



NASA's Space Launch System: A Revolutionary Capability for Science

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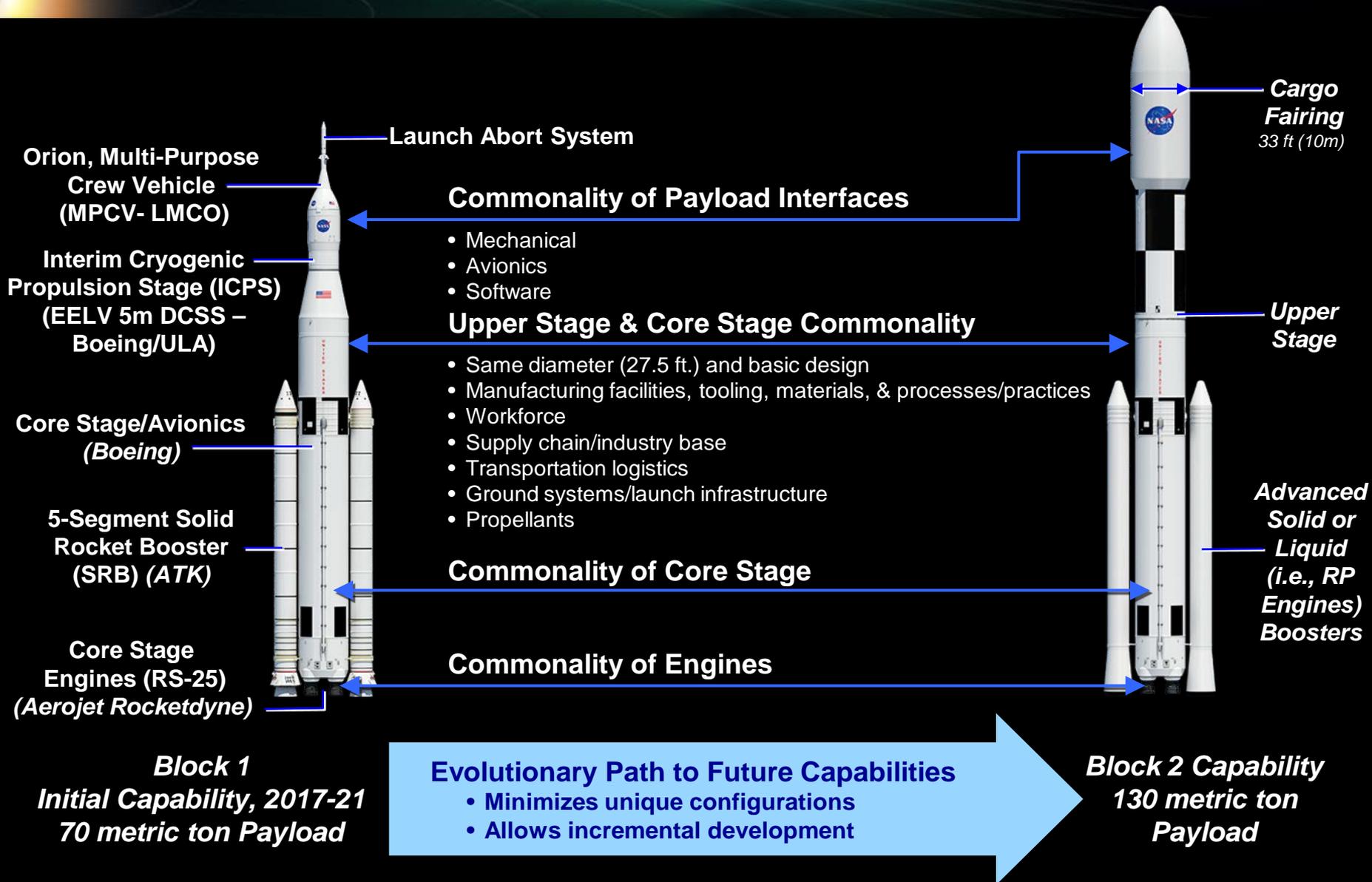
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SLS Spacecraft/Payload Integration and Evolution**

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Space Launch System



SLS: An Evolving Capability



SLS' Primary Mandate



HUMAN EXPLORATION

NASA's Path to Mars



EARTH RELIANT

MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS



Mastering fundamentals
aboard the International
Space Station

U.S. companies
provide access to
low-Earth orbit

PROVING GROUND

MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS



Expanding capabilities by
visiting an asteroid redirected
to a lunar distant retrograde orbit

The next step: traveling beyond low-Earth
orbit with the Space Launch System
rocket and Orion spacecraft

MARS READY

MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS



Developing planetary independence
by exploring Mars, its moons and
other deep space destinations

