

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology
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COST (\$ In Thousand\$)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	73,277	54,027	41,238	41,660	41,120	41,117	42,102	43,434	Continuing	Continuing
3150 Advanced Optics Technology	20,051	11,442	1,707	1,589	1,715	2,622	2,713	2,815	Continuing	Continuing
3151 High Power Semiconductor Laser Technology	7,640	4,440	6,410	10,043	11,448	9,779	10,118	10,499	Continuing	Continuing
3152 High Power Microwave Technology	19,810	14,347	7,363	7,521	7,601	8,570	8,841	9,112	Continuing	Continuing
3647 High Energy Laser Technology	25,776	23,798	25,758	22,507	20,356	20,146	20,430	21,008	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description and Budget Item Justification** This Advanced Technology Development program demonstrates advanced directed energy and optical imaging concepts. Speed-of-light weapons and long-range, high resolution optical imaging through the turbulent atmosphere offer significant payoffs for many Air Force missions, such as theater missile defense, suppression of enemy air defenses, and control of space. This program has already demonstrated many major technological breakthroughs such as removing significant atmospheric distortions from optical transmissions (e.g., laser beams) and producing small, relatively high power laser diode phased arrays. Major emphasis areas include: high power microwave and high energy laser technologies; long-range optical imaging; and high power laser diodes and diode arrays. Because of the unique effects associated with high power microwaves there are many potential applications ranging from low power disruptions to high power destruction of electronic devices. Thus, a wide range of high power microwave technologies are being developed. Within high energy lasers the emphasis is on developing methods to increase the power on target. This is done by continuing to remove more of the atmospheric degradations and to develop more efficient laser devices. Long-range optical imaging offers high resolution images of space objects from the ground for applications such as satellite status assessments. High power diodes offer great potential for very small optical sources at many wavelengths for applications such as infrared illuminators and infrared countermeasure sources as well as high data rate secure communications. This PE will continue to develop a wide range of directed energy technologies for many DOD applications. Note: Congress added \$27 million for laser radar and excimer technologies in FY 1996 and \$10 million for space laser imaging and \$5 million for laser-induced microwave imaging (these were the efforts under the FY 1996 excimer program) in FY 1997 which explains the perceived decrease in FYs 1998 and out.

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(U) B. <u>Program Change Summary (\$ in Thousands)</u>					
	<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>Total Cost</u>
(U) Previous President's Budget	71,603	41,895	40,148	39,798	Cont
(U) Appropriated Value	74,919	56,895			
(U) Adjustments to Appropriated Value					
a. Congressional/General Reductions	-2,016	-1,671			
b. SBIR	-1,300	-1,145			
c. Omnibus/Other Above Threshold Reprogrammings	-613	-52			
d. Below Threshold Reprogrammings	+2,287				
(U) Current Budget Submit/FY 1998 PB	73,277	54,027	41,238	41,660	Cont
(U) Change Summary Explanation:					
Funding: Changes to this PE since the previous President's Budget are due to budget constraints and priorities within the Science and Technology (S&T) Program.					
Schedule: Not Applicable.					
Technical: Not Applicable.					
(U) C. <u>Other Program Funding Summary</u> Not Applicable.					
(U) D. <u>Schedule Profile</u> Not Applicable.					

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3150
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COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
3150 Advanced Optics Technology	20,051	11,442	1,707	1,589	1,715	2,622	2,713	2,815	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification This project develops advanced optical technologies for locating, identifying, and analyzing distant and/or dim objects. This work supports high energy laser technologies because an imaging subsystem is required for target verification, accurate and sustainable laser beam placement on target, and near-real time damage assessment. Several advanced technologies including nonlinear optics, adaptive optics, and specialized signal processing are being developed. The goal is high quality optical image reconstruction, concentrating on removing turbulent atmosphere-induced distortions. Many of these technologies developed/being developed have significant application to astronomy research.

(U) FY 1996 (\$ in Thousands)

- (U) \$3,113 Develop and demonstrate advanced optical imaging technologies that support applications such as space object imaging.
 - (U) Demonstrated daylight satellite imaging concepts using adaptive optics for atmospheric compensation. This capability dramatically increases the number of satellites imaged each day.
 - (U) Demonstrated a more user friendly, advanced electro-optical exploitation software tool for analyzing images. This software significantly reduces user time required for image analysis.
- (U) \$491 Develop nonlinear optics technologies for non-mechanical corrections in optical imaging.
 - (U) Designed and modeled a laboratory breadboard of an ultra-high resolution, lightweight imaging satellite subsystem using nonlinear optics to compensate for deformations in a large diameter, deployable primary mirror.
- (U) \$88 Perform upgrades/demonstrations to the Maui Space Surveillance System located in Maui, HI.
 - (U) Evaluated the potential of laser imaging, detection, and ranging (LIDAR) technology as a permanent addition to the Maui capabilities for 24-hour space object surveillance and identification.
- (U) \$9,623 Develop active imaging technology with application for excimer lasers.
 - (U) Completed delivery and installation of laser illuminator.
 - (U) Completed active imaging receiver and tracker integration with the 3.5 meter telescope at Starfire Optical Range.
 - (U) Conducted initial active imaging field tests and demonstrations.
 - (U) Evaluated feasibility of active imaging techniques for long-range imaging applications.
- (U) \$6,736 Develop the LIDAR field demonstration.
 - (U) Completed installation of the LIDAR system in the Maui Space Surveillance System. This system provides a high-precision ranging and velocity measurement capability for identifying satellite position location to accuracies of two meters or less.
- (U) \$20,051 Total

