

UNCLASSIFIED

PE NUMBER: 0602500F
 PE TITLE: MULTI-DISCIPLINARY SPACE TECH

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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH
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Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	89.761	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5023 Laser & Imaging Space Tech	7.701	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5025 Space Materials Development	19.197	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5026 Rocket Propulsion Component Tech	48.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5027 High Speed Airbreathing Prop Tech	0.239	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5028 Space Sensors, Photonics & RF Proc	1.848	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5029 Space Sensor & CM Tech	1.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5082 Optical Networking Tech	11.589	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2007, Project 625023, Laser and Imaging Space Technology, efforts transfer to PE 0602605F, Directed Energy Technology, Project 6255SP, Laser and Imaging Space Technology; Project 625025, Space Materials Development, efforts transfer to PE 0602102F, Materials, Project 6210SP, Space Materials Development; Project 625026, Rocket Propulsion Component Technology, and Project 625027, High Speed Airbreathing Propulsion Technology, efforts transfer to PE 0602203F, Aerospace Propulsion, Project 6233SP, Space Rocket Component Technology; Project 625028, Space Sensors, Photonics and Radio Frequency (RF) Processes, and Project 625029, Space Sensor and Countermeasure (CM) Technology, efforts transfer to PE 0602204F, Aerospace Sensors, Project 626244 SP, Space Sensors; Project 625030, Applied Space Access Vehicle Technology, efforts transfer to PE 0602201F, Aerospace Vehicle Technologies, Project 6222SP, Applied Space Access Vehicle Technology; and Project 625082, Optical Networking Technology, efforts transfer to PE 0602702F, Command Control and Communication, Project 6266SP, Space Optical Network Technology, in order to more effectively manage and provide oversight of the efforts. Funds for the FY 2007 Congressionally-directed Engineering Tool Improvement Program (ETIP) in the amount of \$2.8 million were moved to PE 0602203F, Aerospace Propulsion, Project 6233SP, Space Rocket Component Technology, and the funds for the Congressional-directed Integrated Control for Autonomous Space Systems were moved to PE 0602601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies, from this PE for execution.

(U) A. Mission Description and Budget Item Justification

This program advances the technology base in multiple disciplines for future space applications with projects focusing on separate technology areas including: 1) laser and imaging space technologies, which develop concepts for advanced, very long-range optical systems and assess the vulnerability of satellites to the effects of high energy laser weapon systems; 2) space materials, which concentrate on the materials technology base for spacecraft and launch systems to improve affordability, maintainability, and performance; 3) rocket propulsion component technologies, which advance technology in liquid propulsion rocket engines, solid rocket motors, spacecraft and upper stage propulsion, ballistic missiles, and application of advanced materials for rockets to achieve revolutionary launch capabilities; 4) high-speed airbreathing propulsion technologies, which develop advanced and combined cycle engine technologies for revolutionary low-cost access to space; 5) space sensors, photonics, and radio frequency processes, which develop technologies to generate, control, process, receive, and transmit opto-electronic signals for space sensor applications; 6) space sensors and countermeasures technologies, which focus on generation, control, reception, and processing of electronic and electromagnetic

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signals for space sensor applications in intelligence, surveillance, reconnaissance, warning, electronic combat, and countermeasures; 7) applied space access vehicle technologies, which develop advanced concepts for affordable on-demand access to space; 8) lightweight satellite antenna technology and affordable antenna terminal technology for communications and surveillance; and 9) optical networking technology, which focuses on the space-based laser communications to provide the warfighter with unlimited communications to any place at any time. Note: In FY 2007, Congress added \$2.8 million for Engineering Tool Improvement Program (ETIP) and \$1.6 million for Integrated Control For Autonomous Space Systems. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	91.694	0.000	0.000	0.000
(U) Current PBR/President's Budget	89.761	0.000	0.000	0.000
(U) Total Adjustments	-1.933			
(U) Congressional Program Reductions				
Congressional Rescissions	-0.005			
Congressional Increases		4.400		
Reprogrammings	-0.383	-4.400		
SBIR/STTR Transfer	-1.545			

(U) **Significant Program Changes:**

Efforts transfer to other programs in FY07 and out to more effectively manage and provide oversight of the efforts.

