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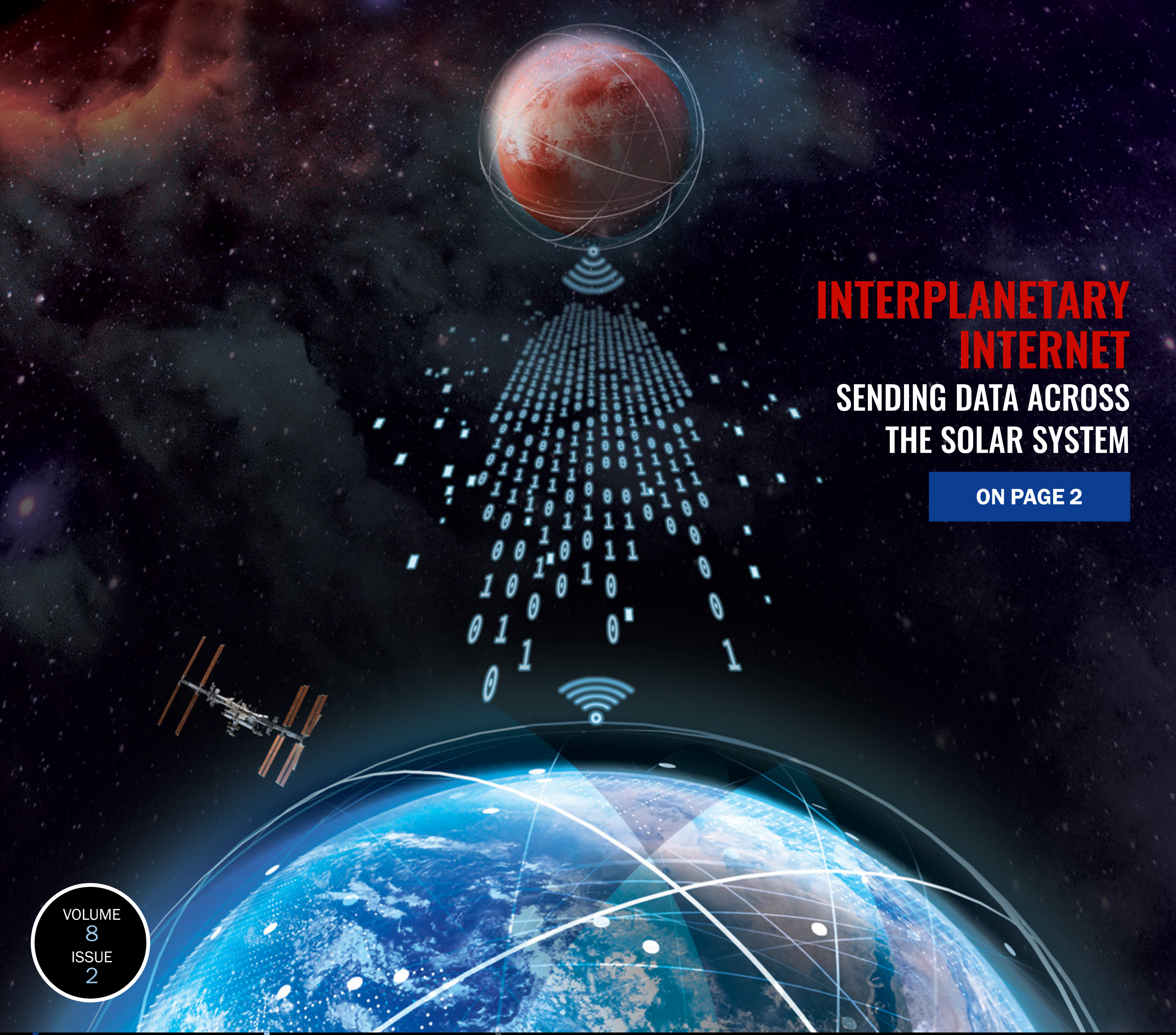

INTERPLANETARY INTERNET

SENDING DATA ACROSS THE SOLAR SYSTEM

ON PAGE 2

VOLUME 8
ISSUE 2

VIEW FROM THE CUPOLA
ANNA-SOPHIA BOGURAEV

THE TUMOR ORACLE

FROM HIGH SCHOOL LABS TO THE ISS

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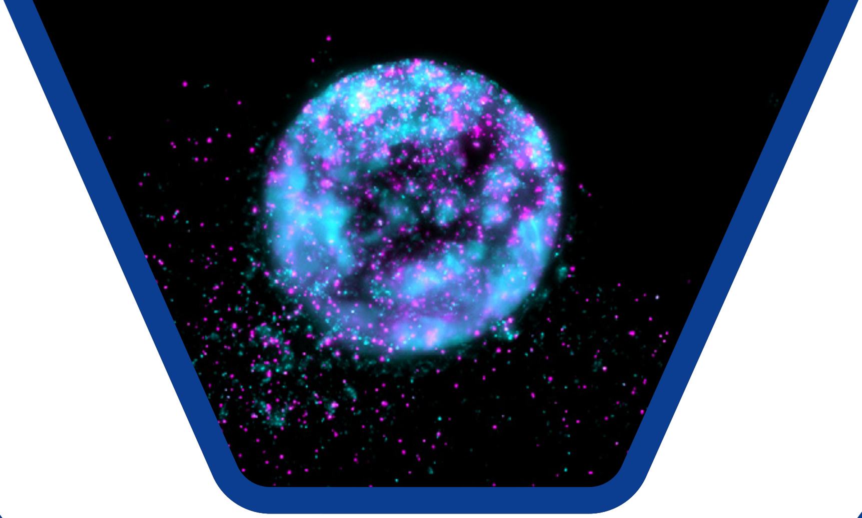

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ISS NATIONAL LABORATORY®
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VIEW FROM THE CUPOLA

By Anna-Sophia Boguraev | M.D.-Ph.D. Student at Harvard and MIT

Anna-Sophia Boguraev, first winner of the Genes in Space competition, is an M.D.-Ph.D. student studying chemical biology and medicine at Harvard University and the Massachusetts Institute of Technology.

In the summer of 2015, I was a 17-year-old high school student at a space conference, surrounded by astronauts, CEOs, and scientists. My only space experience was when I was four years old and built a cardboard rocket ship and then spent the afternoon crying because it wouldn't fly. Back then, I didn't know much about what it meant to be a scientist, but I did know that when I looked into the night sky, I felt something pulling me to dream bigger. I couldn't have imagined that one day I'd send a real experiment to the International Space Station (ISS).

I watched rocket launches and spacewalks outside the ISS, all the while wondering what it would truly mean—and what it would take—for us to live, not just survive, in space. It was that excitement and curiosity that drove me to enter the first Genes in Space contest, an annual student research competition founded by Boeing and miniPCR and supported by the ISS National Lab and New England Biolabs. Since then, everything I learned from Genes in Space has shaped my current career. As an M.D.-Ph.D. student at Harvard Medical School, I'm learning to solve complex medical problems in low-resource environments, a skill I hope to apply both internationally and beyond the stratosphere one day. Before Genes in Space, I didn't even know this kind of science was possible, never mind something I could do.

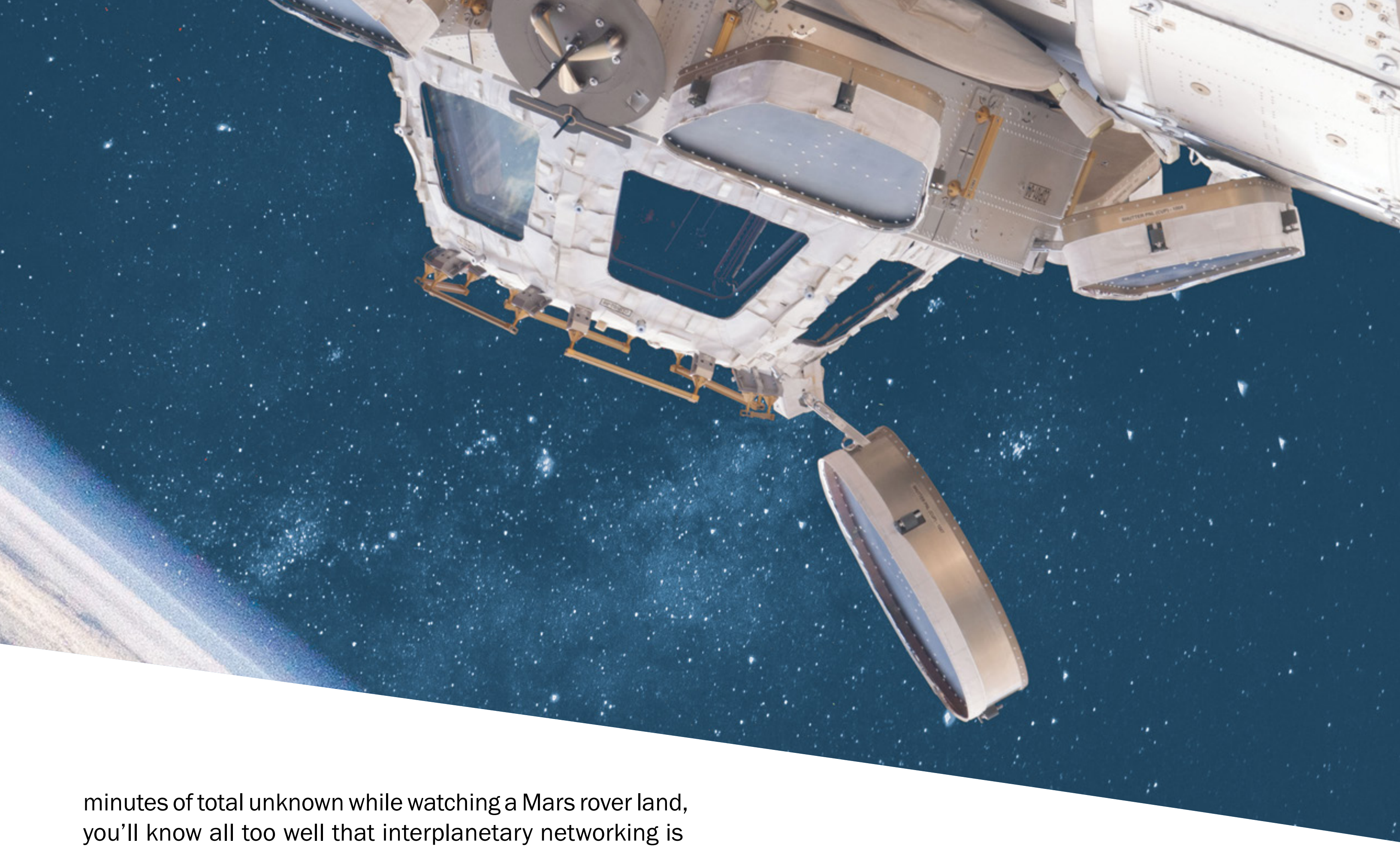
And I'm not the only student to learn how much is possible when we remove the variable of gravity. Over the last decade, I've had the good fortune of staying involved with programs like Genes in Space. I've seen how the opportunity for students to dream bigger, connect with a network of people solving problems in space and on Earth, and watch their own science launch to the ISS has shaped a generation of high schoolers. Many of these students have become my dear friends and colleagues, and all of them have been inspired by a curiosity that is no longer gravitationally tethered.

