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

DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

	COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	57,450	54,884	72,114	60,282	66,072	72,232	88,288	90,806	Continuing	TBD
2181	Spacecraft Payloads	15,964	14,931	19,970	16,109	16,248	18,484	35,169	35,314	Continuing	TBD
3834	Integrated Space Technology Demonstrations	22,823	14,947	20,511	18,633	25,125	27,516	26,543	26,675	Continuing	TBD
4400	Space Systems Protection	5,661	2,732	6,013	3,482	3,515	3,577	3,632	3,682	Continuing	TBD
4938	Space Developmental Planning	4,980	0	0	0	0	0	0	0	0	TBD
5021	Space Systems Survivability	0	3,936	4,171	4,788	4,867	4,992	5,068	5,139	Continuing	TBD
5083	Ballistic Missiles Technology	0	0	6,860	6,877	5,831	4,077	4,139	4,197	Continuing	TBD
682J	Spacecraft Vehicles	8,022	18,338	14,589	10,393	10,486	13,586	13,737	15,799	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, efforts were transferred from PE 0603410F, Space Systems Environmental Interactions Technology, into Project 4400 in this PE, in order to align projects within the Air Force Research Laboratory organization. In FY 2003, selected efforts in Project 4400, were transferred within this PE into Project 5021, in order to focus on improving survivability of space systems in natural environments. In FY 2004 and out, the guidance and control efforts in Project 5083 are put in this PE in order to align projects within the Air Force Research Laboratory organization.

(U) A. Mission Description

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, spacecraft protection, spacecraft and launch vehicles, ballistic missiles, space systems survivability, and development of advanced laser communications technologies to support next generation satellite communication systems. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: In FY 2003, Congress added $13.7 million ($1.2 million for Capacitively Coupled Interconnect, $1.0 million for Next Generation Hybrid Orbital Maneuver Vehicle, $1.0 million for Integrated Spacecraft

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(U) A. Mission Description Continued

Engineering Tool, $1.0 for Streaker Small Launch Vehicle, $7.0 million of Thin Amorphous Solar Arrays, and $2.5 million for Robust Aerospace Composite Materials/Structures).

(U) B. Budget Activity Justification

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing space system upgrades and/or new space system developments that have military utility and address warfighter needs.

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

		FY 2002	FY 2003	FY 2004	Total Cost
(U)	Previous President's Budget	60,932	42,315	53,323	
(U)	Appropriated Value	61,528	56,015		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-596	-658		
	b. Small Business Innovative Research	-1,259			
	c. Omnibus or Other Above Threshold Reprogram		-473		
	d. Below Threshold Reprogram	-1,940			
	e. Rescissions	-283			
(U)	Adjustments to Budget Years Since FY 2003 PBR		0	18,791	
(U)	Current Budget Submit/FY 2004 PBR	57,450	54,884	72,114	TBD

(U) Significant Program Changes:

Changes to this PE since the previous President's Budget are due to higher priorities within the Science and Technology program.

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DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 2181

COST ($ in Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
2181	Spacecraft Payloads	15,964	14,931	19,970	16,109	16,248	18,484	35,169	35,314	Continuing	TBD

(U) A. Mission Description

This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, satellite control hardware and software for advanced satellite surveillance operations, and development of advanced laser communications technologies to support next generation satellite communications systems. Improved space-qualifiable electronics and software for data and signal processing will be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., radiation-hardening) commercial data and signal processor technologies for use in Air Force space systems. For mid-term applications, the Improved Space Computer Program will merge advanced, radiation-hardened space processor, memory, and interconnect technologies with commercially-derived, open system architectures to develop and demonstrate robust, on-board processing capabilities for 21st century Department of Defense satellites. In the long-term, this project area focuses on developing low-cost, easily modifiable software and hardware architectures for fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $9,740 Developed spacecraft microelectronic devices that will include radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems components and applications. These devices and technologies enable next generation high performance, small, lightweight, efficient, and reliable on-board space electronic systems. Designed advanced general purpose embedded processors capable of performing at 500 million instructions per second. Designed digital signal processors capable of performing at 1 billion operations per second. Performed full-scale integration of chalcogenide programmable memory elements into high density, low power chips. Investigated integration of chalcogenide into other component applications. Extended fabrication capability for application specific integrated circuit technology for up to eight million gate devices. Developed and demonstrated a micro-electro-mechanical systems switch box that will use discrete components with non-radiation-hardened control circuitry. Investigated the miniaturization of optical cross-links for advanced packaging applications.

