RDT&E Budget Item Justification Sheet (R-2 Exhibit)							Date**:** February 2005	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 1			R-1 ITEM NOMENCLATURE Insensitive Munitions PE 0602000D8Z					
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Insensitive Munitions	0.000	0.000	5.176	10.285	10.684	10.386	15.535	15.535

A. Mission Description and Budget Item Justification: This program addresses applied research associated with providing the capability for munitions to withstand unplanned stimuli such as heat, shock and impact. The goal is to develop the enabling Insensitive Munition (IM) technologies that will provide the backbone for the Services to leverage as they pull these technologies into their specific weapon programs. This investment strategy was derived from a joint technology roadmap developed by the DoD Insensitive Munitions IPT that examined the IM shortfalls in today's weapons, and focused an investment portfolio on the top 7 DoD weapon technology priorities. Ultimate payoffs to the war fighter include significantly increased platform and crew survivability, increased safety and reduced quantity-distance requirements for munitions storage. Incorporation of IM technology, and the subsequent reduction in hazard classification, can significantly reduce weapon lifecycle costs and reduce the real estate required for munitions storage and handling operations.

B. Program Change Summary:	FY 2004	FY 2005	FY 2006	FY 2007
Previous President's Budget:	0.000	0.000	0.000	0.000
Current FY 2006 President's Budget Submission:	0.000	0.000	5.176	10.285
Adjustments to Appropriated Value:	0.000	0.000	+5.176	+10.285
Congressional Program Reductions:				
Congressional Rescissions:				
Congressional Increases:				
Reprogrammings:				
SBIR/STTR Transfers:				
Other:				
Program Increases:			+5.176	+10.285

C. Other Program Funding Summary: N/A

D. Acquisition Strategy. N/A

E. Performance Metrics: This PE will be incorporated into WE.96, a Defense Technology Objective (DTO) administered by DDRE and subjected to annual review. The DTO also includes additional IM investments from the Army, Navy and Air Force and will enable efforts to be leveraged across all services, while avoiding duplication of efforts.

Exhibit R-2a, RDT&E Project Justification							Date: February 2005	
RDT&E,DW/BA 2				Project Name and Number Insensitive Munitions PE 0602000D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Insensitive Munitions	0.000	0.000	5.176	10.285	10.684	10.386	15,535	15.535

(U) A. Mission Description and Budget Item Justification: The RDT&E effort is a new start (FY 2006) aimed at developing the enabling technologies needed to build weapons in compliance with Insensitive Munitions (IM) requirements established in statute (Title 10, United States Code) and regulation (DoDI 5000.1 and CJCSI 3170.01C). The underlying assumption is that future variants of current weapon systems will have the same, or worse, response to IM stimuli (i.e., they will not improve with the technology available today). New weapon developments will face similar challenges.

B. Accomplishments/Planned Program

Efforts include research and development into the following enabling technologies:

Novel energetic materials and binders including:

Synthesis and scale-up

Crystallization methodologies and constitutive properties of polymeric binders,

Characterization of energetic material defects,

Design of insensitive, high performance rocket motors

Composite and hybrid case materials

Venting concepts and liner materials

High performance and minimum signature propellants

Development of mitigation concepts using eutectics and other novel materials, and

Development of liner materials that provide shock impedance mismatch, gaseous products to over pressurize and vent, and enhanced energy for use in energy balancing concepts.

FY 2006 Plans

FY 2006 Plans: Evaluate, select, and prove novel insensitive high-energy materials, for both warhead propulsion applications, which exploit managed energy release, and are required for improving the lethality and reducing the vulnerability of future gun/missile systems and warheads. Characterize candidate novel insensitive high-energy materials, binders, and liners and additional concepts for mitigating the IM response of candidate systems while maintaining performance. Explore the introduction of additives to propellant formulations to assist in absorbing the energy released during and unplanned exothermic event.

FY2007 Plans

In FY 2007, in addition to those efforts already underway, extend and validate modeling and simulation tools used for design of managed energy systems, and experimentally assess promising materials. Evaluate new and novel methodologies for venting rocket motor and warhead cases, preventing catastrophic energy release.

Exhibit R-2, RDT&E Budget Item Justification						Date: February 2005		
Appropriation/Budget Activity RDT&E, DW/ BA2				R-1 Item Nomenclature Medical Free Electron Laser, PE 0602227D8Z				
Cost ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total PE Cost	17.919	18.322	9.845	10.096	10.392	10.153	10.351	10.591
Medical Free Electron Laser/P483, Subtotal Cost	17.919	18.322	9.845	10.096	10.392	10.153	10.351	10.591

A. Mission Description and Budget Item Justification

(U) The Medical Free Electron Laser (MFEL) program seeks to develop advanced, laser-based applications for military medicine. Free electron lasers (FELs) provide unique pulse features and tunable wavelength characteristics that are unavailable in other laser devices. Thus, FELs broaden the experimental options for the development of new laser-based medical technologies.

(U) This program is focused on developing advanced procedures and equipment for rapid diagnosis and treatment of battlefield-related medical problems. Specific applications under investigation include soft tissue repair, hard tissue surgery, therapies for thermal and chemical burns, warfighter vision correction, photochemical treatment of difficult infectious agents, and new medical imaging modalities. Unique, innovative laser applications will be clinically tested in medical centers, leading to Food and Drug Administration (FDA) approval. There is a high potential for dual use in civilian medicine. Thus far, more than 30 clinical procedures have been developed in several medical specialties, including ophthalmology, orthopedics, thermal and chemical burn treatment, and neurosurgery. Work in these areas will continue in FY 2005 under the current three-year center grants, with the primary focus of the work remaining on the development of militarily relevant laser medicine applications.

(U) Plans include efforts to strengthen interactions of the grantee institutions with military medical research facilities in order to improve both the content of the grant programs and the implementation of new techniques in military medicine.

Exhibit R-2, RDT&E Budget Item Justification	Date: February 2005

B. Program Change Summary:

	FY 2004	FY 2005	FY 2006	FY2007
Previous President's Budget:	18.518	9.668	9.850	10.072
Current FY2006 President's Budget Submission:	17.919	18.322	9.845	10.096
Adjustments to Appropriated Value:	-0.599	+8.654	-0.005	+0.024
Congressional Program Reductions:	-0.139	-0.346		
Congressional Rescissions:				
Congressional Increases:		9.000		
Reprogrammings:				
SBIR/STTR Transfers:	-0.460			
Program Adjustment:			-0.005	+0.024

C. Other Program Funding Summary: Not Applicable

D. Acquisition Strategy: Not Applicable

E. Performance Metrics: Performance in this program is monitored using instances of successful commercialization of new instruments and techniques; the transfer of new clinical methods to regular clinical use; the number, quality and placement of publications in the open scientific literature; and the numbers and content of patent applications filed.

Exhibit R-2a, RDT&E Project Justification						Date: February 2005		
Appropriation/Budget Activity RDT&E, DW/BA 2				Project Name and Number Medical Free Electron Laser, PE 0602227D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Project/Thrust Cost	17.919	18.322	9.845	10.096	10.392	10.153	10.351	10.591

A. Mission Description and Budget Item Justification:

(U) The MFEL Program seeks to develop advanced, laser-based applications for military medicine.

(U) The majority of this program is focused on developing advanced procedures for rapid diagnosis and treatment of battlefield-related medical problems.

(U) A small part of this program is focused on related materials research.

(U) Overall management plans for FY 2005 include continued efforts to strengthen the interactions of the grantee institutions with military medical research facilities in order to improve both the content of the grant programs and the implementation of new techniques in military medicine. Increased emphasis will be placed on investigations of potential photochemical treatments of infectious diseases.