Human Spaceflight and Space Science



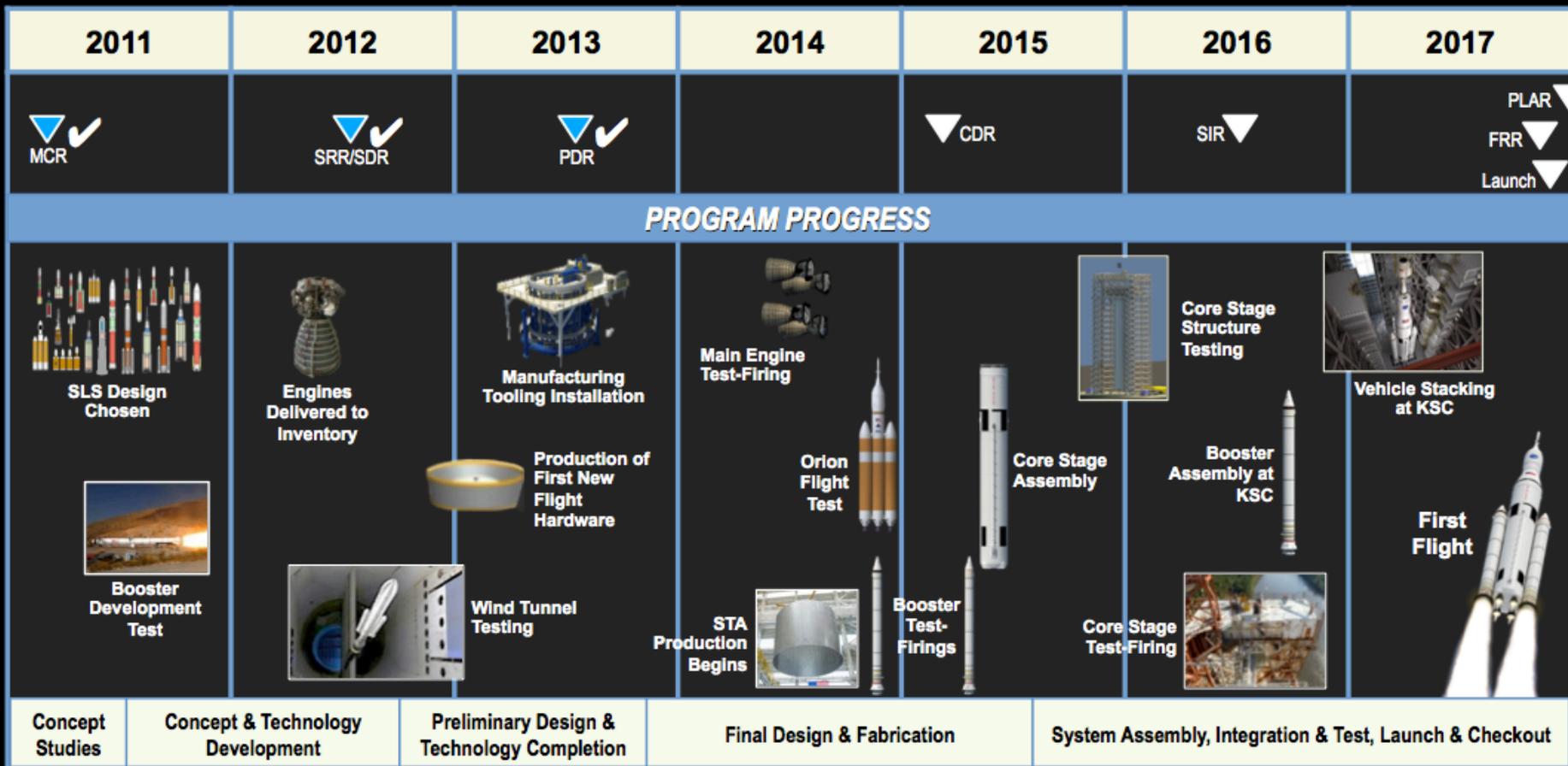
SLS Availability for Space Science



- ◆ **SLS is on schedule and within budget** for to be available for launches beginning in 2017.
- ◆ **5-meter payload fairings** allow for payload envelopes compatible with current EELVs.
- ◆ **Cargo-launch variants** offer the reliability of a human-mission launch and power in excess of any launch vehicle in history.



SLS Development Milestones

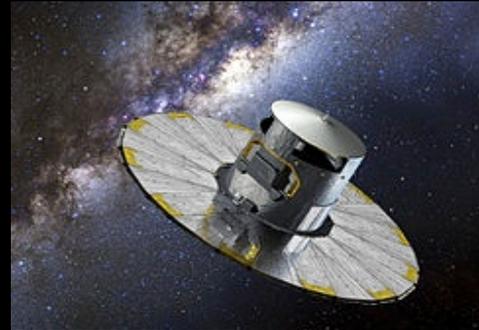


MCR: Mission Concept Review	CDR: Critical Design Review
SRR: System Requirements Review	SIR: System Integration Review
SDR: System Definition Review	FRR: Flight Readiness Review
PDR: Preliminary Design Review	PLAR: Post-Launch Asses. Review

SLS Benefits to Space Science



◆ **Greatest mass lift capability** of any launch vehicle in the world.

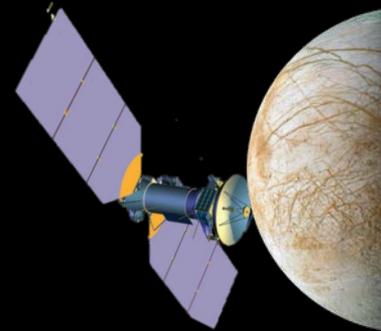


Deep Space Telescope

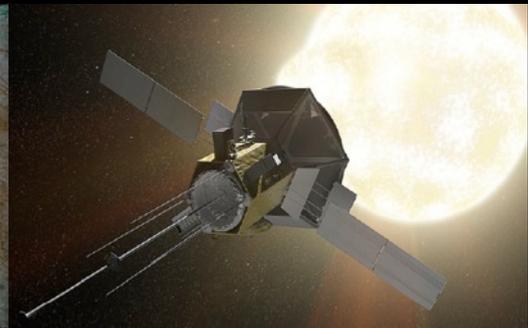


Mars Sample Return

◆ **Largest payload fairings** of any launch vehicle produce greatest available volume.



Europa Clipper



Solar Probe

◆ **High departure energy availability** for missions through the solar system and beyond.



