Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Air Force											Date: May 2017	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602605F / *Directed Energy Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	122.835	127.163	132.993	0.000	132.993	128.039	125.076	126.207	128.448	Continuing	Continuing
624866: *Lasers & Imaging Technology*	-	83.718	92.445	99.946	0.000	99.946	94.480	90.704	90.559	90.876	Continuing	Continuing
624867: *Advanced Weapons & Survivability Technology*	-	39.117	34.718	33.047	0.000	33.047	33.559	34.372	35.648	37.572	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program covers research in directed energy (DE) technologies, primarily high energy lasers (HELs); including devices, optical beam control and integration; and high power electromagnetics (HPEM). Laser research includes moderate to high power laser devices that are applicable to a wide range of Air Force applications, optical technologies to propagate laser beams from a device, and integration of these technologies. In HPEM, this research examines technologies for applications such as counter-electronics and non-lethal weapons. Research into other novel DE applications will be conducted. DE vulnerability/lethality assessments are conducted and protection technologies are developed. Research into other advanced non-conventional/innovative weapons will be conducted. Tools are developed and used to compare solutions and to determine the most effective and efficient DE technologies to meet Air Force needs. This program also performs ground-based optical research for space situational awareness (SSA). In SSA, this research uses the Starfire Optical Range and the Maui Space Surveillance System to develop and implement technologies to identify visual characteristics such as status and health of orbiting space objects. Efforts in this program have been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

In FY 2018, a portion of HQ AFRL S&T civilian manpower in PE 0602605F, Directed Energy Technology, was transferred to PE 0602298F, Science and Technology Management - Major Headquarters Activities, to provide increased transparency to Congress on personnel in Major Headquarters Activities (MHA).

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

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Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602605F / *Directed Energy Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	115.105	127.163	120.059	0.000	120.059
Current President's Budget	122.835	127.163	132.993	0.000	132.993
Total Adjustments	7.730	0.000	12.934	0.000	12.934
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	9.997	0.000			
• SBIR/STTR Transfer	-2.267	0.000			
• Other Adjustments	0.000	0.000	12.934	0.000	12.934

Change Summary Explanation

Increase in FY 2016 reflects reprogramming for Air Dominance activities and to support Research and Development Projects, 10 U.S.C. Section 2358.

Increase in FY 2018 due to realignment of funds for Laser Weapon System priorities.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602605F / *Directed Energy Technology*	Project (Number/Name) 624866 / *Lasers & Imaging Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
624866: *Lasers & Imaging Technology*	-	83.718	92.445	99.946	0.000	99.946	94.480	90.704	90.559	90.876	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project explores the technical feasibility of moderate to high power lasers, including beam control, for applications such as aircraft protection, force protection, and precision engagement from Air Force platforms. This project investigates the effects of laser weapons on a wide range of systems and components as well as producing, modifying, validating and applying DE and non-DE concept development and assessment tools to determine which technology solutions to pursue. Research supporting ground-based optical space situational awareness is conducted.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: High Energy Laser Technologies and Directed Energy Assessments	55.635	65.056	66.657

Description: Develop and demonstrate HEL device technologies for Air Force applications. Develop and demonstrate optical laser beam control technologies including atmospheric compensation and pointing and tracking. Perform laser system level modeling and simulation validated by laser effects and vulnerability testing. Develop tools and perform assessments which allow comparisons among DE concepts and tradeoffs between DE and non-DE solutions. Integrate optical beam control technologies with laser device technologies and demonstrate the combined technologies. Develop and use technologies to better understand the vulnerability of weapon systems to lasers.

FY 2016 Accomplishments:

Continued beam control and monolithic fiber amplifier integration and ground tests. Continued conducting effects testing to establish system requirements and validate modeling efforts. Performed airborne tests of turret beam control technologies. Began integration of beam control and low power laser technologies for aircraft self-protection. Completed Integrated Weapons Environment for Analysis (IWEA) Build 1 and continued to conduct assessments of concepts for laser weapon systems to help users plan weapon investments. Continued to model and characterize foreign HEL threats to blue systems and provide assessments to developers for hardening materials and designs. Completed research supporting the joint Air Force/ DARPA ground HEL demonstration.

