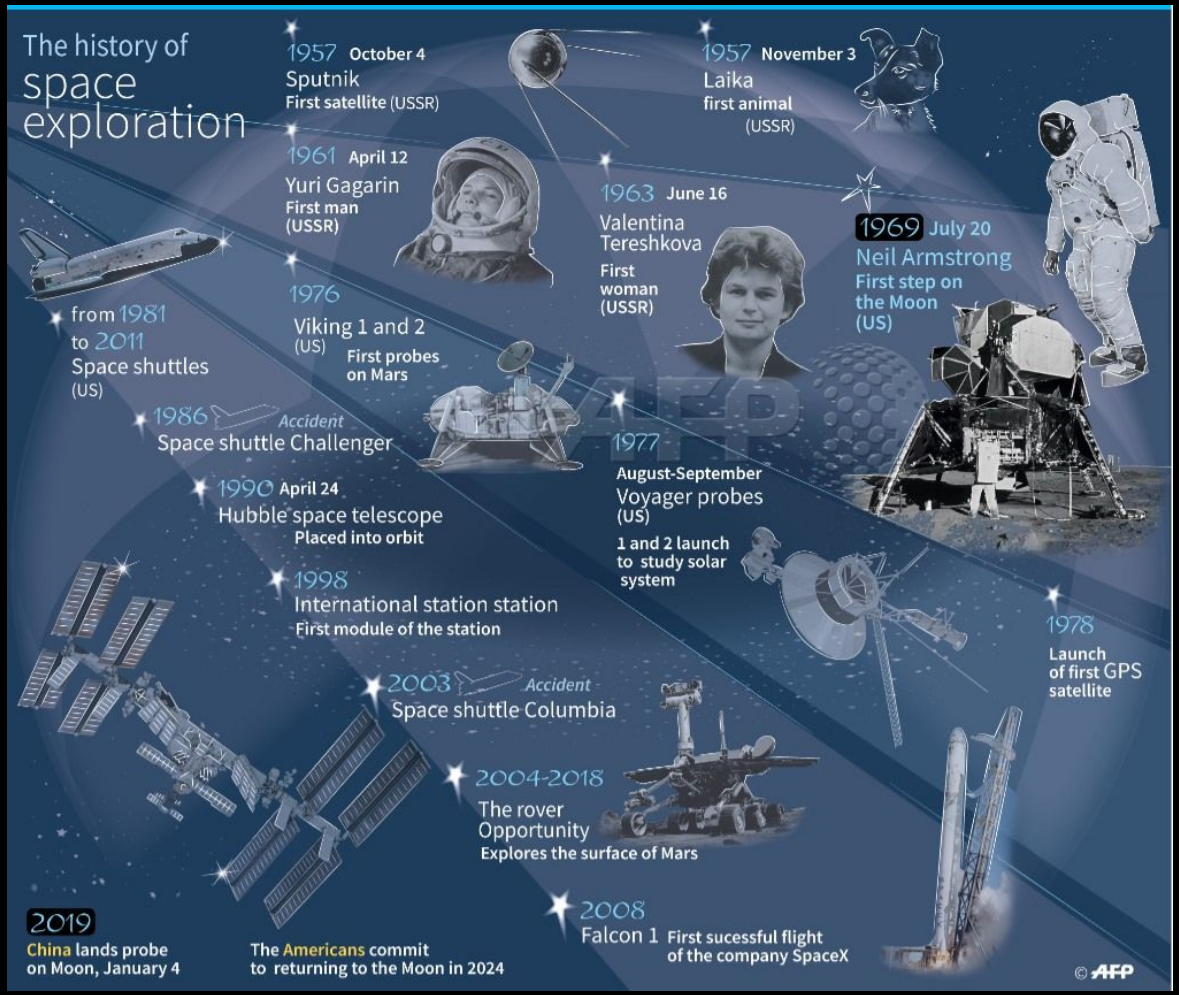
Lecture 1

Space 2.0

4/4/25
Prof. Overbey
University of Austin (UATX)

Space Missions

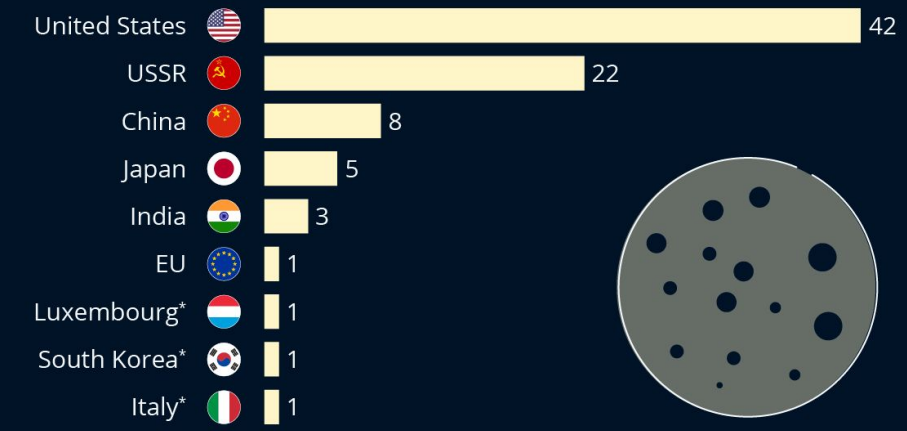
What comes to mind?


The history of space exploration
1957 October 4
Sputnik
First satellite (USSR)
1957 November 3
Laika
first animal (USSR)
1961 April 12
Yuri Gagarin
First man (USSR)
1963 June 16
Valentina Tereshkova
First woman (USSR)
1969 July 20
Neil Armstrong
First step on the Moon (US)
from 1981 to 2011
Space shuttles (US)
1976
Viking 1 and 2 (US)
First probes on Mars
1986 Accident
Space shuttle Challenger
1977
August-September
Voyager probes (US)
1 and 2 launch to study solar system
1990 April 24
Hubble space telescope
Placed into orbit
1998
International station station
First module of the station
1978
Launch of first GPS satellite
2003 Accident
Space shuttle Columbia
2004-2018
The rover Opportunity
Explores the surface of Mars
2008
Falcon 1 First sucessful flight of the company SpaceX
2019
China lands probe on Moon, January 4
The Americans commit to returning to the Moon in 2024
© AFP


AP

Which Countries Have Been to the Moon?

Countries which have landed on, orbited or flown by the moon, by number of successful/semi-successful missions



* Italy, South Korea and Luxembourg (private company) piggybacked on U.S. and Chinese rockets.

As of Aug. 23, 2023

Sources: OMG Space, Statista research

statista

BBC

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The 1968 photo that changed the world

22 April 2024

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Isabelle Gerretsen
Features correspondent • @izzygerretsen

More than 50 years after it was shot, Earthrise continues to be seen as one of the most iconic environmental photographs ever taken.

On Christmas Eve, 1968 the crew of Apollo 8 captured a spectacular sight as they orbited the Moon: the illuminated Earth appearing above the barren lunar horizon.

The Nasa astronauts were awestruck by what they saw.

"Oh my God, look at that picture over there! There's the Earth coming up. Wow, is that pretty!" Bill Anders shouted at fellow astronaut Jim Lovell. "You got a colour film, Jim? Hand me a roll of colour, quick, would you?"

"That's a beautiful shot," said Lovell as Anders clicked the shutter and captured what has become one of the world's most famous photographs.