Uranus Spacecraft

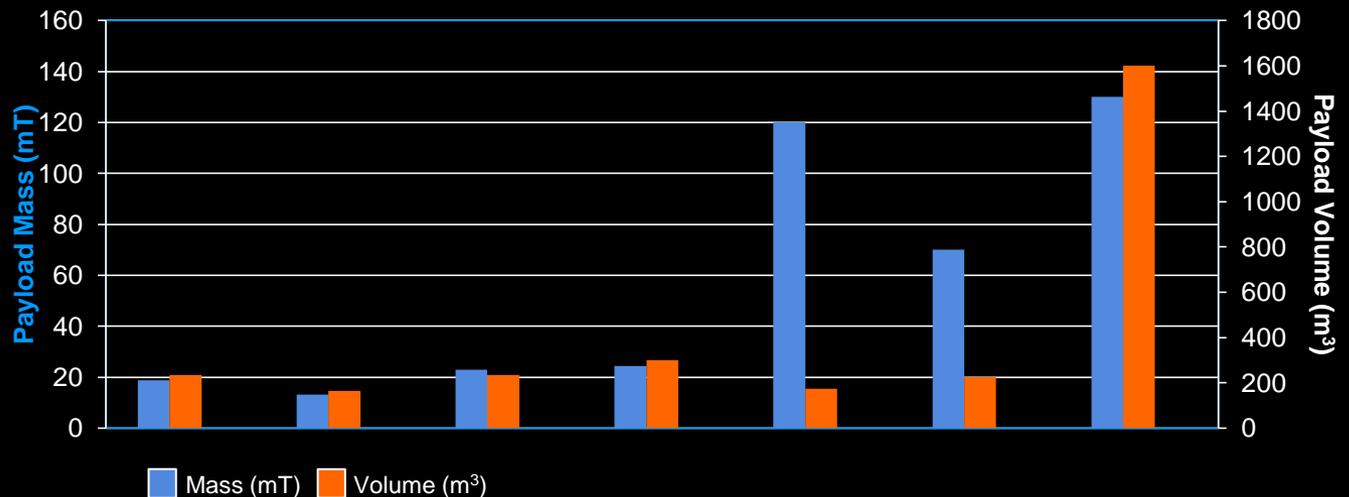
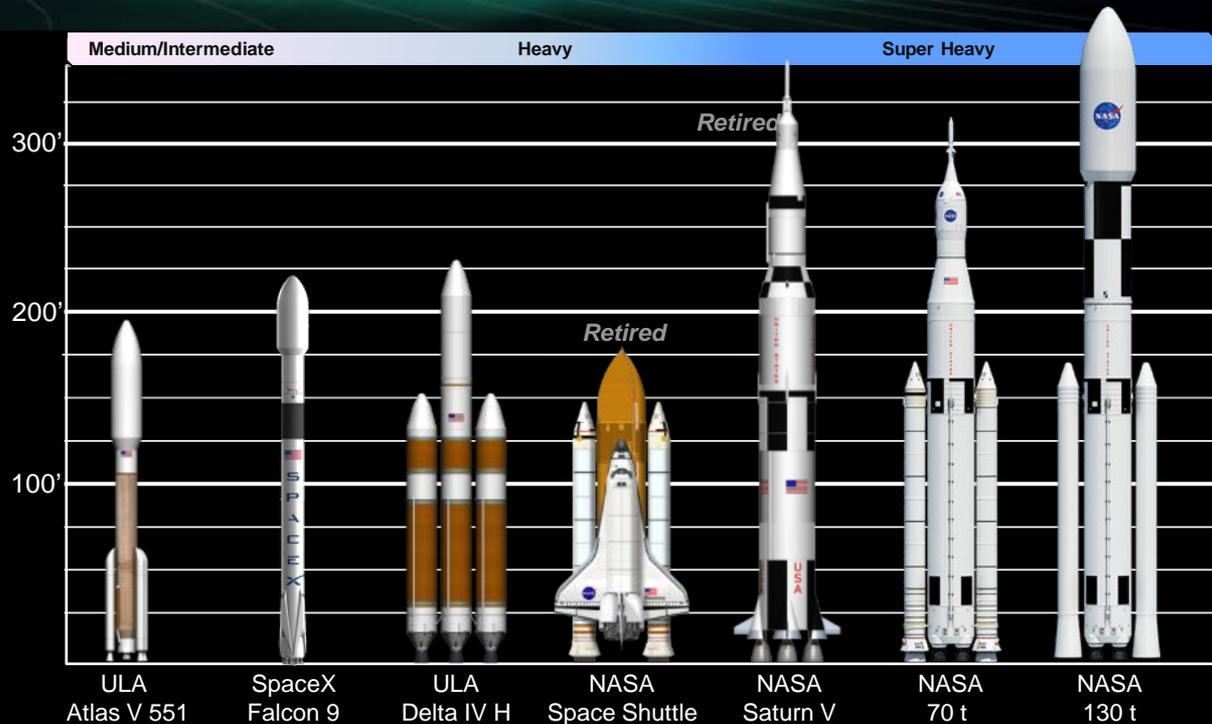


Interstellar

Benefit: SLS Mass Lift Capability



- ◆ SLS initial configuration offers 70 t to LEO.
- ◆ Future configurations offer 105 and 130 t to LEO.
- ◆ Mass capability benefits mean larger payloads to any destination.



Case Study: Mars Sample Return



- ◆ **Mars Sample Return** was identified as a high priority in the “Visions and Voyages” planetary science decadal survey.
- ◆ **SLS offers single-launch option** for Mars Sample Return, versus three launches with EELVs.
- ◆ **Additional benefits of SLS** for Mars Sample Return include reduced mission time, increased sample mass, and reduced mission cost, complexity and risk.



