National Aeronautics and Space Administration

Galileo School for Gifted Learning 5th Grade Science
February 2021

Tracy R. Gill
NASA/Kennedy Space Center
September 2020

My background

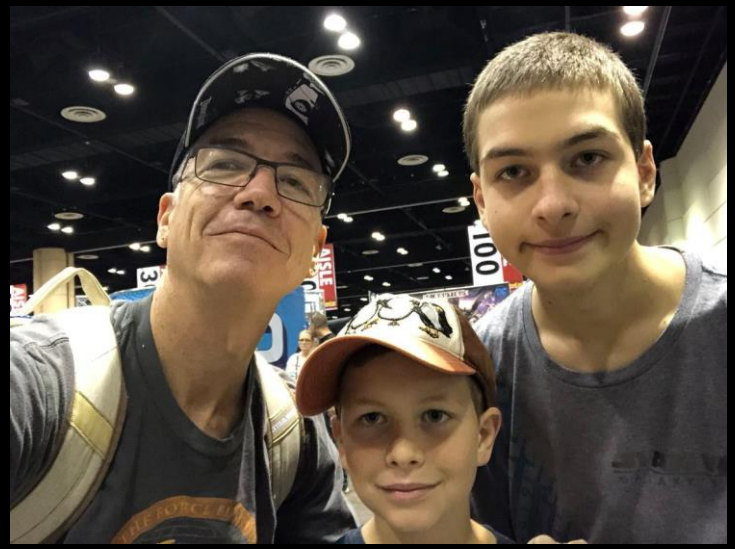
- Tracy holds a BS in Electrical Engineering (1989) and an MS in Aerospace and Mechanical Systems (2000) from the University of Florida, an MS in Space Systems from Florida Tech (1994), and is a graduate of the International Space University Space Studies Program in 2006.
- Tracy is a big sports fan following football and basketball and any team that represents the University of Florida. Tracy enjoys speaking to local schools on various topics in the space field and is an adjunct professor for the International Space University.

And as expected of someone in the space field, he is a fan of popular science fiction including Star Wars and Star Trek and participates in the occasional comic book or sci-fi convention.

Star Wars Celebration 2017

San Diego Comic Con 2016

D23 Expo 2017



Megacon Orlando 2018

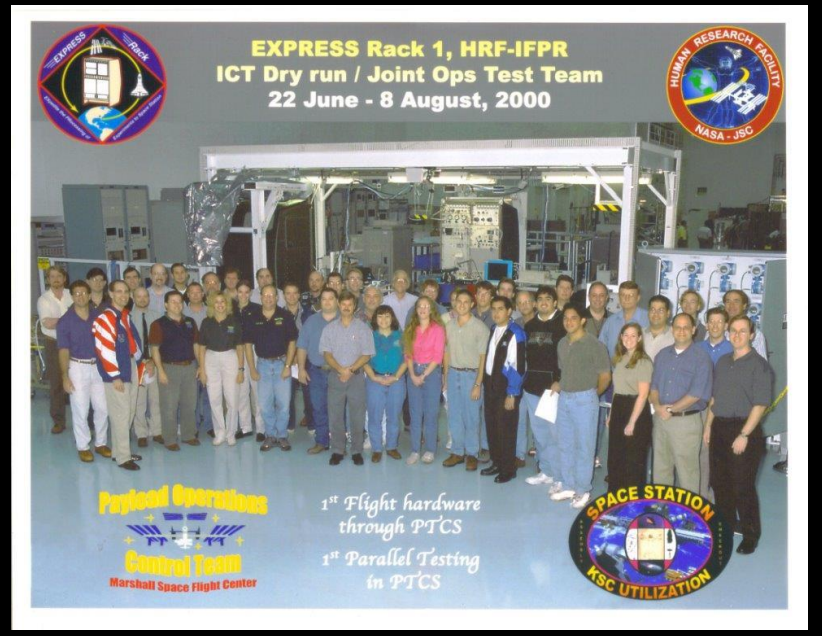
D23 Expo 2019

San Diego Comic Con 2018

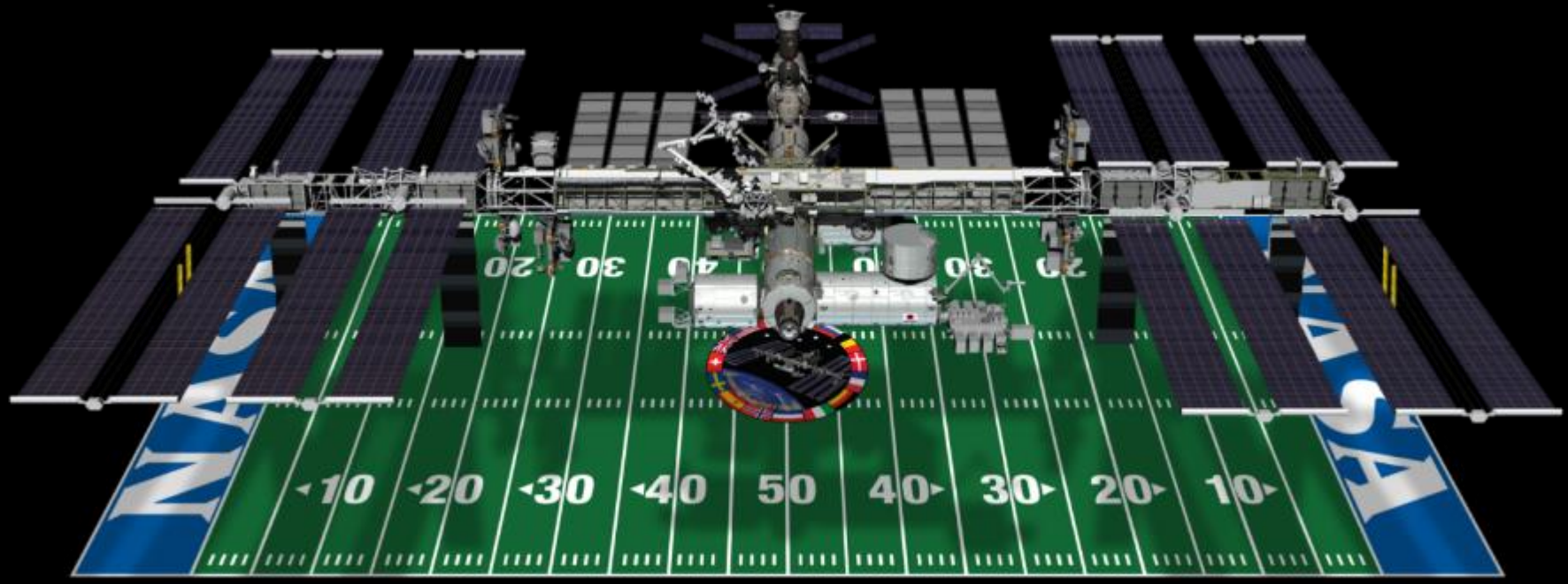
Galileo School connection

- Charter School Founder
- Michele G. Gill, PhD
- Gill was recognized for her dedication, advocacy and actions to transform public education through the application of psychological learning principles. In 2010, Gill designed and founded a free K-8 charter school in the high-poverty area of Midway in Sanford, Fla. based on cutting edge educational research. Currently Galileo School is one of the top performing schools in Seminole County and is known for its educational innovations, such as differentiation for all students, and student-selected “creative productivity” learning blocks. Gill continues to serve the school as chairperson of the Galileo School Board and chair of the Curriculum Committee.

