SUNDAY, JULY 19 2020

SPACE DAY

Celebrating the innovations and technology that will bring us back to the moon... and beyond.

AMERICAN PRECISION MUSEUM

196 Main St
Windsor, VT 05089
www.**americanprecision.**org
802-674-5781

Why does the American Precision Museum celebrate Space Day?

- **Innovation.** We celebrate innovation and ingenuity here, and new ways to solve problems (like creating machine tools to improve precision). As air and space programs create new and better technology and make new discoveries, we all benefit.
- **Jobs**. Space and Air programs invest billions of dollars in the US economy, and create millions of jobs in manufacturing related fields.
- **Precision history.** As we look back to the past at APM, we also like to show you the present and imagine the future. What NASA, Space-X and Boeing are able to do would not be possible without precision manufacturing.

From these perspectives, we'd like to share with you some of NASA's most cutting edge missions and some of the technology being used to make them happen. This packet includes freely available images from NASA's galleries - specifically what a person who appreciates precision might find interesting.

TABLE OF CONTENTS:

Innovation & Business

Commercial Crew: SpaceX

COMMERCIAL CREW PROGRAM - Space-X and Boeing are working on partnership with NASA to supply the ISS. The goal is to have safe, reliable and cost-effective access to and from the International Space Station and foster commercial access to other potential low-Earth orbit destinations.

NASA selected Boeing and SpaceX in September 2014 to transport crew to the International Space Station from the United States. These integrated spacecraft, rockets and associated systems will carry up to four astronauts on NASA missions, maintaining a space station crew of seven to maximize time dedicated to scientific research on the orbiting laboratory. Launches are ongoing - SpaceX's Dragon has had 22 trips to the ISS so far.

Artemis Mission

The **ARTEMIS MISSION** to return to the moon is being built and tested at sites across the nation, and scheduled to launch in 2024. "We will build sustainable elements on and around the Moon that allow our robots and astronauts to explore more and conduct more science than ever before."

- **Overview**
- **Orion**
- **xEMU Suit**
- **SLS**

Mars Rover Perserverance

The **MARS ROVER PERSERVERANCE** (and its helicopter Ingenuity) is scheduled to launch for the Red Planet around July 30th 2020. "The mission takes the next step by not only seeking signs of habitable conditions on Mars in the ancient past, but also searching for signs of past microbial life itself. The Mars Perseverancerover introduces a drill that can collect core samples of the most promising rocks and soils and set them aside in a "cache" on the surface of Mars. The mission also provides opportunities to gather knowledge and demonstrate technologies that address the challenges of future human expeditions to Mars."

Psyche Mission

The **PSYCHE MISSION,** scheduled to launch in 2022, is a mission to explore an asteroid made entirely of metals. Because scientists believe Earth's core is made of metals like this one, research on Psyche may answer questions about how planets form.

SPACE DAY AT APM: NASA INNOVATION

Where do we see NASA's benefits today?

NASA's fundamental research can be traced to ongoing innovation.

NASA'S WORK ON THESE TECHNOLOGIES

- Advanced composite structures
- Chevrons
- Laminar flow aerodynamics
- Advanced computational fluid dynamics (CFD) and numeric simulation tools

- Advanced composite structures
- Chevrons
- Laminar flow aerodynamics
- Advanced computational fluid dynamics (CFD) and numeric simulation tools
- Advanced ice protection system

WAS TRANSFERRED FOR USE HERE

Boeing **747-8**

Boeing **787**

TODAY'S BENEFITS

16% more fuel-efficient/reduced CO_2 emissions

30% noise reduction

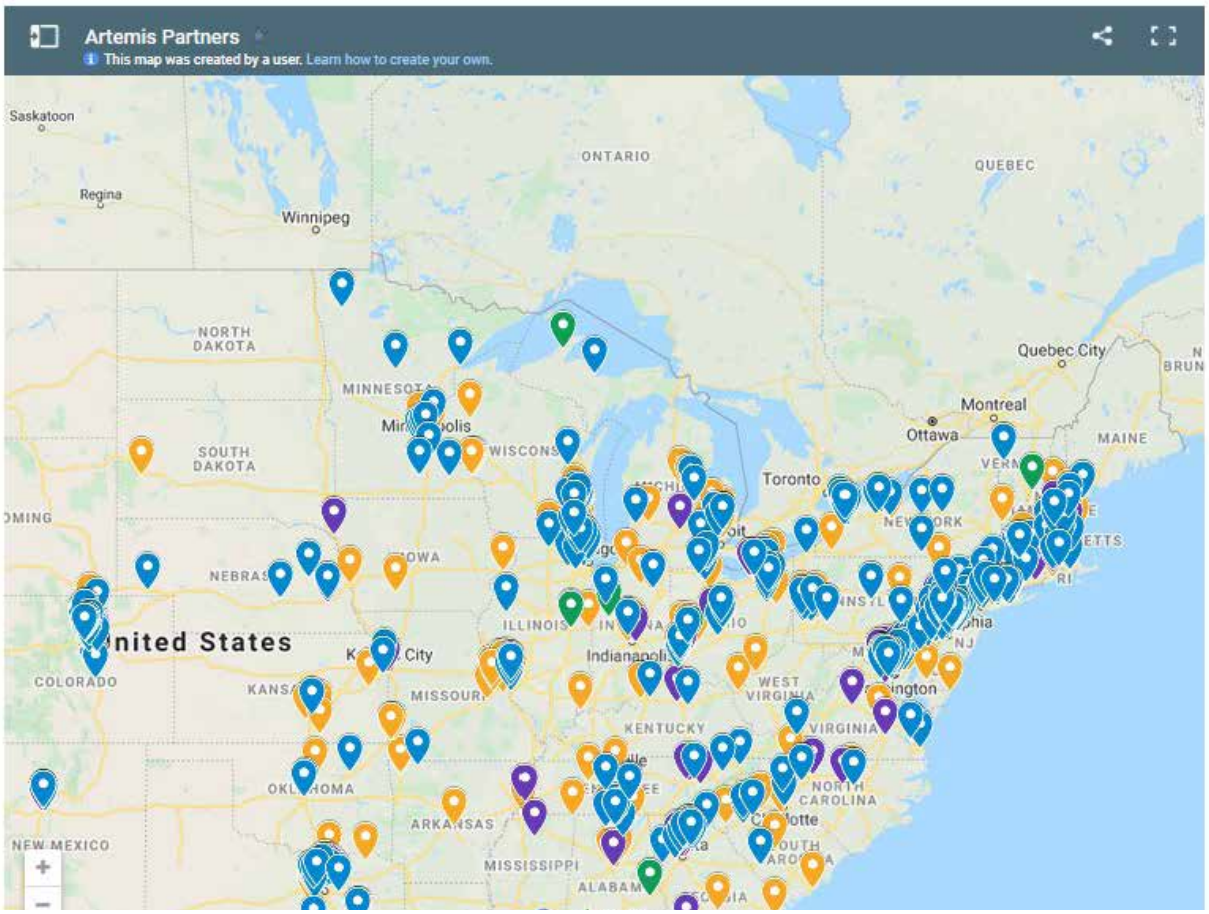
30% lower NO_x emissions

20% more fuel-efficient/reduced CO_2 emissions

28% lower NO_x emissions

60% smaller noise footprint

SPACE DAY AT APM: ARTEMIS CONTRACTS



NASA Prime Contractors Aerojet Rocketdyne, Boeing, Jacobs, Lockheed Martin, and Northrop Grumman currently have over 3,800 suppliers contributing to Orion, the SLS rocket, and the lunar spaceport at Kennedy. With NASA investments, additional U.S. companies, including small businesses, are advancing technologies and systems needed for a sustained presence on the Moon by 2028.

The Gateway will be a small spaceship in orbit around the Moon with components from U.S. companies, as well as international partners. The Gateway will provide access to more of the lunar surface than ever before with living quarters for astronauts, a lab for science and research, ports for visiting spacecraft, and more.

Through NASA's Commercial Lunar Payload Delivery Services (CLPS), American companies of varying sizes will bid on delivering science and technology payloads to the surface of the Moon.

Tipping Point awards support industry-developed space technologies that can foster the development of commercial space capabilities and benefit future NASA missions. A technology is considered at a tipping point if an investment in a demonstration will significantly mature the technology and bring the technology to market for both government and commercial applications.

NASA's Announcement of Collaboration Opportunity (ACO) helps reduce the development cost of commercial space technologies and accelerate their infusion into future missions.

