Exhibit R-2a, RDT&E Project Justification	Date: February 2003
Appropriation/Budget Activity RDT&E, Defense Wide/BA 3	Project Name and Number ***High Energy Laser Advanced Development** **PE 0603924D8Z**

Cost ($ in millions)	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	F 2008	FY 2009
Total Program Element (PE) Cost	15.842	13.086	0	0	0	0	0	0
High Energy Laser Initiative/P924	15.842	13.086	0	0	0	0	0	0

A. Mission Description and Budget Item Justification:

*** Beginning in FY 2004, High Energy Laser advanced Development program management and execution responsibilities will be transferred to the Air Force under PE-0603924F and will result in a more appropriate policy-level role for OSD.**

(U) BRIEF DESCRIPTION OF ELEMENT

U) This program element funds High Energy Laser (HEL) advanced technology development aimed at translating technology solutions for broadly defined military problems into demonstrated performance pay-offs, increased capabilities, increased supportability, or increased affordability. HEL weapons systems have many potential advantages, including speed-of-light time-to-target, high precision, nearly unlimited magazine depth, low cost per kill, and reduced logistics requirements because of no need for stocks of munitions or warheads. As a result, HELs have the potential to perform a wide variety of military missions, including some that are impossible, or nearly so, for conventional weapons. These include 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. Research conducted under this program element develops and demonstrates the technology necessary to enable these and other HEL missions.

(U) This program element is part of an overall DOD initiative in HEL science and technology being conducted by the HEL Joint Technology Office (JTO). The goals of this HEL JTO-funded research are to provide the technology to make HEL systems more effective and also to make them lighter, smaller, cheaper, and more easily supportable on the battlefield. In general, efforts funded under this program element are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions. As a result of this focus and of close coordination with the military departments and defense agencies, this program element complements other DOD HEL programs that are directed at more specific Service and agency needs.

(U) 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. Under this program element these technologies are integrated and tested in sub-scale demonstration systems or sub-systems. Research is conducted by Government laboratories and industry, often teamed together. The program element funds integrated theoretical, computational, and experimental investigations. These integrated investigations are structured to convincingly demonstrate the piercing of technology barriers that currently prevent HELs from being fielded as viable weapon systems. In addition, they are structured to permit rapid technology transition. As results become available, DOD will transmit them to appropriate military-department, defense-agency, and industry programs for technology transition, where appropriate.

B. Accomplishments/Planned Program

(U) Pursuant to Congressional direction the DOD has developing a comprehensive, prioritized investment plan for HEL science and technology. This investment plan was developed by the HEL JTO, in coordination with the military departments and the defense agencies. The plan, which was completed by the beginning of FY 2002, will form the basis for the expanded work to be conducted under this program element in FY 2003 and beyond. The HEL JTO coordinates updates and revisions to the plan through the Technology Council (TC). The TC is comprised of S&T executives from the Army, Navy, Air Force, DARPA, MDA, and DTRA. Work will be conducted in solid-state lasers, free-electron lasers, chemical lasers, tactical beam control, lethality, beam control component technology, and modeling and simulation.

	FY2002	FY 2003	FY 2004	FY2005
Solid State Lasers	2.032	5.005	0	0

(U) Solid-State Lasers

(U) **FY 2002 Accomplishments:** Solid-state lasers have potential as future HEL weapon laser devices because they require only electrical energy in order to run, thereby greatly simplifying systems engineering and supportability. These devices have the potential to eliminate the need for munitions resupply on the battlefield in key mission areas such as tactical strike and air defense. Solid-state-laser technology advanced development emphasizes combining fiber-laser modules, scaling up power in diode-pumped lasers, and testing new systems concepts. Results of these activities are key to developing solid-state lasers with weapons-class power levels. Examples of FY 2002 solid-state-laser technology advanced development activities include the following:

- Developing a design, fabricating, and testing an increased diameter, flat mode oscillator module. Developing the conceptual design will verify the system-level advantages, refine specific performance and configuration needs for oscillator modules, and provide a technical direction for integrating oscillator array-based laser devices and HEL systems.
- Developing power-scaled self-imaging WG lasers which is a critical step on the path to the development of MW-class phased arrays