The image was coined "Earthrise". It was the first colour photograph of Earth taken from space and quickly circulated around the world. The photo is widely credited with propelling the global environmental movement and leading to the creation of Earth Day, an annual event promoting environmental activism and awareness, in 1970.

ars TECHNICA

ANGLING FOR MORE

Firefly's picture-perfect Moon landing shows the way for lunar exploration

"Every single thing was clockwork... We got some Moon dust on our boots."

STEPHEN CLARK – MAR 3, 2025 7:36 AM | 93

Firefly Aerospace became the first commercial company to make a picture-perfect landing on the Moon early Sunday, touching down on an ancient basaltic plain, named Mare Crisium, to fulfill a $101 million contract with NASA.

The lunar lander, called Blue Ghost, settled onto the Moon's surface at 2:34 am CST (3:34 am EST; 08:34 UTC). A few dozen engineers in Firefly's mission control room monitored real-time data streaming down from a quarter-million miles away.

"Y'all stuck the landing, we're on the Moon!" announced Will Coogan, the lander's chief engineer, to the Firefly team gathered in Leander, Texas, a suburb north of Austin. Down the street, at a middle-of-the-night event for Firefly employees, their families, and VIPs, the crowd erupted in applause and toasted champagne.

FIREFLY AEROSPACE


MOON LANDING
FIRST HD FOOTAGE

What about present-day **human spaceflight?**


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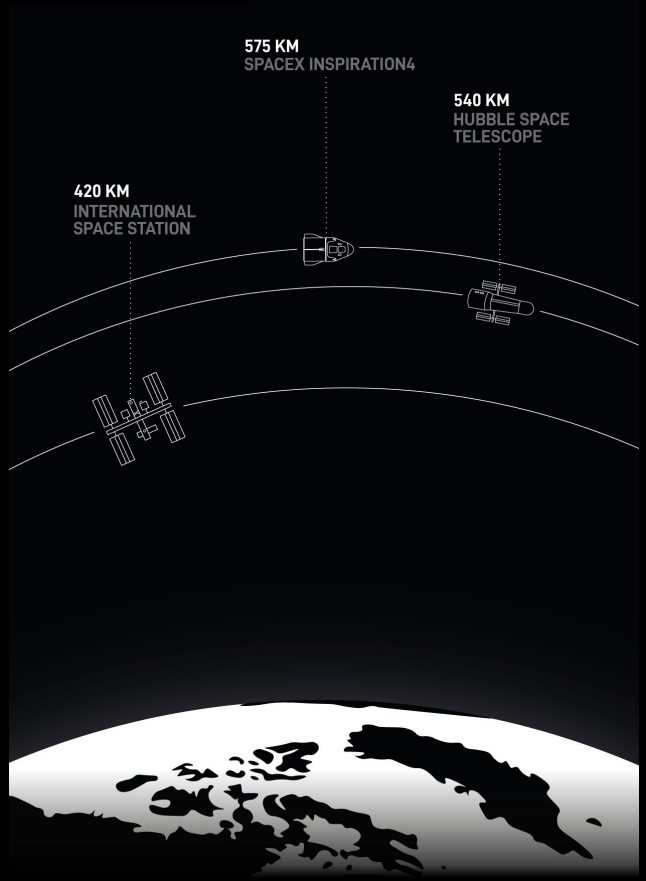
GEAR
CONTACT
SpaceX
The First All-Civilian Mission To Orbit
FOUR CREW MEMBERS REPRESENTED THE MISSION PILLARS OF LEADERSHIP, HOPE, GENEROSITY, AND PROSPERITY


575 KM
SPACEX INSPIRATION4
540 KM
HUBBLE SPACE TELESCOPE
420 KM
INTERNATIONAL SPACE STATION


FROM TIME AND THE DIRECTOR OF 'THE LAST DANCE'
THIS SEPTEMBER, WE'RE ALL GOING TO SPACE.
A NETFLIX DOCUMENTARY SERIES
COUNTDOWN:
INSPIRATION4 MISSION TO SPACE
SEPTEMBER | NETFLIX


TIME
THREE DAYS THAT COULD CHANGE HUMANITY
INSIDE INSPIRATION4
THE FIRST ALL-CIVILIAN TRIP INTO ORBIT
BY JEFFREY KLUGER
WATCH TIME'S COUNTDOWN: INSPIRATION4 MISSION TO SPACE STARTING SEPT. 6
NETFLIX

First all-civilian crew space mission

SpaceX's Crew Dragon capsule without professional astronauts on a three-day orbit around the Earth

HAYLEY ARCENEAUX

Cancer survivor, physician assistant at St Jude's Hospital in Tennessee

Youngest American sent to orbit around Earth and 1st person with prosthesis to go into space

Mission role: medical manager
Seat: represents 'hope'

SIAN PROCTOR

Geology teacher in Arizona, former astronaut candidate

Won seat by creating an online sales site linked to space

Pilot
Seat: represents 'prosperity'

JARED ISAACMAN

Billionaire pilot who chartered the mission

Holds a record for flying around the world in a light jet

Mission commander
Seat: represents 'leadership'