(U) $1,626 Continued to develop intelligent satellite system technologies for satellite control, precision navigation, formation flying, and cluster management technologies for spacecraft constellations. These intelligent satellite systems provide improved capabilities to monitor satellites in real-time, reduce the time required for data collection, processing, and dissemination, and decrease anomaly resolution time and ground operations requirements. Developed flight-ready microsatellite cluster management software. Completed and demonstrated flight-ready microsatellite flying algorithms and initiated development of command and control and navigational capability to perform high-fidelity

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

spacecraft proximity operations. Developed a virtual cluster control ground station capable of commanding and controlling multiple satellite clusters. Initiated development of automated planning and scheduling software and integration of distributed payload processing algorithms with the flight software. Developed a spacecraft and simulation data archiving and storage system.

(U) $803 Continued to develop modeling, simulation, and analysis (MS&A) tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. The MS&A tools provide data and validate research and development systems engineering level technology trade off decisions for space-based surveillance missions/campaign level assessments and for intelligent satellite systems testbeds. Built models for sparse, distributed aperture radio frequency (RF) system simulation to support technology trades, systems engineering, and design reviews for near-term flight test experiments. Built models of sparse aperture RF distributed signal processing to be validated against flight experiment and for systems analysis.

(U) $2,364 Developed advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well 'cold body' targets such as decoys, satellites, and midcourse warheads. Fabricated and delivered low temperature multi-color and low background detectors and focal plane arrays, and higher temperature arrays with improved radiation hardness. Continued iterative development of longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperature mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing space backgrounds.

(U) $1,431 Developed satellite antenna technologies that maximize the use of high density interconnects, embedded the electronics directly onto the antenna itself, and used antenna modules to create large, lightweight space antennas. Satellite antenna technologies will be used to improve the affordability and capability of antenna modules for space-based payload subsystems for surveillance and navigation efforts. Fabricated selected embedded-structural transmit-receive electronics antenna modules. Designed antenna modules that address requirements for minimizing mass and power by embedding lightweight electronics in the structure. Completed fabrication of modular phased-array antenna tiles. Integrated tiles into modules for performance characterization.

(U) $15,964 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $8,281 Develop spacecraft microelectronic devices, including radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems components and applications. Perform simulations and validate designs of a general purpose embedded processor at 500 million instructions per second and digital signal processors at 1 billion operations per second. Fabricate and characterize high density, low power chips comprised of innovative chalcogenide

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(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

programmable memory elements. Begin integration of chalcogenide into components such as field programmable logic and analog microelectronics. Develop macrocell libraries for application specific integrated circuit technology for up to eight million gate devices. Develop and demonstrate a micro-electro-mechanical based switch box multi-chip module and associated heuristics for multi-switch box applications to smart-wiring manifolds.

(U) $1,756 Continue to develop intelligent satellite system technologies for satellite control, precision navigation, formation flying, and cluster management technologies for spacecraft constellations. Continue to develop microsatellite cluster management software for a flight demonstration of collaborating three microsatellite constellation. Continue development of command and control and navigational capability for high fidelity spacecraft proximity operations. Continue developing automated planning and scheduling software for multiple satellite clusters and the spacecraft and simulation data archiving and storage system. Begin development of guidance, navigation, and control algorithms for a tethered power generation system.

(U) $908 Continue to develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. Continue to develop models for sparse, distributed aperture radio frequency (RF) system simulation to support technology trades, systems engineering, and design reviews for near-term flight test experiments. Continue to develop models of sparse aperture RF distributed signal processing to be validated against flight experiment and for systems analysis. Begin building mission operations center to support the collaborating three microsatellite constellation flight experiment.

(U) $482 Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well 'cold body' targets such as decoys, satellites, and midcourse warheads. Demonstrate and characterize low temperature multi-color and low background detectors and focal plane arrays, and higher temperature arrays with improved radiation hardness. Fabricate and deliver longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperature mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing space backgrounds. Transition multi-color quantum well photodetector designs and other promising infrared technologies to large focal plane arrays.

(U) $2,317 Develop satellite antenna technologies which maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to create large, lightweight space antennas. Test and integrate selected embedded-structural transmit-receive electronics antenna modules for future multi-microsatellite constellation space flight experiment. Test, integrate, and evaluate multi-beam, wide-bandwidth transmit-receive electronics antenna modules with payloads for possible airborne, multi-mode flight experiment. Fabricate and test antenna modules which address requirements for minimizing mass and power by embedding lightweight electronics in the structure.

(U) $1,187 Develop integrated circuit interconnection technology based on non-conductive approaches. The new approach will provide denser and more powerful computation capabilities, increased bandwidth within and between electronic systems, and improved flexibility and increased

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(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

reliability. Investigate theoretical basis of capacitively coupled interconnects and assess their performance against traditional approaches. Formulate and conduct feasibility proof of principle based on findings.

