Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Navy												Date: March 2023
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601153N *I Defense Research Sciences*							
COST ($ in Millions)	**Prior Years**	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	511.510	541.513	540.908	-	540.908	558.812	578.932	569.486	591.204	Continuing	Continuing
0000: *Defense Research Sciences*	0.000	462.869	479.480	520.984	-	520.984	538.490	558.203	548.343	569.638	Continuing	Continuing
3465: *In-House Lab Independent Res*	0.000	10.992	19.533	19.924	-	19.924	20.322	20.729	21.143	21.566	Continuing	Continuing
9999: *Congressional Adds*	0.000	37.649	42.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	80.149

A. Mission Description and Budget Item Justification

The Office of Naval Research (ONR) was established by Congress in 1946 to plan, foster and encourage scientific research in recognition of its paramount importance to the maintenance of American naval power and national security. ONR manages the Department of the Navy's (DON) portfolio of Basic Research, Applied Research and Advanced Technology Development investments to ensure naval forces can effectively deter conflict, but when called upon, fight, win and come home safely. This Program Element (PE) supports the Basic Research portion of the Department of the Navy (DON) science and technology (S&T) portfolio, laying the foundation for new innovative technologies and future capabilities for naval warfighters. This PE's efforts include theoretical and experimental investigations directed toward increasing knowledge and understanding of the physical, chemical, engineering, environmental and life sciences. The huge majority of the research in this PE are performed by academia and government labs, both of which play significant roles in developing the S&T workforce of tomorrow in addition to delivery new knowledge and scientific discoveries.

This PE, and the rest of Naval S&T, supports higher guidance defined by the National Defense Strategy, and responds to requirements identified by the Secretary of the Navy through research priorities set by the Chief of Naval Research, coordinated across the Naval Research Enterprise (NRE), and outlined in the Naval R&D Framework. In addition, ONR's S&T investment portfolio supports National Naval Responsibilities (NNR) critical to the naval services where the Navy has historically taken the lead (ocean acoustics, undersea weapons, naval engineering, undersea medicine and sea-based aviation) to ensure decisive naval capability in the maritime domain. Scientific breakthroughs within the current research activities:
Atmosphere & Space Sciences;
Mathematics, Computer, & Information Sciences;
Ocean Sciences;
Materials/Processes;
Human Systems;
Medical/Biology;
Science Addressing Hybrid Threats;
Sensors, Electronics & Electronic Warfare (EW);
Air, Ground & Sea Vehicles;
Weapons; and

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Science & Engineering Education, Career Development & Outreach
lead to more advanced aspects of applied research and technology development and become solutions to Navy and Marine Corps technical challenges via the Future Naval Capabilities (FNCs) pipeline, and new capability options for the future via the Innovative Naval Prototypes (INPs) portfolio. Just as today's Sailors and Marines are enabled by past naval S&T investments, current investments hedge against uncertainty, providing the scientific basis for near-term solutions to commanders today and options for an unknown future.

The work in this PE can be classified between Technology Readiness Level (TRL) 1 (basic principles observed and reported) and TRL 2 (technology concept and/or application formulation).

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	523.324	499.116	510.975	-	510.975
Current President's Budget	511.510	541.513	540.908	-	540.908
Total Adjustments	-11.814	42.397	29.933	-	29.933
• Congressional General Reductions	-	-0.103			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	42.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-11.814	0.000			
• Program Adjustments	0.000	0.000	29.933	-	29.933
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Project: 9999: *Congressional Adds*		
Congressional Add: *Basic Research*	24.134	25.000
Congressional Add: *Bio-inspired Engineering and Design for Naval Applications*	2.896	0.000
Congressional Add: *Generally-capable robotics for naval operations*	3.861	0.000
Congressional Add: *Multifunctional structural batteries*	1.931	3.000
Congressional Add: *Silicon-germanium-tin alloy research*	4.827	5.000
Congressional Add: *Predictive modeling for next generation undersea vehicles*	0.000	3.000

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Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Congressional Add: *Naval Research Laboratory S&T*	0.000	6.500
Congressional Add Subtotals for Project: 9999	37.649	42.500
Congressional Add Totals for all Projects	37.649	42.500

Change Summary Explanation

Funding: $29.933M funding increase for Basic Research Enhancements for Strategic Competition

Technical: No significant change.

Schedule: No significant change

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Appropriation/Budget Activity 1319 / 1					R-1 Program Element (Number/Name) PE 0601153N / *Defense Research Sciences*				Project (Number/Name) 0000 / *Defense Research Sciences*			
COST ($ in Millions)	**Prior Years**	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**Cost To Complete**	**Total Cost**
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Human Systems;
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Science Addressing Hybrid Threats;
Sensors, Electronics & Electronic Warfare (EW);
Air, Ground & Sea Vehicles;
Weapons; and
Science & Engineering Education, Career Development & Outreach
lead to more advanced aspects of applied research and technology development and become solutions to Navy and Marine Corps technical challenges via the Future Naval Capabilities (FNCs) pipeline, and new capability options for the future via the Innovative Naval Prototypes (INPs) portfolio. Just as today's Sailors and Marines are enabled by past naval S&T investments, current investments hedge against uncertainty, providing the scientific basis for near-term solutions to commanders today and options for an unknown future.

