Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Air Force										DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*							
COST ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012 Base**	**FY 2012 OCO**	**FY 2012 Total**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Cost To Complete**	**Total Cost**
Total Program Element	323.753	350.978	364.328	-	364.328	379.046	396.590	414.923	433.592	Continuing	Continuing
612301: *Physics*	49.340	50.470	-	-	-	-	-	-	-	Continuing	Continuing
612302: *Solid Mechanics and Structures*	19.069	20.683	-	-	-	-	-	-	-	Continuing	Continuing
612303: *Chemistry*	40.370	41.587	-	-	-	-	-	-	-	Continuing	Continuing
612304: *Mathematical and Computer Sciences*	32.201	37.697	-	-	-	-	-	-	-	Continuing	Continuing
612305: *Electronics*	39.175	45.066	-	-	-	-	-	-	-	Continuing	Continuing
612306: *Materials*	28.431	32.040	-	-	-	-	-	-	-	Continuing	Continuing
612307: *Fluid Mechanics*	24.974	26.800	-	-	-	-	-	-	-	Continuing	Continuing
612308: *Propulsion*	31.164	34.022	-	-	-	-	-	-	-	Continuing	Continuing
612311: *Information Sciences*	49.622	53.143	-	-	-	-	-	-	-	Continuing	Continuing
613001: *Physics and Electronics*	-	-	110.120	-	110.120	114.306	119.340	124.640	130.225	Continuing	Continuing
613002: *Aerospace, Chemical and Material Sciences*	-	-	139.475	-	139.475	141.880	148.245	154.880	161.037	Continuing	Continuing
613003: *Mathematics, Information and Life Sciences*	-	-	104.313	-	104.313	111.400	116.400	121.538	127.080	Continuing	Continuing
613004: *Education and Outreach*	-	-	10.420	-	10.420	11.460	12.605	13.865	15.250	Continuing	Continuing
614113: *External Research Programs Interface*	9.407	9.470	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, nine legacy Projects 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308 and 2311 were consolidated into three new Projects 3001, 3002, 3003 to more appropriately describe and align the changing focus of the scientific disciplines within the overall Basic Research Program. Also in FY 2012, External Research Programs - Project 4113 was renamed Education and Outreach- Project 3004 to more appropriately describe its mission.

A. Mission Description and Budget Item Justification

This program consists of extramural research activities in academia and industry along with in-house investigations performed in the Air Force Research Laboratory. This program funds fundamental broad-based scientific and engineering research in areas critical to Air Force weapon systems. All research areas are subject to long-

Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Air Force	DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102F: *Defense Research Sciences*

range planning and technical review by both Air Force and tri-Service scientific planning groups. This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation.

B. Program Change Summary ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	328.471	350.978	339.007	-	339.007
Current President's Budget	323.753	350.978	364.328	-	364.328
Total Adjustments	-4.718	-	25.321	-	25.321
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-0.019	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	2.390	-			
• SBIR/STTR Transfer	-7.010	-			
• Other Adjustments	-0.079	-	25.321	-	25.321

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2010	FY 2011
Project: 612301: *Physics*		
Congressional Add: *Development of Deployable Biosensors.*	1.593	-
Congressional Add: *CO2 Sequestration and Utilization*	2.390	-
Congressional Add Subtotals for Project: 612301	3.983	-
Project: 612307: *Fluid Mechanics*		
Congressional Add: *Development and Validation of Advanced Design Technologies for Hypersonic Research*	1.593	-
Congressional Add Subtotals for Project: 612307	1.593	-
Project: 612308: *Propulsion*		
Congressional Add: *Coal Transformation Laboratory*	0.797	-
Congressional Add Subtotals for Project: 612308	0.797	-
Project: 612311: *Information Sciences*		
Congressional Add: *Process Integrated Mechanism for Human-Computer Collaboration and Coordination.*	0.797	-
Congressional Add: *Safeguarding End-User Military Software.*	3.983	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Air Force	DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102F: *Defense Research Sciences*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2010	FY 2011
Congressional Add Subtotals for Project: 612311	4.780	-
Congressional Add Totals for all Projects	11.153	-

Change Summary Explanation

Increase in funding in FY 2012 is due to greater Air Force emphasis on basic research.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612301: *Physics*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612301: *Physics*	49.340	50.470	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3001 in this Program to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Physics basic research seeks to enable revolutionary advances in, and expand the fundamental knowledge supporting laser technologies, sensing and imaging capabilities, communications and navigational systems, fuels and explosives, and directed energy weapons that are critical to the Air Force. The primary areas of research investigated by this Project are laser and optical physics; electro-energetics (includes plasma) physics; atomic, molecular, and particle physics; space sensors and imaging physics; space environment physics; electronics; and physical mathematics and applied analysis.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Investigate regulated, broad-spectrum, variable-energy lasers, laser arrays, and novel bright incoherent light sources. ***FY 2010 Accomplishments:*** Extended high energy solid-state laser research into new materials and materials processing procedures to increase the average power and tunability range of ceramic lasers. Studied novel optical fiber geometries to achieve single mode operation in large core area, thereby allowing high power operation. Studied novel techniques for alleviating deleterious nonlinear optical effects in high power, single mode fiber lasers, and novel means to couple such lasers for very high average powers. ***FY 2011 Plans:*** Extend studies on infrared semiconductor diode lasers to increase available power, efficiency, and wavelength range, at various temperatures. Study efficient nonlinear optical techniques capable of efficiently converting the wavelength of existing lasers to mid- and long-wave infrared, while capable of handling very high average power. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	10.455	11.530	-	-	-
Title: Major Thrust 2.	13.253	14.743	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612301: *Physics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Description: Explore high-energy, electro-energetic device concepts and manipulation of atomic and molecular properties, atomic collision processes. ***FY 2010 Accomplishments:*** Explored properties of ultracold molecules for precision measurement applications. Moved from microfabrication to nanofabrication methodologies to achieve higher frequencies in compact, high-power electromagnetic radiation sources. Exploited new knowledge of quantum-level electron emission physics to create new generation of low work function field-emission (cold) high current density cathodes. Enhanced new simulation code algorithms to full 3-D hybrid modeling of high power microwave (HPM) sources. ***FY 2011 Plans:*** Continue to explore frequency comb techniques and ultracold atoms and molecules for precision measurement applications. Explore techniques in micro- and nano-fabrication that better lend themselves to affordable, high-volume fabrication of ultra-high-frequency, compact high-power electromagnetic radiation sources. Continue examination of materials science innovations that promise to advance the state-of-the-art in low work-function field-emission (cold) high current density cathodes. Continue innovations in 3-D modeling of HPM sources with emphasis on speeding execution times. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Advance technologies for space sensors, imaging, identification and tracking methods, and effective space situational awareness. ***FY 2010 Accomplishments:*** Investigated new sensing modalities to improve resolution and precision limits of ground-based and space-based surveillance of space objects. Continued study of spectral, polarimetric, and temporal signatures of space objects to identify unresolved space objects. Investigated physics involved in active imaging techniques. Investigated inclusion of fundamental processes of the solar-terrestrial system into physics-based models to predict atmospheric density and increase precision of satellite orbit prediction and precision tracking. ***FY 2011 Plans:***	5.770	6.513	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612301: *Physics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Continue to develop new sensing modalities that reduce limits on optical resolution and precision tracking of space objects. Investigate new methods of uniquely identifying unresolved space objects and incorporate this investigation in the identification of uncorrelated space objects. Continue study of the physics of signatures in the scattering and reflection of light during active imaging. Expand research into fundamental processes and energy sources affecting satellite drag leading to improved understanding of precursors to atmospheric density variations. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 4. ***Description:*** Research space environment to improve solar plasma theories and modeling in the areas of solar phenomena, space weather, magneto/ionosphere effects, and adaptive optics. ***FY 2010 Accomplishments:*** Continued developing methods to sense atmospheric and ionospheric quantities using small, inexpensive satellites. Continued study of space plasmas using grid-free modeling techniques. Investigated fundamental processes to enable the forecasting of the near-Earth space environment. Investigated coupling and dependencies of the various environments from the sun through the Earth's atmosphere that would enable the understanding of energy flow throughout the various regions. Investigated plasma instabilities in the equatorial and polar regions that degrade communication and navigation signals. Expanded the study of neutral densities and winds that affect satellite drag. ***FY 2011 Plans:*** Investigate proxy indicators of ionospheric and atmospheric processes that could be sensed using inexpensive but effective techniques. Investigate methods to exploit grid-free calculations of plasma processes in the magnetosphere and ionosphere as well as in the solar atmosphere and solar wind. Continue the study of energy flow between solar and terrestrial environments. Continue to study plasma instabilities and plasma processes in the equatorial and polar ionospheres. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	6.015	6.774	-	-	-
Title: Major Thrust 5.	9.864	10.910	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612301: *Physics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Description: Research physical mathematics and applied analysis to develop accurate models of physical phenomena to enhance the fidelity of simulation. Conduct research in electromagnetics. ***FY 2010 Accomplishments:*** Increased research into the susceptibility to upset of various electronic circuits when exposed to suitable electromagnetic waveforms. Continued to pursue a deeper understanding of the propagation of ultra-short laser pulses through the atmosphere with emphases on managing their attributes as well as exploiting such potentials as sources of terahertz radiation, components of a long-distance spectroscope, and components of laser-guided bombs or ladar when cloud cover is present. Increased support for research into the possibility of identifying electromagnetic waveforms which are optimal from the perspective of instances of various dispersive media (foliage, clouds, buildings, airplane boundary layers), where optimality is defined as securing improved spatial resolution of objects obscured by such media. ***FY 2011 Plans:*** Increase basic research support for designing small, highly directive sources which can provide both secure communication and sophisticated waveforms which optimally propagate through various dispersive media. Such sources will depend crucially on progress in the area of electromagnetic metamaterials and composites which could display attributes not currently available. These sources will also include semiconductor lasers which are optically pumped and, in addition, might be combined to form partially coherent beams which are predicted to be less disturbed by atmospheric turbulence than are standard fully coherent laser beams. Continue support of circuit upset research with emphasis on digital circuits. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	45.357	50.470	-	-	-

