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# NRL

NAVAL RESEARCH LABORATORY

guide



NAVAL RESEARCH LABORATORY  
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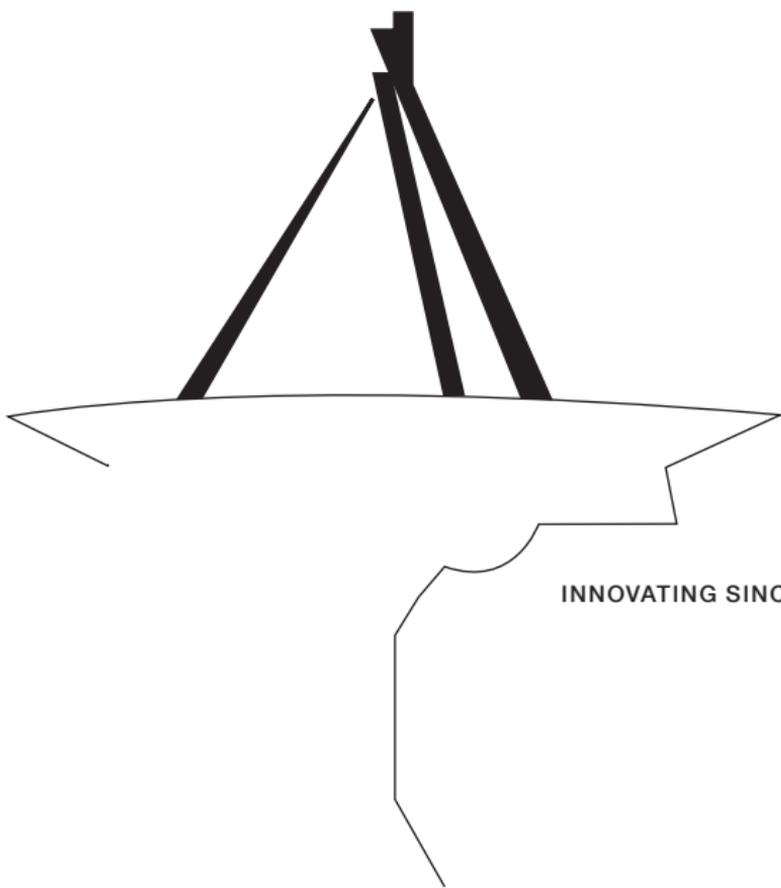
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## **Current Research and Development Efforts**

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### **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

### **Autonomous Systems**

Algorithms for control of autonomous systems  
Cognitive robotics  
Human-robot interaction  
Perception hardware and algorithms  
High-level reasoning algorithms  
Machine learning and adaptive algorithms  
Sensors for autonomous systems  
Power and energy for autonomous systems  
Networking and communications for mobile systems  
Swarm behaviors  
Test and evaluation of autonomous systems

### **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 3D visualization tools and applications

Real-time parallel processing  
Scalable, parallel computing  
Petaflop computing, globally distributed file systems,  
terabit-per-second networking

### **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 millimeter-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 countermeasures (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  
Requirements specification and analysis  
Real-time computing  
Wireless mobile networking  
Behavior detection  
Machine learning  
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  
Simulation-based virtual reality  
High-end, progressive HDTV imagery processing and distribution  
Defensive information warfare  
Virtual reality/mobile augmented reality  
3D multimodal interaction  
Model integration (physical, environmental, biological, psychological) for 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  
Power and energy  
Synthetic biology

## **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**

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## EXECUTIVE DIRECTORATE

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### **INSTITUTE FOR NANOSCIENCE, CODE 1100**

NANOINFO@NRL.NAVY.MIL

#### **NANOSCIENCE AND NANOTECHNOLOGY**

Low-power, high-speed electronics  
Lightweight, high-strength materials  
Highly sensitive molecular sensors  
Efficient energy generation and storage

### **LABORATORY FOR AUTONOMOUS SYSTEMS RESEARCH, CODE 1700**

LASRINFO@NRL.NAVY.MIL

#### **AUTONOMOUS SYSTEMS RESEARCH**

Multidisciplinary research, development, and integration  
in autonomous systems  
Software for intelligent autonomy  
Novel human-systems interaction technology  
Mobility and platforms  
Sensor systems  
Power and energy systems  
Networking and communications  
Trust and assurance

## SYSTEMS DIRECTORATE

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### **RADAR DIVISION, CODE 5300**

RADARINFO@NRL.NAVY.MIL

#### **RADAR ANALYSIS**

Target signature prediction  
Electromagnetics and antennas  
Airborne early-warning radar (AEW)  
Inverse synthetic aperture radar (ISAR)  
Sea clutter modeling  
Periscope detection  
Wideband array simulation and fabrication

#### **ADVANCED RADAR SYSTEMS**

High-frequency over-the-horizon radar  
Signal analysis  
Real-time signal processing and equipment  
Computer-aided engineering (CAE)  
Array architecture optimization

FPGA-based digital processing  
Future identification technology

#### **SURVEILLANCE TECHNOLOGY**

Shipboard surveillance radar  
Ship self-defense  
Electronic counter-countermeasures and  
    electronic protection (EP)  
Target signature recognition  
Digital T/R modules  
Asymmetric and expeditionary warfare  
    spectrum management  
Ultrawideband technology  
Dynamic waveform diversity  
Multistatic radar network  
Information extraction  
Ballistic missile defense  
Mine detection