B. Accomplishments/Planned Program

(Cost in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Imaging Technology	4.474	3.951	2.480	2.542

Optical Coherence Tomography (OCT) applications have been developed to assess the clinical status of burns by combining polarization sensitivity for tissue structure and birefringence with Doppler detection to simultaneously measure blood flow in the tissue. Resolution of the extent of the burn can be made to between 2 and 10 um. OCT applications also have been developed for diagnosis and monitoring of surgical repair of orthopedic injuries and injuries to the trachea and respiratory tract using hand-held probes for imaging. Work on improving the resolution and speed of OCT imaging continues, with resolutions down to 1 um shown to be possible with short pulse lasers. Resolution to 3 um has been obtained and an ophthalmic imaging system using this capability has been made, and is in regular clinical use. A 72-fold increase in imaging speed also provides opportunity to detect subtle changes in tissue to improve the management of various injuries. A tunable, monochromatic x-ray system has been developed using the electron beam of a radio frequency accelerator to scatter beams from a terawatt laser, producing the x-rays through an inverse Compton effect. The monochromatic x-ray system provides significantly improved images when compared

with standard x-ray sources. Other potential technologies include a Pulsed Photothermal Radiometry technique that can be used to determine changes in the optical properties of the skin and provide diagnostic information on wound management and absorption on the skin of possible chemical agents, and Photon Migration techniques to non-invasively monitor hemodynamic parameters such as oxy/deoxy-hemoglobin ratios. Optical diagnostic methods based on Raman scattering and terahertz spectroscopy are being studied to detect and rapidly characterize important biomolecules of interest. Optical methods are also being used to investigate molecular processes in cells tagged with microparticles, and the specific capabilities of molecular biosensors. The potential use of near-field infrared microscopy in cellular imaging is also being examined. Plans for 2005 include work on improving the contrast and depth of OCT imaging with emphasis on its use in burn injury, development of new ultrasmall fiber optic endoscopy systems, continued development of monochromatic x-ray and Pulsed Photothermal Radiometry applications, new applications of Near Field Optical Microscopy, and other IR microscopy techniques.

(Cost in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Laser Surgery Methods	2.125	2.576	1.561	1.624

FELs continue to be used in experimental surgery studies in animals and humans. An FEL has been used in the surgical removal of a human brain surface tumor, and in optical nerve sheath fenestration. Experimental surgery studies are developing laser beam delivery endoscopes for the precision surgical requirements of optic nerve repair and neurosurgical treatment of epileptic foci. Studies examining the most effective laser wave length and pulse duration variables for cutting hard tissue and optimizing post-ablation bone regeneration and healing are also in progress. Studies to determine optimal methods for using lasers for properly shaping collagen materials for use in reconstructive surgery are examining the molecular nature and behavior of the collagen during the reshaping process. Proper shape and shape memory of the material are of critical importance in success of reconstruction efforts. Work under this program has also led to the observation of laser effects on chondrocyte regeneration, critical for effective treatment of arthritic degeneration. An effective animal model for study of corneal healing after laser vision correction surgery has been developed, and subsequent work using this model has described important steps to minimize the scarring which can adversely affect vision correction efforts. Plans for 2005 include continuing studies in neurological and ophthalmic surgery applications of lasers, as well as continuing work on optimal laser parameters for dermal and hard tissue cutting and subsequent healing. New efforts will examine the application of laser-based imaging and laser effects on chondrocyte regeneration for orthopedic repair of cartilage.

(Cost in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
General Clinical Medicine Techniques	2.703	3.271	1.580	1.643

The use of photosensitive materials that can bind to cells, become activated on illumination, and cause a subsequent change in cell activity has been shown to have a number of clinical applications. Photosensitive compounds can be used to tag specific bacteria and lead to virtually complete elimination of the organisms. Antibiotic resistant strains remain vulnerable to such photodynamic

therapy. Wounds infected with ordinarily fatal strains of *Psuedomonas* and various *Staphylococcus* organisms were completely healed following treatment with photosensitive compounds. Studies on the effect of using this technique for the treatment of difficult infections such as Leishmaniasis have being initiated and appear promising. Other photosensitive compounds attached to cells have been shown to be able to modulate cellular activity. For example, chondrocytes, activated by light sensitive molecules, have been able to initiate complex processes that prevent inflammatory destruction of collagen explants. Similarly, light absorbing nanoparticles have been shown to affect various properties of cells, including their permiability, which may provide the possibility of controlling cell processes, as well as improving drug uptake and effectiveness. Photochemical controlled tissue bonding studies have led to the development of materials that provide wound closure that is superior to current mechanical or adhesive methods. The photochemical bonding material was first demonstrated in the closure of the flaps generated during laser vision correction surgery. The material, a sensitizing dye that photochemically crosslinks the tissue surfaces, has been used in repair of blood vessels, the cornea and skin. It is now being tested for effectiveness in nerve and tendon repair, and repair of damage to the trachea. In 2005, studies will continue on photochemical bonding of tissue, developing new photosensitizers and methods for their delivery, mechanisms for controlling various cellular activities, and the use of photodynamic therapy in treating infections of selected microorganisms.

(Cost in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Laser/Tissue Interactions and Wound Healing Studies	2.230	2.502	1.471	1.534

A wide range of studies has examined the interactions of laser energy with tissues, cells and biological macromolecules. Models for laser ablation have been developed and used to examine the course of the post-ablation healing process. Studies using the unique single micropulse capability of the Stanford FEL continue and will provide valuable information on the role of wavelength, pulse structure and pulse sequence in the ablation process on the molecular level. Confocal microscopy with subcellular resolution is being used to follow the processes of fibronectin growth and wound closure. Vasodialation, which is an important factor in wound healing, has also been shown to be sensitive to the application of UVA and blue light *in vivo*. Studies examining the effect on wound healing of this phenomenon and its enhancement by norepinephrin, a known vasoconstrictor, are also underway. Studies on laser ablation and the subsequent healing processes will continue in 2005, with a continuing focus on determining tissue viability at the wound site, as this is critical for effective wound management. Work on wound closure using photochemical tissue bonding will also be a significant focus. Vasodilation studies for treating ischemic wounds will also be continued.

(Cost in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Physical and Materials Science Research	0.947	0.908	0.335	0.335

Research on the improvement of the performance and reliability of the FELs is a continuing effort. Such work includes the development of new materials for waveguides through which the laser energy may be routed as well as refinements in the existing laser systems. In addition, basic efforts are carried out using laser-based spectroscopy methods, on the structure and nature of biologically important macromolecules, on the dynamics of various surface-based processes, and on the nature, formation and deposition processes of complex thin films. Continued work on spectroscopy methods, surface-based processes, and the nature and formation of thin films are planned for 2005.

(Cost in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Laser Operations Support	5.440	5.113	2.418	2.418

A major upgrade in the components of the Duke University FEL system has been completed, greatly improving the efficiency and overall capability of the system for research. Protocols for the use of the system are being developed. A total of more than 5,000 hours of beam time has been provided for the use of various scientists at the three FEL facilities combined. Plans for 2005 include continued efforts to improve FEL performance and reliability at each of the FEL sites, and to supply increased beam time for use by investigators in all of the disciplines noted above.

C. Other Program Funding Summary: Not Applicable

D. Acquisition Strategy: Not Applicable

E. Major Performers: Laboratories/Centers:

Beckman Laser Institute, University of California-Irvine, Irvine, CA
Duke University, Durham, NC
Stanford University Picosecond FEL Center, Stanford, CA
Vanderbilt University FEL Center for Research, Nashville, TN
Wellman Laboratories, Massachusetts General Hospital, Boston, MA

Exhibit R-2, RDT&E Budget Item Justification								Date: February 2005
Appropriation/Budget Activity RDT&E, DW BA 2				R-1 Item Nomenclature: Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) 0602228D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
HBCU/MI	19.533	20.767	13.887	14.199	15.325	15.307	15.591	16.000

A. Mission Description and Budget Item Justification:

The Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) program provides infrastructure support in fields of science and engineering that are important to national defense. The DoD Infrastructure Support Program is the only program that encourages participation of small minority schools as well as research institutions. This competitive program provides support through grants or contracts for research, collaborative research, education assistance, instrumentation purchases, and technical assistance. This project competitively supports programs at minority institutions nationwide in following areas:

- Research. The research grants are to further the knowledge in the basic scientific disciplines through theoretical and empirical activities. Collaborative research allows university professors to work directly with military laboratories or other universities.
- Education. Education assistance funds are used by the selected institutions to strengthen their academic programs in science, mathematics, and engineering thereby increasing the number of under-represented minorities obtaining undergraduate and graduate degrees in these fields. These grants provide equipment, scholarships, cooperative work/study opportunities, visiting faculty programs, summer programs, and a variety of other enhancements designed to support students and to encourage them to pursue careers in science, mathematics, and engineering.
- Infrastructure. This program allows the university to purchase from basic laboratory equipment for education program enhancements to highly sophisticated research instruments, such as lasers and spectrometers.
- Technical assistance. These funds are used to design programs to enhance the ability of minority institutions to successfully compete for future Defense funding. The objective is to assist the HBCU/MI community in areas such as proposal writing and administration of grants and contracts.

