RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

	COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	206,638	226,322	219,144	228,597	232,642	236,796	241,347	Continuing	TBD
2301	Physics	24,704	24,084	22,801	23,368	24,287	24,783	25,285	Continuing	TBD
2302	Solid Mechanics and Structures	11,114	11,439	11,881	12,049	11,987	12,222	12,464	Continuing	TBD
2303	Chemistry	25,852	28,806	29,578	29,904	31,023	31,621	32,218	Continuing	TBD
2304	Mathematical and Computer Sciences	32,061	35,079	33,169	34,879	34,576	35,253	35,923	Continuing	TBD
2305	Electronics	23,444	27,498	24,565	26,494	26,305	26,803	27,300	Continuing	TBD
2306	Materials	13,621	16,355	15,004	17,574	18,464	18,791	19,122	Continuing	TBD
2307	Fluid Mechanics	9,395	9,954	10,599	11,274	12,147	12,383	12,630	Continuing	TBD
2308	Propulsion	20,937	23,104	21,190	21,635	22,102	22,505	22,914	Continuing	TBD
2311	Space Sciences	14,408	16,690	15,531	16,066	16,605	16,938	17,279	Continuing	TBD
2312	Biological Sciences	13,114	13,844	14,383	14,730	15,025	15,324	15,629	Continuing	TBD
2313	Human Performance	13,747	12,885	13,044	13,113	12,471	12,706	12,965	Continuing	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences

4113	External Research Programs Interface	4,241	6,584	7,399	7,511	7,650	7,467	7,618	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	Continuing	TBD

(U) A. Mission Description

The Defense Research Sciences program comprises extramural research activities in academia and industry and in-house investigations performed in the Air Force Research Laboratory. The program element funds fundamental broad-based scientific and engineering research in areas critical to Air Force weapon systems. These areas are: (1) physics; (2) solid mechanics and structures; (3) chemistry; (4) mathematical and computer sciences; (5) electronics; (6) materials; (7) fluid mechanics; (8) propulsion; (9) space sciences; (10) biological sciences; and (11) human performance. All projects are coordinated through the Defense Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds across the Department of Defense. All research areas are subject to long-range planning and technical review by tri-Service scientific planning groups. Note: In FY 2002, Congress added $2.0 million for the Center for Adaptive Optics, $2.5 million for Coal-Derived Jet Fuel, $1.3 million for Focused Ion Beam Systems, $1.0 million for the California Science Center, and $0.75 million for the Center for Solar Geophysical Interactions.

(U) B. Budget Activity Justification

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

(U) C. Program Change Summary ($ in Thousands)

		FY 2001	FY 2002	FY 2003	Total Cost
(U)	Previous President's Budget	212,688	220,869	213,788	
(U)	Appropriated Value	213,649	228,419		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions		-2,097		
	b. Small Business Innovative Research	-5,050			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram				
	e. Rescissions	-1,961			
(U)	Adjustments to Budget Years Since FY 2002 PBR			5,356	
(U)	Current Budget Submit/FY 2003 PBR	206,638	226,322	219,144	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences

(U) C. Program Change Summary ($ in Thousands) Continued

(U) Significant Program Changes:

Fiscal Year 2002 increase of $10.0M for nanosatellites, quantum computing, materials engineering, super energetic propellants, and plasma dynamics for next generation aerospace vehicles is part of the recent DoD Strategy Review.

Fiscal Year 2002 additional increase of $4.2M reflects zero percent real growth.

D. Execution - Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2301

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2301 Physics	24,704	24,084	22,801	23,368	24,287	24,783	25,285	Continuing	TBD

(U) A. Mission Description

Physics research aims to revolutionize advances in laser technologies, sensors and imaging, miniature satellites, and communications. It expands fundamental knowledge of optics, electromagnetics, as well as microwaves and plasmas. The goals are to enable and enhance technologies critical to Air Force lasers, optics, avionics, and microwaves and to improve technologies associated with non-intrusive / non-destructive testing and analysis. Research topics focus on revolutionary improvements in electromagnetic countermeasures, protection against nuclear weapons effects, communications, small satellites, and novel sensors. The primary areas of research investigated by this project are laser and optical physics; atomic, molecular, and imaging physics; and plasma physics.

(U) FY 2001 ($ in Thousands)

(U) $9,662 Performed laser and optical physics research for new technologies associated with laser devices and controls towards enabling spoofing and fatal damage of infrared-seeking missiles, high performance radars, and new directed energy weapons. Continued to investigate semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Investigated a new high-power laser to replace oxygen-iodine for next generation airborne lasers. Examined pico-second and femto-second (extremely fast) lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Expanded studies of micro-electro-mechanical systems (MEMS) and laser photochemical processes to enable specialized devices for micro-satellite applications.

(U) $7,450 Conducted research in plasma physics to investigate fundamental atomic and molecular interactions for future directed energy weapons, affordable low-observables, and space communications and surveillance. Explored physics issues relating to plasma processing of materials at atmospheric pressures to contribute to higher frequency, more efficient, high power microwave systems. Examined the controlled resistive, dielectric, and conducting behavior of plasmas, and the effects of plasmas on transmission, reflection, and absorption of electromagnetic waves to enable novel stealth aircraft mechanisms. Investigated the feasibility of using collisional ionized gas volumes to protect friendly assets from directed energy.

(U) $4,175 Studied atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information for use in improved explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Investigated the trapping and cooling of atoms and ions to enrich high-resolution spectroscopy. Characterized interactions of atoms in strong fields to discover novel lasers for Air Force applications. Continued to examine isomeric, very high density energy storage for flash radiation devices and to make long flight missions possible without refueling.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2301	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U)	$3,417	Studied the performance of the new 30-meter infrared adaptive optical telescope at the Center for Astronomical Active Optics. Continued research on adaptive optics to enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers.
(U)	$24,704	Total

(U) FY 2002 ($ in Thousands)

(U)	$9,936	Perform laser and optical physics research for new concepts in solid state lasers, especially fiber lasers, to attain compact, inexpensive modules in the one kilowatt average power range. The results of this research will enable spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and new directed energy weapons. Study techniques for integrating modules to achieve multiple power levels at affordable cost and useful size for application to airborne or space platforms. Study concepts for achieving very high resolution of deep space objects using very large aperture adaptive telescopes. Explore novel low-cost light sources for high-power ultraviolet lasers capable of high intensity and spectral brightness for disinfection of biological agents, the synthesis of chemical agents, and safely stripping aircraft paint.
(U)	$7,748	Conduct research in plasma physics to investigate fundamental interactions between charged particles and electromagnetic fields for future directed energy weapons, affordable low-observables, and space communications/surveillance. Explore physics relating to the power-efficient production and maintenance of substantial volumes of low-temperature plasma at atmospheric pressures for plasma-based aerodynamic drag reduction. Investigate the controlled resistive, conducting, and dielectric behavior of plasmas, and the effects of plasmas on absorption, reflection, and transmission of electromagnetic waves to create new stealth aircraft mechanisms. Examine the viability of using collisional ionized gas volumes to shield friendly assets from directed energy threats.
(U)	$4,419	Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions for use in improved explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Quantify interactions of atoms in strong electromagnetic fields to enable novel lasers for Air Force applications. Continue research on isomeric, very high density energy storage for flash radiation devices to diminish or eliminate refueling on long endurance flights. Investigate the use of holographic films for correction of distortion and aberration in space surveillance telescopes.
(U)	$1,981	Continue to enhance the research performance of the new 30-meter infrared adaptive optical telescope at the Center for Astronomical Active Optics. Continue research studies on adaptive optics to enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2002
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
01 - Basic Research	0601102F Defense Research Sciences	2301

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $24,084 Total

(U) FY 2003 ($ in Thousands)

(U) $10,261 Conduct laser and optical physics research to study the effect of combining high power solid state lasers with integrated nonlinear and pulse forming optics. Study concepts to achieve high output powers at wavelengths required for space applications. Continue studies of large aperture adaptive telescopes for very high resolution deep space imaging. Explore large, light-weight adaptive optics for space surveillance and high energy laser relay applications. Study laser micro-machining techniques for producing specialized space micro-systems for multi-functional micro- and nano-satellites.

(U) $7,981 Conduct research in plasma physics to investigate fundamental interactions between charged particles and electromagnetic fields for future directed-energy weapons, affordable low-observables, and space communications and surveillance. Explore physics topics relating to the dynamic molecular interactions in combustion and high energy density propellants. Examine the detailed physics of material, surface, and air breakdown in the presence of strong electric fields. These fundamental findings will facilitate creation of more compact, lighter weight, portable pulsed power systems to power future directed-energy weapons systems.

(U) $4,559 Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information to improve explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Investigate fundamental interplay between atoms and strong electromagnetic fields to create new classes of lasers for Air Force applications. Develop isomeric, high energy density storage for flash radiation devices to diminish or eliminate refueling requirements on long endurance flights. Continue basic research of holographic films for correction of distortion and aberration in space surveillance telescopes. Measure UV emission cross sections from electron impact to provide fundamental data needed in satellite surveillance.

