land … and Obeying the Laws of Physics

Many Solutions, One Affordable Answer



"This enterprise is not for the faint of heart."

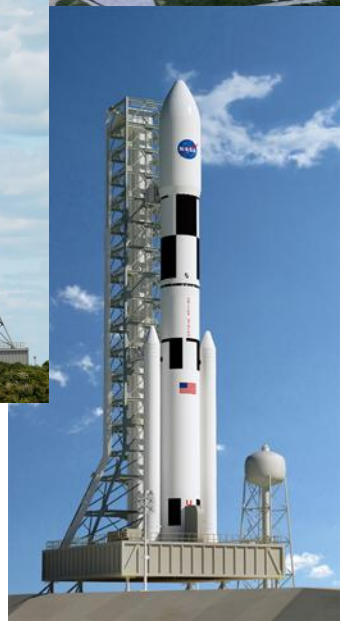
—Wayne Hale, *former Space Shuttle Program Manager*

SLS Driving Objectives

- **Safe: Human-Rated**

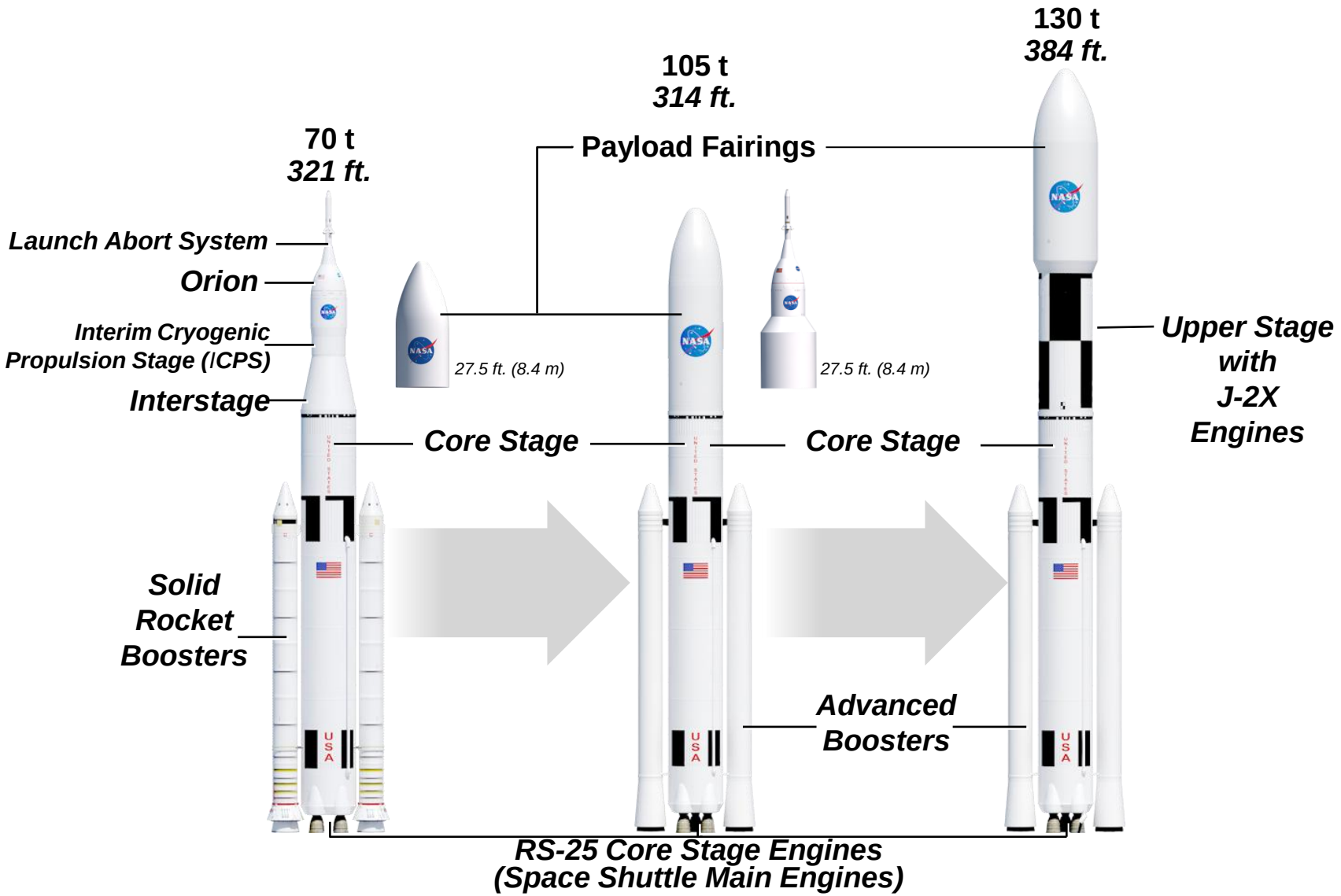
- **Affordable**
  - Constrained budget environment
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Competitive opportunities for affordability on-ramps

