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**Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army** **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	-	93.937	107.584	19.316	-	19.316	-	-	-	-	-	-
AC9: High Energy Laser Tactical Vehicle Demonstrator Te	-	10.657	9.008	-	-	-	-	-	-	-	-	-
AD2: High Energy Laser (HEL) Enabling and Support Techn	-	7.635	9.744	5.991	-	5.991	-	-	-	-	-	-
AD3: Maneuver Air Defense Technology	-	4.027	12.744	7.893	-	7.893	-	-	-	-	-	-
AD5: Next Generation Fires Radar Technology	-	8.875	5.336	1.505	-	1.505	-	-	-	-	-	-
AD7: Missile Fire Control Sensors Technology	-	1.542	-	-	-	-	-	-	-	-	-	-
AD9: Close Combat High Energy Laser Technology	-	7.139	8.467	-	-	-	-	-	-	-	-	-
AE2: Unconventional Countermeasures-Survivability Tech	-	5.690	6.347	3.927	-	3.927	-	-	-	-	-	-
AE4: Collaborative ISR Sensors Technology	-	3.372	2.938	-	-	-	-	-	-	-	-	-
BN6: Advanced Weapons Components (CA)	-	45.000	53.000	-	-	-	-	-	-	-	-	-

**A. Mission Description and Budget Item Justification**

Work in this PE investigates and develops Air and Missile Defense (AMD) technologies to enable defense of ground forces and selected geopolitical assets from aerial attack, missile attack, and surveillance. Major focus areas for AMD Science and Technology include: Missiles, Directed Energy, Gun-Based Air Defense Technologies, and Battlefield Sensors and Supporting AMD Technologies. Missiles Applied Research investigates and develops a broad range of Missile technologies to enhance Army integrated AMD capabilities at extended range. Directed Energy Applied Research investigates and develops critical High Energy Laser (HEL) technologies to explore performance against Air Defense threats and for other Directed Energy applications across Army Modernization Priorities. Gun-Based Air Defense Technologies Applied Research investigates and develops Combined Arms for Air Defense (CAFAD) technologies and components in a laboratory environment. Sensors and Supporting AMD Technologies Applied Research investigates and develops Battlefield Sensor and radar technologies required for detection, acquisition and tracking of air defense targets as well as supporting technologies that enhance AMD.

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Work in this PE complements PE 0603466A (Air and Missile Defense Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work is performed by the United States Army Futures Command (AFC), the United States Army Space and Missile Defense Command/Army Strategic Forces Command (SMDC/ARSTRAT), and the United States Army Rapid Capabilities and Critical Technologies Office (RCCTO).

<b>B. Program Change Summary (\$ in Millions)</b>	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022 Base</b>	<b>FY 2022 OCO</b>	<b>FY 2022 Total</b>
Previous President's Budget	95.771	56.298	51.609	-	51.609
Current President's Budget	93.937	107.584	19.316	-	19.316
Total Adjustments	-1.834	51.286	-32.293	-	-32.293
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	53.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.834	-1.714			
• Adjustments to Budget Years	-	-	-32.293	-	-32.293

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

**Project:** BN6: *Advanced Weapons Components (CA)*

Congressional Add: *Sustainable Energy Materials and Manufacturing*

Congressional Add: *High-Energy Laser Hardware in the Loop*

Congressional Add: *COE in High-Energy Laser and Optical Technology*

Congressional Add: *Cybersecurity and Supply Chain Risk Management*

Congressional Add: *Program increase - beam control systems and industry grade optical fiber fabrication for energy laser*

Congressional Add: *Program increase - high energy laser enabling and support technology*

Congressional Add: *Program increase - Army missile supply chain risk management*

Congressional Add: *Program increase - close combat high energy laser technology*

Congressional Add: *Program increase - fires center of excellence*

Congressional Add: *Program increase - cyber resiliency in weapon systems*

	<b>FY 2020</b>	<b>FY 2021</b>
	12.000	-
	20.000	-
	3.000	-
	10.000	-
	-	12.000
	-	7.000
	-	15.000
	-	8.500
	-	1.500
	-	1.500

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<b>Appropriation/Budget Activity</b> 2040: <i>Research, Development, Test &amp; Evaluation, Army / BA 2: Applied Research</i>	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / <i>Air and Missile Defense Technology</i>
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**Congressional Add Details (\$ in Millions, and Includes General Reductions)**

Congressional Add: *Program increase - countermeasures based on artificial intelligence enabled material analysis and design*

Congressional Add: *Program increase - counter-UAS center of excellence*

Congressional Add Subtotals for Project: BN6

Congressional Add Totals for all Projects

	FY 2020	FY 2021
	-	6.000
	-	1.500
	45.000	53.000
	45.000	53.000

**Change Summary Explanation**

FY2022 funding change due to partial administrative realignments of research to 0602141A (Lethality Technology), the transition of High Energy Laser Tactical Vehicle Demonstrator research to advanced research, and the conclusion of projects AE4 (Collaborative ISR Sensors Technology) and AD9 (Close Combat High Energy Laser Technology).

