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 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602271N *I Electromagnetic Systems Applied Research*

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	89.120	131.288	92.473	-	92.473	95.693	97.614	99.573	100.922	Continuing	Continuing
0000: *Electromagnetic Systems Applied Research*	0.000	83.328	92.288	92.473	-	92.473	95.693	97.614	99.573	100.922	Continuing	Continuing
9999: *Congressional Adds*	0.000	5.792	39.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.792

A. Mission Description and Budget Item Justification

Freedom of maneuver on a global scale for U.S. naval forces depends upon assured access to the electromagnetic spectrum and the ability to deny adversary exploitation. Electromagnetic technologies must fluidly deliver communication, surveillance electronic warfare and digital integration to understand, shape and defend the battlespace. The Electromagnetic Systems Applied Research Program addresses technology needs associated with Naval platforms for new capabilities in Electro-Optic and Infrared (EO/IR) Sensors, Surveillance, Electronic Warfare, Navigation, Solid State Electronics, Vacuum Electronics Power Amplifiers, and Nanoelectronics. The program supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection, Time Critical Strike, and Information Distribution. Activities and efforts within this Program have attributes that focus on enhancing the affordability of warfighting systems.

Today's Sailors and Marines are enabled by Naval Science and Technology (S&T). Since 1946, the Office of Naval Research (ONR) has fostered scientific research related to the maintenance of maritime superiority and national defense. ONR manages the Department of the Navy's (DON) portfolio of naval Basic and Applied research, and Advanced Technology Development investments to ensure naval forces can effectively deter conflict, but when called upon, fight, win and come home safe. Current investments hedge against uncertainty, providing solutions to commanders today, and options for the future. The Naval S&T budget 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.

This Program Element (PE) funds Applied Research, which is the systematic study to understand the means to meet a recognized and specific need. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments).

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

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Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602271N *I Electromagnetic Systems Applied Research*

B. Program Change Summary ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	91.041	92.444	94.160	-	94.160
Current President's Budget	89.120	131.288	92.473	-	92.473
Total Adjustments	-1.921	38.844	-1.687	-	-1.687
• Congressional General Reductions	-	-0.156			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	39.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.921	0.000			
• Program Adjustments	0.000	0.000	-1.687	-	-1.687
• 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: *Dark Swarm in Degraded Environments*	5.792	0.000
Congressional Add: *Submerged electro-optical adaptive littoral sensor (SEALS) system prototypes*	0.000	5.000
Congressional Add: *Advanced antenna technology*	0.000	6.000
Congressional Add: *Dark swarm in degraded and denied enviorments*	0.000	6.000
Congressional Add: *Mini-full spectrum hyperspectral sensors for IEDs*	0.000	7.000
Congressional Add: *Open systems architecture for electronic warfare chiplets*	0.000	15.000
Congressional Add Subtotals for Project: 9999	5.792	39.000
Congressional Add Totals for all Projects	5.792	39.000

Change Summary Explanation

Financial: $1.687M reduction includes realignment of funds to higher priority S&T research.

Technical: No significant change.

Schedule: No significant change.

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602271N / *Electromagnetic Systems Applied Research*	Project (Number/Name) 0000 / *Electromagnetic Systems Applied Research*	

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
0000: *Electromagnetic Systems Applied Research*	0.000	83.328	92.288	92.473	-	92.473	95.693	97.614	99.573	100.922	Continuing	Continuing

