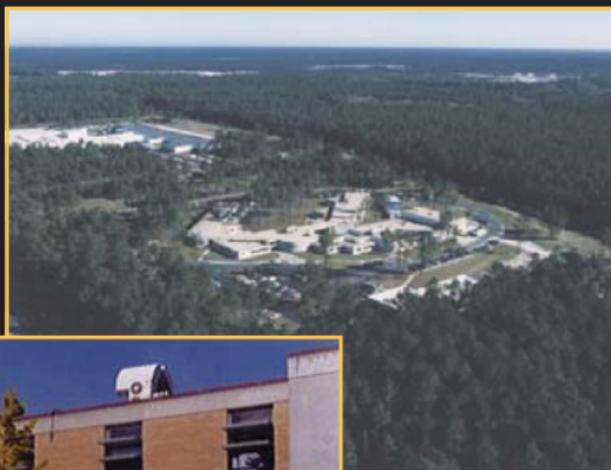


NAVAL RESEARCH LABORATORY

Guide

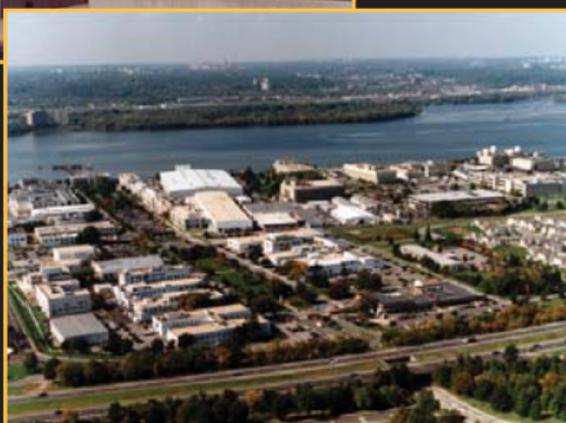
A photograph of a scientist in a white lab coat and safety glasses, sitting and working with a small device. The scene is illuminated by two large, bright yellow circular lights, creating a high-contrast, dramatic effect. The background shows a laboratory setting with various equipment and a red wall.



STENNIS



MONTEREY



WASHINGTON

The Naval Research Laboratory has major facilities on the banks of the Potomac River in southwest Washington, DC; at the Stennis Space Center, Mississippi; and in Monterey, California. NRL was dedicated on July 2, 1923, and is the Navy's only corporate laboratory, charged with the mission of conducting a broadly based, multidisciplinary program of scientific research and advanced technological development.

Research is directed toward maritime applications of new and improved materials; techniques; equipment; systems; ocean, atmospheric, and space sciences; and related technologies. The Navy has established NRL as its "lead laboratory" in space technology, fire research, and artificial intelligence.

**COMMANDING OFFICER
CAPT D.M. SCHUBERT, USN**

**DIRECTOR OF RESEARCH
DR. J.A. MONTGOMERY**

URL: <http://www.nrl.navy.mil>



**Current Research
and Development Efforts 2**

**Research in NRL's
Divisions/Departments 8**

For technical questions or to submit a resumé, simply use the e-mail link found in each research division/department in this guide. The e-mail in each research division title goes to two technical people from that division.

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CURRENT RESEARCH AND DEVELOPMENT EFFORTS

Advanced Radio, Optical, and IR Sensors

- Advanced optical sensors
- EM/EO/meteorological/oceanographic sensors
- Satellite meteorology
- Precise space tracking
- Radio/infrared astronomy
- Infrared sensors and phenomenology
- UV sensors and middle atmosphere research
- Image processing
- VLBI/astrometry
- Optical interferometry
- Imaging spectrometry
- Liquid crystal technology

Computer Science and Artificial Intelligence

- Standard computer hardware, development environments, operating systems, and run-time support software
- Methods of specifying, developing, documenting, and maintaining software
- Human-computer interaction
- Intelligent systems for resource allocation, signal identification, operational planning, target classification, and robotics
- Parallel scientific libraries
- Algorithms for massively parallel systems
- Digital progressive HDTV for scientific visualization
- Adaptive systems: software and devices
- Advanced computer networking
- Simulation management software for networked high performance computers
- Interactive 3-D visualization tools and applications
- Distributed modeling and simulation (e.g., HLA, and FOM development)
- Real-time parallel processing
- Scalable, parallel computing
- Processing graph method for parallel processing
- Teraflop scalable shared memory, massively parallel computer architectures

Directed Energy Technology

- High-energy lasers
- Laser propagation
- Solid-state and fiber lasers
- High-power microwave sources
- RAM accelerators
- Pulse detonation engines
- Charged-particle devices
- Pulse power
- DE effects

Electronic Electro-optical Device Technology

- Integrated optics
- Radiation-hardened electronics
- Nanotechnology
- Microelectronics
- Microwave and MM wave technology
- Hydrogen masers for GPS
- Aperture syntheses
- Electric field coupling
- Vacuum electronics
- Focal plane arrays
- Infrared sensors
- Radiation effects and satellite survivability
- Molecular engineering

Electronic Warfare

- EW/C2W/IW systems and technology
- COMINT/SIGINT technology
- EW decision aids and planning/control systems
- Intercept receivers, signal processing, and identification systems
- Passive direction finders
- Decoys and offboard CM (RF and IR)
- Expendable autonomous vehicles/UAVs
- Repeaters/jammers and EO/IR active countermeasures and techniques
- Platform signature measurement and management
- Threat and EW systems computer modeling and simulations
- Visualization
- Hardware-in-the-loop and flyable ASM simulators
- Missile warning infrared countermeasures
- RF environment simulators
- EO/IR multispectral/hyperspectral surveillance

Enhanced Maintainability, Reliability, and Survivability Technology

- Coatings
- Friction/wear reduction
- Water additives and cleaners
- Fire safety
- Laser hardening
- Satellite survivability
- Corrosion control
- Automation for reduced manning
- Radiation effects
- Mobility fuels
- Chemical and biological sensors
- Environmental compliance

Environmental Effects on Naval Systems

- Meteorological effects on communications
- Meteorological effects on weapons, sensors, and platform performance
- Air quality in confined spaces
- Electromagnetic background in space

- Solar and geomagnetic activity
- Magnetospheric and space plasma effects
- Nonlinear science
- Ionospheric behavior
- Oceanographic effects on weapons, sensors, and platforms
- EM, EO, and acoustic system performance/optimization
- Environmental hazard assessment
- Contaminant transport
- Biosensors
- Microbially induced corrosion

