

FY 2018 Year 4 Extension Annual Performance Document

New York Space Grant Consortium Lead Institution: Cornell University

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Consortium URL: www.nyspacegrant.org

Grant Number: NNX15AK07H

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 2018.

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 (34.9%). 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: 2017 (https://nces.ed.gov/programs/digest/d18/tables/dt18_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 38.6%. 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: 2006–16 ” (<https://nces.nsf.gov/pubs/nsf19304/data>) shows that women earned 38.6% of the bachelor’s degrees awarded in engineering and sciences (excluding psychology and social sciences) in 2016.

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 more industrial affiliates and/or partnerships in New York State by the end of the 2018-19 grant period. Lockheed Martin and Moog Inc. were our only industrial affiliates at the beginning of this grant period. We have since added Ursa Space Systems in Ithaca, NY as an affiliate, and 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: Each year, NYSG partners with the LSAMP Program at Stony Brook University. The LSAMP program is designed to increase the number of under-represented minority students who graduate with degrees with STEM and who ultimately enroll in a STEM graduate degree program. LSAMP strongly encourages its students to get engaged in research early in their academic careers. Each fall, the LSAMP program offers a semester-long course called “Developing Research Skills.” The course is taught by an advanced graduate student and is designed to introduce students to the process of research and to develop basic skills such as performing journal searches, and oral and written presentation skills. The course is used as a pre-qualifier for students to apply for subsequent support for an LSAMP supported undergraduate semester long research project. The Space Grant funds are earmarked for LSAMP students who have completed an undergraduate research project.

This year, NYSG has awarded four LSAMP student internships. These students will be working in the labs of Stony Brook professors working on four projects: Scramjet Propulsion for Hypersonic Vehicles, Compressive Failure of Carbon Fiber Composites Under Multi-Axial Loads, Application of Tip-Enhanced-Raman-Spectroscopy to Examine Physicochemical Properties of Ambient Aerosols, and Establishing Stable Air-to-Ground Optical Links Between Satellites Using Quantum Computing Devices.

Example of NYSG benefit to Research Infrastructure/Higher Education Program Area:

At the Rensselaer Polytechnic Institute, Space Grant-funded students have prototyped a spectrographic telescope for astronomical research. To see the farthest galaxies, find faint exoplanets, and to study the production of elements in the stars of the Milky Way galaxy, RPI is designing a mirrorless system to collect the light with a very thin, flat grating, as a part of the High Entendue Multiple Object Spectrographic Telescope (THE MOST). The grating could be printed on a very long sheet of plastic, and then unrolled on the ground or in space. A much smaller secondary mirror would then be required to focus the light from the grating into a spectrograph, saving money and weight.

Example of NYSG benefits to Informal Education/STEM Engagement Program Area:

At the Sciencenter in Ithaca, NY, children in grades K-6 participated in space and science themed summer camps. Campers had the opportunity to explore space through a variety of activities, including designing seltzer rockets, helicopters, and exploration of the lunar landscape. NYSG also collaborated with the Cornell Cooperative Extension of Jefferson County to fund 4-H club participation in the Student Spaceflight Experiments Program, with over 250 students participating in grades K-12.

D. PROGRAM ACCOMPLISHMENTS:

- NASA Internships, Fellowships, and Scholarships (NIFS):

At Binghamton University, a Space Grant graduate fellow continued research in boron nitride nanotubes and their suitability for aerospace engineering applications, publishing several papers on the topic. Space Grant fellowships/scholarships were awarded to City College of New York graduate and undergraduate students to continue research in 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 Clarkson University simulated turbulent flows through a 90-degree elbow, and his results are being used to improve less computationally intensive methods for simulating these flows. Seven Cornell University graduate fellows' research in astronomy and mechanical & aerospace engineering were supported. Medgar Evers College NIFS undergraduates in Computer Science and Math were involved in research areas aligned with NASA's student flight initiatives, Planetary Science programs as well as astrophysics, including continued work on intelligence software

with a second team engaged in preliminary efforts to develop a communications bus suitable for Cubesats.

