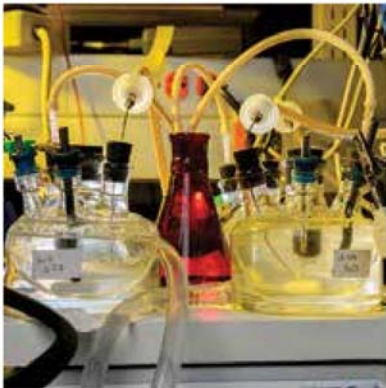


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2020

Annual Report



**U.S. NAVAL
RESEARCH**
LABORATORY

ABOUT NRL

The U.S. Naval Research Laboratory (UIC N00173) has major facilities on the banks of the Potomac River in southeast Washington, D.C., at the Stennis Space Center, Mississippi, Key West, Florida, and in Monterey, California. NRL was dedicated on July 2, 1923, and is the Navy and Marine Corps' corporate laboratory charged with the mission of conducting basic and applied research in a broad, multidisciplinary program to advance science and technological development for the National Defense Strategy.

NRL AND ITS FIELD SITES



Naval Research Laboratory
Washington, DC



Ocean Sciences Division
Stennis Space Center, MS



Marine Meteorology Division
Monterey, CA



Blossom Pt Tracking Facility
Welcome, MD



Chesapeake Bay Detachment
Chesapeake Beach, MD



Scientific Development
Squadron ONE (VXS-1)
NAS Patuxent River, MD



Midway Research Center
Quantico, VA



Free Space Antenna Range
Pomonkey, MD



Marine Corrosion Facility
Key West, FL



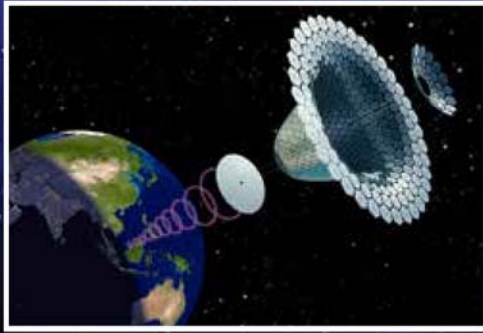
Multiple Research Site
Tilghman Island, MD



www.nrl.navy.mil

For more information, visit the NRL website or join the conversation on social media.





NRL

*dedicated to research
that drives innovative
advances for the U.S.
Navy and Marine Corps
from the seafloor
to space and in the
information domain.*

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NRL is a scientific and engineering command dedicated to research that drives innovative advances for the U.S. Navy and Marine Corps from the seafloor to space and in the information domain. NRL is located in Washington, D.C. with major field sites in Stennis Space Center, Mississippi; Key West, Florida; Monterey, California, and employs approximately 2,500 civilian scientists, engineers and support personnel. For more information, visit the NRL website or join the conversation on Twitter, Facebook, and YouTube.



Researchers at the U.S. Naval Research Laboratory have developed a fleet of autonomous platforms to test the swarming behavior of autonomous systems. They successfully demonstrated the operation of 30 blimps in December 2018. This year they aim to fly more than 100 controlled balloons (also known as miniature autonomous blimps).

Insect behavior, miniature blimps may unlock the key to military swarming technology

Researchers at the U.S. Naval Research Laboratory flew a fleet of 30 miniature autonomous blimps in unison to test the swarming behavior of autonomous systems. The blimps responded to each other while in flight and responded to changing conditions.

Don Sofge, lead for the distributed autonomous systems group at NRL, and his team are working to further research for autonomous super swarms. Their goal is to fly more than 100 controlled miniature blimps this year.

Georgia Tech researchers created the miniature blimp platform and continue to provide design upgrades in

collaboration with Sofge's group. This year, they are upgrading the motors, adding sensors and making design tweaks.

"The process is a constant give-and-take with design and scale," Sofge said. "It's better to start with a simple design. You start with something that works and then make incremental changes. There are challenges with design and there are challenges with scaling. So we are redesigning and then scaling up to produce the 100 blimps. We are taking it one step at a time."



Marine Corps AH-1Z Viper helicopter is painted with one-component (1K) camouflage gray polysiloxane topcoat on the exterior. U.S. Naval Research Laboratory chemists developed the new topcoat for DoD aircraft, which is safer for the environment and easier to apply. (U.S. Naval Research Laboratory)

NRL's new painter-friendly topcoat safer for the environment

NRL's Center for Corrosion Science and Engineering developed a safer and user-friendly topcoat recently applied onto the exterior of Navy and Marine Corps aircraft. The topcoat, a one-component polysiloxane based on organosilane polymers, is a new technology free of harmful isocyanates and other hazardous air polluting chemicals.

Erick Iezzi, Ph.D., senior research chemist at NRL, and engineers at Naval Air Warfare Center – Aircraft Division, applied the new topcoat onto a U.S. Navy F/A-18 Hornet located at Naval Air Station Patuxent River, Maryland. Additionally, the 1K topcoat was applied on Marine Corps UH-1Y Venom and AH-1Z Viper helicopters located at Marine Corps Air Station New River, Jacksonville, North Carolina and Marine Corps Base Camp Pendleton, California, respectively. The 1K polysiloxane topcoat on these aircraft is scheduled for a 1 to 2-year evaluation period.



Sneaky viruses: NRL study uncovers their strategy to evade immune responses

Research biologists identified a new algorithm that could help virologists better understand and treat infections caused by viruses like the Zika virus. While researching the Venezuelan Equine Encephalitis virus, Patricia Legler found a human protein sequence involved in generating the innate immune responses. Her findings showed that these viruses used what she called a “search and delete” algorithm to target and destroy host proteins.

Chemists search for PFAS-free firefighting foam

The U.S. military uses aqueous film-forming foams to rapidly extinguish fuel fires, particularly those involving aircraft. The key ingredient that makes the foams so effective is a fluorocarbon surfactant, said Katherine Hinnant, chemical engineer. The problem with fluorocarbons is that they don't degrade once they're used. And that's not good for humans, she said. The Lab is trying to find a replacement for AFFF that is just as effective at putting out fuel fires but does not contain any PFAS.



Naval Research Lab Chemical Engineer Gopal Ananth and Research Chemist Spencer Giles test an experimental aqueous film-forming foam at the NRL in Washington, Sept. 23, 2019. NRL scientists are conducting research to support the Defense Department's effort to replace firefighting foams containing fluorine.

A groundbreaking process to study barnacle glue

Researchers at the U.S. Naval Research Laboratory developed a new method for identifying the glue proteins that barnacles produce to adhere to ship hulls and other surfaces. The new method, featured on the cover of the May issue of *Integrative Biology*, is faster, safer, improves efficiency of samples and yields more effective results than traditional methods. Researchers hope the discovery will lead to new solutions for dealing with the accumulation of barnacles on ship hulls, which hinders Navy operations by creating drag and increasing fuel costs. These small but mighty crustaceans create a cement-like adhesive layer that is difficult to remove once applied. “We are developing a new way to actually study the adhesive to see what it is composed of,” said Janna Schultzhaus, research biologist and National Research Council Postdoctoral Associate at NRL. “Before we can develop something that will work against it, we have to know what it is.”



