



EXPLORESpace TECH
TECHNOLOGY DRIVES EXPLORATION

Innovation in Sustainability through Early-Stage Partnerships at NASA

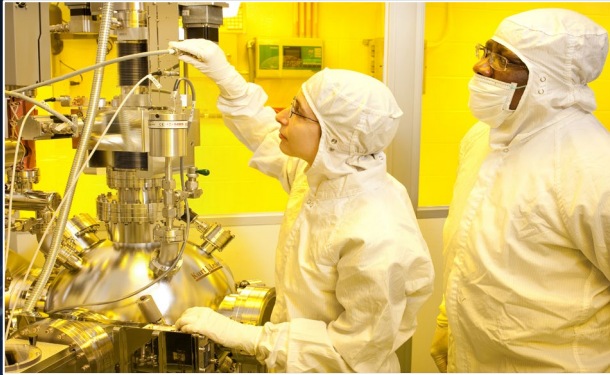
Jason L Kessler, Program Executive, SBIR/STTR Program, NASA STMD

14 September 2022

Ensuring American global leadership in Space Technology



Advance US space technology innovation and competitiveness in a global context



Encourage technology driven economic growth with an emphasis on the expanding space economy



Inspire and develop a diverse and powerful US aerospace technology community

SPACE TECHNOLOGY PORTFOLIO

EARLY STAGE INNOVATION AND PARTNERSHIPS

- Early Stage Innovation
 - Space Tech Research Grants
 - Center Innovation Fund
 - Early Career Initiative
 - Prizes, Challenges & Crowdsourcing
 - NASA Innovation Advanced Concepts
- Technology Transfer

Early Stage Innovation and Partnerships Portfolio

SBIR/STTR PROGRAMS

- Small Business Innovation Research
- Small Business Technology Transfer

TECHNOLOGY MATURATION

- Game Changing Development
- Lunar Surface Innovation Initiative

TECHNOLOGY DEMONSTRATION

- Technology Demonstration Missions
- Small Spacecraft Technology
- Flight Opportunities

Technology Drives Exploration

LOW

MID

Technology Readiness Level

HIGH

The Early-Stage Innovation and Partnerships (ESIP) Portfolio empowers a community of innovators pioneering aerospace research and transformative technology ventures. It enables NASA’s mission and invigorates our economic future.

Working together, ESIP amplifies the value and impact of STMD’s and NASA’s early-stage technology development and tech commercialization programs. Each of ESIP’s programs and activities play an important role in this work.

 NIAC	 STRG	 CIF/ECI	 PCC	 ESIC	 SBIR/STTR	 T2
NASA Innovative Advanced Concepts	Space Tech Research Grants	Center Innovation Fund / Early Career Initiative	Prizes, Challenges, & Crowdsourcing	Early-Stage Innovation and Commerce	Small Business Innovation Research / Small Business Technology Transfer	Technology Transfer
Nurtures visionary ideas that could transform future NASA missions by engaging America’s innovators and entrepreneurs as partners in the journey.	Challenges the spectrum of academic researchers to making science, space travel, and exploration more effective, affordable, and sustainable.	Stimulate and encourage creativity and innovation within the NASA Centers and Early Career leaders .	Makes opportunities available for public participation in NASA research and technology solutions to support.	Advances joint priorities and innovative pilots to under-represented communities, academic research and public private partnerships.	Engages small businesses, research institutions, and entrepreneurs in technology R&D that meet NASA needs and could be commercialized.	Ensures that innovations developed for exploration and discovery are maximizing the benefit to the Nation and enabling spinoffs .
30+ grants annually	300+ grants with dozens of universities	~140 projects across NASA Centers	>40 Activities	~10 pilot investments/ projects	>500 contracts with hundreds of small businesses	>1,500 Active Patents & >700 Licenses

----- Cross-Cutting Activities -----

Diversity, Equity, Inclusion, and Accessibility (DEIA) • I-Corps and Entrepreneurial Projects

NASA Innovative Advanced Concepts (NIAC)

Proposed NIAC concepts **must demonstrate innovation and have a clear potential impact** in transforming future NASA missions

- Early stage concepts for NASA missions 10 to 20+ years out
- High risk, high reward
- Open to ideas from all scientific disciplines
- Projects are technically credible

