New York Space Grant Consortium
Lead Institution: Cornell University
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Consortium URL: http://astro.cornell.edu/spacegrant/
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Lines of Business (LOBs): NASA Internships, Fellowships, and Scholarships; Stem Engagement; Institutional Engagement; Educator Professional Development

A. PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The New York Space Grant Consortium is a Designated Consortium funded at a level of $760,000 for fiscal year 2017.

B. PROGRAM GOALS

The New York Space Grant (NYSG) Consortium aims to inspire, engage, and educate students in science, technology, engineering, and math (STEM) disciplines, and to prepare students across NY State to be the future workforce for NASA and high-technology industries.

NYSG Goal #1: Our NASA Education Outcome 1 (Fellowship/Scholarship, Higher Education, and Research Infrastructure Programs) programs will positively impact the **diversity** of students entering the STEM workforce and pursuing advanced STEM degrees.

SMART Objective 1 – The percentage of NYSG underrepresented minority student awardees (monetary and non-monetary) per budget year shall meet or exceed the minority enrollment percentage in NY higher education institutions (33.4%). Statistics published in the National Center of Education Statistics (NCES) Digest (NCES Table 306.60: Fall enrollment in degree-granting postsecondary institutions, by race/ethnicity of student and state or jurisdiction: 2014 (https://nces.ed.gov/programs/digest/d15/tables/dt15_306.60.asp) are used as the benchmark for this objective.

SMART Objective 2 – The percentage of NYSG female student awardees (monetary and non-monetary) per budget year shall meet or exceed 38%. For this benchmark, data from the

National Science Foundation, Division of Science Resources Statistics, *Women, Minorities, and Persons with Disabilities in Science and Engineering* Table 5-2 "Bachelor's degrees awarded, by field and sex: 2004–14 " (https://www.nsf.gov/statistics/2017/nsf17310/data.cfm) shows that women earned 38% of the bachelor's degrees awarded in engineering and sciences (excluding psychology and social sciences) in 2014.

NYSG Goal #2: Our NASA Education Outcome 1 (Fellowship/Scholarship, Higher Education, and Research Infrastructure Programs) programs will positively impact the **number** of students entering the STEM workforce and pursuing advanced STEM degrees.

SMART Objective 3 – NYSG shall strive for 90% or more of graduating significant awardees to take the next step to STEM employment or STEM advanced. Our progress toward this objective will be measured by data obtained from annual polling of significant student awardees' current status/progress, based on the NASA HQ guidelines on longitudinal student tracking.

NYSG Goal #3: Our consortium will help build NY State higher education-industry collaborations, while assisting with high technology workforce development to decrease the "brain drain" afflicting NY State.

SMART Objective 4 – NYSG shall add 2-3 more industrial affiliates in New York State by the end of the 2015-18 grant period. Lockheed Martin and Moog Inc. were our only industrial affiliates at the beginning of this grant period. We aim to form mutually beneficial relationships with other major science and engineering companies that conduct diverse STEM research & development. This will help increase the number of students engaged in aerospace and NASA-related internships with New York State industries. Internships are a pipeline for industry to recruit and retain future scientists and engineers.

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS

Example of NYSG benefit to NASA Internships, Fellowships, and Scholarships Program Area: Space Grant provided scholarships to fifteen undergraduates who are undertaking the specially designed *Science Thought and Practices* (STP) workshop at the American Museum of Natural History (AMNH) or Onondaga Community College. This 15-week spring 2018 workshop prepares students for summer research – the majority of participating students from City University of New York (CUNY) two-year colleges will conduct research at AMNH under the guidance of a CUNY faculty mentor. STP emphasizes studying the nuances of measurement and data, experimental design, proportional reasoning, graphical representation, etc. Special attention is paid to understanding uncertainty, variation of means, and precision. Each week students are introduced to a new potential mentor and his/her research, and they build their sense of belonging in the AMNH research environment. The precursor to STP has been a successful staple of our former NYSG Community College Partnership Program that was funded from a separate NASA award; building on the success of that program, Space Grant Augmentation funds the current version.

Example of NYSG benefit to Research Infrastructure/Higher Education Program Area: At the University of Rochester, Space Grant-funded graduate students have made considerable progress on two sensor array projects. Long wave infrared detector arrays were further developed

and tested specifically for NEOCam, and are now at Technology Readiness Level 6. Rochester is a major collaborator with NASA Jet Propulsion Laboratory on NEOCam, a proposed telescope to observe and study near-Earth asteroids. Research and development also continued on tetrahertz arrays, which could provide a superior alternative to silicon-arsenic arrays being considered for imaging exoplanets on future NASA missions.