(U) $14,931 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $8,445 Develop spacecraft microelectronic devices, including radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications. Demonstrate functional elements for general-purpose processor at 500 million instructions per second and digital signal processors at 1 billion operations per second. Develop architectures and design electronics circuits in support of adaptable, self-repairing processors and memories. Demonstrate functional elements of chalcogenide-based field programmable logic and analog microelectronics. Continue to develop hardened by design primitive cell libraries enabling the use of state-of-the-art commercial manufacturing plants for high performance, low-cost electronics. Build MEMS and chalcogenide-based switches supporting multi-switch box applications to smart-wiring manifolds.

(U) $2,827 Continue to develop intelligent satellite system technologies for responsive spacecraft operations, and for satellite control, precision navigation, formation flying, and cluster management technologies for spacecraft constellations. Complete and deliver microsatellite cluster management software and integrate into the distributed architecture test bed in preparation for a flight demonstration of collaborating three microsatellite constellation. Continue development of command and control and navigational capability for high fidelity spacecraft proximity operations with application to counterspace operations. Complete development of automated planning and scheduling software for multiple satellite clusters and the spacecraft and simulation data archiving and storage system. Continue development of guidance, navigation, and control algorithms for a tethered power generation system. Begin command and telemetry simulation development for cluster management and mission operations center testing.

(U) $973 Continue to develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. Continue to develop models for sparse, distributed aperture radio frequency system simulation to support systems engineering and hardware integration and testing for near-term flight test experiments. Continue to develop models of sparse aperture radio frequency distributed signal processing to be validated against flight experiment. Complete mission operations center to support the collaborating three microsatellite constellation flight experiment.

(U) $3,285 Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well 'cold body' targets such as decoys, satellites, and midcourse warheads. Accept delivery, for government characterization, higher

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands) Continued

		operating temperature, mid-wave infrared focal plane arrays (FPA). Complete fabrication and characterize higher operating temperature, mid-wave infrared FPAs. Complete fabrication and characterize first-ever dual band (mid-wave, long-wave) FPAs having an extended long-wave infrared response. Initiate radiation hardness by design development for long wavelength infrared FPAs for space-based passive surveillance applications. Begin investigation of detector interfacing concepts for larger-format, higher capability space hyperspectral imaging systems.
(U)	$1,442	Develop and demonstrate satellite antenna technologies that exploit advanced electronic integration, high density interconnects/packaging and advanced phased array component technologies to create large, lightweight space antennas. Deliver flight-ready multi-beam, wide-bandwidth antenna modules for airborne multi-mode flight experiment. Redesign baseline tile using advanced substrate material to reduce antenna module weight by 25%. Develop and demonstrate 10 milliwatt advanced low power, octave-wide bandwidth, low noise amplifier. Apply Application Specific Integrated Circuit technology to achieve a higher level of integration for the transmit-receive cells, reducing discrete components by 25%. Redesign antenna tile architecture to incorporate next generation miniaturized phased array components to support eight simultaneous beams. Design multi-decade-bandwidth antenna architecture.
(U)	$999	Develop technologies for multi-access laser communications space terminals with reduced weight, power and cost for Transformational Communications Systems. Investigate component integration issues and identify technical challenges for space qualification/flight test of a multi-access laser communications system. Begin designs of space flight system experiment.
(U)	$1,999	Develop satellite payload subsystem technologies to exhibit revolutionary capabilities in operability, responsiveness, and cost-effectiveness. These enabling technologies include on-the-fly programmable, configurable logic and modular, reusable, self-initializing software, as well as technologies that enable rapid satellite integration and minimum time on-orbit satellite checkout.
(U)	$19,970	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0303601F, MILSTAR Satellite Communications System.
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603311F, Ballistic Missile Technology.

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

(U) PE 0603215C, Limited Defense System.
(U) PE 0603218C, Research and Support.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0604609F, Reliability and Maintainability Technology Insertion Program (RAMTIP).
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 3834

COST ($ in Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
3834	Integrated Space Technology Demonstrations	22,823	14,947	20,511	18,633	25,125	27,516	26,543	26,675	Continuing	TBD

(U) A. Mission Description

This project is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an operational environment.