CHRIS SEMBROSKI

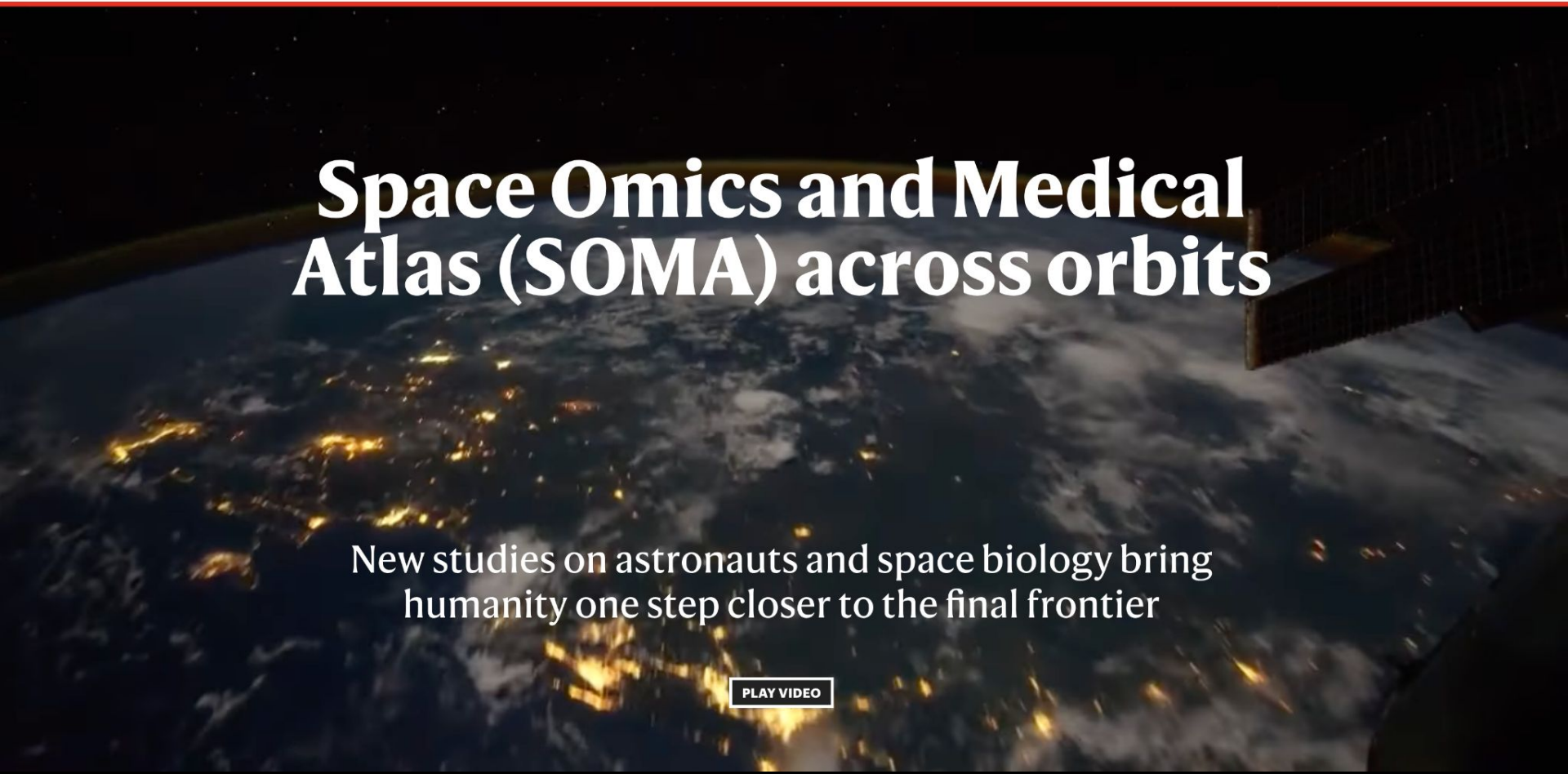
Air Force veteran who served in Iraq

Selected after making a donation as part of a fundraiser for St. Jude's Hospital

Manage cargo on board, communications with Earth
Seat: represents 'generosity'

AFP

AFP Photo/John Kraus/Inspiration4 Source: SpaceX


Space Omics and Medical Atlas (SOMA) across orbits
New studies on astronauts and space biology bring humanity one step closer to the final frontier
PLAY VIDEO

nature

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nature > articles > article

Article | Open access | Published: 11 June 2024

The Space Omics and Medical Atlas (SOMA) and international astronaut biobank

Eliah G. Overbey, JangKeun Kim, Braden T. Tierney, Jiwoon Park, Nadia Houerbi, Alexander G. Lucaci, Sebastian Garcia Medina, Namita Damle, Deena Najjar, Kirill Grigorev, Evan E. Afshin, Krista A. Ryon, Karolina Sienkiewicz, Laura Patras, Remi Klotz, Veronica Ortiz, Matthew MacKay, Annalise Schweickart, Christopher R. Chin, Maria A. Sierra, Matias F. Valenzuela, Ezequiel Dantas, Theodore M. Nelson, Egle Cekanaviciute, ... Christopher E. Mason + Show authors

Nature **632**, 1145–1154 (2024) | Cite this article

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Article | Open access | Published: 11 June 2024

Collection of biospecimens from the inspiration4 mission establishes the standards for the space omics and medical atlas (SOMA)

Eliah G. Overbey, Krista Ryon, JangKeun Kim, Braden T. Tierney, Remi Klotz, Veronica Ortiz, Sean Mullane, Julian C. Schmidt, Matthew MacKay, Namita Damle, Deena Najjar, Irina Matei, Laura Patras, J. Sebastian Garcia Medina, Ashley S. Kleinman, Jeremy Wain Hirschberg, Jacqueline Proszynski, S. Anand Narayanan, Caleb M. Schmidt, Evan E. Afshin, Lucinda Innes, Mateo Mejia Saldarriaga, Michael A. Schmidt, Richard D. Granstein, ... Christopher E. Mason + Show authors

Nature Communications **15**, Article number: 4964 (2024) | Cite this article

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NEXT MEETING: FALL 2025 - AUSTIN, TX

BUILDING THE NEXT ERA OF HUMAN SPACEFLIGHT

SOMA ANNUAL MEETING

The annual gathering for astronaut and scientist contributors to the Space Omics and Medical Atlas (SOMA), a globally-accessible resource dedicated to investigating astronaut health. Our flagship paper was recently published in Nature.

BIOSPECIMEN COLLECTION

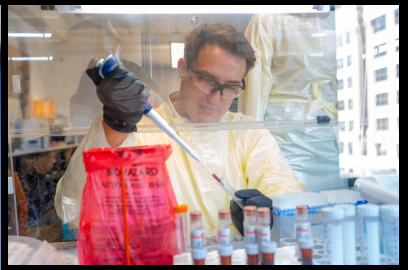
Annual touchpoint for continued sample collection for CAMbank, the first commercial astronaut biobank accessible to the scientific community.

TORCHLIGHT AWARDS

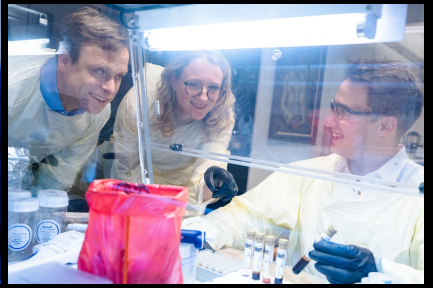
Celebration of the achievements of commercial astronauts who have pushed humanity further into the cosmos.

EXPERT PANELS AND DISCUSSIONS

Concentration of leading figures in the space industry to discuss recent and pressing topics in commercial spaceflight, astronaut health, and the future of space exploration.