Benefit: Unrivaled Payload Volume



- ◆ SLS is investigating utilizing existing fairings for early cargo flights, offering payload envelope compatibility with design for current EELVs
- ◆ Phase A studies in work for 8.4m and 10 m fairing options



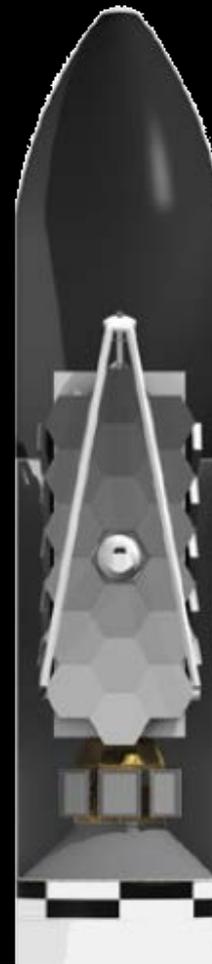
4m x 12m
(100 m³)



5m x 14m
(200 m³)



5m x 19m
(300 m³)



8.4m x 31m
(1200 m³)

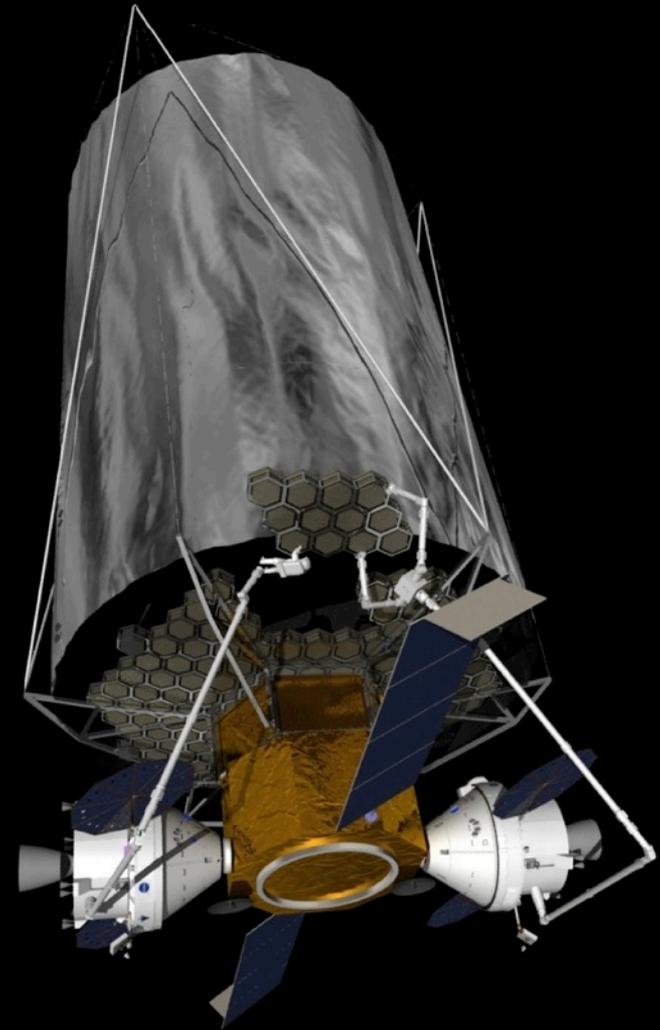


10m x 31m
(1800 m³)

Case Study: ATLAST



- ◆ **Large-aperture spectroscopic telescope** was identified as a vital step in the “Enduring Quests, Daring Visions” astrophysics roadmap.
- ◆ **SLS is uniquely enabling** for largest-diameter telescopes due to fairing-width requirements.
- ◆ **Additional benefits of SLS** for ATLAST include opportunities for human assembly and/or servicing at deep space destinations.



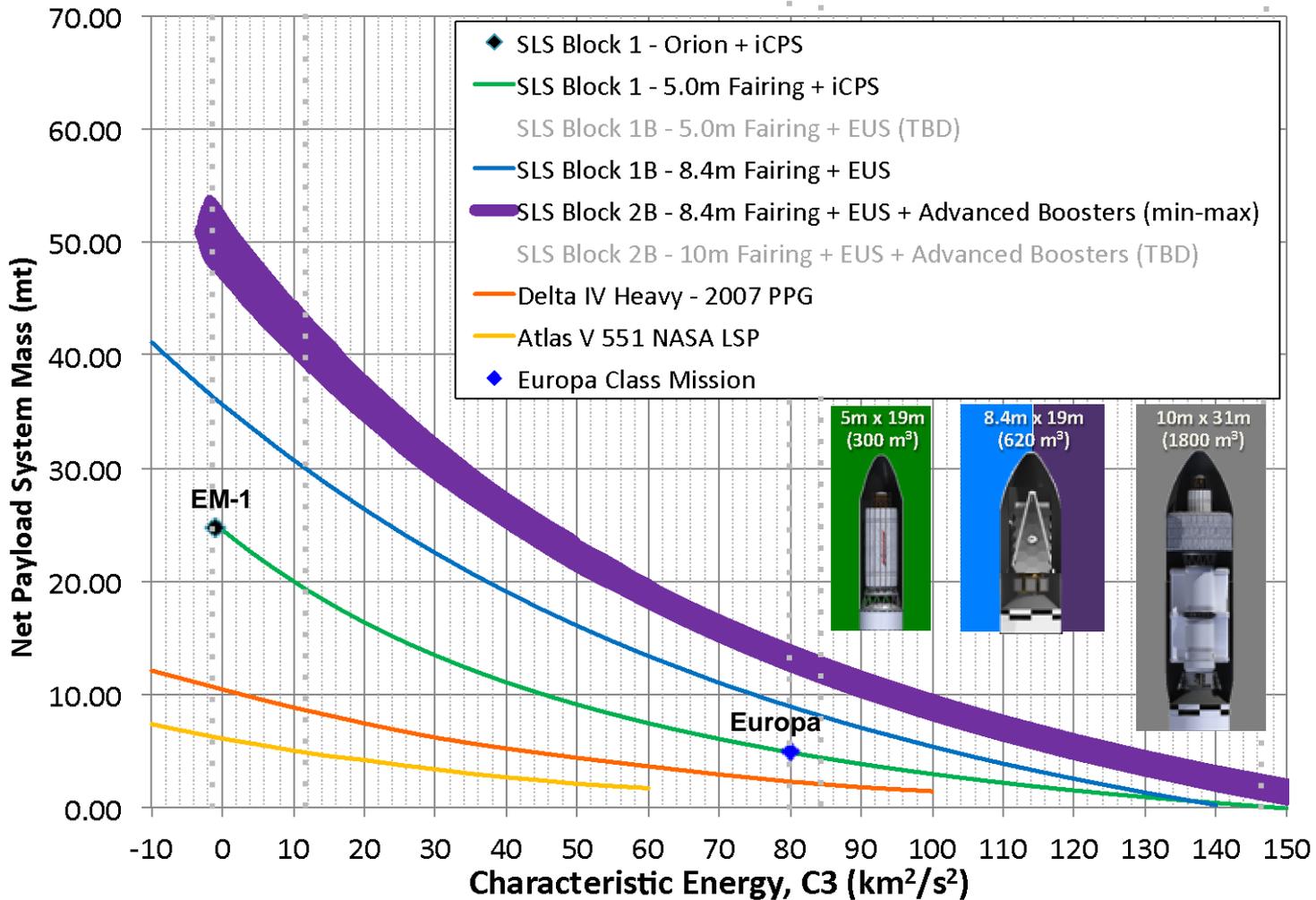
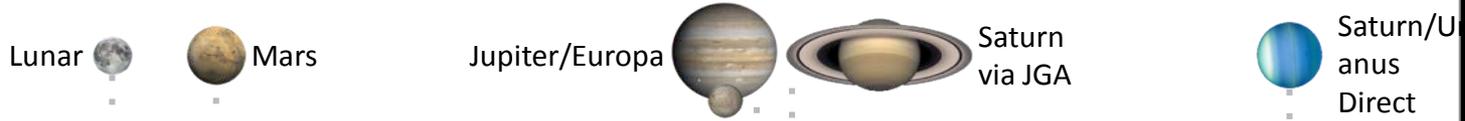
Benefit: High Departure Energy



