PE NUMBER: 0602890F
PE TITLE: High Energy Laser Research

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2006
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602890F High Energy Laser Research

Cost ($ in Millions)	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	48.867	46.669	50.166	50.737	55.026	56.288	57.256	Continuing	TBD
5096 High Energy Laser Research	48.867	46.669	50.166	50.737	55.026	56.288	57.256	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds Department of Defense (DoD) high energy laser (HEL) applied research through the HEL Joint Technology Office. HEL weapon systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DoD HEL Science and Technology program. In general, efforts funded under this program are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, beam control, optics, propagation, and free electron lasers. Note: In FY 2006, Congress added $1.2 million for the High Power Fiber Laser Program, and $0.5 million for Oxygen Laser Optical Source. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary ($ in Millions)

		FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	50.229	45.678	49.598
(U)	Current PBR/President's Budget	48.867	46.669	50.166
(U)	Total Adjustments	-1.362	0.991	
(U)	Congressional Program Reductions		-0.034	
	Congressional Rescissions	-0.050	-0.675	
	Congressional Increases		1.700	
	Reprogrammings			
	SBIR/STTR Transfer	-1.312		
(U)	Significant Program Changes:			

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification		DATE: February 2006
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE: 5096 High Energy Laser Research

Cost ($ in Millions)	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5096 High Energy Laser Research	48.867	46.669	50.166	50.737	55.026	56.288	57.256	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds Department of Defense (DoD) high energy laser (HEL) applied research through the HEL Joint Technology Office. HEL weapon systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DoD HEL Science and Technology program. In general, efforts funded under this program are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, beam control, optics, propagation, and free electron lasers. Note: In FY 2006, Congress added $1.2 million for the High Power Fiber Laser Program, and $0.5 million for Oxygen Laser Optical Source. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST/CONGRESSIONAL ADD: Explore solid state lasers that have potential for the quickest impact in future HEL weapons because of their inherent small size and the fact that they require only electrical energy in order to run, thereby greatly simplifying systems engineering and supportability. Note: This effort includes Congressional Adds of $3.0 million in FY 2005.	11.679	6.238	7.367

(U) In FY 2005: Developed component technologies such as laser gain media with improved opto-thermal-mechanical properties. Developed thermal management techniques leading to reduced optical distortion, modular and scalable architectures for power scaling including beam combining, and optical ceramic materials. For ceramics, enhanced manufacturing processes for laser applications, fully characterized materials, and set stage for performance comparison to single crystal material. Developed and demonstrated more efficient and higher brightness diode arrays that can pump fiber lasers. Developed and demonstrated fiber laser beam combining through spectral and tiled aperture approaches. Developed and demonstrated a heat exchanger building block for phase change thermal management/storage systems. Conducted Service and Agency proposal call for FY 2005 and funded first year of selected efforts. Funded second year of FY 2004 industry proposal call efforts.

(U) In FY 2006: Conduct research to enable power scaling with reduced optical distortion, improved efficiency, and improved size and weight characteristics. Develop technology that will lead to improved fieldability, serviceability, and ruggedness. Develop scalable architectures for laser power scaling including technologies for beam combining. Examine architecture improvements, such as elimination of free-space optics in fiber systems. Conduct an industry

Exhibit R-2a, RDT&E Project Justification		DATE February 2006
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research

