

NASA Report for the 2018 DoD E3 Program Review

It’s Not Rocket Science

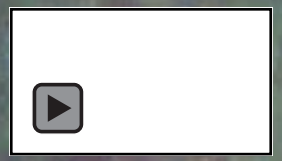
Oh, ……Wait!

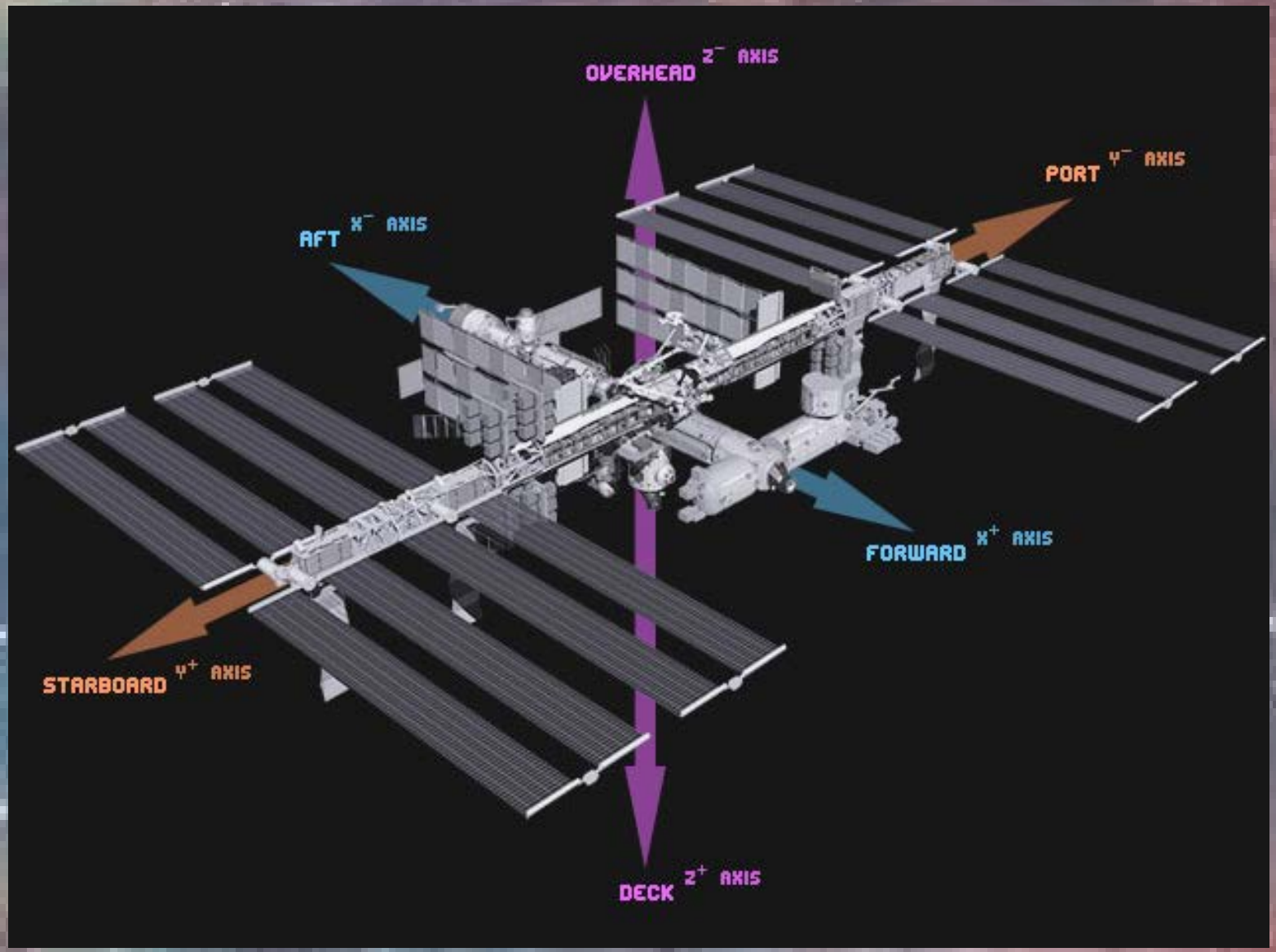
Agenda

- ISS Astronaut Video
  - International Space Station
    - CCP
      - MPCV
        - James Webb Telescope
          - Questions?

The video I am about to show you features a series of time lapse sequences photographed by the Expedition 30 crew aboard the International Space Station. Set to the song "Walking in the Air," by Howard Blake, the video takes viewers around the world, through auroras, and over dazzling lightning displays.

Clearly visible in these sequences is the LEO plasma environment through which ISS operates daily, and which contributes heavily to the overall electromagnetic environment that drives NASA EMC requirements.

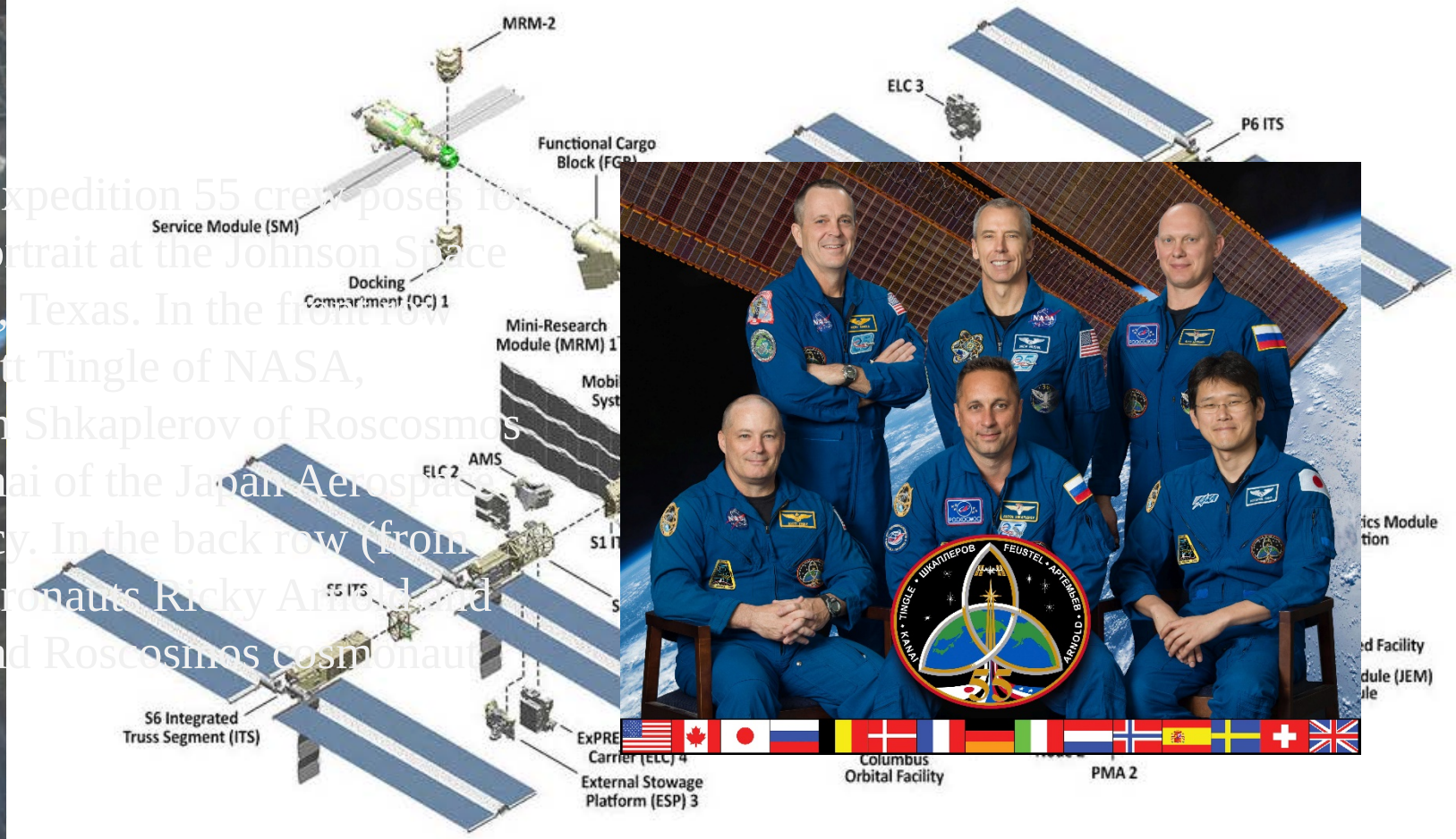




Space Station

Space Station

The six-member Expedition 55 crew poses for an official crew portrait at the Johnson Space Center in Houston, Texas. In the front row (from left) are Scott Tingle of NASA, Commander Anton Shkaplerov of Roscosmos and Norishige Kanai of the Japan Aerospace Exploration Agency. In the back row (from left) are NASA astronauts Ricky Arnold and Andrew Feustel and Roscosmos cosmonaut Oleg Artemyev.



ISS Assembly Sequence [redacted]

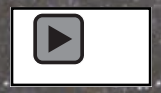
Space Station

- International Space Station Stats
  - Pressurized Volume: 32,333 cubic feet (916 cubic meters)
  - Habitable Volume: 13,696 cubic feet (388 cubic meters)
  - As of January 2018, 230 individuals from 18 countries have visited the International Space Station
  - Lines of Computer Code: approximately 2.3 million
  - > 100,000 orbits (> 2.6 billion miles)
  - In orbit since 1998
  - Truss Length: 357.5 feet (109 meters)
  - Module Length: 167.3 feet (51 meters)
  - Solar Array Length: 239.4 feet (73 meters)
  - Power Generation: 8 solar arrays = 84 kilowatts
  - Mass: 924,739 pounds (419,455 kilograms)

LOTS of videos on YouTube
A nice tour can be viewed here:
https://www.youtube.com/watch?v=qtiUgsuxEXc

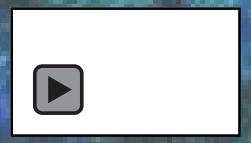
Also, you can now tour ISS in Google Street View at this url:
https://www.google.com/streetview/#international-space-station/

So what happens on ISS?