(U) FY 2002 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$551	Completed the Warfighter-1 technology demonstration effort, which was intended to provide an inexpensive space-based hyperspectral imagery system for user validation in a tactical environment. Completed final reports, detailing and evaluating lessons learned from the Warfighter-1 development and commercial leveraging efforts.
(U)	$1,493	Developed autonomous microsatellite (10-100kg) technologies for an integrated, robust, flexible, modular microsatellite technology concept. Developed microsatellite technologies for non-cooperative, autonomous operational concept and mission planning tools.
(U)	$9,973	Designed, developed, integrated, and tested an autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative, resident space object. Performed design reviews and began component/hardware fabrication for an autonomous operations microsatellite. Developed plans for launch vehicle integration and safety analysis.
(U)	$4,066	Developed microsatellite system test scenarios and designed microsatellite hardware-in-the-loop, software simulations, and mission planning/training tools.
(U)	$5,776	Developed scalable booster technologies and a flight vehicle demonstrator for low-cost launch vehicles. Developed the detailed design and fabricated long-lead components for the SR-XM-2 suborbital flight vehicle. Performed post injector design modification developmental test firings and engine qualification firings for the 20,000 lb. thrust flight-weight ablative booster engine for the SR-XM-2.
(U)	$964	Developed technologies for a small, hybrid propulsion module capable of transferring selected Space Shuttle payloads to higher operational orbits after deployment. This orbital maneuvering capability will reduce both launch cost and risk, while enabling payloads to reach optimal orbit. Developed a conceptual design for the propulsion module that meets National Aeronautics and Space Administration safety and performance requirements. Designed, fabricated, and ground-tested critical, high-risk propulsion module components, evaluating both performance and safety aspects.
(U)	$22,823	Total

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(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$1,829	Develop autonomous microsatellite (10-100kg) technologies for an integrated, robust, flexible, modular microsatellite technology concept. Perform mission operations concept trades using hardware-/software-in-the-loop simulations and mission planning tools for non-cooperative proximity operations.
(U)	$8,699	Design, develop, integrate, and test autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative resident space object (RSO). Complete component development and begin system level integration, functional, and environmental test activities in preparation for launch and operations. Perform final launch vehicle safety analysis and ground test and evaluation.
(U)	$1,452	Use microsatellite hardware-in-the-loop and software simulations to perform comprehensive ground testing of the autonomous micro-satellite around a non-cooperative RSO.
(U)	$989	Develop technologies for a small, hybrid propulsion module capable of transferring selected Space Shuttle payloads to higher operational orbits after deployment. Integrate and ground test fire a propulsion module. Test information will be used to assess whether the hybrid technology meets the relevant orbital transfer and Space Shuttle safety requirements.
(U)	$989	Develop an integrated engineering, modeling, simulation, and design tool to support rapid prototyping and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. This tool will enable quick turnaround, advanced space mission analyses that incorporate future military space requirements to determine the impact on system performance and capabilities. Integrate government and commercial design, analysis, and optimization software into a combined systems analysis and design tool set that advances the capability to predict performance benefits and impacts for new technologies on space and launch vehicle systems.
(U)	$989	Develop technologies for small launch vehicles for rapid and affordable deployment of small satellite and Common Aero Vehicle payloads. Conduct trade studies to define a responsive, simple, cost-effective small launch vehicle. Define preliminary system design requirements and develop a mission model, a system concept, and mission and life cycle cost estimates for a small launch vehicle to place military payloads (200 - 2000 lb.) into Low Earth Orbit.
(U)	$14,947	Total

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$3,077	Develop autonomous microsatellite (10-100kg) technologies for an integrated, robust, flexible, modular microsatellite technology concept. Develop and test a laser range finder subsystem. Develop and test the ground control system for real-time planning and flight operations of proximity operations microsatellite. Test autonomous operations software against simulated faults and anomalies.
(U)	$14,357	Design, develop, integrate, and test autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative resident space object. Compete system level integration of microsatellite, complete functional and environmental tests. Integrate microsatellite with launch system and perform functional and environmental tests. Begin integration with launch vehicle.
(U)	$3,077	Integrate ground control system and satellite software simulations. Perform simulated proximity operations missions for mission operations training and for determination of the simulated spacecraft performance and interaction with ground controllers.
(U)	$20,511	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603605F, Advanced Weapons Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4400

COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
4400 Space Systems Protection	5,661	2,732	6,013	3,482	3,515	3,577	3,632	3,682	Continuing	TBD

Note: In FY 2002, efforts were transferred from PE 0603410F, Space Systems Environmental Interactions Technology, into this project in order to align projects within the Air Force Research Laboratory organization. In FY 2003, selected efforts were transferred within this PE from this project into Project 5021 in order to focus on improving survivability of space systems in natural environments.

(U) A. Mission Description

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in potentially hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to radio frequency (RF) and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment.

(U) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $240 Used multi-threat assessment tool to evaluate space-based electro-optical responses to various candidate RF and laser countermeasures. Provides space platform designees a rapid and robust assessment tool for accurate assessment of various countermeasures. Added interface for analyzing RF and laser interaction effects on satellites. Added response models for satellite subsystems, such as communications, power, and inertial measurement units.