- **Sustainable**
  - Initial capability: 70 metric tons (t), 2017–2021
    - Serves as primary transportation for Orion and exploration missions
    - Provides back-up capability for crew/cargo to ISS
  - Evolved capability: 105 t and 130 t, post-2021
    - Offers large volume for science missions and payloads
    - Modular and flexible, right-sized for mission requirements



Flexible Architecture Configured for the Mission

SLS Architecture Block Upgrade Approach

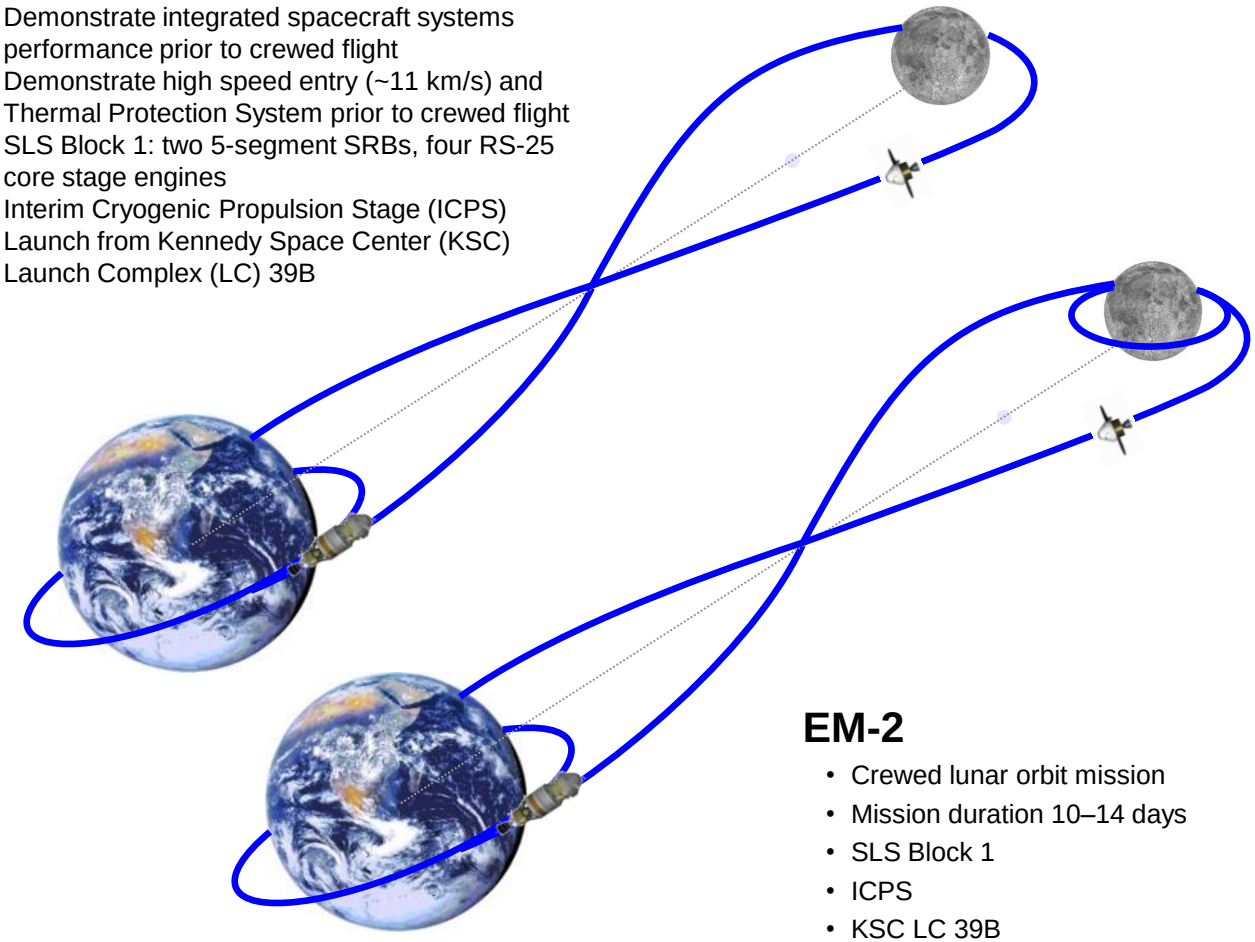


Starting with Available Assets and Evolving the Design

Initial Exploration Missions (EM)