Imaging Research/Systems

- Remotely sensed signatures analysis
- Real-time signal and image processing algorithms/systems
- Image data compression methodology
- Image fusion
- Automatic target recognition
- Scene/sensor noise characterization
- Image enhancement/noise reduction
- Scene classification techniques
- Radar and laser imaging systems studies
- Coherent/incoherent imaging sensor exploitation
- Remote sensing simulation
- Hyperspectral imaging
- Microwave polarimetry

Information Technology

- High performance, all-optical networking
- Antijam communication links
- Next generation, signaled optical network architectures
- Integrated voice and data
- Information security (INFOSEC)
- Voice processing
- High performance computing
- High performance communications
- Requirement specification and analysis
- Real-time computing
- Wireless mobile networking
- Natural environments for distributed simulation
- Collaborative engineering environments
- Information filtering and fusion
- Integrated internet protocol (IP) and asynchronous transfer mode (ATM) multicasting
- Reliable multicasting
- Wireless networking with directional antennas
- Sensor networking
- Communication network simulation
- Bandwidth management (quality of service)
- High assurance software
- Distributed network-based battle management
- High performance computing supporting uniform and nonuniform memory access with single and multithreaded architectures

Distributed, secure, and mobile information infrastructures
Virtual engineering
Simulation-based virtual reality
Advanced distributed simulation
High-end, progressive HDTV imagery processing and distribution
Defensive information warfare
Virtual reality/mobile augmented reality
Motion adaptation and vestibular research
3-D multimodal interaction
Model integration/physical, environmental, biological, psychological) for simulation
Synthetic natural environments for distributed simulation
Command decision support
Data fusion

Marine Geosciences

Marine seismology, including propagation and noise measurement
Geoacoustic modeling in support of acoustic performance prediction
Geomagnetic modeling in support of nonacoustic system performance prediction
Static potential field measurement and analysis (gravity and magnetic) in support of navigation and geodesy
Geotechnology/sediment dynamics affecting mine warfare and mine countermeasures
Foreshore sediment transport
Geospatial information, including advanced seafloor mapping, imaging systems, and innovative object-oriented digital mapping models, techniques, and databases

Materials

Superconductivity
Magnetism
Biological materials
Materials processing
Advanced alloy systems
Solid free-form fabrication
Environmental effects
Energetic materials/explosives
Aerogels and underdense materials
Nanoscale materials
Nondestructive evaluation
Ceramics and composite materials
Thin film synthesis and processing
Electronic and piezoelectric ceramics
Thermoelectric materials
Active materials and smart structures
Computational material science
Paints and coatings
Flammability
Chemical/biological materials

Spintronic materials and half metals
Biomimetic materials
Multifunctional materials

Meteorology

Global, theater, tactical-scale, and on-scene numerical weather prediction
Data assimilation and physical initialization
Atmospheric predictability and adaptive observations
Adjoint applications
Marine boundary layer characterization
Air/sea interaction; process studies
Coupled air/ocean/land model development
Tropical cyclone forecasting aids
Satellite data interpretation and application
Aerosol transport modeling
Meteorological applications of artificial intelligence and expert systems
On-scene environmental support system development/nowcasting
Tactical database development and applications
Meteorological tactical decision aids
Meteorological simulation and visualization

Ocean Acoustics

Underwater acoustics, including propagation, noise, and reverberation
Fiber-optic acoustic sensor development
Deep ocean and shallow water environmental acoustic characterization
Undersea warfare system performance modeling, unifying the environment, acoustics, and signal processing
Target reflection, diffraction, and scattering
Acoustic simulations
Tactical decision aids
Sonar transducers
Dynamic ocean acoustic modeling

Oceanography

Oceanographic instrumentation
Open ocean, littoral, polar, and nearshore oceanographic forecasting
Shallow water oceanographic effects on operations
Modeling, sensors, and data fusion
Bio-optical and fine-scale physical processes
Oceanographic simulation and visualization
Coastal scene generation
Waves, tides, and surf prediction
Coupled model development
Coastal ocean characterization
Oceanographic decision aids
Global, theater, and tactical scale modeling
Remote sensing of oceanographic parameters
Satellite image analysis

Space Systems and Technology

- Space systems architectures and requirements
- Advanced payloads and optical communications
- Controllers, processors, signal processing, and VLSI
- Precision orbit estimation
- Onboard autonomous navigation
- Satellite ground station engineering and implementation
- Tactical communication systems
- Spacecraft antenna systems
- Launch and on-orbit support
- Precise Time and Time Interval (PTTI) technology
- Atomic-time/frequency standards/instrumentation
- Passive and active ranging techniques
- Design, fabrication, and testing of spacecraft and hardware
- Structural and thermal analysis
- Attitude determination and control systems
- Reaction control
- Propulsion systems
- Navigation, tracking, and orbit dynamics
- Spaceborne robotics applications

Surveillance and Sensor Technology

- Point defense technology
- Imaging radars
- Surveillance radars
- Multifunction RF systems
- High-power millimeter-wave radar
- Target classification/identification
- Airborne geophysical studies
- Fiber-optic sensor technology
- Undersea target detection/classification
- EO/IR multispectral/hyperspectral detection and classification
- Sonar transducers
- Electromagnetic sensors—gamma ray to rf wavelengths
- SQUID for magnetic field detection
- Low observables technology
- Ultrawideband technology
- Interferometric imagery
- Microsensor system
- Digital framing reconnaissance canvas
- Biologically based sensors
- Digital radars and processors

Undersea Technology

- Autonomous vehicles
- Bathymetric technology
- Anechoic coatings
- Acoustic holography
- Unmanned undersea vehicle dynamics
- Weapons launch

**RESEARCH IN NRL'S
DIVISIONS/DEPARTMENTS**

**INSTITUTE FOR NANOSCIENCE
NanoInfo@nrl.navy.mil**

Nanoassembly

Nanofilaments: Interactions, manipulation, and assembly
Chemical assembly of multifunctional electronics
Directed self-assembly of biologically based nanostructures
Template-directed molecular imprinting
Chemical templates for nanocluster assembly

Nano-optics

Photonic bandgap materials
Organic and biological conjugated luminescent quantum dots
Organic light emitting materials and devices
Nanoscale-enhanced processes in quantum dot structures

Nanochemistry

Functionalized dendrimeric materials
Polymers and supramolecules for devices

Nanoelectronics

Coherence, correlation, and control in nanostructures
Neural-electronic interfaces

Nanomechanics

Nanoelastic dynamics

SYSTEMS DIRECTORATE

**SIGNATURE TECHNOLOGY OFFICE
SignTechInfo@nrl.navy.mil**

Basic and applied research
Electromagnetic scattering — measurements and codes
EO/IR fundamentals
Materials