A. Mission Description and Budget Item Justification

Freedom of maneuver on a global scale for U.S. naval forces depends upon assured access to the electromagnetic spectrum and the ability to deny adversary exploitation. Electromagnetic technologies must fluidly deliver communication, surveillance electronic warfare and digital integration to understand, shape and defend the battlespace. This project addresses technology opportunities associated with Naval platforms for new capabilities in Electro-Optic and Infrared (EO/IR) Sensors, Surveillance, Electronic Warfare, Navigation, Solid State Electronics, Vacuum Electronics Power Amplifiers, and Nanoelectronics. The project supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection, Time Critical Strike, and Information Distribution. This project directly supports the Department of Defense Joint Warfighter Plan and the Defense Technology Area Plans. Activities and efforts within this program have attributes that focus on enhancing the affordability of warfighting systems. The program also provides for technology efforts to maintain proactive connectivity and collaboration between Department Of the Navy (DON) Science and Technology (S&T) and Joint, Navy, and Marine Corps commands worldwide. Due to the number of efforts in this Program Element (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: Electronic Warfare Technology	40.928	43.777	38.341	0.000	38.341
Description: The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Electronic Warfare (EW) systems across the entire Electromagnetic Spectrum (EMS) that will increase the operational effectiveness and survivability of U.S. Naval units. Technology development is focused on Distributed Electronic Warfare in support of Distributed Maritime Operations. Emphasis is placed on passive sensors and active and passive Countermeasure (CM) systems that exploit and counter a broad range of electromagnetic threats. The focus is on maintaining near perfect, real-time knowledge of the enemy; countering the threat of missiles against deployed Naval forces; precision identification and location of threat emitters; and development of technologies that have broad application across multiple disciplines within the EW mission area. This activity also includes developments to protect these technologies from external interference, and modeling and simulation required to support the development of these technologies. The current objectives are: - Electronic Warfare (EW) Radio Frequency (RF) Technology: Develop and demonstrate technologies in the RF spectrum (covering frequencies from kilohertz to terahertz) that include developments in detection, signal					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
processing and passive/active techniques for wideband Electronic Attack (EA), Electronic Protection (EP) and the Electronic Support (ES) mission areas. - Electronic Warfare (EW) Electro-Optic/Infrared (EO/IR) Technology: Develop and demonstrate counter EO/IR technologies extending from the ultraviolet to the far infrared spectral bands. This includes advances in multispectral sensors, multiband sources, beam forming/steering, and signal processing and transmission. - EW Integrated and Networked Technology: Develop and demonstrate technologies that will enable an increased situational awareness and response across the Electromagnetic Spectrum (EMS) with broad spatial coverage using all available EW assets to provide coordinated, adaptive and networked EW sensing, protection and attack. - Advanced EW Enabling Technologies: Develop classified advanced electronic warfare technology in support of current and predicted capability requirements emphasizing distributive effects. ***FY 2023 Plans:*** Electronic Warfare (EW): - Complete early development and demonstrate implementation of Artificial Intelligence (AI) algorithms and deep learning techniques for adaptive Electronic Attack (EA) and Electronic Support (ES) applications on new AI compute processing architectures developed for Electronic Warfare (EW) applications. - Continue research in federated, coordinated, and integrated Electronic Warfare (EW) systems for the development of distributed Electronic Warfare (EW) technologies for Electronic Surveillance (ES), decoys and countermeasures, and Electronic Attack (EA) against adversary Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance and Targeting (C4ISRT). This EW research includes Electronic Protection (EP) for our own weapons and Command, Control, Communications, Computers, Cyber Defense, Intelligence, Surveillance and Reconnaissance (C5ISR) systems allowing them to operate in a heavily contested environment. - Continue research into developing AI-generated tactics against modern and emerging radar sources to improve naval mission effectiveness. - Continue research and development in the area of hard-kill and soft-kill coordination and planning. - Continue research into simultaneous multi-spectral (Radio Frequency (RF) and optical) countermeasure development to increase survivability across the entire electromagnetic spectrum and continue development of coordinated EW techniques between RF and Electro-Optic/Infrared (EO/IR) transmitters and receivers for single and distributed platforms. - Continue development and implementation of combined EW and cyber effects to increase the reach and effectiveness of each domain in support of distributed maritime operations.