B. Program Change Summary:

	FY 2004	FY 2005	FY 2006	FY 2007
Previous President's Budget:	20.651	14.192	14.440	14.710
Current FY2006 President's Budget Submission:	19.533	20.767	13.887	14.119
Adjustments to Appropriated Value:	-1.118	+6.575	-0.553	-0.591
Congressional Program Reductions:	-0.594	-0.425		
Congressional Rescissions:				
Congressional Increases:		+7.000		
Reprogrammings:				
SBIR/STTR Transfers:	-0.524			
Other:			-0.553	-0.591

C. Other Program Funding Summary: N/A

D. Performance Metrics:

- Percent of students graduating with undergraduate degrees in Science, Mathematics, Engineering, and Technology fields.
- Percent of students pursuing graduate and Ph.D. degrees
- Number of undergraduate students achieving specified GPA average.
- Number of students participating in the Centers of Excellence for Research and Engineering.
- Number of students working in Defense Laboratories.

Exhibit R-2a RDT&E Budget Item Justification								February 2005
Appropriation/Budget Activity RDT&E, DW / BA2			Project Name and Number Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) 0602228D8Z					
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
HBCU/MI	19.533	20.767	13.887	14.199	15.325	15.307	15.591	16.000

A. Mission Description and Budget Item Justification:

(U) BRIEF DESCRIPTION OF ELEMENT

(U) The Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) program provides infrastructure support in fields of science and engineering that are important to national defense. The DoD Infrastructure Support Program is the only program that encourages participation of small minority schools as well as research institutions. This project competitively supports programs at minority institutions nationwide in following areas:

- Research. The research grants are to further the knowledge in the basic scientific disciplines through theoretical and empirical activities.

- Education. Education assistance funds are used by the selected institutions to strengthen their academic programs in science, mathematics, and engineering thereby increasing the number of under-represented minorities obtaining undergraduate and graduate degrees in these fields.

- Infrastructure. This program allows the university to purchase from basic laboratory equipment for education program enhancements to highly sophisticated research instruments, such as lasers and spectrometers.

- Technical assistance. These funds are used to design programs to enhance the ability of minority institutions to successfully compete for future Defense funding.

B. Accomplishments/Planned Program

(U) HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS PROGRAM

	FY 2004	FY 2005	FY 2006	FY 2007
HBCU/MI	19.533	20.767	13.887	14.199

(U) FY 2004 Accomplishments:

Continued evaluation of the awards made with prior year funds. Developed and released the third electronic broad agency announcement (BAA) for the HBCU/MI FY 2004 solicitation. The solicitation closed on December 18, 2003. The program received it largest number of proposals totaling 233 eligible proposals. These included 178 proposals for research and 55 for instrumentation/equipment. Based on Orders of Merit, 25 grants were awarded. The solicitation afforded the HBCU/MI community an opportunity to acquire 13 research grants and 12 equipment grants to enhance science, mathematics, and engineering (SME) programs and to facilitate the education of students in research areas important to the DoD. The research grants will be supported for one year ranging from $300,000 to $500,000. The equipment grants are for a twelve-month performance period and will range from $50,000 to $200,000. The Army Research Office and the Air Force Office of Scientific Research will execute the awards.

The FY 2004 program also contains two congressional adds which resulted in two separate BAAs. The FY 2004 DoD Appropriations Act added an additional $2.6 million in the HBCU/MI Program for Tribal Colleges and Universities (TCUs). The Army Research Office was designated manager for the special solicitation and allocated $2.400 million after taxes. The BAA closed on April 30, 2004. Sixteen proposals were received. Eight proposals were judged to be worthy of support and eight equipment grants to the TCUs were made ranging from $141,000 to $393,000 and will have a 12 month performance period. Also, in FY 2004 the DoD Appropriations Act added an additional $4.200 million in the HBCU/MI Program for Hispanic Serving Institutions (HSIs). The Army Research Office issued a separate solicitation in April 2004 for HSIs to compete. The BAA closed on July 8, 2004. The Army Research Office received 71 proposals. DoD awarded fifteen grants to HSIs totaling $3.969 million after taxes. Seven equipment grants (ranging from $37,000 to $200,000) and eight research grants (ranging from $240,000 to $499,000) with performance periods of 12 and 36 months respectively.

(U) FY 2005/ FY 2006 Plans:

Continue evaluation of the awards made with prior year funds. In FY 2005/ FY 2006, the HBCU/MI Infrastructure Program will continue to build infrastructure through instrumentation and equipment awards by issuing three separate solicitations; the first one for the Infrastructure Support Program; the second announcement for HSIs, and the third solicitation for TCUs. The objective is to increase the quality of education provided in SME and build HBCU/MIs that currently offer advanced degrees in SME. In FY 2005 a review of the four new Centers of Excellence started in FY 2003 will be conducted to access the number of students participating in

the Centers for science, mathematics, and engineering (SME) the performance of the centers, and the business process used by the centers to ensure the education of students in research and education areas important to the DoD. The FY 2005 and FY 2006 competitions will be for new minority research, education, equipment, and infrastructure building awards.

(U) FY 2007 Plans:

Continue evaluation of awards made with prior year funds. FY 2007 competitions for instrumentation/research equipment, three-five year research projects, undergraduate scholarships and graduate fellowships awards.

C. Other Program Funding Summary: Not Applicable

Exhibit R-2, RDT&E Budget Item Justification							Date: February 2005	
Appropriation/Budget Activity RDT&E., Defense-Wide BA2				R-1 Item Nomenclature: Lincoln Laboratory 0602234D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total PE 0602234D8Z Cost	25.945	24.846	29.914	30.493	31.887	31.715	32.296	32.960
Lincoln Laboratory **P534**	25.945	24.846	26.914	27.493	28.887	28.715	29.296	29.960
Technical Intelligence **P535**	0.000	0.000	3.000	3.000	3.000	3.000	3.000	3.000

A. Mission Description and Budget Item Justification:

(U) The Lincoln Laboratory (LL) Line program is an advanced technology research and development effort conducted through a cost reimbursable contract with the Massachusetts Institute of Technology (MIT). LL is operated as an FFRDC administered by the DoD, and is unique among DoD FFRDC's: the laboratory is operated (under A-21) by MIT with no fee. Thus, the Research Line is the laboratory's only dedicated source of funding for innovative research and development efforts.

(U) The LL Line funds advanced research activities that directly lead to the development of new system concepts, new technologies, and new components and materials. These activities enable the DoD to address latent technology needs that affect a broad spectrum of missions, services, and transformational operational capabilities. The Lincoln Laboratory Research Line contributed foundation technologies to two systems which received the 2002 Packard Excellence in Acquisition Award: (1) the Bio-aerosol sensing and micro-laser technologies were transferred to industry and are in production for the Joint Biological Defense Sensor (JBPDS), and (2) the Free-space optical communications technologies were used in the GeoLite optical communications satellite demonstration system. The GeoLite demonstration provides the underpinnings of the Transformation Communications Architecture. Other recent successes include a compact 3D imaging laser radar that uses unique photon-counting avalanche photodiode arrays and has demonstrated, in the DARPA Jigsaw program, high quality imagery of targets obscured by dense foliage or camouflage, and a biosensor that uses genetically engineered immune cells and has demonstrated the ability to identify major bio-warfare agents in under two minutes with high sensitivity and low false alarm rate.

(U) The LL Line program currently has impact in five core technology thrusts:

(U) Surveillance Systems and Decision Support, with emphasis on revolutionary sensing techniques, algorithms for detecting and recognizing battlefield targets both in the clear and in difficult deployments, and high performance computing to enable rapid prosecution of suspected targets. The advanced sensing techniques include simultaneous multi-mode operation to improve the ability to monitor multiple ground surveillance sites.

These improvements are complemented with innovations in algorithm techniques to efficiently extract information from multi-modalities operation. Develop signal processing computing architectures to respond in real-time on-board the sensor platform. The multi-modality sensing is fused with archived data to improve target ID and classification. These techniques will enable dramatic improvements in ground surveillance targeting, identification and classification.

