Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 1: *Basic Research*					R-1 Program Element (Number/Name) PE 0601101A *I In-House Laboratory Independent Research*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	11.936	12.010	11.585	-	11.585	11.779	12.017	12.262	12.504	Continuing	Continuing
91A: *ILIR-AMC*	-	11.035	11.069	10.626	-	10.626	10.800	11.018	11.242	11.464	Continuing	Continuing
F16: *ILIR-SMDC*	-	0.901	0.941	0.959	-	0.959	0.979	0.999	1.020	1.040	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Program Element (PE) supports basic research at the Army laboratories through the In-House Laboratory Independent Research (ILIR) program. Basic research lays the foundation for future developmental efforts by identifying fundamental principles governing various phenomena and appropriate pathways to exploit this knowledge. The ILIR program serves as a catalyst for major technology breakthroughs by providing laboratory directors flexibility in implementing novel research ideas, by nurturing promising young scientists and engineers, and is used to attract and retain top doctoral degreed scientists and engineers. The ILIR program also provides a source of competitive funds for peer reviewed efforts at Army laboratories to stimulate high quality, innovative research with significant opportunity for payoff to Army warfighting capability.

This PE supports ILIR at the Army Materiel Command's (AMC) six Research, Development, and Engineering Centers (Project 91A), and at the U.S. Space and Missile Defense Command (SMDC) Technical Center (Project F16).

Work in the PE provides a foundation for applied research initiatives at the Army laboratories and research, development and engineering centers.

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

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	12.381	12.010	11.594	-	11.594
Current President's Budget	11.936	12.010	11.585	-	11.585
Total Adjustments	-0.445	0.000	-0.009	-	-0.009
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.440	-			
• Adjustments to Budget Years	-	-	-0.009	-	-0.009
• FFRDC	-0.005	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*

Change Summary Explanation

DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / *In-House Laboratory Independent Research*	Project (Number/Name) 91A / *ILIR-AMC*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
91A: *ILIR-AMC*	-	11.035	11.069	10.626	-	10.626	10.800	11.018	11.242	11.464	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Project funds basic research within the Army Materiel Command's (AMC) Research, Development, and Engineering Centers (RDECs) and lays the foundation for future developmental efforts by identifying the fundamental principles governing various phenomena and appropriate pathways to exploit this knowledge.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology focus areas and the Army Modernization Strategy in new combat vehicle, armor, and robotics/autonomy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Edgewood Chemical Biological Center	0.995	1.056	0.973
Description: Funds basic research in chemistry, biology, biotechnology, and aerosol for countering improvised explosive devices (IEDs), obscurants, and/or target defeat. Work in this Project provides theoretical underpinnings for Program Element (PE) 0602622A (Chemical, Smoke, and Equipment Defeating Technologies). ***FY 2018 Plans:*** Conduct fundamental research in synthetic biology focusing on understanding genetic drift, mutation rates, as well as the structure function relationships of proteins. Explorations into molecular toxicology focus on developing the use of human and animal pluripotent stem cells to derive toxicological end points rather than using whole animal studies. Physical and mathematical investigations into aerosol particle behaviors to help develop knowledge on their behavior during deposition into the atmosphere as well as in the respiratory tract. ***FY 2019 Plans:*** Will conduct fundamental research in hierarchical systems through selective deposition and growth of metal-organic frameworks; synthetic biology will focus on understanding genetic drift, mutation rates, as well as the structure function relationships of proteins; and will extend physical and mathematical investigations into aerosol particle charge behaviors that will help develop knowledge on their behavior during deposition into the atmosphere as well as in the respiratory tract. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.			
Title: Armaments Research, Development and Engineering Center	1.498	1.417	1.435

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*	**Project (Number/Name)** 91A / *ILIR-AMC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Funds basic research in weapons component development, explosives synthesis/detection and area denial. Work in this Project provides theoretical underpinnings for PE 0602307A (Advanced Weapons Technology). ***FY 2018 Plans:*** Perform basic research in light-weight thermoplastic composites, compact and more lethal warheads, synthesis and characterization of more powerful and less sensitive explosives, area denial technologies, advanced structural materials and new materials for electronic sensing devices. ***FY 2019 Plans:*** Will continue to conduct basic research that provides the underpinnings necessary for developing new explosives and propellants, smaller and more lethal warheads, lighter and stronger composite materials for guns and weapon platforms, algorithms for future intelligent munitions, and area denial technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding level increase reflects growth due to inflation.			
Title: Tank-Automotive Research, Development and Engineering Center ***Description:*** Funds basic research in ground vehicle technologies to include power, mobility, and unmanned systems. Work in this Project provides theoretical underpinnings for PE 0602601A (Combat Vehicle and Automotive Technology). ***FY 2018 Plans:*** Conduct efforts to further basic research in areas of strategic importance to Army ground vehicles such as increased control/ mobility of autonomy enabled-systems involving latency compensation using innovative numerical techniques, teleoperation in high-speed, long distance scenarios, anticipatory dynamic Bayesian network for intelligent navigation, methods for detection of high velocity projectiles, real-time panorama generation in tele-immersive combat vehicle operations, deep incremental learning and trust algorithms, novel computationally-efficient numerical modeling of vehicle interactions with deformable terrain, diesel engine heat transfer model development, machine learning, and quantum modeling and computation. ***FY 2019 Plans:*** Will solicit research proposals to improve understanding and accelerate technology development focused on those topics of strategic importance to the Army ground vehicle community such as; semi-, fully-, and multiple autonomous vehicle operation and control, ground vehicle cybersecurity threat detection algorithms and resilience, lightweight materials and dissimilar material joining for thick section materials, advanced energy storage materials, corrosion modeling, and early detection mechanisms, and electrophoretic displays. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	1.300	1.306	1.230