Commercial Crew Development

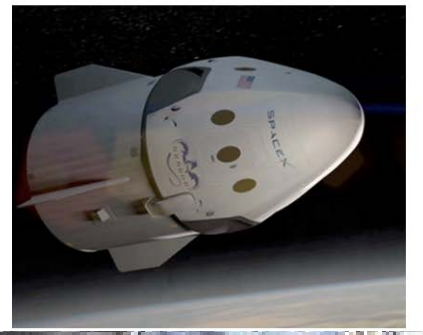
COMMERCIAL
CREW
PROGRAM



Commercial Crew Development

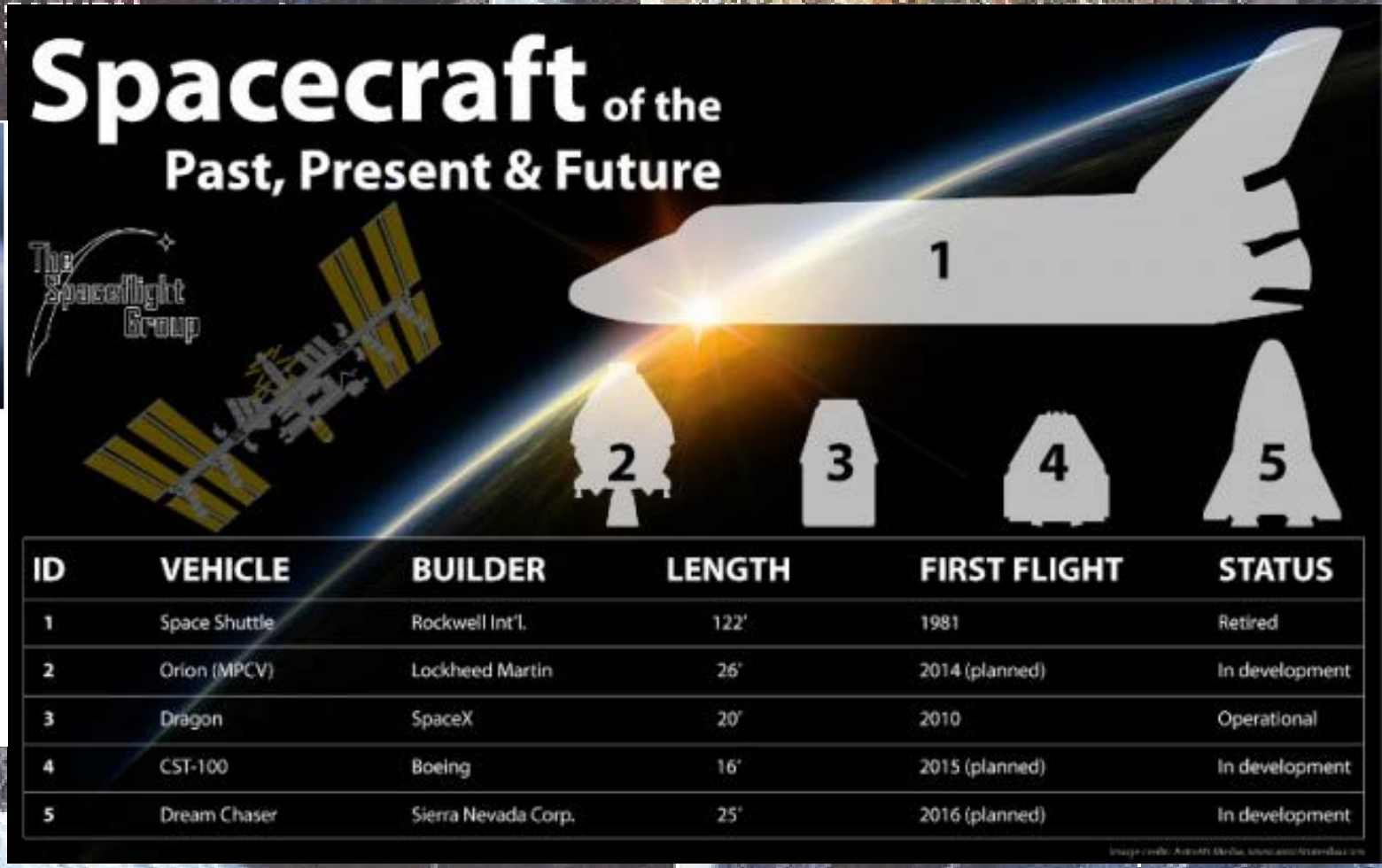






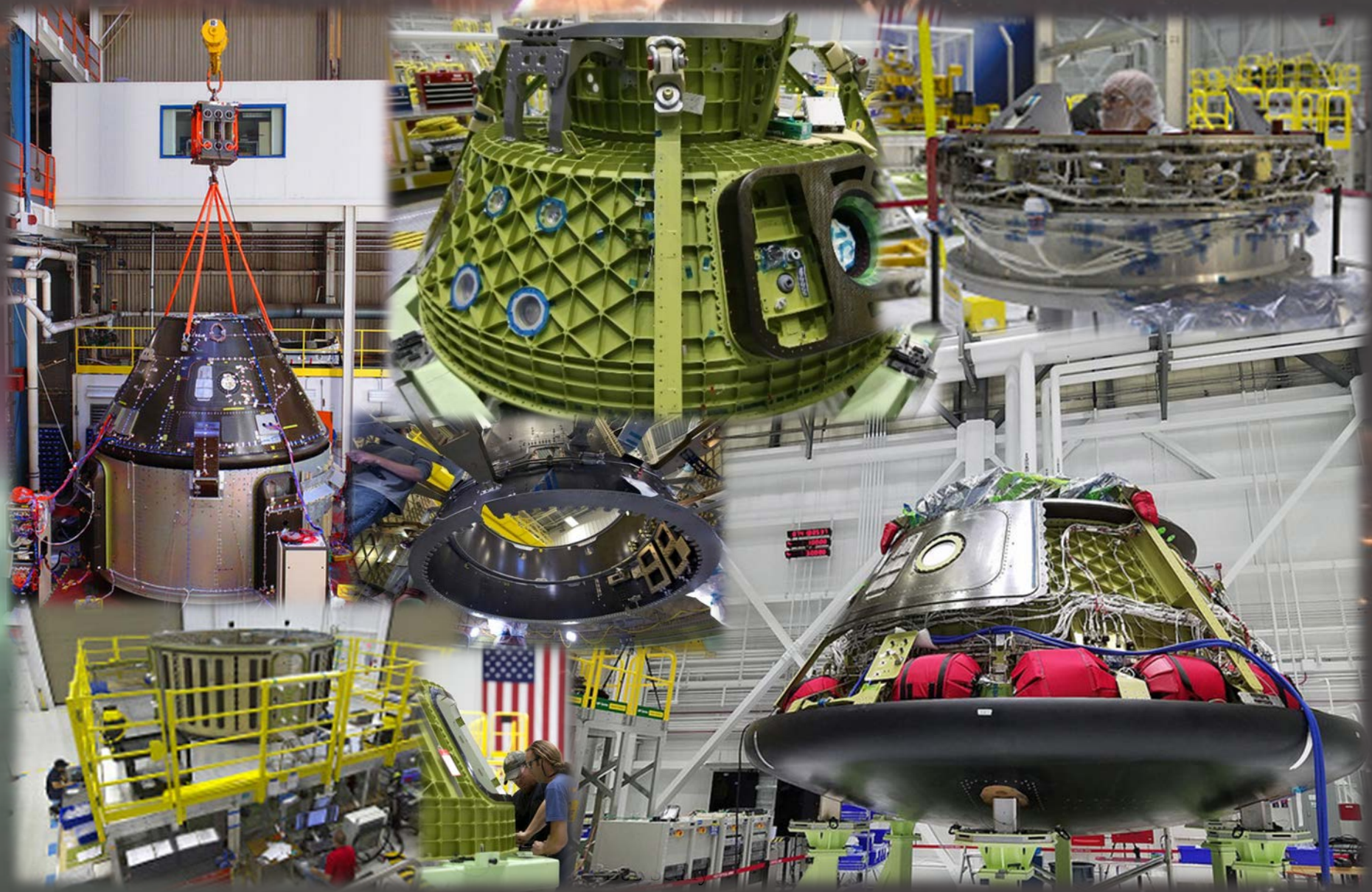


Spacecraft of the Past, Present & Future



ID	VEHICLE	BUILDER	LENGTH	FIRST FLIGHT	STATUS
1	Space Shuttle	Rockwell Int'l.	122'	1981	Retired
2	Orion (MPCV)	Lockheed Martin	26'	2014 (planned)	In development
3	Dragon	SpaceX	20'	2010	Operational
4	CST-100	Boeing	16'	2015 (planned)	In development
5	Dream Chaser	Sierra Nevada Corp.	25'	2016 (planned)	In development

