Welcome Aboard

Naval Research Laboratory

WASHINGTON, DC

http://www.nrl.navy.mil

CAPT Paul C. Stewart is the 36th Commanding Officer of the Naval Research Laboratory. He directs the activities of more than 2700 scientists, engineers, and support personnel in their mission to conduct leading-edge research and provide new technological capabilities to the Navy and Marine Corps.

Capt. Stewart holds a B.S. in mathematics from Hartwick College, an M.S. in physics (meteorology and oceanography) from the Naval Postgraduate School, and an M.S. in national security strategy from the National War College. He was commissioned at Officer Candidate School, Newport, Rhode Island. His operational tours include assignment on board USS *Constant* (MSO 427) as Executive Officer; on board USS *Princeton* (CG 59) as Combat Information Center and Assistant Operations Officer; at the Naval Pacific Meteorology and Oceanography Center as Command Duty Officer; and on board USS *George Washington* (CVN 73) as Staff Oceanographer, Assistant Operations Officer, and Fleet Tactical Action Officer.

His other billets have included requirements officer for the Oceanographer of the Navy; Special Assistant for Ocean Resources and International Activities to the Assistant Secretary of the Navy (Installations and Environment); Commanding Officer/Director of the National Ice Center; Deputy Director for the Ocean Battlespace Sensing Department at the Office of Naval Research (ONR); and Division Director of the Ocean, Atmospheric and Space Sensing and Systems Division at ONR.

His awards include the Legion of Merit, two Meritorious Service Medals, three Navy and Marine Corps Commendation Medals, four Navy and Marine Corps Achievement Medals, and various campaign and service awards.

Dr. John A. Montgomery is the Director of Research of the Naval Research Laboratory, where he oversees research and development programs with expenditures of approximately $1 billion per year.

Dr. Montgomery holds a B.S., M.S., and Ph.D. in physics. He joined NRL in 1968 as a research physicist in the Advanced Techniques Branch of the Electronic Warfare Division. In 1980, he was selected to head the Off-Board Countermeasures Branch. In 1985, he was appointed to the Senior Executive Service (SES) and was selected as Superintendent of the Tactical Electronic Warfare Division. He led that division until he was appointed Director of Research in 2002. Throughout his career, Dr. Montgomery has been responsible for numerous electronic warfare systems that have been developed/approved for operational use by the Navy and other services, and has had great impact through the application of advanced technologies to solve unusual or severe operational deficiencies noted during world crises.

Dr. Montgomery was awarded the Presidential Rank of Meritorious Executive in 2007, as well as in 1988 and 1999. He was also awarded the Presidential Rank of Distinguished Executive in 1991 and 2002. He received the DoD Distinguished Civilian Service Award in 2001, the DON Distinguished Civilian Service Award in 1999, and the DON Meritorious Civilian Service Award in 1986. He also received the Laboratory Director of the Year Award from the Federal Laboratory Consortium for Technology Transfer in 2006, the 1997 Dr. Arthur E. Bisson Prize for Naval Technology Achievement, awarded by the Chief of Naval Research in 1998, and the Association of Old Crows (Electronic Defense Association) Joint Services Award in 1993. He was an NRL Edison Scholar, and is a member of Sigma Xi. He served as the U.S. National Leader of The Technical Cooperation Program's multinational Group on Electronic Warfare until 2002, and served a five-year term as its Executive Chairman.

Welcome

Welcome to the Naval Research Laboratory, a vital and innovative research institution with a proud, 85-year heritage of discovery and invention. As the Department of the Navy's corporate laboratory, NRL performs a wide range of basic and applied research leading to future naval materials, components, sensors, systems, and capabilities. Our efforts push beyond current technology boundaries to make our Navy and Marine Corps the most advanced in the world.

NRL's most important asset is its people. We number 2555*, including 767 Ph.D.'s, a Nobel laureate, and many aspirants. We are a motivated, inquiring, and diverse community.