NIAC in Chicago

- **Out of this World** - 16 book series for grades 4-12 in partnership with World Book, based in Chicago.
- **Science Fiction to Science Fact** – Annual event held at science museums across the US, began at Museum of Science and Industry in Chicago

PHASE I

9 Months
Up to \$175K
For concept definition and initial analysis

PHASE II

2 Years
\$Up to \$600K
For further development, mission analysis, path forward, spin offs

PHASE III

2 Years
Up to \$2M
To strategically transition Ph II's with highest potential impact to NASA and partners

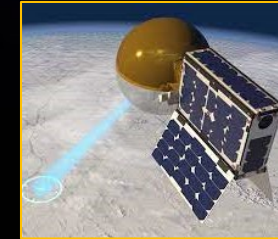


PROGRAM MILESTONES



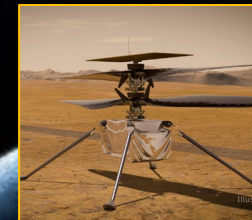
MarCO Mission

- 1st inter-planetary cubesats



Cat Sat Mission

- University of AZ
- Student led
- Increase Data Return (5G)



Ingenuity Helicopter

- Inspired 1st flight mission



Astrobotic

- Lunar Landers and Autonomous Rovers

NASA Inventors Hall of Fame: Robert Youngquist



New material for missions with extreme heat/cold

2022 NIAC Symposium: FREE and open to the PUBLIC!



NIAC Symposium
Tucson, AZ at
University of Arizona

You're invited to the
NIAC Symposium!
September 20-22, 2022
<https://www.nasa.gov/content/niac-symposium>



Seed Funding ->
NASA missions

Space Technology Research Grants Program

NASA Space Technology Graduate Research Opportunities (NSTGRO)

Up to \$80K per year
249 active awards

Early Career Faculty (ECF)

Up to \$200K per year
39 active awards

Early Stage Innovations (ESI)

Up to \$200K per year
51 active awards

Lunar Surface Technology Research (LuSTR) Opportunities

Up to \$2M, 2 years
9 active awards

Space Technology Research Institutes (STRI)

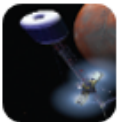
Up to \$3M per year, 5 years
6 active awards



TA01
Launch Propulsion
30 Awards



TA02
In-Space Propulsion
84 Awards



TA03
Space Power &
Energy Storage
50 Awards



TA04
Robotics &
Autonomous Systems
125 Awards



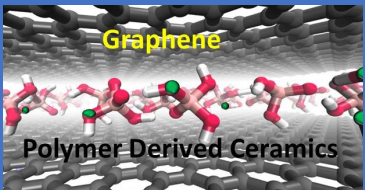
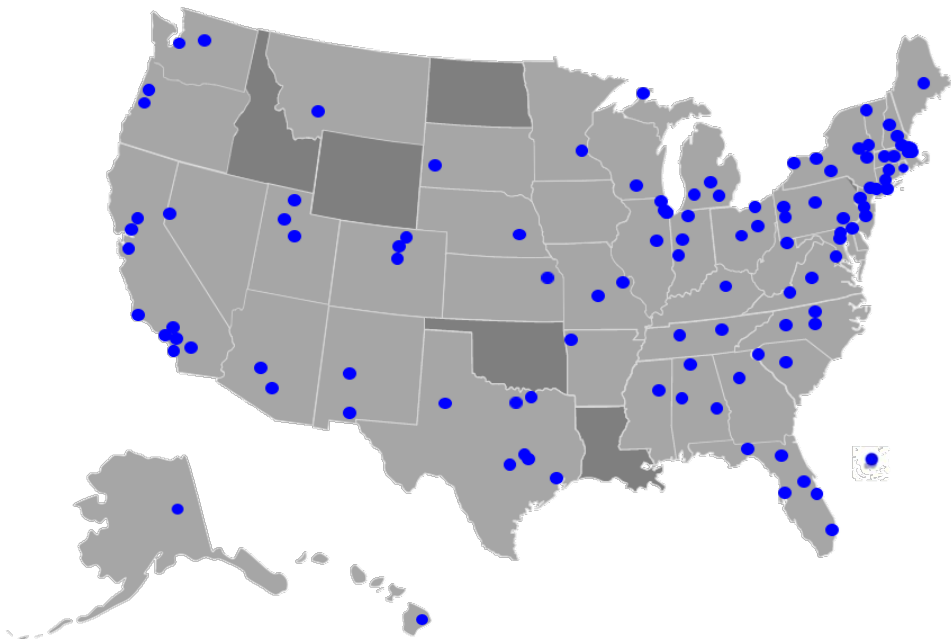
TA05
Communications, Navigation &
Orbital Debris Tracking
95 Awards



