National Aeronautics and Space Administration

SIGNAL

THE SCAN INTERNSHIP PROJECT JOURNAL

GODDARD SPACE FLIGHT CENTER

SUMMER 2022

SIGNAL

THE SCAN INTERNSHIP PROJECT JOURNAL

SUMMER 2022

GODDARD SPACE FLIGHT CENTER

EDITORIAL, ART, & INTERN TEAM

EDITORS IN CHIEF: Korine Powers, Mariah Pulver
EDITORIAL TEAM: Kendall Murphy, Katherine Schauer
WRITERS: Jessica Hinkle, Kendall Murphy, Korine Powers, Mariah Pulver
ART DIRECTOR: David Ryan
GRAPHIC DESIGNERS: Kasey Dillahay, David Ryan
INTERN PROGRAM COORDINATORS: Jimmy Acevedo, Korine Powers

SIP Overview

NASA's Space Communications and Navigation program, or SCaN, oversees all of the agency's space communications and navigation activities, currently enabling the success of more than 100 NASA and non-NASA missions. In addition to SCaN's commitment to advancing and expanding its space communications, navigation, and data systems to support NASA's long-term vision for exploration, we are also dedicated to developing the workforce that will imagine, maintain, and operate the next generation of SCaN systems.

The brightest star of SCaN's workforce development efforts is the SCaN Internship Project (SIP), which connects students with NASA mentors to perform beneficial work for the agency. From an operational demonstration of LunaNet's core features to designing a software simulation of a laser communications payload, SIP interns contribute to agency missions and SCaN technologies.

In addition to their main summer project, SIP offers participating NASA interns supplementary events and programming to enhance their internship experience. The professional development workshops, networking opportunities, and social events that SIP organizes fosters friendship, fellowship, and professionalism in interns as early into their careers as high school and as experienced as doctoral candidates or continuing studies professionals. SIP coordinators also empower interns and mentors with the logistical and programmatic support needed to successfully complete their projects and meet program requirements.

In accordance with NASA guidelines during the COVID-19 pandemic, SIP summer interns across the country worked toward their goals both virtually and at NASA's Goddard Space Flight Center in Greenbelt, Maryland. SIP coordinators adjusted programming for this hybrid environment to create new possibilities for connection and professional development. No matter where in the United States our interns were working from, we remained united in our efforts to support NASA's commitment to advancing technologies like laser and quantum communications, preparing for missions like Artemis, and fostering relationships with the industry.

In this journal, interns share how they supported SCaN through the Exploration and Space Communications (ESC) projects division. The division provides full-coverage communications and navigations services and technical expertise to move NASA into the future. The Near Space Network connects science and human exploration missions in the near-space region — out to two million kilometers away — with essential communications and navigation services, empowering discoveries and expanding capabilities.

Our summer 2022 interns supported SCaN's vision by advancing NASA with new innovations, new experiments, new automation, and new cost-effective solutions to our communications and navigation efforts. With the aid of their brilliant, passionate mentors, SIP interns contributed to agency initiatives across a wide variety of disciplines, including cybersecurity, education, quantum communications, and engineering of all kinds.

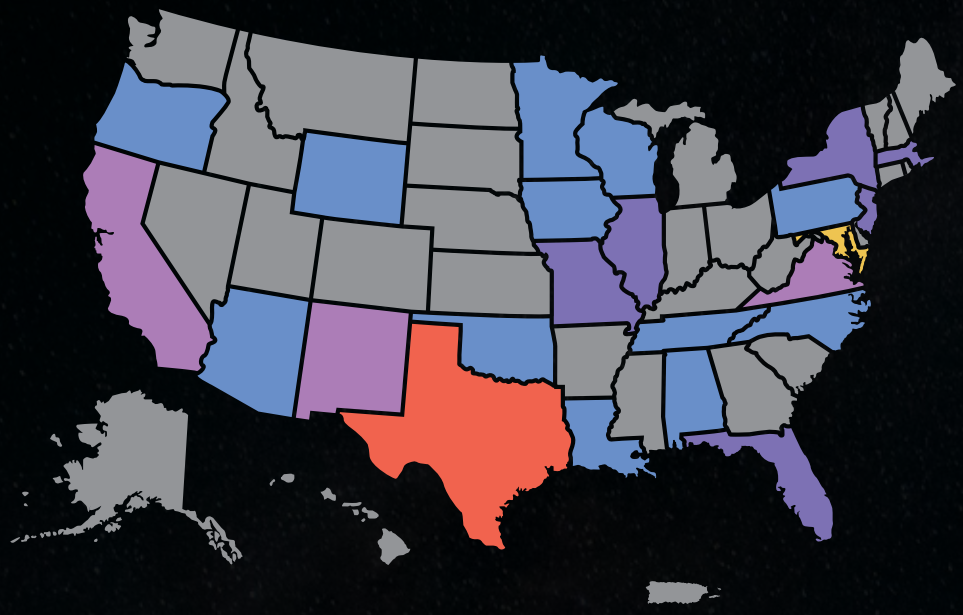
Some of these interns will continue with SIP in the fall. Some will join the NASA workforce. Others will move into industry or academia, evangelizing SCaN's mission outside the agency. However, all have left their mark on NASA.

Table of Contents

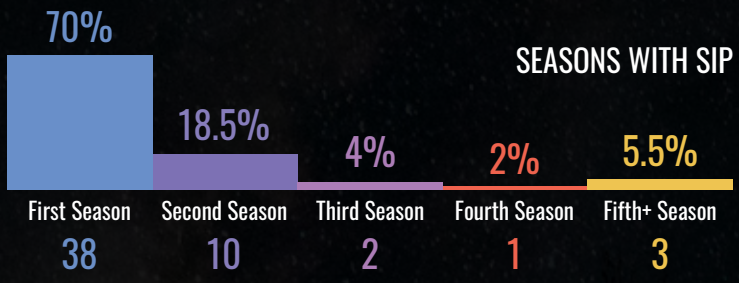
2022 Intern Demographics

The interns participating in the summer session of SIP 2022 hail from towns across the nation, each with a diverse background. Below are some key metrics about our students — where they live, what they study, and which SCaN discipline they represented this summer.

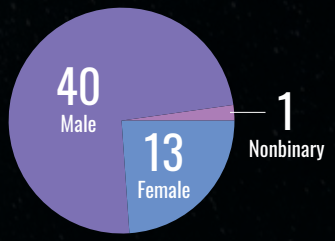
54 TOTAL INTERNS



SEASONS WITH SIP



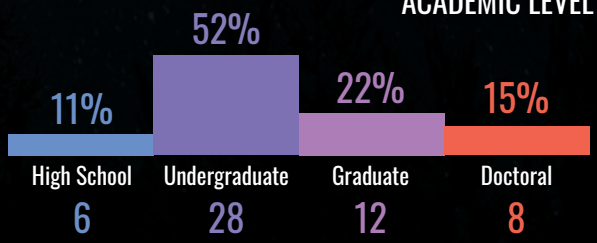
INTERNS BY GENDER



INTERNS BY DISCIPLINE

Communications	1	2%
Cybersecurity	1	2%
Education	3	5.5%
Electrical Engineering	2	4%
Laser Communications	9	16%
Navigation	4	7%
Network Engineering	11	20.5%
Quantum Communications	5	9%
Remote Sensing	1	2%
Software Engineering	7	13%
Systems Engineering	2	4%
Telecommunications	8	15%

INTERNS BY ACADEMIC LEVEL



*Percentages rounded for clarity.

Message from Badri Younes

Deputy Associate Administrator for SCaN
NASA Headquarters — Washington, D.C.

At SCaN, we believe in developing and supporting the next generation of leaders, and the SCaN Internship Project is a critical part of that. Each of you has the potential to move the agency forward into the future, which you proved with your hard work and contributions this summer. Thank you to each of you.

As you continue along your journey - academically, professionally, and personally – maintain your focus, motivation, passion, and, most importantly, your curiosity. You are part of the NASA and SCaN family now – please reach out if we can help you along your path. Together we can explore further than ever before, to the Moon, Mars, and beyond.

The future is yours to define and shape for the better. I wish you the best of luck and hope to see you back at NASA soon.

Ad astra!

Badri Younes

Message from Barbara Adde

SCaN Policy and Strategic Communications Director
NASA Headquarters — Washington, D.C.

Summer is our favorite season at SCaN, thanks to our great group of interns each year. For ten weeks, our students enthusiastically accept the challenge of completing meaningful work across SCaN's diverse portfolio of projects, missions, and technology development efforts. Your energy, creativity, and innovation inspire us all.

Each SIP session, our interns gain valuable experience, contributing to their future academic and professional endeavors. But NASA, SCaN, and the mentors also benefit, gaining new insight, knowledge, and ideas. And after a few virtual SIP seasons, we were so excited to meet some of our interns in person and get to know them this summer!

Congratulations and thank you for spending your summer with us. We hope to see you in the future.

All the best,

Barbara Adde

Mentor a SIP Intern

CONNECT, INSPIRE, AND GROW THE NEXT GENERATION

The SCaN Internship Project is looking for mentors like you, who can share knowledge and foster the next generation of communications and navigation talent. As we plan for the future with new missions, technologies, and capabilities, preparing the next generation of the NASA workforce is crucial.

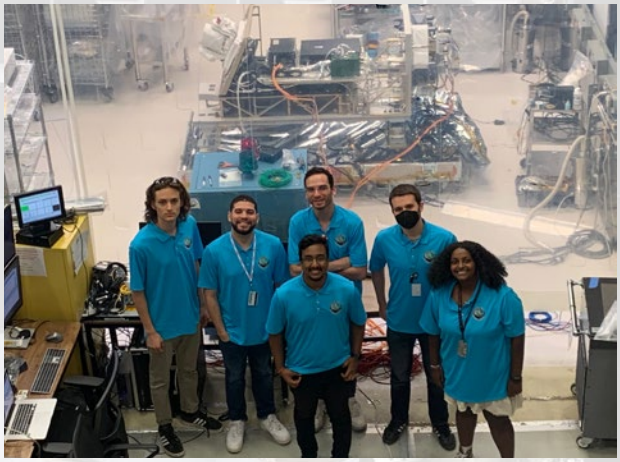
Mentoring a student is a valuable opportunity to gain new insight and perspectives on your project, enhance leadership skills, and more. If you are interested, sign up today!

Members of the SCaN workforce are eligible to be mentors, whether you have a specific project in mind or want to give back to the community. Email us to learn more about becoming a mentor:

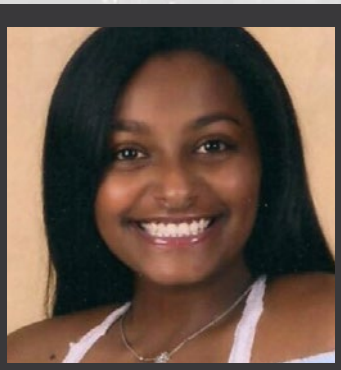
gsfc-sip-intern@mail.nasa.gov

The March to Launch: ILLUMA-T Integration and Testing

REBEKAH ABRAHAM, AKSHYAT DUMKA
MENTOR: TRISHA RANDAZZO



This summer, Rebekah Abraham and Akshyat Dumka developed technical documentation for NASA's Integrated LCRD Low-Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T). This optical terminal is set to fly aboard the International Space Station in 2023 and will communicate with the Laser Communications Relay Demonstration (LCRD) relay satellite to be the first fully operational end-to-end laser communications system. Abraham and Dumka contributed to ILLUMA-T's mission readiness by building integration and testing documents, including the payload user manual, ground systems user manual, and operational constraints documents. In addition to their work researching and outlining these documents, Abraham and Dumka also applied their research, observation of testing procedures, and discussions with developers to crafting questions for the operator certification exam. Their work on these user manuals and the operator certification will ensure the technical readiness of the ILLUMA-T payload and prepare operators to make the most out of ILLUMA-T's enhanced data capabilities.



REBEKAH ABRAHAM

HOMETOWN: Parkville, Maryland

Rebekah Abraham is a rising senior studying computer and electrical engineering at Loyola University Maryland. In the fall of 2021, Abraham studied in Dubai for a semester to further her degree abroad. At Loyola Maryland, Abraham participated in independent research on quantum computing from an intermediate-level gate perspective. Abraham is a Greyhound Ambassador and an intern in undergraduate admissions. In her free time, Abraham enjoys traveling, skateboarding, and finding new trails to hike.