	FY 2010	FY 2011
Congressional Add: Development of Deployable Biosensors.	1.593	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612301: *Physics*

	FY 2010	FY 2011
FY 2010 Accomplishments: Research to investigate the fundamental effects of chemistry, geology and environment on carbon sequestration and the impact of these effects on the economic viability of utilization and sequestration of carbon dioxide produced by alternative energy sources. ***FY 2011 Plans:***		
Congressional Add: CO2 Sequestration and Utilization ***FY 2010 Accomplishments:*** Research to investigate the fundamental effects of chemistry, geology and environment on carbon sequestration and the impact of these effects on the economic viability of utilization and sequestration of carbon dioxide produced by alternative energy sources. ***FY 2011 Plans:***	2.390	-
Congressional Adds Subtotals	3.983	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612302: *Solid Mechanics and Structures*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612302: *Solid Mechanics and Structures*	19.069	20.683	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3002 in this Program to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Solid mechanics and structures basic research aims to improve load-bearing performance of air and space structures through the prediction and control of multi-scale phenomena ranging from micro-level deformation and fracture of materials to the structural dynamics of large platforms. The goals are cost-effective development and safe, reliable operation of superior Air Force weapon and defensive systems. Fundamental knowledge of "multi-functional" structures with smart materials, sensors, actuators, and control systems integrated to accomplish damage control, thermal management, vibration reduction, and reconfigurable shapes. Research topics include: the modeling of non-linear static/dynamic behavior of structures; mechanical reliability of micro-devices; design of multi-functional materials; mechanical behavior of nanomaterials; and composite materials for structures.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Explore the integration of advanced materials, nano-materials,and devices into turbine engines, air vehicles, space systems, and other weapon systems. ***FY 2010 Accomplishments:*** Expanded research in the area of multifunctional materials and microsystems for reconfigurable structures allowing shape change and property tuning. Continued research in the area of multifunctional hybrid composite systems for sensing and neutralization of exogenous threats to load-bearing capability. Continued research in the areas of diagnostics, prognostics, autonomics, self-healing, thermal management, energy harvesting/ storage, electromagnetic energy radiation/transmission, and micro-/nano-mechanics to enable safer and more durable aerospace structures with improved performance characteristics. Further developed the fundamental knowledge required to design and manufacture multi-functional aerospace material systems and devices and to predict their performance and structural integrity. ***FY 2011 Plans:***	9.140	9.930	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612302: *Solid Mechanics and Structures*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Expand research in the area of multifunctional materials and microsystems for autonomic sensing and self-diagnosis of exogenous threats. Continue research in the area of multifunctional materials and microsystems for reconfigurable structures allowing shape change and property tuning. Continue research in the areas of prognostics, autonomics, self-healing, thermal management, energy harvesting/storage, electromagnetic energy radiation/transmission, and micro-/nano-mechanics to enable safer and more durable aerospace structures with improved performance characteristics. Further develop the fundamental knowledge required to design and manufacture multi-functional aerospace material systems and devices and to predict their performance and structural integrity. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Analyze structural fatigue and mechanics, adaptive structures, and material properties to improve the design, robustness, and performance of air and space systems. ***FY 2010 Accomplishments:*** Searched for unprecedented new and revolutionary flight structure concepts that will permit broader operational capabilities, a faster reconfigurable ability, and more affordable accelerated fabrication; this search included morphing aircraft structures. Investigated novel actuation devices and materials for Air Force aircraft and space structural applications. Expanded scientific knowledge related to new structures of the novel materials developed under the advanced materials programs. Expanded development of structural health monitoring sensors and techniques towards an integrated vehicle health monitoring and operational capability prognosis. Studied a risk-based approach to structural systems lifetime prognosis and reliability. Broadened understanding of mechanical and dynamical behavior of flight structures under extreme environments such as intense vibration, nonlinear structural dynamics, unsteady aero-thermo-elastic effects on flight structure, and directed energy with objective of enhancing operational survivability and mission success. ***FY 2011 Plans:*** Continue to seek new and revolutionary flight structure concepts that will permit broader operational capabilities, a faster reconfigurable ability, and more affordable accelerated fabrication. Investigate new structures of novel materials developed under the advanced materials programs. Expand the understanding of structural health monitoring sensors and techniques and test the developed new science under laboratory conditions. Enhance	9.929	10.753	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612302: *Solid Mechanics and Structures*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
the understanding of dynamic and mechanical behavior of flight structures under extreme environments such as intense vibration, nonlinear structural dynamics, unsteady aero-thermo-elastic effects, directed energy effects to increase operational survivability and mission success. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	19.069	20.683	-	-	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612303: *Chemistry*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612303: *Chemistry*	40.370	41.587	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3002 in this Program to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Chemistry basic 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 laser weaponry and allow predictions of the infrared, optical, and radar signatures of reaction products and intermediates that advance reliable target assessment and tracking. Critical research topics include: novel synthesis and characterization of lower cost, higher performance functional and structural materials, electronics, and photonic materials; nanostructures; electromagnetics; and conventional weaponry. Focused investigations include bio-derived mechanisms for lifetime extension of materials and catalysis 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 reaction dynamics; theoretical chemistry; polymer chemistry; biophysical mechanisms; and surface and interfacial science.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	16.972	17.485	-	-	-
Description: Research and characterize molecular dynamics, reaction mechanics/interactions, and theoretical chemistry to model, predict, control, and exploit atomic and molecular energetics. ***FY 2010 Accomplishments:*** Advanced the development of experimental and theoretical methods to understand and control chemical reactivity and energy in molecular systems. Developed the understanding of catalytic mechanisms in systems that can improve energy utilization in propulsion applications. Explored synthetic methods and computational screening procedures to streamline the production of novel propellants. Investigated methods for producing energetic metastable species and analyzing their lifetimes. Explored the mechanisms of processes induced by plasmonic structures and its impact on chemical processes. Performed experiments and theoretical analysis to provide benchmarks for models of chemistry in the space environment. Investigated novel approaches for high-power hybrid electric-chemical lasers. ***FY 2011 Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612303: *Chemistry*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Create a fundamental understanding of basic chemical and physical processes on the nanoscale. Develop methods that can describe material behavior from the atomic level through mesoscopic and macroscopic scales and simulate chemical processes to model bulk scale properties. Develop theoretical methods to predict energy and density of novel energetic materials. Explore methods to use catalysis to improve energy utilization and storage. Create new selective and sensitive sensors for detecting trace species. Perform experiments and simulations to understand chemical processes in space for situational awareness. Investigate processes needed to assess scalability of hybrid laser concepts. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Enhance fundamental understanding of polymer chemical structures, reactivity, molecular engineering, processing controls, and materials technologies. ***FY 2010 Accomplishments:*** Further exploited advances in nanotechnology to improve properties of magneto-dielectric materials for antenna substrate applications. Explored hybrid materials approach to enhance optical limiting behavior and optical filtering response for broadband laser protection applications. Improved charge mobility of organic transistors to enable higher speed responses for Air Force applications. ***FY 2011 Plans:*** Explore organic transistors with flexibility, mechanical robustness and higher performance or equivalent of a-Si transistors. Explore rewritable color 3-D hologram displays using photorefractive polymers. Assess feasibility of controlling chirality of molecular structures to achieve negative index behavior in the optical or infrared range. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	13.155	13.510	-	-	-
Title: Major Thrust 3. ***Description:*** Characterize, model, and exploit the fundamental chemistry and physics that govern surface and interfacial degradation from completely frictionless to total deterioration. ***FY 2010 Accomplishments:***	10.243	10.592	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102F: *Defense Research Sciences*	**PROJECT** 612303: *Chemistry*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Continued to develop theoretical and predictive methods for the fundamental understanding of the structure and reactivity of surfaces and interfaces, particularly under non-equilibrium conditions. Continued to investigate phenomena at surfaces and interfaces, including the fundamental mechanisms of friction and wear, lubrication, corrosion, material degradation in extreme environments, and thermal transport. Developed methods for understanding and controlling interfacial chemistry in the creation of complex materials, including nano-composite lubricants that provide function over a wide variety of extreme environments. Developed instrumentation and methodologies capable of examining surface chemistry and kinetics with high spatial resolution. ***FY 2011 Plans:*** Apply knowledge of chemical and morphological effects on degradation of simple surfaces towards development of theoretical and predictive models for degradation of complex and hybrid surfaces and materials across multiple length scales. Investigate fundamental chemistry and physics of surface wear driving towards a comprehensive understanding of the role of the chemical environment. Develop real-time nano-tribological instrumentation capable of in-situ friction, adhesion, and wear experimentation. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	40.370	41.587	-	-	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612304: *Mathematical and Computer Sciences*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612304: *Mathematical and Computer Sciences*	32.201	37.697	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3003 in this Program to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Mathematics and computing sciences basic research develops novel techniques for mathematical modeling and simulation, algorithm development, complex systems control, and innovative analytical and high performance computing methods for air and space systems. Basic research provides fundamental knowledge enabling improved performance and control of systems and subsystems 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, optimization and discreet mathematics, and computational mathematics.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	16.410	19.161	-	-	-
Description: Perform dynamics and control research to develop innovative techniques for design and analysis of complex control systems. ***FY 2010 Accomplishments:*** Developed the design and analysis techniques for cooperative control systems in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, remotely piloted aircraft (RPAs), and constellations of small satellites with an emphasis on heterogeneous agents and mixed human-robot interactions. Expanded additional research for teams of micro air vehicles operating at various altitudes in complex environments to execute assigned missions with variable operator intervention to include adaptive control and machine learning. Developed control methodologies to improve non-equilibrium behavior of complex, nonlinear systems. Advanced image processing and sensor technologies for use in RPA controllers and smart munitions to include target tracking and ownship state estimation. Developed mathematical control theoretic models that capture the robust, nonlinear, hybrid dynamics of microbiological systems. Developed methods for design and analysis of bio-inspired sensing systems, controls, and computational systems. Continued					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612304: *Mathematical and Computer Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