Example of NYSG benefits to Informal Education Program Area:
In the heart of Manhattan, Columbia University faculty and students set up telescopes on campus for the public to view the solar eclipse on August 21, 2017; approximately 3,000 people stopped by that afternoon. On the Rensselaer Polytechnic Institute campus near Albany, prior Space Grant fellowship recipients ran a viewing event attended by ~1,500 visitors who viewed the eclipse via solar telescopes (some at ground level to allow handicapped access), various pinhole cameras and projected images, and live video feed of images from across the country.

D. PROGRAM ACCOMPLISHMENTS

- NASA Internships, Fellowships, and Scholarships (NIFS):
  At Binghamton University, a Space Grant graduate fellow researched boron nitride nanotubes and their suitability for aerospace engineering applications. Space Grant fellowships/scholarships were awarded to City College of New York graduate and undergraduate students who studied the effect of mechanical loading on bone maintenance, a topic of considerable interest to NASA for long-duration spaceflight. A Space Grant-supported graduate fellow at Columbia University developed a new technique to characterize stellar hosts precisely; this method may play an important role for NASA's upcoming Transiting Exoplanet Survey Satellite (TESS) mission. Cornell University graduate fellows' research in astronomy and mechanical & aerospace engineering was supported. Medgar Evers College NIFS undergraduates investigated factors governing Mars seasonality, guided by a former NASA JPL researcher; investigated how newly discovered chemical reactions affect North American air quality and climate; and engaged in CubeSat- and BalloonSat-related computer science projects involving intelligent software and machine learning.

  At Rensselaer Polytechnic Institute, Space Grant supported graduate and undergraduate fellows' astronomy research. Rochester Institute of Technology's graduate and undergraduate students' research included developing a novel millimeter-wave imaging spectrometer which could be a low-cost, high-speed solution for NASA and future large-scale survey instruments, and studying luminous infrared galaxies using Hubble Space Telescope imagery. Stony Brook University supported undergraduate minority students' summer research projects in mechanical engineering, astronomy and physics, and nanomaterials. Syracuse University supported an undergraduate summer intern's environmental field research project. Union College supported undergraduate summer research on a variety of topics in physics, astronomy, computer science, mechanical engineering, and nanomaterials University at Buffalo undergraduate and graduate students were competitively awards fellowships to pursue their research in a variety of engineering fields. Managed by NYSG's York College affiliate director, the community college enhancement project awarded scholarships to students attending various CUNY two-year colleges and Onondaga Community College. These students are undertaking special

Science Thought and Practices workshops during spring 2018 to better prepare them for conducting intensive STEM research this summer.

NYSG sponsored eight students' summer 2017 internships at Ames Research Center, Goddard Institute for Space Studies, Goddard Space Flight Center, Wallops Flight Facility, and the NASA Academy and NASA Robotics Academy at Marshall Space Flight Center. These interns worked directly on projects such as testing systems that form a CubeSat attitude control system testbed, radiative-transfer modeling of planetary regolith spectra, ferromagnetic shape memory alloy characterization for a nano-positioning actuator, multi-wavelength study of jets in coronal holes, studying the physical behavior of aurora over varying spatial and temporal scales, investigating the efficacy of a Computational Fluid Dynamics solver developed specifically for rotorcraft, studying how three non-coastal cities have utilized and responded to climate change projections, and improving the performance of a simulator for a single-person, deep-space habitat maintenance system.

Six undergraduates completed NYSG-funded summer internships at Lockheed Martin in Owego, NY and Moog in East Aurora, NY. The Lockheed Martin interns worked as a team to design and build a battle-bat rover with a claw that, under control of an Android or iOS phone app, can be used to pick up and deliver objects to designated locations. This cradle-to-grave project provided the three students, one physics and two engineering majors, with valuable experience in systems engineering and product development processes. Rovers based on their design will be used in an upcoming Lockheed Martin Engineering Explorers high school competition. Moog interns worked on a variety of engineering projects including investigating and solving issues with failing valves, running stress analyses on rotors, and additive manufacturing research and development. In addition, NYSG supported an undergraduate CUNY Lehman College student's summer research at the Flatiron Institute's Center for Computational Astrophysics in New York City. She investigated Damped Lyman Alpha cross-sections in cosmological simulations.

- Higher Education projects:

Colgate University utilized Space Grant funds to support undergraduate students' astronomy research and development of Visualization Laboratory/planetarium modules for use in college coursework and K-12 school group visits. Students from many institutions across NY were partially supported to travel and present at conferences such as the 231st American Astronomical Society meeting in Washington D.C., the 2017 IEEE MIT Undergraduate Research Technology Conference in Cambridge, MA, and the 2017 Materials Research Society Fall Meeting in Boston, MA. Space Grant fully sponsored two undergraduate students, competitively selected from applicants state-wide, to participate in the June 2017 Helicopter/UAS Workshop run by the Connecticut Space Grant Consortium.