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue the development of artificial intelligence algorithms to automatically classify tracks for an advanced weapons system and to distinguish anomalous targets, which have not been previously seen by the combat system. - Continue the development of a quantitative understanding of the relationship between laser fluence profiles and resultant emission, determine to what extent fluctuation in irradiance and fluence profile affects spatial, temporal, and spectral characteristics of generated emission and demonstrate improved quantitative prediction of effects in laboratory and at range based upon deeper understanding. - Continue the development of a variable-ratio coupler approach to phase demodulation, allowing for the active tuning of a photonics based processor. Electromagnetic Warfare: - Continue diverse research spanning multiple projects across a broad spectrum of RF and EO/IR technologies that cover the detection of energy in the environment to the formulation of active and passive engagement techniques. - Continue efforts with focus on near-real-time geolocation of stationary (or slowly moving) RF emitters, and in particular, emerging threat radars employing unusual waveforms resulting in accurate geolocation. - Continue novel real-time signal processing techniques to dramatically increase the useful information content reported in receiver measurements of radar-band signals providing the warfighter with a low-ambiguity warning of detection. - Continue efforts to improve the effectiveness of emitter classification of modern radars for several functions including Automated Identification Systems (AIS) validation increasing Maritime Domain Awareness. - Continue research applying recently developed machine learning methods to the problem of functional classification of radar emissions and demonstrate the ability to perform the functional classification in real time to overcome the inadequacy conventional emitter classification methods. - Continue efforts focused on discovering and defeating unknown and adaptive radios by developing algorithms to observe their behavior, analyze their networking protocols, and optimize engagement techniques to interfere with their objectives. - Continue research to develop and demonstrate high gain distributed aperture technologies compatible with micro-jammer glide vehicles to increase the effective radiated power of a ground-based micro-jammer constellation to provide sufficient power to radars. - Continue development and demonstration of an evolvable Electronic Warfare (EW) transceiver design that optimizes cuing receiver processing to increase situational awareness and enable adaptive electronic attack					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
response in complex electromagnetic environments to provide effective processing of emergent complex radar modes. - Initiate the development of technology and waveforms to detect the emissions of and deny launch platform targeting radars and/or anti-ship missile seekers the capability to acquire and track ship targets across the electromagnetic spectrum. ***FY 2024 Base Plans:*** Electronic Warfare (EW): - Complete the development of a quantitative model to understand the relationship between laser fluence profiles and resultant emission; developed model will help determine to what extent fluctuation in irradiance and fluence profile affects spatial, temporal, and spectral characteristics of generated emission and demonstrate improved quantitative prediction of effects in laboratory and at range based upon a deeper understanding of laser-material interactions. - Complete the development of a variable-ratio coupler approach to phase demodulation , allowing for the active tuning of a photonics based processor. - Continue research in federated, coordinated, and integrated Electronic Warfare (EW) systems for the development of distributed EW technologies for Electronic Surveillance (ES), decoys and countermeasures, and Electronic Attack (EA) against adversary Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance and Targeting (C4ISRT). This EW research includes Electronic Protection (EP) for our own weapons and Command, Control, Communications, Computers, Cyber Defense, Intelligence, Surveillance and Reconnaissance (C5ISR) systems allowing them to operate in a heavily contested environment. - Continue research into developing Artificial Intelligence (AI)-generated tactics against modern and emerging radar sources to improve naval mission effectiveness. - Continue research and development in the area of hard-kill and soft-kill coordination and planning. - Continue research into simultaneous multi-spectral (Radio Frequency (RF) and optical) countermeasure development to increase survivability across the entire electromagnetic spectrum and continue development of coordinated EW techniques between RF and Electro-Optic/Infrared (EO/IR) transmitters and receivers for single and distributed platforms. - Continue development and implementation of combined EW and cyber effects to increase the reach and effectiveness of each domain in support of distributed maritime operations.					