### **INFORMATION TECHNOLOGY DIVISION, CODE 5500**

ITDINFO@NRL.NAVY.MIL

#### **FREESPACE PHOTONICS COMMUNICATIONS OFFICE**

Extended spectrum communications  
Atmospheric channel effects on photonic transfer  
Studies in marine miraging  
Analog modulation techniques on freespace optical  
    carriers  
Modulating retroreflector based communications  
Signature studies for ISR  
Adaptive optics for freespace optical communications

#### **ADVERSARIAL MODELING AND EXPLOITATION OFFICE**

Hostile intent and deception detection  
Behavior detection research  
Geospatial modeling and simulation  
Dynamic semantic networks  
Behavioral modeling, analysis, and metrics  
Spatially integrated social science  
Integrated intelligence, surveillance, and reconnaissance  
Automated video analysis and retrieval

#### **NAVY CENTER FOR APPLIED RESEARCH IN ARTIFICIAL INTELLIGENCE**

Intelligent decision aids  
Natural language and multimodal interfaces  
Intelligent software agents  
Machine learning and adaptive systems

Robotics software and computer vision  
Neural networks  
Novel devices/techniques for HCI  
Spatial audio  
Immersive simulation  
Autonomous and intelligent systems  
Case-based reasoning and problem-solving methods  
Machine translation technology evaluation  
Cognitive architectures  
Human-robot interaction

**TRANSMISSION TECHNOLOGY**

Communication system architecture  
Communication antenna/propagation technology  
Communications intercept systems  
Virtual engineering  
Secure voice technology  
Satellite and tactical networking  
Satellite communications research  
Satellite architecture analysis  
RF systems analysis

**CENTER FOR HIGH ASSURANCE COMPUTER SYSTEMS**

Secure service oriented architectures (SOA) and  
Secure Enterprise Architectures (SEA)  
Formal specification/verification of system security  
COMSEC application technology  
Technology and solutions to secure networks and  
databases  
Software engineering for secure systems  
Key management and distribution solutions  
Information systems security (INFOSEC) engineering  
Formal methods for requirements specification and  
verification  
Security product development  
Secure wireless network and wireless sensor technology  
Network security protocol modeling, simulation, and  
verification  
Cross-domain solution technology development  
Computer Network Defense (CND) technology  
Hardware/software co-design  
Malicious code analysis  
Information hiding (watermarking, covert channel  
analysis, etc.)  
Anonymizing systems  
Quantum information science  
Logical foundations of security

## **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  
Communication network simulation  
Networking protocols for directional antennas  
Policy-based network management  
Tactical voice over IP  
Sensor networks  
Advanced tactical data links  
Cognitive radio technology

## **INFORMATION MANAGEMENT AND DECISION ARCHITECTURES**

Virtual reality/mobile augmented reality  
Visual analytics  
Scientific visualization  
Computer graphics  
Human-computer interaction  
Service oriented architecture  
Service orchestration  
Data and information management  
Human-centered design  
Parallel and distributed computation  
Distributed modeling and simulation  
Natural environments for distributed simulation  
Intelligent decision support  
Information sharing  
Semantic web technology  
Data mining  
Software agents for data fusion

## **CENTER FOR COMPUTATIONAL SCIENCE**

Transparent optical network research and design  
Parallel computing  
Scalable high performance computing and networking  
for Navy and DoD  
Large data in distributed computing  
Scientific visualization  
High-performance file systems  
High-definition video technology  
NRL labwide computer network and related services

Labwide support for web, e-mail, and other  
information services

ATDnet and leading-edge WAN research networks

#### **RUTH H. HOOKER RESEARCH LIBRARY**

Desktop/workbench access to relevant scientific resources

NRL scientific digital archive (TORPEDO)

Authoritative database of NRL-produced publications  
(NRL Online Bibliography)

Comprehensive literature/citation/classified searches

Extensive collection of print and digital books, journals,  
and technical reports

### **OPTICAL SCIENCES DIVISION, CODE 5600**

OPTINFO@NRL.NAVY.MIL

#### **OPTICAL MATERIALS AND DEVICES**

Advanced infrared optical materials

IR fiber-optic materials and devices

IR fiber chemical and environmental sensors

IR transmitting windows and domes

Transparent ceramic armor materials

Planar waveguide devices

IR nonlinear materials and devices

Ceramic laser gain materials

Advanced solar cell materials

Fiber lasers/sources and amplifiers

Radiation effects

#### **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

Nanoscale electro-optical research

Aerosol optics

#### **APPLIED OPTICS**

UV, optical, and IR countermeasures

Ultraviolet component development

Missile warning sensor technology

UV, visible, and IR imager development

Multispectral/hyperspectral sensors

Multispectral/hyperspectral/detection algorithms

Framing reconnaissance sensors  
Novel optical components  
Sensor control and exploitation system development  
IR low observables  
EO/IR systems analysis  
Atmospheric IR measurements  
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  
Micro-electro-optical-mechanical systems  
Optical clocks  
Microwave photonics

**OPTICAL TECHNIQUES**

Fiber-optic materials and fabrication  
Fiber Bragg grating sensors/systems  
Fiber-optic sensors/systems (acoustic, magnetic,  
gyroscopes)  
Integrated optics