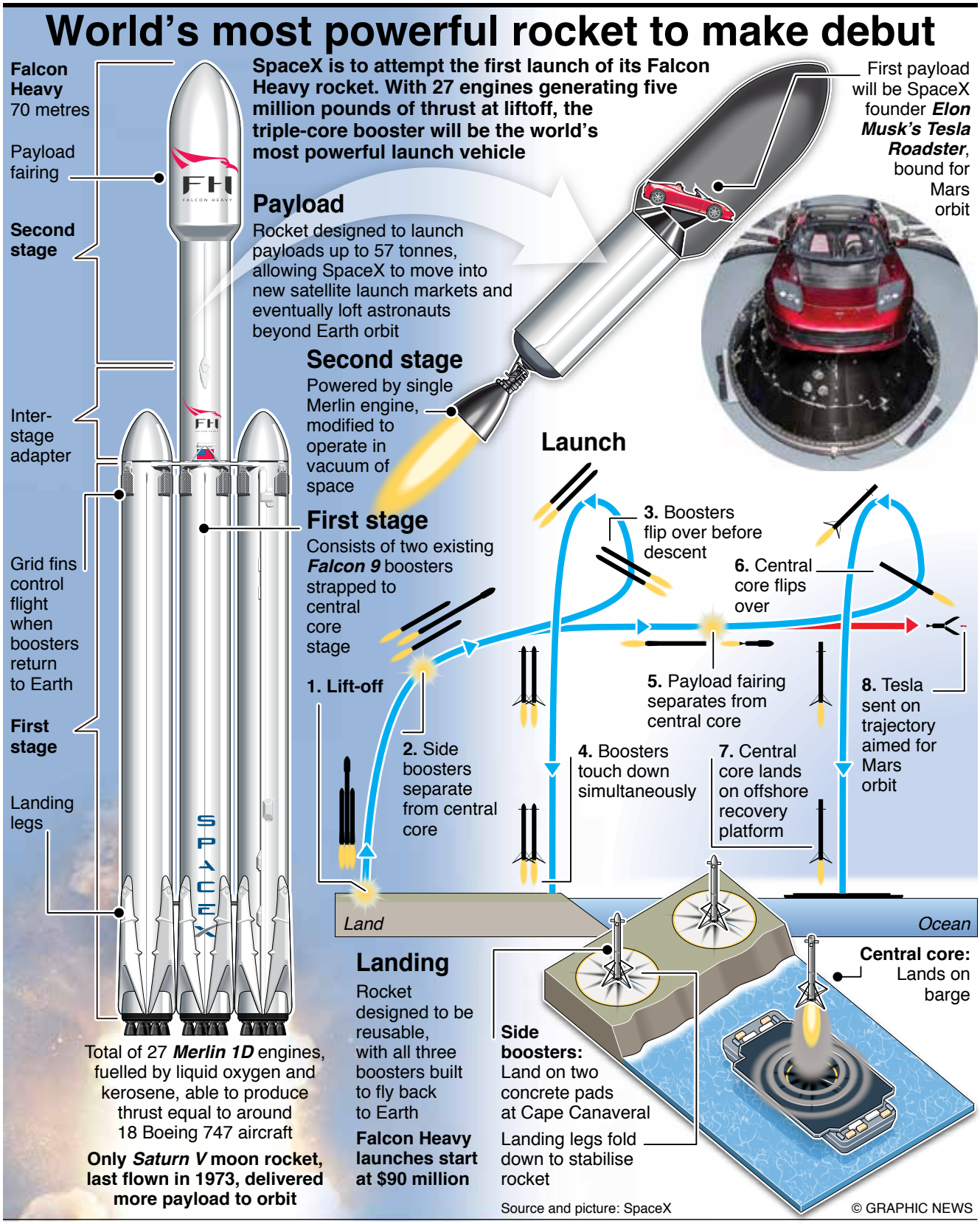
The Game Changing Development (GCD) program identifies and rapidly matures high-impact capabilities and space technologies.

NASA's Small Business Innovation Research (SBIR) program provides an opportunity for small companies and research institutions to participate in government-sponsored research and development efforts in key technology areas.

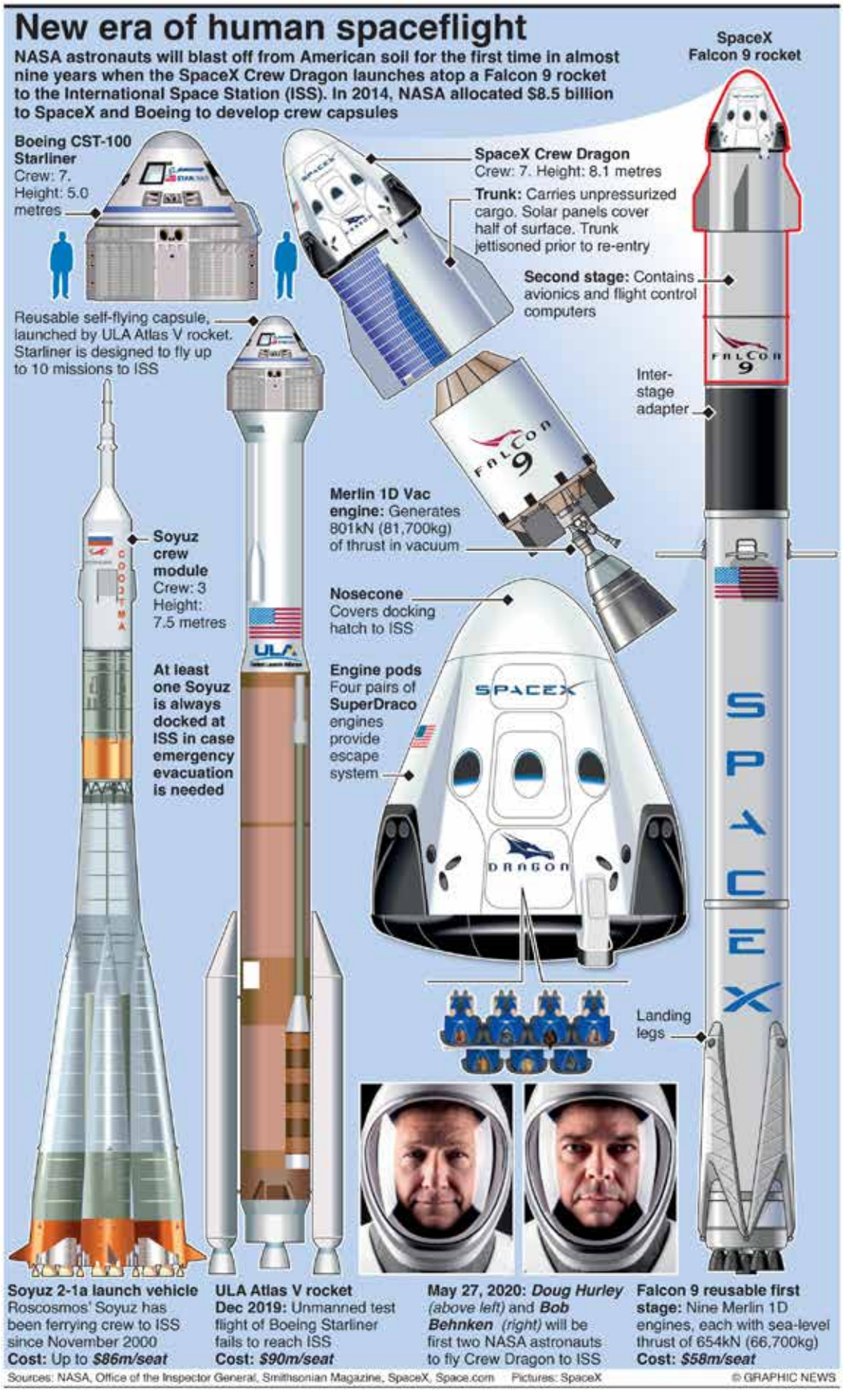
While the Artemis Partners map highlights the United States, this endeavor reaches internationally.

