



ISS NATIONAL LABORATORY®
CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE®

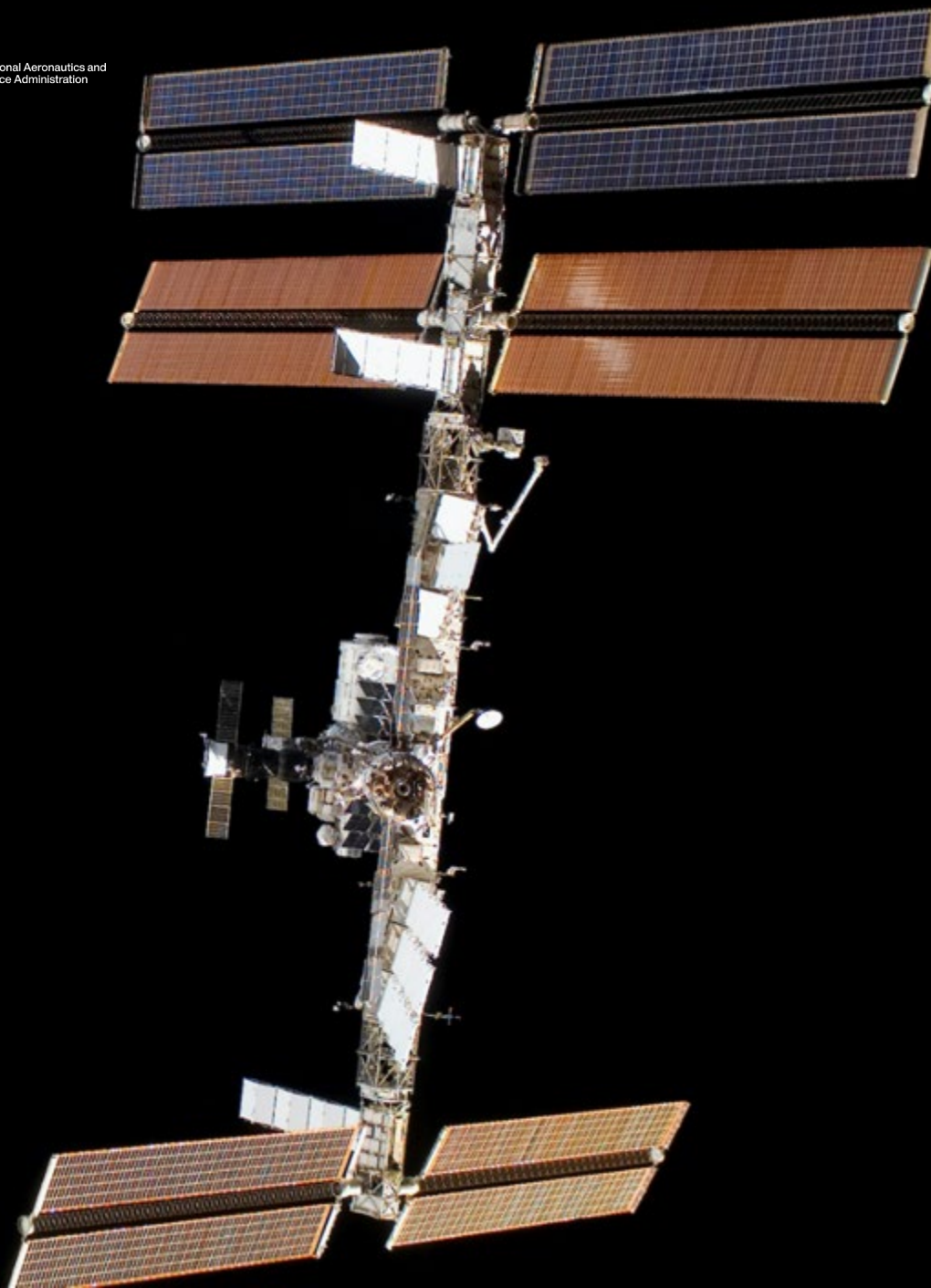
Models and Outcomes of Public-Private Partnerships on the International Space Station

CBPSS Fall 2025 Meeting

Michael Roberts, PhD
Chief Scientific Officer
ISS National Lab



National Aeronautics and
Space Administration



SPACE STATION TODAY

We are in the third, most productive, and final decade of the ISS ... a *Decade of Results*

- Focused on science to advance human exploration, benefit humanity, create economic value for the nation, and expand commercial utilization and partnership

ISS is busier today than ever before

- Crew time utilization for research has been at an all-time high

Research in low Earth orbit (LEO) maintains U.S. leadership in space, supports NASA's exploration strategy, and benefits life on Earth

- The ISS is the premier, continuously-crewed, multi-user μg platform in space enabling research in the unique LEO environment.
- Lessons learned from nearly 25 years of ISS operations and research inform the next generation of exploration destinations.

2024 Visiting Vehicles

CARGO

CREW



Ax-3



NG-20



**Progress
87**



Crew-8



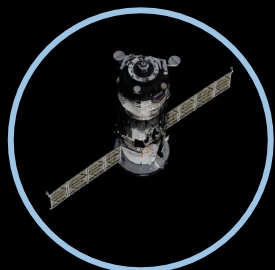
SpX-30



**71
Soyuz**



**Boeing-
CFT**



**Progress
88**



NG-21



**Progress
89**



**72
Soyuz**



Crew-9



SpX-31

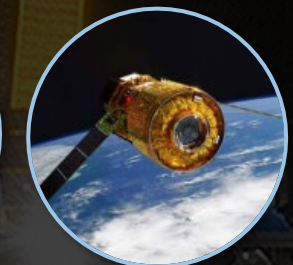


**Progress
90**

2025 Visiting Vehicles

CARGO

Cygnus XL



NG-23

SpX-32

SpX-33

HTV-X1

DCC-1

~~NG-22~~



Progress
91

Progress
92

Progress
93

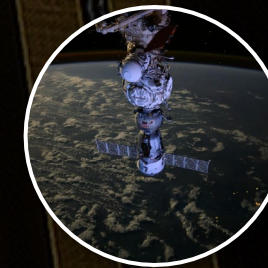
CREW



Crew-10

Crew-11

Ax-4



73
Soyuz

74
Soyuz

Starliner-1

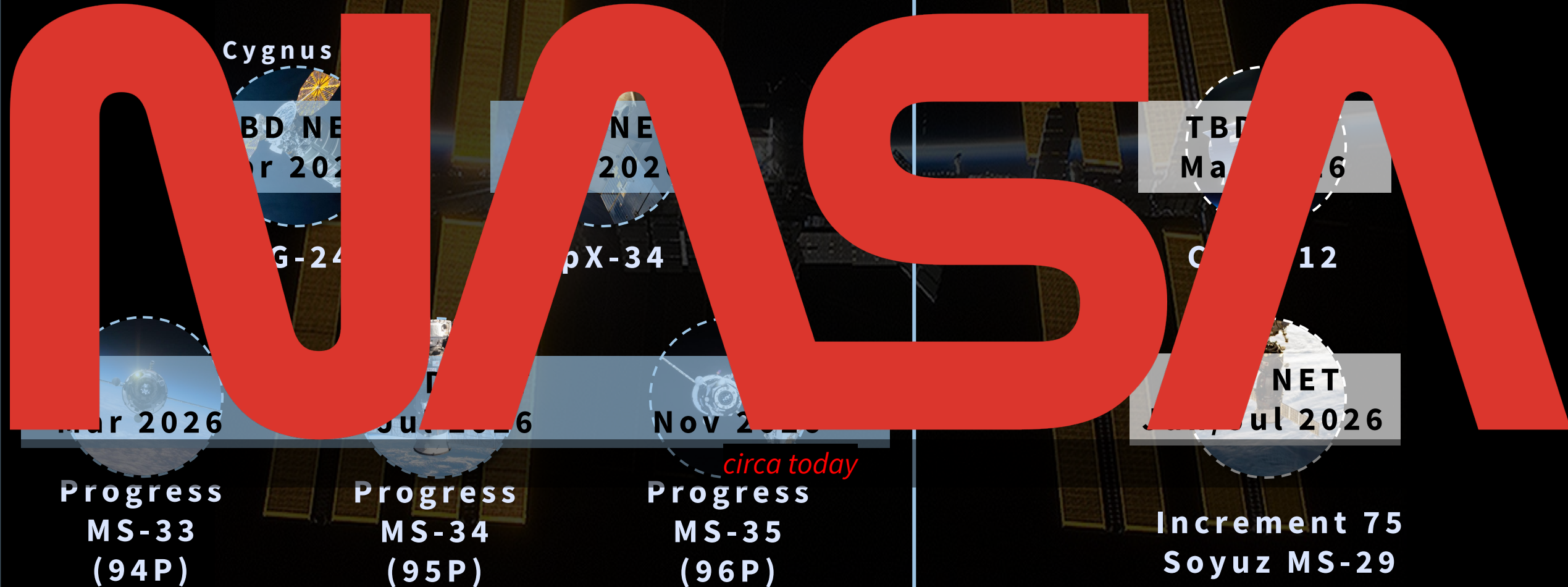
2026 Visiting Vehicles (pre-decisional; subject to change)



National Aeronautics and
Space Administration

CARGO

CREW





ISS NATIONAL LAB MISSION TODAY

...manage the premier space laboratory, providing expertise, connection, and inspiration to visionaries.

