

National Aeronautics and Space Administration



# COMM & NAV 2023 FY ANNUAL REPORT

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# MESSAGE FROM THE ASSOCIATE DIRECTOR

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Another year has passed where NASA Goddard Space Flight Center's Communications and Navigation Community has yielded numerous accomplishments that are advancing the agency's capabilities. I want to thank the entire community for its unwavering dedication. Now that we have embraced the in-person work culture again, it has been wonderful strengthening bonds with familiar faces in the office.

Over the fiscal year (FY), NASA's Near Space Network flawlessly supported 24 launches in addition to the many satellites and spacecraft supported by the network each day. One of these launches included our seamless support to the Artemis I mission, which was a show of extensive collaboration between the Near Space Network, NASCOM, Flight Dynamics Facility, Search and Rescue (SAR) office, and the entire agency. The network also

enabled essential commercial crew and cargo launches to the International Space Station, supported science mission launches like SuperBIT, and upgraded the network for international partner rockets like the JAXA H-IIA. Our work impacts the NASA user community, who rely on our robust network to bring critical data back to Earth for investigation and discovery.

FY23 was also an outstanding year for optical and quantum communications. The Orion Artemis II Optical Communications System (O2O) and the Integrated LCRD Low Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T) were delivered to NASA's Kennedy Space Center for launch preparations. The Laser Communications Relay Demonstration (LCRD) conducted over 300 experiment configurations, helping the aerospace community refine optical communications. The TeraByte InfraRed Delivery (TBIRD) payload hit a world record – downlinking 4.8 terabytes of error-free data at 200 gigabits-per-second in under five minutes! Lastly, the quantum team communications teams set up state-of-the-art labs and are regularly running groundbreaking experiments.

In addition to making strides within the walls of NASA, our teams regularly engaged with the broader aerospace community, including industry, academia, and other government agencies. Leveraging new engagement methods and forward-thinking strategies, we are embracing the growing aerospace industry, producing multiple solicitations, and hosting impactful and result-oriented conversations.

This report details the Goddard Communications and Navigation Community's commitment to technology and capability advancement and showcases how we enable the vision of the Space Communications and Navigation (SCaN) program office at NASA Headquarters.

A stylized, handwritten signature in blue ink, consisting of a large 'R' and a long, sweeping horizontal line.

Robert J. Menrad  
Associate Director of Flight Projects,  
Exploration and Space Communications

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# EXPLORATION AND SPACE COMMUNICATIONS

## OVERVIEW

The Exploration and Space Communications (ESC) projects division provides communications and navigation services as well as technical expertise to missions within two million kilometers of Earth. The workforce is dedicated to developing new technologies and embracing the capabilities of the aerospace industry and other agencies.

Our community develops innovative communications and navigation solutions for the agency's major initiatives, including the Artemis missions to the Moon, the endeavor to place humans on Mars, and our continuous investigation into the universe.

## EXECUTIVE LEADERSHIP TEAM

Associate Director:  
**Bob Menrad**

Deputy Program Manager/  
Strategic Initiatives:  
**La Vida Cooper**

Deputy Program Manager/Execution:  
**Vir Thanvi**

Deputy Program Manager/Implementation:  
**Glenn Jackson**

## MISSION STATEMENT

As a national resource, ESC enables human and robotic endeavors in space by providing innovative and mission-effective communications, navigation, and exploration solutions to a large community of diverse users.

## VISION STATEMENT

We are collaborative leaders extending the reach of humanity's quest for discovery and passion for knowledge as sought-out experts worldwide and trusted providers of innovative exploration, communications, and navigation solutions.

# ESC BUDGET AND WORKFORCE

## BUDGET PROFILE FY23 (DIRECT & REIMBURSABLE)





## NEAR SPACE NETWORK PROJECT

### LEADS

Project Manager: **Kurt Lindstrom**  
 Deputy Project Manager: **Carrie White**  
 Deputy Project Manager/Technical: **Brandon Bethune**  
 Deputy Project Manager/Resources: **Cristy Wilson**  
 Financial Management Specialist: **Celina Hanewich**

The Near Space Network delivers critical communications and navigation services to missions observing the Earth, studying the Sun, and exploring the Moon and beyond. Spacecraft within 2 million kilometers of Earth can rely on the network's space relay fleet and ground system antennas to get critical data back to Earth. The network is a one-stop-shop, connecting robotic, technology, and human spaceflight missions to either government or commercial assets from the launchpad to through their orbiting lifecycles.