(U) $22,801 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Space Technology.

(U) PE 0602204F, Aerospace Sensors.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2301	

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

(U) PE 0602605F, Directed Energy Technology.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2302

COST ($ in Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2302	Solid Mechanics and Structures	11,114	11,439	11,881	12,049	11,987	12,222	12,464	Continuing	TBD

(U) A. Mission Description

Solid Mechanics and Structures basic research aims to dramatically improve the behavior of aerospace materials and structures via better description of wear and damage dynamics. It expands fundamental knowledge of the aeroelastic and acoustic behavior of airframes and engine structures as well as the fluid behavior of launch vehicles and space structures. The goals are cost-effective development and safe, reliable operation of superior Air Force weapons and defensive systems. Research topics include: the design of advanced material structures on the micro- and nano-scale; modeling and simulation of the dynamic behavior of aircraft, missiles, and large space structures; and technology integration for the performance and survivability enhancement of these systems. The primary areas of research investigated by this project are mechanics of composite materials, structural mechanics, and structural dynamics.

(U) FY 2001 ($ in Thousands)

(U) $2,332 Studied mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles to enable revolutionary improvements in capability and design of air and space weapon systems. Continued to explore the fundamental behavior of dynamic systems and develop efficient computational techniques and design methodologies for turbine engines, air vehicles, launch systems, and orbital systems. Continued efforts to seek fundamental knowledge on air vehicle components, including metallic and inter-metallic alloys, advanced composite materials, and solid rocket propellants and liners to enhance air and space vehicle performance and longevity.

(U) $7,157 Conducted structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission uninhabited air vehicles. Evaluated the behavior of distributed sensor and actuator systems to improve the design and performance prediction of aerospace systems. Identified fundamental structural design characteristics underpinning the life cycle of airframe structures. Developed techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapons.

(U) $1,625 Performed dynamics and shock physics research to identify the fundamental damage mechanisms in structural materials to model and predict effects of weapon impacts and assess damage of penetrating munitions. Devised fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems. Investigated the mechanical and dynamic behavior of micro-scale structures to enable micro-electro-mechanical systems (MEMS) that can sense environments and respond accordingly (smart structures).

(U) $11,114 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2302	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $2,401 Study mechanics of materials to accelerate utilization of advanced materials such as composites, high-temperature alloys, and ceramic matrix composites in aerospace vehicles, turbine engines, space systems, and weapon systems. Explore synergistic combinations of information technology and multiscale modeling to design new materials and new structures. Explore nanomechanics to bridge the gap between continuum mechanics and atomistic modeling. Establish theoretical foundations for multifunctional mechanics, including nonlinear behavior, to enable the development of multifunctional structures used in advanced space systems such as microsatellites and micro-vehicles.

(U) $4,970 Conduct research into structural and material aspects of high-cycle metal fatigue and other aging mechanisms of aircraft. Develop techniques for predictive computer simulation of structural response. Research metal fatigue-generation due to vibration of jet engine compressor and turbine blades and the interaction of blade motion with fluid mechanics. Study material science to identify and mitigate material degeneration in a timely and cost-efficient manner. Develop techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapon systems.

(U) $4,068 Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission uninhabited air vehicles. Evaluate the behavior of distributed sensor and actuator systems to improve the design and performance prediction of aerospace systems. Research predictive techniques capable of modeling the interaction of structural motion with high-speed aerodynamics characteristic of uninhabited air vehicles. Continue investigating the mechanical and dynamic behavior of micro-scale structures to enable micro-electro-mechanical systems (MEMS) that can sense environments and respond accordingly (smart structures).

(U) $11,439 Total

(U) FY 2003 ($ in Thousands)

(U) $2,495 Research mechanics of advanced materials to accelerate their use as composites, high-temperature alloys, and ceramic matrix composites. Results will have direct application in aerospace vehicles, turbine engines, space systems, and weapons systems. Develop methods to synergistically combine multiscale modeling and information technology to design new materials and structures. Establish foundations of nanomechanics which transitions between continuum mechanics and atomistic modeling. Apply multifunctional mechanics with nonlinear behavior to design multifunctional materials and structures used in advanced aerospace systems such as micro-satellites and micro-vehicles.

(U) $5,109 Conduct research into the structural and material aspects of high-cycle metal fatigue and other aging mechanisms of aircraft. Develop fundamental computer simulations to predict structural response to assorted stimuli. Explore metal fatigue-generation caused by vibration of compressor and turbine blades and blade motion/fluid flow coupling. Study material science to quickly and inexpensively identify and mitigate

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2302

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

material degeneration and degredation. Develop novel system techniques to analyze vehicle integrity to significantly increase the robustness of Air Force weapon systems.

(U) $4,277 Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission unmanned aerial vehicles (UAV). Investigate the behavior of distributed sensor and actuator systems to improve the design and performance characterization of aerospace systems. Develop models to predict the interaction between structural motion and high-speed aerodynamics characteristic of UAVs. Exploit the mechanical and dynamic behavior of micro- and nano-scale structures to achieve exceptional capabilities in micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems.

(U) $11,881 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602201F, Aerospace Flight Dynamics.

(U) PE 0602202F, Human Effectiveness Applied Research.

(U) PE 0603211F, Aerospace Structures.

(U) PE 0602203F, Aerospace Propulsion.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2303

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2303 Chemistry	25,852	28,806	29,578	29,904	31,023	31,621	32,218	Continuing	TBD

(U) A. Mission Description

Chemistry research seeks bold innovations in understanding, modeling, and controlling chemical reactions for developing new materials, improving synthesis of existing materials, controlling energy flow and storage, and regulating interactions between materials and their environments. Studies expand fundamental understanding of properties regulating the chemical dynamics and energy transfer processes that foster advances in lasers; the infrared, optical, and radar signatures of reaction products and intermediates; and the synthesis of new chemical propellants. Critical research topics include: novel synthesis and characterization of lower cost, higher performance functional and structural materials, electronics, and photonic materials; nano-structures; electromagnetic and conventional weaponry; and propellants. Focused investigations include the effects of chemical and morphological structures on functional and mechanical properties of polymeric materials and the exploration of atomic and molecular surface interactions that limit performance of electronic devices, compact power sources, and lubricant materials. Primary areas of research include molecular dynamics and theoretical chemistry, polymer chemistry, and surface and interfacial science.

(U) FY 2001 ($ in Thousands)

(U) $11,434 Performed molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and developed predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Evaluated methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Examined the use of molecular nano-clusters for use as catalysts and sensors. Developed new high energy density materials for rocket propellants and novel chemical laser systems.

(U) $8,686 Conducted polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions for advanced polymeric materials that significantly improve aircraft and spacecraft performance and life-spans. Improved spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigated polymer coatings to enable smart skins and advanced sensors for air and space weapon systems. Evaluated the stability of functional polymers in space environments to enhance survivability of vehicles exposed to space radiation. Continued to seek fundamental knowledge to formulate materials that have optical transitions suitable for highly efficient optical limiting properties.

(U) $5,732 Studied surface science to investigate the chemistry of surface processes for accurate detection and prevention of corrosion and degradation of air and space systems and for formulation of novel lubricants. Continued investigation of surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Developed predictive and experimental models for

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2303

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

molecular lubrication in high-temperature, high-wear environments. Explored the reactions and mechanisms for protection of aluminum aircraft from corrosion. Examined surface structures with enhanced energy-densities for significantly improved weapon system energy storage and delivery.

(U) $25,852 Total

(U) FY 2002 ($ in Thousands)

(U) $11,801 Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Seek understanding of mechanisms of using ion and plasma chemistry to reduce drag and/or enhance combustion. Synthesize novel chemical monopropellants for satellite and rocket applications. Determine the gain and loss mechanisms in chemical laser systems to permit operation at higher powers. Identify inputs required to model chemically reacting flows in rocket plumes. Develop theoretical methods to predict properties of structural materials.

(U) $9,120 Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions to develop advanced polymeric materials for significantly improved Air Force systems performance and life-spans. Explore chemistry concepts based on organic materials that will enable protection of Air Force personnel and sensors from agile lasers. Investigate nanocomposites to improve thermal and mechanical properties of polymers for lightweight aerospace structures. Devise controls of nanostructure assembly to attain new photonic and electronic functions.

(U) $5,903 Study the chemistry of surface and interfacial processes for accurate detection and prevention of corrosion and degradation of air and space systems, and development and design of novel lubricants. Develop new long-life, low-friction surface structures and coatings for terrestrial and space environments. Examine environmentally compliant nanostructured coating systems for corrosion protection of aluminum aircraft. Investigate novel three-dimensional surface nanostructures for sensor, optical, and power applications. Examine nanoscale surface structures with enhanced energy densities for significantly improved weapon system energy storage and delivery. Develop theoretical and predictive methods for surface and interfacial chemical processes.