	B. Accomplishments/Planned Program ($ in Millions)	FY 2005	FY 2006	FY 2007
	proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.			
(U)	In FY 2007: Continue maturing technologies that will provide system level performance commensurate with fieldable devices. Provide power scaling with good beam quality and suitable size and weight. Develop technology that will lead to improved fieldability, serviceability, and ruggedness. Explore power scaling technology that will lead to a broader application space. Develop new power-scalable architectures including technologies for beam combining. Continue to fund the industry proposal call efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.			
(U)				
(U)	MAJOR THRUST: Explore free electron lasers (FEL) that have potential in future HEL weapons because they require only electrical energy in order to run and can be designed to operate at the best wavelength for a specific application within a large range of wavelengths.	8.727	8.513	9.425
(U)	In FY 2005: Developed FEL system components for power scaling. The 10 kilowatt laboratory demonstrator will be used as a test bed. Developed a separate photocathode test bed and refine photocathode models as a tool to design advanced robust, long-life photocathodes. Fabricated a high average current radio frequency cavity and study beam breakup mitigation technology. Performed laboratory tests to determine the suitability of high power optical components. Determined if currently planned technology for power scaling of the optical cavity will be satisfactory; explored alternatives as necessary. Conducted Service and Agency proposal call for FY 2005 and funded first year of selected efforts. Funded second year efforts on FY 2004 industry proposal call.			
(U)	In FY 2006: Conduct research in power scaling for powers in the 100 kilowatt class. Design high-average-current photocathode and injector capability, suitable beam-breakup thresholds, and power scaling capability of the optical resonator. Continue component testing with the 10 kilowatt laboratory demonstrator to define a development path for scaling to a 100 kilowatt class field test demonstrator and eventual megawatt class FEL. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.			
(U)	In FY 2007: Conduct system-level technology development and trade studies to facilitate scaling of FELs to weapon class power levels and shipboard integration. As appropriate, augment the existing 10 kilowatt laboratory testbed or build new testbeds with components showing traceability to larger systems, including radio frequency power systems, and optical and electron beam lines. Continue to investigate the development path for scaling toward 100 kilowatt field test demonstrator and eventual megawatt class FEL. Continue to fund the industry proposal call efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2006
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research

	B. Accomplishments/Planned Program ($ in Millions)	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop advanced solid state laser technologies that are applicable to future HEL weapon laser devices. Note: This effort included Congressional Adds of $2.4 million in FY 2005.	12.551	13.805	15.092
(U)	In FY 2005: Demonstrated components for power scaling technology in concert with the 25 kilowatt Joint High Power Solid State Laser (JHPSSL). Developed hardware that can be used for quantitative characterization of the 25 kilowatt JHPSSL lasers. Developed enabling technologies that will support improved performance at 25 kilowatt and are traceable to 100 kilowatt.			
(U)	In FY 2006: Mature enabling technologies through applied research necessary for the demonstration of solid state lasers at initial weapon-grade power levels. Support technology development for the JHPSSL system in the 100 kilowatt program phase.			
(U)	In FY 2007: Continue to support the JHPSSL program design and demonstration of 100 kilowatts devices. Examine the potential for new technologies, such as dopant-tailored ceramics to impact this program.			
(U)				
(U)	MAJOR THRUST: Develop beam-control technologies that are directly applicable to surface, air, and space mission areas. Results of these activities will be transitioned to near-term HEL systems and will also serve to enhance the HEL related technology base and industrial capability. Develop atmospheric characterization technologies and techniques aimed at making precise absorption measurements in interesting atmospheric windows, measuring and assimilating information on turbulence at locations relevant to tactical HEL systems, and developing and testing real-time characterization tools to assist the HEL operator.	10.147	8.434	9.329
(U)	In FY 2005: Developed architecture and component technology that can be used to support integrated beam-control technology demonstrations. Addressed multiple architecture approaches, such as passive and active wavefront control, and target-in-the loop as well as wavefront-reconstruction based techniques. Explored next-generation component technology for phase control such as micro-electrical-mechanical and high power, high speed spatial light modulators. Explored improvement of optical coatings technology. Developed technology for conformal windows and improved wavefront sensors for high scintillation environments. Conducted atmospheric characterization and propagation studies for low-altitude tactical scenarios in order to increase the lethal range. Conducted Service and Agency proposal call for FY 2005 and funded first year of selected efforts. Funded second year efforts on FY 2004 industry proposal call.			
(U)	In FY 2006: Develop technology to support high performance beam control systems and integrated demonstrations. Explore advanced components and control techniques for difficult environments such as those found in high speed flight, high turbulence, and extended range. Advanced techniques include conformal and tiled apertures, and fiber-based technologies with improved isolation from platform disturbance. Develop component technology including durable optical coatings. Provide critical technology options for use in tactical scenarios on platforms such			

Exhibit R-2a, RDT&E Project Justification		DATE February 2006
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research