Additional cycles of NYSG's Opportunity Grants program, initiated last year from Augmentation funding, were administered in FY2017. This program helps NYSG more equitably handle increasing numbers of ad hoc requests for funding for student project teams/competitions, conference/research travel, or other NASA-related efforts through a timely process. Grants were competitively awarded to thirteen college students/teams and

two faculty members from Binghamton University, Columbia University, Cornell University, CUNY New York City College of Technology, Pratt Institute, Rensselaer Polytechnic Institute, Rochester Institute of Technology, SUNY at Albany, and CUNY York College. Student grant recipients used NYSG funds to support travel to present at conferences, conduct research (e.g., observations at the Keck Observatory, August 2017 solar eclipse data from the path of totality), or participate in NASA competitions (e.g., NASA's Micro-G NeXT). Student teams also utilized funds to purchase materials and supplies for building entries to NASA's Robotic Mining Competition and the Intercollegiate Rocket Engineering Competition (at Spaceport America Cup). Faculty grant recipients used NYSG funds to purchase astronomy instrumentation for use in student research, and to support a new interdisciplinary workshop that spans planetary science, spacecraft navigation, and space situational awareness. In addition, two Opportunity Grants were awarded to two precollege projects; their activities are described below.

A NYSG Faculty Grant recipient at Stony Brook University completed his project on developing a three-course sequence that provides college students with foundational knowledge on the history, issues, policies, and promises of space exploration. Additional new Faculty Grants were competitively awarded to York College for faculty and student engagement in NASA's Robotic Mining and Swarmathon Competitions, and Rochester Institute of Technology for updating undergraduate and graduate curricula to include contemporary issues of integrating Unmanned Aircraft Systems into the national airspace system. During summer 2017 Cornell University professors worked on initial development of an interdisciplinary course bridging engineering and the humanities.

- Research Infrastructure projects:

  Undergraduate student researchers at Alfred University analyzed astronomical photometry data that contributed to the Center for Backyard Astrophysics project. Barnard College undergraduates performed spectral and imaging analysis of a pulsar wind nebula using data from NASA's NuSTAR and Chandra X-ray Observatory, and studied Flat Spectrum Radio Quasars during the summer. Clarkson University utilized Space Grant funds to support two graduate students, one of whom collaborated with the new Clarkson Center for Complex Systems Science (C3S2) to develop cutting-edge analytical tools to solve complex engineering problems. Space Grant-supported research into advanced control technology and mechatronics continued at New York University's Mechatronics, Controls, and Robotics Laboratory. SUNY Geneseo undergraduate students conducted research on cavity ringdown spectroscopy, photometric study of an open cluster, and searching for extragalactic Planetary Nebulae candidates using Hubble Telescope imagery. A University at Buffalo graduate researcher developed a method to collect space charge data within dielectric polymer composite materials. At the University of Rochester, considerable progress was made on two Space Grant-supported projects: development of long wave infrared detector arrays for space applications (including collaboration with NASA JPL on the proposed NEOCam to discover near-earth asteroids), and the development and characterization of terahertz sensor arrays.

A NYSG Faculty Grant recipient at Columbia University initiated a CubeSat project through the Columbia Space Initiative. Additional new Faculty Grants were competitively awarded to Cornell University to investigate relationships between musculoskeletal responses under different artificial gravity conditions and exercise/workload intensities; SUNY Geneseo for exploring time-resolved particle tomography for atmospheric and space research; and Rensselaer Polytechnic Institute for developing and building a double-diffracting telescope prototype and studying the applicability of this new technology with a spectroscopic survey of Milky Way stars.

- Precollege projects:

  The NYSG affiliate director at New York University (NYU) and Space Grant-supported students conducted teacher professional development training in robotics for middle and high school teachers, including one which collaboratively engaged teachers with high school students in hands-on, guided robotics projects. During summer 2017 five high school students participated in research at NYU to design, develop, prototype, and assess a variety of mechatronics and robotics systems. Primary and secondary school teachers attended workshops at the Museum of Science and Technology (MOST) to learn concepts in rocketry, thermodynamics, energy transfer, and robotics. Participating teachers used the training and knowledge to guide their student teams enrolled in science & engineering competitions run by MOST, partnered with NYSG affiliate Syracuse University. Space Grant funds supported the Physics Constants Workshop at Union College, during which high school physics teachers and students conducted hands-on experiments. The University at Buffalo's NYSG affiliate director and Space Grant fellows conducted hands-on science experiments and in-classroom science lessons for elementary and middle school classes at Westminster Community Charter School.