- ◆ Even the Initial configuration of SLS offers orders of magnitude greater payload-to-destination energy compared to existing launch vehicles; future configurations improve C3 performance even further.
- ◆ Departure energy offers faster transit time to destination, including 4-7 year reduction to Saturn or 6 years to Uranus.
- ◆ Higher departure energy offers more launch opportunities.
- ◆ Trade space exists between departure energy and mass capability; a Jovian mission could see 3-year transit reduction or 13 t mass increase.



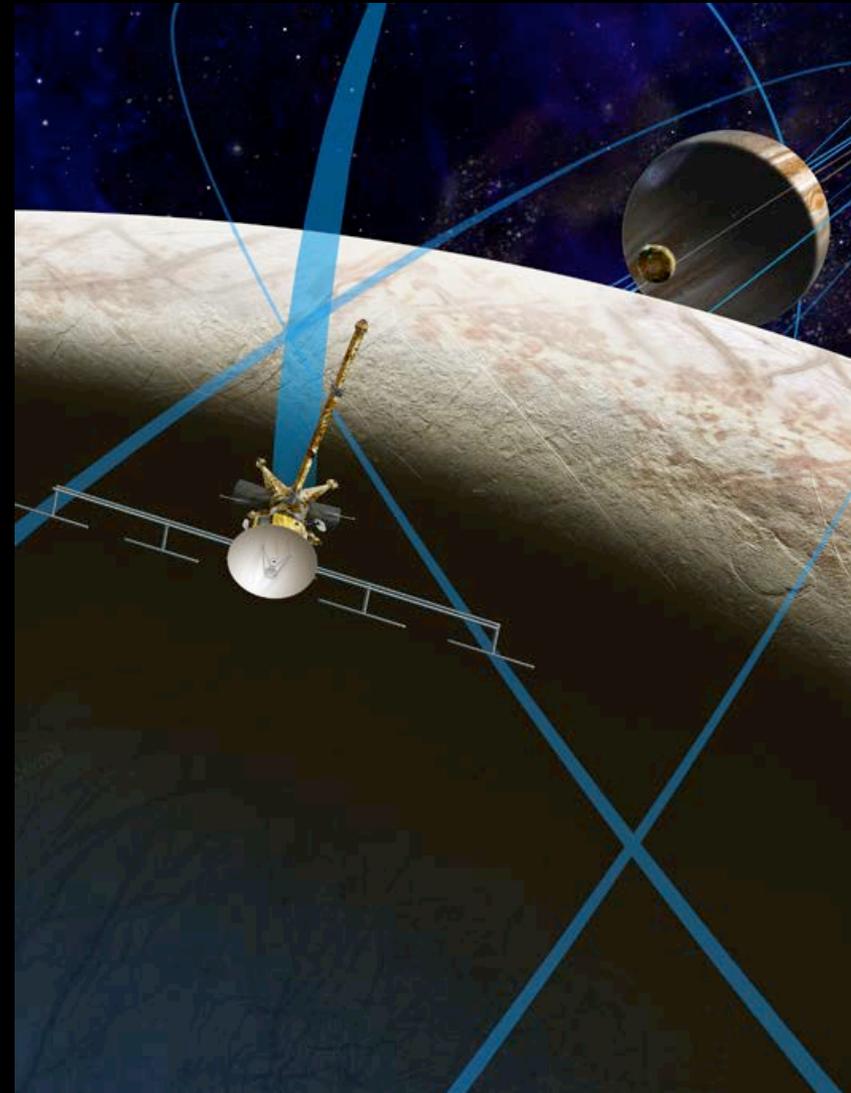
SLS Evolved Performance



Case Study: Europa Clipper



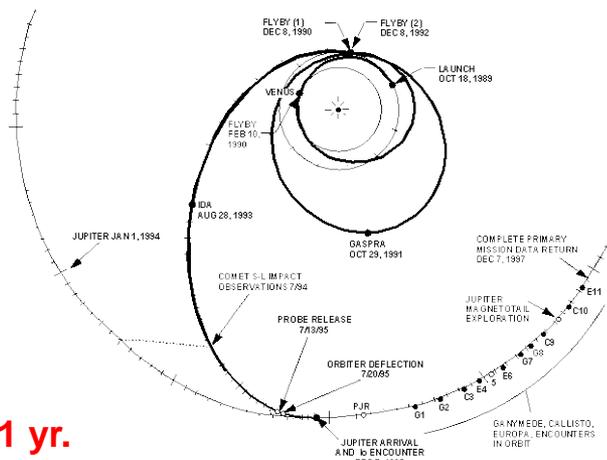
- ◆ **Europa exploration** was identified as a high priority in the “Visions and Voyages” planetary science decadal survey.