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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 development of artificial intelligence algorithms to automatically classify tracks for an advanced weapons system and to distinguish anomalous targets, which have not been previously seen by the combat system. - Initiate research into distributed EA techniques to develop advanced, coordinated countermeasures against the entire kill chain from far left of launch through terminal phase; components of this research will also include hardware/software payload re-configurability, multi-functionality and heterogeneity in low size, weight and power formats. Electromagnetic Warfare: - Complete diverse research spanning multiple projects across a broad spectrum of RF and EO/IR technologies that cover the detection of energy in the environment to the formulation of active and passive engagement techniques. - Complete efforts with focus on near-real-time geolocation of stationary (or slowly moving) RF emitters, and in particular, emerging threat radars employing unusual waveforms resulting in accurate geolocation. - Complete novel real-time signal processing techniques to dramatically increase the useful information content reported in receiver measurements of radar-band signals providing the warfighter with a low-ambiguity warning of detection. - Complete efforts to improve the effectiveness of emitter classification of modern radars for several functions including Automated Identification Systems (AIS) validation increasing Maritime Domain Awareness. - Complete research applying recently developed machine learning methods to the problem of functional classification of radar emissions and demonstrate the ability to perform the functional classification in real time to overcome the inadequacy conventional emitter classification methods. - Complete efforts focused on discovering and defeating unknown and adaptive radios by developing algorithms to observe their behavior, analyze their networking protocols, and optimize engagement techniques to interfere with their objectives. - Complete research to develop and demonstrate high gain distributed aperture technologies compatible with micro-jammer glide vehicles to increase the effective radiated power of a ground-based micro-jammer constellation to provide sufficient power to radars. - Complete development and demonstration of an evolvable Electronic Warfare (EW) transceiver design that optimizes cuing receiver processing to increase situational awareness and enable adaptive electronic attack response in complex electromagnetic environments to provide effective processing of emergent complex radar modes.					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue the development of technology and waveforms to detect the emissions of and deny launch platform targeting radars and/or anti-ship missile seekers the capability to acquire and track ship targets across the electromagnetic spectrum. - Initiate efforts into the development of a novel, high-power, Ultra-Wideband (UWB), Ka-band pulse source to prove the utility and effectiveness of unique UWB waveforms for multi-spectral defeat of Radio-Frequency (RF) multi-mode threat systems through modeling, simulation, and measurement. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** FY 2023 to FY 2024 decrease is due to higher-level requirements in physical oceanography, ocean acoustics, and Intelligence, Surveillance, Reconnaissance, Target Electro Optical/Infrared and (ISRT-EO/IR) research. Funds realigned to PE 0602435N and Activities Physical Oceanography and Task Force Ocean; and funds realigned within PE 0602271N to Activities Surveillance Technology and EO/IR Sensor Technologies.					
Title: EO/IR Sensor Technologies ***Description:*** The overarching objective is to develop technologies that enable affordable, wide area, persistent surveillance optical architectures. Included are modeling and simulation required to support the development of these technologies. Efforts will also include the development of optical Radio-Frequency (RF) components, infrared technologies including lasers and focal plane arrays using narrow bandgap semiconductors. The current specific objectives are: - Optically Based Terahertz (THz) and Millimeter Wave (MMW) Distributed Aperture Systems: Develop Optically Based Terahertz (THz) and Millimeter Wave distributed aperture systems for imaging through clouds, fog, haze and dust on air platforms. - Wide Area Optical Architectures: Develop wide area optical architectures for persistent surveillance for severely size constrained airborne applications. - Hyperspectral sensors and processing: Develop visible, shortwave Infrared (IR), mid-wave IR, and long-wave IR hyperspectral sensors, along with processing algorithms to detect anomalies and targets. - Coherent Laser Radar (LADAR): Develop and improve components for LADAR applications including fiber lasers, coherent focal planes, and advanced processing.	7.062	7.887	12.682	0.000	12.682