**TACTICAL ELECTRONIC WARFARE DIVISION,  
CODE 5700**

EWINFO@NRL.NAVY.MIL

**OFFBOARD COUNTERMEASURES**

Expendable technology and devices  
Unmanned air vehicles  
Offboard payloads  
Decoys

**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 and deception

EW antennas  
High power microwaves (HPM) research

**ELECTRONIC WARFARE SUPPORT MEASURES**

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

**ADVANCED TECHNIQUES**

Analysis and modeling simulation  
Experimental systems  
EW concepts  
Infrared technology

**INTEGRATED EW SIMULATION**

Hardware-in-the-loop simulation  
Data management technology  
Flyable ASM seeker simulators  
Foreign materiel exploitation (FME)

**EW MODELING AND SIMULATION**

High-fidelity threat models and simulations  
Advanced system visualization  
EW tactical decision aids  
RF environmental and propagation modeling

**MATERIALS SCIENCE AND  
COMPONENT TECHNOLOGY  
DIRECTORATE**

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**LABORATORIES FOR COMPUTATIONAL PHYSICS  
AND FLUID DYNAMICS, CODE 6040**

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 modeling  
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

## **CHEMISTRY DIVISION, CODE 6100**

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  
Alternate energy sources

### **MATERIALS CHEMISTRY**

Synthesis and evaluation of innovative polymers and composites  
Functional organic coatings  
Polymer characterization  
Magnetic resonance  
Degradation and stabilization mechanisms  
High-temperature resins  
Bio-inspired materials  
Novel nanotubes and nanofibers  
Reactive nanometals

### **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 sensors  
Surface reaction dynamics  
Adhesion  
Bio/organic interfaces  
Diamond films  
Energy storage materials  
Nanostructured materials and interfaces  
Electrochemistry  
Plasmonics  
Synchrotron radiation applications

## **SAFETY AND SURVIVABILITY**

Combustion dynamics  
Fire protection and suppression  
Personnel protection  
Modeling and scaling of combustion systems  
Mobility fuels  
Chemometrics/data fusion  
Trace analysis

## **MATERIALS SCIENCE AND TECHNOLOGY DIVISION, CODE 6300**

MATERIALINFO@NRL.NAVY.MIL

## **MATERIALS AND SENSORS**

Superconducting materials  
Magnetic materials  
Optoelectronic materials  
Electroceramic materials  
Radar absorbing materials  
THz sources and detectors  
Bioelectronics  
Remote video surveillance  
Chemical sensors  
Chaos theory  
Thin film deposition  
    Pulsed laser deposition  
    Ion-beam-assisted deposition  
    Variable balance magnetron sputtering  
Laser direct write  
Ion implantation  
Glass fiber draw tower

Polymer synthesis and characterization  
Precision calorimetry  
Analysis of extrasolar materials  
Ballistic materials  
Personal protective equipment  
Explosives detection

#### **MULTIFUNCTIONAL MATERIALS**

Biomechanical surrogate development for threat response  
characterization  
Biomechanical simulation  
Composite material systems  
    Multifunctional structure + other (e.g., power, etc.)  
    Hierarchical and tiled architectures  
    Armor protection  
Corrosion simulation and control  
    Modeling of electrochemical corrosion systems  
    Evaluation of cathodic protection performance  
Image-based modeling  
Materials by design  
Mesoscale material characterization and simulation  
Physical metallurgy  
    Ferrous, nonferrous, and intermetallic alloys  
    Hot/cold isostatic pressing  
    Micro/nanostructure characterization  
    Three-dimensional microstructure characterization  
    Synthesis/processing of metal  
    Rapid solidification  
    Welding/joining technology  
    Heat treating and phase transformations  
Synthesis and processing of advanced ceramics  
    High energy density dielectrics  
    Piezoelectrics

#### **COMPUTATIONAL MATERIALS**

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  
Protein modeling  
Continuum multiphysics modeling

## **PLASMA PHYSICS DIVISION, CODE 6700**

PLASMAINFO@NRL.NAVY.MIL

### **RADIATION HYDRODYNAMICS**

Radiation hydrodynamics of Z-pinch 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

Plasma discharge physics

Dense plasma atomic physics, equation of state

Numerical simulation of high-density plasma

Laser driven ion/neutron sources

### **LASER PLASMA**

Nuclear weapons stockpile stewardship

Laser fusion, inertial confinement

Megabar high-pressure physics

Rep-rate KrF laser development

Impact fusion

Laser fusion technology

Laser fusion energy

Detection of chemical/biological/nuclear materials

### **CHARGED PARTICLE PHYSICS**

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

Plasma processing of energy sensitive materials

Atmospheric and ionospheric GPS sensing

Ionospheric effects on communications

Electromagnetic launchers

Radiation belt remediation

### **PULSED POWER PHYSICS**

Production, focusing, and propagation of intense electron and ion beams

High-power, pulsed radiography

Plasma radiator and bremsstrahlung diode sources

Capacitive and inductive energy storage

Nuclear weapons effects simulation

Electromagnetic launchers

Detection of Special Nuclear Materials

Advanced energetics via stimulated nuclear decay

## **BEAM PHYSICS**

Advanced accelerators and radiation sources  
Microwave, plasma, and laser processing of materials  
Microwave sources: magnicons and gyrotrons  
Nonlinear dynamics of coupled lasers  
Ultrahigh-intensity laser-matter interactions  
Free electron lasers and laser synchrotrons  
Theory and simulation of space and solar plasmas  
Global ionospheric and space weather modeling  
Laser propagation in the atmosphere  
Underwater laser interactions