RADAR DIVISION
RadarInfo@nrl.navy.mil

Radar Analysis

Target signature prediction
Electromagnetics and antennas
Airborne early-warning radar (AEW)
Inverse synthetic aperture radar (ISAR)
Space-time adaptivity

Advanced Radar Systems

High-frequency over-the-horizon radar
Signal analysis
Real-time signal processing and equipment
Computer Aided Engineering (CAE)
Electromagnetic Compatibility (EMC)
Electromagnetic Interference (EMI)
Mark XII IFF improvements
Future identification technology

Surveillance Technology

Shipboard surveillance radar
Ship self-defense
Electronic counter-countermeasures
Target signature recognition
Digital T/R modules
Sea clutter characterization
Ultrawideband technology
Dynamic waveform diversity
Information extraction
Ballistic missile defense
Mine detection

INFORMATION TECHNOLOGY DIVISION
ITDInfo@nrl.navy.mil

**Navy Center for Applied Research in
Artificial Intelligence**

Intelligent decision aids
Natural language interfaces
Intelligent software agents
Machine learning
Robotics software and computer vision
Neural networks
Novel devices/techniques for HCI
Spatial Audio
Immersive Simulation

Transmission Technology

Arctic communication
Communication system architecture
Communication antenna/propagation technology
Communications intercept systems
Signal analysis systems
Virtual engineering

Center for High Assurance Computer Systems

- Security architecture
- Formal specification/verification of system security
- COMSEC application technology
- Secure networks
- Secure databases
- Software engineering for secure systems
- Key management and distribution
- Certification and Infosec Engineering
- Formal methods for requirements specification and verification
- Security product development

Networks and Communication Systems

- Communication system engineering
- Mobile, wireless networking technology
- Bandwidth management (quality of service)
- Joint service tactical networking
- Integration of communication and C2 applications
- Automated testing of highly mobile tactical networks
- Reliable multicast protocols and applications
- Integrated IP and ATM multicasting
- Communication network simulation
- Networking protocols for directional antennas
- Policy-based network management
- Tactical voice-over IP
- Sensor networks
- Fastlane and Taclane crypto testing

Advanced Information Technology

- Multiagent systems
- Scalable parallel computing
- Joint C4ISR and operational M&S systems
- Data fusion
- 3-D multimodal interaction
- Real-time parallel processing
- Distributed modeling and simulation (e.g., HLA, FOM development)
- Spatial feature temporal analysis
- Virtual reality/mobile augmented reality
- Natural environments for distributed simulation
- Collaborative engineering enterprise
- Model integration (physical, environmental, biological, psychological) for simulation
- Motion adaptation and vestibular research
- Agent technology for command center

Center for Computational Science

- Transparent optical network research and design
- Parallel computing
- Scalable high performance computing for Navy and DoD
- Distributed computing environments
- Scientific visualization
- Advanced networking streams
- High-definition video technology

End user support for information technology and operational networks
Lab-wide support for web, email, and other information services
Test bed for global information grid

OPTICAL SCIENCES DIVISION

OptInfo@nrl.navy.mil

Infrared Materials and Chemical Sensors

Advanced infrared glasses and fibers
IR fiber-optic materials and devices
IR fiber chemical and environmental sensors
IR transmitting windows
Transparent armor material
Planar waveguide devices
IR nonlinear materials

Optical Physics

Laser materials diagnostics
Nonlinear frequency conversion
Optical instrumentation and probes
Optical interactions in semiconductor superlattices and organic solids
Laser-induced reactions
Organic light emitting devices
Nano-optical and electrical research

Applied Optics

Detection signal processing studies
Optical and IR countermeasures
Optical technology
Ultraviolet component development and UV countermeasures
Multispectral sensors and processing
Missile warning sensor technology
UV, visible, and IR imager development
Framing reconnaissance sensors
Novel optical components
IR Range Facility
IR low observables
Multispectral/hyperspectral/detection algorithms
EO/IR systems analysis
Atmospheric IR measurements
Ship IR signatures
Airborne IR search and track technology

Photonics Technology

Fiber and solid-state laser/sources
High-speed (<100 fs) optical probing
High-power fiber amplifiers
High-speed fiber-optic communications
Antenna remoting
Free space communication
Photonic control of phased arrays
Optical clocks
Microwave photonics

Optical Techniques

Radiation effects
Fiber lasers/sources and amplifiers
Fiber-optic materials and fabrication
Fiber Bragg grating sensors/systems for smart structures
Fiber-optic sensors/systems (acoustic, magnetic, gyroscopes)
Integrated optics
Optical sources for sensors

TACTICAL ELECTRONIC WARFARE DIVISION EWInfo@nrl.navy.mil

Offboard Countermeasures

Expendable technology and devices
Unmanned air vehicles
Offboard payloads
Decoys

Electronic Warfare Support Measures

Intercept systems and direction finders
RF signal simulators
Systems integration
Command and control interfaces
Signal processing

Airborne Electronic Warfare Systems

Air systems development
Penetration aids
Power source development
Jamming and deception
Millimeter-wave technology
Communications CM

Ships Electronic Warfare Systems

Ships systems development
Jamming technology
Deception techniques
EW antennas

Advanced Techniques

Analysis and modeling simulation
New EW techniques
Experimental systems
EW concepts
Infrared technology

Integrated EW Simulation

Hardware-in-the-loop simulation
Data management technology
Flyable ASM seeker simulators
Foreign military equipment exploitation

**MATERIALS SCIENCE AND COMPONENT
TECHNOLOGY DIRECTORATE**

**LABORATORY FOR STRUCTURE
OF MATTER**

MatterInfo@nrl.navy.mil

**CHEMISTRY DIVISION
ChemInfo@nrl.navy.mil**

Chemical Diagnostics

Optical diagnostics of chemical reactions
Kinetics of gas phase reactions
Trace analysis
Atmosphere analysis and control
Ion/molecule processes
Environmental chemistry/microbiology
Methane hydrates
Laboratory on a chip

Materials Chemistry

Synthesis and evaluation of innovative polymers
Functional organic coatings
Polymer characterization
Magnetic resonance
Degradation and stabilization mechanisms
High-temperature resins
OMCVD materials

**Center for Corrosion Science
and Engineering**

Materials failure analysis
Marine coatings
Cathodic protection
Corrosion science
Environmental fracture and fatigue
Corrosion control engineering

Surface/Interface Chemistry

Tribology
Surface properties of materials
Surface/interface analysis
Chemical/biological microdetectors
Surface reaction dynamics
Diamond films
Nanostructures
Electrochemistry
Synchrotron radiation applications
Radiation detection and measurement

Safety and Survivability

- Combustion dynamics
- Fire protection and suppression
- Personnel protection
- Modeling and scaling of combustion systems
- Chemical and biological defense
- Mobility fuels