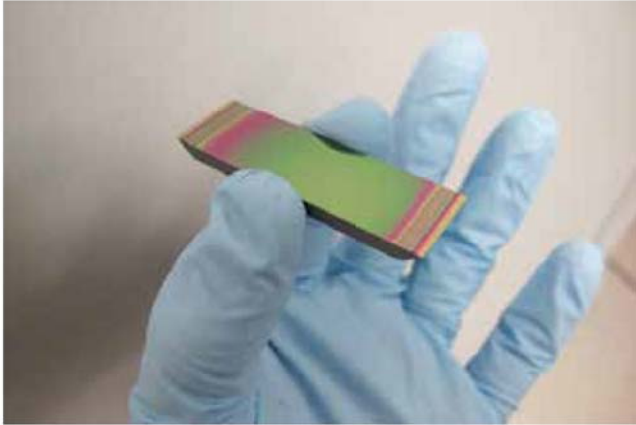
Barnacle samples in pressure cycling technology (PCT) tubes and bullet with barnacle samples in the background are used for proteomics analysis. The barnacle base plate covers the glue, illustrating how difficult sample collection is; the tubes and bullet are specially designed to handle high pressure conditions.

Pigment package for ships slows discoloration, lowers solar temperature load



NRL is currently working with Naval Sea Systems Command, Naval Systems Engineering Directorate, Ship Integrity & Performance Engineering (SEA 05P) to transition the new pigment combination into a military specification. The most recent vessel to receive it was USS George Washington (CVN 73). (U.S. Navy/Released)

A pigment package designed by the lab to slow discoloration of the exterior coating on surface ships has started to make its way into the fleet and is producing early, positive results. NRL researchers created the pigment combination to satisfy the fleet requirement for the Navy standard “haze gray” paint that will remain color stable longer than current coatings. While many paint manufacturers produced coating technologies to solve problems such as corrosion and delamination, some ships still showed discoloration in as little as 18 months. Additionally, different coatings from different manufacturers fade to different hues, resulting in inconsistent appearances.



Steerable electro-evanescent optical refractor (SEEOR) chip.

NRL develops laser processing method to increase efficiency of optoelectronic devices

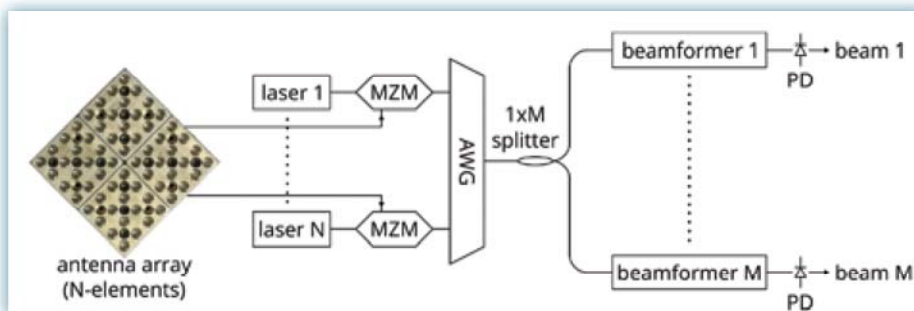
Scientists discovered a new method to passivate defects in next generation optical materials to improve optical quality and enable the miniaturization of light emitting diodes and other optical elements. "From a chemistry standpoint, we have discovered a new photocatalytic reaction using laser light and water molecules, which is new and exciting," said Saujan Sivaram, lead author of the study. "From a general perspective, this work enables the integration of high quality, optically active, atomically thin material in a variety of applications, such as electronics, electro-catalysts, memory, and quantum computing applications."

Waveguides for non-mechanical beam steering in the mid-wave infrared

In a combined effort between the Optical Sciences Division, the Center for Biomolecular Science and Engineering, and the Tactical Electronic Warfare Division, the lab is developing an agile non-mechanical beam steerer suitable for advanced defense-related applications and exploring its potential for expansion into other optical bands. The new NRL beam steerer, called a Steerable Electro-Evanescent Optical Refractor, is based on a variable refractive index waveguide first developed by Vescent Photonics with the Navy Small Business Innovation Research funding.

Simultaneous optical beam forming for phase-array applications

As platforms for electronic warfare continue to decrease in size, phased-array-based apertures offer potential improvements in effective power; reductions in size, weight, power and cost (SWaP-C), and new capabilities including direction-finding from a static aperture.



Schematic of a receive-mode optical simultaneous beam-forming architecture. MZM: Mach-Zehnder modulator; AWG: arrayed-waveguide grating; PD: photodiode.



Weather forecasting team tracks, predicts 'fire-breathing cloud' phenomenon

Lab meteorologists dramatically advanced their ongoing work to understand and predict formation of pyrocumulonimbus (pyroCb) clouds in 2019, collecting the most detailed sampling of the clouds in history. PyroCbs are massive thunderstorm clouds created by heat and fire. Such clouds, which can reach heights of more than 8 kilometers, heave intense wind, thunderbolts, and smoke toward anything in their path, sometimes even igniting new fires. Between July and September, our researchers took part in multi-agency studies of pyroCbs in the western and central United States.



NRL tropical cyclone forecast updates go live

NRL meteorologists updated COAMPS-TC®, their tropical cyclone prediction software, just before the first tropical system of the season to reach the U.S. made landfall July 13. The updated prediction model, one of a handful used by the National Hurricane Center, featured accuracy improvements for intensity, track, and structure forecasts. “Many people are unaware that the Navy is a contributor to the suite of models utilized by the National Hurricane Center,” said meteorologist Jonathan R. Moskaitis. “We are working to predict tropical cyclones and contributing to the official forecasts released to and depended on by the public.”



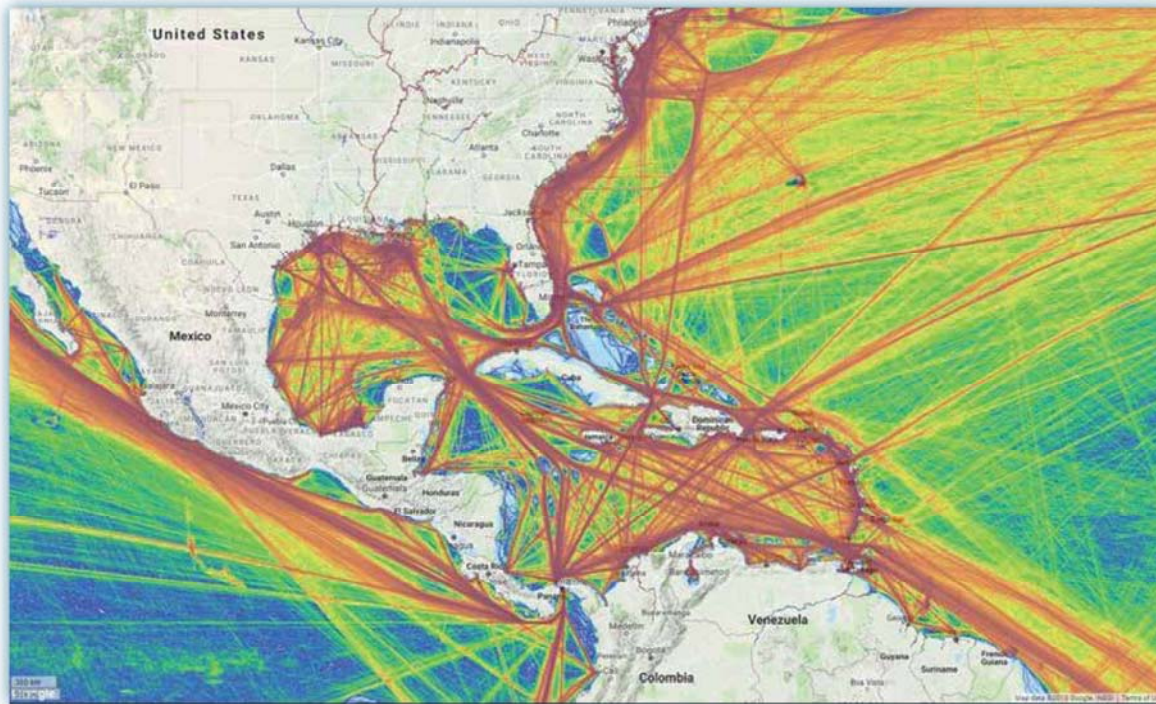
U.S. Naval Research Laboratory's Michelson Interferometer for Global High-Resolution Thermospheric Imaging (MIGHTI) payload launched on NASA's Ionospheric Connection Explorer (ICON) mission to study the effects of terrestrial weather and solar influences on the Earth's ionosphere from a height of about 350 miles. (Graphic courtesy of NASA)