TA06
Human Health, Life Support &
Habitation
65 Awards



TA07
Human Exploration
Destination Systems
44 Awards



Dr. Elizabeth Barrios
University of Central Florida
NSTRF16

Ceramic / Graphene Thermoelectric Material

Loading a graphene network into a silicon oxycarbide ceramic has created electrically conductive ceramics that are also thermally and mechanically stable. This can enable lower cost, less toxic thermoelectric materials useful in radioisotope thermoelectric generators and other applications.

TA08
Science Instruments,
Observatories and
Sensor Systems
101 Awards



TA09
Entry, Descent & Landing
96 Awards



TA10
Nanotechnology
44 Awards



TA11
Modeling, Simulation, IT &
Processing
44 Awards



TA12
Materials, Structures,
Mechanical Systems &
Manufacturing
112 Awards



TA13
Ground & Launch Systems
1 Award



TA14
Thermal Management
38 Awards



STRG: Cutting edge chemistry for sustainable space exploration, energy and climate

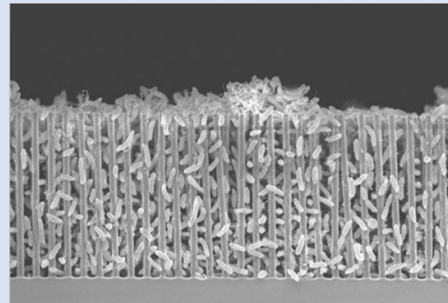
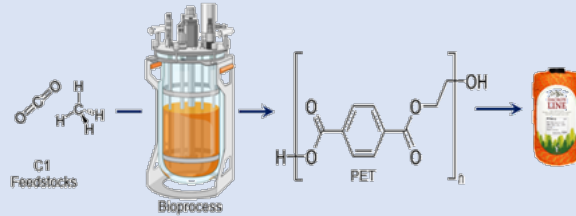
Center for the Utilization of Biological Engineering in Space

Space Technology Research Institute (STRI) led by UC Berkeley



Bioplastics from ISRU CO₂

- Developed pioneering methods to incorporate an aromatic ring in the backbone of a bio-polyester
- Paving the way to a new high-performance biomaterials



UC Berkeley image

Energy

- Biohybrid solar cell: electrophilic bacteria tightly packed around silicon nanowires
- Close packing results in more efficient conversion of solar energy to chemical bonds in bacterial production of acetate

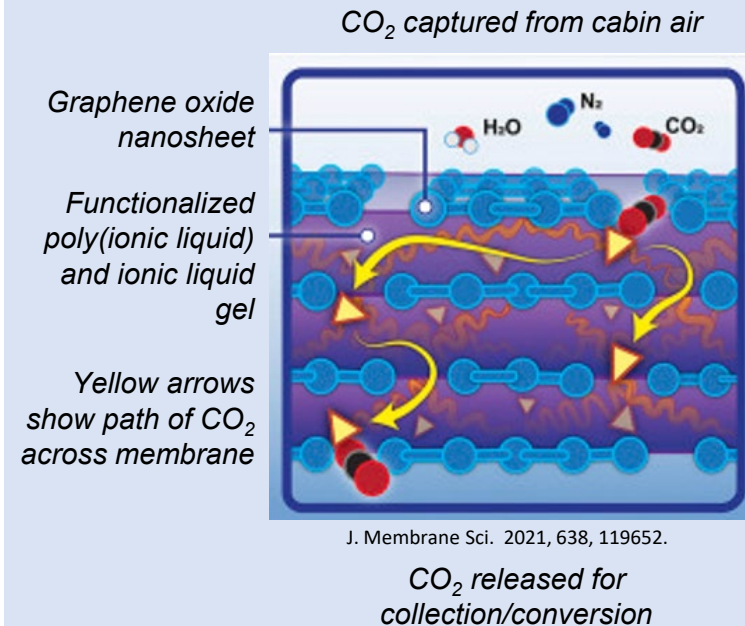
Pharmaceutical Production

- Transgenic lettuce for production of therapeutics to mitigate bone loss in space
- Novel nanoparticle-based purification system

