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Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Navy **Date:** February 2020

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy / BA 1: Basic Research</i>	R-1 Program Element (Number/Name) PE 0601103N / <i>University Research Initiatives</i>
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	0.000	155.539	167.850	116.816	-	116.816	119.141	121.595	124.040	126.521	Continuing	Continuing
0000: <i>University Research Initiatives</i>	0.000	114.993	116.850	116.816	-	116.816	119.141	121.595	124.040	126.521	Continuing	Continuing
9999: <i>Congressional Adds</i>	0.000	40.546	51.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	91.546

A. Mission Description and Budget Item Justification

The Office of Naval Research's (ONR) mission is to ensure the technological advantage of U.S. Naval forces. ONR fosters scientific research necessary for the discovery, development and delivery of new technologies. Often this research is done in partnership with academia. Multidisciplinary University Research Initiative (MURI) efforts involve teams of researchers investigating high priority topics and opportunities that intersect more than one traditional technical discipline. This program includes support for multidisciplinary basic research in a wide range of naval relevant scientific and engineering disciplines that enables the U.S. Navy to maintain technological superiority and for the university research infrastructure to acquire the research instrumentation needed to maintain and improve the quality of university research important to the Navy. For many military problems this multidisciplinary approach serves to stimulate innovation, accelerate research progress and expedite transition of results into Naval applications. The Defense University Research Instrumentation Program (DURIP) supports university research infrastructure essential to high quality, Navy-relevant research. The instrumentation program complements other Navy research programs by supporting the purchase of high cost research instrumentation that is necessary to carry out cutting-edge research. The program supports Presidential Early Career Awards for Scientists and Engineers (PECASE), single investigator research efforts performed by outstanding academic scientists and engineers early in their research careers. This program provides the knowledge base, scientific concepts, and technological advances for the maintenance of Naval power and national security. The Minerva Research Initiative is funded in partnership with the Office of the Secretary of Defense to support basic social science and multi-disciplinary research aimed at improving national security and international stability. The goals of this program are to enhance connections between DoD and academia and build cultural and foreign area knowledge on topics ranging from the mechanisms of radicalization to geopolitical power projection strategies in a multi-polar world.

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 Basic Research and systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. 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).

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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. Program Change Summary (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	161.433	116.850	116.816	-	116.816
Current President's Budget	155.539	167.850	116.816	-	116.816
Total Adjustments	-5.894	51.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	51.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-5.894	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 9999: Congressional Adds

- Congressional Add: *Defense University Research Instrumentation Program*
- Congressional Add: *Radar Technology*
- Congressional Add: *Biocoherent Energy*
- Congressional Add: *Basic Research*
- Congressional Add: *Aircraft Fleet Readiness and Sustainment*
- Congressional Add: *University research initiatives*
- Congressional Add: *Advanced digital radars*
- Congressional Add: *Multi-disciplinary university research*

	FY 2019	FY 2020
	9.654	10.000
	5.792	0.000
	5.792	0.000
	9.654	0.000
	9.654	8.000
	0.000	20.000
	0.000	8.000
	0.000	5.000
Congressional Add Subtotals for Project: 9999	40.546	51.000
Congressional Add Totals for all Projects	40.546	51.000

Change Summary Explanation

Funding: No significant change.