C. Performance Metrics

(U) Under Development.

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BUDGET ACTIVITY 02 Applied Research					PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH			PROJECT NUMBER AND TITLE 5023 Laser & Imaging Space Tech		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5023 Laser & Imaging Space Tech	7.701	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602605F, Directed Energy Technology, Project 6255SP, Laser and Imaging Space Technology, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

Develop advanced, long-range, optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large, lightweight optics; and optical coatings that support relay mirror systems. Relay mirror systems can greatly extend the range of high-power laser weapons, as well as low-power imaging systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop advanced, long-range, optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large, lightweight optics; and optical coatings that support relay mirror systems. Relay mirror systems can greatly extend the range of high-power laser weapons, as well as low-power imaging systems.	5.796	0.000	0.000	0.000
(U) In FY 2006: Investigated two-beam propagation techniques. Investigated critical advanced wavefront control devices for both monolithic and phased array imaging and beam projection from space.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Assess the vulnerability of satellites to the effects of high-energy laser weapons and maintain and update catalogued satellites.	1.905	0.000	0.000	0.000
(U) In FY 2006: Assessed the survivability and vulnerability of aerospace systems to the effects of high-energy laser and other directed energy systems. Updated response databases for continued improvement of predictive avoidance analyses and provided data to U.S. Strategic Command for the performance of Laser Clearinghouse functions. Updated previously completed assessments on catalogued satellites. Enhanced and refined finite state modeling process, physical, and functional models for space systems that will enable rapid characterization of new launches and provide a better estimate of on orbit space systems capabilities for improved space situational awareness. Updated assessment methodology by anchoring modeling tools to empirical data. Incorporated improved algorithms and hardware for rapidly characterizing space objects and new launches into current data				

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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
fusion workstations needed for satellite assessments and for the space situational awareness mission.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	7.701	0.000	0.000	0.000

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0602605F, Directed Energy Technology.										
(U) PE 0603444F, Maui Space Surveillance Systems.										
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.										
(U) PE 0603605F, Advanced Weapons Technology.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										
(U) <u>D. Acquisition Strategy</u>										
Not Applicable.										

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BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH			PROJECT NUMBER AND TITLE 5025 Space Materials Development			
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5025 Space Materials Development	19.197	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602102F, Materials, Project 6210SP, Space Materials Development, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project develops the materials and processing technology base for spacecraft and launch systems to improve affordability, maintainability, and performance of current and future Air Force space systems. Families of affordable lightweight materials are being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites to provide new capabilities for spacecraft, ballistic missile, and propulsion systems to meet the future space requirements. Rocket propulsion materials development in this project supports the Integrated High Payoff Rocket Propulsion Technology (IHRPRT) program. Advanced high-temperature protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet space and ballistic missile requirements. Materials technologies are also being developed to enable surveillance and terrestrial situational awareness systems and subsystems for space and ballistic missile applications.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop materials and processes to dramatically improve performance, durability, and cost of rocket propulsion systems.	10.899	0.000	0.000	0.000
(U) In FY 2006: Evaluated suitability of materials for high-speed turbopumps, ducts, valves, solid rocket casings, insulation, nozzle throats, and spacecraft propulsion applications. Fabricated subscale articles and tested in representative rocket engine environment to validate materials performance. Analyzed material behavior in rocket combustion environment for solid rocket nozzles, exit cones, throats, and spacecraft propulsion components. Validated materials performance goals for direct replacement of materials. Evaluated processes for scale-up from coupon-level testing to more complex shapes and sizes. Demonstrated innovative concepts and technologies that could enable new engine designs. Characterized material candidates, analyzed material performance, and identified ways to improve thrust chambers, nozzles, and catalysts.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop affordable, advanced structural and non-structural materials and processing technologies for Air Force space applications.	6.777	0.000	0.000	0.000