https://www.nasa.gov/content/artemis-partners

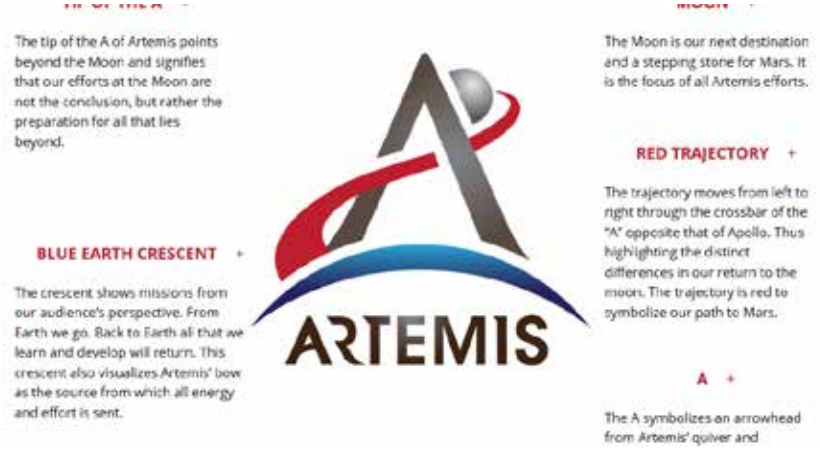
SPACE DAY AT APM: SPACE-X

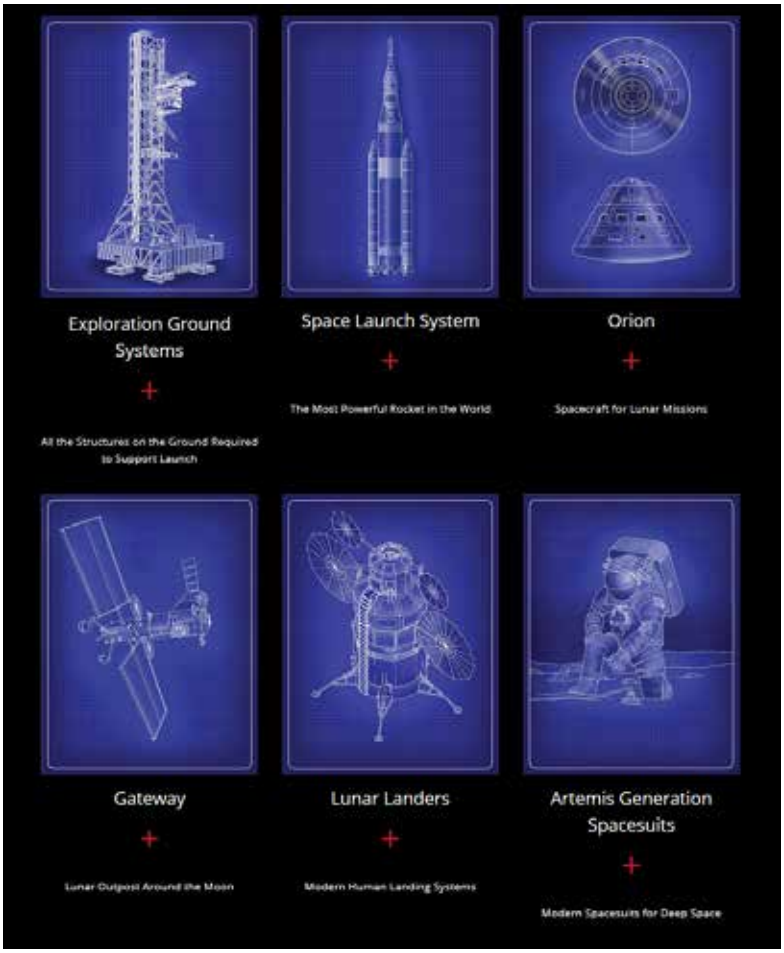


SPACE DAY AT APM: SPACE-X



SPACE DAY AT APM: ARTEMIS





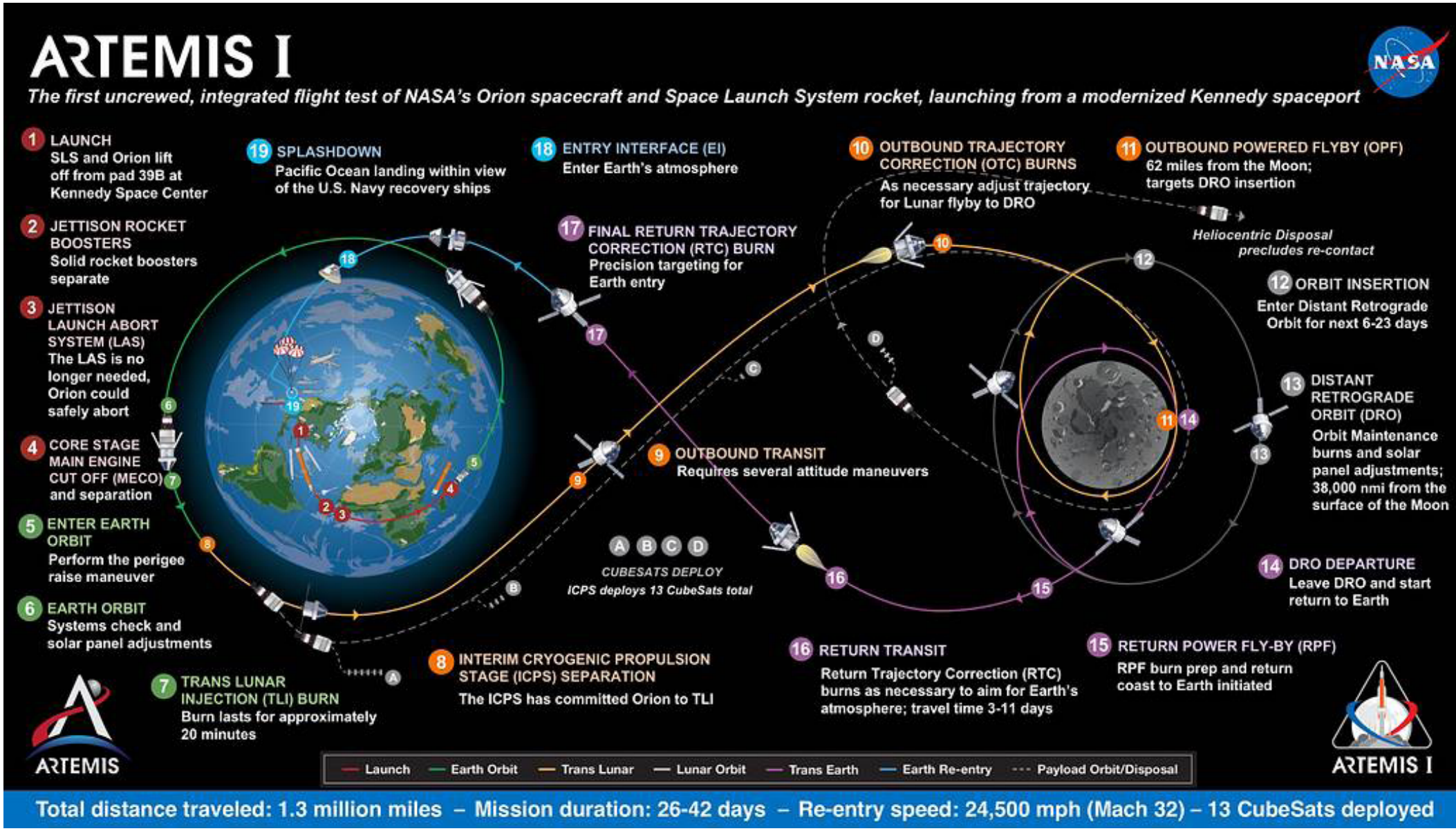
With the Artemis program, NASA will land the **first woman and next man on the Moon by 2024,** using innovative technologies to explore more of the lunar surface than ever before. We will collaborate with our commercial and international partners and establish sustainable exploration by the end of the decade. Then, we will use what we learn on and around the Moon to take the next giant leap – **sending astronauts to Mars.**

The Artemis Mission is an amibitious project that features

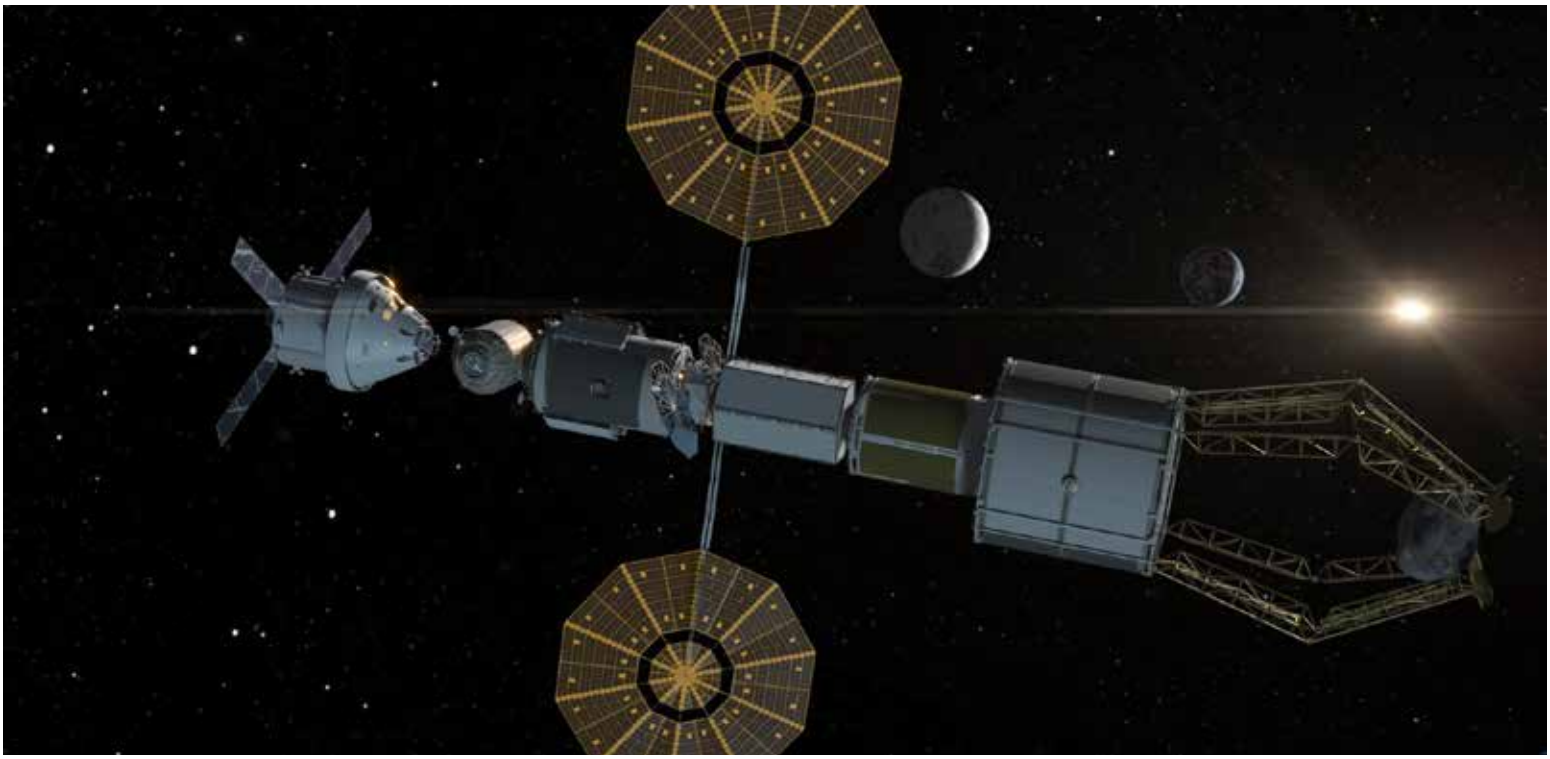
- new ground launch systems,
- space launch systems,
- a new lunar craft names Orion,
- a lunar outpost named Gateway,
- lunar landers,
- and new Exploration Extravehicular Mobility Units (xEMUs)