MATERIALS SCIENCE AND TECHNOLOGY DIVISION

MaterialInfo@nrl.navy.mil

Physical Metallurgy

- Ferrous and intermetallic alloys
- Synthesis/processing of metals
- Welding technology
- Micro-/nanostructure characterization

Directed Energy Effects

- Laser-hardened materials and systems
- Laser point defense
- Nanostructure optics
- High-power laser interactions with materials and systems
- Atomic and molecular interactions with surfaces and interfaces
- Spectroscopy of superconductors

Material Physics

- Superconducting materials
- Magnetic materials
- Thermoelectric materials
- Nonlinear (chaotic) phenomena

Multifunctional Materials

- Composite multifunctional material systems
 - Structure-plus-power
 - Structure-plus-conduction
 - Structure-plus-acoustics
- Corrosion simulation and control
 - Modeling of electrochemical corrosion systems
 - Evaluation of cathodic protection system performance
- Computational modeling of active materials
- Mesoscale material characterization and simulation
 - Image-based modeling
 - Materials by design
- Biochemical surrogates and response simulation
- Synthesis and processing of advanced ceramics
 - High energy density dielectrics
 - Piezoelectrics
- Rapid prototyping

Surface Modification

- Thin film deposition
 - Pulsed laser deposition
 - Ion-beam-assisted deposition
 - Variable balance magnetron sputtering

Ion engineering
 Ion implantation
 Reactive ion etching
Functional materials
 Optoelectronics
 Electroceramics
 Chemical sensors
Analysis
 Surface analysis by accelerator techniques
 Trace element accelerator mass spectrometry
 Mechanical loss spectroscopy

Computational Materials Science

Condensed matter theory
Electronic structure of solids and clusters
Molecular dynamics
Quantum many-body theory
Theory of magnetic materials
Theory of alloys
Semiconductor and surface physics
Theoretical studies of phase transitions
Atomic physics theory
Theory of piezoelectric materials

LABORATORY FOR COMPUTATIONAL PHYSICS AND FLUID DYNAMICS ComPhysInfo@nrl.navy.mil

Reactive Flows

Fluid dynamics in combustion
Turbulence in compressible flows
Multiphase flows
Turbulent jets and wakes
Turbulence modeling
Computational hydrodynamics
Propulsion systems analysis
Contaminant transport modelling
Fire and explosion mitigation

Computational Physics Developments

Laser plasma interactions
Inertial confinement fusion
Solar physics modeling
Dynamical gridding algorithms
Advanced graphical and parallel processing systems
Electromagnetic and acoustic scattering
Microfluidics
Fluid structure interaction
Shock and blast containment

PLASMA PHYSICS DIVISION PlasmaInfo@nrl.navy.mil

Radiation Hydrodynamics

Radiation hydrodynamics of Z-pinchs and laser-produced plasmas
X-ray source development

Cluster dynamics in intense laser fields
X-ray channeling and propagation
Plasma kinetics for directed energy and fusion applications
Plasma discharge physics
Dense plasma atomic physics, equation of state
Numerical simulation of high-density plasma

Laser Plasma

Nuclear weapons stockpile stewardship
Laser fusion, inertial confinement
Megabar high-pressure physics
Rep-rate KrF laser development
Strongly coupled plasmas
Laser fusion technology
Laser fusion energy

Charged Particle Physics

Electrodeless plasma discharges for lighting
Applications of modulated electron beams
Rocket, satellite, and shuttle-borne natural and active experiments
Laboratory simulation of space plasma processes
Large-area plasma processing sources
Atmospheric and ionospheric GPS sensing
Ionospheric effects on communications
Electromagnetic launchers

Pulsed Power Physics

Production, focusing, and propagation of intense electron and ion beams
High-power, pulsed radiography
Plasma radiator and bremsstrahlung diode source development
Capacitive and inductive energy storage
Nuclear weapons effects simulation
Electromagnetic launchers
Ion-beam inertial confinement fusion

Beam Physics

Advanced accelerators and radiation sources
Microwave, plasma, and laser processing of materials
Microwave sources: Magnicons and gyrotrons
Nonlinear dynamics
Ultrahigh intensity laser-matter interactions
Free electron lasers and laser synchrotrons
Theory and simulation of space and solar plasmas
Ionospheric modification
Space weather modeling
Rocket and space diagnostics
Laser propagation in the atmosphere

**ELECTRONICS SCIENCE AND
TECHNOLOGY DIVISION
ElecInfo@nrl.navy.mil**

Electronic Materials

Preparation and development of magnetic, dielectric, optical, and semiconductor materials including micro and nanostructures
Electrical, optical, and magneto-optical studies of semiconductor microstructures and nano-structures, superlattices, surfaces, and interfaces
Impurity and defect studies
Surface research and interface physics
Theoretical solid state physics

Microwave Technology

Microwave and millimeter-wave integrated circuits and components research
High-frequency device design, simulation, and fabrication
Reliability and failure physics of electronic devices and circuits
High temperature superconductors

Power Electronics

Power device design, simulation, and fabrication
High voltage/high temperature power device and components research
Growth and characterization of wide bandgap and thin film materials for power devices
Wafer bonding for power devices and novel substrates
Reliability and failure physics of power devices

Nanoelectronics

Characterization of nanosurfaces and interfaces
Nanoelectronic device research and fabrication
Processing research for nanometric devices

Radiation Effects

Space experiments and satellite survivability
Single event and total ionizing dose effects
Radiation tolerant ultralow-power microelectronics/design and test
Ultrafast charge collection
Environmental hazard remediation
Advanced photovoltaic technologies
Femtosecond laser research
Radiation effects in microelectronics and photonics

Solid State Devices

Solid state optical sensors
Hardening of electronic devices, circuits, and optoelectronic sensors
Very far infrared photodiodes/arrays
Microelectronics device research and fabrication
Solid state circuits research
Signal processing research

Vacuum Electronics

Compact microwave and millimeter wave power amplifier research and development
Cathode research and development
Materials development for RF electronics applications
Electron emission science
High power millimeter-wave components:
fabrication and cooling technology
Techniques for high data rate digital communications

CENTER FOR BIO/MOLECULAR SCIENCE AND ENGINEERING

BioMolInfo@nrl.navy.mil

Biologically Derived Microstructures

Self-assembly, molecular machining
Synthetic membranes
Nanocomposites
Tailored electronic materials
Low observables
Molecular engineering, biomimetic materials
Molecular imprinting
Viral scaffolds

Biosensors

Binding polypeptides and proteins
Cell-based biosensor
DNA biosensor
Fiber-optic biosensor
Flow immunosensor
Array-based sensors