**24** LAUNCHES SUPPORTED

**2.2 MILLION** DIRECT-TO-EARTH MINUTES SUPPORTED

**9.6 MILLION** RELAY MINUTES SUPPORTED

### NEAR SPACE NETWORK SUPPORTED LAUNCHES IN FY23:

ATLAS V/SES 20-21

SPACEX CREW-5

CYGNUS NG-18

ATLAS V / JPSS-2

ARTEMIS I

TEAM MILES

SPACE X CRS-26

PETITSAT / SPACEX CRS-25

SOYUZ 69S

SOYUZ 70S

SPACEX CREW-6

SPACEX CRS-27

SPB TEST / SUPERBIT

SPACEX STARSHIP ORBITAL DEMO

SPB TEST / EUSO SPB2

SPACEX AXIOM-2

SHIPE

VULCAN

SPACEX CRS-28

DELTA IV / NROL-68

CYGNUS NG-19

SPACEX CREW-7

H-IIA / XRISM

ATLAS V / SILENT BARKER

### FY23 HIGHLIGHTS

- The Near Space Network seamlessly supported the historic Artemis I mission during its launch, early orbit, re-entry, and splashdown phases.
- The Near Space Network released a Request for Proposal (RFP) seeking commercial relay and direct-to-Earth service providers. This RFP provided an acquisition of services to support multiple science and exploration missions across the network's portfolio.
- The network hosted leadership from the Japan Aerospace Exploration Agency (JAXA) and installed routers in the Near Space Operations Control Center (NSOCC) to support to the H-IIA rocket launch, which launched the X-Ray Imaging and Spectroscopy Mission (XRISM).
- The network hosted the German Aerospace Center and discussed the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO), an operational mission consisting of two satellites that receive services from our network. This is another example of the network's international collaboration efforts.
- The Near Space Network hosted Artemis team members from across the agency for a Lunar Technical Interchange Meeting. During the meeting they covered topics like LunaNet, spectrum planning, requirements, and future Artemis mission needs.





# COMMERCIALIZATION, INNOVATION, AND SYNERGIES OFFICE

## LEADS

Chief: **Neal Barthelme**

Deputy Chief: **Dr. Ruma Das**

Senior Resources Analyst: **Melissa Gross**

The Commercialization, Innovation, and Synergies (CIS) office is dedicated to increasing commercial provider base for the Near Space Network while also investigating external technologies and capabilities that complement SCan's goals. The office advances the communications and navigation community's partnerships by fostering relationships and hosting events with mission teams, industry, academia, and other government agencies. Additionally, the office has a small team of exploration experts advancing capabilities in areas like lunar landing sites, flight software, and avionics.

1,000+	COMPANIES ENGAGED
28	SERVICE INQUIRIES RECEIVED THROUGH MISSION ENGAGEMENT WORKING GROUP
17	LAUNCH PAD SESSIONS HELD
17	UNIQUE OTHER GOVERNMENT AGENCY ENGAGEMENTS ACROSS US AND INTERNATIONAL AGENCIES
5	INDUSTRY ENGAGEMENT OUTREACH EVENTS
4	SOLICITATIONS EXECUTED
3	CONNECTION SESSIONS HELD

## FY23 HIGHLIGHTS

- The CIS industry team successfully launched its newest engagement series: Launch Pad, which enables a consistent pipeline of industry interaction and enhances NASA's knowledge of current commercial capabilities, emerging trends, and partnership opportunities.
- The CIS mission engagement team was critical in assessing and funneling 28 mission service requests into the Near Space Network.
- CIS led the development, release, and execution of NASA's Broad Agency Announcement II NextSTEP Appendix L soliciting studies on Wideband Satellite Communications, Phased Array Ground Systems, or Constellation Topology Analysis. Four companies were selected.
- The CIS team published two Requests for Information. One to passively track Artemis I, and the other on optical ground terminal demonstrations. The team's forward-thinking approach earned them an Opportunities Captured Robert H. Goddard award.
- The Mission Engagement team created a new process to maintain up to date mission messaging about the Near Space Network's Menu of Services.
- Exploration Systems team assisted major agency strides in Artemis lunar architecture and asset development, science and utilization definition, and vehicle/mobility partner insight. This included coordinating agreements for the Lunar Terrain Vehicle, assessing human safety factors, and delivering Core Flight Draco-rc4 Software to the Gateway program.