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Exhibit R-2A, RDT&E Project Justification: PB 2021 Navy										Date: February 2020		
Appropriation/Budget Activity 1319 / 1					R-1 Program Element (Number/Name) PE 0601103N / <i>University Research Initiatives</i>				Project (Number/Name) 0000 / <i>University Research Initiatives</i>			
COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
0000: <i>University Research Initiatives</i>	0.000	114.993	116.850	116.816	-	116.816	119.141	121.595	124.040	126.521	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Office of Naval Research's (ONR) mission is to ensure the technological advantage of U.S. Naval forces. ONR fosters scientific research necessary for the discovery, development and delivery of new technologies. Often this research is done in partnership with academia. Multidisciplinary University Research Initiative (MURI) efforts involve teams of researchers investigating high priority topics and opportunities that intersect more than one traditional technical discipline. This program includes support for multidisciplinary basic research in a wide range of naval relevant scientific and engineering disciplines that enables the U.S. Navy to maintain technological superiority and for the university research infrastructure to acquire the research instrumentation needed to maintain and improve the quality of university research important to the Navy. For many military problems, this multidisciplinary approach serves to stimulate innovation, accelerate research progress, and expedite transition of results into Naval applications. The DURIP project supports university research infrastructure essential to high quality, Navy-relevant research. The instrumentation project complements other Navy research programs by supporting the purchase of high cost research instrumentation that is necessary to carry out cutting-edge research. The PECASE project supports single-investigator research efforts performed by outstanding academic scientists and engineers early in their research careers. This project provides the knowledge base, scientific concepts, and technological advances for the maintenance of Naval power and national security.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Defense University Research Instrumentation Program (DURIP)	23.374	23.266	23.272	0.000	23.272
Description: DURIP funds are awarded to universities to purchase relatively high cost research instrumentation that is normally not included in single-investigator research grants. Individual grants range from \$50K to \$1.5M. Funding for DURIP efforts is awarded after the Office of the Secretary of Defense (OSD) selects and announces the awardees, which typically takes place towards the second half of the fiscal year. In turn, universities need to purchase the instrumentation and take delivery before any billing occurs. It frequently takes several months for delivery and billing to be completed. DURIP is a one-year program.					
FY 2020 Plans: Provide funding for instrumentation to enhance basic research, such as: human-machine interfaces, basic research on communications and networks, basic research on power generation and storage, basic research on high-performance materials, and basic research in the ocean sciences and underwater acoustics. Implement the instrumentation investments made for research efforts, such as: transmission electron microscopy, infrared optoelectronic measurements, an underwater acoustic communication system, basic thermal property					

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
<p>measurements, cardiorespiratory physiology phenotyping, and high-speed stereographic imaging for multiphase flows.</p> <p>FY 2021 Base Plans: - Research Instrumentation: Funding for instrumentation to enhance basic research through numerous focus areas including photonic diagnostics for the development of advanced materials, high fidelity laser profiling of biologically active sediments for seabed models, instrumentation for studies of high Reynolds Number non-equilibrium flows, a dynamic material testing system for characterizing, investigating and designing artificial muscle, and instrumentation for the development and characterization of solid propulsion, among many others.</p> <p>FY 2021 OCO Plans: N/A</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: There is no significant change from FY 2020 to FY 2021</p>					
<p>Title: Multidisciplinary University Research Initiative (MURI)</p> <p>Description: Research efforts include high priority topics that intersect more than one traditional discipline. MURI topics are selected to address Naval Science and Technology (S&T) Framework Priorities as described in the Naval Research and Development Framework. Funding for MURI efforts is awarded after Office of the Secretary of Defense (OSD) announces the awardees, which typically takes place towards the second half of the fiscal year. Since the MURI program funds academic researchers, execution of the efforts typically ramp up during the summer months. MURI projects make significant contributions to Navy and Department of Defense (DOD) objectives by speeding up scientific programs, by cross-fertilization of ideas, by hastening the transition of basic research to practical applications, and by training students in cross-disciplinary approaches to science and engineering research of importance to DoD. MURI projects are five-year programs.</p> <p>FY 2020 Plans: The MURI program will support multidisciplinary basic research topics, such as: the role of epigenetics in human performance, research on understanding scenes and events through joint parsing, cognitive reasoning and lifelong learning, research on bio-inspired adaptive sonar for classification and guidance in complex environments, research on neural circuits underlying symbolic processing in primate cortex and basal ganglia, and research on chemistry and physics at extreme temperature and pressure: molecules, crystals and microstructures. These investigations support high</p>	83.363	84.823	81.827	0.000	81.827