(U) Communications and Networks, with emphasis on high bandwidth, low probability of intercept, jam resistant communication links and machine-to-machine applications that operate over a network of these links. Links include advanced antenna designs, RF technology, and high-rate fiber and free-space optical communications systems. Develop network protocols (including for mobile users with lightweight transceivers) for "socketing" sensors into the network and the interconnection of these very disparate modalities into a global defense network that can truly realize the vision of a "from sensor to decider to shooter" communications infrastructure. Develop unique intrusion detection/response techniques to protect computer networks and applications that fuse information for presentation to decision makers.

(U) Applied Optics, including advanced 3D laser radars (ladars), high-energy-laser (HEL) technology, and active and passive hyper spectral imaging (HSI). The ladar efforts develop and test advanced concepts in both 3D direct detection ladar and in coherent ladar. These ladar efforts are providing the enabling technology for a variety of new DoD systems, including target identification systems as part of the Army Future Combat Systems (FCS) and discrimination systems for advanced ballistic-missile-defense (BMD) seekers. The HEL technology efforts focus on improving beam control for stressing atmospheric conditions (e.g., tactical HELs in near-surface engagements) and on developing novel, more efficient lasers to reduce the size and weight of future HEL systems. The HEL efforts will potentially enable future HEL systems, such as Block upgrades to the Airborne Laser (ABL) and an Advanced Tactical Laser with a solid-state laser as the weapon laser. The HSI efforts have been principally focused on active sensing and the combining of HSI sensing with ladar sensing.

(U) Advanced Electronics Technology, with emphasis on development of materials, devices, and subsystems utilizing microelectronic, photonic, biological, and chemical technologies to enable new system approaches to DoD sensors. Specific focus areas include work on high performance focal plane arrays such as 3-D imaging and photon-counting arrays for ISR and advanced missile seekers, high efficiency, high brightness semiconductor lasers for active illuminators, countermeasures, and other directed energy applications, new sensors for rapidly detecting and identifying low concentrations of bio-warfare agents, components for miniaturized RF systems for electronic intelligence and communications, and high-speed, radiation hard, ultra-low power analog and digital circuits tailored for DoD applications.

(U) Bio-Chem Defense, including technology, analysis and systems aimed at defeating enemy use of biological and chemical weapons, and including efforts in agent detection, diagnosis and treatment, and informatic systems. Agent detection is aimed at rapid, accurate, and sensitive methods for collecting, analyzing and reporting the presence of biological and/or chemical agents, and involves analysis of chemical and physical properties of the agents, such as DNA, RNA, antigens and various other proteins. Both stand-off (remote) detection and point sensing are included. Treatment methodologies include novel anti-microbial techniques that open new immune-system pathways for biological-warfare agent-induced diseases that might otherwise be untreatable. Bioinformatics systems are specifically targeted at the analysis of micro array images, applying first to

pattern recognition techniques for agent identification, but expanding into large integrated systems.

(U) Supporting these five core technology thrusts is a new work effort titled Technical Intelligence. Technical Intelligence combines efforts in two areas: 1) from the university community through the JASONs program and 2) through information on the technology maturation and development throughout the rest of the world.

1. (U) JASONs is a group of approximately 50 appropriately cleared experts who provide detailed independent technical assessment of the most difficult technological problems. JASON members are mostly fully tenured professors in physics, mathematics, engineering, and hold active SCI-level clearances. Output from JASON studies are provided to levels up to the Secretary of Defense and their studies shape programmatic and technical decisions involving literally hundreds of millions of dollars. JASONs were previously funded through university research programs, but their level of technology maturity is appropriate for incorporation into Applied Research.

2. (U) Technical Intelligence will support detailed understanding of technology advancement in important scientific area and other scientific disciplines such as nanotechnology, directed energy and propulsion. Some details are classified, but one effort, called Global Dialogue on Emerging Science and Technology will be jointly sponsored by DOD, Department of State, and CIA will give very detailed insight in such topics as Software Engineering in India, Nanotechnology in South East Asia, European Laser development, for example. This information will in turn assist in development of US capabilities.

B. Program Change Summary:

	FY 2004	FY 2005	FY 2006	FY 2007
Previous President's Budget:	26.830	25.441	26.854	27.367
Current FY 2006 President's Budget Submission:	25.945	24.846	29.914	30.493
Adjustments to Appropriated Value:	-0.885	-0.595	+3.060	+3.126
Congressional Program Reductions:	-0.204	-0.595		
Congressional Rescissions:				
Congressional Increases:				
Reprogrammings:				
SBIR/STTR Transfers:	-0.681			
Other:				
Program Increase:			+3.060	+3.126

C. Other Program Funding Summary: N/A

D. Acquisition Strategy: N/A

E. Performance Metrics: (U) Performance in the Lincoln Laboratory program is managed with a sustained and agile focus on matching emerging technology opportunities to latent national security needs. As a DoD FFRDC, Lincoln Laboratory is focused on increasing the Technology Readiness Level (TRL) of the applicable enabling technologies to support critical new DoD capabilities. An essential element of a sustained thrust is the demonstration of new systems capability in relevant (field) environments. Each thrust is structured to bring the new capability up to the TRL 5-6 range. At the same time, continuing adaptation of the emerging enabling technologies (at the TRL 2-3) assures that the critical national systems expertise is enhanced and sustained, so that additional innovations can quickly be transitioned to the services and industry as rapidly as possible. Performance in the Technical Intelligence program is managed to produce results in two areas: 1) timely advice from seasoned, tenured university representatives through the JASONs program and 2) critical insight on the technology maturation and development throughout the rest of the world.

Exhibit R-2a, RDT&E Project Justification							Date: February 2005	
Appropriation/Budget Activity RDT&E, Defense-Wide BA2				Project Name and Number Lincoln Laboratory 0602234D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Lincoln Laboratory **P534**	25.945	24.846	26.914	27.493	28.887	28.715	29.296	29.960

A. Mission Description and Budget Item Justification:

(U) The Lincoln Laboratory (LL) Line program is an advanced technology research and development effort conducted through a cost reimbursable contract with the Massachusetts Institute of Technology (MIT). The LL Line funds advanced research activities that directly lead to the development of new system concepts, new technologies, and new components and materials, with impact in five core technology thrusts:

(U) Surveillance Systems and Decision Support, with emphasis on revolutionary sensing techniques, algorithms for detecting and recognizing battlefield targets both in the clear and in difficult deployments, and high performance computing to enable rapid prosecution of suspected targets.

(U) Communications and Networks, with emphasis on high bandwidth, low probability of intercept, jam resistant communication links and machine-to-machine applications that operate over a network of these links

(U) Applied Optics, including advanced 3D laser radars (ladars), high-energy-laser (HEL) technology, and active and passive hyper-spectral imaging (HSI).

(U) Advanced Electronics Technology, with emphasis on development of materials, devices, and subsystems utilizing microelectronic, photonic, biological, and chemical technologies to enable new system approaches to DoD sensors.

(U) Bio-Chem Defense, including technology, analysis and systems aimed at defeating enemy use of biological and chemical weapons, and includes efforts in agent detection, diagnosis and treatment, and informatic systems.

B. Accomplishments/Planned Program

Surveillance Systems & Decision Support	FY 2004	FY 2005	FY 2006	FY 2007
Accomplishment/ Effort/Subtotal Cost	6.605	5.419	5.874	6.000

FY 2004 Accomplishments:

(U) Advanced High Performance Computing Technologies: Integrated wideband Very Large Scale Integrated (VLSI) channelized receiver with electronically-scanned phased array antenna to demonstrate Space-Based Radar Electronic Counter-Countermeasures (ECCM) and signal processing functionality.

(U) Surface Surveillance Phased Array System: Built several channels of advanced conformal phased-array architecture for airborne and space-based Ground Surveillance radars, and demonstrated improvements in time-energy utilization using mode interleaving and multiple simultaneous beam formation. Characterized and quantified sensor performance to detect targets in the presence of high levels of ground clutter and other signal interferers.

(U) Array Element Level Digitization: Developed innovative architectures to enable digitization at the element level. Integrated digital signal processor with radiating antenna manifold. These architectures eliminate the existing complexity present with more conventional analog hardware architecture.

