



Space Technology Mission Directorate

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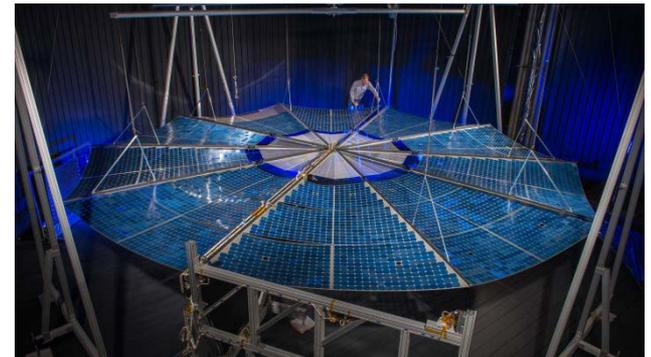
Technology Drives Exploration



Space Technology Guiding Principles:

- Addressing **tough technology problems for NASA** including in-space propulsion, deep space navigation, lightweight structures and entry, descent and landing
- Responding to **aerospace industry challenges** in areas such as in-space communications, propulsion, manufacturing, robotics and materials through contracts, grants and public private partnerships
- Leveraging limited funding through **partnering and cost sharing** to maximize investment in tight budget environment
- Employing Small Businesses, academia and partnerships to **foster innovation, tapping into the Nation's entrepreneurs** to tackle key challenges

Utilizing prize competitions to address challenges including: robotics, deep-space cubesat operations, autonomous systems, additive manufacturing, and Europa ice excavation





Space Technology Portfolio



Transformative & Crosscutting Technology Breakthroughs

Pioneering Concepts/Developing Innovation Community

Creating Markets & Growing Innovation Economy

Technology Demonstration Missions

bridges the gap between early proof-of-concept tests and the final infusion of cost-effective, revolutionary technologies into successful NASA, government and commercial space missions.



NASA Innovative Advanced Concepts (NIAC)

nurtures visionary ideas that could transform future NASA missions with the creation of breakthroughs—radically better or entirely new aerospace concepts—while engaging America’s innovators and entrepreneurs as partners in the journey.



Centennial Challenges

directly engages nontraditional sources advancing technologies of value to NASA’s missions and to the aerospace community. The program offers challenges set up as competitions that award prize money to the individuals or teams that achieve a specified technology challenge.



Small Spacecraft Technology Program

develops and demonstrates new capabilities employing the unique features of small spacecraft for science, exploration and space operations.



Space Technology Research Grants

seek to accelerate the development of “push” technologies to support future space science and exploration needs through innovative efforts with high risk/high payoff while developing the next generation of innovators through grants and fellowships.



Flight Opportunities

facilitates the progress of space technologies toward flight readiness status through testing in space-relevant environments. The program fosters development of the commercial reusable suborbital transportation industry.

Game Changing Development

seeks to identify and rapidly mature innovative/high impact capabilities and technologies that may lead to entirely new approaches for the Agency’s broad array of future space missions.



Center Innovation Fund

stimulates and encourages creativity and innovation within the NASA Centers by addressing the technology needs of the Agency and the Nation. Funds are invested to each NASA Center to support emerging technologies and creative initiatives that leverage Center talent and capabilities.



Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)

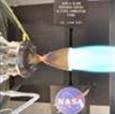
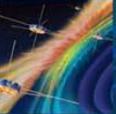
Programs provide an opportunity for small, high technology companies and research institutions to develop key technologies addressing the Agency’s needs and developing the Nation’s innovation economy.