Our scientists, engineers, and support personnel work in a campus-like atmosphere that fosters creative thought and encourages interdisciplinary studies. Our collaborations are not only NRL-wide, but extend to other professionals in government, academia, and industry. We have world-class facilities, attract and retain highly qualified staff, and take pride in the publications, patents, and licenses that recognize the accomplishments of our work. We never lose sight of our primary mission – to perform the research necessary to ensure the technological superiority of the U.S. Navy and Marine Corps against any threat.

NRL places a high value on scientific and technical excellence, and on producing relevant research results. Our goal is to continue to create a nurturing climate for inventiveness and productivity that supports the needs of the Naval services and our nation.

*Current as of February 10, 2009.

Mission

NRL conducts a broadly based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, equipment, systems, and ocean, atmospheric, and space sciences and related technologies. To meet this goal, NRL provides

- primary in-house research for the physical, engineering, space, and environmental sciences;
- broadly based exploratory and advanced development programs in response to identified and anticipated Navy needs;
- broad multidisciplinary support to the Naval Warfare Centers;
- and space and space systems technology development and support.

History

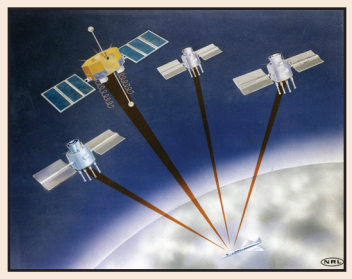
The Naval Research Laboratory began operations in 1923, seven years after inventor Thomas Edison suggested that the Government establish "a great research laboratory." The new institution on the Potomac River boasted two research divisions, Radio and Sound. Divisions in Heat and Light (later Optics), Physical Metallurgy, Chemistry, and Mechanics and Electricity soon followed. Early research achievements included the explanation of the radio "skip distance effect"; the development of the fathometer and early sonar; and the development of the first operational American radar, in time for use in World War II.

NRL's Jerome Karle was awarded the Nobel Prize for Chemistry in 1985 for pioneering work in using electron and X-ray diffraction methods for understanding the structure of complicated organic molecules. From this work, Isabella Karle developed methods that enabled the characterization of potent toxins, antitoxins, heart drugs, antibiotics, anti-addictive substances, anticarcinogens, antimalarials, and explosives and propellants.

The period after World War II was a time of great expansion for NRL. The Laboratory continued to develop its programs in radio, radar, underwater sound, chemistry, metallurgy, and optics. It also added new research areas in nuclear science and cosmic rays; upper atmosphere research, using V-2 and successor rockets; radio astronomy; electron and X-ray diffraction analysis of molecular structures; and enhanced programs in antisubmarine warfare, electronic countermeasures, surface chemistry, solar physics, and more.

The Laboratory's Vanguard satellite project was possibly its most famous postwar R&D program. Less well known was its development and launch of America's first operational intelligence satellite in 1960, an achievement not declassified until 1998. Laboratory scientists have designed, built, and launched more than 85 satellites since the late 1950s, including prototypes for the Global Positioning System (GPS). In the oceans, NRL's Ocean Engineering Branch, working with the Navy's Deep Submergence Project Office, acquired a worldwide reputation for searching the oceans' abyssal depths. On the molecular scale, NRL's Dr. Jerome Karle in the Laboratory for Structure of Matter pioneered work that led to his receiving the Nobel Prize for Chemistry in 1985.

NRL's Project Vanguard was a progenitor of American space exploration. *Vanguard I*, launched in 1958, achieved the highest altitude of any man-made vehicle to that time, confirmed the Earth's pear shape, initiated the use of miniature circuits, and was the first satellite to use solar cells as a power source. *Vanguard I* still orbits the Earth.



In 1964, NRL's Roger Easton developed the satellite-based time navigation (TIMATION) concept that formed the basis of today's Global Positioning System (GPS). NRL launched a series of TIMATION satellites, the last of which was the first demonstration satellite for the Navstar GPS. This system is a constellation of orbiting satellites providing precise time and navigation data to military and civilian users.