MIGHTI ICON: NRL launches space weather instrument on NASA satellite

An NRL space weather instrument aboard NASA's Ionospheric Connection Explorer (ICON) satellite launched from Cape Canaveral, Florida, Oct. 10. MIGHTI (Michelson Interferometer for Global High-Resolution Thermospheric Imaging) will measure wind and temperature profiles and contribute to a critical data set for scientists as they study how energy and dynamics from the lower atmosphere propagate into the space environment.

Orbital debris can tell us about Earth's changing atmosphere

John Emmert first got involved in studying orbital debris while studying climate change in the upper atmosphere. For research physicist Emmert, pieces of debris in low Earth orbit are an opportunity to use them as atmospheric probes, tracking them to infer the density of the atmosphere. He found that increasing levels of carbon dioxide exert a gradual but dramatic effect on the upper atmosphere. More carbon dioxide in the atmosphere causes the atmosphere to contract.



MarineTraffic's Density Map format showing vessel trajectories from billions of data points from 2017. The 'cool' colored lines signify that a route has not been taken often, the 'warm' colored lines signify where routes are often utilized. The result is a global dataset of ship tracking density. (Source: MarineTraffic)

AI researcher offers insight on promise, pitfalls of machine learning

An artificial intelligence (AI) researcher at the lab believes one AI technique might be getting a little too much attention. Ranjeev Mittu heads NRL's Information Management and Decision Architectures Branch and has been working in the AI field for more than two decades. "I think people have focused on an area of machine learning—deep learning (aka deep networks)—and less so on the variety of other artificial intelligence techniques," Mittu said. "While deep learning has been highly successful, it is also currently limited because there is little visibility into its decision rationale. Until we truly reach a point where this technique becomes fully "explainable", it cannot inform humans or other automation as to how it arrived at a solution, or why it failed. We have to realize that deep networks are just one tool in the AI tool box."



Cognitive robotics

Research in the Human and Machine Intelligence (HMI) Section at the Navy Center for Applied Research in Artificial Intelligence (NCARAI) focuses on improving the ability of robots and other artificial agents to understand and interact with humans. HMI scientists and researchers do this by taking an integrative approach to cognitive science, sensor processing, and robotics guided by a theory-first systems perspective. This unique, multidisciplinary focus provides a better understanding of how humans interact with the world and can be used to improve robot behaviors.

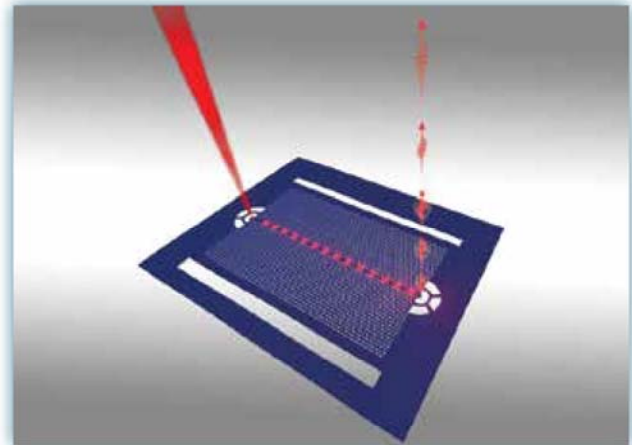


NRL researcher ventures to the Antarctic in search of cosmic dust

After arriving at McMurdo Station on the unforgiving continent of Antarctica, it still took physicist Rhonda Stroud two days of safety training and a four-hour flight before she was finally where she needed to be: the bottom of the world. For two years, Stroud worked on an experiment to collect atmospheric dust, also known as cosmic dust, at the South Pole. According to Stroud, the South Pole is an ideal spot for cosmic dust collection because it has some of the purest air on our planet. Her research will provide clues to the origins of our solar system: the formation of planets, the composition of comets and asteroids, and the evolution of the primordial gas and dust into the Earth and life as we know it today.

NRL connects the dots for quantum networks

Researchers developed a new technique that could enable future advancements in quantum technology. The technique squeezes quantum dots, tiny particles made of thousands of atoms, to emit single photons (individual particles of light) with precisely the same color and with positions that can be less than a millionth of a meter apart. "This breakthrough could accelerate the development of quantum information technologies and brain-inspired computing," said Allan Bracker, a chemist at NRL and one of the researchers on the project.



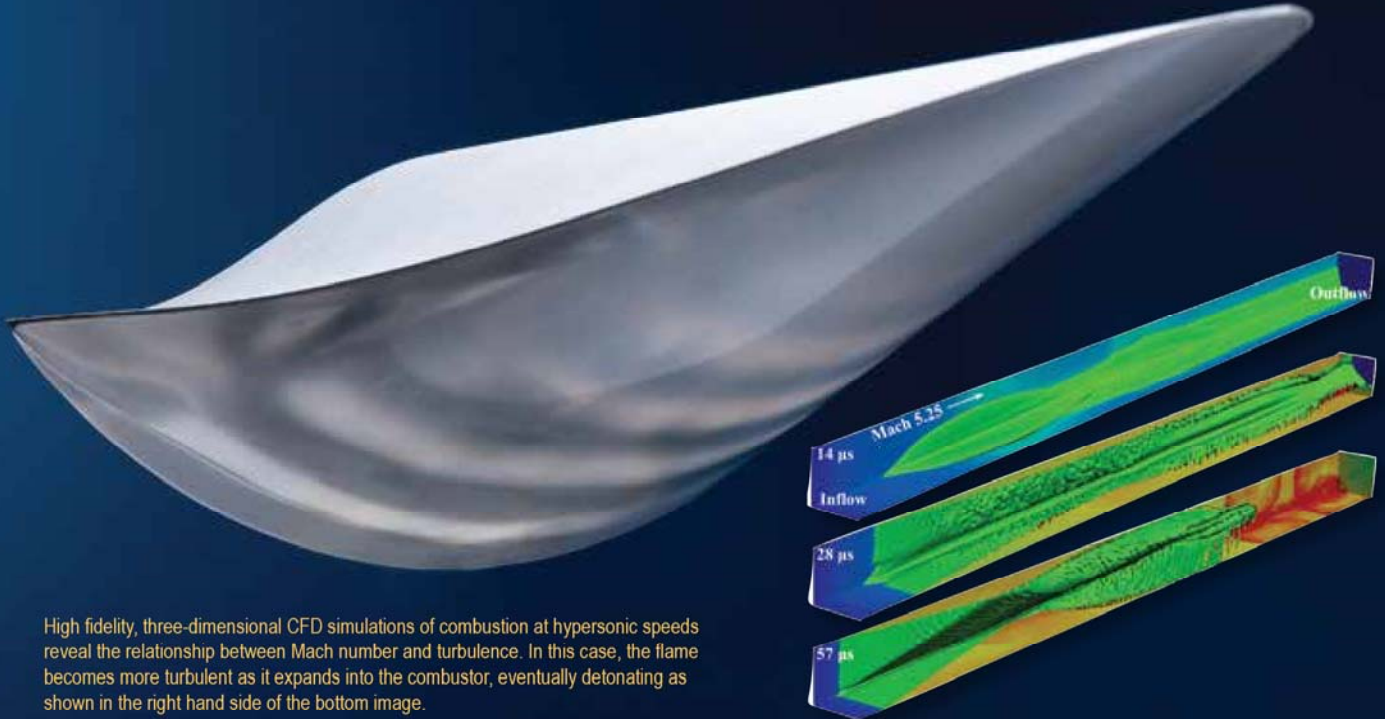
Schematic of a nanoscale structure called a 'photonic crystal waveguide' that contains quantum dots that can interact with one another when they are tuned to the same wavelength. (Image credit: Chul Soo Kim, U.S. Naval Research Laboratory)