## **ELECTRONICS SCIENCE AND TECHNOLOGY DIVISION, CODE 6800**

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 nanostructures, 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  
Oxide- and carbon-based electronics for high-frequency devices

### **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 hardening of electronics devices, circuits, and optoelectronic sensors

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

Photovoltaic research and development

Mid- and far-infrared photodiodes/arrays

Microelectronics device research and fabrication

Solid-state circuits research

Signal processing research

### **VACUUM ELECTRONICS**

Compact millimeter-wave power amplifier research and development

Cathode research and electron emission science

Materials development for microwave and millimeter-wave applications

Development of microfabrication techniques for upper millimeter-wave devices

Theory and numerical techniques for modeling of fast-wave and slow-wave devices

Techniques for broadband, complex waveform generation and analysis for high data rate communications and electronic warfare

## **CENTER FOR BIO/MOLECULAR SCIENCE AND ENGINEERING, CODE 6900**

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  
Multifunctional decontamination coatings

#### **BIOSENSORS**

Binding polypeptides and proteins  
Cell-based biosensors  
DNA biosensors  
Fiber-optic biosensors  
Flow immunosensors  
Array-based sensors  
Optical biosensors  
Microfluidics

#### **NOVEL MATERIALS**

Soil/groundwater explosives detection  
Antifouling paint, controlled release  
Single chain antibodies  
Liquid crystal nanoparticles  
Liquid crystal elastomers  
Nano- and mesoporous materials  
Quantum dot and protein conjugates  
Biomimetic materials

#### **MOLECULAR BIOLOGY**

Genomics and proteomics of marine bacteria  
Tissue engineering  
Gene arrays, biomarkers  
System and synthetic biology

#### **ENERGY HARVESTING**

Biomaterials for charge storage  
Ocean floor biofuel cell  
Photo-induced electron transfer

## **OCEAN AND ATMOSPHERIC SCIENCE AND TECHNOLOGY DIRECTORATE**

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### **ACOUSTICS DIVISION, CODE 7100**

ACOUSINFO@NRL.NAVY.MIL

#### **PHYSICAL ACOUSTICS**

Structural acoustics  
Quantum effects in phononic crystals  
Nanomechanical devices  
Fiber-optic acoustic sensors

Acoustic transduction  
Inverse scattering  
Target strength/radiation modeling  
Flow-induced noise and vibration  
Active sonar classification  
Underwater distributed, networked sensing  
AUV-based sensing

#### **ACOUSTIC SIGNAL PROCESSING AND SYSTEMS**

Underwater acoustic communications and networking  
Limits of array performance  
Waveguide invariant processing  
Acoustic field uncertainty  
Acoustic interactions with transonic/supersonic flows  
Acoustic noise forecasting  
Long-range underwater communications  
Underwater distributed sensing networks  
Ocean boundary scattering  
Acoustic propagation  
Acoustic inversion  
Characterization of reverberation  
Acoustic metamaterials  
Acoustics of microfluidic bubbly emulsions  
Active sonar performance modeling  
Compressive sensing  
Acoustic classification  
Nonlinear propagation  
Underwater acoustic network warfare

#### **ACOUSTIC SIMULATION, MEASUREMENTS, AND TACTICS**

Ocean acoustic propagation and scattering models  
Fleet application acoustic models  
High-frequency seafloor and ocean acoustic  
measurements  
Riverine acoustics  
Distributed sensing networks  
Incorporating uncertainty in predictive models  
Tactical acoustic simulations and databases  
Warfare effectiveness studies and optimization  
Environmental assessment and planning tools

## REMOTE SENSING DIVISION, CODE 7200

REMSENINFO@NRL.NAVY.MIL

### REMOTE SENSING

#### Sensors

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

#### Research areas

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

### 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  
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, CODE 7300**

NRL/STENNIS SPACE CENTER, MISSISSIPPI  
OCEANINFO@NRL.NAVY.MIL

**OCEAN DYNAMICS AND PREDICTION**

Circulation

Global resolution of circulation and mesoscale fields  
Littoral circulation at the coast, bays, and estuaries  
Satellite observation processing and assimilation  
UUV adaptive sampling  
Observation system simulation experiments  
Ice volume and ice drift  
Tidal currents and heights

Surface effects

Surface wave effects globally and into bays  
Wave breaking  
Mixed layer dynamics  
Swell propagation and dynamics  
Phase averaged wave evolution  
Phase resolved wave dynamics

Nearshore

Wave breaking at the shore  
Rip currents at the shore  
Tidal currents and heights into rivers  
Nonlinear wave interaction  
Sensor deployment optimization

Acoustic effects

Sound speed variation for acoustic propagation

Internal waves, solitons, and bores for beam focusing  
Wave bubble entrainment and noise generation