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<u>(U) FY 1997 (\$ in Thousands)</u>		
– (U) \$680	Develop and demonstrate advanced optical imaging technologies that support applications such as space object imaging. – (U) Transition technology for daytime imaging of low-earth orbit satellites to the Maui Space Surveillance System 3.67 meter telescope. This capability dramatically increases the number of satellites imaged each day.	
– (U) \$309	Develop nonlinear optics technologies for non-mechanical corrections in optical imaging. – (U) Construct, characterize, and demonstrate a laboratory breadboard of the telescope subsystem for an ultrahigh resolution, lightweight imaging satellite telescope concept which uses nonlinear optics to compensate for deformations in a large diameter deployable primary mirror.	
– (U) \$863	Develop and demonstrate advanced, very long-range optical imaging technologies which increase resolution and data fusion to support missions such as space object identification and ground target identification from space. – (U) Begin development of field hardware to demonstrate feasibility of long-range optical imaging for space object identification/mission payload assessment, extending our reach, for the first time, to geosynchronous altitudes.	
– (U) \$9,590	Develop technologies for active imaging of space objects such as excimer lasers.	
– (U) \$11,442	– (U) Conduct active imaging field tests and demonstrations.	
– (U) \$11,442	Total	
<u>(U) FY 1998 (\$ in Thousands)</u>		
– (U) \$1,156	Develop and demonstrate advanced, very long-range optical imaging technologies which increase resolution and data fusion to support missions such as space object identification and ground target identification from space. – (U) Continue development of field hardware to demonstrate feasibility of long-range optical imaging for space object identification/mission payload assessment, extending our reach, for the first time, to geosynchronous altitudes.	
– (U) \$551	– (U) Demonstrate target identification using multispectral images from space to improve battle damage assessment and allow imagery of targets under all types of camouflage while reducing satellite size, weight, and cost. Develop nonlinear optics technologies for non-mechanical corrections in optical imaging. – (U) Design and model a brassboard based on the FY 1997 telescope subsystem breadboard for characterization in a space environmental chamber to evaluate operational properties.	
– (U) \$1,707	Total	

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<p>(U) <u>FY 1999 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> <li>– (U) \$1,030 Develop and demonstrate advanced technologies which increase resolution and data fusion for very long range optical imaging to support missions such as space object identification and ground target identification from space. <ul style="list-style-type: none"> <li>– (U) Continue development of field hardware to demonstrate feasibility of long-range optical imaging for space object identification/mission payload assessment, extending our reach, for the first time, to geosynchronous altitudes. <li>– (U) Demonstrate fusion of multispectral images gathered in FY 1998 with data from other space assets to improve battle damage assessment, defeat all types of camouflage, and reduce satellite size, weight and cost. <li>– (U) \$559 Develop nonlinear optics technologies for non-mechanical corrections in optical imaging. <ul style="list-style-type: none"> <li>– (U) Construct the ultra-high resolution, lightweight imaging satellite telescope brassboard designed in FY 1998; and test in a space environmental chamber to determine operational properties. <li>– (U) \$1,589 Total 		
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3151
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COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
3151 High Power Semiconductor Laser Technology	7,640	4,440	6,410	10,043	11,448	9,779	10,118	10,499	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification This project continues to yield revolutionary breakthroughs in compact, robust, and affordable laser system technology for a wide range of military applications requiring small compact laser sources with low to moderate optical power. This is a long-term technology development project with both near-term and long-term goals. Near-term goals include developing compact, reliable infrared sources for a range of applications including night vision systems, landing zone markers, remote sensing and covert communication systems. Longer term goals focus on producing compact, significantly higher power sources for military applications including aircraft protection. This project leads the development of and builds upon a wide range of commercial advancements. Commercially available semiconductor lasers are widely used due to their low cost, small size and weight, high reliability, and high efficiency in converting electricity to laser energy. The project preserves these attractive features while continually scaling output to higher powers/efficiencies and/or to military application-specific wavelengths. The project is divided into three technology areas. The first area investigates methods to increase output power from individual laser diodes while increasing power density onto a small spot. Secondly, semiconductor laser array integration methods, which produce a single, high quality laser beam at significantly higher power levels are developed. Thirdly, wavelength-specific laser diodes for military applications are developed. Project scientists/managers also work directly with field users to develop proof-of-capability demonstrations and field tests for these revolutionary laser sources. This technology has many commercial applications, especially for eye-safe lasers.