The Laboratory's current research program spans the scientific spectrum, including studies in biomolecular engineering, remote sensing, virtual reality, superconductivity, nanoscience, and solar corona monitoring. Indeed, NRL is the Navy's lead laboratory in space systems research, fire research, tactical electronic warfare, microelectronic devices, artificial intelligence, and research in ocean and atmospheric sciences. With 85 years of growth and development, NRL shines as the Navy's corporate laboratory and as one of the Federal Government's leading in-house centers for innovative research in the national interest.

Facilities

In support of its diverse programs, NRL has an impressive array of modern tools for research, many of which are unique. A sampling is listed below.

- Distributed Center for High Performance Computing
- Laboratory for Large Data Research
- Global Information Grid – Evaluation Facility
- Robotics and Autonomous Systems Laboratory
- Virtual Reality Laboratory
- Cyber Defense Development Laboratory
- Mobile and Dynamic Network Laboratory
- Central Target Simulation Facility
- Versatile facilities for high magnetic field and cryogenics research
- Variety of GaAs and solid-state lasers, including devices of very high power and brightness
- Institute for Nanoscience
- Nike krypton-fluoride 5-kilojoule laser
- Spacecraft fabrication, assembly, test, shock and vibration facilities
  - Radio frequency anechoic chambers and controls
  - Dual 6 D.O.F. robotic lab
  - Thermal vacuum and acoustic reverberation chambers
- Satellite telemetry, tracking, and control facilities
- Advanced purification and growth facilities for optical ceramics
- Advanced Multifunction RF Concept (AMRFC) Test Bed
- High-power 94 GHz tracking radar system (WARLOC)
- Optical Fiber Fabrication Facility
- Missile Seeker Evaluation Facility
- Table-Top Terawatt (T3) laser
- Large-volume space chamber
- Laboratory for Advanced Materials Synthesis
- Molecular Beam Epitaxy Center for advanced electronic devices
- Trace element mass spectrometer
- Matrix assisted pulsed laser evaporation system
- Microwave processing facility
- Railgun system
- Laboratory for Structural Acoustics
  - Acoustic Holography Pool Facility
  - In-Air Acoustic Laboratory
- Naval Prototype Optical Interferometer
- Ocean Dynamics and Prediction Network
- Environmental Microscopy Facility
- Satellite Receiving and Processing Center
- Space Instrument Test Facility
- Ocean Optics Facility
- Sea-going Measurement Systems Facility
- WindSat Spaceborne Sensor

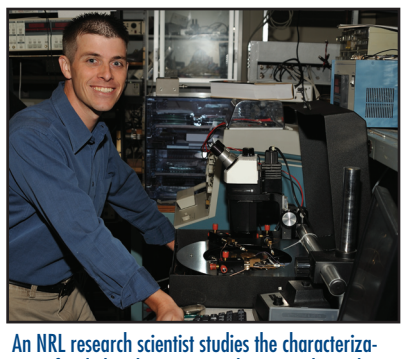
NRL–Stennis Space Center (Bay St. Louis, Mississippi) and NRL–Monterey (California) perform R&D in marine geology and geophysics, oceanography, ocean acoustics, and atmospheric sciences. Other NRL locations include the Chesapeake Bay Detachment in Chesapeake Beach, Maryland; two smaller Maryland sites, Pomonkey and Tilghman Island; and the Marine Corrosion Facility in Key West, Florida.

Mobile research platforms contribute greatly to NRL's research. These include three uniquely configured NP-3D Orion and two RC-12 aircraft at the Scientific Development Squadron One (VXS-1) located at the Patuxent River Naval Air Station in Lexington Park, Maryland; and one ship, the ex-USS *Shadwell* (LSD 15), berthed in Mobile Bay, Alabama.

Organization and Administration

The Naval Research Laboratory is a field command under the Chief of Naval Research, who reports to the Secretary of the Navy via the Assistant Secretary of the Navy for Research, Development, and Acquisition.

