ARMY RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2005

BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
0602303A - MISSILE TECHNOLOGY

	COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
	Total Program Element (PE) Cost	89332	82781	62524	65801	55487	44711	40017	38322
214	MISSILE TECHNOLOGY	37320	34104	44824	53869	55487	44711	40017	38322
223	AERO-PROPULSION TECHNOLOGY	24446	28280	0	0	0	0	0	0
340	SWORD	2922	0	0	0	0	0	0	0
G02	ARMY HYPERSONICS APPLIED RESEARCH	7891	8749	17700	11932	0	0	0	0
G04	AIR DEFENSE TECHNOLOGIES (CA)	4481	1343	0	0	0	0	0	0
G05	MISSILE TECHNOLOGY INITIATIVES (CA)	3312	3595	0	0	0	0	0	0
G06	UNMANNED SYSTEMS TECHNOLOGIES (CA)	8960	6710	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: This applied research Program Element (PE) researches and investigates advanced technologies for missiles, rockets, and launch systems for use in the Future Force and, where feasible, exploits opportunities to enhance Current Force capabilities. The overall objectives of the PE are to increase the survivability of launch systems; provide greater lethality and effectiveness under adverse battlefield conditions; increase kill probabilities against diverse targets; and provide powerful new simulation and virtual prototyping analysis tools. A major cross-cutting theme is developing missile technology that is smaller, lighter weight and more affordable. Major technology areas include missile guidance systems, air defense systems, multi-spectral seekers, high fidelity simulations, missile aerodynamics and structures, missile propulsion including research to help solve the insensitive munitions requirements for missiles, hypersonic missile efforts, and the maturation of a common high-gravitational force (high-g), low cost, Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU). The goal of the high-g MEMS IMU program is to design and develop reliable precision guidance for missiles and guns at a significantly lower cost than current systems. A second objective of the high-g, low cost MEMS program is a deeply-integrated guidance and navigation unit (DIGNU). The DIGNU effort will develop and demostrate an IMU or Inertial Sensor Assembly (ISA) with the same 1.0 deg/hr, and greater than 20,000 g's survivability requirements of the initial program with an additional "deeply-integrated" or "deeply-coupled" GPS military receiver incorporating a single microprocessor architecture and integrated hardware within a Selective Availability and Anti-Spoofing Module (SAASM) and software anti-jam (AJ) capability. The deliverable DIGNUs will be less than 4 cubic inches and will use a single microprocessor to absorb the mission computer processing functions found in 90% of all DoD guided munitions and missiles.The high-g MEMS IMU program is a joint project between the Armament Research, Development and Engineering Center, and Aviation and Missile Research, Development and Engineering Center. The MEMS IMU effort is funded by a combination of applied research funding, in this PE, and manufacturing technology funding, in PE 0708045A (Industrial Preparedness). Another major thrust in the PE is to deliver small, light weight force protection technology that is needed to cost effectively counter the rocket, artillery and mortar (RAM) threats to the Current

and Future Force. The Extended Area Protection and Survivability (EAPS) program is an effort to develop the interceptor and fire control technology necessary to provide the Future Combat Systems Unit of Action (UA) an air defense capability, particularly against Rockets, Artillery, and Mortars (RAM). The Army Hypersonics Applied Research program explores and matures the critical technologies required for expendable hypersonic missiles and will advance the national goals in hypersonic weapon maturation and access to space. This program element contains no duplication with any effort within the Military Departments. The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed at the Aviation & Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

B. Program Change Summary	FY 2005	FY 2006	FY 2007
Previous President's Budget (FY 2005)	51993	59900	46443
Current Budget (FY 2006/2007 PB)	82781	62524	65801
Total Adjustments	30788	2624	19358
Net of Program/Database Changes			
Congressional Program Reductions	-8923		
Congressional Rescissions			
Congressional Increases	41650		
Reprogrammings			
SBIR/STTR Transfer	-1939		
Adjustments to Budget Years		2624	19358

Change Summary Explanation:
FY07 - Increased funding ($19358) provides active protection against Unmanned Vehicles, Missiles and RAM.

Eight FY05 Congressional Adds totaling $41650 were added to this PE.

FY05 Congressional Adds with no R-2A:
($1438) Army Flight Test, Project 223: The purpose of this one year Congressional add is to fund research on Army flight tests. No additional funding is required to complete this project.

($959) Agile MEMS/Nano-Technology for Wireless Security and Defense Applications, Project G05: This one year Congressional add is to fund research on nano-technology for wireless security and defense. No additional funding is required to complete this project.

($14386) Hypersonic Army Missile Technology, Project 223: The purpose of this one year Congressional add is to advance distributed processing for hypersonic computational fluid dynamics. No additional funding is required to complete this project.

($2397) LENS X Hypervelocity Ground Testing, Project 223: The purpose of this one year Congressional add is to fund research on LENS X hypervelocity ground testing. No additional funding is required to complete this project.

($1343) Maneuver Air Defense System (MADS), Project G04: The purpose of this one year Congressional add is to perform force-level trade studies and mission requirements analysis, establish a best technical approach and begin demonstrating critical technologies in support of the Extended Area Air Defense System (EAADS). No additional funding is required to complete this project.