	B. Accomplishments/Planned Program ($ in Millions)	FY 2005	FY 2006	FY 2007
	as aircraft, ground vehicles, and ships. Continue the study of atmospheric limitations in low-altitude tactical scenarios such as turbulence, thermal blooming, and with platform disturbances. Begin to plan an outdoor thermal blooming experiment. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.			
(U)	In FY 2007: Mature existing and develop new technologies that support integrated beam control demonstrations. Continue technology development to support next-generation control technologies, such as all-solid fiber laser systems with conformal apertures and active control for boundary-layer mitigation. Provide technology options for laser use on multiple platforms (aircraft, ground vehicles, and ships). Continue study of atmospheric compensation technology. Continue to fund the industry proposal call efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.			
(U)				
(U)	MAJOR THRUST: Develop chemical laser technologies that provide higher performance and better supportability. Results of these activities will result in chemical lasers that are lighter and more affordable. Emphasis in this area is being reduced based on the relative maturity of chemical lasers.	2.511	4.392	4.859
(U)	In FY 2005: Developed and demonstrated closed-cycle chemical lasers, especially chemical oxygen iodine lasers. Developed chemical laser generators that are capable of operating in a gravity free environment and conducted proof-of-concept testing of these devices. Evaluated advanced chemical or electrochemical cycles that promote improved recycling and use less hazardous materials. Conducted Service and Agency proposal call for FY 2005 and funded first year of selected efforts. Funded second year efforts on FY 2004 industry proposal call.			
(U)	In FY 2006: Continue to develop and demonstrate closed-cycle chemical lasers, especially chemical oxygen iodine laser-derived devices. Conduct technology development/experiments to allow selection of the most promising chemical generators and chemical regeneration techniques that can be scaled for tactical weapon applications. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.			
(U)	In FY 2007: Continue to develop and demonstrate closed-cycle chemical lasers, especially chemical oxygen iodine laser-derived devices. Conduct technology development/experiments to allow selection of the most promising chemical laser generators and chemical regeneration techniques that can be scaled for tactical weapon system applications. Continue to fund the industry proposal call efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.			
(U)				
(U)	MAJOR THRUST: Develop lethality technologies that concentrate on providing a strong scientifically-based understanding of laser kill mechanisms to allow the design of future HEL systems with the maximum kill probability	3.252	3.611	4.094

Exhibit R-2a, RDT&E Project Justification		DATE February 2006
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research

	B. Accomplishments/Planned Program ($ in Millions)	FY 2005	FY 2006	FY 2007
	for the minimum system size and cost.			
(U)	In FY 2005: Explored feasibility of developing a predictive, physics-based model for target lethality that would reduce the need for detailed lethality testing with the large number of known targets. Developed databases that will be accepted by the HEL community and validated models that will be available to systems designers. Developed a subset of target folders for future tactical laser weapons. Conducted Service and Agency proposal call for FY 2005 and funded first year of selected efforts.			
(U)	In FY 2006: Continue work to establish a predictive, physics-based methodology for prediction of target lethality based on previously gained understanding of the mechanisms of interaction between laser beams and targets. Continue to develop databases that will be accepted by the high energy laser (HEL) community and validated models that will be available to systems designers. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.			
(U)	In FY 2007: Continue to develop lethality information that will be accepted by the HEL community and validated models that will be available to systems designers. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.			
(U)				
(U)	CONGRESSIONAL ADD: High Power Fiber Laser Program.	0.000	1.183	0.000
(U)	In FY 2005: Not Applicable.			
(U)	In FY 2006: Conduct Congressionally-directed effort for the High Power Fiber Laser Program.			
(U)	In FY 2007: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Oxygen Laser Optical Source.	0.000	0.493	0.000
(U)	In FY 2005: Not Applicable.			
(U)	In FY 2006: Conduct Congressionally-directed effort for the Oxygen Laser Optical Source.			
(U)	In FY 2007: Not Applicable.			
(U)	Total Cost	48.867	46.669	50.166

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

	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) PE 0602500F, Multi-Disciplinary Space Technology.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2006
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**	PROJECT NUMBER AND TITLE **5096 High Energy Laser Research**

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

(U) PE 0601108F, High Energy Laser Research Initiatives.

(U) PE 0603444F, Maui Space Surveillance System.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) PE 0603924F, High Energy Laser Advanced Technology Program.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0602307A, Advanced Weapons Technology.

(U) PE 0602114N, Power Projection Applied Research.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.