### **OCEAN SCIENCES**

Dynamical processes

Optical turbulence

Biological sensing and modeling

Optical thin layers

Coastal current systems

Waves and bubbles

Coupled systems

Air/ocean/acoustic coupling

Coupled bio/optical/physical processes

Coupled physical/sediment processes

Remote sensing applications

3D optical profiling

Color/hyperspectral signatures

Ocean optics

Sea surface salinity

Microbiologically influenced corrosion

Metal-microbe interaction

## **MARINE GEOSCIENCES DIVISION, CODE 7400**

NRL/STENNIS SPACE CENTER, MISSISSIPPI

GEOSCIINFO@NRL.NAVY.MIL

### **MARINE GEOLOGY**

Sedimentary processes

Sediment microstructure

Pore fluid flow

Diapirism, volcanism, faulting, mass movement

Biogenic and thermogenic methane

Hydrate distribution, formation, and dissociation

Small-scale granular/fluid dynamics

### **MARINE GEOPHYSICS**

Seismic wave propagation

Physics of low-frequency acoustic propagation

Acoustic energy interaction with topography and  
inhomogeneities

Gravimetry and geodesy

Geomagnetic modeling

### **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  
Biomineralization of palladium species  
Physics-based and numerical modeling of sediment strength

#### **GEOSPATIAL SCIENCES AND TECHNOLOGY**

Digital database design  
Digital product analysis and standardization  
Data compression techniques and exploitation  
Hydrographic survey techniques  
Bathymetry extraction techniques from remote and acoustic imagery  
Modeling of nearshore morphodynamics  
Geospatial portal design with 2D and 3D interfaces  
Characterization of the littoral from airborne platforms

#### **IN SITU AND LABORATORY SENSORS**

High-resolution subseafloor 2D and 3D 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 METEOROLOGY DIVISION, CODE 7500**

NRL/MONTEREY, CALIFORNIA  
METEORINFO@NRL.NAVY.MIL

#### **ATMOSPHERIC DYNAMICS AND PREDICTION**

Global to tactical scale  
Deterministic and probabilistic  
Large eddy simulation  
Boundary layer  
Land surface  
Coastal  
Arctic  
Urban effects  
Massively parallel computing

Coupled ocean/atmosphere  
Tropical cyclones  
Aerosols  
Topographically forced flow  
Predictability  
Ensembles design  
Advanced numerical methods

#### **DATA ASSIMILATION**

Hybrid techniques  
3D and 4D variational analysis  
Ensemble Transform Kalman Filter (ETKF)  
Quality control and bias correction  
Tropical cyclone initialization  
Remotely sensed data assimilation  
Adjoint applications  
Direct radiance assimilation  
Radar data assimilation  
Targeted observations  
Data selection techniques  
Aerosol assimilation  
UAV data assimilation

#### **TACTICAL ENVIRONMENTAL SUPPORT**

Rapid environmental assessment  
Through-the-sensor measurements  
Atmospheric impact on weapons systems  
Chem-bio transport and dispersion  
Data fusion  
Nowcasting  
Visualization  
Expert systems  
Aviation risk assessment

#### **ATMOSPHERIC PHYSICS**

Air-sea interaction  
Cloud and aerosol microphysics  
Radiative transfer  
Aerosol characterization  
Tropical cyclone structure

#### **SATELLITE DATA/IMAGERY**

Automated classification of cloud properties  
Sensor calibration/validation  
Satellite imagery analysis and enhancement  
Multisensor data fusion  
Tropical cyclone characterization  
Dust/aerosols

Rain rate and snow cover  
Nighttime environmental analysis  
JPSS preparation  
Tactical meteorology

#### **DECISION AIDS**

Refractivity/ducting  
Ceiling/visibility  
Fog/turbulence/icing  
Atmospheric acoustics  
EM/EO propagation effects  
Tropical cyclones/consensus forecasts  
Nuclear/chemical/biological transport and dispersion  
Port studies  
Typhoon havens  
Forecaster handbooks  
Quantification of uncertainty  
Counter-piracy guidance  
Tropical cyclone sortie guidance  
Forecast difficulty guidance  
Ship wind and wave limits  
Optimal ship routing–fuel savings

### **SPACE SCIENCE DIVISION, CODE 7600**

SPASCIINFO@NRL.NAVY.MIL

#### **GEOSPACE SCIENCE AND TECHNOLOGY**

Research to observe, understand, model, and forecast the Earth's operational environment that extends from the lower atmosphere to the magnetopause, in which region both terrestrial and solar effects influence the space environment.

#### **HIGH ENERGY SPACE ENVIRONMENT**

Research of energetic particle,  $\gamma$ -ray, and X-ray/ultra-violet environments in space and for other applications of interest to the DoD, homeland security, and national programs, such as detection and surveillance of nuclear materials in terrestrial and space applications.

#### **SOLAR AND HELIOSPHERIC PHYSICS**

Research to develop a fundamental physical understanding of highly variable transient and long-term solar activity; the radiative, plasma, and particulate emissions associated with the activity; and the responses of the heliosphere and the terrestrial magnetosphere to the activity. Relevant empirical data is collected

by conceiving, developing, and operating state-of-the-art imaging, spectrometric, and in situ space flight sensors on national and international space missions. Physics-based models are hypothesized, tested with the collected empirical data and computer simulation, and developed.