(U) **FY 2003 Plans:** Solid-state-laser work will focus on phasing of fiber lasers, the design and manufacture of reliable diode lasers as pump sources, and the thermal control of laser media. There were two advanced technology development projects that began in this thrust area in FY 2002. The efforts were selected based on the competitive evaluation of proposals submitted under the BAA solicitation to industry. The technical efforts that began in FY 2002 are expected to continue in FY 2003. The projects from this thrust area are as follows: High Power Illuminator and Rectangular Self-Imaging Waveguide Lasers for High Power Phased Arrays.

A major focus for FY 2003 is the Joint-High Power Solid State Laser (Joint HPSSL) project. The objective is accelerate the demonstration of the Solid State Laser at initial weapon grade power levels. The power scaling will be 25kW in two years leading to 100kW in an additional two years.

(U) **FY 04 – FY 05 Plans:** Solid-state-laser demonstration. Assemble successful pieces from individual applied-research projects (e.g., reliable pump diode lasers, diode-laser drivers, thin-disk amplifiers, phase-conjugate mirrors, mist cooling) into a demonstration sub-system scalable to weapons power levels.

	FY 2002	FY 2003	FY 2004	FY 2005
Beam Control Technology	9.767	3.874	0	0

(U) Beam Control Technology

(U) **FY 2002 Accomplishments:** Beam-control technology advanced development centers on those technologies directly applicable to surface, air, and space mission areas, as well as development of supporting technologies. 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. Examples of FY 2002 beam-control technology development activities include the following:

- Developing and assembling the hardware and software and ready them for the functional and performance testing of the Transform Wavefront Sensor (TWS) prototype using a set of phase plates to simulate the scintillated environment. The test data will then be analyzed and reported. Parallel to the testing and data analysis, the development of a plan for closed-loop testing or field testing for further assessment of application and utility of the prototype TWS will be completed
- Developing and assembling the hardware for the functional and performance testing of the Dual Stage Deformable Mirror prototype.
- Developing more sophisticated advanced HEL optical coating technology techniques. These efforts are focused on developing optical coating methods that are more environmentally robust, have a significant reduction in scatter, and produce a smother substrate surface than the current methods

(U) **FY2003 Plans:** Tactical beam control work will focus on the development and testing of techniques for pointing and tracking in cluttered tactical backgrounds, the development and testing of thermal-blooming compensation and turbulence compensation in tactical scenarios, and demonstrating beam control on appropriate tactical platforms. Beam control component technology efforts will focus on improving components that will be capable of supporting multiple HEL missions. This area will also help enhance the fragile manufacturing base in this critical area. . There were several advanced technology development projects that began in this thrust area in FY 2002. The efforts were selected based on the competitive evaluation of proposals submitted under the BAA solicitation to industry. The technical efforts that began in FY 2002 are expected to continue in FY 2003. The projects from this thrust area are as follows: Micromachined Mirrors, Lightweight Gas Fusion ULE Mirror Substrates, Advanced HEL Optical Coating Technology Development, High Performance Wavefront Sensor and Target in the Loop Beam Control.

	FY 2002	FY 2003	FY 2004	FY 2005
Free Electron Lasers	0.864	1.500	0	0

(U) Free-Electron Laser

(U) **FY 2002 Accomplishments:** Free-electron laser (FEL) advanced development focus on technologies to scale to high power and technologies to permit FELs to be fielded on military platforms. Specifically, the FY 2002 FEL activities included the following:

- Developing the enabling technologies, which will support the transition of Free Electron Laser (FEL) Systems from the laboratory to the Armed Forces, as an operational Directed Energy Weapon

(U) **FY 2003 Plans:** Free-electron-laser (FEL) work will focus on technologies to scale to high power and technologies to permit FELs to be fielded on military platforms. There were advanced technology development projects that began in this thrust area in FY 2002 from both Industry and Service & Agency. The efforts were selected based on the competitive evaluation of proposals submitted under the BAA solicitation to industry and the Service & Agency Call for Proposals. The technical efforts that began in FY 2002 are expected to continue in FY 2003. The projects from this thrust area are as follows: a project managed by the Navy called Simulation of High Efficiency Phase Displacement Undulators and Multiphoton Atmospheric Effects and a contract effort being performed by Northrop Grumman.