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Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Title: Air, Ground and Sea Vehicles	55.534	56.993	57.168	0.000	57.168
Description: Sailors and Marines operate air, ground and sea vehicles in some of the most extreme environments on the planet. Basic research advances the capacity of naval platforms operating under, on and above the seas, and to project power ashore. Ongoing research in the Air, Ground and Sea Vehicles activity will increase platform performance, reliability, improve human-machine teaming, reduce the cost of at-sea operations and enhance the effectiveness of distributed maritime operations. The efforts research focus include: surface and subsurface signatures; free-surface, subsurface, and propulsor hydromechanics; hull life assurance; advanced ship concepts; distributed intelligence for automated survivability; advanced electrical power systems; air vehicles; air platforms propulsion and power; air platforms survivability and signature control; special aviation projects; environmental quality; logistics; power generation, energy conversion, and storage; and advancements in naval technology innovations. ***FY 2023 Plans:*** Aerospace Structures and Materials Research is focused on basic research for developing lightweight, reliable, survivable, sustainable, and affordable airframes for naval and marine corps aircraft and weapons. - Continue research on galvanic corrosion and mitigation strategies for metallic airframes in naval environment. - Continue efforts on multiaxial fatigue of hybrid airframes. - Continue research on high fidelity composites prediction methodologies that span multiple length scales. - Continue work on novel out of autoclave and out of oven curing technologies. - Continue research on short fiber thermoplastic composite forming and joining. - Continue work on high strain rate characterization of materials. - Continue computer assisted iterative material development for armor applications. - Continue investigating lightweight material solutions for multifunctional structures for airframes and weapons. Flight Dynamics & Control					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Research will develop theory and analysis methods to understand the phenomena and natural dynamics of air vehicles operating in the marine environment. Collaborative research will improve our knowledge of control system interactions between piloted aircraft and human performance. - Continue efforts to increase the operational envelop for air vehicles, tailor airframe dynamics with novel control effectors, improve threat engagement performance, develop fundamentals for coupled human/machine dynamics, adapt to variable airframe conditions. - Continue work on multibody control systems and the ability to demonstrate guaranteed performance relative to a desired end state. - Continue work designed to achieve robust and precise control in the presence of highly turbulent flow fields. - Continue developing algorithms to enable precise ship-relative navigation in GPS-denied environments. Aerodynamics Research will enhance understanding of Naval-unique aerodynamic challenges by developing advanced computational and experimental methods. - Continue researching the fully coupled aerodynamic interface between ships and aircraft. - Continue investigating novel state-of-the-art in-situ diagnostics and reduced-order modeling of complex flow fields. - Continue researching innovative technologies enabling increased range and/or maneuverability suitable for aircraft operating from the maritime environment and attritable systems such as unmanned aerial systems and high-speed weapons. - Continue research on the interactional and transitional aerodynamics of multi-rotor systems in complex fluid dynamic environments involving multi-body relative motion. Science of Autonomy and Control of Unmanned Systems Research related to critical multidisciplinary autonomy challenges that cut across areas/domains, including air, sea, undersea and ground. - Continue investigating the scalable and robust distributed collaboration among autonomous systems. - Continue research on human/unmanned system collaboration. - Continue work on perception-based adaptation across uncertain naval environments. - Continue investigating embodied and situated intelligence and architectures. - Continue developing theory-based tools and methods for safe, assured, robust, verifiable, and trustable autonomy. Propulsion, Power and Thermal Management					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Complete research in flow control in offset diffusers. - Continue research to advance the technical superiority of Naval Aircraft - Propulsion, Power and Thermal management with emphasis on propulsion cycles, subsystems, propulsion integration, turbo machinery and drive systems, and hot section materials and coatings. - Continue research to improve the power density, fuel efficiency, speed, range and operating reliability of future large, medium and small engines. - Continue studies with Rotating Detonation Engines and integration into platforms and weapon systems using thermodynamic models, Computational Fluid Dynamics and sub-scale experiments. - Continue research for high stage-loading and efficient turbomachinery including distortion tolerant fans, casing treatments and advanced methods in blade-disk aerodynamics; advanced cooling and thermal management for engines and auxiliary systems including new concepts of heat collection, distribution and rejection; advanced turbine engine materials and coatings; highly integrated propulsion inlets and exhausts and dust ingestion research, including modeling, separating, deposition, coatings and sensing. - Continue to improve jet engine material durability and temperature rate capabilities in both benign and corrosive environments. - Continue to develop advanced radio-frequency based sensors to provide ingestion and foreign object damage sensing, as well as overall prognostics. - Initiate research of fundamental modeling of distributed combustion in the turbine. Platform Design and Engineering Conduct basic research related to platform performance and platform autonomy and control. Efforts include, but are not limited to, the following: - Continue research related to Naval Engineering and Platform Design (NNR), Basic Surface Ship Dynamics, Propulsion Hydromechanics, Basic Subsurface Hydromechanics, Basic Surface Ship Hydrodynamics, Adaptive Control and Centers for Innovative Naval Technology - Continue and expand research associated with Digital Twin Science efforts. Conduct basic research related to platform survivability and tactical submarine evolution plan (TSEP) S&T. Efforts include, but are not limited to, the following: - Continue research related to Structural Reliability Science, Metamaterials, Structural Acoustic Science, Underwater Electromagnetic Signatures, Electromagnetic Signatures, Signature Management Science, Submarine Security S&T - Detectability and Submarine Security S&T - Susceptibility. Power, Energy & Propulsion					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Conduct basic research related to heat transfer and thermal management, power generation, energy storage and power management, distribution and control, and power electronics and electro-magnetics. - Initiate basic research efforts related to climate resiliency and clean energy. Materials - Continue research related to enabling enhanced performance and resiliency of systems and platforms through a collection of related efforts. Work includes Corrosion Control Science (for conventionally and additive manufactured materials) for enhanced resiliency and sustainability of naval platforms and systems; Nano-Engineered Materials for extended performance and sustainability of legacy systems and platforms and emerging opportunities for structural and functional (optical, electro-active, etc.) properties that will enable new system designs; Scarce Materials Mitigation Strategies to explore new compositions to reduce requirements for certain elements; Electrochemical Materials and Functional Polymeric and Organic Materials to understand phenomenology that can be applied to more efficient energy capture and power storage and distribution for a wide distribution of naval emerging requirements, and Computer-Aided Material Design to accelerate research in all areas described here.					
FY 2024 Base Plans: Aerospace Structures and Materials Research focused on the development of lightweight, reliable, survivable, sustainable, and affordable airframes for naval and marine corps aircraft and weapons. Research efforts include the following: - Continue research on galvanic corrosion and mitigation strategies for metallic airframes in naval environment. - Continue research on high fidelity composites prediction methodologies that span multiple length scales. - Continue investigations of novel out-of-autoclave and out-of-oven curing technologies. - Continue research efforts on short fiber thermoplastic composite forming and joining. - Continue research investigations of high strain rate characterizations of materials. - Continue material development efforts regarding armor applications. - Continue investigating lightweight material solutions for multifunctional structures for airframes and weapons. - Complete computer-assisted iterative material development for armor applications. - Complete research efforts regarding multiaxial fatigue of hybrid airframes. - Initiate fundamental research on manipulating material micro structure for function. Flight Dynamics & Control Research to develop the theory and analysis methods necessary to understand the phenomena and natural dynamics of air vehicles operating in the marine environment. Collaborative research efforts in this area improve					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
our knowledge of control system interactions between piloted aircraft and human performance. Research efforts include the following: - Continue research investigations to increase the operational envelop for air vehicles, tailor airframe dynamics with novel control effectors, improve threat engagement performance, develop fundamentals for coupled human/ machine dynamics, adapt to variable airframe conditions. - Continue research regarding multibody control systems and the ability to demonstrate guaranteed performance relative to a desired end-state. - Continue research efforts to achieve robust and precise control in the presence of highly turbulent flow fields. - Continue research efforts to develop software algorithms that enable precise ship-relative navigation in GPS-denied environments. Aerodynamics Research efforts focused on enhancing our understanding of Naval-unique aerodynamic challenges by developing advanced computational and experimental methods. Research efforts include the following: - Continue researching the fully coupled aerodynamic interface between ships and aircraft. - Continue investigating novel state-of-the-art in-situ diagnostics and reduced-order modeling of complex flow fields. - Continue researching innovative technologies enabling increased range and/or maneuverability suitable for aircraft operating from the maritime environment and attritable systems such as unmanned aerial systems and high-speed weapons. - Continue research on the interactional and transitional aerodynamics of multi-rotor systems in complex fluid dynamic environments involving multi-body relative motion. Science of Autonomy and Control of Unmanned Systems Research investigations regarding critical multidisciplinary autonomy challenges that cut across areas/domains, including air, sea, undersea and ground. Research efforts include the following: - Continue investigating the scalable and robust distributed collaboration among autonomous systems. - Continue research on human/unmanned system collaboration. - Continue work on perception-based adaptation across uncertain naval environments. - Continue investigating embodied and situated intelligence and architectures. - Continue developing theory-based tools and methods for safe, assured, robust, verifiable, and trustable autonomy. Propulsion, Power and Thermal Management					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Research efforts with focused emphasis regarding critical areas such as propulsion cycles, subsystems, propulsion integration, turbo machinery and drive systems, and high-temperature (hot section) materials and coatings. Research efforts include the following: - Continue research to advance the technical superiority of Naval Aircraft - Propulsion, Power and Thermal management with emphasis on propulsion cycles, subsystems, propulsion integration, turbo machinery and drive systems, and hot section materials and coatings - Continue research to improve the power density, fuel efficiency, speed, range and operating reliability of future large, medium and small engines. - Continue studies with Rotating Detonation Engines and integration into platforms and weapon systems using thermodynamic models, Computational Fluid Dynamics and sub-scale experiments. - Continue research for high stage-loading and efficient turbomachinery including distortion tolerant fans, casing treatments and advanced methods in blade-disk aerodynamics; advanced cooling and thermal management for engines and auxiliary systems including new concepts of heat collection, distribution and rejection; advanced turbine engine materials and coatings; highly integrated propulsion inlets and exhausts and dust ingestion research, including modeling, separating, deposition, coatings and sensing. - Continue to improve jet engine material durability and temperature rate capabilities in both benign and corrosive environments. - Continue to develop advanced radio-frequency based sensors to provide ingestion and foreign object damage sensing, as well as overall prognostics. - Continue research of fundamental modeling of distributed combustion in the turbine. - Initiate Hierarchical nonlinear Control of Integrated Propulsion, Power, and Thermal Management Systems for Naval Aircraft - Initiate Inter-Turbine burning for enhanced performance - Initiate Enhancing Jet Breakup via High-Frequency Ultrasound Platform Design and Engineering Research efforts regarding platform performance, platform survivability in support of future platform-building programs, platform autonomy, autonomous systems, and control for naval systems. Research efforts include the following: - Continue research related to Naval Engineering and Platform Design (a National Naval Responsibility area), Basic Surface Ship Dynamics, Propulsion Hydromechanics, Basic Subsurface Hydromechanics, Basic Surface Ship Hydrodynamics, Adaptive Control and Centers for Innovative Naval Technology.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research efforts associated with Digital Data Science including Autonomous Systems (Machinery/ Platform), Digital Threads, Digital Twins, Condition Based Maintenance, and Digital Engineering. - Continue research regarding Structural Reliability and Resiliency focusing efforts on Alternative Hull/Structural Materials, Composite Structures and engineered Metamaterials. - Continue research in Platform Signature Related Sciences to include: Structural Acoustics, Underwater Electromagnetic Signatures, Electromagnetic Signatures, Submarine Detectability, and Undersea Platform Susceptibility. - Initiate research efforts related to System Complexity and Resiliency for Naval Platforms and Systems. - Initiate research in Non-Acoustic Signatures Science for Advanced Naval Platforms. - Initiate research efforts regarding Digital Decision Metrics for Naval Platform Design and Engineering. Power, Energy & Propulsion Research relevant to the power, energy & propulsion of naval systems. Research efforts include the following: - Continue climate research to improve understanding of the environmental impacts on future platforms and reduce the impact of platforms on the environment. - Initiate fundamental electrical power, energy and propulsion research. - Initiate research in heat transfer and thermal management science and materials to enable effective cooling of future directed energy systems, power electronics, personnel, etc. - Initiate power generation research to improve operational endurance, energy storage, distribution, power management and control. - Initiate power electronics research for improved energy conversion efficiency, and electromagnetic materials research to achieve compatibility with high frequency power electronics. - Initiate to advance material science for electrochemical energy storage, alternative fuels, fuel cells, dielectrics, and photovoltaics. - Initiate physics-based modeling efforts, and the development of digital twins for power and energy materials, components, and systems. Materials Research relevant to enabling enhanced performance and resiliency of naval systems and platforms. Research efforts include the following: - Continue research efforts regarding Corrosion Control Science (for conventionally and additive manufactured materials) for enhanced resiliency and sustainability of naval platforms and systems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research investigations of Nano-Engineered Materials for extended performance and sustainability of legacy systems and platforms and emerging opportunities for structural and functional (optical, electro-active, etc.) properties that will enable new system designs. - Continue research of Electrochemical Materials and Functional Polymeric and Organic Materials to understand phenomenology that can be applied to more efficient energy capture and power storage and distribution for a wide distribution of naval emerging requirements. - Continue research investigations of Computer-Aided Material Design to accelerate research in all areas described here. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** There is no significant funding change from FY 2023 to FY 2024.					
Title: Atmosphere and Space Sciences	26.855	27.597	30.462	0.000	30.462
Description: Effective Naval operations depend upon accurately understanding the maritime and littoral operating environment and predicting its characteristics at high spatial and temporal resolution in areas that may be inaccessible. Understanding atmospheric phenomena and their impact on the electromagnetic spectrum from the sea surface to space provides a significant warfighting advantage. Efforts include: Battlespace Environments, Marine Meteorology and Prediction and Space Research. These efforts support basic research on physical process studies, fundamental observations, data discovery, and modeling and forecasting of the atmosphere and space with the goal of improving the ability to predict the battlespace environment of the Navy and Marine Corps, anywhere on the globe. Emphasis is placed on the marine atmosphere, the tropics, polar regions, the upper atmosphere and ionosphere and other areas where new understanding is needed in order to overcome predictability barriers that limit the accuracy of current forecast models. Efforts are underway to understand the interactions of physics between the atmosphere, space, land, ocean and ice, represent these coupled processes in models, and extend them across scales from local to planetary, with the goal of extending the skill of predictions up to seasonal and interannual timescales. Recent efforts have also focused on the processes that control tropical cyclone formation, structure and intensity changes and phenomena that affect electromagnetic and electro-optic signal propagation in the marine atmosphere and near space domains. Research results provide the foundation for improved global and regional forecasts of the operational environment and for development of next-generation, fully coupled, high resolution prediction systems. Research areas evolve in response to priorities of the Oceanographer of the Navy.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
FY 2023 Plans: Battlespace Environments - Continue to improve the quality of the environmental analysis and prediction provided in support of warfighters, including the assessment of the impact of the atmosphere and ionosphere-thermosphere-magnetosphere on the performance of sensors, platforms and weapon systems, and the advancement of our basic understanding of atmospheric processes across spatial scales and the interactions of the atmosphere with the land, sea, wave, ice, and thermosphere. - Continue to exploit environmental observations and to characterize environmental processes more accurately, thus providing improved forecast models for the Navy and Marine Corps in regions where operations take place, including: the littoral zone, where complex topography and air-sea-land contrasts impact the environment on very short time and space scales; the tropics and sub-tropics; and the Arctic, where longer time scale atmospheric changes affect short-term weather events. - Continue research on the coupled processes in the high atmosphere, between the troposphere and stratosphere and the stratosphere/mesosphere and ionosphere and their effect on weather and space weather prediction. - Continue research on atmospheric or Earth system coupled processes that are not well understood, including cloud and aerosol interaction, marine boundary layer and coastal prediction, and diurnal and mesoscale variability to improve their representation in forecast models. Marine Meteorology and Prediction -Continue to investigate key physical processes, including clouds and moisture phenomena to improve their representation in atmospheric predictive models. -Continue exploration of new and non-conventional observational data sources and novel methodologies for their assimilation into operational predictive models. -Continue deployment of observing systems in the upper troposphere, middle and upper atmosphere and the near-space environment to allow extension of prediction systems into the middle and upper atmosphere and provide longer and higher fidelity forecasts. -Continue observing experiments to understand the processes that contribute to the poorly predicted rapid intensification of tropical cyclones. -Continue field and modeling initiatives that focus on the origin, evolution and effects of Arctic cyclones believed to have a strong influence on Arctic sea ice motion and extent. -Continue to investigate the distribution, transport and time evolution of aerosols in the atmosphere and their impact on atmospheric visibility and laser propagation.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
-Complete the Land-Air-Sea Interaction research initiative to improve understanding and prediction of coupled near- shore atmospheric and oceanographic phenomena impacting naval littoral operations. -Initiate new research in cloud processes, predictability and uncertainty and utilization of nontraditional space-based and airborne sensors towards these goals. Space Research Perform innovative sensor development and physics-based modeling and forecasting integrated across three environmental space areas: geospace, heliospace, and high-energy space. Geospace: - Continue research into affordable small-sat sensors to investigate and specify the three dimensional structure and evolution of the electromagnetic signal propagation environment in the ionosphere, including ionospheric bubbles. Employ stereo imaging and tomographic reconstruction to access the three dimensional structure and evolution of the upper atmosphere and ionosphere, relevant to Naval communications, intelligence, surveillance and reconnaissance, and geolocation. - Continue development of our understanding and computational representation of upper atmospheric, ionospheric relevant plasma processes and their coupling to the lower atmosphere and solar inputs, towards a future physics-based ionospheric prediction capability. - Continue a small-sat investigation into improved ionospheric observation and understanding through use of new signal processing approaches, based on anomalous refraction of Global Navigation System transmissions. Heliospace: - Continue efforts to advance the understanding, and advance the forecastability of, the solar radiation and particle fluxes, and magnetic fields. Investigate how they influence the near-Earth environment and the relevant Naval systems that rely on that environment. - Continue to investigate efforts to improve solar event warning times, using newly available observations. - Continue efforts to understand particle acceleration mechanisms in high energy solar flares by studying gamma-ray and neutron emissions that are measured in space. - Continue efforts to leverage millisecond pulsars as stabile timing sources for precision navigation and timing applications. - Initiate efforts to improve solar event warning times, using newly available observations. High-Energy Space: - Initiate efforts to investigate new high-energy radiation and neutron detector materials for space-based observations.					
FY 2024 Base Plans:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Battlespace Environments - Continue research investigations to improve the quality of the environmental analysis and prediction provided in support of warfighters, including the assessment of the impact of the atmosphere and ionosphere-thermosphere-magnetosphere on the performance of sensors, platforms and weapon systems, and the advancement of our basic understanding of atmospheric processes across spatial scales and the interactions of the atmosphere with the land, sea, wave, ice, and thermosphere. - Continue research efforts to exploit environmental observations and to characterize environmental processes more accurately, thus providing improved forecast models for the Navy and Marine Corps in regions where operations take place, including: the littoral zone, where complex topography and air-sea-land contrasts impact the environment on very short time and space scales; the tropics and sub-tropics; and the Arctic, where longer time scale atmospheric changes affect short-term weather events. - Continue research on the coupled processes in the high atmosphere, between the troposphere and stratosphere and the stratosphere/mesosphere and ionosphere and their effect on weather and space weather prediction. - Continue research efforts regarding atmospheric or Earth system coupled processes that are not well understood (cloud and aerosol interactions, etc.), marine boundary layer and coastal prediction, and diurnal and mesoscale variability to improve their representation in forecast models. Marine Meteorology and Prediction - Continue research efforts regarding marine atmospheric boundary layer gradients and processes important for low and mid-cloud evolution and structure. - Continue research investigations regarding key physical processes (marine atmospheric clouds, moisture and aerosol phenomena, etc.) to improve their representation in weather prediction models. - Continue research investigations of new and non-conventional observational data sources and novel methodologies for their assimilation into operational predictive models. - Continue efforts regarding the deployment of observing systems in the upper troposphere, middle and upper atmosphere and the near-space environment to allow extension of prediction systems into the middle and upper atmosphere and provide longer and higher fidelity forecasts. - Continue research investigations regarding the distribution, transport and time evolution of aerosols in the atmosphere and their impact on atmospheric visibility and laser propagation. - Complete observing experiments to understand the processes that contribute to the poorly predicted rapid intensification of tropical cyclones. - Complete field and modeling initiatives that focus on the origin, evolution and effects of Arctic cyclones believed to have a strong influence on Arctic sea ice motion and extent.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate new research in satellite-based environmental remote sensing algorithms and techniques tailored to improved retrievals for phenomena and regions of particular Naval interest. Space Research Continue research efforts on innovative sensor development, physics-based modeling and forecasting efforts integrated across three environmental space areas: geospace, heliospace, and high-energy space. Research efforts include: Geospace: - Continue research into affordable small-sat sensors to investigate and specify the three dimensional structure and evolution of the electromagnetic signal propagation environment in the ionosphere, including ionospheric bubbles. Employ stereo imaging and tomographic reconstruction to access the three dimensional structure and evolution of the upper atmosphere and ionosphere, relevant to Naval communications, intelligence, surveillance and reconnaissance, and geolocation. - Continue development of our understanding and computational representation of upper atmospheric, ionospheric relevant plasma processes and their coupling to the lower atmosphere and solar inputs, towards a future physics-based ionospheric prediction capability. - Complete a small-sat investigation into improved ionospheric observation and understanding through use of new signal processing approaches, based on anomalous refraction of Global Navigation System transmissions. - Initiate development of new imaging techniques to examine the structure and avolution of additional airglow chemical species in the ionosphere for dayside and nightside processes. - Initiate the development of new neutral density atmospheric observations for the mesosphere. - Initiate observational research in polar ionospheric processes for improved regional prediction of the ionosphere at high latitudes. - Initiate efforts into understanding basic plasma processes in the near-earth space to protect and understanding the effects on Naval C4IRS capabilities. Heliospace: - Continue efforts to advance the understanding, and advance the forecastability of solar radiation and particle fluxes and their interaction with magnetic fields. Investigate how they influence the near-Earth environment and the relevant Naval systems that rely on that environment. - Continue to investigate efforts to improve solar event warning times, using newly available observations. - Continue efforts to understand particle acceleration mechanisms in high energy solar flares by studying gamma-ray and neutron emissions that are measured in space.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue efforts to leverage millisecond pulsars as stabile timing sources for precision navigation and timing applications. - Continue research efforts to improve solar event warning times, using newly available observations. - Initiate efforts into forecasting physically-derived solar irradiance variability and the ionosphere-thermosphere-mesosphere (ITM) response. High-Energy Space: - Continue research investigations of new high-energy radiation and neutron detector materials for space-based observations. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY 2023 to FY 2024 in Atmosphere And Space Sciences will be used to conducted increased Basic Research in areas but not limited to ocean, littoral, atmosphere, and space environment.					
Title: Science Addressing Hybrid Threats	23.937	24.248	21.129	0.000	21.129
Description: Naval expeditionary forces increasingly face hybrid adversaries using conventional weapons combined with terror, crime, cyber, information operations, etc. A hybrid adversary is flexible and adapts quickly to synchronize advanced state weapons systems, disruptive commercial technologies, cheap expedient homemade weapons, and a variety of novel tactics. The Sciences Addressing Hybrid Threats (SAHT) (formerly Counter Improvised Explosive Device (IED)) activity seeks to establish and nurture science to counter these growing challenges, while collaborating with and leveraging results from more traditional Naval research portfolios. The SAHT Sciences program provides research for Naval Forces to fight hybrid threats and adversaries in expeditionary operations. Naval Expeditionary Forces need science advances to address a range of research challenges that result from physical and operational environmental limitations so harsh that solutions push basic discovery and invention. Naval Forces able to operate amphibiously and in the littoral will have all of their capabilities exposed to degrading sea and land physical effects. Expeditionary forces must be agile and lethal but will be constrained by size, weight, and power requirements and must be sustained across large areas. Research efforts include: machine perception, reasoning and collaborative behavior; artificial intelligence enabling future intelligent systems; optics, electronics, and photonics research to enable revolutionary					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
spectral awareness in small low power sensors; computer and network science to enable expeditionary computing; fundamental chemistry and materials science research to advance technologies to support sustainment; materials research to explore and improve armor and structural materials; electrochemical energy conversion and storage research to sustain the force; chemistry and physics to provide disruptive energetics for expeditionary fires; and biology, physiology, and cognitive sciences addressing Naval Expeditionary warfighter capabilities. ***FY 2023 Plans:*** - Continue basic research in sensors and sensing technologies to enable stand-off detection and rapid neutralization of explosive hazards in multiple expeditionary mission environments while maintaining operational tempo. - Continue research into reconstructing human physiological features from audio samples based upon brain science to pair vocal tract features with identifiable facial characteristics. - Continue research into enabling secure and efficient sharing of computer hardware accelerators in systems restricted by size, weight, area and power. - Continue work in immersive sciences for automated methods for generating content and behaviors, and conduct research studies to examine questions, such as usability and training effectiveness, to increase understanding and use of Extended Reality (XR) technologies for naval applications. - Continue research into methods to identify coherent courses of action with effective outcomes using Artificial Intelligence (AI) agents. - Continue investigating learning theories to enable complex, collaborative, human-robot interactions. - Continue research for modeling autonomy, for the purpose of creating systems that operate in complex undersea/surface/land/air/space domains. - Continue research methods that model how diverse autonomous systems interact with each other in complex environments. - Continue work on means and methods for evaluating the reliability and effectiveness of collective decision making by autonomous systems and humans. - Continue researching the creation of Artificial Intelligence (AI) hybrid learning theories for the purpose of creating heterogeneous multi-agent collaborative autonomy. - Continue research to create theories for multi-agent collaborative autonomy that mimic the organizational principles found in social insects/birds/fishes. - Complete exploring concepts, techniques and methods, for the design, growth, and characterization of electronic and electro-optic sensors to counter improvised explosive devices (IEDs).					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate a follow-on and focused research effort on investigation on security aspect of non-volatile main memory usage for future computing systems. - Initiate research to provide fundamental understanding of biological olfactory sensing and processing of relevant odor representation in order to apply toward chemical sensor design and processing principles. - Initiate research of ultra-low size, weight, and power communications in a contested environment. - Initiate research to explore robotic behaviors for locating and mitigating threats from hazards in building clearing. - Initiate a follow-on and focused research effort for the machine learning investigation of multifactorial information environment parameters in order to automate the process of detecting, identifying and distinguishing intent. - Initiate a follow-on and focused research effort for discovery research on multi-class, multi-objective deep reinforced learning algorithms with automated training.					
FY 2024 Base Plans: Mathematics, Electronics, and Quantum Fundamental Research - Continue a focused research effort for discovery research on multi-class, multi-objective deep reinforced learning algorithms with automated training. - Complete research into reconstructing human physiological features from audio samples based upon brain science to pair vocal tract features with identifiable facial characteristics. Mine & Expeditionary Warfare - Continue research efforts in sensors and sensing technologies to enable stand-off detection and rapid neutralization of explosive hazards in multiple expeditionary mission environments while maintaining operational tempo. - Initiate research into rethinking data security in a speculative, hammerable, and heterogeneous world. - Initiate research into third generation network intrusion detection and prevention systems. Platform Design and Engineering - Continue research of ultra-low size, weight, and power communications in a contested environment. - Complete a focused research effort on investigation on security aspect of non-volatile main memory usage for future computing systems. - Complete research to provide fundamental understanding of biological olfactory sensing and processing of relevant odor representation in order to apply toward chemical sensor design and processing principles.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Complete research investigations into enabling secure and efficient sharing of computer hardware accelerators in systems restricted by size, weight, area and power. - Initiate efforts to study the complex energy-supply problem with deployed vehicles in contested environments en route to developing a novel decision-support framework for planning and managing adaptive transportation systems for naval logistics. - Initiate research to study, characterize, understand, and exploit anionic redox phenomena in lithium-ion and sodium-ion batteries and solve fundamental challenges en route to improving and designing new materials that could increase the cathode capacity of these battery chemistries by exploiting the anionic redox processes. Human-Level AI and Autonomy - Continue research investigations regarding learning theories to enable complex, collaborative, human-robot interactions. - Continue research for modeling autonomy, for the purpose of creating systems that operate in complex undersea/surface/land/air/space domains. - Continue research methods that model how diverse autonomous systems interact with each other in complex environments. - Continue research efforts on means and methods for evaluating the reliability and effectiveness of collective decision making by autonomous systems and humans. - Continue research investigations regarding the creation of Artificial Intelligence (AI) hybrid learning theories for the purpose of creating heterogeneous multi-agent collaborative autonomy. - Continue research to create theories for multi-agent collaborative autonomy that mimic the organizational principles found in social insects/birds/fishes. - Continue a follow-on and focused research effort for the machine learning investigation of multifactorial information environment parameters in order to automate the process of detecting, identifying and distinguishing intent. - Complete research into methods to identify coherent courses of action with effective outcomes using Artificial Intelligence (AI) agents. - Complete research to explore robotic behaviors for locating and mitigating threats from hazards in building clearing. - Initiate research to study novel collaborative methods for swarming autonomous entities to reliably determine true/relative position in GPS-denied operations. Training and Education for Naval Readiness					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue work in immersive sciences for automated methods for generating content and behaviors, and conduct research studies to examine questions, such as usability and training effectiveness, to increase understanding and use of Extended Reality (XR) technologies for naval applications. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The decrease from FY 2023 to FY 2024 is due to a more appropriate alignment of materials, biomedical and survivability research efforts to the Material/Processes Research Activity.					
Title: Human Systems ***Description:*** Sailors and Marines operate across multiple domains: under, on and above the seas. This Activity focuses on understanding the human aspects of Naval operations with the objective of planning and execution for mission success. The long-term goal of this research is to increase total system performance by maximizing the effectiveness of human-machine systems to ensure mission effectiveness. Research areas include: attention and decision making in goal-directed behaviors, computational and neural foundations of cognitive skills and underlying processes, information exchange processes in human-human and human-machine teaming tasks, human interactions with autonomous systems, preparation and adaptation to novel challenge, new approaches to training and training assessment, personnel assessment, information conflicts, and humanitarian assistance/disaster relief. ***FY 2023 Plans:*** Command Decision Making - Continue context-based decision making research for mission planning & execution. - Complete research to explore Command and Control (C2) human-machine collaboration and management of algorithms that adapt recommendations using machine learning (ML). - Complete work to utilize machine learning algorithms for analysis and forecasting of "what if" planning scenarios. - Initiate research for creating Collaborative Artificial Intelligence and investigate methods that enable algorithms to learn task procedures and task context from human explanations. - Initiate research into methods to "close-the-loop" where decision support AI can explain recommendations and context to the user.	20.460	20.310	22.251	0.000	22.251