# ACCESS

## ADVANCED COMMUNICATIONS CAPABILITIES FOR EXPLORATION AND SCIENCE SYSTEMS PROJECT

### LEADS

Project Manager (Acting): **Vir Thanvi**

Deputy Project Manager: **Vacant**

Deputy Project Manager/Operations: **Richard Von Wolff**

Deputy Project Manager/Resources: **Michelle Hamilton**

The Advanced Communications Capabilities for Exploration and Science Systems (ACCESS) project ensures successful operation and maintenance of the government systems within NASA's Near Space Network. The ACCESS team also advances its capabilities by researching and applying new communications solutions for the network, including low-cost optical ground stations and quantum networking.

**128,184**

SPACE RELAY SERVICE EVENTS  
OVER 160,002 HOURS

**19,991**

DIRECT-TO-EARTH SERVICE  
EVENTS OVER 14,042 HOURS



**99.96%**  
SR PROFICIENCY

**99.85%**  
DTE PROFICIENCY

### FY23 HIGHLIGHTS

- The ACCESS project completed the Preliminary Design Review for Lunar and Lagrange direct-to-Earth network enhancements. These upgrades will support lunar-based mission such as Gateway and Roman Space Telescope.
- ACCESS passed all four Operational Readiness Reviews for the NSN Initiative for Ka-band Advancement (NIKA) antennas. Now, the tri-band stations are operational and can support current and future spacecraft with high-rate downlink services.
- ACCESS completed the System Requirements Review for Artemis II emergency communications network enhancements. This effort included prototyping and automating a relay satellite capability to reduce the amount of time required to transition Artemis II support from normal to emergency services.
- The ACCESS team finalized multiple upgrades to the White Sands Complex, including valve pit replacements, utility circuit breaker retrofits, and roof replacements.
- ACCESS executed the final passivation and deactivation for TDRS-9 after providing NASA missions with 30 years of communications services and well exceeding its 15-year planned mission life.





# SEARCH AND RESCUE OFFICE

## LEADS

Chief: **Lisa Mazzuca**

Deputy Chief: **Tony Foster**

Mission Manager of National Affairs: **Cody Kelly**

Senior Resources Analyst: **Melissa Gross**

NASA's Search and Rescue office develops the technologies needed to rescue explorers in distress – both on Earth and in space. For over 40 years, NASA has provided technical expertise to the Cospas-Sarsat program, the international satellite-aided search and rescue effort. The NASA Search and Rescue office designs and tests Cospas-Sarsat's 406 MHz distress beacons and its supporting flight and ground systems.

Once the beacons are activated, they send signals to satellites in space, which then relay the distress signals to ground stations. The network uses these signals to pinpoint the user's location and then sends it to first responders, who initiate rescue operations. These beacons enable explorers with a sense of safety as they venture out on land, air, or seas.

Additionally, the office investigates technology innovations, develops locator beacons for Artemis astronauts, conducts safety studies, enhances aircraft safety, supports human space flight missions like the Commercial Crew Program, and envisions search and rescue capabilities on the Moon.



## SAR SAVES IN FY23

## FY23 HIGHLIGHTS

- Members of the Search and Rescue (SAR) office supported the Artemis I splashdown from the USS PORTLAND. Using the Search & Rescue Intelligence Terminal (SAINT) application and location beacons, NASA was able to pinpoint the capsule's exact location and begin recovery operations in the Pacific Ocean. SAINT will support the upcoming Artemis II crewed mission.
- SAR attended the 4th Annual International Humans in Space Summit in Australia where Office Chief Lisa Mazzuca and Cody Kelly presented the NASA LunaSAR concept of operations as part of the Distinguished Speaker Series.
- In preparation for the first crewed Boeing Crew Space Transportation (CST)-100 Starliner launch, the SAR office worked with NASA's Flight Operations Directorate and the Commercial Crew Program to coordinate NOAA and NASA System Use Agreements for effective SAR data distribution for Boeing CST-100 flights.
- The SAR team received Artemis II Underway Recovery Test (URT) – 10 accolades for flexibility in capsule tracking and situational tool development in real-time to support nighttime and inclement weather operations. SAR's accomplishments will ensure NASA recovery teams can track Artemis II astronauts when they return from the Moon.