development of algorithms for control of and over dynamic, large-scale networks. Developed theory and algorithms for specification, design, verification, and validation of distributed embedded control systems. ***FY 2011 Plans:*** Further develop heterogeneous and mixed human-robot interaction concepts for the design and analysis of cooperative control systems in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, RPAs, and constellations of small satellites. Develop increased levels of high-confidence adaptive control and machine learning techniques for teams of micro air vehicles operating at various altitudes in complex environments to execute assigned missions with variable operator intervention. Continue development of control methodologies to improve non-equilibrium behavior of complex, nonlinear systems. Advance image processing and sensor technologies for use in cooperative teams of RPAs and smart munitions to include multiple target tracking, ownship and world state estimation. Continue development of mathematical control theoretic models that capture the robust, nonlinear, hybrid dynamics of microbiological systems. Further develop methods for design and analysis of bio-inspired sensing systems, controls, and computational systems. Continue development of algorithms for control of and over dynamic, large-scale networks. Continue development of theory and algorithms for specification, design, verification, and validation of distributed embedded control systems. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Conduct research in optimization, as well as computational and discrete mathematics, to validate and further advance mathematical methods, algorithms, and modeling and simulation. ***FY 2010 Accomplishments:*** Placed emphasis on development of innovative mathematical and numerical algorithms that enhance modeling and simulation capabilities in understanding and forecasting of complex physical phenomena and design and control of systems of interest to the Air Force. The application areas of interest included non-equilibrium plasma, non-steady aerodynamics for various flight regimes, material design, and structural mechanics. Emphasized development of algorithms for efficient and robust multidisciplinary design and optimization as well as understanding and quantifying the effects of uncertainties in computational models. ***FY 2011 Plans:***	15.791	18.536	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612304: *Mathematical and Computer Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Continue developing mathematically rigorous numerical algorithms for enhancing the modeling and simulations of large, complex, multi-scale, and nonlinear systems and phenomena of interest to the Air Force. The application areas in plasma, aerodynamics, structural mechanics, and materials will emphasize the increasing challenges in capturing the unsteady, dynamic, multi-physics, and multi-scale nature of the problems. Support development and integration of novel optimization strategies with high-order, time-accurate solutions for superior design of Air Force systems. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	32.201	37.697	-	-	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612305: *Electronics*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612305: *Electronics*	39.175	45.066	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3001 in this Program to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Electronics basic research generates and exploits fundamental knowledge and understanding of novel solid-state electronic, sensor, and optoelectronic materials and device implementation schemes vital to advance Air Force operational capabilities in surveillance, information and signal processing, communications, command and control, electronic countermeasures, stealth technologies, and directed energy weapons. Solid-state electronics research discovers and develops new materials, advances processing and fabrication sciences, and develops and implements advanced physical modeling and simulation capabilities essential to evaluate novel electronic, sensor, and optoelectronic structures and device concept implementation schemes. Research stresses high-risk, far-term, game-changing capability breakthroughs essential for future leaps in warfighter system performance, functionality, reliability, and survivability while simultaneously reducing component and system power, size, mass, and life cycle costs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	9.526	10.987	-	-	-
Description: Investigate novel detector and electronic materials, device concepts, and circuit architecture and implementation schemes important to future military space platforms. ***FY 2010 Accomplishments:*** Investigated novel methods for achieving integrated multi-mode electromagnetic spectra detection utilizing spatial, spectral, polarimetric, radiometric, phase, and temporal imaging and non-imaging detection and discrimination techniques, to include adaptive reconfigurable 'pixel' and/or detector element approaches spanning multiple-modes, and in one or more ultraviolet-infrared bands; biologically inspired detection processes and concepts were also considered. Possible novel detector structures included, but were not limited to, integrated monolithic and/or hybrid approaches utilizing homogeneous and/or heterogeneous semiconductor and oxide material structures, potentially enabled by 0D, 1D, and/or 2D quantum-based structures. Additionally, bulk and nanostructure based electronic defect engineering physics were studied to determine opportunities for modifying electronic band structure that critically affects photon absorption and carrier transport properties. ***FY 2011 Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612305: *Electronics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Continue investigating novel multi-modal electromagnetic spectra detection approaches and concepts utilizing increased understanding of phenomenological interactions between target/background radiation and novel nano-materials, -structures, and -devices. Specific emphasis shall be placed on achieving material structures yielding linearly-graded semiconductor bandgap behavior or capable of dynamic bandgap tuning over the range ~ 0.2 - 2.5eV. In addition, novel materials and/or device structures capable of dynamic absorption coefficient tuning will be studied, along with concepts for thin-film spectra-filter tuning. Continued emphasis shall be placed on physics controlling semiconductor hetero-interface band misalignments that critically control carrier transport properties. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Investigate quantum and optoelectronic materials/devices, memory, information processing, and nanoscience for wide-field spectral sensors and critical, high-speed communication. ***FY 2010 Accomplishments:*** Further supported research activities to better understand the fundamental nature of multi-ferroic alloys and composite materials for potential applicability to spin-gain devices, dynamic magnetic field detection for radio frequency (RF) and microwave applications, and very high efficiency and compact piezoelectric AC to AC and DC to DC transformers. Continued to investigate meta-materials, phase-change and state-change semiconducting and dielectric materials for exploitation in reconfigurable logic, memory, and dynamic analog devices and systems. Further investigated silicon photonics as a mechanism for all optical fiber device signal and power interconnect. Further supported research activities in the development of interconnectable photonic crystal modules so that integrated, all-optical photonic crystal logic and control systems can be subsequently developed as a transition from basic research. ***FY 2011 Plans:*** Continue advanced research efforts to better determine the optimal implementation of multi-ferroic materials for a wide variety of technologically advanced applications for the warfighter. Continue to explore the suitability of spintronic device elements that can be integrated into high performance, ultra-miniature logic and control systems. Further explore special semiconducting and electronic materials that enable all photonic signal processing and logic technology, and begin to explore integration of these advanced technologies with RF micro electro-mechanical systems concepts. Further explore wide band gap semiconductors for high performance,	15.313	16.967	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612305: *Electronics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
high power RF applications with an in-depth understanding of device reliability issues. Continue research on special materials and nanostructures that will permit an expansion of device functionality beyond the current limits on silicon technology. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Exploit advances in nanotechnology to support multi-spectral detection technology, chip-scale optical networks, and compact power. ***FY 2010 Accomplishments:*** Continued to develop revolutionary infrared sensors with new functionality that would greatly limit the complexity, cost, and size of conventional imaging systems. Created mid-infrared detectors with nanoscale-patterned metallic photonic crystal structures supporting frequency-specific optical resonances that achieve dramatic improvement in the conversion efficiency of detectors. Investigated the fundamental science, materials, processes, and novel device architectures for surface plasmon-based, complimentary metal-oxide semiconductor-compatible (CMOS), optical elements, with focus on ultracompact, robust, and highly efficient photonic networks that are optimally suited for insertion into mobile military platforms. Exploited nanoscience to further understand and improve solar cells, fuel cells, thermoelectrics, and supercapacitors, by examining approaches such as quantum dots, nanowires, nanocrystals, nanotubes, nanomembranes, and non-traditional materials. ***FY 2011 Plans:*** Pursue research in light localization below the wavelength scale, using concepts of plasmon optics, photonic crystal, and metamaterial nanophotonics for ultra-compact integrated photonic systems, ultra-compact optically functional devices, light-harvesting elements for molecular and nanocrystalline-based photovoltaic devices, lithographic patterning at deep sub-wavelength dimensions, and aberration-free lenses that enable optical imaging with unprecedented resolution. Continue to exploit silicon-compatible components for photonics and take advantage of the mature processing and manufacturing expertise that silicon technology affords. Pursue smaller and more highly integrated optical subsystems for telecommunications applications and high speed processing. Explore thermoelectric applications of silicon and germanium based nanomembranes made into nanowires and nanoribbons plus nanowire photovoltaic devices. Enhance solar-energy conversion through	6.946	8.328	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612305: *Electronics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
plasmon enhanced photovoltaic films, and investigate the feasibilities of nitride based and non-traditional material nanostructures for applications in photoelectrochemical cell technology, and thermoelectric device technology. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 4. ***Description:*** Investigate quantum electronic solids phenomena to explore superconducting, magnetic, negative index, and nanoscopic materials. ***FY 2010 Accomplishments:*** Discovered more useful, more economical superconductors for power and electronic applications, and progress toward identifying promising materials to set in motion new efforts in physics, chemistry and materials science. Further explored new concepts in superconducting electronics by using both magnesium diboride and yttrium-barium-copper-oxide superconducting films to determine if these unique structures have a potential to become the basis for improved radar systems. Continued research to find routes to make nanoscale ordered structures that will open the use of metamaterials to the optical and infrared part of the electromagnetic spectrum; at microwave frequencies, metamaterials were formed to produce sub-wavelength imaging. Demonstrated denser memory elements by using crossbar architecture in contact with standard complimentary metal-oxide semiconductor-compatible (CMOS) circuitry. ***FY 2011 Plans:*** Utilize implanted defect structures in diamond films to produce a system of addressable electron spin states that can be manipulated and entangled so that concepts in quantum information science may be tested at room temperature. Investigate nanoelectronic elements utilizing carbon nanotubes to form the basis for a new generation of sensors and circuit elements. Continue metamaterials research in coordination with Air Force laboratories to produce more efficient and smaller, omni-directional antennas. Continue search for new classes of superconductors to begin to produce several new superconducting materials that will be much more cost effective. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	7.390	8.784	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612305: *Electronics*