AKSHYAT DUMKA

Hometown: Dallas, Texas

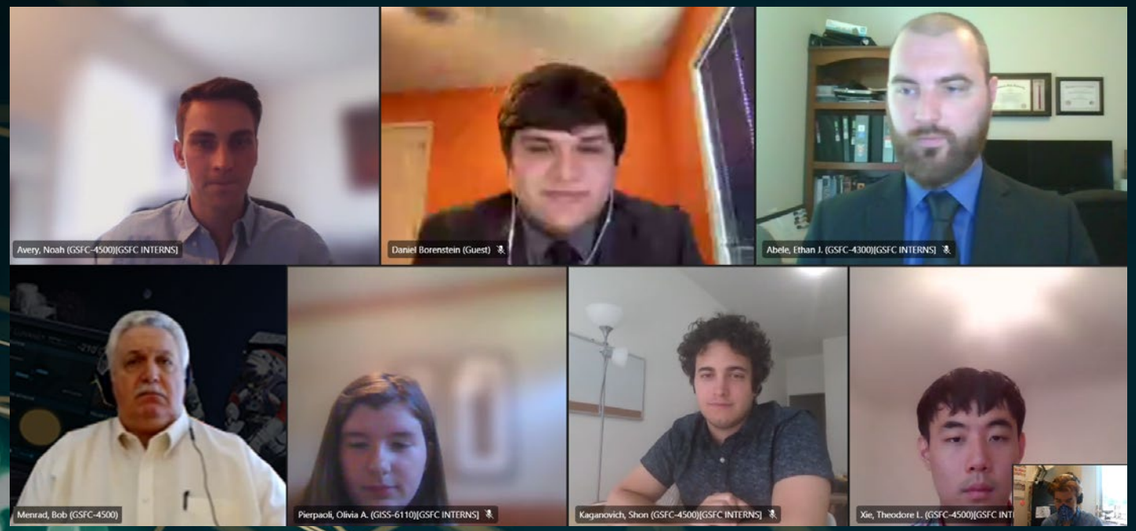
Akshyat Dumka is a rising junior at Texas A&M University pursuing a Bachelor of Science in multidisciplinary engineering technology with a concentration in mechatronics and minors in computer science and embedded systems. Previously, Dumka participated in the Workforce Development Program at NASA L'SPACE Academy, where he developed an extraterrestrial atmospheric pollination drone and a $150 million rover concept to analyze components in lunar soil. Outside of engineering, Dumka participates in cricket and martial arts, and plays the violin.

NexTEra Data Streaming Project

NOAH AVERY, DANIEL BORENSTEIN, SHON KAGANOVICH, ELIZABETH SMITH
MENTOR: BRANDON BETHUNE

Noah Avery, Daniel Borenstein, Shon Kaganovich, and Elizabeth Smith worked together on the NexTEra project, which will use cloud infrastructure instead of terrestrial links to allow satellite telemetry data to be sent between satellite receivers and mission control. After the data is sent to a receiver, the NexTEra Data Streaming Project is responsible for pulling it and storing in the cloud.

Kaganovich and Borenstein adapted existing code to push satellite data into the Amazon Web Services (AWS) Kinesis data stream and adapted an existing AWS function to break down the data stream into smaller readable files that are then stored and accessed through the cloud. Avery, the systems engineer, created documentation, requirements definitions, test plans, and procedures. Smith, an experienced Pathways intern, aided the team's coding and documentation efforts with support, guidance, and feedback. The team's work on the NexTEra project will help NASA reduce latency and infrastructure costs, improve data center uptime, and better verify data retention.



NOAH AVERY

HOMETOWN: San Diego, California

Noah Avery is pursuing a master's degree in aerospace engineering with a focus in Remote Sensing, Earth & Space Sciences at the University of Colorado Boulder. This May, he completed his undergraduate degree at CU Boulder in aerospace engineering with a minor in engineering management. Avery is a self-proclaimed film connoisseur who enjoys traveling and photography.

DANIEL BORENSTEIN

HOMETOWN: Phenix City, Alabama

Daniel Borenstein is a senior pursuing a bachelor's degree in computer science at Auburn University in Alabama. Upon graduation, he plans on becoming a software engineer. Outside of work, Borenstein enjoys watching movies, playing video games, and spending time with his friends and family.

SHON KAGANOVICH

HOMETOWN: Potomac, Maryland

Shon Kaganovich is a sophomore at the University of Maryland, Baltimore County studying computer science. When he is not coding, Kaganovich enjoys rock-climbing, white-water kayaking, and backpacking.

ELIZABETH SMITH

HOMETOWN: Greenbelt, Maryland

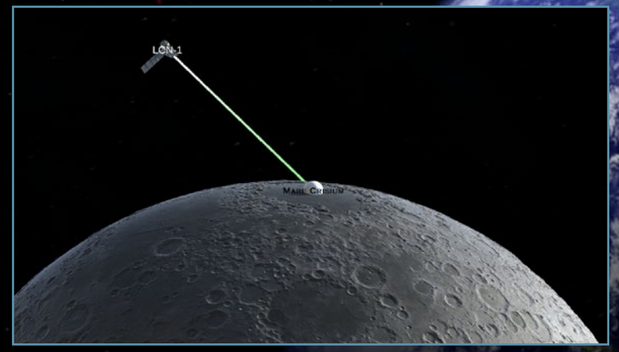
Elizabeth Smith is a senior at the University of Maryland pursuing a bachelor's degree in computer science. Prior to joining NASA, she interned at the National Institutes of Health. Upon graduation in August 2022, she hopes to become a NASA civil servant and pursue a master's degree in cybersecurity. She enjoys board games, outdoor activities, and exercising her love of learning.

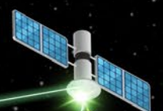
Mission Visualization Toolkit

ADITYA DUTT, AMAN GARG, ARYA KAZEMNIA, ZOE SCHOENEMAN-FRYE, LEO WANG

MENTORS: GEORGE BUSSEY, ELANA RESNICK (GILMAN SCHOOL)

Aditya Dutt, Aman Garg, Arya Kazemnia, Zoe Schoeneman-Frye, and Leo Wang collaborated on a low-cost mission visualization toolkit designed to simulate Earth, the Moon, and generative communications scenarios related to Earth or lunar ground stations and surrounding satellites. Kazemnia used a combination of Python and C# scripts to convert large, complex files into a readable and compact format. Dutt saved these files to a local database for quick and efficient retrieval. Wang loaded the converted files into the simulation to create the visualization and simulate communication connections between the Earth and the Moon. Schoeneman-Frye ran link budgeting calculations for the toolkit and verified the accuracy of the simulation by comparing her team's work with other simulation efforts. Garg built the models within the visualization and worked on publishing the application to a public-facing website. Their project will provide a cheaper, more efficient solution to simulating what-if communications scenarios and trade studies for future Artemis missions.

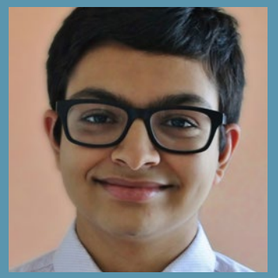




ARYA KAZEMNIA

HOMETOWN: Baltimore, Maryland

Arya Kazemnia is a rising high school junior at the Gilman School in Baltimore, Maryland. Upon graduation, he plans to pursue a career in biomedical or electrical engineering. Kazemnia is also interested in 3D visualization, robotics, and space-related research. During his downtime, he loves 3D printing, playing piano, and doing robotics.



ADITYA DUTT

HOMETOWN: East Brunswick, New Jersey

Aditya Dutt is a rising high school senior at the Middlesex County Academy in Edison, New Jersey. He plans to go to college for computer science and engineering. After graduating college, he wants to be a software developer, hopefully at NASA! In his free time, he loves playing with his two pet parakeets and using his 3D printer.

AMAN GARG

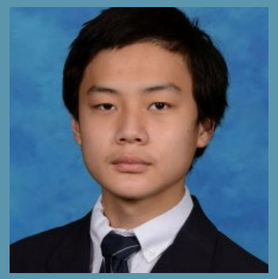
HOMETOWN: Baltimore, Maryland

Aman Garg is a rising high school junior at the Gilman School in Baltimore, Maryland. After graduation, he plans to study computer science and pursue an advanced degree in medicine. For now, he hopes to learn more about programming by taking part in software development internships. Outside of work, he enjoys tinkering with 3D printers and playing tennis.

ZOE SCHOENEMAN-FRYE

HOMETOWN: Takoma Park, Maryland

Zoe Schoeneman-Frye is a rising freshman at the University of Maryland, Baltimore County (UMBC). She is taking a gap year in 2023 to teach reading skills to Delaware elementary schoolers through the AmeriCorps program. At UMBC, Schoeneman-Frye intends to major in computer science and pursue a career in computer programming or graphic design. In her free time, she enjoys drawing, swing dancing, and badminton.



LEO WANG

HOMETOWN: Baltimore, Maryland

Leo Wang is a rising high school junior at the Gilman School in Baltimore, Maryland. He plans on becoming a software developer after graduating. In the meantime, Wang is pursuing internships with a focus on creating new, innovative programs. When not working, he enjoys playing video games.

SIP Celebrates National Intern Day

By Kendall Murphy - Originally published on esc.gsfc.nasa.gov/news

On July 28, 2022, we celebrated National Intern Day! This day recognizes the fresh perspectives and bright ideas brought to NASA by our interns. Each intern who participates in SIP makes valuable contributions. Below are highlights from four students across the program.

VEENA SREEKANTAMURTHY, Low-Cost Optical Terminal

Veena Sreekantamurthy is a first-time SIP intern, pursuing a Master of Science in electrical engineering with a focus on radar tracking at the Pennsylvania State University. Her interest in space began as a child through frequent visits to the Air and Space Museum with her father. During high school, she spent one summer at Langley Research Center in Hampton, Virginia, shadowing engineers. There, she was exposed to the interesting work being done at NASA. For her senior capstone project at Virginia Tech, Sreekantamurthy and her team designed CubeSat subsystems. For her SIP project this summer, she worked with the Low-Cost Optical Terminal (LCOT) team and used trajectory data to measure how the degradation of orbit information is relevant to LCOT orbit predictions. Learn more in her project section!

"My favorite part of this internship program is networking with other interns and mentors, and attending meet and greets and colloquiums," said Sreekantamurthy. "I enjoy listening to my peers and learning more about other NASA projects, and I hope to maintain these connections beyond this internship."

ANDREA KARINA VARGAS, Tracking and Data Relay Satellites

Andrea Karina Vargas, or Kari, another first-time SIP intern, is an undergraduate senior at the University of Texas at El Paso (UTEP), pursuing a degree in mechanical engineering with minors in computer engineering and mathematics. Her fascination with robotics in space and passion for aerospace is what brought her to NASA. This spring, Vargas landed a systems engineering internship working on state of health support for Tracking and Data Relay Satellites (TDRS) at NASA's White Sands Complex in Las Cruces, New Mexico. During her summer internship, Vargas worked to ensure that the TDRS antennas' digital systems continue to connect mission critical ground systems to users like the International Space Station. Learn more in her project section!

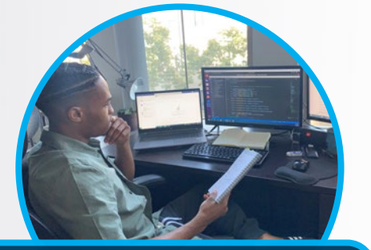
"NASA has given me the opportunity to challenge myself to learn more about different areas of aerospace," said Vargas. "I am thrilled to know that my systems engineering knowledge, along with my work performed here with TDRS, will help further the team's mission."

JEREMY QUAIL, Near Space Network

First-time SIP intern Jeremy Quail is a third-year mathematical sciences Ph.D. student at the University of Vermont. During his undergraduate studies, Quail took a combinatorics class and enjoyed the creativity in mathematical problem solving which inspired him to continue his studies in graduate school. He heard about SIP from a fellow student and the program caught his interest. This summer, Quail began building the theoretical foundations for modeling the Near Space Network, helping lay the foundation for a Solar System Internet using features of Delay/Disruption Tolerant Networking (DTN). Learn more in his project section!