Poly(ionic liquid)-Ionic Liquid Membranes Reinforced by Graphene Sheets for CO₂ Capture and Conversion in Microgravity

2018 Early Career Faculty (ECF) project led by **Dr. Burcu Gurkan**, Case Western Reserve University

Direct Air Capture of CO₂ via Facilitated Transport in Membrane System



J. Membrane Sci. 2021, 638, 119652.

- CO₂ capture/release by ionic liquid via reversible reaction
- Novel membrane system
- NASA life support systems benefits:
 - Dust-free
 - CO₂ available for conversion to O₂
- Earth applications include:
 - Climate change-negative emissions
 - Systems to improve building air quality

NSTGRO solicitation allows graduate student researchers to select research topics they are passionate about.

- ~20% of recent projects are developing climate & clean energy related technologies



Temperature-Modulated Radiative Coatings for Dynamic Thermal Management of Spacecraft

Sydney Taylor (NSTRF16) from Arizona State University

- A vanadium dioxide (VO₂) variable emittance radiator based on Fabry-Perot (FP) resonance cavities was developed and demonstrated during this project
- Dr. Taylor is now continuing her work with passive thermal control systems as at NASA

Prizes, Challenges, and Crowdsourcing

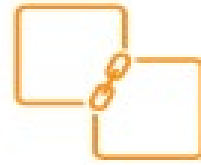
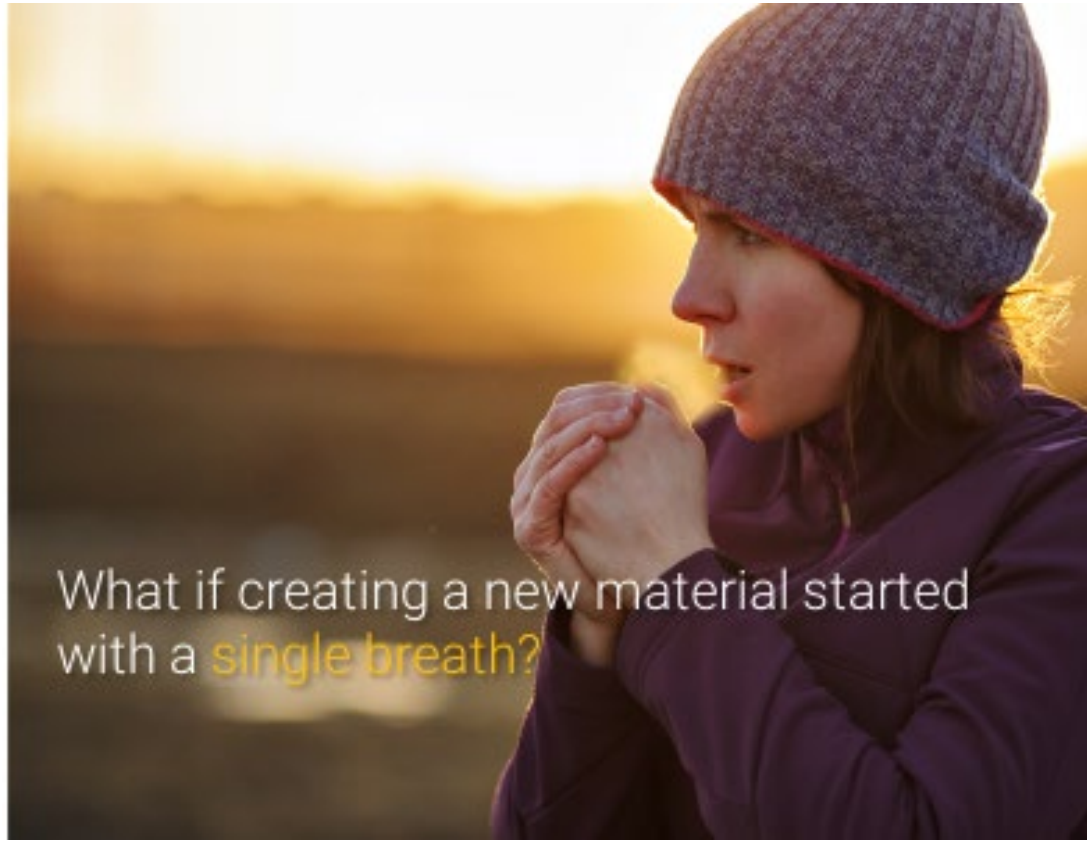
In fiscal year 2021:

- NASA ran 65+ crowdsourcing projects and competitions
- Prizes totaled more than \$9 million
- Current & future opportunities: nasa.gov/solve



NASA CO₂ Conversion Challenge

The NASA CO₂ Conversion Challenge asked teams to design and demonstrate abiotic technologies to manufacture sugars to feed bioreactors from CO₂ and hydrogen molecules, to produce materials needed for traveling and living in space.



Two Phases: Concept Design and Build/Test



\$1,000,000 Prize Purse was Awarded



Innovative Solutions

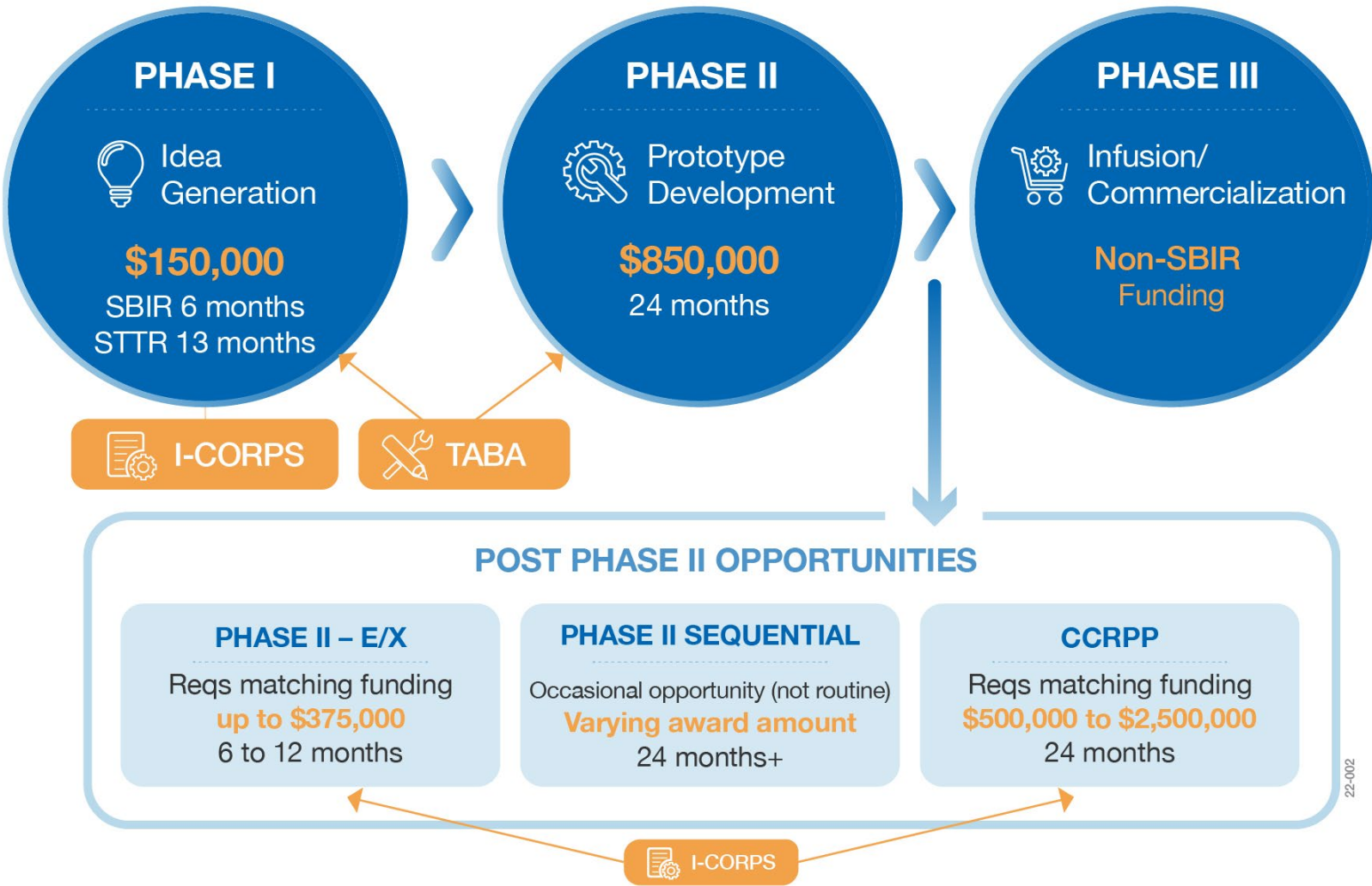


3 Teams Ultimately Successfully Demonstrated this Process

SBIR/STTR Program Phases

The annual NASA SBIR/STTR Solicitation typically opens in January of each year. Find out more: www.sbir.nasa.gov