(U) FY 1996 (\$ in Thousands)

- (U) \$2,563 Develop laser diodes for improved performance/higher power in near-term applications such as illumination, designation, and communication and for incorporation into laser diode array architectures.
 - (U) Demonstrated three watts of continuous output power from a single-mode fiber, improving current semiconductor laser state-of-the-art by a factor of two. This demonstration identified technical issues which must be solved to reach higher power levels for increased space laser communication data rates and increased system security.
 - (U) Demonstrated semiconductor laser devices that will have the potential to be modulated and scaled to higher powers, with payoff to optical communications applications.
- (U) \$2,463 Develop coherent laser diode arrays for improved performance/higher power in applications requiring high power levels.
 - (U) Demonstrated 200 watts continuous power from an array of diode lasers. This laser array, while not phased, is the first step in achieving a 200 watt, continuous power, phased array for high performance aircraft and space asset self-protection system designs.
 - (U) Demonstrated the ruggedness and reliability of a high power system with a one cubic foot laser head. This laser design will demonstrate the feasibility of a compact, high-power laser system.

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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3151
<ul style="list-style-type: none"> - (U) \$1,985 - (U) \$629 - (U) \$7,640 	<ul style="list-style-type: none"> Develop high power laser diodes and diode arrays at alternate wavelengths that will be transitioned to many military applications such as eye-safe optical systems and infrared countermeasures (IRCM). <ul style="list-style-type: none"> - (U) Demonstrated 60 milliwatt electrically pumped diode laser output power at 4 micron wavelength and 80 degrees Kelvin. - (U) Demonstrated lasing of a one watt electrically-pumped laser diode at a wavelength of 3.3 microns. - (U) Demonstrated 425 milliwatts continuous direct diode laser output power at a 3.4 micron wavelength and 80 degrees Kelvin. This laser device may reduce the size, weight, and complexity of sources used in Band 2 IRCM systems. - (U) Demonstrated 3 watts continuous output power from a 2.0 micron wavelength diode laser array operating at room temperature. This device may reduce the size, weight, and complexity of sources used for Band 1 IRCM systems. Investigate applications for these advanced semiconductor laser diodes and diode arrays. <ul style="list-style-type: none"> - (U) Transitioned Pocket Laser Communicator to an industry partner for commercialization. - (U) Continued transition of semiconductor laser technology to multiple users for illumination/designation field applications. Total 	
<p>(U) <u>FY 1997 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$2,420 - (U) \$2,020 - (U) \$4,440 	<ul style="list-style-type: none"> Develop laser diodes for improved performance/higher power in near-term applications such as illumination, designation, and communication and for incorporation into laser diode array architectures. <ul style="list-style-type: none"> - (U) Demonstrate five watts of continuous wave output power from a single-mode fiber, improving current semiconductor laser state-of-the-art by a factor of two. This demonstration will identify technical issues which must be solved to reach higher power levels for increased space laser communication data rates and increased system security. - (U) Demonstrate devices that will have the potential to be modulated and scaled to high powers. Develop coherent laser diode arrays for improved performance/higher power in applications requiring high power levels. <ul style="list-style-type: none"> - (U) Develop phasing methods for the 200 watt continuous output power diode laser array developed in FY 1996. - (U) Demonstrate 100 watts continuous wave output power from a one cubic foot laser head. This laser design will demonstrate the feasibility of a compact, high-power laser system. Total 	

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<u>(U) FY 1998 (\$ in Thousands)</u>		
– (U) \$1,519	Develop laser diodes for improved performance/higher power as sources in near-term applications infrared countermeasures, illumination, designation, and communication and for incorporation into laser diode array architectures.	
	– (U) Demonstrate ten watts of continuous wave output power from a single-mode fiber, improving current semiconductor laser state-of-the-art by a factor of two. This demonstration will form the baseline for advanced space laser communications by reducing optics size, enabling higher data rates, and increasing system security.	
	– (U) Demonstrate devices that will have the potential to be modulated and scaled to higher powers. These devices will provide the enabling technology to extend current and future communication systems for geosynchronous and deep-space operation.	
– (U) \$1,072	Develop coherent laser diode arrays for improved performance/higher power as sources in applications requiring high power levels.	
	– (U) Evaluate design and trade off decisions related to high power semiconductor diode array ruggedness, compactness, and portability for integration into system application designs.	
– (U) \$3,819	Develop semiconductor laser diode and optically-pumped semiconductor lasers for sources to support future advanced infrared countermeasures (IRCM) system upgrades to tactical fixed and rotary-wing aircraft. Development will focus on concepts with the potential for high efficient, compact IR laser sources covering Bands 2 and 4.	
	– (U) Demonstrate two watt coherent peak output power at quasi-continuous wave operation from a single, Band 2 semiconductor diode at an operating temperature of 200 degrees Kelvin. This device will demonstrate the necessary powers needed to jam Band 2 infrared surface-to-air missiles.	
	– (U) Demonstrate two watt coherent peak output at quasi-continuous wave operation from a single, Band 4 optically-pumped semiconductor laser at an operating temperature of 85 degrees Kelvin. The collected data will demonstrate the necessary powers needed to jam Band 4 infrared surface-to-air missiles.	
– (U) \$6,410	Total	
<u>(U) FY 1999 (\$ in Thousands)</u>		
– (U) \$1,981	Develop laser diodes for improved performance/higher power as sources in near-term applications infrared countermeasures, illumination, designation, and communication and for incorporation into laser diode array architectures.	
	– (U) Demonstrate a rugged, fully packaged ten watt continuous wave power breadboard laser device for applications such as laser communications and laser radar.	
	– (U) Identify reliability and failure mode issues to validate advanced high-power, reliable, long-life diode laser systems for military and applications.	