(U) $1,932 Developed passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Designed plasma shield experiments to determine effectiveness of filtering RFs to allow only selected frequencies to reach the satellite communications antennas. Initiated evaluations and ground-based demonstrations of visible and near-infrared laser protection techniques in preparation for space demonstrations. Initiated assessments of the impact of satellite self-protection and situational awareness technologies on space systems operations.

(U) $1,348 Developed sensors to specify and forecast conditions in the space environment that degrade the operation of space-based systems. Supported integration, launch, and on-orbit operations of instrumentation to improve space radiation hazard specification and forecasting. Specifying and forecasting hazardous space conditions will improve space system designs and lifetime, and enhance operational capabilities for the warfighter. Initiated integration of plasma sensor for the Communications/Navigation Outage Forecasting System onto payload. Prepared to launch all-sky camera to detect solar disturbances one to three days prior to Earth impact and completed initial on-orbit validation. Completed integration of relativistic detector for mission to map the dynamic radiation belts and quantify hazards to space systems.

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U)	$932	Conducted collaborative experiments and developed tools to improve the survivability of advanced spacecraft power, communications, and surveillance systems. Developed preliminary design of second-generation miniaturized charge control system to autonomously protect satellites from harsh charging environments. Initiated conceptual design of an experiment to quantify the effects of space plasma on tethered power generation systems. Developed interface between dynamic space plasma and meteor specification and forecast models and web-based spacecraft charging design tool.
(U)	$1,209	Developed technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards and to mitigate the effect of the space environment on Department of Defense space systems. Space environment hazard warnings minimize loss of space assets due to component and system level failures and, when widely deployed, provide global situational awareness of hazards. Control of spacecraft charging levels and high-energy radiation effects will significantly improve space system reliability and availability and reduce operational costs. Completed validation of compact environment anomaly sensor for geosynchronous and highly elliptic orbits and transition to operational use. Developed detailed design for miniaturized space environment distributed anomaly resolution sensor for on-orbit detection of space particle, chemical, and impact hazards. Completed ground tests of particle enhancement and depletion technologies and began conceptual design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.
(U)	$5,661	Total

(U) FY 2003 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$422	Use multi-threat assessment tool to assess space-based electro-optical responses to various candidate radio frequency and laser countermeasures. Begin verification and accreditation of weapons effects satellite assessment tools, complete documentation for users, and continue to develop additional tools for satellite subsystems, such as processor assemblies, optical trains, and satellite buses.
(U)	$1,549	Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Design plasma shield to selectively filter the radio frequencies reaching the satellite communications antennas; prepare for conceptual space demonstration. Conduct design and trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Investigate technologies to support automatic wartime deployment of protection technologies for satellites whose peacetime mission would be compromised by on-board protection systems. Investigate electronic protection techniques for optical sensors and systems.
(U)	$761	Develop and demonstrate visible and near-infrared laser protection technologies. Continue evaluations and ground-based demonstrations of visible and near-infrared laser protection techniques in preparation for space demonstrations.
(U)	$2,732	Total

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$1,877	Use multi-threat assessment tool to assess space-based electro-optical, communication, and other responses to various candidate radio frequency and laser countermeasures and directed energy threats and techniques to mitigate these thrusts. Use existing satellite subsystem response data to continue verification of single satellite models of weapons effects for processor assemblies, optical trains, and satellite buses. Integrate single satellite models into satellite constellation analysis tool. Assess electro-optical designs of planned space systems for radio frequency and laser susceptibility and potential mitigation techniques. Assess directed energy threat susceptibility and potential for mitigation techniques for key satellite subsystems, such as communications.
(U)	$2,755	Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Complete plasma shield design and define potential system applications. Complete design trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Investigate mitigation technologies such as deployable shields and triggered automatic gain control for radio frequency threats.
(U)	$1,381	Develop and demonstrate visible and near-infrared laser protection technologies. Develop adaptive signal processing techniques to mitigate laser interference effects on readout electronics and focal plane array sensor subsystem components. Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Develop an optical sensor subsystem threat mitigation techniques using solutions such as acousto-optical switches to deflect incoming laser energy from the focal plane array.
(U)	$6,013	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603605F, Advanced Weapons Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2003
BUDGET ACTIVITY 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology
	PROJECT 4400

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4938

COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
4938 Space Developmental Planning	4,980	0	0	0	0	0	0	0	0	TBD

(U) A. Mission Description

This project funds the developmental planning for military space technologies. The project focuses on the Pre-Milestone I systems engineering and integration, studies and analysis, concept development, and architecture efforts needed to transition technology into promising space concepts, capabilities, and systems. Of particular importance is the analysis work performed to link military technologies to mission needs through the strategy-to-task methodology of the Air Force modernization process. Another key aspect of this project is the defining, refining, and demonstrating of select space concepts offering significant future military utility to the warfighter, especially those that integrate existing or planned capabilities from across the entire national space community. A key component of this program is the demonstration of future space capabilities for wargames, exercises, experiments, and demonstrations. This project also funds Modeling and Simulation tools and related infrastructure development that are necessary to conduct studies and provide analysis on future space concepts and capabilities.