NASA SBIR/STTR PHASES



22-002

Success Story | Nature's Fynd



Nature's Fynd is developing technology that could provide sustainable food in space and on Earth

Low-Maintenance Bioreactor Cultivates Fungi for Sustainable Food Source in Space

LOCATION: Chicago, Illinois – HQ; Bozeman, Montana – R&D

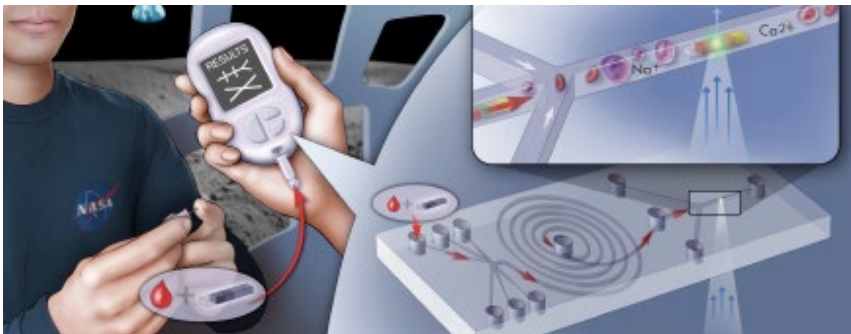
FOLLOW-ON SUCCESS:

Hundreds of millions in investor funds related to climate change applications and more

SNAPSHOT:

Nature's Fynd partnered with Montana State University on NASA STTR contracts to further develop a micro-gravity biofilm-biomaat reactor, which cultivates a unique fungus to form a dense protein material. The resulting "biomaat" could serve as a nutritious food source for life away from Earth. Nature's Fynd has received more than \$500M in external investments and recently launched its meatless and dairy-free foods in retailers.

READ MORE: [Web](#) | [PDF](#)



Two different lasers are used to detect the test strip and the targets in the blood sample to generate a comprehensive health profile.

Easy and Non-Intrusive Nanoscale Diagnostic Platform

LOCATION: Cambridge, Massachusetts

FOLLOW-ON SUCCESS:

\$525,000 Grand Prize winner of the Nokia XChallenge. Several million dollars in funding from private investors, and multiple biotech and pharmaceutical partners.

SNAPSHOT:

DMI developed a self-diagnosis tool for astronauts to use on long missions in outer space. rHEALTH is an innovative blood analysis system that can generate comprehensive medical test results within minutes using a single drop of blood. While rHEALTH was designed for astronauts, it has expanded to support health on Earth. In 2021, rHEALTH received funding from the National Institutes of Health's (NIH) RADx initiative, whose goals include enhancing efforts to diagnose COVID-19. In May 2022, a successful technology demonstration of the rHEALTH ONE blood analyzer was completed aboard the ISS.

READ MORE: [Web](#) | [PDF](#)

NASA Technology Transfer Program



Technology Transfer University

- Student entrepreneurs build case studies with NASA's patent portfolio
- Learn about commercialization and licensing opportunities
- <https://technology.nasa.gov/t2u>

Technology Transfer Expansion Initiative

- FedTech Startup Studio

<https://technology.nasa.gov/fedtech-startup-studio-cohort>

- Dynamic experiential training program using NASA technology
 - Designed to turn ambitious entrepreneurs into lean startup companies

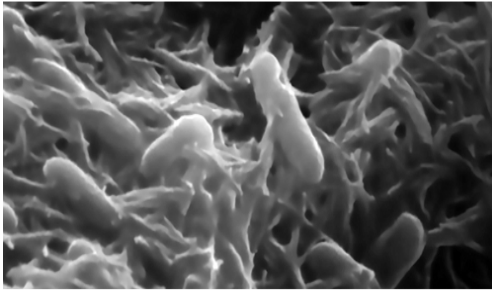
- Tech Center Research Park Accelerator Network Program