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Cognitive Science for Human-Machine Teaming - Continue research to understand the foundation of human intelligence that enables cognitive functions, such as communication, social interaction, and context understanding. - Continue research in computational modeling and natural language processing to support the framework and architectures necessary to develop higher-level intelligence in robotic and autonomous systems. - Complete work into modeling structured goals for monitoring the performance of autonomous agents. Schoolhouse Training - Continue efforts to create novel models for learning aimed at producing durable learning. - Continue to create skill decay models that can be used to predict when refresher training is needed for maintenance procedures. - Continue to investigate individual differences to optimize training techniques. - Continue efforts to understand how to facilitate the acquisition of generalized problem solving. - Complete research that created computationally-executable model of processes required for training dynamic maintenance tasks. Elements include attention, planning, memory, and motor action. - Complete research to measure the impact of video games on enhancing cognitive and perceptual skills. - Initiate researching neuro-psychometric tests that can reliably predict complex skill learning (e.g., second language & computer programing). - Initiate research to discover neuro-imaging analytical techniques to assess learning from written passages. - Initiate work to create new training techniques for spatial ability which facilitates learning STEM skills. Computational Neuroscience - Continue research to identify and understand neural circuits and pathways that will be used to develop models of sensorimotor control and spatial navigation. The long-term goal is to understand the neural foundation of intrinsic cognitive skills, such as attention, memory formation, perception, and problem solving in order to develop novel intelligent systems. - Complete research on neural basis of spatial navigation. - Initiate efforts to explore the neural basis of the control of reaching, grasping and manipulation to inform robotics. Human Interaction with Autonomous Systems - Continue exploring the principles of warfighter collaboration with autonomous and mission-capable robotic systems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research to explore training of robots to perform complex manipulation skills using machine learning and human demonstration. The long-term goal is to provide better interfaces with autonomous systems, as well as provide transfer of control of autonomous platforms and payloads amongst operators. - Complete the analysis of human impressions (e.g., trust) of robotic teammates. - Initiate research exploring the combination of robot mobility with dexterous manipulation in assisting humans on Naval relevant tasks, such as shipboard maintenance and building clearing of hazards. Attention in Sensory Processing and Intelligent Sensing - Continue efforts on attention in intelligent sensing with a focus on the auditory modality, both with reflected and radiated acoustic signals on underwater targets. - Complete research in novel, brain-inspired deep-learning techniques applied to computer vision. - Initiate explorations into novel Artificial Intelligence-based approaches for Adaptive Training. Social, Cultural, and Behavioral Modeling - Continue research to improve current methods (e.g., algorithms, models) for detecting adversarial information maneuvers across social media platforms. - Complete research on detection of computer algorithms (bots) that manipulate social media traffic to influence content. - Initiate research on emerging and novel threats in cyberspace and in key military operations to include humanitarian assistance/disaster relief, civil stability, counter-terrorism and countering influence operations. - Initiate work to explore anthropological, sociological and socio-psychological research to improve blunting, mitigating and defeating influence operations against US interests abroad. Social Networks and Computational Social Science - Continue research to improve techniques in influence discernment, and the creation of effective communications strategies in the face of information conflict, modeling human behavior, the perception of information and cyber warfare. - Complete research on global models to monitor and explore social media. - Initiate research to explore social science methods and techniques to detect, mitigate, blunt, and defeat influence campaigns. - Initiate research and models on the impact of hybrid warfare and geo-political shifts on the future of conflict in the next decade. Manpower, Personnel, Training and Education for Future Warfighting					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research to understand the underlying mechanisms that optimize an individual's intellectual readiness and adaptability to military-relevant emerging technologies (e.g., Artificial Intelligence, autonomous systems) or novel operational challenges. - Continue research to improve psychometric properties of selection/assessment for high performance in military settings. - Continue research to improve analytical approaches to understand human behavior based on unstructured, interdependent, and complex data. The long-term goal is to establish a cohesive strategy for optimizing the readiness and effectiveness of the human capital enterprise. - Complete research evaluating the feasibility of virtual reality (VR) and augmented reality (AR) gaming technology to improve mental health outcomes and transition research results. - Initiate research exploring innovative technologies for real-time sensing and observation of individual behavioral responses to social and operational stressors. - Initiate research into methods to predict and detect destructive social behaviors, with a focus on novel theoretical frameworks and approaches, conducive to application in military settings. - Initiate research to create integrated modeling approaches to support management of the Naval workforce, leveraging real-time monitoring, observation, and comprehension of unit behavioral health.					
FY 2024 Base Plans: Command Decision Making - Continue research application of artificial intelligence analytic methods for enabling decision support in military team decision making. - Complete decision making research for game-based mission planning and execution tasks. - Complete research to investigate methods that enable learning algorithms for task procedures and task context derived from human explanations. - Initiate research in artificial intelligence to create bidirectional collaboration in human-machine teaming and decision making. Cognitive Science for Human-Machine Teaming - Continue research to understand the foundation of human intelligence that enables cognitive functions, such as communication, social interaction, and context understanding. - Continue research regarding natural language processing and computational modeling to support the framework and architectures necessary to develop higher-level intelligence in robotic and autonomous systems. Schoolhouse Training					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research to create novel models for learning aimed at producing durable learning. - Continue research investigations regarding the creation of skill-decay models that can be used to predict when refresher training is needed for maintenance procedures. - Continue research to understand how individual differences impact training effectiveness and how to tailor training for each individual. - Continue research efforts to understand the underlying mechanisms by which generalized problem-solving skills are acquired. - Continue research in systematically studying complex skill learning (e.g., second language, computer programming, machine troubleshooting) to understand neurological and cognitive predictors of gaining these skills. - Continue research investigations of neuro-imaging analytical techniques to assess learning from written passages. - Continue research efforts regarding training techniques for spatial ability which facilitates learning STEM skills. Computational Neuroscience - Continue research to identify and understand neural circuits and pathways that will be used to develop models of sensorimotor control. The long-term goal is to understand the neural foundation of intrinsic cognitive skills, such as attention, memory formation, perception, and problem solving in order to develop novel intelligent systems. - Continue exploring the neural basis of the control of reaching, grasping and manipulation to inform robotics. - Initiate research exploring the combination of robot mobility with dexterous manipulation in assisting humans on Naval relevant tasks, such as shipboard maintenance and building clearing of hazards. Human Interaction with Autonomous Systems - Continue research investigations regarding principles of warfighter collaboration with autonomous and mission-capable robotic systems. - Continue research efforts to explore training of robots to perform complex manipulation skills using machine learning and human demonstration. The long-term goal is to provide better interfaces with autonomous systems, as well as provide transfer of control of autonomous platforms and payloads amongst operators. - Continue research exploring the combination of robot mobility with dexterous manipulation in assisting humans on Naval relevant tasks, such as shipboard maintenance and building clearing of hazards. Attention in Sensory Processing and Intelligent Sensing					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research of attention in intelligent sensing with a focus on radiated acoustic signals in noisy environments. - Continue research regarding the understanding of Artificial Intelligence-based approaches for adaptive training, tailored to the individual learner. - Complete research efforts aimed at characterizing the fundamental aspects of how humans understand reflected acoustic signals on underwater targets. - Initiate research efforts to systematically study the neuro-cognitive processes of attention and its control. Social, Cultural, and Behavioral Modeling - Continue research of emerging and novel threats in cyberspace and in key military operations to include humanitarian assistance/disaster relief, civil stability, and countering influence operations. - Continue research of understanding the anthropological, sociological and socio-psychological factors that alter the effects of influence operations against US interests abroad. - Continue research to improve current methods (e.g., algorithms, models) for detecting adversarial information maneuvers across social media platforms. - Initiate research investigations of country-centric, descriptive and computational models of national resource and security issues to lay the foundation for forecast models relevant to military missions. Social Networks and Computational Social Science - Continue research efforts to develop models on the impact of spreading false information and geo-political shifts on the future of conflict in the next decade. - Continue research investigations to understand effective communications strategies in the face of information conflict, modeling human behavior, and the perception of information and cyber warfare. - Continue research efforts exploring social science methods and techniques to detect, mitigate, blunt, and defeat influence campaigns. - Initiate research to develop understanding of how influence campaigns in digital and social media affect decision making. Manpower, Personnel, Training and Education for Future Warfighting - Continue research efforts to increase our understanding of psychometric properties of selection/assessment for high performance in military settings. - Continue research to improve analytical approaches to understand human behavior based on real world (unstructured, interdependent, and complex) data.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research exploring innovative technologies for real-time sensing and observation of individual behavioral responses to social and operational stressors. - Continue research on the theories of destructive social behaviors (e.g., attempting suicide, compulsive activities, risky behavior, overusing alcohol, toxic leadership). - Continue research to understand fundamentals of unit behavioral health. - Complete research efforts regarding the understanding of underlying mechanisms that optimize an individual's intellectual readiness and adaptability to military-relevant emerging technologies (e.g., Artificial Intelligence, autonomous systems) or novel operational challenges. Minerva Research Initiative - Initiate research efforts to address novel conflict problems such as water security, malware, information warfare, ransomware, and basic research in social shifts relevant to national security issues, hybrid warfare and other novel conflict problems. - Initiate research investigations regarding mechanisms of crowd manipulation, social hysteria, rumor and propaganda in online and offline audiences. - Initiate multidisciplinary basic research efforts regarding national security issues, hybrid warfare, and related issues to address information advantage relevant to US military missions. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY2023 to FY2024 is due to the transfer of requirements and associated funding for the Minerva Research Initiative (MRI) activity in PE 0601103N / Project 0000 to the Human Systems activity in PE 0601153N / Project 0000. This transfer better represents the Basic Research focus and objectives of the Minerva Research Initiative.					
Title: Mathematics, Computer, and Information Sciences ***Description:*** This activity includes basic research efforts directed toward increasing scientific, mathematical, and computational foundations for integrated command, control, communications, cyber intelligence, surveillance, reconnaissance and targeting. The purpose is to sustain U.S. Naval Science and Technology (S&T) superiority, provide new technological concepts for the maintenance of naval power and national security, and help avoid scientific surprise.	58.966	61.701	63.334	0.000	63.334