My time with Genes in Space also led me to spend a summer at NASA Ames, where I worked with a phenomenal team of fellow college students, problem-solving and launching high-altitude balloons. It was there that I realized I wanted to be a doctor and a scientist—someone who, one day, stands with my feet on the ground and my eyes to the sky, bringing science done off the planet back to help patients still on it.

Educational programs like Genes in Space, which enable kids with big dreams and exciting ideas to consider space as an intellectual playground rather than a distant, unreachable place, are essential to developing the STEM workforce and space innovators of tomorrow. The eager students of today—who are in awe at space conferences, running around the expo, snagging astronaut keychains while learning about what we can do, and what we hope to accomplish, in low Earth orbit (LEO)—will be the astronauts, engineers, and scientists of tomorrow. They are the ones who will keep our future space stations and interplanetary outposts running and push the boundaries of what we think is possible.

In this issue of Upward, you'll hear about some of the scientists who are problem-solving for this spacefaring future and how Genes in Space has kept students involved and excited over the years.

The cover story highlights Spatiam Corporation and the technology it's developing to enable interplanetary Internet for communications and data transfer in LEO, on the Moon, and eventually on Mars. If you've ever endured the several



minutes of total unknown while watching a Mars rover land, you'll know all too well that interplanetary networking is challenging. The long distances data must travel results in delays, and planetary motion disrupts the connection. Spatiam utilized the ISS to successfully validate a commercial platform that enables networking in this challenging environment. In the future, technology like Spatiam's will be essential for maintaining connectivity across space stations and planets, ensuring seamless science and supporting the emotional well-being of astronauts as they expand human knowledge beyond Earth.

In the second feature, you'll read about a brilliant biological innovation made possible by the microgravity environment of the space station—the same quirk of off-Earth science that made me so excited a decade ago. Encapsulate, a Connecticut-based startup, is using the ISS to culture 3D tumor models grown from cancer patient biopsy samples. These models enable a rapid and truly personalized evaluation of which chemotherapy drugs are most likely to treat the patient's cancer effectively. Not only is this platform revolutionary, but it also demonstrates the viability of space-based diagnostics as a tool for patients both on and off the planet. Not to spoil the story's ending, but so far, Encapsulate's microgravity-tested tumors have a predictive value of 100 percent for which chemotherapy drugs will work.

Finally, you'll learn about the past decade of Genes in Space and how the program has shaped the lives of many young scientists. From medical school to astrophysics Ph.D.s to tech startups, the alums of Genes in Space are thriving in their fields, and many are still chasing that passion for the stars that brought them to the contest as high schoolers. With the increasing commercial interest in space, we now, more than ever, need to support eager students (like me!) to build the space workforce of tomorrow.

Together, these features tell the same story that drives me and much of the space research community. Science has always followed the path of the stars—from ancient math, observation, and navigation to current advancements and those of the future that today's students will make. The engineering that will take people off Earth, the biology that will keep them alive, and the discoveries we'll make outside our atmosphere will all be brought back to benefit people here on Earth.

Ten years ago, I was 17, realizing that if I could send my science to space, I could probably do pretty much anything I put my mind to. Today, I'm nearly (I hope) done with my Ph.D. and halfway to becoming a medical doctor. Ten years from now, I'll have a career where I'll consider problems of survival. Whether those problems are untreatable diseases on Earth or the details of human spaceflight, I'll know how to tackle them because I was introduced to the potential of space at a young age, which changed my perspective on what is possible. That's how you make a scientist: You take kids who are curious and make sure they know that the sky is quite literally no longer the limit.

Interplanetary Internet

Sending Data Across the Solar System

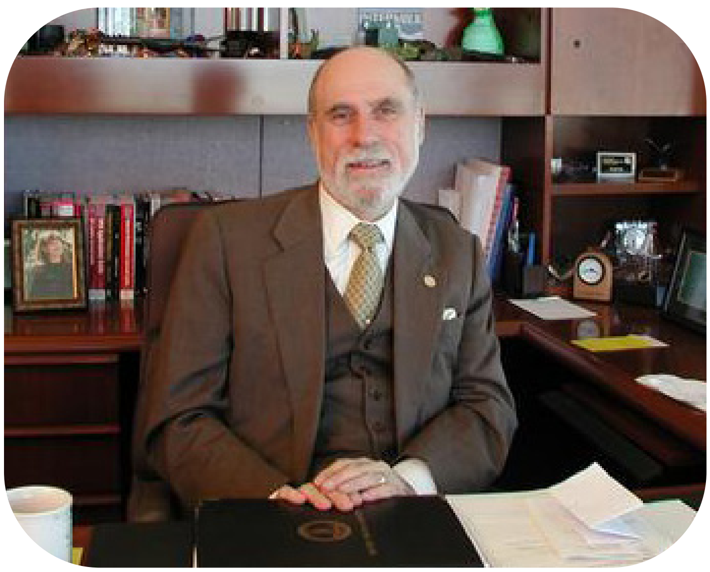
By Amelia Williamson Smith,
Managing Editor

Imagine—your spacecraft lands at a future colony on Mars, and you're eager to explore life on a new planet. You see the dusty red terrain stretching to the horizon. Olympus Mons, the tallest volcano in the solar system, rises in the distance. You want to share photos with your family and friends. But then you realize: there's no Internet. You can't communicate with others like you're used to.

You arrive at your new home and need to look up some information and send an email to your coworker, so you pull out your laptop. Suddenly, it hits you. You can't do that either. Frustrated, you decide to listen to some music, but then it dawns on you. There's no online music library on Mars. You can't watch your favorite TV shows and movies either.

You feel totally cut off and lost. Without the Internet, life as you know it is totally different.

As we look to a future where missions to other planets will not only be possible but commonplace, a key question looms: How will we communicate and transmit data? For nearly three decades, someone has been working on the solution—Vint Cerf, one of the two "fathers of the Internet" who co-developed the protocols that allow networks to connect.



Vint Cerf in his MCI office in the early 1990s.
Carla LaFever

It was the spring of 1998, and Cerf was excited by the success of the NASA Mars Pathfinder mission and Sojourner, the first robotic rover to explore the Martian surface. As he envisioned a future where humans would one day set foot on the red planet, his mind shifted to an important question. "What should we be doing now that we're going to need 25 years from now for space communications?"

Dressed in his signature three-piece suit in his office at Google headquarters, where he now serves as the company's vice president and chief Internet evangelist, Cerf recalled a conversation he had with scientists at NASA's Jet Propulsion Laboratory back in 1998. When he posed his question to the group, the answer became clear. "We needed to design an interplanetary backbone network to support human and robotic space exploration."

Such a network would connect people across the solar system. But there are challenges to creating an interplanetary Internet—the distances data must travel are much longer, and there's not always a connection as planets and satellites move and block the signal. To address these issues, Cerf co-led the development of Delay and Disruption Tolerant Networking (DTN), in which the network stores "bundles" of data at intermediate nodes until a reliable path to the next node or the final destination becomes available.

Now, we are on the verge of the future Cerf envisioned. With plans for commercial space stations, sending astronauts back to the Moon, and human missions to Mars, the time has come to make interplanetary Internet a reality—and Spatiam Corporation is up for the challenge. The startup built a commercial platform for space communications based on DTN. However, to advance the technology, Spatiam needed to test it in the environment where it will operate: space. And to do that, the company turned to the International Space Station (ISS) National Laboratory.

"The most important thing for us as a company is being able to gain the operational experience to manage networks in space, and having access to that through the ISS National Lab was a fantastic opportunity," said Spatiam CEO and co-founder Alberto Montilla. "The ISS was the ideal place to demonstrate our DTN platform for interplanetary networking because it provides a real-life operational scenario."

Overcoming Connectivity Challenges in Space

The Internet connects billions of devices worldwide, putting global communication and data transfer at our fingertips 24/7. When data is sent through the Internet, it is broken into smaller units called packets. These packets travel through network devices like routers that determine the best path for each packet to take. Once the packets arrive at their destination, they are reassembled to recreate the original data.

When you think about the Internet on Earth, it has two key characteristics, Montilla explained. One is immediacy—given the relatively short distances data must travel between locations on Earth, the connection speed is incredibly fast. Delays are on the order of milliseconds, which is quicker than the blink of an eye. The other is ubiquity—anyone can connect to the network from anywhere in the world at any moment.

However, in space, things are radically different. Instead of immediacy and ubiquity, there is delay and disruption.

"When you go to space, especially when you think about going to the Moon, signal delays—the time it takes for radio or light waves to move from one place to another—are in seconds, and when you go to Mars, it's minutes," Montilla explained.

Alberto Montilla presented preliminary findings from Spatiam's ISS technology demonstration at the 2024 Space-Terrestrial Internetworking Workshop in Mountain View, California.

Juan Fraire

Disruption is also a problem. When sending data from the Moon or Mars to a location on Earth, the two points do not always have a direct line of sight, leading to gaps in connectivity. Even on the ISS, communication is not continuous. Each day, there are several brief disruptions as the ISS orbits Earth and moves in and out of contact with ground stations and satellites.

"The TCP/IP protocols we created for the terrestrial Internet work well in a relatively low-latency, high-connectivity environment, but they're not so attractive when you get to the deep space environment," Cerf said. "So, we started working on new protocols, which we now call the Bundle Protocol Suite, for DTN."

Vint Cerf during an ARPANET demonstration in 1974.

Keith Uncapher, USC/ISI

Enabling Reliable Communications

Currently, most data sent to and from space uses a direct link, which allows data to be sent from one entity to another when there is contact. The data moves from point A to point B—from the spacecraft to payload operations on the ground, for example. To transfer the data to a scientist at point C, a separate connection must be established.

It's feasible to work around brief connectivity disruptions and manage contacts between one spacecraft, such as the ISS, and the operations team on the ground. However, managing contacts for a multitude of users sending data between Earth and commercial space stations or the Moon and Mars would be much more challenging, and a DTN platform will be vital.

"We're moving from an entity that has been largely managed by a few space agencies to an entire ecosystem where there are going to be other government agencies along with a plethora of commercial companies of all types and sizes," Montilla said.