SOMA

BIOHAZARD






What Keeps Me Up at Night
Conceptual foundation
Multi-system resilience



Add a comment



POLARIS

Jared Isaacman

MISSION COMMANDER

Scott Poteet

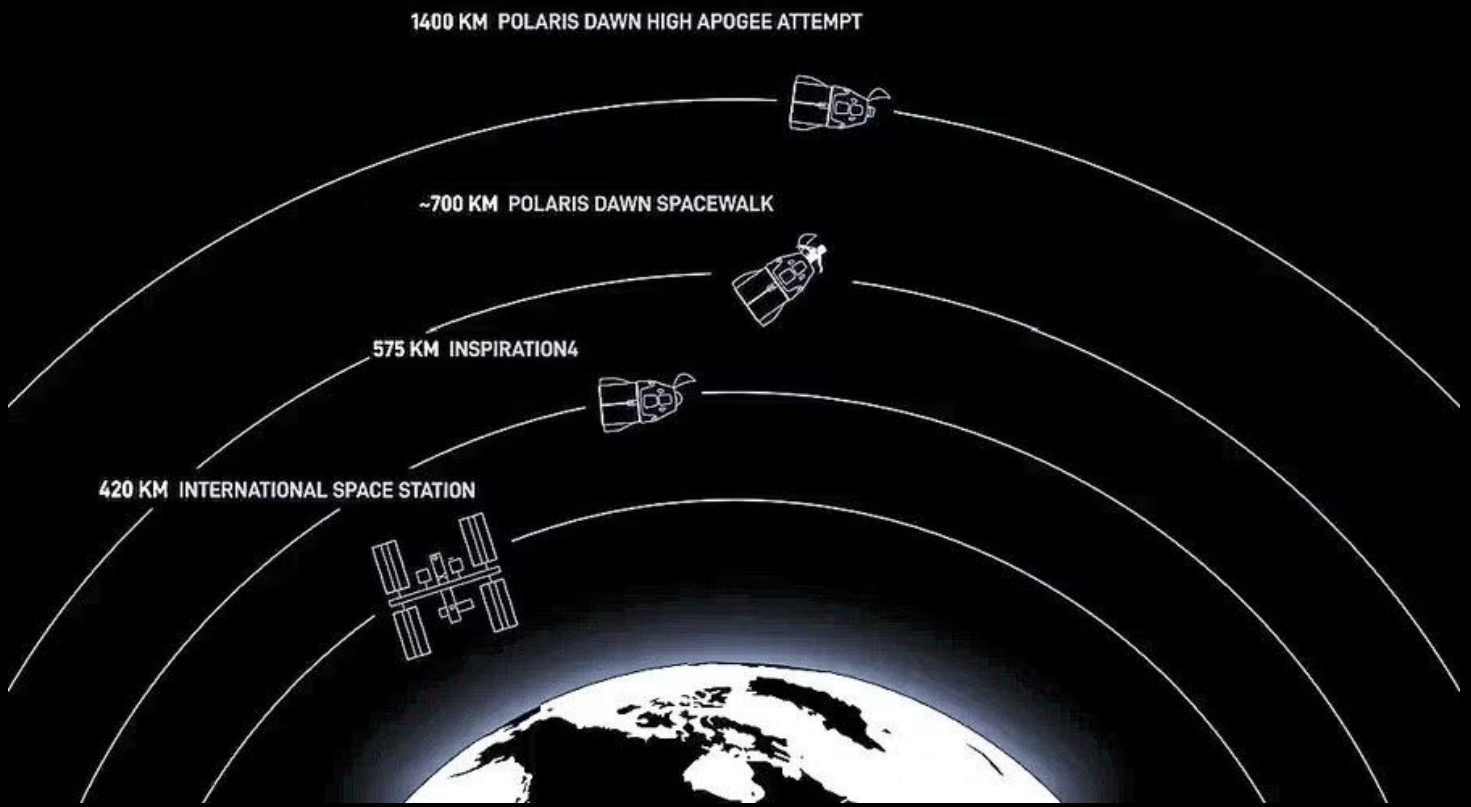
MISSION PILOT

Sarah Gillis

MISSION SPECIALIST

Anna Menon

MISSION SPECIALIST & MEDICAL OFFICER

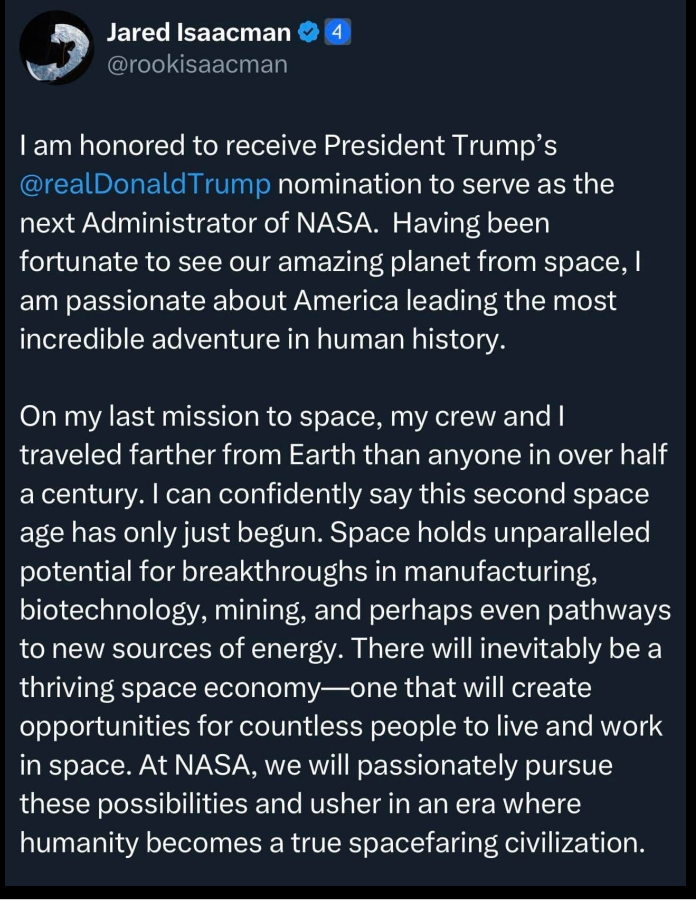

1400 KM POLARIS DAWN HIGH APOGEE ATTEMPT
~700 KM POLARIS DAWN SPACEWALK
575 KM INSPIRATION4
420 KM INTERNATIONAL SPACE STATION

Role Reversal? Private Sector Influencing NASA

Donald J. Trump
@realDonaldTrump

I am delighted to nominate Jared Isaacman, an accomplished business leader, philanthropist, pilot, and astronaut, as Administrator of the National Aeronautics and Space Administration (NASA). Jared will drive NASA's mission of discovery and inspiration, paving the way for groundbreaking achievements in Space science, technology, and exploration. Over the past 25 years, as the Founder and CEO of Shift4, Jared has demonstrated exceptional leadership, building a trailblazing global financial technology company. He also co-founded and served as CEO of Draken International, a defense aerospace company, for over a decade, supporting the U.S. Department of Defense, and our Allies. Jared's passion for Space, astronaut experience, and dedication to pushing the boundaries of exploration, unlocking the mysteries of the universe, and advancing the new Space economy, make him ideally suited to lead NASA into a bold new Era. Congratulations to Jared, his wife Monica, and their children, Mila & Liv!

200 ReTruths **838** Likes Dec 04, 2024, 9:58 AM



Jared Isaacman 4
@rookisaacman

I am honored to receive President Trump's @realDonaldTrump nomination to serve as the next Administrator of NASA. Having been fortunate to see our amazing planet from space, I am passionate about America leading the most incredible adventure in human history.

On my last mission to space, my crew and I traveled farther from Earth than anyone in over half a century. I can confidently say this second space age has only just begun. Space holds unparalleled potential for breakthroughs in manufacturing, biotechnology, mining, and perhaps even pathways to new sources of energy. There will inevitably be a thriving space economy—one that will create opportunities for countless people to live and work in space. At NASA, we will passionately pursue these possibilities and usher in an era where humanity becomes a true spacefaring civilization.

SPACENEWS

Policy & Politics

Senate schedules confirmation hearing for Isaacman's nomination to lead NASA

by **Jeff Foust** April 3, 2025

WASHINGTON — The Senate Commerce Committee will hold a confirmation hearing for Jared Isaacman to be NASA administrator next week after a push by industry, and even some members of the committee, to take up the nomination.