## **NAVAL CENTER FOR SPACE TECHNOLOGY**

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### **SPACE SYSTEMS DEVELOPMENT DEPARTMENT, CODE 8100**

SPASYSINFO@NRL.NAVY.MIL

#### **ADVANCED SPACE/AIRBORNE/GROUND 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  
Onboard orbit propagation  
GPS space navigation  
Satellite coverage and mission analysis  
Geolocation systems  
Orbit dynamics  
Interplanetary navigation

#### **COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE**

Communications theory and 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 AND AIRBORNE PAYLOAD DEVELOPMENT**

Space and airborne system payload concept definition,  
design, and implementation; hardware and software

Detailed electrical/electronic design of electronic and electromechanical payload and systems and components

Design and verification of real-time embedded multi-processor software

Payload antenna systems

Space and airborne payload fabrication, test, and integration

Launch and on-orbit payload support

#### **LASER COMMUNICATIONS RESEARCH**

Ship-to-ship laser communications

Space-to-ground laser communications

Satellite laser ranging for precise orbit determination

#### **SPACE AND AIRBORNE MISSION DEVELOPMENT**

Mission development and requirements definition

Systems engineering and analysis

Concepts of operations and mission simulations

Mission evaluation and performance assessments

#### **PRECISION NAVIGATION AND TIME**

Advanced navigation satellite technology

Precise Time and Time Interval (PTTI) technology

Atomic time/frequency standards/instrumentation

Passive and active ranging techniques

Precision tracking of orbiting objects from space/ground

National and international standards for timekeeping/

Universal Coordinated Time/UTC (NRL)

## **SPACECRAFT ENGINEERING DEPARTMENT, CODE 8200**

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

#### **SPACE MECHANICAL SYSTEMS DEVELOPMENT**

Research and development in spacecraft technology

Conceptual design trade studies

Integrated engineering design and analysis

Structural and thermal design and analysis

Development and transition of prototype hardware  
Development and integration of experimental payloads  
Mission integration and development

### **CONTROL SYSTEMS**

Attitude determination and control systems  
Precision pointing  
Optical line-of-sight stabilization  
Propulsion systems  
Precision cleaning and component testing  
Propellant and pressurization systems  
Hydraulic and pneumatics control  
Test systems and services  
Analytical design and mission planning  
Navigation, tracking, and orbit dynamics  
Expert systems  
Flight operations support  
Computer simulation  
Computer animation  
Robotics systems engineering  
Proximity operations  
Autonomous servicing  
Autonomous inspection  
End effector design  
Compliance control  
Trajectory planning  
Machine vision  
Fault detection, isolation, and recovery

### **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

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### **Technology Transfer Office**

NRL has a long history of working with industry and academia to assist in the transfer of its inventions for nonmilitary applications. Many of NRL's research efforts result in materials, techniques and other products that 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 for the public good.

The Technology Transfer Office markets NRL's technologies in various ways, including distributing and posting fact sheets describing available technologies, participating in NRL exhibits at scientific and Navy conferences and working with local economic development groups. NRL's social media program is also in TTO and provides another venue for marketing.

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

E-MAIL: [TECHTRAN@RESEARCH.NRL.NAVY.MIL](mailto:TECHTRAN@RESEARCH.NRL.NAVY.MIL)

URL: [HTTP://WWW.NRL.NAVY.MIL/TECHTRANSFER](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, nonprofit organizations, universities, state and local governments, and licensees of inventions owned by 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://www.nrl.navy.mil/techtransfer/cradas.php>.

E-MAIL: [TECHTRAN@RESEARCH.NRL.NAVY.MIL](mailto:TECHTRAN@RESEARCH.NRL.NAVY.MIL)

URL: [HTTP://WWW.NRL.NAVY.MIL/TECHTRANSFER](http://WWW.NRL.NAVY.MIL/TECHTRANSFER)

### **Licensing of Navy Inventions**

Since the enactment of FTTA, the effort to encourage commercial use of government-funded technology has expanded in the federal laboratories. Title 35, Section 209, of the United States Code authorizes federal agencies to license their patentable inventions. A license grants the licensee the right to make, use, import and sell a product based on the licensed technology in exchange for royalty payments that are shared by the Laboratory and the inventors. NRL supports an active licensing program and has over 900 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, and foreign and multinational businesses.

To begin the process of acquiring a license, the potential licensee is required to fill out the Application to Practice a Navy Invention (found at <http://www.nrl.navy.mil/techtransfer/licenses.php>). This application must include a detailed business/commercialization plan that covers the important aspects of product development, marketing and sales, including a development plan with milestones, timelines, and relevant expertise; the source of funding for development of the invention; the risks associated with the technology and the market; and a projected sales forecast 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). 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 attract the investment of risk capital necessary to bring the invention to practical application. The proposed scope of exclusivity must not be greater than the licensee capabilities for developing and commercializing the technology, and granting the license must not substantially lessen competition.

For partially exclusive or exclusive licenses, 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.

Typical financial components to each license are: (1) a lump-sum upfront fee paid on execution of the license, (2) milestone fees, (3) a running royalty for sales other than to the federal government, and (4) a minimum annual royalty.

E-MAIL: [TECHTRAN@RESEARCH.NRL.NAVY.MIL](mailto:TECHTRAN@RESEARCH.NRL.NAVY.MIL)

URL: [HTTP://WWW.NRL.NAVY.MIL/TECHTRANSFER](http://WWW.NRL.NAVY.MIL/TECHTRANSFER)

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## **Work for Nonfederal Parties**

NRL has many unique capabilities that may enhance the R&D efforts of organizations external to NRL. NRL may sell testing and other services, articles, models, and software if: NRL's capabilities are unique; the sale would not constitute undue competition with industry; making them available for sale is in the interest of national defense; 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, but incremental funding by task is often acceptable. The procedures for the approval of sales to nonfederal entities are covered in NRL Instructions.