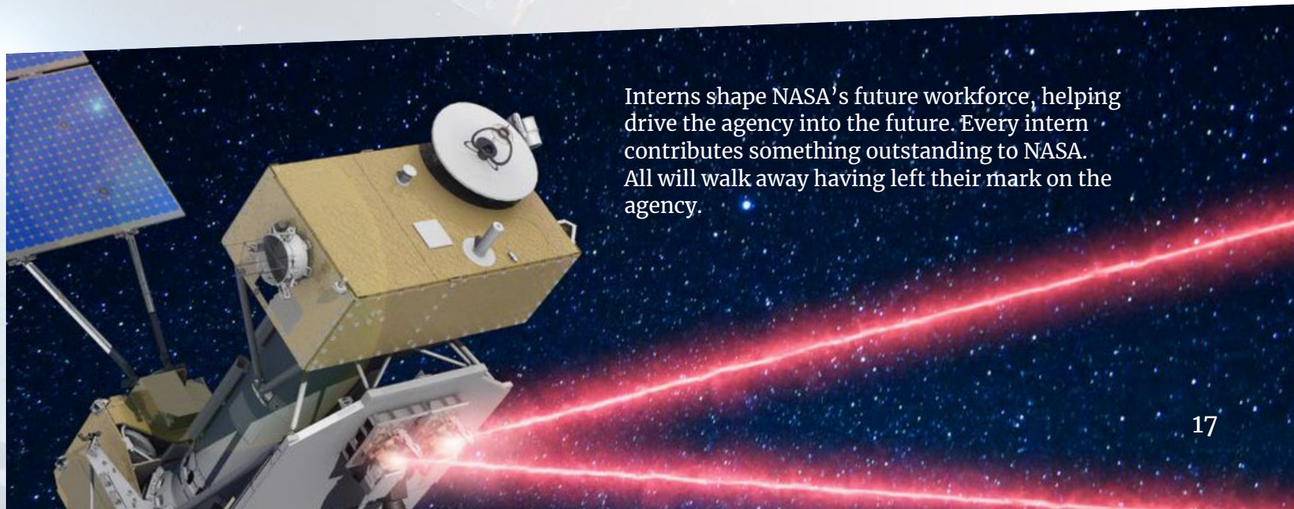
"Our project works toward the creation of a scalable space-based network that would enable efficient communications and navigation in near space and farther," said Quail. "I am grateful for the opportunity to help NASA address the challenge of time-synchronization across a time-varying network. Our work here will complete the next step needed for communications on the Moon and beyond."

CARTER EDMOND, LunaNet



Returning SIP intern Carter Edmond is a rising senior at San Jose State University, pursuing a bachelor's degree in computer science with a minor in astronomy. He used his previous year's SIP experience as a learning tool for new interns, helping them make connections, providing tips, and answering any questions they had about NASA. Edmond became passionate about computer programming during his freshman year of high school. Edmond's love for computer science grew as he programmed simulations and worked with robotic software. Now, his internship allows him to expand his capabilities into performing simulations and configuring computer networks. This summer, Edmond leveraged his previous summer's work with DTN and designed an operational demonstration to highlight LunaNet's core features. Learn more in his project section!

"I really enjoy helping out new interns," said Edmond. "I was in their shoes last summer, and I like to use my knowledge to answer any questions my peers may have and to make them feel as welcome as possible."



Interns shape NASA's future workforce, helping drive the agency into the future. Every intern contributes something outstanding to NASA. All will walk away having left their mark on the agency.

Space Relay Modem Test Bed

ELIZABETH HSIEH, CARO MEDELIUS, NEAL SHAH

MENTORS: TOMMY CAO, ZAC SMITH

Elizabeth Hsieh, Caro Medelius, and Neal Shah created multiple databases and Graphical User Interfaces (GUIs) for the Space Relay Modem Test Bed (SMTB). The SMTB supports efficient setup, execution, and analysis for ground-based space relay modem testing. Hsieh, Medelius, and Shah used a Python cross-platform toolkit to create standalone GUIs to display and modify the databases created in MySQL, an open-source database management system. By making modem testing more efficient and extensible—and using free or low-cost tools like Visual Studio and Git—Hsieh, Medelius, and Shah abbreviated the lengthy setup process for NASA's modem testers.

ELIZABETH HSIEH

HOMETOWN: North Potomac, Maryland

Elizabeth Hsieh is a rising junior at Johns Hopkins University majoring in computer science. She is currently interested in working with machine learning and artificial intelligence to improve high-risk jobs and procedures. In addition to her studies, Hsieh is also on the Hopkins Varsity Volleyball team and enjoys hiking and photography.

CARO MEDELIUS

HOMETOWN: St. Petersburg, Florida

Caro Medelius is in the final year of her computer science master's program at the University of Pennsylvania. In 2020, she graduated from the University of Florida with a Bachelor of Science in information systems and minors in computer science and Russian. In her free time, Medelius enjoys kiteboarding, skiing, and board games.

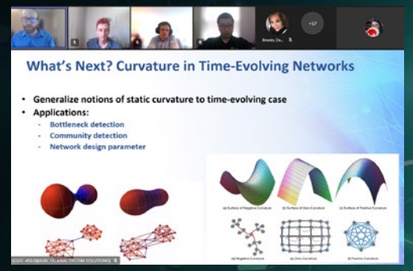
NEAL SHAH

HOMETOWN: Odenton, Maryland

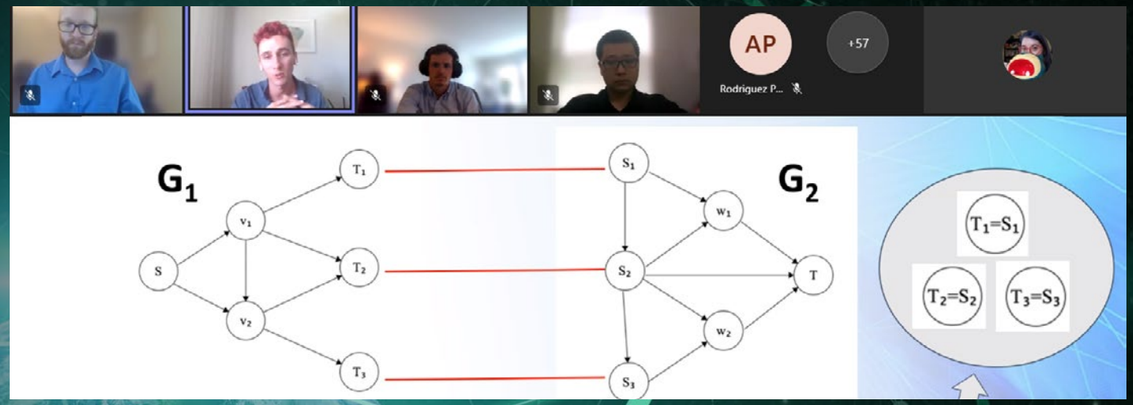
Neal Shah is a senior at the University of Maryland majoring in aerospace engineering. Prior to joining SIP, he interned at the Federal Aviation Administration and KBR, Inc. Shah is set to graduate this summer, after which he will pursue a graduate degree and full-time position in aerospace engineering. He spends his free time hiking and playing sports, especially soccer and disc golf.

The Mathematics of the Solar System Internet

JI HUN HWANG, COLIN LEVAUNT, BRENDAN MALLERY, JEREMY QUAIL, JONATHAN QUARTIN, MARK RONNENBERG, NATALIE TSUEI
MENTOR: ALAN HYLTON



Mathematicians and computer scientists Ji Hun Hwang, Colin Levaunt, Brendan Mallery, Jeremy Quail, Jonathan Quartin, Mark Ronnenberg, and Natalie Tsuei applied pure mathematics to the process of modeling and studying the structure of the satellite networks that form the Near Space Network. The group developed a theory for the application of sheaves—mathematical tools for systemically tracking data—and graphed the results into simplified theoretical models of routing within Delay Tolerant Networks (DTNs). This has enabled modeling of cross domain routing in DTNs for the first time. They also developed a theoretical, geometry-based framework for time-synchronization across a satellite-dispersed network, which addresses a long-standing issue in realizing a Solar System Internet (SSI) built on DTN. Furthermore, the team developed mathematical tools for characterizing and studying time-varying networks using category theory, functional analysis, and tropical geometry techniques. These structures are the foundation for future algorithms, standards, and policies, all of which are necessary for the scalability needed by an SSI. Their work developing the mathematics of the Near Space Network lays the foundation for building and studying space-based networks with greater efficiency, autonomy, and scalability. In addition, their mathematical research will result in new tools for studying satellite networks and inform future Near Space Network designs.



BRENDAN MALLERY

HOMETOWN: Hong Kong

Brendan Mallery is a second year Ph.D. student in mathematics at Tufts University. He is returning for his third internship at NASA to continue his work developing mathematical foundations for the study of time-evolving networks. He is particularly interested in mathematical approaches involving a mix of metric geometry, probability, and dynamics. When not performing research, Mallery enjoys running, painting, and playing music.

JI HUN HWANG

HOMETOWN: Gwangmyeong, South Korea

Ji Hun "Jimmy" Hwang is a first year Ph.D. student in computer science at Purdue University specializing in information theory and cryptography. Prior to joining Purdue, Hwang earned his Master of Science in computer science and Bachelor of Science in mathematics from the University of Massachusetts Amherst. Outside of his research, Hwang can be found jogging, watching documentaries, and solving puzzles.

COLIN LEVAUNT

HOMETOWN: Shoreview, Minnesota

Colin Levaunt is a mathematics Ph.D. student at the University of Vermont. He received his Bachelor of Science in mathematics and physics from the University of Wisconsin-La Crosse in 2018. Beyond mathematics, Levaunt enjoys reading, taking walks, hiking, skiing, and spending time with his loved ones.

JEREMY QUAIL

HOMETOWN: New York City, New York

Jeremy Quail is a third year mathematical sciences Ph.D. student at the University of Vermont. He received his Bachelor of Arts in mathematics from Queens College, City University of New York. Quail's graduate research is studying mathematical objects called positroids through the lens of graph theory. In his free time, Quail enjoys long walks, boardgames, reading, and going to the beach.

JONATHAN QUARTIN

HOMETOWN: Miami, Florida

Jonathan Quartin, or JQ, is a Ph.D. candidate at the University of Colorado Boulder studying mathematics. His research focuses on the Deformation Theory of sheaves and their global sections. In 2017, JQ earned his bachelor's degree in mathematics from the University of California at Berkeley. In his spare time, JQ enjoys cooking, hanging out with friends, and making electronic music.

The Mathematics of the Solar System Internet (CONTINUED)

JI HUN HWANG, COLIN LEVAUNT, BRENDAN MALLERY, JEREMY QUAIL,
JONATHAN QUARTIN, MARK RONNENBERG, NATALIE TSUEI
MENTOR: ALAN HYLTON

MARK RONNENBERG

HOMETOWN: Cedar Rapids, Iowa

Mark Ronnenberg is a Ph.D. candidate at Indiana University studying mathematics. Previously, he earned a Bachelor of Arts in mathematics from the University of Northern Iowa. His thesis research is in the field of low dimensional topology. When not doing math, Ronnenberg enjoys playing guitar, reading, and hanging out with his wife and cats.

NATALIE TSUEI

HOMETOWN: Greensboro, North Carolina

Natalie Tsuei is a rising sophomore at American University studying computer science and international studies with a concentration in cybersecurity and national security. Outside of studying and research, Natalie enjoys spending time with her dogs, reading, and playing piano.

Telerobotics Activity Design with ARISS

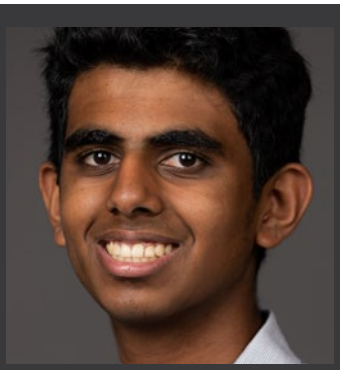
UNSH RAWAL, NITIN VEGESNA
MENTOR: FRANK BAUER

This summer, Unsh Rawal and Nitin Vegesna developed a software interface that allows students to control robots through local and remote wireless connections. Rawal and Vegesna used JavaFX — a software platform for creating web and desktop applications — to create a mission controller through which users can operate local robots through Wi-Fi and Bluetooth, and remote robots through internet and radio signals. Mission controllers can use the instant messaging platform Discord to connect with each other over the internet and issue commands to their robots. Vegesna developed the mission controller user interface while Rawal worked on Discord functionality. The team then applied and tested their interface on both local and distant robot control commands encoded as radio packets in an Automatic Packet Reporting System. Their project highlights the educational and applicational possibilities of applying wireless communications to robotics.