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army										<b>Date:</b> May 2021		
<b>Appropriation/Budget Activity</b> 2040 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology				<b>Project (Number/Name)</b> AC9 / High Energy Laser Tactical Vehicle Demonstrator Te			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022 Base</b>	<b>FY 2022 OCO</b>	<b>FY 2022 Total</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>FY 2025</b>	<b>FY 2026</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
AC9: High Energy Laser Tactical Vehicle Demonstrator Te	-	10.657	9.008	-	-	-	-	-	-	-	-	-

**A. Mission Description and Budget Item Justification**

This Project investigates component technologies for mobile high energy laser (HEL) weapon systems in solid state lasers (SSL) for use in protecting fixed and semi-fixed sites from Rocket, Artillery, and Mortars (RAM), Unmanned Aerial Systems (UAS) and advanced Air Defense threats. The Project researches advanced technologies for HEL weapon systems to enable more efficient laser systems with significantly greater power output for future HEL weapons to augment current kinetic Air Defense Artillery (ADA) systems and address additional missions with a low cost-per-kill exchange ratio. This includes technologies to support development of alternate laser sources, precision optical pointing and tracking components and adaptive optics to overcome laser degradation due to atmospheric effects to gain great lethality permitting expansion of threats set. Additionally development of compact and lighter weight energy generation and storage devices, and more efficient thermal management systems to remove excess heat will permit integrating laser weapons on additional combat platforms.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD1 (High Energy Laser Tactical Vehicle Demonstrator Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy and supports the Army's future capability opportunities for leap-ahead technology for directed energy.

Work is performed by the United States (US) Army Rapid Capabilities and Critical Technologies Office (RCCTO).

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

	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<b>Title:</b> High Energy Laser Tactical Vehicle Demonstrator Technology	10.657	9.008	-
<b>Description:</b> This effort develops technologies for robust beam control and SSL subsystems in the HEL Tactical Vehicle Demonstrator (TVD). Technologies developed under this effort will enable lighter, more agile beam control systems for tactical Army platform development and SSL technologies that enhance effectiveness against emerging air defense threats and increase efficiencies, enabling reductions in size, weight and power (SWaP) and improving the ability to integrate SSL systems into multiple Army weapon platforms.			
<b>FY 2021 Plans:</b> Conducts experimentation with prototype HEL TVD surrogate beam control system to characterize the performance of the base design: assess Adaptive Optics (AO) component demonstration and incorporate state-of-the-art optical focal planes to extend effectiveness of laser system in challenging environments to inform the HEL TVD beam control system design; Prepares beam control subsystem for integration with other subsystems in the system integration laboratory; Continues investigation, modeling &			

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<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> AC9 / High Energy Laser Tactical Vehicle Demonstrator Te		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
simulation, assessment, and development of laser subsystems (e.g. laser sources, power and thermal subsystems) necessary for defeat of emerging and advanced air defense threats for the HEL TVD.				
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> The beam control technologies and subsystems developed and demonstrated in FY2021 will transition to the HEL-TVD system integration and laboratory demonstration under PE 0603466A / Air and Missile Defense Advanced Technology Project AD1 High Energy Laser Tactical Vehicle Demo Advanced Technology.				
<b>Accomplishments/Planned Programs Subtotals</b>		10.657	9.008	-
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A				
<b>Remarks</b>				
<b>D. Acquisition Strategy</b> N/A				

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**Exhibit R-2A, RDT&E Project Justification:** PB 2022 Army **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology				<b>Project (Number/Name)</b> AD2 / High Energy Laser (HEL) Enabling and Support Techn			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022 Base</b>	<b>FY 2022 OCO</b>	<b>FY 2022 Total</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>FY 2025</b>	<b>FY 2026</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
AD2: High Energy Laser (HEL) Enabling and Support Techn	-	7.635	9.744	5.991	-	5.991	-	-	-	-	-	-

**Note**

In FY 2022, a portion of this effort (High Energy Laser Enabling Technologies for Tactical Directed Energy Weapons) is administratively realigned to PE 0602141A Project CF7 Solid-state Laser Concepts and Architectures.