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B. Accomplishments/Planned Programs (\$ in Millions)					
priority topics and scientific opportunities to address strategically important Department of Defense (DoD) research areas that intersect more than one traditional technical discipline.					
FY 2021 Base Plans:					
- Multidisciplinary Research: Initiate multidisciplinary basic research efforts on the fundamental limits on information latency, advanced analytical and computational modeling of arctic sea ice, molecularly programmable graphene, identifying invariances for improved modeling and prediction of oceanographic phenomena, high performance organic electronics, bio-inspired models of distributed information processing, active perception and knowledge exploitation in navigation and spatial awareness, the advanced dynamics of coupled human/machine systems.					
- Fund previous years basic research efforts in other high priority topics for the Navy and DoD.					
FY 2021 OCO Plans:					
N/A					
FY 2020 to FY 2021 Increase/Decrease Statement:					
The funding decrease from FY 2020 to FY 2021 is due to funds being realigned from this R2 Activity to the new Minerva Research Initiative R2 Activity. Minerva Research Initiative efforts have been funded since 2010 and were previously included in the MURI R2 Activity of this PE. In an effort to increase visibility and improve tracking, funds have been realigned into the new R2 Activity.					
Title: Presidential Early Career Awards (PECASE)					
8.256					
8.761					
8.764					
0.000					
8.764					
Description: PECASE awards are made to academic scientists early in their research careers for extremely prestigious, single-investigator research in areas of vital importance to the Navy. Awards provide national recognition and research grants of up to \$200K per year for five years. OSD, with policy and oversight responsibility for the PECASE program, awards a minimum of four new awards per year. PECASE is a five year program.					
FY 2020 Plans:					
The program will support early career investigators in research areas within the Navy Research and Development (R&D) framework priority objectives, such as: the design of an end-to-end protocol for dynamic spectrum access networks; the determination of multiscale interactions in tropical cyclone structure and intensity changes; the engineering of nonreciprocal acoustic materials and microwave systems through phonon-assisted					

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
directional coupling; and the development of therapeutic hydrogel sensors for the monitoring and treatment of wounds, among others. FY 2021 Base Plans: - Fund new basic research projects in Naval priority areas including efficient information processing, layered chalcogenide heterointerfaces, information retrieval by exploiting the unique geometry of sparse arrays, and the prediction, design and control the assembly of hierarchically mesostructured materials. - Support previous year ongoing basic research projects performed by early career investigators. FY 2021 OCO Plans: N/A FY 2020 to FY 2021 Increase/Decrease Statement: There is no significant change from FY 2020 to FY 2021					
Title: Minerva Research Initiative (MRI) (Social Science Networking) Description: The Minerva Research Initiative is funded in partnership with the Office of the Secretary of Defense to support basic social science and multi-disciplinary research aimed at improving national security and international stability. The goals of this program are to enhance connections between DoD and academia and build cultural and foreign area knowledge on topics ranging from the mechanisms of radicalization to geopolitical power projection strategies in a multi-polar world. FY 2020 Plans: N/A FY 2021 Base Plans: - Create and implement a theoretical framework to automate cyber vulnerability assessment and remediation for information operations in social contexts, for example, the injection of disinformation into social networks to influence the political attitudes or those exposed to it. Investigate models and methods for understanding online influence. FY 2021 OCO Plans: N/A FY 2020 to FY 2021 Increase/Decrease Statement:	0.000	0.000	2.953	0.000	2.953

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
The funding increase from FY 2020 to FY 2021 is due to funds being moved from the MURI R2 Activity to this new Minerva Research Initiative (MRI) R2 Activity. MRI efforts have been funded in the MURI R2 Activity of this PE since 2010. In an effort to increase visibility and improve tracking, funds have been realigned from the MURI R2 Activity into this new R2 Activity.					
Accomplishments/Planned Programs Subtotals	114.993	116.850	116.816	0.000	116.816