Diamonds & Quantum: researcher discovers noble gas in doped nanodiamond

Rhonda Stroud made a scientific discovery that astounded her fellow researchers. She found argon trapped inside laboratory-grown nanodiamonds. The finding, published in *Scientific Reports*, has implications for advanced quantum computing technology. "We discovered we could flexibly dope nanodiamonds with nearly any other atomic species we wanted without having to resort to ion irradiation," Stroud said. "This allows us to better control optical and electronic properties of the diamond."

Leading edge: NRL in the hypersonics realm

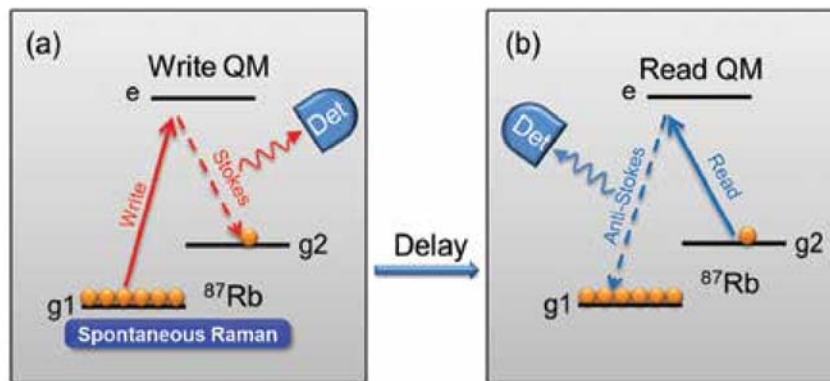
Engineers in the Space Mechanical Systems Development Branch are looking to an innovation from the earliest days of manned flight, specifically one pioneered by the Wright brothers, as inspiration for their new design for a hypersonic aircraft. They're calling it a morphing waverider.



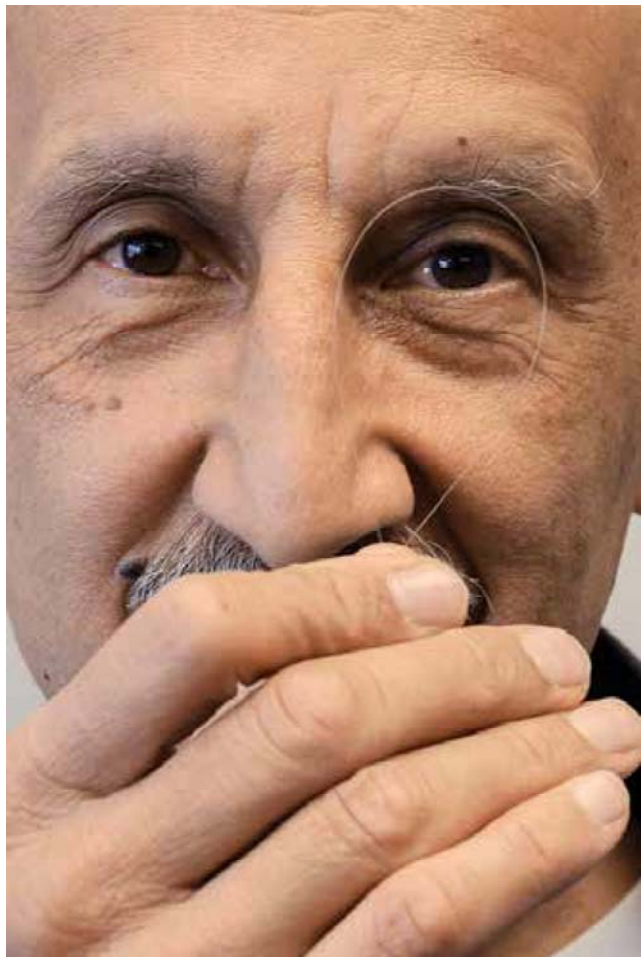
High fidelity, three-dimensional CFD simulations of combustion at hypersonic speeds reveal the relationship between Mach number and turbulence. In this case, the flame becomes more turbulent as it expands into the combustor, eventually detonating as shown in the right hand side of the bottom image.

Quantum memories based on optically trapped neutral atoms

Key components of secure quantum communication and quantum information processing schemes, quantum memories use matter to store and retrieve quantum information. The memories typically use an interface with an optical channel that transmits single photons. The Optical Sciences Division is developing a quantum memory in ensembles of laser-cooled rubidium atoms, making progress toward the creation of a quantum repeater based on four such memories.



Writing and reading quantum memory based on ^{87}Rb atom.



Jas Sanghera, U.S. Naval Research Laboratory branch head for Optical Materials and Devices, holds up optical fiber that will be used to produce eye safer lasers.

Nanoparticle power: researcher uses nanoparticles to increase power, improve eye safety of fiber lasers

Scientists devised a new process for using nanoparticles to build powerful lasers that are more efficient and safer for your eyes. They're doing it with what's called "rare-earth-ion-doped fiber." Put simply, it's laser light pumping a silica fiber already infused with rare earth ions of holmium. According to Jas Sanghera, head of the Optical Materials and Devices Branch, they have achieved an 85 percent efficiency with their new process. "Doping just means we're putting rare earth ions into the core of the fiber, which is where all the action happens," Sanghera said. "That's how we've produced this world record efficiency, and it's what we need for a high-energy, eye-safer laser."

A new manufacturing process for ultra-thin flexible crystalline silicon solar cells

Researchers submitted a patent application for a new method of manufacturing ultrathin flexible silicon solar cells. The new manufacturing method alters off-the-shelf crystalline silicon cells in a way that allows them to curve while still maintaining adequate performance at a reasonable cost. Many commercially available silicon solar cells are bulky and glass-like, rendering them unsuitable for many military applications because bending can damage them.