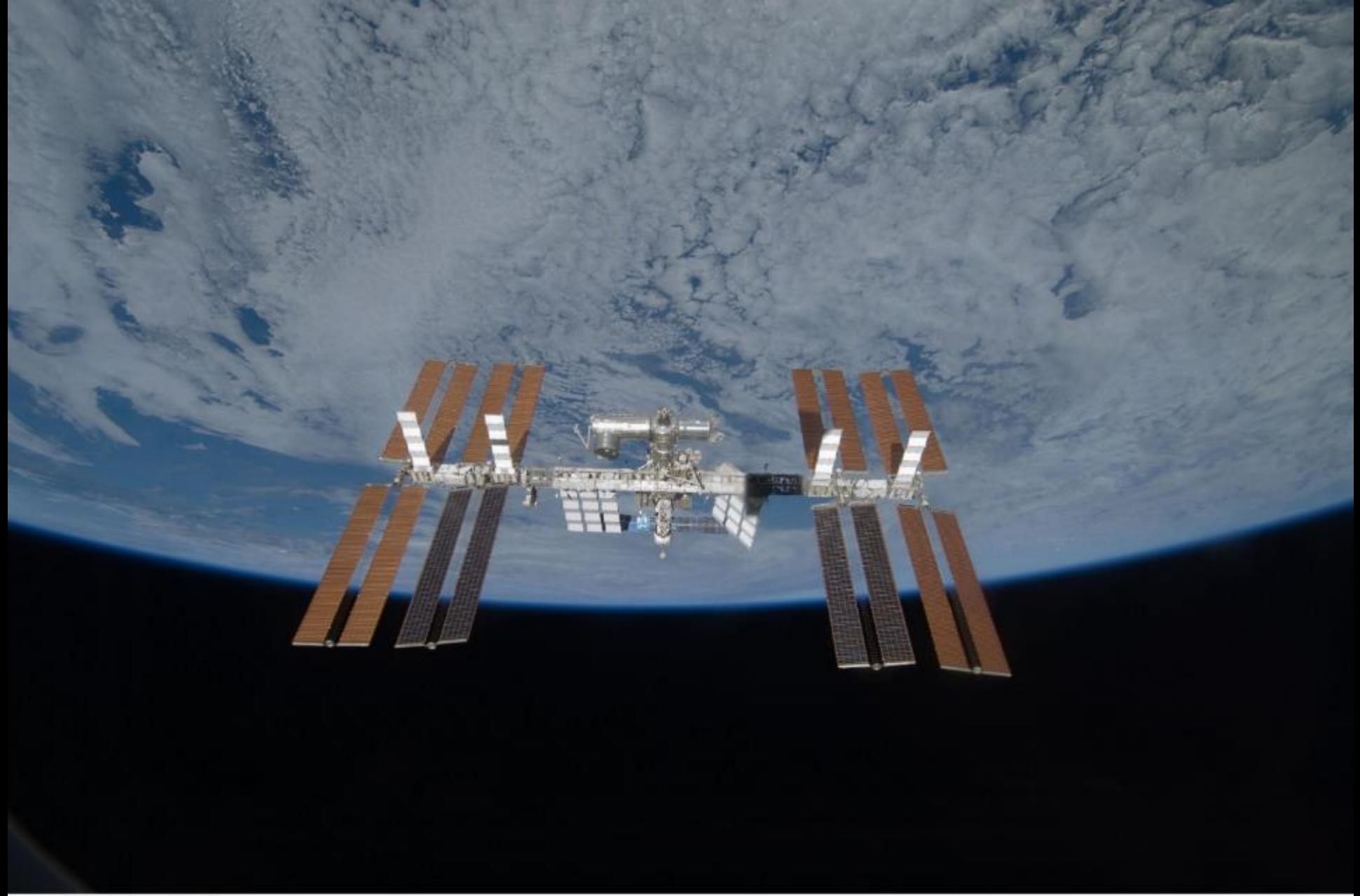
NASA "Action" Shots



INTERNATIONAL SPACE STATION (ISS)



- **Spacecraft Mass: +800,000 lb (+362,874 kg)**
- **Velocity: 17,500 mph (28,200 kph)**
- **Orbits: 16 times around the Earth/day (~every 90 minutes)**
- **Altitude: 220 miles above Earth**
- **Power: 80 kW continuous**



See the ISS pass overhead your area! - https://spotthestation.nasa.gov/

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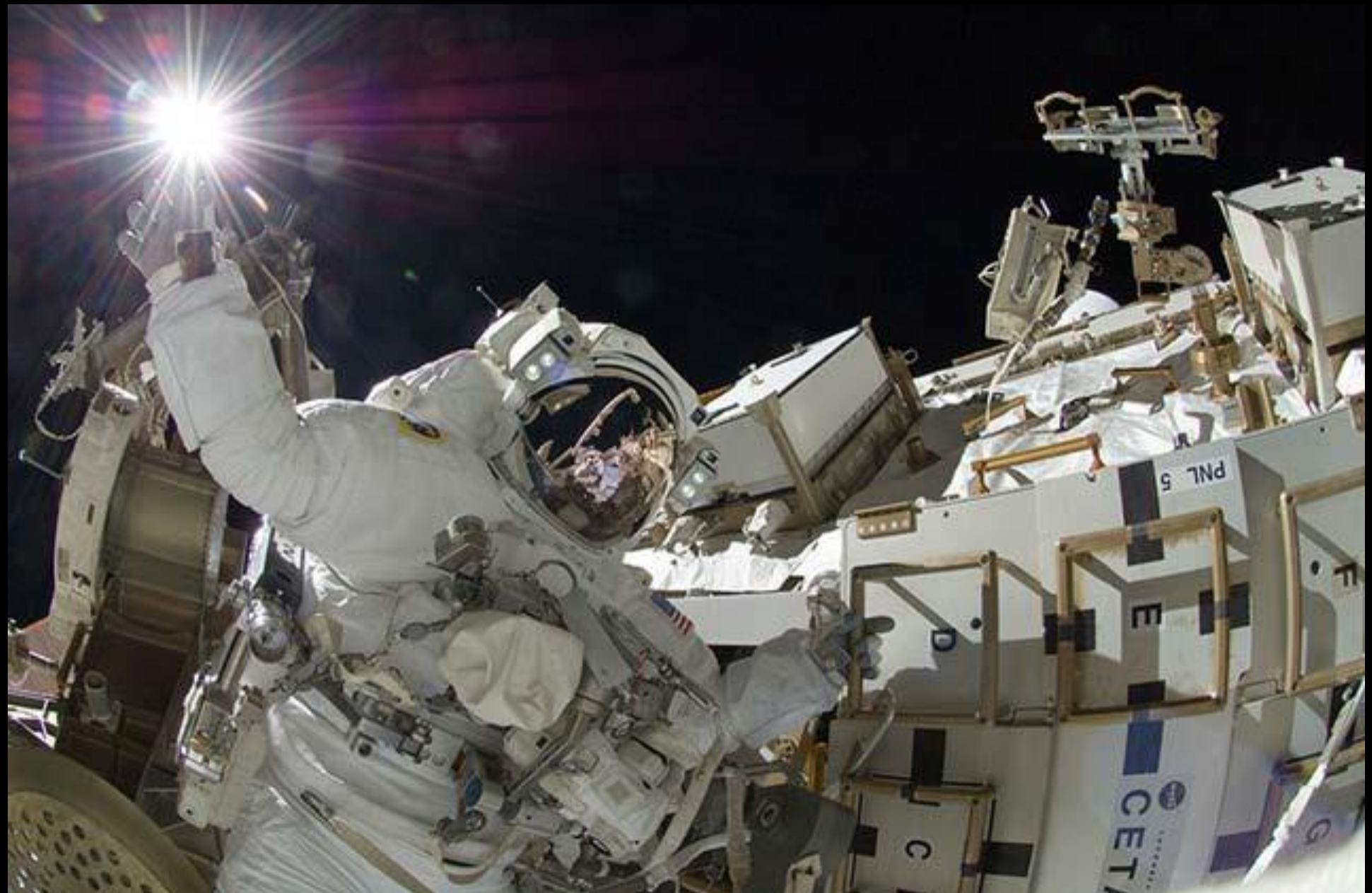
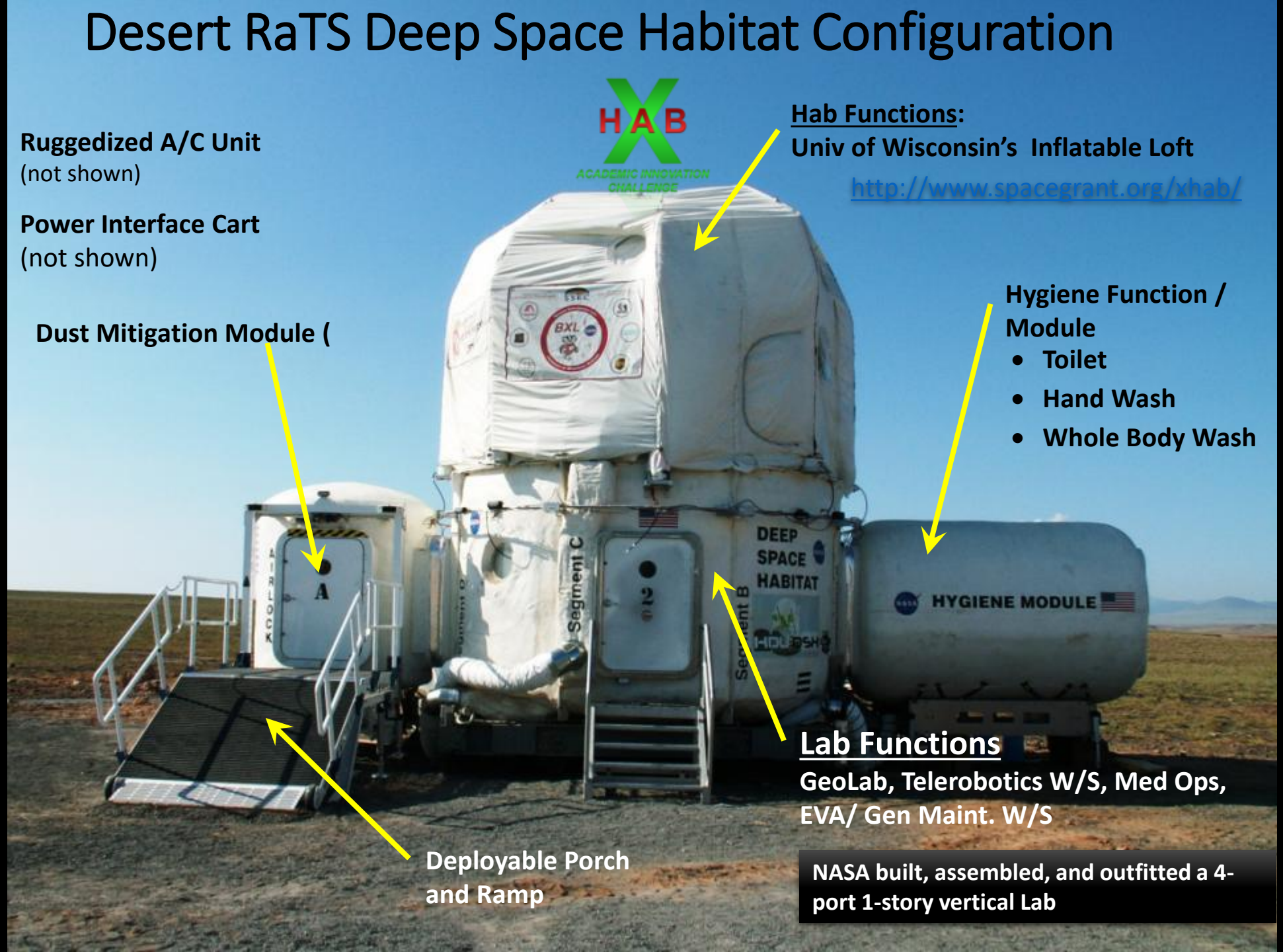
Living and doing vital research in a national laboratory