Why maintain a National Lab in LEO?

Research in low Earth orbit not only **enables exploration**, but it also **accelerates scientific discovery** for the translation of observations into applications for humanity that improve health outcomes on Earth, **fuels innovation** in manufacturing and in materials science, and **creates economic value** for the nation.

INTERNATIONAL SPACE STATION NATIONAL LABORATORY TIMELINE

2011

NASA awards the Center for the Advancement of Science in Space (CASIS) a Cooperative Agreement to manage the ISS National Lab in partnership with NASA to broadly:

- Sustain access to LEO for full utilization of the ISS to enable research and technology development that benefits humanity,
- Expand commercial presence in LEO to explore the viability of and lay the foundation for sustainable economic activities in space.

2010

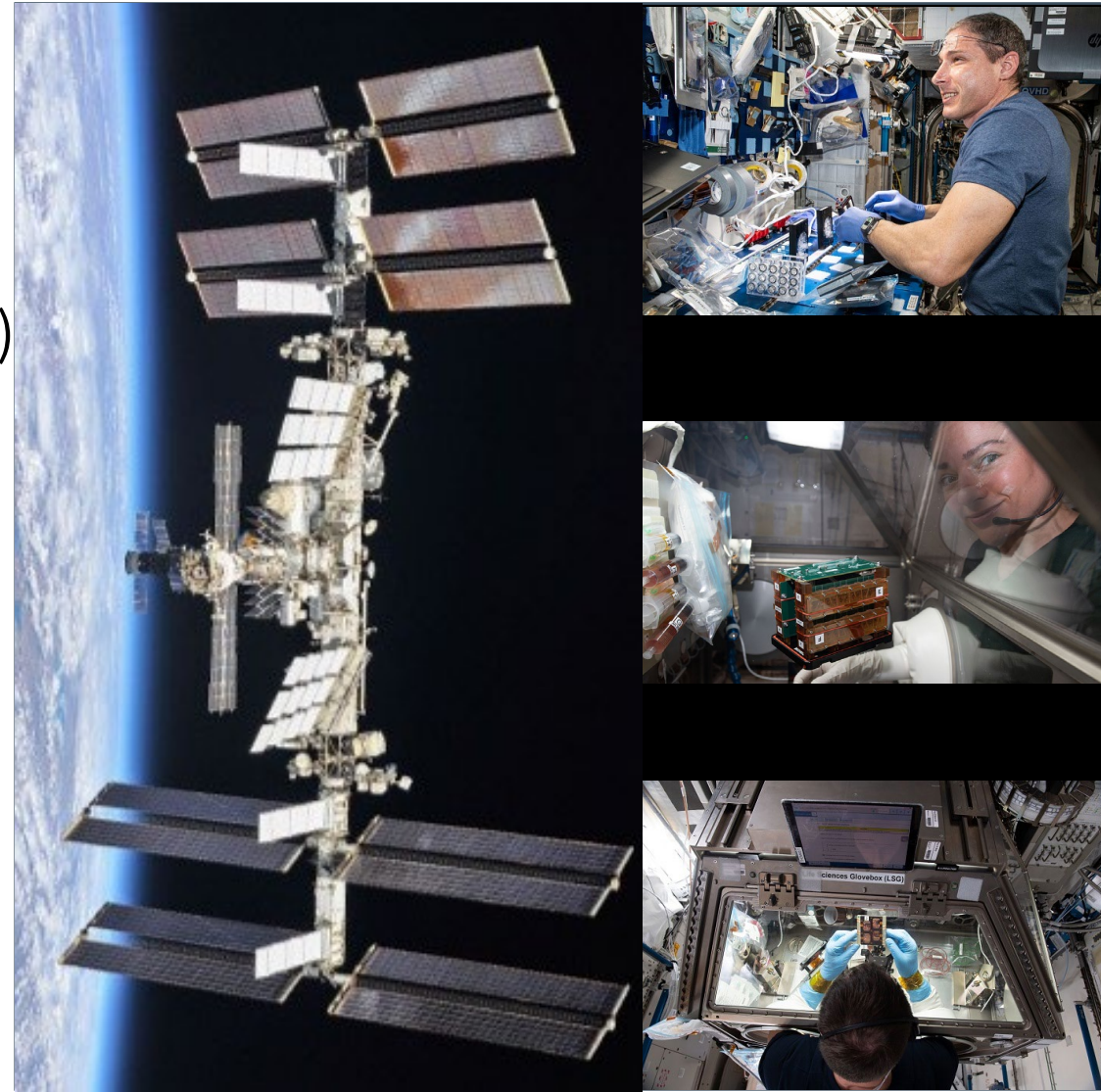
Congress directs NASA to partner with a not-for profit entity and guarantee access to, and utilization of, not less than 50% of the U.S. research capacity allocation, including power, cold stowage, and crew time onboard ISS.

2005

Congress designates the U.S. segment of the ISS as a national laboratory

ISS National Lab Model: Portfolio by Strategic Focus Area

- Fundamental Science (Interagency Partnerships)
- Igniting Innovation to Cure Disease
- In-Space Production Applications (InSPA)
- Technology Development & Demonstration
- Commercial Service Provider Utilization
via Resource Request Form (RRF) submission



ISS National Lab Model: Portfolio by Ecosystem Partner

Academic

- U.S. Universities and Colleges (i.e., IHEs)
- Not for profit research institutions

DEMAND

Commercial

- Implementation Partners, Commercial Service Providers (CSPs), Commercial LEO Destination developers (CLDs) and space-as-a-service adjacent companies