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Autonomous and Networked sensing: Develop algorithms and processing that supports autonomous sensing for Unmanned Autonomous Vehicles (UAV) platforms and that supports networked sensing over multiple sensors and/or sensor platforms. ***FY 2023 Plans:*** EO/IR Sensor Technologies: - Complete demonstration and test performance of previously developed sensitive passive Millimeter Wave (MMW) detectors for detection of targets in degraded visual environments (e.g., clouds, fog, haze and dust) and explore extending capability to sparse apertures to increase resolution. - Continue to develop novel techniques for Electro-Optic/Infrared (EO/IR) countermeasures to detect, track and/or jam sensors. - Continue demonstration and test real-time combat Identification (ID) algorithms for detecting and tracking simultaneous targets from networked, high-resolution, wide field of view, and persistent surveillance systems. - Continue work on active imaging laser systems to significantly extend operational range and imaging capabilities in degraded conditions (e.g., dense maritime fog). - Continue efforts to develop and test optical architectures to demonstrate simultaneous wide Field Of View (FOV) and high-resolution imaging for search, detection, classification, identification and targeting functions. - Continue research and development of novel ISR and counter-ISR applications with tailored optical beams. - Initiate research into extreme low light imaging cameras built using low-cost Si foundry services as a way to provide all domain imaging for some missions or platforms that can't afford infrared sensors. Electromagnetic Warfare: - Continue development of Electro-Optical/Infra-Red (EO/IR) and Radio Frequency (RF) technologies to improve imaging, target identification, threat detection, and engagement capabilities for the war fighter. - Continue development and demonstration of a low Size Weight and Power (SWaP) transceiver laser system with high accuracy, covert detection, and threat wavelength discrimination using Non-Mechanical Beam Steering technology (NMBS). - Continue development and optimization of Resonant-Cavity Infrared Detectors (RCIDs) that provide higher sensitivity and reduced optical clutter systems using active imaging. - Initiate demonstration of new high performance single band Short-Wave (SW) and dual band SW/Mid-Wave (MW) Infrared (IR) sensors that will substantially improve the Navy's primary night & day maritime MWIR systems, which will show that a broad range of Naval MWIR imagers can be upgraded with a much more					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
capable monolithic SW/MWIR dual band sensor technology, with minimal impact on Size Weight and Power (SWaP) and system cost.					
FY 2024 Base Plans: EO/IR Sensor Technologies: - Continue to develop novel techniques for Electro-Optic/Infrared (EO/IR) countermeasures to detect, track and/or jam sensors. - Continue demonstration and test real-time combat Identification (ID) algorithms for detecting and tracking simultaneous targets from networked, high-resolution, wide field of view, and persistent surveillance systems. - Continue work on active imaging laser systems to significantly extend operational range and imaging capabilities in degraded conditions (e.g., dense maritime fog). - Continue efforts to develop and test optical architectures to demonstrate simultaneous wide Field Of View (FOV) and high-resolution imaging for search, detection, classification, identification and targeting functions. - Continue research and development of novel ISR and counter-ISR applications with tailored optical beams. - Continue research into extreme low light imaging cameras built using low-cost Si foundry services as a way to provide all domain imaging for some missions or platforms that can't afford infrared sensors. Electromagnetic Warfare: - Complete development and demonstration of a low Size Weight and Power (SWaP) transceiver laser system with high accuracy, covert detection, and threat wavelength discrimination using Non-Mechanical Beam Steering technology (NMBS). - Complete development and optimization of Resonant-Cavity Infrared Detectors (RCIDs) that provide higher sensitivity and reduced optical clutter systems using active imaging. - Continue development of EO/IR and Radio Frequency (RF) technologies to improve imaging, target identification, threat detection, and engagement capabilities for the war fighter. - Continue the demonstration of new high performance single band Short-Wave (SW) and dual band SW/Mid-Wave (MW) Infrared (IR) sensors. These sensors will substantially improve the Navy's primary night & day maritime MWIR systems, which will show that a broad range of Naval MWIR imagers can be upgraded with a much more capable monolithic SW/MWIR dual band sensor technology, with minimal impact on Size Weight and Power (SWaP) and system cost.					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate efforts to demonstrate analog signals via free-space optical (FSO) channel with sufficient fidelity, coherence and timing accuracy for RF signals to be useful for Electronic Support Measure (ESM) functions. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase from FY 2023 to FY 2024 is due to increased emphasis in Intelligence, Surveillance, Reconnaissance, Target Electro Optical/Infrared and (ISRT-EO/IR) research. Funds realigned within PE 0602271N from Vacuum Electronics Power Amplifiers and Electronic Warfare Technology Activities.					
Title: Navigation Technology ***Description:*** The overarching objective of this activity is to develop technologies that enable the development of affordable, effective and robust Position, Navigation and Timing (PNT) capabilities using non-Global Positioning System (GPS) navigation devices, and atomic clocks. This project will increase the operational effectiveness of U.S. Naval units. Emphasis is placed on GPS Anti-Jam (AJ) Technology; Precision Time and Time Transfer Technology; and Non- GPS Navigation Technology (Inertial aviation system, bathymetry, gravity and magnetic navigation). The focus is on the mitigation of GPS electronic threats, the development of atomic clocks that possess unique long-term stability and precision, and the development of compact, low-cost Inertial Navigation Systems (INS). The following are non-inclusive examples of plans for projects funded in this activity. ***FY 2023 Plans:*** Navigation Technology: - Complete research on automated celestial navigation for submarine platforms to increase operational effectiveness. - Complete research on thermal atomic beam inertial capability to improve non-Global Positioning System (GPS) navigation. - Complete development of navigation capability using very low frequency signals. - Continue research on next generation atomic clocks to improve long-term stability and precision. - Continue development of earth magnetic anomaly maps for improved magnetic navigation. - Continue development of a gravity navigation system using a strap down gravimeter.	11.087	14.366	14.515	0.000	14.515