Environmental Quality

Soil/groundwater explosives detection
Antifouling paint, controlled release

Molecular Biology

Proteomics of marine bacteria
Tissue engineering
Gene arrays, biomarkers

Polymers and Liquid Crystals

Ferroelectric liquid crystals
Advanced materials/information processing
Flexible displays, noninvasive alignment technique
Liquid crystal-based cell imaging
Liquid crystal elastamers

Surfaces and Interfaces

Uncooled IR detectors/imagers
Submicron resists and microlithography
Specifically activated thin films
Neuronal patterning

Energy Harvesting

Biomaterials for charge storage
Ocean Floor Biofuel Cell

**OCEAN AND ATMOSPHERIC SCIENCE
AND TECHNOLOGY DIRECTORATE**

**ACOUSTICS DIVISION
AcusInfo@nrl.navy.mil**

Acoustic Signal Processing

Random media propagation
Limits of acoustic array performance
Underwater acoustic communications
Undersea noise signal characterization and modeling
Surf zone noise generation
Shallow water acoustic surveillance methods
Fish absorption of acoustic signals
Geophysical inversion
Matched field processing and inversion
High-frequency acoustic flow visualization

Physical Acoustics

Structural acoustics
Active sound control
Fiber-optic acoustic sensors
Acoustics of coatings
Dynamics of complex structures
Target strength/radiation modeling
Acoustic transduction
Inverse scattering
Nanomicrostructure dynamics

Acoustic Systems

Ocean boundary scattering
Shallow water active classification
Statistical characterization of reverberation
Active sonar performance modeling
Matched field processing
Acoustic inversion techniques
Acoustic propagation
Nonlinear signal propagation
Acoustics of bubbly media

**Acoustic Simulation, Measurements,
and Tactics**

Coupled dynamic ocean and acoustic modeling
Ocean acoustic propagation and scattering models
Ocean ambient noise models and simulation
Superconductor and scalable acoustic models
Fleet application acoustic models
Environmental acoustic assessments and characterizations
High-frequency seafloor and ocean acoustic measurements
Coastal acoustic measurements and studies
Biologic ocean volume reverberation measurements
Multisensor system optimization

Tactical oceanography simulations and databases
Warfare effectiveness studies and optimizations

REMOTE SENSING DIVISION
RemSensInfo@nrl.navy.mil

Remote Sensing

Sensors

- SAR
- Imaging RAR
- Passive microwave imagers
- CCDs and focal plane arrays
- Fabry-Perot spectrometers
- Imaging spectrometers
- Radio interferometers
- Optical interferometers
- Adaptive optics
- Lidar
- Spaceborne and airborne systems

Areas

- Radiative transfer modeling
- Coastal oceans
- Marine ocean boundary layer
- Polar ice
- Middle atmosphere
- Global ocean phenomenology
- Environmental change
- Ocean surface wind vector
- Ionosphere

Astrophysics

- Optical interferometry
- Radio interferometry
- Fundamental astrometry and reference frames
- Fundamental astrophysics
- Star formation
- Stellar atmospheres and envelopes
- Interstellar medium, interstellar scattering
- Pulsars
- Low-frequency astronomy

Physics of Atmospheric/Ocean Interaction

- Mesoscale, fine-structure, and microstructure
- Aerosol and cloud physics
- Mixed layer and thermocline applications
- Sea-truth towed instrumentation techniques
- Turbulent jets and wakes
- Nonlinear and breaking ocean waves
- Stratified and rotating flows
- Turbulence modeling
- Boundary layer hydrodynamics
- Marine hydrodynamics
- Computational hydrodynamics

Imaging Research/Systems

- Remotely sensed signatures analysis/simulation
- Real-time signal and image processing algorithm/systems

Asymmetric optical communications
Image data compression methodology
Image fusion
Automatic target recognition
Scene/sensor noise characterization
Image enhancement/noise reduction
Scene classification techniques
Radar and laser imaging systems studies
Coherent/incoherent imaging sensor exploitation
Numerical modeling simulation
Environmental imagery analysis

OCEANOGRAPHY DIVISION
NRL/Stennis Space Center, Mississippi
OceanInfo@nrl.navy.mil

Ocean Dynamics and Prediction
NRL/STENNIS SPACE CENTER, MISSISSIPPI

Ocean prediction
 Large scale
 Arctic
 Shipboard
 Data assimilation
 Coastal and semi-enclosed sea
Ocean observing system simulation
Coastal scene generation

Ocean Sciences
NRL/STENNIS SPACE CENTER, MISSISSIPPI

Dynamical processes
 Coastal current systems
 Waves and bubbles
Coupled systems
 Air/ocean/acoustic coupling
 Biodynamics
Remote sensing applications
 Color/hyperspectral signatures
 Ocean optics

MARINE GEOSCIENCES DIVISION
NRL/Stennis Space Center, Mississippi
GeoSciInfo@nrl.navy.mil

In Situ and Laboratory Sensors
NRL/Stennis Space Center, Mississippi
High-resolution seafloor 2-D and 3-D seismic
 imaging
Laser/hyperspectral bathymetry/topography
Swath acoustic backscatter imaging
Sediment pore water pressure, permeability, and
 undrained shear strength
Compressional and shear wave velocity and
 attenuation
Airborne geophysics, gravity, and magnetics
Seafloor magnetic fluctuation

Sediment microfabric change with pore fluid and/or gas change
Instrumented mine shapes
Bottom currents and pressure fluctuations

Marine Physics
NRL/Washington, D.C.

Marine Geology
Sedimentary processes
Foreshore sediment transport
Sediment microstructure
Pore fluid flow
Diapirism, volcanism, faulting, mass movement
Biogenic and thermogenic methane
Hydrate distribution, formation, and dissociation
Marine Geophysics
Seismic wave propagation
Earthquake seismology
Physics of low-frequency acoustic propagation
Acoustic energy interaction with topography and inhomogeneities
Gravimetry and geodesy
Geomagnetic modeling

Seafloor Sciences
NRL/Stennis Space Center, Mississippi

Marine Geotechnique
Acoustic seafloor characterization
Geoacoustic modeling
Geotechnical properties and behavior of sediments
Measurement and modeling of high-frequency acoustic propagation and scattering
Mine burial processes
Marine biogeochemistry
Animal-microbe-sediment interactions
Early sediment diagenesis
Sedimentary microbial respiration of manganese and iron
Whole-cell bioluminescent reporter strain construction

Mapping, Charting, and Geodesy
NRL/Stennis Space Center, Mississippi

Digital database design
Digital product analysis and standardization
Data compression techniques and exploitation
Hydrographic survey techniques
Bathymetry extraction techniques from remote and acoustic imagery
Utility software development for digital mapping databases
Observation and modeling of nearshore morphodynamics

