OSD RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

APPROPRIATION/ BUDGET ACTIVITY	PE NUMBER AND TITLE
RDTE, Defense Wide BA 02	**0602227D8Z - Medical Free Electron Laser**

COST ($ in Millions)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
P483 Medical Free Electron Laser	15.487	2.385					

A. Mission Description and Budget Item Justification: (U) Funding for the Medical Free Electron Laser (MFEL) Program was terminated effective in FY 2008. Purpose of the program has been to develop advanced, laser-and optical-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 facilitate the experimental options for the development of new laser-based medical technologies. This program has been focused on developing advanced procedures and equipment for rapid diagnosis and treatment of battlefield-related medical problems.

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008)	15.813		
Current BES/President's Budget (FY 2009)	15.487	2.385	
Total Adjustments	-0.326	2.385	
Congressional Program Reductions		-0.015	
Congressional Rescissions			
Congressional Increases		2.400	
Reprogrammings			
SBIR/STTR Transfer	-0.433		
Other	0.107		

Congressional add of $2.4 million in FY 2008.

C. Other Program Funding Summary Not applicable for this item.

D. Acquisition Strategy Not applicable for this item.

E. Performance Metrics: Not Applicable.

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B. Accomplishments/Planned Program:

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
Medical Free Electron Laser	15.487	2.385	

FY 2007 Accomplishments: Optical Coherence Tomography (OCT) applications have been developed for examining the structure of joint cartilage and are being used for early diagnosis of degenerative disease and monitoring of surgical repair of orthopedic injuries. Endoscopic imaging using hand-held OCT probes can detect minor changes in epithelial cells of gastrointestinal and respiratory tracts, and such devices have been used to obtain optical biopsies for early assessment of injuries to the trachea and respiratory tract. Work on improving the resolution and speed of OCT imaging continued, obtaining axial resolutions of 3 um. A 100-fold increase in OCT imaging speed provides new opportunities to detect subtle changes in various tissues to improve injury management and to use OCT for diagnostic purposes. Ophthalmic OCT imaging is in regular clinical use to monitor retinal morphology and pathologic changes. Diffuse Optical Spectroscopy techniques potentially can be used to non-invasively determine changes in hemodynamic parameters such as oxy/deoxy-hemoglobin ratios and tissue perfusion; recent work demonstrated the application of these techniques to the study of cortical depression and tissue perfusion in brain following blast and penetrating injury. Optical diagnostic methods based on Raman scattering and terahertz spectroscopy were studied to detect and rapidly characterize biomolecules of interest. UV-FEL analysis of tissue associated with Parkinson's disease has indicated a possible marker for quantitative measurement of disease progression. Optical methods using passive infrared imagers are being used to recognize and evaluate clinical conditions such as collapsed lung and hemorrhagic shock in a forward casualty care setting. Experimental surgery studies have developed laser beam delivery endoscopes that meet the demands of precision surgical requirements. The Pulsed Electron Avalanche knife has been improved to permit its use in dissection of any tissue with a variety of blade sizes while preserving the cellular-scale precision of the tool. Studies examining the most effective laser wavelength and pulse duration variables for cutting hard tissue and optimizing post-ablation bone regeneration and healing have demonstrated an optimal effectiveness at 6.45um, and commercial partnerships have been developed to construct an inexpensive, compact infrared laser at this wavelength for medical applications. Parameters for control and minimization of collateral cell damage and fostering healing during laser surgery have been examined. Studies to determine optimal methods for using lasers for properly shaping cartilage materials for use in facial and upper airway reconstructive surgery are essentially complete and clinical trials have been initiated. An effective animal model for study of corneal healing after laser vision correction surgery has been developed, and subsequent work has described important steps to minimize scarring which can adversely affect vision correction. 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 important clinical applications. Photosensitive compounds can be used to tag specific bacteria and lead to virtually complete elimination of the organisms. Antibiotic resistant strains are 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 on difficult infections such as Leishmaniasis also have been shown to be effective, and clinical trials of photodynamic treatment are planned. Bacteria in wounds become embedded in a polysaccharide matrix or biofilm that protects them from antibiotics and immune defense mechanisms; laser-based analysis of biofilm structure and development are examining methods to counter the protective nature of these films. Other photosensitive compounds attached to cells are able to modulate cellular activity--for example, light absorbing nanoparticles have been shown to affect various properties of cells, including

their permeability, allowing control of cell processes, as well as improving drug uptake and effectiveness. Stimulation of specific nerve fibers is important for the diagnosis of nerve injury, but peripheral nerve stimulation can result in injury to the nerve. Optical stimulation offers many advantages for both diagnosis and treatment of nerve injury. The laser beam can be precisely directed to stimulate a single nerve within a bundle, the entire nerve fiber, or several fibers at once. Photochemical tissue bonding studies have led to the development of materials that provide wound closure 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, an FDA approved sensitizing dye that photochemically crosslinks the tissue surfaces, has been used in repair of blood vessels, the cornea, skin, and has recently been shown to be effective in nerve and tendon repair, and repair of damage to the trachea. A wide range of studies have 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. These studies have also demonstrated the nature and extent of collateral damage due to short term temperature effects, and improved healing of laser surgical methods compared to conventional bone cutting in cranial surgery. Work on the use of osteogenic liposomes has shown new bone formation induced at sites of injury. Effective closure of various wounds and blood vessels has been accomplished using photochemical tissue bonding. Research on the improvement of the performance and reliability of FELs continued, including development of new materials for waveguides through which laser energy may be routed. In addition, basic efforts have been carried out using laser-based spectroscopy methods on the structure and nature of biologically important macromolecules such as proteins; on the dynamics of various surface-based processes; and on the nature, formation and deposition processes of complex thin films.

FY 2008 Plan: Improve contrast and depth of OCT imaging, investigate its use in burn and respiratory tract injury, and develop new ultrasmall fiber optic endoscopy systems for general surgical use. Continue studies in reconstructive and ophthalmic surgery applications of lasers, particularly those applicable to current military casualty treatment. Continue studies on developing new photosensitizers and methods for their delivery, developing small battery powered laser nerve stimulation package for forward clinical use, and use of photodynamic therapy in treating infections of selected microorganisms. Studies on laser ablation and the subsequent healing processes will continue, with a continuing focus on determining tissue viability at the wound site.

FY 2009 Plan: Not applicable.

C. Other Program Funding Summary Not applicable for this item.

D. Acquisition Strategy Not applicable for this item.

E. Major Performers Not applicable for this item.