SPACE DAY AT APM: ARTEMIS

https://www.nasa.gov/sites/default/files/thumbnails/image/artemis-1-update.jpg

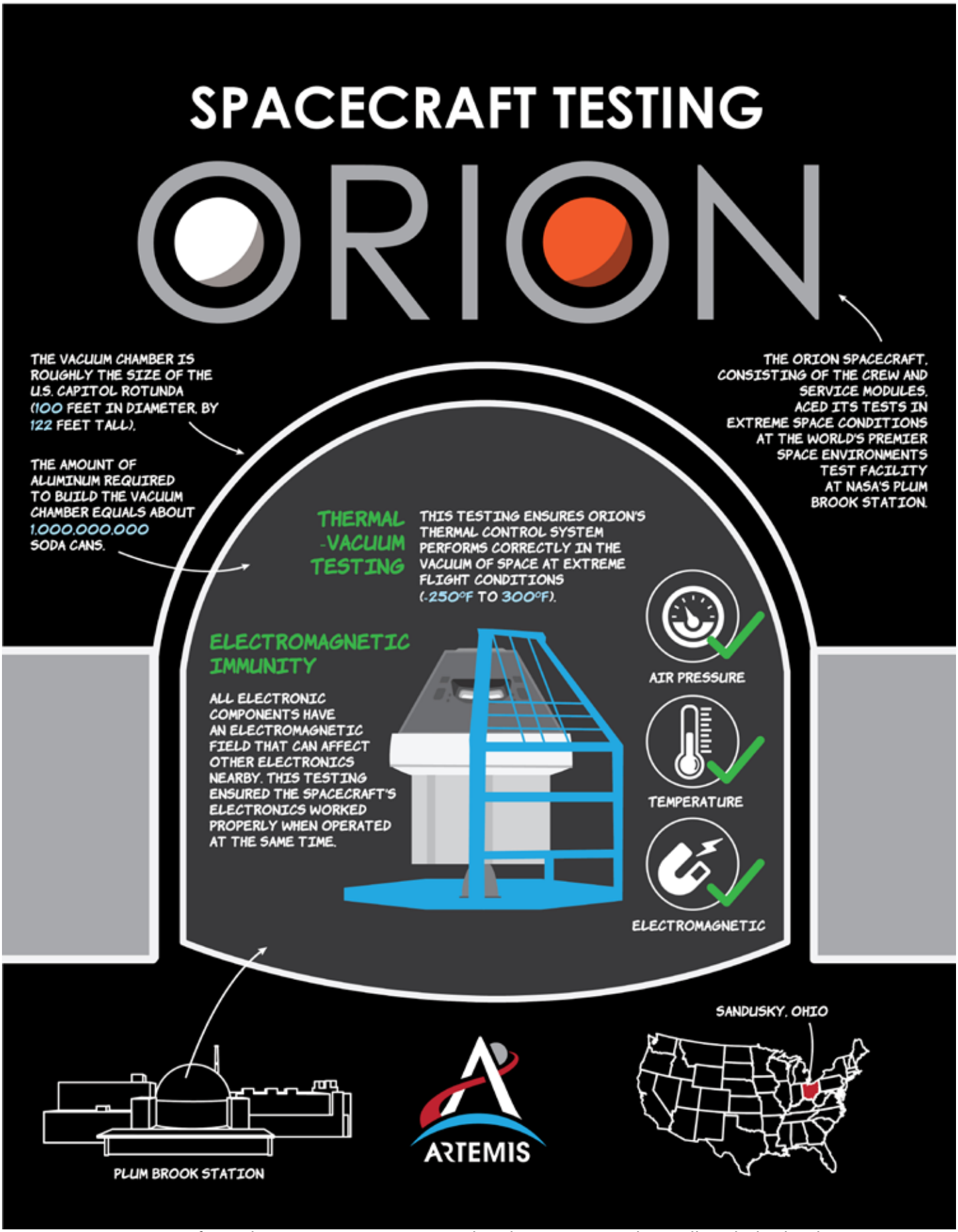


SPACE DAY AT APM: ORION



Images from: https://www.nasa.gov/exploration/systems/orion/gallery/index.html

SPACE DAY AT APM: ORION



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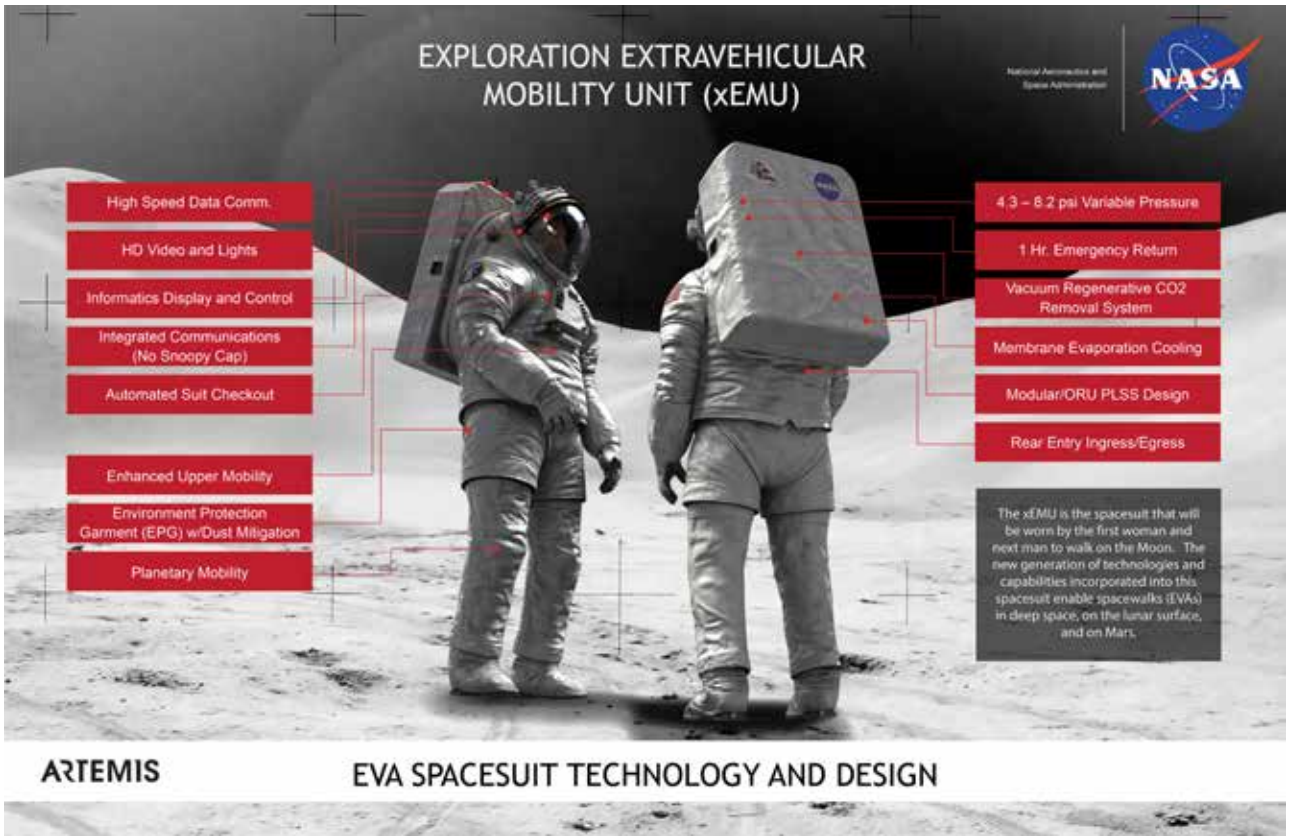
SPACE DAY AT APM: ARTEMIS AND SUITS