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Efforts include: Scientific foundations and understanding for robust communications and networking; foundations for novel computing hardware, including nanoscale materials, emerging devices and circuits, emerging computational architecture and nanofabrication; basic research on novel techniques for controlling quantum states; algorithms for analyzing massive datasets in real time and heterogeneous information integration; science base and computational methods for building versatile intelligent agents; theory, algorithms and tools for decision support; mathematical optimization for resource allocation and usage; modeling and computation of complex physical phenomena; computation and information foundations for cyber defense; secure and reliable information infrastructure for command and control; information assurance; and research to extend state-of-the-science in artificial intelligence for the unique challenges of the Naval domain. ***FY 2023 Plans:*** Communications and Networks - Continue developing the scientific foundation and understanding of wireless communications and networking technologies that enable the naval warfighter to maintain access to mission critical information in contested environments. Research thrust areas include Tactical Communications and Tactical Networks. Tactical Communications - Continue developing new techniques for wireless distributed computing and device-to-device communication. - Continue novel coding and modulation techniques to improve the efficiency, capacity and/or resilience of wireless communications. Tactical Networks - Continue developing a feedback control model to determine the limit of fast adaptive traffic engineering. - Continue investigations in to new algorithms, protocols and middleware for dynamic and scalable multi-hop ad hoc wireless networking in contested environments. - Continue Artificial Intelligence/Machine Learning techniques for multi-dimensional Quality-of-Service optimization. - Continue development of cognitive methods and algorithms to maintain network resiliency under link disruptions without adding excess overhead. Spectrum Superiority / Networked Sensing - Continue efforts exploring advanced photonics techniques to maximize information extraction from individual photons and through tailored optical beams with the goal of being able to image at long-ranges and in degraded conditions.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue efforts on fundamental implications of classical entanglement on imaging and metrology. - Continue efforts to discover highly sensitive, multi-spectral detector materials and active sensing modalities for imaging through clouds, fog, haze and dust. - Continue efforts to explore novel optical processing architectures to significantly increase signal-processing bandwidth and to enable novel, real-time, distributed sensing applications. - Initiate efforts into direct measurement of current and phase at optical and infrared light frequencies to enable wider flexibility in signal extraction and waveforms. Nanoscale Computing Devices and Systems - Continue research on ultra-low power nanoelectronic devices, circuits and systems. - Continue research on spin based electronics, focusing on single atom and single molecule level control. - Continue research combining molecular quantum science and synthetic electronics. - Continue research on experimental routes to topologically-protected quantum computation with non-abelian any on quasiparticles in solid-state devices. - Complete research on atomic precision control of graphene nanostructures using chemical synthesis techniques. - Complete research on carbon based quantum systems that are compatible with bottom-up chemical synthesis paradigm. - Initiate research on device physics enabling probabilistic computing in stochastic networks. Quantum Information Sciences - Continue research on novel techniques for controlling quantum states to improve performance of information processors, sensors and clocks. Continue research on demonstrations of systems having a quantum advantage in the solution of optimization problems and quantum simulation of complex physical systems. - Continue research on the utilization of photonic and phononic devices for high performance quantum information processing. - Initiate research exploring the distribution of entanglement in a quantum network and applications thereof. Mathematical Data Science - Continue basic research in mathematics, probability, statistics, signal processing, machine learning, data engineering, and information theory. - Continue to develop advanced algorithms for analyzing massive datasets in real time, identify real patterns and avoid false positives.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue to develop advanced methods that can integrate and extract common features from large heterogeneous domains. - Continue research on privacy in complex networks. - Initiate development of scalable reinforcement learning. - Initiate research in approximate dynamic programming. Machine Reasoning and Intelligence - Continue developing the science base and computational methods for building versatile intelligent agents, which can function autonomously in uncertain, unstructured, uncontrolled, open-world environments, and can collaborate seamlessly with humans and other agents. - Continue basic research in developing new mathematical methods for principled design of deep learning architectures and analysis of their behavior. This program is expected to develop techniques for predicting performance learning-based systems, to improve their generalization abilities, and to reduce the need for empirical verification. - Continue basic research for developing robust computer vision systems, based on human vision, for automated understanding of surveillance imagery, perception for autonomous agents, and managing image/video libraries for after-action analysis and planning. - Initiate basic research in machine self-learning for intelligent agents, inspired by human learning, for understanding real-world environments. Optimization and Discrete Mathematics - Continue to identify exploitable mathematical structures within specific decision problems for the purpose of devising superior solution algorithms. - Continue investigation into methods for strategically formulating and solving optimization problems that arise in resource allocation, logistics, and system planning. - Continue investigations into new techniques that utilize convex optimization and duality theory to solve non-convex optimization problems. - Complete investigations on discrete and nonlinear-continuous programs for which input parameters are known with certainty, but for which the acquisition of optimal decision strategies can be computationally intensive. - Complete research on optimizing stochastic programs that, due to incomplete or partial information, have input parameters that are not known with certainty. - Initiate research on integrating machine-learning techniques with algorithms for stochastic and combinatorial optimization.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate research on developing novel first-order methods for solving general classes of problems that include saddle point problems, problems with a large number of constraints, and machine learning problems. - Initiate investigations into applying topological data analysis to combinatorial optimization problems. Applied and Computational Mathematics - Continue basic research in developing analytical and computational tools for models of physical phenomena of critical interest to the Navy waves, flows, materials, structures and information processing. - Continue to develop robust, reliable and near-real-time computational models for predicting environmental behavior in atmospheric and oceanic processes. - Continue to develop theoretical and computational tools to predict the onset of extreme events, whether in materials, such as formation of shocks, cracks and other discontinuities. - Continue to develop reduced models to enable speed up of computational models in acoustics, electromagnetics and optics, in regimes of special interest to the Navy. - Continue research to develop mathematically rigorous algorithms for employing variable-precision computations in very large-scale multi-physics problems. Complex Software Systems and Cybersecurity - Continue to investigate and develop novel computing concepts that lead toward robust, resilient, and dependable cyber systems. - Continue to explore novel application of ONR's concept of hybrid, formal-statistical machine learning in cyber security and software systems environment. - Continue to explore physics-based approaches to various security aspect of cyber-physical systems, including authentication, vulnerability testing, and exploit resilience. - Continue critical emphasis on improving scalability and capability of bottom-up formal analysis that would enable users to prove security properties about binaries directly. - Continue research on novel methods for attack surface maneuver for cyber physical systems and systems with complex apertures and sophisticated sensing apparatus, to include lightweight decoy synchronization and other resilience techniques. Complete development of tools and environment for programmability of heterogeneous multiple instruction set architecture systems. - Initiate research on autonomous cyber operations to explore what facets of cyber activities can be done fully autonomously or semi autonomously with human input. Science of Artificial Intelligence					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue to explore principled frameworks for integrating domain knowledge and machine learning for fast, robust learning of diverse complex concepts and tasks with light supervision. - Continue to explore artificial intelligence to advance the scientific understanding of collaborative, complex decision-making that is typical of naval command decision making. - Continue to explore formal verification and validation methods for artificial intelligence in the naval domain to enhance trust. - Continue to explore explainable artificial intelligence to enhance human-machine collaboration. - Continue to explore decentralized perception and planning in dynamic environments to develop a unified framework perception and planning for resources distributed across multiple platforms, autonomous systems and agents. - Continue to explore new brain-inspired artificial intelligence algorithms and architecture that provide richer computational capabilities than current deep learning networks, with an emphasis on memory systems and higher vision. - Continue to explore neuromorphic spiking neuron hardware designs based on brain models that are suitable for future edge computing and signal processing in small naval platforms. - Continue to explore autonomous problem solving and curiosity driven search for robust performance under unexpected conditions. - Initiate research to identify, characterize and model adversarial AI. - Initiate research exploring theory and algorithms for learning and decision making in multi-agent systems, particularly in adversarial situations. Information Technology - Continue development of improved methods for producing, analyzing, and securing Naval software systems. - Continue to design new concepts for future Naval tactical communication systems and networks. - Continue research in intelligent autonomy and improved interaction with autonomous systems, and improved methods for information analysis, fusion, and presentation.					
FY 2024 Base Plans: Communications and Networks - Continue research to develop the scientific foundation and understanding of wireless communications and networking technologies to enable the naval warfighter to maintain access to mission critical information in contested environments. Research thrusts in this area includes Tactical Communications and Tactical Networks. Tactical Communications					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research efforts to develop new techniques for wireless distributed computing and device-to-device communication. - Continue investigations regarding novel software coding and modulation techniques to improve the efficiency, capacity and/or resilience of wireless communication systems. Tactical Networks - Continue research efforts to develop feedback control models for determining the limit of fast adaptive traffic engineering. - Continue research investigations of algorithms, protocols and middleware regarding dynamic and scalable multi-hop ad hoc wireless networking in contested environments. - Continue research efforts regarding Artificial Intelligence/Machine Learning techniques relevant to multi-dimensional Quality-of-Service optimization issues. - Continue research efforts on the development of cognitive methods and algorithms to maintain network resiliency when experiencing communications link disruptions without adding excess overhead resources. Spectrum Superiority / Networked Sensing - Continue research investigations regarding fundamental implications of classical entanglement on imaging and metrology. - Continue research efforts regarding the exploration of highly sensitive, multi-spectral detector materials and active sensing modalities for imaging through clouds, fog, haze and dust. - Continue research efforts to explore novel optical processing architectures to significantly increase signal-processing bandwidth and to enable novel, real-time, distributed sensing applications. - Continue research investigations into the direct measurement of current and phase at optical and infrared light frequencies to enable wider flexibility in signal extraction and waveforms. - Complete research efforts exploring advanced photonics techniques to maximize information extraction from individual photons and through tailored optical beams with the goal of being able to image at long-ranges and in degraded conditions. Nanoscale Computing Devices and Systems - Continue research efforts on ultra-low power nanoelectronic devices, circuits and systems. - Continue research investigations of experimental routes to topologically-protected quantum computation with non-abelian quasiparticles in solid-state devices. - Continue research efforts regarding device physics enabling probabilistic computing in stochastic networks. - Complete research combining molecular quantum science and synthetic electronics.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Complete research investigations of spin-based electronics, focusing on single atom and single molecule level control. Quantum Information Sciences Research of quantum states, devices, phenomena relative to the simulation, information processing and computing performance needs of naval systems. Research efforts include the following: - Continue research on novel techniques for controlling quantum states to improve performance of information processors, sensors and clocks. - Continue research on demonstrations of systems having a quantum advantage in the solution of optimization problems and quantum simulation of complex physical systems. - Continue research on the utilization of photonic and phononic devices for high performance quantum information processing. - Continue research exploring the distribution of entanglement in a quantum network and applications thereof. Mathematical Data Science - Continue basic research in mathematics, probability, statistics, signal processing, machine learning, data engineering, and information theory. - Continue efforts to develop advanced algorithms for analyzing massive datasets in real time, identify real patterns and avoid false positives. - Continue investigations regarding the development of advanced methods to integrate and extract common features from large heterogeneous domains. - Continue research investigations of privacy in complex networks. - Continue research efforts regarding the development of scalable reinforcement learning. - Complete research efforts in approximate dynamic programming. - Initiate research investigations of causal dependences in complex networks. Machine Reasoning and Intelligence - Continue developing the science base and computational methods for building versatile intelligent agents, which can function autonomously in uncertain, unstructured, uncontrolled, open-world environments, and can collaborate seamlessly with humans and other agents. - Continue basic research in developing new mathematical methods for principled design of deep learning architectures and analysis of their behavior. This program is expected to develop techniques for predicting performance of learning-based systems, to improve their generalization abilities, and to reduce the need for empirical verification.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue basic research for developing robust computer vision systems, based on human vision, for automated understanding of surveillance imagery, perception for autonomous agents, and managing image/video libraries for after-action analysis and planning. - Continue basic research in machine self-learning for intelligent agents, inspired by human learning, for understanding real-world environments. - Initiate basic research in learning and decision-making in multi-agent systems in dynamic, uncertain settings where there are many competitive and cooperative agents and information about intentions and rewards are not fully known. This research area has a wide range of applications in tactical and strategic planning, economic planning, etc. Optimization and Discrete Mathematics - Continue to identify exploitable mathematical structures within specific decision problems for the purpose of devising superior solution algorithms. - Continue investigation into methods for strategically formulating and solving optimization problems that arise in resource allocation, logistics, and system planning. - Continue investigations into new techniques that utilize convex optimization and duality theory to solve non-convex optimization problems. - Continue research on integrating machine-learning techniques with algorithms for stochastic and combinatorial optimization. - Continue research on developing novel first-order methods for solving general classes of problems that include saddle point problems, problems with a large number of constraints, and machine learning problems. - Continue investigations into applying topological data analysis to combinatorial optimization problems. - Initiate investigations into finding solutions to various forms of multiagent, multiround games. Applied and Computational Mathematics - Continue basic research in developing analytical and computational tools for models of physical phenomena of critical interest to the Navy in waves, flows, materials, structures and information processing. - Continue to develop robust, reliable and near-real-time computational models for predicting environmental behavior in atmospheric and oceanic processes. - Continue to develop theoretical and computational tools to predict the onset of extreme events, whether in materials, such as formation of shocks, cracks and other discontinuities. - Continue to develop reduced models to enable speed up of computational models in acoustics, electromagnetics and optics, in regimes of special interest to the Navy.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research to develop mathematically rigorous algorithms for employing variable-precision computations in very large-scale multi-physics problems. Complex Software Systems and Cybersecurity - Continue to investigate and explore novel computing concepts that lead toward robust, resilient, and dependable cyber systems. - Continue to explore novel application of ONR's concept of hybrid, formal-statistical machine learning in cyber security and software systems environment. - Continue to explore physics-based approaches to various security aspect of cyber-physical systems, including authentication, vulnerability testing, and exploit resilience. - Continue critical emphasis on improving scalability and capability of bottom-up formal analysis that would enable users to prove security properties about binaries directly. - Continue research on novel methods for attack surface maneuver for cyber physical systems and systems with complex apertures and sophisticated sensing apparatus, to include lightweight decoy synchronization and other resilience techniques. - Continue research on autonomous cyber operations to explore what facets of cyber activities can be done fully autonomously or semi autonomously with human input. - Initiate Exploration of new alternatives for computing devices and architectures. Science of Artificial Intelligence - Continue research exploring principled frameworks for integrating domain knowledge and machine learning for fast, robust learning of diverse complex concepts and tasks with light supervision. - Continue research efforts regarding the use of artificial intelligence to advance the scientific understanding of collaborative, complex decision-making that is typical of naval command decision making. - Continue research of formal verification and validation methods for artificial intelligence in the naval domain to enhance trust. - Continue research investigations exploring explainable artificial intelligence to enhance human-machine collaboration. - Continue research regarding decentralized perception and planning in dynamic environments to develop a unified framework perception and planning for resources distributed across multiple platforms, autonomous systems and agents. - Continue research exploring new brain-inspired artificial intelligence algorithms and architecture that provide richer computational capabilities than current deep learning networks, with an emphasis on memory systems and higher vision.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research investigations of neuromorphic spiking neuron hardware designs based on brain models that are suitable for future edge computing and signal processing in small naval platforms. - Continue research efforts regarding autonomous problem solving and curiosity driven search for robust performance under unexpected conditions. - Continue research efforts to identify, characterize and model adversarial AI. - Continue research exploring theory and algorithms for learning and decision making in multi-agent systems, particularly in adversarial situations. - Initiate research efforts exploring computational models of vision-language interactions for intelligent agents that can learn and reason bout the real world with high levels of complexity. Information Technology - Continue development of improved methods for producing, analyzing, and securing Naval software systems. - Continue to design new concepts for future Naval tactical communication systems and networks. - Continue research in intelligent autonomy and improved interaction with autonomous systems, and improved methods for information analysis, fusion, and presentation. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY 2023 to FY 2024 includes increased emphasis and investments in areas such as Human-Level AI and Autonomy, Information Superiority, and fundamental Mathematics, Electronics, and Quantum Fundamental Research.					
Title: Materials/Processes ***Description:*** Lighter, faster, stronger is a winning combination. Naval materials research produces quieter submarines, fuel-efficient ships/vehicles and systems capable of operating under extreme temperature and chemical environments. New materials will result in warfighting advantages, as well as, systems that ensure environmental compliance, improved system reliability/resilience, stealthier materials, reduced manufacturing/ maintenance and lower total ownership costs. The Materials/Processes activity generates fundamental scientific understanding for new, advanced and improved materials, and to accelerate materials-driven concepts essential to Naval superiority. The research is conducted in a cross-cutting and interdisciplinary manner covering Structural Materials, Functional Materials, Manufacturing, Chemistry and Undersea Materials to ensure future Naval power and maritime superiority.	56.288	59.945	68.964	0.000	68.964

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Fundamental challenges include understanding atomic-scale to meso-scale phenomena; developing robust, accurate and validated computational modeling and simulation capabilities; and translating this understanding into materials composition, synthesis, processing, properties and performance design principals for engineered devices, components and systems. This activity also includes peer-review basic research to develop innovative solutions and enhance the science and engineering base. Research directions in the Focus Area are selected to generate new, advanced and improved materials that enable innovative new technologies or can close critical technology gaps. Successes provide breakthroughs for higher performing, cost effective and/or timely technologies supporting Navy and Marine Corps acquisitions, operations and sustainment. Accomplishments and plans described below are examples for each effort category. ***FY 2023 Plans:*** Structural Materials - Continue foundational research that provides the underpinnings for robust systems and platforms, exploring and understanding phenomenology of structural properties as functions of with the aim to improve performance and predict and mitigate component degradation, captured in quantitative data and physics-driven models that utilize an Integrated Computational Materials Engineering (ICME) approach and support machine learning. Research domains include Basic Materials Research, Structural Metals, Polymer Composite Materials, Propulsion Materials, Materials for Additive Manufacturing, Sensors & NDE Prognostics, and Alternative Hull Materials & Structures. - Complete efforts in Structural Cellular Materials and Solid Mechanics, as technology areas have matured and attention turns to other emerging research areas. Functional Materials - Continue research to explore opportunities for controlling material composition and atomic structure through characterization and modeling enabling and utilizing an ICME approach to enhance electro-mechanical coupling for next generation Acoustic Transduction Materials; better understand the chemical and mechanical properties of Material Science for Environment Quality; and accelerate research efforts through Computer Aided-Material Design - Functional Materials. Manufacturing					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Complete basic manufacturing science research efforts, migrating fundamental work to portfolios of the relative disciplines including Structural Metals and Materials for Additive Manufacturing. Materials and Chemistry Continue the development of the scientific foundations for molecular-level understanding of materials synthesis, processing, and physical properties aimed at propelling, equipping and sustaining the US Navy and Marine Corps with tactical and strategic advantage. These efforts include: -Continue efforts into nanoparticle surface chemistry for plasmonic mediated reactions, photocatalysis, hydrogen storage, energetic materials, and fuel additives which will enable new high power and energy density generation, storage, release and harvesting materials and technologies. These fuel generation, energetic, fuel cell and battery material will enable next generation Navy autonomous undersea and air vehicles. -Continued research efforts on combustion and reacting transport, coupled with advanced mutiphysics computational simulation, will advance fire suppression for damage control as well as liquid and solid-fueled power and energy for hypersonics. Combinatorial and multivariate chemical approaches inform sensor system designs for aviation fuel surety and complex shipboard atmosphere environment monitoring. -Continue advancements into quantum computing simulations of quantum systems which1 model aqueous chemistries to allow design of anti-corrosion additives. Understanding fundamental electrochemistry, (tribo)corrosion, and biofouling will guide materials solutions for fleet sustainment through manpower and life-cycle cost reductions. Undersea Materials - Continue laboratory and theoretical/numerical work focusing on creation of new techniques for understanding, predicting, and controlling the interactions between acoustic and elastic waves and the processing routes for associated new materials; high performance source transducer materials that achieve high powered performance with reduced cost and complexity; and high efficiency silicon-based thin film thermoelectric modules for undersea warfare applications. - Continue research into high performance source transducer materials, such as textured ferroelectric ceramics, that should achieve high power receiver performance at reduced cost and complexity. This would enable high throughput production of high performace tranducer ceramics, providing alternatives to current costly and difficult to produce single crystal technology. - Continue the creation of high efficiency silicon-based thin film thermoelectric modules for undersea warfare applications by exploiting nanocrystallization and multilayering to control thermal conductivity.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Complete research on advanced underwater material coupling architectures that achieve a broad range of passive and active acoustic impedances and control.					
FY 2024 Base Plans: Structural Materials - Continue foundational research that provides the underpinnings for robust systems and platforms, exploring and understanding phenomenology of structural properties as functions of with the aim to improve performance and predict and mitigate component degradation, captured in quantitative data and physics-driven models. Research domains include Basic Materials Research, Structural Metals, Polymer Composite Materials, Propulsion Materials, Materials for Additive Manufacturing, Sensors & NDE Prognostics, and Alternative Hull Materials & Structures. Functional Materials - Continue research to explore opportunities for controlling material composition and atomic structure through characterization and modeling to enhance electro-mechanical coupling for next generation Acoustic Transduction and Sensor Materials; better understand the chemical and mechanical properties of Material Science for Environment Quality; and accelerate research efforts through Computer Aided-Material Design. Materials and Chemistry Continued research in Materials and Chemistry is essential to develop the scientific foundations required for a molecular-level understanding of materials synthesis, processing, and physical properties aimed at propelling, equipping and sustaining the US Navy and Marine Corps with tactical and strategic advantage. Research efforts include the following: - Continue efforts into nanoparticle surface chemistry for plasmonic mediated reactions, photocatalysis, hydrogen storage, energetic materials, and fuel additives which will enable new high power and energy density generation, storage, release and harvesting materials and technologies. These fuel generation, energetic, fuel cell and battery material will enable next generation Navy autonomous undersea and air vehicles. - Continued research efforts on combustion and reacting transport, coupled with advanced mutiphysics computational simulation, will advance fire suppression for damage control as well as liquid and solid-fueled power and energy for hypersonics. Combinatorial and multivariate chemical approaches inform sensor system designs for aviation fuel surety and complex shipboard atmosphere environment monitoring. - Continue advancements into quantum computing simulations of quantum systems which1 model aqueous chemistries to allow design of anti-corrosion additives. Understanding fundamental electrochemistry,					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
(tribo)corrosion, and biofouling will guide materials solutions for fleet sustainment through manpower and life-cycle cost reductions. - Initiate efforts into how to understand and predict oleophobic and synergistic mechanisms thru machine learning to design/develop more effective surfactant molecules for fire suppression. Undersea Materials - Continue laboratory and theoretical/numerical research efforts focusing on creation of new techniques for understanding, predicting, and controlling the interactions between acoustic and elastic waves and the processing routes for associated new materials; high performance source transducer materials that achieve high powered performance with reduced cost and complexity; and high efficiency silicon-based thin film thermoelectric modules for undersea warfare applications. - Continue research into high performance source transducer materials, such as textured ferroelectric ceramics, that should achieve high power receiver performance at reduced cost and complexity. This would enable high throughput production of high performace tranducer ceramics, providing alternatives to current costly and difficult to produce single crystal technology. - Continue the creation of high efficiency silicon-based thin film thermoelectric modules for undersea warfare applications by exploiting nanocrystallization and multilayering to control thermal conductivity. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY 2023 to FY 2024 is due to a more appropriate alignment of materials and biomedical efforts from the Science Addressing Hybrid Threat (SAHT) research activity and increased focus on quantum computing research and increases in Materials/Processes research. Increased emphasis will be placed on Basic Research in Materials/Processes in areas such as but not limited to materials, mathematics, electronics, and quantum fundamental research.					
Title: Medical and Biological Sciences ***Description:*** The health and performance of Sailors and Marines is a top priority. Extensive research in the medical and biological sciences discover and leverage breakthroughs to improve Naval warfighter performance, so they can fight, win and come home safe. Sailors and Marines operate in the harshest working environments at sea and around the world. Conducting research to gain a better understanding of the biologic challenges of warfighters in their operating environments will ensure optimal performance, prevent injury, and equip the DON to provide the best care for its warfighters.	15.655	15.675	15.306	0.000	15.306