MARINE METEOROLOGY DIVISION
NRL/Monterey, California
MeteorolInfo@nrl.navy.mil

Atmospheric Dynamics and Prediction
NRL/MONTEREY, CALIFORNIA

Numerical Weather Prediction

- Global
- Mesoscale
- On-scene
- Large eddy simulation
- Boundary layer
- Coastal
- Massively parallel computing
- Coupled ocean/atmosphere/wave
- Tropical cyclones
- Aerosols
- Topographically forced flow
- Predictability

Data Assimilation

- Optimum interpolation
- 3D and 4D variational analysis
- Quality control
- Synthetic soundings
- Remotely sensed data
- Physical initialization
- Direct radiance assimilation
- Radar data assimilation
- Targeted observations

Tactical Environmental Support

- Naval Integrated Tactical Environmental Subsystem
- Data fusion
- Nowcasting
- Visualization
- Port studies
- Typhoon havens
- Forecaster handbooks
- Expert systems

Meteorological Applications Development
NRL/MONTEREY, CALIFORNIA

Satellite Data/Imagery

- Automated cloud classification
- Satellite imagery analysis
- Case study development
- Multisensor data fusion
- Tropical cyclone intensity
- Water vapor-tracked winds
- Cloud-tracked winds
- Dust/aerosols
- Rain rate

Decision Aids

- Refractivity
- Ceiling/visibility
- Fog/turbulence/icing

Electromagnetic propagation
Electro-optical propagation
Tropical cyclones

SPACE SCIENCE DIVISION
SpaSciInfo@nrl.navy.mil

Space Weather and Atmospheric Physics

Remote sensing of the ionosphere and thermosphere
Middle atmospheric investigations
Global modeling
Upper atmospheric physics

Space Astronomy

X-ray observation, analysis, and theory of space
astronomical sources
Gamma-ray astrophysics, solar-flare gamma rays,
and space cosmic ray particle environment
Gamma-ray Large Area Space Telescope (GLAST)
NASA space mission

Solar Physics

Solar ultraviolet and visible light spectroscopy and
photometry from rockets, satellites, and the Space
Shuttle
Extreme-ultraviolet Imaging Spectrometer (EIS)
Sun Earth Connection Coronal and Heliospheric
Investigation (SECCHI) for the Stereo Mission

Solar-Terrestrial Relationships

Solar X-ray/EUV plasma diagnostics; coronal effects
on Earth

**NAVAL CENTER FOR
SPACE TECHNOLOGY**

**SPACE SYSTEMS
DEVELOPMENT DEPARTMENT**
SpaSysInfo@nrl.navy.mil

Advanced Space Systems Technologies

Space systems architectures and requirements
Advanced payloads and optical communications
Controllers, processors, signal processing, and VLSI
Data management systems and equipment
Embedded algorithms and software
Satellite laser ranging

Astrodynamics

Precision orbit estimation
Onboard autonomous navigation
Star catalog development
Onboard orbit propagation
GPS space navigation

Satellite coverage and mission analysis
Geolocation systems
Orbit dynamics
Interplanetary navigation

Command, Control, Communications, Computers, and Intelligence

Communications theory and systems
Tracking, telemetry, and control systems
Satellite ground station engineering and implementation
Transportable and fixed ground antenna systems
High-speed fixed and mobile ground data collection, processing, and dissemination systems
Tactical communication systems

Space Electronic Systems Development

Space system concept definition, design, and implementation including hardware and software
Detailed electrical/electronic design of electronic and electromechanical systems and components
Design and verification of real-time embedded multiprocessor software
Spacecraft antenna systems
Space systems fabrication, test, and integration
Launch and on-orbit support

Space Electronic Warfare

Design criteria for counter-surveillance and counter-targeting
Data search, analysis, and synthesis of information related to special sensor performance

Space Mission Development

Mission development and requirements definition
Systems engineering and analysis
Concepts of operations and mission simulations
Mission evaluation and performance assessments

Space Surveillance, Navigation, and Time

Advanced navigation satellite technology
Precise Time and Time Interval (PTTI) technology
Atomic-time/frequency standards/instrumentation
Passive and active ranging techniques
Detection and precision tracking of orbiting objects from space and ground

SPACECRAFT ENGINEERING DEPARTMENT
SpaEngInfo@nrl.navy.mil

Design, Test, and Processing

Design, fabrication, and testing of spacecraft and hardware
Preliminary and detailed design, fabrication, testing, and integration onto launch vehicle
Systems engineering for new spacecraft proposals
Start-to-finish responsibility for NCST spacecraft mechanical systems

Systems Analysis

Research and development in spacecraft technology
Conceptual design trade studies
Integrated engineering design and analysis
Structural and thermal analysis
Development and transition of prototype hardware
Development and integration of experimental payloads

Control Systems

Attitude determination and control systems
Reaction control
Precision pointing
Optical line-of-sight stabilization
Propulsion systems
Analytical design and mission planning
Navigation, tracking, and orbit dynamics
Expert systems
Flight operations support
Computer simulation
Computer animation
Robotics engineering and control
Spaceborne robotics applications
Autonomous rendezvous and capture

Space Electronic Systems Development

Space system concept definition, design, and implementation including hardware and software
Detailed electrical/electronic design of electronic and electromechanical systems and components
Implementation of real-time flight software and embedded command, control, and telemetry software
Design and verification of real-time embedded multi-processor software
Spacecraft antenna systems
Space systems fabrication, test, and integration
Launch and on-orbit support
Space test systems and electronic launch support equipment
Space TT&C and control systems
Space communication systems

• **DOING BUSINESS WITH NRL** •

NRL Technology Transfer Office (TTO)

NRL has a long history of working with industry and academia to assist in the transition of its products into nonmilitary applications. Many of NRL's research efforts have applications well beyond their original defense-oriented objectives. Products, materials, and techniques developed by NRL research programs often have additional applications in the commercial or civilian sectors. NRL developments in areas such as radar, radio, satellite navigation, fire fighting, and a wide variety of materials and

coatings have made significant contributions to the safety and welfare of the civilian sector. Technology transfer ensures full use of the results of the nation's federal investment in research and development by transferring federally owned or originated technology to the private sector.

Mechanisms for technology transfer include Cooperative Research and Development Agreements (CRADAs) and licensing of inventions.