# TECHNOLOGY ENTERPRISE AND MISSION PATHFINDER OFFICE

## LEADS

Chief (Acting): **Kendall Mauldin**

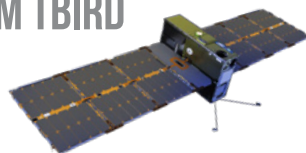
Deputy Chief: **Brad Hill**

Financial Management Specialist: **Benjamin Hall**

The Technology Enterprise and Mission Pathfinder Office (TEMPO) expands the bounds of communications and navigation capabilities by enabling innovative technology development. The team leads concept studies, identifies capability gaps, oversees technology infusion, coordinates and executes experiments, and applies aggressive industry methods to deliver results. TEMPO strives to be the innovation engine that turns the most promising communications and navigations concepts into the next generation of NASA mission successes.

**300+** EXPERIMENT CONFIGURATIONS ON LCRD

**4.8** TERABYTES DOWNLINKED FROM TBIRD



## FY23 HIGHLIGHTS

- The TeraByte InfraRed Delivery (TBIRD) payload downlinked 4.8 terabytes of data in a less than 5-minute pass. This is the highest data rate ever achieved by laser communications technology.
- The Laser Communications Relay Demonstration (LCRD) Experimenters Program conducted over 300+ experiment configurations, including relay capabilities, optometrics, adaptive optics, etc.
- The delay/disruption tolerant networking (DTN) team passed their preliminary design review. DTN enables a store and forward capability along the data path and ensures data reaches its destination.
- The Lunar GNSS Receiver Experiment (LuGRE) hardware and software was delivered to Firefly Aerospace. LuGRE is a part of "Blue Ghost" lunar lander and will investigate whether signals from two GNSS constellations can provide precise navigation on the Moon.
- The TEMPO team conducted multiple studies this year, investigating 3GPP/5G, optical communications for Earth science, time-domain and multi-messenger astrophysics, and more.
- TEMPO supported the Lunar Experiment Survey System and Handling – Placed (LESSH-PL) project, which passed its System Requirements Review and preliminary design peer reviews of its communications subsystem.



# LCRNS

## LUNAR COMMUNICATIONS RELAY AND NAVIGATION SYSTEMS PROJECT

### LEADS

Project Manager: **Jamie Esper**

Deputy Project Manager: **Lori Perkins**

Deputy Project Manager/Resources: **Beverly Thomas**

The Lunar Communications Relay and Navigation Systems (LCRNS) project is enabling NASA's greatest endeavor: the creation of a long-term human presence on the Moon. To do this, LCRNS is supporting the development of a lunar communications and navigation infrastructure that is sustainable, meets NASA's needs, and can be applicable Mars. The LCRNS project is enabling an interoperable service approach that will allow missions anywhere on the Moon – including the far side – to communicate through government and commercial assets.

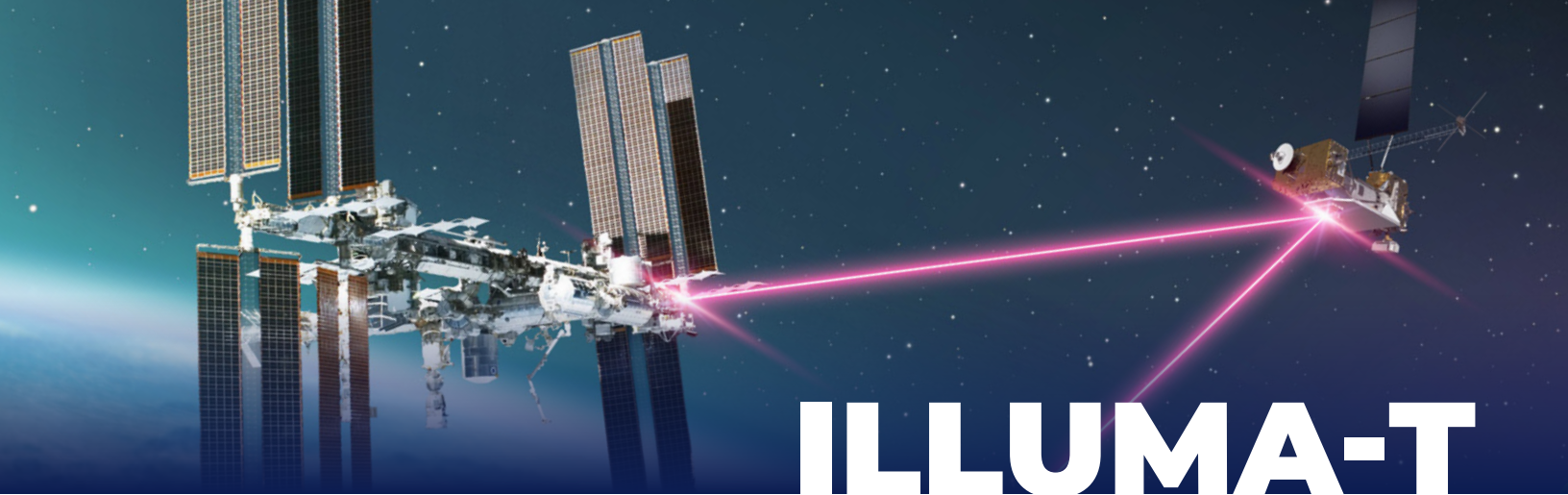
### SUPPORTING STAKEHOLDER NEEDS FOR ARTEMIS III, IV, AND V