FY 2017 Plans:

Continue with beam control and scaling of monolithic fiber amplifier scaling using advanced fibers. Continue with the development of beam control aero-effects mitigating techniques. Continue with the conduct of effects tests to establish system requirements and validity models. Continue integration of beam control and low power laser system for future pod-mounted moderate power laser demonstration. Transition IWEA Build 1 to external users and complete IWEA Build 2. Conduct assessments of DE and/

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Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602605F / *Directed Energy Technology*	**Project (Number/Name)** 624866 / *Lasers & Imaging Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
or synergistic DE/Kinetic Energy (KE) weapon capabilities to help users plan weapon investments. Continue to model and characterize foreign HEL threats and provide information to develop mitigation techniques to protect blue assets. ***FY 2018 Plans:*** Continue with beam control and scaling of monolithic fiber amplifier scaling using advanced fibers. Continue with the development of beam control aero-effects mitigating techniques. Continue with the conduct of effects tests to establish system requirements and validity models. Continue integration of beam control and low power laser system for future pod-mounted moderate power laser demonstration. Transition IWEA Build 2 to external users and complete IWEA transition into an advanced framework to support Air Force Research Laboratory (AFRL)-wide Modeling, Simulation & Analysis (MS&A) environment. Conduct assessments of DE and/or synergistic DE/KE weapon capabilities to help users plan weapon investments. Continue to model and characterize foreign HEL threats, and provide information to develop mitigation techniques to protect blue assets.			
Title: Optical Space Situational Awareness and Satellite Vulnerability	28.083	27.389	33.289
Description: Develop advanced, long-range, electro-optical technologies that support ground-based optical SSA. Develop and use technologies to better understand the vulnerability of blue satellite systems to lasers. Operate the Starfire Optical Range in support of internal and customer requirements. ***FY 2016 Accomplishments:*** Began integration of geosynchronous satellite characterization and local-space search as components of a dynamic telescope demonstration to keep track of potential threat objects in space. Initiated comparison of capabilities for extending telescope operation into daylight hours to provide Air Force Space Command programs with technology options for their requested products. Demonstrated techniques for persistent monitoring of space events and capability to detect threat objects in close proximity to our high-value satellite assets, including those in geosynchronous orbits. ***FY 2017 Plans:*** Complete integration of geosynchronous satellite characterization and local-space search for bright objects as components of a dynamic telescope demonstration to keep track of potential threat objects in space. Investigate daylight detection of geosynchronous satellites to address the long-duration gaps during daytime hours when satellites cannot normally be detected by our optical systems. Explore techniques to detect smaller objects and characterize their relative orbits around our assets. Investigate through modeling and simulation the susceptibility of satellite optical systems to laser threats to support course of action decision-making for protection and design improvements for resilience. ***FY 2018 Plans:*** Complete integration of geosynchronous satellite characterization and local-space search for dim objects as a component of a dynamic telescope demonstration to keep track of potential threat objects in space. Mature daylight detection of geosynchronous satellites to allow custody through the long-duration gaps during daytime hours when satellites cannot normally be detected by our ground-based optical systems. Mature 24/7 real-time optical imaging of near-earth satellites to allow characterization on tactical			

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Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602605F / *Directed Energy Technology*	**Project (Number/Name)** 624866 / *Lasers & Imaging Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
timelines. Investigate through modeling and simulation the susceptibility of satellite optical systems to laser threats to support course of action decision-making for protection and design improvements for resilience.			
Accomplishments/Planned Programs Subtotals	83.718	92.445	99.946