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<u>(U) B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2006: Developed candidate metallic systems for thin gage structures for component operation in robust high-temperature, long duration cruise or access to space environments. Refined analytical methods to understand behavior of materials in cryogenic environments and analyzed liquid oxygen compatibility research results through integrated technical working groups with industry and National Aeronautics and Space Administration (NASA). Developed subscale high-temperature protection systems for leading edges, nosetips, and aeroshells for expendable and reusable high-speed vehicle applications. Demonstrated oxidation-protected carbon-carbon materials in environments relevant to high-speed vehicle applications. Developed advanced composite technologies for thermal management and dimensionally stable structural space applications. Developed wear-resistant materials, lubricants, and micro-electro-mechanical systems devices for moving mechanical assemblies on spacecraft. Evaluated candidate space materials and collected critical data to facilitate materials transition.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop materials and materials processing technologies to enable improved performance and affordability of surveillance, tracking, targeting, and situational awareness systems.	1.521	0.000	0.000	0.000
(U) In FY 2006: Demonstrated electro-optic polymers for optical communications, data links, and radio frequency (RF) system control architectures. Explored processes to allow advanced materials design and architecture development for very long wavelength alternative materials operating at 40 Kelvin. Developed materials and materials process technologies for application in combined optical and RF communication system apertures.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	19.197	0.000	0.000	0.000

<u>(U) C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0602102F, Materials.										

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5025 Space Materials Development

(U) **C. Other Program Funding Summary (\$ in Millions)**(U) PE 0603112F, Advanced
Materials for Weapon
Systems.(U) This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and
eliminate duplication.(U) **D. Acquisition Strategy**

Not Applicable.

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BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH				PROJECT NUMBER AND TITLE 5026 Rocket Propulsion Component Tech		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5026 Rocket Propulsion Component Tech	48.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602203F, Aerospace Propulsion, Project 6233SP, Space Rocket Component Technology, in order to more effectively manage and provide oversight of the efforts. Funds for the 2007 Congressionally-directed Engineering Tool Improvement Program (ETIP) in the amount of \$2.8 million were moved from this Project to PE 0602203F, Aerospace Propulsion, Project 6233SP, Space Rocket Component Technology, for execution.

(U) A. Mission Description and Budget Item Justification

This project develops advances in rocket propulsion technologies for space access, space maneuver, and ballistic missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, Technology for Sustainment of Strategic Systems (TSSS) Phase 1, and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of future space and missile launch subsystems. Technologies are developed to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the IHRPT program, a joint Department of Defense, NASA, and industry effort to focus rocket propulsion technology on national needs.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, and reduced-toxicity monopropellants to increase space launch payload capability and refine new propellants synthesis methods. Efforts include evaluation and development of reduced-toxicity ionic salt, high-energy-density oxidizers, nano-materials, catalyst, and polymeric binders; determining optimized paths for incorporating these materials into propellants; and for selected propellants perform laboratory and demonstrator engine evaluations. Efforts seek monopropellants with performance equivalent to bipropellants that reduce the cost of space access and space operations. Phases are referring to the IHRPT program phases.	3.420	0.000	0.000	0.000
(U) In FY 2006: Downselected potential propellant ingredients and scaled-up promising high energy-density materials candidates. Evaluated propellants in advanced combustion devices to determine materials compatibility and performance and prepare for large-scale motor tests. Incorporated initial solid propellants ingredients into Phase III solid propellant formulations. Completed efforts to address ablation effects on laser-propelled lightcraft fuel and fuel system. Modeled and analyzed advanced propulsion concepts with enhanced performance and reliability such as rocket-based combined cycle engines.				
(U) In FY 2007: Not Applicable.				

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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) MAJOR THRUST: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. Efforts include modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as aerovehicles and potential launch systems. Phases are referring to the IHRPT program phases.	7.900	0.000	0.000	0.000	
(U) In FY 2006: Characterized, studied, and evaluated shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Developed experiments to enhance the thermal management of upper stage engines for better performance, chamber life, and reliability. Analyzed and tested causes and issues that lead to combustion instability in hydrocarbon fueled liquid rocket engines reducing the need for conducting large numbers of costly full-scale component and engine tests. Developed advanced synthetic hydrocarbon fuels to meet Phase II goals.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in advanced combustion devices and propulsion systems for current and future rocket propulsion systems.	5.147	0.000	0.000	0.000	
(U) In FY 2006: Developed advanced, recyclable, ablative components using nano-reinforced hybrid polymers that are two times better than previously developed materials. Characterized and developed processing technologies to improve nano-reinforced high temperature polymers and carbon-carbon materials. Developed new advanced materials for use with high-energy propellants. Completed transition of specific advanced high temperature materials to air and space systems to reduce system weight and cost, and increase performance. Developed processing methodology for using nanocomposites for liquid rocket engine tanks.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					