(U) FY 2002 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$1,015	Conduct concept development on promising space concepts. Products include comprehensive, high-level, integrated and scientifically sound design solutions across the myriad of space disciplines. Functions include space concept design, cost engineering, and measure of performance/ effectiveness inputs to Air Force Space Command's Optimizer of Utility Toolkit model.
(U)	$1,186	Conduct in-depth studies and analysis to assess and quantify the military worth of select space concepts. Provides decision-aiding analysis on space capabilities 15 to 25 years into the future.
(U)	$1,027	Conduct continuing system-of-systems engineering and integration for promising space concepts. Defines and refines concepts offering significant military utility to the warfighter, focusing on the integration of air and space capabilities. Supports systems security protection measures for current and planned capabilities across the national space community.
(U)	$963	Develop capability to demonstrate relationship, impacts, and effects of space assets on the military campaign in Air Force campaign and theater simulation models/tools to include processing and presentation hardware and software, model database upgrades, and networking and leased communications lines to support virtual and distributed simulation capability.
(U)	$512	Develop and integrate architectural concepts addressing technology transition opportunities against space mission deficiencies and needs.
(U)	$277	Decrease the time to transition innovative space technology to the warfighter by demonstrating promising future space capabilities in exercises, wargames, experiments, and demonstrations.
(U)	$4,980	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2003
BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 4938

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$0	No Activity
(U)	$0	Total

(U) FY 2004 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$0	No Activity
(U)	$0	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Not Applicable.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 5021

COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
5021 Space Systems Survivability	0	3,936	4,171	4,788	4,867	4,992	5,068	5,139	Continuing	TBD

Note: In FY 2003, efforts were transferred within this PE from Project 4400 into this project, in order to focus on improving survivability of space systems in natural environments.

(U) A. Mission Description

This project develops and demonstrates technologies to improve space system survivability and reliability of current and future Department of Defense space systems that must continue operation despite natural space hazards. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.

(U) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $0 No Activity

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $962 Develop sensors to specify and forecast conditions in the space environment that degrade the operation of space-based systems. Support integration, launch, and on-orbit operations of instrumentation to provide improved space radiation hazard specification and forecasting. Launch, complete initial on-orbit checkout, and commence validation of solar disturbances forecasting algorithms using space-based all-sky camera. Begin joint agency collaboration to fly relativistic electron and proton detector and demonstrate ability to perform on-orbit mapping of the dynamic radiation belts to quantify hazards to space systems. Begin conceptual design of advanced all-sky, white light camera for operational space weather forecasting system.

(U) $981 Conduct collaborative experiments and develop tools to improve the survivability of advanced spacecraft power, communications, and surveillance systems. Complete design and began fabrication design of second-generation miniaturized charge control system. Complete conceptual design of an experiment to quantify the effects of space plasma on tethered power generation systems and determined feasibility of a space flight test to demonstrate on-orbit electrical power generation. Complete interface between dynamic space plasma and meteor models and web-based spacecraft design tools.

(U) $1,993 Develop technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards and to mitigate the effect of the space environment on Department of Defense space systems. Develop data assimilation techniques to produce improved dynamic radiation belt

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2003
BUDGET ACTIVITY 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 5021

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

models using data from multiple compact environment anomaly sensors. Begin fabrication of miniaturized space environment distributed anomaly resolution sensor for on-orbit detection of space particle, chemical, and impact hazards. Develop detailed design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.

(U) $3,936 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $1,043 Develop sensors to specify and forecast conditions in the space environment that degrade the operation of satellite, communication, navigation, and surveillance systems. Support integration, launch, validation, and operation of instrumentation to provide improved space radiation and ionospheric hazard specification and forecasting. Continue validation of solar disturbance forecast algorithms derived from all-sky heliospheric imager. Develop instrument and data plan for joint-agency mission to map the high-intensity region of the radiation belt that limits choices for spacecraft orbits. Expand space weather forecasting system conceptual design to include interplanetary in situ plasma and magnetic field sensors in addition to miniaturized white-light camera. Begin development of micro- and nano-technology based concepts to miniaturize energetic particle, neutral density, and low energy plasma sensors needed to characterize space weather hazards.