(U) $1,982 Conduct research in chemical synthesis and detection techniques, chemical theory, and modeling and simulation that will lead to breakthroughs in new fuels and rocket propellants that are environmentally benign, have reduced signatures, and are less sensitive to accidental detonations. Investigate applications of these potential fuels in flight vehicles to study the benefits of increasing mass of payloads put into space and increasing the lifetime of satellites on orbit. Study application of any potential fuels breakthroughs to the development of hydrocarbon-fueled

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2303

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

scramjets and combined-cycle engines for space applications.

(U) $28,806 Total

(U) FY 2003 ($ in Thousands)

(U) $12,135 Conduct molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow. Results will enable development of next generation predictive tools for designing new materials and processes for advanced, super energetic propellants and high-energy lasers. Explore uses of ion and plasma chemistry for flow control applications. Model interactions between aerospace systems and the space environment. Investigate concepts of reactive energetic nano-structures for applications to propulsion and munitions. Develop and validate theoretical methods to predict and design behavior and properties of nano-structures. Model chemically reacting flows associated with hypersonic vehicles. Research new chemical sources of electronic excited states needed to fuel chemical laser systems.

(U) $9,377 Conduct polymer chemistry research to improve fundamental understanding of chemical structures, reactivity, and processing conditions to develop advanced polymeric materials. Research findings aimed at significantly improving Air Force systems performance and life-spans. Explore magnetic, conductive, and optical properties of coating materials to achieve smart skin concepts with on-demand tunable properties. Investigate biologically inspired polymer concepts to achieve previously unattainable material properties and complex supramolecular structures. Explore molecular conformational changes to achieve controllable mechanical actuation in polymeric materials.

(U) $6,066 Investigate the chemistry of surface and interfacial processes for accurate detection and prevention of corrosion and degradation of air and space systems. Explore physical properties of novel lubricants. Create new low-friction long-life coatings and surface structures for terrestrial and space environments. Research novel three-dimensional surface nano-structures for sensor, optical, and power applications. Probe nano-scale surface structures with enhanced energy-densities for better weapon system energy storage and delivery. Develop theoretical and predictive methods for surface and interfacial chemical processes.

(U) $2,000 Research novel chemical synthesis and detection techniques, chemical theory, and modeling and simulation focused on revolutionary breakthroughs in new fuels and rocket propellants that are more energetic, are environmentally benign, have reduced signatures, and are less sensitive to accidental detonations. Identify and investigate applications of these potential fuels in flight vehicles so as to enhance the benefits of increasing mass of payloads put into space and increasing the lifetime of satellites on orbit. Study application of any potential fuels breakthroughs to the development of hydrocarbon-fueled scramjets and combined-cycle engines for space applications.

(U) $29,578 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2303	

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Space Technology.
(U) PE 0602602F, Conventional Munitions.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2304

COST ($ in Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2304	Mathematical and Computer Sciences	32,061	35,079	33,169	34,879	34,576	35,253	35,923	Continuing	TBD

(U) A. Mission Description

Mathematical and computer sciences research develops novel techniques for mathematical modeling and simulation, algorithm development, complex systems control, and innovative analytical and high performance computing methods for aerospace systems. Basic research provides fundamental knowledge enabling improved performance and control of aerospace systems through accurate models and computational tools, artificial intelligence, and improved programming techniques and theories. The primary areas of research investigated by this project are dynamics and control, physical mathematics and applied analysis, computational mathematics, optimization and discrete mathematics, signals communication and surveillance, as well as complex systems and software.

(U) FY 2001 ($ in Thousands)

(U) $6,603 Performed dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Developed modeling, identification, and control capabilities necessary for the integrated control of vehicle aerodynamics and engine performance. Continued creating control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition by deployable laser platforms. Expanded active and adaptive control algorithms to enable autonomous air, space, and ground operations.

(U) $6,576 Conducted computational systems, software, artificial intelligence, and software reliability research to investigate unique computer technologies to devise critical software and computational systems for battlespace information management. Continued automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Refined distributed, automatic resource management approaches for advanced methods of mobile agent resource allocation and protection.

(U) $6,461 Conducted physical mathematics, applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Investigated the feasibility of coherently propagating short laser pulses through the air for superior accuracy in laser-guided munitions. Predicted nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Formulated optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Devised methods to penetrate tree cover and recognize targets.

(U) $4,675 Studied optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expanded transportable agent technology to support defensive information warfare applications and formulated real-time problem solving strategies to support dynamic planning and execution.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2304	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U)	$3,493	Performed computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Continued integrating new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Devised methods to reduce computation time for chemical laser simulations from months to days. Investigated failure modes of bonded composite materials by inserting novel computational methods into mission support software tools.
(U)	$2,609	Studied signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, wireless, and networked communications systems, and strengthens performance of surveillance and targeting functions through autonomous and human-assisted sensing/response platforms. Investigated irreducible expansions of signals, soft thresholding, and efficient source-channel coding in wireless communication to achieve major improvements in cost versus performance trade-offs. Expanded probabilistic process theory, functional analysis techniques, and information theory to eliminate current limits of sensing and communication system performance.
(U)	$1,644	Researched the mathematical foundations of external aerodynamics to develop fundamental knowledge of basic fluid dynamics and plasma-aerodynamics to predict and control supersonic and hypersonic flows over combat maneuvering flight vehicles. Devised accurate flow solvers for optimal design of aircraft wings and novel aerospace components. Refined plasma-aerodynamic optimization techniques to enable design of superior aerospace vehicles.
(U)	$32,061	Total

(U) FY 2002 ($ in Thousands)

(U)	$6,950	Perform dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Expand program on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned vehicles, and constellations of small satellites. Develop new techniques for the control of nonequilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion and materials processing.
(U)	$6,950	Conduct research in complex systems and software, artificial intelligence, automatic knowledge acquisition; study high performance knowledge bases to allow rigorous construction of highly complex battlefield information systems. Identify advanced techniques in intelligent and mobile agents for next generation information systems. Conduct research in information operations, including support for language-based security, mobile code security, protected execution, and dynamic, adaptive intrusion detection for protection of future battlespace and infosphere systems and networks.
(U)	$6,618	Conduct physical mathematics/applied analysis and electromagnetics research to devise accurate models of physical phenomena to enhance

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2304

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

controls and signal processing techniques. Investigate the feasibility of coherently propagating short laser pulses through the air for superior accuracy in laser-guided munitions. Predict nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluate methods to penetrate tree cover and recognize targets with wide band radar. Investigate feasibility of incorporating virtual time-reversal methodology onboard a formation of small satellites to enhance imaging of radar-acquired moving targets.

(U) $4,634 Study optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expand algorithmic research which produces a feasible solution within the time constraint of military operations. Develop techniques for hierarchical model building to accommodate multiple levels of aggregation and complexity, to reflect time and computational constraints.

(U) $3,640 Perform computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Integrate new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, munitions, and other aerospace components. Investigate efficient methods to quantify uncertainty in non-linear multidisciplinary design models. Continue devising methods to reduce computation time for chemical simulations from months to days. Improve algorithms for plasma dynamics simulations, munition penetration simulations, and ground-based image reconstruction.

(U) $2,649 Study signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, networked communications systems, and strengthen the performance of surveillance and targeting functions. Improve the efficiency of source-channel coding in wireless communication through technical advances such as optical transmission. Continue research in probabilistic and analytic theory to achieve higher information rates and greater reliability under stringent military covertness constraints. Develop promising areas such as super-resolution imaging and trellis-coded modulation.

(U) $1,982 Construct quantum computer devices that enable atomic level computing a million times faster than today's silicon chip. Design, implement, and test quantum computing algorithms and architectures enabling fast, accurate solutions of complex fluid dynamics problems eliminating the need for multiple design iterations and prototype testing. Develop scalable quantum computers for automatic target recognition and target characterization.

(U) $1,656 Explore mathematical and computational methods of external aerodynamics associated with hypersonic weapon release. Expand plasma aerodynamics algorithms to include magneto hydrodynamic (MHD) augmentation of complete scramjet engines. Computationally investigate the effects of dynamic aero structural tailoring during combat maneuvers on end-game targeting. Computationally explore hypersonic boundary layer transition on transatmospheric vehicles to reduce heat transfer and viscous drag to enable long-range, high-payload hypersonic

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2304

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

vehicles.

(U) $35,079 Total

(U) FY 2003 ($ in Thousands)

(U) $7,131 Perform dynamics and control research to develop new techniques for design and analysis of control systems. Research findings will significantly enhance capabilities and performance of aerospace vehicles. Focus of the research is on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned aerial vehicles (UAVs), and constellations of small satellites. Explore means to improve control of nonequilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion and materials processing. Foster advances in image processing and sensor technology that can be utilized in controller design for UAVs, smart munitions, nondestructive testing of aging or stealth aerospace vehicles. Design computational models to analyze biological processes for adaptation to aerospace systems.