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602605F / *Directed Energy Technology*	Project (Number/Name) 624867 / *Advanced Weapons & Survivability Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
624867: *Advanced Weapons & Survivability Technology*	-	39.117	34.718	33.047	0.000	33.047	33.559	34.372	35.648	37.572	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project explores the use of HPEM and other unconventional/innovative weapon concepts to support applications such as nonlethal counter-personnel and electronic warfare including disruption, degradation, and damage of electronic infrastructure on Air Force platforms. This research includes weapon technology that can provide covert effects and/or no collateral or human damage. The project also investigates the effects of potential adversary HPEM weapons and how to mitigate those effects on US assets, as well as producing and applying DE and non-DE concept development and assessment tools to determine which technology solutions to pursue. HPEM includes but is not limited to high power microwaves, plasmas, particle beams and millimeter waves.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: HPEM and Unconventional Weapon Technologies	20.038	18.120	10.598
Description: Investigate technologies for HPEM components. Investigate HPEM and other unconventional weapon concepts using innovative technologies. Investigate advanced technologies that support force protection tactical applications, including non-lethal counter-personnel applications. ***FY 2016 Accomplishments:*** Refined initial ultra-short pulsed laser atmospheric propagation studies. Conducted effects studies on electronics based on the assessments from FY15. Continued work on compact 50 kilovolt solid state switch. Completed preliminary designs for 100 megavolt test facility accelerator. Began design of smaller, higher power, source technology for the Next Generation High Power Microwaves(HPM) demonstration. ***FY 2017 Plans:*** Refine ultra-short pulsed laser atmospheric propagation studies. Conduct effects studies on electronics based on the assessments from FY15 and FY16. Continue compact 50 kilovolt solid state switch research. Complete research on smaller, higher power, source technology for joint Air Force-Navy HPM technologies. ***FY 2018 Plans:*** Begin ultra-short pulsed laser atmospheric propagation studies in a density gradient. Conduct effects studies on electronics based on the assessments from FY16 and FY17 to support HIgh power Joint Electromagnetic Non-Kinetic Strike (HiJENKS). Complete compact 50 kilovolt solid state switch for a militarily relevant platform. Initiate design of smaller, higher power, source technology for the joint AF-Navy HiJENKS HPM demonstration.			
Title: HPEM Effects and Mitigation Research	19.079	16.598	22.449

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602605F / *Directed Energy Technology*	**Project (Number/Name)** 624867 / *Advanced Weapons & Survivability Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: Assess the effects/lethality of HPEM technologies. Develop and apply sophisticated models to enhance the development of HPEM and related technology. Develop tools and perform assessments which allow comparisons among DE concepts and tradeoffs between DE and non-DE solutions. Investigate technologies to counter the effects of HPEM. ***FY 2016 Accomplishments:*** Completed source for effects testing that operates in three microwave bands. Tested and validated Phase 1 of DE High Performance Computing Software Applications Institute software, which allows modeling of DE sources and propagation that involves plasmas. Assessed potential improvements to US weapons systems from employing HPEM weapons technologies for platform protection and target prosecution. Conducted assessments of HPEM and kinetic energy (KE) weapon concepts in a common environment to help users plan weapons investments. Continued to model and characterize HPEM threats to blue systems and provide assessments developers for hardening materials and designs. ***FY 2017 Plans:*** Test and validate Phase 2 of DE High Performance Computing Software Applications Institute software, which allows modeling of DE sources and propagation that involves plasmas and laser DE weapons. Continue to assess potential improvements to US weapons systems from employing HPEM weapons technologies for platform protection and target prosecution. Continue further assessments of HPEM and KE weapon concepts in a common environment to help users plan weapons investments. Transition Modeling, Simulation & Analysis (MS&A) tools to the broader MS&A community. Continue to model and characterize current and projected HPEM threats to blue systems and provide assessments to developers for hardening materials and designs. ***FY 2018 Plans:*** Test and validate Phase 3 of DE High Performance Computing Software Applications Institute software, which allows modeling of DE sources and propagation that involves plasmas and laser DE weapons. Assess potential improvements to US weapons systems from employing HPEM weapons technologies for platform protection and target prosecution. Continue assessments of HPEM and synergistic/KE weapon concept capabilities to help users plan weapons investments. Transition MS&A tools to the broader MS&A community.			
Accomplishments/Planned Programs Subtotals	39.117	34.718	33.047

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.