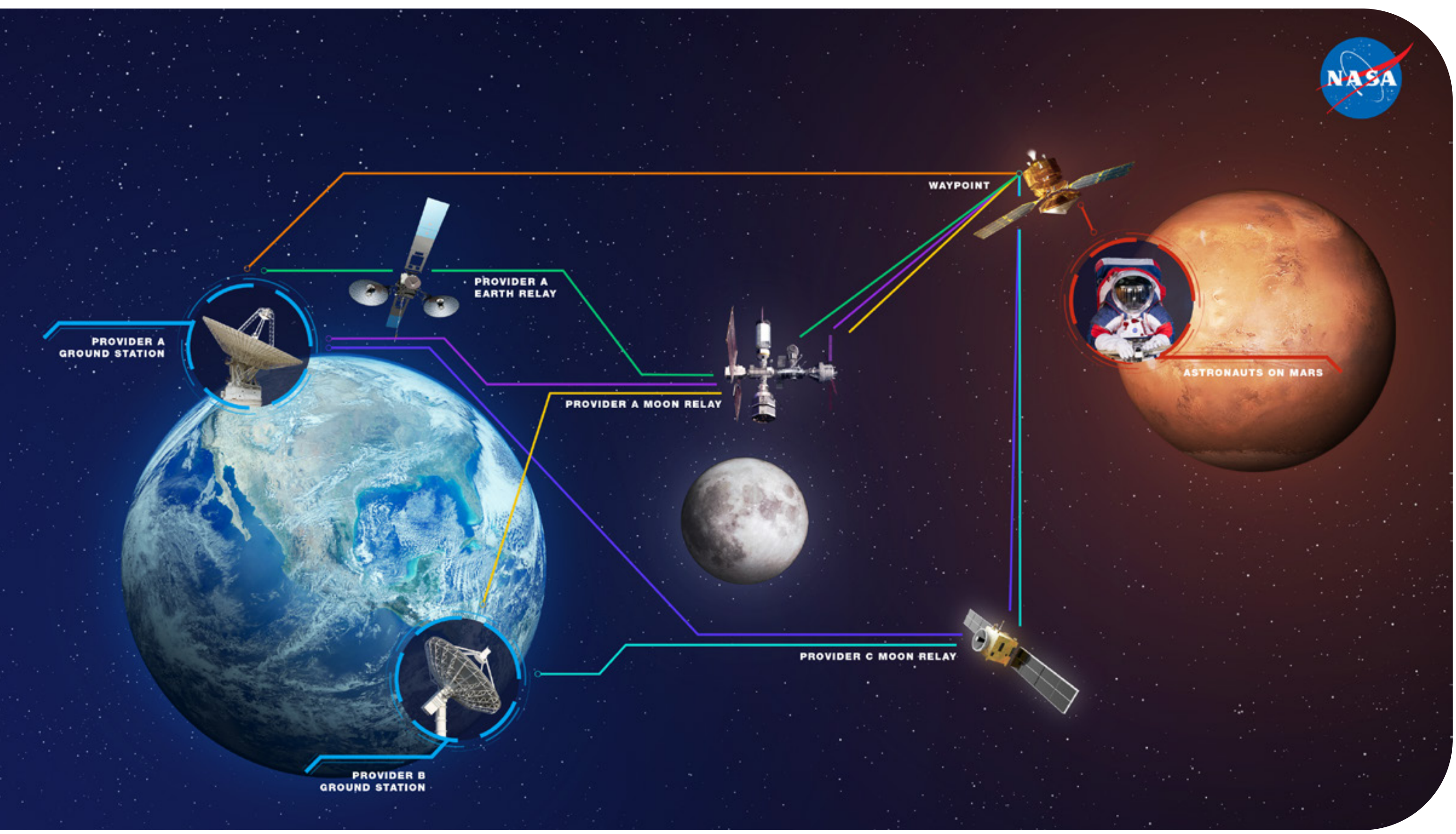
By 2004, Cerf and his team had developed prototype software for DTN, and the first DTN operations on the ISS took place in 2009. Having reliable communications and navigation systems connecting space and Earth is crucial, said Philip Baldwin, assistant deputy associate administrator for the SCaN (Space Communications and Navigation) Program at NASA Headquarters in Washington.

"NASA uses DTN technology to safely store and forward data when a path opens," Baldwin said. "Implementing these internetworking capabilities in space will decrease data loss, ensure data delivery, and provide mission teams with an ability to identify the location and timeline of data."

From Nodes to Networks

Building on NASA's extensive experience, Spatiam aims to develop the first commercial DTN platform for commercial space stations and operations on the Moon and Mars. Spatiam's platform has three main elements: a DTN manager, DTN-managed instances (or nodes), and a DTN command line interface.

As its name suggests, the DTN manager directs the network, which is composed of several nodes. You can think of a network like a web, and each point where the web crosses is a node. You can transfer data from any point on the web to any other point by moving bundles of data from node to node until they reach the destination. The DTN manager configures the nodes to determine the best path for data to travel through the network. Through the DTN command line



Delay and Disruption Tolerant Networking (DTN) enables the use of multiple paths and providers to efficiently deliver data.
NASA

Patch for the Spatiam DTN technology demonstration on the ISS.

Spatiam Corporation

interface, users can send or request data without needing to know when contact occurs. Once the command is sent, the system holds the data and sends it during the next contact.

In addition to delivering core DTN capabilities, Spatiam's platform also provides advanced features that go beyond what's currently possible on the ISS. One such feature supports a service provider architecture that uses bundle-in-bundle encapsulation, where a bundle of data is carried inside another bundle. This allows the inner bundle to be transmitted more securely and reliably through the network. Another feature is the ability to stream audio and video, allowing future astronauts to transmit ultra-high-definition video from the Moon's surface to Earth, as is currently planned for NASA's Artemis missions. The platform also allows multiple administrators to access the network and control nodes.

"This is important because it's very different from the NASA network, which is administered by NASA alone," Montilla said. "We wanted to demonstrate that we can create networks that have many different administrators, similar to the way the Internet is on Earth."

Alberto Montilla (back right) and Veronica Acosta (front right) with members of the Spatiam team in Allen, Texas.

Spatiam Corporation

A Steppingstone to Commercialization

To test its DTN platform, Spatiam worked with ISS National Lab Commercial Service Provider Axiom Space, which provided the hardware for the investigation—an Amazon Snowcone edge computer on the space station. The Axiom team held weekly meetings with Spatiam to help navigate NASA requirements and daily meetings leading up to the ISS demonstration to resolve any issues.

Throughout the project, Spatiam ran more than 95 unique tests and successfully validated the core capabilities of its DTN platform, the performance of its DTN manager, and the platform's advanced features. The team tested the DTN manager's ability to set up an initial network of four nodes (two on the ISS and two on Earth), add new nodes, and change node configuration.

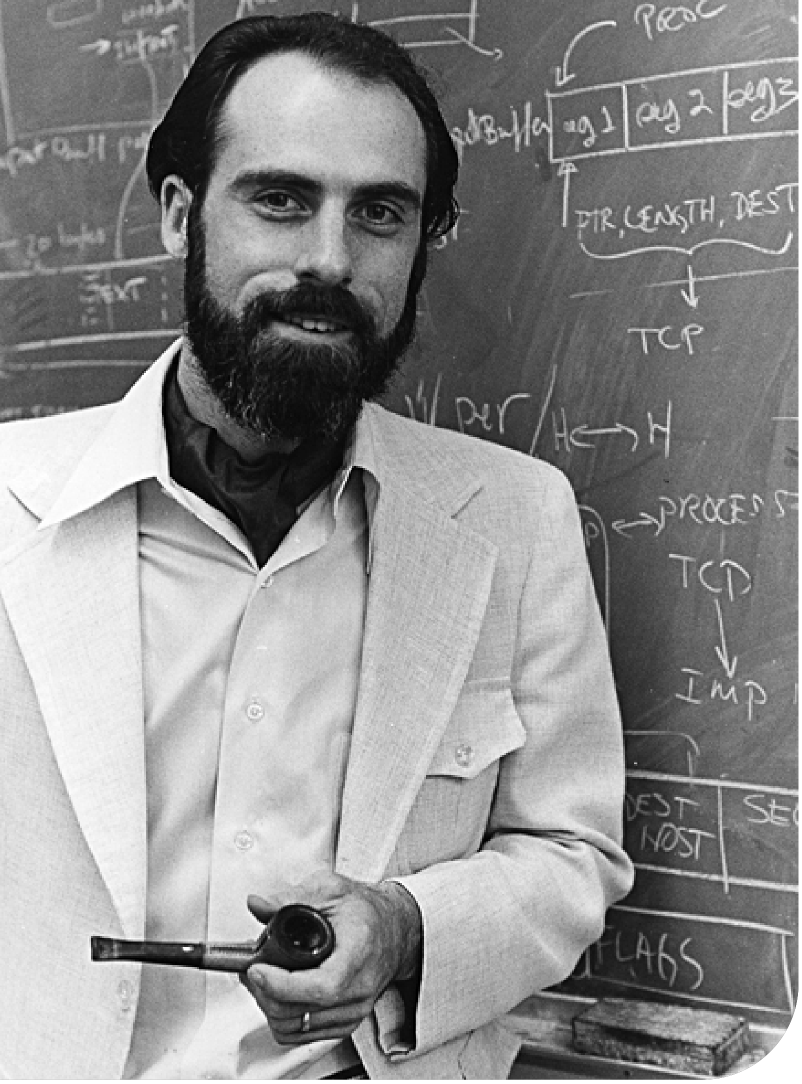
Amazon Snowcone onboard the ISS.

NASA

Using the DTN platform, the team successfully transferred multiple types of data to and from the ISS, including telemetry data, text commands and responses, text files, and binary files. The platform also successfully streamed audio and video. Bundle-in-bundle encapsulation—which had never been done in space before—was used during the entire 18-day demonstration.

With successful validation on the ISS, Spatiam raised the technology readiness level (TRL) of its DTN platform to TRL 7, which is one step away from being flight-certified and ready for commercialization. Montilla stressed that access to the space station through the ISS National Lab was critical for advancing the company's platform.

By supporting the development of new technologies like DTN, the U.S. government lays the foundation for successful commercialization. Cerf explained, "The Internet spread, in part, because the government made early investments and then the private sector said, 'Oh, we can actually build and service and sell equipment and software to support the use of the Internet.' Many of the applications of the terrestrial Internet have come from the private sector, driven not by government investment but by the government-created potential for private-sector investment."



Vint Cerf at Stanford University in 1974.
Carolyn Tajnai, Stanford

The future LunaNet will bring terrestrial Internet capabilities to astronauts, rovers, and orbiters.
NASA/Reese Patillo

The Future of Networking in Space

Following Spatiam's successful validation, the company received recognition across the industry. "This was an amazing opportunity to demonstrate our platform, and it has opened so many doors for us," said Spatiam Business Development Manager Veronica Acosta. "We are very proud of these accomplishments and look forward to what's next in advancing the space economy."