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Research areas include: bio-inspired autonomous systems; bioengineering; biophysics; microbial synthetic biology; microelectronics; microbial electrophysiology; microbiome research; bio-inspired multi-spectral camouflage and sensing; sensory neuroscience and physiology; Naval force health protection; undersea medicine; stress responses, health monitoring and modeling research; and health and welfare of the Navy's marine mammals. ***FY 2023 Plans:*** Bio-Inspired Autonomous Systems and Soft Robotics - Continue research to explore novel bio-inspired sensing, control, and fluid dynamics of underwater propulsion and control systems to expand capabilities of underwater autonomous and unmanned systems. This research will include: (i) Exploration of experimental sensing capabilities and modeling for bio-sensing to enable sensorimotor control including fish schooling for passive swarm coordination in underwater vehicles; (ii) Exploration of bio-inspired locomotion from amphibious animals to enable technologies for amphibious and cross-domain vehicles; (iii) Investigation of bio-inspired design principles of distributed sensing, actuation, and control in soft biological structures for underwater propulsion and manipulation; and (iv) Design bio-inspired soft robots (e.g., worm-like robots) to characterize and measure geotechnical properties of the ocean floor. The long-term result will be bio-inspired propulsion and control systems to enable high-lift, stealthy propulsion without propellers and achieve high maneuverability for underwater vehicles. - Complete investigation of fish lateral line pressure sensing for navigation and obstacle avoidance of underwater vehicles. - Initiate research to explore multi-fin control, propulsion and maneuver with robotic fish prototypes. Bioengineering and Life Sciences - Continue the exploration of computational tools and fabrication methods for producing materials with targeted properties from the molecular level (nanometers) to the macroscopic level (meters) for Naval applications. - Continue investigation of bioinspired and biomimetic adhesives and reversible adhesives that cure in seawater for underwater applications. - Continue the exploration of computational design tools and characterization methods for nanostructures made from DNA, and their application to optical computing, data storage, and cell-free bioconversion systems for bioproduct manufacturing. - Continue experimentation with synthetic biology to establish new biomanufacturing strategies for complex and living materials. - Continue the exploration					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
of water absorption-evaporation cycling in biomaterials to develop hydro- and thermo-responsive textiles and as a power source for maritime sensing surveillance systems. Naval Biosciences and Synthetic Biology for Naval Applications (This thrust includes the efforts previously listed under Warfighter Augmentation in the FY22 plan.) - Continue research to investigate: (i.) bio-inspired mechanisms for multi-spectral camouflage (adaptive texture/ shape, color, and near- to mid- infrared concealment), and (ii.) bioengineering bacteria for sensing, materials, and functionalized microbial communities. - Continue researching the construction of bacterially synthesized biomaterials for capturing and enriching rare earth elements to establish a secure source of these critical materials for defense-related applications. - Continue the investigation of novel materials and electroactive bacteria to improve energy generation from bacteria powered fuel cells and for use of components in synthetic biology applications. Auditory Science for the Naval Domain (This thrust was previously part of the Sensory Neuroscience and Physiology FY22 plan. The name was changed to more accurately describe the research.) - Complete studies that led to the discovery of small molecule therapeutics for the potential treatment of auditory system injuries associated with noisy Naval environments. - Initiate studies investigating how biological systems use acoustic camouflage and design bio-inspired acoustic dampening metamaterials. Physiological Monitoring and Modeling - Continue to research the use of nucleic acid cleavage in creation of detection systems for the Warfighter. This will enable easily adapted nucleic acid detection with orders of magnitude lower sensitivity and specificity. - Complete research on innovative communications capabilities for discreet transmission of individual and team health and geolocation data. - Initiate research to characterize new physiologic signal monitoring capabilities. - Initiate research into innovative technologies for real-time sensing and observation of individual responses to environmental and operational stressors. Naval Force Health Protection - Continue research into methods for modeling and simulation approaches to improve Warfighter protection and injury treatment.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue to investigate nanotechnologies, microelectronics, artificial intelligence, and autonomy for use in medical care of combat casualties to repair damage at the scale of cells, tissues, and whole body. - Continue research to understand use of composite materials, additive manufacturing, and microelectronics to enhance warfighter protective equipment by providing increased biomedical sensing of warfighter status and greater operator situational awareness. The long-term goal of this research is to explore to optimize medical treatment, logistics, and casualty evacuation in the tactical environment. - Continue use of fundamental principles of physics to determine material properties of biological tissues. Undersea Medicine - Continue studies to enhance our understanding of human physiology (and leverage insights from comparative physiology studies of marine mammals) in the undersea environment. - Continue work to create synthetic biology approaches for thermal protection during dive operations. - Continue research to identify novel technologies to support underwater breathing apparatus to include utilizing resources naturally present in the ocean for gas management (e.g., oxygen supply and carbon dioxide disposal). - Complete research that identified the role of specific gas channels (AQP1 and 4) now being explored as potential targets for limiting oxidative stress caused by elevated oxygen exposures encountered in dive operations. - Initiate research on respiratory plasticity in relation to metabolic efficiency, immunologic resilience and thermal tolerance with a particular focus on respiratory loads in altered breathing gas states (e.g., hyperoxia, hypercapnia, hypoxia). Stress Response - Continue to investigate the clinical, neurobiological, and genetic factors that predict differences in stress reactivity for constructing a multi-modal predictor of stress responsiveness, and for identifying targets for intervention. - Continue to examine the interaction of a chronically stressful environment and changes in light/dark periods on the function of the stress response system. - Continue to explore the feasibility of continuous and unobtrusive stress detection, tracking, and mitigation for a wearable closed-loop system capable of monitoring stress and providing bioelectronic therapy.					
FY 2024 Base Plans: Bio-Inspired Autonomous Systems and Soft Robotics - Continue research to explore novel bio-inspired sensing, control, and fluid dynamics of underwater propulsion and control systems to expand capabilities of underwater autonomous and unmanned systems. This research					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
will include: (i) Exploration of experimental sensing capabilities and modeling for bio-sensing to enable sensorimotor control including fish schooling for passive swarm coordination in underwater vehicles; (ii) Exploration of bio-inspired locomotion from amphibious animals to enable technologies for amphibious and cross-domain vehicles; (iii) Investigation of bio-inspired design principles of distributed sensing, actuation, and control in soft biological structures for underwater propulsion and manipulation; and (iv) Design bio-inspired soft robots (e.g., worm-like robots) to characterize and measure geotechnical properties of the ocean floor. The long-term result will be bio-inspired propulsion and control systems to enable high-lift, stealthy propulsion without propellers and achieve high maneuverability for underwater vehicles. - Continue research investigations exploring multi-fin control, propulsion and maneuver with robotic fish prototypes. Bioengineering and Life Sciences - Continue research investigations using synthetic biology to establish new biomanufacturing pathways/ strategies for complex and living materials. - Continue exploration of building and characterizing DNA nanostructures for use in optical computing, data storage, materials, and cell synthesis. - Complete basic research on computational tools for producing materials with targeted properties from the molecular level (nanometers) to the macroscopic level (meters) for Naval applications. - Complete research investigation of bioinspired and biomimetic adhesives and reversible adhesives that cure in seawater for underwater applications. Naval Biosciences and Synthetic Biology for Naval Applications - Continue research investigations into bio-inspired mechanisms for multi-spectral camouflage. - Continue basic research efforts regarding the use of bioengineering bacteria for sensing and materials synthesis. - Continue investigations of the use of novel materials and electroactive bacteria to improve energy generation from microbial powered devices. - Continue research efforts to understand electroactive bacteria and their components for use in synthetic biology/bioelectronics applications. - Complete research investigations of bacterially synthesized biomaterials for capturing and enriching rare earth elements to establish a secure source of these critical materials. Auditory Science for the Naval Domain					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research investigations regarding biological systems' use of acoustic camouflage and design of bio-inspired acoustic dampening metamaterials. Physiological Sciences and Monitoring - Continue research investigations to characterize novel physiologic signal monitoring capabilities. - Continue research efforts into innovative technologies for real-time sensing and observation of individual responses to environmental and operational stressors. - Continue Physiological Monitoring and Modeling research efforts regarding the use of nucleic acid cleavage in creation of detection systems for the Warfighter. This will enable easily adapted nucleic acid detection with orders of magnitude lower sensitivity and specificity. - Complete research efforts regarding the use of nucleic acid cleavage in the creation of detection systems for the Warfighter. - Initiate research efforts regarding concepts for passive or semi-passive location and identification of people lost at sea. - Initiate research into the development of functional bio/nanohybrid materials that will enable the ability to reprogram cellular behavior without the manipulation of the cell's genetic material. Naval Force Health Protection - Continue research into methods for modeling and simulation approaches to improve Warfighter protection, injury treatment, and safer platforms. - Continue investigations into nanotechnologies, microelectronics, artificial intelligence and autonomy that will inform future applications for estimation of combat casualty injury severity, improve care and facilitate casualty evacuation. - Continue research regarding the understanding of fundamental principles of composite materials, additive manufacturing, and microelectronics to enhance warfighter protection, health and situational awareness. - Continue research regarding the understanding of fundamental principles of physics to determine material properties of biological tissues to allow for physics based prediction and modeling of tissue damage resulting from insult or injury. - Complete research efforts regarding computational cellular biology investigations of blast effects to allow physics-based prediction and modeling of cavitation damage of tissues. - Initiate research regarding microelectronic detection of warfighter brain health to guide transcranial stimulation research into attentiveness, sleep, and mission focus. Undersea Medicine					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue studies to enhance our understanding of human physiology (and leverage insights from comparative physiology studies of marine mammals) in the undersea environment. - Continue work to create synthetic biology approaches for thermal protection during dive operations. - Continue research to identify novel technologies to support underwater breathing apparatus to include utilizing resources naturally present in the ocean for gas management (e.g., oxygen supply and carbon dioxide disposal). - Continue fundamental research to understand the pulmonary physiology of exposure to altered levels of oxygen and carbon dioxide. -Initiate studies to explore use of porous liquids as novel gas management for biomedical applications to include Nitrogen capture for DCS mitigation. Stress Response - Continue research investigations regarding neurobiological and genetic factors that predict differences in stress reactivity for constructing a multi-modal predictor of stress responsiveness, and for identifying targets for intervention. - Continue research efforts to examine the impact of an acutely stressful environment on the function of the stress response system. - Continue research efforts to explore the feasibility of continuous and unobtrusive stress detection, tracking, and mitigation for a wearable closed-loop system capable of monitoring stress and providing bioelectronic therapy. - Complete research efforts regarding clinical factors that predict differences in stress reactivity for constructing a multi-modal predictor of stress responsiveness, and for identifying targets for intervention. - Complete research investigations regarding impact of changes in light/dark periods on the function of the stress response system. - Initiate comprehensive investigation of physiological and cognitive stress response following acute exposure to high stress operational or emergency scenarios/environments (i.e. extreme heat/cold, smoke/fire, unexpected water immersion), which will inform future development of countermeasures against these exposures. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** There is no significant funding change from FY 2023 to FY 2024.					
Title: Ocean Sciences ***Description:*** Understanding and predicting oceanographic and acoustical phenomena provides significant warfighting advantages to naval forces. Ocean Sciences research addresses the full spectrum of acoustics and	81.741	84.169	89.591	0.000	89.591