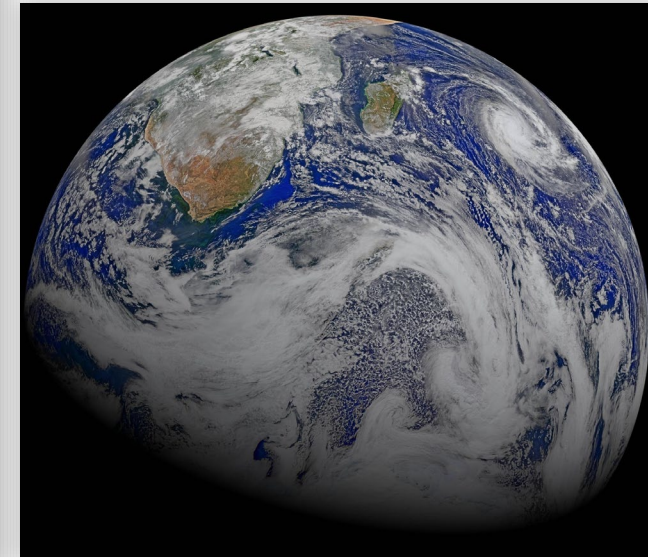
SUPPLY

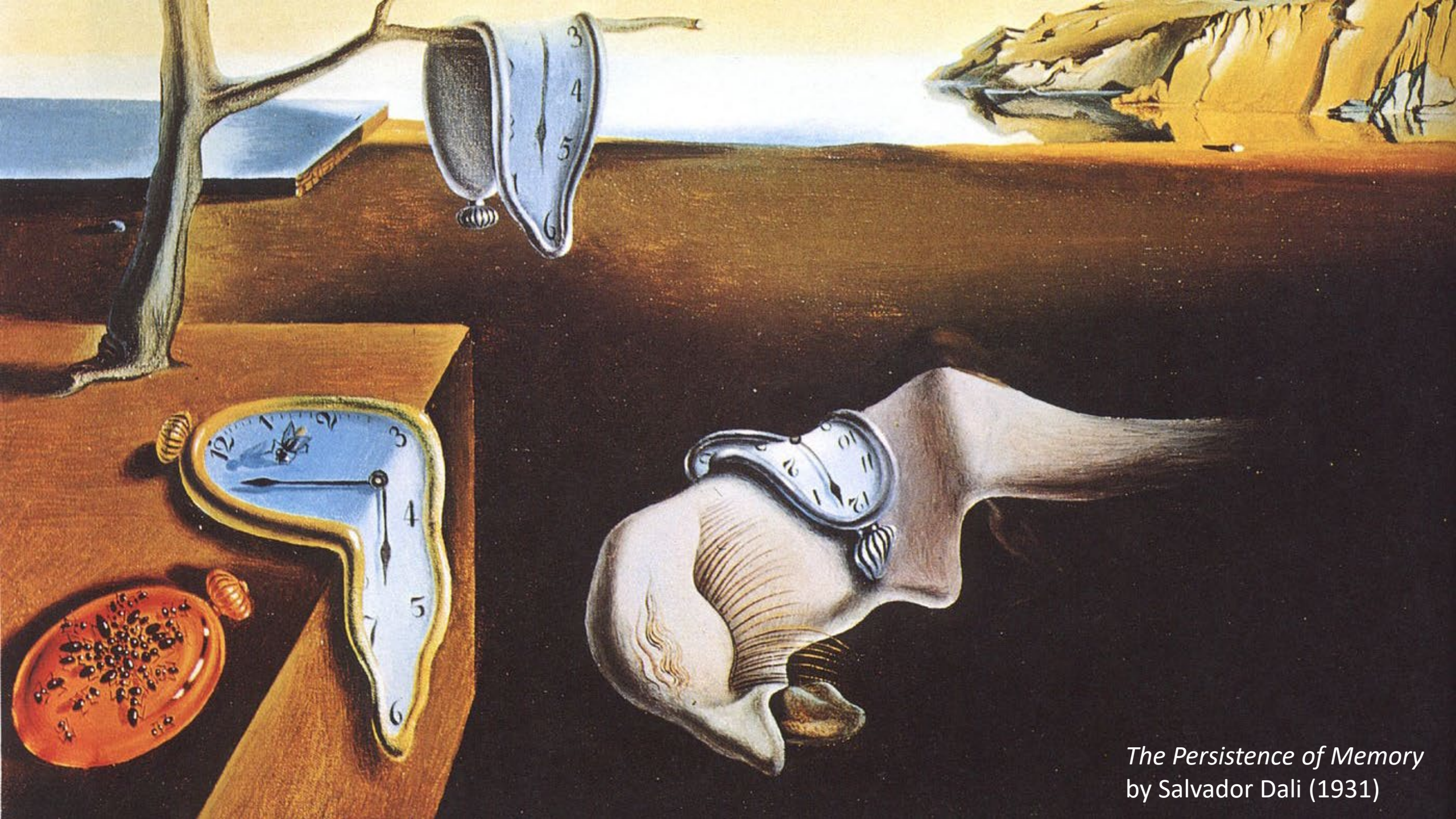
- **SUPPLY and DEMAND**

Government

- Other U.S. Government Agencies (OGAs) and NASA

DEMAND





The Persistence of Memory
by Salvador Dali (1931)

circa 2010

circa 2010



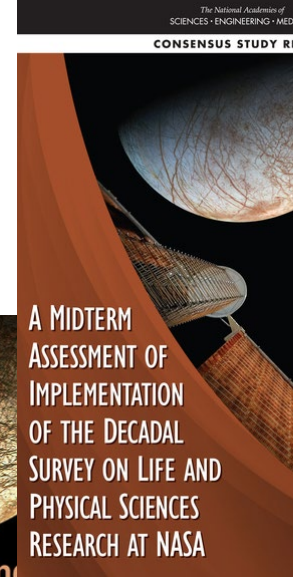
Historically, the Decadals from the National Academies have informed the ISS National Lab science portfolio

- Key recommendations across the decadals informed research priorities for the ISS National Lab portfolio:
 - ISS and future LEO platforms should support **national research priorities** for the advancement of science, technology, engineering, and education to maintain U.S. leadership in space and benefit humanity.
 - NASA and the ISS National Lab should **strengthen relationships with other government agencies** (and across NASA divisions) to sustain R&D continuity in LEO, accelerate infrastructure development, and facilitate the growth of public and private investment in LEO.

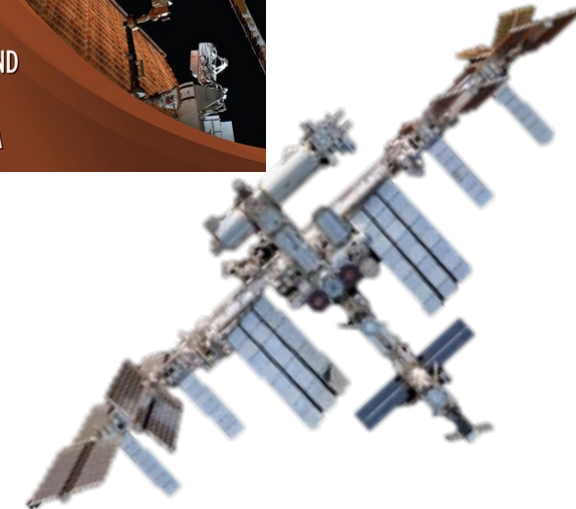
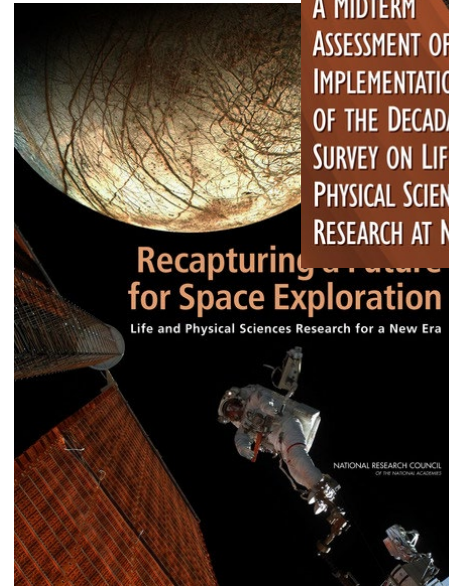
2023



2018



2011





NASA

circa December 2024

THE LEO MICROGRAVITY STRATEGY

- **ADVANCE** GLOBAL SCIENCE & TECHNOLOGY GOALS
- **FOSTER** INTERNATIONAL PARTNERSHIPS
- **REVOLUTIONIZE** A COMMERCIAL LOW EARTH ORBIT ECONOMY
- **INSPIRE** FUTURE GENERATIONS TO IMPROVE THE WORLD THROUGH SPACE ENDEAVORS

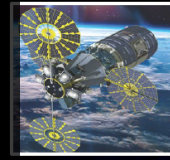


circa December 2024

- NASA is one of many customers in a robust low Earth orbit economy
- Commercially-owned and operated transportation for cargo and crew
- Commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective
- Regular production, distribution, and trade of goods and services
- Ongoing research and science activities including a LEO National Lab
- Continuation of human spaceflight exploration objectives
- Sustained presence and U.S. leadership in LEO

Slide courtesy of NASA.

COLLABORATIONS FOR COMMERCIAL SPACE CAPABILITIES



Northrop Grumman



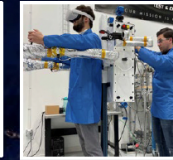
Blue Origin



Sierra Space



SpaceX



Special Aerospace Services



ThinkOrbital Inc.