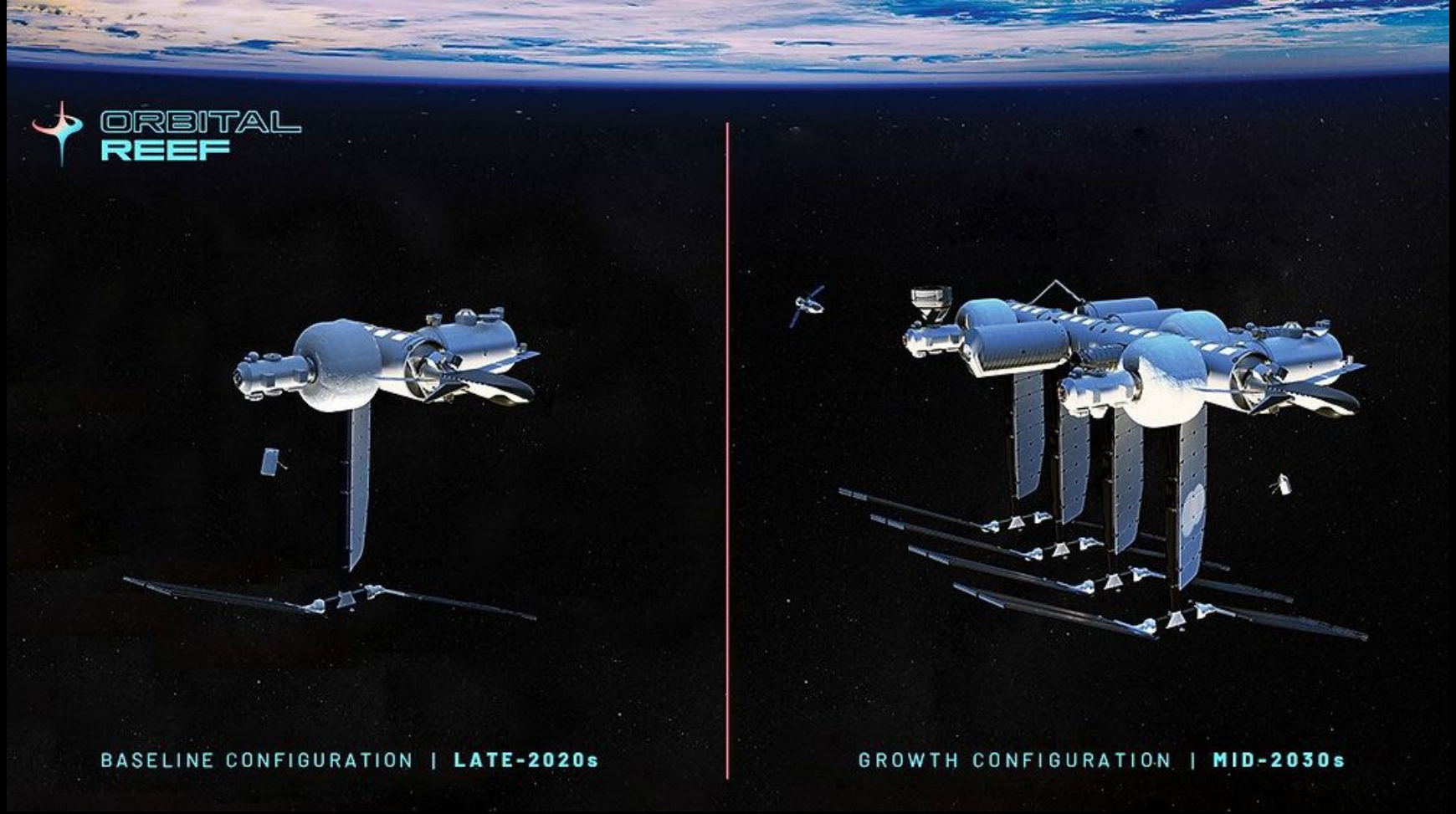
The committee announced late April 2 that it will hold a confirmation hearing for Isaacman on April 9 at 10 a.m. Eastern. The hearing will also consider the nomination of Olivia Trusty to be a member of the Federal Communications Commission.

The announcement relieves some of the impatience and anxiety in the space industry, which has largely supported Isaacman's nomination. President Trump **announced his intent to nominate Isaacman in December**, before taking office, and formally submitted the nomination Jan. 20. The committee, though, had not scheduled a hearing even as it took up nominations at other agencies.

Supporters of Isaacman have argued his background as a businessman and as a private astronaut make him ideal to lead NASA at a time when the agency is expected to rely even more on commercial capabilities.

FRAM2

Free-Flyers
vs
Space Stations


ORBITAL
REEF
BASELINE CONFIGURATION | LATE-2020s
GROWTH CONFIGURATION | MID-2030s


Nanoracks
VOYAGER SPACE
LOCKHEED MARTIN

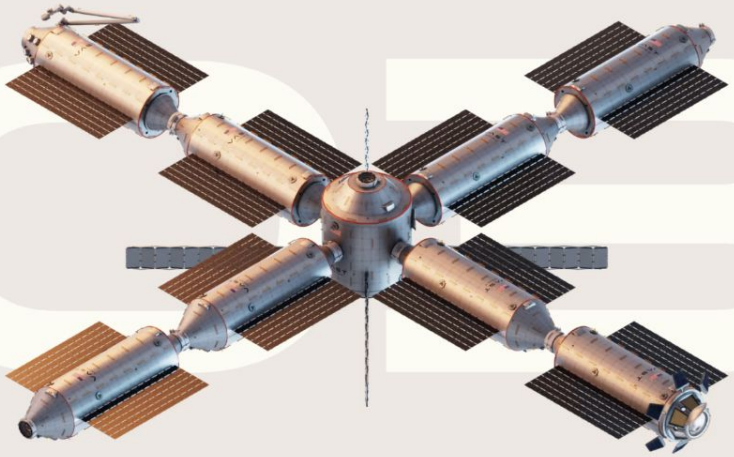
VAST


Domed window
Common area
Laboratory
Deployable table
Crew quarters
Crew interfaces
Corridor

2032: Haven-2 Fully Constructed

Surpassing the capabilities of the International Space Station and other sovereign space stations

› Learn more



HABITABLE VOLUME: 500 M^3
PRESSURIZED VOLUME: 1160 M^3
CREW: 12

AXIOM SPACE

BUILDING THE WORLD'S FIRST COMMERCIAL SPACE STATION

AxH1 | 2024

The Axiom Hub module, containing living quarters for four crew members and volume to accommodate research and manufacturing applications, is the nucleus of future human activity in Earth's orbit. Each personal crew quarter is equipped with a large Earth-viewing window and touch-screen comms panel. A docking adapter allows visiting vehicles to dock to the Axiom Station; four radial ports on the Hub provide for the addition of future modules and increase the station's docking capability.

AxH2 | 2025

The addition of the second Hub and its four additional crew quarters brings the crew capacity of the Axiom Station to eight. After it is launched and attached, Axiom offers twice the research volume and features a total of eight radial ports for the docking of visiting vehicles and addition of further modules.

AxL | 2026

The legacy ISS module once flown as the Multi-Purpose Logistics Module is repurposed and newly outfitted as the Axiom Lab module, a state-of-the-art research and manufacturing facility in space. The Lab provides a larger volume for industrialized research applications and scalable manufacturing opportunities, tended by astronauts on board the Axiom Station.

AxPT | 2027

The Axiom Power Tower attaches to the zenith port of the Hub, with its solar array producing an equivalent amount of power as the ISS. It expands on Axiom Station's environmental control and life support (ECLSS) capabilities, adds additional storage and payload capability, and provides an airlock to be utilized for EVAs (spacewalks) by astronauts on board Axiom Station. At any point following the Power Tower's addition, Axiom Station is capable of separating from the ISS and free-flying independently into the future.