Analogs

- Why do we use Analog Missions?
- Analog missions prepare us for near-future exploration to the Moon and Mars. Analogs play a significant role in problem solving for spaceflight research.
  - Not all experiments can be done in space – there is not enough time, money, equipment, and manpower.
  - Ground-based analog studies are completed more quickly and less expensively. For example
    - Deserts for Moon and Mars
    - Underwater for simulating microgravity
    - Isolation facilities for long duration missions

Desert RaTS Deep Space Habitat Configuration



Ruggedized A/C Unit
(not shown)

Power Interface Cart
(not shown)

Dust Mitigation Module (

Hab Functions:
Univ of Wisconsin's Inflatable Loft
http://www.spacegrant.org/xhab/

Hygiene Function / Module
- **Toilet**
- **Hand Wash**
- **Whole Body Wash**

Lab Functions
GeoLab, Telerobotics W/S, Med Ops, EVA/ Gen Maint. W/S

Deployable Porch and Ramp

NASA built, assembled, and outfitted a 4-port 1-story vertical Lab

Deep Space Habitats

Habitat Demonstration Unit (2011-2013)

Multi-Purpose Logistics Module: Donatello – to be used in NextSTEP Habitat project

HDU Lab deck

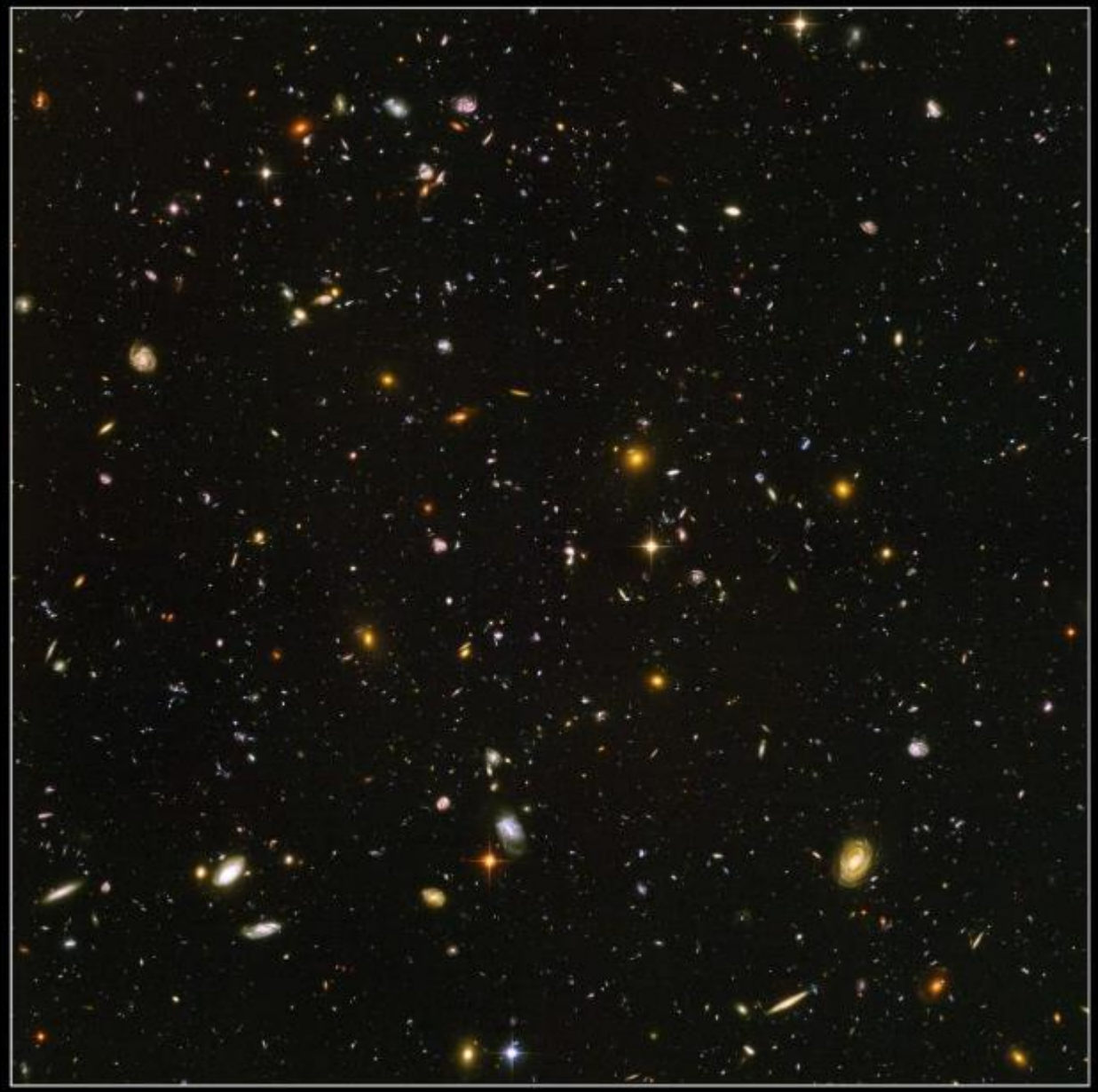
Dust Module

X-Hab Inflatable Loft

Hygiene Module

S109E5660

Hubble Space Telescope
Deepest Views of the Early Universe



This “Deep Field” view of nearly 10,000 galaxies is the deepest visible-light image of the cosmos.

The smallest, reddest galaxies, about 100, may be among the most distant known, existingwhen the universe was just 800 million years old.