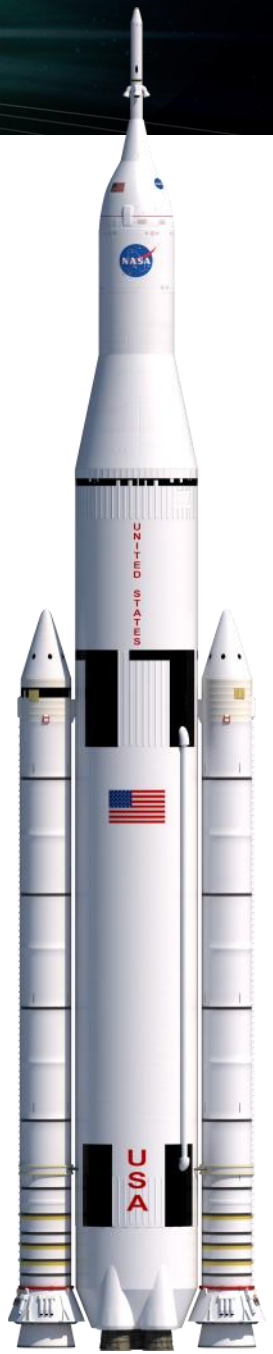
EM-1

- 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
- SLS Block 1: two 5-segment SRBs, four RS-25 core stage engines
- Interim Cryogenic Propulsion Stage (ICPS)
- Launch from Kennedy Space Center (KSC) Launch Complex (LC) 39B



EM-2

- Crewed lunar orbit mission
- Mission duration 10–14 days
- SLS Block 1
- ICPS
- KSC LC 39B

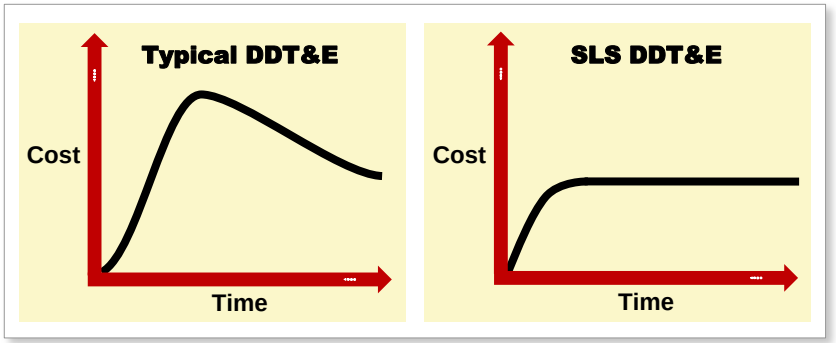


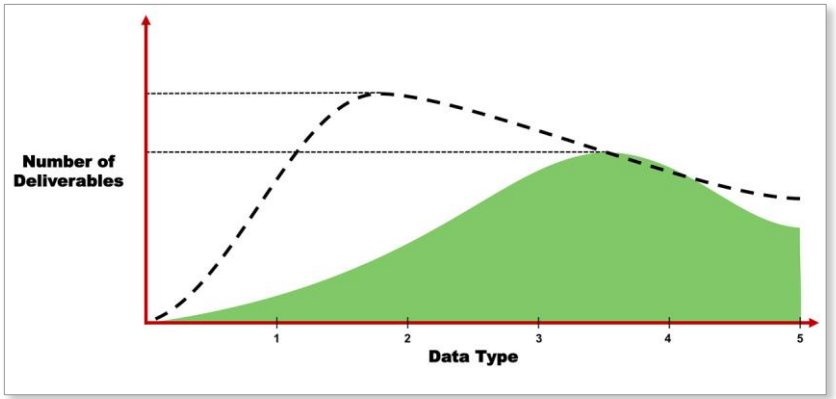
Assets in Inventory and Testing in Progress

First Flight 2017

SLS Affordability Begins with Accountability

- Evolvable Development Approach
- Robust Designs and Margins
- Risk-Informed Government Insight/Oversight Model
- Right-Sized Documentation and Standards
- Lean, Integrated Teams with Accelerated Decision Making



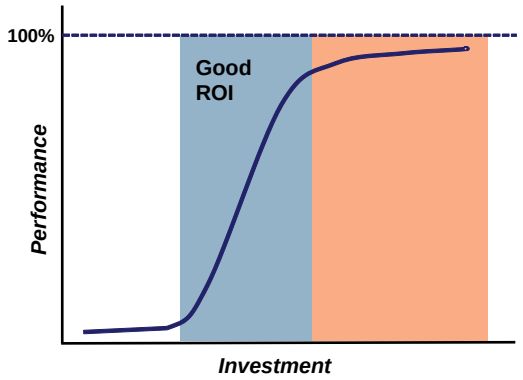


Focuses on the Data Content and Access to the Data

Affordability: The ability to develop and operate the SLS within the National means, to sustain funding for the Program.

