

Education and Outreach at NASA's Goddard Space Flight Center

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NASA's Space Communications and Navigation (SCaN) Program Office maintains a year-round educational program for undergraduate and graduate students. Within NASA's Goddard Space Flight Center, the Exploration and Space Communications Projects Division implements the SCaN intern program with a focus on space operations, including operations of orbiting spacecraft, space communications, ground activities and networking. The intern program enables students to work with various NASA projects in solving real-world problems inside the Exploration and Space Communications division. Goddard interns have been assigned to the NASA's Near Earth Network facilities in Greenbelt, Maryland, and Wallops, Virginia. They have also been assigned to NASA's Space Network facilities in Greenbelt, Maryland, and Las Cruces, New Mexico.

I. Introduction

The Space Communications and Navigation (SCaN) intern program maintains a variety of opportunities for students from high school through post-graduate studies to interact on NASA projects and experience working in the NASA environment. Students who are U.S. citizens have three main paths to internships with the SCaN intern program: 1.) NASA-university internships are competitive opportunities arranged in partnership with universities that have ties to NASA. 2.) NASA internships are competitive opportunities for summer, fall and spring internships with NASA. 3.) NASA-contractor internships are competitive opportunities for internships created by NASA contractors, with employment by the contractor. The majority of SCaN student interns participate during a 10-week summer internship. During the 2017 summer session, NASA's Goddard Space Flight Center had approximately 300 interns, of which 58 were in the Exploration and Space Communications Projects Division. The division supports the NASA headquarters SCaN Program Office and implements SCaN's intern program. Students from the high school level to the graduate level are involved. Each intern is assigned a mentor who works closely with the intern and provides guidance in executing summer projects. The summer 2017 interns worked on individual projects and had opportunities to attend classroom lectures by mentors in topics such as the basics of space communications, guidance and navigation. Some interns were able to visit NASA's Wallops Flight Facility in Virginia, which is operated by NASA's Near Earth Network project. The internship program also scheduled a collaboration and innovation "boot camp," hosted lunch-and-learn discussions and held several social functions. Interns managed by Goddard contractors were also integrated with the government interns such that no distinction was made.

In addition to a robust intern program, the SCaN program works with educational institutions in other ways, including supporting academic capstone projects related to NASA and providing guest lecturers to describe the various disciplines (such as space communications) involved in accomplishing successful space projects. These activities augment the existing curricula of partner institutions.

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II. Goals of the Intern Program

The main goals of the SCaN intern program at the Exploration and Space Communications division are to:

- Foster teamwork and camaraderie among students in completing projects
- Teach students how to attack real-world problems and find solutions
- Develop students' technical writing skills
- Develop students' public presentation skills
- Augment formal classroom training

Throughout the course of a SCaN internship, students are required to make presentations and communicate the status of their activities to project managers and SCaN leaders. They learn to work with students from different backgrounds and manage themselves to achieve team objectives. The intern coordinators set up various activities for the summer interns. Figure 2 displays some of the activities that have been organized to enhance the summer intern experience and acclimate students to the NASA environment.



Figure 1. The activities were available to student interns in 2017 to promote awareness of NASA concepts, foster collaboration and teach critical thinking.

A. The Intern Ambassador Program

NASA SCaN's intern coordinators are maturing a program to help interns return to their communities and spread information about the intern experience. They are also compiling data on intern experiences and using the feedback to improve future summer internship sessions. Co-author Sandra Vilevac is developing the Ambassador Program at Goddard to extend intern experiences beyond the internship. Figure 3 summarizes the approach for this program.



Figure 2. The intern Ambassador Program is under development at NASA's Goddard Space Flight Center.

III. Scope of the Internships

A. NASA-University Internships

Universities such as the Massachusetts Institute of Technology (MIT) maintain a four-week, mid-semester internship program between the fall and spring semesters in which select students come to Goddard to work on NASA projects. The students focus on short projects of a highly technical nature. Within the Exploration and Space Communications division, MIT student interns have worked on projects such as CubeSat instrument development and development of laser ranging concepts for a CubeSat mission. A student's final poster is shown in Figure 4.

Goddard also maintains relationships with universities that are closely associated with NASA facilities, both geographically and operationally. For instance, Goddard has a relationship with the University of Alaska at Fairbanks through which student interns can get experience working on a NASA Near Earth Network ground station there, which is operated by the university. In the next round of planned activities, the University of Alaska at Fairbanks and the Near Earth Network project will:

- Make a junior operator internship position available to a University of Alaska student.
- Design, develop and deliver two teaching modules at the Alaska Summer Research Academy (ASRA) each year of the grant during the ASRA two-week summer academy.
- Provide tuition, housing or transportation scholarships for secondary students to attend ASRA; the scholarship is targeted for students living off the road system in Alaska or those in Alaska with demonstrated travel hardships.
- Partner in other existing educational efforts as opportunities arise.