E-mail: techtran@utopia.nrl.navy.mil

URL: <http://www.nrl.navy.mil/techtransfer>

Cooperative Research and Development Agreements (CRADAs)

To promote the timely transfer of technology from government laboratories to the private sector and to improve the competitiveness of U.S. industry, Congress passed the Federal Technology Transfer Act (FTTA) of 1986. With this legislation, Congress authorized federal organizations to enter into CRADAs with nonfederal parties. The objective of a Navy CRADA is cooperative research that will enhance the mission of the Navy and benefit the non-Navy party. The CRADA defines the individual responsibilities of the Navy and non-Navy parties toward achieving the objective, as well as rights to intellectual property developed under the CRADA. The Navy party in a CRADA may provide personnel, facilities, and equipment to perform the cooperative research. The non-Navy party may provide personnel, facilities, equipment, and funding. CRADAs can be established with industrial organizations, industrial development organizations, non-profit organizations, universities, state and local governments, licensees of inventions owned by federal agencies, and other federal agencies.

NRL signed the Navy's first CRADA in 1989. Since that time, the Laboratory has continued to pursue and promote this program actively. NRL has entered into CRADAs directed at the development of novel techniques for airport luggage screening, detectors for drugs of abuse, location and mapping devices for unexploded ordnance, fiber-optic dosimeters for radiation exposure, and other technological advances that have impacted the military and the civilian sectors. Information on our CRADA process, including the CRADA boilerplate and questionnaire can be found at <http://techtransfer.nrl.navy.mil/cradas.php>.

E-mail: techtran@utopia.nrl.navy.mil

URL: <http://www.nrl.navy.mil/techtransfer>

Licensing of Navy Inventions

Because of the enactment of the FTFTA, the effort to encourage the commercial use of government-funded technology has expanded in the federal laboratories. Title 35, Section 207, of the United States Code authorizes federal agencies to license their inventions. The license authorizes the licensee to manufacture and market the product while allowing government inventors and the laboratories where they work to share the royalties generated by commercial licensing of their inventions. NRL supports

an active licensing program and has over 1,000 patents and patent applications available for licensing in fields as diverse as advanced materials, chemistry, biotechnology, optics, ocean and atmospheric sciences, electronics, radar, and satellite technology. NRL has licenses with small and large U.S. businesses, foreign and multinational businesses, and nonprofit organizations and universities.

Briefly, the licensing process works as follows:

First step is to fill out the Application to Practice a Navy Invention. This can be found at <http://www.nrl.navy.mil/techtransfer/pdfs/patform.pdf>. Typically, a company views this form as a cover sheet, attaching a detailed business case/plan that covers the important aspects of the application such as what the company plans to do with the invention, the timeframe involved for development including milestones (if applicable), the source of funding the company has to work on the development of the invention, the risks associated with the technology and the market, and a projected sales forecasts with the underlying assumptions used to generate the forecast.

Key items in the application are: the field of use and the type of license (non-exclusive, partially-exclusive, or exclusive), where partially exclusive means exclusive in a field of use. For partially exclusive or exclusive licenses, the licensee's plan submitted with the application must meet certain determinations from the federal regulations showing that exclusive licensing is a reasonable and necessary incentive to call forth the investment of risk capital and expenditures to bring the invention to practical application. The proposed scope of exclusivity must not be greater than reasonably necessary to provide the incentive for commercialization of the technology and granting the license must not tend to substantially lessen competition.

For partially exclusive or exclusive licenses, the availability of the patent(s) for license must be advertised in the Federal Register for 90 days. Then, if the application is acceptable and reasonable terms and conditions can be negotiated successfully, an "Intent to Grant" notice is published in the Federal Register for a minimum of 15 calendar days before a license can be executed. The Intent to Grant notice lists the company name and the field of use for the license.

There are three financial components to each license that are required by the Navy: (1) a lump-sum upfront fee typically paid on execution of the license, (2) a running royalty for sales other than to the federal government, and (3) a minimum annual royalty.

E-mail: techtran@utopia.nrl.navy.mil

URL: <http://www.nrl.navy.mil/techtransfer>

Work for Nonfederal Parties

NRL has many unique capabilities that may enhance the R&D efforts of organizations external to NRL. When NRL's capabilities are unique and making them available to the public would not constitute undue competition with

industry, NRL may sell testing, other services, and articles to nonfederal parties. If it is in the interest of national defense, NRL may make the capabilities of its facility available for the testing of materials, equipment, models, computer software, and other items. NRL may sell articles, or services other than testing at NRL, if the sale requires no more than incidental subcontracting and the nonfederal party agrees to hold harmless and indemnify the United States. The Navy requires advance payment, and incremental funding is often acceptable.

Call (202) 767-2244.

Letters of Intent

With increasing frequency, funding agencies are granting R&D programs to consortia consisting of industry, national laboratory, and/or university members. NRL participates actively in research consortia on programs funded by ONR, DARPA, and other public and private funding agencies. At the proposal phase of such programs, NRL may submit a letter of intent describing the work NRL will perform on a best efforts basis, if the proposal is funded. The funded programs may result in a CRADA between NRL and one or more of the other consortium members or, in those cases where NRL's contributions are unique, may be structured as a work for nonfederal parties agreement whereby a government contractor subcontracts work to NRL from its prime contract. Whenever possible, NRL arranges for direct funding of its efforts by a U.S. Government agency via the Economy Act.

Call (202) 767-2244.

Memoranda of Understanding

NRL scientists participate actively with scientists from other federal laboratories and organizations on projects of national interest. Such collaborations among federal organizations may be formalized with a Memorandum of Understanding or a Memorandum of Agreement that defines the scope of the work and the responsibilities of each federal party toward achieving the objectives. NRL has entered into Memoranda of Understanding or Agreement with the Army, Navy, Air Force, Marine Corps, Department of Energy, and other U.S. Government activities.

Call (202) 767-2244.

Funding External Activities

In addition to actively performing research, NRL supports various R&D projects that directly relate to its ongoing work. This support is provided through contracts and grants with industrial firms, colleges and universities, and nonprofit organizations.

NRL outsources an average of \$360 million per year for contracts and grants and about \$50 million per year for small purchases. Performers are competitively selected after review of proposals submitted in response to Broad Agency Announcements (BAAs) or Requests for Proposals (RFPs).

NRL encourages industry, educational institutions, small

businesses, small/disadvantaged business concerns, historically black colleges and universities, and minority institutions to submit proposals in response to BAAs.

Broad Agency Announcements

BAAs are issued under the provisions of paragraphs 35.016 and 6.102(d)(2) of the Federal Acquisition Regulation, which provides for the competitive selection of research proposals for scientific study or experimentation directed toward advancing the state of the art or increasing knowledge or understanding. Proposals submitted in response to a BAA that are selected for award are considered to be the result of full and open competition and are in full compliance with the provisions of Public Law 98-369, "The Competition in Contracting Act of 1984." The typical range of funding for contracts under NRL BAAs is \$100,000 to \$2 million. In FY 1999, NRL awarded \$50 million under BAA procedures.