B. Accomplishments/Planned Programs ($ in Millions)

	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Accomplishments/Planned Programs Subtotals	39.175	45.066	-	-	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612306: *Materials*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612306: *Materials*	28.431	32.040	-	-	-	-	-	-	-	Continuing	Continuing

Note

In FY 2012, all efforts were moved from this Project to Project 3002 in this Program (except the natural systems and extremophiles major thrust efforts moved to Project 3003) to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Materials basic research enhances the performance, cost, and reliability of structural materials to eliminate reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. This research expands fundamental knowledge of material properties that leads to the development of novel materials for airframe, turbine engine, and spacecraft structures. The goals of this Project are to develop improved materials for air and space vehicles that provide increased structural efficiency and reliability, increase the operating temperature of aerospace materials, and further increase thrust-to-weight ratio of engines. A primary research focus is on refractory alloys, intermetallics, polymer composites, metal and ceramic matrix composites, advanced ceramics, and new material processing methods. Basic research is also conducted in natural materials and systems to exploit unique properties and products for use in the development of advanced weapon technologies. Research is conducted to mimic the natural detection systems of organisms at the molecular level for use in developing novel man-made sensors. Research in natural materials focuses on using existing organisms or bioengineered organisms to manufacture new materials, or using the organisms themselves as materials. The primary areas investigated by this Project are ceramics, non-metallic hybrid composites, metallic materials, and natural materials and systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	11.607	12.872	-	-	-
Description: Perform non-metallic, ceramic, and hybrid materials research to identify/design new materials and composites with very-high (above 1400F) and ultra-high (above 2500F) temperatures.					
FY 2010 Accomplishments: Explored the connectivity of molecular scale modeling and micromechanics modeling to link the influence of constituents' properties to properties of fiber reinforced composites, ceramic matrix composites, and metallic composites. Continued investigating interfacial properties of hybrid materials and their influence on component durability. Continued further study into damage initiation due to oxidation of high temperature polymer matrix composites.					
FY 2011 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612306: *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Investigate the impact of incorporation of carbon nanotubes in carbon fibers. Study the incorporation of nano-particle incorporation in thermoplastic composites to improve its crystallization rate in filament winding conditions. Investigate the influence of nanoparticle networks within amorphous materials on high temperature mechanical properties. Continue modeling of interfacial properties between matrix and fiber in fiber reinforced composites. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Perform research in metallic, ceramic and hybrid materials to understand their properties at temperatures above 1000C. ***FY 2010 Accomplishments:*** Expanded the investigation of complex laminates for aerospace materials to include understanding of failure mechanisms within these novel systems. Expanded the development and verification of multi-scale equilibrium models to study the response of the material in a non-equilibrium environment. Refined the development of the informatics tools to accelerate the discovery of novel materials. Evolved the research on the fundamental science of friction and thermal effects during friction stir processing to focus on the role of the interface within metallic composites. Explored novel and alternative mechanisms to rapidly accelerate the processing and certification of advanced high temperature aerospace materials. ***FY 2011 Plans:*** Continue optimizing the thermal and mechanical stability of high temperature aerospace materials for air and space applications. Exploit new approaches to designing hybrid high temperature materials and to enhance performance in harsh thermal environments. Further examine innovative concepts for developing stronger and more damage-tolerant high temperature hybrid materials. Further explore opportunities to reduce system weight and/or size, increased operational lifetime, and high temperature performance of aerospace structures. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	12.475	13.779	-	-	-
Title: Major Thrust 3.	4.349	5.389	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612306: *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Description: Explore mimetics, natural materials, and natural/synthetic interfaces to enable development of novel sensors, engineering processes, and mechanisms. ***FY 2010 Accomplishments:*** Explored the manipulation of materials to mimic the desirable properties found in autonomous materials for maintenance, self-healing, and repair. Probed and manipulated chromophores and photoluminescent characteristics in natural systems for applications to military sensor systems. Conducted research of natural materials' extension into new electronic and photonic systems by utilizing the self-assembly of these materials into unique electronic and optical architectures for intelligence, surveillance, reconnaissance (ISR) applications. ***FY 2011 Plans:*** Continue to manipulate materials to mimic the desirable properties found in autonomous materials for maintenance, self-healing, and repair. Continue to probe and manipulate chromophores and photoluminescent characteristics in natural systems for applications to military sensor systems. Expand the research of natural materials' extension into new electronic and photonic systems by utilizing the self-assembly of these materials into unique electronic and optical architectures for ISR applications. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	28.431	32.040	-	-	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612307: *Fluid Mechanics*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612307: *Fluid Mechanics*	24.974	26.800	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3002 in this Program (exception: the sensory information systems major thrust efforts moved to Project 3003) to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Fluid mechanics basic research advances fundamental knowledge, tools, data, concepts, and methods for improving the efficiency, effectiveness, and reliability of air and space vehicles. The goals are to improve theoretical models for aerodynamic prediction and design, as well as to originate flow control concepts and predictive methods used to expand current flight performance boundaries through enhanced understanding of key fluid flow (primarily high-speed air) phenomena. Vehicle control principles based upon natural flight sensory and sensorimotor systems applicable to small remotely piloted aircraft (RPAs) and ultraslow flight are also examined. Basic research emphasis is on turbulence prediction and control, unsteady and separated flows, subsonic/supersonic/hypersonic flows, and internal fluid dynamics. The primary approach is to perform fundamental experimental investigations and to formulate advanced computational methods for the simulation and study of complex flows, prediction of real gas effects in high-speed flight, and control and prediction of turbulence in flight vehicles and propulsion systems. Primary areas of research investigated by this Project are unsteady aerodynamics, supersonic and hypersonic aerodynamics, turbulence, and rotating and internal flows characteristic of turbomachinery flows.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	8.198	9.348	-	-	-
Description: Investigate and characterize complex phenomena in supersonic, hypersonic, boundary layers, and turbulent flows to enable and optimize the design of air and space vehicles systems. ***FY 2010 Accomplishments:*** Characterized and modeled fundamental phenomena of high-speed boundary laminar-turbulent transition to include interactions between multiple instability modes and realistic surface conditions including roughness. Validated high-fidelity, unsteady numerical simulation methodologies for shock-dominated flows including non-equilibrium effects, laminar-turbulent transition and automated grid refinement. Explored strategies for control of excessive heat transfer, unsteadiness, and separation in hypersonic flows to reduce severe local loads on systems. Characterized and modeled interactions between severe phenomena in aerothermodynamic					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612307: *Fluid Mechanics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
environment and high-temperature vehicle materials with the goal of reducing thermal protection system complexity and increasing system performance. ***FY 2011 Plans:*** Characterize and model fundamental phenomena of high-speed boundary layers, including interactions between multiple instability modes in laminar-turbulent transition and the influence of realistic surface conditions including roughness, ablation and surface chemistry. Continue validation of high-fidelity, unsteady numerical simulation methodologies for shock-dominated flows, including non-equilibrium effects and laminar-turbulent transition and implementation of potential control methods via simulation of benchmark canonical problems. Refine strategies for control of excessive heat transfer, unsteadiness, and separation in hypersonic flows to reduce severe local loads on systems. Develop multidisciplinary simulation capability for prediction of interactions between severe phenomena in aerothermodynamic environment and high-temperature vehicle materials with the goal of reducing thermal protection system complexity and increasing system performance. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Expand fundamental knowledge of unsteady flows in integrated theoretical, experimental, and computational efforts. Study complex flow phenomena related to unsteady phenomena. ***FY 2010 Accomplishments:*** Explored reduced order, closed-loop flow control mechanisms on unsteady flows of complex geometries and flexible structures and identified canonical problems. Characterized and modeled promising applications of flow control techniques to optimize fluid-structure interactions and aerodynamic efficiency for a wider range of flight operating conditions. Validated tools for predicting and controlling unsteady, vortex-dominated flows on RPAs. Explored scientific issues related to multidisciplinary simulation of unsteady fluid-structure interactions. ***FY 2011 Plans:*** Develop physically accurate descriptions of unsteady flows over complex geometries and highly flexible structures. Derive and assess reduced order models of canonical flow problems that lead to robust, closed-loop flow control approaches. Refine modeling of promising flow control techniques to optimize fluid-structure interactions and aerodynamic efficiency for a wider range of flight operating conditions. Continue validation of	9.103	10.288	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612307: *Fluid Mechanics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
tools for predicting and controlling unsteady, vortex-dominated flows on RPAs in a range of scales. Develop numerical tools for multidisciplinary simulation of unsteady fluid-structure interactions. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Research novel sensing and control mechanisms applicable to small RPAs and low Reynolds Number flight regimes. Expand fundamental knowledge of natural flight control and navigation. ***FY 2010 Accomplishments:*** Characterized and modeled sensor-effector systems for natural flight control, target pursuit, and spatial navigation, with emphasis on robust agility at low Reynolds Numbers. Studied sensory information processing mechanisms, including multi-modal sensing, to understand autonomous spatial orientation and optimal flight path guidance. Characterized closed-loop control mechanisms to optimize performance capabilities of flexible airfoils, e.g., with respect to sensing and handling of airflow disturbances, Coriolis forces, and wing loading. Developed and tested neuromorphic emulations to enable adoption in engineered technology for autonomous or semi-autonomous air vehicles. ***FY 2011 Plans:*** Investigate natural flight capabilities applicable to multiple, coordinated air vehicles operating in cluttered and/or unpredictable environments. Develop mathematical approaches for intelligent, autonomous flight control and navigation in multi-vehicle arrays and cooperative swarms, based upon natural systems of sensing and guidance, with emphasis on possible applications to small RPAs operating in low Reynolds Number regimes. Continue to develop mathematical and neuromorphic algorithms based upon sensorimotor information processing to enable new capabilities in autonomous flight. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	6.080	7.164	-	-	-
Accomplishments/Planned Programs Subtotals	23.381	26.800	-	-	-

	FY 2010	FY 2011
Congressional Add: Development and Validation of Advanced Design Technologies for Hypersonic Research	1.593	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612307: *Fluid Mechanics*