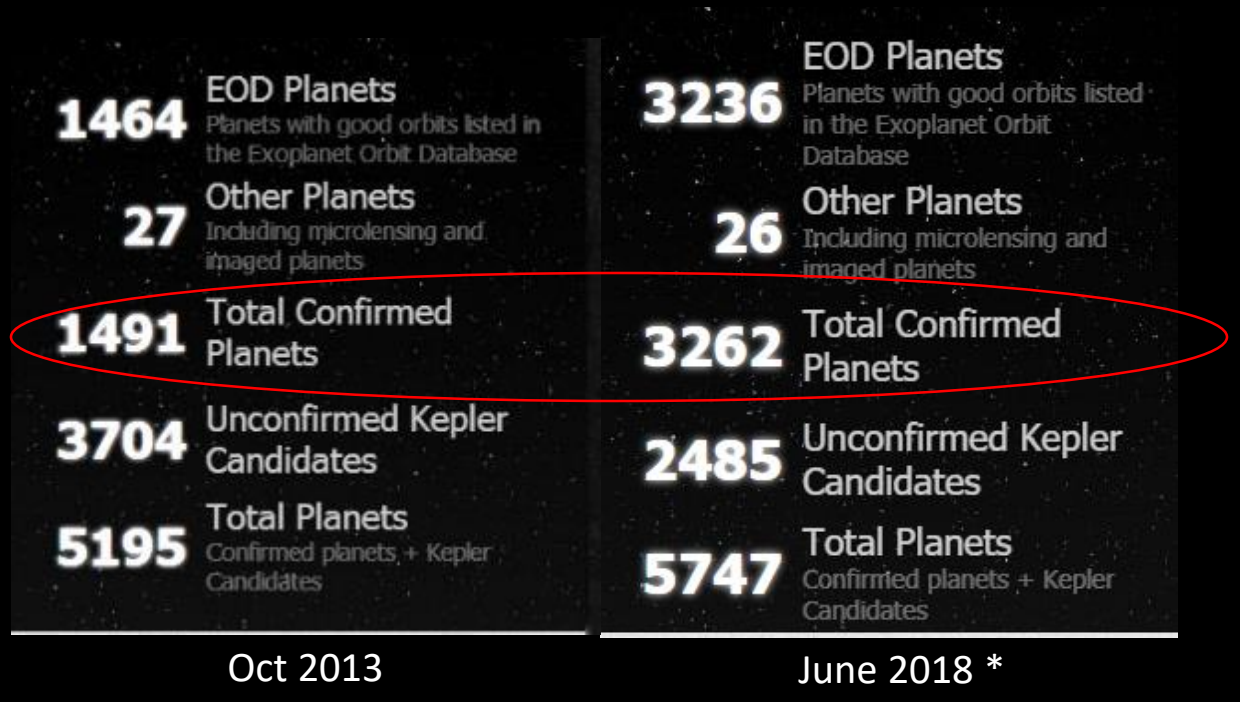
The nearest galaxies - the larger, brighter, well-defined spirals and ellipticals - thrived about 1 billion years ago, when the cosmos was 13 billion years old.

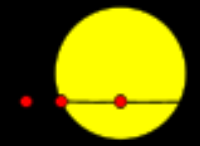
Peering into the Ultra Deep Field is like looking through an eight-foot-long soda straw.

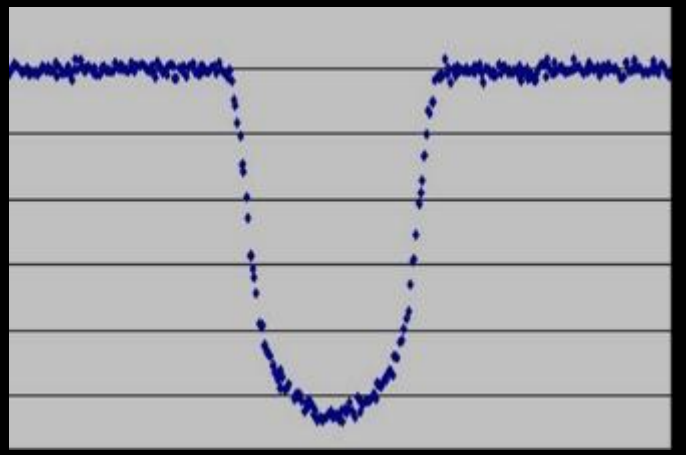
The image required 800 exposures taken over the course of 400 Hubble orbits around Earth.

Exoplanets

Transit method of detecting extrasolar planets. The graph below the picture demonstrates the light levels received over time by Earth. This method takes months to years of observations.





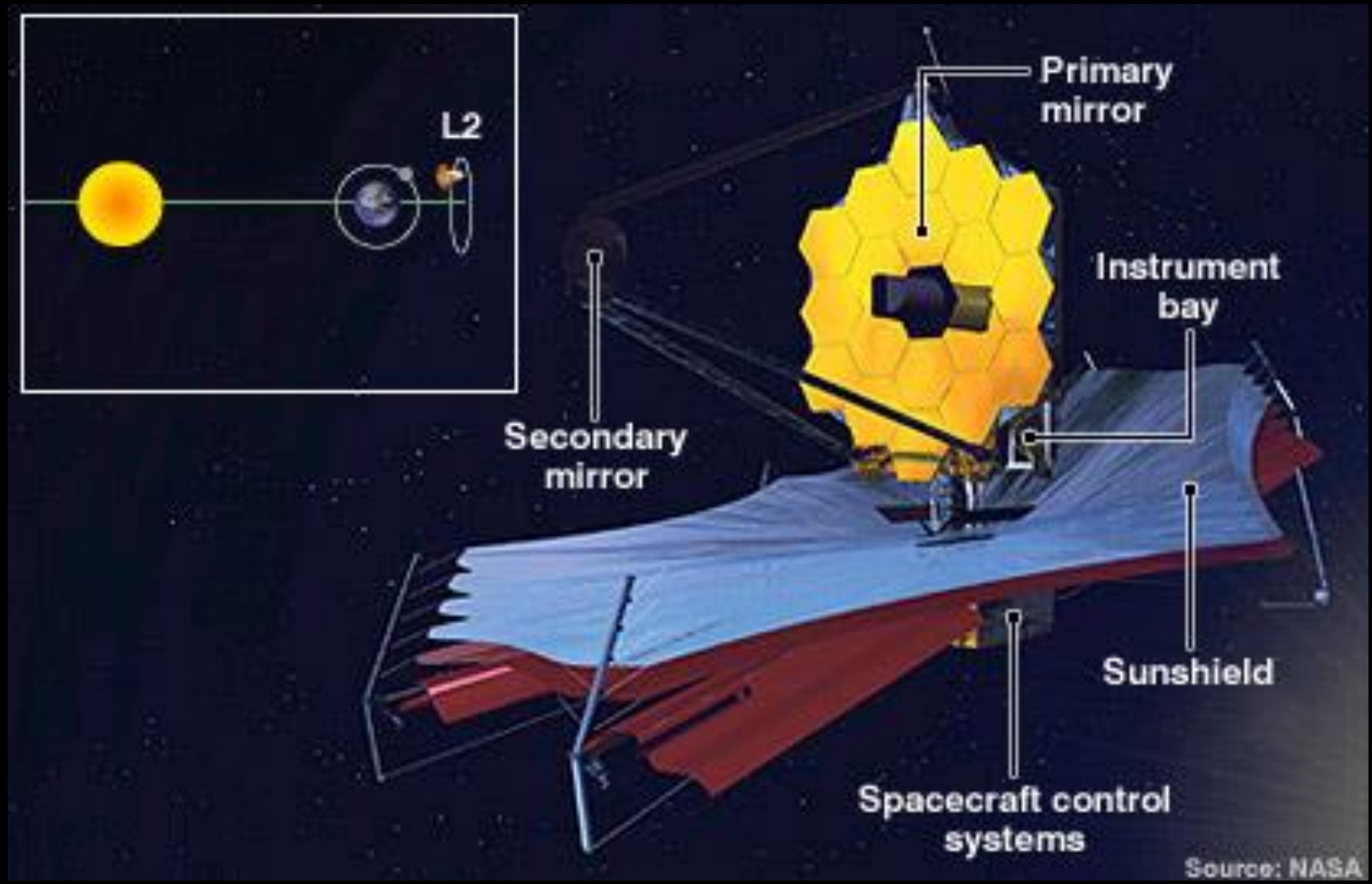


We can only do this with stars in the Milky Way. Estimate 100 Billion stars in Milky Way and average of more than one planet per star from Kepler telescope data

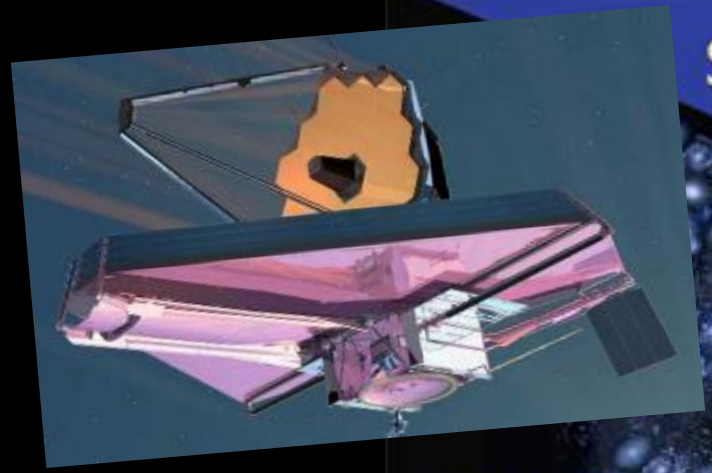
* Last update - see exoplanets.org for other references
"This research has made use of the Exoplanet Orbit Database and the Exoplanet Data Explorer at exoplanets.org."