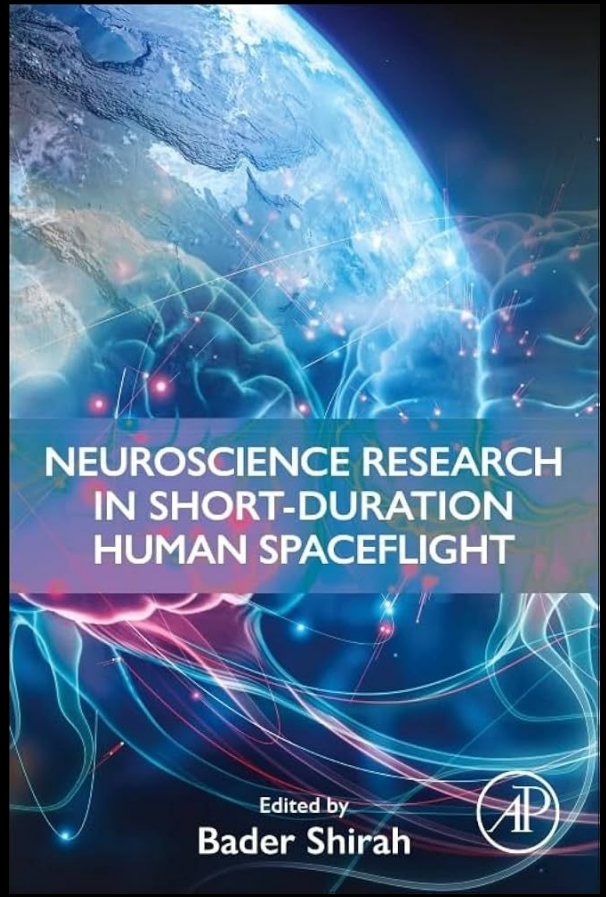
AxStation | 2028

Axiom Station is a self-sustaining orbital platform that has pressurized and unpressurized payload capacity comparable to the ISS.