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– (U) \$1,149	Develop coherent laser diode arrays for improved performance/higher power as sources in applications requiring high power levels.	
	– (U) Apply optimization criteria to 100-200 watt class semiconductor diode arrays to minimize size and weight and maximize operating temperature range and vibration, shock, dust, and water/humidity resistance. The application of these parameters to high power arrays will provide system designers a fully fieldable weapon system design which can be incorporated into protection/offensive systems to meet next generation threats.	
– (U) \$6,913	Develop semiconductor laser diode and optically-pumped semiconductor lasers for sources to support future advanced infrared countermeasures (IRCM) system upgrades to tactical fixed and rotary-wing aircraft. Development will focus on concepts with the potential for high efficient, compact IR laser sources covering Bands 2 and 4.	
	– (U) Demonstrate a less than three times diffraction limited beam at one watt peak output power from a single, Band 2 semiconductor diode laser at an operating temperature of 200 degrees Kelvin. This demonstration will provide the necessary beam quality needed to directionally focus the power downrange and jam Band 2 infrared surface-to-air missiles.	
	– (U) Demonstrate a less than three times diffraction limited beam at one watt peak output power from a single, Band 4 optically-pumped semiconductor laser at an operating temperature of 85 degrees Kelvin. This device will demonstrate the necessary beam quality needed to directionally focus the power downrange and jam Band 4 infrared surface-to-air missiles.	
– (U) \$10,043	Total	