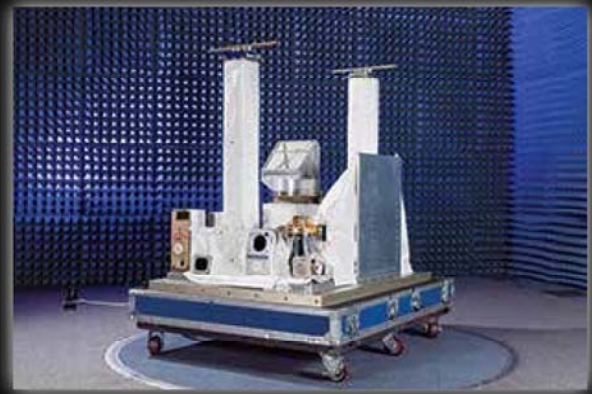


PTROL: Researchers transmit energy with laser in 'historic' power-beaming demonstration

During a three-day-long demonstration at the David Taylor Model Basin at the Naval Surface Warfare Center in West Bethesda, Maryland, attendees gathered May 23 to see a long-range, free-space power beaming system. The system had two 13-foot-high towers: one with a 2-kilowatt laser transmitter, the other had a receiver of specially designed photovoltaics. The laser beaming 400 watts of power across 325 meters was invisible to the naked eye.

NRL tests sensor aboard the ISS to protect space-based assets

The SpaceX Dragon resupply mission CRS-17 launched May 4 carried an NRL experiment from the Kennedy Space Center, Florida to the International Space Station. Developed by the Plasma Physics Division and the Spacecraft Engineering Department, the Space Plasma Diagnostic suite (SPADE) experiment is integrated with the Space Test Program-Houston 6 (STP-H6) pallet, and is designed to monitor background space plasma conditions on-orbit and provide early warning of hazardous levels of spacecraft charging.



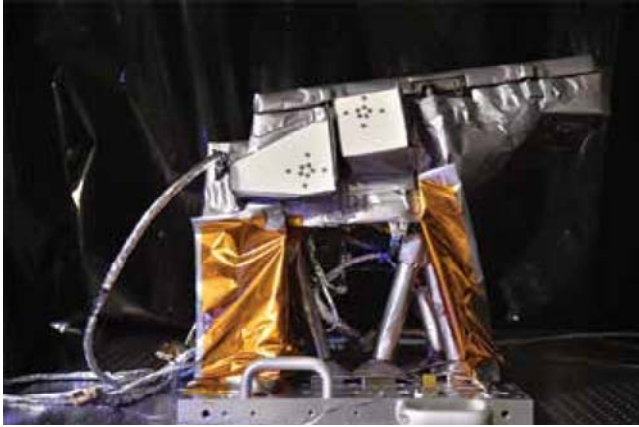
The Space Plasma Diagnostic suite (SPADE) experiment (tower-like structure in photo).

WISPR: NRL instrument produces Sun imagery with unprecedented clarity



Early returns from the U.S. Naval Research Laboratory's camera on NASA's Parker Solar Probe mission to study the Sun's corona revealed on Dec. 4 a star more complex than ever imagined. NRL's Wide-field Imager for Solar Probe (WISPR) is the only imaging instrument aboard, and is now 84 percent of the way to the Sun. WISPR produced multiple scientifically relevant photos, capturing the beginning of a dust-free zone around the Sun, detailed plasma eruptions, magnetic flux ropes, and the first image of a magnetic island around the Sun, a small region of space with a circulating magnetic field.

NRL Space Science Division experiment WISPR aboard the Parker Solar Probe spacecraft launched toward the Sun on August 12, 2018.



NRL camera aboard NASA spacecraft confirms asteroid phenomenon

An NRL-built camera mounted on the NASA Parker Solar Probe revealed an asteroid dust trail that has eluded astronomers for decades. Wide-Field Imager for Solar Probe (WISPR) enabled researchers to identify the dust cloud trailing the orbit of the asteroid 3200 Phaethon. “This is why NRL’s heliospheric imagers are so ground-breaking,” said Karl Battams, computational scientist. “They allow you to see near-Sun outflows massively fainter than the Sun itself, which would otherwise blind our cameras. And in this case, you can also see solar system objects extremely close to the Sun, which most telescopes cannot do.”

Eyes on the skies: the challenges of tracking orbital debris

Aerospace engineers, astrodynamists, research physicists, and others are working with the U.S. Air Force, NASA, and others to approach the problem of space junk in a number of ways. The lab’s Mathematics and Orbit Dynamics Section works with partners to track orbital debris while preparing for the completion of a new “space fence” that will radically transform our view of orbital debris from Earth.

Space debris: big data for a big problem

For decades, NRL has worked with the operations center in Dahlgren, developing software products and advanced methods for space situational awareness (SSA). These days, researchers in the Mathematics and Orbit Dynamics Section are helping the U.S. Air Force harness the potential of the ever-growing trove of private-sector SSA data collected by telescope networks and radars operated by universities, small startups, and other commercial entities.

Project LARADO

In March 2015, the International Space Station crew had only 90 minutes of advance warning of an approaching Russian satellite fragment. It was the fourth time in the station’s history that astronauts had to seek shelter because of debris. “This is likely a problem that will rapidly increase—especially since we’re putting more and more satellites in orbit,” said Chris Englert, who heads NRL’s Geospace Science and Technology Branch. “The commercial sector is talking about putting thousands of satellites into Earth orbit in the not too distant future.” With Andrew Nicholas, head of the Sensor Development and Applications section, Englert has been developing a method to detect orbital debris and micrometeoroids. Their project is called LARADO, for Light-sheet Anomaly Resolution and Debris Observation, and it’s a space-based design concept for using satellite and laser technology to detect orbital debris in sizes that currently aren’t detectable from the ground.



Joshua Brooks, heads the Blossom Point Tracking Facility.

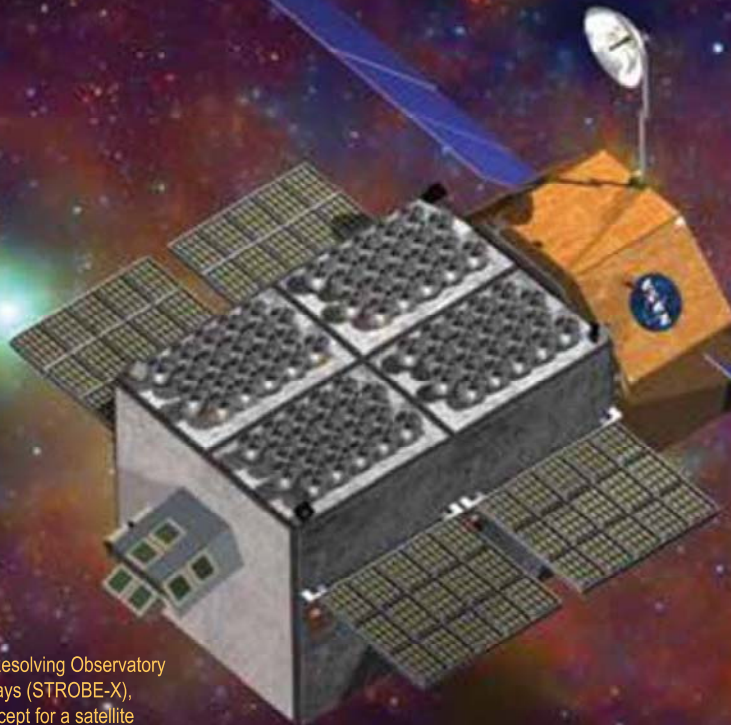
OCEAN: we hit go, and it works

Anytime a satellite has to maneuver, whether it’s to adjust its orbit or evade collision with space debris, its lifespan shortens. No one knows this better than Joshua Brooks, who heads NRL’s Blossom Point Tracking Facility, which today is actively flying five satellites. Managing operations for multiple satellites at Blossom Point once involved crews of operators manning terminals on shifts, 24 hours a day, seven days a week. Today, nearly all of that is automated, managed by a handful of operators.