(U) $7,131 Conduct research in complex systems and software, artificial intelligence, automatic knowledge acquisition, and high performance knowledge bases to allow rigorous construction of highly complex battlefield information systems. Explore methods to enhance research in information operations, including support for language-based security, mobile code security, protected execution, and dynamic, adaptive intrusion detection for protection of future battlespace/infosphere systems and networks. Develop new computational techniques/software in extremely large (10,000,000+ axioms) knowledge bases to provide deep, adaptive, expert decision support to battlefield commanders.

(U) $6,799 Conduct research in physical mathematics and applied analysis and in electromagnetics to develop accurate models of physical phenomena to enhance the fidelity of simulations and predictability of devices. Investigate the properties of coherently propagating short laser pulses through the air in relationship to the superior accuracy of laser guided munitions and electronic warfare. Develop algorithms to simulate nonlinear optical effects within semiconductor lasers and nonlinear optical media. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluate methods to penetrate tree cover with wide band radar to recognize and track targets. Study feasibility of designing reconfigurable warheads by suitable placement/time of microdetonators. Pursue description of dynamics of internal stores released from transonic platforms.

(U) $4,809 Conduct research in optimization and discrete mathematics to validate and further advance mathematical methods for solving complex problems in logistics, engineering design, and strategic/tactical planning for battlespace information management. Evaluate 'anytime' algorithms -- those that produce a feasible, but not necessarily optimal, solution. Examine new modeling techniques and computer algorithms for various urgent Air Force problems such as target tracking, mobilization planning, and manufacturing.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2304

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

(U)	$4,478	Perform computational mathematics research to create unique simulations and designs of advanced Air Force systems. Devise means to integrate new multidisciplinary design optimization strategies with high-order, time-accurate solvers in order to design superior jet engines, aircraft wings, munitions, and other aerospace components. Develop new algorithms for unsteady reactive flow, munition penetration and fragmentation, and plasmadynamics for directed energy weapons. Develop quantum computing algorithms, architectures, and implementations to enable exponential improvements in speed, accuracy, and fidelity of fluid dynamics simulations, signal processing, and data mining.
(U)	$2,821	Investigate signals communication and surveillance to expand the capability of critical mobile, networked communications, and surveillance/reconnaissance and targeting systems through examination of fundamental principles governing signal analysis. Areas of study include linear operator theory, generalized functions and probability, harmonic methods, and asymptotic expansions. Explore source-channel encoding methods for robust wireless communication using optical transmission phenomenology. Develop a rigorous basis for and delineate the domain of applicability of self learning, trial and error (heuristic) methods such as super-resolution imaging. Research technologies with higher information rates and higher reliability of communications.
(U)	$33,169	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702F, Command, Control, and Communications.
(U) PE 0603789F, C3I Advanced Development.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2305

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2305 Electronics	23,444	27,498	24,565	26,494	26,305	26,803	27,300	Continuing	TBD

(U) A. Mission Description

Electronics basic research aims to enhance fundamental understanding of electronic materials, devices, and systems to advance Air Force operational capabilities in directed energy weapons, stealth technologies, electronic countermeasures, information and signal processing, and communications. It enables development of electronic processes to model and predict performance of electronic materials, devices, and systems for power generation, optical signal processing, radiation effects, and high-speed signal processing. The goals are to firmly control the complexity and reliability of electronic systems, increase data transmission and information processing speeds of Air Force systems, and improve the security and reliability of electronic information. The primary areas of research investigated by this project are space electronics, optoelectronic materials, optoelectronic information processing, optoelectronic memory technologies, and quantum electronic solids.

(U) FY 2001 ($ in Thousands)

(U) $7,658 Performed space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Continued characterizing surface and interface states to prevent electronic device degradation. Explored wide bandgap semiconductor materials ideal for radio frequency (RF) power sources and high-temperature operations. Identified fundamental radiation effects on electronic and semiconductor materials and devised methods to prevent space system degradation or destruction.

(U) $7,572 Conducted optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Invented unique materials to protect critical optical systems from enemy attack. Devised laser materials to detect, degrade, or blind an adversary's detection capabilities. Created new detectors for characterization of the battlespace, surveillance, and to obtain target signatures in spectral ranges appropriate for quick target recognition.

(U) $4,457 Studied optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigated high bandwidth, multi-wavelength modulators and detectors to refine complex semiconductor structures for imaging and communication systems. Created optical materials for maximum high-bandwidth communication and parallel signal processing for enabling secure satellite communications and the increased data transfer speeds required for military operations.

(U) $3,757 Performed quantum electronic solids research to investigate superconducting, magnetic, and nanoscopic materials and devices for advanced sensing communications, signal processing, and superior data storage capabilities. Created high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms and directed energy weapons. Formulated innovative

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2305

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

approaches to measure active corrosion in aircraft structures to extend performance lifespan.

(U) $23,444 Total

(U) FY 2002 ($ in Thousands)

(U) $7,991 Perform space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Study the effects of intense RF pulses on electronic circuits and systems. Devise means to prevent surface and interface states from degrading electronic device performance. Explore wide bandgap semiconductor materials as promising candidates for RF power sources and high-temperature operations. Identify fundamental radiation effects on electronic and semiconductor materials and devise methods to prevent space system degradation or destruction.

(U) $7,762 Conduct optoelectronic materials research for detection and emission of optical radiation from far infrared to the ultraviolet spectral range to achieve spectral dominance of the battlespace. Investigate new non-linear optical materials to protect critical optical systems from laser fire, and access laser wavelengths and power not available with solid state or semiconductor lasers. Study basic mechanisms that limit the efficiency and uncooled operation of lasers and detectors. Formulate laser materials to degrade or blind an adversary's detection and tracking capabilities. Investigate fast multiband detectors for characterization of the battlespace, surveillance, target tracking, and target signatures. Study unique properties available from nanoscale combinations of optoelectronic materials.

(U) $4,602 Study optoelectronic information processing to explore development and application of electro-optical materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigate high bandwidth, multi-wavelength modulators and detectors to develop and refine complex semiconductor structures for imaging and communication systems. Create optical materials for maximum high-bandwidth communication and parallel signal processing. Investigate the use of new optical materials for enabling secure satellite communications and increased data transfer speeds required for military operations.

(U) $3,875 Perform quantum electronic solids research to investigate superconducting, magnetic, and nanoscopic materials and devices for advanced sensing communications and signal processing, and superior data storage capabilities. Improve high-temperature, high-current superconducting tapes and cables for enhanced storage and power generation on Air Force space platforms and directed energy weapons. Develop new techniques to quantify active corrosion in aircraft structures to increase lifespan. Investigate new high-temperature magnetic materials with sufficient mechanical strength for utilization in aircraft with higher electric workloads.

(U) $1,981 Conduct research addressing the scientific barriers to miniaturization of components enabling much lighter, more compact, highly capable microsatellites and nanosatellites. Research nanopropulsion and power schemes, smart skins, radiation hardening and quantum effect

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2305

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

electronics to reduce satellite cost, weight, and size each by a factor of ten. Investigate nanosatellite benefits for improving access to space, mission flexibility, ease of augmentation and upgrade, and graceful degradation during end of service life.

(U) $1,287 Establish focused ion beam research associated with system optimization and characterization. Investigate properties for establishing and regulating the narrowest beam diameter at relatively high energy. Investigate the effects and benefits derived from a wide range of isotopes provided by various liquid metal ion sources. In addition research means to enable advancing computing, sensing, and image processing associated with ion beam research.

(U) $27,498 Total

(U) FY 2003 ($ in Thousands)

(U) $8,883 Conduct research on military space platform unique electronic circuits aimed at greatly reducing component size and weight while increasing reliability. Expand study of intense radio frequency pulse effects on electronic circuits and systems. Design, fabricate, and evaluate wide bandgap semiconductor materials to achieve an unique combination of high radio frequency power output, high efficiency, low noise, robustness, and radiation hardness. Devise nano-satellite electronic device concepts and initiate efforts to identify electronic approaches to increasing spacecraft survivability. Conduct research on the interaction of systems and sensors with the space environment. Develop models to predict the effects of terrestrial and space backgrounds and radiation on sensor performance in order to promote secure, wide bandwidth communication through the atmosphere and ionosphere as well as between satellites.

(U) $7,861 Conduct optoelectronic materials research for detection and emission of optical radiation from the far infrared to ultraviolet spectral range to achieve spectral dominance of the battlespace. Investigate unique non-linear optical materials to protect critical optical systems from laser radiation. Assess basic electronic mechanisms to improve the efficiency and reduce the cooling requirements of lasers and detectors. Synthesize laser materials to degrade or blind an adversary's detection and tracking capabilities. Create fast multiband detectors for characterization of the battlespace, surveillance, target tracking, and target signatures. Develop nano-fabrication technology for unique optoelectronic material properties.