UNSH RAWAL

HOMETOWN: Houston, Texas

Unsh Rawal is a rising senior at the Harmony School of Advancement and the captain of his high school's FIRST Tech Challenge robotics team. Upon graduation, he plans to pursue a bachelor's degree in computer science or robotics. In his free time, Rawal likes to play chess and ping-pong. He also loves video games and watching movies.



NITIN VEGESNA

HOMETOWN: San Jose, California

Nitin Vegesna is a junior studying computer science at the Georgia Institute of Technology. He hopes to continue exploring how NASA can use amateur radio techniques to manually control robots across close and vast distances. In his free time, Vegesna loves to play sports, listen to music, and hang out with friends.

What Makes SIP Great?

HEAR CURRENT SIP INTERNS SHARE THEIR ANSWERS!

"The SCaN Internship Project has been an amazing opportunity to connect with fellow students and NASA employees at all levels – while having the chance to work on some neat applications of theoretical math for NASA's future missions! The intern coordinators have been phenomenal at organizing events, keeping interns feeling connected, helping us network, and supporting our projects."

JEREMY QUAIL

"I love all the opportunities we get to meet people and see different areas of NASA outside the scope of our projects. The support we receive is great too- everyone is really invested in our experiences."

CARO MEDELIUS

"Whether it's having casual conversations with my mentors about shared hobbies, attending meet-and-greet sessions with passionate NASA staff, or getting to see the cleanroom where the James Webb Space Telescope was built, every single experience has been nothing but amazing."

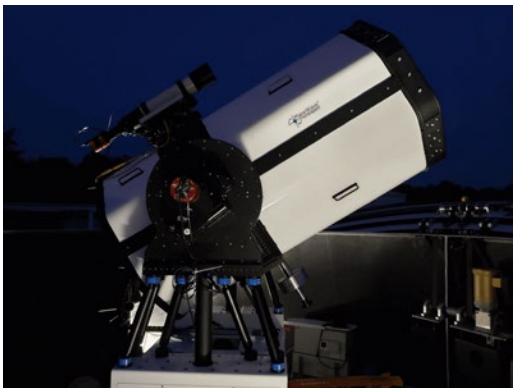
LUCAS IZQUIERDO

"It's amazing to be a part of the Artemis generation. Like so many others, I've dreamt about being a part of NASA. As an intern, it's been incredible to have that dream come true. I've had the opportunity to interact with NASA scientists, engineers, and administrators and see their excitement about intern contributions to their missions firsthand."

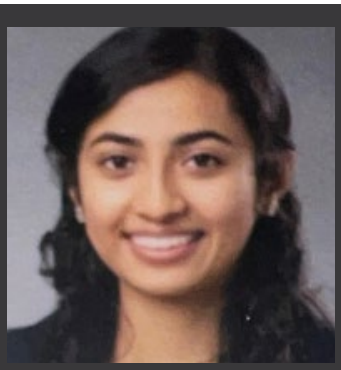
COLIN LEVAUNT

Market Research for Laser Communications Terminal and Tracking Simulation

VEENA SREEKANTAMURTHY, THEODORE XIE
MENTOR: HALEH SAFAVI



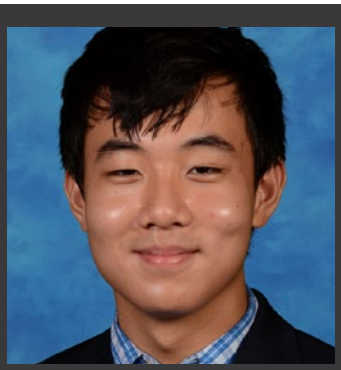
Veena Sreekantamurthy and Theodore Xie worked on group and individual projects this summer. Together, Sreekantamurthy and Xie performed market research for a Low-Cost Optical Terminal (LCOT) capable of supporting multiple NASA missions for under $1 million. Their research involved a survey of available low-cost optical ground terminals supporting low-Earth orbit missions, contacting vendors for additional product information and cost estimates, and interviewing LCOT project leads and subject matter experts to ensure these options met system requirements. Individually, Sreekantamurthy used trajectory data to measure how the degradation of orbit information encoded in two-line element (TLE) data impacted the accuracy of LCOT orbit predictions, which in turn tells operators when TLE needs to be updated. For his individual project, Xie wrote code in Python that calculates the angle needed for connection between a ground terminal and satellite. His work resulted in a tool that can automatically calculate the angles needed for successful connections between a satellite and a LCOT. Their individual and collective work—culminating in a final presentation of LCOT options, TLE projections, and a tool for satellite-to-LCOT connections—reduces NASA's project costs while making LCOTs more accurate and easier to use.



VEENA SREEKANTAMURTHY

HOMETOWN: Yorktown, Virginia

Veena Sreekantamurthy is pursuing a Master of Science in electrical engineering with a focus on radar target tracking at Pennsylvania State University. In 2021, she earned her bachelor's degree in electrical engineering from Virginia Tech. Sreekantamurthy hopes to have a future career at NASA advancing space technology. In her free time, Sreekantamurthy enjoys outdoor activities and spending time with family.



THEODORE XIE

HOMETOWN: Reisterstown, Maryland

Theodore Xie is a rising junior studying computer science and applied mathematics at Johns Hopkins University. He is particularly interested in statistical learning. Outside of academics, Xie enjoys weightlifting, horror movies, and reading.

Growing in Groups

INTERN SMALL GROUPS MASTER THEIR HYBRID INTERNSHIPS TOGETHER

SIP's 2022 interns were divided into smaller cohorts of students loosely based on project areas, education level, and time zone. These cohorts — named after NASA missions — attended many of the summer's activities together and relied on one another for support during their internship experience.

Cohort A: ATTREX
Nishanth Anand
Brandon Byford
Carter T. Edmond
Alyssa Johnson
Nicholas Sebasco
Veena Sreekantamurthy

Cohort B: BARREL
Ashish Dhanalakota
Lucas Izquierdo
Katrina Lee
Leonardo Muñoz
Unsh Rawal
Fernando G. Salinas, Jr.
Andrea Vargas
Nitin Vegesna

Cohort C: CALIPSO
Ji Hun Hwang
Colin Levaunt
Brendan Mallery
Jeremy Quail
Jonathan Quartin
Mark Ronnenberg
Natalie Tsuei

Cohort D: DAVINCI
Brian Chhour
Mark Hartigan
Elizabeth Hsieh
Caro Medelius
Vaishnavi Ramanan
Neal Shah
Jonathan Tran

Cohort E: EPOXY
Rebekah Abraham
Akshyat Dumka
Thomas Francois
Collin Frink
Nomel Simmons
Kimberly Stringer
Mitchell Zakocs

Cohort F: FAST
Ever Dominguez Rodriguez
Aditya Dutt
Aman Garg
Arya Kazemnia
David Martinez, Jr.
Zoe Schoeneman-Frye
Matthew Tomlinson
Leo Wang

Cohort G: GRAIL
Ethan Abele
Noah Avery
Daniel Borenstein
Shon Kaganovich
Olivia Pierpaoli
Andre Williams
Theodore Xie

Cohort V: VERITAS
Manon Bart
Noah Cowper
Naveed Naimipour
Elizabeth Smith

Channel Measurements for Switching Strategies in Hybrid RF/Optical Communications

ETHAN ABELE

MENTOR: SERHAT ALTUNC

This summer, Ethan Abele used experimental measurements to investigate hybrid radio frequency and optical communications technologies. Abele first built an ultra-long test system using mirrors to fold the optical path through an enclosed chamber. He then created scale versions of atmospheric turbulence within the chamber and developed code to send real data through the channel. By varying the turbulence and other test parameters, Abele could replicate the performance of the optical link under various simulated weather conditions. The results of these tests will aid the development of reliable, maximized switching criteria for hybrid networks using both radio frequency and optical channels. Abele's project improves NASA's understanding of optical link performance and advances optical link integration into the Near Space Network.

HOMETOWN: Stillwater, Oklahoma

Ethan Abele is pursuing a Ph.D. in electrical engineering at Oklahoma State University, where he is researching hybrid radio frequency and optical communications systems. In his 2021 summer and fall SCaN internships at Goddard, Abele developed simulation models for link budget analysis on five CubeSat missions. When not working with radios, he enjoys backpacking, weightlifting, and playing video games.

Quantum Communications Experiments

NISHANTH ANAND

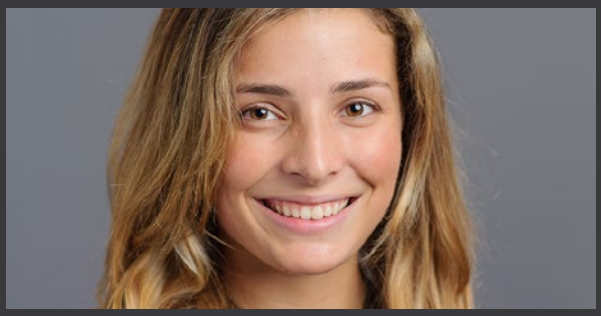
MENTOR: HARRY SHAW

Nishanth Anand experimented with multiple quantum communications technologies this summer. For his first experiment, Anand performed a demonstration of quantum key distribution, a communications method that involves the secure sharing of a set of bits called a quantum key to encrypt and decrypt communications over a standard computer channel. Anand then performed a quantum eraser experiment involving the measurement of wave interference to demonstrate both quantum entanglement, the phenomenon where quantum states of entangled particles are not independent of each other, and complementarity, the idea that objects have pairs of properties that cannot be simultaneously observed and measured. Finally, Anand investigated the generation of entangled photon pairs for use in communications. These experiments and Anand's assessments of their results will inform NASA's development of secure data transfer and new quantum communications protocols resistant to interception and eavesdropping.

HOMETOWN: Herndon, Virginia

Nishanth Anand is a senior at the University of California, Berkeley studying astrophysics and computer science. After graduating, he plans to pursue a master's degree in aerospace engineering. Apart from his work, Anand enjoys lifting weights, stargazing, long drives, and the outdoors.

Machine Learning for Free-Space Optical Communications



HOMETOWN: Baton Rouge, Louisiana

Manon Bart received dual bachelor's degrees in physics and chemical engineering from Louisiana State University in 2020. She just finished her second year as a graduate student at Tulane University, where she works in the Quantum Information and Nonlinear Optics Group. Her research focus is machine learning and quantum information. This summer is Bart's third session as a NASA intern and her first in the Pathways program. In her free time, she enjoys traveling, baking, and fishing.

MANON BART

MENTORS: HARRY SHAW, HALEH SAFAVI

This summer Manon Bart simulated and studied atmospheric effects on free-space optical communications. For her project, Bart used machine learning to mitigate losses associated with various optical communications modulation schemes. She first created a neural network that ran a series of algorithms designed to recognize latent information in large data sets. Bart then simulated optical communications signals sent through a high loss atmospheric environment in Python while a neural network recognized and demodulated the signal. The success of her machine learning algorithm was compared to adaptive optics, another technology currently used to reduce the effects of distortions in optical signals. The results of Bart's comparative experiments will help NASA mitigate data losses due to atmospheric attenuation and turbulence in current and future optical communications projects. Bart's work in machine learning will pave the way for a toolkit that can demodulate an optical communications signal without adding to its size, weight, and power requirements.

All-Sky Infrared Cloud Imaging System

HOMETOWN: Las Cruces, New Mexico

Brandon Byford is a Ph.D. student at New Mexico State University (NMSU) studying electrical engineering. As part of his focus on digital image processing, Byford has done projects for the Sunspot Observatory and Virtual Telescope for X-Ray Observations satellite. His master's degree, also in electrical engineering from NMSU, focused on how the parameters of star tracking cameras can affect system accuracy. When not working, Byford likes to hike and rock climb.