Vast Space LLC

COMMERCIAL CARGO & CREW TRANSPORTATION

Operational



Northrop Grumman

Final Dev



SpaceX



Sierra Space

Operational



SpaceX

Final Dev



Boeing

Concept Maturation



Sierra Space

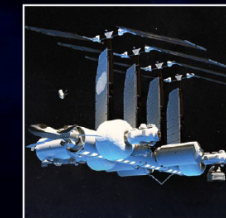


Blue Origin

COMMERCIAL LEO DESTINATIONS



Axiom Station
Axiom Space



Orbital Reef
Blue Origin



Starlab
Airbus, Nanoracks, Northrop Grumman, Voyager Space

MORE ELEMENTS OF A STRONG LEO ECONOMY



Private Astronaut Missions & Space Tourism



Commercial Marketing, Advertisement & Entertainment Activities



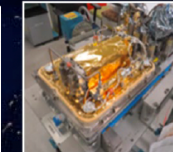
Inspiration for Student STEM Activities



Technology Demonstrations



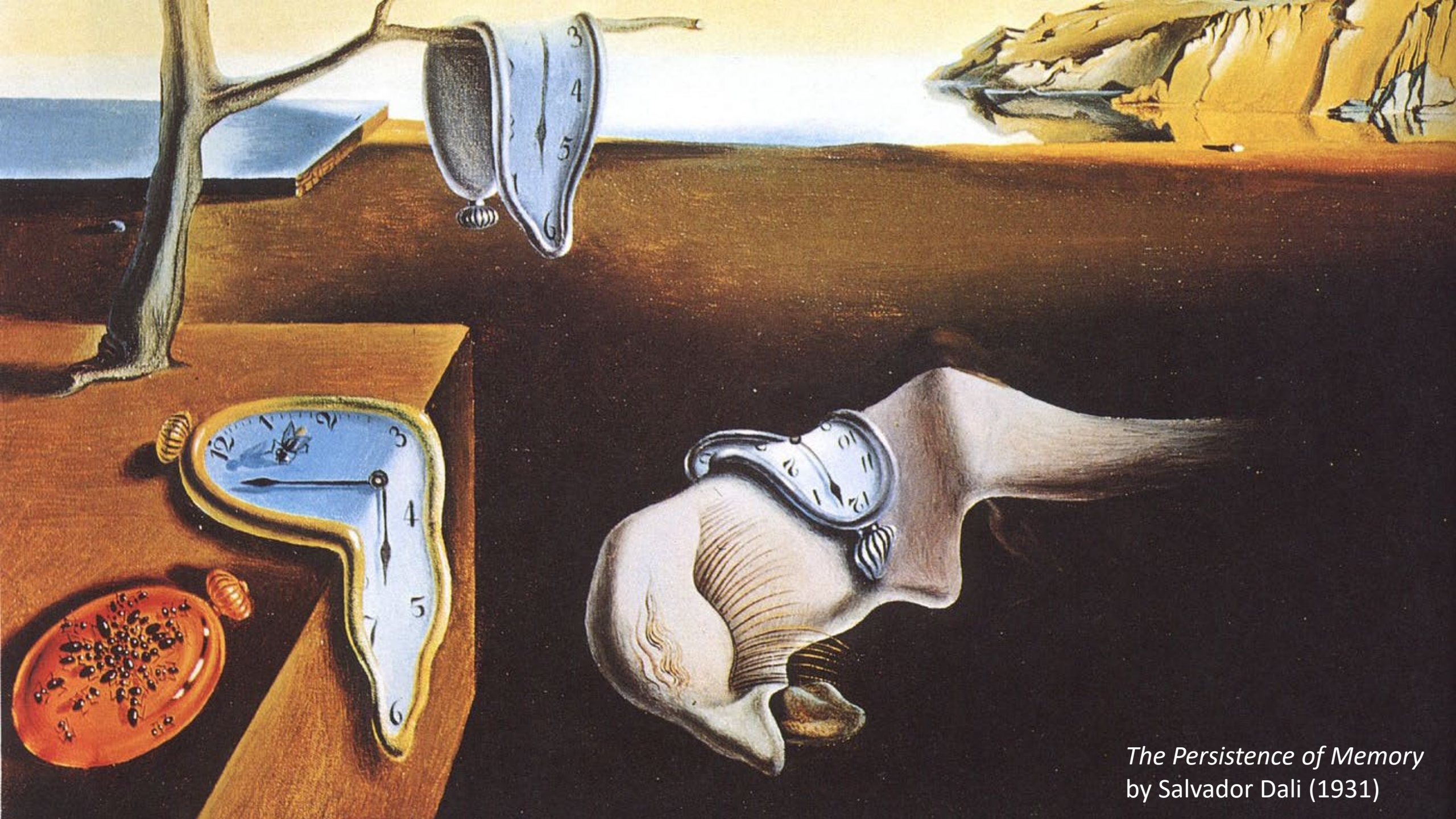
In-Space Manufacturing & Production



LEO National Lab

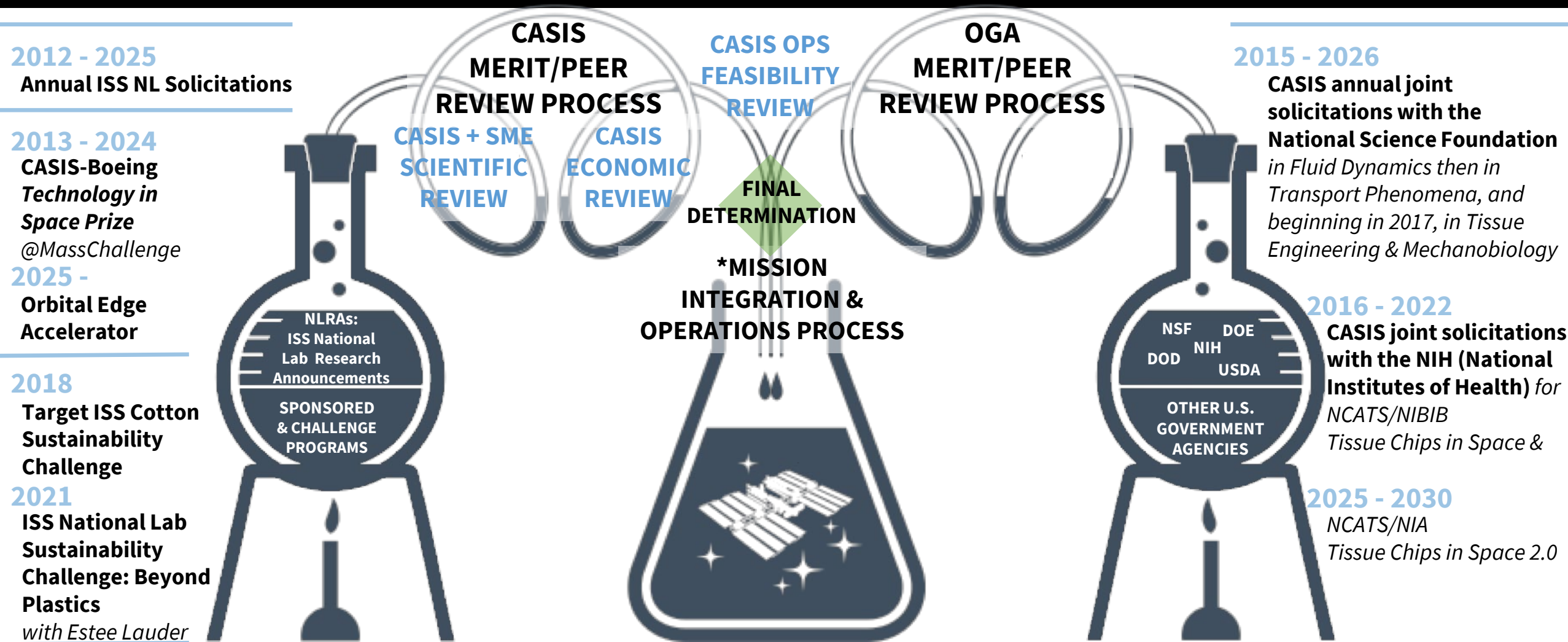


Human Research



The Persistence of Memory
by Salvador Dali (1931)

The ISS National Lab Review Process



*CASIS + NASA + Implementation Partners and Commercial Service Providers:

Payload Development → Prioritization → Mission Integration → Launch to ISS → On Orbit Operations → Return of data and/or samples

circa 2016

ISS National Lab Portfolio by Strategic Focus Area

- Fundamental Science (Interagency Partnerships)

- Igniting Innovation to Cure Disease

- In-Space Production Applications (InSPA)

- Technology Development & Demonstration

- Commercial Service Provider Utilization
via Resource Request Form (RRF) submission



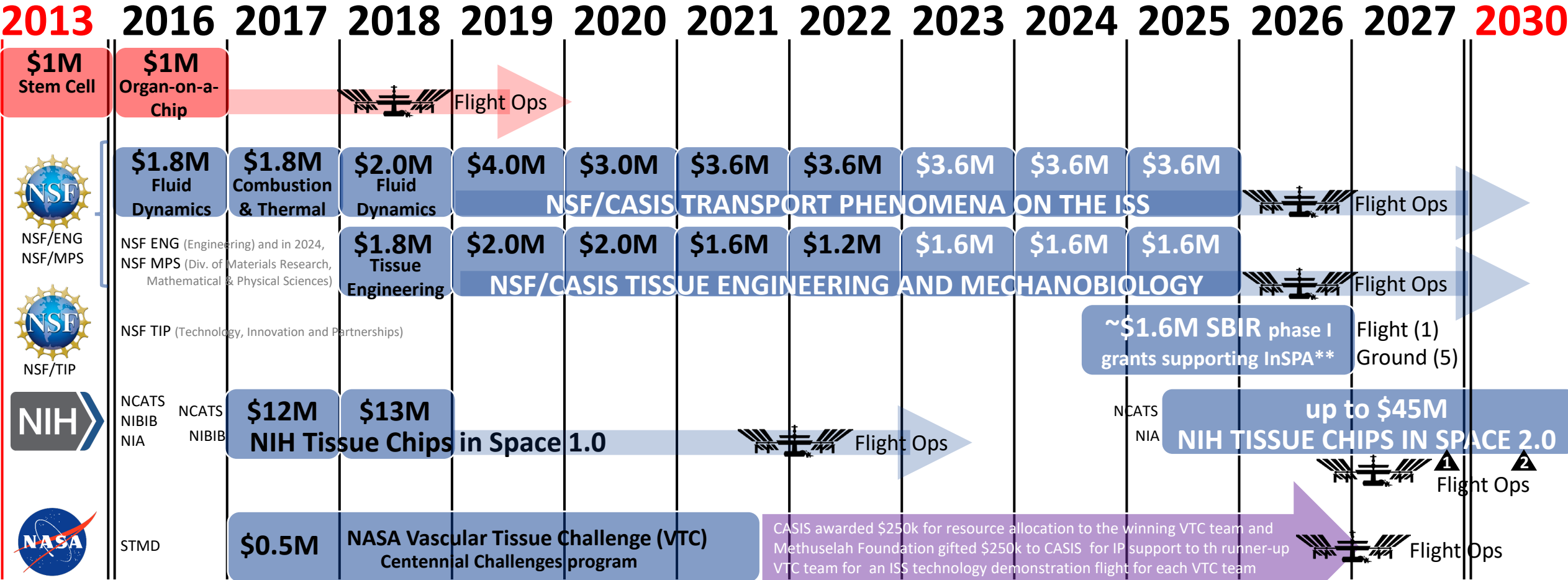
Other Government Agency (OGA)* Sponsored Research with the ISS National Laboratory



ISS National Lab funding

Other Government Agency funding

Public:Private funding



* Funding committed by a U.S. Government Agency other than NASA SOMD (Space Operations Mission Directorate) for research on the ISS sponsored by ISS National Lab.