Space Technology Roadmaps



TA 1		LAUNCH PROPULSION SYSTEMS	TA 9		ENTRY, DESCENT, AND LANDING SYSTEMS
TA 2		IN-SPACE PROPULSION TECHNOLOGIES	TA 10		NANOTECHNOLOGY
TA 3		SPACE POWER AND ENERGY STORAGE	TA 11		MODELING, SIMULATION, INFORMATION TECHNOLOGY, AND PROCESSING
TA 4		ROBOTICS AND AUTONOMOUS SYSTEMS	TA 12		MATERIALS, STRUCTURES, MECHANICAL SYSTEMS, AND MANUFACTURING
TA 5		COMMUNICATIONS, NAVIGATION, AND ORBITAL DEBRIS TRACKING AND CHARACTERIZATION SYSTEMS	TA 13		GROUND AND LAUNCH SYSTEMS
TA 6		HUMAN HEALTH, LIFE SUPPORT, AND HABITATION SYSTEMS	TA 14		THERMAL MANAGEMENT SYSTEMS
TA 7		HUMAN EXPLORATION DESTINATION SYSTEMS	TA 15		AERONAUTICS
TA 8		SCIENCE INSTRUMENTS, OBSERVATORIES, AND SENSOR SYSTEMS			

CY Major Events & Milestones



Partnering with Universities to Solve the Nation's Challenges



U.S. Universities have been very successful in responding to STMD's competitive solicitations

- STMD-funded university space technology research spans the entire roadmap space
- More than **250** U.S. universities have led (*or are STTR partners on*) more than **650** awards since 2011
- In addition, there are many other partnerships with other universities, NASA Centers and commercial contractors

Program	# awards	# University-led awards	Upcoming Opportunities
 Space Technology Research Grants	284	284	<ul style="list-style-type: none"> • Early Career Faculty • Early Stage Innovations • NASA Space Technology Research Fellowships <i>Annually</i>
 NIAC	93	26	<ul style="list-style-type: none"> • NIAC Phase I • NIAC Phase II <i>Annually</i>
 Game Changing Technology Dev	37	14	Various topics released as Appendices to SpaceTech-REDDI <i>Annually</i>
 Small Spacecraft Technology	22	13	Smallsat Technology Partnerships – new in 2013 – annual opportunities beginning in 2015
 Flight Opportunities	117	50	Tech advancement utilizing suborbital flight opportunities – NRA to U.S. Universities, non-profits and industry are planned. <i>Twice Annually</i>
 STTR	192	181 w/ univ partners	<i>Annual STTR solicitation</i>
 Centennial Challenges	4 Challenges (2 university-run)	40 teams (9 univ-led, 1 univ-led winner)	<ul style="list-style-type: none"> • One or more challenges annually • Challenge competitions with a procurement track to fund university teams via grants



STMD University Engagement



University Research Integrated throughout STMD Portfolio

NASA Space Technology Research Fellowships

Space technology research efforts conducted by graduate students tied to Technology Area Roadmaps; research conducted on university campuses and at NASA Centers and not-for-profit R&D labs

Early Career Faculty

Focused on supporting outstanding faculty researchers early in their careers as they conduct space technology research of high priority to NASA's Mission Directorates

Early Stage Innovations

University-led, possibly multiple investigator, efforts on early-stage space technology research of high priority to NASA's Mission Directorates

Paid teaming with other universities, industry and non-profits and collaboration with NASA, OGAs and FFRDCs permitted

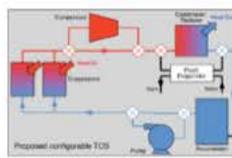
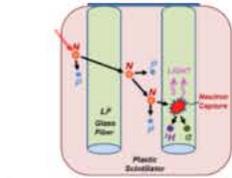
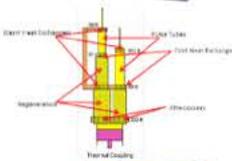
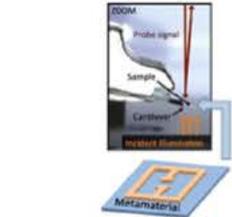
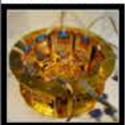
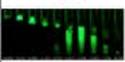
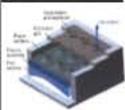
Advanced Concept Studies, Center Partnerships, and Challenges

Engaging university community in visionary early studies, projects at NASA Centers around the nation, and open challenges trying to change the way that NASA makes progress

Game Changing Technology Development

Mid-level TRL technology development in focused areas such as energy storage, micro-propulsion, robotics, technology payloads for suborbital testing.