**A. Mission Description and Budget Item Justification**

This Project conducts static and dynamic High Energy Laser (HEL) vulnerability and lethality analyses and investigates advanced component technologies to enhance performance of future HEL weapons systems against advanced threats. In addition, this Project includes laboratory efforts for HEL applied research as well as concepts analysis for Army core competencies in Directed Energy (DE). This Project also investigates advanced laser technologies based on unconventional solid-state laser concepts, architectures, and thermal/power management schemes for the development of low size, weight, and power (SWaP) Army DE weapons and tactical laser developers.

Work in this effort compliments other Army Directed Energy efforts conducted under PE 0602150A (Air and Missile Defense Technology) and PE 0603466A (Air and Missile Defense Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and supports the Army's future capability opportunities for leap-ahead technology for Directed Energy.

Work is performed by the United States Army Space and Missile Defense Command - Technical Center (USASMDC-TC) and the United States Army Combat Capabilities Development Command, Army Research Lab (CCDC-ARL).

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

	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<b>Title:</b> High Energy Laser Enabling and Support Technology	6.446	7.739	5.991
<b>Description:</b> This effort provides the underlying data for future High Energy Laser weapons to effectively engage an array of threats. The data includes prioritized aim points on each threat as well as time to defeat the threats for each aim point. This activity includes the full spectrum of target lethality investigations and engagement of flying targets in relevant scenarios. This part of the activity is primarily executed at the Solid State Laser Testbed (SSLT) facility at White Sands Missile Range, New Mexico.			
This effort also focuses on developing core Army expertise through laser and beam control technology assessments, applied research, and other technical core competencies. This effort focuses on developing in-house expertise in Adaptive Optics (AO), Beam Control, laser diodes, target illuminators lasers and beacon illuminator lasers, laser diagnostics, and new tracking			

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<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> AD2 / High Energy Laser (HEL) Enabling and Support Techn		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<p>algorithms. These technologies can be integrated into future laser systems to locate, identify, and engage critical targets. Results of this research may reduce the SWaP requirements, and the efficacy of laser weapons systems on Army platforms in the future. This part of the activity is primarily executed in Huntsville, Alabama.</p> <p><b>FY 2021 Plans:</b> Conduct experiments to inform fixed wing threat assessment and develop defeat methodologies; will begin preliminary assessment of high energy laser effectiveness against Anti-Tank Guided Missile threats; will continue development of lethality database for RAM threats supporting the Maneuver - Short Range Air Defense (M-SHORAD) mission. Continue to evaluate and conduct experiments with advanced AO algorithms for deep turbulence atmospheric conditions. Integrate the Enhanced Tracking Sensor for Acquisition Tracking onto the MBC SIL for dynamic experiments. Complete Candidate Sensor Technology analysis for HEL Fine Tracking and Aimpoint designation in a pulsed illuminator and gated sensor configuration.</p> <p><b>FY 2022 Plans:</b> Will conduct lethality studies and analysis of new/evolving threats and sustain core competency (SSLT and expertise) in HEL Lethality. Will advance AO studies and analysis to compensate for deep turbulence atmospheric conditions. Will fund research to show proof of concept of a tapered amplifier phased array laser system concept that compensate for atmospheric turbulence.</p> <p><b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Decrease in funding from FY21 to FY22 shifts this effort into providing basic studies, analysis, assessments and retaining the Army core competency in Lethality, Lasers and Beam Control Technologies capability. Lethality testing will transition to a customer reimbursable mode. HEL Advanced Research will conduct in-house analysis of advanced HEL subsystem enhancements with no funding for hardware, field testing, or contracted subject matter expertise support.</p> <p>This impacts the ability to conduct S&amp;T for future HEL System upgrades or improvements to meet future PoR Technology Transition Points.</p>				
<p><b>Title:</b> High Energy Laser Enabling Technologies for Tactical Directed Energy Weapons</p> <p><b>Description:</b> Research novel solid-state laser concepts, architectures, and components in support of the Army's HEL weapons strategy; exploit breakthroughs in laser technology, develop and employ innovative laser gain material, and utilize photonics to meet the stringent weight/volume requirements for Army platforms, especially to enhance and improve the generation, transmission, and reception of lasers.</p> <p><b>FY 2021 Plans:</b></p>		1.189	2.005	-