Commercial Crew Development



Commercial Crew Development







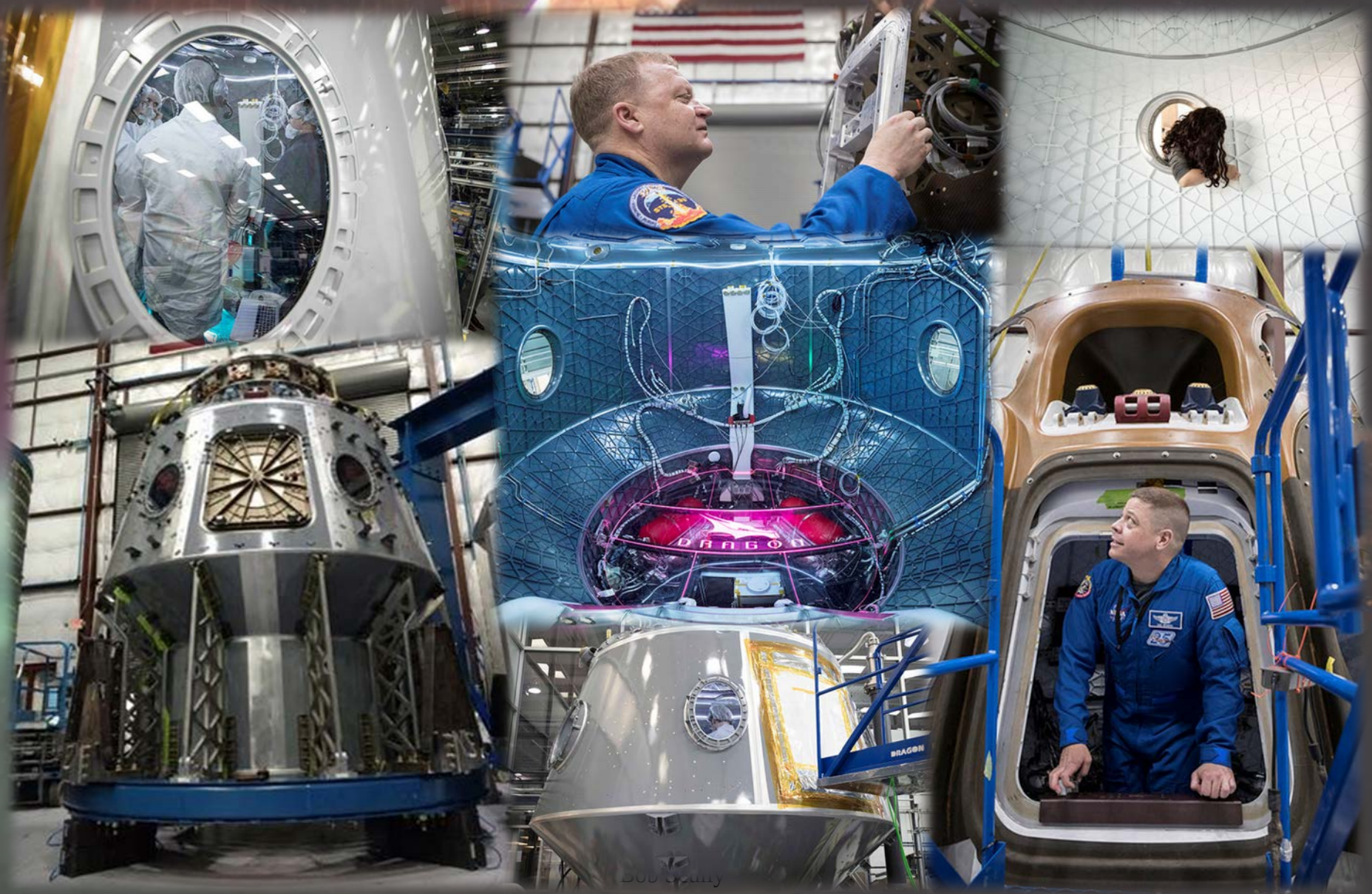
Commercial Crew Development





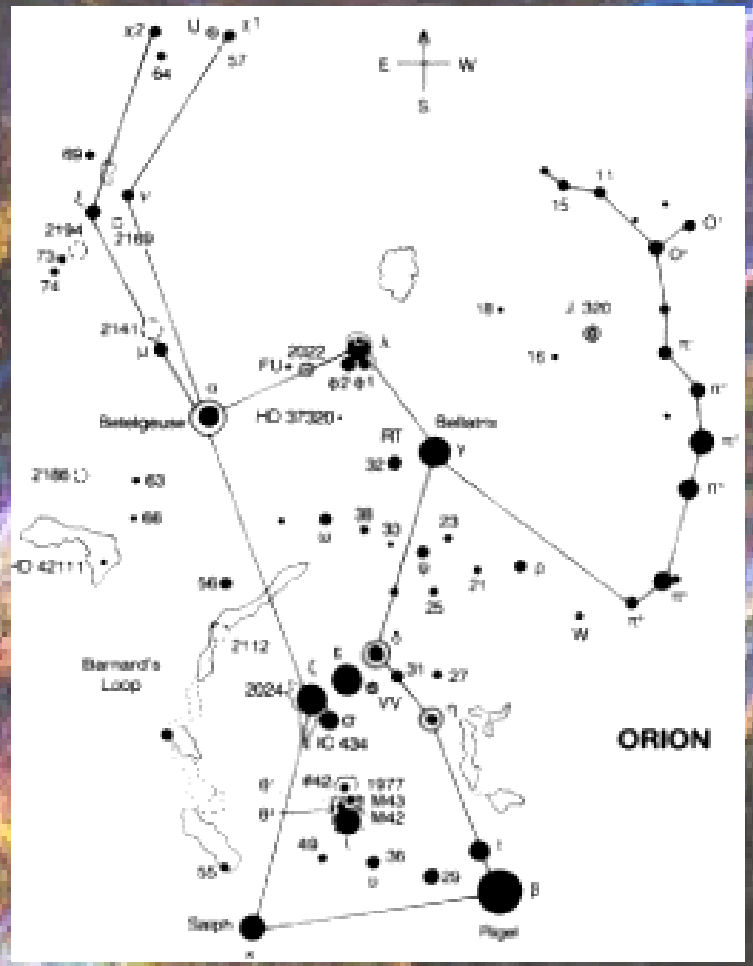


Commercial Crew Development



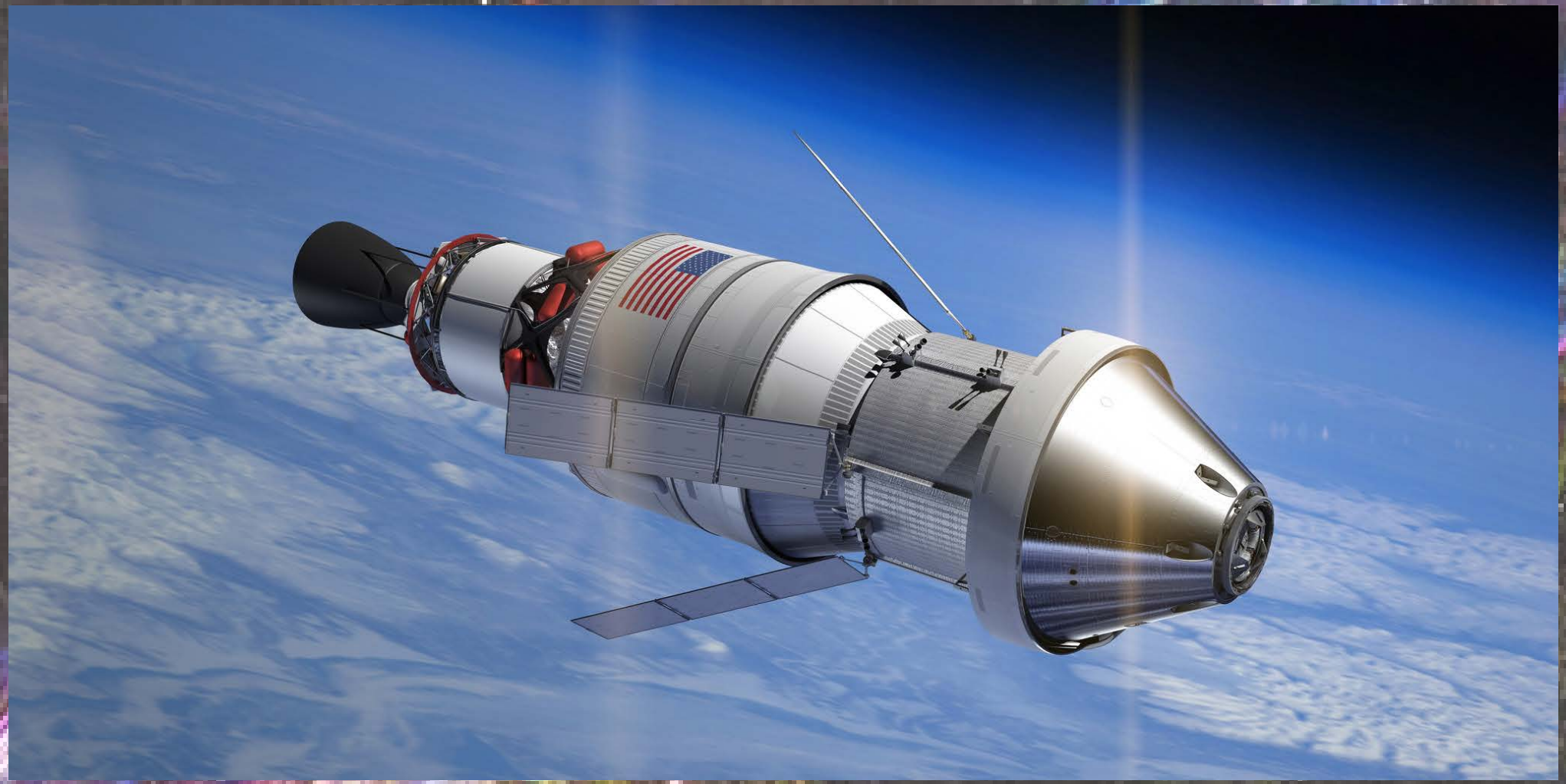
MPCV/Orion




Betelgeuse
HD 37320
Bellatrix
Barnard's Loop
IC 434
ORION


ORION
Pl. 29.
GEMINI
MONOCEROS
LEPUS

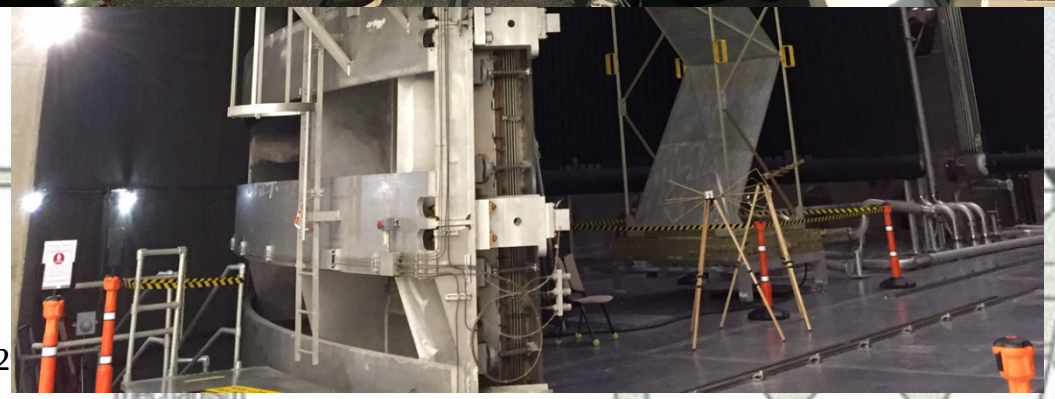
MPCV/Orion

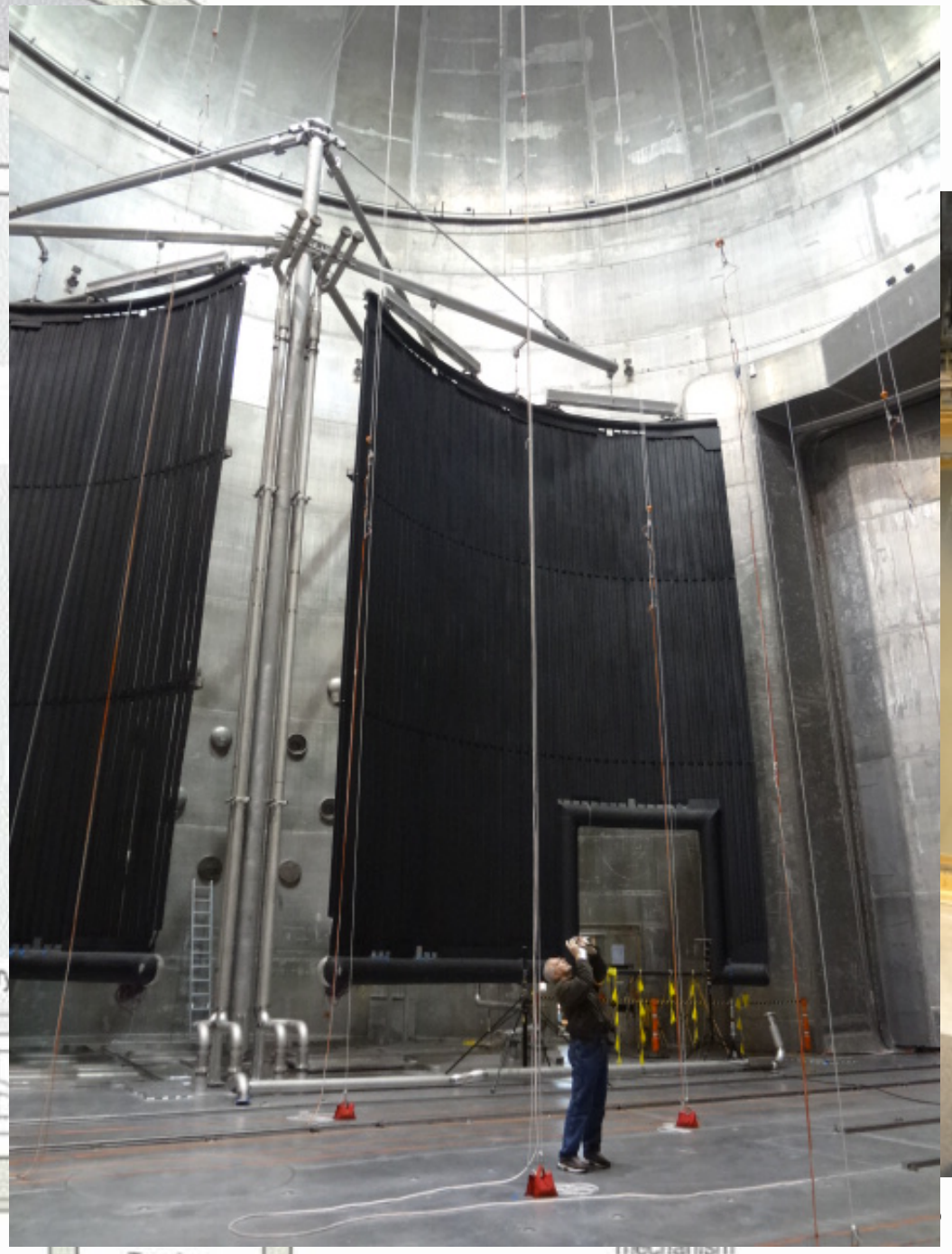


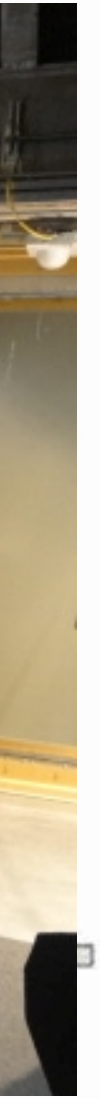


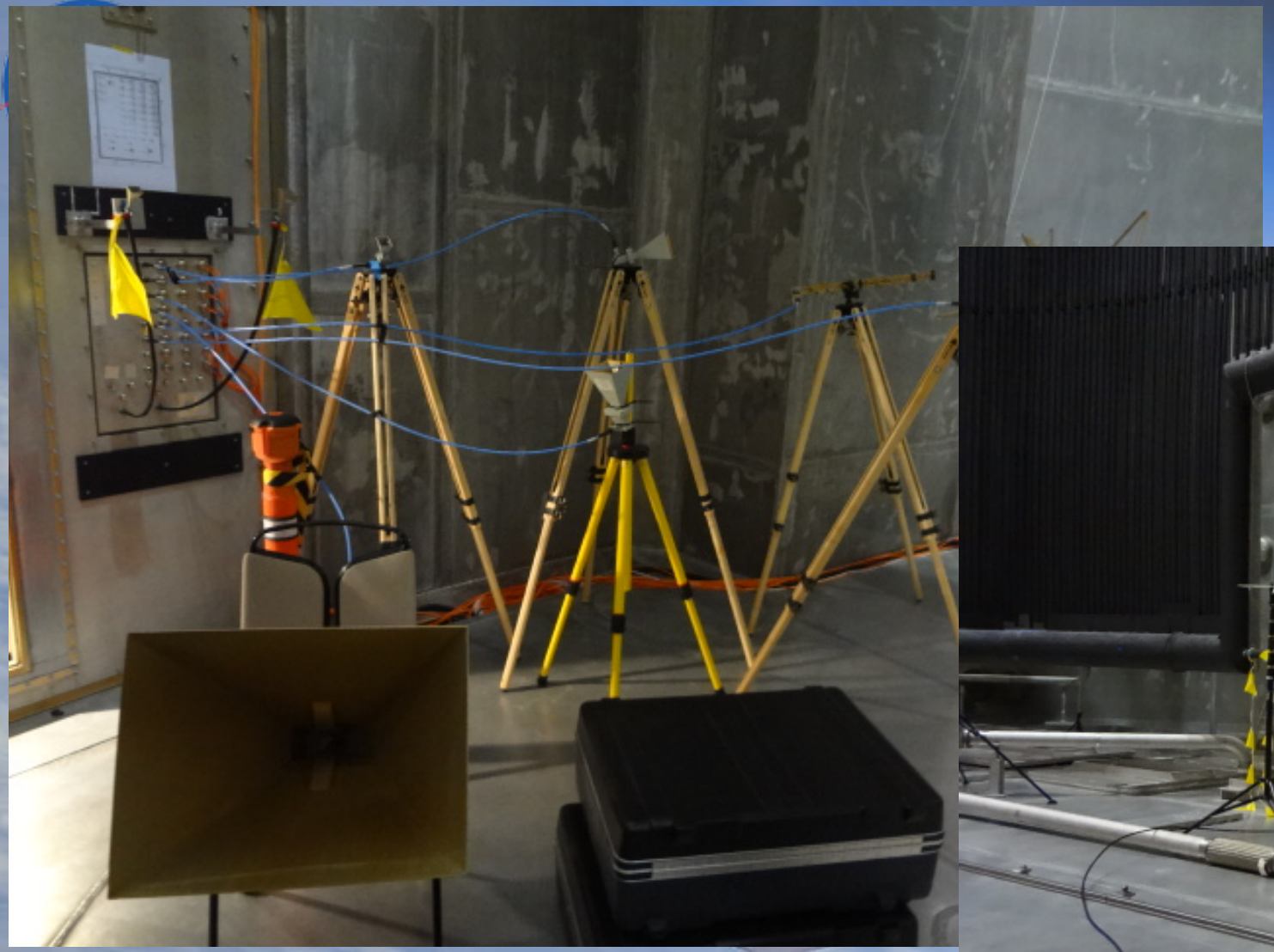








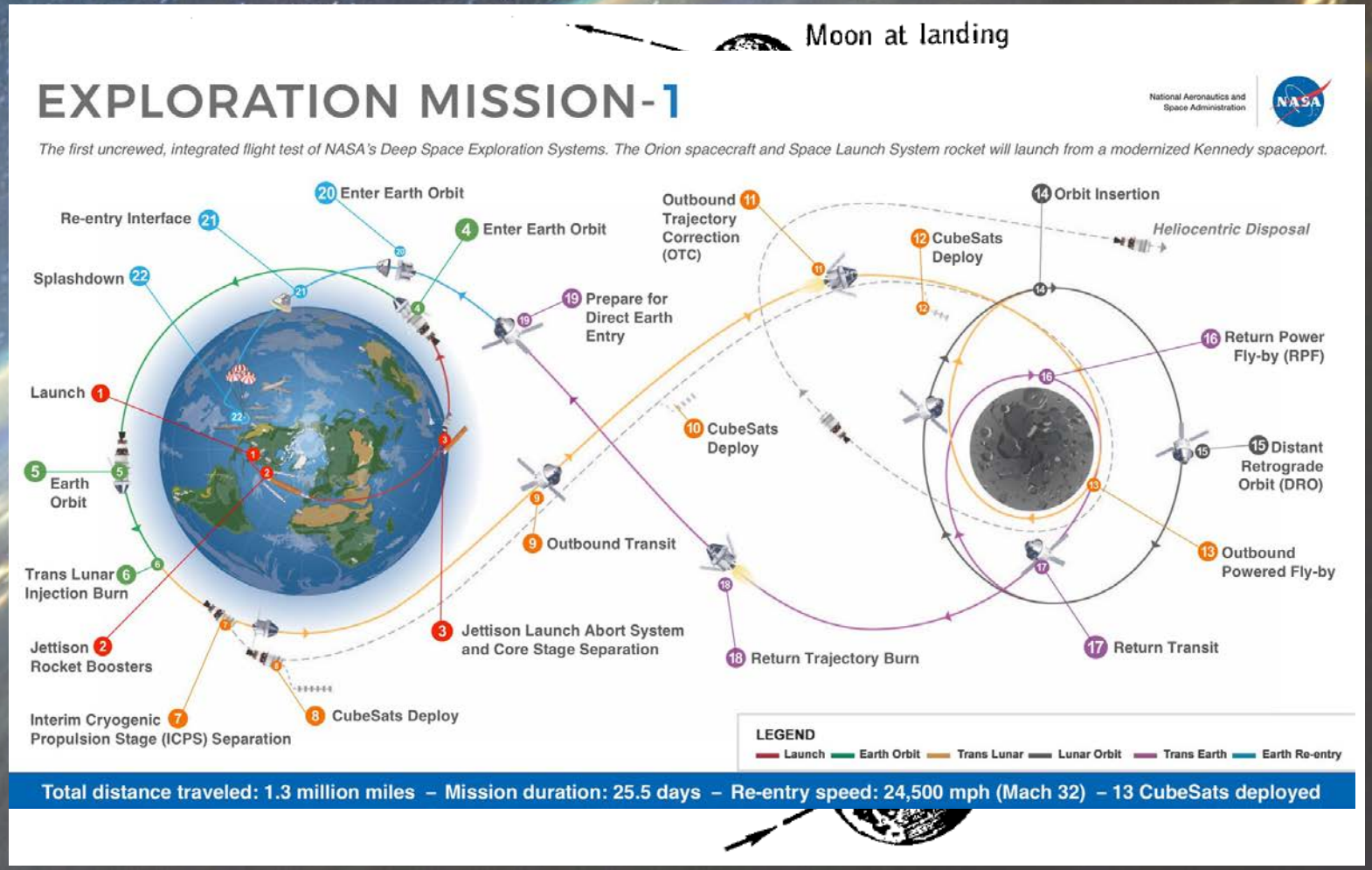


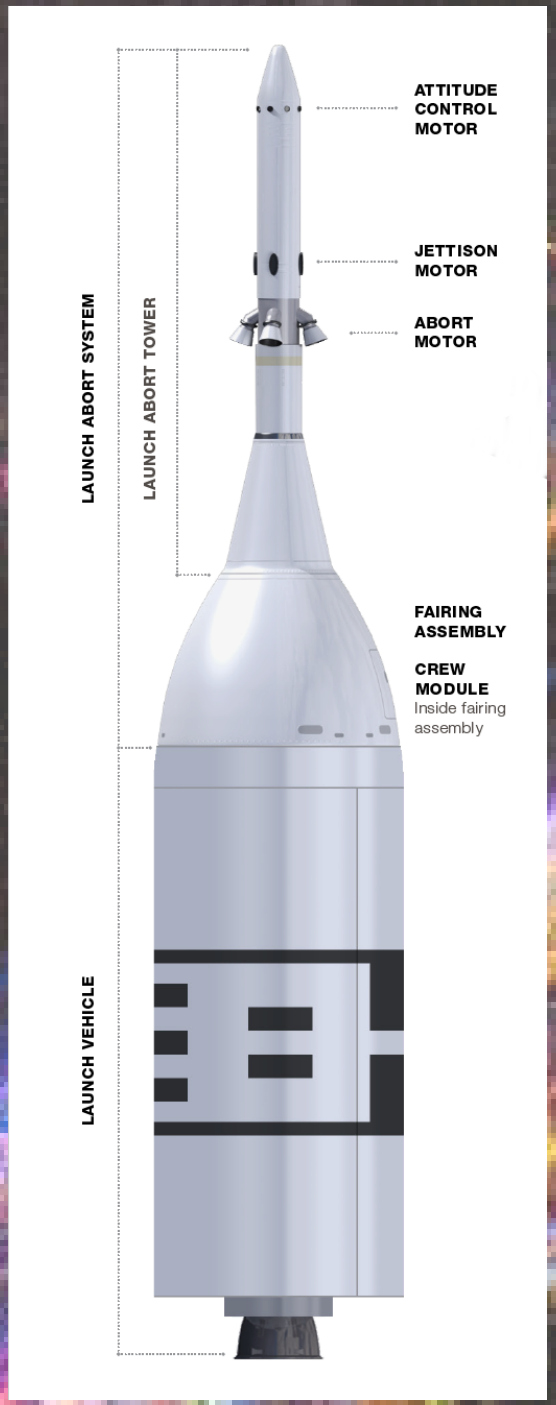


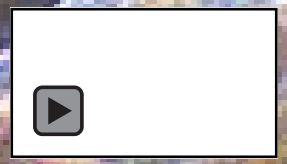