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
9999: <i>Congressional Adds</i>	0.000	40.546	51.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	91.546

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2019	FY 2020
<p>Congressional Add: Defense University Research Instrumentation Program</p> <p>FY 2019 Accomplishments: This increase will provide additional Defense University Research Instrumentation Program (DURIP) awards to enable performers to take advantage of the evolving technological advances in scientific instrumentation to study the physical, chemical, biological, geological and geophysical processes of the oceans. The global ocean environment is the primary Navy-relevant operational environment and ocean research requires specialized sea-going marine equipment.</p> <p>FY 2020 Plans: Provide additional Defense University Research Instrumentation Program (DURIP) awards to enable performers to take advantage of the evolving technological advances in scientific instrumentation to study the physical, chemical, biological, geological and geophysical processes of the oceans.</p>	9.654	10.000
<p>Congressional Add: Radar Technology</p> <p>FY 2019 Accomplishments: Conduct efforts for the design, construction and testing of a mobile, ground-based, active aperture array (active electronically scanned antenna - AESA) utilizing cutting-edge science and technology for critical aperture components (receiver and transmitter).</p> <p>FY 2020 Plans: N/A</p>	5.792	0.000
<p>Congressional Add: Biocoherent Energy</p> <p>FY 2019 Accomplishments: Basic science research to identify mechanisms to enhance coherent energy transfer between photoactive molecules attached to nucleic acid nanostructures for application to synthetic light harvesting systems, optoelectronic devices, information processing systems, and possibly quantum computing. - AIM 1: Conduct and develop computational and experimental approaches to identify the best structures of photoactive molecules and their nucleic acid nanostructures that can efficiently transfer energy coherently.</p>	5.792	0.000

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	
- AIM2: Assemble the superior photoactive molecules into structures using nucleic acid self-assembly and assess performance. <i>FY 2020 Plans:</i> N/A			
Congressional Add: Basic Research <i>FY 2019 Accomplishments:</i> This increase furthers the U. S. Navy's efforts to support multidisciplinary basic research in a wide range of scientific and engineering disciplines that enable the U.S. Navy to maintain its technological superiority. This increase will fund additional Multidisciplinary University Research Initiative (MURI) awards and Presidential Early Career Awards for Scientists and Engineers (PECASE). Additional new MURI topics will address the most critical Naval R&D priorities to translate future force attributes into research objectives. Additional outstanding young scientists and engineers will be funded under PECASE to address the continued need for scientists and engineers to address future Naval problems. These research objectives include improving human-machine interfaces, increasing the flexibility and reach of the naval force through the incorporation of autonomous systems, enabling maneuverability, efficiency and resiliency for sustained operations, transforming vast data into timely knowledge; and enabling offensive and defensive actions that are multi-domain, integrated, and cost-effective. <i>FY 2020 Plans:</i> N/A	9.654	0.000	
Congressional Add: Aircraft Fleet Readiness and Sustainment <i>FY 2019 Accomplishments:</i> Basic research focus on advanced laboratory equipment and capabilities in support of Aviation Structures. <i>FY 2020 Plans:</i> Continue basic research for focus on advanced laboratory equipment and capabilities in support of Aviation Structures.	9.654	8.000	
Congressional Add: University research initiatives <i>FY 2019 Accomplishments:</i> N/A <i>FY 2020 Plans:</i> Conduct University basic research initiatives	0.000	20.000	
Congressional Add: Advanced digital radars <i>FY 2019 Accomplishments:</i> N/A <i>FY 2020 Plans:</i> Conduct basic research supporting Advanced digital radars.	0.000	8.000	
Congressional Add: Multi-disciplinary university research	0.000	5.000	

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020
<i>FY 2019 Accomplishments:</i> N/A		
<i>FY 2020 Plans:</i> Conduct Multi-disciplinary university research.		
Congressional Adds Subtotals	40.546	51.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A