- ◆ **SLS can provide direct injection to Jupiter**, eliminating several years of planetary gravity assists to reduce flight time to Europa from 6.3 years to 2.7.
- ◆ **Additional benefits of SLS** for Europa Clipper include reduced operational costs, reduced mission risk, and greater mass margin.



Outer Planet EELV Trajectories

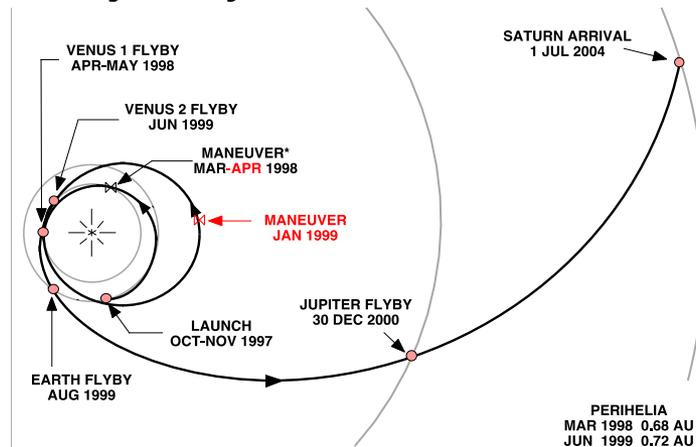


Galileo Trajectory To Jupiter



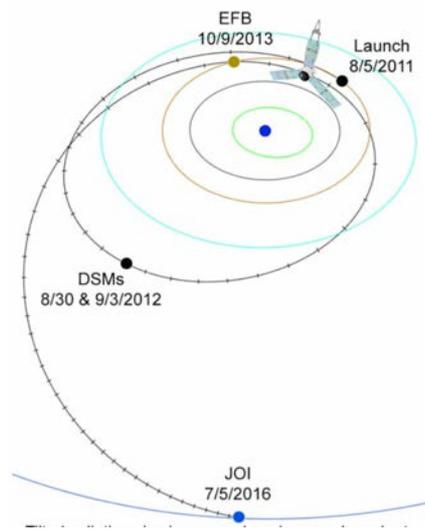
Cruise: 6.1 yr.

Cassini Trajectory to Saturn



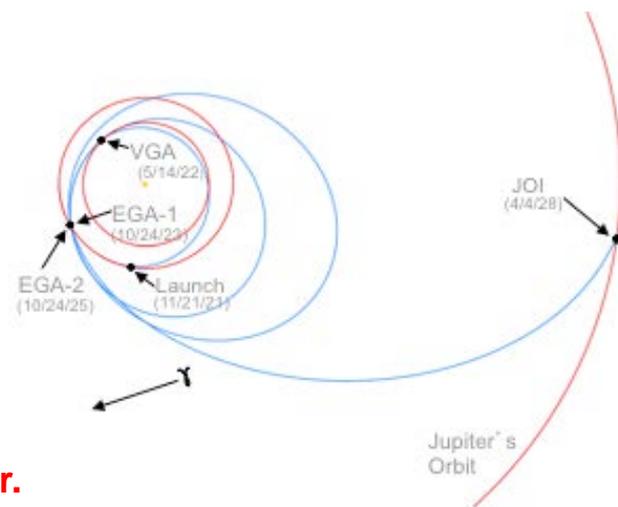
Cruise: 6.7 yr.

JUNO Trajectory To Jupiter



Cruise: 4.9 yr.

Atlas V Clipper Trajectory

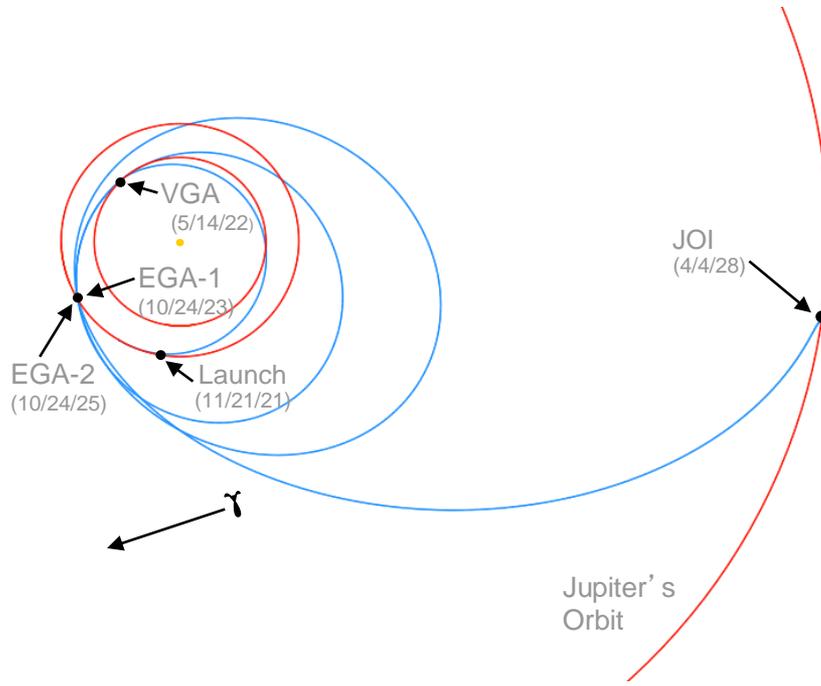


Cruise: 6.4 yr.