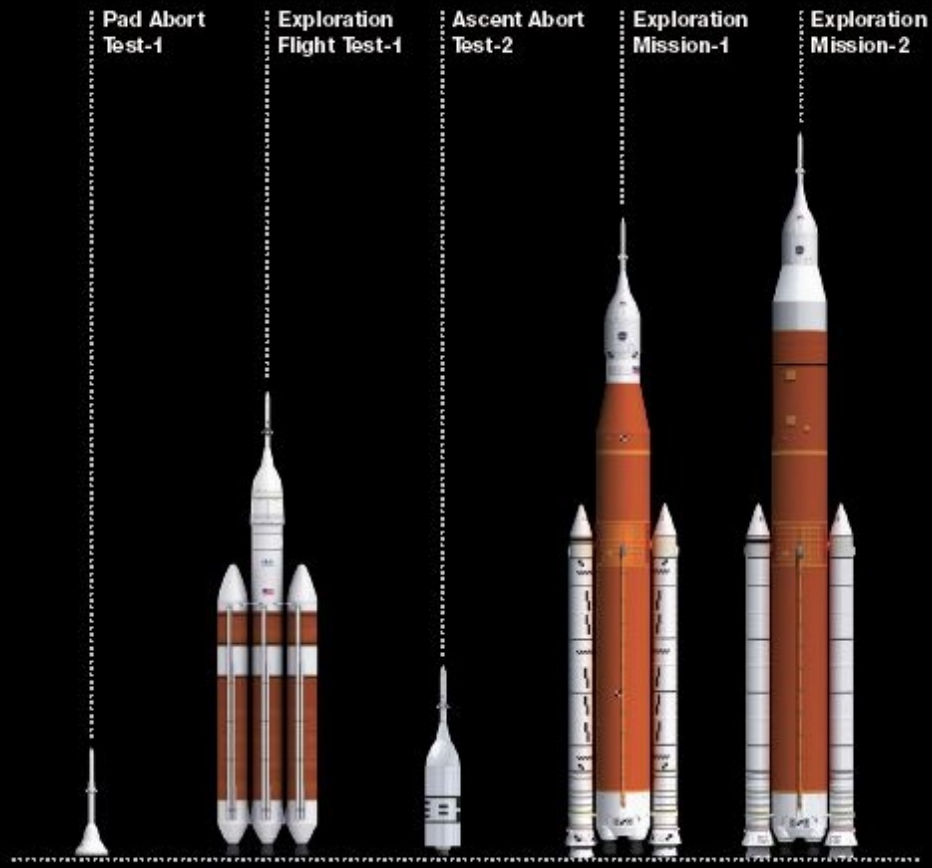
Exploration Mission 1

Exploration Mission 1 (EM-1) is currently scheduled for launch of the Artemis 1 mission on the Space Launch System rocket in 2019.



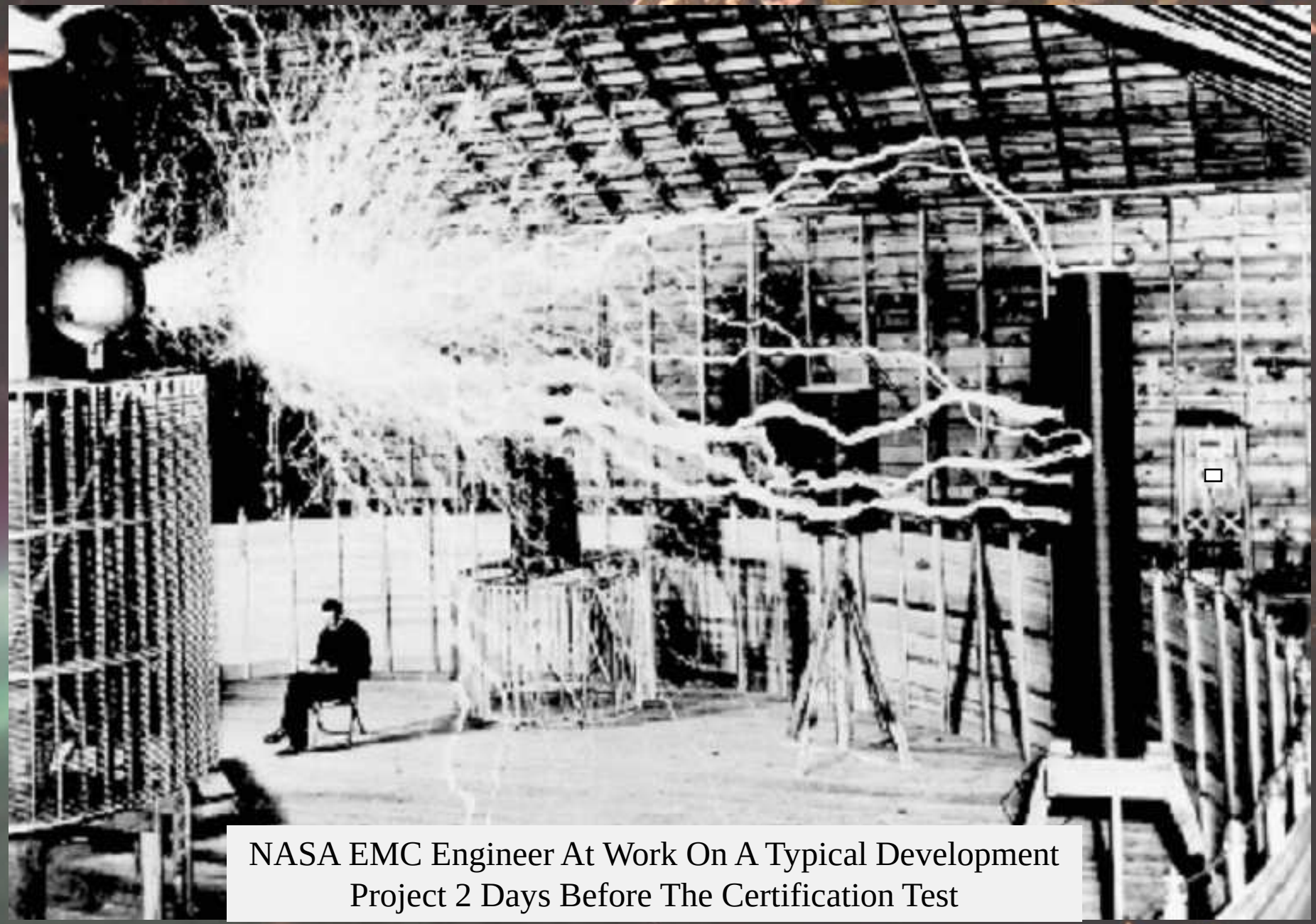






In 2010, an earlier version of Orion's LAS was successfully tested to evaluate the performance of the system from the launch pad during Pad Abort Test-1 at White Sands Missile Range in New Mexico. For Exploration Mission-1 (EM-1) – NASA's first integrated flight test of Orion atop the powerful SLS – the abort system will not be fully active since astronauts will not be inside the spacecraft.