To be eligible for a contract award, prospective offerors (with the exception of other federal government activities) must meet certain minimum standards pertaining to financial resources, adequacy of accounting systems, ability to comply with performance schedules, record of prior performance, integrity, organizational structure, experience, operational controls, technical skills, facilities, and equipment.

Current BAA information, including award considerations and instructions for submitting proposals, is available on the Internet at the following address:

<http://heron.nrl.navy.mil/contracts/baa.htm>

Commercial Contracts/Procurements

Information for small businesses may be obtained by calling (202) 767-6263, FAX (202) 767-0494.

NRL also contracts with commercial firms, nonprofit organizations, and academic institutions to obtain specific products and services. These contracts and purchases are for equipment (either complete systems or components), professional and technical services supporting the Laboratory's ongoing R&D programs, and special projects. NRL contract opportunities are announced as Request for Proposals (RFPs) and are advertised in the *Commerce Business Daily*.

For contracts, contact the Contracting Division at (202) 767-5227. For simplified acquisitions, contact the Supply Division at (202) 767-2374.

Grants

A grant is another mechanism used by NRL to fund outside activities. Grants are made primarily to educational and nonprofit organizations for proposals submitted under BAAs. NRL occasionally enters into cooperative agreements for research traineeships or fellowships and awards small grants for S&T conferences and symposia. NRL awards from 40 to 60 grants per year. In FY 1999, the Laboratory awarded \$10 million through grants and cooperative agreements.

For grants, contact the Contracting Division at (202) 767-5227.

• CAREER OPPORTUNITIES AT NRL •

Research Associateships at NRL

In the program sponsored by NRL, a Research Associate is a guest investigator, not an employee of the National Research Council or of the Laboratory. Associateships are analogous to fellowships or similar temporary programs at the postdoctoral level in universities and other organizations. They are not intended to be, or to compete with, permanent professional career positions.

No commitment on the part of an Associate, the sponsoring laboratory, or the National Research Council with regard to later employment is implied or should be inferred by the offer or acceptance of an award.

Associates must devote their full-time effort to the research program proposed in their applications and must be in residence at the sponsoring laboratory during the entire period of the Associateship. No period of tenure may be spent in residence at another laboratory or institution. Associates have the status of visiting scientists or engineers but are subject to the general regulations of the Laboratory.

No additional monetary aid or other remuneration may be accepted from another appointment, fellowship, or similar grant, except for sabbatical leave, during the period of the Associateship.

NRL Research Associateships are awarded to persons who have held the doctorate less than five years at the time of application and are made initially for two years.

Opportunities at NRL are open to citizens of the United States and to legal permanent residents.

Call (202) 404-7450 or e-mail lrenfro@hro.nrl.navy.mil

NAVY-ASEE Summer Faculty Research Program

This program engages university faculty members in the research programs of NRL to develop the basis for continuing research of interest to the Navy and to establish continuing relations among faculty members and their professional peers.

Stipend level is based on experience and ranges from \$900 to \$1,500 per week for 10 weeks. A relocation allowance is available, and travel expenses are reimbursed. Applicants must hold a teaching or research position at a U.S. college or university.

Application deadline is January 15. Applications may be obtained from ASEE or from NRL's Program Coordinator.

Call (202) 404-7450 or e-mail lrenfro@hro.nrl.navy.mil

Careers at NRL:

- Research Chemist
- Computer Scientist
- Computer Engineer
- Meteorologist
- Material Scientist
- Material Engineer
- Metallurgist
- Mathematician
- Geologist
- Electrical Engineer
- Mechanical Engineer
- Aerospace Engineer
- Research Physicist
- Astronomer
- Astrophysicist
- Oceanographer
- Geophysicist

Please use the Division or Department e-mail in this guide to submit a resumé.

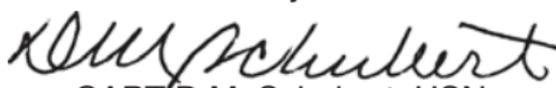
Current job vacancies can be found at <http://hroffice.nrl.navy.mil/jobs/vacancy.htm>

Student Career Experience Program

This program employs students in study-related occupations. The program is conducted in accordance with a planned schedule and a working agreement between NRL, the educational institution, and the student. Primary focus is on students pursuing bachelor degrees in engineering, computer science, or the physical sciences.

Call (202) 767-8314 or e-mail lbowie@hro.nrl.navy.mil.

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February 2005


CAPT D.M. Schubert, USN
Commanding Officer

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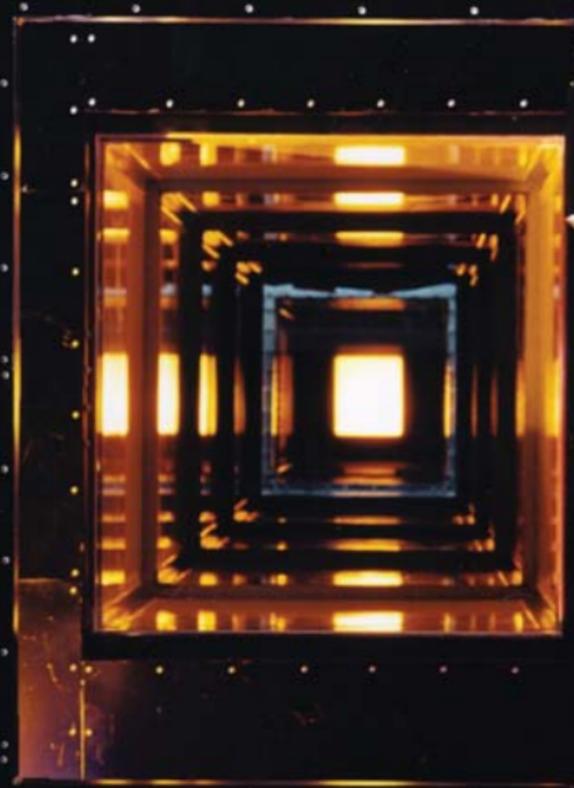
*Join a team that makes a difference to
DoD and our Nation*

The Naval Research Laboratory nurtures a multidisciplinary research environment to stimulate and support creative and innovative concepts in the Physical Sciences and Engineering. Young scientists and engineers are encouraged to team with the Lab's world-renown researchers to promote individual creativity and to develop new technologies in support of the Navy, the Marine Corps, and the Nation . . .

For information or to submit a resumé, simply use the e-mail link found in each research division of this guide.



Cover photo:
Propagation bay of NRL's NIKE Laser Facility



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URL: <http://www.nrl.navy.mil>