(U) $2,334 Conduct research in optoelectronic information processing to explore the design, development, and application of novel optoelectronic materials and devices to enhance critical communication system accuracy and speed. Examine complex semiconductor structures and develop optical materials for use in high bandwidth, multi-wavelength modulators and detectors for secure satellite imaging and faster data transfer rate communication systems. Explore optoelectronic nanotechnologies: nanophotonics, nanoelectronics, and nanosensors and opportunities in terahertz technologies.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2002
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2305

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

(U)	$3,930	Perform quantum electronic solids research to investigate superconducting, magnetic and nanoscopic materials for advanced sensing, communications, and signal processing. Investigate superconducting quantum systems for adaptation to quantum computing and encryption. Develop high-current, high-temperature superconducting cables and tapes for enhanced power generation and storage on Air Force directed energy weapons and space platforms. Develop new high-temperature magnetic materials with sufficient mechanical strength for use in aircraft with higher electric workloads.
(U)	$1,557	Perform research in optoelectronic memory technologies and persistent spectral hole-burning systems for data storage and processing. Develop page-oriented or holographic memory configurations in two or three dimensions. Explore capabilities to buffer, store, and retrieve data at rates and quantities anticipated for multispectral devices. Develop new technogies to increase capabilities in high speed image capture, data storage and processing for surveillance, target discrimination, and autonomous navigation.
(U)	$24,565	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602702F, Command, Control, and Communications.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603789F, C3I Advanced Development.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2306

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2306 Materials	13,621	16,355	15,004	17,574	18,464	18,791	19,122	Continuing	TBD

(U) A. Mission Description

Materials research enhances the performance, cost, and reliability of structural materials to eliminate reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. It expands fundamental knowledge of material properties that will enable novel materials for airframe, turbine engine, and spacecraft structures. The goals of this project are to develop improved aerospace vehicle structural materials, increase the operating temperature of engine materials, and further increase thrust-to-weight ratio of engines. Basic research emphasis is on refractory alloys, inter-metallics, polymer composites, metal and ceramic matrix composites, advanced ceramics, such as alumina, silicon carbide, silicon nitride, and carbon/carbon, and in new material processing methods. The primary areas investigated by this project are ceramic and non-metallic materials, metallic materials, and organic matrix composites.

(U) FY 2001 ($ in Thousands)

(U) $4,429 Performed ceramic and non-metallic materials research to examine the fundamentals of very-high temperature, non-metallic materials for airbreathing and rocket engines and space vehicle applications. Investigated coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for jet engine blade applications. Sought fundamental knowledge to formulate ultra-high temperature materials systems based on carbides for rocket propulsion applications.

(U) $7,211 Conducted metallic materials research to evaluate novel metallic systems for propulsion and airframe applications. Explored thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Evaluated tailorable transition-phase materials for superior thermal barrier coatings.

(U) $1,981 Studied organic matrix composites to expand knowledge of polymer matrix composites and increase the strength and life-span of air and space vehicle structures. Explored thermal cycling effects of polymer matrix composites down to cryogenic temperature range to better understand durability issues in liquid fuel tank environments. Investigated innovative fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $13,621 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2306

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$4,743	Perform ceramic and non-metallic materials research to understand optimum strength of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Study thermal and mechanical stability interaction of very-high temperature oxide and non-oxide composites for jet engine blade applications. Advance fundamental materials knowledge to develop ultra-high temperature material systems based on carbides for rocket propulsion applications.
(U)	$7,473	Conduct metallic materials research to develop affordable and durable metallic systems for advanced engines and aerospace structural applications. Expand investigations of thermal and mechanical stability of metal refractory alloys, intermetallics, and composites for very-high temperature aircraft applications. Research tailorable transition-phase materials for superior thermal barrier coatings and develop advanced metals for multifunctional space systems.
(U)	$2,157	Perform organic matrix composites research to advance polymer matrix composite knowledge and increase the life-span and strength of aerospace structures. Study thermal cycling effects of polymer matrix composites at cryogenic temperatures to improve material durability in liquid fuel tank environments. Research novel fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.
(U)	$1,982	Develop new mathematical and computational strategies to reduce maturity time for new materials by ~50% and to minimize the costs of new structural materials for aerospace systems. Explore scientific basis for computational design to reduce amount of costly experimentation required. Develop high performance materials more affordably through synchronization of material development and engineering system design.
(U)	$16,355	Total

(U) FY 2003 ($ in Thousands)

(U)	$4,952	Perform ceramic and non-metallic materials research to design new materials and composites for very-high temperature, hostile environment air and space applications. Optimize thermal and mechanical stability of very-high temperature oxide composites and eutectics for aircraft and jet engine blade applications. Develop concepts for the application of advanced fundamental knowledge to create ultra-high temperature materials systems based on carbides for rocket propulsion applications. Design and optimize multifunctional ceramic materials to enable structurally enhanced fuell cells, sensors, and actuators.
(U)	$7,802	Conduct metallic materials research to develop affordable and durable metallic systems for advanced engines and aerospace structural applications. Investigations focus on mechanical and thermal stability of composites, metal refractory alloys, and intermetallics for very-high temperature aircraft applications. Develop functionally gradient structures for superior thermal barrier coatings. Create advanced metals for

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2306	

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

multifunctional space systems.

(U) $2,250 Perform organic matrix composites research to advance polymer matrix composites knowledge to increase the strength and life-span of aerospace structural materials. Analyze effects of cyclic thermal loads on polymer matrix composites down to cryogenic temperatures to increase durability in liquid fuel tank materials. Develop new fiber sizing techniques in glass fiber reinforced structures to minimize degradation of mechanical and electromagnetic properties due to moisture.

(U) $15,004 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0708011F, Industrial Preparedness.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602601F, Space Technology.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2307

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2307 Fluid Mechanics	9,395	9,954	10,599	11,274	12,147	12,383	12,630	Continuing	TBD

(U) A. Mission Description

Fluid Mechanics research advances fundamental knowledge, tools, data, concepts, and methods for improving the efficiency, effectiveness, and reliability of aerospace vehicles. The goals are to improve theoretical models for aerodynamic prediction and design as well as to originate flow control concepts and predictive methods to expand current flight performance boundaries through enhanced understanding of key fluid flow, primarily high-speed air, phenomena. Basic research emphasis is on turbulence prediction and control, unsteady and separated flows, hypersonics, and internal fluid dynamics. The primary approach is to formulate advanced computational methods to: simulate and study complex flows; predict real gas effects in high-speed flight; and control and predict turbulence in flight vehicles and propulsion systems. Primary areas of research investigated by this project are unsteady aerodynamics, hypersonic aerodynamics, turbulence and flow control, and rotating flows.

(U) FY 2001 ($ in Thousands)

(U) $2,349 Performed unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize current Air Force air vehicle designs and enable revolutionary future weapon systems. Investigated unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Continued to devise design tools for flow control to minimize flow separation and air vehicle drag. Continued to develop fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $2,818 Conducted hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Advanced concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques. Developed high-speed flow prediction codes to quantify thermal stresses.

(U) $2,350 Sought fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in air vehicles. Evaluated novel micro-electro-mechanical systems (MEMS), actuators, and investigate actuation coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements. Evaluated the use of MEMS devices for flow control on swept wing air vehicles with a goal of substantial drag reduction.

(U) $1,878 Studied rotating flows to evaluate internal flow characteristics for enhancing the performance and reliability/maintainability of airbreathing propulsion systems. Evaluated promising MEMS devices for turbine engine control and Large Eddy Simulation methodology for affordable high fidelity predictions of gas turbine engine flow fields and heat transfer effects.

(U) $9,395 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2307	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $2,490 Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize future Air Force air vehicle designs and enable revolutionary future weapon systems. Investigate unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Complete the development of design tools for flow control to minimize flow separation and air vehicle drag. Complete the development of fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $2,987 Conduct hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Research advanced concepts for hypersonic flow control such as plasma or magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses. Investigate high temperature mitigation techniques for hypersonic flight vehicles.

(U) $2,487 Seek fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts. Investigate flow control concepts to enhance the performance, controllability, and stability in air vehicles. Develop new predictive tools for the air vehicle design process. Evaluate promising flow control actuation concepts and investigate flow control coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements.

(U) $1,990 Study complex rotating flow phenomena as they relate to turbomachinery and jet engine applications. Evaluate unsteady flow phenomena for enhancing the performance and reliability/maintainability of airbreathing propulsion systems. Continue development of Large Eddy Simulation methodology for affordable high fidelity predictions of gas turbine engine flow fields and heat transfer effects. Develop understanding of high cycle fatigue aerodynamic forcing. Evaluate possible flow control applications in turbine engines.