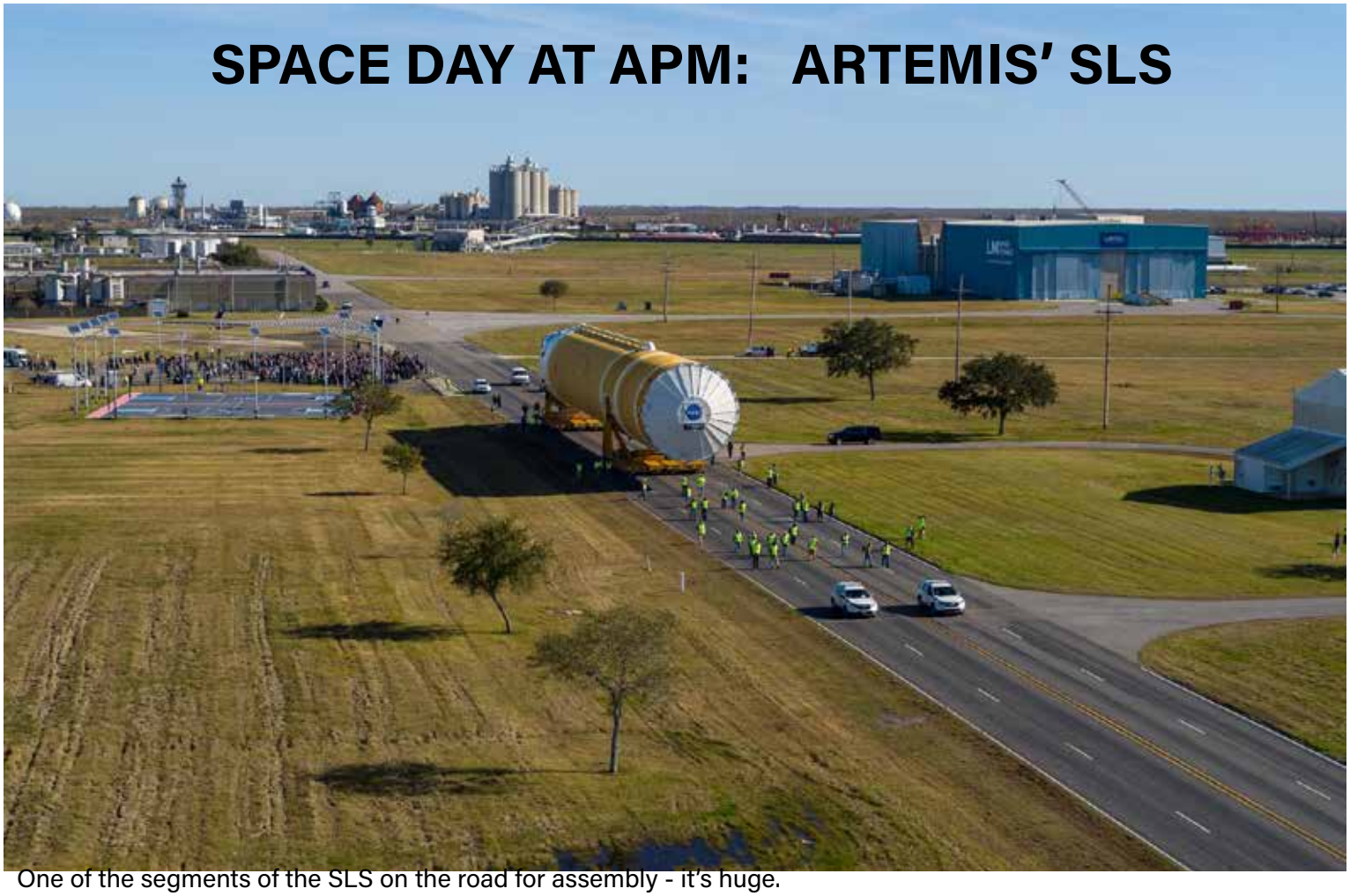
Exploration EMU (xEMU) Development Unit. Computer-aided design (CAD) graphic rendering side view. The xEMU is an improved design for increased mobility necessary for the Artemis program. The xEMU project patch which will eventually be replaced with the EVA patch.

Images from:
https://www.nasa.gov/suitup/spacesuit-gallery
and
https://www.nasa.gov/suitup/gallery

SPACE DAY AT APM: ARTEMIS AND SUITS

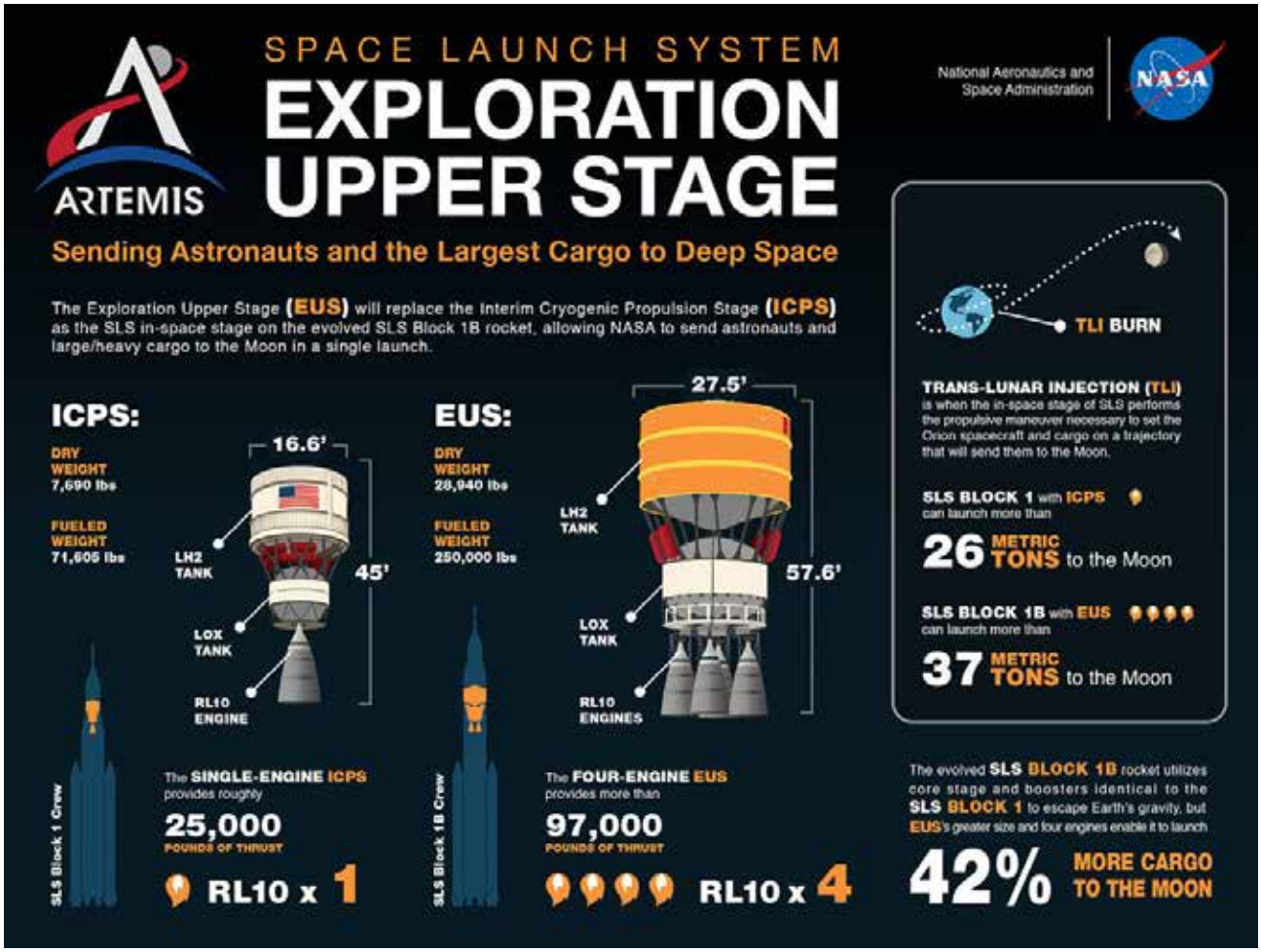
Above left: Photo of Upper Torso assembly without Thermal Micrometeoroid Garment cover layer and above right: with the layer. The shoulder is an improved design for increased mobility necessary for the Artemis program. The pink anodizing of the aluminum is a protective layer and the distinctive color helps engineers to identify this prototype. *From https://www.nasa.gov/suitup/spacesuit-gallery*

SPACE DAY AT APM: ARTEMIS' SLS



One of the segments of the SLS on the road for assembly - it's huge.