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate development of magnetic anomaly aided navigation systems. ***FY 2024 Base Plans:*** Navigation Technology: - Continue research on next generation atomic clocks to improve long-term stability and precision. - Continue development of a gravity navigation system using a strap-down gravimeter. - Continue development of earth magnetic anomaly maps for improved magnetic navigation. - Continue development of magnetic anomaly-aided navigation systems. - Initiate development of collaborative navigation capability using multiple tactical networks. ***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: Solid State Electronics	9.347	10.140	9.795	0.000	9.795
Description: The overarching objective of this activity is to develop higher performance components and subsystems for all classes of military Radio-Frequency (RF) systems that are based on solid state physics phenomena and are enabled by improved understanding of these phenomena, new circuit design concepts and devices, and improvements in the properties of electronic materials. An important subclass are the Very High Frequency (VHF), Ultra-High Frequency (UHF), Microwave (MW), and Millimeter Wave (MMW) power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapon systems. Another subclass are the analog and high speed, mixed signal components that connect the electromagnetic signal environment into and out of digitally realized, specific function systems. These improved components are based on both Silicon (Si) and compound semiconductors (especially the wide bandgap materials and narrow bandgap materials), low and high temperature superconductors, novel nanometer scale structures and materials. Components addressed by this activity emphasize the MMW and Submillimeter Wave (SMMW) regions with an increasing emphasis on devices capable of operating in the range from 50 Gigahertz (GHz) to 10 Terahertz (THz). The functionality of the technology developed cannot be obtained through Commercial-Off- The-Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, linearity, operational and instantaneous bandwidth, weight, and size. Effort will involve					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
understanding the properties of engineered semiconductors as they apply to quantum information science and technology. ***FY 2023 Plans:*** Solid State Electronics: - Complete efforts into Acoustoelectric Scandium Aluminum Nitride (ScAlN) Radio-Frequency (RF) Signal Processing Devices (T080-21) and Continuous 3D-Cooled Atom Beam Gyroscope. - Continue research of solid-state devices for high frequency analog and digital operation; high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications; superconducting and other technologies which are prototyped to demonstrate the ability of these components to deliver superior functionality in a system environment. - Continue development and transition of nitrogen-polar based High-Electron-Mobility Transistor (HEMT) technology for advanced linear receivers and efficient transmitters. - Continue development of new materials, devices, components, and circuits that apply quantum phenomena of entanglement, superposition and/or wave function correlation for performance not achievable by classical methods. - Continue integrated circuit technologies in conventional superconductors and Gallium Nitride (GaN) as platforms for quantum-based functional components. - Continue development of superconducting GaN/niobium nitride heterostructures for Josephson junctions and Millimeter Wave (MMW) resonator circuits. - Continue Millimeter Wave (MMW) to Terahertz (THz) plasmonic photomixer-based focal plane arrays for imaging systems. - Continue development of chip-scale, acoustic RF signal processing components, utilizing acoustoelectric effect with high internal gain, in the 1 to 18 Gigahertz (GHz) range using a ScAlN based device architecture with enhanced power handling up to 10 W. - Continue development of Phase-Change Material (PCM) based couplers with dynamically controllable coupling coefficients to create broadband, low loss, high-tap-count analog canceler filters to provide enhanced TX/RX isolation. - Initiate metal nitride heterostructure mm-wave device investigations. - Initiate relaxed III-nitride channel mm-wave N-polar device development. - Initiate investigations into high throughput, large-area nano-scale lithography for plasmonic devices.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate development of new types of quantum based sensors for the measurement of motion and fields, which combine high sensitivity with features that improve the practicality of the technologies, to include continuous, high-bandwidth measurement, and low Size Weight and Power (SWaP).					
FY 2024 Base Plans: Solid State Electronics: - Complete development of chip-scale, acoustic Radio-Frequency (RF) signal processing components, utilizing acoustoelectric effect with high internal gain, in the 1 to 18 Gigahertz (GHz) range using a ScAlN based device architecture with enhanced power handling up to 10 W. - Complete development of Phase-Change Material (PCM) based couplers with dynamically controllable coupling coefficients to create broadband, low loss, high-tap-count analog canceler filters to provide enhanced TX/RX isolation. - Complete research activity in high throughput, large-area nano-scale lithography for plasmonic devices. - Continue metal nitride heterostructure mm-wave device investigations. - Continue research of solid-state devices for high frequency analog and digital operation; high efficiency, highly linear amplifiers for microwave, millimeter-wave, low-noise, and power applications; superconducting and other technologies which are prototyped to demonstrate the ability of these components to deliver superior functionality in a system environment. - Continue development and transition of nitrogen-polar based High-Electron-Mobility Transistor (HEMT) technology for advanced linear receivers and efficient transmitters. - Continue development of new materials, devices, components, and circuits that apply quantum phenomena of entanglement, superposition and/or wave function correlation for performance not achievable by classical methods. - Continue integrated circuit technologies in conventional superconductors and Gallium Nitride (GaN) as platforms for quantum-based functional components. - Continue development of superconducting GaN/niobium nitride heterostructures for Josephson junctions and Millimeter Wave (MMW) resonator circuits. - Continue Millimeter Wave (MMW) to Terahertz (THz) plasmonic photomixer-based focal plane. - Continue relaxed III-nitride channel mm-wave N-polar device development. - Continue development of new types of quantum based sensors for the measurement of motion and fields, which combine high sensitivity with features that improve the practicality of the technologies, to include continuous, high-bandwidth measurement, and low Size Weight and Power (SWaP). (NRL)					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate low-cost substrate GaN technology for ubiquitous mm-wave transceivers deployment. - Initiate efforts into the flexible manufacturing of High Power Amplifiers using MicroElectronics Transfer-printed Assembly (META). (NRL) ***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: Surveillance Technology ***Description:*** The overarching objective of this activity is to develop advanced sensor and sensor processing systems for continuous, high volume, theater-wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection and discrimination, Target Identification (ID) and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments, affordable apertures, distributed sensing systems, and includes modeling and simulation required to support the development of these technologies. The current specific objectives are: 1) Radar Architectures, Sensors, and Software which address Ballistic Missile and Littoral Requirement Shortfalls: Develop radar architectures, sensors, and software, which address Ballistic Missile and Littoral requirement shortfalls including: sensitivity; clutter rejection; and flexible energy management. 2) Algorithms, Sensor Hardware, and Signal Processing Techniques for Automated Radar Based Contact Mensuration and Feature Extraction: Develop algorithms, sensor hardware, and signal processing techniques for automated radar based contact mensuration and feature extraction in support of asymmetric threat classification and persistent surveillance to address naval radar performance shortfalls caused by man-made jamming and Electronic Counter Measures (ECM), unfavorable maritime conditions, and atmospheric and ionosphere propagation effects. 3) Software and Hardware for a Multi-Platform, Multi-Sensor Surveillance System: Develop software and hardware for a multi-platform, multi-sensor surveillance system for extended situational awareness of the battlespace. ***FY 2023 Plans:*** Surveillance Technology: - Continue efforts to develop affordable and scalable advanced antenna apertures.	13.143	14.087	15.744	0.000	15.744