(U) $9,954 Total

(U) FY 2003 ($ in Thousands)

(U) $2,649 Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize current Air Force air vehicle designs and enable revolutionary future weapon systems. Investigate unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Investigate rapid maneuver unmanned air vehicle aerodynamics. Investigate highly separated flow situations occurring in complex air vehicle and weapon systems.

(U) $3,181 Investigate complex phenomena in hypersonic flows to enable the design of future Air Force trans-atmospheric vehicles and flight control systems. Complete development of hypersonic flow control concepts, including plasma and magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses and design mitigation techniques for hypersonic flight vehicles.

(U) $2,649 Explore fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts. Investigate new areas and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
01 - Basic Research	0601102F Defense Research Sciences	2307

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

methods of flow control on aircraft wings and jet engines to enhance the performance, controllability, and stability in air vehicles. Develop reduced order models for turbulent flow control applications and affordable engineering predictive models for the air vehicle design process. Assess quality of promising flow control actuation concepts on realistic geometries. Continue investigating flow control coupling mechanisms in turbulent flows to enable agile flight vehicles.

(U) $2,120 Study complex rotating flow phenomena as they relate to turbomachinery and jet engine applications. Evaluate unsteady flow phenomena and develop understanding of forcing modes in turbomachinery to predict and avoid high cycle and thermal failures in jet engines. Investigate application of Large Eddy Simulation techniques to explore complex gas turbine engine flow fields and heat transfer effects. Evaluate flow control measurement and actuation devices for use in harsh environments such as turbine engines.

(U) $10,599 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0603211F, Aerospace Structures.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2308

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2308 Propulsion	20,937	23,104	21,190	21,635	22,102	22,505	22,914	Continuing	TBD

(U) A. Mission Description

Propulsion research seeks fundamental knowledge to enable and enhance efficient utilization of energy in airbreathing engines, chemical and non-chemical rockets, and combined cycle propulsion systems for access to space. Basic research thrusts include airbreathing propulsion, space power and propulsion, high altitude signature characterization and contamination, propulsion diagnostics, and thermal management of space-based power and propulsion systems. Two key basic research areas include reacting flows and non-chemical energetics. Study of chemically reacting flows involves the complex coupling between energy release through chemical reaction and the flow processes that transport chemical reactants, products, and energy. Study of non-chemical energetic systems include plasma and beamed energy propulsion for orbit raising space missions and efficient ultra-high energy techniques for space-based energy utilization. Primary areas of research investigated by this project are space power, propulsion, combustion, and diagnostics.

(U) FY 2001 ($ in Thousands)

(U) $7,048 Performed space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Increased thrust and control of micro-satellite and nano-satellite propulsion systems to enable high-precision clusters of cooperating autonomous micro-satellites. Examined self-consuming satellites and mechanical-electric energy conversion to increase payload and thrust capabilities. Continued to develop new concepts, such as pulsed detonation, hybrid rockets, and combined cycle engines, to enable very high temperature and pressure (supercritical) combustion for optimal rocket propulsion. Studied experimental and numerical characteristics of high-altitude ultraviolet and infrared signatures and satellite contamination to develop techniques to protect space assets.

(U) $6,577 Studied combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Enhanced computer models to increase efficiency by predicting unsteady behavior such as combustion instability. Examined primary and secondary atomization and mixing of fuels to optimize fuel injection to increase thrust output.

(U) $4,384 Investigated advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Obtained essential data through multiplexed diode-laser spectroscopy that enabled simultaneous detection of temperature and pressure within chemical propulsion systems to increase their thrust and efficiency.

(U) $2,928 Continued coal-derived jet fuels research to investigate refinery processing techniques for coal processing with petroleum, additives to suppress fuel system fouling, combustion characteristics of candidate fuels, and fuel-material interactions. Produced small quantities (50 gallons) of coal-derived fuel for large-scale combustion, fuel system fouling, and ignition experiments.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2308

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $20,937 Total

(U) FY 2002 ($ in Thousands)

(U) $7,263 Perform space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Enable clusters of cooperating autonomous micro-satellites by improving thrust and control of micro- and nano-satellite propulsion systems. Research mechanical-electric energy conversion and self-consuming satellites to increase payload and thrust. Explore supercritical combustion for optimal rocket propulsion using hybrid rockets and/or combined cycle engines. Perform research on digital propulsion and pulsed detonation rocket engines. Exploit experimental university satellites to measure thrust and cross-contamination in micro-satellite constellations. Develop novel space diagnostic techniques and 100 gram class sensors for accurate measurements on micro- and nano-satellites.

(U) $6,915 Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Increase combustion efficiency and reduce fuel consumption through enhanced computer models that can predict unsteady behavior such as combustion instability. Advance the state of turbulent combustion simulation methods by incorporating refined models for chemistry and fuel droplets. Investigate enhancements to ignition and flame stabilization by weakly ionized flows.

(U) $4,470 Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Apply picosecond spectroscopic techniques to characterize turbulent combustion statistical behavior and supercritical fuel properties.

(U) $1,980 Research methods for improving aerodynamics for next generation aerospace vehicles for long range strike. Expand research to develop sound scientific basis for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies enabling hypersonic vehicles by reducing drag and improving range by more than 10%. Perform demonstrations to prove plasma control effects and to determine how to engineer them into operational systems. Investigate plasma effects on lowering fuel consumption, improving propulsion system performance, providing on-board power generation, and alleviating sonic boom and engine noise.

(U) $2,476 Continue researching coal-derived jet fuels to investigate refinery processing techniques for coal processing with petroleum, additives to suppress fuel system fouling, combustion characteristics of candidate fuels, and fuel-material interactions. Produce small quantities (50 gallons) of coal-derived fuel for large-scale combustion, fuel system fouling, and ignition experiments. Investigate potential for coal-derived fuel production scale-up.

(U) $23,104 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2308

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands)

(U)	$7,484	Explore space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Study means to improve thrust and control of propulsion systems to develop high-precision constellations of cooperating micro-satellites. Expand understanding of mechanical-electric energy conversion to increase payload and thrust. Study feasibility of excess silicon as a space propellant in developing concepts for self-consuming satellites. Continue researching new engine concepts such as pulsed detonation engines, hybrid rockets, and combined cycle engines. Create advanced supercritical combustion models and leverage computational capability to enhance the design of new engines. Research plasma turbulence and its effect on the transport coefficients to develop a new class of more versatile plasma thrusters.
(U)	$7,100	Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Develop enhanced computer models that predict unsteady behavior, such as combustion instability, to increase combustion efficiency and reduce fuel consumption. Advance the state of Large Eddy Simulation methods for turbulent combustion by incorporating upgraded subgrid-scale models for chemistry and fuel droplets.
(U)	$4,606	Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Study laser-induced fluorescence and absorption spectroscopic measurements in relation to infrared and ultraviolet excitation wavelength regimes.
(U)	$2,000	Study methods for enabling and improving aerodynamics for next generation aerospace vehicles for long range strike. Further expand research studies to develop sound scientific basis for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies enabling hypersonic vehicles by reducing drag and improving range by more than 10%. Demonstrate plasma control effects and evaluate means to engineer them into operational systems. Investigate plasma effects on lowering fuel consumption, improving propulsion system performance, providing on-board power generation, and alleviating sonic boom and engine noise.
(U)	$21,190	Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2308

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Space Technology.

(U) PE 0603211F, Aerospace Structures.

(U) PE 0602269F, Hypersonic Technology Program.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2311

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2311 Space Sciences	14,408	16,690	15,531	16,066	16,605	16,938	17,279	Continuing	TBD

(U) A. Mission Description

Space Sciences research provides fundamental understanding of the space environment for optimum design of Air Force systems operating in near-Earth orbit, geosynchronous orbit, and deep space. The goal is to enable greater, more cost-affordable, protection of space assets from space debris, solar wind, solar flares, cosmic rays, and geomagnetic storms. Basic research focuses on specifying the flow of mass, momentum, and energy through space to develop a global model that connects solar activity with the deposition of energy at the Earth. In order to enhance the effectiveness of Air Force global dominance through space operations, methods are developed to forecast the turbulent plasma phenomena that mediate the flow of energy through space. The primary areas of research investigated by this project are solar physics and astrophysical observation techniques, solar wind transport and magnetospheric physics, ionospheric physics and scintillation, and energization processes in the Earth's radiation belts.

(U) FY 2001 ($ in Thousands)

(U) $5,762 Continued support to Sacramento Peak Solar Observatory to analyze solar phenomena to characterize and model solar phenomena for much better prediction of large-scale disruptions in the space environment and to advance development of protective spacecraft structures and defensive operational techniques. Discovered the physics of solar plasma arcades, solar flares, and coronal mass ejections to establish the physical basis for solar disturbance models. Continued investigating sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar eruptions and predict risk to critical Air Force space operations.