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
Investigate the potential of true-continuous wave fiber laser power scaling with crystalline core/crystalline cladding fibers; investigate power scaling potential of directly diode-cladding pumped Raman fiber laser.				
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> In FY 2022, this effort is administratively realigned to PE 0602141A Project CF7 Solid-state Laser Concepts and Architectures.				
<b>Accomplishments/Planned Programs Subtotals</b>		7.635	9.744	5.991
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A				
<b>Remarks</b>				
<b>D. Acquisition Strategy</b> N/A				

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army										<b>Date:</b> May 2021		
<b>Appropriation/Budget Activity</b> 2040 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology				<b>Project (Number/Name)</b> AD3 / Maneuver Air Defense Technology			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022 Base</b>	<b>FY 2022 OCO</b>	<b>FY 2022 Total</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>FY 2025</b>	<b>FY 2026</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
AD3: <i>Maneuver Air Defense Technology</i>	-	4.027	12.744	7.893	-	7.893	-	-	-	-	-	-

**A. Mission Description and Budget Item Justification**

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by investigating and developing critical missile technologies and components necessary for an affordable short range air defense interceptor capability to defeat Cruise Missile (CM), Rotary Wing (RW), Tactical / Lethal Unmanned Aerial System (UAS), and Fixed Wing (FW) threats. This effort also designs and develops technologies to provide reduced size weight and power and cost for Maneuver Short Range Air Defense (MSHORAD), Short Range Air Defense (SHORAD), and Lower Tier essential to maintain overmatch against mid-/far-term threats.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD4 (Maneuver Air Defense Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

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

	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<b>Title:</b> Maneuver Air Defense Technology	4.027	10.586	7.893
<b>Description:</b> Investigates and develops critical missile technologies and components necessary for an affordable short range air defense interceptor capability to defeat RW, Tactical / Lethal UAS, and FW threats.			
<b>FY 2021 Plans:</b> Continue development of critical missile technologies for detection and tracking of hovering RW targets; develop and investigate an active radar seeker with integrated warhead fuzing capabilities through HWIL techniques for emulating hovering RW targets and other large Maneuver Short Range Air Defense (MSHORAD) targets in a laboratory environment.			
<b>FY 2022 Plans:</b> Will continue component maturation and software integration of seeker, guidance electronics, and control subsystems, then will integrate and validate performance of those subsystems in a dynamic HWIL environment; will conduct warhead lethality experiments to validate ability achieve an immediately observable kill against emulated threats.			
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Decrease in funding based on planned lifecycle events. Maturation and demonstration of technologies continue in PE 0603466A/AD4.			
<b>Title:</b> Future Air Defense Missile Enabling Technology	-	2.158	-

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<p><b>Description:</b> Designs and develops reduced cost advanced Air Defense missile critical components essential to maintain overmatch against Mid/Far term Maneuver-Short Range Air Defense threats.</p> <p><b>FY 2021 Plans:</b> Perform component level trade studies and explore and develop new technologies to address emerging Maneuver-Short Range Air Defense (MSHORAD) threats and reduce space, weight, power and cost for future Air Defense missile guidance/maneuverability/control, aerstructures, and propulsion technologies.</p> <p><b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Efforts continue/realigned in FY 2022 to PE 0602141A/Project N49 (Future Air Defense Missile Enabling Technology)</p>			
<b>Accomplishments/Planned Programs Subtotals</b>	4.027	12.744	7.893

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A

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<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> AD5 / Next Generation Fires Radar Technology
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AD5: Next Generation Fires Radar Technology	-	8.875	5.336	1.505	-	1.505	-	-	-	-	-	-

**Note**

In Fiscal Year (FY) 2020 this Project was realigned from:  
 Program Element (PE) 0602303A Missile Technology:  
 \* Project 214 Missile Technology  
 PE 0602120A Sensors and Electronic Survivability  
 \* Project H16 S3I Technology  
 PE 0602705A Electronics and Electronic Devices  
 \* Project H94 Elect & Electronic Devices