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
oceanography to enable observation, modeling, and prediction of the maritime environment. Efforts include: studying common operating areas for naval forces in the open oceans, the Arctic, the littorals, and nearshore and river mouths and inlet environments; elucidating the coupling between oceanographic, geophysical and acoustical phenomena relevant to such mission areas such as Anti-Submarine Warfare and Mine Warfare; development of global, regional and local predictive models that fully couple the ocean-atmosphere-wave-ice domains; development and use of autonomous systems and sampling technologies for the collection of environmental observations and continuing support to research vessels of the U.S. Academic Research Fleet to enable at-sea oceanographic science. Research within the Ocean Sciences subactivity responds to mission needs of the Navy and Marine Corps as guided by the Oceanographer of the Navy. At-sea research involves ancillary studies to ensure full compliance with environmental requirements. ***FY 2023 Plans:*** Littoral Geosciences and Optics Areas of research include the highly nonlinear coupling between atmospheric phenomena and surface gravity and internal waves; the transport of sediment by waves and currents; and the bathymetric evolution of the nearshore and coastal environment using integrated field observations, modeling, experimental and remote sensing studies. - Continue studies of surface gravity waves, currents, tides and internal wave processes along rocky coastlines. - Continue autonomous, scalable, hydrographic charting and coastal parameter sampling studies with concomitant remote sensing for data-assimilative coastal models. - Continue research using airborne and satellite active and passive microwave sensors, overhead optical sensors, and ship or shore-based radars to observe coastal and nearshore phenomena. - Continue field studies of coastal oceanographic phenomena using sonar-equipped autonomous underwater vehicles in conjunction with ground-based, airborne and satellite remote sensing. - Continue research to predict physical, geological, geochemical, geoacoustic and geotechnical properties of the seafloor in shallow-water coastal environments. - Initiate studies of the dynamics of shallow coastal inlets; specific areas include their formation and maintenance processes by tides, waves, currents, discharge and sediment type and supply. Physical Oceanography and Prediction Areas of research include ocean circulation, thermodynamics and mixing, and the dynamics of surface gravity waves, nonlinear internal waves and the interaction of waves with sea ice in order to understand the sub-					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
mesoscale physical oceanography parameters from the tropics to the poles. Sub-mesoscale understanding of the ocean is necessary to support the required fidelity and accuracy of ocean feature inputs to Naval warfighting applications. - Continue study of three-dimensional Lagrangian ocean circulation and the prediction of vertical pathways in field experiments in the Mediterranean Sea. - Continue exploration of novel expeditionary ocean instrumentation to support targeted observing. - Continue study of ocean fronts, eddies and turbulence; ocean thermodynamics including mixing and acoustic impacts; and ocean boundary layer processes and surface gravity waves. - Continue study of the rapid evolution of the upper ocean in the high North Atlantic between Iceland and the European continent to understand the physical processes that control vertical and horizontal density structures in the upper ocean. - Continue study of the seasonal variability of processes that control sea surface temperature in the Arabian Sea to understand the relevant space and time scales that enable improved ocean and weather forecasts through the reduction of ocean temperature biases in coupled models. - Complete study of sources and sinks of near-inertial shear and energy in the ocean in the Greenland, Iceland, United Kingdom (GIUK) region. - Initiate studies to explore the cascade of energy in the sub-mesoscale ocean, including the physics and dynamics of ocean features such as current meanders, vortices, and filiaments, with a field program in the Western Pacific, to expand the knowledge of the lifecycle of these features and enable improved predictions. Arctic Sciences Areas of research include the complex processes governing the interaction of the arctic atmosphere, ocean, and sea ice, including formation, deformation, and melting. Physical processes in the arctic are inherently different from those in non- polar regions. - Continue studies to characterize the behavior of sea ice, including melt and reformation, ice rheology and motion, and interactions with ocean stratification, surface waves and the atmosphere. - Continue development of Arctic System models and data assimilation techniques for improved prediction of the Arctic region and development of new sensors and unmanned platforms to collect observations of the Arctic environment. - Continue development of algorithms enabling the space-based remote sensing of bulk properties of Arctic sea-ice that previously could be sampled only by localized in-situ methods. - Initiate studies of the circulation of the Arctic Ocean to explore the fate of heat flowing in through the Bering Strait and the impact on the upper ocean density structure of the Beaufort Sea.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Ocean Acoustics Ocean Acoustics continues as one of five National Naval Responsibilities (NNR). Research and education supported under this PE contributes to a vigorous science and technology base to ensure continuing U.S. leadership in the critically important discipline of Ocean Acoustics. Areas of research contribute to improved basic understanding of the physical, seafloor and biological parameters that impact acoustic propagation in the ocean. Accurate acoustic predictions are required to keep our undersea assets undetected as well as to enable the detection and tracking of adversary assets. - Continue research to understand propagation and scattering of acoustic energy in shallow-water ocean environments. Specific efforts include shallow-water scattering mechanisms related to reverberation and clutter; seabed acoustic measurements supporting geoacoustic inversion; acoustic propagation through internal waves and coastal ocean processes and the development of unified ocean/seabed/acoustic models, including scattering from rough surfaces, biologics and bubbles; and penetration/propagation within the porous seafloor. - Continue the investigation in optimal representations information contained in acoustic data. Specific efforts will include the investigation summary statistics and sparse encoding of underwater acoustic data. The objective is to enable efficient analysis and compact representations of acoustic scenes. - Continue efforts in naturalization applicable to the ocean battlespace. Specific efforts will include investigations into source separation, characterization, and recombination along with physical, biological, and anthropogenic sound generating mechanisms. The objective is to model and simulate acoustic phenomena in undersea environments to be rendered as virtual soundfields. - Continue research into the effects of environmental variability induced by ocean internal waves, internal tides and mesoscale processes, and by bathymetric features including seamounts and ridges, on the stability, statistics, spatial distribution, and predictability of broadband acoustic signals, as well as the coherence and depth dependence of deep-water ambient noise. - Continue investigations into the effects of Arctic conditions on acoustic propagation and ambient noise, particularly in under-ice environments. - Continue the joint physical oceanography and acoustic field studies to investigate propagation and scattering in regions characterized by complex bathymetry and/or meteorological and oceanographic forcing. Specific efforts will include processes studies with the objective of linking observed ocean and acoustic phenomena. An objective is to characterize oceanographic phenomena and the effects on acoustic propagation and scattering at different frequencies. - Continue efforts in characterizing and forecasting sediment acoustic properties. Specific efforts will include investigations aimed at linking local physical and biological processes to acoustic observables. Continue analysis efforts related to acoustic seabed characterization experiment. Specific efforts will include development					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
and verification of geoacoustic models and inference techniques for soft sediments based on experimental evidence. - Initiate analysis of data from a previous trans-arctic basin collection effort to extend studies of under-ice environments. Marine Mammals and Biology The Marine Mammals and Biology Program conducts basic research to understand and characterize the effects of sound exposure on marine mammals to enable Navy to meet operational training and testing objectives in an environmentally responsible and legal manner. Areas of research include monitoring and detection of marine mammals, integrated ecosystem research, hearing in large whales, and effects of sound on marine mammals. - Continue development and testing of new and existing technologies to detect, classify, localize and potentially track marine mammals. - Continue multidisciplinary ecosystem research including tagging, visual surveys, and passive acoustics to collect baseline measures of marine mammal behaviors and distributions relative to environmental features and marine mammal prey fields. - Continue research on sound reception mechanisms in large whales. - Continue research on the effects of sound include behavioral, physiological and population-level consequences of sound exposure on marine life. - Continue studies to characterize and quantify the cumulative effects of multiple stressors on marine mammal populations. - Continue research to develop framework for understanding the ecology of eDNA, including the origin, state, transport, and fate of extraorganismal genetic material. - Initiate studies to design appropriate primers and bioinformatics workflows to effectively and efficiently detect and identify target biological communities and ecosystems, and advance our understanding of the relationships between eDNA and the abundance of marine megafauna. Battlespace Environments - Continue research is to improve basic understanding of physical, seafloor and biological oceanographic processes on space and time scales of naval interest. Emphasis is on improved measurements, laboratory and model based experiments to quantify and understand important oceanographic processes that lead to the development of ocean dynamic/thermodynamic models from global to sub-mesoscale scales, and to couple these oceanographic models with atmospheric, ice, biological, sediment response, and optical models. While today's numerical analysis and prediction systems are more capable of resolving and predicting highly variable phenomena than were the systems of 10-20 years ago, there are still oceanographic processes that are not					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
well understood and must be studied including aspects of ocean circulation (fronts, eddies and turbulence), thermodynamics (mixing and acoustic impacts), waves (including their impact on sea ice and rogue waves), sea ice (including landfast ice) as well as ocean boundary layer processes. Navy and Marine Corps requirements also include: a) an improved use of overhead (airborne and satellite) active and passive microwave sensors, overhead optical sensors, surface-based (ships and ground-based) grazing angle microwave sensor, b) use of remote sensing of bulk properties of Arctic sea-ice over broad two-dimensional areas that previously could be sampled only at spot locations by in-situ sampling, and c) use of newly available higher resolution (sub-mesoscale) oceanographic data.					
FY 2024 Base Plans: Littoral Geosciences and Optics Research efforts regarding nonlinear coupling between atmospheric phenomena and surface/waves, sediment transport dynamics, and the study of bathymetric environments using field observations, modeling, and remote sensing data. Research efforts include the following: - Continue studies of surface gravity waves, currents, tides and internal wave processes along rocky coastlines. - Continue autonomous, scalable, hydrographic charting and coastal parameter sampling studies with concomitant remote sensing for data-assimilative coastal models. - Continue research using airborne and satellite active and passive microwave sensors, overhead optical sensors, and ship or shore-based radars to observe coastal and nearshore phenomena. - Continue studies of the dynamics of shallow coastal inlets; specific areas include their formation and maintenance processes by tides, waves, currents, discharge and sediment type and supply. - Continue research to predict physical, geological, geochemical, geo-acoustic and geotechnical properties of the seafloor in shallow-water coastal environments. - Complete field studies of coastal oceanographic phenomena using sonar-equipped autonomous underwater vehicles in conjunction with ground-based, airborne and satellite remote sensing. - Initiate research to investigate sub-seabed geophysical properties. Physical Oceanography and Prediction Research of ocean circulation, thermodynamics and mixing, and the dynamics of surface gravity waves, nonlinear internal waves and the interaction of waves with sea ice in order to understand the sub-mesoscale physical oceanography parameters from the tropics to the poles. Sub-mesoscale understanding of the ocean is necessary to support the required fidelity and accuracy of ocean feature inputs to Naval warfighting applications. Research efforts include the following:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research efforts exploring novel expeditionary ocean instrumentation to support targeted observing. - Continue research regarding the study of ocean fronts, eddies and turbulence; ocean thermodynamics including mixing and acoustic impacts; and ocean boundary layer processes and surface gravity waves. - Continue research investigations of the rapid evolution of the upper ocean in the high North Atlantic between Iceland and the European continent to understand the physical processes that control vertical and horizontal density structures in the upper ocean. - Continue research efforts to explore the cascade of energy in the sub-mesoscale ocean, including the physics and dynamics of ocean features such as current meanders, vortices, and filaments, with a field program in the Western Pacific, to expand the knowledge of the lifecycle of these features and enable improved predictions. - Complete research investigations of three-dimensional Lagrangian ocean circulation and the prediction of vertical pathways in field experiments in the Mediterranean Sea. - Complete research regarding the seasonal variability of processes that control sea surface temperature in the Arabian Sea to understand the relevant space and time scales that enable improved ocean and weather forecasts through the reduction of ocean temperature biases in coupled models. - Initiate research investigations of air-sea interaction in the Arabian Sea to understand the origin of monsoon moisture and precipitation biases that exist in all coupled climate models (including the Navy's forecasting system) at subseasonal and shorter timescales. Program will leverage new observations of the ocean and atmosphere collected with regional partners. Arctic Sciences Research of complex processes governing the interaction of the arctic atmosphere, ocean, and sea ice, including formation, deformation, and melting. The physical processes in the arctic are inherently different from those in non-polar regions. Research efforts include: - Continue research efforts to characterize the behavior of sea ice, including melt and reformation, ice rheology and motion, and interactions with ocean stratification, surface waves and the atmosphere. - Continue research investigations regarding the development of Arctic System models and data assimilation techniques for improved prediction of the Arctic region and development of new sensors and unmanned platforms to collect observations of the Arctic environment. - Continue research development of algorithms enabling the space-based remote sensing of bulk properties of Arctic sea-ice that previously could be sampled only by localized in-situ methods. - Continue research efforts into studies of the circulation of the Arctic Ocean to explore the fate of heat flowing in through the Bering Strait and the impact on the upper ocean density structure of the Beaufort Sea. Ocean Acoustics					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Ocean Acoustics research continues as one of five National Naval Responsibilities (NNR) S&T investment areas. Research and education supported under this PE contributes to a vigorous science and technology base to ensure continuing U.S. leadership in the critically important discipline of Ocean Acoustics. Research in these areas contribute to improved basic understanding of the physical, seafloor and biological parameters that impact acoustic propagation in the ocean. Accurate acoustic predictions are required to keep our undersea assets undetected as well as to enable the detection and tracking of adversary assets. Research efforts include the following: - Continue research efforts to understand propagation and scattering of acoustic energy in shallow-water ocean environments. Specific efforts include shallow-water scattering mechanisms related to reverberation and clutter; seabed acoustic measurements supporting geoacoustic inversion; acoustic propagation through internal waves and coastal ocean processes and the development of unified ocean/seabed/acoustic models, including scattering from rough surfaces, biologics and bubbles; and penetration/propagation within the porous seafloor. - Continue research investigations regarding optimal representations information contained in acoustic data. Specific efforts will include the investigation summary statistics and sparse encoding of underwater acoustic data. The objective is to enable efficient analysis and compact representations of acoustic scenes. - Continue research investigations regarding naturalization applicable to the ocean battlespace. Specific efforts will include investigations into source separation, characterization, and recombination along with physical, biological, and anthropogenic sound generating mechanisms. The objective is to model and simulate acoustic phenomena in undersea environments to be rendered as virtual sound-fields. - Continue research into the effects of environmental variability induced by ocean internal waves, internal tides and mesoscale processes, and by bathymetric features including seamounts and ridges, on the stability, statistics, spatial distribution, and predictability of broadband acoustic signals, as well as the coherence and depth dependence of deep-water ambient noise. - Continue research investigations into the effects of Arctic conditions on acoustic propagation and ambient noise, particularly in under-ice environments. - Continue research efforts regarding joint physical oceanography and acoustic field studies to investigate propagation and scattering in regions characterized by complex bathymetry and/or meteorological and oceanographic forcing. Specific efforts will include processes studies with the objective of linking observed ocean and acoustic phenomena. An objective is to characterize oceanographic phenomena and the effects on acoustic propagation and scattering at different frequencies. - Continue research efforts regarding characterizing and forecasting sediment acoustic properties. Specific efforts will include investigations aimed at linking local physical and biological processes to acoustic observables. Continue analysis efforts related to acoustic seabed characterization experiment. Specific efforts					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
will include development and verification of geoacoustic models and inference techniques for soft sediments based on experimental evidence. - Continue research efforts regarding the analysis of data from a previous trans-arctic basin collection effort to extend studies of under-ice environments. Marine Mammals and Biology - Continue research efforts regarding the development and testing of new and existing technologies to detect, classify, localize and potentially track marine mammals. - Continue multidisciplinary ecosystem research including tagging, visual surveys, and passive acoustics to collect baseline measures of marine mammal behaviors and distributions relative to environmental features and marine mammal prey fields. - Continue research investigations of sound reception mechanisms in large whales. - Continue research efforts regarding the effects of sound include behavioral, physiological and population-level consequences of sound exposure on marine life. - Continue research investigations to characterize and quantify the cumulative effects of multiple stressors on marine mammal populations. - Continue research to develop framework for understanding the ecology of eDNA, including the origin, state, transport, and fate of extra-organismal genetic material. - Continue studies to design appropriate primers and bioinformatics workflows to effectively and efficiently detect and identify target biological communities and ecosystems, and advance our understanding of the relationships between eDNA and the abundance of marine megafauna. Battlespace Environments - Continue research efforts to improve basic understanding of physical, seafloor and biological oceanographic processes on space and time scales of naval interest. Research emphasis is on improved measurements, laboratory and model based experiments to quantify and understand important oceanographic processes that lead to the development of ocean dynamic/thermodynamic models from global to sub-mesoscale scales, and to couple these oceanographic models with atmospheric, ice, biological, sediment response, and optical models. While today's numerical analysis and prediction systems are more capable of resolving and predicting highly variable phenomena than were the systems of 10-20 years ago, there are still oceanographic processes that are not well understood and must be studied including aspects of ocean circulation (fronts, eddies and turbulence), thermodynamics (mixing and acoustic impacts), waves (including their impact on sea ice and rogue waves), sea ice (including landfast ice) as well as ocean boundary layer processes. Navy and Marine Corps requirements also include: a) an improved use of overhead (airborne and satellite) active and passive microwave sensors,					