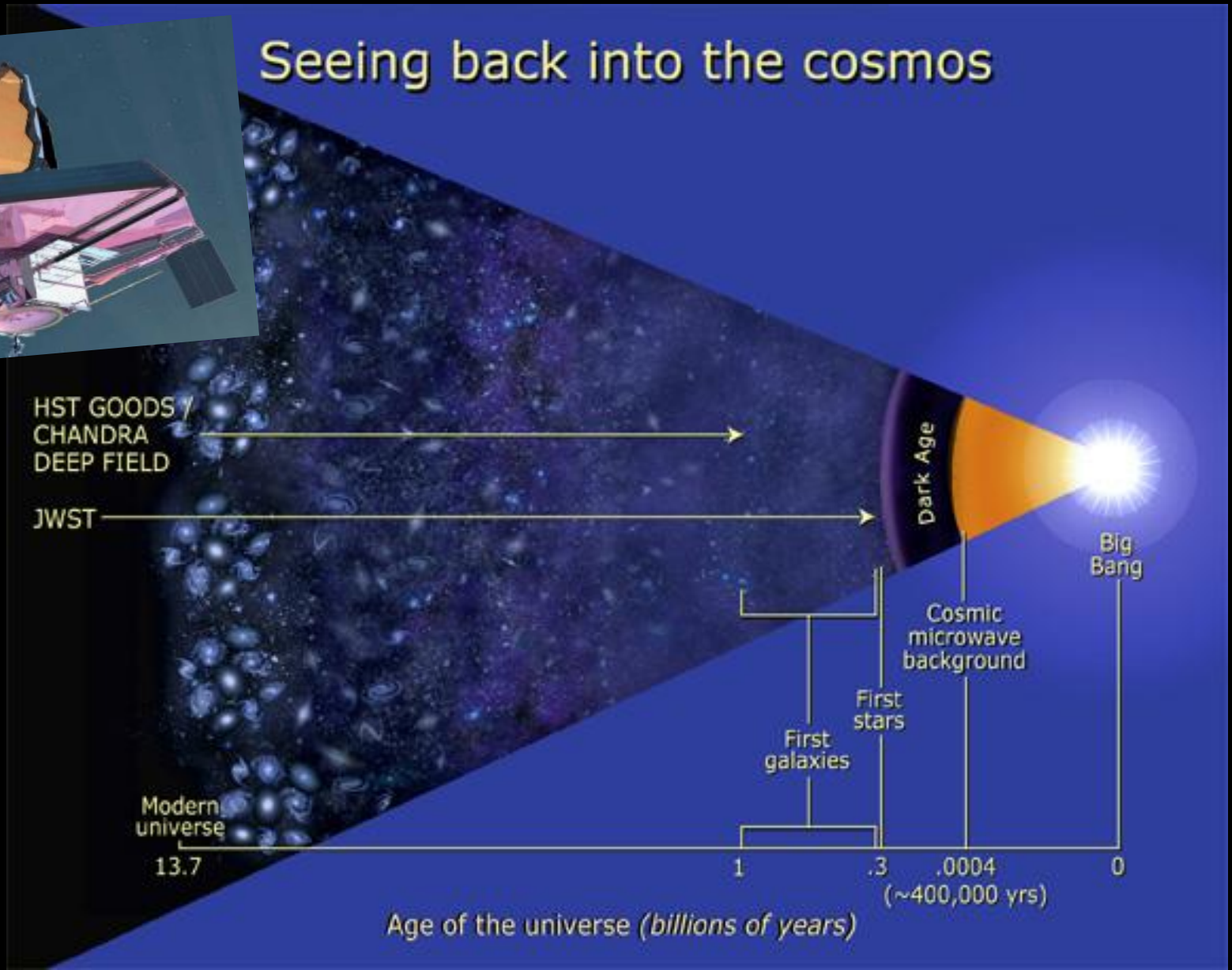
James Webb Space Telescope

- The successor to the Hubble Space Telescope
- Scheduled for launch in October 2021
- JWST will study every phase in the history of our Universe, from the first luminous glows after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own Solar System.


L2
Primary mirror
Instrument bay
Secondary mirror
Sunshield
Spacecraft control systems
Source: NASA

JAMES WEBB SPACE TELESCOPE (JWST)





Moon Before Mars

On the Moon, we can take reasonable risks while astronauts are just three days away from home.

There we will prove technologies and mature systems necessary to live and work on another world before embarking on what could be a 2-3 year mission to Mars.

The Artemis Program

Artemis is the twin sister of Apollo and goddess of the Moon in Greek mythology. Now, she personifies our path to the Moon as the name of NASA's program to return astronauts to the lunar surface by 2024.

When they land, Artemis astronauts will step foot where no human has ever been before: the Moon's South Pole.

With the horizon goal of sending humans to Mars, Artemis begins the next era of exploration.

NextSTEP Appendix A – Habitation Contract Phases

NextSTEP Phase 1: 2015-2016

Cislunar habitation concepts that leverage commercialization plans for LEO


LOCKHEED MARTIN


BIGELOW AEROSPACE


ORBITAL ATK


BOEING

FOUR SIGNIFICANTLY DIFFERENT CONCEPTS RECEIVED

Partners develop required deliverables, including concept descriptions with concept of operations, NextSTEP Phase 2 proposals, and statements of work.

NextSTEP Phase 2: 2016-2019

- Partners refine concepts and develop ground prototypes.
- NASA leads standards and common interfaces development.


BIGELOW AEROSPACE


BOEING


LOCKHEED MARTIN


SIERRA NEVADA CORPORATION


NORTHROP GRUMMAN

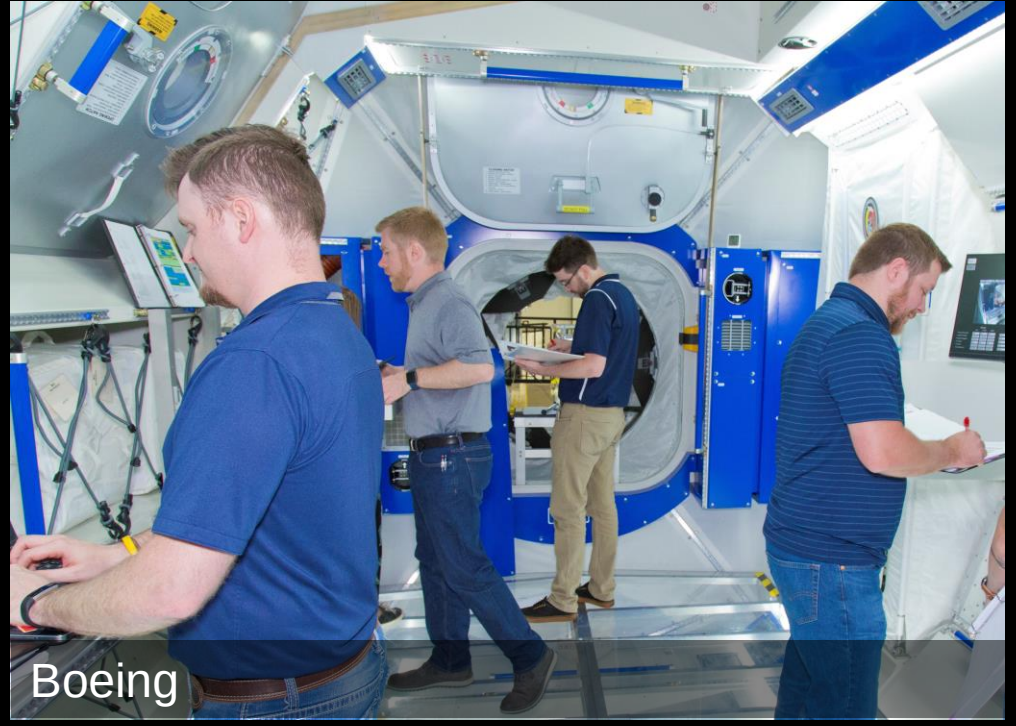

NANORACKS

NASA defines reference habitat architecture in preparation for Phase 3.