NASA EMC Engineer At Work On A Typical Development Project 2 Days Before The Certification Test



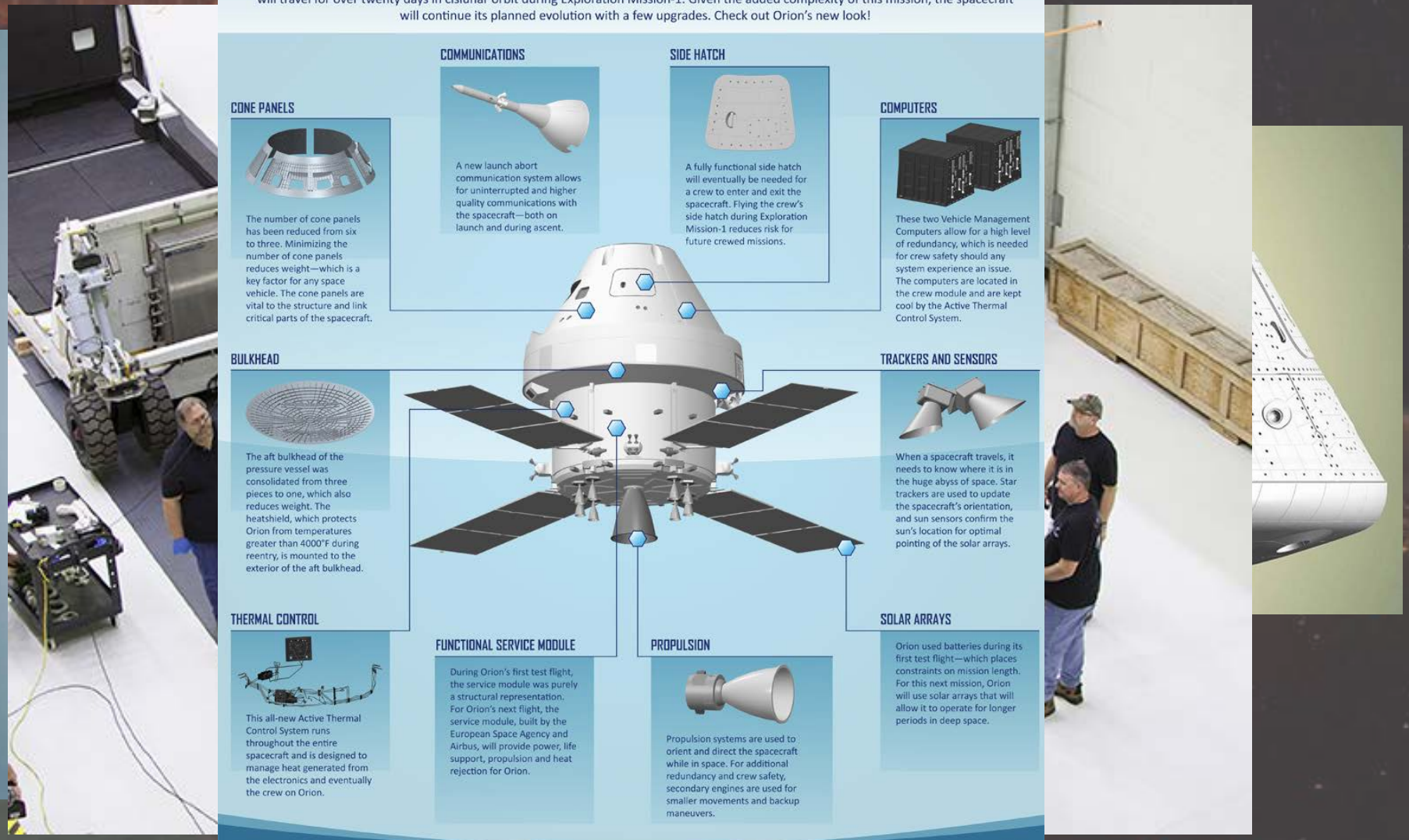
BACKUP

New Astronaut Candidates



NASA announced its 2017 Astronaut Candidate Class on June 7, 2017. The 12 candidates, pictured here at NASA's Ellington Field in Houston, are Zena Cardman, U.S. Marine Corps Maj. Jasmin Moghbeli, U.S. Navy Lt. Jonny Kim, U.S. Army Maj. Francisco "Frank" Rubio, U.S. Navy Lt. Cmdr. Matthew Dominick, Warren "Woody" Hoburg, Robb Kulin, U.S. Navy Lt. Kayla Barron, Bob Hines, U.S. Air Force Lt. Col. Raja Chari, Loral O'Hara and Jessica Watkins. Credits: NASA/Robert Markowitz

Mult PCV)



EVOLUTION OF A SPACECRAFT
ORION

Much like we grow over the course of our lifetimes, so does a spacecraft. With each new flight, elements are added to provide more capability, modified to reduce weight or updated with the latest technology. In Orion's next step on the #JourneytoMars, the spacecraft will travel for over twenty days in cislunar orbit during Exploration Mission-1. Given the added complexity of this mission, the spacecraft will continue its planned evolution with a few upgrades. Check out Orion's new look!

CONE PANELS

The number of cone panels has been reduced from six to three. Minimizing the number of cone panels reduces weight—which is a key factor for any space vehicle. The cone panels are vital to the structure and link critical parts of the spacecraft.

COMMUNICATIONS

A new launch abort communication system allows for uninterrupted and higher quality communications with the spacecraft—both on launch and during ascent.

SIDE HATCH

A fully functional side hatch will eventually be needed for a crew to enter and exit the spacecraft. Flying the crew's side hatch during Exploration Mission-1 reduces risk for future crewed missions.

COMPUTERS

These two Vehicle Management Computers allow for a high level of redundancy, which is needed for crew safety should any system experience an issue. The computers are located in the crew module and are kept cool by the Active Thermal Control System.

BULKHEAD

The aft bulkhead of the pressure vessel was consolidated from three pieces to one, which also reduces weight. The heatshield, which protects Orion from temperatures greater than 4000°F during reentry, is mounted to the exterior of the aft bulkhead.

TRACKERS AND SENSORS

When a spacecraft travels, it needs to know where it is in the huge abyss of space. Star trackers are used to update the spacecraft's orientation, and sun sensors confirm the sun's location for optimal pointing of the solar arrays.

THERMAL CONTROL

This all-new Active Thermal Control System runs throughout the entire spacecraft and is designed to manage heat generated from the electronics and eventually the crew on Orion.

FUNCTIONAL SERVICE MODULE

During Orion's first test flight, the service module was purely a structural representation. For Orion's next flight, the service module, built by the European Space Agency and Airbus, will provide power, life support, propulsion and heat rejection for Orion.

PROPULSION

Propulsion systems are used to orient and direct the spacecraft while in space. For additional redundancy and crew safety, secondary engines are used for smaller movements and backup maneuvers.

SOLAR ARRAYS

Orion used batteries during its first test flight—which places constraints on mission length. For this next mission, Orion will use solar arrays that will allow it to operate for longer periods in deep space.

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MPCV/Orion



Orion Summary

Number of crew	4
Total change in velocity	4,390 ft/s
Gross liftoff weight	78,010 lbs
Injected mass	58,467 lbs

Launch Abort System – Emergency Crew Escape System

Mass Properties

Dry mass/propellant	11,120 lbs
Gross liftoff weight	16,850 lbs

Crew Module – Crew and Cargo Transport

Pressurized volume (total)	690.6 ft³
Habitable volume (net)	316 ft³
Reaction control system (RCS) vacuum engine thrust	160 lbf/engine
Return payload	220 lbs

Mass Properties

Dry mass/propellant	22,397 lbs
Oxygen/nitrogen/water	133 lbs
Propellant	370 lbs
Landing weight	20,500 lbs
Gross liftoff weight	22,900 lbs