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(U) B. <u>Program Change Summary (\$ in Thousands)</u>					
	<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	Total <u>Cost</u>
(U) Previous President's Budget	7,640	4,697	4,229	6,852	Cont
(U) Current Budget Submit/FY 1998 PB	7,640	4,440	6,410	10,043	Cont
(U) Change Summary Explanation:					
Funding: Changes to this project since the previous President's Budget are due to budget constraints and priorities within the Science and Technology (S&T) Program.					
Schedule: Not Applicable.					
Technical: Not Applicable.					
(U) C. <u>Other Program Funding Summary</u>					
(U) <u>Related Activities</u>					
- (U) PE 0602102F, Materials.					
- (U) PE 0602204F, Aerospace Avionics.					
- (U) PE 0602601F, Phillips Laboratory.					
- (U) PE 0602234N, Systems Support Technology.					
- (U) Representatives from Army, Navy, Ballistic Missile Defense Organization, National Laboratories, and Air Force using commands are members of the government review team for this technology.					
- (U) Joint field demonstrations of this technology are ongoing with: the Air Force Pararescue School; the Air Force Special Operations Command; the U.S. Coast Guard; and the U.S. Customs Service.					
- (U) This project has been coordinated through the Project Reliance process to harmonize efforts and eliminate duplication.					
(U) D. <u>Schedule Profile</u> Not Applicable.					
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BUDGET ACTIVITY 3 - Advanced Technology Development					PE NUMBER AND TITLE 0603605F Advanced Weapons Technology				PROJECT 3152	
COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
3152 High Power Microwave Technology	19,810	14,347	7,363	7,521	7,601	8,570	8,841	9,112	Continuing	Continuing
<p>(U) A. Mission Description and Budget Item Justification This project develops high power microwave generation technologies. It also develops a susceptibility/vulnerability/lethality data base to identify potential vulnerabilities of U.S. systems to high power microwave threats and to provide a basis for future offensive and defensive weapons system decisions. Representative U.S. and foreign assets will be tested to understand real system susceptibilities. Both wideband (wide frequency range) and narrowband (very small frequency range) technologies are being developed. The technologies developed in this project will demonstrate the applicability of high power microwaves that can damage/degrade/deny/destroy electronic systems and subsystems for missions such as suppression of enemy air defense, command and control warfare, and aircraft self-protection.</p> <p>(U) FY 1996 (\$ in Thousands)</p> <ul style="list-style-type: none"> - (U) \$1,951 Develop generic high power microwave technology. <ul style="list-style-type: none"> - (U) Continued development of narrowband and wideband high power microwave sources and antennas. - (U) \$500 Evaluate the susceptibility of representative military hardware and software to high power microwave effects. <ul style="list-style-type: none"> - (U) Conducted effects studies of electromagnetic propagation into facilities. - (U) Completed database on various ground and flightline maintenance equipment. - (U) Completed susceptibility report for large U.S. aircraft and began hardening criteria development. - (U) Completed experiments to determine coupling of high power microwave energy into hangers. - (U) \$1,615 Develop suppression of enemy air defense technologies. <ul style="list-style-type: none"> - (U) Conducted low power coupling and high power damage experiments on selected integrated air defense assets. - (U) Refined system parameter requirements to guide technology development. - (U) \$2,000 Develop aircraft self-protection technologies. <ul style="list-style-type: none"> - (U) Downselected high power microwave wideband source and began source/antenna brassboard design. - (U) Initiated field test planning for technology demonstration with downselected source. - (U) Conducted vulnerability/susceptibility testing and dynamic simulations of three guided missiles. - (U) \$11,070 Develop the laser-induced microwave emissions related technologies including excimer laser technology. <ul style="list-style-type: none"> - (U) Developed an integrated response model of the laser-induced microwave emissions phenomenon. - (U) Conducted laboratory and field experiments on operational systems to quantify effects and compare with models and predictions. - (U) Developed conceptual designs that will satisfy military mission requirements. Construct critical hardware and conduct feasibility experiments of laser-induced microwave emissions applications. - (U) Quantified the physical mechanisms associated with this technology such as coupling mechanisms. 										
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– (U) \$1,722	Develop command and control warfare technologies.	
	– (U) Continued development of compact wideband sources and antennas for both damage and disruption missions.	
	– (U) Performed limited in situ experiments on command/control/communications equipment in building/facilities.	
	– (U) Extended materials studies to in situ effects applications.	
– (U) \$952	Develop high power microwave space control technologies.	
	– (U) Completed broad-level application concept studies.	
	– (U) Completed and reported on vulnerability assessment of two satellite receivers and two satellite imaging subsystems.	
– (U) \$19,810	Total	
(U) FY 1997 (\$ in Thousands)		
– (U) \$3,125	Develop suppression of enemy air defense technologies.	
	– (U) Conduct experiments on selected integrated air defense assets.	
	– (U) Complete detailed systems engineering specifications for high power microwave suppression of enemy air defenses weapon concept.	
	– (U) Complete explosive pulse power development for suppression of enemy air defenses weapon concept.	
	– (U) Complete source development for suppression of enemy air defenses weapon concept.	
– (U) \$3,004	Develop aircraft self-protection technologies.	
	– (U) Complete high power microwave hardening criteria evaluation for large U.S. aircraft.	
	– (U) Complete required electromagnetic hardening on range assets used for technology demonstration field test.	
	– (U) Continue development of wideband high power microwave brassboard for field demonstrations.	
	– (U) Conduct laboratory experiments on missiles to identify alternative/enhanced kill mechanisms.	
	– (U) Complete technology demonstration field test planning.	
	– (U) Initiate plan to transition technology to large aircraft system program offices.	
– (U) \$1,168	Develop command and control warfare technologies.	
	– (U) Continue equipment characterization of command and control assets.	
	– (U) Expand propagation studies and models for various construction materials/techniques.	
	– (U) Continue development of wideband sources and antennas for command and control warfare applications	
	– (U) Initiate studies of potential delivery and implementation techniques.	
– (U) \$4,795	Develop laser-induced microwave emissions technology.	
	– (U) Validate the integrated response model of the laser-induced microwave emissions phenomenon.	
	– (U) Complete experiments, begun in FY 1996, on operational systems and develop draft hardening specifications.	
	– (U) Complete feasibility experiments and analyze results for various applications.	