	FY 2010	FY 2011
FY 2010 Accomplishments: Conducted Congressionally-directed effort.		
FY 2011 Plans:		
Congressional Adds Subtotals	1.593	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612308: *Propulsion*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612308: *Propulsion*	31.164	34.022	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3002 in this Program (exception: the bioenergy major thrust efforts moved to Project 3003) to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Propulsion basic research expounds fundamental knowledge to enable and enhance efficient utilization of energy in airbreathing engines, chemical and non-chemical rockets, and combined cycle propulsion systems for future rapid global reach and on-demand space access. Basic research thrusts include airbreathing propulsion, space power and propulsion, high altitude signature characterization and contamination, propulsion diagnostics, thermal management of space-based power and propulsion, and the synthesis of new chemical propellants. These thrusts can be grouped into reacting flows and non-chemical energetics. Study of reacting flows involves the complex coupling between energy release through chemical reaction and the flow processes that transport chemical reactants, products, and energy. Non-chemical energetics research includes both plasma and beamed-energy propulsion for orbit-raising space missions and ultra-high energy techniques for space-based energy utilization. Primary areas of research investigated by this Project are space power, propulsion, combustion, and diagnostics. As a newly emerging research direction within this Project, bioenergy and catalysis will investigate the economical production of renewable biofuels for airbreathing engines and will explore biocatalysis for compact power applications.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Research and model space propulsion and power in the areas of chemistry, electronics, miniaturization, and contamination/signature. ***FY 2010 Accomplishments:*** Continued to research high altitude plume signature and contamination, including ice formation and optical scattering in geosynchronous orbits. Continued investigating alternate launch systems using electromagnetic forces and beamed energy. Investigated electrothermal materials in plasma propulsion to achieve regenerative power, thereby resulting in higher efficiencies and lower waste heat in satellites. Investigated novel energetic propellants for space propulsion to achieve cryogenic propellant performance with non-cryogenic systems. Introduced nano-energetics in liquid or gel propellants to increase specific impulse in liquid propulsion systems,	11.229	12.477	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612308: *Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
and investigated various spray techniques for these novel propellant systems. Enhanced novel diagnostic techniques for characterization of combustion instabilities in high pressure, harsh, optically thick environments. ***FY 2011 Plans:*** Continue the study of novel energetic propellants for space propulsion, including nano-aluminum, ammonium borane, silicon, and hydrogen peroxide to achieve cryogenic propellant performance with non-cryogenic propellants in both launch and in-space systems. Continue investigation of nano-energetics in liquid and gel propellants to increase specific impulse in liquid propulsion systems, and study the dynamic behavior of such systems, including three-phase, high-pressure, and temperature combustion phenomena. Continue investigating alternate launch systems using electromagnetic forces and beamed energy. Investigate new electric propulsion concepts for nano, micro, and macro satellites, including electrodeless and propellantless systems, and power regeneration through thermoelectric materials. Conduct research on near-space propulsion alternatives, including air-breathing plasma propulsion systems. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Explore combustion, propulsion, and diagnostics in subsonics, supersonics, and hypersonics. Investigate multi-phase, turbulent reacting flows. ***FY 2010 Accomplishments:*** Continued improving laser diagnostic measurement capabilities, investigations of molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions, and prediction methodologies, which are both quantitatively accurate and computationally tractable, for turbulent combustion models. Initiated research on the coupling between plasma chemistry and fuel combustion chemistry to understand ignition and combustion enhancement by plasmas. Continued exploitation of strategies for using alternate hydrocarbon fuels by inserting reduced fuel representations into comprehensive combustion models such as large eddy simulations. In support of the Energy Conservation-Assured Fuels Initiative, initiated studies of novel propulsion system design based on alternative fuel properties to achieve optimization with respect to performance, environmental impact, cost, and assured supply. ***FY 2011 Plans:***	13.126	14.449	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612308: *Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Continue improving laser diagnostic measurement capabilities, investigations of molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions, and prediction methodologies, which are both quantitatively accurate and computationally tractable, for turbulent combustion models. Continue research on the coupling between plasma chemistry and fuel combustion chemistry to understand ignition and combustion enhancement by plasmas. Continue exploitation of strategies for using alternate hydrocarbon fuels by inserting reduced fuel representations into comprehensive combustion models such as large eddy simulations. In support of the Energy Conservation-Assured Fuels Initiative, continue studies of novel propulsion system design based on alternative fuel properties to achieve optimization with respect to performance, environmental impact, cost, and assured supply. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Identify, characterize, and bioengineer photosynthetic and/or non-photosynthetic microorganisms and their metabolic pathways. ***FY 2010 Accomplishments:*** Continued researching the biosolar generation of hydrogen by seeking to understand and manipulate the metabolic, genetic, and biophysical mechanisms utilized by some photosynthetic microbes (algae and cyanobacteria) in generating renewable hydrogen energy. Began researching algal oil generation as a renewable jet fuel source by bio-prospecting for unique, oil-generating strains of algae whose genes may be used to enhance the production of algal oil. Continued research on biological fuel cells that explore the biophysical and catalytic mechanisms required for efficient electron transfer between electrodes and microbial materials, enabling the future utilization of complex, impure biofuels for compact power needs. ***FY 2011 Plans:*** Continue to study biosolar hydrogen research to redirect the photosynthetic flow of electrons to the hydrogen-generating enzyme by eliminating and/or adding genes that code for alternative pathways of electron flow and for the oxygen-sensitive inhibition of the hydrogen-generating enzyme. Expand bio-prospecting research to identify and clone unique algal oil-generating genes that metabolically engineer into one strain, optimizing the control and enhancement of algal oil for use as a future source of jet fuel. Continue research on microbial fuel	6.012	7.096	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612308: *Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
cells that may potentially enhance power generation by exploring and characterizing newly discovered bacterial nanowires to understand their role in transporting electrons from microbial biofilms to electrodes. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	30.367	34.022	-	-	-