**Phase I NSF seed funding (SBIR/STTR) in the NSF Space (SP) technology topic area supporting NASA-ISS National Lab InSPA related projects.

Accelerating Space Economy: “More Shots on Goal”

NSF, NASA, ISS and other agencies (e.g. DARPA, Air Force) have funded higher throughput approaches



Innovating a national level acceleration model in space:

- Exceptional opportunities for advantage and benefits across CHIPS and science technology (biotechnology, semiconductors, energy, communications...).
- Opportunity to prioritize highest potential impact commercially focused R&D
- Potential for more wins and impacts faster, by developing more in parallel, data sharing and information
 - Hundreds of entities interested in space commercialization and R&D
 - Need to incorporate diverse and rich skills from other terrestrial areas of expertise (AI, robotics, advanced materials, bio, energy...). Building “plug and play” ramps into space R&D (without in-depth space expertise)
- Ability to amplify through AI, data sharing and fast iteration
- Make the most of limited assets (space and time constrained)
 - LEO platforms (such as ISS) are constrained (container sized modules), so enhanced prioritization and speed of throughput enable us to make the most of the valuable microgravity environment
 - Expansion of what is possible in a given space/time expected to be even more important on Mars (& Moon potentially)
- Opportunity for enhanced capital formation and tools to facilitate build out

Launch Cadence:

Stoke Space

Building towards rocket reusability and daily access

Rocket Propulsion Systems

Lower cost engines and capsule cost that are customizable and rapidly scalable for manufacturing

Communications:

Swarm (SpaceX acquired)

Cube satellite swarms enabling higher connectivity, expanding global internet access

Flawless Photonics

Higher throughput production of ZBLAN fiber in-space (kms), potential for repeaterless undersea cables

Biotechnology:

Rhodium Scientific

Building an in-space biobank to increase access and usability

Space Tango

Expansion of cryovial biology throughput to many hundreds per unit

Semiconductors:

United

*Semiconductors
Building microgravity equipment to accelerate many semiconductors in parallel*

Miniaturization:

Matiq

Ability to screen orders of magnitude higher materials

AI/Data & Cyber

NDF

Consortium working group focused on high throughput in-space manufacturing

ForwardEdge AI

Cybersecurity for data sharing across in-space assets, enabling higher levels of exchange



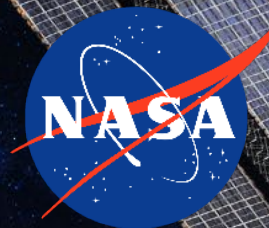
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Igniting Innovation: Science in Space to Cure Disease on Earth, A partnership between BPS and ISSNL

NLRA 2023-10

Cancer Moonshot and projects to accelerate the translation of stem cell- and organoid-based disease models and advanced technologies for biomanufacturing.

NLRA 2024-9

Cancer and Neurodegenerative Diseases

2024 Igniting Innovation Awards

- **Cedars-Sinai Medical Center:** Aims to grow cardiac spheroids with blood vessels from induced pluripotent stem cells in space for cardiovascular disease modeling and to test how cancer drugs affect the heart.
- **Easra Biotech & University of Connecticut:** Seeks to produce cancer therapeutics in space using Janus base nanomaterials (JBNs) designed to target drug delivery to solid tumors, improving cancer treatment and reducing side effects.
- **University of California, San Diego:** Seeks to use patient-derived tumor organoids to study accelerated cancer development in microgravity and identify new cancer therapeutic targets.
- **University of Texas MD Anderson Cancer Center:** Aims to use microgravity to better understand how T cells work and develop new immunotherapy treatments for cancer and autoimmune diseases.
- **Wake Forest Institute for Regenerative Medicine (WFIRM):** Seeks to use organoids created from cells recovered from colorectal cancer patients to develop improved chemotherapies.



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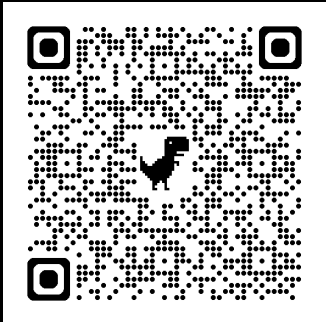
Partnering with the NASA InSPA program to Accelerate Advanced Manufacturing & Biomanufacturing

- As of the end of FY2025, NASA and the ISS National Lab have invested over \$75M and awarded over 25 InSPA awards via NRAs and NLRAs to U.S. entities seeking to demonstrate the production of advanced materials and products on the International Space Station.
- InSPA awards help companies raise the technological readiness level of manufacturing processes and products by leveraging μg to accelerate their transition to market, propelling U.S. industry toward the sustainable, scalable, and profitable demand for services and products manufactured in low Earth orbit for use on Earth.

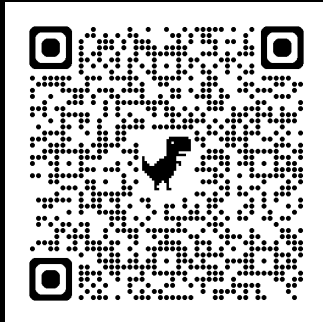


InSPA: In Space Production Applications

- Investing in scalable, sustainable, and economically viable manufacturing technologies to create microgravity-enhanced products that support Earth markets and ignite innovation in LEO
 - ↑ Return of direct benefits to humanity by improving manufacturing processes and products for terrestrial and space applications
 - ↑ U.S. competitiveness in industries that serve national interests
 - ↑ U.S. leadership in LEO thru public-private partnerships enabling commercialization
- Aligned to National Priorities
 - CHIPS & Science Act (i.e., semiconductors)
 - Cancer Moonshot
 - Domestic Biomanufacturing
 - Maintaining U.S. Preeminence in LEO



InSPA @ISS National Lab



InSPA @NASA.gov

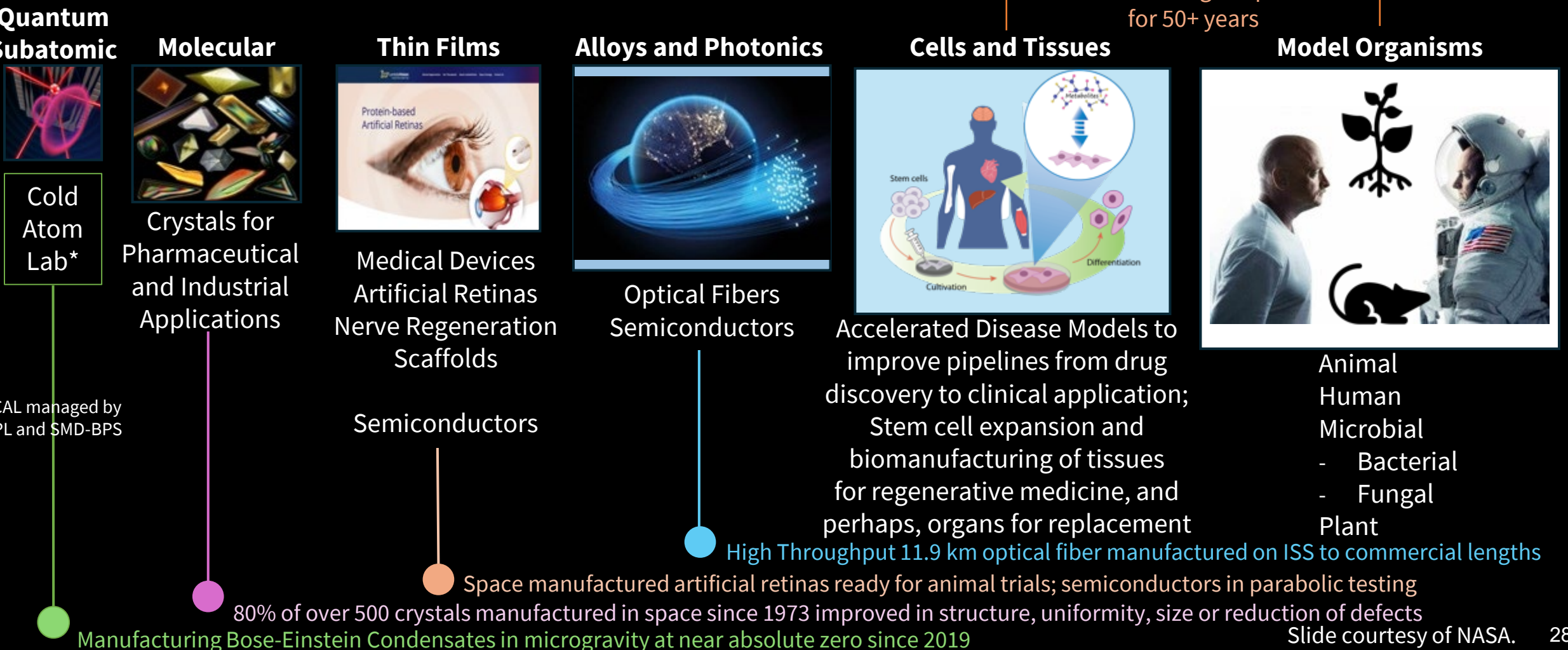


In Space Production Applications (InSPA): Leveraging LEO To Benefit Humanity



National Aeronautics and
Space Administration

Translating over 50 years of human exploration and space research into transformational new technologies with high-value applications on Earth... scaling from subatomic to societal impacts