Cost is a Function of Performance

- **Extreme requirements drive up costs by 215%.**
- **Question: Is a 14% increase in maximum speed (performance) *worth* a 215% increase in cost?**
- **Question: Is a 28% increase in 0 – 60 mph acceleration (performance) *worth* a 215% increase in cost?**



	Porsche 911 Carrera	*Porsche 911 Turbo*	*Porsche 911 GT2 RS*
			
Cylinders	6	6	6
Engine layout	Rear	Rear	Rear
Performance	180 mph	195 mph	205 mph
0-60 mph	4.7 sec	3.5 sec	3.4 sec
MSRP	$77,800	$160,700	$245,000
	Horsepower 345	*Horsepower 530*	*Horsepower 620*

— Source: Porsche website

We Will Factor the Real Cost into Our Decisions

The *Real* Cost of Launch Vehicle Development

- **Affordability requirements demand that we develop the SLS in a faster and more efficient manner, including the decision-making process.**

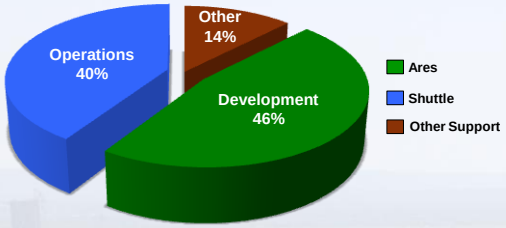
- **We cannot afford to delay decisions … or delay getting behind them!**

Time Is The One Resource That We Can Never Regain

SLS Program Organization at MSFC

041212

Marshall Workforce Supporting SLS



A Learning Organization Dedicated to Doing Things Differently

Program Manager Todd May

Deputy Manager Jody Singer

Associate Program Manager Jerry Cook

Assistant Program Manager Sharon Cobb

Hard line programmatic

Matrix relationship

Chief Engineer (CE) Garry Lyles

Deputy CE *Vacant* (ED01)

Program Planning & Control Acting Manager Jerry Cook

Deputy Manager Daryl Woods

Strategic Development Manager Steve Creech

Chief Safety Officer (CSO) Rick Burt

Deputy CSO Dan Mullane

Procurement Manager Earl Pendley

Boosters Manager Alex Priskos

Deputy Manager Bruce Tiller

Engines Manager Mike Kynard

Deputy Manager Sheryl Kittredge

Stages Manager Tony Lavoie

Deputy Manager John Honeycutt

Ground Operations Liaison Manager Brian Matisak

Assistant Manager Andy Warren

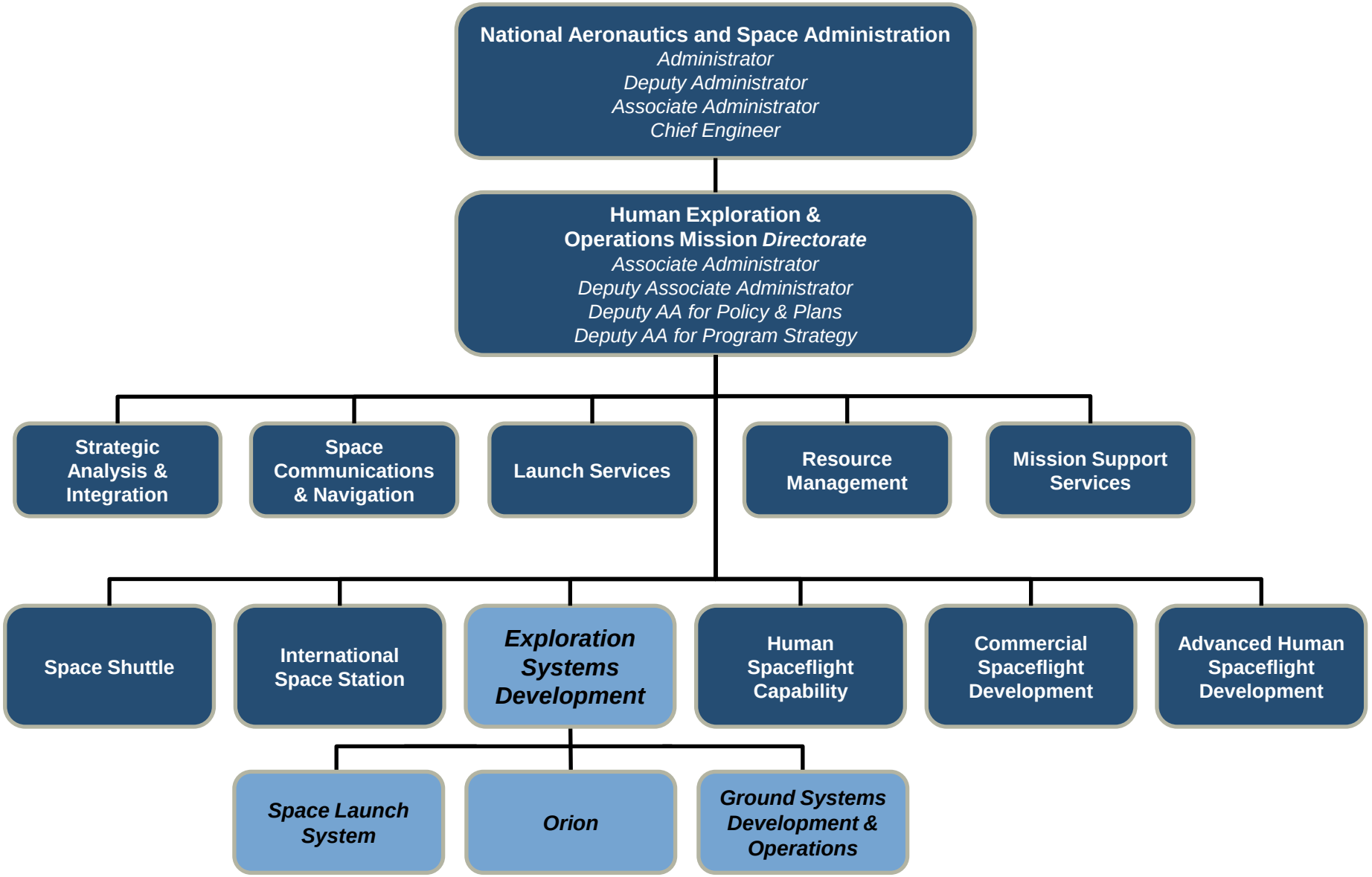
Advanced Development Office Manager Fred Bickley