  NYSG Opportunity Grants were competitively awarded to the Western New York (WNY) STEM Hub and the St. Monica Rocketry Club. Funds to the WNY STEM Hub supported participation of K-12 students and teachers from eleven schools in the Buffalo-Niagara Falls region (many high-need urban schools), plus two rural schools in Olean and Wellsville, in Student Spaceflight Experiments Program (SSEP) Mission 12. The winning student experiment is scheduled for launch to the International Space Station some time in spring 2018. The St. Monica Rocketry Club placed 12th nationwide in the May 2017 Team America Rocketry Challenge, which earned them a spot in the 2018 NASA Student Launch Initiative (SLI). NSYG funds have been crucial for this team of home-schooled students from New York and Connecticut to purchase materials and supplies to build and test their rocket, plus travel to the SLI competition in Huntsville, Alabama in April 2018.

- Informal Education projects:
  A Space Grant-funded Clarkson University graduate student was closely involved with Horizons summer camps which provided hands-on STEM projects and team-building exercises to 7th- and 8th-grade female students. An NYSG-supported undergraduate student presented public shows and gave sky talks to K-12 and civic group visitors at Colgate University's Ho Tung Visualization Laboratory during the summer. NYSG funding provided valuable support of Columbia University's Department of Astronomy outreach

coordinator, who organized numerous educational events at Rutherford Observatory and all around Manhattan and surrounding boroughs. Examples include an annual Spanish-language astronomy lecture to educate and foster connections with the community in the Columbia neighborhood, a twice-monthly public lecture and stargazing series, bringing telescopes and stargazing guidance to Brooklyn Bridge Park for the World Science Festival, and collaboration with Project Rousseau to host and engage at-risk youth during public observatory nights.

The Intrepid Sea, Air & Space Museum in Manhattan utilized Space Grant funds to support four Family Astronomy Nights, provided free to the public. NASA Goddard Space Flight astrophysicist Amber Straughn described her cutting-edge research and the capabilities of the James Webb Space Telescope, Matei Ciocarlie from Columbia University explained the investigative processes involved in creating human-robotic devices and brought his MyHand robotic prototype for families to try, Mimi Aung from NASA Jet Propulsion Laboratory presented high-tech simulations and a helicopter prototype that may be used to explore Mars, and Noah Petro from NASA Goddard Spaceflight Center taught families about the geology of the Moon and described NASA's past and future lunar missions. The Sciencenter continued to raise awareness about NASA's missions and increase STEM literacy in Ithaca and surrounding rural areas. Four Family Science Nights held at elementary schools engaged students and families in hands-on space and earth science activities, as well as exploration of the night sky in a StarLab portable planetarium. NASA activities were incorporated into the Sciencenter's space-themed summer camp program, in which elementary-aged children learned about astronomy, engineering, and geology. A new kiosk at the Sciencenter will help guests connect experiences at the hands-on infrared camera exhibit to how NASA scientists utilize infrared imaging to observe solar system objects. Syracuse University utilized Space Grant funds to partner with the Museum of Science and Technology (MOST) for the following STEM competitions in central NY: Rocket Team Challenge, Steamboat Challenge, Bridge Build'em and Bust'em, and VEX Robotics Challenge. These competitions engaged more than 1,000 students in grades 4-12 in Syracuse and beyond. Space Grant funds supported outreach programs conducted by Union College's Society of Physics Students. The Tech Savvy day-long conference at the University at Buffalo, supported by Space Grant resources, provided hands-on workshops and information about STEM education and careers to middle school girls.

E. PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS

Include summary data for the bulleted list below:

- **Diversity**: Diverse institutions comprise the NY Space Grant Consortium: higher education institutions that are public and private, small and large; informal education/non-profit organizations; and industry. Space Grant programs at affiliate institutions, spread throughout upstate NY and the New York City area, are led by affiliate directors (faculty and professionals) from many different STEM fields. Nine of the twenty-three (39%) NYSG affiliate directors are women (not including the associate director at the lead institution). Diversity of student participants is the primary aim of SMART Objectives #1 and #2.

- **Minority Serving Institution Collaborations**: Three NYSG affiliates are minority-serving institutions: City College of New York, Medgar Evers College, and York College. While Stony Brook University is not a minority institution, NYSG is partnered with its Louis Stokes Alliance for Minority Participation (LSAMP) program to support NASA-related research opportunities for minority students.