NASA Goddard will expand this activity to New Mexico State University in Las Cruces, New Mexico, which is geographically situated near NASA's White Sands Complex and has been a source of student interns.

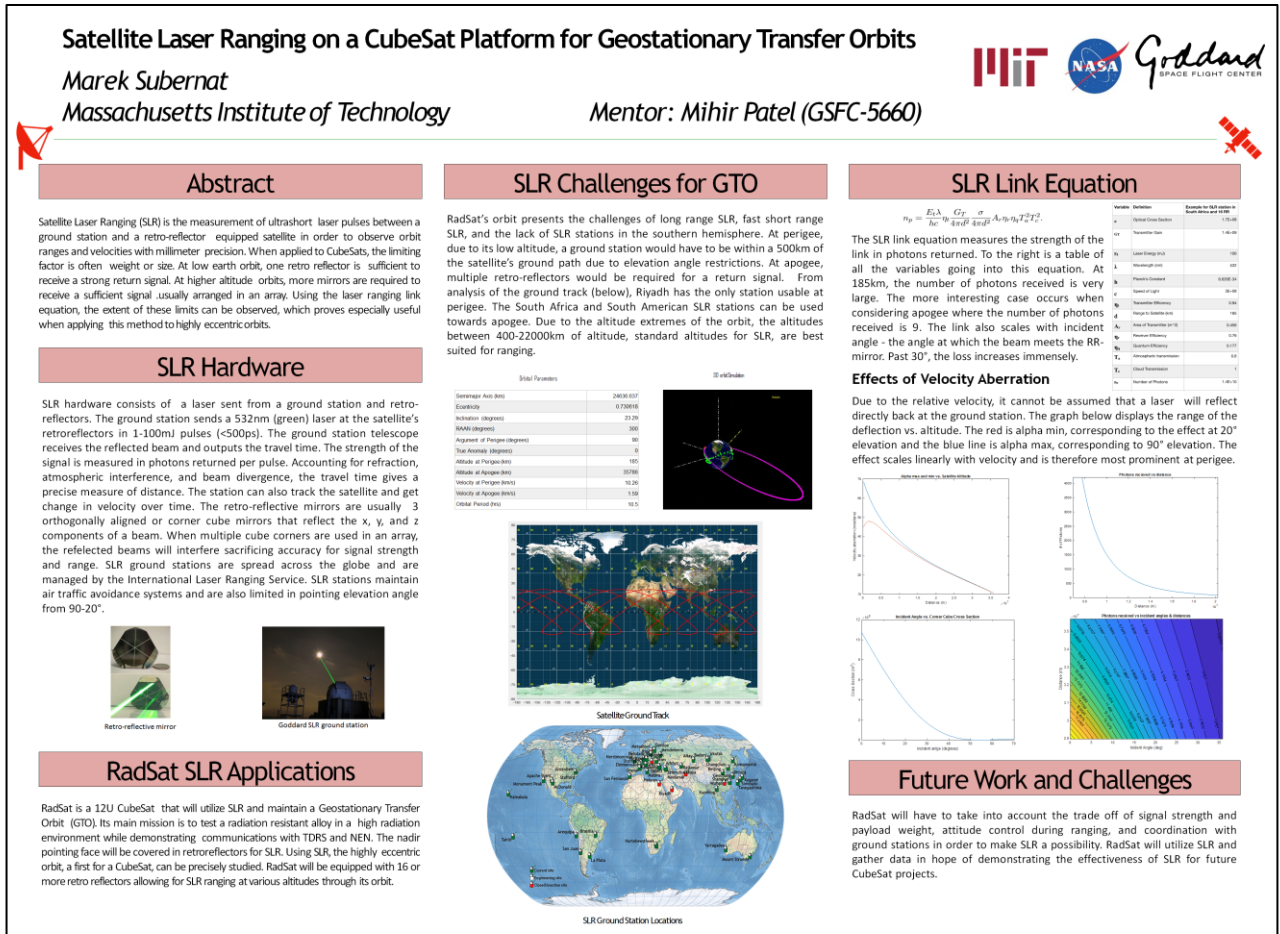


Figure 3. An MIT student intern's poster above summarizes his 2018 internship activities.