Heading the Laboratory with joint responsibilities are CAPT Paul C. Stewart, USN, Commanding Officer, and Dr. John A. Montgomery, Director of Research. Line authority passes from the Commanding Officer and the Director of Research through the Associate Directors to the research divisions. Research is performed in the following organizational units: Systems Directorate, Materials Science and Component Technology Directorate, Ocean and Atmospheric Science and Technology Directorate, and Naval Center for Space Technology.



An NRL research scientist studies the characterization of wide bandgap semiconductors such as silicon carbide and gallium nitride for power electronic and optoelectronic applications.

NRL operates as a Navy Working Capital Fund (NWCF) activity. As an NWCF activity, all costs, including overhead, are paid by benefiting customers. Funding in FY2008 came from the Chief of Naval Research, the Naval Systems Commands, and other Navy sources; government agencies, such as the U.S. Air Force, the Defense Advanced Research Projects Agency, the Department of Energy, and the National Aeronautics and Space Administration; and several nongovernment activities.

NRL People

NRL today* employs 2555 personnel — 30 military officers, 75 enlisted men and women, and 2450 civilians. In the research staff, there are 767 doctoral degrees, 337 master's degrees, and 570 bachelor's degrees. The support staff assists the research staff by providing administrative help, computer-aided design, machining, fabrication, technical information services, exhibit services, personnel development, information retrieval, computer support, contracting, and supply management services.

* As of February 10, 2009.

SCIENTISTS/ENGINEERS:	1541
Physicists	393
Chemists	103
General Physical Scientists	45
Mathematicians	28
Astronomers	35
Metallurgists	11
Computer Scientists	141
Electronics Engineers	352
Mechanical Engineers	62
Aerospace Engineers	54
Oceanographers	53
Meteorologists	51
Other	213

Technology Transfer

Many of NRL's research efforts have spun off commercial applications in addition to the defense-oriented objectives for which they were originally developed. NRL developments in areas such as radar, radio, satellite navigation, fiber optics, chemical and biological sensors, and a wide variety of materials and coatings have made significant contributions to the safety and welfare of the civilian community.

NRL has licensed the Transparent Spinel Ceramic technology to MER Corporation.

The transitioning of NRL's dual-use technologies to the private sector is facilitated by NRL's Technology Transfer Office. This office implements the Technology Transfer Act by which Congress authorized Federal Laboratories such as NRL to participate in Cooperative Research and Development Agreements (CRADAs) and patent licensing agreements. NRL has entered into more than 250 CRADAs with industry, universities, nonprofit organizations, and other government organizations. In addition, NRL has executed over 80 licenses to its inventions. These licenses authorize the licensees to manufacture and sell a product based on NRL's technology in exchange for royalty payments that are shared by the Laboratory and the inventors.

Current Research

The list below outlines broad fields of NRL research and some of the specific topics that NRL is investigating for the benefit of the Naval services and other sponsoring organizations. Some details of this work are published in the annual *NRL Review*.

Computer Science and Artificial Intelligence

- Advanced distributed simulations for design and warfighting
- Methods of specifying, developing, and verifying software
- Expert systems for resource allocation, signal identification, operational planning, target classification, and robotics
- Machine learning
- Information security
- Virtual reality and interactive visual systems
- Distributed interactive simulations

Device Technology

- RF photonics
- Fiber sensor devices
- Quantum electronics
- Power electronic devices
- IR sensors
- Solid state devices
- Radiation-hardened electronics
- Microwave and millimeter wave components and techniques
- Hydrogen masers for GPS
- Aperture syntheses
- Vacuum electronics
- Parallel scientific libraries, algorithms for massively parallel, shared memory systems
- Digital progressive HDTV for scientific visualization
- High-performance, all-optical networking
- Signature technology

Directed Energy Technology

- Laser propagation
- High-power microwave sources
- Pulsed power
- High-energy and chemical lasers
- Pulse detonation engines
- Ram accelerators