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*	**Project (Number/Name)** 91A / *ILIR-AMC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.			
Title: Natick Soldier Research, Development, and Engineering Center ***Description:*** Funds basic research in food sciences, textiles, and lightweight materials with potential for individual protection. Work in this Project provides theoretical underpinnings for PE 0601102A (Defense Research Sciences), Project H52 (Equipment for the Soldier). ***FY 2018 Plans:*** Explore the feasibility of creating a conductive fibrous platform through the integration of iridium oxide nanoparticles; characterize the structure and electrochemical properties of the iridium oxide nanoparticles and explore applicability to wearable sensing and power; design frequency selective surface antenna arrays tailored for chemical detection; explore discrimination of surface antenna arrays through numerical electromagnetic simulations that explore parameters such as individual antenna element shape/ dimensions, spacing between antenna elements, choice of metal, and spectral shifts produced by metal oxides. ***FY 2019 Plans:*** Will combine theoretical and experimental studies to investigate point contact antenna response to infrared/visible laser beams and understand photon-assisted tunneling (PAT), conductance, and rectification to advance future capability of lightweight, tunable visible/infrared Soldier borne power harvesting systems. Will explore creating liquid crystals with tunable melting points and establish an understanding of the phases, and phase transitions of liquid crystals when confined in polymer matrices to enable future development of lightweight ?smart? textiles that can efficiently respond to external stimuli. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.	1.200	1.150	1.123
Title: Aviation and Missile Research, Development and Engineering Center: Missile Efforts ***Description:*** Funds basic research in guided missile and rocket systems, directed energy weapons, unmanned vehicles, and related components. Work in this Project provides theoretical underpinnings for PE 0602303A (Missile Technology). ***FY 2018 Plans:*** Investigate chaotic dynamics in linear and piecewise linear systems; understand new paradigm in continuum electrodynamics by deriving self-consistent treatment that includes relativity and conservation of momentum and energy; conclude demonstration of proof-of-concept ultraviolet photocatalytic splitting of molecular bonds using plasmonic metal nanoparticles; complete investigation	2.392	2.439	2.345

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*	**Project (Number/Name)** 91A / *ILIR-AMC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
on polarization-sensitive terahertz holographic imaging (for mapping strain in opaque materials); and explore efficient opto-electro-plasmonic devices through electromagnetic interactions at artificial surfaces. ***FY 2019 Plans:*** Will investigate optimal signal detection using mutual information to improve radar performance; will explore the connection between nonlinear dynamics and communication theory to engineer chaotic oscillators in wireless datalinks, radar, and acoustic sensor devices; design hybrid nano-antennas based on nested and nearly overlapping plasmonic resonant modes for enhanced sensing, detection, energy harvesting, and nanoscale light manipulation; will explore effects of low pressure collision broadening and interatomic forces for atom-based inertial navigation sensors; will investigate linear and nonlinear optical materials with dielectric constant near zero for accurate clocks used for GPS and inertial navigation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.			
Title: Aviation and Missile Research, Development and Engineering Center: Aviation Efforts ***Description:*** Funds basic research for aviation enabling technologies in the areas of aerodynamics, structural dynamics, and material science. Work in this Project provides theoretical underpinnings for PE 0602211A (Aviation Technology). ***FY 2018 Plans:*** Conduct interactional aerodynamics investigations of the wake physics and inflow dynamics of multiple rotor configurations; explorer improved design of fluidic control actuators through boundary layer flow control studies; extend higher order unstructured grid solvers that leverage emerging exascale computer architecture to flow over complex geometries. ***FY 2019 Plans:*** Will conduct research on measurement techniques such as a hub-based camera system for rotor blade deformation measurements, microelectromechanical systems based sensors for unsteady airfoil pressure gradient measurements, and tomographic particle image velocimetry for volumetric flow measurements; will conduct research on parallel-in-time computational fluid dynamics algorithms to realize the computation speed benefits of emerging peta-scale computer architecture. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.	1.400	1.411	1.337
Title: Communications-Electronics Research, Development, and Engineering Center	2.250	2.290	2.183

