PE NUMBER: 0601108F
PE TITLE: High Energy Laser Research Initiatives

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY: 01 Basic Research

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Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	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	11.611	12.223	11.894	12.263	12.339	13.374	13.685	13.917	Continuing	TBD
5097	High Energy Laser Research Initiatves	11.611	12.223	11.894	12.263	12.339	13.374	13.685	13.917	Continuing	TBD

Note: In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the High Energy Laser Joint Technology Office.

(U) A. Mission Description and Budget Item Justification

This program funds basic research aimed at developing fundamental scientific knowledge to support future Department of Defense (DoD) High Energy Laser (HEL) systems. HEL 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 ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DoD effort in HEL science and technology conducted by the HEL Joint Technology Office. In general, efforts funded under this program are chosen for their potential to have a broad impact on multiple HEL systems and 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. The program funds theoretical, computational, and experimental investigations.

This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the DoD invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	11.961	12.331	12.467	12.716
(U)	Current PBR/President's Budget	11.611	12.223	11.894	12.263
(U)	Total Adjustments	-0.350	-0.108		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.108		
	Congressional Increases				
	Reprogrammings				
	SBIR/STTR Transfer	-0.350			

(U) Significant Program Changes:

In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the High Energy Laser (HEL) Joint Technology Office (JTO).

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C. Performance Metrics
Under Development.

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	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5097	High Energy Laser Research Initiatves	11.611	12.223	11.894	12.263	12.339	13.374	13.685	13.917	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds basic research aimed at developing fundamental scientific knowledge to support future Department of Defense (DoD) High Energy Laser (HEL) systems. HEL 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 ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DoD effort in HEL science and technology conducted by the HEL Joint Technology Office. In general, efforts funded under this program are chosen for their potential to have a broad impact on multiple HEL systems and 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. The program funds theoretical, computational, and experimental investigations.

This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the DoD invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Conduct fundamental research in solid state lasers focused on breaching the cost, power, and efficiency barriers to achieving the promise of simplified logistics, platform integration, and man-machine interface.	3.038	2.713	2.743	2.773

(U) In FY 2004: Conducted research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with the ability to operate at high temperatures, athermal laser gain media, modular and scalable architectures for laser power scaling, means of increasing efficiency in excess of 20%, materials that can operate in harsh environments, and corrections for thermally induced distortions in gain media. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with the ability to operate at high temperatures, athermal laser gain media, modular and scalable architectures for laser power scaling, means of increasing efficiency in excess of 20%, materials that can operate in harsh environments, and corrections for thermally induced distortions in gain media. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to

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receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with the ability to operate at high temperatures, athermal laser gain media, modular and scalable architectures for laser power scaling, means of increasing efficiency in excess of 30%, materials that can operate in harsh environments, and corrections for thermally induced distortions in gain media. Research focuses on ceramic gain material fabrication methods, low absorption laser gain media, laser-diode pump sources, fiber lasers, and vertical external cavity laser brightness and power extraction through advancements in cooling and fabrication techniques. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas begun during FY 2002 will continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with the ability to operate at high temperatures, athermal laser gain media, modular and scalable architectures for laser power scaling, means of increasing efficiency in excess of 30%, materials that can operate in harsh environments, and corrections for thermally induced distortions in gain media. Research focuses on ceramic gain material fabrication methods, low absorption laser gain media, laser-diode pump sources, fiber lasers, and vertical external cavity laser brightness and power extraction through advancements in cooling and fabrication techniques. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(U)

(U) MAJOR THRUST: Conduct fundamental research in high-power, lightweight optics.	1.606	1.795	1.584	1.719

(U) In FY 2004: Conducted research in areas of interest including basic materials and fabrication techniques, large optics lightweight structure and deployment concepts, high energy laser (HEL) optical coatings, multipurpose materials. (e.g., wave front correction combined with aperture adjustment), and control mechanisms. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including basic materials and fabrication techniques, large optics lightweight structure and deployment concepts, HEL optical coatings, multipurpose materials. (e.g., wave front correction combined with aperture adjustment), and control mechanisms. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including basic materials and fabrication techniques,

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large optics lightweight structure and deployment concepts, high energy laser (HEL) optical coatings, multipurpose materials (e.g., wave front correction combined with aperture adjustment), and control mechanisms. Develop negative thermal expansion optical coating materials to match zero expansion substrates and measure thermal and strain responses of these coatings. Investigate heat transfer in micromachined adaptive mirrors. Develop methods to fabricate, measure, align, and coat large off axis aspherical optics. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas begun during FY 2002 will continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including basic materials and fabrication techniques, large optics lightweight structure and deployment concepts, HEL optical coatings, multipurpose materials (e.g., wave front correction combined with aperture adjustment), and control mechanisms. Develop negative thermal expansion optical coating materials to match zero expansion substrates and measure thermal and strain responses of these coatings. Investigate heat transfer in micromachined adaptive mirrors. Develop methods to fabricate, measure, align, and coat large off axis aspherical optics. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(U)