STROBE-X headed to Decadal Survey

After two years of intensive work led by the Space Science Division, the design for a conceptual space-based observatory is headed to the National Academies of Science, Engineering, and Medicine's Decadal Survey on Astronomy and Astrophysics. STROBE-X (Spectroscopic Time-Resolving Observatory for Broadband Energy X-rays) is a mission concept for an X-ray observatory that will specialize in rapid time variability. The satellite would gather information from black holes, neutron stars, transient events and cosmic explosions such as the violent destruction of stars in the grip of black holes and binary neutron star collisions.

The Spectroscopic Time-Resolving Observatory for Broadband Energy X-rays (STROBE-X), a probe-class mission concept for a satellite that would gather information from black holes, neutron stars and cosmic explosions.

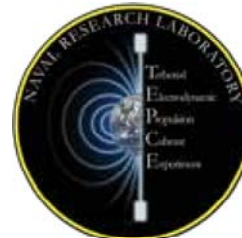


Payloads launch on SpaceX rocket to study space weather and spacecraft propulsion

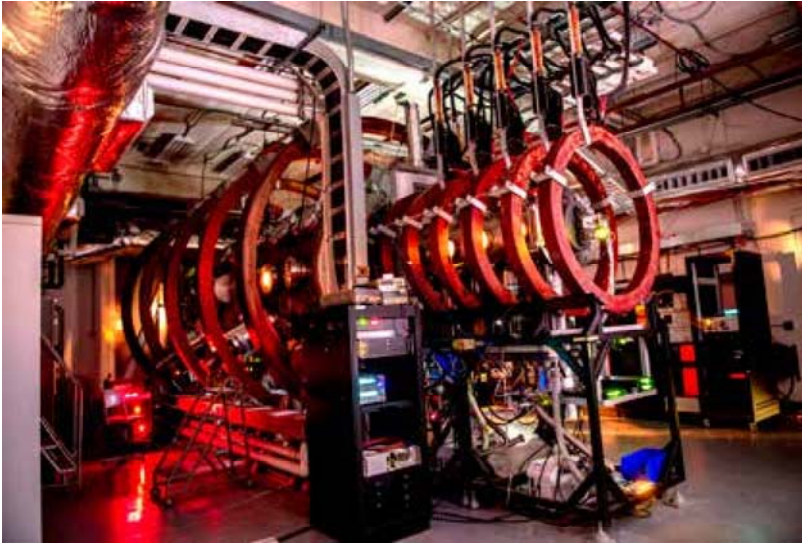
Researchers designed and built two science payloads that went up with SpaceX's Falcon 9 Heavy rocket launch on June 25. The Small Wind and Temperature Spectrometer (SWATS) will help researchers understand the dynamics of the upper layers of Earth's atmosphere, while the Tether Electrodynamic Propulsion CubeSat Experiment (TEPCE) will investigate orbital energy created by the Earth's magnetic field that could propel future spacecraft.



Tether Electrodynamic Propulsion CubeSat Experiment (TEPCE)



Big Plasma: Plasma Physics Division seeking collaborators for space chamber



While naturally-occurring plasmas are rare on the Earth's surface, man-made plasmas can be found in such everyday things as neon signs and fluorescent lights. They can also be found at NRL's Plasma Physics Division, where Bill Amatucci and his team of research physicists have been using a massive chamber to create and study them. A large-scale vacuum vessel for the creation of space-like conditions, the space physics simulation chamber is one of only a handful of its kind in the United States and one of the biggest in the world. Now the researchers who operate it are looking for external partners who might want to use it to conduct space plasma experiments or test spacecraft hardware. "There are a lot of people within the Department of Defense who build experiments to fly in space, and this is a place where you could test them in a realistic environment prior to flight," Amatucci said.

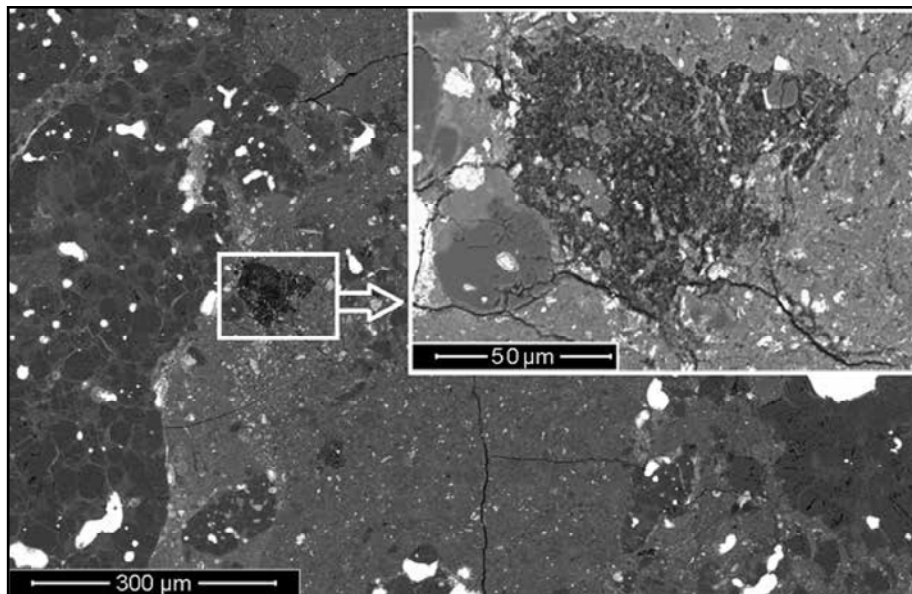
NRL introduces newly acquired aircraft for airborne research



Cmdr. Jared Tharp, Scientific Development Squadron One's (VXS-1) executive officer, stands in front of the UV-18 Twin Otter at Naval Air Station Patuxent River, Maryland.

NRL's premier science and technology research squadron, Scientific Development Squadron (VXS) 1, unveiled the UV-18 Twin Otter May 11 as the newest addition to the squadron's unique fleet of aircraft research platforms. The UV-18 is the military equivalent of the DeHavilland DHC-6 — a high-wing, unpressurized twin engine turbine powered aircraft with fixed tricycle landing gear. "The Twin Otter is a safe, highly maneuverable and extremely versatile aircraft," said Cmdr. Erik Thomas, commanding officer for VXS-1. "The fact that it is unpressurized simplifies modifications and will accelerate our ability to get projects airborne for the Naval Research Enterprise." The aircraft complements the VXS-1 "Warlocks" fleet by providing an affordable and stable research platform with slow flight capabilities and an operational payload of up to 3,000 pounds.

Researchers use NRL Nanoscience Institute for insight into the formation of the solar system in ancient comet dust



Materials science researchers found a remnant of ancient dust from the early stages of the solar system inside a primitive meteorite, named La Paz Icefield 02342 after the location of its discovery in Antarctica. Rhonda Stroud and Bradley De Gregorio contributed to a paper describing the find, which published April 15 in *Nature Astronomy*. To examine these tiny grains within the larger particle, the researchers relied on a unique capability of NRL's Nanoscience Institute, which has a state-of-the-art aberration-corrected scanning transmission electron microscope that can shape its emitted electron beam

to optimize image quality and resolution. The microscope is one of only a few of its kind in the world. Along with other state-of-the-art measurement and nanofabrication equipment located in the Institute, it enables NRL scientists and engineers to discover and develop new nanotechnology for the Navy and the Marine Corps.