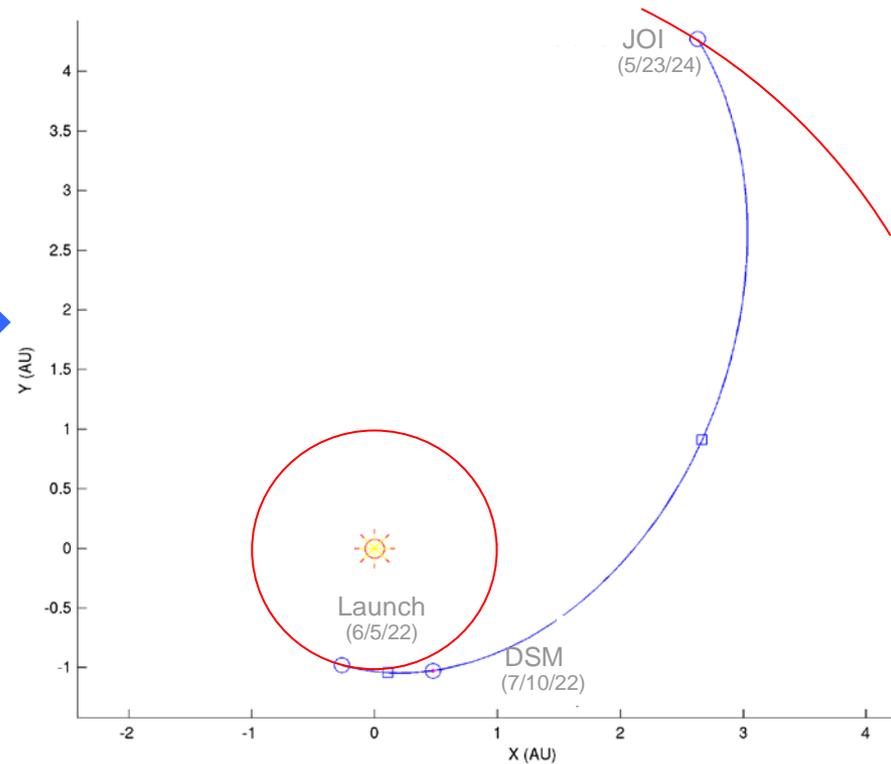
Europa Trajectory Comparison



Atlas V 551: VEEGA



SLS: Direct

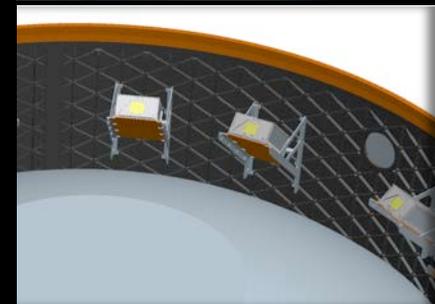


REDUCES TRANSIT TIME TO EUROPA FROM 6.5 TO 2.7 YEARS

SLS Secondary Payload Capability



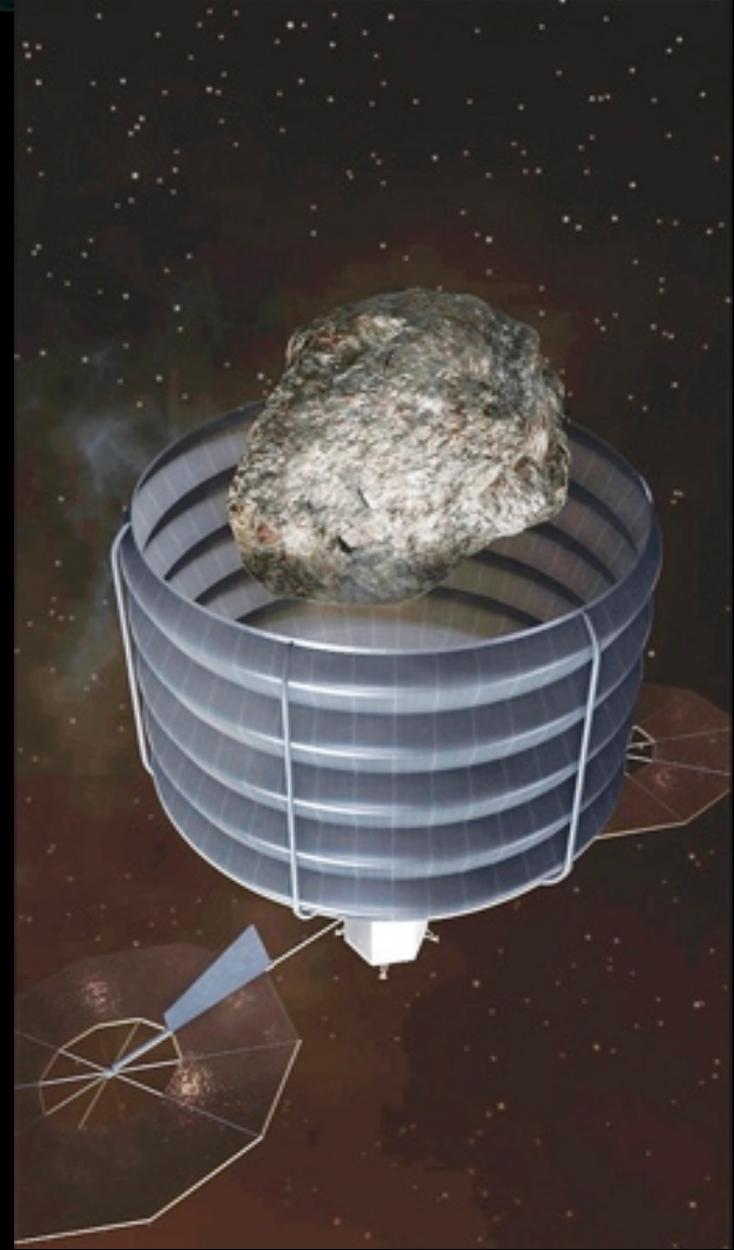
- ◆ SLS is providing accommodations for secondary payloads on EM-1 and subsequent launches
- ◆ Secondary payloads will be accommodated in the Orion- MPCV Spacecraft Adapter (MSA) on EM-1
- ◆ 6U equivalent volume/mass is the current standard; 12U volume can be accommodated
 - 12U mass still being evaluated
 - Additional mounting locations are being evaluated
- ◆ SLS provides secondary payload science opportunities beyond EELVs capabilities (Lunar and beyond)