**A. Mission Description and Budget Item Justification**

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by investigating and developing advanced radar technologies for insertion into Multi-Mission Army Radar systems. This Project addresses challenges facing simultaneously achieving high linearity and efficiency at high frequencies, accuracy in the underlying high frequency device and circuit models, integration of new material into Silicon complementary metal-oxide-semiconductor (CMOS) processing flows, and electronics reliability that appear as new semiconductor materials are developed and feature sizes shrink.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD6 (Next Generation Fires Radar Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC)

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

	FY 2020	FY 2021	FY 2022
<b>Title:</b> Advanced Fire Control Radar Technologies	3.619	-	-
<b>Description:</b> This effort develops advanced radar technologies for insertion into Multi- Mission Army Radar systems			
<b>Title:</b> Multi-Mode Air Defense Radar	1.510	1.522	1.505
<b>Description:</b> This research supports the technical challenges associated with air defense radar technology. In particular, this effort will analyze current and emerging radio frequency (RF) spoofing, RF jamming, and RF signature management technologies to determine their impact on the performance of air defense radars. Electromagnetic modeling, RF measurements, and experiments will be used to identify mitigation techniques for spoofing and jamming, and to identify useful signature			

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
management technologies. This will also include research in electronic devices, sub-assembly design, and laboratory experiments to advance the state-of-the-art of air defense radars operating in contested electronic environments.				
<b>FY 2021 Plans:</b> Develop algorithms for digital radar on laboratory hardware and assess compatibility with Army digital radar designs and testbeds; develop and model techniques and algorithms for survivable, cognitive, and distributed radar and quantify implications for radar device technology.				
<b>FY 2022 Plans:</b> Will leverage digital radar algorithms and modeling to evolve enhanced concepts for distributed and passive RF Sensing; validate and apply algorithms to distributed sub-array architectures and model system-level requirements for expanding battlefield sensing through distributed architectures.				
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Funding change reflects planned lifecycle of this effort				
<b>Title:</b> Antennas and RF Device Components for Advanced Electronic Systems		3.746	3.814	-
<b>Description:</b> This effort designs, characterizes, and validates high performance antennas, microwave components, and software for multifunction radar, RF sensing, and communication and position/timing systems. Research areas include scanning techniques, broadbanding, beamforming, polarization, platform integration, and affordability. For microwave components, research areas include software defined radios, analog-to-digital conversion rates, bandwidth resolution, bit accuracy, circuit design and affordability.				
<b>FY 2021 Plans:</b> Validate additively manufactured RF antenna arrays for scalability; validate efficient, multi-band, and survivable high power components and research ultra-wide bandgap semiconductor device technology for meeting power efficiency challenges.				
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> In FY 2022, this effort has been realigned to a new Project titled Advanced Radar Concepts and Technologies in PE/Proj 0602141A CF7.				
<b>Accomplishments/Planned Programs Subtotals</b>		8.875	5.336	1.505
<b>C. Other Program Funding Summary (\$ in Millions)</b>				
N/A				
<b>Remarks</b>				

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**D. Acquisition Strategy**  
N/A

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**Exhibit R-2A, RDT&E Project Justification:** PB 2022 Army **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology				<b>Project (Number/Name)</b> AD7 / Missile Fire Control Sensors Technology			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AD7: Missile Fire Control Sensors Technology	-	1.542	-	-	-	-	-	-	-	-	-	-

**A. Mission Description and Budget Item Justification**

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by designing and developing technologies for advancements in next generation fire control sensor technology and target signature modeling.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD6 (Next Generation Fires Radar Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

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

	FY 2020	FY 2021	FY 2022
<b>Title:</b> Missile Fire Control Sensors Technology	1.542	-	-
<b>Description:</b> Design and develop technologies for advancements in next generation fire control sensor technology and target signature modeling.			
<b>Accomplishments/Planned Programs Subtotals</b>	1.542	-	-

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A

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**Exhibit R-2A, RDT&E Project Justification:** PB 2022 Army **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology				<b>Project (Number/Name)</b> AD9 / Close Combat High Energy Laser Technology			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022 Base</b>	<b>FY 2022 OCO</b>	<b>FY 2022 Total</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>FY 2025</b>	<b>FY 2026</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
AD9: Close Combat High Energy Laser Technology	-	7.139	8.467	-	-	-	-	-	-	-	-	-

**Note**

In Fiscal Year 2020 (FY20) this Project was realigned from:  
 Program Element (PE) 0062307A Advanced Weapons Technology  
 \* Project 042 High Energy Laser Technology

**A. Mission Description and Budget Item Justification**

This Project investigates and develops technologies for compact, highly efficient lasers, and compact beam control for close-combat platforms. This project investigates and develops advanced technologies for High Energy Laser (HEL) weapon systems to enable more efficient laser systems with greater power output, which in-turn enables laser weapons on smaller vehicles for additional missions. This includes technologies to support development of alternate laser sources, precision optical pointing and tracking components, adaptive optics to overcome laser degradation due to atmospheric effects, more compact and lighter weight energy generation and storage devices, and more efficient thermal management systems to remove excess heat.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AE1 (Close Combat High Energy Laser Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, and the Army Modernization Strategy, and supports the Army's future capability opportunities for leap-ahead technology for directed energy.