NAUTILUS: Novel instrument enhances ability to measure nuclear materials



Evan Groopman (left), a research physicist and Dr. David Willingham (right), a research chemist and head of the Accelerator Mass Spectrometry Section, gather in front of the NAUTILUS instrument

Researchers designed and built a unique mass spectrometer called NAUTILUS to provide new measurement capabilities unlike those available at other laboratories to measure nuclear, cosmo/geo-chemical, and electronic materials. The Accelerator Mass Spectrometry Section entered NAUTILUS in an international round-robin exercise, called Nuclear Signatures Inter-laboratory Measurement Evaluation Program (NUSIMEP-9) at the end of 2018 to measure microscopic particulate samples with "unknown" uranium isotope ratios. "NRL recently received the final report from the international round-robin exercise and found that the Laboratory performed quite well, correctly identifying all of the "unknown" isotopic compositions," said David Willingham, research chemist and head of the Section.



Renewed collaboration to detect, respond to airborne hazards

NRL extended its partnership agreement with the University Graduate Center in Kjeller, Norway, in January to continue work on a tool that provides emergency responders with predictions of where and how airborne chemical, biological, and radiological (CBR) hazards would disperse in the city of Oslo. Dubbed CT-Analyst-Oslo, the project is an Oslo-specific, real-time modeling tool based on CT-Analyst, developed by NRL to provide accurate and instantaneous 3D predictions of hazardous plumes in urban settings.

NRL, Georgetown School of Foreign Service talk autonomous systems



Students from Georgetown University's School of Foreign Service visited the NRL for a two-day academic exchange February 26-27, 2019 with a classroom lecture and tour of the Laboratory for Autonomous Systems Research facilities (LASR). Karen Swider-Lyons, director of LASR, talked about autonomous systems research with the students. "Engaging students in fields like these is invaluable, as the research created here will influence policies these students will face in their careers," Swider-Lyons said.

NRL, AFRL develop direct-write quantum calligraphy in monolayer semiconductors

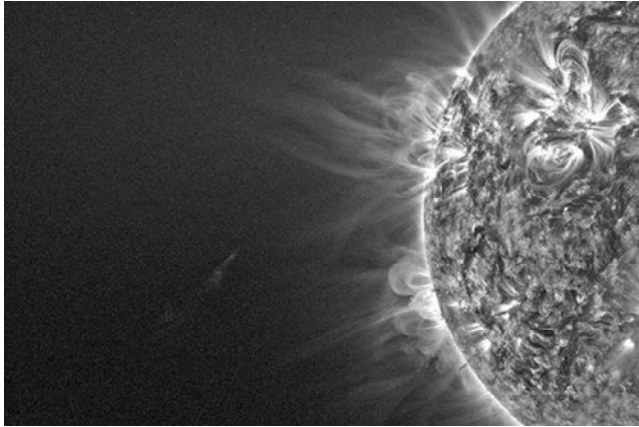
Scientists at the Lab and the Air Force Research Laboratory (AFRL) developed a way to directly write quantum light sources, which emit a single photon of light at a time, into monolayer semiconductors such as tungsten diselenide. Single photon emitters, or quantum emitters, are key components in a wide range of nascent quantum-based technologies, including computing, secure communications, sensing and metrology.

Technology Transfer Office awarded 2019 excellence award

NRL's Technology Transfer Office was recognized by the Federal Laboratory Consortium for Excellence in Technology Transfer at the 2019 FLC National Meeting April 24 in Orlando, Florida. The FLC's Excellence in Technology Transfer Award is presented annually to federal employees who have accomplished outstanding work in the process of transferring federally developed technology. This year's award identifies 30 recipients from 27 different laboratories. NRL's transferred technology is the Laser Analysis and Sorting Instrument (LASI), a Navy-patented device and method of using lasers to separate and characterize particles in fluids.

NRL, Southwest Research Institute to add PUNCH to NASA's Solar Mission Lineup

Space Science Division researchers partnered with the Southwest Research Institute (SwRI) in San Antonio to create PUNCH, a constellation of four suitcase-sized microsatellites, giving them an unprecedented wide view of the solar wind in three dimensions in low Earth orbit. The Polarimeter to Unify the Corona and Heliosphere will shine a light on the impact of the solar atmosphere on the interplanetary medium between the Earth and the Sun including the Earth's atmosphere and magnetic field. "This mission really has two focuses," said Robin Colaninno, an astrophysicist in the division. "Trying to look at the creation of the solar wind from the corona and then also looking at the propagation of the coronal mass ejections in the solar wind."



Sungrazer at 15: how crowdsourcing changed comet hunting

When Karl Battams started his career at NRL 15 years ago, he was an astrophysics graduate, eager to do almost anything in his field. Inheriting a languishing citizen science project certainly qualified as “anything.” After more than 15 years, the project has now produced some of the most scientifically exciting discoveries of Battams’ career. Named for a type of comet that passes extremely close to the Sun, the Sungrazer project identifies previously unknown comets with the help of anyone willing to look through a library of images from two NRL space-based imaging telescopes: the Large Angle Spectrometric and Coronagraph (LASCO) telescopes on the joint European Space Agency/NASA and the Solar and Heliospheric Observatory (SOHO), and the Sun-Earth Connection Coronal and Heliospheric Investigation (SECCHI) instrument suite on the Solar Terrestrial Relations Observatory (STEREO). The multidecades-volume of data from LASCO and SECCHI are publicly available online for anyone who would like to join the comet hunt. “All someone really needs to find comets is an internet connection and lots of patience,” Battams said.

Cyber Week

U.S. Naval Research Laboratory guest speakers joined Oxon Hill High School students and faculty in a group photo during a Cyber Week event in Oxon Hill, MD, Dec. 4, 2019. The event covered topics including science, technology, engineering, and math careers, internships, and scholarships.

Rapid R&D: Researchers tour destroyer for operational exchange

Researchers toured Norfolk, Virginia-based destroyer USS James E. Williams (DDG 95) to find ways for more rapid transfer of science and technology to the Navy’s fleet. “I’ve been interested for a while in getting aboard Navy ships and talking to Sailors working with sensing systems,” said Steve Bennett, materials scientist in the Material Science and Technology Division. “Before, I had a theoretical idea of how my research is applied to the Navy, but this first-hand experience provided the clarity necessary to focus my research in a way that would lend itself to more rapid transfer to the fleet.”



Drs. Luciano Boglione, Louis Pecora, John Rodgers, and Steve Bennett stop for a pose just before their operational tour aboard the USS James E. Williams (DDG 95). All four researchers work in divisions part of the Material Science and Component Technology Directorate at NRL.

Take Our Daughters and Sons to Work 2019

This celebration gives children a taste of their futures while helping them experience the working world and develop confidence. NRL created activities and programs for children to learn about their parents’ jobs, build skills, and have fun.



2019 American Geophysical Union Fellow



RUSSELL HOWARD, head of the Lab's Solar and Heliospheric Physics, Flight Projects Section, was inducted as an American Geophysical Union Fellow in 2019 for his more than 50 years of service and many contributions to the scientific community. "It's just amazing how technology has really changed. On our first mission, we didn't even have computers that displayed the image," Howard said. "We had to print out the image on a piece of paper then color and draw isophotes around the image. We did develop a display system, which built up an image on a Polaroid camera. We still have some of those pictures. Then the idea of the displays came out and became much easier. Who knows what it's going to be like in 10 years."