Axiom Space Crews

Michael López-Alegría | Larry Connor | Eytan Stibbe | Mark Pathy

Ax-2 Astronauts in SOMA

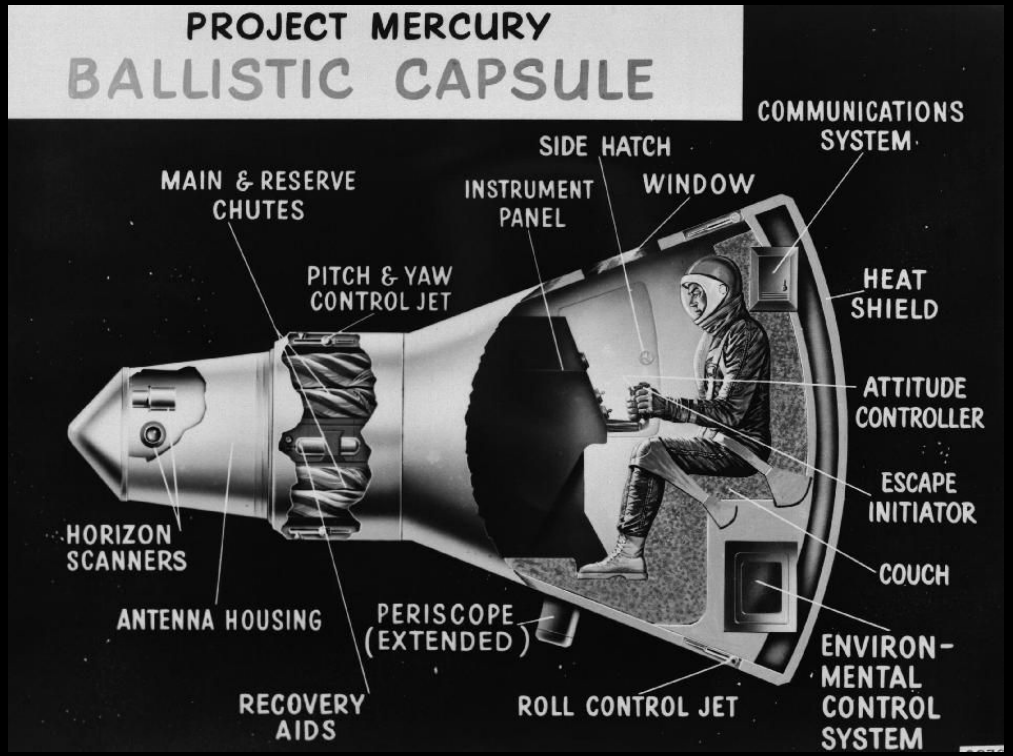


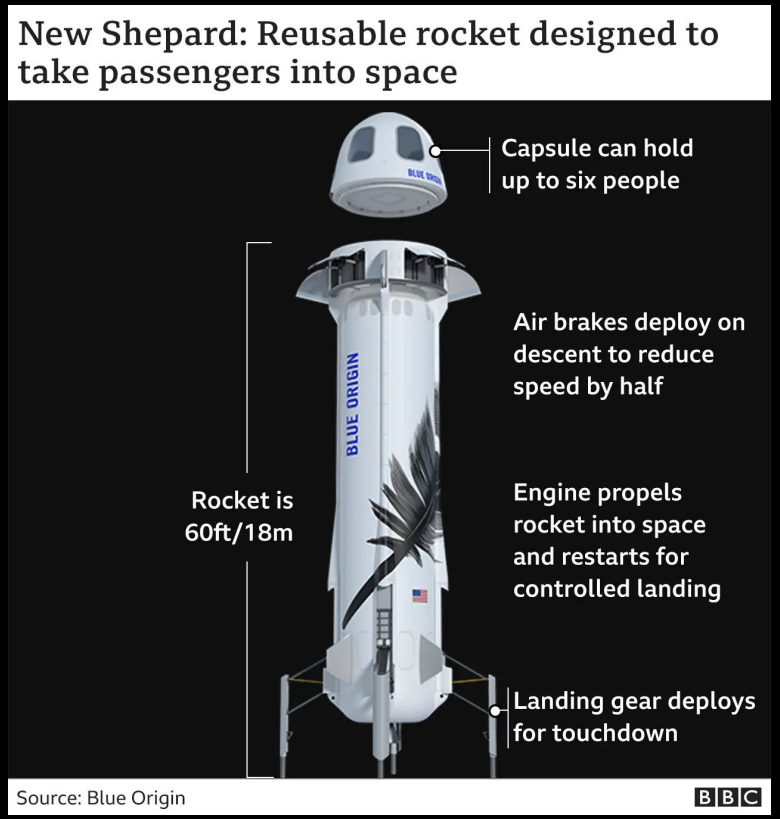
Space 2.0

The shift from government to commercial sector

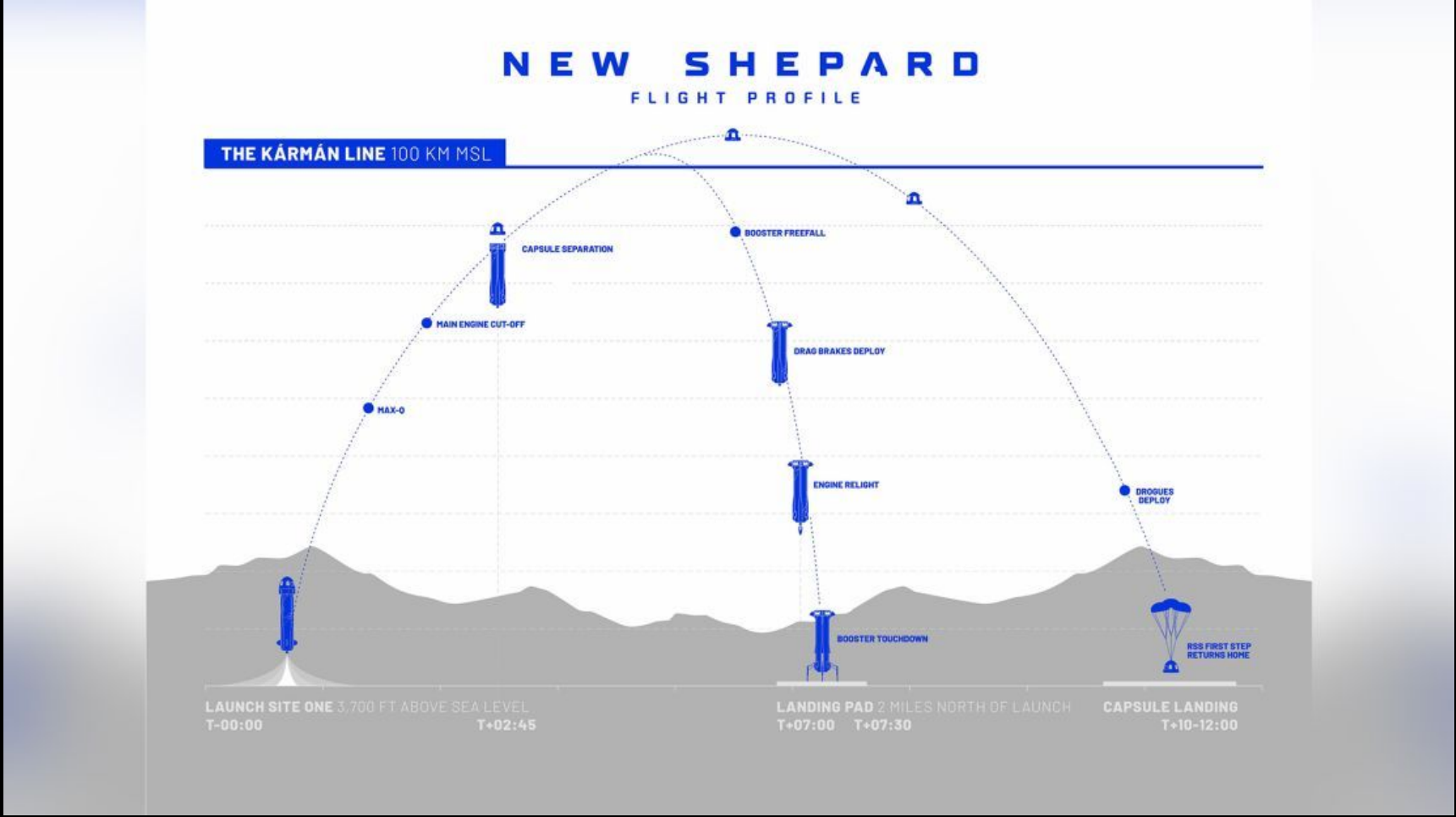
What was the first commercial mission to cross the Karman Line?

Project Mercury vs New Shepard





Project Mercury vs New Shepard


NEW SHEPARD
FLIGHT PROFILE
THE KÁRMÁN LINE 100 KM MSL
CAPSULE SEPARATION
BOOSTER FREEFALL
MAIN ENGINE CUT-OFF
DRAG BRAKES DEPLOY
MAX-Q
ENGINE RELIGHT
DROGUES DEPLOY
BOOSTER TOUCHDOWN
RSS FIRST STEP RETURNS HOME
LAUNCH SITE ONE 3,700 FT ABOVE SEA LEVEL
T-00:00
T+02:45
LANDING PAD 2 MILES NORTH OF LAUNCH
T+07:00
T+07:30
CAPSULE LANDING
T+10-12:00


HIGHLIGHTS

Blue Origin Crews

Scope of this class

Space Exploration and Research Agency (SERA)

// 01

OUR FIRST MISSION

In June 2022, Victor Hespanha, a 28-year old civil engineer from Belo Horizonte, Brazil, was selected from the SERA community to travel to space onboard Blue Origin's 21st New Shepard mission. He became the second Brazilian astronaut and a national hero.

The mission's success of this Mission opened the door to a new partnership with Blue Origin, and the launch of a new human spaceflight program.

Victor now works for SERA full-time as a science communicator, business development lead for South America, and a beacon of Brazil's new space economy.

Victor's Instagram

Space Exploration and Research Agency (SERA)

// 02

OUR NEXT MISSION

SERA has partnered with Blue Origin to develop a human spaceflight program to provide the opportunity for everyday citizens from around the world to become astronauts and participate in space science.

SERA has reserved six seats on an upcoming New Shepard flight. Six individuals will become astronauts, some will be their nation's first.

LEARN MORE

SERA Trailer

https://vimeo.com/939453383

Space Exploration and Research Agency (SERA)

// SUIT.UP

CREW SELECTION

We are giving 6 members of the global public, selected mainly from the 150 countries that have never had an astronaut, the opportunity to go to space on Blue Origin's New Shepard rocket.

5 SEATS

For citizens of Nations that have had no or very few astronauts

1 SEAT

For everyone else on the planet

0 BIAS

Unlike human spaceflight programs of the past, there is no 'finger on the scale' of astronaut selection

The final crew is voted by you

Space Exploration and Research Agency (SERA)

SERA Opens Up Space Exploration and Scientific Research to the World

Research partnerships with the Mason Lab at Weill Cornell Cornell Medicine and the Overbey Lab at UATX invite community-driven experiments on an upcoming Blue Origin mission

October 24, 2024 - The Space Exploration & Research Agency (SERA) today announced research partnerships with Weill Cornell Medicine and the University of Austin (UATX) for its upcoming mission with Blue Origin to bring underrepresented nations to space. The mission's crew of citizen astronauts will help conduct biomedical experiments during the spaceflight chosen and designed by the global public.

Historically, scientific research in space has been confined to narrow academic disciplines and limited to a few select countries. More than 80% of astronauts have come from just three countries. SERA is aiming to break down structural barriers to space and make spaceflight and scientific research more accessible and inclusive.

Earlier this year, SERA formed a strategic partnership with Blue Origin to purchase six seats onboard a Blue Origin New Shepard rocket. Five of the seats are allocated to partner nations that have never had an astronaut or very few. The sixth seat will be open to a person from any partner nation. Anyone can apply and be selected by the voting public.

Now, SERA is announcing research partnerships with the Mason Lab at Weill Cornell Medicine and the Overbey Lab at the University of Austin (UATX), preeminent institutions in space research, that will empower the public to participate in scientific research during the mission. Each of the six seats will be allocated a series of both autonomous and astronaut-tended experiments. These experiments will focus on the effects of microgravity on human physiology, cell biology and fluid dynamics, to better understand the human experience in space.

2 Competitions

EXPERIMENT COMPETITION

SERA will be giving its members the opportunity to propose and select the science experiments the crew will perform while in space. All submissions will be curated by partner space agencies and research institutions, with the final selection made by SERA members.

There will be three areas of experimentation:

CELLULAR BIOLOGY

Autonomous experiments exploring the effects of microgravity on biological cell structures

FLUID DYNAMICS

Astronaut-tended experiments exploring new ways to experiment with fluids in space

HUMAN PHYSIOLOGY

Wearable, sensor-based experiments examining the effects of suborbital flight on the human body

Fluid Dynamics Competition

Objective
To design a 1.5mL Eppendorf tube that can securely contain liquids in microgravity, preventing spillage during handling in space.