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overhead optical sensors, surface-based (ships and ground-based) grazing angle microwave sensor, b) use of remote sensing of bulk properties of Arctic sea-ice over broad two-dimensional areas that previously could be sampled only at spot locations by in-situ sampling, and c) use of newly available higher resolution (sub-mesoscale) oceanographic data. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY 2023 to FY 2024 includes increased emphasis and efforts in Physical Oceanography, Littoral Geosciences and Optics, Atmosphere, and Space Environment related research areas.					
Title: Science and Engineering Education, Career Development and Outreach	43.986	47.405	65.196	0.000	65.196
Description: The Science and Engineering Education, Career Development and Outreach activity addresses the critical need to grow and maintain a highly skilled technical naval workforce. These efforts inspire, engage, educate and attract participants to pursue naval careers and build the extramural performer base. DON Science, Technology, Engineering and Math (STEM) education and outreach is designed to increase the number of students and naval civilians with naval-relevant skills and degrees, expand capabilities of the current and future workforce by developing curricula and augmenting education, and augment awareness of Naval opportunities through localized education and outreach initiatives that foster the talent pipeline. This activity supports both the Naval Research Enterprise Intern Program (NREIP) for college students and the Science and Engineering Apprenticeship Program (SEAP) for high school students to encourage participants to pursue science and engineering careers. The objective is to further education via mentoring by laboratory personnel and their participation in research, and to make them aware of Department of the Navy (DON) research and technology efforts. This program serves as a recruitment tool for employment within the DON. Participating students at 45 DON laboratories will spend eight to ten weeks during the summer conducting research. The separately-managed Department of the Navy's (DON) Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) program oversees the Navy's efforts to engage and support research in our nation's HBCU/MIs and is responsible for developing and managing efforts that strengthen and support the capabilities of HBCU/MIs to participate in basic, applied, and advanced development research programs within the Naval Research Enterprise.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
The ONR Young Investigator Program (YIP) attracts outstanding faculty members to the Department of Navy's basic research program by identifying individuals that show exceptional promise for doing creative research and encourage their teaching and research careers through long term support. Young Investigator awards are for a period of three years. Proposals are solicited annually via a funding opportunity announcement open to tenure-track faculty in science, engineering, and mathematics. YIP awardees are competitively selected based on faculty achievements, technical proposal, benefit to the Navy and Marine Corps, and university endorsement. The Naval Research Institution was established through a Memorandum of Understanding between the United States Naval Academy (USNA) and the Office of Naval Research. This effort contributes to the technical education of midshipmen by providing a research experience in STEM and its impact on fleet and forces capabilities. This activity also supports the Office of Naval Research Global mission to serve as the enduring Navy and Marine Corps global presence in technical and operational communities, investing in trusted partnerships to discover and connect science and technology leaders for sustained maritime security. This is accomplished by establishing quality, relevant connections between the international research and development community, Naval fleet/forces, Department of Defense, other US Government agencies and international partners. The direct impact of this investment is to leverage international basic research during increasingly dynamic global interdependence and improve the ability to solve DON Science & Technology challenges through shared knowledge with partners. ***FY 2023 Plans:*** Science, Technology, Education and Mathematics (STEM) - Continue existing successful efforts, while examining approaches to further scale up these efforts to achieve greater impact across the DON. - Continue the development of highly scalable pilot efforts to expand STEM education and outreach, with a focus on reaching underrepresented students, through the development of new virtual and in-person curricula as well as virtual and in-person experiential learning activities. - Continue activities targeting regional efforts to augment awareness of naval opportunities and increase diverse workforce opportunity for the naval science and technology community. - Continue to support the Naval Research Institution efforts that provide hands-on and virtual research experiences in STEM fields for United States Naval Academy (USNA) midshipmen and faculty members to enhance the midshipmen's educational environment at the USNA.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue NREIP and SEAP opportunities for students to participate in Navy and Marine Corps-relevant research at Naval Warfare Centers and Laboratories by expanding the number of participating sites, mentors, and interns. Historically Black Colleges and Universities / Minority Institutions (HBCU/MI): - Continue to provide innovative research opportunities, such as faculty fellowships and student internships that address critical Naval S&T challenges through collaborations between academic researchers and Naval scientists and engineers. - Continue to advance Naval-relevant research, by cultivating long-term partnerships that leverage knowledge sharing and empower scientific global discovery. - Continue new outreach initiatives to increase the number of HBCU/MI white paper and grant proposal submissions. - Initiate new efforts to increase applications and participants in the HBCU/MI Post-doctoral program that impacts the number of HBCU/MI PhD candidates working within the Navy STEM related fields. - Initiate new efforts to increase the number of science fairs at HBCU/MI that have partnerships with local junior and high schools. Young Investigator Program (YIP): - Continue YIP awards to 25 to 35 assistant professors that have demonstrated exceptional promise for performing creative research. Recent YIP topics include innovative technical approaches to: autonomy, deep learning, optimization, artificial intelligence, wireless communications, energetics, power and energy, propulsion, turbulence, hypersonics, remote sensing, bio-sensors, bionic composites, nanocomposites, ocean sciences, marine mammal health, multi-function materials and additive manufacturing. These and other research topics will benefit today's and the next generation warfighter by improving lethality, survivability, and communications. Additionally, many of these investigators will provide long-term support and knowledge in solving Naval related S&T challenges. - Complete Young Investigator Program topics initiated in previous fiscal years. - Initiate Young Investigator Program topics selected in fiscal year 2023. ONR Global - Continue international outreach efforts to foster collaboration through doctoral-level scientists located in Europe, South America, Canada, Asia and Australia, providing coverage in these regions by awarding grants					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
in innovative basic research to discover, access and assess revolutionary, high-payoff technologies for future Naval missions and capabilities.					
FY 2024 Base Plans: Science, Technology, Education and Mathematics (STEM) - Continue existing successful efforts, like the Navy and Marine Corps Junior Reserve Officers' Training Corps (JROTC) Flight Academy, while examining approaches to further scale up these efforts to achieve greater impact across the DON. - Continue the development of highly scalable pilot efforts, like Naval Horizons, to expand STEM education and outreach, with a focus on reaching underrepresented students, through the development of new virtual and in-person curricula as well as virtual and in-person experiential learning activities. - Continue activities targeting regional efforts to augment awareness of naval opportunities, like SeaPerch, and increase diverse workforce opportunity for the naval science and technology community. - Continue to support the Naval Research Institution efforts that provide hands-on and virtual research experiences in STEM fields for United States Naval Academy (USNA) midshipmen and faculty members to enhance the midshipmen's educational environment at the USNA. - Continue Naval Research Enterprise Internship Program (NREIP) and Science and Engineering Apprenticeship Program (SEAP) opportunities for students to participate in Navy and Marine Corps-relevant research at Naval Warfare Centers and Laboratories by expanding the number of participating sites, mentors, and interns. - Continue NREIP and SEAP internship opportunities for students to participate in Navy and Marine Corps-relevant research at Naval Warfare Centers and Laboratories. Continue to increase the number of participating sites resulting in additional mentors and interns. - Initiate new STEM efforts to address Naval skilled technical workforce needs. Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) - Continue with increasing the number of internships at SYSCOMs: NRL, NAVSUP, NAVAIR, NAVFAC, BUMED and NAVWAR for students at HBCU/MIs. - Continue to provide faculty fellowships for HBCU/MI faculty to conduct naval relevant research at all Naval Warfare Centers and Labs working naval scientist and engineers. - Continue new outreach initiatives to increase the number of HBCU/MI white paper and grant proposal submissions - to include making more grant awards. - Continue to increase the number of science fairs at HBCU/MI that have partnerships with local junior and high schools to include providing more CNR scholarships.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Expand the DoN HBCU/MI Post-doctoral program that impacts the number of HBCU/MI PhD candidates working within the Navy STEM related fields. Young Investigator Program (YIP) - Continue FY2022 & FY2023 YIP awards to assistant professors that have demonstrated exceptional promise for performing creative research. Recent YIP topics include innovative technical approaches to a broad range of naval-relevant research topics, including improved ocean wave forecasting; bio-inspired wings for unmanned systems; hypersonic aerodynamics; bio-degradable polymers; and advanced metal alloys for improved thermal management. These and other research topics will benefit today's and the next generation warfighter by improving lethality, survivability, and communications. Additionally, many of these investigators will provide long-term support and knowledge in solving Naval related S&T challenges. - Complete Young Investigator Program topics initiated in previous fiscal years. - Initiate Young Investigator Program topics selected in fiscal year 2024. ONR Global - Continue international outreach efforts to foster collaboration through doctoral-level scientists located in Europe, South America, Asia and Australia, providing coverage in these regions by awarding grants in innovative basic research to discover, access and assess revolutionary, high-payoff technologies for future Naval missions and capabilities. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY 2023 to FY2024 is due to increased focus on STEM education, career awareness and outreach activities and expanding Global collaboration activities.					
Title: Sensors, Electronics and Electronic Warfare (EW) ***Description:*** Basic research efforts directed toward increasing knowledge, components and algorithmic advances for electronics, sensing and EW ensuring the Navy can counter current and future threats. These efforts are applicable to sensing and EW on individual Naval platforms, as well as, efforts that aggregate capabilities in a Distributed Maritime Operation. The efforts research focus include: sensing, diagnostics, and detectors; navigation and timekeeping; nanoelectronics; wide band gap power devices; real-time targeting; Electro-Optical/Infra-Red (EO/IR)	52.502	55.113	61.328	0.000	61.328