B. NASA Internships and NASA-Contractor Internships

NASA internships, coordinated by the Goddard Office of Education, comprise the majority of internship activity within the Exploration and Space Communications division. Students apply through a common website (<https://ossi.nasa.gov/ossi/web/public/main/>), which permits them to search all opportunities throughout NASA that have been posted by NASA mentors. Mentors and potential students can evaluate each other and determine if a good fit exists between the two parties for an internship. Figure 5 summarizes the demographics of the 2017 student cohort for Exploration and Space Communications division.

2017 summer interns were assigned to projects at:

- The Near Earth Network in Greenbelt, Maryland
- The Near Earth Network in Wallops, Virginia
- The Space Network in Greenbelt, Maryland
- The Space Network at the White Sands Complex in Las Cruces, New Mexico

The internships last 10 weeks and cover a wide range of space operations, communications and navigation topics. Some internships concentrate on practical aspects of space operations, and some concentrate on theoretical topics. A sample list of topics from 2017 is shown in Table 1.

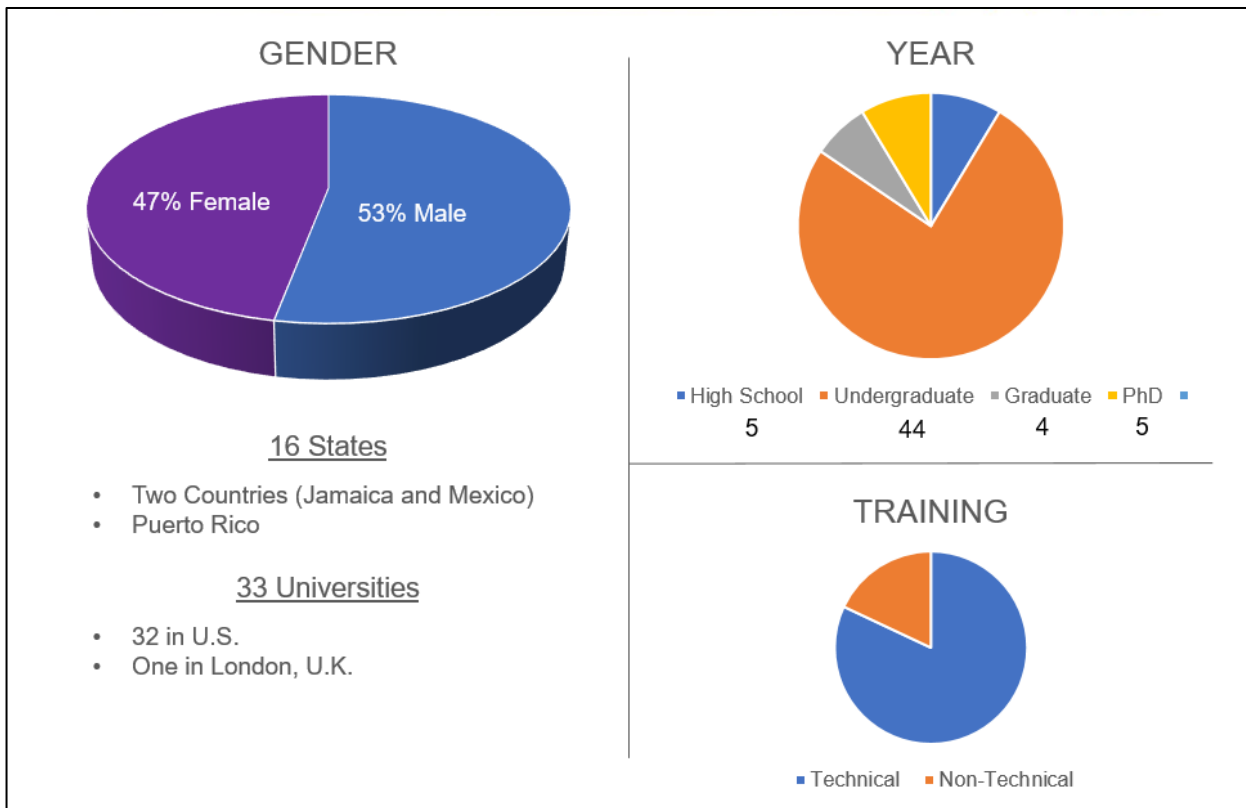


Figure 4. Shown above are the demographics for the 2017 Exploration and Space Communications division summer cohorts.