BRANDON BYFORD

MENTOR: ARMEN CAROGLANIAN

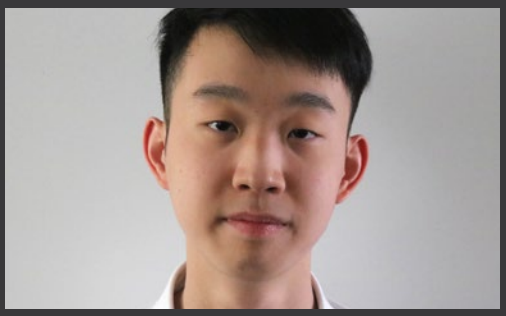
For his past two internships, Brandon Byford has written image recognition code and built software for the All-Sky Infrared Cloud Imaging (ICI) system, a component of the atmospheric monitor system for optical communications ground stations. The ICI system uses a long wave infrared camera and mirror to take a picture of the sky. The image is processed to extract positions and classifications of the clouds above optical communications ground stations. In addition to writing the algorithms for identifying clouds within the images, Byford also created the software for running the ICI and weather station. This summer, Byford began documenting the process and his findings so that other users can replicate and further develop his low-cost ICI and weather station systems. Byford's work ensures that NASA's optical communications ground stations have the weather information they need to successfully establish and maintain optical links to satellites at a significantly reduced cost.

Commanding Autonomous Spacecraft Navigation and Operation

BRIAN CHHOUR

MENTOR: SARAH DANGELO

OpenC3. is an operations and test environment that provides monitor and control functionality from individual circuit boards to full satellites. Brian Chhour spent his summer configuring OpenC3, formerly called the COSMOS software suite, to send and receive messages from NASA's Autonomous Navigation, Guidance, and Control (autoNGC), an onboard autonomous software that integrates and controls spacecraft navigation and control components. Chhour began by researching autoNGC and Core Flight Systems to understand how his application would communicate with autoNGC. After familiarizing himself with autoNGC's function and processes, Chhour began the process of making OpenC3. compatible with autoNGC software. Chhour's work will make it easier to test and debug autoNGC functionality, which in turn ensures that NASA spacecraft are safer and more easily automated.



HOMETOWN: The Bronx, New York

Brian Chhour is a junior at Carnegie Mellon University studying electrical and computer engineering with a minor in computer science. He plans on completing a concurrent master's in electrical and computer engineering by the end of his senior year. In his free time, he enjoys playing basketball and video games.

Quantum Lab Demonstrations

NOAH COWPER

MENTOR: HARRY SHAW

Noah Cowper worked on a variety of optics experiments focusing on the production and detection of light in relation to quantum entanglement and orbital angular momentum (OAM). Cowper detected a light wave using a spiral phase plate, spatial light modulator, and charged-coupled device video camera. By projecting holograms on the modulator, Cowper tested for multiple simultaneous OAMs. He also built and tested a separate entanglement setup for experiments in collaboration with the University of Maryland, Baltimore County. In addition to his project, he trained other quantum interns of the process of verifying the polarization entanglement of two photons.

Cowper's experiments and mentorship will help NASA build the groundwork for quantum secured communications and superdense quantum coding.

HOMETOWN: Laramie, Wyoming

Noah Cowper is going into his fifth year of a physics doctoral program at the University of Wyoming, where he also completed his undergraduate degree. Beyond the sciences, he enjoys studying history and visiting the mountains. Cowper is a part of the Pathways program and hopes to gain a full-time position at Goddard Space Flight Center upon graduation.

Student and Teacher Education via Radio Experimentation and Operations (STEREO)

HOMETOWN: St. Louis, Missouri

Ashish Dhanalakota is a sophomore studying aerospace engineering with minors in computer science and mathematics at the University of Illinois at Urbana-Champaign. Last year, Dhanalakota led the design team for his university's Micro-g Neutral Buoyancy Experiment Design Teams (NExT) program, helping to design and build a tool for astronauts to use in NASA spacewalks and lunar missions. Outside of his interest in aerospace, Dhanalakota enjoys playing games with his brother, working out, and exploring new places with his friends.

ASHISH DHANALAKOTA

MENTOR: FRANK BAUER

Ashish Dhanalakota designed and tested an educational radio kit intended to teach middle and high schoolers about waves, circuits, and amateur radio communications. Dhanalakota first reviewed the beta lesson plans and instructional materials created by the Amateur Radio on the International Space Station (ARISS) organization. After annotating the preexisting lessons and materials with proposed improvements, Dhanalakota performed regression testing on the software for the radio kit's Raspberry Pi. Dhanalakota then set up a long-term improvement plan for expanding the kit's outreach and availability. The result of Dhanalakota's designs and testing, the Student and Teacher Education via Radio Experimentation and Operations (STEREO) project, will help students and teachers all over the world learn more about waves, circuits, amateur radio, and satellite communications.

White Sands Complex Field Technician

HOMETOWN: El Paso, Texas

Ever Dominguez Rodriguez is a junior at the University of Texas at El Paso studying electrical engineering with a concentration in computer engineering. He plans to get his master's degree in electrical engineering concurrently. This is his first time working for NASA. His pastimes consist of playing video games and listening to music such as hip hop, classic metal, and R&B.

EVER J. DOMINGUEZ RODRIGUEZ

MENTOR: ERIC SLETTEN

As part of maintaining 24/7 communications for the critical Tracking and Data Relay Satellite (TDRS) infrastructure, the White Sands Test Facility maintains complex networks of video distributors, venerable paging systems, security controls, and over 900 phone endpoints. This summer, Ever Dominguez Rodriguez flexibly responded to a wide range of operational engineering needs. As a field technician, his work included installing, modifying, and repairing equipment to ensure the integrated systems, subsystems, and software at White Sands operate at maximum efficiency. Dominguez Rodriguez's work ensures that TDRS operations can proceed round-the-clock, both directly supporting TDRS systems and indirectly supporting the personnel who make that work possible.

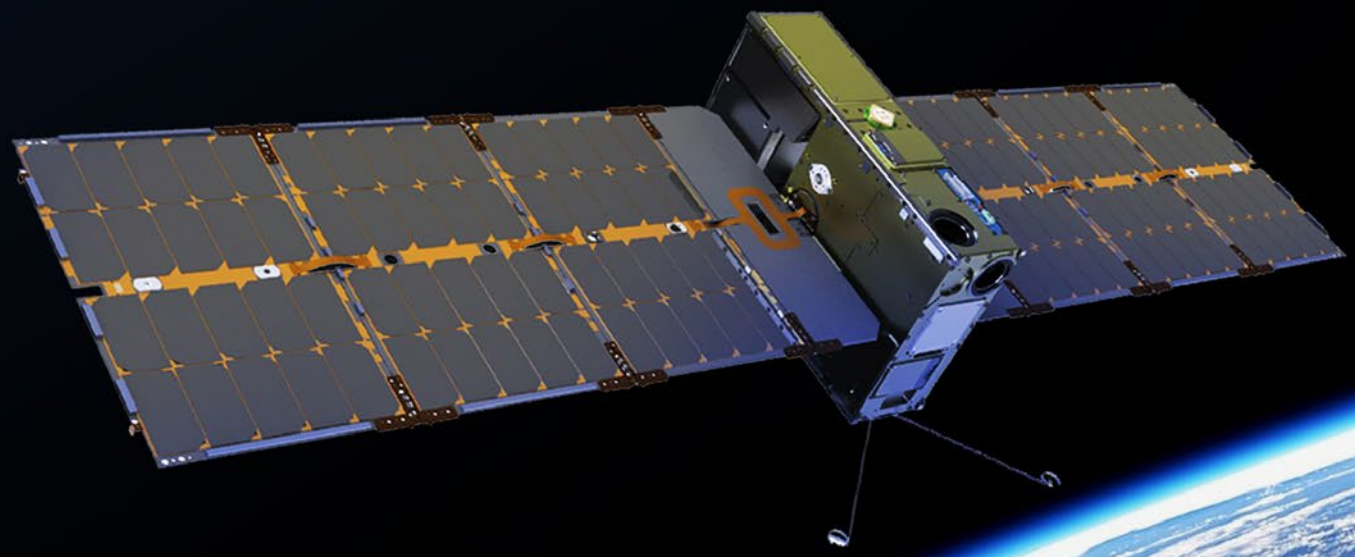
Welcome Back to the Goddard Family

RETURNING INTERNS CONTINUE TO EMPOWER SPACE COMMUNICATIONS AND NAVIGATION

SCaN prides itself on building lasting relationships with its interns. Many former interns go on to become NASA employees, continuing their contributions to agency objectives as civil servants or contractors. All of our interns can count on SCaN to play a role in their education and careers through the relationships and skills they develop during their SIP tenure.

This summer, SCaN had fifteen interns continue their journeys with NASA through SIP. Some are continuing work on long-term projects with their mentors. Others have expanded their impact and grown their knowledge by embracing new projects and mentors. In either case, we are proud to have them rejoin our community.

Below are the interns who have returned to SIP this summer:



Ethan Abele
Adrian Amado
Manon Bart
Brandon Byford
Noah Cowper
Carter Edmond
Aman Garg
Alyssa Johnson
Katrina Lee
Thomas Montano
Leonardo Muñoz
Naveed Naimipour
Fernando Salinas, Jr.
Zoe Schoeneman-Frye
Elizabeth Smith
Kimberly Stringer
Leo Wang

LunaNet Experiment Design for Student-NASA Research Partnerships

HOMETOWN: San Jose, California

Carter Edmond is a rising senior at San Jose State University pursuing a bachelor's degree in computer science with a minor in astronomy. He plans to pursue a master's degree in machine learning next year. In addition to his coursework, Edmond works as student researcher studying quantum gravity and serves as the president of his university's CubeSat club. In his free time, Edmond enjoys practicing photography, watching movies, driving, and stargazing.

CARTER T. EDMOND

MENTOR: DAVE ISRAEL

LunaNet is an innovative, extensible framework that aims to create a lunar infrastructure to aid NASA's long-term presence on the Moon with new, robust communications, navigation, and networking capabilities. This summer Carter Edmond designed an operational demonstration concept to highlight Delay/Disruption Tolerant Networking (DTN) and other core features that are critical to LunaNet. His project involved collaboration across multiple NASA centers, including the Technical Education Satellite (TES) program at Ames Research Center to fly his experiment on one of their satellites. Edmond began his project by reviewing current LunaNet interoperability standards and investigating the core technical constraints of the TES program. After finalizing the core LunaNet features for demonstration on a TES nano (TES-n) CubeSat, Edmond worked with his Goddard mentor and experts at Ames to decide which TES-n satellite would best host the experiment. Finally, Edmond outlined the mission plan and conducted a feasibility and benefit analysis. The results of his experiment will advance the development of LunaNet by providing a cost-efficient option for demonstrating the core features of its future architecture.

Automation of Radio Frequency Compatibility Test Sets

HOMETOWN: St. Louis, Missouri

Thomas Francois is a senior at the Missouri University of Science and Technology studying electrical engineering. After graduation he is looking to enter the workforce with special interest in pursuing a career in RF wireless communications and circuit design. Francois' hobbies include working on amateur radios (call sign KX0STL), using flight simulators, playing viola and guitar, and spending time with his cat, Ozark.

THOMAS FRANCOIS

MENTORS: JAKE BARNES, TYLER WILLIAMS, PAUL SEGARS

Thomas Francois explored the feasibility of using OpenC3 software for controlling, logging, and analyzing various lab equipment in compact telescoping array (CTA) test sets. Francois began his internship by familiarizing himself with the various instrumentation, simulation tools, and ground station equipment in the CTA test lab and OpenC3 software. He then developed a plan for device integration, beginning with instrumentation devices with fewer parameters, such as radio frequency (RF) power meters and attenuators, before moving on to more complex devices, including a spectrum analyzer and ground station modem. After a careful review of manufacturer manuals to determine interface details and syntax requirements, Francois utilized NASA-approved open-source tools to create a centralized monitor and control dashboard for all RF test equipment. These efficiency and data collection improvements to compatibility testing will benefit all future customers of NASA's Near Space Network services, including Artemis missions, the Roman Space Telescope, and the Plankton, Aerosol, Cloud, ocean Ecosystem satellite.

Intern with NASA

JOIN THE SCAN INTERNSHIP PROJECT

Apply for the Space Communications and Navigation (SCaN) Internship Project (SIP) today!

As a SIP intern, you will complete meaningful projects, expand your NASA network, learn valuable professional development skills, and enhance space communications and navigation capabilities. Internships are available in a variety of disciplines, including engineering, computer science, education and outreach, finance, and more.