Call (202) 767-2244 if you have any questions regarding work for nonfederal parties.

## **Letters of Intent**

With increasing frequency, funding agencies are sponsoring R&D programs that are performed by “teams” consisting of industry, national laboratory, and/or university members. NRL participates actively in such programs that are 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 to the team lead that describes the work NRL will perform on a best efforts basis if the proposal is funded. Whenever possible, NRL arranges for direct funding of its efforts by a sponsoring U.S. government agency via the Economy Act. In the event that NRL cannot be directly funded by a federal sponsor, NRL will use its best efforts to negotiate an authorized agreement under applicable law and regulation with the team lead under which NRL will perform and be compensated for its assigned tasks under the proposal.

Call (202) 767-2244 if you have any questions regarding Letters of Intent.

## **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 if you have any questions regarding establishing MOUs and MOAs with NRL.

## **Funding External Activities**

NRL is the Navy’s corporate laboratory, conducting basic and applied research for the Navy in a variety of scientific and technical disciplines. The basic research program is driven by perceptions about future requirements of the Navy. 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. The North American Industry Classification System (NAICS) Code is 541710 — Research and Development in the Physical, Engineering, and Life Sciences.

Performers are competitively selected after review of proposals submitted in response to Broad Agency Announcements (BAAs) or Requests for Proposals (RFPs).

Proposals may be submitted by any nongovernmental entity, including commercial firms, institutions of higher education with degree-granting programs in science or engineering (universities), or by consortia led by such concerns. NRL encourages small businesses, veteran-owned small businesses, service-disabled veteran-owned small businesses, small disadvantaged businesses, HUBZone small businesses, woman-owned small businesses, and 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. Proposals may range from theoretical studies to proof-of-concept to include fabrication and delivery of a prototype. BAA topics include all NRL sites located in the Washington, DC area, the Stennis Space Center, MS, and Monterey, CA. Proposals submitted in response to a BAA announcement 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 selection of proposals for contract award will be based on a scientific review of proposals submitted in response to each BAA. The major purpose of the evaluation will be to determine the relative merit of the technical approach of each proposal. Business and contractual aspects, including cost realism, will also be considered as part of the evaluation. Selection of proposals for award will be based on the potential benefits to the government weighed against the cost of the proposals, in view of the availability of funds.

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/index02.htm>.

### **Commercial Contracts/Procurements**

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 Requests for Proposals (RFPs) and NRL acquisitions are announced on the Federal Business Opportunities (Fed-BizOpps) website under Department of the Navy (USN), Office of Naval Research (ONR). ONR is NRL's parent organization. NRL RFPs are also available from the NRL Contracting Division website. NRL RFPs are linked to the NECO site's Associated Links under "ONR-Office of Naval Research."

Purchases at or below the simplified acquisition threshold, orders against GSA schedule contracts, and MILSTRIP requisitions are processed by the Purchasing Branch (Code 3410) in the NRL Supply and Information Services Division (Code 3400).

More information on "Doing Business" with the Naval Research Laboratory is available on the Internet at the following address: <http://heron.nrl.navy.mil/contracts/>.

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

## Career Opportunities at NRL

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[HTTP://HROFFICE.NRL.NAVY.MIL/JOBS](http://hroffice.nrl.navy.mil/jobs)

NRL is always looking to recruit talented individuals in many fields of science. In addition to vacancies announced at <http://hroffice.nrl.navy.mil/jobs/vacancy.htm>, there are many programs for postdocs and students.

### Research Associateships

Every year, NRL hosts several postdoctoral research associates through the National Research Council (NRC) and American Society for Engineering Education (ASEE) postdoctoral associateship and fellowship programs. These competitive positions provide postdoctoral scientists and engineers opportunity to pursue research at NRL in collaboration with NRL scientists and engineers. Research associates are guest investigators, not employees of the Naval Research Laboratory.

#### **NRL/NRC COOPERATIVE RESEARCH ASSOCIATESHIP**

**PROGRAM:** The NRC conducts a national competition to recommend and make awards to outstanding scientists and engineers at recent postdoctoral levels for tenure as guest researchers at participating laboratories.

The objectives of the NRC program are (1) to provide postdoctoral scientists and engineers of unusual promise and ability opportunities for research on problems, largely of their own choice, that are compatible with the interests of the sponsoring laboratories and (2) to contribute thereby to the overall efforts of the federal laboratories. The program provides an opportunity for concentrated research in association with selected members of the permanent professional laboratory staff, often as a climax to formal career preparation.

NRL/NRC Postdoctoral Associateships are awarded to persons who have held a doctorate less than five years at the time of application and are made initially for one year, renewable for a second and possible third year. Information and applications may be found at <http://www.national-academies.org/rap>. To contact NRL's program coordinator, call (202) 404-7450 or email [nrc@hro.nrl.navy.mil](mailto:nrc@hro.nrl.navy.mil).

#### **NRL/ASEE POSTDOCTORAL FELLOWSHIP PROGRAM:**

The ASEE program is designed to significantly increase the involvement of creative and highly trained scientists and engineers from academia and industry in scientific and technical areas of interest and relevance to the Navy.

Fellowship awards are based upon the technical quality and relevance of the proposed research, recommendations by the Navy laboratory, academic qualifications, reference reports, and availability of funds.