Images in this section from https://www.nasa.gov/exploration/systems/sls/multimedia/images.html



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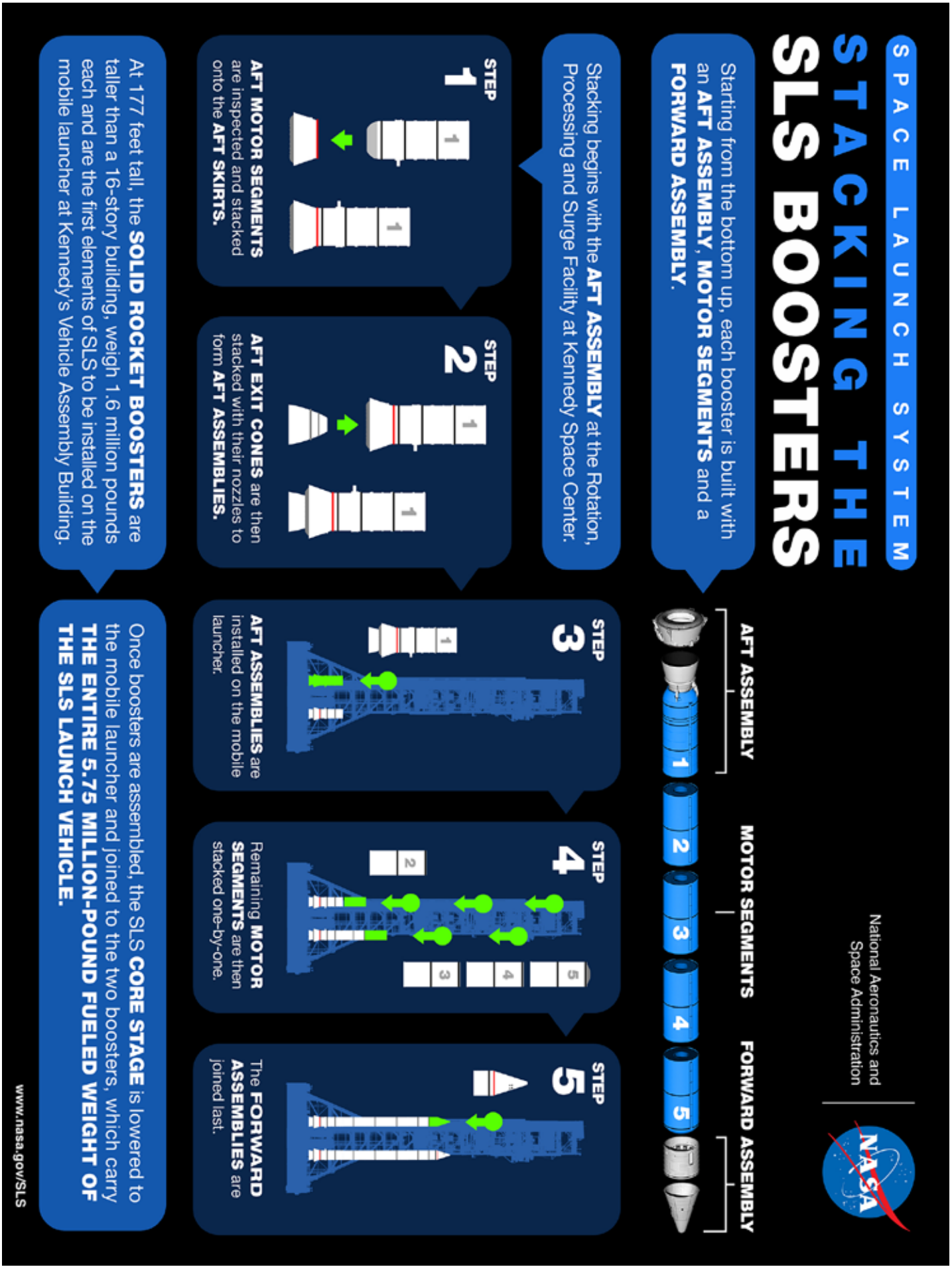

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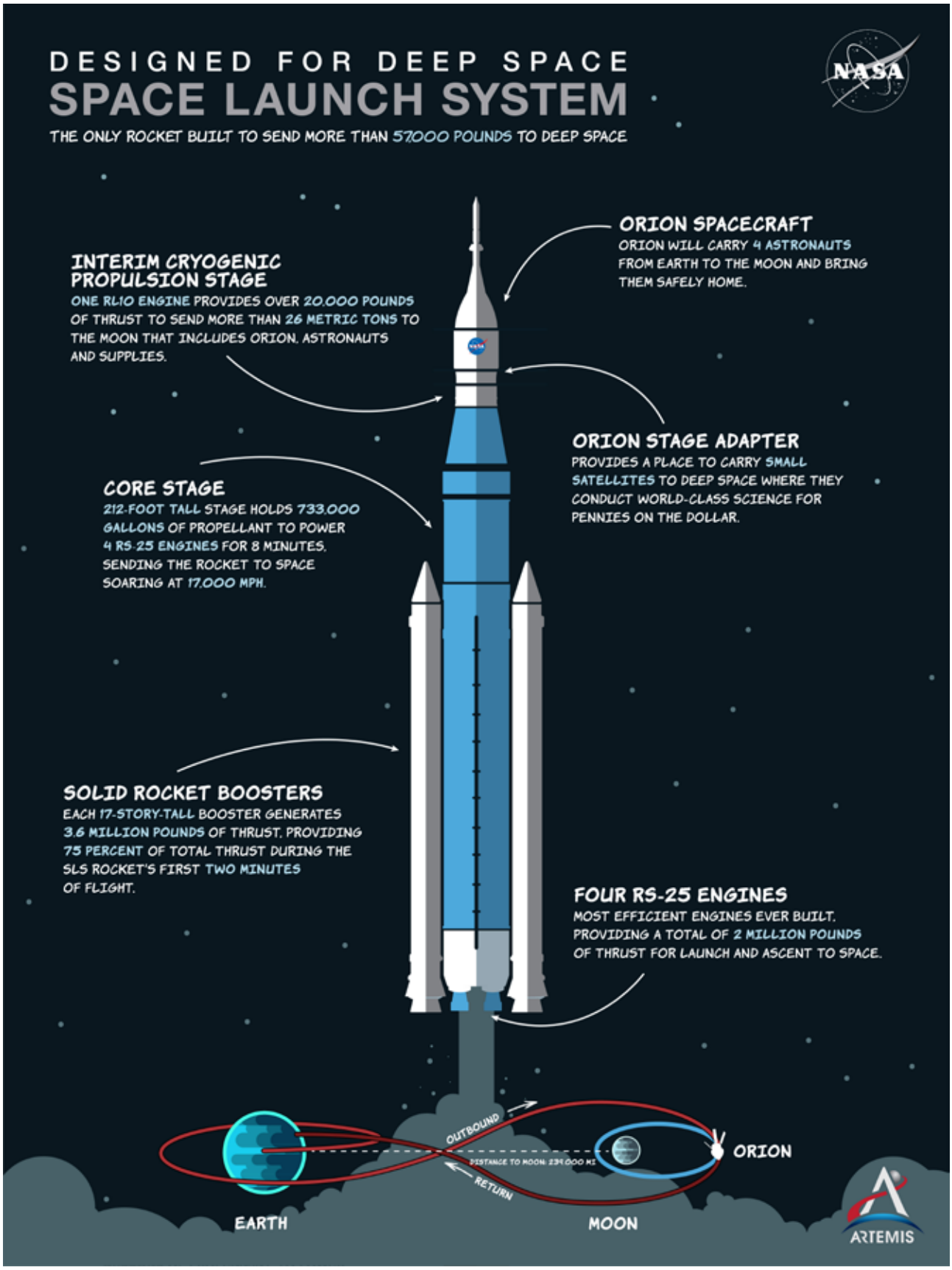

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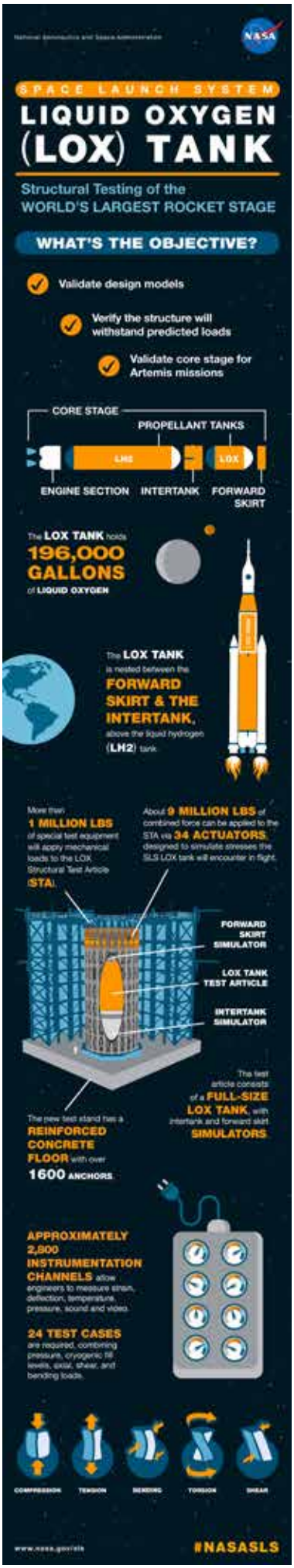