### FY23 HIGHLIGHTS

- The LCRNS team finalized and published the LCRNS Service Requirements Document (SRD) - a balanced set of requirements implemented incrementally over an Initial Operations Capability phasing schedule.
- NASA's Moon to Mars Architecture Definition Document featured LCRNS and how communications and navigation services will be provided through a combination of NASA and partner assets.
- LCRNS, alongside SCA and ESA, published draft Version 5 of the LunaNet Interoperability Specification and an associated document on Augmented Forward Signals. LunaNet is envisioned as a network of cooperating networks upon which providers can deliver services for users at the Moon.
- LCRNS participated in several SCA Technical Interchange Meetings regarding Artemis requirements, service verification and validation, cybersecurity, collaborations, priorities, and more.
- The LCRNS team passed their Systems Requirements Review for the Position Navigation and Timing (PNT) instrument. The LCRNS PNT instrument is an essential element in the risk mitigation activities geared to supporting the successful development and evolution of commercial lunar relay service navigation capabilities.





# ILLUMA-T

## INTEGRATED LCRD LOW-EARTH ORBIT USER MODEM AND AMPLIFIER TERMINAL

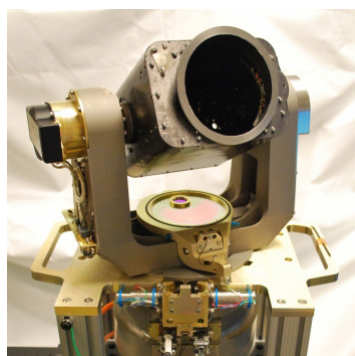
### LEADS

Project Manager (Acting): **Glenn Jackson**

Deputy Project Manager: **Matt Magsamen**

Deputy Project Manager/Resources: **Nylse Ortiz Collazo**

NASA's Integrated LCRD Low Earth Orbit (LEO) User Modem and Amplifier Terminal (ILLUMA-T) is a laser communications terminal launching to the International Space Station in November 2023. There, the terminal will send high-resolution information from the space station to LCRD in geosynchronous orbit, which will then relay that data down to Earth. ILLUMA-T will complete NASA's first end-to-end bidirectional laser communications relay system and will be LCRD's first operational user. Together, LCRD and ILLUMA-T will showcase the benefits of laser communications and how it can provide a user in low Earth orbit with enhanced data rate capabilities.



**1.244**  
GIGABITS PER SECOND  
(GBPS)

### FY23 HIGHLIGHTS

- ILLUMA-T was shipped and delivered to Kennedy Space Center for unloading and processing in the facility's clean tent.
- After processing, the terminal was delivered to SpaceX Dragonland for placement into the Dragon trunk.
- The ILLUMA-T project completed Mission Readiness Testing 3, which demonstrated the payload's ability to point to LCRD using the STPSat-6 location data. The success of this test shows that LCRD and ILLUMA-T can find each other using current orbit information.
- ILLUMA-T management presented to NASA Administrator Bill Nelson, Deputy Administrator Pam Melroy, and other NASA leadership about the benefits of laser communications and the impact higher data rates can have for science and human spaceflight missions.
- The ILLUMA-T project participated in over 30 outreach events, reaching over 25,000 people in the months leading up to its November launch.