Service Module – Propulsion, Electrical Power, Fluids Storage

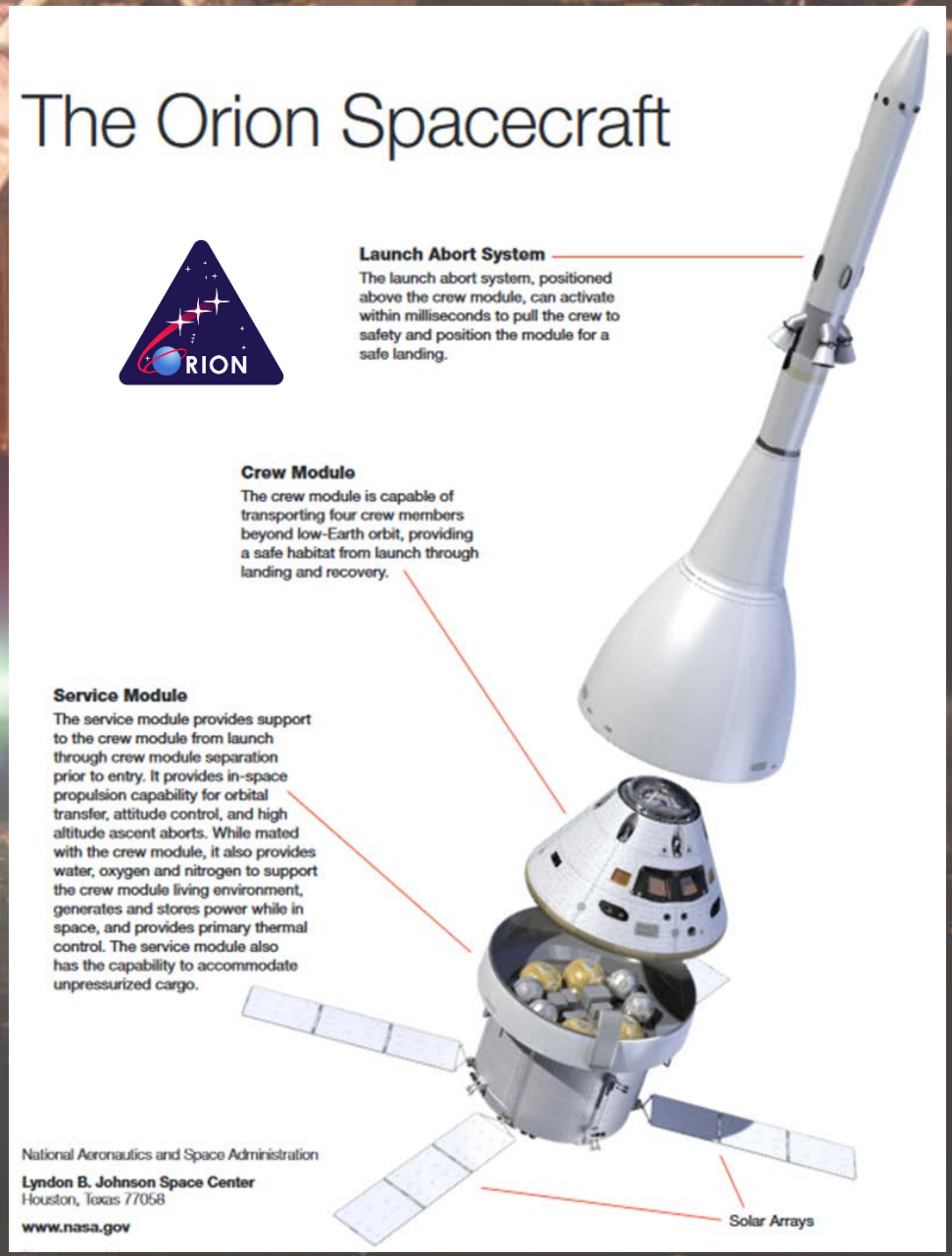
Mass Properties

Dry mass	13,635 lbs
Gross liftoff weight	34,085 lbs

Orion-to-Stage Adapter

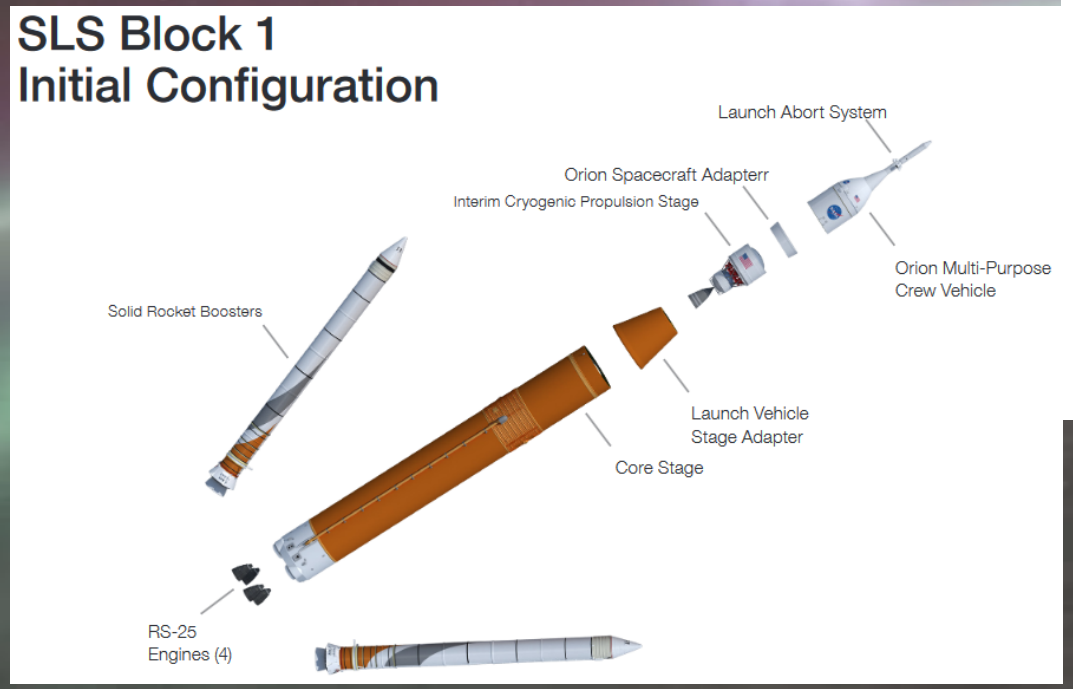
Mass Properties

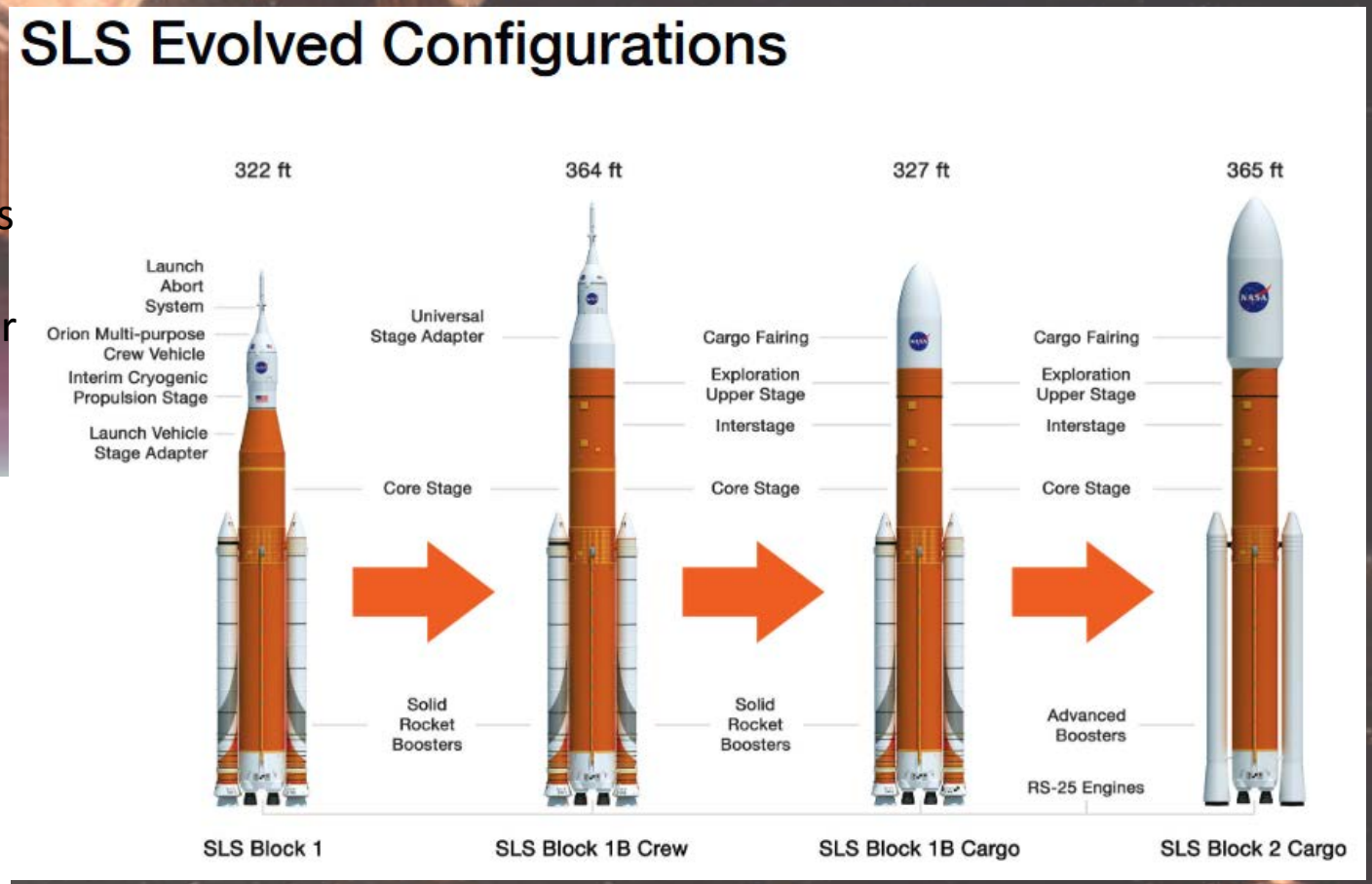
Jettisoned Fairings	3,050 lbs
Spacecraft Adapter	1,125 lbs



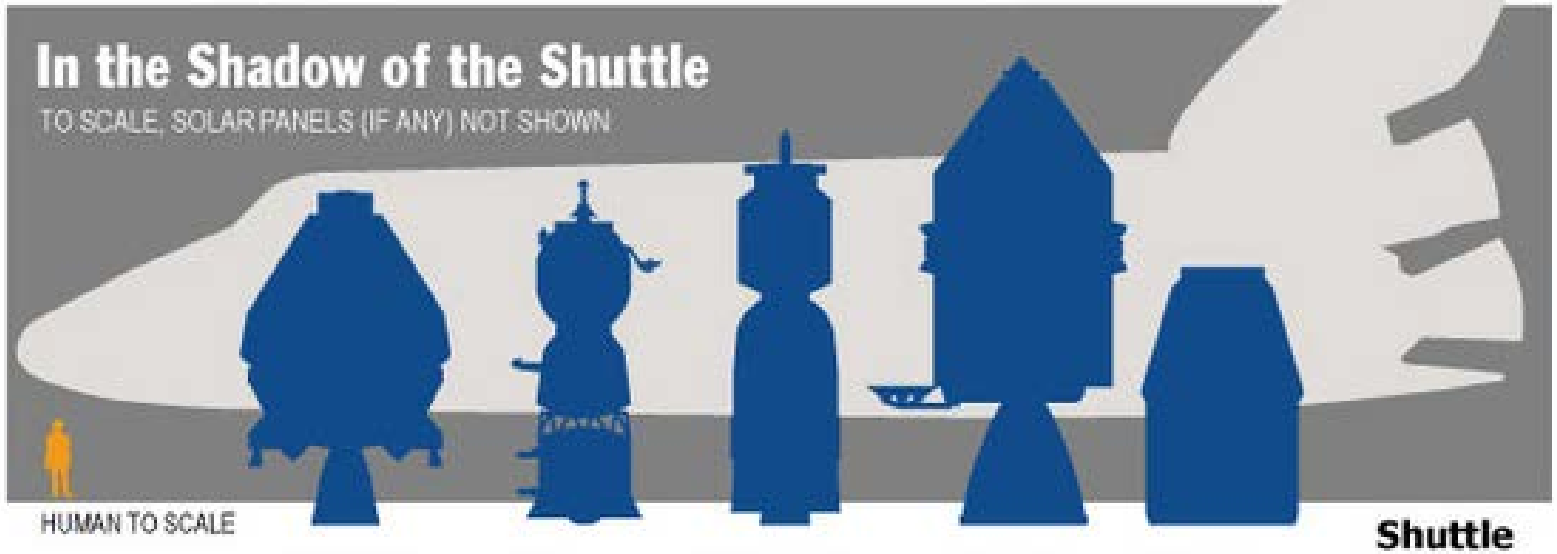
Multi-Purpose Crew Vehicle (MPCV)

NASA's Space Launch System, or SLS, is an advanced launch vehicle for a new era of exploration beyond Earth's orbit into deep space. SLS, the world's most powerful rocket, will launch astronauts in the agency's Orion spacecraft on missions to an asteroid and eventually to Mars, while opening new possibilities for other payloads including robotic scientific missions to places like Mars, Saturn and Jupiter.





Multi-Purpose Crew Vehicle (MPCV)



	MPCV	Soyuz	Shenzhou	Apollo	Dragon	Shuttle Orbiter
Builder	Lockheed Martin	RSC Energia	China	Rockwell Int'l.	SpaceX	Rockwell Int'l.
First launch	2016 or later	1967	1999	1968	2010	1981
Crew	4	3	3	3	7	7
Launch vehicle	SLS	Soyuz FG	Changzheng 2F	Saturn	Falcon 9	STS
Length overall	26 ft (8 m)	24.5 ft (7.5 m)	30 ft (9.25 m)	36 ft (11 m)	20.4 ft (6.2 m)	122 ft (37.2 m)
Liftoff weight	46,848 lb (21,250 kg)	15,763 lb (7,150 kg)	16,760 lb (7,600 kg)	66,871 lb (30,332 kg)	26,460 lb (12,000 kg)	240,000 lb (109,000 kg)

A Look Back at a Few Events in 2015

Hubble Turned 25

On April 24, 1990, the space shuttle Discovery lifted off from Earth with the Hubble Space Telescope nestled securely in its bay. The following day, Hubble was released into space, ready to peer into the vast unknown. Since then, Hubble has reinvigorated and reshaped our perception of the cosmos and uncovered a universe where almost anything seems possible within the laws of physics. Hubble has revealed properties of space and time that for most of human history were only probed in the imaginations of scientists and philosophers alike. Today, Hubble continues to provide views of cosmic wonders never before seen and is at the forefront of many new discoveries.

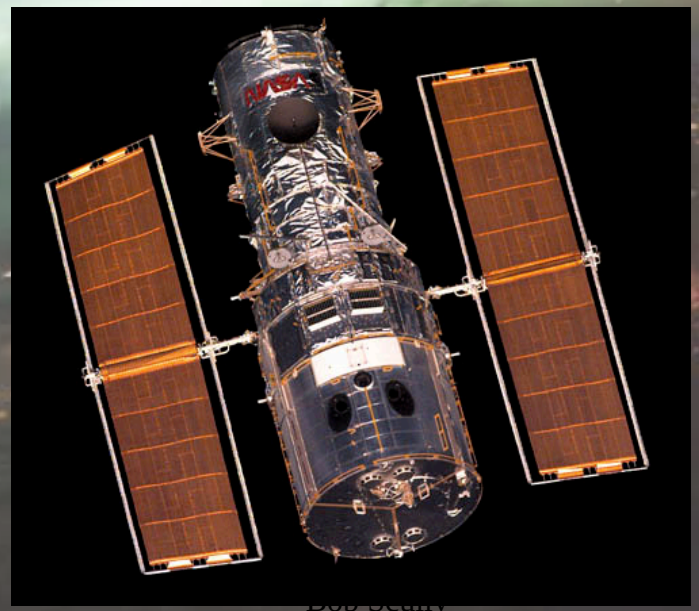
Shortly after Hubble was deployed in 1990, the observatory's primary mirror was discovered to have a flaw that affected the clarity of the telescope's early images. Astronauts repaired Hubble in December 1993. Including that trip, there have been five astronaut servicing missions to Hubble. The first servicing mission occurred Dec. 2-13, 1993. Subsequent servicing missions occurred on Feb. 11-21, 1997; Dec.19-27, 1999; March 1-12, 2002; and May 11-24, 2009.

A Closer Look at Hubble

NASA named the world's first space-based optical telescope after American astronomer Edwin P. Hubble (1889—1953). Dr. Hubble confirmed an expanding universe, thus providing the foundation for the Big Bang theory.