	FY 2010	FY 2011
Congressional Add: Coal Transformation Laboratory	0.797	-
FY 2010 Accomplishments: Conducted Congressionally-directed effort. ***FY 2011 Plans:***		
Congressional Adds Subtotals	0.797	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612311: *Information Sciences*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
612311: *Information Sciences*	49.622	53.143	-	-	-	-	-	-	-	Continuing	Continuing

Note

Note: In FY 2012, all efforts were moved from this Project to Project 3003 in this Program (exception: the sensing, surveillance, and navigation major thrust efforts moved to Project 3001) to more appropriately describe and align the changing focus of the scientific disciplines within the overall Program.

A. Mission Description and Budget Item Justification

Information sciences basic research generates fundamental knowledge and understanding to support critical Air Force capabilities in information superiority, precision targeting (or strike), and improved battle space awareness. Areas of research focus are (1) access to disparate data and information, (2) information fusion and distribution, and (3) conversion of information into knowledge to support decision making. The data, fusion engines, and command and control functions reside on interlocking systems connected by networks leading to a system of systems architecture. Areas of research underpinning these team-focused, network-enabled systems are those in networks and communications, software, information management, and human-system interactions. Complementing these overall focus areas, research is occurring in the following areas: information operations network, software, and system architectures; information fusion; information forensics; communications and signals and control of large systems. Information Sciences also derive mathematical models and computational algorithms designed to optimize information intelligently and problem-solving under adverse conditions, including sustained operations, non-cooperative environments, and multi-interactive command and control.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Conduct fundamental research in signals analysis for enhancement of sensing, surveillance, and targeting capabilities, increased awareness, and improved reaction/response. ***FY 2010 Accomplishments:*** Studied and refined results of selected solid state partially coherent laser designs together with the propagation of partially coherent laser beams through surrogate turbulent media. Moved toward an evaluative assessment of practicality of free-space optical communication based on reduced or variable beam coherence. Conducted research in compressive sensing and image reconstruction to effect fusion of diverse sensors under multi-modal regime and data from sensor networks and countermeasures. Continued assessment of technical alternatives for feasibility of super-resolution millimeter and search and rescue imagery. ***FY 2011 Plans:***	9.584	12.180	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612311: *Information Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Conduct further research in innovative sensing and multi-modal data acquisition, and promote the ways and means for integration of electro-optical, radar, ladar, and inertial systems with global positioning satellite (GPS) in electromagnetically and physically challenged environments. Scientific issues connected with radar imaging (and target identification) include the determination of advantageous classes of transmit waveforms, for bi-static, multiple-output, or some other distributed set-up, together with the needed conceptual mathematics and computational techniques. Covertness and encryption requirements in "free-space" communication lead to problems of information theory/optics whose solutions provide new methods of sequence key encryption. In precision navigation and timing, new basic results in the integration of sensing GPS data over multiple platforms are needed. Progress in this domain will facilitate confident actions under many military scenarios, such as the mutual updating of geo-location and timing data for a group of remotely piloted aircraft, allowing their seamless cooperation for surveillance, pursuit, and attack. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Conduct research in complex systems and algorithms for highly flexible, reliable, secure, and rich information systems supporting battlefield commanders. ***FY 2010 Accomplishments:*** Focused studies on how to develop software-intensive systems that take into account the deep interaction between humans and computers. Initiated information operations research on attack attribution and hardware/ software interface security, and continued research on covert channel discovery. Developed fundamental mathematical methods for the description of local, global, and dynamic phenomena in networks and the assurance of the associated protocols. Developed techniques that enable integration of information and processes on networked systems in order to achieve high levels of situation awareness and response. ***FY 2011 Plans:*** Increase emphasis on developing a science of cyber security. Develop new software systems modeling techniques that incorporate human behavioral models into software architectures to capture fundamental human-computer interaction. Initiate information operations research on artificial diversity. Expand research on how fundamental mathematical methods translate into improved reliability and security of existing and future	24.542	27.617	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612311: *Information Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
networks. Continue developing fundamental science of information integration and fusion that provides for situation and impact assessment to achieve predictive response. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Evaluate fundamental mechanisms and build mathematical descriptions of cognitive decision-making, including adaptation to non-cooperative interactions. ***FY 2010 Accomplishments:*** Investigated high-order cognitive processes critical for decision-making and problem-solving, with emphasis on the challenges of sustained operations in environments that require efficient operations under risk, uncertainty, high workload, and fatigue. Elucidated brain mechanisms that may inform computational approaches to information analysis, including mathematical representations of coupled neural oscillation, modulation filtering, and compressive sampling. Sought deeper scientific insight into principles of adaptive intelligence. Developed new approaches to optimize problem-solving in dynamic environments, with emphasis on decision strategies for adversarial, multi-dimensional, and multi-cultural conflict. Developed the basic research foundation, using computational and modeling approaches, to understand and anticipate competitive and cooperative interactions among decision-makers in a cross-cultural context. ***FY 2011 Plans:*** Continue to investigate high-order cognitive processes, and explore new mathematical frameworks to enable, in a principled way, upward scaling of cognitive information processing approaches from simpler to more complex and realistic decision-making tasks. Develop and test algorithms for applications in reinforcement learning, sequential sampling, kernel-based classification and generalization, Bayesian forecasting, and optimization of attentional resources. Develop new techniques to understand, measure, and control informational masking to enhance speech communication and situational awareness. Investigate the fundamental constraints and limits of computationally-based socio-cultural prediction, including scalability from individual or small groups to larger coalitions. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	10.716	13.346	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 612311: *Information Sciences*