(U) UAV Video Exploitation: Developed video processing algorithms to process large amounts of video data from Unmanned Air Vehicles (UAVs) presently overloading image analysts and precluding fast turn around responses. Rapid confirmation of suspected targets was enabled by correlating multiple frames to quickly identify mobile threats within a 3-D scene under surveillance.

(U) Parallel and Distributed Processing: Developed techniques to implement signal processing algorithms across a number of heterogeneous computing platforms. Demonstrated unique approaches on small cluster of computing nodes. Transitioned technology to a grid of cluster of computers to facilitate rapid prototyping on ground and airborne platform.

FY 2005 Plans:

(U) Surface Surveillance Phased Array System: Demonstrate prototype system instrumented on-board of a sensor platform. Apply advanced signal processing algorithms to collected data to verify predicted performance.

(U) Array Element Level Digitization: Develop hardware design and build concept hardware with key enabling technologies. Begin demonstration on a sub-scale prototype.

(U) UAV Video Exploitation: Demonstrate video processing algorithms based on representative scenario data. Quantify improvements compared to today's conventional approaches. Implement algorithms in real-time on-board an experimental Navy airborne sensor platform.

FY 2006 Plans:

(U) Surface Surveillance Phased Array System: Demonstrate prototype system instrumented on-board of a sensor platform. Apply advanced signal processing algorithms to collected data to verify predicted performance. Demonstrate revolutionary improvements in simultaneous sensing leveraging multiple ISR functions from the same array.

(U) Array Element Level Digitization: Develop hardware design and build concept hardware with key enabling technologies. Begin demonstration on a sub-scale prototype.

(U) UAV Video Exploitation: Demonstrate video processing algorithms based on representative scenario data. Quantify improvements compared to today's conventional approaches. Implement algorithms in real-time on-board an experimental Navy airborne sensor platform.

FY 2007 Plans:

(U) Surveillance Systems: Demonstrate enabling technologies to permit simultaneous sensing from single sensor and the network centric exploitation of ISR data together with video processed inputs. The multi-sensor capabilities will address the critical problem of detecting, identifying and prosecuting time critical targets. These capabilities will lead to a real-time performance. New algorithms will be verified with real data from experimental platforms.

Communications & Networks	FY 2004	FY 2005	FY 2006	FY 2007
Accomplishment/ Effort/Subtotal Cost	2.377	1.067	1.156	1.181

FY 2004 Accomplishments:

(U) Global Networks: Refined the architecture and technology for global high-rate military communications to permit seamless line-of-sight and over-the-horizon connectivity for peer-to-peer computer-based tactical applications to include distributed operations centers, distributed sensor ground processing, and integrated C2 of reconnaissance and strike assets. Technologies include moving to a "packet-based" network design, redesigning crypto and transec to retain Information Assurance in a packet topology, revising network control via a "Connectivity Broker" to provide both tactical on-demand connectivity and transient provisioning of large data pipes for sensor flows with predictive connection topology change rather than just reactive change.

(U) Defensive Information Warfare: Focused on the problems of robustness and security of collaborative applications, including chat, against information attacks and varying link availability in an airborne C4ISR environment. Developed new chat application software with linked but independent chat servers on airborne platforms; tested with good initial results in JEFX-04.

(U) Airborne C2 Node: Used the Air Force Paul Revere Test bed to test new communications, command, and control concepts for ISR and for interface to strike, including the electronic threat environment as influenced by Electronic Countermeasures (ECM) and jamming. Extend multi-INT system to include ID sensors, and use experimental system to form a substrate for the time-critical strike lattice. Developed cueing strategies and use of contextual information in behavior databases.

FY 2005 Plans:

(U) Global Networks: Continue to develop, demonstrate, and transfer technologies for high speed optical and RF networked communications into funded DoD programs that put global connectivity into the hands of the war fighter. Extend "Connectivity Broker" concept to optimize use of both narrow-band and wideband tactical links to maximize network throughput in air- and ground-mobile environments, taking into account time-varying user traffic connectivity demands.

(U) Defensive Information Warfare: Continue focus on tactical ISR used to support joint air-sea and air-land networks, working the wired and wireless robustness and security issues facing net-centric warfare, with attention to robustness for collaborative applications. Develop techniques for secure authentication of distributed users in collaborative environments on fragile tactical networks

(U) Airborne C2 Node: Continue use of the Air Force Paul Revere Test bed to exploit Global Airspace Traffic Management data to enhance the air picture; provide computer-to-computer network interfaces to the Navy Cooperative Engagement assets; and to provide firepower support to transformational army elements. Optimize ability of "Connectivity Broker" to increase throughput in these complex, time-varying network topologies. Extend system to include multiple synoptic and narrow field-of-view sensors such that the system provides the mechanism of linking sensors in the reconnaissance/strike lattice. Transfer technology to BMC2 contractor for use in Command Air Operations Center (CAOC), Distributed Common Ground Station (DCGS) and Multi-mission Command and Control

Aircraft (MC2A).

FY 2006 Plans:

(U) Global Networks: Continue to develop, demonstrate, and transfer technologies for high speed optical and RF networked communications into funded DoD programs that put global connectivity into the hands of the war fighter.

(U) Defensive Information Warfare: Continue focus on tactical ISR used to support joint air-sea and air-land networks, working the wired and wireless robustness and security issues facing net-centric warfare, with attention to robustness for collaborative applications.

(U) Airborne C2 Node: Use the Air Force Paul Revere Test bed to exploit Global Airspace Traffic Management data to enhance the air picture; provide computer-to-computer network interfaces to the Navy Cooperative Engagement assets; and to provide firepower support to transformational army elements. Extend system to include multiple synoptic and narrow field-of-view sensors such that the system provides the mechanism of linking sensors in the reconnaissance/strike lattice. Transfer technology to BMC2 contractor for use in Command Air Operations Center (CAOC), Distributed Common Ground Station (DCGS) and Multi-mission Command and Control Aircraft (MC2A).

FY 2007 Plans:

(U) Continue to develop, demonstrate, and transfer technologies for high speed optical and RF networked communications in support of military operations, particularly in the tactical theater. This includes work to protect these essential networks, and the collaborative user applications that run over them, particularly in the networks that support C2ISR connectivity among sensors, deciders, and shooters.

Applied Optics	FY 2004	FY 2005	FY 2006	FY 2007
Accomplishment/ Effort Subtotal Cost	5.179	3.816	4.136	4.225

FY 2004 Accomplishments:

(U) Laser Radar: Achieved a significant milestone with the first-ever demonstration of photon-counting coherent detection. This milestone enables the development of multi-function laser-radar systems, which combine 3-D imaging and range-Doppler sensing, for applications to BMD interceptors, combat identification, and foliage penetration. These systems use the same laser transmitter and the

same photon-counting avalanche photodiode (APD) array for both direct-detection laser radar for 3D imaging and coherent laser radar for range-Doppler imaging. Completed the development of a Geiger-mode avalanche photodiode array sensitive at 1 μm. Fielded this array in a 3D ladar system.

(U) High Energy Laser (HEL) Technology: Conducted lab experiments to demonstrate the utility of multi-conjugate adaptive-optics (MCAO) for atmospheric compensation. MCAO should potentially provide improve HEL system performance in stressing propagation scenarios and in relay-mirror scenarios. A new lab experiment was implemented to explore non-linear phase conjugation and initial results were obtained. The Slab-Coupled Optical Waveguide Laser (SCOWL) laser demonstrated the highest brightness ever out of a diode laser. A novel fiber-laser for scaling to very high power was designed and fabricated

(U) Hyper Spectral Imaging (HSI): An HSI system for combined HSI/ladar measurements was designed and fabricated.

FY 2005 Plans:

(U) Laser Radar: Continue to develop multi-function laser-radar systems for applications in advanced ballistic and tactical seekers, surface surveillance, and combat identification to demonstrate operational form, fit, and function. This includes efforts at electronics miniaturization using Application Specific Integrated Circuits (ASIC) components to generate systems that show a direct development path to fit on a seeker, hand carried sensor, or small UAV. Initiate development of ultra-high-resolution ladar for applications such as long-range face recognition.

(U) High Energy Laser Technology: Continue MCAO and nonlinear-phase-conjugation efforts with particular emphasis on thermal-blooming compensation. Continue the exploration of real-time decision aids to help optimize the performance of HELs in varying atmospheric conditions. Continue modeling and simulation work with the ultimate goal of developing a complete “photon birth-to-death” model. Test microstructure fiber laser. Demonstrate combined spectral and coherent beam combining for high-power fiber lasers.