NextSTEP Phase 3: 2019-2021

- Continued Habitation Development -> Bigelow, Boeing, Lockheed Martin, Sierra Nevada Corp
  - Further mature Gateway Habitation Module requirements and system definition
  - Additional habitat ground prototype development and/or other risk reduction activities that address key risk areas.
  - Extensibility studies to assess use of Gateway habitat concept(s) and technologies for lunar surface and Mars transport habitat applications.
- Results available to feed forward for future habitation application(s).


Lockheed Martin


Boeing


Northrop Grumman


Sierra Nevada Corporation

Bigelow Aerospace

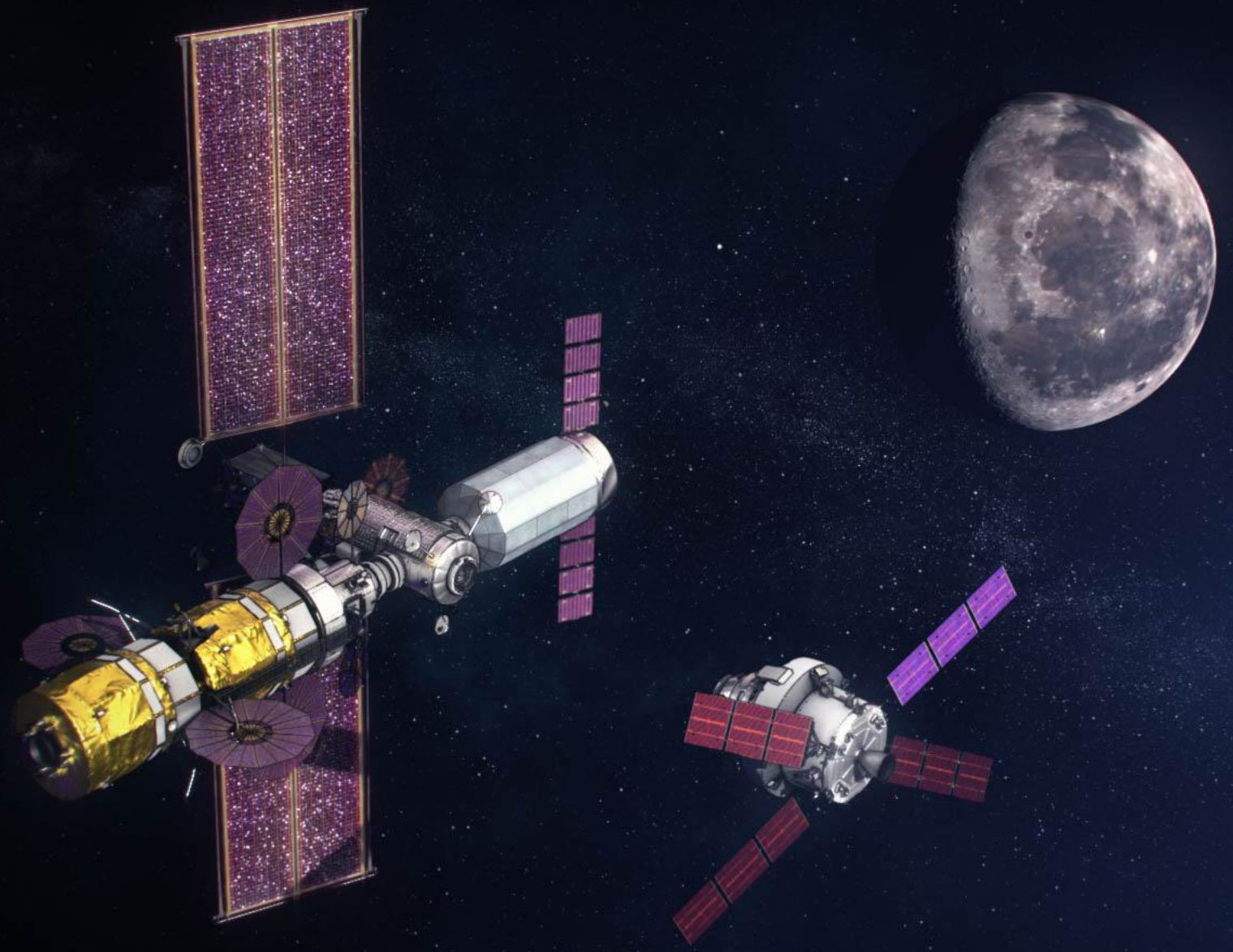
Gateway

Today through 2024

Missions and systems required to achieve landing humans on the surface of the Moon in 2024

Sustainability by 2028

Establish a sustainable long-term presence on and around the Moon



Power and Propulsion Element

- **Power** – 60 kW+ provided by Roll Out Solar Array (ROSA) and Maxar's 1300 commercial power subsystem
- **Propulsion** – Leverage NASA development of 12.5 kW Electric Propulsion (EP), and internal Maxar advanced EP development, with Maxar expertise in system accommodation of EP elements
- **Communications** – Ka-band, X-band
- **Guidance Navigation and Control**
- **Gateway Interface Support** –docked components, visiting vehicles, robotics, science payloads, Human Landing System
- **Payload Transfer** – 1000kg for lunar lander or science instruments

Gateway HALO

(Habitation and Logistics Outpost)

- Contract issued to Northrop Grumman
- Minimum capability necessary to support a lunar mission, with significant reliance on Orion life support and crew systems

Gateway Logistics Services (GLS)

SPACEX

- SpaceX selected as the first U.S. commercial provider under the Gateway Logistics Services contract to deliver cargo, experiments and other supplies to the agency's Gateway in lunar orbit

- Multiple supply missions planned in which the cargo spacecraft will stay at the Gateway for six to 12 months at a time
  - 5 MT delivered cargo capability
  - Power to internal and external payloads
  - Trash removal
  - Automated RPOD (docking/undocking)

- Firm-fixed price, indefinite delivery/indefinite quantity contract
  - Guaranteed two missions per logistics services provider with a maximum total value of $7 billion across all contracts as additional missions are needed

Companies Selected to Develop Human Landers for Artemis Moon Missions

Awards announced April 30, 2020

CBR - Certification Baseline Reviews, ATP+3 months – August 2020

- Baseline updated requirements, standards, interfaces
- Finalize guidance and evaluation criteria for adjusted Option A proposals

CR - Continuation Reviews, ATP+7 months – December 2020

- Contractors submit adjusted proposals (evaluation and down-select by ATP+9 months

- Blue Origin– a three-stage lander to be launched on commercial launch vehicles
- Dynetics – a single structure providing the ascent and descent capabilities that will launch using the ULA Vulcan launch system.
- SpaceX is developing the Starship – a fully integrated lander that will use the SpaceX Super Heavy rocket.

Surface Suit

Exploration Extravehicular Mobility Unit (xEMU)

- In-house build for 2024 expedition
- Testing component and full suit on ISS through 2023
- RFI issued Oct. 4 seeking industry input on transitioning production line to private sector for 2025 and beyond

Moon Hoax? – No way!