Assistant Manager Tim Flores

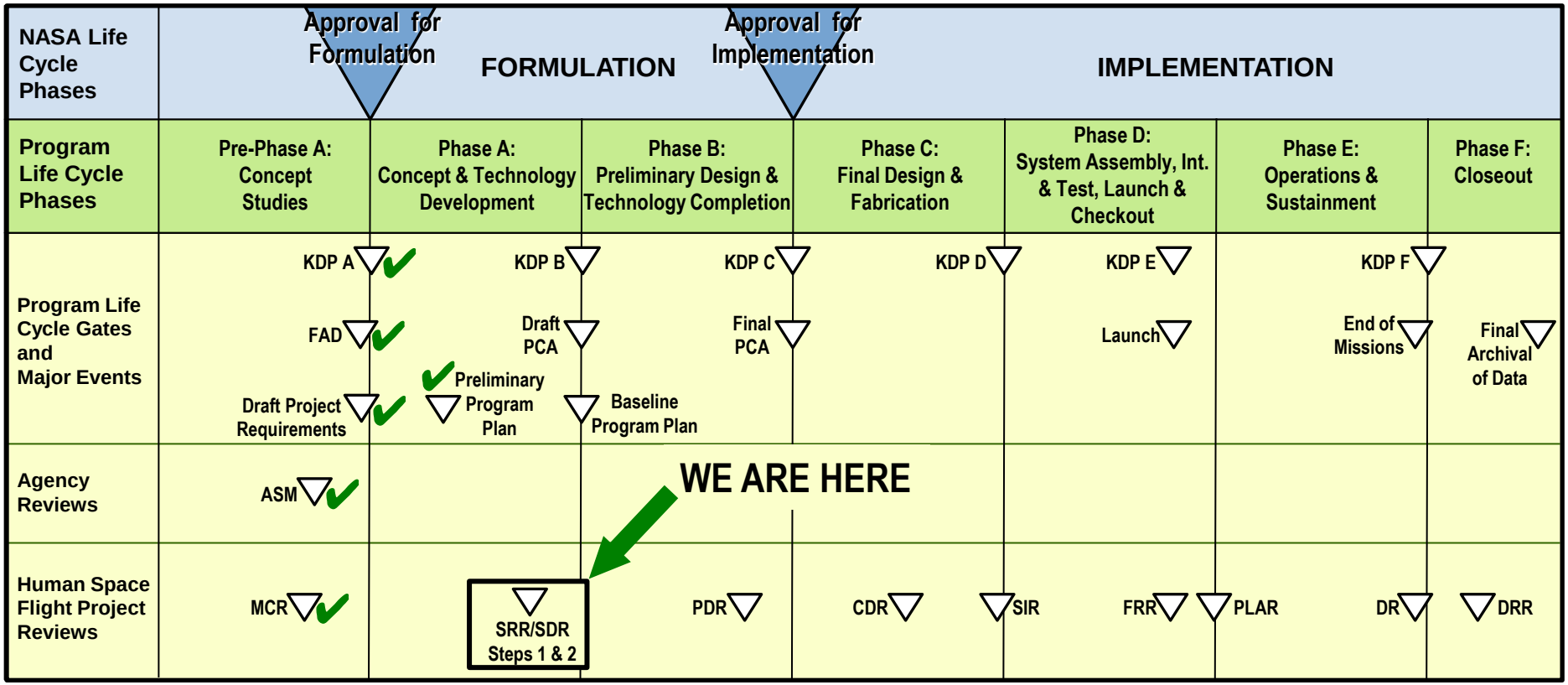
Spacecraft & Payload Integration Manager David Beaman