# LASER-ENHANCED MISSION COMMUNICATIONS, NAVIGATION, AND OPERATIONAL SERVICES PIPELINE

## LEADS

Project Manager: **Steven Horowitz**

Deputy Project Manager: **Peter Rossoni**

Financial Management Specialist: **Nicole Turner**

The Orion Artemis II Optical Communications System (O2O) is a revolutionary laser communications payload integrated on the upcoming Artemis II mission to the Moon. Managed by the Laser-Enhanced Mission Communication Navigation and Operational Services (LEMNOS) Pipeline project, O2O will demonstrate the “operational utility” of laser communications on a crewed lunar mission. O2O, which uses infrared light rather than traditional radio waves to send more data to Earth, will transmit 4K high-definition video, enhanced science data, procedures, pictures, flight plans, communications, and be a link between Orion and mission control on Earth.

# 80-260

MBPS UPLINK



# 4K

VIDEO

## FY23 HIGHLIGHTS

- The O2O team completed spacecraft interface test dry runs with NASA Johnson Space Center's Mission Control Center (MCC) and Lockheed Martin's Integrated Test Lab. The tests demonstrated using laser communications between a simulated Orion spacecraft and the MCC.
- During these tests, the O2O team obtained and flow simulated astronaut data, including 4K video, from the Orion capsule to the laser communications terminal.
- In May, three O2O assemblies - the inner wall assembly, the optical module, and the controller electronics module - were shipped to the Kennedy Space Center and were mechanically and electrically integrated and tested with the Orion spacecraft.
- The O2O ground system team hosted the Artemis Program's Mission Managers and their team at the Optical Communications Ground Integration and Test Lab. Representatives from both O2O's space and ground teams discussed maximizing laser communications' operational utility for human exploration.





# INSPIRE

## INTEGRATED STRATEGIC PRODUCTS, INFORMATION, AND RESOURCES ENTERPRISE

### LEADS

Chief (Acting): **Bob Menrad**

Deputy Chief: **Vacant**

Senior Resources Analyst: **Melissa Gross**

The INtegrated Strategic Products, Information, and Resources Enterprise (INSPIRE) office supports the Exploration and Space Communications projects division with communications and outreach activities. The team shares the importance of communications and navigation to the general public, students, the NASA community, and the aerospace industry through in-person and virtual outreach, technical writing, design, strategic communications, digital media, social media, and more.