Work is performed by the United States (US) Army Rapid Capabilities and Critical Technologies Office (RCCTO).

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

<b>Title:</b> Close Combat High Energy Laser Technology	<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<b>Description:</b> This effort develops laser and beam control technologies with extremely low size, weight, and power (SWaP) requirements enabling high energy lasers in small, agile close combat platforms. Extremely low SWaP laser systems will expand the laser weapons mission set. Reduction in SWaP also provides for higher power systems on the large tactical vehicles that enable countering the current threat set at longer ranges as well as laser-hardened threats.	7.139	8.467	-
<b>FY 2021 Plans:</b> Continue developing and validating laser and beam control technologies with extremely low SWaP to integrate on a risk reduction platform. Conducts modeling & simulation to inform experimentation and conduct experimentation with instrumented risk-reduction			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army		<b>Date:</b> May 2021		
<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / <i>Air and Missile Defense Technology</i>	<b>Project (Number/Name)</b> AD9 / <i>Close Combat High Energy Laser Technology</i>		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
platform for collecting and analyzing data for validation of technology and assessing its suitability for a Close Combat Platform risk reduction effort.  <b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> This effort has concluded.				
<b>Accomplishments/Planned Programs Subtotals</b>		7.139	8.467	-
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A				
<b>Remarks</b>				
<b>D. Acquisition Strategy</b> N/A				

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**Exhibit R-2A, RDT&E Project Justification:** PB 2022 Army **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> AE2 / Unconventional Countermeasures-Survivability Tech
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
<i>AE2: Unconventional Countermeasures-Survivability Tech</i>	-	5.690	6.347	3.927	-	3.927	-	-	-	-	-	-

**A. Mission Description and Budget Item Justification**

This Project designs and develops technologies to deter tactical surveillance and targeting by adversarial area denial systems and munitions. The Project investigates methods to increase survivability of critical assets against precision-guided near-peer advanced weapons threats, investigates and develops tonedown methods for signature management, and computationally develops novel countermeasures. This Project also develops a suite of high-fidelity, physics-based modeling and simulation tools for the design and development of unconventional countermeasures and survivability enhancers applicable to a wide range of operating environments.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is conducted by the United States (U.S.) Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AE3 (Unconventional Countermeasures-Survivability ATech).

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

	FY 2020	FY 2021	FY 2022
<b>Title:</b> Development of Unconventional Countermeasures for Enhanced Survivability (DeUCES)	3.171	4.075	-
<b>Description:</b> This effort designs and develops countermeasures to defeat near-peer advanced weapons through computational modeling and enhanced tonedown measures.			
<b>FY 2021 Plans:</b> Conduct experiments to investigate techniques and materials for hyperspectral and tone down response and validate their use on critical assets as either integrated systems or temporary coatings for various environments.			
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Funding decrease in FY22 reflects planned lifecycle for this effort, ending in in FY 2021.			
<b>Title:</b> Model-Based Assessment of Sensors and Countermeasures	2.519	2.272	2.492
<b>Description:</b> This effort develops a suite of high-fidelity, physics-based modeling and simulation tools for the design and development of unconventional countermeasures for a wide range of operating environments; develops tools for the evaluation of threat detection and object identification.			
<b>FY 2021 Plans:</b>			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army		<b>Date:</b> May 2021		
<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> AE2 / Unconventional Countermeasures-Survivability Tech		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>	<b>FY 2022</b>
<p>Develop and investigate computational environments for sensor-algorithm performance in a range of simulated environments. These efforts couple large scale physics based sensor models with high resolution environmental test beds to develop medium-to short-range sensor performance models for guided weapons.</p> <p><b>FY 2022 Plans:</b> Will integrate EO/IR sensor models and generated synthetic, physics based imagery into a computational testbed for the evaluation of unconventional countermeasure designs.</p> <p><b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Funding increase in FY22 supports integration of sensor models into the computational testbed.</p>				
<p><b>Title:</b> Advanced Integrated Unconventional Countermeasures Applications</p> <p><b>Description:</b> This effort develops methods and materials to defeat peer advanced reconnaissance, surveillance, targeting methods through advancements in material science and computational prototyping to reduce targetable signatures and confuse targeting systems.</p> <p><b>FY 2022 Plans:</b> Will conduct experiments to develop materials and techniques for hyperspectral camouflage and thermal tonedown utilizing novel waste heat rejection and recovery methods integrated into critical assets.</p> <p><b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Funding increase in FY22 reflects planned lifecycle for this effort, beginning in in FY 2022.</p>		-	-	1.435
<b>Accomplishments/Planned Programs Subtotals</b>		5.690	6.347	3.927
<b>C. Other Program Funding Summary (\$ in Millions)</b>				
N/A				
<b>Remarks</b>				
<b>D. Acquisition Strategy</b>				
N/A				