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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U)					
(U) MAJOR THRUST: Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles.	19.189	0.000	0.000	0.000	
(U) In FY 2006: Developed advance modeling and simulation tool for advanced cryogenic liquid rocket upper stage technologies. Designed hardware for advanced cryogenic upper stage technologies - turbopumps and thrust chambers. Evaluated second set of potential hydrocarbon fuels and adjust/modify/develop fuel characterization test rig. Developed second concept for lightweight nozzles for liquid rocket engines.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites, microsattellites, and satellite constellations. Phases are referring to the IHRPT program phases.	4.219	0.000	0.000	0.000	
(U) In FY 2006: Completed initial development and test of monopropellant thruster ignition and combustion sustainment component technologies for chemical-based space propulsion. Completed Phase II lifetest and evaluated Phase III plasma thrusters for microsattellites propulsion systems. Completed development and test of a controlled solid propellant.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Engineering Tool Improvement Program (ETIP).	4.168	0.000	0.000	0.000	
(U) In FY 2006: Provided additional modeling and simulation tool development for Hall-effect thruster physical models, improvements to the ROCKET Engine Transient Simulation (ROCETS) graphical user interface, and added rocket-based combined cycle models to the Integrated Propulsion Analysis Tool code for future fully reusable launch vehicle concepts. Added capability to analyze advanced propulsion concepts such as Field Reversed Configuration.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					

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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Universal Small Launch Vehicle	4.070	0.000	0.000	0.000
(U) In FY 2006: Integrated propellant tanks with clusters of axi-symmetric aero-spike engine rocket plug nozzles to gain increases in mission performance by employing a vortex combustion, cold-walled liquid oxygen/methane rocket engine concept. This technology could be used on highly operable, highly reusable space transportation systems.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	48.113	0.000	0.000	0.000

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0601102F, Defense Research Sciences.										
(U) PE 0602114N, Power Projection Applied Research.										
(U) PE 0602203F, Aerospace Propulsion.										
(U) PE 0602303A, Missile Technology.										
(U) PE 0602805F, Dual Use Science and Technology.										
(U) PE 0603216F, Aerospace Propulsion and Power Technology.										
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.										

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**5026 Rocket Propulsion Component
Tech****(U) C. Other Program Funding Summary (\$ in Millions)**

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

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BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH				PROJECT NUMBER AND TITLE 5027 High Speed Airbreathing Prop Tech		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5027 High Speed Airbreathing Prop Tech	0.239	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602203F, Aerospace Propulsion, Project 6233SP, Space Rocket Component Technology, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project develops revolutionary, airbreathing, hypersonic propulsion technology options to enable affordable, on demand access to space for the Air Force. The short-term focus is on hydrocarbon fueled engines capable of operating over a broad range of flight Mach numbers and longer term focus will be on hydrogen fueled scramjet powered engines that can enable the higher Mach numbers to achieve access to space. Technologies developed under this program enable capabilities of interest to both the Department of Defense and the NASA. Efforts include modeling and simulation, proof of concept tests of critical components, advanced component development, and ground-based tests.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Conduct assessments, system design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies in support of the development of affordable, on-demand access to space vehicles to meet future warfighter needs.	0.239	0.000	0.000	0.000
(U) In FY 2006: Conducted system trade studies to determine military payoff and establish component technology goals. Defined new component and engine performance objectives to enable development of affordable hypersonic CCEs.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	0.239	0.000	0.000	0.000

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	Actual	Estimate								
(U) Related Activities:										
(U) PE 0601102F, Defense Research Sciences.										
(U) PE 0602201F, Aerospace										

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BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

**0602500F MULTI-DISCIPLINARY
SPACE TECH**

PROJECT NUMBER AND TITLE

**5027 High Speed Airbreathing Prop
Tech****(U) C. Other Program Funding Summary (\$ in Millions)**

Flight Dynamics.