# 128 MILLION IN REACH ON SOCIAL MEDIA

2.36

MILLION IN IMPRESSIONS  
ON SOCIAL MEDIA

13

ARTICLES ON  
NASA.GOV

9

ARTICLES ON ESC BLOG

72

INTERNS HOSTED THROUGH  
SPRING, SUMMER, AND FALL

21,346

FOLLOWERS GAINED

98

OUTREACH EVENTS  
ATTENDED

10

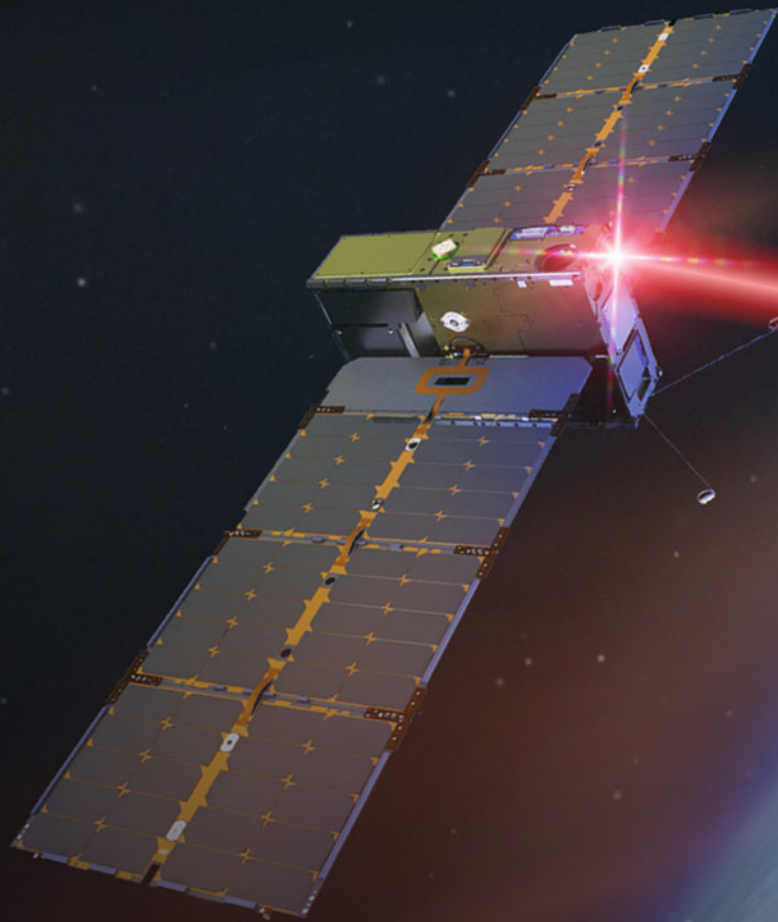
VIDEOS  
PRODUCED

17

AWARDS  
WON



# COLLABORATIVE ORGANIZATIONS



## RESOURCES

Lead: **Dr. Sharla Rice-Moore**

ESC’s business branch provides all program planning, control implementation, and oversight to the division’s projects and offices. Our resources team executes each project’s budget, along with all formulation responsibilities required for the annual budget submittals, which includes workforce management. They ensure each budget is aligned to maintain mission success and carries out the division’s vision and goals.

## SYSTEMS ENGINEERING

Lead: **Michelle Bonzo**

Systems engineers enable scientific and technological advancement by providing systems engineering expertise for the NASA activities that span the entire life cycle from advanced concepts through implementation. Our systems engineers act as the technical authority for the ESC, coordinating multiple flight projects, network assets, and technological pursuits. They perform capability assessments, technology roadmaps, and develop infusion plans.

## NAVIGATION

Navigation Lead: **Cheryl Gramling**  
Flight Dynamics Director: **Sam Schreiber**

Missions need navigation data to successfully reach their orbits and execute their science and exploration objectives. Navigation engineers serve NASA in a variety of ways, analyzing mission trajectories while developing technologies that enhance spacecraft navigation and guidance. World-renowned space navigation experts design the satellite navigation systems and architectures of the future while serving as experts on the international stage.

## SAFETY AND MISSION ASSURANCE

Lead: **Sanjeev Sharma**

The Safety and Mission Assurance (SMA) team ensures each project is successful and meets all its performance goals by analyzing risks, guaranteeing protocol is followed, and documenting any mishaps. In addition, SMA contributes to and applies policy guidelines set by NASA Headquarters and the Goddard Center Director.



# O2O AND ILLUMA-T AT KSC

Over the summer, two laser communications payloads arrived at NASA's Kennedy Space Center in Florida – the Integrated LCRD Low Earth Orbit User Modem and Amplifier Terminal, commonly known as ILLUMA-T, and the Orion Artemis II Optical Communications System, or O2O.

Laser communications uses invisible infrared light to send and receive information at higher data rates, providing spacecraft with the capability to send more data back to Earth in a single transmission and expediting discoveries for researchers.

O2O



In June, the laser communications system for the Artemis II mission – O2O – arrived at Kennedy for mechanical integration with the Orion spacecraft. Mechanical integration included the installation of the inner wall assembly, optical module, and controller electronics module. Additionally, the team completed an end-to-end integrated lab test with the mission control center.

Orion will carry astronauts around the Moon for the first time since the Apollo era and O2O will send down data at 260 megabits per second. This includes transmitting high-definition videos, pictures, procedures, flight plans, and more.

ILLUMA-T



In August, ILLUMA-T was shipped and delivered to Kennedy's Space Station Processing Facility. Upon arrival, the team unloaded and processed the payload in the facility's clean tent to prepare ILLUMA-T for launch. ILLUMA-T will launch to the International Space Station in November 2023 to demonstrate how missions in low Earth orbit can benefit from laser communications. The payload will work with LCRD to complete NASA's first two-way, laser relay system sending 1.2 gigabits-per-second down to one of two optical ground stations in Table Mountain, California or Haleakala, Hawaii.







Exploration  
& **SPACE**  
Communications

**EXPLORATION AND  
SPACE COMMUNICATIONS  
PROJECTS DIVISION**

**FY23 REPORT**

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