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**Exhibit R-2A, RDT&E Project Justification:** PB 2022 Army **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> AE4 / Collaborative ISR Sensors Technology
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AE4: Collaborative ISR Sensors Technology	-	3.372	2.938	-	-	-	-	-	-	-	-	-

**A. Mission Description and Budget Item Justification**

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by designing and developing Intelligence, Surveillance, Reconnaissance (ISR) sensors with extended range threat detection and enhanced survivability by cooperative sensing while on-the-move.

Work in this Project complements PE 0603466A Air and Missile Defense Advanced Technology / Project AD6 Next Generation Fires Radar Advanced Technology.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

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

	FY 2020	FY 2021	FY 2022
<b>Title:</b> Collaborative ISR Sensors Technology	3.372	2.938	-
<b>Description:</b> Design and develop ISR sensors with extended range threat detection and enhanced survivability by cooperative sensing while on-the-move.			
<b>FY 2021 Plans:</b> Continue to develop techniques and waveforms for clutter suppression and synchronization between platforms with non-traditional Radar sensing; develop algorithms to perform data collections to validate test cases; research non-traditional Radar sensing; continue to research best technology enablers for Multi-Domain Operations capability.			
<b>FY 2021 to FY 2022 Increase/Decrease Statement:</b> Funding change reflects the planned lifecycle completion of this effort.			
<b>Accomplishments/Planned Programs Subtotals</b>	3.372	2.938	-

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A

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**Exhibit R-2A, RDT&E Project Justification:** PB 2022 Army **Date:** May 2021

<b>Appropriation/Budget Activity</b> 2040 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology				<b>Project (Number/Name)</b> BN6 / Advanced Weapons Components (CA)			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BN6: <i>Advanced Weapons Components (CA)</i>	-	45.000	53.000	-	-	-	-	-	-	-	-	-

**Note**

Congressional Interest Item funding provided for Advanced Weapons Components.

**A. Mission Description and Budget Item Justification**

Congressional Interest Item funding provided for Advanced Weapon Components.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

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

	FY 2020	FY 2021
<b>Congressional Add:</b> Sustainable Energy Materials and Manufacturing <b>FY 2020 Accomplishments:</b> Program Increase supported applied research on Sustainable Energy Materials and Manufacturing.  Work executed under the direction of the Army Futures Command.	12.000	-
<b>Congressional Add:</b> High-Energy Laser Hardware in the Loop <b>FY 2020 Accomplishments:</b> Program Increase supported applied research on High-Energy Laser Hardware in the Loop.  Work executed under the direction of the Army Futures Command.	20.000	-
<b>Congressional Add:</b> COE in High-Energy Laser and Optical Technology <b>FY 2020 Accomplishments:</b> Program Increase supported applied research on COE in High-Energy Laser and Optical Technology.  Work executed under the direction of the Army Futures Command.	3.000	-
<b>Congressional Add:</b> Cybersecurity and Supply Chain Risk Management <b>FY 2020 Accomplishments:</b> Program Increase supported applied research on Cybersecurity and Supply Chain Risk Management.	10.000	-