To apply, make a profile at intern.nasa.gov and search for keyword "SCaN." For more information, contact us at:

gsfc-sip-intern@mail.nasa.gov

Quantum Algorithm Development and Quantum Communications Lab Experiments

HOMETOWN: Shoreview, Minnesota

Collin Frink is a senior at the University of Wisconsin-Madison pursuing a double major in applied math, engineering, physics (AMEP), and computer science. After graduating this fall, he plans to apply to graduate programs in quantum computing. Frink enjoys soccer, listening to music, and rock climbing.

COLLIN FRINK

MENTORS: ERIKA JONES, HARRY SHAW

Collin Frink spent this summer brainstorming low-cost solutions to quantum computing problems, particularly in quantum algorithm development. Frink began his investigation of applications for low-cost quantum computing by familiarizing himself with potential implementation tools. His primary tool was Qiskit, an open-source software development kit based on Python. Frink implemented Shor's and Grover's algorithms, two training benchmarks for quantum cryptography. Once large-scale quantum computers are physically realized, Frink's research will support efforts to create low-cost implementations of quantum algorithms to speed up and further secure quantum communications, quantum key distribution, and more. Today, Frink's work supports other NASA experiments in quantum tomography, quantum compressive sensing, and quantum communications—all growing topics in NASA's exploration of efficient and novel communications solutions.

autoNGC Maneuver Planning Capability Development

HOMETOWN: Pittsburgh, Pennsylvania

Mark Hartigan received his Bachelor of Science in aeronautical and astronautical engineering from Purdue University in 2021 and is currently pursuing a Ph.D. in aerospace engineering at the Georgia Institute of Technology. His research is in spacecraft guidance, navigation, and control with a focus on cislunar navigation. When not tinkering with electronics and software, Hartigan is an avid runner and enjoys climbing, camping, and hiking whenever the Atlanta weather allows.

MARK HARTIGAN

MENTOR: NOBLE HATTEN

Mark Hartigan performed orbital and navigational analysis to optimize momentum wheel desaturation, or "dumping" momentum from the reaction wheel that controls the altitude of spacecraft, onboard Lunar Communications Relay and Navigation Systems (LCRNS) satellites. He determined the feasible orbit locations and thrust directions in which to conduct these maneuvers by running simulations in Goddard's General Mission Analysis Tool (GMAT) and Orbit Determination Toolbox (ODTBX). By analyzing how a desaturation maneuver perturbs the satellite off its intended path and affects the satellite's knowledge of its own state, Mark determined the magnitude, direction, and cadence of maneuvers to meet mission requirements. Mark worked closely with members of the LCRNS and autoNGC projects, as well as ODTBX developers, to create a strategy that met the use-case specifics and project constraints of LCRNS satellites. Mark's research and analysis will minimize disturbances to the LCRNS navigation service, allowing uninterrupted GPS-like service to NASA's future lunar missions.

Lunar Communications Software Test Development

LUCAS IZQUIERDO

MENTORS: SHAWN MCGRAW, JON VERVILLE

Lucas Izquierdo spent the summer enhancing the network simulation testbed's visualization systems. Izquierdo used Django, an open-source Python framework, to pull out and reformat the network data he needed to create front-end data visualization charts. After rigorous testing for data accuracy, he built an outline of his visualization dashboard and added a software "trigger" for data acquisition to ensure its graphs were built from up-to-date information. Izquierdo then created a polished front-end interface to improve the tool's clarity and ease-of-use, and finally integrated the visualization system into existing front-end testbed software. Izquierdo's work on network simulation will strengthen and clarify the way lunar communications data is presented, evaluated, and utilized in future missions, including the Artemis moon missions.

HOMETOWN: Bethesda, Maryland

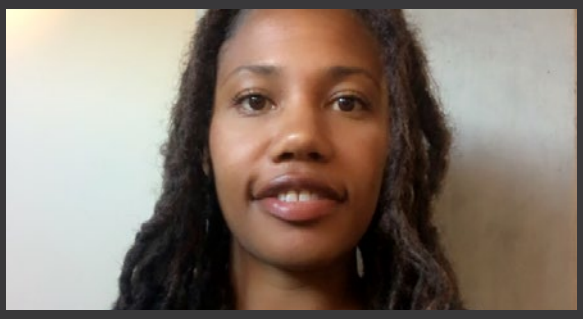
Lucas Izquierdo is a rising junior studying computer engineering at Virginia Tech. When he is not working at the Autonomous Master Prototyping lab or with the Hybrid Electric Vehicle team to build autonomous systems, Izquierdo enjoys playing video games, strumming his guitar, working on cars, and designing circuitry.

Experiment Design for the Laser Communications Relay Demonstration

ALYSSA JOHNSON

MENTORS: RICK BUTLER, DAVID HAHN, DAVE ISRAEL, WILLIAM MUSCOVICH

Alyssa Johnson supported the Laser Communications Relay Demonstration (LCRD) Experimenter program by developing tests that demonstrate user data systems for an optical communications system. Their LCRDEX-156 single-user relay demonstration experiment showcases LCRD's ability to relay user data to project ideal configurations for future experiments. Johnson created link configuration matrices that highlight high-priority links to use during initial LCRD tests. In addition, Johnson worked on additional single-user relay demonstrations, including a handover testing experiment designed to follow LCRDEX-156. Johnson's LCRD experiments further NASA's research on the benefits of an optical communications system.



HOMETOWN: Columbia, Maryland

Alyssa Johnson recently earned a Bachelor of Science in physics with a concentration in astronomy from the California State Polytechnic University, Humboldt. They will be starting at the University of California, San Diego this fall, working toward a Ph.D. in astronomy with a focus on experimental cosmology. Johnson loves being outside and especially enjoys biking, camping, hiking, and painting.

ILLUMA-T Communications and Internal Engagement

HOMETOWN: Vienna, Virginia

Katrina Lee is a rising senior at Virginia Commonwealth University Honors College studying business administration, homeland security, and emergency management. As a returning SCaN communications and technical writing intern, she is excited about continuing to promote NASA's upcoming communications efforts. Her other passions include writing and editing for her university's paper and going to concerts.

KATRINA LEE

MENTORS: KATHERINE SCHAUER, MARIAH PULVER

This summer, Katrina Lee developed a comprehensive communications plan detailing engagement events, promotional materials, and products related to the Integrated LCRD Low-Earth-Orbit User Modem and Amplifier Terminal (ILLUMA-T) launch. Lee applied her previous summer intern experience working on communications for the LCRD project—and her boundless creativity—to increase SCaN workforce interest and engagement in ILLUMA-T's 2023 launch.

In addition, Lee contributed to external communications by researching and writing blogs and social media posts for both ILLUMA-T and SIP. These promotions required her to work directly with ESC's INSPIRE office to assist in designing graphics, planning events, and creating content. Lee's work engaging and exciting the NASA community and the greater public will increase excitement about the ILLUMA-T launch and other upcoming laser communications technologies.

Network Infrastructure and Monitoring Systems

HOMETOWN: Horizon City, TX

David Martinez is about to start his junior year as an electrical engineering major at the University of Texas at El Paso. His interest in computer engineering has given him experience with computer architecture and coding microcontrollers for embedded systems. In his free time, Martinez enjoys playing video games, watching movies, and bowling.

DAVID MARTINEZ, JR.

MENTORS: MICHAEL ALVILLAR, MICHAEL KRAJEWSKI

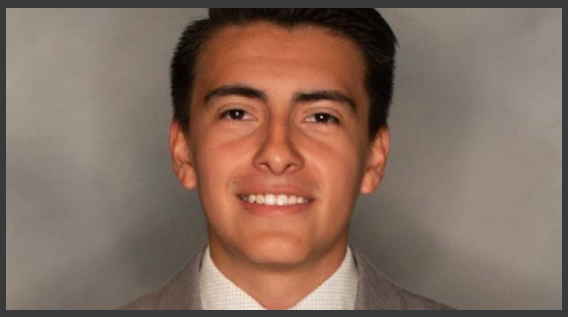
David Martinez installed two fiber nodes in the Tracking and Data Relay Satellite System (TDRSS) ground terminal. These nodes grant the Hardware Maintenance Depot access to the Operations Support local area network and the Software Maintenance and Training Facility, providing the depot with both an internet connection and testing capabilities. Martinez first worked with the networking and implementations departments for guidance on installing the nodes and presented his installation strategy to the White Sands Engineering Review Board. Upon approval, Martinez submitted the work order for installation and collaborated with implementation specialists to set up racks and install cables throughout the hardware maintenance depot. The fiber nodes Martinez installed allows hardware maintenance users to access online training and testing resources from their desk and lays the groundwork for continuous updates to a critical center resource as their data needs evolve.

Insight: Automating Security Control Assessments at the White Sands Complex

LEONARDO MUÑOZ

MENTORS: RICHARD PACHECO, SCOTT HENKLE

Leonardo Muñoz's project minimized the amount of time information systems security engineers spend performing security control assessments on computer systems prior to entering production. Muñoz began the software development process by interviewing members of the White Sands Complex's IT security department about security and automation requirements. Insight, the tool Muñoz developed, was built in HTML, Cascading Style Sheets, and JavaScript without third-party web development frameworks. Insight automates the data analysis process for completing security control assessments and gathers information metrics for detecting patterns. In addition to streamlining policy decisions and security engineers' work processes, Muñoz's work on Insight builds on the organizational strength of NASA's cybersecurity.



HOMETOWN: El Paso, Texas

Leonardo Muñoz is a senior at the University of Texas at El Paso studying computer science with a minor in mathematics. He plans on continuing his graduate studies within computer science with a focus on bioinformatics. Outside of school and work, Muñoz enjoys sports, movies, and grilling.

Quantum Lab Setup and Operation

NAVEED NAIMIPOUR

MENTOR: HALEH SAFAVI

Naveed Naimipour, an experienced Pathways intern, supported Goddard Space Flight Center's quantum laboratory this summer with equipment procurement, lab setup, experiment design, exploration of theoretical quantum concepts, and intern mentorship. Naimipour performed research based on viable quantum concepts that align with NASA and Goddard's long and short-term quantum visions and coordinated experiments with the subject matter experts. His achievements this summer include researching equipment capabilities along with simulating promising quantum concepts in MATLAB, Python, Qiskit, Amazon Braket, Lumerical, and more prior to conducting full experiments. In addition, Naimipour mentored interns exploring quantum concepts and gaining new experience in optical and quantum communications. His research and mentorship ensure that Goddard is a leader in the next generation of space communications.

HOMETOWN: Chicago, Illinois

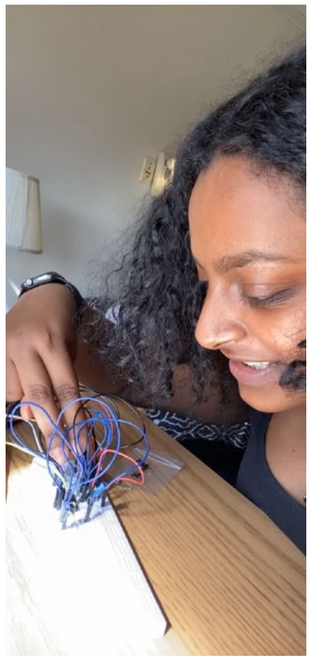
Naveed Naimipour is pursuing a doctorate in electrical engineering at the University of Illinois Chicago, where he works in the Waveform Optimization Laboratory led by Dr. Mojtaba Soltanalian. A veteran of the NASA intern program, Naimipour joined the Pathways program in 2018 and helped create the quantum communications lab at Goddard, in addition to performing a multitude of machine learning work in signal detection, signal security, and quantum compressive sensing.

Rebekah Abraham:
Lighting the Way to Laser Communications

By Jessica Hinkle - Originally published on esc.gsfc.nasa.gov/news

Rebekah Abraham spent the last year exploring new places and studying new technologies to help her achieve her goals. From a study abroad program in Dubai, to independent research on quantum computing, Abraham is excited to continue expanding her knowledge and interests this summer with a NASA internship.

Abraham is a member of the Space Communications and Navigation (SCaN) Internship Project (SIP) at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Her summer has been spent on-site at Goddard working closely with the Integrated LCRD Low-Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T) integration and testing team.



ILLUMA-T, targeted to launch in 2023, can provide astronauts and experiments on the International Space Station with enhanced data capabilities. It will communicate with NASA's Laser Communications Relay Demonstration (LCRD), completing an end-to-end optical communications system. ILLUMA-T will send information to LCRD via optical links; LCRD will then relay the data to two optical ground stations in Haleakala, Hawaii and Table Mountain, California.