Electronic Warfare

- Repeaters/jammers, EO/IR active countermeasures and decoys
- EW/C^{3}CM systems and technology
- Intercept receivers, signal processing, and identification systems
- Unmanned autonomous vehicles (UAVs)
- Effectiveness of Naval EW Systems (ENEWS)
- Threat and EW systems modeling and simulation
- Microwave photonics
- Advanced Multifunction RF Concept (AMRFC) Test Bed
- High-power 94 GHz tracking radar system (WARLOC)

Enhanced Maintainability, Reliability, and Survivability Technology

- Coatings
- Lubricants and greases
- Water additives and cleaners
- Fire safety and fire suppression
- Laser hardening
- Satellite survivability
- Missile blast survivability

Environmental Effects on Naval Systems

- Meteorological effects on electro-optical system performance
- Air quality in confined spaces
- Solar and geomagnetic activity
- Oceanographic effects on acoustic system performance
- Magnetospheric and space plasma effects
- Contaminant transport
- Structure and variability of the middle atmosphere

Information Technology

- Antijam communication links
- High-assurance computer systems
- Information security
- Communication and information theory
- Networking: mobile, local, metro wide area
- Telecommunications: terrestrial, littoral, space
- Switched optical networking
- Distributed applications
- Battle management information systems
- High-performance computing
- Next-generation signaled optical network architecture
- Teraflop scalable shared memory
- Massively parallel computer architectures
- Distributed, secure, and mobile information infrastructures
- High-end, progressive, HDTV imagery distribution
- Satellite and space communication systems
- Voice/data compression technology
- Medium- and high-frequency propagation research
- Shipboard electromagnetic interference mitigation technology
- Reconnaissance, surveillance, targeting development

Marine Geosciences

- Geoacoustic modeling
- Marine seismology
- Geomagnetic modeling
- Geotechnology/sediment dynamics
- Geospatial information systems

Materials

- Biocorrosion
- Biomolecular engineering
- Theory of materials
- Mobility fuels/explosives/propellants
- Materials processing
- Advanced alloy systems
- Rapid solidification technology
- High-temperature materials
- Laser fabrication and processing
- Ceramics and composite materials
- Superconductivity
- Thin films and coatings
- Structural characterization of materials

Meteorology

- Air/sea interaction effects on operations
- Data assimilation techniques
- Global/regional forecasting
- Tactical database development
- Meteorological tactical decision aids

Nanoelectronics and Microelectronics

- Novel, nanostructure-based sensors
- New materials and nano devices

Oceanography

- Open-ocean, littoral, and nearshore oceanographic forecasting
- Shallow water tactical oceanography
- In situ oceanographic sensors and data fusion
- Bio-optical and fine-scale physical processes
- Waves, tides, and surf prediction
- Data assimilation techniques
- Remote sensing of in-water environmental parameters using hyperspectral imaging

Plasma Physics

- Radiation hydrodynamics
- Laser plasma interactions
  - Pulsed power
  - Large-area plasma processing
  - Space plasma simulations

Space Research and Technology

- Advanced space systems
- Ionospheric studies
- Space sensing applications
- Sun Earth interactions
- Space environment astrophysics
- Remote sensing of the Earth from space
- Satellite communications
- Spacecraft design, engineering, and integration
- Satellite ground station design
- Navigation technology
- Astrodynamics
- Mesospheric studies

Surveillance and Sensor Technology

- Imaging radars
- Target classification/identification
- Underwater acoustic propagation, reverberation, and noise
- Electromagnetic sensors–gamma ray to RF wavelengths
- SQUID for magnetic field detection
- Low observables technology

Undersea Technology

- Anechoic coatings
- Fiber-optic acoustic sensors
- Shallow water environmental acoustics and sensor systems
- Target reflection, diffraction, and scattering
- Unmanned undersea vehicle dynamics
- Weapons launch