Missions
Launch: April 24, 1990 from space shuttle Discovery (STS-31)
Deployment: April 25, 1990
Servicing Mission 1: December 1993
Servicing Mission 2: February 1997
Servicing Mission 3A: December 1999
Servicing Mission 3B: February 2002
Servicing Mission 4: May 2009





Size
Length: 43.5 ft (13.2 m)
Weight: 24,500 lb (11,110 kg)
Maximum Diameter: 14 ft (4.2 m)

Cost at Launch
$1.5 billion

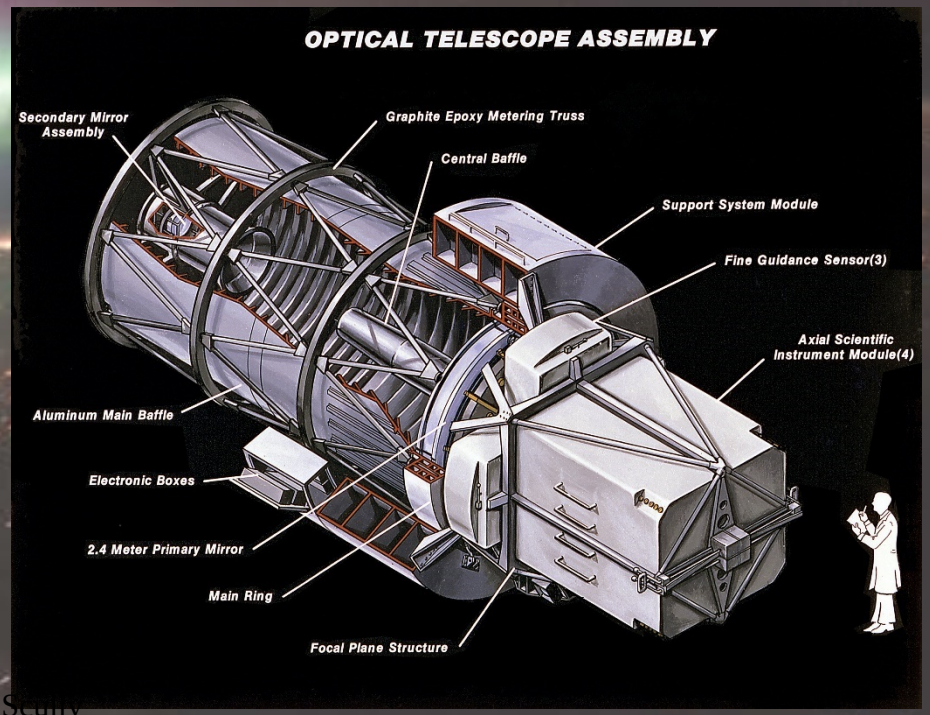
A Closer Look at Hubble

Hubble orbits at an altitude of 298 nautical miles (552 km, or 343 miles), inclined 28.5 degrees to the equator
Time to Complete One Orbit: 97 minutes
Speed: 17,500 mph (28,000 kph)

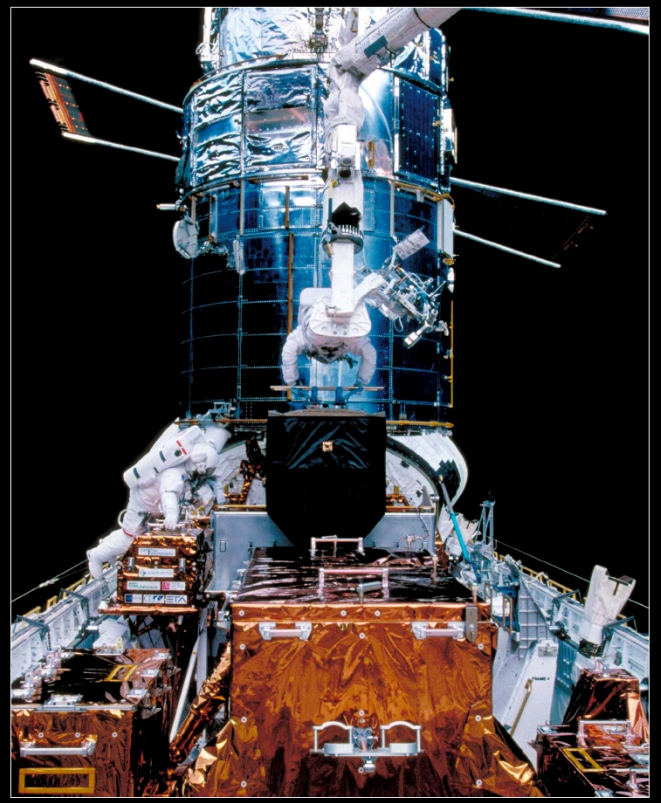
Optical Capabilities
In order to take images of distant, faint objects, Hubble must be extremely steady and accurate. The telescope is able to lock onto a target without deviating more than 7/1000th of an arcsecond, or about the width of a human hair seen at a distance of 1 mile.

Sensitivity to Light:
Ultraviolet through infrared (115—2500 nanometers)
First Image: May 20, 1990 - Star Cluster NGC 3532

Hubble's Mirrors
Primary Mirror Diameter: 94.5 in (2.4 m)
Primary Mirror Weight: 1,825 lb (828 kg)
Secondary Mirror Diameter: 12 in (0.3 m)
Secondary Mirror Weight: 27.4 lb (12.3 kg)



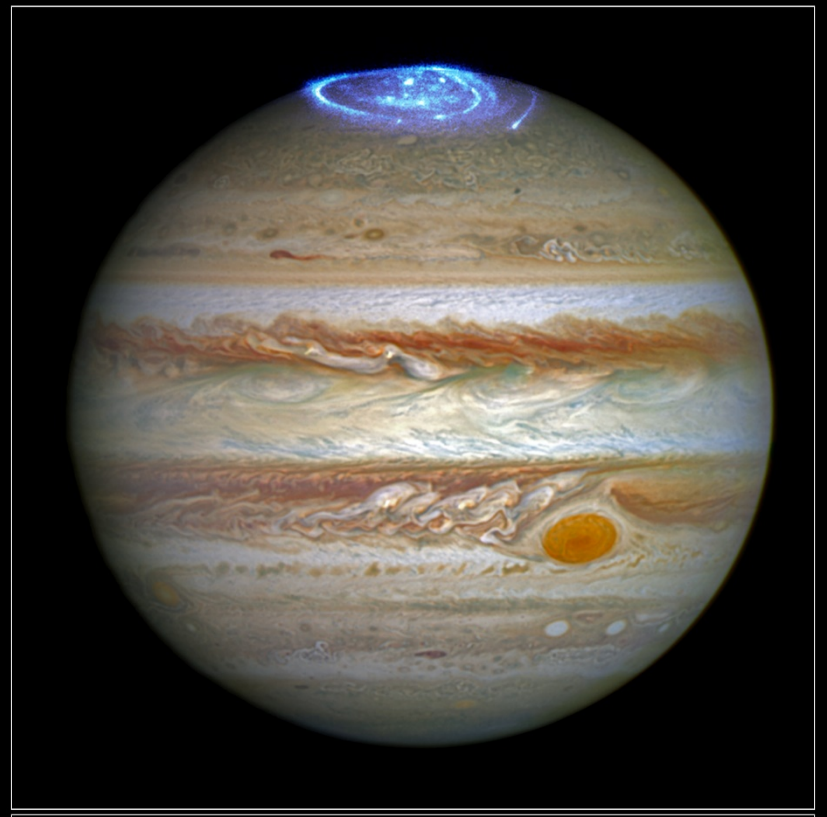
A Closer Look at Hubble



Giving Guidance: Replacing the Fine Guidance Sensors
Image Credit: NASA, 1997

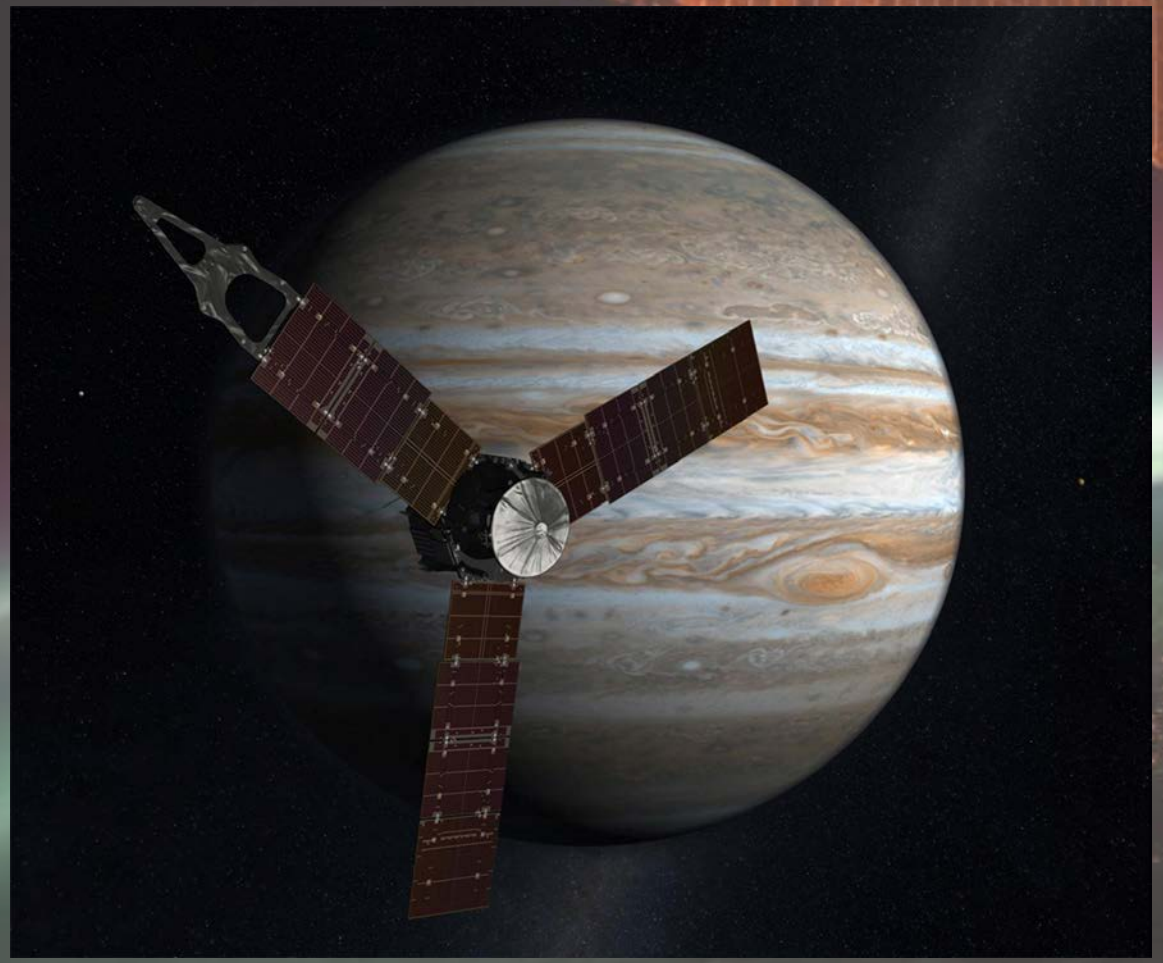


Grappling Hubble
Image Credit: NASA, 2009



Jupiter and Aurora
Hubble Space Telescope ▪ WFC3/UVIS ▪ STIS
NASA, ESA, and J. Nichols (University of Leicester) STScI-PRC16-24a