Spatiam's goal is to enable the DTN portion of the future LunaNet network on the Moon. LunaNet will serve both NASA and lunar commercial service providers, paving the way for networking on future missions to Mars. Although not part of the startup's original plan, after working with the ISS National Lab, Spatiam realized there are also significant opportunities for DTN in the future LEO economy.

"As commercial space stations start to fly and NASA begins using commercial facilities in LEO, we have identified use cases where our DTN platform is valuable," Montilla said. "So, our plan is to expand our platform to support not only missions to the Moon and Mars but also in LEO."

Looking to the future, the ability to communicate and transfer data will be crucial for exploration missions across our solar system. However, these capabilities will also be invaluable to the astronauts on those missions. Connection and communication are a central part of our humanity. With the help of DTN technology, astronauts on the Moon and Mars may be able to chat with family and friends back on Earth and send photos just as easily as we do today. And who knows—maybe one day, they'll even be able to enjoy their favorite music, TV shows, and movies, too.

"I feel like I'm at the beginning of a much longer novel," said Cerf, who is now in his 80s. "I won't see the end of it, but I don't regret that. I'm having too much fun being at the first few chapters and feeling like I have a front row seat for the evolution of a new capability that will one day serve humankind going off planet."

Photo Credit: SpaceX

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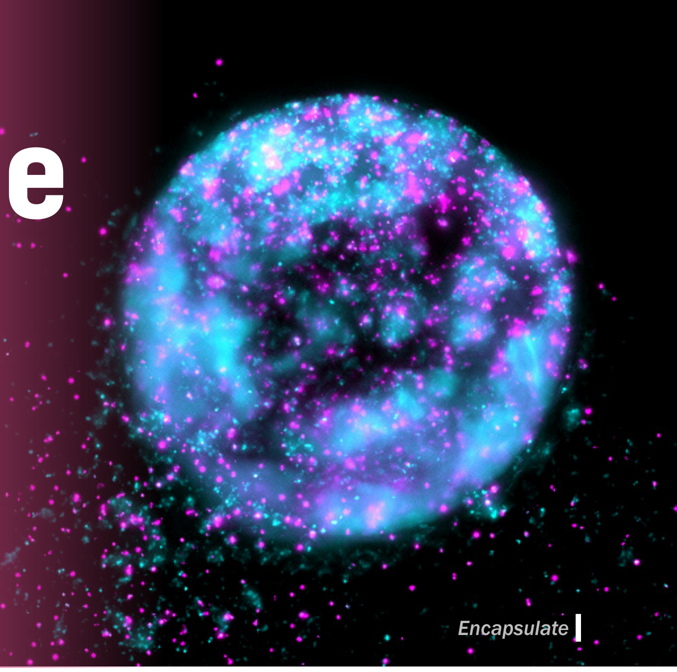
The Tumor Oracle

How a Startup is Using the ISS to Outwit Cancer

By Stephenie Livingston,
Staff Writer



Encapsulate

The matte-gray box resembles a lunchbox except that you half expect steam to hiss out when the lid cracks open. It doesn't hint at its contents: cloned tumors nestled inside clear chambers—miniature versions of real patients' cancers, arranged like seedlings in a hydroponic tray. This tumor-on-a-chip system is a diagnostic device that sends microtumors into space to forecast how the cancer will respond to chemotherapy before the patient ever takes a dose.

Encapsulate, the Connecticut-based company that developed the system, started in a sort of orbit, circling the medical community and struggling to land an idea many dismissed as sci-fi. Armin Rad, a young biomedical engineer with a stubborn streak, co-founded the company with Leila Daneshmandi. In 2018, along with their team, they started shuttling between Connecticut and Boston, pitching the concept in scrappy accelerator sessions and to anyone who would listen: What if you could test cancer drugs on a replica of a patient's actual tumor—outside their body—and get an answer in days?

"Everyone else was thinking that, okay, this is a crazy idea. Why are you wasting your time doing that?" says Rad.

The biotech startup originally created the platform to test chemotherapy treatments on Earth. Each chip hosts a biopsy sample—often from solid tumors like colorectal or pancreatic cancer—and grows it into several tiny, biologically identical tumors. Each microtumor gets a different pharmaceutical treatment.

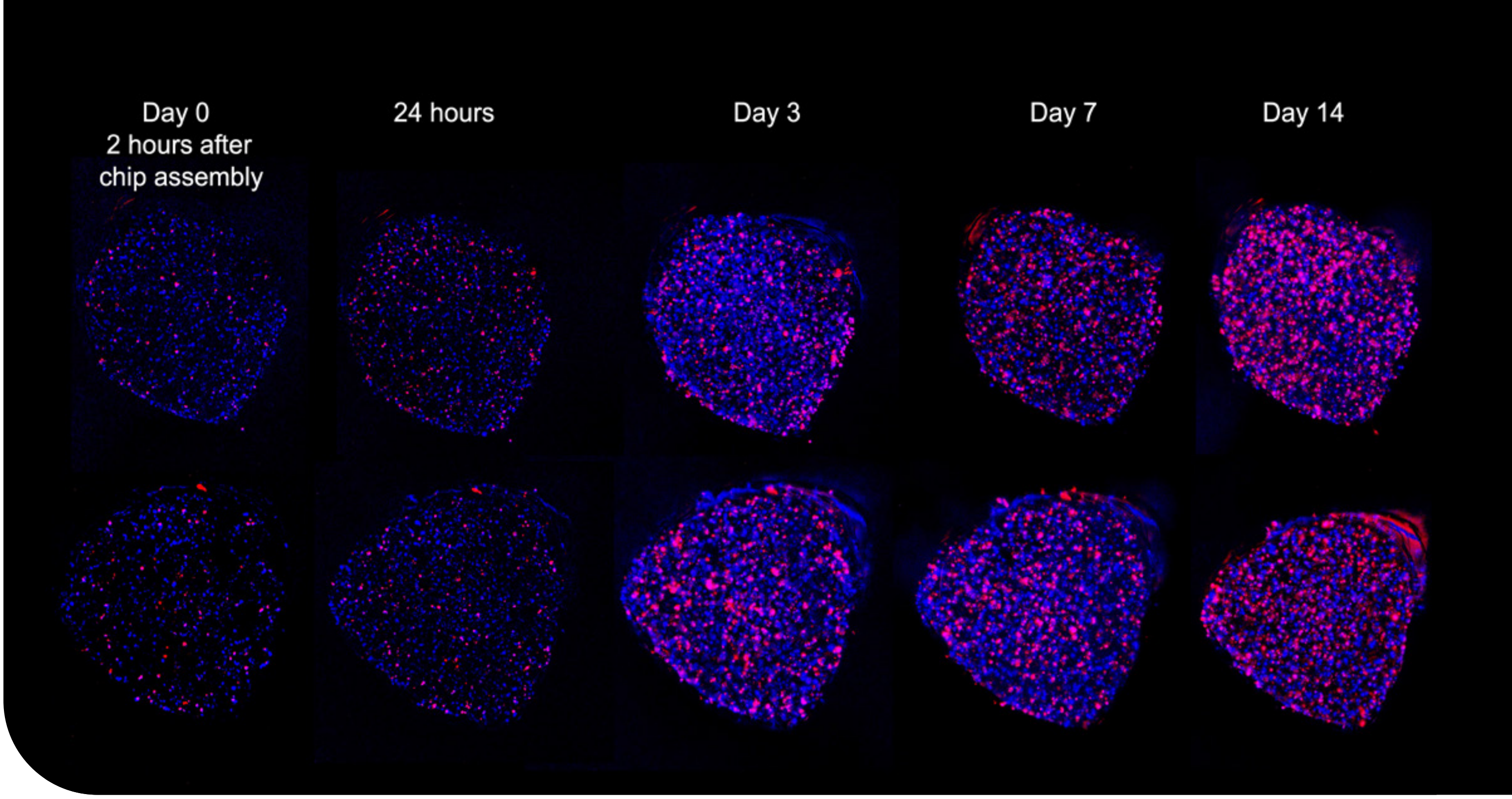
The goal? Skip the trial-and-error approach that defines much of cancer therapy, identify the most targeted treatment, and save time—time that can mean the difference between life and death. Most oncologists rely on statistical hunches: Drug A worked better than Drug B in a trial with a few hundred patients. But the patient sitting in front of them isn't a statistic. Encapsulate wants to predict, within seven days, what will actually work for that individual.

The team could have stopped at Earth, but they encountered a problem that prevented them from accurately accessing the most drug-resistant cancers. Traditional lab models distort reality. In plastic dishes, tumor cells sprawl into single-layer sheets. Human tumors don't behave this way. Although they could still get readings for simpler cancers, results for rare and complex ones were less reliable. They suspected gravity might be the issue and needed to escape it.

Rad found traction for his idea at MassChallenge, a global startup accelerator, where he found a potential solution. He learned that the environment on the International Space Station (ISS), suspended in microgravity, encourages cells to float and self-assemble. In this weightless state, tumor cells group together and form clusters that closely mimic their behavior within the human body, providing a more accurate testing model than traditional lab cultures. The potential was too promising to ignore.

At the 2019 MassChallenge awards ceremony, from left: Scott Copeland (Boeing), Rachel Clemens (ISS National Lab), Reza Amin, Leila Daneshmandi, Armin Rad (Encapsulate), and Kevin Foley (Boeing).

Encapsulate



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

In 2019, Encapsulate was chosen for the Technology in Space Prize, which provides grant funding for MassChallenge participants to do research utilizing the ISS National Laboratory. With this support, the team sent the system into space—and over the course of months, everything changed. There, the tumor samples responded exactly as Rad had hoped, forming realistic 3D structures that let the team observe, in real time, how different treatments worked. It was no longer just theoretical.

"Technically, it's not even a prediction now. It's an observation of what would work the best on the tumor," Rad says. "The fact is that you can save lives with this crazy idea—something people thought was impossible—and now it's leading to something that's never been done before."

What They Found

A delayed launch. Months of waiting. Cold storage constraints. A pandemic. When the box finally went up, Rad watched the data come in with equal parts terror and joy. Somewhere above Earth, six tumors from six patients sat in engineered microclimates.