(U) $4,322 Studied solar wind transport to evaluate the magnetic transport of solar eruptions to formulate accurate maps of environmental vulnerability and to identify orbits that ensure continued, reliable performance of Air Force satellites. Integrated solar magnetic field and coronal data to discover the science underpinning solar ejection paths and devised accurate modeling techniques. Evaluated effects of the solar wind, the interplanetary magnetic field, and the Earth’s magnetosphere to enhance space weather specification and forecast models.

(U) $4,324 Studied the transient and long-term effects of the Earth's magnetospheric and radiation belt energization processes to predict performance degradation levels in Air Force space systems. Examined charged particle dynamics and magnetohydrodynamic fluid flow for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth’s satellite environment. Related fundamentals of turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $14,408 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2311

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$3,751	Analyze, characterize, and model solar phenomena for much better prediction of large-scale solar disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Obtain high-resolution observations of solar plasma arcades, solar flares, and coronal mass ejections to establish the physical basis for solar disturbance models. Continue investigating sunspots, solar oscillation modes, and solar magnetic field spin states to enable forecasting of solar eruptions and predict environmental risks to critical Air Force space operations. Develop solar vector magnetographs using adaptive optics.
(U)	$3,734	Study solar wind effects on the Earth's magnetospheric and radiation belt energization processes and morphology. Enhance space systems performance degradation models. Develop models that provide realistic coupling of the magnetosphere - ionosphere system. Conceive magnetohydrodynamic (MHD) models to develop a theoretical understanding of magnetic reconnection and self-organized criticality in the magnetosphere.
(U)	$4,482	Study ionospheric scintillation and turbulence to enhance global surveillance, geolocation, and communication. Observe atmospheric gravity wave interactions from high-latitude and tropical observation sites using light detection and ranging (LIDAR) techniques. Conduct airglow and auroral emission observations and characterize the chemical and physical dynamics of the mesosphere, thermosphere, and ionosphere to develop comprehensive seasonal and climatic maps of high-altitude phenomena.
(U)	$2,990	Characterize the populations of space debris particles derived from comets and asteroids to predict threats to Air Force spacecraft. Provide a test bed for advanced deep space surveillance techniques through new astronomical instrumentation and observational methods. Expand laser guide-star development and observations of space backgrounds and optical signatures of orbital targets over the tropics. Research the variable energy deposited in near-Earth space by cosmic rays and energetic particles from deep space to identify risks to Air Force systems.
(U)	$743	Research space weather phenomena through the investigation of several solar variables observed from thousands of sun-like stars. Model the evolution of our sun. Research supported through the Center for Solar Geophysical Interactions at the Mt. Wilson Observatory.
(U)	$990	Support basic research and educational outreach projects at the California Science Center to assure the Air Force access to superior scientific and engineering talent in future years. Efforts include research to increase the fundamental understanding of atmospheric conditions, weather phenomena, and expand into biological sensory systems.
(U)	$16,690	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2311	

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands)

(U)	$3,856	Analyze solar phenomena to characterize and model solar phenomena for enhanced prediction of large-scale disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Explore technology requirements to enable development of a new ground-based Advanced Technology Solar Telescope. Advance adaptive optics techniques in solar observations. Investigate scientific analysis of space-based data. Continue investigating solar dynamo, solar oscillation modes, solar flares, coronal mass ejections, and solar magnetic field helicity to enable forecasting of solar eruptions and predict environmental risks to critical Air Force space operations.
(U)	$3,856	Develop mitigation techniques for ionospheric scintillation and plasma turbulence to enhance global surveillance, geolocation, and communication. Develop data assimilation techniques to modernize ionospheric and space weather forecasting. Continue to observe atmospheric gravity wave interactions from high and low geomagnetic latitudes, as well as tropical observation sites, using light detection and ranging (LIDAR) techniques in order to develop seasonal and climatic models of ionospheric phenomena.
(U)	$4,628	Study ionospheric scintillation and turbulence to enhance global surveillance, geolocation, and communication. Develop data assimilation techniques to modernize ionospheric and space weather forecasting. Continue to observe atmospheric gravity wave interactions from high-latitude and tropical observation sites using LIDAR techniques in order to develop seasonal and climatic models of ionospheric phenomena.
(U)	$3,191	Predict threats to Air Force space assets by cataloging and tracking the populations of Near Earth Objects and space debris particles derived from comets and asteroids. Develop advanced astronomical instrumentation and observational methods. Explore laser guide-star development for observations of Near Earth Objects and ballistic and orbital targets over the tropics. Investigate the variable energy deposited in near-Earth space by energetic particles from deep space and by cosmic rays to quantify risks to Air Force systems.
(U)	$15,531	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602601F, Space Technology.

(U) PE 0602702F, Command, Control, and Communications.

(U) PE 0603410F, Space System Environmental Interactions Technology.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2311	

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2312

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2312 Biological Sciences	13,114	13,844	14,383	14,730	15,025	15,324	15,629	Continuing	TBD

(U) A. Mission Description

Biological Science research aims to provide the fundamental knowledge necessary to enable Air Force technologies and understanding in chemical and physical agent toxicity, biomimicry for electromagnetic sensors, biomolecular materials, biochromatics and luminescence, as well as neuroscience and chronobiology. The goal is to exploit biological properties so as to control and manipulate operational environments. Research topics in toxicology explore the interaction of Air Force chemicals and physical agents (lasers and microwaves) with human tissues and associated effects to enable safety assessment strategies in order to ensure the hazard-free development and use of future aerospace materials and directed energy systems. Research in biomimetic sensors strives to mimic the biological detection systems of organisms at the molecular level in development of novel man-made sensors. Basic research in biocatalysis characterizes cellular enzymes that will catalyze the synthesis of chemical feedstocks used in the safe production of space and aerospace materials. Research in neuroscience and chronobiology provides new strategies to prevent impaired operational performance due to jet lag and shift-work, night operations, and the loss of life and/or aircraft due to stress, inattention, or lack of vigilance. The primary areas of research investigated by this project are bioenvironmental sciences, biocatalysis, chronobiology and neural adaptation, and biomimetic sensors.

(U) FY 2001 ($ in Thousands)

(U) $6,428 Studied bioenvironmental sciences to investigate and predict biological effects of novel aerospace chemicals and directed energy systems to assure the safety, health, and high-performance of military personnel during and after mission-directed activities. Evaluated underlying biochemical alterations related to the adverse effects of JP-8 jet fuel and began to identify specific protein targets responsible for triggering the toxic responses. Explored in vitro biodynamic alterations that together with biokinetic parameters aid in predicting toxicity and integrate into the computational design of new, safer, aerospace materials. Examined the effects of novel forms of directed energy (microwaves and lasers) on gene expression and identified specific sub-cellular targets of directed energy.

(U) $3,283 Researched biocatalysis to discover and characterize enzymes from living cells used as biocatalysts to reduce cost, increase efficiency, and assure safety for synthesizing chemical feedstocks for manufacturing aerospace materials. Sub-cloned various bacterial enzymes to enhance the level of gene expression so the enzymes could be produced in sufficient yields for additional research and biotechnology development. Identified and isolated bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of aerospace materials synthesis.

(U) $1,834 Performed chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2312

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

environment, and individual performance capabilities to improve skilled human performance. Interpreted the mechanism by which serotonin regulates the circadian clock, determined if modafinil prevents adverse effects on performance without disrupting sleep, and investigated the combination of countermeasures such as optimally-timed rest periods and wake promoting compounds.

(U) $1,569 Investigated biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identified methods to enhance these systems. Analyzed, predicted, and modeled biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Isolated and began to model alternate mechanisms of near ambient infrared sensing systems in snakes and beetles to enable room-temperature, compact infrared sensors. Investigated and adapted chromophores and photoluminescent characteristics in microbial and protein-based biological systems for insights to military sensor applications.

(U) $13,114 Total

(U) FY 2002 ($ in Thousands)

(U) $6,783 Study bioenvironmental sciences to investigate the biological effects of exposure to military aerospace chemicals and directed energy systems used by the military to assure the safety, health, and high performance of personnel before, during, and after mission-directed activities. Explore the molecular and cellular effects of JP-8 jet fuel on the lung, brain, skin, and immune system and continue to identify specific molecular pathways involved in eliciting and blocking toxic responses. Continue to develop reliable in vitro simulators of in vivo toxic responses and learn to use them to rapidly acquire and predict toxic profiles at a sub-cellular level. Continue to identify and quantify subtle, gene-induced effects of directed energy (microwaves and lasers) on cellular targets and determine the approximate exposure levels at which these effects are significant.

(U) $3,462 Research biocatalysis to discover and characterize enzymes from living cells for use as biocatalysts to reduce cost, increase efficiency, and assure safety in chemical feedstocks synthesis for aerospace materials. Discover, isolate, clone, and sequence genes of novel enzymes of use to the military. Biochemically characterize the enzymes and investigate their mechanisms of reaction, kinetics, substrate range, and specificity.