~ Reinvigorate the pipeline of high-risk/high-payoff space technologies across the Technology Readiness Spectrum ~



Game Changing Development (GCD)



Goals:

To identify and rapidly mature innovative/high impact capabilities and technologies that may lead to entirely new approaches for the Agency's future space missions.

The program will investigate novel ideas and approaches that have the potential to revolutionize future space missions.

BIG IDEA Challenge:

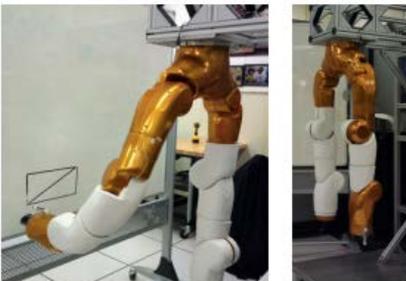
- In the 2017 Breakthrough, Innovative, and Game-changing (BIG) Idea Challenge, NASA is engaging university-level students in its quest to reduce the cost of deep space exploration.
- The 2017 BIG Idea Challenge invites teams and their faculty advisors to work together to design and analyze potential modular concepts and systems that provide the ability to construct large Solar Electric Propulsion (SEP) tugs in space. Concepts can employ:
 - New approaches for packaging modules in one or more launch vehicles that minimize launch loads
 - Modular solar arrays and ion engines
 - Robust robotic assembly of the modules that form the SEP tug.
- Interested teams of three to five undergraduate and/or graduate students are asked to submit robust proposals describing their concepts by Nov. 30
- Each finalist team will receive a \$6,000 stipend to facilitate full participation in the forum. BIG Idea Challenge winners will receive offers of paid internships with the GCD team at NASA Langley, where they can further develop their concept.



NS - Power Conversion Unit



NGLS-Rapid Cycle Amine



R2 Engineering Development Unit Legs



NGLS-Variable Oxygen Regulator

Centennial Challenges



Goal: Engage non-traditional participants such as makers, non-government funded entities, and educational institutions to achieve the nation's challenging technology goals.

How: Offers competitive challenges that award prize money to the individuals or teams that achieve the specified technology requirements.

ACCOMPLISHMENTS

Sample Return Robot Challenge demonstrates robots that can locate and retrieve samples from a wide and varied terrain without human control or terrestrial navigation aids.

- In the 2016 challenge, West Virginia University accomplished Level II and was awarded \$750,000.

Current Challenges

- **The Space Robotics Challenge:** is a \$1 million prize competition designed to push the boundaries of robotic dexterity. Teams must program a virtual robot, modeled after NASA's Robonaut 5 (R5) robot, to complete a series of tasks in a simulation that includes periods of latency to represent communications delay from Earth to Mars.
- **The Vascular Tissue Challenge:** is a \$500,000 prize purse to be divided among the first three teams who can successfully create thick, human vascularized organ tissue in an in-vitro environment while maintaining metabolic functionality similar to their in vivo native cells throughout a 30-day survival period.
- **Cube Quest Challenge:** is a \$5 million challenge that requires teams to design, build and deliver flight-qualified CubeSats capable of advanced operations near and beyond the moon.





Flight Opportunities



Goals:

- *Matures technologies by providing affordable access to space environments*
- *Facilitates the development of the commercial reusable suborbital transportation industry*

Flights:

- **Four companies** on contract to provide integration and flight services aboard commercial reusable sub-orbital vehicles
- Uses **parabolic flights** to carry payloads in reduced gravity and near the boundary of space

Payloads:

- *Unfunded payloads selected through Announcements of Flight Opportunities (AFO)*
- *Funded payloads selected through FY 2012 and FY 2013 NASA Research Announcements*
- *Collaborating with Science Mission Directorate (e.g., USIP) and other NASA programs to make space available for technologies appropriate for the available platforms within the Flight Opportunities program*