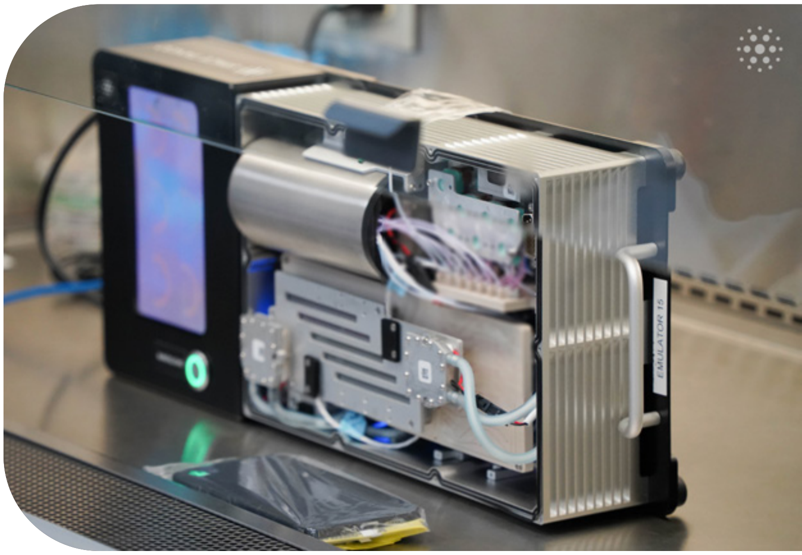
Encapsulate partnered with Space Tango to develop a custom, flight-ready version of their system, which installs in a power cube called a CubeLab and operates autonomously.

"The astronauts didn't need to touch anything," Rad said, chuckling. "Honestly, they just plugged it in like a coffee machine."

Everything is contained in the box, he says. The tumor-on-a-chip experiments monitor temperature, oxygen, and carbon dioxide. And they show how cancer exposed to drugs behaves when you take away gravity's effects. Then, the system watches, records, and relays the results through built-in video and software.

"What you can observe in, like, 12 months on Earth can be observed in a much shorter time— a few weeks, up to a month—up on the space station," Rad says.

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



Flight samples are prepared for launch on the SpaceX CRS-30 mission.
Space Tango

The Four Reasons Encapsulate Went to Space

1. Better self-aggregation of tumor cells
2. Higher fidelity to in-body behavior
3. Novel drug responses under microgravity
4. Test a fully automated, hands-free platform

Encapsulate's Duran Gonzalez prepares flight samples at Kennedy Space Center for the SpaceX CRS-30 mission.
Encapsulate

Initially, the study aimed to test three different patient-derived tumors and two drugs. COVID delays stretched timelines but provided an opportunity: more time to prepare. Encapsulate doubled the patient count and more than doubled the treatments tested before launch on SpaceX's 30th commercial resupply services mission to the ISS, contracted by NASA.

Some results surprised them. Tumors with specific mutations responded to chemotherapy in space—but not on Earth, suggesting that microgravity unmasked hidden cellular behaviors that might otherwise go undetected. In several cases, the tumors in space took on structural features that hadn't appeared in their Earth-grown counterparts.

"We noticed that certain mutations, such as APC, would cause certain behavior, like higher or lower sensitivity to a certain chemo drug, under microgravity that you do not see here," Rad said.

Strangely, some tumor-on-chip samples exhibited movement patterns that may signal early metastasis—cells from tumors known to have later spread behaved differently than those from tumors that did not. The patient's cancer hadn't yet spread. But in microgravity, the cloned tumor cells hinted at a future turn.

Still, the key question lingers: If tumors behave differently in orbit, how does that help a patient on Earth? The answer lies in pattern recognition. The behaviors seen in space aren't dismissed—they're decoded. The question isn't whether microgravity changes outcomes, Rad explained. It's whether those changes reveal something we couldn't detect otherwise—that still exists in the tumor's biology back on Earth.

Encapsulate Scores NASA and NSF Grants

In July 2025, Encapsulate received $3.63 million from NASA's in-space production applications program to develop a Metastasis-on-a-Chip device onboard the ISS. The startup also secured $1.25 million from the U.S. National Science Foundation to advance its biochip platform, which screens drugs on patient-derived microtumors to personalize cancer treatment, with clinical studies planned for pancreatic and colorectal cancers.

The implication? The platform might not just identify a working treatment by predicting how the tumor will respond. It could warn doctors about how a tumor plans to spread.

If a tumoroid can reveal future behaviors—drug resistance and metastasis—how early does biology begin to script that story? Joel Levine, a gastrointestinal cancer specialist at UConn Health, calls it a pre-echo of metastasis.

"If I told you that you could predict that event from the day of the biopsy, you would have thought that's counterculture," Levine said. "But maybe we've been watching cancer unfold too late in the story."

From Bedside to Space and Back

By leveraging the ISS National Lab, the team demonstrated that space-based diagnostics are achievable. Rad notes that the data they collected in orbit has already closely matched real-world results on Earth. "We monitored the same patients clinically to prove that our predictions were really happening in the clinic," he said.

Even though the team only tested six patients, what they saw was enough to change how we think about time and tumor behavior, Rad says.

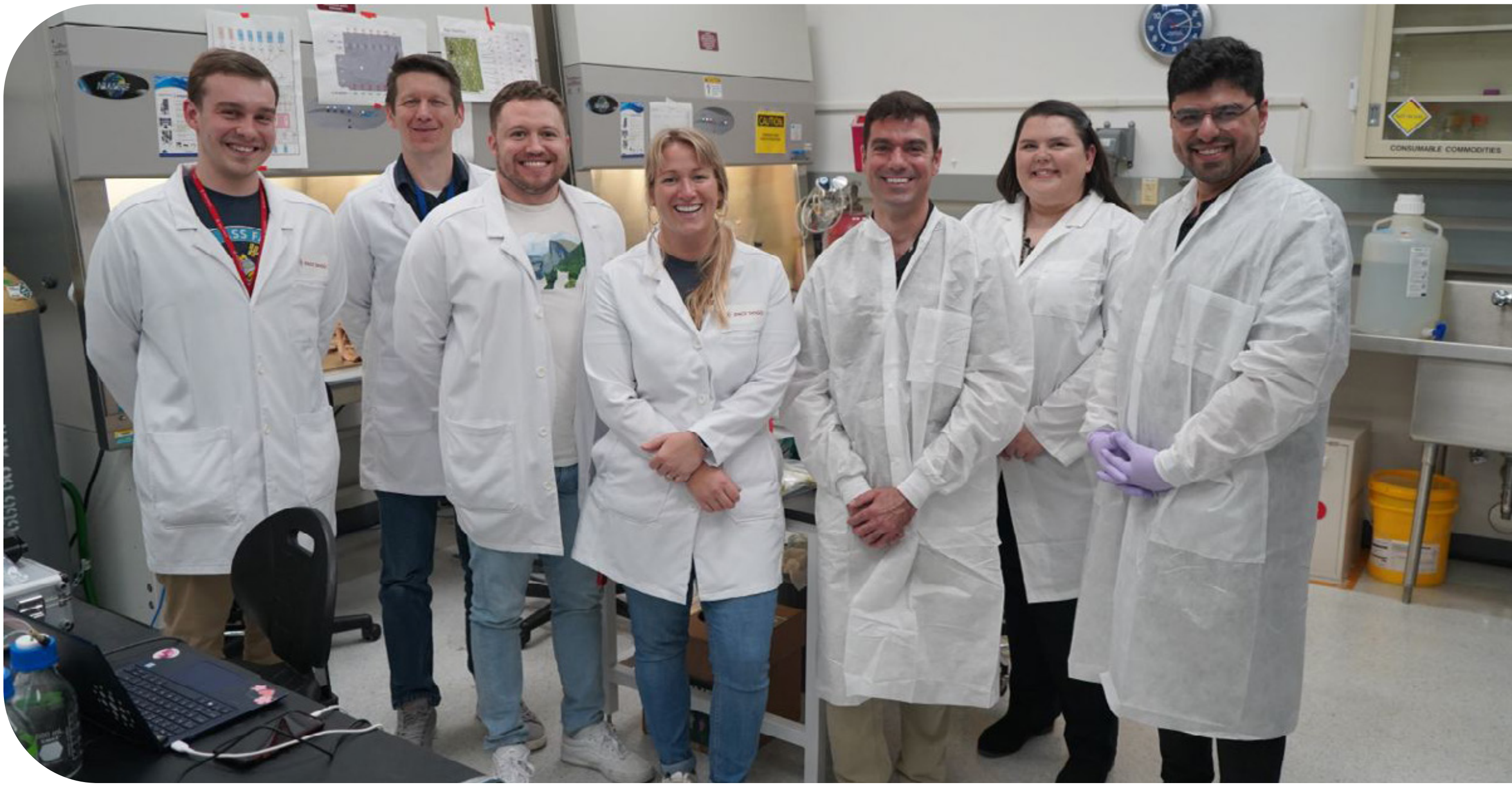
Encapsulate's next step: a multi-site pancreatic and colorectal cancer trial. UConn Health, Moffitt Cancer Center, Memorial Sloan Kettering Cancer Center, and others plan to enroll 100 to 200 patients. Each patient's tumor will be profiled using Encapsulate's system. The results won't guide treatment—yet. They'll be compared against real-world outcomes.

Rad describes it as a low-key moonshot.

In earlier blind trials on archived samples, Encapsulate's predictions matched clinical reality. The platform's predictability was over 96 percent.

From left: Mark Reeves, Zach Jacobs, Kendall Nelson, Taylor Stallings-Pinnick (Space Tango), John Catechis, Erica Bumgardner (ISS National Lab), and Armin Rad (Encapsulate) at a Kennedy Space Center lab, preparing flight samples for SpaceX CRS-30.

Encapsulate



"It's what the tumor does," says Levine. "What you get out of the test of that tumor is really analogous to this being tested in you."

Immunotherapy is up next. Unlike chemotherapy, which directly kills cancer cells, it trains the patient's immune system to recognize and attack tumors. Although it has improved outcomes in some cancers, responses remain unpredictable. Rad's team aims to adapt the chip to model tumor–immune interactions ex vivo, monitoring how cancer cells and immune cells interact. This will involve immune markers, co-culture systems, and advanced monitoring; however, the chip's core architecture stays the same.

Encapsulate's long-term plan involves using space-derived data to train AI systems on subtle cues like morphological shifts, response curves, and even behavioral signatures that precede drug resistance or metastasis. With enough examples, the system could identify the same cues in Earth-grown models (or even in imaging scans) without needing to send them to space.

A flight-ready CubeLab, integrated with Encapsulate's biochips and microfluidic device for cancer research, is tested preflight on Space Tango's emulator.

Space Tango

Levine says this sort of precision medicine in space is challenging our understanding of the nature of cancer. "If it stays where it is and never moves, is it even cancer?" It forces you to question the basic assumptions about the ways we treat cancer, he says.