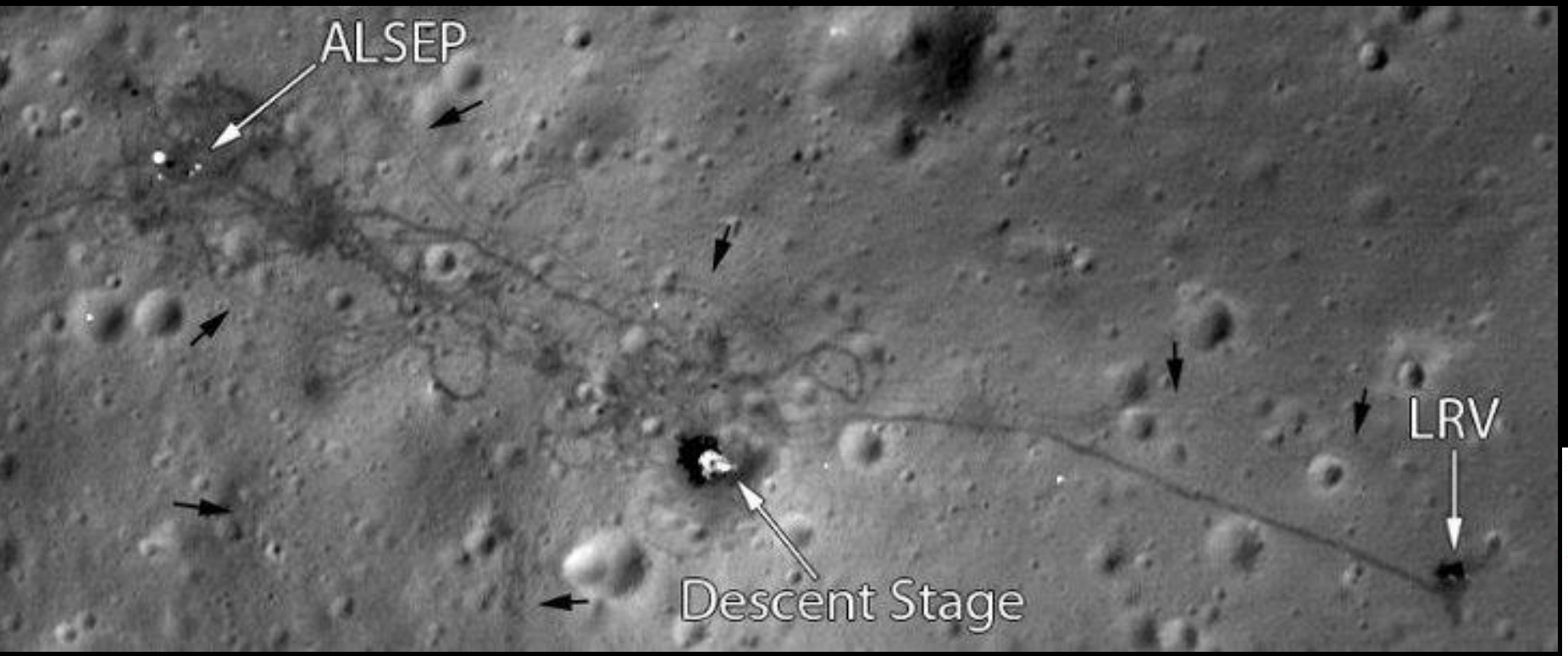
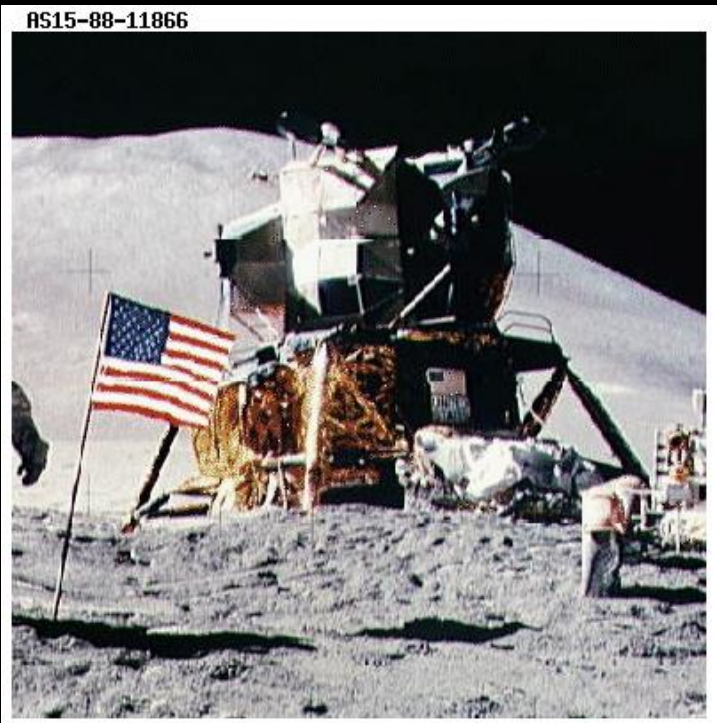
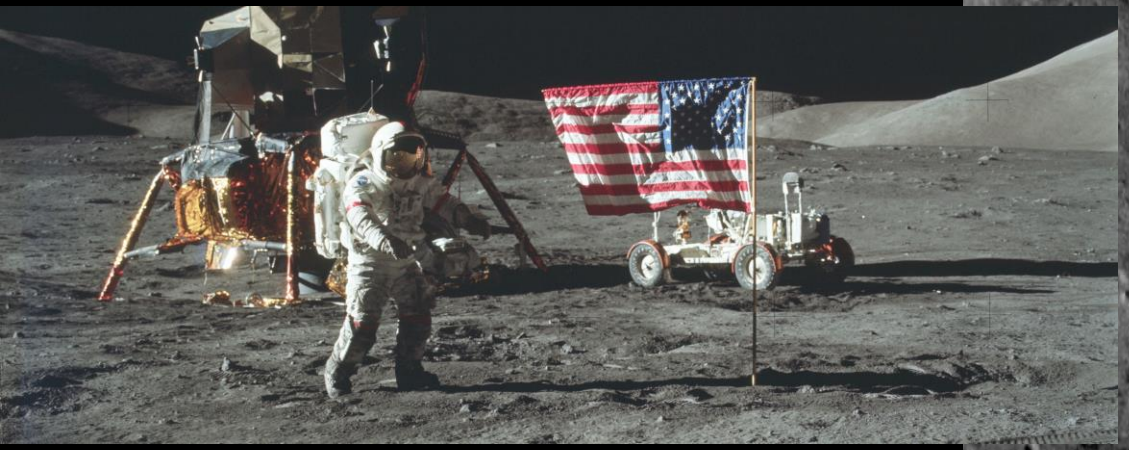