<https://technology.nasa.gov/tech-center-research-park-accelerator-network-pilot-program>

- 3-month cohort comprised of minority and under-represented entrepreneurs turning NASA innovations into globally-impactful products and services



Electrified Bacteria Clean Wastewater, Generate Power



Shewanella oneidensis bacteria, discovered in 1988, were the first microbes known to be able to breathe by transferring an electric charge to a metal outside their cell membrane. NASA recently sent a batch of *Shewanella* to the ISS to see how they react to the spacecraft environment, as they could be useful for life-support systems.

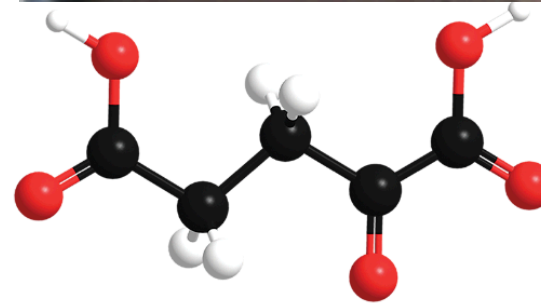


Gas Processors Turn Oil Drilling Emissions into Fuel for Sale



Flaring at drilling sites releases about 350 million tons of carbon dioxide per year and is associated with health problems among nearby populations. It's also a major waste, as the gases being burned, if properly processed and separated, can be valuable fuels.

Organic Compound Turns Toxic Waste into Harmless Byproducts



Working with a team of researchers at New Mexico Highlands University under a Space Act Agreement with Johnson Space Center, organic chemist Rudy Martinez thought the molecular configuration of alpha-ketoglutaric acid (AKGA) might make it a good identifier of the presence of hydrazine. He found instead that it relatively quickly and safely neutralized hydrazine, a toxic, flammable compound used in small spacecraft thrusters and a number of industrial processes. Image



NASA I-Corps Pilot

The NASA I-Corps™ Pilot aims to reduce the time and risk of translating promising ideas and technologies **from the laboratory to the marketplace** through training grants. Selected awardees receive **up to \$10K** to participate in a NSF regional course, and **may apply up to \$40K** in additional support for the NSF national course.



(Photo by John De La Rosa / NREL). Alt Text: A person providing a practice pitch and two other I-Corps teams providing feedback

Eligibility: Only non-profit (non-governmental) organizations are eligible to propose. Proposing team(s) need not have received a previous NASA award to apply.

- **Promoting a culture that will cultivate an entrepreneurial mindset** leading to teams potentially launching start-ups.
- **Fostering inclusive mechanisms for participation** aimed at both NASA awarded and currently non-NASA awarded researchers supporting diversity, equity, inclusion, and accessibility.
- **Accelerate research outcomes & commercialization** by strengthening researchers' overall viability and their capability through a customer discovery experience.

Sites and Contacts

STMD Solicitations & Funding Opportunities: <https://www.nasa.gov/directorates/spacetech/solicitations>

STMD Programs: <https://www.nasa.gov/directorates/spacetech/programs>

NASA Innovative Advanced Concepts

Acting Program Executive, Michael LaPointe: michael.r.lapointe@nasa.gov, hq-niac@mail.nasa.gov

Space Technology Research Grants

Program Executive, Claudia Meyer: claudia.m.meyer@nasa.gov

Prizes, Challenges and Crowdsourcing

Program Executive, Amy Kaminski: amy.p.kaminski@nasa.gov

Technology Transfer

Program Executive, Dan Lockney: daniel.p.lockney@nasa.gov

SBIR/STTR

Program Executives, Jason Kessler, Gynelle Steele and Damian Taylor: sbir@reisystems.com

Lunar Surface Innovation Consortium

Technical Communications Specialist, Andrea Harman: ams573@alumni.psu.edu, SES-LSIC-Web@jhuapl.edu

Flight Opportunities

Program Executive, Chris Baker: christopher.e.baker@nasa.gov, nasa-flightopportunities@mail.nasa.gov

Small Spacecraft Technology

Program Executive, Chris Baker: christopher.e.baker@nasa.gov, rodolphe.derosee@nasa.gov

Thank you!