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army		<b>Date:</b> May 2021
<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / <i>Air and Missile Defense Technology</i>	<b>Project (Number/Name)</b> BN6 / <i>Advanced Weapons Components (CA)</i>
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2020</b>	<b>FY 2021</b>
Work executed under the direction of the Army Futures Command.		
<p><b>Congressional Add:</b> Program increase - beam control systems and industry grade optical fiber fabrication for energy laser</p> <p><b>FY 2021 Plans:</b> Program increase supporting applied research in beam control systems and industry grade optical fiber fabrication for energy laser.</p> <p>This effort will develop Army capability to characterize and optimize a diverse set of fiber laser systems, optics, and photonics to support technology development and maturation for high energy laser weapon systems.</p> <p>Develop a Fiber Amplifier Laser Characterization and Optimization lab for evaluating kW class laser modules; the lab will be an open architecture design that will facilitate the capability to provide independent Army evaluation and verification of high energy laser source components.</p> <p>Conduct laboratory and field experiments to validate performance of the technologies.</p> <p>Work executed by the Rapid Capabilities and Critical Technologies Office under the direction of Army Futures Command.</p>	-	12.000
<p><b>Congressional Add:</b> Program increase - high energy laser enabling and support technology</p> <p><b>FY 2021 Plans:</b> Program increase supporting applied research in high energy laser enabling and support technology.</p> <p>This effort supports the design and development of agile and lightweight beam control system technology including gimbals and telescopes for High Energy Lasers (HEL). Researching innovative design solutions to revolutionize technology for improved size, weight, and power (SWaP), and cost in next generation HEL weapon systems. Researching and developing HEL platform Enhanced Tracking (ET) capabilities to improve current acquisition tracking and clutter, and fine tracking in deep turbulence in adverse weather conditions. Researching and developing improved HEL beam propagation techniques to achieve a higher laser power on target and improve the effectiveness of a HEL weapon system.</p>	-	7.000

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army		<b>Date:</b> May 2021	
<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> BN6 / Advanced Weapons Components (CA)	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2020</b>	<b>FY 2021</b>
Work executed by the Rapid Capabilities and Critical Technologies Office under the direction of Army Futures Command.			
<b>Congressional Add:</b> Program increase - Army missile supply chain risk management <b>FY 2021 Plans:</b> Conduct applied research in Army Missile Supply Chain Risk Management.		-	15.000
Work executed by Army Futures Command.			
<b>Congressional Add:</b> Program increase - close combat high energy laser technology <b>FY 2021 Plans:</b> Program increase supporting applied research in close combat high energy laser technology.  This effort will focus on integrating a 300 kW-class laser into a U.S. Army combat vehicle. This High Energy Laser platform will be capable of performing a wide variety of missions including air and missile defense as well as lethal engagement of enemy ground targets such as armored vehicles, artillery and rocket systems, logistics, and communications systems.		-	8.500
Work executed by the Rapid Capabilities and Critical Technologies Office under the direction of Army Futures Command.			
<b>Congressional Add:</b> Program increase - fires center of excellence <b>FY 2021 Plans:</b> Conduct applied research in Fires Center of Excellence.		-	1.500
Work executed by Army Futures Command.			
<b>Congressional Add:</b> Program increase - cyber resiliency in weapon systems <b>FY 2021 Plans:</b> Conduct applied research in Cyber Resiliency in Weapon Systems.		-	1.500
Work executed by Army Futures Command.			
<b>Congressional Add:</b> Program increase - countermeasures based on artificial intelligence enabled material analysis and design <b>FY 2021 Plans:</b> Conduct applied research in Countermeasures Based on Artificial Intelligence Enabled Material Analysis and Design.		-	6.000

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2022 Army	<b>Date:</b> May 2021
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<b>Appropriation/Budget Activity</b> 2040 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602150A / Air and Missile Defense Technology	<b>Project (Number/Name)</b> BN6 / Advanced Weapons Components (CA)
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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2020</b>	<b>FY 2021</b>
Work executed by Army Futures Command.		
<b>Congressional Add:</b> Program increase - counter-UAS center of excellence	-	1.500
<b>FY 2021 Plans:</b> Program increase supporting applied research in Counter-Unmanned Aerial Systems (C-UAS) Center of Excellence.  This effort supports the development of enhancements for High Energy Laser modeling and simulation capabilities to improve current force-on-force models for Counter-small Unmanned Aerial Systems (C-sUAS). Enables C-sUAS force planning, experimentation, and Tactics, Techniques, and Procedures development.  Work executed by the Rapid Capabilities and Critical Technologies Office under the direction of Army Futures Command.		
<b>Congressional Adds Subtotals</b>	45.000	53.000

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A