B. Accomplishments/Planned Programs ($ in Millions)

	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Accomplishments/Planned Programs Subtotals	44.842	53.143	-	-	-

	FY 2010	FY 2011
Congressional Add: Process Integrated Mechanism for Human-Computer Collaboration and Coordination. ***FY 2010 Accomplishments:*** Conducted Congressionally-directed effort. ***FY 2011 Plans:***	0.797	-
Congressional Add: Safeguarding End-User Military Software. ***FY 2010 Accomplishments:*** Conducted Congressionally-directed effort. ***FY 2011 Plans:***	3.983	-
Congressional Adds Subtotals	4.780	-

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613001: *Physics and Electronics*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
613001: *Physics and Electronics*	-	-	110.120	-	110.120	114.306	119.340	124.640	130.225	Continuing	Continuing

Note

Note: In FY 2012, all efforts from Projects 2301 and 2305 in this PE as well as the sensing, surveillance, and navigation major thrust effort in Project 2311 in this PE moved to this new Project to more appropriately describe and align the changing focus of the scientific disciplines within the overall program

A. Mission Description and Budget Item Justification

Basic research in the Physics and Electronics Project seeks to enable revolutionary advances in, and expand the fundamental knowledge supporting technologies critical to the future of the Air Force. Research stresses high-risk, far-term, game-changing capability breakthroughs essential for future leaps in warfighter system performance, functionality, reliability, and survivability while simultaneously reducing component and system power, size, mass, and life cycle costs. Major thrust areas being investigated in this Project are complex electronics and fundamental quantum processes; plasma physics and high energy density non-equilibrium processes; and optics, electromagnetics, communication, and signal processing.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Complex Electronics and Fundamental Quantum Processes: Scientific focus areas are atomic and molecular physics, laser and optical physics, quantum electronic solids, adaptive multi-mode sensing and ultra-high speed electronics, semiconductor and electromagnetic materials, and optoelectronics. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research includes exploration and understanding of a wide range of complex engineered materials and devices, including non-linear optical materials, optoelectronics, meta-materials, cathodes, di-electric and magnetic materials, high energy lasers, semiconductor lasers, new classes of high-temperature superconductors, quantum dots, quantum wells and graphene. Also includes generating and controlling quantum states, such as superposition and entanglement, in photons and ultra-cold atoms and molecules. ***FY 2012 OCO Plans:***	-	-	64.971	-	64.971
Title: Major Thrust 2.	-	-	14.316	-	14.316

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613001: *Physics and Electronics*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Description: Plasma Physics and High Energy Density Non-Equilibrium Processes: Scientific focus areas are electro-energetic physics and space sciences. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research includes a wide range of activities characterized by processes sufficiently energetic to require the understanding and managing of plasma phenomenology and the non-linear response of materials to high-electric and magnetic fields. This includes such endeavors as space weather, plasma control of boundary layers in turbulent flow, plasma discharges, radio frequency (RF) propagation, RF-plasma interaction, and high-power, beam-driven microwave devices. ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Optics, Electromagnetics, Communication and Signal Processing Research: Scientific focus areas are physical mathematics and applied analysis, electromagnetics, remote sensing and imaging physics, and surveillance and navigation. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research includes all aspects of producing and receiving complex electromagnetic and electro-optical signals, as well as their propagation through complex media, including adaptive optics and optical imaging; it also covers aspects of the phenomenology of lasers and non-linear optics. It focuses on the development of physical devices to enable such activities, and also includes sophisticated mathematics and algorithm development for extracting information form complex and/or sparse signals. ***FY 2012 OCO Plans:***	-	-	30.833	-	30.833
Accomplishments/Planned Programs Subtotals	-	-	110.120	-	110.120

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613001: *Physics and Electronics*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613002: *Aerospace, Chemical and Material Sciences*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
613002: *Aerospace, Chemical and Material Sciences*	-	-	139.475	-	139.475	141.880	148.245	154.880	161.037	Continuing	Continuing

Note

Note: In FY 2012, all efforts from Projects 2302, 2303, 2306 (except the natural systems and extremophiles major thrust effort, which moved to Project 3003), 2307 (except the sensory information systems major thrust effort, which moved to Project 3003), and 2308 (except the bioenergy major thrust effort, which moved to Project 3003) in this Program moved to this new Project to more appropriately describe and align the changing focus of the scientific disciplines within the overall program.

A. Mission Description and Budget Item Justification

Basic research in the Aerospace, Chemical, and Materials Sciences Project seeks to enable revolutionary advances in, and expand the fundamental knowledge supporting technologies critical to the future of the Air Force. Research stresses high-risk, far-term, game-changing capability breakthroughs essential for future leaps in warfighter system performance, functionality, reliability, and survivability while simultaneously reducing component and system power, size, mass, and life cycle costs. Major thrust areas being investigated in this Project are aero-structure interactions and control; energy, power, and propulsion; and complex materials and structures.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Aero Structure Interactions and Control: Scientific focus areas are high temperature aerospace materials, hypersonics and turbulence, and flow control and aeroelasticity. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research focuses on the characterization, modeling, and exploitation of interactions between the unsteady aerodynamic flow field and the dynamic air vehicle structure to enable enhanced performance in next generation Air Force systems. Of particular interest is the synergy gained from an interdisciplinary look at multiple technologies and the integration of core disciplines of fluid mechanics, structures, and materials. ***FY 2012 OCO Plans:***	-	-	34.868	-	34.868
Title: Major Thrust 2.	-	-	46.027	-	46.027

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613002: *Aerospace, Chemical and Material Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Description: Energy, Power, and Propulsion: Scientific focus areas are thermal control, theoretical chemistry, molecular dynamics, space power and propulsion, and combustion and diagnostics. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research in this cross-cutting, multi-disciplinary thrust area seeks to harvest technological innovations and develop potentially revolutionary technologies by integrating core disciplines of combustion, plasma dynamics, chemistry, hybrid simulation, structures, and materials. Focus is on underlying processes associated with the production, storage, and utilization of energy, specifically for Air Force systems. Examples include developing novel energetic materials as well as understanding and optimizing combustion processes. ***FY 2012 OCO Plans:***					
Title: Major Thrust 3. ***Description:*** Complex Materials and Structures: Scientific focus areas are mechanics of multifunctional materials and microsystems, multi-scale mechanics and prognosis, surface and interfacial sciences, low density materials, and polymer chemistry. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research is on future materials and structures composed of different classes of materials that may be able to change functionality or performance characteristics to enhance the mission versatility of future air and space systems, with a key goal of increasing functionality while decreasing weight and volume. The concentration is on complex materials, microsystems, and structures that incorporate hierarchical design and functionality from the nano-scale through the meso-scale, ultimately leading to controlled, well-understood material or structural behavior capable of dynamic functionality and/or performance characteristics to enhance mission versatility. ***FY 2012 OCO Plans:***	-	-	58.580	-	58.580
Accomplishments/Planned Programs Subtotals	-	-	139.475	-	139.475

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613002: *Aerospace, Chemical and Material Sciences*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613003: *Mathematics, Information and Life Sciences*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
613003: *Mathematics, Information and Life Sciences*	-	-	104.313	-	104.313	111.400	116.400	121.538	127.080	Continuing	Continuing

Note

Note: In FY 2012, all efforts from Projects 2304 and 2311 with the exception of sensing, surveillance, and navigation major thrust effort, which moved to Project 3001. In addition the natural systems and extremophiles major thrust effort in Project 2306, the sensory information systems major thrust effort in Project 2307, and the bioenergy major thrust effort in Project 2308 of this Program moved to this new Project to more appropriately describe and align the changing focus of the scientific disciplines within the overall program.