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<ul style="list-style-type: none"> - (U) \$500 Develop active denial technology. <ul style="list-style-type: none"> - (U) Begin application concept studies for next-generation technology. - (U) \$ 1,755 Develop high power microwave space control technologies. <ul style="list-style-type: none"> - (U) Complete concept study threat basing mode analysis. - (U) Perform subsystem and component level susceptibility experiments on satellite communication, imaging and control technologies. - (U) Evaluate source technologies for threat demonstration. - (U) \$14,347 Total 		
(U) <u>FY 1998 (\$ in Thousands)</u>		
<ul style="list-style-type: none"> - (U) \$3,191 Develop suppression of enemy air defense technologies. <ul style="list-style-type: none"> - (U) Conduct critical experiments of integrated pulsed power generator and high power microwave source. - (U) Conduct subsystem level effects test of an integrated air defense asset. - (U) Start engineering design of high power microwave suppression of enemy air defenses weapon brassboard. - (U) \$2,404 Develop aircraft self-protection technologies. <ul style="list-style-type: none"> - (U) Complete wideband high power microwave brassboard for technology demonstration field test. - (U) Conduct field experiments for demonstrate self-protect technology. - (U) Complete plan to transition technology to large aircraft systems program office. - (U) Final assessment of wideband high power microwave technology's ability to effectively counter missile threats prior to transition to large aircraft system program offices. - (U) \$1,268 Develop command and control warfare technologies. <ul style="list-style-type: none"> - (U) Expand equipment characterization experiments and effects database. - (U) Begin selection of wideband source and pulse power designs. - (U) Develop delivery and implementation options. - (U) \$500 Develop active denial technology. <ul style="list-style-type: none"> - (U) Continue application concept studies for next-generation technology. - (U) \$7,363 Total 		
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<p>(U) <u>FY 1999 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$3,421 Develop suppression of enemy air defense technologies. <ul style="list-style-type: none"> - (U) Complete high power microwave suppression of enemy air defenses weapon brassboard for technology demonstration in FY 2000. - (U) Continue to conduct experiments on selected integrated air defense asset. - (U) \$2,404 Develop aircraft self-protection technologies. <ul style="list-style-type: none"> - (U) Continue development of wideband high power microwave sources and antennas for aircraft self-protect applications to counter next generation infrared missiles and to expand application to electro-optical, radio frequency, and laser threats. - (U) Demonstrate and integrate self-protection technologies for aircraft applications. - (U) Transition technology to large aircraft system program offices. - (U) \$1,196 Develop command and control warfare technologies. <ul style="list-style-type: none"> - (U) Finalize first wideband source and pulse power design for ground control network application. - (U) Complete equipment characterization of command and control assets. - (U) Continue effects experiments of electromagnetic propagation into command and control facilities. - (U) \$500 Develop active denial technology. <ul style="list-style-type: none"> - (U) Complete application concept studies for next-generation technology. - (U) \$7,521 Total 		
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3647
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COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
3647 High Energy Laser Technology	25,776	23,798	25,758	22,507	20,356	20,146	20,430	21,008	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification This project provides for the development, demonstration, and detailed assessment of technology needed for high energy laser weapons. Near-term focus is on ground-based and airborne high energy laser missions, although the technology developed for this project is directly applicable to most high energy laser applications. Critical technologies demonstrated include: scaleable laser devices, with near-term emphasis on the Chemical Oxygen-Iodine Laser (COIL); optical components; and laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Detailed computational models to establish high energy laser weapon effectiveness and satellite and missile vulnerability will be developed. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most high energy laser applications. The beam control technology developed in this project has a significant benefit to the astronomy community.

(U) FY 1996 (\$ in Thousands)

- (U) \$4,060 Develop and demonstrate high energy laser device components for potential weapon applications.
 - (U) Completed advanced diagnostics development and conduct diagnostic Chemical Oxygen-Iodine Laser (COIL) testing to quantitatively determine the excited oxygen generator yield, water vapor pressure, and laser cavity gas temperature.
 - (U) Evaluated COIL diagnostic data to improve understanding of current COIL device performance and identify areas for further development to improve performance.
 - (U) Began development of hardware to demonstrate efficient wavelength-shifting with a COIL device, to establish the technology base for COIL-based illuminator laser for active tracking.
- (U) \$1,713 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems that are protected against laser threats.
 - (U) Conducted laser vulnerability experiments on satellite subsystems.
 - (U) Began detailed vulnerability analysis on satellite optical payload systems.
 - (U) Began detailed satellite vulnerability assessments using newly incorporated uncertainty method.
 - (U) Assessed the potential of near-term laser countermeasures on satellites.
- (U) \$1,434 Perform atmospheric measurements and characterization of the high energy laser beam propagation environment from ground and airborne platforms.
 - (U) Completed analysis and evaluation of optical measurements collected in high altitude airborne flights during FY 1995. The data was used to validate computer models which predict atmospheric effects on Airborne Laser military effectiveness.

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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3647
<ul style="list-style-type: none"> - (U) \$2,124 - (U) \$16,445 - (U) \$25,776 	<ul style="list-style-type: none"> Develop and demonstrate active imaging technology to support ground-based laser beam control for target verification, aimpoint designation, and damage assessment. <ul style="list-style-type: none"> - (U) Demonstrated feasibility and performance of promising active imaging concepts, using the active imaging receiver developed during FY 1995, coupled to the 3.5 meter telescope at the Starfire Optical Range (SOR). Provides critical design information for advanced optical systems with imaging applications. Perform atmospheric compensation/beam control experiments from ground-based and airborne platforms to support applications ranging from weaponization to space object identification. <ul style="list-style-type: none"> - (U) Completed development and integration of 600 watt laser for active (laser illuminated) 24-hour satellite tracking at SOR. - (U) Demonstrated real-time correction of turbulence-induced track jitter on stars at the SOR's 1.5 meter telescope, establishing basis for laser weapon aimpoint maintenance. - (U) Completed construction of adaptive optics and installation of relay optics system for SOR 3.5 meter telescope. First generation adaptive optics provides initial compensated images and identifies hardware and software issues which need to be addressed to improve atmospheric compensation performance. - (U) Initiated active satellite tracking experiments with 1.0 meter laser beam director and 1.5 meter telescope using 400 watt laser. Experimental results provided data necessary to implement 24-hour tracking capability. - (U) Initiated design of a two laser beacon system for full-scale atmospheric compensation of the 3.5 meter telescope. - (U) Began integrated active tracking/atmospheric compensation experiments in static ground testing simulating the high-altitude, horizontal propagation path for theater missile defense scenarios. - (U) Conducted initial active tracking experiments against boosting missiles at White Sands Missile Range, reproducing realistic target phenomenology for the theater missile defense scenario. Total 	
<p>(U) <u>FY 1997 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$2,970 	<ul style="list-style-type: none"> Develop and demonstrate high energy laser components for potential weapon applications. <ul style="list-style-type: none"> - (U) Demonstrate a 10-20% additional improvement in Chemical Oxygen-Iodine Laser (COIL) performance, based on advanced concepts developed from diagnostic testing and evaluation during FY 1996. - (U) Demonstrate a pulsed, multi-kilowatt COIL device with good beam quality, suitable for high efficiency wavelength-shifting for illuminator applications. 	