(U) PE 0602203F, Aerospace
Propulsion.**(U)** PE 0602602F, Conventional
Munitions.**(U)** PE 0602702E, Tactical
Technology.**(U)** PE 0603111F, Aerospace
Structures.**(U)** PE 0603216F, Aerospace
Propulsion and Power
Technology.**(U)** PE 0603601F, Conventional
Weapons Technology.**(U)** Program is reported
to/coordinated by the Joint
Army/Navy/NASA/Air Force
(JANNAF) Executive
Committee.**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and
eliminate duplication.**(U) D. Acquisition Strategy**

Not Applicable.

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BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH				PROJECT NUMBER AND TITLE 5028 Space Sensors, Photonics & RF Proc		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5028 Space Sensors, Photonics & RF Proc	1.848	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602204F, Aerospace Sensors, Project 6244SP, Space Sensors, in order to more effectively manage and provide oversight of the efforts. Funds for the 2007 Congressionally-directed Integrated Control for Autonomous Space Systems in the amount of \$1.6 million were moved from this Project to PE 0602601F, Space Technology, Project 628809, Spacecraft Vehicle Technology, for execution.

(U) A. Mission Description and Budget Item Justification

This project focuses on developing methods of generating, controlling, receiving, transmitting, and processing photonic, optical, and opto-electronic (mixed) signals for RF space sensor applications. The enabling technologies will be used for intelligence, surveillance, reconnaissance, electronic warfare, and precision engagement sensors based in space. The project aims to demonstrate significantly improved military space sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. This project also develops and assesses multi-dimensional adaptive techniques in radar technology for affordable and reliable space surveillance and reconnaissance systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Study adaptive processing techniques for large, multi-mission, space-based conformal arrays.	1.000	0.000	0.000	0.000
(U) In FY 2006: Developed adaptive processing techniques suitable for implementation on space-qualified computing architectures for multi-intelligence intelligence, surveillance, and reconnaissance (ISR) sensing from space-based platforms. Studied signal processing methods and novel adaptive transmit waveform techniques for a space surveillance platform.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop advance photonic component technology for space-base sensors that focuses on improving performance and reducing size, mass, and prime power. Supports ISR capability. Note: In FY 2006, photonics technology efforts moved into this thrust from previous major thrusts in this Project.	0.848	0.000	0.000	0.000
(U) In FY 2006: Developed and demonstrated photonic component technology enabling low loss true time delay for wideband phased array applications.				
(U) In FY 2007: Not Applicable.				

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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH	PROJECT NUMBER AND TITLE 5028 Space Sensors, Photonics & RF Proc
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	1.848	0.000	0.000	0.000

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>							
(U) Related Funding:										
(U) PE 0602204F, Aerospace Sensors.										
(U) PE 0603203F, Advanced Aerospace Sensors.										
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										
(U) <u>D. Acquisition Strategy</u>										
Not Applicable.										

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BUDGET ACTIVITY 02 Applied Research					PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH			PROJECT NUMBER AND TITLE 5029 Space Sensor & CM Tech		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5029 Space Sensor & CM Tech	1.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602204F, Aerospace Sensors, Project 6244SP, Space Sensors, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project focuses on developing processes and techniques for electronic and electromagnetic signal processing for ISR space sensor applications. This project develops the baseline technologies required to manage and perform on-board space sensor information fusion for timely and comprehensive communications and situational awareness. Through modeling and simulation, this project develops and evaluates innovative electromagnetic and electronic countermeasures for space applications.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop space-qualified precision time, position, and velocity sensors capable of operating in jamming environments enabling multiple platform sensor-to-shooter operations. Note: In FY 2006, effort completed.	0.339	0.000	0.000	0.000
(U) In FY 2006: Demonstrated highly accurate and robust precision time, position, and velocity sensor techniques for space-based applications. Developed constructive systems engineering model to assess space-based assured reference techniques in terms of measures of performance and warfighter utility.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop advanced active phased array antenna subsystems to meet the unique requirements of affordable space based sensing including the restrictions on mass, size, power. Utilize advanced materials, to demonstrate low-mass, low cost, reliable and scalable apertures. Supports intelligence, surveillance, and reconnaissance capability.	0.735	0.000	0.000	0.000
(U) In FY 2006: Developed low-mass shallow-depth microwave antenna panels with integrated active elements and low RF distribution loss.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	1.074	0.000	0.000	0.000