A. Mission Description and Budget Item Justification

Basic research in the Mathematics, Information, and Life Sciences Project seeks to enable revolutionary advances in, and expand the fundamental knowledge supporting technologies critical to the future of the Air Force. Research stresses high-risk, far-term, game-changing capability breakthroughs essential for future leaps in warfighter system performance, functionality, reliability, and survivability while simultaneously reducing component and system power, size, mass, and life cycle costs. Major thrust areas being investigated in this Project are information and complex networks; decision making; dynamical systems, optimization, and control; and natural materials and systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	-	-	29.208	-	29.208
Description: Information and Complex Networks: Scientific focus areas are systems and software, information operations and security, information fusion, and complex networks.					
FY 2010 Accomplishments:					
FY 2011 Plans:					
FY 2012 Base Plans: Focuses on research required to enable reliable and secure exchange of information and predicable operation of networks and systems. Though it includes traditional aspects of information assurance and research into reliable systems, the emphasis is on the mathematics that underlies fundamental new secure-by-design architectures of networked communications and decision-making platforms. Sub-areas supporting this scientific focus include system and network performance prediction, design and analysis, and modeling of human-machine systems.					
FY 2012 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613003: *Mathematics, Information and Life Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 2. ***Description:*** Decision Making: Scientific focus areas are mathematical modeling of cognition and decision making, chronobiology, and collective behavior and socio-cultural modeling. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research focuses on the discovery of mathematical laws, foundational scientific principles, and new robust algorithms. They all underlie intelligent, mixed human-machine decision making to achieve accurate real-time projection of expertise and knowledge into and out of the battlespace. It includes efforts to advance the critical knowledge base in information sciences and information fusion, and to model individual and group cognitive processing and decision making. ***FY 2012 OCO Plans:***	-	-	14.604	-	14.604
Title: Major Thrust 3. ***Description:*** Dynamical Systems, Optimization, and Control: Scientific focus areas are computational mathematics, dynamics and control, and optimization and discrete mathematics. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Emphasizes mathematical research for discovering new scientific concepts supported by rigorous analysis for advancing the science of autonomy and promoting the understanding necessary to analyze and design complex multi-scale systems as well as provide guaranteed levels of performance. It includes novel adaptive control strategies for coordinating heterogeneous, autonomous, or semi-autonomous aerospace vehicles in uncertain, information rich, dynamically changing, adversarial, and networked environments. ***FY 2012 OCO Plans:***	-	-	39.638	-	39.638
Title: Major Thrust 4.	-	-	20.863	-	20.863

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613003: *Mathematics, Information and Life Sciences*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Description: Natural Materials and Systems: Scientific focus areas are bioenergy; natural materials, systems, and extremophiles; and sensory information systems. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Research focuses on multi-disciplinary approaches for studying, using, mimicking or altering the novel ways natural systems accomplish their required tasks. Many of these natural systems include exquisite materials and sensors that often outperform man-made versions. This scientific thrust discovers how to mimic existing natural sensory systems and adds existing capabilities to these organisms for more precise control over their material production. ***FY 2012 OCO Plans:***					
Accomplishments/Planned Programs Subtotals	-	-	104.313	-	104.313

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613004: *Education and Outreach*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
613004: *Education and Outreach*	-	-	10.420	-	10.420	11.460	12.605	13.865	15.250	Continuing	Continuing

Note

Note: In FY 2012, all efforts from Project 4113 of this PE moved to this new Project to more appropriately describe and align the changing focus of outreach development within the overall program.

A. Mission Description and Budget Item Justification

The major thrust areas in this Science & Technology (S&T) Outreach Development Project are to facilitate interactions between the international and domestic research communities and Air Force researchers, and to support and develop scientists and engineers with an awareness of Air Force basic research priorities. These professional interactions and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities to the research community as a whole, and attract talented scientists and engineers to address Air Force needs. International interactions facilitate future interoperability of coalition systems and foster relationships with future coalition partners. This Project also seeks to enhance educational interactions with historically black colleges and universities, Hispanic serving institutions, and other minority institutions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1.	-	-	5.238	-	5.238
Description: Outreach to International S&T Community: Foster international S&T cooperation by supporting direct interchanges with a broad range of key international researchers and communities. Identify and leverage international scientific advances when appropriate.					
FY 2010 Accomplishments:					
FY 2011 Plans:					
FY 2012 Base Plans: Provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Capitalize on foreign investments by influencing and acquiring world-class scientific research on specific topics of Air Force interest. Seek and maintain access to technical briefs and publications on unique foreign research capabilities. Support international visits by high-level DoD S&T delegations, and provide primary interface to coordinate international S&T participation among Deparment of Defense (DoD) organizations.					
FY 2012 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 613004: *Education and Outreach*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 2. ***Description:*** Outreach to U.S. S&T Workforce: Strengthen science, mathematics, and engineering research and educational infrastructure in the U.S., thereby strengthening current and future Air Force S&T capabilities. ***FY 2010 Accomplishments:*** ***FY 2011 Plans:*** ***FY 2012 Base Plans:*** Increase awareness of Air Force research needs and opportunities throughout the civilian scientific community, while simultaneously identifying, recruiting, and increasing opportunities for new young investigators to participate in critical Air Force research. Support science, mathematics, and engineering research, and educational outreach programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. ***FY 2012 OCO Plans:***	-	-	5.182	-	5.182
Accomplishments/Planned Programs Subtotals	-	-	10.420	-	10.420

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force			DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 614113: *External Research Programs Interface*	

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
614113: *External Research Programs Interface*	9.407	9.470	-	-	-	-	-	-	-	Continuing	Continuing

Note

In FY 2012, as part of the realignment of the overall Program to reflect the changing focus of the scientific disciplines, this Project was renamed Education and Outreach - Project 3004 to more appropriately describe its mission.

A. Mission Description and Budget Item Justification

The primary elements in this Project are to facilitate interactions between the international and domestic research communities and Air Force researchers, and to support and develop scientists and engineers with an awareness of Air Force basic research priorities. These professional interactions and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities to the research community as a whole, and attract talented scientists and engineers to address Air Force needs. International interactions facilitate future interoperability of coalition systems and foster relationships with future coalition partners. This Project also seeks to enhance educational interactions with historically black colleges and universities, Hispanic serving institutions, and other minority institutions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Title: Major Thrust 1. ***Description:*** Foster international science and technology cooperation by supporting the Air Force's international strategy mission. Identify and leverage unique foreign research capabilities. ***FY 2010 Accomplishments:*** Continued to provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Continued to capitalize on foreign investments by influencing and acquiring world-class scientific research. Continued to seek and maintain access to technical briefs and publications on unique foreign research capabilities. Continued to support international visits of high-level DoD delegations and provide primary interface to coordinate international participation among DoD organizations. ***FY 2011 Plans:*** Continue to provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Continue to capitalize on foreign investments by influencing and acquiring world-class scientific research. Continue to seek and	5.193	5.238	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 614113: *External Research Programs Interface*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
maintain access to technical briefs and publications on unique foreign research capabilities. Continue to support international visits of high-level DoD delegations and provide primary interface to coordinate international participation among DoD organizations. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***					
Title: Major Thrust 2. ***Description:*** Strengthen science, mathematics, and engineering research as well as educational infrastructure in the U.S., thereby strengthening Air Force technical capabilities. ***FY 2010 Accomplishments:*** Supported science, mathematics, and engineering research, and educational outreach programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Increased awareness of Air Force research needs throughout civilian scientific community, while simultaneously identifying/recruiting the best scientific talent to participate in critical Air Force research. ***FY 2011 Plans:*** Continue to support science, mathematics, and engineering research, and educational outreach programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Increase awareness of Air Force research needs throughout civilian scientific community, while simultaneously identifying/recruiting the best scientific talent to participate in critical Air Force research. ***FY 2012 Base Plans:*** ***FY 2012 OCO Plans:***	4.214	4.232	-	-	-
Accomplishments/Planned Programs Subtotals	9.407	9.470	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Air Force		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102F: *Defense Research Sciences*	PROJECT 614113: *External Research Programs Interface*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
• Activity Not Provided: *Title Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.