Design Requirements

1. Containment:
   - The design must prevent liquid from floating out of the tube in microgravity conditions.
   - Must include a snap cap that ensures a tight seal.
2. Size and Volume:
   - The tube must have a minimum volume of 1.5mL and maximum volume of 2.0mL.
3. Ergonomics and Usability:
   - The tube should be easy to handle with gloved hands.
   - The design should facilitate easy filling and extraction of liquids using a pipette.
   - Consideration will be given to the visibility of the liquid level inside the tube.
4. Microgravity Adaptations:
   - Designs must address the challenges of fluid behavior in microgravity, such as surface tension and capillary action.
   - Innovative features to ensure liquid stability inside the tube are encouraged.

Submission Requirements

1. CAD Model:
   - Submit a 3D CAD model in a commonly used file format (e.g., STL, STEP).
   - Include detailed annotations and measurements.
2. Design Description:
   - Provide a written description of the design, explaining how it meets the competition objectives and requirements.
   - Highlight the innovative features and how they address microgravity challenges.

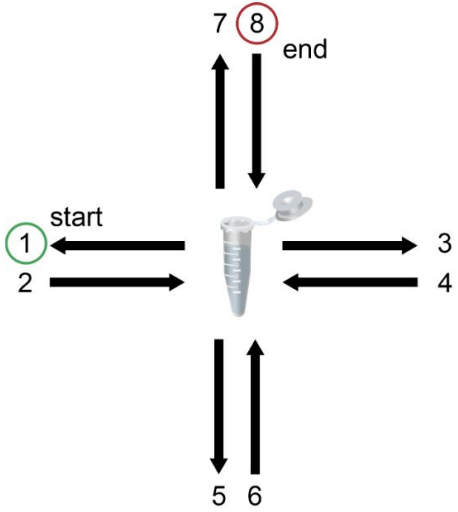
Fluid Dynamics Competition

Testing Criteria
The top-scoring design from each nation will be selected for the First of Nations mission on the Blue Origin New Shepard.

Three of each tube type will be 3D printed at UATX. Each tube will contain a different volume to be tested in-flight:
Tube 1: 0.5 mL
Tube 2: 1.0 mL
Tube 3: Maximum capacity (1.5-2.0 mL)

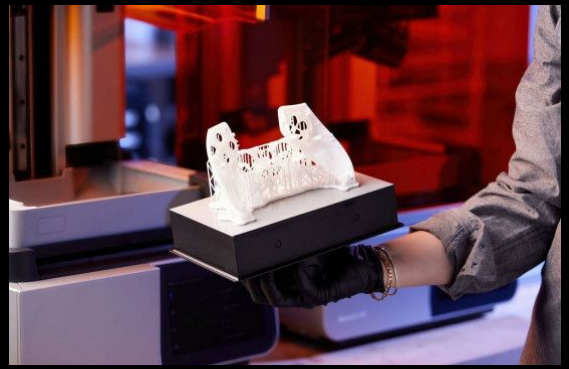
To test the selected designs, crew will perform a series of movements in microgravity and record the movement of fluid in the tubes.

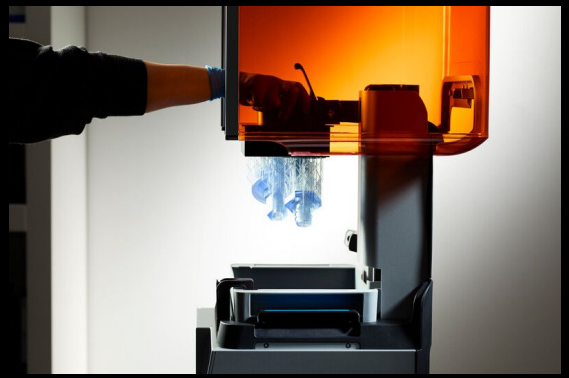
Microgravity Movements

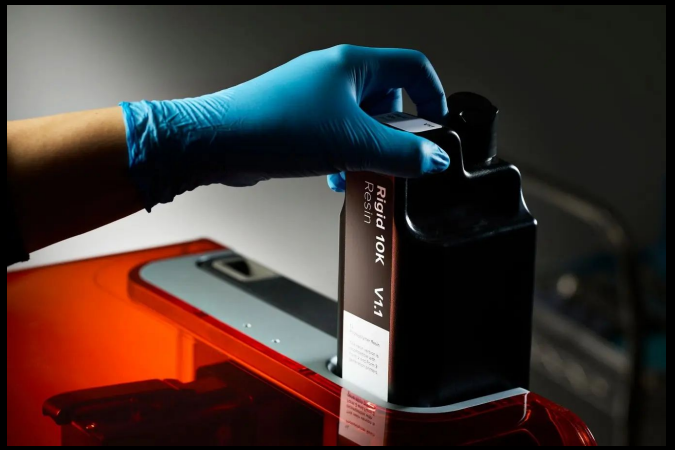


Movements will be performed in individual, discrete movements, with a 1 second pause between each motion.

Form4



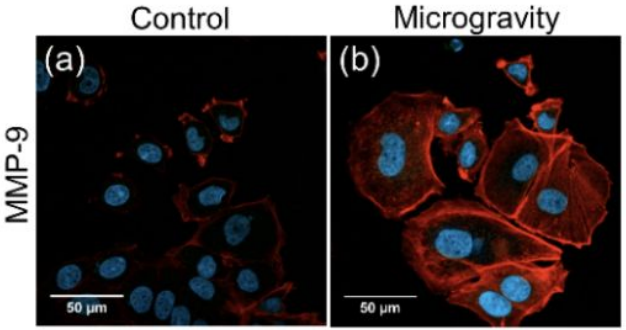




Cell Biology Competition

Experiment Type: Passive (Under the Seat)

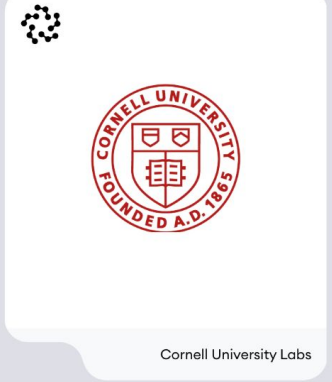
The impact of microgravity on cellular morphology is a critical area of study in the context of space exploration and its implications for human health. In the unique environment of microgravity, cells undergo notable changes in their shape and internal structure. Research has shown that these alterations are particularly evident in the organization and function of the cytoskeleton, the structure that maintains cell shape and integrity. For instance, studies have documented the rearrangement of key cytoskeletal components such as F-actin and tubulin in cancer cells exposed to microgravity conditions, leading to changes in cell shape, size, and adhesion. These changes are not just limited to cancer cells; various types of cells, including immune and endothelial cells, have exhibited significant cytoskeletal remodeling when subjected to the microgravity environment. This body of research is crucial for understanding how microgravity affects cellular behavior and function, and for preparing for the potential health challenges associated with long-term space missions.



Space Exploration and Research Agency (SERA)

Partners

We're proud to share who is helping make this historic mission happen



Course Objectives

50%

Fluid Dynamics Competition Proposal

- Creating a novel design
- Entering your design into the SERA competition
- Class Presentation on your final printed design

50%

Readings, Reflections, Quizzes, Essays

Next Class: Talk and Q&A with SERA Founding Team