To support ILLUMA-T, Abraham is working with another SIP intern to create payload and ground system user manuals, as well as compiling a program for operator certification for the payload. These items will help operations run smoothly for the first six months before beginning the 2-year experimentation phase.

"It all needs to get written down, and as they get ready for operations, making sure that the knowledge is transferred on to other people. It will also help optical communications operations in the future." Abraham said.

Growing up in a family that is more medically oriented, Abraham is focused on engineering and finding her own path. She plans to use her internship this summer to gain direction and clarity for her future and working closely with her mentor Trisha Randazzo has had a huge impact. SIP pairs interns with mentors at NASA who provide direction on interns' projects, share valuable knowledge, support their growth, and help them to reach their goals.

Currently, Abraham is entering her senior year at Loyola University Maryland in Baltimore, Maryland. She hopes to graduate in spring 2023 with a double concentration in computer and electrical engineering. Her non-engineering coursework at Loyola has been beneficial to her current role with ILLUMA-T too. She utilized writing and technical writing skills learned in class and will take many new skills learned during her internship back to the classroom in the fall.

"Writing for my engineering classes and writing for my English classes are not the same, and those are both different from technical documentation writing," said Abraham. "But improving my writing skills across multiple mediums will help, especially for my capstone engineering design project during my senior year."

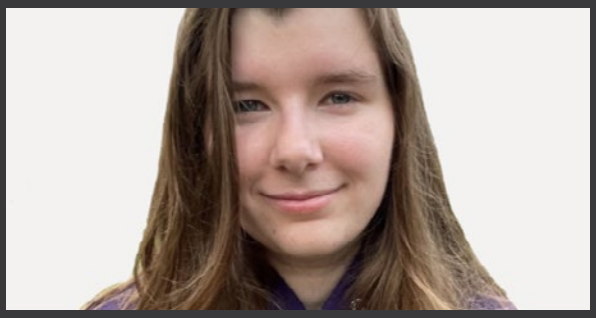
The previous academic year was a banner one for Abraham. In the fall of 2021, she studied abroad in Dubai at American University in Dubai.

"It was probably one of the best experiences of my life," said Abraham. "It's one of those things that if I start talking about it, I never stop."

In spring of 2022, she participated in independent research on quantum computing with her advisor, with a focus on intermediate gates.

Aside from her internship, Abraham works as a Greyhound Ambassador and Intern for Undergraduate Admissions for her school, giving tours to prospective students. She enjoys traveling, hiking, and listening to true crime podcasts. She also recently took up skateboarding during the COVID-19 pandemic, using her new skills cruising through her neighborhood and at her local skate park.

Merging and Analysis of Multi-Sensor Imagery over Polar Regions



HOMETOWN: Chicago, Illinois

Olivia Pierpaoli is in her final year at the University of Washington where she studies atmospheric science. She plans to enter a Ph.D. program in atmospheric science next year. She has participated in two previous NASA internships at Ames Research Center and the Goddard Institute for Space Studies. In her free time, Pierpaoli enjoys hiking, skiing, and rock climbing.

OLIVIA PIERPAOLI

MENTOR: MATTEO OTTAVIANI

For her summer project, Olivia Pierpaoli merged and co-located data from multiple satellite sensors. The merged files will be used in algorithms retrieving data on snow properties. Pierpaoli began by using a preexisting processing script to merge and co-locate passive imaging instruments, including POLarization and Directionality of the Earth's Reflectances (POLDER), Moderate Resolution Imaging Spectroradiometer (MODIS), and Cloud-Aerosol LIDAR and Infrared Pathfinder Satellite Observations (CALIPSO). Once the files were processed, Pierpaoli drew samples from Greenland's snow and analyzed its polarization properties. After ensuring that no clouds were present in the data, Pierpaoli analyzed snow properties such as grain shape, size, and impurities. Pierpaoli's research on snow properties in polar regions will help climate scientists better understand of the mechanics of Earth's climate and predict its future evolution.

New Optical Navigation Results Using Historical MESSENGER Data

HOMETOWN: Scotch Plains, New Jersey

Vaishnavi Ramanan is preparing to pursue her master's degree in aerospace engineering from the Georgia Institute of Technology, where she previously graduated with a bachelor's degree in aerospace engineering. Her main scientific interests include Earth-centered satellite technology, remote sensing, and trajectory and mission design. In her free time, Ramanan enjoys mixing and listening to music, crafting with paper and clay, and laying out in the sun.

VAISHNAVI RAMANAN

MENTOR: MIKE SHOEMAKER

NASA's MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) was the first spacecraft to orbit Mercury, revealing new information about the geological and chemical composition of the planet and delivering over 200,000 visible and near-infrared orbital images. To improve NASA's optical navigation capabilities, Vaishnavi Ramanan parsed historical MESSENGER mission images and generated landmarks, created a Concept of Operations document that describes MESSENGER's system characteristics based on currently available data, and wrote a paper for submission to Georgia Tech's Space Exploration Analysis Laboratory's (SEAL) 3rd Space Imaging Workshop. Ramanan generated and identified landmarks for multiple mission phases using Python scripts to sort through images of Mercury's surface, output landmark coordinates, interpolate Digital Terrain Model (DTM) information based on the coordinates, and convert the DTM data into a usable format. NASA's preexisting astrodynamics libraries (MONTE) and camera calibration and optical navigation tools (GIANT) used this coordinate data to produce navigation solutions for each mission phase. Ramanan's project represents an innovative use of existing planetary mission data to build navigation improvements with MONTE and GIANT, refining Goddard's optical navigation capabilities and setting a baseline for planetary navigation results that will inform future autonomous flight software.

Keeping the Lights On: System Administration at the White Sands Complex

FERNANDO G. SALINAS, JR.

MENTOR: MICHAEL VILLA

Fernando Salinas, Jr. migrated the functions of the White Sands Complex's virtual satellite plotting system into a physical server for long-term storage. Salinas first worked with the manufacturer to communicate the server's exact needs and specifications. Once the server arrived, Salinas moved the server to a test rack, built software in accordance with NASA's security standards, and installed the necessary programs to ensure the server is user functional. Finally, Salinas installed the server into its permanent home, ensuring that White Sands can safely and properly store vital plotting and telemetry data for its missions.

HOMETOWN: Las Cruces, New Mexico

Fernando Salinas is graduating with a Bachelor of Science in computer science from New Mexico State University in December 2022. This is his second year with SIP. During his free time, Salinas enjoys traveling, going to concerts, and trying out new foods from different cultures.

Entangled Photon Interaction in Nonlinear Crystals

NICK SEBASCO

MENTORS: NOAH COWPER, HARRY SHAW

This summer, Nick Sebasco explored the process of entangling photons in nonlinear crystals using spontaneous parametric down-conversion, an optical process that converts one high-energy "pump" photon into a pair of lower energy "signal" and "idler" photons. Sebasco began by researching modern spontaneous parametric down-conversions to understand fundamental concepts and applications of the process. Next, he carried out photonic entanglement experiments using the quED entanglement demonstrator — a physics kit for exploring quantum mechanics — in Goddard's quantum lab. Sebasco's experiments included a verification of CHSH inequality, evidence that certain consequences of quantum entanglement are not influenced by immediate surroundings or the definiteness of measurements that have not been performed, and the Hong-Ou-Mandel dip experiment, in which identical input photons perfectly overlap and become indistinguishable from each other. Finally, Sebasco ran experiments with a Franson interferometer — a means of measuring photon-pair arrival-time correlations with applications in photonic entanglement, quantum networking, and quantum communications. Sebasco recorded his results in a user manual, including information on theoretical aspects of the device. Generating entangled photons is a crucial component of quantum communications, and Sebasco's work contributes to NASA's state-of-the-art communications protocol for securely transmitting scientific data in the age of quantum computing.

HOMETOWN: Memphis, Tennessee

Nick Sebasco is a graduate student at Michigan State University studying electrical and computer engineering. He developed a novel graph-based image segmentation algorithm while completing his master's degree in mathematics. In his free time, Sebasco loves programming and playing sports.

SIP Interns at Work

This summer, the SCaN Internship Project was a hybrid format, with interns participating both virtually and in-person. See where our interns worked and get a sneak peek into where all their projects and innovations were completed!

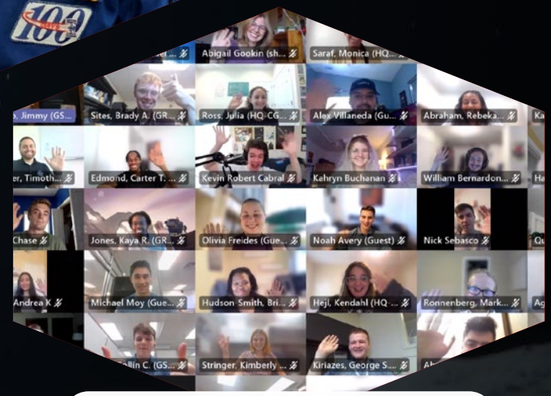
SIP interns Rebekah Abraham, M... Thomas Francois, Kim Stringer, and A... Dumka joined other on-site students for a tour of Goddard, including the James Webb Space Telescope studio.

SIP interns celebrated the release of the first images from the James Webb Space Telescope.

SIP intern Nishanth Anand explains a quantum demonstration lab apparatus to SCaN leadership and STEM Fellows.

2021 & 2022 summer intern Carter Edmond met INSPIRE Office Chief Dan Tani at the 2022 SGx Space Generation youth leaders' conference in Washington, DC.

Lucas Izquierdo celebrates finishing his SIP intern video recording session.



Students from all three SIP centers convened to meet one another, as well as SCaN leaders from across the agency.

Simulation of the Doppler Effect for NASA Satellite Communications

HOMETOWN: Prince George's County, Maryland

Nomel Simmons is a graduating senior at Morgan State University studying electrical engineering. Prior to this internship, Simmons interned with NASA's Goddard Space Flight Center in Spring 2020, where she assisted with the Advanced Telescope for High ENergy Astrophysics mission. Outside of aerospace, Simmons enjoys working on hardware equipment, especially breadboarding, and taking advantage of Maryland's spring and autumn weather to spend time outdoors with friends.

NOMEL SIMMONS

MENTOR: ROCIO RIVERA

Nomel Simmons' summer project consisted of researching and developing a program that remotely and automatically controls an electrical waveform generator to simulate velocity effects on satellite communications signals. Additionally, Simmons simulated distortions to the satellite signal during its transmission between the ground station and the satellite. Simmons first performed extensive research on arbitrary waveform generators: she studied the user manual, contacted the waveform generator vendor, and researched cost-effective programming languages and software. The result of her work was a Python or MATLAB script that remotely and automatically controls the electrical waveform generator to simulate a signal changed or distorted during its transmission as well as the Doppler effect — a change in the frequency of waves as the wave source and its observer move toward or away from one another. Simmons also used a NASA modem to demonstrate the impact of signal distortions on the reception of satellite signals and the Doppler effect. The program Simmons created will serve as a foundation that NASA engineers can build upon to test modems with higher fidelity signal distortions.

Mechanical Support for ILLUMA-T Integration and Testing

HOMETOWN: Cheverly, Maryland

Kimberly Stringer is a rising senior at the Georgia Institute of Technology studying mechanical engineering and philosophy. This is her third internship with NASA and her second summer with SIP. In the long term, she hopes to combine her two passions – engineering and philosophy – to find ethical solutions to real problems. Outside of work, Stringer enjoys running, writing, backpacking, and learning to play the guitar.

KIMBERLY STRINGER

MENTOR: TED GOODHUE

Kimberly Stringer contributed to the ILLUMA-T payload with data research and hands-on mechanical work with space hardware. Stringer first shadowed the mechanical team and examined low-risk mechanical hardware slated for launch in 2023. After the team finished the final stages of testing on the qualification sled — a final prototype before building the payload that will travel to space — Stringer intimately studied the overall structure of the project and engineering diagrams. Stringer used this knowledge in various information technology and mechanical responsibilities, including cataloging equipment, crafting reports on payload mass, and being on-call for the mechanical team! Stringer's work this summer helps the ILLUMA-T team document the precise mass and location of each component of the ILLUMA-T payload, ensuring that ILLUMA-T, when launched, can demonstrate the benefits of laser communications to NASA missions.