(U) Hyper-Spectral Imaging: Install the HSI system developed in FY 2004 on an aircraft and take simultaneous measurements with the HSI system and with a 3D ladar system. Develop algorithms to combine the two different kinds of data.

FY 2006 Plans:

(U) Laser Radar: Demonstrate a miniaturized multi-function ladar. Continue development and lab testing of ultra-high-resolution ladar.

(U) High Energy Laser Technology: Test new compensation algorithms in the lab. Complete “photon birth-to-death” model. Scale up

power level for hybrid—spectral and coherent—beam combining for fiber lasers. Implement a proof-of-principle real-time decision aid.

(U) Hyper-Spectral Imaging: Expand combined HSI and ladar experiments by incorporating extended wavebands in the HSI system.

FY 2007 Plans:

(U) Demonstrate an ultra-high-resolution ladar in field tests. Perform atmospheric propagation and beam control tests with a beam-combined fiber-laser system. Continue critical technology development to enable fiber-laser systems to scale to very high powers.

Advanced Electronics Technology	FY 2004	FY 2005	FY 2006	FY 2007
Accomplishment/ Effort Subtotal Cost	6.605	7.100	7.678	7.843

FY 2004 Accomplishments:

(U) Continued development of photon-counting focal plane technologies with emphasis on larger array sizes, smaller pixels, new concepts for per-pixel electronics, and longer wavelength response, for ISR and seeker applications. Developed silicon-on-insulator-based process technologies for 3-D integration to build smart focal planes and high-clock-rate low-power digital processing functions, and demonstrated working circuits using three vertically interconnected silicon layers. Developed technologies for advanced focal planes which allow 2-D tiling of large arrays. Demonstrated new process for small-pixel size CCDs capable of scene jitter removal. Designed and simulated ultra-low-noise imager readout structure for use in low-light and high-frame-rate imaging. Developed component integration technologies including integrated passives and frequency control elements, silicon active RF components, and MEMs switches, enabling low-cost, miniaturized receiver-on-a-chip and receiver-in-a-package solutions tailored to DoD applications. Developed low-loss hermetic packaging for RF MEMs for millimeter-wave systems. Completed design and demonstration of a pre-prototype video micro-sensor being developed for long endurance unattended ground sensors. Continued work to extend the scaling of integrated circuits to nanometer dimensions, including emerging techniques such as molecular electronics. Demonstrated a new approach for efficient UV generation for bio-aerosol sensors. Developed component technologies for analog photonic systems. Continued our technology transfer efforts to industry.

FY 2005 Plans:

(U) Develop improved photon-counting arrays and related readout circuits, for both active illumination and passive imaging applications. Extend photon counting detector performance further into the near- and mid-wave IR spectral region. Develop three-

dimensionally integrated detectors and mixed-signal readout circuits. Develop technologies for highly integrated RF front ends, with emphasis on film bulk acoustic resonators and SOI CMOS RF transistors. Develop technologies for long endurance micro-sensors. Investigate potential of cryogenic operation of silicon-on-insulator CMOS for both analog processing and high performance computing applications. Continue development of advanced electro-optical and cell-based bio-defense sensors. Investigate approaches for improving detection of explosives. Continue development of solid state and semiconductor laser illuminators for active sensing, countermeasures, and high power laser applications. Develop new approaches to electronic devices to allow continued scaling and performance improvements for defense and commercial electronics. Continue our efforts to transition technology to a wide range of DoD system demonstrations, and to industry for volume manufacturing.

FY 2006 Plans:

(U) Develop technologies for focal planes which enable new approaches to DoD electro-optical sensors, with emphasis on improved photon-counting arrays and related readout circuits, three-dimensionally integrated detectors and mixed-signal readout circuits, and unique designs and processes for ultra-low power operation, high data collection rates, or operation in stressing environments. Develop technologies for highly integrated RF front ends, including silicon-based transceivers for use in low cost and reconfigurable RF systems. Continue development of advanced electro-optical and cell-based bio-defense sensors. Continue development of solid state and semiconductor laser illuminators for active sensing, countermeasures, and high power laser applications. Develop new approaches to electronic devices to allow continued scaling and performance improvements for defense and commercial electronics. Continue our efforts to transition technology to a wide range of DoD system demonstrations, and to industry for volume manufacturing.

FY 2007 Plans:

(U) Develop micro system technologies enabling new approaches to DoD sensor systems, with emphasis on advanced focal planes, highly integrated RF electronics, technologies for unattended ground sensors, lasers for active imaging, countermeasures, and directed energy applications, and chemical and biological agent sensors. Develop new device concepts and process technologies, enabling continued scaling of microelectronic devices, lower cost, higher performance, and lower power operation. Transfer technologies to industry, both for specialized DoD systems as well for commercially important dual-use applications.

Bio-Chem Defense	FY 2004	FY 2005	FY 2006	FY 2007

Accomplishment/ Effort Subtotal Cost	5.179	7.444	8.069	8.243

FY 2004 Accomplishments:

(U) Bio and Chem Agent Detection Systems: Tested the combined BAWS-CANARY in chambers with simulants and in realistic outdoor conditions under a variety of backgrounds, resulting in the production of Receiver Operating Characteristics (ROC) curves for a trigger-identifier system for the first time. Initiated new efforts in improving logistics of CANARY sensor, particularly addressing cell lifetime in storage and handling. Demonstrated CANARY (normally used on antigens) can be used to detect and identify DNA. Concluding effort in trapping, manipulating and analyzing individual bio-aerosol particles. Initiated efforts aimed at taking advantage of bacterial cell signaling as a sensor modality.

(U) Diagnosis and Treatment: Expanded exploration of chemical signatures of bacteria in the breath, looking for new exhalants, by applying techniques in hospital setting with real samples. Collected ambient disease agent backgrounds in hospital conditions, anticipating next year's flu season. Transitioned work on anti-viral therapies into broader-based antimicrobials.

(U) Bioinformatics: Concluding efforts in applying automated target recognition techniques to micro-array data and images, working toward building a pathogen signature data base.

(U) Facility Defense: Initiated efforts aimed at neutralizing agents in ventilation systems, utilizing aerosol chamber and germicidal ultraviolet light. Conducted tests in post-attack exposure assessment under realistic indoor and outdoor conditions. Explore defense of potable water systems through test bed approach.

FY 2005 Plans:

(U) Agent Detection Systems: Based on data from field trials, improve upon BAWS-CANARY sensor, and continue tests under varied background conditions. Continue efforts in improving response and logistics of CANARY sensor, emphasizing dried-cell techniques. Conclude efforts aimed at taking advantage of bacterial cell signaling as sensor modality. Will collect background hospital environmental data during flu season to see if detectable on surfaces. Advanced standoff sensing designs employing simple bi-static components are to be considered. Establish new methodologies for sensor testing, moving beyond current industry approaches that are largely threshold event driven. Promulgate use of ROC curves as method of fair comparison among sensors.

(U) Analysis and Modeling: Develop advanced models for biological and chemical sensors. Develop and incorporate additional analytical tools in disease progression, fluid dynamics, distribution modeling (of food). Develop predictive strategies that can be employed at special events. Understand better how agent fate and transport affects realistic bio threats and vulnerabilities.

(U) Facility Defense: Establish test beds for defense against bio and chem attack. Explore alternative architectures involving sensing and HVAC control as well as other proactive and response strategies such as portal screening. Incorporate results from FY04 on the use of ultraviolet light as neutralization approach. Continue to explore defense of potable water systems, taking advantage of inherent system latencies. Develop and employ command and control models for protection systems.

FY 2006 Plans:

(U) Agent Detection Systems: Pursue new compact, affordable designs for BAWS-CANARY sensor, and conduct field tests. Conclude efforts in logistics of CANARY sensor, emphasizing dried-cell techniques. Finalize standoff sensing designs employing simple bi-static components and employ in limited field tests. Continue to develop sensor testing methodologies, and apply to a number of in-house as well as industry-based sensors. Continue to promulgate use of ROC curves as method of fair comparison.

