Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Air Force											Date: February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	110.725	125.866	115.604	-	115.604	118.401	118.193	119.622	122.077	Continuing	Continuing
624866: *Lasers & Imaging Technology*	-	78.304	76.270	76.290	-	76.290	84.230	83.872	84.670	86.410	Continuing	Continuing
624867: *Advanced Weapons & Survivability Technology*	-	32.421	49.596	39.314	-	39.314	34.171	34.321	34.952	35.667	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; ground-based optical space situational awareness (SSA); and high power electromagnetics (HPEM). Laser research includes moderate to high power laser devices that are applicable to a wide range of applications, optical technologies to propagate lasers beams from a device, and integration of these technologies. 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. 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. 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.

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.

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	112.783	125.955	117.559	-	117.559
Current President's Budget	110.725	125.866	115.604	-	115.604
Total Adjustments	-2.058	-0.089	-1.955	-	-1.955
• Congressional General Reductions	-	-0.089			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.058	-			
• Other Adjustments	-	-	-1.955	-	-1.955

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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*

Change Summary Explanation

In FY16 decrease due to higher DoD priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
624866: *Lasers & Imaging Technology*	-	78.304	76.270	76.290	-	76.290	84.230	83.872	84.670	86.410	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. 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 2014	FY 2015	FY 2016
Title: High Energy Laser Technologies and Directed Energy Assessments	52.244	51.192	51.890

Description: Develop and demonstrate high energy laser (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 2014 Accomplishments:

Continued to conduct research supporting a joint Air Force/Defense Advanced Research Projects Agency (DARPA) ground demonstration of a high power solid state laser with a beam control system. Prepared for future flight tests of beam control technologies. Continued integration and began testing of horizontal propagation compensation concepts. Began developing analysis tools including platform, optics, controls, and atmospheric effects as well as target predictions supporting future weapons analysis for an Integrated Weapons Environment for Analysis (IWEA) to analyze directed and kinetic energy weapons in a common environment to help plan weapons investments. Conducted effects testing to establish system requirements and validate modeling efforts. Designed a narrow line width (sub-gigahertz) monolithic fiber amplifier with good beam quality. Began design of laser system for aircraft self-protection.

FY 2015 Plans:

Continue to conduct research supporting a joint Air Force/DARPA ground demonstration of a high power solid state laser with a beam control system. Use effects testing to establish system requirements and validate modeling efforts. Evaluate subscale turret beam control technologies. Update and use IWEA to analyze directed and kinetic energy weapons in a common environment to help plan weapons investments. Use intelligence information to evaluate foreign HEL threats and provide

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
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 2014	FY 2015	FY 2016
weapon system and technology developers with tools and criteria to help protect US systems. Begin integration of beam control technologies and monolithic fiber amplifier for ground to air field tests. Continue design of laser system for aircraft self-protection. ***FY 2016 Plans:*** Complete beam control and monolithic fiber amplifier integration and ground tests. Conduct effects testing to establish system requirements and validate modeling efforts. Perform airborne tests of subscale turret beam control technologies. Begin integration of beam control and low power laser technologies for aircraft self-protection. Complete IWEA Build 1 and conduct assessments of concepts for laser weapon and SSA systems to help users plan weapons investments. Model and characterize foreign HEL threats to blue systems and provide assessments to developers for hardening materials and designs.			
Title: Optical Space Situational Awareness and Satellite Vulnerability ***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. Operated the Starfire Optical Range in support of internal and customer requirements. ***FY 2014 Accomplishments:*** Demonstrated capability to determine orientation of geosynchronous satellites. Demonstrated use of laser guidestar to enable detection of objects the size of a basketball in close proximity to geosynchronous satellites. Developed data analysis techniques to understand and keep track of potential threat objects in space. Developed initial capabilities for extending existing techniques into 24-hour operations. Developed technologies to quantify the vulnerability and protection needs of certain blue satellite components. ***FY 2015 Plans:*** Develop dynamic telescope control to keep track of potential threat objects in space. Demonstrate data analysis techniques to understand characteristics of potential space threats and satellite anomalies. Demonstrate capabilities for extending existing techniques into 24-hour operations. Evaluate concepts for persistent monitoring of space events and capability to image and search the local space around our high-value satellite assets, including low power testing for those in geosynchronous orbits. ***FY 2016 Plans:*** Begin 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. Perform comparison of capabilities for extending telescope operation into daylight hours to advise Air Force Space Command programs on technology options. Demonstrate 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.	26.060	25.078	24.400
Accomplishments/Planned Programs Subtotals	78.304	76.270	76.290

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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*

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: PB 2016 Air Force			Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
624867: *Advanced Weapons & Survivability Technology*	-	32.421	49.596	39.314	-	39.314	34.171	34.321	34.952	35.667	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. 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 2014	FY 2015	FY 2016
Title: HPEM and Unconventional Weapon Technologies	19.933	30.268	19.810
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 2014 Accomplishments:*** Developed state-of-the-art components to further shrink antennas, microwave sources, and energy storage/prime power systems. Investigated technologies to provide frequency agile, broadband sources. Conducted assessments on the feasibility of particle beam weapons for counter-electronics. ***FY 2015 Plans:*** Begin ultra-short pulsed laser atmospheric propagation studies. Conduct effects studies on electronics based on the assessments from FY14. Develop compact 50 kilovolt solid state switch. Develop designs for 100 megavolt test facility accelerator. Increase development of technologies leading to more efficient, smaller, lighter, and more powerful HPEM systems. ***FY 2016 Plans:*** Refine ultra-short pulsed laser atmospheric propagation studies. Conduct effects studies on electronics based on the assessments from FY15. Complete compact 50 kilovolt solid state switch. Complete designs for 100 megavolt test facility accelerator. Begin design of smaller, higher power, source technology for the Next Generation high power microwave demonstration.			
Title: HPEM Effects and Mitigation Research	12.488	19.328	19.504

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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 2014	FY 2015	FY 2016
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 2014 Accomplishments:*** Began incorporating effects of high bandwidth and smart waveform technologies and techniques into numerical simulations. Began funding the Air Force portion of the High Power Microwave Software Applications Institute. This is an Air Force/DoD High Performance Computing Modernization Program for the development of advanced, user friendly, modeling and simulation capability for entire HPEM systems. ***FY 2015 Plans:*** Develop source for effects testing that operates in three microwave bands. Complete integration of software into DE High Performance Computing Software Applications Institute, which allows modeling of DE sources and propagation that involves plasmas. Assess potential improvements to US weapons systems from employing HPEM weapons technologies for platform protection and target prosecution. Use intelligence information to evaluate foreign HPEM threats and provide weapon system and technology developers with tools and criteria to help protect US systems. ***FY 2016 Plans:*** Complete source for effects testing that operates in three microwave bands. Test and validate DE High Performance Computing Software Applications Institute software, which allows modeling of DE sources and propagation that involves plasmas. Assess potential improvements to US weapons systems from employing HPEM weapons technologies for platform protection and target prosecution. Conduct assessments of HPEM and kinetic energy weapon concepts in a common environment to help users plan weapons investments. Model and characterize HPEM threats to blue systems and provide assessments developers for hardening materials and designs.			
Accomplishments/Planned Programs Subtotals	32.421	49.596	39.314

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602605F / *Directed Energy Technology*	**Project (Number/Name)** 624867 / *Advanced Weapons & Survivability Technology*

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.