NRL/ASEE Fellowship awards are made to persons who have held a doctorate for less than seven years at the time of application and are made for one year, renewable for a second and possible third year. Information and applications may be found at <http://www.asee.org/nrl/>. To contact NRL's program coordinator, call (202) 404-7450 or email [asee@hro.nrl.navy.mil](mailto:asee@hro.nrl.navy.mil).

### **Office of Naval Research Summer Faculty Research and Sabbatical Leave Program**

This program provides for university faculty members to work for ten weeks (or longer, for those eligible for sabbatical leave) with professional peers in participating Navy laboratories on research of mutual interest. Applicants must hold a teaching or research position at a U.S. college or university. Contact NRL's program coordinator at [sfrp@hro.nrl.navy.mil](mailto:sfrp@hro.nrl.navy.mil).

### **NRL/United States Naval Academy Cooperative Program for Scientific Interchange**

This program allows faculty members of the U.S. Naval Academy to participate in NRL research. This collaboration benefits the Academy by providing the opportunity for USNA faculty members to work on research of a more practical or applied nature. In turn, NRL's research program is strengthened by the available scientific and engineering expertise of the USNA faculty. Contact NRL's program coordinator at [usna@hro.nrl.navy.mil](mailto:usna@hro.nrl.navy.mil).

### **Student Programs**

The **NAVAL RESEARCH ENTERPRISE INTERN PROGRAM (NREIP)** This program offers summer appointments at Navy laboratories to current college sophomores, juniors, seniors, and graduate students from participating schools. Application is online at [www.asee.org/nreip](http://www.asee.org/nreip) through the American Society for Engineering Education. Electronic applications are sent for evaluation to the point of contact at the Navy laboratory identified by the applicant. Contact NRL's program coordinator at [nreip@hro.nrl.navy.mil](mailto:nreip@hro.nrl.navy.mil).

The **NATIONAL DEFENSE SCIENCE AND ENGINEERING GRADUATE FELLOWSHIP PROGRAM** helps U.S. citizens obtain advanced training in disciplines of science and engineering critical to the Navy. The three-year program

awards fellowships to recent outstanding graduates to support their study and research leading to doctoral degrees in specified disciplines such as electrical engineering, computer sciences, material sciences, applied physics, and ocean engineering. Award recipients are encouraged to continue their study and research in a Navy laboratory during the summer. Contact NRL's program coordinator at (202) 404-7450 or ndseg@hro.nrl.navy.mil.

The **PATHWAYS INTERN PROGRAM** (formerly STEP and SCEP) is designed to provide students enrolled in a wide variety of educational institutions, from high school to graduate level, with opportunities to work at NRL and explore Federal careers while still in school and while getting paid for the work performed. Students can work full-time or part-time on a temporary or non-temporary appointment. Students must be continuously enrolled on at least a half-time basis at a qualifying educational institution and be at least 16 years of age. The primary focus of our **Non-temporary** intern appointment is to attract students enrolled in undergraduate and graduate programs in engineering, computer science, or the physical sciences. Students on non-temporary appointments are eligible to remain on their appointment until graduation and may be non-competitively converted to a permanent appointment within 120 days after completion of degree requirements. Conversion is dependent on work performance, completion of at least 640 hours of work under the intern appointment before completion of degree requirements, and meeting the qualifications for the position. The **Temporary** intern appointment is up to one year in duration and may be extended for one additional year. This program enables students to earn a salary while continuing their studies and offers them valuable work experience. Our Intern Program opportunities are announced on USAJOBS. For additional information on our Intern Program, contact (202) 767-8313.

The **STUDENT VOLUNTEER PROGRAM** helps students gain valuable experience by allowing them to voluntarily perform educationally related work at NRL. Applications are accepted year-round. For additional information on our Student Volunteer Program, contact (202) 767-8313.

The **DoD SCIENCE AND ENGINEERING APPRENTICESHIP PROGRAM (SEAP)** provides an opportunity for high school students who have completed at least Grade 9, and are at least 15 years of age to serve as junior research associates. Under the direction of a mentor, for eight weeks in the summer, students gain a better understand-

ing of research, its challenges, and its opportunities through participation in scientific, engineering and mathematics programs. Criteria evaluated for acceptance are science and mathematics courses completed and grades achieved; scientific motivation, curiosity, the capacity for sustained hard work; a desire for a technical career; teacher recommendations; and exceptional test scores. The NRL program is one of the largest in DoD. For detailed information visit <http://seap.asee.org/>, or call (202) 767-8324, or email [seap@hro.nrl.navy.mil](mailto:seap@hro.nrl.navy.mil).



## CAREERS AT NRL

- Research Chemist
- Chemical Engineer
- Computer Scientist
- Computer Engineer
- Meteorologist
- Materials Research Engineer
- Metallurgist
- Mathematician
- Geologist
- Research Biologist
- Electrical Engineer
- Electronics Engineer
- Mechanical Engineer
- Aerospace Engineer
- Research Physicist
- Astrophysicist
- Oceanographer
- Geophysicist

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

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

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CAPT Anthony J. Ferrari, USN  
Commanding Officer

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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, artificial intelligence, tactical electronic warfare, and microelectronic devices.



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The Naval Research Laboratory nurtures a multidisciplinary research environment to stimulate and support creative and innovative concepts in the physical sciences, engineering, and information technology. Young scientists and engineers are encouraged to team with the Lab's world-renowned 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.

*the NAVY's corporate laboratory*