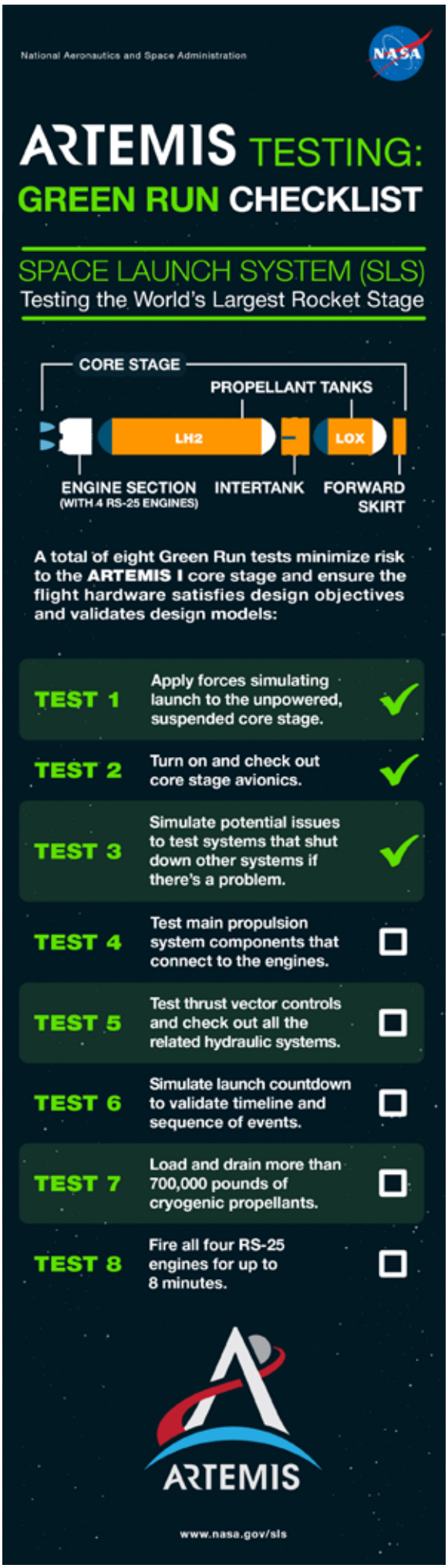


Image from: https://www.nasa.gov/exploration/systems/sls/multimedia/images.html

SPACE DAY AT APM:
ARTEMIS NEXT MOON STEP CHALLENGE

YOUR CHALLENGE IS:

TELL US WHAT YOU'D SAY IF YOU STEPPED FOOT ON THE MOON AND CREATE AN IMAGE OF YOUR FOOTPRINT (PHOTO OR ARTWORK)

ENTRIES DUE: July 21, 2020 | 8:59 PM PST

The American Precision Museum is participating in the nationwide challenge for K-12 students to submit a quote of what they would say if they stepped foot on the Moon. They must also create an image of their footprint (actual or drawing). Please register at the web address shown above to submit your quote and image online. The "Next Moon Step" is a summer challenge leading up to an Artemis essay contest this fall, and we're excited to start some out-of-this world brainstorming now! More information about the Artemis Mission and challenge rules can be found at: https://www.futureengineers.org/nextmoonstep

1. Make a footprint in the sand, or draw a footprint on paper.
2. What would you say, in 20 words or less?
2. Take a picture and tag @americanprecisionmuseum or #nextmoonstep

The "Next Moon Step" is a summer challenge leading up to an Artemis essay contest this fall, and we're excited to start some out-of-this-world brainstorming now! When Neil Armstrong first stepped foot on the Moon in 1969, he famously said, "That's one small step for a man, one giant leap for mankind." Now over 50 years later, NASA's Artemis program will return astronauts to the Moon. We want to hear what it means to you!

Your challenge is to create an image of your footprint (photo or artwork) and tell us what you would say, in 20 words or less, if you were the next person to step foot on the Moon. Your entry must be appropriate and original, and must not have been submitted for any other challenge or previously published. Exceptional entries may be marked in the gallery with "NASA gold stars". PLEASE DO NOT include your face or name in your entry. Be sure to check out the RULES for all details.

Here's some exciting information about the Artemis program, but the EDUCATION RESOURCES section below has even more information about lunar exploration. NASA's Artemis program has the bold challenge of landing "the first woman and the next man" on the Moon, specifically at the lunar south pole region by 2024. Working with its industry and international partners, NASA will fine-tune precision landing technologies and develop new mobility capabilities that allow robots and crew to travel greater distances and explore new regions of the Moon. On the Moon's surface, NASA has proposed building a new Artemis Base Camp with habitat and rovers, to test new power systems and more to prepare for future human exploration of Mars.

AN EDUCATION PROGRAM FOR THE INNOVATORS OF TOMORROW

The "Next Moon Step" Challenge is presented in support of NASA's Artemis program. The student challenge is part of NASA's efforts to engage the public in its missions to the Moon and Mars. NASA is returning to the Moon for scientific discovery, economic benefits, and inspiration for a new generation. Working with its partners throughout the Artemis program, the agency will fine-tune precision landing technologies and develop new mobility capabilities that allow robots and crew to travel greater distances and explore new regions of the Moon. On the surface, the agency has proposed building a new habitat and rovers, testing new power systems and much more to get ready for human exploration of Mars. Charged with returning to the Moon in the next four years, NASA's Artemis program will reveal new knowledge about the Moon, Earth, and our origins in the solar system.

IN SUPPORT OF NASA'S ARTEMIS PROGRAM

FUTURE ENGINEERS NASA

SPACE DAY AT APM: MARS ROVER "PERSERVERANCE"