- **Office of Education Annual Performance Indicators**:
  - API 2.4.1: ED-17-1 - **62** (Number of higher education students receiving significant, direct awards who are racially or ethnically underrepresented, women, persons with disabilities, or veterans so far, out of 99 significant awardees.)

  - API 2.4.2: ED-17-2 - **305** (Number of educators who have participated so far.)

  - API 2.4.4: ED-17-4 - STEM strategic partnerships were maintained between NYSG and three informal education institutions: Sciencenter in Ithaca; Museum of Science & Technology (MOST) in Syracuse; and Intrepid Sea, Air & Space Museum in New York City. Refer to the Informal Education section above for more details.

  - API 2.4.5: ED-17-5 - **3890** (Number of elementary and secondary students who have participated so far.)

F. IMPROVEMENTS MADE IN THE PAST YEAR

Medgar Evers College is creating a Computer Engineering concentration within its Computer Science major to support student interest and NASA-related programs. Advertising an on-campus, Space Grant-funded summer internship opportunity to minority student organizations, the NYSG affiliate director at Rensselaer discovered that a wealth of minority students interested in NASA research were in the Math department. This revelation may help others to recruit more underrepresented minorities.

G. CURRENT AND PROJECTED CHALLENGES

At Medgar Evers College, student interest and participation in Space Grant activities is exceeding available faculty mentors.

H. PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

1. **Alfred University**, Alfred, NY *[Four-year, small, highly residential, private]* undergraduate research
2. **Barnard College**, New York, NY *[Four-year, small, highly residential, private*] liberal arts **college for women,** undergraduate research
3. **Clarkson University**, Potsdam, NY *[Four-year, medium, highly residential, private]* graduate research, research infrastructure, and informal education

4. **Colgate University**, Hamilton, NY *[Four-year, small, highly residential, private]* undergraduate research and informal education
5. **Columbia University**, New York, NY *[Four-year, large, highly residential, private]* NIFS, informal education
6. **Cornell University**, Ithaca, NY *Four-year, large, highly residential, private and public (land grant)]* **NYSG lead institution**, NIFS, other consortium-wide projects such as summer internship programs, higher education, and research infrastructure.
7. **CUNY City College of NY**, New York, NY *[Four-year, large, primarily nonresidential, public]* **Minority Serving Institution,** NIFS
8. **CUNY Medgar Evers College**, Brooklyn, NY *[Four-year, medium, primarily nonresidential, public]* **Minority Serving Institution,** NIFS, student flight projects (BallonSats and CubeSats)
9. **CUNY York College**, Jamaica, NY *[Four-year, medium, primarily nonresidential, public]* **Minority Serving Institution,** NIFS including community college students
10. **Intrepid Sea, Air & Space Museum**, New York, NY – Non-profit informal education affiliate (science museum)
11. **Lockheed Martin**, Owego, NY – Aerospace industry affiliate; student internships
12. **Moog, Inc.**, East Aurora, NY – Aerospace industry affiliate; student internships
13. **New York University (formerly NYU-Poly)**, Brooklyn, NY *[Four-year, large, primarily residential, private]* Research infrastructure and precollege
14. **Rensselaer Polytechnic Institute**, Troy, NY *[Four-year, medium, highly residential, private]* NIFS and informal education
15. **Rochester Institute of Technology**, Rochester, NY *[Four-year, large, highly residential, private]* NIFS
16. **Sciencenter**, Ithaca, NY – Non-profit informal education affiliate (science museum)
17. **SUNY - Binghamton University**, Binghamton, NY *[Four-year, large, highly residential, public]* NIFS
18. **SUNY Geneseo**, Geneseo, NY *[Four-year, medium, highly residential, public]* undergraduate research, research infrastructure
19. **SUNY - Stony Brook University**, Stony Brook, NY *[Four-year, large, highly residential, public]* **NYSG is partnered with the LSAMP program,** NIFS
20. **SUNY - University at Buffalo**, Buffalo, NY *[Four-year, large, primarily residential, public]* NIFS, research infrastructure, precollege, and informal education
21. **Syracuse University**, Syracuse, NY *[Four-year, large, highly residential, private]* NIFS, precollege and informal education projects with partner Museum of Science and Technology (MOST) in Syracuse
22. **Union College**, Schenectady, NY *[Four-year, small, highly residential, private]* NIFS, precollege and informal education
23. **University of Rochester**, Rochester, NY *[Four-year, medium, highly residential, private]* undergraduate and graduate research, research infrastructure
24. **Ursa Space Systems**, Ithaca, NY – Aerospace industry affiliate; student internships.