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue efforts to develop electronics and signal processing to enable Radio Frequency (RF) agility and waveform diversity to provide enhanced capability to find, fix, track, target, and assess targets and threats as well as provide automatic target identification. - Continue research in the use of interferometric, polarimetric, RF agility, and sophisticated signal processing algorithms to enable the detection, geolocation, tracking, and identification of targets in harsh natural and man-made clutter and interference. - Continue efforts to develop methods to mitigate Electronic Attack (EA) and Electromagnetic Interference (EMI) to RF sensors and networks. - Continue development low-cost dielectric lens antennas and material resilience in high power transmitters. - Continue development of hardware and software for arbitrary waveform generation for agile radar systems. - Continue development of low-cost components for High Frequency (HF) sensor systems with reduced size, weight, and power needs. - Continue development of distributed aperture radar systems with improved spatial and waveform agility. - Complete research in sensors, networking and communication connectivity for developing an affordable and fully automated network of collaborative time-coordinated mono-static and Multi-Input Multi-Output (MIMO), surveillance sensors providing real-time tracking, identification, targeting and engagement information with persistent wide area awareness. - Complete research to enable sensor Radio Frequency (RF) convergence, surveillance allocations, data fusion, multi-hypothesis decision-making, multi-target tracking, and methods for handling and fusing disparate and intermittent data sources. - Complete development of advanced signal processing and signal data converter. - Complete experimentation with fixed and mobile digital array radars to test and validate Multi-Input Multi-Output (MIMO) capabilities to provide improved detection, tracking, targeting, electronic protection and survivability. - Initiate development of front-end components and phased array architectures that enable concurrent wideband radar and Electronic Support (ES) functions. Electromagnetic Warfare: - Continue development of radar techniques for detection and identification of small Unmanned Autonomous Vehicles (UAV) and to develop classification and identification techniques for addressing evolving DHS/USMC requirements for assessing this type of threat in tactical environments. - Continue validation of algorithms using innovative concepts from discrete mathematics to accurately predict ship Radar Cross Section (RCS) so as better assess platform vulnerability.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Continue the development of innovative target detection and clutter suppression algorithms for Ultra-High Frequency (UHF) SAR that exploits fluctuation and motion within the scene to provide wide-area, automated detection of small targets at long ranges. - Complete the development of the maritime target detection capabilities of a Ultra-High Frequency (UHF) SAR through novel approaches to the fundamental challenge of separating target backscatter from ocean clutter by exploiting both differences in the manner in which the polarimetric signatures of the target and clutter vary as a function of aspect angle and RF frequency, as well as differences between target and clutter motion characteristics. - Initiate applied research into technology base for Radio Frequency (RF) surveillance using active and passive monostatic and distributed sensor concepts. Current efforts seek to contribute to this objective by developing and demonstrating improved planar antennas and cylindrical.					
FY 2024 Base Plans: Surveillance Technology: - Complete development of low-cost components for High Frequency (HF) sensor systems with reduced size, weight, and power needs. - Complete development low-cost dielectric lens antennas and material resilience in high power transmitters. - Continue development of front-end components and phased array architectures that enable concurrent wideband radar and Electronic Support (ES) functions. - Continue efforts to develop affordable and scalable advanced antenna apertures. - Continue efforts to develop electronics and signal processing to enable Radio Frequency (RF) agility and waveform diversity to provide enhanced capability to find, fix, track, target, and assess targets and threats as well as provide automatic target identification. - Continue research in the use of interferometric, polarimetric, Radio-Frequency (RF) agility, and sophisticated signal processing algorithms to enable the detection, geolocation, tracking, and identification of targets in harsh natural and man-made clutter and interference. - Continue efforts on methods to mitigate Electronic Attack (EA) and Electromagnetic Interference (EMI) to RF sensors and networks. - Continue development of hardware and software for arbitrary waveform generation for agile radar systems. - Continue development of distributed aperture radar systems with improved spatial and waveform agility. - Initiate development of novel field sensors and transducers for future radar architectures.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Initiate effort focused on novel signal processing architectures for phased array radar systems that efficiently implement non-traditional radar algorithms. Electromagnetic Warfare: - Complete development of radar techniques for detection and identification of small Unmanned Autonomous Vehicles (UAV) and to develop classification and identification techniques for addressing evolving DHS/USMC requirements for assessing this type of threat in tactical environments. - Complete validation of algorithms using innovative concepts from discrete mathematics to accurately predict ship Radar Cross Section (RCS) so as better assess platform vulnerability. (NRL) - Complete the development of innovative target detection and clutter suppression algorithms for Ultra-High Frequency (UHF) SAR that exploits fluctuation and motion within the scene to provide wide-area, automated detection of small targets at long ranges. - Continue applied research into technology base for RF surveillance using active and passive monostatic and distributed sensor concepts. Current efforts seek to contribute to this objective by developing and demonstrating improved planar antennas and cylindrical. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The funding increase from FY 2023 to FY 2024 is due to increased emphasis on Intelligence, Surveillance, Reconnaissance, Target Electro Optical/Infrared and (ISRT-EO/IR) research. Funds realigned with PE 0602271N from Vacuum Electronics Power Amplifiers and Electronic Warfare Technology Activities.					
Title: Vacuum Electronics Power Amplifiers	1.761	2.031	1.396	0.000	1.396
Description: The overarching objective of this activity is to develop Millimeter Wave (MMW) and sub-MMW power amplifiers for use in Naval all-weather radar, surveillance, reconnaissance, electronic attack, and communications systems. The technology developed cannot, for the most part, be obtained through Commercial Off The Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. Responding to strong interests from the various user communities, efforts are focused on the development of technologies for high-data-rate communications, electronic warfare and high-power radar applications at Millimeter Wave (MMW) and upper-MMW regime. The emphasis is placed on achieving high power at high frequency in a compact form factor. Technologies include utilization of spatially distributed electron					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
beams in amplifiers, such as sheet electron beams and multiple-beams, and creation of simulation based design methodologies based on physics-based and geometry driven design codes. The current specific objectives are: - High Power Millimeter and Upper Millimeter Wave Amplifiers: Develop science and technology for high power millimeter and upper millimeter wave amplifiers including high current density diamond cathodes, sheet and multiple electron beam formation and mode suppression techniques in overmoded structures. - Lithographic Fabrication Techniques: Develop lithographic fabrication techniques for upper-millimeter wave amplifiers. - Accurate and Computationally Effective Device-Specific Multi-Dimensional Models for Electron Beams: Develop accurate and computationally effective device-specific multi-dimensional models for electron beam generation, large-signal and stability analysis to simulate device performance and improve the device characteristics. ***FY 2023 Plans:*** - Complete the development of broadband (3:1) traveling-wave-tube amplifier circuit using hybrid manufacturing techniques. - Complete the development of low-Size, Weight, and Power (SWaP)-C millimeter-wave traveling-wave tube amplifier technology for unmanned platforms, based on Additive Manufacturing and a high level of RF component integration. - Initiate the development of Millimeter Wave and sub-MMW power amplifiers for use in Naval all-weather radar, surveillance, reconnaissance, electronic attack, and communications systems. Efforts are focused on the development of technologies for high-data-rate communications, electronic warfare and high-power radar applications at MMW and sub-MMW regimes. ***FY 2024 Base Plans:*** - Continue the development of Millimeter Wave and sub-MMW power amplifiers for use in Naval all-weather radar, surveillance, reconnaissance, electronic attack, and communications systems. Efforts are focused on the development of technologies for high-data-rate communications, electronic warfare and high-power radar applications at MMW and sub-MMW regimes. ***FY 2024 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 0000 / *Electromagnetic Systems Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** FY 2023 to FY 2024 decrease is due to higher-level requirements in Intelligence, Surveillance, Reconnaissance, Target Electro Optical/Infrared and (ISRT-EO/IR) research. Funds realigned within PE 0602271N to Activities Surveillance Technology and EO/IR Sensor Technologies.					
Accomplishments/Planned Programs Subtotals	83.328	92.288	92.473	0.000	92.473