Features of the new Perserverance Rover

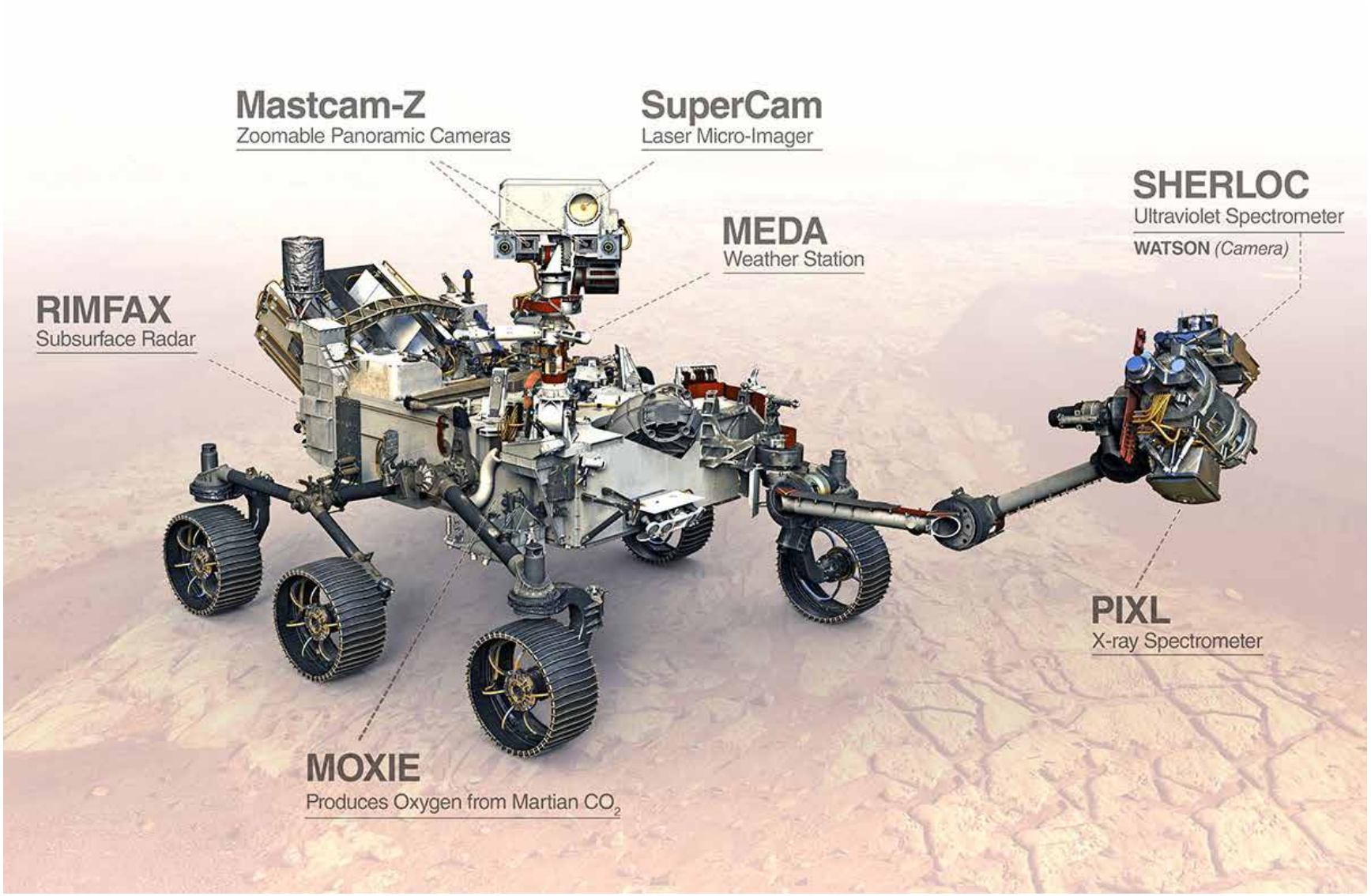


Image from: https://www.nasa.gov/perseverance/images

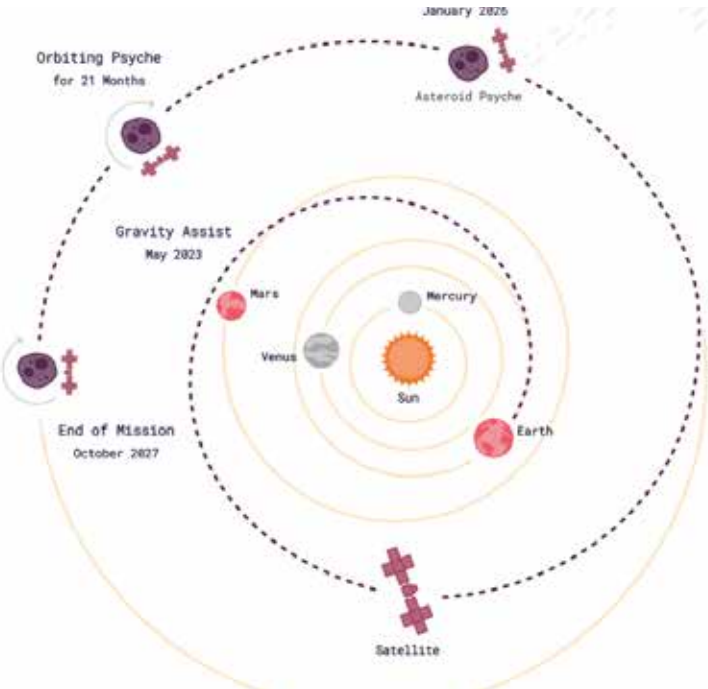
SPACE DAY AT APM: MARS ROVER "PERSERVERANCE"

Ingenuity: the Perserverance Rover's Helicopter

Rover Wheel Design Update

Images from: https://www.nasa.gov/perseverance/images

SPACE DAY AT APM: PSYCHE



TRAJECTORY

The Psyche spacecraft is targeted to launch in summer 2022 and travel to the asteroid using solar-electric (low-thrust) propulsion, arriving in 2026, following a Mars flyby and gravity-assist in 2023. After arrival, the mission plan calls for 21 months spent at the asteroid, mapping it and studying its properties.

WHERE ARE WE NOW?

A space mission typically has six phases, A-F. The Psyche mission is currently in "Phase C," which lasts until January 2021. In this phase, the mission is focused on final design and subsystem fabrication, assembly, and testing.

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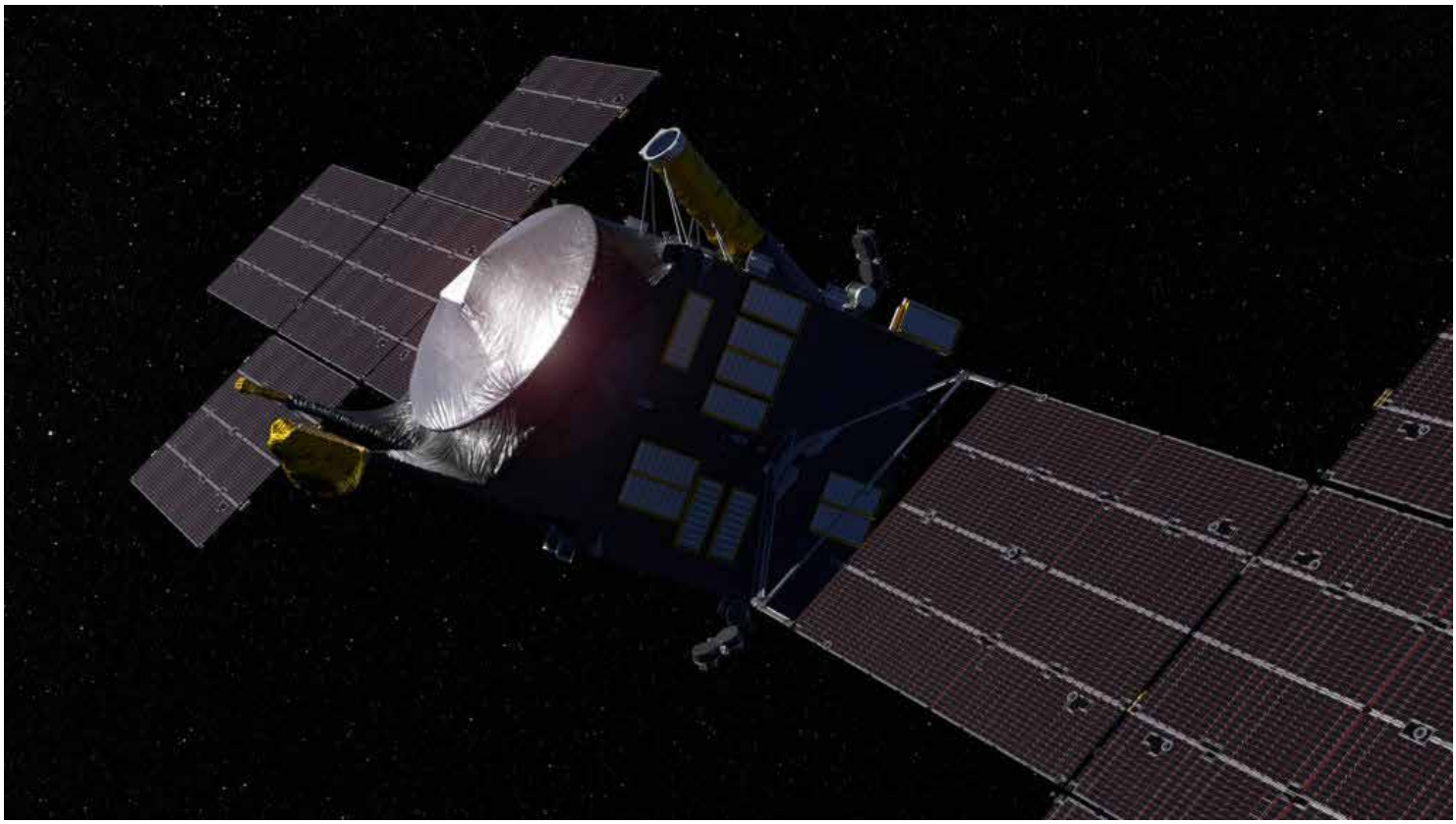
Images from https://psyche.asu.edu.

SPACE DAY AT APM: PSYCHE



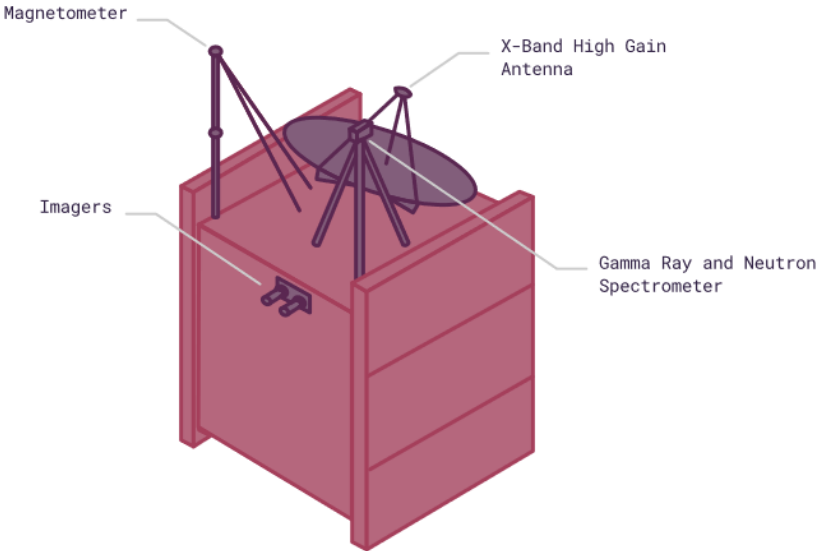
Psyche Spacecraft (Artist's Concept)

This artist's concept, updated as of June 2020, depicts NASA's Psyche spacecraft. The image was created by Peter Rubin.

Arizona State University in Tempe leads the mission. NASA's Jet Propulsion Laboratory in Southern California is responsible for the mission's overall management, system engineering, integration and test, and mission operations. For more information about NASA's Psyche mission go to: http://www.nasa.gov/psyche or https://psyche.asu.edu Credit: NASA/JPL-Caltech/ASU

FULLY-EQUIPPED

The spacecraft will include a Gamma Ray and Neutron Spectrometer, a Multispectral Imager, a Magnetometer and an x-band radio telecommunications system. The Psyche mission will also test a sophisticated new laser communication technology, called Deep Space Optical Communication (DSOC), that encodes data in photons to communicate between the spacecraft and Earth.



AMERICAN PRECISION MUSEUM

APM would like to thank the Vermont Space Grant Consortium for its continued support of the education program. The Vermont Space Grant Consortium (VTSGC) is an organization consisting of academic institutions, private industry, and public entities. Funded by a grant from NASA's National Space Grant College and Fellowship Program, key goals of the VTSGC are: to build aerospace-related research infrastructure within the state; to promote science, technology, engineering and mathematics (STEM) education among Vermont students; and to train and encourage students to pursue careers in aerospace-related areas.

This aligns with the museum's mission to capture the imaginations of young and old with the spirit of innovation, problem solving and design demonstrated through the dynamic storyof the manufacturing industry in America.

Vermont Space Grant Consortium