Possible Next Step: ARRM



- ◆ **The Asteroid Redirect Robotic Mission** is an early step on NASA's Path to Mars.
- ◆ **SLS offers reduced transit time**, providing earlier redirection of target and/or greater launch opportunities.
- ◆ **Additional benefits of SLS** for ARRM offer the potential for redirecting a larger object and for enabling a wider variety of targets.
- ◆ **SLS could launch an ARRM spacecraft** as early as 2019.



Summary



◆ SLS provides capability for human exploration missions.

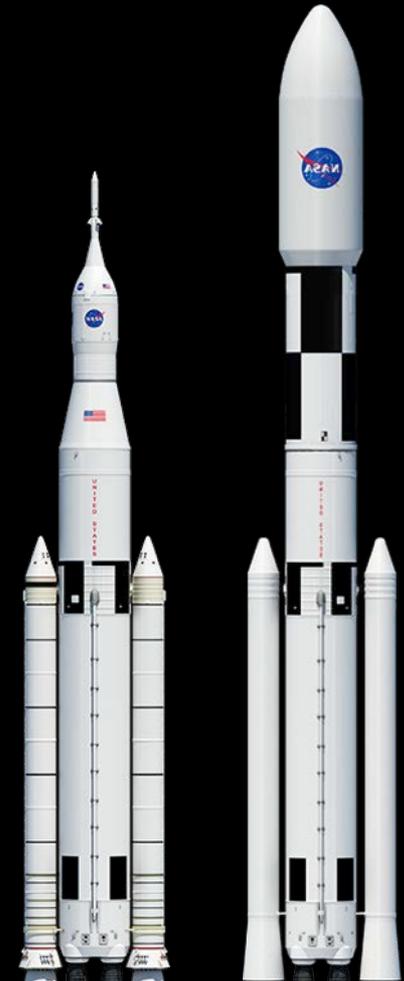
- 70 t configuration enables EM-1 and EM-2 flight tests.
- Evolved configurations enable missions including humans to Mars.

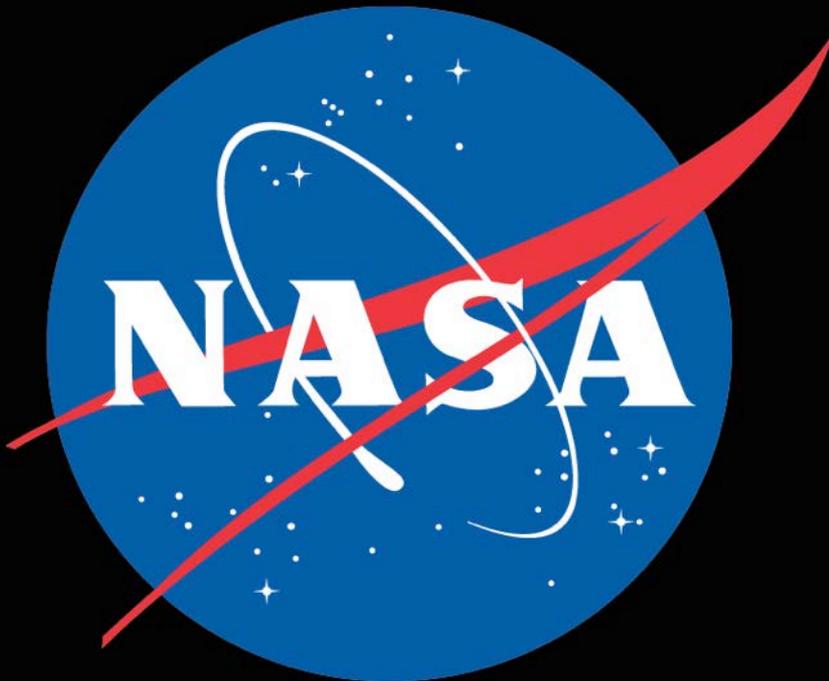
◆ SLS offers unrivaled benefits for a variety of missions.

- 70 t provides greater mass lift than any contemporary launch vehicle; 130 t offers greater lift than any launch vehicle, ever.
- With 8.4m and 10m fairings, SLS will offer greater volume lift capability than any other vehicle.
- Initial ICPS configuration and future evolution will offer highest-ever C3.

◆ SLS is currently on schedule for first launch in December 2017.

- Preliminary design completed in July 2013; SLS is now in implementation.
- Manufacture and testing are currently underway.
- Hardware now exists representing all SLS elements.





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

— Carl Sagan

For More Information

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