For Encapsulate, low Earth orbit isn't just a research venue—it's clinical infrastructure. The company envisions a tiered system: standard cases stay on Earth, while the toughest, drug-resistant tumors get a ride to space for analysis in microgravity. Only about 10-15 percent of cancers would require this specialized testing; most patients could be treated using Earth-based models. Space, meanwhile, provides advanced profiling where existing tools fall short. Although capacity is limited, partnerships with firms like Space Tango aim to make the system more automated, compact, and affordable. Within 5 to 10 years, these advancements could enable scalable testing for patients who need it most.

It sounds extravagant—until you tally the cost of advanced cancer care. Encapsulate pegs its method at a few thousand dollars per patient. By contrast, late-stage cancer treatment often runs more than $500,000.

Matthew Strickland, a GI oncologist at Mass General, envisions a day when a single biopsy triggers two returns: pathology and a treatment profile. The system, ideally, tells him what works before he writes the first prescription.

"I dream about a future where the tumor has been sent to a laboratory where a model fully representative of that patient's tumor has been established and is growing on a chip. Further, the drugs that work and don't work have already been tested," Strickland said

.

Strickland has flown his experiments onboard a SpaceX rocket to the space station. His early data suggest that microgravity may blunt apoptosis, the cellular self-destruct mechanism that many cancer treatments rely on. His lab recently completed RNA sequencing on tumors grown in space.

"I think that the symbolism is that there are no limits to how far we're going to go and explore to discover new therapies for patients," Strickland said. "Even to space."

Whether those microgravity behaviors hold the key to understanding cancer in the human body remains to be seen. Rad doesn't speculate. He points out that six patients are a small sample, and there's still a long road ahead. But the early signal is this: A tumor's intent might not be random. It might be clocked early—early enough to pick the right drug to fight it, possibly before symptoms appear and before it spreads.

He wants to know what happens when we shrink more cancers into a chip, shoot them into space, and see what they have to say for themselves.

Perhaps, if Rad gets his way, cancer itself will become less mysterious, Levine says. Or maybe it becomes something else entirely: predictable, treatable—telling us from the start what it will do.

"Everything starts in a place you cannot see. Remember that. Then you light it up and you say, that was always there. I just didn't see it."

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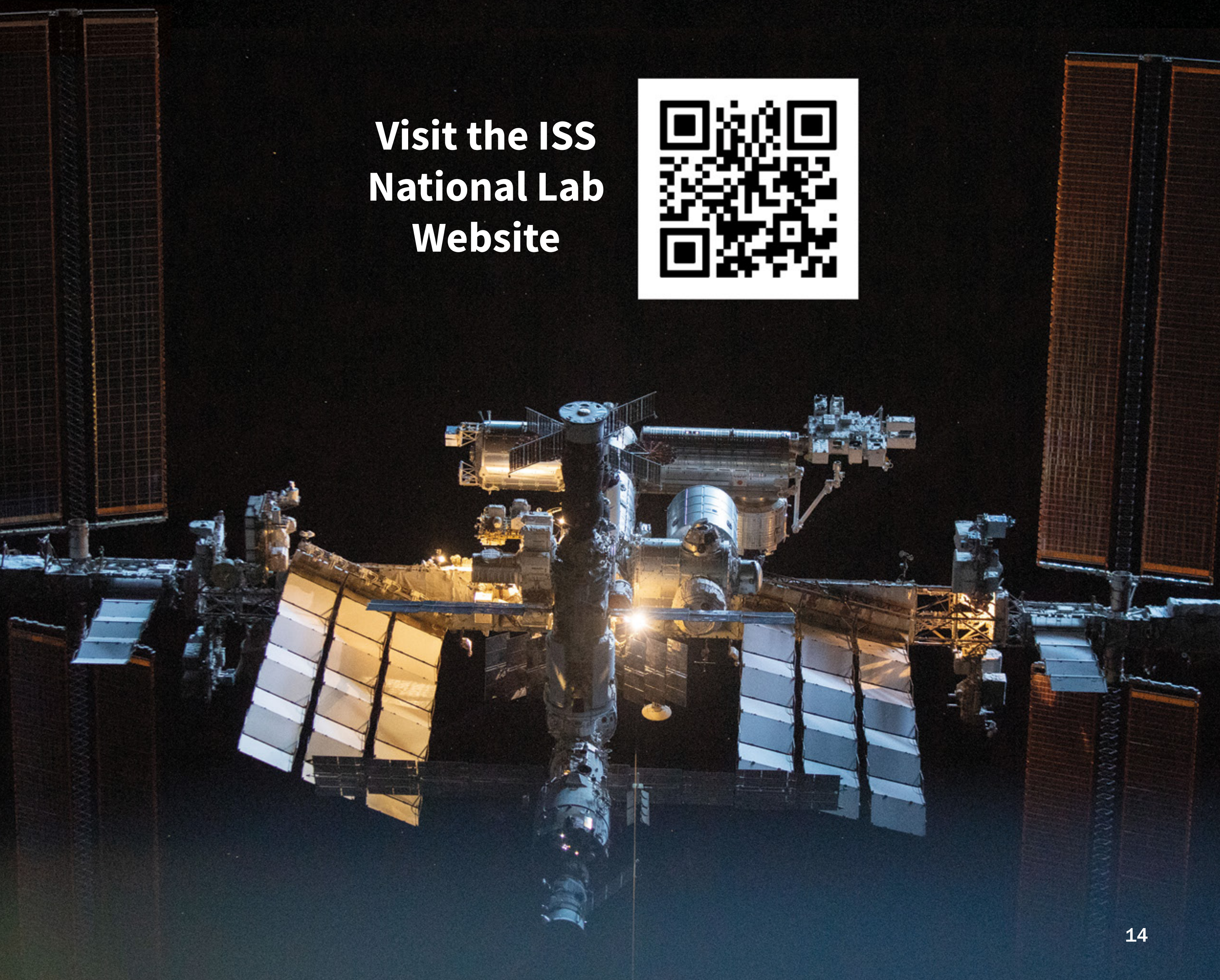

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From High School Labs to the ISS

How Genes in Space Shaped the Future of Four Young Scientists

By Diana Rugg,
Staff Writer

As kids, their ambitions were sky-high. Kaylie Hausknecht imagined herself as a neurosurgeon and idolized Albert Einstein, even dressing up as the physicist for a third-grade project. Aarthi Vijayakumar pictured a future in medicine or science. Anna-Sophia Boguraev gazed at the stars, hoping to become an astronaut, and Jonathan Chang envisioned a career in the NBA but recognized that his true strengths lay in math and science.

Those childhood dreams didn't vanish—they evolved into careers in science, medicine, and technology. And for each of them, one transformative experience shaped their future: the opportunity to design a DNA research project for the International Space Station (ISS).

In high school, all four became finalists in the annual Genes in Space™ competition, proposing biotechnology experiments that utilize the unique space environment of the ISS. Co-founded in 2015 by Boeing and miniPCRbio® and supported by the ISS National Laboratory® and New England Biolabs, the contest for grades 7-12 offers a hands-on, immersive introduction to science, technology, engineering, and mathematics (STEM), paving the way for future careers in science and space.

"Engaging the next generation of engineers and scientists means bringing real-world scientific experiences to the classroom," said Scott Copeland, director for ISS research integration at Boeing and co-founder of Genes in Space. "Genes in Space is designed to spark student interest in science and biology while fostering creativity, collaboration, and critical thinking skills in young innovators."

As the U.S. faces a pressing need for a strong future STEM workforce, programs like Genes in Space help pique curiosity and inspire careers in science. Each year, hundreds of students nationwide submit proposals, and five finalist teams receive expert mentoring and a trip to the annual ISS Research and Development Conference (ISSRDC) to present their ideas to a panel of judges. Only one team wins and sends their project to space, but other finalists say the journey itself leaves an indelible mark on their lives.

"I think I would be somewhere very different, but I couldn't even begin to guess where that is," says Boguraev, the first Genes in Space winner in 2015, who credits the program with giving her a clear vision of the biologist and researcher she could become.

Other finalists share similar stories of eye-opening experiences that shaped their paths and launched them from student projects to STEM careers. In each case, it all began with a single, creative idea about science in space.

From Ideas to Launch

Boguraev had always looked forward to a career in space. She laughs, recalling how, at four years old, she built a cardboard rocket ship and sobbed when it wouldn't fly. Never taking her sights off the stars, she read books under her desk in school and met teachers who shared her enthusiasm for the final frontier.

That lifelong interest led to a winning Genes in Space proposal to investigate whether spaceflight conditions—including microgravity and radiation—trigger epigenetic changes that suppress immune function. Epigenetic changes are modifications that affect gene activity without altering the underlying DNA sequence, potentially influencing how the body responds to stressors like those encountered during space travel. Boguraev proposed using a process called polymerase chain reaction (PCR) that makes millions of copies of specific DNA targets, allowing scientists to study genes more easily.

"This was a very ambitious proposal, given we had never done PCR in space," she said. Her experiment, however, successfully reached a huge technical milestone: "We validated PCR on the ISS."

The same year Boguraev won the Genes in Space competition, Chang and his Seattle-area teammate were finalists. They read about a hardy bacterium that survived for a year and a half in an experiment outside the space station and proposed to unwind its DNA. They theorized that perhaps the bacteria's longevity could be applied to questions about long-term health.

The team developed its proposal with guidance from a Harvard mentor and even went a step further by reaching out to the University of Washington genome lab. It was an eye-opening experience to be surrounded by professional scientists and their work, he says. The team's visit to ISSRDC also expanded Chang's perspective on careers in STEM.

"Having that opportunity exposed us to so much more. I really didn't have any crazy direction before that," he recalled with a chuckle.

In 2018, Genes in Space winner Vijayakumar and her three teammates from the suburbs of Minneapolis plowed new ground by using a powerful, new gene-editing tool called CRISPR to break DNA in space and study how it repaired itself. Inspired by NASA's Twins Study of astronauts Mark and Scott Kelly, they wanted to explore how microgravity conditions might alter DNA repair and contribute to the increased risk of cancer that astronauts are known to experience after spaceflight. Their MIT mentor helped connect their ideas to broader issues related to diagnosing human diseases.

"We took a human health problem down to a molecular level, and that was kind of the goal all along," Vijayakumar said.

After winning the competition, the team collaborated with scientists and engineers from Boeing, miniPCR bio®, MIT's Whitehead Institute, and NASA for a year to prepare their project for flight. Along the way, they developed solutions to unexpected challenges, helped create new protocols with Boeing, visited NASA's Johnson Space Center, and ultimately witnessed their experiment launching to the ISS.

Vijayakumar remembers watching the rocket rise from the ground and feeling amazed, knowing that her science was on its way to space. "It was the opportunity of a lifetime," she said.