(U) $1,937 Perform chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the environment, and individual performance capabilities to improve skilled human performance. Continue to analyze the mechanism by which serotonin regulates the circadian clock. Continue researching the effect of modafinil on preventing adverse performance effects without disrupting sleep. Optimize the combination of fatigue countermeasures such as optimally-timed rest periods and alertness promoting compounds.

(U) $1,662 Conduct biomimetic research to enable the development of novel sensors, engineering processes, and mechanisms. Investigate fundamental

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2312

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

biological properties and processes of infrared sensitive biosystems at the cellular, sub-cellular, and molecular levels to enable the development of novel infrared materials and devices with enhanced structural and functional capabilities. Identify, isolate, and model alternate mechanisms of near ambient infrared sensing in biosystems to enable and/or enhance compact, room-temperature infrared sensors. Probe the functionality of alternative sensors for time-response characteristics. Investigate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for application to military sensors.

(U) $13,844 Total

(U) FY 2003 ($ in Thousands)

(U) $7,047 Study bioenvironmental sciences to investigate the biological effects produced by exposure to aerospace chemicals and directed energy systems used by the military to assure the safety, health, and high performance of the warfighter before, during, and after mission-directed activities. Continue to identify organ-specific molecular pathways altered by JP-8 jet fuel exposures and evaluate various biomolecular indicators and mediators of the toxic response for use as potential biomarkers of human exposure and to enable the development of protective strategies. Explore mechanisms and develop novel molecular descriptors that will help integrate in vitro toxicity data into a mathematical format for use in the rapid computational prediction of toxicity of aerospace chemicals and new forms of directed energies. Investigate the biological effects of chronic low level exposures to directed energy by profiling and modeling intracellular molecular responses and identifying potentially harmful extra-cellular mediators.

(U) $3,596 Research biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety in the process of synthesizing chemical feedstocks used in the manufacture of aerospace materials. Continue the essential and fundamental process of enzyme discovery and characterization. Genetically modify the natural biocatalytic potential of enzymes to meet various synthetic manufacturing requirements by extending substrate ranges and specificities or altering reaction rates. Explore alternative metabolic engineering techniques for maintaining or enhancing reaction rates during large scale production.

(U) $2,014 Perform chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the environment, and individual performance capabilities to improve skilled human performance. Explore the mechanism by which serotonin influences the circadian clock. Conduct studies using optimally-timed rest periods and wake promoting compounds to extend waking activity. Develop a mathematical model to recommend the best use of light exposure, caffeine, modafinil, and brief naps to counter the effects of jet lag and sustained sleep deprivation.

(U) $1,726 Continue to conduct biomimetic research to enable the development of novel sensors, engineering processes, and mechanisms. Model the

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2312

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

fundamental principles, processes, and designs of infrared sensitive biosystems at the sub-cellular, molecular and genomic levels to enable the further development of infrared materials, devices, and systems with enhanced structural and functional capabilities. Identify, model, and construct alternative biomimetic, near ambient infrared sensing devices. Probe and manipulate the functionality of alternative sensors for time-response characteristics. Adapt biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems.

(U) $14,383 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702F, Command, Control, and Communication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2313

COST ($ in Thousands)	FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2313 Human Performance	13,747	12,885	13,044	13,113	12,471	12,706	12,965	Continuing	TBD

(U) A. Mission Description

Human Performance research aims to provide the fundamental knowledge necessary to examine all aspects of human information processing critical to Air Force operations. The goal is to develop useful quantitative models of the way people: perceive, navigate, and manipulate their environment; make decisions in complex tasks under stress or uncertainty; and adapt to extreme sensory, biophysical, or cognitive workloads. Sensory research emphasizes visual, auditory, vestibular, and kinesthetic systems and their optimal integration. Basic research topics focus investigations on the scientific foundation for several developing Air Force technologies including the design of interactive displays, simulators, intelligent control systems, sensors and fused-image displays, and adaptive systems for operator and team training. The primary areas of research investigated by this project are sensory and perceptual systems, cognition, and team performance.

(U) FY 2001 ($ in Thousands)

(U) $3,449 Performed sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Refined theories of visual search and scene analysis, control of attention, perception of orientation, and localization of sound for optimal cockpit performance. Analyzed the perceptual and cognitive requirements for accurate simulation of virtual environments and for effective design of informative displays. Gained understanding of human multisensory integration to enable the design of automated sensing devices.

(U) $4,853 Conducted cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew member interactions. Enhanced human performance via intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations. Developed and tested training protocols to maximize team effectiveness under stress and sustained operation.

(U) $4,468 Studied cognitive workload to formulate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss to enable cognitive performance modeling and prediction. Invented innovative approaches to understanding individual skill differences and created new training and selection systems relevant to modern, technology-dependent environments. Studied behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $977 Supported basic research and educational outreach projects at the Chabot Observatory and Science Center to assure the Air Force access to superior scientific and engineering talent in future years. Efforts included research to increase the fundamental understanding of the upper atmosphere.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2313

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $13,747 Total

(U) FY 2002 ($ in Thousands)

(U) $3,480 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Develop theories for models of human-machine interaction in Air Force weapon systems. Critically test theories of visual search and scene analysis, and control of attention using measures of performance identified in several task domains. Create models for perceptual and cognitive requirements for accurate simulation and for effective design of informative displays. Develop laboratory apparatus to test theories of sensory integration for image understanding.

(U) $4,895 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Develop models of enhanced human performance aided or augmented by intelligent systems. Discover and evaluate theories of training for operator and team effectiveness under stress and sustained operation.

(U) $4,510 Study cognitive workload to validate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance. Model relationships between individual skill differences and interactions with new training methodologies. Study behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $12,885 Total

(U) FY 2003 ($ in Thousands)

(U) $3,522 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Critically test theories of sensory and perceptual systems for enhanced human-machine interaction and sensor processing in Air Force weapon systems. Discover improved methods for evaluating design options for visual displays used in scene analysis and command and control in several task domains. Evaluate theories and models of perception and cognition for accurate simulation and fused sensor processing. Using performance metrics, critically test theories of sensory integration for image understanding.

(U) $4,957 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Extend models of cognitive dimensions of human performance in complex command and control tasks to inform studies of automated decision making. Test models of enhanced human performance aided or augmented by intelligent systems. Determine mechanisms affecting training effectiveness for operator and team performance under stress and sustained operation.

(U) $4,565 Study cognitive workload by using developed metrics to critically test behavioral and physiological theories of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance. Develop theories for modeled relationships between individual skill

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 2313

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

differences and interactions with envisioned training pedagogies. Determine behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $13,044 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602202F, Human Effectiveness Applied Research.

(U) PE 0602702F, Command, Control, and Communication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 4113

COST ($ in Thousands)		FY 2001 Actual	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4113	External Research Programs Interface	4,241	6,584	7,399	7,511	7,650	7,467	7,618	Continuing	TBD

(U) A. Mission Description

External research programs interface optimizes interactions between the international and domestic research community and Air Force researchers. These professional interchanges and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities, and attract talented scientists and engineers to address Air Force needs. Consideration is provide to enhance educational interactions with historically black colleges and universities (HBCU) and minority institutions (MI). The primary elements of this effort are international strategy, international technology liaison, and scientist and engineer research interchange.

(U) FY 2001 ($ in Thousands)

(U) $1,400 Supported the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provided the primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.

(U) $1,664 Supported international technology liaison missions to identify unique international research capabilities making them available to the Air Force. Used the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations and support international visits of high level Department of Defense delegations. Sustained and funded Air Force commitments to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,177 Supported scientist and engineer education to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging relationships between premiere scientists and the Air Force Research Laboratory. Improved awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.

(U) $4,241 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2002
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
01 - Basic Research	0601102F Defense Research Sciences	4113

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$2,170	Support the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provide the primary interface with Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.
(U)	$2,569	Support international technology liaison missions to identify unique international research capabilities, and makes them available to the U.S. Air Force. Use the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations, and support international visits of high level Department of Defense delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.
(U)	$1,845	Support scientist and engineer exchange efforts to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging relationships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.
(U)	$6,584	Total

(U) FY 2003 ($ in Thousands)

(U)	$2,441	Support the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provide the primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and the Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.
(U)	$2,886	Support international technology liaison missions to identify unique international research capabilities, and make them available to the U.S. Air Force. Through the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development provide on-site coordination with international research organizations and support international visits of high level Department of Defense delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.
(U)	$2,072	Support scientist and engineer education at U.S. colleges and universities, including historically black colleges and universities (HBCU) and minority institutions (MI), to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging associateships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2002
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 4113

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

to participate in critical Air Force research.

(U) $7,399 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0601103D, University Research Initiative.
(U) PE 0602102F, Materials.
(U) PE 0602202F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602204F, Aerospace Avionics.
(U) PE 0602269F, Hypersonic Technology Program.
(U) PE 0602601F, Space Technology (formerly Phillips Lab).
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702F, Command, Control and Communication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.