Intern Projects
Cyber Security Risk Identification and Communication
Search And Rescue Unmanned Aerial Vehicle and Components Assessment for the U.S. Coast Guard
User-Initiated Services Technology Maturation
Genetic Algorithm Application in Analyzing Performance in Network Response to Variations in User Needs
TDRS-M Mission Launch Campaign
GPS Signal Simulator
Optical/Quantum Communications
Solid-State Quantum Communications
Forward-Error Correction Code for Optical Communications
Deployable High-Gain Antenna for CubeSats
High-Efficiency, Solid-State Power Amplifiers for CubeSats

Table 1. The table shows a sample of 2017 Exploration and Space Communications division summer intern projects.

Students work on individual projects or as team members on group projects. Interns present their contributions to their project at the end of the internship. Figure 6 shows an example of the level of content expected from interns.

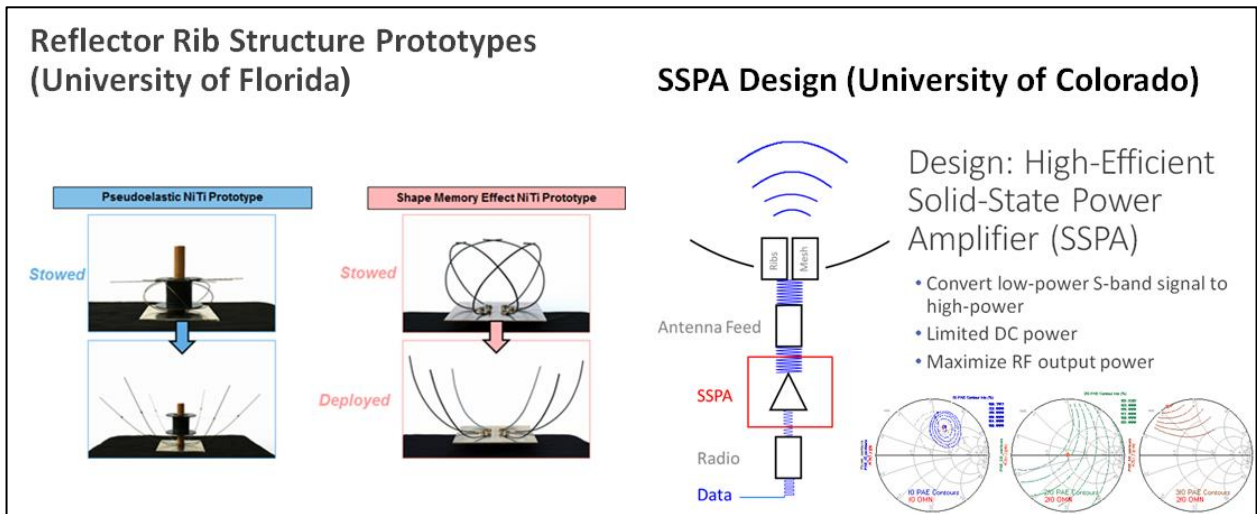


Figure 5. Shown above are graduate student summer intern projects. On the left, the student performed prototype work for shape-memory alloy-based ribs for a high-gain antenna design. On the right, the student performed design work for a high-efficiency solid-state power amplifier that was prototyped by the student.

IV. Additional Educational Activities at Goddard

NASA Goddard also supports engineering curricula at various universities by supporting engineering capstone projects and participating in university design reviews. Capstone projects generally address the complete life cycle of a project and may include hands-on lab activities. Capstone projects involving mission design attempt to adhere to NASA policy guides on project management, including:

- NASA/SP-2014-3705 NASA Space Flight Program and Project Management Handbook
- NASA SP-2016-6105 NASA Systems Engineering Handbook

Capstone projects have ranged from subsystem development to full mission concepts. Full mission capstone projects may require one or two semesters to complete and may include:

- Hierarchical descriptions of requirements starting at Level 0
- NASA-compliant work breakdown structures
- Concepts of operations
- Orbital parameters
- Launch and early-orbit operations
- Preliminary size, weight and power estimates
- Design of major systems and subsystems
- 3D mechanical renderings
- Thermal, mechanical stress and vibration analyses
- Preliminary design reviews
- Critical design reviews

- Project schedules and milestones
- Budget estimates

After completing a full mission capstone project, students attain a feel for the processes of mission design and the NASA project life cycle from pre-formulation through launch and operations. One capstone project from the University of Florida is now being pursued as CubeSat flight project based upon original student work.

V. Summary

NASA's SCaN internship program at the Exploration and Space Communications Projects Division at Goddard Space Flight Center provides a variety of educational outreach services to enhance understanding of space operations, communications and advanced technologies to students across the U.S. There are a variety of paths for students to get involved with the program, and students are encouraged to apply for internships. The demand for NASA services to support educational development of students is growing as more institutions become aware of the opportunities for engagement in science and engineering at all levels.

Acknowledgements

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