MassChallenge: Technology In Space Prize

Past Awards

2024

Fourier LLC
RedPoint Oncology

2023

Symphony Biosciences
FluxWorks LLC

2022

MachineBio

2021

Krtrl Inc.
Oculogenex

2019

Axonis Therapeutics
Encapsulate LLC

2018

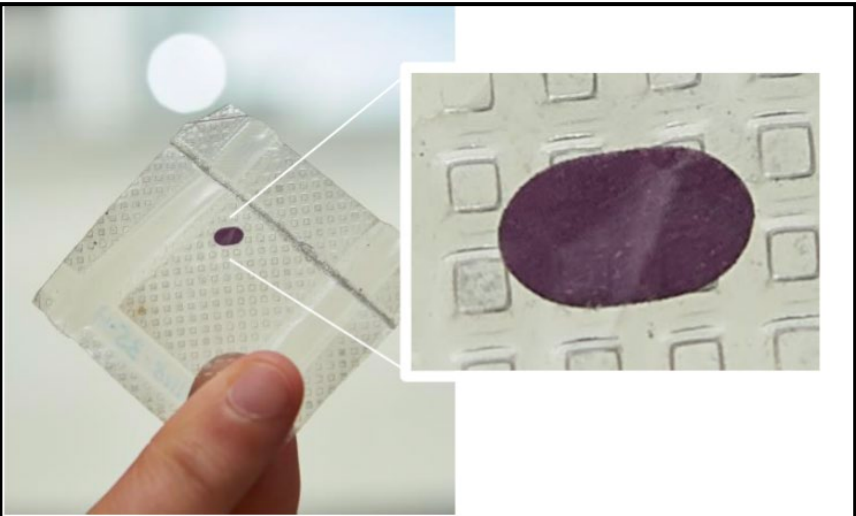
Kernal Biologics, Inc.
MicroQuin

2017

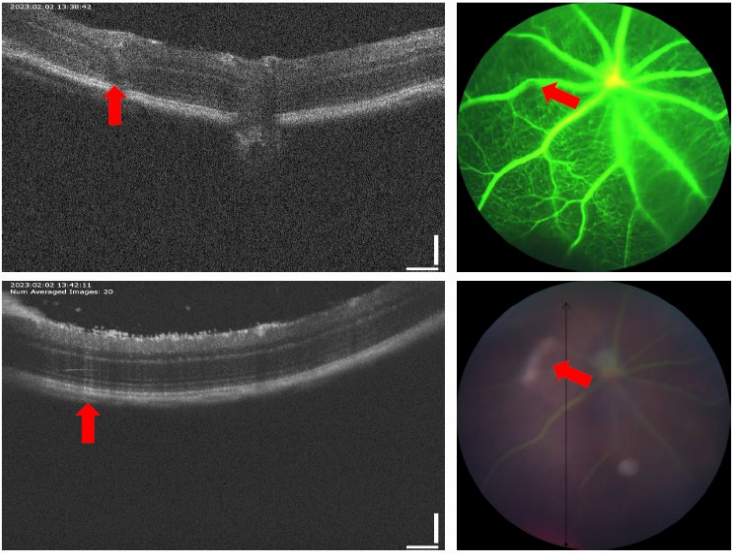
Cellino Biotech, Inc.
Guardian Technologies
MakerHealth

2016

Angiex, Inc.
Dover Lifesciences
LambdaVision, Inc.



LambdaVision, Inc. & Space Tango

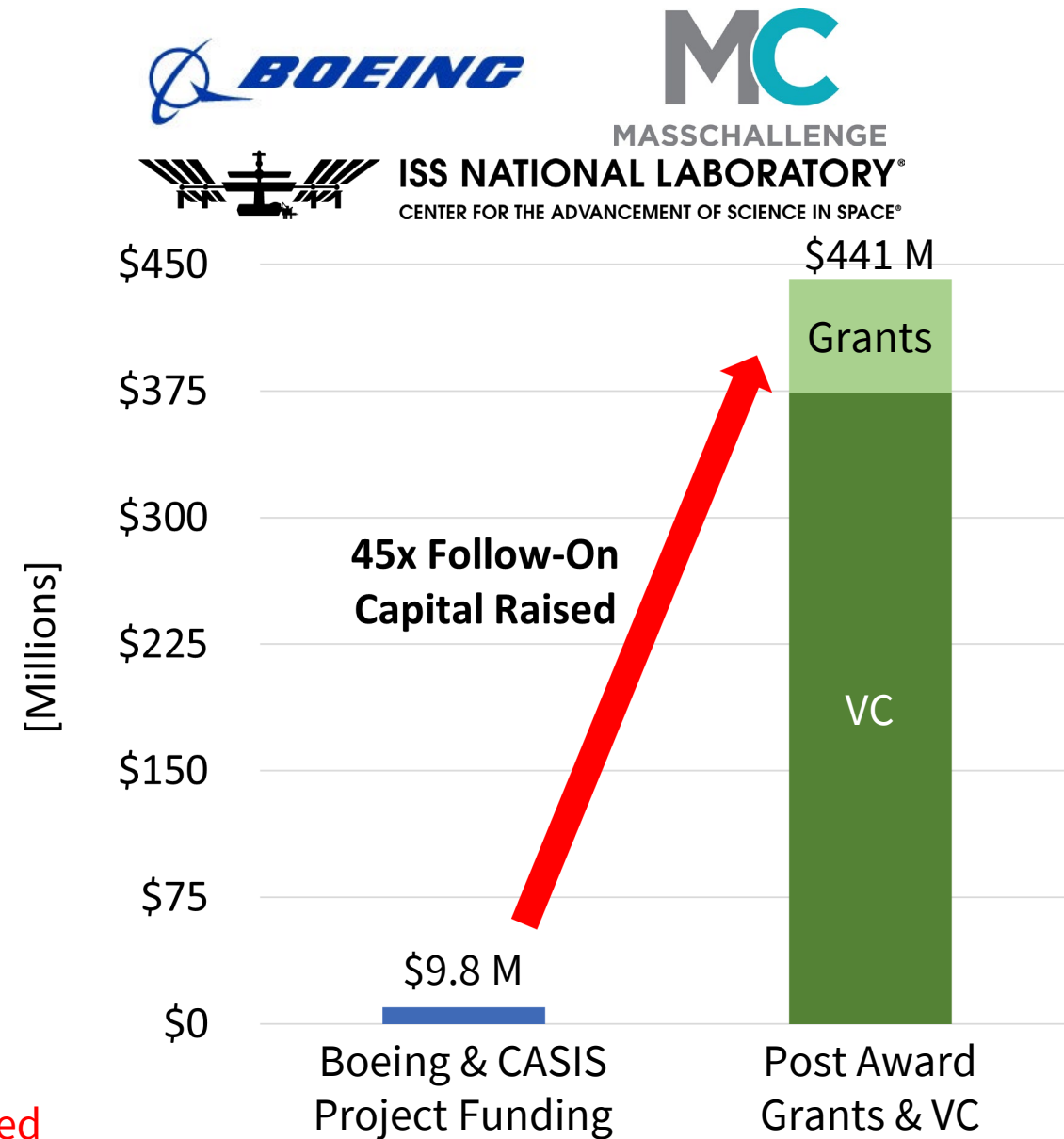


Oculogenex

Oculogenex

Technology in Space Prize (TISP)

- Partnership between CASIS, Boeing, and MassChallenge initiated in 2013
- Enables startups to conduct innovative R&D on International Space Station to benefit life on Earth
- A TISP award provides:
 - Funding that can be used for PI team project costs and/or Implementation Partner (IP) services
 - ISS NL resource allocation for ISS upmass / downmass and astronaut crew time
- Open to all startups that are part of the MassChallenge U.S. Early-Stage Program
 - Not only space-focused startups
- In collaboration with MassChallenge, Boeing and CASIS have awarded almost \$10M to 31 seed-stage companies
- Post award, companies have raised nearly 45x the capital awarded



TISP Follow-On Funding: 2013 to 2024



ORBITAL EDGE ACCELERATOR



POWERED BY



IN PARTNERSHIP WITH



Orbital Edge: Partners and Roles

Role

Partners

Engagement

Startup Investment



Investment partners:

- Commit a specific investment amount of funding and invest into each of the cohort startups in return for modest equity
- Alongside the ISS National Lab, lead startup selection
- Provide mentorship to startup founders
- Support accelerator operations, including funding as needed

Spaceflight



ISS National Lab (ISS NL):

- Supply ISS resource allocation for ISS NL selected projects¹
- Provide flight project-related design and execution mentoring
- Provide operations funding for accelerator program