(U) Analysis and Modeling: Apply advanced models for biological and chemical sensors. Continue to develop, incorporate and integrate analytical tools in disease progression, fluid dynamics, distribution modeling (of food, water, etc.). Apply predictive strategies that can be employed at special events. Through continued measurements, understand better how agent fate and transport affects realistic bio threats and vulnerabilities. Compare data with predictions.

(U) Facility Defense: Employ test beds aimed at defense against bio and chem attack in air, food and water. Continue to explore alternative architectures involving sensing and HVAC control as well as other proactive and response strategies such as vehicle screening and standoff detection. Incorporate newly developed techniques for agent neutralization. Test advanced command and control models in protection systems.

FY 2007 Plans:

(U) Build and field new designs for BAWS-CANARY, utilizing results from cell drying efforts. Also field bi-static components in more formal field trials. In all cases collect data sufficient for ROC curves. Based on analysis and modeling efforts, establish predictions of component performance and compare with data. Translate these efforts into larger system-based solutions, to involve both chemical and biological defense measures. Employ advanced command and control architectures in realistic situations.

Exhibit R-2a, RDT&E Project Justification							Date: February 2005	
Appropriation/Budget Activity RDT&E, Defense-Wide BA2				Project Name and Number Lincoln Laboratory 0602234D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Technical Intelligence **P535**	0	0	3.000	3.000	3.000	3.000	3.000	3.000

A. Mission Description and Budget Item Justification:

(U) The Technical Intelligence Line reflects the DoD need for timely advice from seasoned, tenured university representatives:

(U) Technical Intelligence is a research area that will combine the work of academia and international work to focus the Department's future work.

(U) Supporting these five core technology thrusts is a new work effort titled Technical Intelligence. Technical Intelligence combines efforts in two areas: 1) from the university community through the JASONs program and 2) through information on the technology maturation and development throughout the rest of the world.

1. (U) JASONs is a group of approximately 50 appropriately cleared experts who provide detailed independent technical assessment of the most difficult technological problems. JASON members are mostly fully tenured professors in physics, mathematics, engineering, and hold active SCI-level clearances. Output from JASON studies are provided to levels up to the Secretary of Defense and their studies shape programmatic and technical decisions involving literally hundreds of millions of dollars. JASONs were previously funded through university research programs, but their level of technology maturity is appropriate for incorporation into Applied Research.

2. (U) Technical Intelligence will support detailed understanding of technology advancement in important scientific area and other scientific disciplines such as nanotechnology, directed energy and propulsion. Some details are classified, but one effort, called Global Dialogue on Emerging Science and Technology will be jointly sponsored by DOD, Department of State, and CIA will give very detailed insight in such topics as Software Engineering in India, Nanotechnology in South East Asia, European Laser development, for example. This information will in turn assist in development of US capabilities.

B. Accomplishments/Planned Program

FY 2004 Accomplishments:

(U) Until 2002, the JASON program was funded as a separate project under the Defense Advanced Research Projects Agency. In

2002, the program was transferred, by the Under Secretary of Defense (AT&L) to the Director, Defense Research and Engineering and was covered outside this PE. JASON studies in 2004 include: Technical approach to Horizontal Integration (joint DoD – CIA study to increase interoperability); Improvised Explosive Device Technology Options; Thermal Management (to allow battlefield lasers); Tagging, Tracking, and Locating High Value Targets (Classified); Theoretical Limits on Remote Sensing Chemical Weapons; Intelligent Application of Aspherical Optics (Next generation reconnaissance); Feasibility of Large Deployable Space Telescopes; and about 10 other studies. Output from JASON studies are provided to levels up to the Secretary of Defense and their studies shape programmatic and technical decisions involving literally hundreds of millions of dollars. For the other portion of Technical Intelligence, nothing was accomplished as the program was not in existence yet.

FY 2005 Plans:

(U) Continue to focus the JASON studies and Technical Intelligence in areas critical to national security. JASON will be focused depending on the area most important in the security environment at the time. For the Technical Intelligence portion, support detailed understanding of technology advancement in important areas of nanotechnology, directed energy, and so forth. Some details are classified, but one effort, called Global Dialogue on Emerging Science and Technology will be jointly sponsored by DOD, Department of State, and CIA. This program will sponsor 4-5 conferences in countries and technologies of interest. These conferences will be completely open, but will give very detailed insight in such topics as Software Engineering in India, Nanotechnology in South East Asia, European Laser development, for example. By funding and carefully targeting these opportunities, the DDR&E will be able to better shape the S&T program.

FY 2006 Plans:

(U) Continue to focus the JASON studies and Technical Intelligence in areas critical to national security. JASON will be focused depending on the area most important in the security environment at the time. For the Technical Intelligence portion, support detailed understanding of technology advancement in important areas of nanotechnology, directed energy, and so forth. Some details are classified, but one effort, called Global Dialogue on Emerging Science and Technology will be jointly sponsored by DOD, Department of State, and CIA. This program will sponsor 4-5 conferences in countries and technologies of interest. These conferences will be completely open, but will give very detailed insight in such topics as Software Engineering in India, Nanotechnology in South East Asia, European Laser development, for example. By funding and carefully targeting these opportunities, the DDR&E will be able to better shape the S&T program.

FY 2007 Plans:

(U) Continue to focus the JASON studies and Technical Intelligence in areas critical to national security. JASON will be focused

depending on the area most important in the security environment at the time. For the Technical Intelligence portion, support detailed understanding of technology advancement in important areas of nanotechnology, directed energy, and so forth. Some details are classified, but one effort, called Global Dialogue on Emerging Science and Technology will be jointly sponsored by DOD, Department of State, and CIA. This program will sponsor 4-5 conferences in countries and technologies of interest. These conferences will be completely open, but will give very detailed insight in such topics as Software Engineering in India, Nanotechnology in South East Asia, European Laser development, for example. By funding and carefully targeting these opportunities, the DDR&E will be able to better shape the S&T program.

Exhibit R-2, RDT&E Budget Item Justification				Date: February 2005				
Appropriation/Budget Activity RDT&E,DW/BA2				R-1 Item Nomenclature: Medical Technology, PE 0602787D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total PE Cost	11.588	13.204	0.000	0.000	0.000	0.000	0.000	0.000
Medical Technology/P505, Subtotal Cost	11.588	13.204	0.000	0.000	0.000	0.000	0.000	0.000

A. Mission Description and Budget Item Justification:

(U) This program supports applied research to investigate new approaches that will lead to advancements in biomedical strategies for preventing, treating, assessing and predicting the health effects of human exposure to ionizing radiation. Program objectives focus on mitigating the health consequences from exposures to ionizing radiation that represent the highest probable threat to US forces under current tactical, humanitarian and counter-terrorism mission environments. New protective and therapeutic strategies will broaden the military commander's options for operating within nuclear or radiological environments by minimizing both short- and long-term risks of adverse health consequences. Advancements in field-based biological dose assessment systems to measure radiation exposures will enhance triage, treatment decisions and risk assessment. Accurate models to predict casualties will promote effective command decisions and force-structure planning to ensure mission success.

(U) The program has three primary goals: (1) rational development of prophylactic and therapeutic strategies based on fundamental knowledge of radiation-induced pathophysiology and on leveraging advances in medicine and biotechnology from industry and academia; (2) development of novel biological markers and delivery platforms for rapid, field-based individual dose assessment; and (3) understanding toxic consequences from exposure to internal contamination from isotopes such as uranium.

B. Program Change Summary:

	FY 2004	FY 2005	FY 2006	FY2007
Previous President's Budget:	11.641	10.084	10.266	10.488
Current FY 2006 President's Budget Submission:	11.588	13.204	0.000	0.000
Adjustments to Appropriated Value:	-0.053	+3.120	-10.266	-10.488
Congressional Program Reductions:	-0.053	-0.280		
Congressional Rescissions:				
Congressional Increases:		+3.400		
Program Transfer:			-10. 266*	-10.488*
SBIR/STTR Transfers:				
Program Adjustment:				

*NOTE 1: Program transfers effective FY 2006 from RDT&E Budget Activity 3, Program Element 0602787D8Z to Defense Health Program (DHP).

NOTE 2: FY 2005 congressional increase of $3.4 for hibernation genomics to be transferred to appropriate agency for execution.

C. Other Program Funding Summary: Not applicable.

D. Acquisition Strategy: Not applicable.

E. Performance Metrics:
By FY 2006 identify at least 6 drugs or therapeutic approaches that are promising for treatment of radiation injury.
By FY 2008 identify at least 2 new biodosimetric approaches to determine individual radiation exposure.
By FY 2010 develop decision criteria for antibiotic use after radiation injury.