Assistant Manager Craig McArthur

Programmatic Authority Flow



SLS Program Life Cycle



We are Following NPR 7120.5

SRR/SDR Step 1: Complete

Systems Requirements Review/System Definition Review (SRR/SDR)

- **Solid planning and effective execution**
  - Teamwork and collaboration at all levels
- **Plan in place to address and close 154 items identified during Review Item Discrepancy (RID) process**
- **Pre-board and Board met during the week of March 26, 2012**
  - **Technical solutions vetted:**
    - Designs close on technical requirements
    - Options identified that address challenges
- **Findings presented to Marshall's Center Management Council (CMC) on April 4, 2012**
- **Integrated baseline (including life-cycle costs) to be addressed in detail in Step 2**

The Path Forward

- **Prepare and review inputs for Planning, Programming, Budgeting, and Execution (PPBE14) to Marshall, Exploration Systems Development (ESD), and Human Exploration and Operations Mission Directorate (HEOMD).**
  - ✓ SLS Program Review – April 12, 2012
  - ✓ ESD Review – April 16–18, 2012
  - ✓ MSFC Submit – April 19, 2012
  - Agency Submit – April 27, 2012
- **Baseline/Drop Documents for SRR/SDR Step 2, May 14, 2012**
- **Step 2 – Standing Review Board (SRB) Assesses Cost and Technical**
  - Assessment – May 14–June 8, 2012
  - SRB Outbrief to SLS – June 12, 2012
  - Joint CMC/Directorate Program Management Council (DPMC) – June 20, 2012
  - Agency Program Management Council (APMC)/Key Decision Point B (KDP-B) – June 27, 2012

Goal: **Integrated baseline updated for the SLS Program and approval of Key Decision Point to move to Phase B (Preliminary Design and Technology Completion)**

Cross-Program Integration

- **Synchronizing SLS reviews with:**
  - **ESD**
    - ✓Cross-Program SRR (CP-SRR) – Fall 2011
    - ✓Cross-Program SDR (CP-SDR) – Winter 2012
  - **Orion Multi-Purpose Crew Vehicle (MPCV) and Ground Systems and Development Operations (GSDO)**
    - MPCV re-synch activities – Summer 2012
    - GSDO SRR/SDR kickoff – July 2012
  - **SLS Elements**
    - Spacecraft and Payload Integration (SPIO) SRR Kickoff – April 2012
    - Stages SRR Kickoff – May 2012
    - Boosters Requirements Review Kickoff and Board – June and July 2012
    - Other Elements maturing, with reviews planned in 2012

Cross Program Integration: Key to Success

Space Launch System – Steady Progress

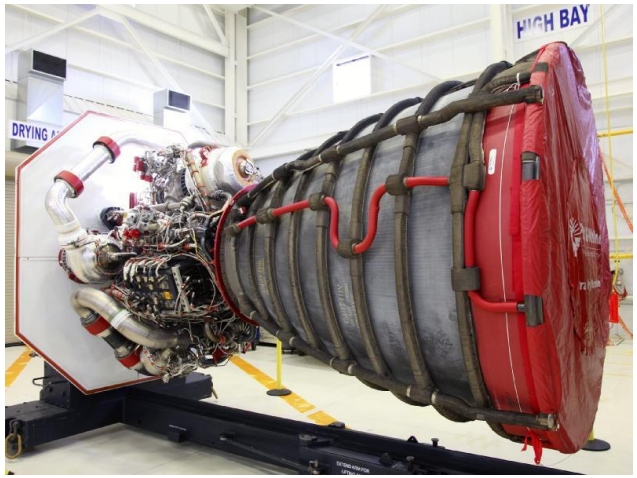
SLS Industry Day at U.S. Space & Rocket Center

Stages Industry Day at Michoud Assembly Facility

"Pass the Torch" Lecture at U.S. Space & Rocket Center

J-2X Test, Control Room Monitoring

Engineers and technicians install the J-2X powerpack into the Stennis Space Center (SSC) A-1 test stand



RS-25D in the Engine Processing Facility at Kennedy

First J-2X Stability Test: 80-sec duration test firing; NASA began characterizing the rocket engine's combustion stability

J-2X 500-sec test firing at SSC

Stages Element Progress

Completed Orbiter Vehicle (OV) 103 Main Propulsion System Hardware Removal

- Orbiter hardware reuse study concluded significant cost and schedule savings.
- OV-103, OV-104, and OV-105 hardware removal in process.