At Rensselaer Polytechnic Institute, Space Grant supported graduate and undergraduate fellows' astronomy research. Rochester Institute of Technology's graduate and undergraduate students' research included compiling a catalog of galaxies from Hubble Space Telescope data that show evidence of merger activity, and analyzing those galaxies for dust embedding. Stony Brook University supported undergraduate minority students' summer research projects through the LSAMP program in mechanical engineering, astronomy and physics, as well as nanomaterials. Syracuse University supported two undergraduate summer interns urban and rural environmental field research projects. Union College supported 11 undergraduate summer 2018 research projects in physics and astronomy. A University at Buffalo graduate student was competitively awarded a fellowship to pursue his research in the use of low-power wide-area network (LPWAN) radios mounted on unmanned aerial vehicles (UAVs).

NYSG sponsored eight students' summer 2018 internships at Ames Research Center, Goddard Institute for Space Studies, Goddard Space Flight Center, Armstrong Flight Research Center, Langley Research Center, and the NASA Academy at Glenn Research Center and Marshall Space Flight Center. These interns worked directly on projects such as machine learning techniques to analyze satellite imagery, computational fluid dynamics, modeling urban agriculture's effect on temperature change in cities, hardware design and parts modeling for instruments on the International Space Station, modeling load distribution on the wingspan of the PRANDTL-D aircraft, improving propulsion systems, and developing better mobility for unmanned air vehicles in urban areas.

Seven undergraduates completed NYSG-funded summer internships at Lockheed Martin in Owego, NY, Ursa Space Systems in Ithaca, NY, and Moog in East Aurora, NY. The Lockheed Martin interns worked as a team to design and build a recyclable sorting rover dubbed Recyclops. This machine would take a recyclable from a person, determine if it was metal, glass, or plastic, then navigate a maze autonomously to recycle it in its proper bin. It would then return to the person for another recyclable. This cradle-to-grave project provided three students with valuable experience in systems engineering, team-led development, and product development processes. Moog interns worked on a variety of engineering projects including load capacity testing and analysis on Thrust Vector Control Actuators, used on rockets for Boeing, Blue Origin, and United Launch Alliance (ULA). The Ursa Space Systems intern tested multiple detection algorithms attempting to identify flares in the SWIR bands of multispectral satellite imagery. The objective was to find an algorithm that could quickly and accurately process large amounts of data without producing too many false alarms.

- Higher Education projects:

Colgate University continued to support undergraduate students' astronomy research and development of Visualization Laboratory/planetarium modules for use in college coursework

and K-12 school group visits. Space Grant travel funds were awarded to Union College to support four astronomy students who attended the 50th anniversary meeting of the Astronomical Society of New York at American Museum of Natural History.

Additional cycles of NYSG's Opportunity Grants program, initiated two years ago, were administered in FY2018. 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. Student team at York College utilized funds to outfit their entry to NASA's Robotic Mining Competition, and to travel to multiple demonstration locations in New York. In addition, four Opportunity Grants were awarded to precollege projects; their activities are described below.

- Research Infrastructure projects:

Two undergraduate student researchers at Alfred University participated in research projects in astrophysics and fluid physics. One student did differential photometry on cataclysmic variable stars at the Stull Observatory and the other student studied interfacial mass transfer in microfluidic systems. Clarkson University utilized Space Grant funds to support a graduate student doing research on granular flows. To study these flows, the student is doing direct numerical simulations of flow in a 90° elbow, using the Texas Advanced Computing Center's Stampede2 supercomputer. At NYU, Space Grant funding supported diverse research, education, and outreach activities at the Mechatronics, Controls, and Robotics Lab. These activities have focused on advanced control technology, mechatronics related experimental effort, and pre-college outreach. SUNY Geneseo undergraduate students conducted research on cavity ringdown spectroscopy and observational astronomy projects. A University at Buffalo student is finalizing the development of attitude and orbital estimation algorithms for the LinkSat spacecraft, and is exploring the ratio to estimate the Attitude of a broadcasting satellite. At the University of Rochester, students (graduate and undergrad) primarily work to finalize the development of the IR cameras for NEOCam – Near Earth Object Camera. Researchers are evaluating a slightly longer wavelength “walk through” part which employs all aspects of a space qualified array. In addition, they have also worked on longer wavelength HgCdTe arrays (13 microns cutoff) as well as 15+ micron arrays, all of which can be passively cooled with current technology in space.