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602271N / *Electromagnetic Systems Applied Research*	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	5.792	39.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.792

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: Dark Swarm in Degraded Environments ***FY 2022 Accomplishments:*** Conduct applied Dark Swarm in Degraded Environments applied research. ***FY 2023 Plans:*** N/A	5.792	0.000
Congressional Add: Submerged electro-optical adaptive littoral sensor (SEALS) system prototypes ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Conduct submerged electro-optical adaptive littoral sensor (SEALS) system prototypes research.	0.000	5.000
Congressional Add: Advanced antenna technology ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Develop dual-band antenna technologies and electronics to support additional functionality for E-2D.	0.000	6.000
Congressional Add: Dark swarm in degraded and denied enviorments ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Conduct dark swarm in degraded and denied environments research.	0.000	6.000
Congressional Add: Mini-full spectrum hyperspectral sensors for IEDs ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Conduct effort to develop and deliver a full-spectrum hyperspectral imagery (HSI) collection and analysis suite applicable for use from small unmanned aerial vehicles (UAVs)	0.000	7.000
Congressional Add: Open systems architecture for electronic warfare chiplets	0.000	15.000

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602271N / *Electromagnetic Systems Applied Research*	**Project (Number/Name)** 9999 / *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2022 Accomplishments: N/A ***FY 2023 Plans:*** Conduct open systems architecture for electronic warfare chiplets research.		
Congressional Adds Subtotals	5.792	39.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A