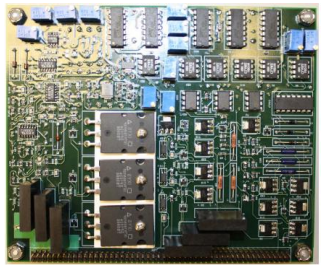
Thrust Vector Control Auxiliary Power Unit

NASA Budget Rollout at the Michoud Assembly Facility

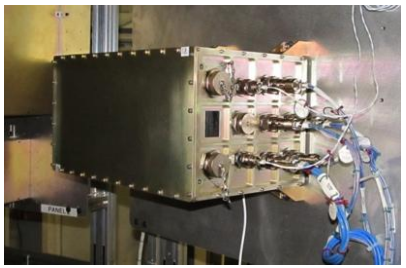
Avionics Developments

- Completed early prototype design and development for high-risk items.

PTS Prototype



3 Channel RPC Prototype

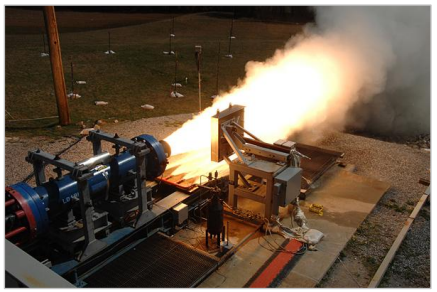


Redundant Inertial Navigation Unit

- **Fabricated and demonstrated Power Transfer Switch (PTS) and Remote Power Controller (RPC) prototypes in April 2011.**
- **Completed long-cable test simulating Mobile Launch Equipment in Nov 2011.**
- **Completed initial integration with flight software.**

Boosters Element Progress

- **Development Motor-3 (DM-3) Static Test**
  - Successfully conducted on Sept 8, 2011, at ATK
- **Value Stream Mapping (VSM)**
  - 46% cycle-time improvement (308 sources of waste and 447 moves eliminated)
- **Subscale Solid Motor 20-Sec Test-Firing**
  - Low-cost replica (9-ft long, 2-ft dia) of SLS solid rocket motor
  - Hot-fired at Marshall on March 14 to test new motor insulation materials

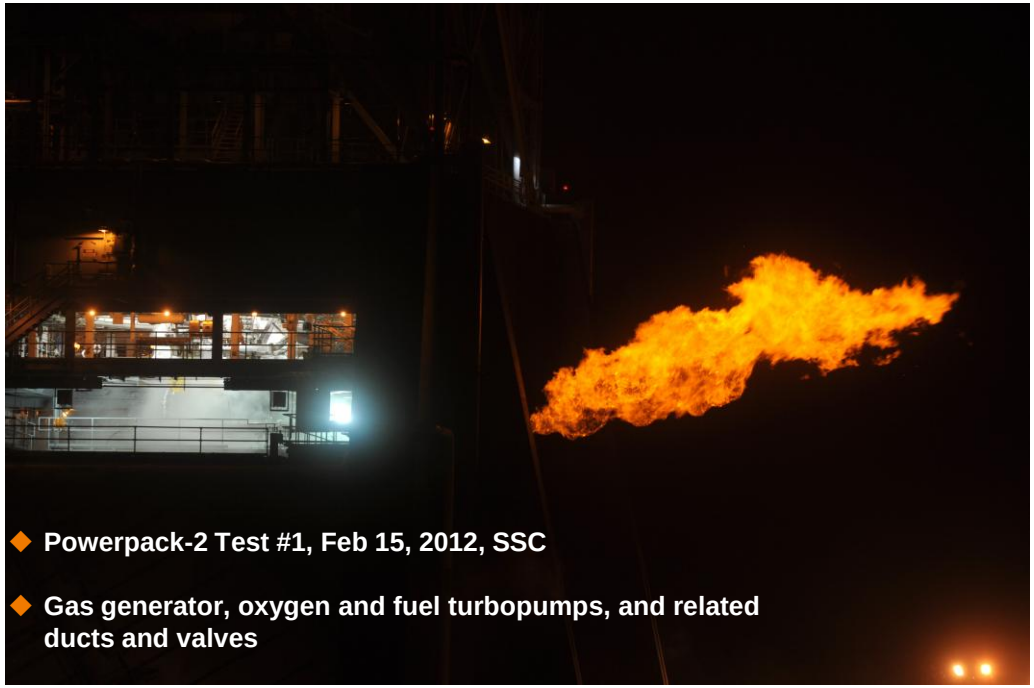


- **Booster Avionics Flight Control Test 1**
  - Scheduled for March 29
  - Full-scale hot-fire test of new avionics boxes controlling the thrust vector control system within a flight-like aft skirt
- **Qualification Readiness Review (QRR)**
  - Major motor components (case, propellant, liner, insulator, nozzle, final assembly) to establish the motor's baseline
  - Nozzle QRR and final assembly scheduled for April 10