(U) $1,461 Conduct collaborative space and laboratory experiments and develop hardware and software tools to improve the survivability of spacecraft power, communications, navigation, and surveillance systems. Complete model testing of miniaturized charge control system and begin construction of space experiment for the hazardous geosynchronous environment. Begin development of a space experiment to validate on-orbit electrical power generation and particle scattering capabilities of space tether. Initiate development of a suite of comprehensive spacecraft environment effect tools for operational use by integrating full range of environment specification and forecast models with spacecraft hazard, trans-ionsopheric link degradation, and satellite drag specification tools. Begin design of active antenna and passive detection hardware for space experiment to demonstrate techniques of lowering radiation belt intensities to protect satellites.

(U) $1,667 Develop technology to warn of spacecraft radiation, charging, and kinetic impact hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems. Complete first-generation data assimilation models specifying global radiation levels based on data from multiple compact environment anomaly sensors. Continue development of space hazard detector components of distributed anomaly resolution sensor and finalize space hardware design. Continue detailed design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.

(U) $4,171 Total

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BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology
PROJECT: 5021	

(U) B. Project Change Summary

Not Applicable.

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

(U) PE 0602601F, Spacecraft Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 5083

COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
5083 Ballistic Missiles Technology	0	0	6,860	6,877	5,831	4,077	4,139	4,197	Continuing	TBD

Note: This is a new project, but not a new start. The efforts are part of ongoing work performed in PE 0603311F, Ballistic Missile Technology, and are put in this PE to align efforts within the Air Force Research Laboratory organization.

(U) A. Mission Description

This project develops, integrates, and demonstrates advanced technologies for sustainment and modernization of strategic ballistic missiles. The project focuses on developing robust, low maintenance inertial navigation instruments to sustain current ballistic missile systems as well as provide new, small, low-powered, high precision instrumentation for next generation missile systems.

(U) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $0 No Activity

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $0 No Activity

(U) $0 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $2,940 Develop, integrate, and demonstrate advanced navigation instrumentation applied to emerging vehicle designs and other technologies that sustain current strategic missile systems. Provide critical missile technologies for future systems. Integrate the advanced gyro and accelerometer systems into a breadboard demonstration of a reduced size and reduced power navigation instrument system that approaches or exceeds ballistic missile mission goals.

(U) $2,940 Develop, integrate, and demonstrate advanced navigation technologies with new vehicle designs to provide robust, flexible, lower cost solutions for sustaining current strategic missile systems. Provide the technological base for future systems. Integrate advanced thermal materials into long glide vehicles to provide greater controllability and selective targeting. Demonstrate lower cost, robust leading edge, and control surface materials in a test flight to validate improved properties for future vehicle designs. Demonstrate that robust onboard navigation instruments and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2003
BUDGET ACTIVITY 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology
PROJECT 5083	

(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands) Continued

range safety devices can withstand loads greater than 100G in all axes in laboratory tests.

(U) $980 Investigate advanced, novel concepts critical to advance navigation instrumentation in the next generation of ballistic missiles. Evaluate the most promising technologies. Fabricate and demonstrate an enhanced navigation device that uses the established design and performance goals. Validate the performance goals of the demonstrated technology.

(U) $6,860 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) PE 0601102F, Defense Research Sciences.
(U) PE 0602601F, Space Technology.
(U) PE 0603311F, Ballistic Missile Technology.
(U) PE 0603601F, Conventional Weapons Technology.
(U) PE 0603851F, Intercontinental Ballistic Missile-Dem/Val.
(U) PE 0604851F, Intercontinental Ballistic Missile-EMD.
(U) PE 0605860F, Rocket System Launch Program-Space.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: February 2003

BUDGET ACTIVITY: 03 - Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 682J

COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
682J Spacecraft Vehicles	8,022	18,338	14,589	10,393	10,486	13,586	13,737	15,799	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates compact, low-cost, spacecraft and launch vehicle power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation activities focus on lightweight, low-cost, low-volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen and sodium sulfur spacecraft batteries and flywheel energy storage systems for extended (five to ten year) satellite missions. The project's power distribution efforts focus on producing lightweight, high-efficiency, standardized power busses for use on future space programs.

(U) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $1,862 Developed and evaluated performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules. Ground demonstrated deployment and operation of large, free-flying, lightweight, flexible, radiation resistant, array of thin film solar cells. Integrated 32% efficient multi-junction solar cells and 10% efficient thin film solar cells into large modules. Began integration into full arrays.

(U) $769 Developed space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. Ground demonstrated integrated attitude control and energy storage system. Evaluated feasibility of microflywheel technology based on conceptual design; fabricated and tested microflywheel components.

(U) $1,269 Developed technologies for long life, efficient, low vibration, lightweight mechanical cryocoolers for space applications. Characterized performance of 10K model cryocooler. Developed and delivered high efficiency multi-stage cryocooler with radiation-hardened control electronics. Began development of high capacity multi-stage 10K cryocooler system for advanced space surveillance and tracking sensor.