Exhibit R-2a, RDT&E Project Justification							Date: February 2005	
Appropriation/Budget Activity RDT&E, D BA 2				Project Name and Number Medical Technology, PE 0602787D8Z				
Cost ($ in millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Medical Technology/P505, Subtotal Cost	11.588	13.194	0.000	0.000	0.000	0.000	0.000	0.000

A. Mission Description and Budget Item Justification:

(U) This program supports applied research to investigate new approaches that will lead to advancements in biomedical strategies for preventing, treating, assessing and predicting the health effects of ionizing radiation.

(U) The program has three primary goals: (1) rational development of prophylactic and therapeutic strategies based on fundamental knowledge of radiation-induced pathophysiology and on leveraging advances in medicine and biotechnology from industry and academia; (2) development of novel biological markers and delivery platforms for rapid, field-based individual dose assessment; (3) understanding toxic consequences from chronic exposure to tissue-embedded depleted uranium (DU).

B. Accomplishments/Planned Program

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Mechanisms of 5-AED Radioprotection	1.340	1.359	0.000	0.000

FY 2004 Accomplishments: To address the FDA requirement for an understanding of the mechanisms responsible for 5-AED's radioprotective actions, demonstrated that 5-AED modulates the spleen levels of several cytokines, which mediate signals of the immune system.

FY 2005 Plans: Initiate experiments on effects of 5-AED on the function of peritoneal macrophages, a critical, non-circulating component of the immune system. Continue to assess changes in cytokines in the spleen.

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Radioprotective effects of isoflavones and vitamin derivatives	1.110	0.996	0.000	0.000

FY 2004 Accomplishments: Previously, demonstrated that the soybean derived isoflavone genistein has radioprotective effects. Improved the vehicle for administration of the isoflavones and determined the dose response curve for radioprotection by genistein in rodents. Determined the optimal time for administration of genistein for radioprotection. Completed the screening of tocopherol isomers - alpha, gamma, and delta-tocopherol for radioprotection; alpha and delta-tocopherols were found to be equally effective while gamma-tocopherol was less effective. Assessed the effects of alpha- tocopherol on radiation-induced thrombocytopenia (reduced the duration) and neutropenia (marginal improvement in recovery).

FY 2005 Plans: Establish the dose-response relationship for a second soy isoflavone, daidzein, for radiation protection and determine

the optimal time for administration. Evaluate the hematological effects of genistein with radiation exposure. Assess antimicrobial properties of genistein. Determine the dose-reduction factor of the most effective isomer of tocopherol. Compare pharmacokinetics of this isomer given subcutaneously in irradiated and non-irradiated mice.

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Radioprotectants/Therapeutics Screening	2.110	1.998	0.000	0.000

FY 2004 Accomplishments: Continued systematic screening of potential radioprotectant and therapeutic compounds under a drug screen protocol. Among the drugs tested in FY2004 was a promising DHEA derivative that is effective in an oral preparation. Drugs that show potential will be targeted for further development. Evaluated drug release from liposomes using in vitro and in vivo (pharmacokinetic) assays.
FY 2005 Plans: Continued systematic survey of potential radioprotectant and therapeutic compounds under a drug screen protocol. There are currently about 20 drugs in the queue for analysis. Among those with the highest priority are CpG oligonucleotides, statins, SOD mimics, dipeptidyl peptidase inhibitors, and truncated flagellin.

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
PCC Cytogenetic Assay	0.230	0.515	0.000	0.000

FY 2004 Accomplishments: Optimized the temperature and humidity conditions for the premature chromosome condensation (PCC) aberration assay that permits rapid analysis of radiation exposure across a broad dose range from interphase lymphocytes of peripheral blood. Optimized the PCC induction protocol for small blood volumes.
FY 2005 Plans: Continue to improve sample preparation by promoting signal transduction mechanisms for inducing PCC in peripheral blood lymphocytes. These efforts will improve the efficiency of the assay.

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Molecular Biomarkers- DNA mutations	0.456	0.534	0.000	0.000

FY 2004 Accomplishments: Developed real-time PCR for detection of DNA mutations (common mitochondria DNA deletion) in genomic DNA samples providing a significant advance in quantitative assessment of target sequences. Initiated studies to optimize the real-time and cytological DNA mutation bioassay to detect low-frequency DNA mutations.
FY 2005 Plans: Develop and evaluate modified deletion primers for quantitative fluid phase PCR bioassay in Human Peripheral Blood Lymphocytes (HPBL). Begin evaluation of low level multiplex detection.

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Blood-Based Cell and Protein Markers	0.397	0.872	0.000	0.000

FY 2004 Accomplishments: Optimized the microassay to measure concentration of a specific marker protein (GADD45) in human blood samples. Characterized the relationship for GADD45 levels with radiation dose and post-exposure time, demonstrating feasibility of approach.
FY 2005 Plans: Initiate *in vitro* studies evaluating radiation-responsive blood protein biomarkers involving other protein targets. Initiate protein biomarker studies to evaluate inter-individual, partial body, and combined agent effects.

Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Toxicity of DU and Tungsten	0.433	0.020	0.000	0.000
FY 2004 Accomplishments: Determined that depleted uranium (DU) and tungsten alloys (WA) induce mutations in a marker gene (HPRT) in vitro; embedded WA causes rabdomyosarcoma in rats; DU can increase incidence of carcinogenicity in susceptible mice. (The related Defense Technology Objective completes in FY 2004.) FY 2005 Plans: Complete evaluation of heavy metals on viability of pulmonary macrophages and cell function.				
Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Late-Arising Radiation Injuries	0.205	0.401	0.000	0.000
FY 2004 Accomplishments: Determined that phenylacetate and epigallocatechin (EGCG) can effectively suppress radiation-induced human cell transformation in vitro (i.e, block development of pre-cancerous cells). FY 2005 Plans: Initiate radiation leukemogenesis studies with phenylacetate and EGCG.				
Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
New Approaches to Treatment of Post Radiation Infection	1.969	1.603	0.000	0.000
FY 2004 Accomplishments: Identified the bacterial species that cause sepsis in lethally irradiated animal. Initiated in vitro studies on properties of probiotics (microbes that can be ingested to combat pathogenic bacteria of the gut). Determined that *Lactobacillus reuteri* is not susceptible to ciprofloxacin. FY 2005 Plans: Determine the effects of the quinolones against a polymicrobial infection from endogenous pathogens with lethal doses of radiation. Evaluate the effectiveness of *L. reuteri* as a probiotic protective agent when mice are challenged with *S. sonnei* and sub-lethal radiation exposure.				
Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Noninvasive “biomodulation” system (Congressional add)	2.400	0.000	0.000	0.000
FY 2004 Accomplishments: Funds were transferred to the appropriate agency for execution.				
Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Host-Defense Mechanisms	0.938	0.922	0.000	0.000
FY 2004 Accomplishments: Differentiated at least two mechanisms by which certain prospective radioprotectants protect mammalian cells from virally-induced cell death. FY 2005 Plans: Evaluate the effect of antioxidants and radioprotectants including genistein on changes induced by virus infection and radiation exposure using cell survival, apoptotic markers, and cytokine production as endpoints. Assess a variety of pathways that can result in cell death with and without viral infection in an effort to uncover cellular processes targeted by therapeutic drugs.				
Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Hibernation genomics (Congressional add)	0.000	3.400	0.000	0.000

NOTE: Funds to be transferred to appropriate agency for execution				
Cost (in $ Millions)	FY 2004	FY 2005	FY 2006	FY 2007
Internal contamination – Health Effects and countermeasures	0.000	0.574	0.000	0.000

FY 2005 Plans: Initiate studies to evaluate the effects of radioisotopes on a macrophage cell line in vitro to model the response of the lung macrophages to inhaled contaminants. To understand how late carcinogenic consequences develop after internal contamination and to develop effective countermeasures, studies will be initiated to evaluate the contribution of radiation (v. the chemical nature of the contaminant) to genomic instability and transformation.

C. Other Program Funding Summary: Not applicable.

D. Acquisition Strategy: Not applicable.

E. Major Performers: Armed Forces Radiobiology Research Institute, Bethesda, MD.