Preventative Maintenance Trend Analysis

MATTHEW TOMLINSON

MENTORS: CARLOS TORO, FERDINAND TAUSCHECK

Even well-designed equipment can be subject to periodic hardware and software issues. This summer, Matthew Tomlinson performed preventative maintenance on antenna equipment at the White Sands Complex to ensure that potential data relay errors are proactively addressed and prevented. Tomlinson digitized over three years of preventative maintenance data and used Microsoft Excel to analyze and plot historical trends in equipment failure. After building his own data charts, Tomlinson then compared his data to previous work order requests to predict when and where antenna equipment might fail over time. His project dramatically increases the efficiency of NASA's preventative maintenance records and performance, ensuring greater accuracy in predictive software and hardware malfunction diagnoses.

HOMETOWN: El Paso, Texas

Matthew Tomlinson is a junior at the University of Texas at El Paso majoring in electrical engineering with a concentration in computer engineering. Upon graduation, he plans to earn his master's degree in electrical engineering. Outside of his studies, Tomlinson enjoys lifting weights, working on his car, and improving his Land Search and Rescue program.

Compliant Flight Navigation Software for Optical Navigation Tools

JONATHAN TRAN

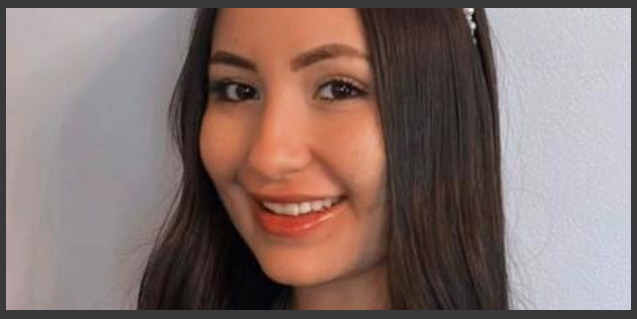
MENTOR: NOBLE HATTEN

This summer Jonathan Tran modified the C++ version of the Goddard Image Analysis and Navigation Tool (cGIANT), an optical navigation software, to be compliant with NASA's flight software guidelines. Tran began by using debugging and static analysis tools to detect guideline deviations and formulate a plan of action. In particular, he eliminated data management software routines and dynamic memory allocation that might fail to free allocated memory when it is no longer needed and risk slow-down or program failure. Tran replaced these processes with safer static memory allocation, then performed tests to ensure that the flight software still functioned correctly. His work provides a buildable model for compliance updates and ensures that cGIANT meets NASA's safety and efficiency standards.

HOMETOWN: Portland, Oregon

Jonathan Tran is a master's student at Cornell University studying computer science. He is studying auto-vectorization and has a strong interest in programming languages and compilers. Outside of work, Tran enjoys playing tennis and competing in trivia games.

State-of-Health for Tracking and Data Relay System Digital Signal Distribution



HOMETOWN: El Paso, Texas

Andrea Karina Vargas is an undergraduate senior at the University of Texas at El Paso (UTEP) pursuing a degree in mechanical engineering with minors in computer engineering and mathematics. She plans to enter a master's program in mechanical engineering after her graduation in the spring of 2023. During her junior year at UTEP's aerospace center, she researched additive manufacturing in space using robotics technology. She also loves dancing, trying new coffee shops, and spoiling her dog, Ollie.

ANDREA KARINA VARGAS

MENTOR: ALEXA MORTENSON

The goal of Andrea Karina Vargas' project was to determine the probability of failure—and uncover future solutions—within components of the Tracking and Data Relay Satellite's (TDRS) digital signal distribution system. In order to make these determinations, Vargas needed to decompose or segregate components of the system's technical interconnections. She began by creating taxonomy diagrams in Microsoft Visio to visualize the signal distribution system's design. She then reviewed discrepancy reports using Maximo to identify trends in failures or potentially overlooked corrective actions. Vargas combined Maximo and comprehensive discrepancy system software to determine the root cause of previous system failures and identify probable future discrepancies. Her work will ensure that the TDRS antenna's digital systems continue to successfully connect mission critical ground systems to users like the International Space Station.

Post-Mission Performance Analysis Software for the Near Space Network

HOMETOWN: Houston, Texas

Andre Williams recently earned his master's in computer science with a focus in data science and artificial intelligence from Florida Atlantic University. He hopes to begin a Ph.D. in computer science in spring 2023. Prior to his internship, Williams served as a working professional in the railroad industry where he designed signal systems for freight and passenger trains. Outside of his work, Williams is a retro shoe collector, an avid runner, and artificial intelligence enthusiast.

ANDRE WILLIAMS

MENTOR: DEREK OTERMAT

The old saying that "a picture is worth a thousand words" applies to data, too. Andre Williams spent his summer developing data visualization software to provide detailed information about how the Near Space Network performed during human spaceflight, launch vehicle, and robotics/science missions. Williams compiled and processed text logs from previous Near Space Network missions and processed the logs into data frames—table-like data structures that provide a shorter and often more functional style for several popular coding languages. Then, Williams translated that data into an easy-to-read graph detailing how various equipment performed during these missions. These visualization graphs were then merged into a single, sleek dashboard that gives customers a wide performance analysis overview of the mission being visualized. The dashboard Williams created will save NASA both time and manpower, as thousands of lines of log files about network performance are converted into an easy-to-read series of graphs that allow users to pinpoint network success or failure in a matter of seconds.

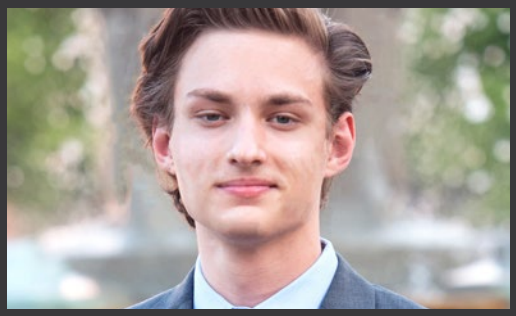
ILLUMA-T Payload Simulator

MITCHELL ZAKOCS

MENTOR: TRISHA RANDAZZO

Michell Zakocs created a software simulator that supports basic functionality for the ILLUMA-T payload while simultaneously making it easier to perform operator training and system regression testing. Zakocs began his project by building a planning document to map the overall design and structure of the software. After building a map of projected software subsystems, performing research, and reviewing early drafts, Zakocs wrote the simulator in Python, rigorously tested his code, and reviewed the software with the ILLUMA-T operations team to ensure its reliability and usability prior to the payload launch. The resulting software ensures that ILLUMA-T operators can practice a full catalogue of commands, telemetry monitoring, and payload states without any risk to the actual hardware.

Zakocs' work this summer ensures that the operations team is well-trained in mission procedures in a safe, low-cost environment. The accessible, modular Python framework Zakocs built also lays the groundwork for future optical software simulators as Goddard's optical network expands.



HOMETOWN: Phoenix, Arizona

Mitchell Zakocs is a rising sophomore at Arizona State University (ASU) studying computer science with a special interest in computer security. In addition to his studies, Zakocs writes software for the Sun Devil Satellite Lab, the Laboratory of Security Engineering for Future Computing, Shellphish, and the ASU Hacking Club. Zakocs also enjoys traveling, biking, and competing in Capture-the-Flag computer security challenges in his free time.

Leading By Example

THE INVALUABLE CONTRIBUTIONS OF 2022 SIP MENTORS

Empowering Goddard's 54 SIP interns with the technical and logistical support they need to successfully complete their summer projects is an enormous task. It takes commitment from the entire SCaN and ESC community to ensure a successful internship.

Below is a list of mentors and seasoned Pathways students who formally participated in SIP for summer 2022. SCaN and ESC would like to thank them, as well as every NASA employee who lent their time and talents to nurturing this year's crop of young innovators and explorers.

Jimmy Acevedo
Serhat Altunc
Michael Alvillar
Jake Barnes
Frank Bauer
Brandon Bethune
George Bussey
Rick Butler
Tommy Cao
Armen Caroglanian
Noah Cowper
Sarah Dangelo
Ted Goodhue
David Hahn
Noble Hatten
Scott Henkle
Alan Hylton
Dave Israel
Erika Jones
Mike Krajewski
Jonathan Mahaffey
Shawn McGraw
Alexa Mortenson
William Muscovich
Naveed Naimipour
Derek Otermat

Matteo Ottaviani
Richard Pacheco
Korine Powers
Mariah Pulver
Trisha Randazzo
Elana Resnick (Gilman School)
Jose Rivera
Rocio Rivera
Haleh Safavi
Katherine Schauer
David Schuchman
Paul Segars
Harry Shaw
Mike Shoemaker
Steve Sirotzky
Eric Sletten
Elizabeth Smith
Zac Smith
Steve Stochaj (NMSU)
Ferdinand Tauscheck
Carlos Toro
Nicole Torres
Jon Verville
Michael Villa
Timothy Walker
Tyler Williams

Additional Summer Projects

We'd like to acknowledge a few interns who were not able to join us for a typical ten-week summer session but completed valuable work nonetheless! A SIP internship enables students to grow both professionally and personally; flexibility in the program allows students to take on multiple opportunities and expand their knowledge.

Adrian Amado worked part-time at the White Sands Complex this summer under the direction of mentor Jose Rivera. His project was to provide facility development and maintenance guidance for ACCESS's space relay. Amado also participated in SIP in spring 2022 and will return for the autumn session.

Brittney Hudson-Smith, following the guidance of mentors Jimmy Acevedo and Korine Powers, supported the INSPIRE office's education and outreach team for part of the summer. Using her experience as a teacher, she developed new educational materials and researched ways to improve our current outreach portfolio.

Eight-time SIP intern **Thomas Montano**, with the direction of mentor George Bussey, continued his work on ray tracing for radio propagation modeling as part of designing the communication infrastructure for lunar landing sites. He transitioned to a full-time civil servant position at Goddard midway through the summer. Congratulations!

Message from Bob Menrad

Associate Director of Flight Projects for Exploration and Space Communications NASA's Goddard Space Flight Center — Greenbelt, Maryland

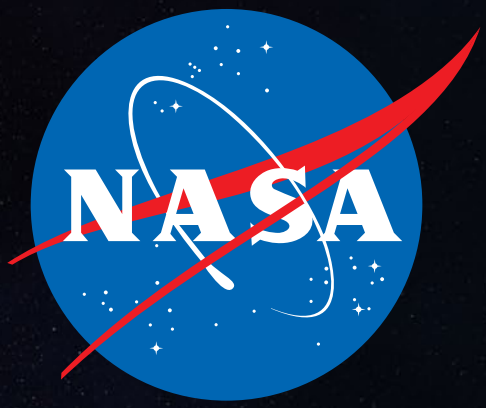
Congratulations to this year's summer intern cohort! ESC takes great pride in executing an intern program that advances SCaN's vision to develop the next generation of space explorers while embodying the standard of excellence that is Goddard Space Flight Center. The entire Communications and Navigation Community is extremely proud of the results each intern produced during this 10-week program. Guided by dedicated mentors who volunteer their time and world-class knowledge, each intern has brought their own unique skillset to this division and advanced our community's work on projects like quantum communications, Delay/ Disruption Tolerant Networking, integration and testing, and so much more. This year was the first-ever hybrid NASA internship session, and each intern showcased their adaptability, dedication, and agility to overcome the challenges associated with producing results in a unique environment. To the students: thank you for joining us this summer and contributing to our mission. We trust that you are wiser because of your mentors and a more mature practitioner thanks to those you collaborated with. We hope you are leaving with a new-found confidence that arises from seeing your amazing capacity to meet the challenges associated with exploring space. Well done!

A Thank You to Our Partners

The SCaN Internship Project would like to acknowledge the partners who support our students, our program, and our mission. We appreciate and value the generosity of our partners, who help make internship opportunities possible and enable the next generation of STEM students. They provide essential funding, knowledgeable and insightful project direction, and continued mentorship — their support is invaluable!

This summer, we thank:

Amateur Radio on the International Space Station
Gilman School
National Reconnaissance Office
National Space Club and Foundation Scholars Program
New Mexico State University
Oklahoma State University Grant Program
University of Texas at El Paso



SPACE COMMUNICATIONS AND NAVIGATION PROGRAM OFFICE

GODDARD SPACE FLIGHT CENTER

National Aeronautics and Space Administration

Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771
www.nasa.gov/goddard

www.nasa.gov

NP-2022-7-830-GSFC