- **Booster Requirements Review (BRR)**
  - Scheduled for June 2012
- **Qualification Motor-1 (QM-1)**
  - Static test scheduled for Spring 2013

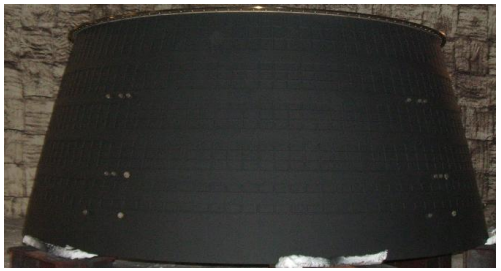
DM-3 Static Test

Liquid Engines Element Progress



- Powerpack-2 Test #1, Feb 15, 2012, SSC
- Gas generator, oxygen and fuel turbopumps, and related ducts and valves

- Reinstalling J-2X E10001 in A-2 test stand at SSC.
- Preparing for second engine test series.



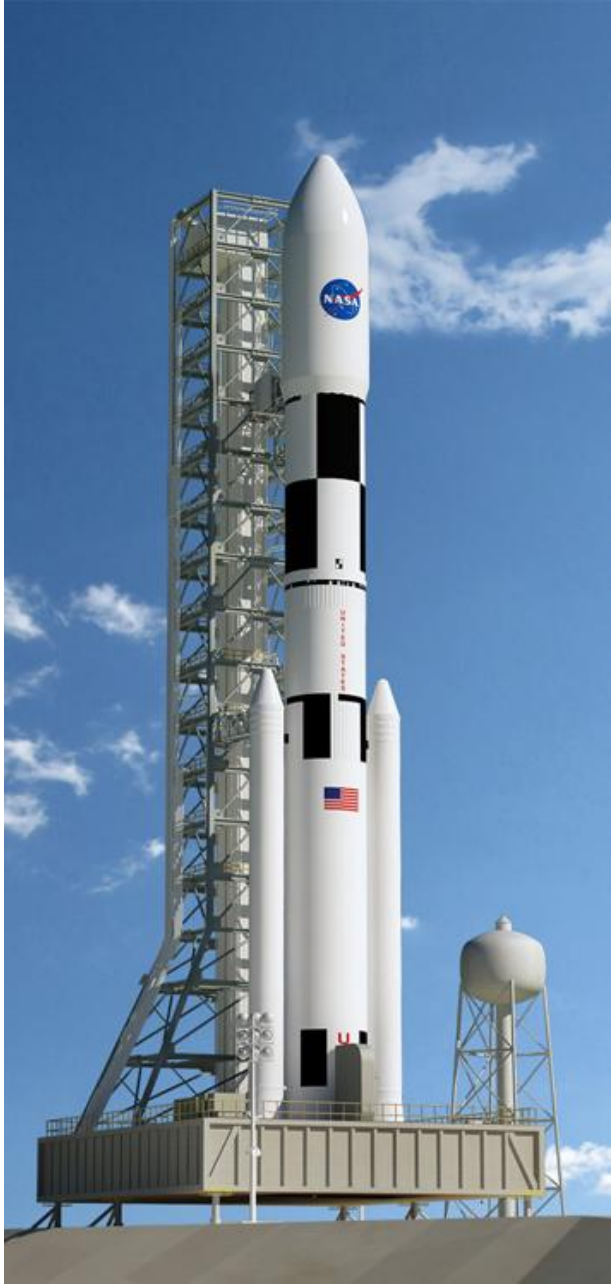
- J-2X E10001 Nozzle Extension for second engine test series in A-2 .

Transporting RS-25 core stage engines from Kennedy Space Center to storage at SSC.

NASA's Space Launch System Summary

- **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 Exploration Systems Development (HQ), Orion and Ground Operations Programs, and Centers.**
- **Prime contractors on board, engaging the U.S. aerospace workforce and infrastructure.**
- **Competitive opportunities for innovations that affordably upgrade performance.**
- **On track for first flight in 2017.**

For More Information ***www.nasa.gov/sls***



Space Launch System: Future Frontier Video

http://www.nasa.gov/multimedia/videogallery/index.html?media_id=131955371


Somewhere, something incredible is waiting to be known.
— Carl Sagan