Anna-Sophia Boguraev works in the vaccine lab at the Ragon Institute of Harvard, MIT, and Mass General Brigham.
Anna-Sophia Boguraev

Hausknecht also joined the Genes in Space finalist ranks, building on her lifelong interest in science. As a child, she was fascinated by a model of the human brain her dad kept at home. Using her school's Lab in a Box miniPCR kit, which equips high school classrooms with the same molecular biology tools used on the space station and provides accompanying curriculum, she laid the groundwork for testing biological responses in space. Her Genes in Space proposal examined how cyanobacteria, which use photosynthesis to produce oxygen, could be engineered to withstand the conditions on the ISS.

"With these tools, students and teachers develop skills that will help support and foster a low Earth orbit economy," said Marc Bliss, program lead for Genes in Space at miniPCR bio. "We've built a strong community of alumni, graduate student mentors, and dedicated STEM teachers to inspire the next generation of researchers and space pioneers."

With help from her mentor, an MIT graduate student, Hausknecht refined her Genes in Space idea into an investigation of how cells adapt to changes caused by microgravity. The project would utilize PCR to amplify specific DNA sequences and observe changes in gene expression triggered by space conditions—particularly those related to changes in the cells' metabolism and physical environment, like gravity, that can cause stress.

Hausknecht's visit to ISSRDC boosted her confidence, especially the way scientists treated her as a peer. "Genes in Space helped me see space science not as a dream but as a path I could realistically pursue," she said. "It really increased my intellectual maturity."

The Journey From Student to Scientist

The Genes in Space experience also shaped each finalist's next step: choosing a college and a major. For Chang, the connection was fairly direct. He toured Tufts University while in Boston for ISSRDC and locked in his decision to pursue a demanding double major in engineering and computer science.

He credits Genes in Space with giving him the confidence to pursue the workload and for introducing him to a Tufts professor who worked with NASA. While assisting with the professor's research, Chang created an image processing tool to analyze hours of years-old videos depicting materials investigations on the space shuttle. This experience led to an internship with a NASA contractor, where he worked on space systems.

After completing the internship and graduating, Chang entertained several full-time job offers in the space and tech industries before accepting a position at a Series A robotics startup in Boston. After a year at the startup, he went on to develop a text-based platform that enables creators, such as artists and influencers, to more easily connect with their followers. To commercialize the platform, he founded Boston-based startup Markit AI, which has raised \$1.8 million in investor funding and sends more than one million text messages per month. Chang also serves as president of Techstars' Boston alumni chapter and is an Entrepreneur in Residence at Boston University.

(Below) Kaylie Hausknecht dressed up as Albert Einstein for a school project in 2009.

Kerin Hausknecht

Kaylie Hausknecht fills a dewar with liquid nitrogen at the Harvard-Smithsonian Center for Astrophysics 1.2-meter telescope.

Kaylie Hausknecht

"I only pursued engineering because of my experience at ISSRDC," says the entrepreneur with two STEM degrees, looking back at the 17-year-old who attended the conference. "There would be no way I would have even started a company if I didn't have the technical ability to do that—the career trajectory is insane."

Boguraev charted an ambitious course of her own. After graduating from Yale, she began an eight-year M.D.-Ph.D. program at MIT and Harvard. She is working toward a Ph.D. in chemical biology, focusing on immunity and vaccine design at the Ragon Institute. Building on her Genes in Space research, she focuses on engineering proteins to create more targeted vaccines against viruses such as Dengue, Zika, and West Nile, which disproportionately affect low-resource regions. The parallels between her current work and her early space experiment are striking: both require tools that are compact, portable, and user-friendly, whether for use in orbit or remote clinics on Earth.

"There's a relationship between doing science in space and doing medicine in low-resource communities on Earth," Boguraev explains. "Doing Genes in Space was the first time I began to see that connection."

After spending a summer in the Space Life Sciences training program at NASA's Ames Research Center, Boguraev says she would love to return to space-based research if an opportunity arose for translational medicine studies on the diseases she is focused on. But whether her work returns to space or not, she says it was the opportunity to send an experiment to the space station that launched her career.

"I think having that perspective has made me approach science much more creatively and also made me see connections across different disciplines of science," she said.

Just across campus from Boguraev, Vijayakumar is now a second-year medical student in the Harvard-MIT Health Sciences and Technology program. During her undergraduate years at Yale, Vijayakumar and her team took their Genes in Space project a step further. They published a peer-reviewed article on their results and presented findings at a technical session at ISSRDC the following year.

(Above) Aarthi Vijayakumar is pictured here at Harvard Medical School's White Coat Day in July 2023.

Devi Vijayakumar

Aarthi Vijayakumar and teammates Michelle Sung and David Li pose with their mentor Deniz Atabay and the Genes in Space trophy at ISSRDC in 2018.

While Vijayakumar always knew she wanted to pursue a career in biology, her Genes in Space experience refined the trajectory of her college studies, leading her to pursue undergraduate research on immune system regulation.

Eventually, Vijayakumar wants a career where she can apply her studies in a clinical setting with patients. Her current research is focused on the development of HIV therapeutics, and she's excited that her lab's principal investigator is actively involved in clinical trials for other vaccines.

Chang's Markit AI founding team includes his brother Peter Chang and his Tufts classmate Ned Carlson.

Markit AI Team

Jonathan Chang participates in a panel at the Derby Entrepreneurship Center at Tufts University.

Jonathan Chang

"And it's all because of Genes in Space," she said. "I understood that I could contribute to solving a human health problem and could be treated like a scientist and collaborator at such a young age."

Not every finalist's journey to their career was a direct one, however—the pandemic proved that to Hausknecht. Her experience with Genes in Space and ISSRDC, though, smoothed the steps in front of her at a time when she could have easily tripped. During her first year at Harvard, students returned home to learn remotely due to the COVID-19 pandemic. Faced with a sophomore year of remote learning, she looked for a fall internship she could do instead, only to learn that the deadlines had already passed.

Hausknecht reached out for advice to her Genes in Space mentor, who pointed her to a NASA scientist also involved with the Genes in Space program. With encouragement and an application that drew heavily on both her Genes in Space experience and her work in a condensed matter physics lab at Harvard, Hausknecht secured a fall internship in the Computational Fluid Dynamics Division at NASA's Langley Research Center.

Then, in the spring, she interned at NASA Ames, where she helped detect exoplanets—her group found 301 new ones—and was selected for NASA's Sally Ride Internship Award.

"It really wouldn't have been possible without my experience at Genes in Space," said Hausknecht. Her internships at NASA opened new opportunities, including three additional NASA internships, and reaffirmed her goal to pursue a Ph.D. in physics. She's now living out that dream at MIT, where she has been pursuing research at the intersection of machine learning and statistical physics.

"I'm so thrilled to be where I am," she said. "It was always a dream of mine as a kid to learn what Einstein's E=mc2 meant, and now I'm studying physics!"

Paying it Forward

While the finalists' hometowns cheered them on, their schools also reaped benefits. The students' sponsoring teachers accompanied them to ISSRDC, providing valuable exposure to space science that they could bring back to their classrooms. Additionally, each school received a miniPCR machine to conduct DNA experiments.

Hausknecht's science teacher was awarded a grant to purchase additional miniPCR machines and now leads the school's science department. Inspired by her mentors and the Genes in Space experience, Hausknecht hopes to build a career that blends physics research, teaching, and mentorship—maybe even as a NASA scientist.

"Genes in Space gave me the confidence and the tools that made me feel like I could be a scientist and set me on that path," she said, encouraging high school students to apply for the Genes in Space program. "No idea is too big or too small, so don't be intimidated," she advises.

At Vijayakumar's high school in Minnesota, the use of miniPCR became part of the curriculum, helping new teams enter the competition. Today, Vijayakumar is always happy to offer advice to the "home team." She relishes the opportunities that new generations at her alma mater now possess. "It's many students' first lab experience, and it's rewarding to see them excited," she says. "It was nice to be able to give something to our school and our teacher, who supported us all the way."

Chang compares entering Genes in Space to the butterfly effect, or the idea that a small change can eventually lead to a drastically different outcome.

"Any opportunity that comes up, you have no idea where it could possibly take you," he says. "But if you don't take it—if you don't flap your wings—nothing's going to happen. You never know what that opportunity can become."

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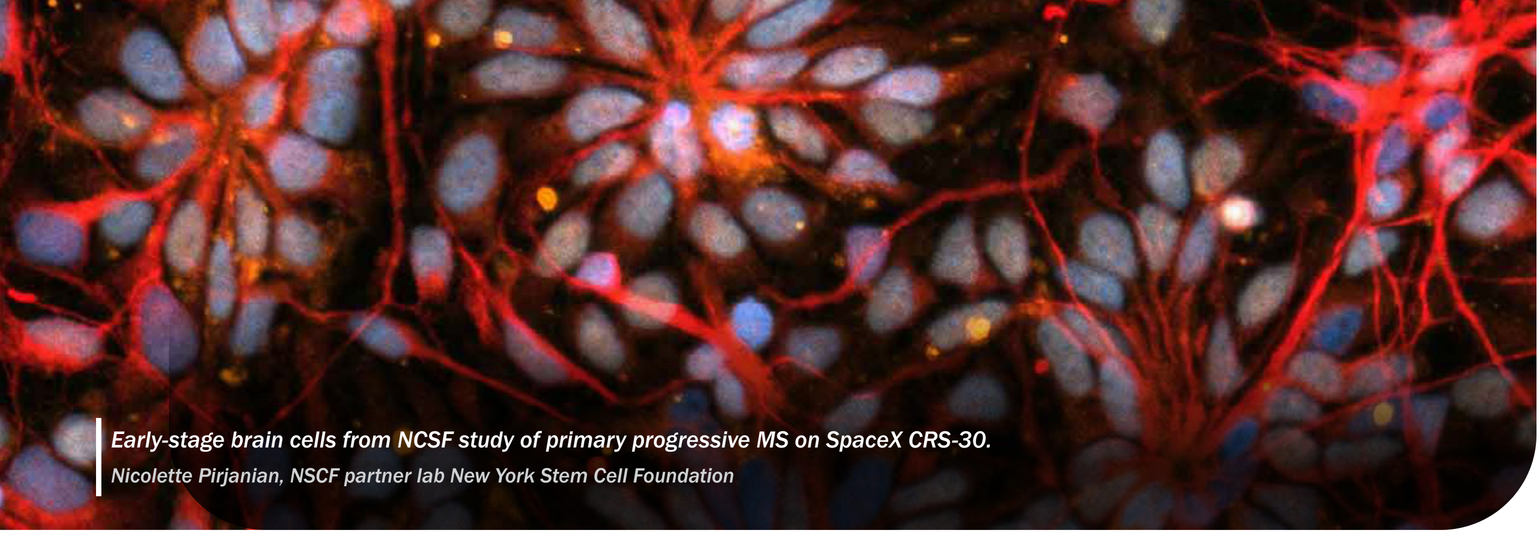


Early-stage brain cells from NCSF study of primary progressive MS on SpaceX CRS-30.
Nicolette Pirjanian, NSCF partner lab New York Stem Cell Foundation

Space Could Unlock Cures for Neurodegenerative Diseases

By Anne Wainscott-Sargent, Contributing Author

Millions of Americans live with Parkinson's, multiple sclerosis (MS), and Alzheimer's—neurodegenerative diseases with no cure and no significant biomarkers to enable early intervention. Fortunately, breakthrough research on the International Space Station (ISS) offers promising avenues to better understand and fight these devastating diseases.