Image of the Apollo 15 landing site from the Lunar Reconnaissance Orbiter

Apollo 15 image from the lunar surface





Apollo 17 Landing Site
LROC NAC M168000580LR
Low Periapse orbit

100 meters

ALSEP Equipment

Challenger Descent Stage

Geophone Rock

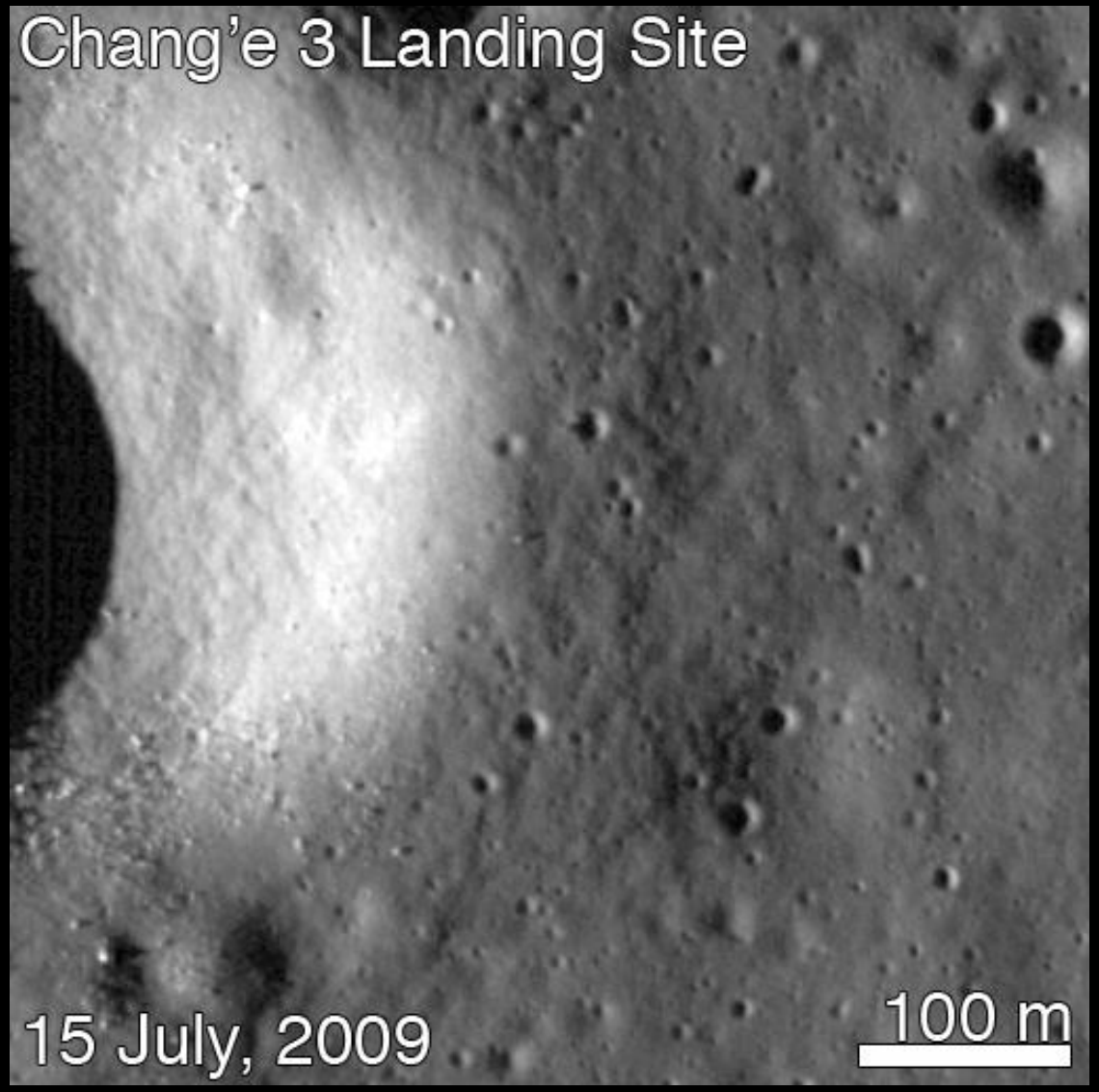
LRV

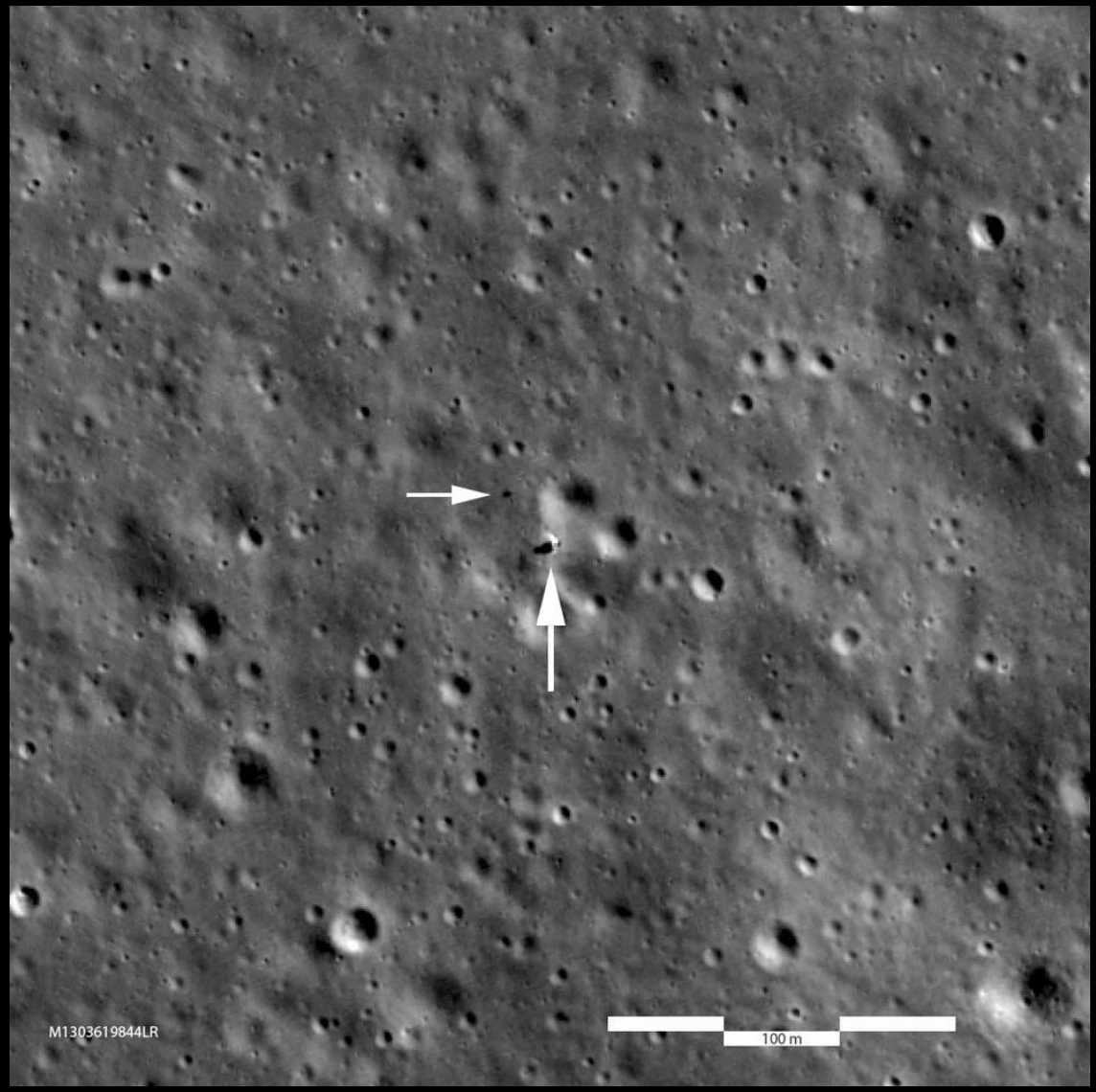
Challenger 3x Enlargement

December 11
1972

Apollo 17
landing Site

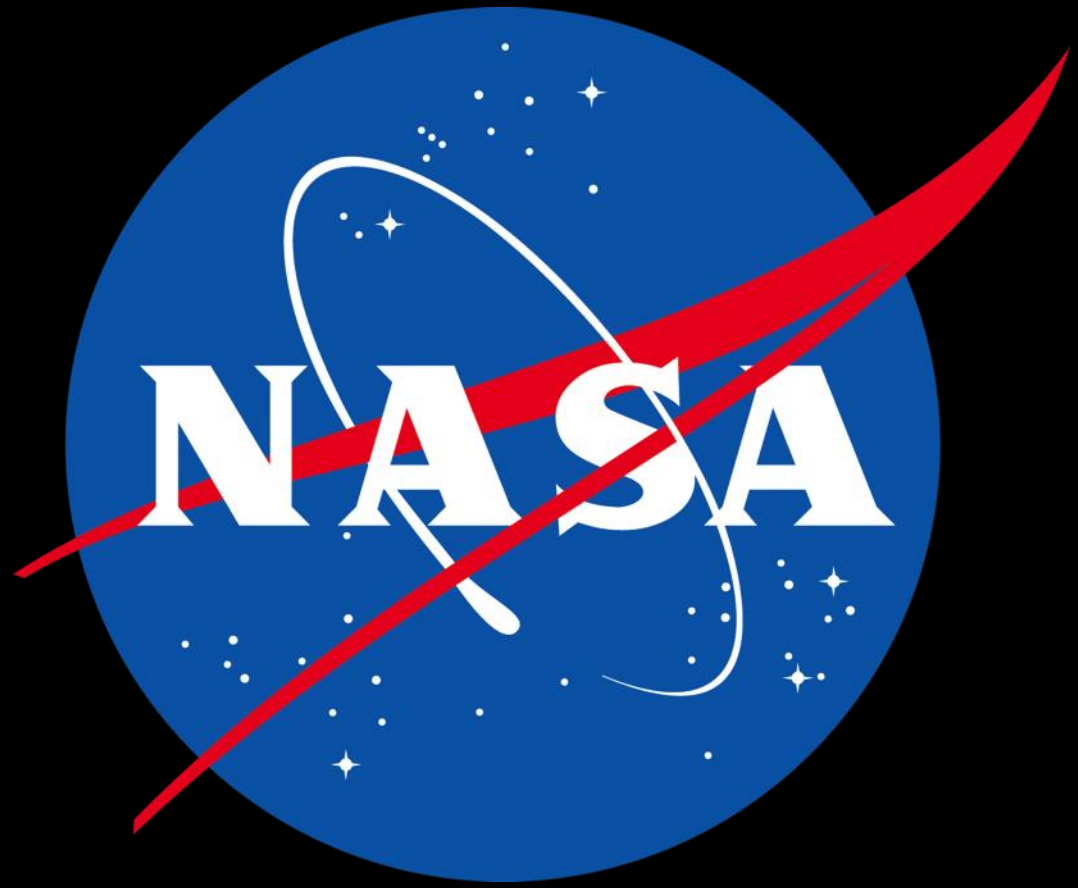
Chang’e 4 – Feb 1, 2019





NASA Opportunities

- *60% of the jobs are Professional, Engineering, and Scientific –* **Aerospace Engineer**
- *24% are Administrative and Management –* **Public Affairs Specialist**
- *9% are Technical and Medical Support –* **Electronics Technician**
- *7% are Clerical and Administrative Support –* **Procurement Clerk**
- *Less than 1% are Trades and Labor -* **High Voltage Electrician**



Questions?

References

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- *NASA Outlines Lunar Surface Sustainability Concept*, (Sept 2020).
- Han, Eunkyu; Wang, Sharon X.; Wright, Jason T.; Feng, Y. Katherina; Zhao, Ming; Fakhouri, Onsi; Brown, Jacob I.; Hancock, Colin. *Exoplanet Orbit Database. II. Updates to Exoplanets.org*. Publications of the Astronomical Society of the Pacific, Volume 126, Issue 943, pp. 827 (2014).