(U) $1,219 Developed composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Developed spacecraft to demonstrate multifunctional structures technologies. Flight demonstrated grid stiffened shrouds and thermal protection structures. Completed development of inflatable support structures. Continued ground test of multifunctional structures. Initiated integration of power and thermal technologies into multifunctional structures. Ground tested full-scale secondary payload adapter structure for an expendable launch vehicle.

(U) $2,903 Developed technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems. Developed launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Ground demonstrated smart passive payload isolation

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BUDGET ACTIVITY 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 682J

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

systems. Designed operational active acoustic attenuation system. Developed and ground demonstrated passive acoustic attenuation system. Integrated low shock separation devices and whole spacecraft vibration isolation systems. Developed autonomous satellite docking and deployment mechanisms. Developed modular vibration-isolating spacecraft transport container.

(U) $8,022 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $1,790 Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules. Flight demonstrate deployment and operation of large, free-flying, lightweight, flexible, radiation resistant, array of thin film solar cells. Continue integration of 32% efficient multi-junction solar cells and 10% efficient thin film solar cells into full arrays.

(U) $903 Develop innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. Flight demonstrate integrated attitude control and energy storage system. Develop microflywheel demonstration system.

(U) $1,354 Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications. Continue development of high capacity multi-stage cryocooler technologies to meet the needs of high resolution, space-based infrared surveillance and tracking sensors with larger focal planes and optics.

(U) $1,293 Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Develop spacecraft to demonstrate multifunctional structures technologies. Complete evaluation of operational grid stiffened structures. Fabricate multifunctional spacecraft bus for small satellites. Complete ground test of full-scale Evolved Expendable Launch Vehicle secondary payload adapter structure.

(U) $3,598 Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems. Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Flight demonstrate smart passive payload isolation systems. Ground demonstrate operational active acoustic attenuation system. Flight demonstrate passive acoustic attenuation system. Integrate low shock separation devices into multiple payload adapter. Ground demonstrate smart docking and deployment mechanisms. Complete development of modular vibration-isolating spacecraft transport container.

(U) $6,927 Develop amorphous silicon solar cells for higher performance, next-generation flexible, thin film solar arrays. These thin film arrays will be 3 to 5 times lighter, cost 5 times less, require 5 times less stowed volume, and be more radiation resistant than state-of-the-art rigid panel arrays.

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BUDGET ACTIVITY 03 - Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 682J

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

Increase specific power (Watts/kg) of amorphous silicon solar cells by increasing cell efficiency and developing processes to deposit solar cells on lightweight polymer substrates. Develop monolithic integration technology for the low-cost interconnection of thin film solar cells.

(U) $2,473 Develop a new generation of advanced composite materials to support improved manufacturing techniques for low-cost, lightweight spacecraft adapter and fairing designs. Composite materials decrease primary structure mass and cost by 40% and decrease manufacturing lead times by 50% over conventional metallic structures. Assess material properties and identify suitable epoxy and fiber materials for spacecraft adapter and fairing applications. Develop procedures to flight qualify suitable materials and confirm unique manufacturing processes. Fabricate and test candidate materials identified as viable candidates.

(U) $18,338 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $2,211 Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules. Demonstrate integration methods for thin-film solar cells on polymer substrates into full arrays. Integrate 32% efficient reduced-mass wafers into full arrays.

(U) $1,359 Develop technologies for long life, efficient, low vibration, lightweight mechanical cryocoolers for space applications. Begin protoflight development of high capacity, multi-stage, low temperature cryocooler system. Develop and characterize performance of second generation engineering design model high capacity 10 Kelvin cryocooler for advanced space surveillance and tracking sensor. Begin development of component cryocooler technologies for regenerative and recuperative cycle devices to transition enabling technology to protoflight cryocooler designs.

(U) $3,933 Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Continue to develop spacecraft to demonstrate multifunctional structures technologies. Complete fabrication of multifunctional spacecraft bus components for small satellites. Flight qualify full-scale Evolved Expendable Launch Vehicle secondary payload adapter. Begin design and characterization of linerless composite cryogenic tanks. Initiate development of large deployable optics structures using nanotechnology-enhanced materials.

(U) $7,086 Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems. Continue to develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Flight demonstrate operational active acoustic attenuation systems. Flight demonstrate low-shock multiple payload adapter technologies. Build deployment and isolation mechanisms for large

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands) Continued

free-flying solar array and integrate with thin-film solar cell components. Design flight hardware to demonstrate smart docking and deployment mechanisms. Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Develop micro-electro-mechanical attitude control components.

(U) $14,589 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603218C, Research and Support.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.