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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3647
<ul style="list-style-type: none"> - (U) \$1,468 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems that are protected against laser threats. <ul style="list-style-type: none"> - (U) Continue to conduct laser vulnerability experiments on satellite subsystems. - (U) Continue to perform detailed vulnerability analysis on satellite optical payload systems. - (U) Continue detailed satellite vulnerability assessments on satellites using newly incorporated uncertainty methodology. - (U) Continue assessing the potential of near-term laser countermeasures on satellites. - (U) \$10,070 Perform atmospheric compensation/beam control experiments from ground-based and airborne platforms to support applications ranging from weaponization to space object identification. <ul style="list-style-type: none"> - (U) Initiate development of a two laser beacon system for full scale atmospheric compensation on the 3.5 meter telescope. - (U) Demonstrate real-time compensation of atmospheric turbulence-induced distortions on satellite images. - (U) Continue satellite active tracking experiments to evaluate synergistic effects with atmospheric compensation and demonstrate 24-hour satellite tracking. - (U) Complete testing of first-generation adaptive optics on Starfire Optical Range (SOR) 3.5 meter telescope using stars and satellites. Testing results will identify hardware and software issues which need to be addressed to improve atmospheric compensation performance. - (U) Complete construction of second-generation adaptive optics system to maximize resolution and compensation of the SOR 3.5 meter telescope. - Demonstrate real-time compensated imaging of satellites without laser beacon on SOR 3.5 meter telescope. - (U) \$9,290 Characterize atmospheric attenuation and distortion on laser beam propagation, conduct atmospheric compensation and beam control experiments, and develop an airborne ultra-precision inertial pointing system to enhance boost phase theater ballistic missile tracking. <ul style="list-style-type: none"> - (U) Analyze and evaluate FY 1995 atmospheric optical data that simulates airborne high energy laser operating conditions. - (U) Collect atmospheric aerothermal data for strategic locations worldwide to develop parametric database for high energy laser (operational assessments) analysis. - (U) Correlate atmospheric aerothermal and optical parameters in an analytical model to provide a cost effective method of determining laser weapon effectiveness against specific threats. - (U) Design near full-scale acquisition, tracking, and pointing experiments to demonstrate and validate atmospheric compensation, tracking, and laser beam control techniques against fixed targets and boost phase theater ballistic missiles. The experiments will be conducted at White Sands Missile Range, NM. - (U) Design small-scale laboratory and field experiments to explore innovative atmospheric compensation, tracking, and laser beam control options reducing the technical risk of developing airborne high energy laser weapons. 		
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BUDGET ACTIVITY
3 - Advanced Technology Development