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*	**Project (Number/Name)** 91A / *ILIR-AMC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Funds basic research for communication and network enabling technologies in the areas of antenna design, network management, power generation and storage, and sensors. Work in this Project provides theoretical underpinnings for PE 0602705A (Electronics and Electronic Devices). ***FY 2018 Plans:*** Conduct research on the intrinsic efficiencies of non-foster matching methods at radio frequencies with a focus on full stability analysis; splitting of radio network traffic over multipath to maximize throughput performance for traffic flows by using new fluid-flow models to support dynamic topology; research 3D printing of tunable coils and matching networks with precisely controlled impedance and resonant frequencies resulting in tunable structures that can be activated in a controlled manner to change the shape or configuration of the solid in response to an external stimulus; determine the most effective information visualization methods and/or perspectives for commander understanding of the cyber domain and its relationship to mission command in the physical domain; research high performance, rechargeable, safe Lithium Sulphur (LiS) battery chemistry; experimentally confirm the performance of synthesized catalysts that can promote the production of synthesis gas (carbon monoxide (CO) and hydrogen (H2)) from carbon dioxide and hydrogen with high CO selectivity and high yield; research novel optical properties of retro-reflections, with an emphasis on polarization, to characterize and discriminate between different objects; research active and passive longwave infrared (LWIR) detection with a long term goal of produce focal plane arrays capable of passive longwave and active 3D imaging; research novel molecular beam epitaxy growth techniques that mitigate antimony cross incorporation in Gallium-free superlattice detectors; research novel characterization techniques, investigate the inherent materials issues, and associated processes that limit the performance of LWIR focal plane arrays with diffraction-limited pixel-pitch. ***FY 2019 Plans:*** Will conduct research on techniques for reducing the computational complexity and burden associated with massive multiple input ? multiple output antenna arrays; will research the mathematical relationship between the electric permittivity, magnetic permeability and thickness of the metamaterial in a conformal antenna; will research energy harvesting which has a net zero or net positive effect on the metabolic rate by only harvesting energy during certain stages of the gait cycle; will research deep learning algorithms and confidence-based likelihoods associated with classification decisions; will innovate and create new integrable material solutions to enable smaller, lower cost phase shifters and tunable filters for use in radar, electronic warfare and communications systems; will research phase shifting diode networks to use with 2-dimensional planar phased array with integrated antennas that operate at 60GHz ~ 1 THz; and will research material parameters and device models for high fidelity simulation of III-V and II-VI optoelectronics. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*	**Project (Number/Name)** 91A / *ILIR-AMC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
DODI Funding and Execution Guidelines state the ILIR program should have a target ceiling of 2.5% of the total 6.1 budget. The reduction in funding is to better align the ILIR budget with DODI guidance.			
Accomplishments/Planned Programs Subtotals	11.035	11.069	10.626

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / *In-House Laboratory Independent Research*	Project (Number/Name) F16 / *ILIR-SMDC*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
F16: *ILIR-SMDC*	-	0.901	0.941	0.959	-	0.959	0.979	0.999	1.020	1.040	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Project provides In-house Laboratory Independent Research (ILIR) at the United States (U.S.) Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), Technical Center. This basic research on lasers and directed energy lays the foundation for future developmental efforts on high energy lasers and directed energy systems by identifying the fundamental principles governing various directed energy phenomena.

Work in this project is related to, and fully coordinated with, efforts in Program Element (PE) 0602307A (Advanced Weapons Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: SMDC In-house Laboratory Independent Research	0.901	0.941	0.959
Description: Funds basic research to investigate laser propagation phenomenology for application in modeling and simulation and future directed energy weapons design. Activities in this Project transition to High Energy Laser Technology in PE 0602307A (Advanced Weapons Technology). ***FY 2018 Plans:*** Complete experiments to understand the feasibility of a diode pumped Xenon gas laser; conduct an experiment of a direct diode concept to measure efficiency and beam quality and see how the results compare to traditional solid state lasers; and complete analysis of the beaconless adaptive optics approach for correcting a laser beam for propagation in the presence of particulates. ***FY 2019 Plans:*** Will complete data analysis and verification of engineering models to understand the viability of increasing the power to 10?s of watts for a diode pumped Xenon gas laser; will investigate a laboratory bench top experiment of a direct diode concept to combine 10?s of diode sources into a single laser beam at the milli-watt level to understand key laser metrics and begin to evaluate scalability of the approach to watt class; and will complete investigation of the beaconless adaptive optics approach for correcting a high energy laser beam (greater than 10kW) for propagation in the presence of particulates beyond 1km. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding levels increased due to inflation.			
Accomplishments/Planned Programs Subtotals	0.901	0.941	0.959

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 1	**R-1 Program Element (Number/Name)** PE 0601101A / *In-House Laboratory Independent Research*	**Project (Number/Name)** F16 / *ILIR-SMDC*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A