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BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602500F MULTI-DISCIPLINARY
SPACE TECH

PROJECT NUMBER AND TITLE
5029 Space Sensor & CM Tech

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

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BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH				PROJECT NUMBER AND TITLE 5082 Optical Networking Tech		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5082 Optical Networking Tech	11.589	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transfer to PE 0602702F, Command Control and Communications, Project 6266SP, Space Optical Network Technology, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project develops the technology base for the next generation of ultra-wide- bandwidth, multi-channeled, air and space-based communications networks on and between platforms. As the application of laser-based, point-to-point communications between satellites emerges, air and space-based optical networks, whose communications capacities are thousands of times greater than current communications satellites, become a realistic possibility. This project will assess and adapt the emerging communication and information technologies, for applications in air and space. This project will explore technologies for implementing photonic chip scale optical Code Division Multiple Access (CDMA) and Wavelength Division Multiplexed (WDM) transceivers and prototype networks, built to demonstrate the benefits associated with the advanced fiber optic, wireless, platform, and satellite networks that can be built from them. This project will develop and demonstrate technology to integrate current Radio Frequency with high data rate Optical LASER communications, along with network management techniques, tools and software to support them. These technologies have potential applications in specific military systems including reliable, high bandwidth, jam-resistant communications at the theater level, and multiplexing of multiple DoD users onto a common networking infrastructure for reduced manning and logistics.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and assess optical network technologies for application in the space environment.	1.511	0.000	0.000	0.000
(U) In FY 2006: Designed and developed a multi-path interconnection network that provides for redundancy, fault tolerance, self-routing and non-blocking switching required for air and space-based networks. Demonstrated a highly integrated multi-gigabit optical network with 4 x 4 optical data router and optical backbone interface chips.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop and assess existing and emerging Optical CDMA and WDM modulation schemes and protocols for use in space-based optical networks.	2.926	0.000	0.000	0.000
(U) In FY 2006: Demonstrated industry standard single mode optical communications bus interface chip for airborne platforms. Designed and developed optical burst switching and optical label switching protocols for applicability to air and space-based optical networks. Performed a flight demonstration of				

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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH	PROJECT NUMBER AND TITLE 5082 Optical Networking Tech
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
industry standard single mode optical communications bus interface chip for airborne platforms.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop and demonstrate heterogeneous, seamless, secure, self-configuring high capacity air/space/surface wireless networks that integrate current RF with high data rate Optical Laser communications.	4.050	0.000	0.000	0.000
(U) In FY 2006: Designed and developed waveform, coding, management, and atmospheric mitigation technologies for a combined RF/laser communications brassboard. Characterized and developed an industry standard single mode optical communications bus for airborne platforms and air-to-air or air-to-ground RF and laser networked communication.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Space Qualification of the Common Data Link.	3.102	0.000	0.000	0.000
(U) In FY 2006: Modified the Common Data Link (CDL), previously developed for Joint Surveillance and Target Attack Radar System, U-2, Global Hawk, and Airborne Warning and Control System, and performed qualifications testing for operation in the space environment. Enhanced current CDL capabilities by developing higher throughput space qualifiable terminals to enable airborne and surface CDL terminals to receive direct downlinks for space borne assets				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	11.589	0.000	0.000	0.000

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) PE 0602702F, Command, Control, and Communications.										

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BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

**0602500F MULTI-DISCIPLINARY
SPACE TECH**

PROJECT NUMBER AND TITLE

5082 Optical Networking Tech**(U) C. Other Program Funding Summary (\$ in Millions)****(U)** PE 0603789F, C3I Advanced
Development.**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and
eliminate duplication.**(U) D. Acquisition Strategy**

Not Applicable.