"Cells mature more rapidly in space, which means you can see what's happening in an accelerated way. It would take you much longer to see those changes on the ground," said Paula Grisanti, CEO of the National Stem Cell Foundation (NSCF).

Since 2019, NSCF has conducted six space station investigations using human brain organoids, tiny 3D replicas that mimic how cells behave in the brain. A $3.1 million NASA award announced this spring will enable NSCF to continue its groundbreaking microgravity studies, funding three additional ISS projects through 2027.

In earlier investigations sponsored by the ISS National Laboratory®, the team examined brain organoids made from the cells of people with Parkinson's disease and primary progressive MS. Together, these two conditions affect at least 2 million people in the U.S.

"These were the first 3D human patient-specific organoid models made from the cells of people with these diseases sent to the International Space Station," Grisanti said. "In space, you can see cells talking to each other in a way that's not possible on Earth. It's providing valuable new insight into how these disorders develop, accelerating biomarker discovery for early diagnosis and opening a whole new door to potential cell, gene, and drug therapies that don't currently exist for these diseases."

The upcoming flights will build on the team's past research by adding organoids made from the cells of people with Alzheimer's disease. Approximately 6.7 million Americans live with Alzheimer's, resulting in an annual economic impact of more than $321 billion.

Brain Organoids in Space

NSCF scientists produce brain organoids from induced pluripotent stem cells (iPSCs) derived from human skin cells. "Stem cells mimic the very early stages of development in a mother's womb and have the potential to become any cell type in the human body," explained Pinar Mesci, NSCF space project advisor who serves as senior program manager for in-space biomanufacturing at Axiom Space.

Kentucky Senate President Stivers and Paula Grisanti, National Stem Cell Foundation CEO, announce a multimillion-dollar award from NASA for pioneering space-based research.
National Stem Cell Foundation

Skin cells are turned into stem cells through a process called cellular reprogramming, and the stem cells can then be developed into brain cells.

In previous flights to the ISS, the NSCF team found that brain cells mature faster in space. In the upcoming experiments, NSCF scientists will test existing drugs and new ones in development to see if they interfere with disease progression. “The ability to see what happens to these cells in space as they mature is particularly valuable for diseases that are diagnosed later in life,” explained Grisanti.

Studies from stem cell-derived organoid models have significant advantages over traditional animal studies, Mesci said. For her doctorate in neuroscience from Pierre & Marie Curie University in Paris, Mesci used mouse models to study Lou Gehrig’s disease, or ALS, a fatal motor neuron disease.

“Mouse models are good to study certain aspects of diseases, but unfortunately, none of the treatments that we tried in those animals were translatable enough to develop a cure or to significantly treat symptoms in patients,” she explained. Organoids more closely represent how brain cells function in the human body, providing a more robust and accurate model.

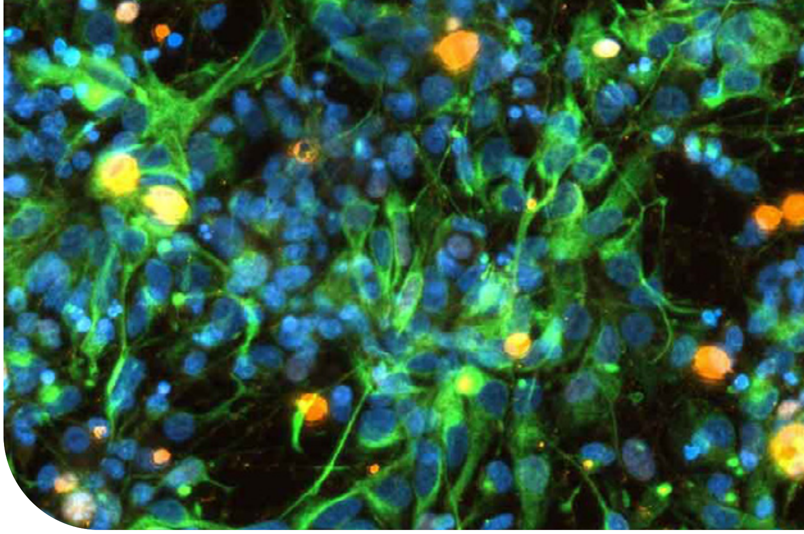
Tracing Inflammation Pathways

In the upcoming series of NSCF projects, the team will trace the inflammation pathways involved in neurodegenerative diseases. Findings could help researchers better understand disease onset and identify possible biomarkers.

“Unfortunately, studies have been done for many decades but have yet to lead to any treatment options, mainly because we lack a good biomarker,” Mesci said. “Biomarkers allow us to identify damage before the disease gets to the point that symptoms appear, at which stage it’s often already too late to intervene. For instance, in a disease like ALS, which is very aggressive, patients die within two to five years after symptoms begin.”

In the case of Parkinson’s disease, once tremors begin, significant nerve damage has already occurred. Estimates suggest that by the time symptoms are noticeable, a person may have lost almost 70% of the dopamine-producing cells in their brain, which regulate body functions like movement.

“Once you have a lot of things dying in the brain, chronic inflammation will amplify everything,” said Mesci. Using the analogy of a forest fire, she noted, “It’s much easier to put a fire out when it first starts than when hundreds of acres have already burned.”



Early-stage brain cells from NSCF study of Parkinson’s disease on SpaceX CRS-30.

Nicolette Pirjanian, NSCF partner lab New York Stem Cell Foundation

Building on Learnings from Past Missions

NSCF will leverage processes developed from earlier space station missions, including techniques for optimizing experiments to focus on the disease pathways. The team hopes to answer questions such as: What are the drivers of these diseases? What can human organoid models tell us about the diseases’ early stages when no symptoms exist? And how can we intervene?

Ultimately, NSCF plans to make its disease models available to pharmaceutical and life science companies for drug discovery and the development of new therapeutic options for neurodegenerative diseases.

“The ability to see and analyze cell interactions in a way not possible on Earth is creating an unprecedented opportunity to accelerate the discovery of new therapies for these and other neurodegenerative diseases that affect tens of millions worldwide,” Grisanti said. “This is a transformative moment in history for finding treatments and cures for some of the most costly and terrible diseases of our time.”

This content was abridged from an article that originally appeared on issnationallab.org/ISS360/.

FORGING THE PATH

Sven Eenmaa is the Chief Economist for the ISS National Lab, where he works with entrepreneurs, investors, and industry partners to identify and mature promising economic value creation opportunities that can leverage the unique space environment

By Sven Eenmaa | Chief Economist, ISS National Lab

Need to Invest in Space-Based R&D, Not Cut

Many of us who are space enthusiasts love to read about the prospects of the multi-trillion-dollar space industry that prolific industry consultants are so happily projecting. However, with the current FY26 federal budget proposals, it is important to remind ourselves what the near-term revenue and funding mix for nascent segments and companies in the space economy truly looks like. While the dependence on government funding varies, it's fair to say that the earlier in the development and scale-up stage a space company is, the higher the chance of the company needing government-affiliated funding or demand, directly or indirectly. Furthermore, we have seen a recent shift in several newer but already well-established space companies toward defense opportunities that are driven by government budgets.

As characterized by some of the space industry veterans, the FY26 federal budget process looks more dramatic than anything they have seen in a while. Accounting for inflation, the White House budget request takes NASA funding back to the level last seen in 1961. When it comes to research and technology development (R&D) in low Earth orbit (LEO), the following quote from NASA's FY 2026 Budget Technical Supplement drives home the point:

"The budget significantly reduces research and other activities on board the ISS. ISS is replanning with a focus on maintaining minimal safe operations and very limited research essential to support Moon and Mars exploration until its retirement in 2030. ISS is evaluating how much to reduce the current U.S. crew and crew/cargo vehicle cadence."

With a risk of stating the obvious, cutting cargo capacity and R&D throughput on the ISS, and hence cutting ISS National Lab capabilities, for the sake of near-term cost savings will have direct, substantial implications. It will significantly reduce the ability to develop, test, and validate technologies and products for a broad range of commercially viable applications. This, in turn, will reduce the ability to attract private capital to fully fund these new technologies and unlock their long-term economic potential.

What is likely not obvious for an external observer is that an extensive pipeline of R&D projects destined for the ISS already exists. Now, with substantially reduced resources, these projects will absorb most of the capacity that's left, with little to no room for next-level iterations that drive technology closer to commercialization. There is now a very real risk of a near-term, multi-year gap in access to orbit for the R&D needed for several of these technologies to reach the commercialization finish line. Aside from the ISS, there is no comparable, alternative value proposition for the companies that require this R&D. This, in turn, will shrink the new business pipeline for the companies that provide the hardware and services to conduct R&D in space. It will introduce a severe risk of viability for these service companies. And it threatens the business prospects and services value chains for future commercial infrastructure for space-based R&D. It also dims the hopes of NASA becoming "one of many customers" for future commercial space stations.

We at ISS National Lab have already demonstrated material positive impact from R&D in LEO, working with close to 100 startups collectively raising more than $2.4 billion after their ISS flight projects. In 2023, ISS National Lab awards to companies for technology development allowed the companies to bring in additional funding from other sources that was eight times the amount originally awarded by the ISS National Lab. In early 2024, the matched funding increased to a ratio of nine to one. There have been new products launched and patents filed based on research through the ISS National Lab. Our recently launched Orbital Edge Accelerator, in partnership with global investors Cook Inlet Region, Inc., E2MC, and Stellar Ventures, is seeing strong demand from the space community. The value proposition here is very clear, and it works. ISS flight projects reduce the early-stage technology development and validation risk, allowing private capital to step in and take the lead.

It should be a priority for our nation to build a self-sustaining economy with private-capital-funded businesses in LEO that would provide a capital-efficient "steppingstone" to broader space exploration efforts for decades to come. There are strong geopolitical competitiveness merits to this and a strong potential for U.S. economic growth. But for that, we need to invest in R&D in LEO now, supporting innovation in areas with a line of sight to private capital engagement. Over the life of the ISS, R&D results have only gotten stronger. We're now at the edge of reaching truly transformational results—on the verge of solving some of humanity's biggest challenges. This is not the time to pull back, but rather, to accelerate.

This piece is part of our Forging the Path series in which CASIS® experts and partners share knowledge and insight from their experience managing a national lab in space.

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