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
electronics; EO/IR electronic warfare; EO/IR sensors for surface/aerospace surveillance; Radio Frequency (RF) sensors for surface/aerospace surveillance; solid state electronics; vacuum electronics; and RF electronic warfare. ***FY 2023 Plans:*** Electronics Technology - Continue to create new knowledge and understanding and explore new concepts, components, techniques and methods, for the design, growth, and characterization of electronic, electromagnetic, quantum phenomenology, and electro-optical materials, fabrication processes, electronic and electro-optic components, including novel electromagnetic concepts and techniques, and plasma phenomena and theory. - Continue efforts in nitrogen-polar GaN materials and device development. - Continue efforts in superconducting GaN materials and device development. - Continue efforts in plasmonic photomixer devices and circuits. - Continue effort to use generative neural networks to design topology-optimized metasurfaces and apply results to generate dual-level short-wave infrared antireflective coatings. - Continue efforts to develop novel materials for linear, low-power, broadband switches, including phase-change materials such as GeTe, as well as two-dimensional hexagonal boron nitride. - Continue work on squeezed lasers, optical cooling, and new superconducting sensors of magnetic field sources, even if cloaked. - Continue work on quantum entanglement and measurement as applied to RF signal analysis. - Continue device reliability studies of nitrogen-polar GaN devices. - Continue studies on superconducting GaN functional circuits. - Continue efforts to create new knowledge and understanding for quantum computing algorithms and their use to create new understanding of materials by design, process optimization, and quantum simulation. - Continue to improve full spectrum, real time, fully adaptive reception of many simultaneous signals-of-interest by exploiting the unique quantum properties of superconductor microelectronics and photonics. - Continue to investigate how to realize increased receiver dynamic range over entire DC to 200 GHz spectrum and enhance functional density to produce lighter and smaller receivers. - Initiate research in epitaxial synthesis of p-type crystalline metal nitrides. - Initiate transport studies of p-type and crystalline metal nitrides. - Initiate investigations into p- and n-type crystalline metal nitrides heterostructures. - Initiate architectural studies for implementing priority based processing utilizing the combination of wideband reception and machine learning algorithms. Such systems will be applicable to all RF applications while being most important to Surveillance, Electronic Warfare (EW), signal intelligence (SIGINT).					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Quantum Measurement Architectural Devices (formerly Quantum Information Sciences) - Continue the development of protocols for sensing and timekeeping devices based on quantum systems, including clocks with improved short and long-term performance and electromagnetic field sensors. - Continue the development of inertial and gravity sensors based on light-atom interferometry. - Initiate research on the capabilities of non-equilibrium many-body systems for novel metrology. Electromagnetic Warfare - Continue research efforts with the overarching objective of establishing the mathematical constructs, techniques, computational procedures, and scientific foundations for analysis/design of signal, image, control, and data generating systems. - Continue the development of ultrafast, efficient, and accurate time domain (TD) algorithms to predict the ultra-wideband radar cross-section (RCS) of complex naval platforms by solving the long-standing late-time instability problem. - Continue research efforts to enable the imaging of self-illuminating thermal objects occluded by walls by sensing non-specular reflections from rough surfaces such as open doors and around corners, to allow for asymmetric warfare through image recovery in previously denied conditions. - Complete the research to develop advanced multi-dimensional Convolutional Neural Network approaches and algorithms to investigate and demonstrate improved means of analyzing high-dimensional data resulting in improved results for classification, segmentation, anomaly/ target detection. Complete the investigation of mathematical, statistical and algorithmic issues associated with performing robust and adaptive detection and discrimination of targets when sensed by multiple, resource-constrained, unmanned vehicle sensors operating in a decentralized fashion and in highly cluttered environments. - Complete research efforts to establish basic feasibility of novel emerging non-linearized imaging and feature extraction techniques with respect to existing and/or realistic multi-static sensing geometries, research to utilize and enhance the understanding and applicability of topological techniques to enable improved capabilities for target detection, object identification, and data fusion. - Initiate the investigation into novel approaches to deep-generative machine learning-based algorithms and architectures for multistatic radar imaging to enable better noise robustness and resolution performance. Materials and Chemistry - Continue the design and fabrication of single-monolayer or low-dimensional materials with unique and useful fundamental properties, e.g. ferromagnets and semiconductors, distinct from bulk materials and capable of being functionalized for high performing sensors, computer memory elements and electronic components.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue the use of precision molecular placement and orientation to design and create bio-inspired materials exploiting quantum phenomena to perform functions such as ultrasensitive photon detectors and energy generation - Continue highly sensitive measurement and modeling techniques to design, detect, diagnose and/or quantify physical, chemical and biological processes and properties affected by trace impurities, subtle composition changes and chemical species with high spatial resolution, sensitivity, and precision. Undersea Warfare - Continue to conduct laboratory, field, and theoretical/numerical studies to investigate physical phenomena related to acoustic propagation and scattering in oceanic environments such as: prediction of the scattering signature of a structure using noise sources of opportunity; fundamental physical phenomena of wave propagation in ocean environments; approaches to separate an acoustical field from turbulent flow on an acoustic array; new structural acoustics theory for scattering from large, complex undersea objects; and creation of new approaches to monitoring the acoustic signature and structural state of undersea vessels.					
FY 2024 Base Plans: Electronics Technology - Continue research efforts in nitrogen-polar GaN materials and device development. - Continue research investigations in superconducting GaN materials and device development. - Continue research efforts in plasmonic photomixer devices and circuits. - Continue research efforts regarding device reliability studies of nitrogen-polar GaN devices. - Continue studies on superconducting GaN functional circuits. - Continue research investigations into p-type and n-type crystalline metal nitride materials, transport properties and heterostructures. - Continue research to improve full spectrum, real time, fully adaptive reception of many simultaneous signals-of-interest by exploiting the unique quantum properties of superconductor microelectronics and photonics. - Continue research investigations regarding methods to realize increased receiver dynamic range over entire DC to 200 GHz spectrum and enhance functional density to produce lighter and smaller receivers. - Continue architectural studies correlating the type of superconducting logic used to the expected performance and circuit SWaP when performing in the cryogenic environment specific digital signal processing tasks highly relevant to the naval environment. Such systems will be applicable to all RF applications while being most important to Surveillance, Electronic Warfare (EW), signal intelligence (SIGINT). - Complete research efforts regarding squeezed lasers and optical cooling of solids.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Complete research investigations regarding the use of generative neural networks to design topology-optimized metasurfaces and apply results to generate dual-level short-wave infrared antireflective coatings. - Complete research efforts developing novel materials for linear, low-power, broadband switches, including phase-change materials such as GeTe, as well as two-dimensional hexagonal boron nitride. - Complete research efforts on quantum entanglement and measurement as applied to RF signal analysis. - Complete research efforts to create new knowledge and understanding for quantum computing algorithms and their use to create new understanding of materials by design, process optimization, and quantum simulation. - Continue research efforts to create new knowledge and understanding and explore new concepts, components, techniques and methods, for the design, growth, and characterization of electronic, electromagnetic, quantum phenomenology, and electro-optical materials, fabrication processes, electronic and electro-optic components, including novel electromagnetic concepts and techniques, and plasma phenomena and theory. - Initiate research exploring new classes of analog superconducting devices including dynamically tunable resonators for analog processing and 3D stacks of predeposited YBCO as low loss interconnects. - Initiate research efforts to create new knowledge and understanding for quantum computing algorithms and their use to create new understanding of materials by design, process optimization, and quantum simulation. - Initiate research investigations into the use of molecular excitonics as a platform for quantum technologies such as quantum computing and quantum communications - Initiate research investigations into integrated mm-wave plasmonic photomixer receivers. - Initiate research efforts to evaluate RF properties of low Vpi electro-optical modulators made of thin film LiNbO3 deposits for airborne analog data links, including when hybridized with III-V, Si and SiN photonic devices. Quantum Measurement Architectural Devices - Continue research efforts regarding the development of protocols for sensing and timekeeping devices based on quantum systems, including clocks with improved short and long-term performance and electromagnetic field sensors. - Continue research into the development of inertial and gravity sensors based on light-atom interferometry. - Continue research efforts on the capabilities of non-equilibrium many-body systems for novel metrology. Electromagnetic Warfare - Continue research efforts with the overarching objective of establishing the mathematical constructs, techniques, computational procedures, and scientific foundations for analysis/design of signal, image, control, and data generating systems for use in Navy, other DoD, dual-use, or commercial development programs. Each					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
project has defined objectives within the contexts of the Naval Research Enterprise Research and Development Strategic Framework and Marine Corps S&T Strategic Plan. - Continue research investigation into novel approaches to deep-generative machine learning-based algorithms and architectures for multi-static radar imaging to enable better noise robustness and resolution performance. - Complete research efforts regarding the development of ultrafast, efficient, and accurate time domain (TD) algorithms to predict the ultra-wideband radar cross-section (RCS) of complex naval platforms by solving the long-standing late-time instability problem. - Complete research efforts to enable the imaging of self-illuminating thermal objects occluded by walls by sensing non-specular reflections from rough surfaces such as open doors and around corners, to allow for asymmetric warfare through image recovery in previously denied conditions. Materials and Chemistry - Continue the design and fabrication of single-monolayer or low-dimensional materials with unique and useful fundamental properties, e.g. ferromagnets and semiconductors, distinct from bulk materials and capable of being functionalized for high performing sensors, computer memory elements and electronic components. - Continue the use of precision molecular placement and orientation to design and create bio-inspired materials exploiting quantum phenomena to perform functions such as ultrasensitive photon detectors and energy generation. - Continue highly sensitive measurement and modeling techniques to design, detect, diagnose and/or quantify physical, chemical and biological processes and properties affected by trace impurities, subtle composition changes and chemical species with high spatial resolution, sensitivity, and precision. Undersea Warfare - Continue to conduct laboratory, field, and theoretical/numerical studies to investigate physical phenomena related to acoustic propagation and scattering in oceanic environments such as: prediction of the scattering signature of a structure using noise sources of opportunity; fundamental physical phenomena of wave propagation in ocean environments; approaches to separate an acoustical field from turbulent flow on an acoustic array; new structural acoustics theory for scattering from large, complex undersea objects; and creation of new approaches to monitoring the acoustic signature and structural state of undersea vessels.					
FY 2024 OCO Plans: N/A					
FY 2023 to FY 2024 Increase/Decrease Statement:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
The increase from FY 2023 to FY 2024 in Sensors, Electronics And Electronic Warfare (EW) is due to increased Basic Research in such as areas but not limited to undersea warfare, mathematics, electronics, and quantum fundamental research.					
Title: Weapons	26.945	26.324	26.255	0.000	26.255
Description: The Weapons activity focuses on a number of fundamental scientific areas aimed at expanding the underlying understanding of disciplines that are broadly useful for a wide range of naval weapon applications, including undersea weaponry; air weaponry; energetic materials and solid rocket propulsion; both laser and high power microwave directed energy systems; counter directed energy phenomena; and hypersonic aerodynamics and materials to address the unique challenges of extreme temperatures and air flow. ***FY 2023 Plans:*** Undersea Weaponry - Continue research on Undersea Warheads (characterization and modeling of explosive formulations), Advanced Concepts for Sea Warfare and Weapons (unconventional power and energy technology), Cooperative Autonomous Swarm Technology and the Naval Undersea Research graduate-level STEM program, which supports the development of the Navy lab workforce. Air Weaponry - Continue efforts in the areas of solid and hybrid rocket propulsion, advanced structural and aperture materials, navigation, aerodynamics, single and multi-missile control, and power management. - Continue research on multifunctional material structures include making missile skins with embedded (woven-in) antennas, sensors, power sources, computational resources, and energetic materials. These efforts will enable missiles with greatly increased speed, range and lethality to meet future naval warfare needs. -Initiate research to develop models and tool to provide robust bearings without oil. Directed Energy and Counter Directed Energy Directed energy weapons are defined as electromagnetic systems capable of converting chemical and/or electrical energy to radiated energy and focusing it on a target, resulting in damage that degrades, neutralizes, defeats, or destroys an adversarial capability. Directed Energy Weapons efforts include High Energy Lasers that emit photons and High Power Microwaves that release radiofrequency waves. The ability to focus the radiated energy reliably and repeatedly at range, with precision and controllable effects, while producing measured physical damage, is the measure of effectiveness - requiring understanding of the basic sciences in high					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
energy physics, optics, quantum mechanics and material sciences. The U.S. Navy applies the basic research knowledge through follow on applied technology programs for power projection and integrated defense missions. Energetic Materials and Rocket Propulsion - Continue research investigating advanced energetic materials, which provide reactive, explosive, and propulsive phenomena including high-energy ingredient synthesis, modeling, characterization, and the fundamentals of initiation, decomposition, combustion and shock. - Continue and expand research in energetic material ingredients and material concepts with superior specific energy / energy density, brisance, and insensitivity for useful warhead fills and tactical propulsion. - Continue and expand research in novel diagnostic method development for improved understanding of energetic material combustion, shock response, and related dynamic phenomena. - Continue and expand efforts in advanced modeling and simulations on energetic materials to further understand and predict energetic material properties, response to stimuli, and performance. - Complete efforts in ingredient development, experimental diagnostics, and modeling that have not shown promise. - Initiate research focused on novel synthetic methodology development for carbon/hydrogen/nitrogen/oxygen-based energetic ingredients in addition to new metal based fuel particle design and other inorganic and hybrid energetic material concepts; - Initiate research into fundamental understanding of material interfacial physics/chemistry relevant to energetic formulation development and advanced manufacturing. Hypersonics - Continue research that will address technologies needed for long-range weapon components that are able to survive high temperature exposure for several minutes and thwart anti-access/ area denial countermeasures; - Continue investigating the hypersonic boundary-layers and shock-wave / boundary-layer interactions, prediction of hypersonic weapon flight performance and control, environment-material interactions, exploration of ultrahigh temperature materials, and technologies needed for high-speed propulsion. High Energy Lasers - Continue the exploration of the physics of photonic creation, materials interaction, energy release and interactions with optical materials via computational and mathematical modeling methods, including machine learning.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research on next-generation photon waveform and mode shaping interactions with materials, including metamaterials, examining high efficiency energy conversion designs within unique nanostructured materials with goal of increasing efficiency from source to release. - Continue examination of high energy laser-launched collimated photon interactions with the atmosphere, which are unique in propagation within the maritime domain, examining unique physical and optical interactions related to absorption, reflectance, scatter and turbulence often seen in expeditionary and at-sea conditions; - Continue research that will contribute to identifying new nanostructured materials, metamaterials and optical coatings processing for naval applications and investigate unique interactions of high energy photons with materials and coatings; High Power Microwaves - Continue research into solid-state and vacuum electronic based sources and amplifiers, antennas, high voltage storage/switching components and power supplies, novel high power capable materials, radio-frequency coupling and electronic device interaction physics, predictive effects and modeling tools along with novel sensors and instrumentation. Ultra Short Pulse Laser - Initiate research on interaction of intense laser pulses with nanostructured surfaces, the role of disorder in promoting synchronization in technological systems of relevance to the Navy, hybrid quantum devices with the greatest technological impact to photonics and solid-state laser components, and extension of mode-locked laser and optical frequency comb technologies from the traditional near-infrared regime to new spectral regions. - Initiate research on generation of high-average power ultra-broadband radio frequency and mid-infrared radiation in dielectrics and plasmas, effects of atmospheric turbulence on the propagation of laser beams having orbital angular momentum, demonstration of a compact solid-state laser source, demonstration of highly efficient frequency conversion of ultrashort pulse laser sources, and demonstration of ultrahigh peak power compact ultrashort sources in specific spectral ranges via advanced mode locking and chirped pulse amplification techniques.					
FY 2024 Base Plans: Undersea Weaponry - Continue research investigations of Undersea Warheads with respect to the characterization and modeling of explosive formulations. - Continue research efforts regarding Advanced Concepts for Sea Warfare and Weapons regarding unconventional power and energy technologies.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue research investigations of Cooperative Autonomous Swarm Technology. - Continue research efforts relevant to the Naval Undersea Research graduate-level STEM program to support the development of the Navy laboratory workforce. Air Weaponry - Continue efforts in the areas of solid and hybrid rocket propulsion, advanced structural and aperture materials, navigation, aerodynamics, single and multi-missile control, and power management. - Continue research on multifunctional material structures include making missile skins with embedded (woven-in) antennas, sensors, power sources, computational resources, and energetic materials. These efforts will enable missiles with greatly increased speed, range and lethality to meet future naval warfare needs. - Continue research to develop models and tools to provide robust bearings without oil. Energetic Materials and Rocket Propulsion - Continue research investigating advanced energetic materials, which provide reactive, explosive, and propulsive phenomena including high-energy ingredient synthesis, modeling, characterization, and the fundamentals of initiation, decomposition, combustion and shock. - Continue and expand research in advanced synthetic methodologies and motifs for energetic material ingredients and material concepts with superior specific energy / energy density, brisance, and insensitivity for useful warhead fills and tactical propulsion, including new metal-based fuel particle designs and other inorganic and hybrid energetic material concepts. - Continue and expand research in novel diagnostic method development for improved understanding of energetic material decomposition, pyrolysis, combustion, shock response, and related dynamic phenomena. - Continue and expand efforts in advanced modeling and simulations on energetic materials to further understand and predict energetic material properties, response to shock, thermal and other stimuli, and performance. - Continue and expand research into fundamental understanding of material interfacial physics/chemistry relevant to energetic formulation development and advanced manufacturing. - Continue research focused on novel synthetic methodology development for carbon/hydrogen/nitrogen/oxygen-based energetic ingredients in addition to new metal based fuel particle design and other inorganic and hybrid energetic material concept Hypersonics - Continue research to address technologies needed for long-range weapon components that are able to survive high temperature exposure for several minutes and defeat anti-access / area denial countermeasures.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue investigating the hypersonic boundary-layers and shock-wave / boundary-layer interactions, prediction of hypersonic weapon flight performance and control, environment-material interactions, exploration of ultrahigh temperature materials, and technologies needed for high-speed propulsion. Directed Energy and Counter Directed Energy Directed energy weapons are defined as electromagnetic systems capable of converting chemical and/or electrical energy to radiated energy and focusing it on a target, resulting in damage that degrades, neutralizes, defeats, or destroys an adversarial capability. Directed Energy Weapons efforts include High Energy Lasers that emit photons and High Power Microwaves that release radiofrequency waves. The ability to focus the radiated energy reliably and repeatedly at range, with precision and controllable effects, while producing measured physical damage, is the measure of effectiveness - requiring understanding of the basic sciences in high energy physics, optics, quantum mechanics and material sciences. The U.S. Navy applies the basic research knowledge through follow-on applied technology programs for power projection and integrated defense missions. High Energy Lasers - Continue the exploration of the physics of photonic creation, materials interaction, energy release and interactions with optical materials via computational and mathematical modeling methods, including machine learning. - Continue research on next-generation photon waveform and mode shaping interactions with materials, including metamaterials, examining high efficiency energy conversion designs within unique nanostructured materials with goal of increasing efficiency from source to release. - Continue examination of high energy laser-launched collimated photon interactions with the atmosphere, which are unique in propagation within the maritime domain, examining unique physical and optical interactions related to absorption, reflectance, scatter and turbulence often seen in expeditionary and at-sea conditions. - Continue research that will contribute to identifying new nanostructured materials, metamaterials and optical coatings processing for naval applications and investigate unique interactions of high energy photons with materials and coatings. High Power Microwaves (HPM) - Continue research into solid-state and vacuum electronic based sources and amplifiers, antennas, high voltage storage/switching components and power supplies, novel high power capable materials, radio-frequency coupling and electronic device interaction physics, predictive effects and modeling tools along with novel sensors and instrumentation. Planned research efforts include the following:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- research investigations in HPM technologies including not only consideration of sources, but also the supporting pulsed power, antennas, and other subsystems. - research efforts in Solid-state and vacuum electronic based HPM sources capable of flexible waveforms. - research in Distributed array sources for agile beamforming. - research in Wide-bandwidth high-power frequency agile amplifiers. - research investigations of Low profile steerable antennas; high energy density capacitors, solid-state high voltage switches; high voltage power supplies, power electronics switches, hardened controls. - research in Novel materials - dielectric insulators, 3D printed materials, improved radome materials. - research efforts in RF coupling, device interaction physics and component level effects. - research in Prediction of effects on electronics with improved techniques for HPM lethality testing and analysis from L band to X band and above. - research in Novel HPM sensors including electronic battle damage indication (eBDI) instrumentation. Ultra Short Pulse Laser - Continue research on interaction of intense laser pulses with nanostructured surfaces, the role of disorder in promoting synchronization in technological systems of relevance to the Navy, hybrid quantum devices with the greatest technological impact to photonics and solid-state laser components, and extension of mode-locked laser and optical frequency comb technologies from the traditional near-infrared regime to new spectral regions. - Continue research on generation of high-average power ultra-broadband radio frequency and mid-infrared radiation in dielectrics and plasmas, effects of atmospheric turbulence on the propagation of laser beams having orbital angular momentum, demonstration of a compact solid-state laser source, demonstration of highly efficient frequency conversion of ultrashort pulse laser sources, and demonstration of ultrahigh peak power compact ultrashort sources in specific spectral ranges via advanced mode locking and chirped pulse amplification techniques. - Initiate research investigation of improved AI deep learning approaches for beaconless atmospheric turbulence prediction and compensation for deep turbulence. - Initiate research into the evaluation of wavefront sensing, reconstruction, and control methods for deep turbulence in the laboratory.					
FY 2024 OCO Plans: N/A					
FY 2023 to FY 2024 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 0000 / *Defense Research Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
There is no significant funding change from FY 2023 to FY 2024.					
Accomplishments/Planned Programs Subtotals	462.869	479.480	520.984	0.000	520.984

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 1	R-1 Program Element (Number/Name) PE 0601153N / *Defense Research Sciences*	Project (Number/Name) 3465 / *In-House Lab Independent Res*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
3465: *In-House Lab Independent Res*	0.000	10.992	19.533	19.924	-	19.924	20.322	20.729	21.143	21.566	Continuing	Continuing

Note

Effective in FY 2022, In-house Laboratory Independent Research (ILIR) funding and associated requirements are realigned from Program Element (PE) 0601152N, Project 0000 to PE 0601153N, Project 3465.

A. Mission Description and Budget Item Justification

The In-house Laboratory Independent Research (ILIR) initiative seeks to improve the quality of defense research conducted predominantly through the Naval Warfare Centers/Laboratories. It also supports the development of technical intellect and education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in a military laboratory environment. Initial research focus is often conducted in an unfettered environment since it is basic research, but many projects focus on applying recently developed theoretical knowledge to real world military problems with the intention of developing new capabilities and improving the performance of existing systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Title: In-House Laboratory Independent Research (ILIR)	10.992	19.533	19.924	0.000	19.924
Description: The In-house Laboratory Independent Research program provides opportunities to strengthen the Naval Science and Engineering workforce through basic research conducted at the Naval Warfare Centers and Laboratories. These research efforts address high risk/high payoff warfighter science and technological needs, as well as attract the next generation of researchers to consider employment within the Department of the Navy. ILIR also provides opportunities for advanced degrees, technical publications, presentations, and patents. ***FY 2023 Plans:*** Continue: Further develop and maintain the Science and Engineering workforce by providing funding to Naval Warfare Centers and Laboratories to foster high risk/ high reward basic research initiatives of Naval interest. Each naval site conducts peer reviews for existing research projects, assess the quality of the research, and determine if projects should continue. Complete: Conclude research topics that initiated in FY 2021. Assess opportunities for technology transition through coordination with various resource sponsors. Transfer successful efforts to research, development, test, and evaluation-sponsored programs.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 3465 / *In-House Lab Independent Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Initiate: The participating warfare centers or laboratories generate new three-year research topics where priority is given to warfighter needs, technology alignment, high quality research, and the recruitment and retention of outstanding scientists and engineers. Topics cover a broad range of naval relevant research areas critical to the support of warfare center and laboratory missions. ***FY 2024 Base Plans:*** Continue: - Further develop and maintain the Science and Engineering workforce by providing funding to Naval Warfare Centers and Laboratories to foster high risk/ high reward basic research initiatives of Naval interest. Each Naval site conducts peer reviews for existing research projects, assess the quality of the research, and determine if projects should continue. Complete: - Research topics that initiated in FY 2022. Assess opportunities for technology transition through coordination with various resource sponsors. Transfer successful efforts to research, development, test, and evaluation-sponsored programs. Initiate: - The participating warfare centers or laboratories generate new three-year research topics where priority is given to warfighter needs, technology alignment, high quality research, and the recruitment and retention of outstanding scientists and engineers. Topics cover a broad range of naval relevant research areas critical to the support of warfare center and laboratory missions. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** There is no significant funding change between FY 2023 and FY 2024.					
Accomplishments/Planned Programs Subtotals	10.992	19.533	19.924	0.000	19.924

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 3465 / *In-House Lab Independent Res*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy											Date: March 2023	
Appropriation/Budget Activity 1319 / 1					R-1 Program Element (Number/Name) PE 0601153N / *Defense Research Sciences*				Project (Number/Name) 9999 / *Congressional Adds*			
COST ($ in Millions)	**Prior Years**	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**Cost To Complete**	**Total Cost**
9999: *Congressional Adds*	0.000	37.649	42.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	80.149

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
Congressional Add: Basic Research ***FY 2022 Accomplishments:*** Conduct basic research efforts including scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research effort subject areas include: Autonomous Systems; Artificial Intelligence/Machine Learning; Command, Control, Communications and Computers (C4); Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support (Education and Outreach). ***FY 2023 Plans:*** Provide significant new opportunities for basic research across the spectrum of activities in the 0601153N Program Element performed in the five departments of the Office of Naval Research.	24.134	25.000
Congressional Add: Bio-inspired Engineering and Design for Naval Applications ***FY 2022 Accomplishments:*** Conduct basic research on mobility, maneuverability and agility, with focus on locomotion and mechanics (e.g., fin-based swimming, flapping flight and legged locomotion), modalities of distributed sensing and processing (visual, echolocation, lateral-line and vibrissae "imaging" and cognitive-neural processing, neuroscience and machine learning), and distributed actuation (neural activation and muscle mechanics, hard and soft robotics). ***FY 2023 Plans:*** N/A	2.896	0.000
Congressional Add: Generally-capable robotics for naval operations ***FY 2022 Accomplishments:*** Conduct basic research focused on generally-capable robotics for naval operations ***FY 2023 Plans:*** N/A	3.861	0.000
Congressional Add: Multifunctional structural batteries	1.931	3.000

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 1	**R-1 Program Element (Number/Name)** PE 0601153N / *Defense Research Sciences*	**Project (Number/Name)** 9999 / *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2022 Accomplishments: Conduct basic research in multifunctional structural batteries ***FY 2023 Plans:*** Objective to investigate the important basic engineering science challenges that can substantially advance the naval undersea systems technologies.		
Congressional Add: Silicon-germanium-tin alloy research ***FY 2022 Accomplishments:*** Conduct basic research on silicon-germanium-tin alloys ***FY 2023 Plans:*** This project is to deliver breakthroughs in semiconductor science and technology for the fabrication of new and novel focal-plane array digital imaging systems.	4.827	5.000
Congressional Add: Predictive modeling for next generation undersea vehicles ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Conduct research in predictive modeling for next generation undersea vehicles.	0.000	3.000
Congressional Add: Naval Research Laboratory S&T ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Conduct Congressional Interest Science and Technology at the Naval Research Laboratory	0.000	6.500
Congressional Adds Subtotals	37.649	42.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A