(U)	MAJOR THRUST: Conduct research focused on the scientific concerns associated with atmospheric beam control including atmospheric characterization in aerial, battlefield, and maritime-like environments. These efforts could lead to substantial increases in the lethality of HEL systems without the need for significantly increased power levels.	0.680	1.110	1.122	1.135

(U) In FY 2004: Conducted research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the

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presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Research focuses on new methods for wave front control, imaging and tracking through turbulence, and modeling and simulation of beam propagation. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Research focuses on new methods for wave front control, imaging and tracking through turbulence, and modeling and simulation of beam propagation. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(U)

(U)	MAJOR THRUST: Conduct fundamental research in chemical lasers to improve the understanding of the processes necessary for the realization of truly closed cycle, lightweight, high-power, continuously operating chemical lasers.	0.792	1.426	1.209	1.341

(U) In FY 2004: Conducted research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser architectures. Measured chemical kinetics for an all gas phase chemical laser and studied plasma physics of an electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser architectures. Measure chemical kinetics for an all gas phase chemical laser and study plasma physics of an electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above

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research areas that were begun during FY 2002 will continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(U)

(U)	MAJOR THRUST: Conduct fundamental research in high-average-power ultra-short-pulse free electron lasers to significantly increase the average power obtainable by ultra-short-pulse free electron lasers, while decreasing relative size and cost.	2.655	1.480	1.496	1.513

(U) In FY 2004: Conducted research in areas of interest including high-current devices and control methods, higher damage threshold resonator optics, advanced optical cavity designs for high power and compact spaces, and design methods for scaling free electron lasers to reach multi-megawatt class average power levels. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including high-current devices and control methods, higher damage threshold resonator optics, advanced optical cavity designs for high power and compact spaces, and design methods for scaling free electron lasers to reach multi-megawatt class average power levels. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser architectures. Measure chemical kinetics for an all gas phase chemical laser and study plasma physics of an electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser architectures. Measure chemical kinetics for an all gas phase chemical laser and study plasma physics of an electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative

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program, areas that were begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(U)

(U)	MAJOR THRUST: Conduct fundamental research in modeling and simulation for high energy lasers (HEL).	1.140	1.479	1.496	1.513

(U) In FY 2004: Continued development of models and simulation techniques to achieve a balance between high-fidelity technical analyses, engineering trade studies that allow analyses of a wide range of systems, and analyses of high energy laser systems' military utility in a broad range of missions. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 continued to receive funding.

(U) In FY 2005: Continue development of models and simulation techniques to achieve a balance between high-fidelity technical analyses, engineering trade studies that allow analyses of a wide range of systems, and analyses of HEL systems' military utility in a broad range of missions. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Continue development of models and simulation techniques to achieve a balance between high-fidelity technical analyses, engineering trade studies that allow analyses of a wide range of systems, and analyses of HEL systems' military utility in a broad range of missions. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of modeling and simulation to achieve a balance between high-fidelity technical analyses, engineering trade that allow analyses of a wide range of systems, and analyses of HEL system's military utility in a broad range of missions. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards. Conduct proposal call for FY 2007 new starts.

(U)

(U)	MAJOR THRUST: Conduct fundamental research in beam control component technology to improve high energy laser (HEL) systems.	1.700	2.220	2.244	2.269

(U) In FY 2004: Continued to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles, and technology to fabricate conformal HEL windows for tactical air vehicles. Developed wavefront sensors that are insensitive to high scintillation environments and prepare to benchmark performance in a simulated high scintillation environment. Established a government optical

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metrology capability to precisely measure adsorption and reflectivity of optical coatings. Developed methods for discrimination, pointing, and tracking in high clutter using three-dimensional imaging. Continued to develop characterizations that concentrate on understanding atmospheric limitations in low-altitude tactical scenarios in order to increase the lethal range. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continued to receive funding.

(U) In FY 2005: Continue to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles, and technology to fabricate conformal HEL windows for tactical air vehicles. Develop wavefront sensors that are insensitive to high scintillation environments and prepare to benchmark performance in a simulated high scintillation environment. Establish a government optical metrology capability to precisely measure adsorption and reflectivity of optical coatings. Develop methods for discrimination, pointing, and tracking in high clutter using three-dimensional imaging. Continue to develop characterizations that concentrate on understanding atmospheric limitations in low-altitude tactical scenarios in order to increase the lethal range. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Continue to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles. Develop technology to fabricate conformal HEL windows for tactical air vehicles. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Continue to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles. Develop technology to fabricate conformal HEL windows for tactical air vehicles. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards. Conduct proposal call for FY 2007 new starts.

(U)	Total Cost	11.611	12.223	11.894	12.263

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

	FY 2004 Actual	FY 2005 Estimate	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.										
(U) PE 0602890F, High Energy Laser Research.										
(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.										

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(U) D. Acquisition Strategy

Not Applicable.