Presidential Early Career Award for Scientists and Engineers



ADAM DUNKELBERGER, research chemist, was recognized July 25 with the Presidential Early Career Award for Scientists and Engineers (PECASE) at a ceremony held in Washington. The PECASE award is the highest honor given by the U.S. government to scientists and engineers beginning their research careers. Dunkelberger received the award for the discovery of tunable energy relaxation in vibration-cavity polaritons; for demonstrating ultrafast modulation of surface-phonon polariton resonances; and for mentoring and supporting postdoctoral associates and students.

2019 Dr. Delores M. Etter Top Scientists and Engineers Award



RECIPIENTS

Corey Love – Emergent Scientist Investigator Category

Jason McKinney – Individual Scientist Category

The Shipboard Engagement Activity Monitoring System (SEAMS) Development Team: Scott Sarama, James Waterman, Jason Edelberg, Michael Wilson, and Dale Linne von Berg – Team Category

Congratulations!

U.S. Naval Research Laboratory welcomes
40th commander



Capt. Ricardo Vigil relieved Capt. Scott Moran and assumed command as the 40th commanding officer of the U.S. Naval Research Laboratory June 17, 2019.

NRL computer security
pioneer retires



John D. McLean, superintendent, Information Technology Division retired March 1, 2019 after 39 years of service.

NRL names Associate Director of
Research for Business Operations



Jay L. Cooper became Associate Director of Research for Business Operations February 25, 2019, responsible for providing executive management, policy development, and program administration.

U.S. Naval Research Laboratory's squadron
welcomes 13th commander



Cmdr. Jared Tharp relieved Cmdr. Erik Thomas and assumed command of the NRL's Scientific Development Squadron (VXS) 1 "Warlocks" August 2, 2019.

Clementine: 25th anniversary of a historic lunar orbiter

Developed and built by the Lab's Naval Center for Space Technology, the Deep Space Program Science Experiment (DSPSE), better known as "Clementine," launched Jan. 25, 1994 from Vandenberg Air Force Base, California. Clementine flight-qualified advanced high-tech and lightweight technologies for critical national security missions. Exceeding mission objectives, Clementine returned magnitudes of valuable lunar data for the international civilian scientific community including the first discovery of ice on the Moon. The mission also provided an opportunity to test missile intercept applications using the near-Earth asteroid Geographos as a target. Delivered in only 22 months at a cost less than \$80 million, the Lab demonstrated the great strides in developing low cost, advanced space technologies.



73 YEARS IN SPACE

1946 – 2019

A timeline that highlights some milestones in NRL's space program as it developed from those postwar years to the present.

<https://www.nrl.navy.mil/space/73-years-space-timeline>

Timeline also printed in *Future Force*, a professional magazine of the naval science and technology community published by the Office of Naval Research (Vol. 5, No. 4, 2019).

FY2019 PERSONNEL

.....
Total FTP Personnel: 2579

.....
Military on Board: 96

.....
Scientists/Engineers: 1711

Social Science	2
Psychology	9
Program Management	1
General Natural Resources Management and Biological Sciences	29
Microbiology	3
General Engineering	12
Safety Engineering	1
Fire Protection Engineering	1
Materials Engineering	61
Architecture	1
Civil Engineering	8
Environmental Engineering	4
Mechanical Engineering	119
Electrical Engineering	61
Computer Engineering	53
Electronics Engineering	357
Aerospace Engineering	83
Chemical Engineering	18
General Physical Science	54
Health Physics	11
Physics	359
Geophysics	5
Chemistry	98
Metallurgy	5
Astronomy and Space Science	28
Meteorology	54
Geology	5
Oceanography	58
Operations Research	7
Mathematics	31
Computer Science	173

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Doctorate	901

.....



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FY 2019 Source of New Funds (Actual)

	\$M Reimbursable	\$M Direct Cite	Total (\$M)
Office of Naval Research (ONR)	361.2	14.1	375.3
Naval Sea Systems Command (NAVSEA)	61.0	6.6	67.6
Space and Naval Warfare Systems Command (SPAWAR)	12.6	0.9	13.5
Naval Air Systems Command (NAVAIR)	18.5	25.1	43.6
Other Navy	104.7	17.3	122.0
All Other	<u>451.2</u>	<u>68.4</u>	<u>519.6</u>
Total Funds	1,009.2	132.4	1,141.6

FY 2019 Total New Funds by Category

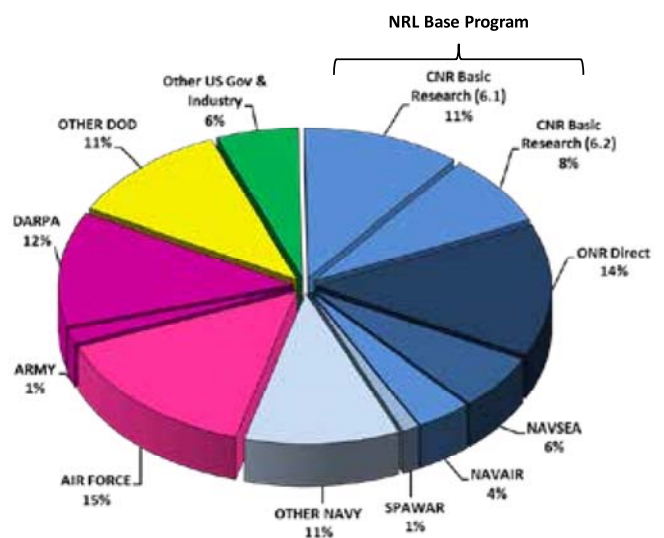
	\$M Navy	\$M Non-Navy	Total (\$M)
BA1 Basic Research	141.3	6.4	147.7
BA2 Applied Research	150.9	35.4	186.3
BA3 Advanced Technology Development	42.3	235.5	277.8
BA4 Advanced Component Development Prototypes	82.5	50.6	133.1
BA5 System Development and Demonstration	46.3	23.6	69.9
BA6 RDT&E Management Support	42.0	5.2	47.2
BA7 Operational System Development	<u>23.5</u>	<u>23.4</u>	<u>46.9</u>
Subtotal RDT&E	528.9	380.1	909.0
Operations and Maintenance	54.7	33.9	88.6
Procurement	22.2	34.4	56.6
Other	<u>16.2</u>	<u>71.3</u>	<u>87.5</u>
Total New Funds	622.0	519.6	1,141.6

FY 2019 Distribution of Funds

	\$M
Direct Labor	292.3
General Overhead	97.3
Indirect Overhead	117.9
Direct Material, Travel, and Other	149.4
Direct Contracts	<u>499.7</u>
Total Costs*	1,156.6

*Costs based on CFO statements; direct contracts include costs for reimbursable-funded contracts and obligations for direct cite-funded contracts.

RESEARCH FUNDING



All data as of September 30, 2019.



Chris Depuma, U.S. Naval Research Laboratory program manager for Photovoltaic Direct Current to Radio Frequency Antenna Module (PRAM), catalogs data during testing of PRAM inside thermal vacuum chamber. PRAM is a space solar power system that uses solar cells to collect energy to convert to direct current, generating a microwave signal that then uses an antenna to transport energy to the earth. (U.S. Navy photo by Jonathan Steffen)

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