A Recent 4th of July Event

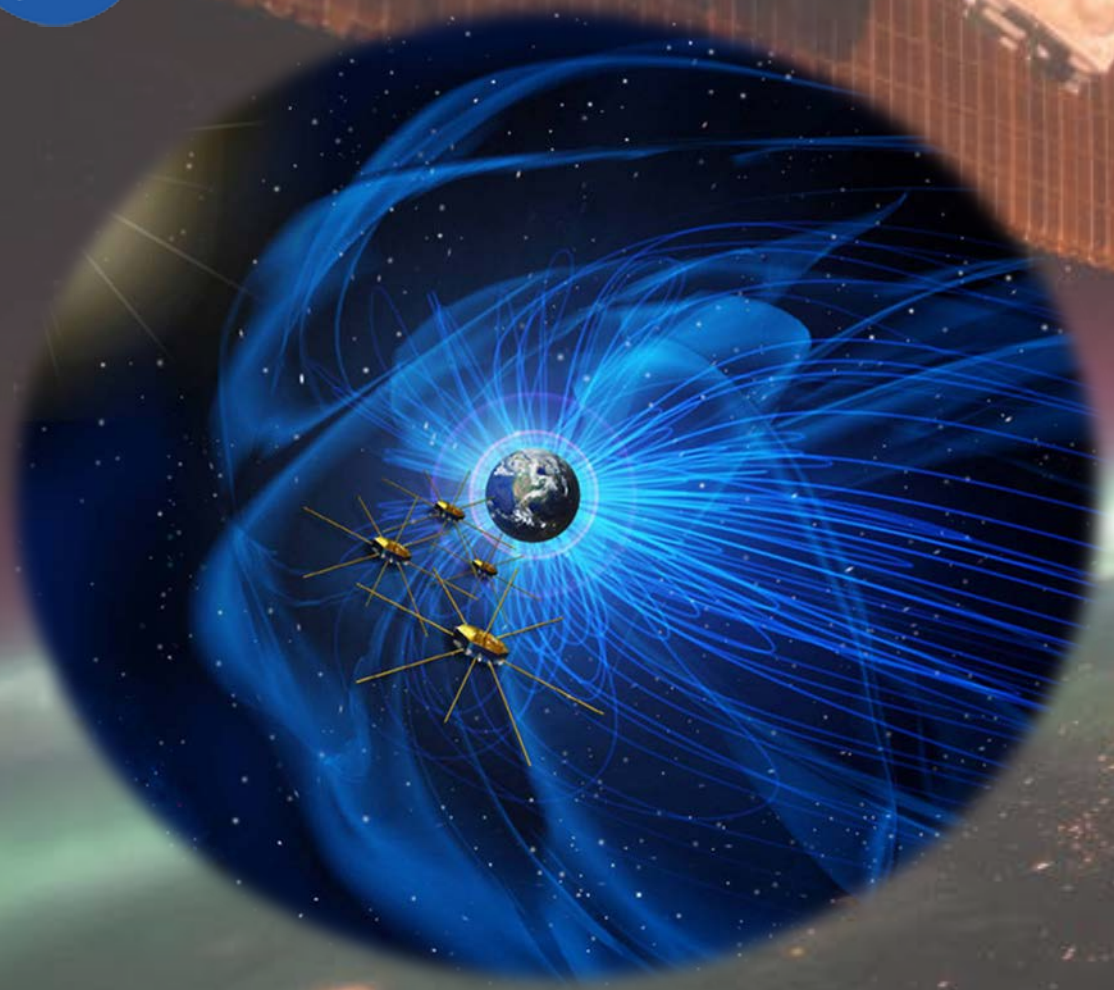


NASA's Juno Spacecraft in Orbit Around Mighty Jupiter

The Juno spacecraft launched on Aug. 5, 2011 from Cape Canaveral Air Force Station in Florida. After an almost five-year journey to the solar system's largest planet, NASA's Juno spacecraft successfully entered Jupiter's orbit at 8:53 p.m. PDT (11:53 p.m. EDT) Monday, July 4 during a 35-minute engine burn.

"Independence Day always is something to celebrate, but today we can add to America's birthday another reason to cheer -- Juno is at Jupiter," said NASA administrator Charlie Bolden. "And what is more American than a NASA mission going boldly where no spacecraft has gone before? With Juno, we will investigate the unknowns of Jupiter's massive radiation belts to delve deep into not only the planet's interior, but into how Jupiter was born and how our entire solar system evolved."

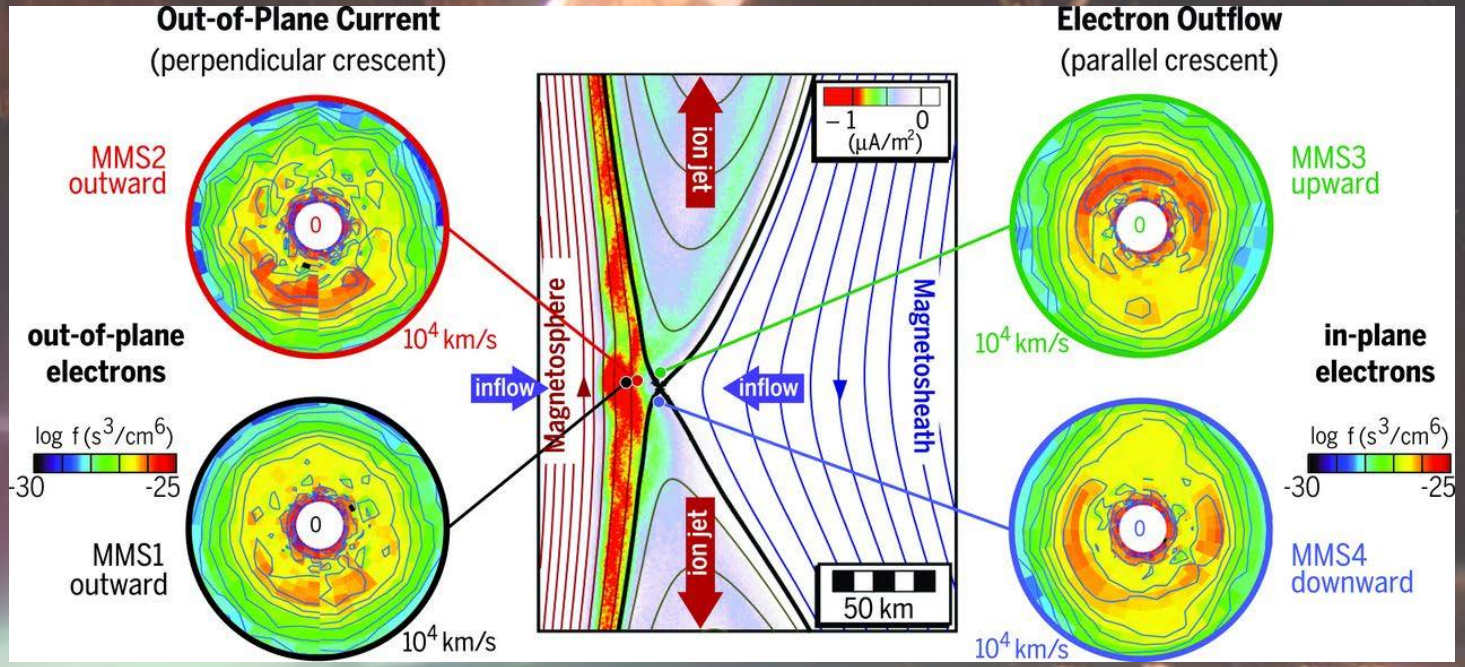
Magnetospheric MultiScale (MMS)



To advance understanding of magnetic reconnection with a definitive experiment in space, NASA developed and launched the Magnetospheric Multiscale (MMS) mission in March 2015. Flying in a tightly controlled tetrahedral formation, the MMS spacecraft are able to sample the magnetopause, where the interplanetary and geomagnetic fields reconnect, and make detailed measurements of the plasma environment and the electric and magnetic fields in the reconnection region.

Because the reconnection dissipation region at the magnetopause is thin (a few kilometers) and moves rapidly back and forth across the spacecraft (10 to 100 km/s), high-resolution measurements are needed to capture the microphysics of reconnection. The most critical measurements are of the three-dimensional electron distributions, which must be made every 30 ms, or 100 times the fastest rate previously available.

Magnetospheric MultiScale (MMS)



Electron dynamics controls the reconnection between the terrestrial and solar magnetic fields. The process of magnetic reconnection has been a long-standing mystery. With fast particle measurements, NASA's Magnetospheric Multiscale (MMS) mission has measured how electron dynamics controls magnetic reconnection. The data in the circles show electrons with velocities from 0 to 104 km/s carrying current out of the page on the left side of the X-line and then flowing upward and downward along the reconnected magnetic field on the right side. The most intense fluxes are red and the least intense are blue. The plot in the center shows magnetic field lines and out-of-plane currents derived from a numerical plasma simulation using the parameters observed by MMS.

Magnetospheric MultiScale (MMS)

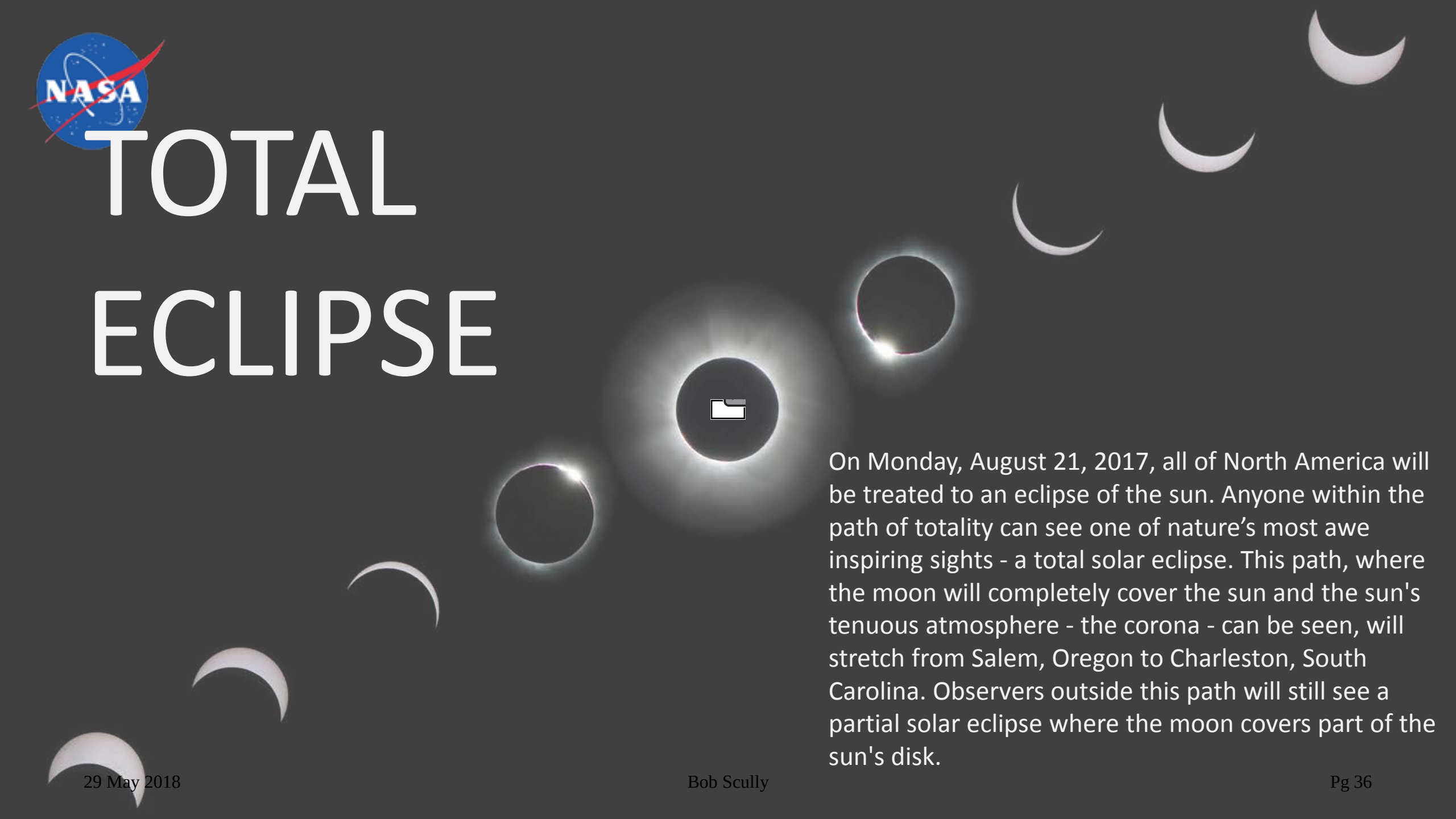
MMS has yielded insights into the microphysics underlying the reconnection between interplanetary and terrestrial magnetic fields. The persistence of the characteristic crescent shape in the electron distributions suggests that the kinetic processes causing magnetic field line reconnection are dominated by electron dynamics, which produces the electric fields and currents that dissipate magnetic energy. The primary evidence for this magnetic dissipation is the appearance of an electric field and a current that are parallel to one another and out of the plane of the figure. MMS has measured this electric field and current, and has identified the important role of electron dynamics in triggering magnetic reconnection.

The principal investigator and the MMS team have published a detailed technical report on the mission and these most recent results in the magazine Science. The article is titled “Electron-Scale Measurements of Magnetic Reconnection in Space”, and may be found at http://science.sciencemag.org/content/352/6290/aaf2939

J. L. Burch et alia, “Electron-Scale Measurements of Magnetic Reconnection in Space”, Science, 03 Jun 2016, Vol. 352, Issue 6290, DOI: 10.1126/science.aaf2939

Video at: https://www.youtube.com/watch?v=0vY4nDPrEKg

TOTAL ECLIPSE



On Monday, August 21, 2017, all of North America will be treated to an eclipse of the sun. Anyone within the path of totality can see one of nature’s most awe inspiring sights - a total solar eclipse. This path, where the moon will completely cover the sun and the sun's tenuous atmosphere - the corona - can be seen, will stretch from Salem, Oregon to Charleston, South Carolina. Observers outside this path will still see a partial solar eclipse where the moon covers part of the sun's disk.