Operating Services



TechConnect:

- Provide operations and organizational services for the accelerator program for a fee

Marketing Partners / Sponsors



All marketing partners / sponsors:

- Provide funding for various engagements (dinners, happy hours, experiences, etc.)
- Provide mentorship opportunities to founders
- Provide services to startups

1: ISS flights pending ISS National Lab approval at ISS National Lab sole discretion via established review process for Resource Request Forms submitted by Commercial Service Providers (CSPs)

ISS National Lab Portfolio by Strategic Focus Area

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An early example from ISS of the value of in space manufacturing for Earth



November 19, 2024

Media > News releases > News release

Merck Announces Phase 3 Trial of Subcutaneous Pembrolizumab With Berahyaluronidase Alfa Met Primary Endpoints

According to information from Merck, there are currently over **1,600 clinical trials studying Keytruda across a wide variety of cancers and treatment settings.**

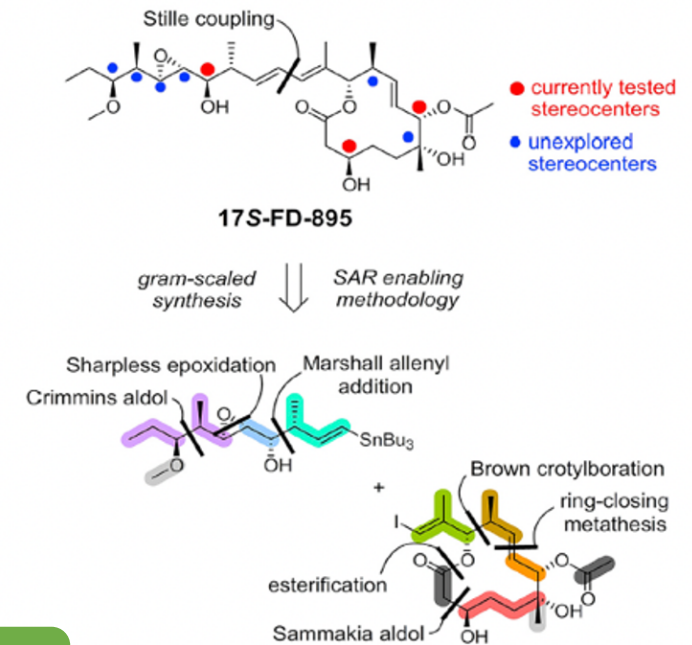
- **Large research program:** Merck has one of the largest immuno-oncology clinical research programs in the industry.
- **Wide range of cancers:** Trials are exploring Keytruda's use in various cancers, including melanoma, non-small cell lung cancer, head and neck cancer, and more.
- **Combination therapies:** Many trials investigate Keytruda in combination with other treatments.

Merck's goal was to produce many crystals of uniform size in space in order to develop a safer and more effective therapeutic formulation to treat cancer. **It worked extraordinarily well.**

Rebecsinib: The First Cancer-Stem-Cell-Targeting-Drug With A Development Path to Clinical Application Accelerated By Space

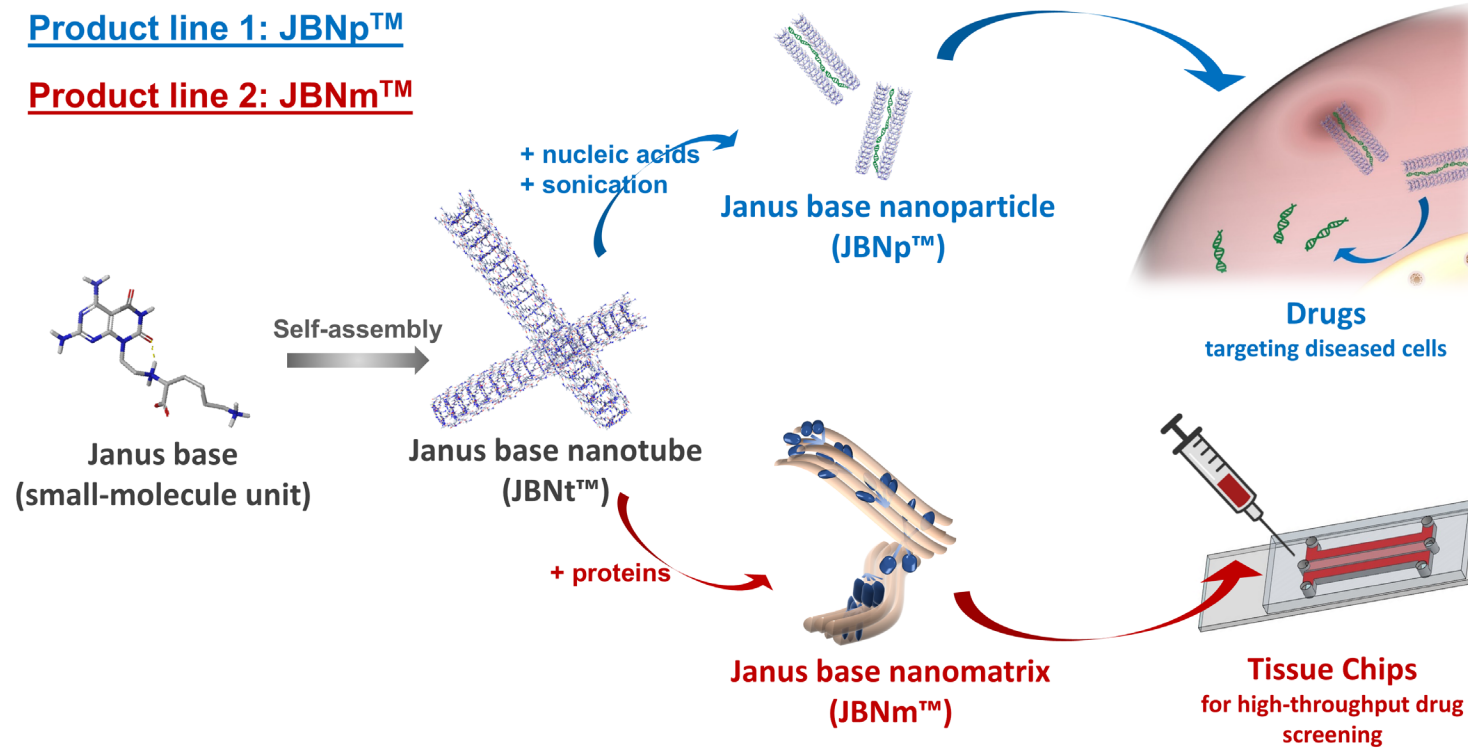
- Potent, first-in-class small spliceosome inhibitor that impairs ADAR1^{p150} isoform generation
- Chemoenzymatic manufacturing process enables cost-effective synthesis, analog development & new composition of matter IP
- Kg batch GMP synthesis nearing completion
- Favorable safety, pharmacodynamic, & pharmacokinetic properties in late-stage IND studies

IND approval from FDA for Phase 1 clinical trials granted March 14, 2025



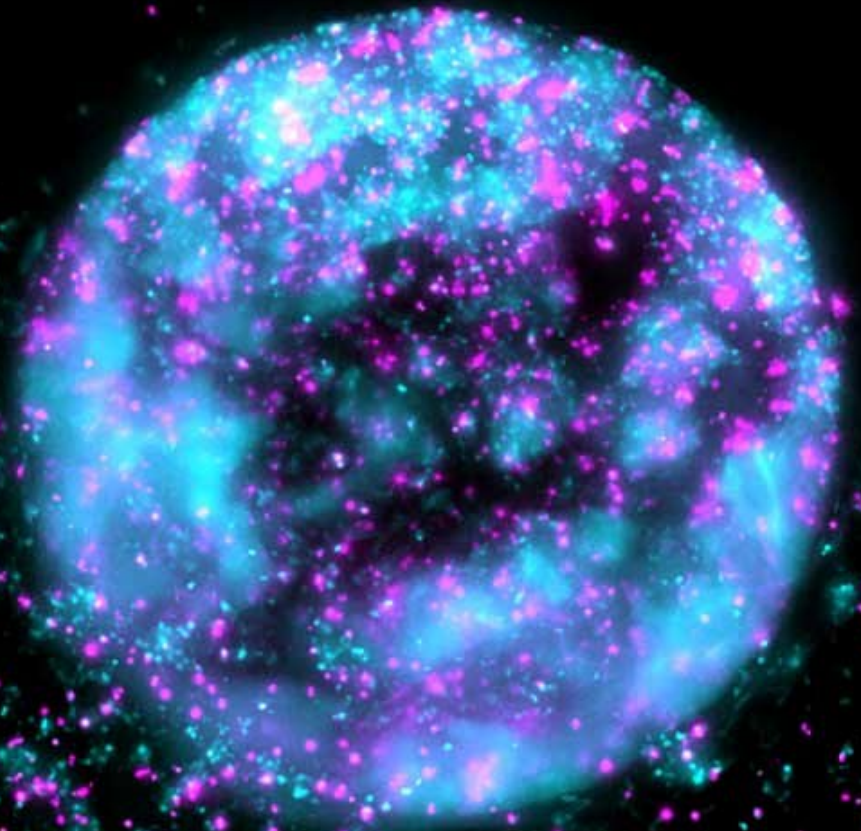
Product line 1: JBNp™

Product line 2: JBNm™



- Eascra Biotech has developed two therapeutics produced and tested in space:
 Janus base nanoparticle (JBNp™) for nucleic acid delivery **treating osteoarthritis and solid tumors**.
 Janus base nano-matrix (JBNm™)—an injectable scaffold—making tissue chips for **high-throughput drug screening and testing**.
- Eascra has successfully completed four missions: **Ax-2, NG-20, SpX-30 and SpX-31**.
- Eascra aims to establish **a complete R&D-Manufacturing-QA/QC chain in space**, including drug screening, production, and testing.