Highlights:

- Conducted 5 parabolic flight campaigns and 8 reusable suborbital flight campaigns flying 38 technology payloads in relevant flight environment FY2014
- UP Aerospace Corporation successfully launched SpaceLoft-7 (SL-8) with six program sponsored technology payloads in Nov 2013 and SL-9 with four payloads in October 2014 from the New Mexico Spaceport America
- Masten Space Systems flew in Feb and Jun 2014 open-loop and closed-loop flights, respectively, of Astrobotic Technology's newly developed autonomous landing system. These tests validated Astrobotic's optical and Light Detection and Ranging (LIDAR) based system that will be used to perform a lunar soft landing in 2015 for the Google X-Prize. In Dec 2014, Masten completed a flight campaign for a JPL landing technology that could in Mars 2020 mission.
- Near Space Corporation (NSC) successfully flew a small balloon from Madras, Oregon for University of Central Florida's Planetary Atmosphere Minor Species Sensor (PAMSS) payload in July 2014
- In FY2015, Program has plans to fly technologies every month on multiple commercial platforms (Near Space, Paragon, Masten, UP Aerospace)
- Program plans to complete a commercial capability development initiative in FY2015

Current Solicitation:

- Technology Advancement Utilizing Suborbital Flight Opportunities:
 - Max Award: up to \$300,000



Career



Highlights:

- NASA's Space Technology Mission Directorate seeks proposals from accredited U.S. universities on behalf of outstanding Early Career Faculty (ECF).
- The grant will sponsor research in specific, high priority areas of interest to America's space program.
- Aligned with NASA's Space Technology Roadmaps and priorities identified by the National Research Council.
- NASA awards about five grant per year, funded up to \$200,000 each per year for as many as three years (based on the proposals and availability of funds).
- This Appendix seeks proposals that are responsive to one of the four topics that are aligned with NASA Space Technology Roadmaps:
 - Topic 1: Dynamic Tensegrity Technologies for Space Science and Exploration
 - Topic 2: High Temperature Solar Cells
 - Topic 3: Fundamental Aerothermodynamic Model Development
 - Topic 4: Synthetic Biology Technologies for Space Exploration
- This ECF Appendix seeks to tap into that talent base, challenging early career faculty to examine the theoretical feasibility of new ideas and approaches that are critical to making science, space travel, and exploration more effective, affordable, and sustainable.
- At both the faculty and student levels, ECF is aimed at creating, fortifying, and nurturing the talent base of highly-skilled engineers, scientists, and technologists to improve America's technological and economic competitiveness.





Open



- Information Available at:
 - NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES)
 - <http://nspires.nasaprs.com>
- Space Technology Mission Directorate:
 - <http://www.nasa.gov/directorates/spacetech/home/index.html>





Education



- **NASA Community College Aerospace Scholars (NCAS):**
 - <https://nas.okstate.edu/ncas/>
 - Eligibility:
 - U.S. citizenship
 - High school graduate or equivalent and at least 18 years of age
 - Registered at a U.S. community college in the semester prior to the onsite workshop
 - Concurrent enrollment or completion of 9+ hours of STEM coursework
 - Able to commit to a 5 week online session
 - Internet access
 - Onsite Workshops at a NASA Center: September/October 2016
- **National Space Grant and Fellowship Program:**
 - <http://www.nasa.gov/offices/education/programs/national/spacegrant/home/index.html>
 - NASA's Office of Education awarded more than \$17.3 million through the National Space Grant and Fellowship Program to increase student and faculty engagement in science, technology, engineering and mathematics (STEM) at community colleges and technical schools across the U.S. Each award has a two-year performance period and a maximum value of \$500,000
 - The 35 awards were granted after a solicitation to members of the national Space Grant Consortia. Winning proposals outlined ways to attract and retain more students from community and technical colleges in STEM curricula, develop stronger collaborations to increase student access to NASA's STEM education content, and increase the number of students who advance from an associate to a bachelor's degree.