Faculty Grants were completed at 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:

NYU's Space Grant Affiliate Director engaged with 33 teachers in programs ranging from three weeks to six week durations. In one program, 16 HS teachers along with 36 HS teachers attended a four-week PD project to learn about robotics and entrepreneurship. Similarly, in another three-week PD project, six teachers collaborated with project team to develop robotics-based science lessons that align with the three dimensional model of the Next

Generation Science Standards within the 5E Instructional Framework. Five high school students also conducted summer research in NYU's Mechatronics Lab. The students collaborated with MCRL graduate students to design, develop, prototype, and assess a variety of mechatronics and robotics systems, including swarm robotics location tracking, the design and initial prototype of an adaptive support system for stroke patients, the design and prototyping of a frog robot using series-elastic actuators; and the design, prototyping, and testing of a robot hand controlled through EMG signal.

Primary and secondary school teachers attended continuing 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 were used to support BEAM (Buffalo Engineering Awareness for Minorities and Women) at the University at Buffalo. BEAM is a non-profit organization dedicated to building diversity in STEM fields by encouraging, supporting and preparing underrepresented students of all ages to pursue a future in STEM. Volunteers and curriculum support for summer workshops and a summer week long camp are provided.

NYSG Opportunity Grants were competitively awarded to the Western New York (WNY) STEM Hub and the Cornell Cooperative Extension of Jefferson County. Funds supported participation of K-12 students and teachers from multiple schools in the Buffalo-Niagara Falls region and the Jefferson County 4-H program to participate in the Student Spaceflight Experiments Program (SSEP). In addition, an Opportunity Grant was awarded to a researcher at SUNY Fredonia to facilitate NASA GLOBE teacher training workshops throughout the state, and another Opportunity Grant was awarded to purchase equipment and program supplies for the Rising Star Internship program at Dudley Observatory in Schenectady, NY. This program offers students in grades 6-10 and teachers in grades K-12 the opportunity to deepen their understanding of astronomy through a year-long hands-on astronomy workshops.

- Informal Education projects:

Two NYSG-supported undergraduate students 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 continued to provide 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.

The Intrepid Sea, Air & Space Museum in Manhattan utilized Space Grant funds to support three Family Astronomy Nights, provided free to the public. NASA astronaut Peggy Whitson participated in the Museum's Kids Week Festival. The evening centered on NASA's live game show So You Want to Go to Mars? featuring Dr. Whitson as a panelist, along with members of NASA's Orion team. Dr. Jacqueline Faherty, senior scientist at the American

Museum of Natural History, taught the basics of stargazing and explained how to navigate Manhattan using only the position of the sun and the orientation of the city grid, and CUNY professor Dr. Viviana Acquaviva gave a talk on dark energy, and shared with attendees the reasons why the universe accelerates and what will happen to it after billions of years. The Sciencenter continued to raise awareness about NASA's missions and increase STEM literacy in Ithaca and surrounding rural areas. Five 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. In summer 2018, the Sciencenter doubled the size of their summer camp, offering twice as many space science sessions, and developing a new space-themed camp for younger campers (in grades K-1). 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, Bridge Build'em and Bust'em, and VEX Robotics Challenge. These competitions engaged more than 800 students in grades 4-12 in the Syracuse area.

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. Eight of the twenty-three (35%) 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 3.3.3: STEM-18-1

NYSG has 28.24 percent underrepresented minority representation, and 38.82 percent female representation among college students so far this year.
- API 3.3.5: STEM-18-5

NYSG has produced 43 paper presentations and peer-reviewed research publications arising out of Space Grant funded projects so far in this year.

F. IMPROVEMENTS MADE IN THE PAST YEAR:

NYSG has established connections with two new aerospace industry companies: Harris Corporation in Rochester, NY and Cosmoptera, Inc. in Ithaca, NY. Cosmoptera will join NYSG as an Affiliate member starting in 2019.

G. CURRENT AND PROJECTED CHALLENGES:

At Medgar Evers College, student interest and participation in Space Grant activities continues to available faculty mentors. We are seeking out resources and computer science-based partnerships in the area to ameliorate this.

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
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.