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- (U) \$23,798 Total

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BUDGET ACTIVITY		February 1997
3 - Advanced Technology Development	PE NUMBER AND TITLE	PROJECT
	0603605F Advanced Weapons Technology	3647
<p>(U) <u>FY 1998 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$3,054 Develop and demonstrate high energy laser components for potential weapon applications. <ul style="list-style-type: none"> - (U) Increase fieldability of the Chemical Oxygen Iodine Laser (COIL) for airborne and ground-based weapon systems by examining new nozzle designs, transport gases, and cavity design to increase efficiency, and reduce size and weight. - (U) Demonstrate efficient wavelength shifting of a pulsed, multi-kilowatt, COIL device which would double the range of the targeting system of the airborne and ground based laser weapon systems. - (U) \$2,182 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems that are protected against laser threats. <ul style="list-style-type: none"> - (U) Continue to conduct laser vulnerability experiments on satellite subsystems. - (U) Continue to perform detailed vulnerability analysis on satellite optical payload systems. - (U) Continue detailed satellite vulnerability assessments using newly incorporated uncertainty methodology. - (U) Continue assessing the potential of near-term laser countermeasures on satellites. - (U) \$1,095 Investigate and develop advanced, high energy laser optical components. <ul style="list-style-type: none"> - (U) Continue to develop and evaluate techniques to monitor optical components installed in an operational high-energy laser system. - (U) Continue to optimize deposition techniques and characterization of low absorption, low-scatter optical thin film coatings for uncooled optics and other specialized applications. Transfer technology to industry for scaling. Low absorption, low scatter, durable coatings are critical to the performance of uncooled optics planned for use in future high energy laser systems. - (U) Evaluate the performance of a cooled, transmissive optical element in the Thermal Distortion Test Facility. Determine the distortion due to simulated high-energy laser heating. - (U) \$11,570 Perform atmospheric compensation and laser beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification. <ul style="list-style-type: none"> - (U) Complete development of two-laser beacon system to enable full-scale atmospheric compensation on the 3.5 meter telescope. - (U) Integrate second-generation adaptive optics system on 3.5 meter telescope to improve image quality of observed space objects. - (U) Continue satellite active tracking experiments to evaluate synergistic effects with atmospheric compensation and demonstrate 24-hour satellite acquisition and tracking capability 		
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BUDGET ACTIVITY		PROJECT
3 - Advanced Technology Development	0603605F Advanced Weapons Technology	February 1997 3647
<ul style="list-style-type: none"> - (U) \$7,857 Characterize atmospheric attenuation and distortion on laser beam propagation, conduct atmospheric compensation and beam control experiments, and develop an airborne ultra-precision inertial pointing brassboard to enhance boot phase theater ballistic missile tracking. <ul style="list-style-type: none"> - (U) Conduct near full-scale acquisition, tracking, and pointing experiments that demonstrate and validate atmospheric compensation, tracking, and laser beam control techniques against fixed targets and boost phase theater ballistic missiles. The experiments will be conducted at White Sands Missile Range, NM. - (U) Conduct small-scale laboratory and field experiments to explore innovative atmospheric compensation, tracking, and laser beam control options reducing the technical risk of developing airborne high energy laser weapons. - (U) Implement a sequence of experiments to develop an airborne ultra-precision inertial pointing system which improves pointing accuracy by rejecting vibrations from the aircraft. - (U) \$25,758 Total 		
(U) FY 1999 (\$ in Thousands)		
<ul style="list-style-type: none"> - (U) \$2,729 Develop and demonstrate high energy laser components for potential weapon applications. <ul style="list-style-type: none"> - (U) Continue to improve performance and fieldability of the Chemical Oxygen Iodine Laser to support the transition of the airborne laser weapon system to the operational community. - (U) Conduct high-power laser research for ground and space-based laser systems to insure operation control of space and the tactical and strategic theaters. - (U) \$1,727 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems that are protected against laser threats. <ul style="list-style-type: none"> - (U) Continue to conduct laser vulnerability experiments on satellite subsystems. - (U) Continue to perform detailed vulnerability analysis on satellite optical payload systems. - (U) Continue detailed satellite vulnerability assessments using newly incorporated uncertainty methodology. - (U) Continue assessing the potential of near-term laser countermeasures on satellites. - (U) \$761 Investigate and develop advanced, high energy laser optical components. <ul style="list-style-type: none"> - (U) Continue to evaluate techniques to monitor optical components installed in an operational high-energy laser system. Transfer monitoring equipment to users. Such techniques are useful for predicting performance degradation and/or catastrophic failure of an optical component in an operational high energy laser system. - (U) Continue to optimize very low absorption, low-scatter optical thin film coatings. Transfer technology to industry for scaling. Low absorption, low scatter, durable coatings are critical to the performance of uncooled optics planned for future high-energy laser systems. - (U) Use the cooled, transmissive optical element in imaging experiments to demonstrate its thermal loading capability in an operational system. 		
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology PROJECT 3647	
<ul style="list-style-type: none"> - (U) \$11,425 - (U) \$5,865 - (U) \$22,507 	<ul style="list-style-type: none"> Perform atmospheric compensation and laser beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification. <ul style="list-style-type: none"> - (U) Demonstrate atmospheric compensation of images using dual laser beacon system on 3.5 meter telescope. - (U) Demonstrate compensated laser propagation to satellites on 3.5 meter telescope. - (U) Continue active satellite tracking to investigate phenomena resulting from satellite illumination for various targets and engagements. - (U) Use track jitter compensation with atmospheric compensation and active tracking to point a laser with sufficient accuracy to maintain a selected aimpoint on a satellite target. Characterize atmospheric attenuation and distortion on laser beam propagation, conduct atmospheric compensation and beam control experiments, and develop an airborne ultra-precision inertial pointing brassboard to enhance boost phase theater ballistic missile tracking. <ul style="list-style-type: none"> - (U) Collect atmospheric aerothermal data for strategic locations worldwide to develop parametric database for high energy laser (operational assessments) analysis. - (U) Conduct near full-scale acquisition, tracking, and pointing experiments that demonstrate and validate atmospheric compensation, target tracking, and laser beam control techniques against fixed targets and boost phase theater ballistic missiles. The experiments will be conducted at White Sands Missile Range, NM. - (U) Conduct small-scale laboratory and field experiments to explore innovative atmospheric compensation, tracking, and laser beam control options reducing the technical risk of developing airborne high energy laser weapons. - (U) Perform a sequence of experiments to develop an airborne ultra-precision inertial pointing system to enhance tracking of boost phase missiles. Total 	
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