	FY 2002	FY 2003	FY 2004	FY 2005
Chemical Lasers	1.970	2.007	0	0

(U) Chemical Laser

(U) **FY 2002 Accomplishments:** Chemical-laser advanced technology efforts concentrate on developing improved predictive and design capabilities, new chemical-laser concepts, and higher performance and more supportable chemical-laser technologies. Despite the fact that chemical lasers are the most mature of the HEL laser device technologies, further technology development has the potential to greatly enhance their viability as weapon systems. Results of these activities will result in chemical lasers that are lighter and more affordable. Examples of FY 2002 chemical-laser technology advanced development activities include the following:

- Developing more sophisticated computational models for accurate performance prediction, thereby greatly improving design capabilities for future Hydrogen Fluoride/Deuterium Fluoride (HF/DF) and Chemical Oxygen Iodine (COIL) chemical lasers, particularly in the critical area of mixing nozzle design
- Designing, testing, and fabricating advanced mixing nozzles on HF/DF laser devices, thereby improving performance, reducing weight, and increasing effective magazine size on future space-based and ground-based HEL weapon systems
- Installing and testing a 20 kilowatt closed-cycle (sealed exhaust) COIL device as a means of assessing closed cycle COIL performance and supporting design of future closed-cycle chemical lasers, thereby offering the potential for chemical lasers that can reuse their chemical supplies, which greatly improves their supportability
- Designing, fabricating, and testing a novel means of delivering iodine chemicals to a COIL laser system in a way that eliminates the need for complex chemical tanks, thereby reducing weight and increasing reliability of future airborne chemical-laser-based HEL weapon systems, as well as simplifying iodine-associated logistics requirements

(U) **FY 2003 Plans:** Chemical-laser research will include efforts to develop COIL lasers appropriate for space-based and tactical applications. There were several advanced technology development projects that began in this thrust area in FY 2002. The efforts were selected based on the competitive evaluation of proposals submitted under the BAA solicitation to industry. The technical efforts that began in FY 2002 are expected to continue in FY 2003. The projects from this thrust area are as follows: Closed Cycle Chemical Laser Technology, MEMS Chip Based High Power Chemical Modules and EC COIL Reagent Production Development.

	FY 2002	FY2003	FY 2004	FY2005
Modeling and Simulation	1.209	0.700	0	0

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(U) Modeling and Simulation

(U) **FY 2002 Accomplishments:** Modeling and Simulation advanced technology efforts are focused on proving a fully realistic model of end-to-end system performance, from birth of photons in the laser to their death at the target, thereby improving the design of HEL systems and reducing the need for expensive field testing. Specifically, the FY 2002 efforts include:

- Developing an easy-to-use, fast running, non-proprietary HEL system engagement simulation with the ability to predict M on N performance of present and future HEL system concepts
- Developing a generalized HEL systems modeling tool to characterize end-to-end system performance of many different HEL weapon constructs to enhance the rapid transition from HEL technology to HEL systems warfighting employment

(U) **FY 2003 Plans:** Modeling and simulation efforts will be increased with the goal of providing a fully realistic model of end-to-end system performance, from birth of photons in the laser to their death at the target, thereby improving the design of HEL systems and reducing the need for expensive field testing. There were two advanced technology development projects that began in this thrust area in FY 2002. The efforts were selected based on the competitive evaluation of proposals submitted under the BAA solicitation to industry. The technical efforts that began in FY 2002 are expected to continue in FY 2003. The projects from this thrust area are as follows: HEL Integrated System Model Development and HEL System End-to-End Model Development.

C. Other Program Funding Summary.

D. Acquisition Strategy.