The Tumor Oracle: How a Startup is Using the ISS to Outwit Cancer



This microscopic image shows a cloned tumor sample from a SpaceX CRS-30 investigation that used Encapsulate's tumor-on-a-chip system to grow patient-derived cancer cells and test chemotherapy drugs in microgravity. Image Credit: Encapsulate



Encapsulate presented the Technology in Space Prize by CASIS and Boeing at the 2019 MassChallenge awards ceremony. Media Credit: Encapsulate



A flight-ready CubeLab is tested preflight on Space Tango's emulator. Image Credit: Space Tango

The Tumor Oracle: How a Startup is Using the ISS to Outwit Cancer

24 hours

Day 3

Day 7

Day 14

Encapsulate Awarded NASA and NSF Grants

In July 2025, Encapsulate received \$3.6 million from NASA to develop a Metastasis-on-a-Chip device onboard the ISS as part of the NASA and ISS National Lab partnership for **in-space production applications** (InSPA)

Encapsulate also secured \$1.25 million from the U.S. National Science Foundation (NSF) TIPS in July 2025 for an SBIR Phase II award to advance its biochip platform for drugs screens on patient-derived microtumors to personalize cancer treatment, with clinical studies planned for pancreatic and colorectal cancers in collaboration with UConn Health, Moffitt Cancer Center, Memorial Sloan Kettering Cancer Center, and Hartford HealthCare (HHC) to clinically validate the technology.

This microscopic image captures how microgravity allows tumor cells to self-assemble into clusters, mimicking their behavior in the human body. Image Credit: Encapsulate

ISS National Lab Model – Science Impact

This slide is a summary of the science deliverables (i.e., publications, patents, and products or services) of all ISS National Lab-sponsored projects. This includes all on-going and completed CASIS-selected projects, and RRFs.

Thru FY24 (September 30, 2024), CASIS has identified 535 science deliverables:

- 493 total publications (concentrated in Fundamental Science)
 - 439 peer-reviewed publications with an **average impact factor of 5.6 (top ~5% of journals)**
 - **97 top tier* journal publications with an average impact factor of 8 (top ~3% of journals)**
- 20 patents (split almost evenly between the Fundamental Science and Technology Development lines of business)
- 22 products or services (concentrated in the Technology Development line of business)

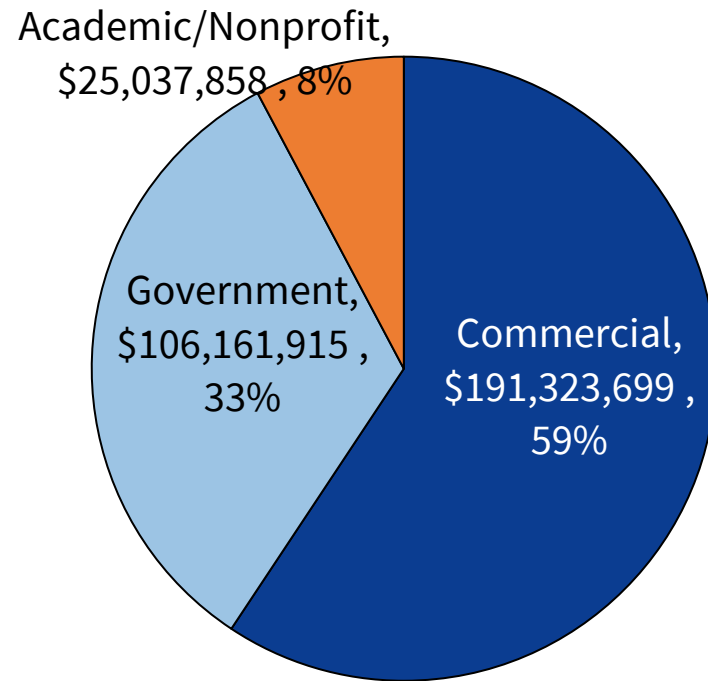
**Top tier journals are the 100 most-cited journals over a 3-year period*

ISS National Lab Model Economic Impact



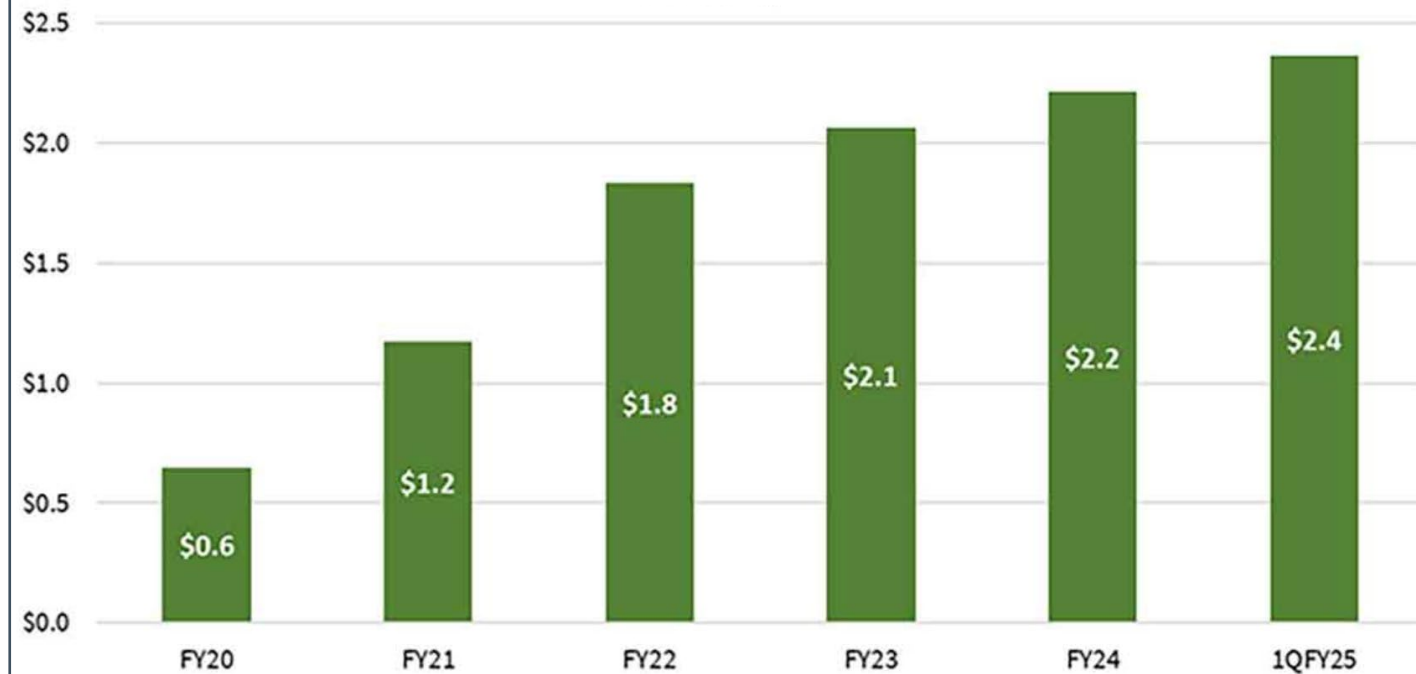
ISS NATIONAL LABORATORY®
CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE®

All-Time External Funding, by Source



No NASA Grants included

Cumulative Funding Raised by Startups Post ISS National Lab Flights (\$ billions)



Media Credit: Company public reports and regulatory filings.



ISS NATIONAL LABORATORY®
CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE®

THANK YOU

Discover the unique advantages of research in
microgravity with the ISS National Lab.



ISS National Lab



ISS_CASIS



ISS National Lab



ISS National Lab



ISSNationalLab.org

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From the painting, *Not to Be Reproduced* (La reproduction interdite), by René Magritte (1937)







"Mission mode change detected, now in Monument Mode"

"Goodnight friends."

"After exchanging our final bits of data, I will hold vigil on this spot in Mare Crisium to watch humanity's continued journey to the stars."

"Here, I will outlast your mightiest rivers, your tallest mountains, and perhaps even your species as we know it. But it is remarkable that a species might be outlasted by its own ingenuity. "

"Here lies Blue Ghost, a testament to the team who, with the loving support of their families and friends, built and operated this machine and its payloads."



Image courtesy of Firefly Aerospace.