($10069) MARIAH II Hypersonic Wind Tunnel Development Program, Project 223: The purpose of this one year Congressional add is to develop component technologies required for pilot scale test facility to produce actual flight conditions for timeframes orders of magnitude greater than currently available. No additional funding is required to complete this project.

($2637) Microelectromechanical Systems (MEMS) and Nanotechnology, Project G05: This one year Congressional add is to fund research on microelectromechanical systems and nanotechnology. No additional funding is required to complete this project.

($6712) Unmanned Systems Initiative (USI) at the Aviation and Missile Research Development and Engineering Center (AMRDEC), Project G06: The purpose of this one year Congressional add is to focus on immediate efforts to support the development of unmanned systems through interoperability and the delivery of lethal payloads to better position the military for situations in homeland defense and urban scenarios. No additional funding is required to complete this project.

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602303A - MISSILE TECHNOLOGY**	**214**

COST (In Thousands)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
214 MISSILE TECHNOLOGY	37320	34104	44824	53869	55487	44711	40017	38322

A. Mission Description and Budget Item Justification: This project focuses on missile and rocket technologies that support lightweight, highly lethal weapons concepts with greatly reduced logistics requirements for the Future Combat Systems (FCS) and Future Force and, where feasible, exploits opportunities to enhance Current Force capabilities. Major technology areas investigated are missile guidance systems, air defense target acquisition systems; multi-spectral seekers; high fidelity simulations; missile aerodynamics and structures; and missile propulsion including research to help solve the insensitive munitions requirements. A theme embedded in the efforts in this project is developing Smaller, Lighter weight, and Cheaper (SLC) missile technology to reduce the cost and logistics burden of precision munitions. Research objectives are to enhance the survivability of launch systems, provide greater effectiveness under adverse battlefield conditions, increase kill probabilities against diverse targets, and provide powerful new simulation and virtual prototyping analysis tools. The major effort in this project is the high-gravitational force (high-g), low cost Micro Electro-Mechanical Systems (MEMS) Inertial Measurement Unit (IMU) program. The Army is the Service lead in the investigation of low cost MEMS IMUs capable of supporting precision guidance requirements of DoD's missile and gun launched precision munitions programs. The MEMS IMU effort is funded by a combination of applied research funding, in this PE, and manufacturing technology funding, in PE 0708045A (Industrial Preparedness.) The High-g MEMS IMU will also be transitioned to Excalibur, Extended Range Gun Munition (ERGM), and 120-mm Line-of-Sight / Beyond Line-of-Sight (LOS / BLOS) Advanced Technology Demonstration (ATD). This is a joint program with the Armament Research, Development and Engineering at Picatinny Arsenal. A second objective of the high-g, low cost MEMS program is to develop a deeply-integrated guidance and navigation unit (DIGNU). The DIGNU effort will develop and demonstrate an IMU or Inertial Sensor Assembly (ISA) with the same 1.0 deg/hr, and greater than 20,000 gs survivability requirements of the initial program with an additional "deeply-integrated" or "deeply-coupled" GPS military receiver incorporating a single microprocessor architecture and integrated hardware within a Selective Availability and Anti-Spoofing Module (SAASM) and software anti-jam (AJ) capability. Another effort, Guidance Electronics Miniaturization and Structronics (GEMS), is working to significantly reduce the size, weight, and cost of guidance electronics. GEMS incorporates commercial electronics miniaturization (die stacking, wafer thinning, etc.) and seeks to apply structronics technologies to the electronics substrate such that the substrate becomes the chassis, wiring harness, and printed wiring board for the electronics. Each of these elements will be incorporated into a series of Integrated Guidance Units (IGU's) which will consist of a guidance computer and an inertial measurement unit. Also included in this project is an effort to develop the technology necessary to provide the Unit of Action (UA) an air defense capability, particularly against rockets, artillery, and mortars (RAM). The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed at the Aviation & Missile Research, Development, and Engineering Center, Redstone Arsenal, AL.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- High-G Microelectromechanical Systems (MEMS) Inertial Measurement Unit (IMU) - High-G MEMS IMU - In FY04, matured and live-fire tested IMUs to meet the parameters: Gyro Bias < than 20 degrees/hour, Vol. less than 4 cubic inches, Acceleration Bias less than 4 milli-g's, Gun-Hardened to 20,000g; performed electronic miniaturization necessary to fit on the two-inch diameter electronics board; redesigned the vibration isolation system for the modified mass. In FY05, perform test and evaluation on the Phase 2 IMUs. The Phase 2 IMUs will be tested to meet the following parameters: gyro bias less than 20 deg/hr, volume less than 4 cubic inches, accel. bias less than 4 millig, and gun-hardened to 20,000 gs. Laboratory characterization tests will be performed on software selectable spin rates: a 4 Hz roll rate version required for missiles and a 20 Hz roll-rate version required for munitions; perform additional electronics miniaturization to reduce the volume of the IMU to four cubic inches; improve digital IMU electronics design; and perform missile flight tests with the Phase 2 IMUs. In FY06, will use advanced die packaging techniques to support miniaturization of IMUs to less than 4 cubic inches volume; incorporate out-of-plane gyros and in-plane accelerometers or other novel sensor packaging strategies to get to smallest possible IMU volume; develop die attach methods, develop a new design process for Application-Specific integrated Circuits (ASICs), design a new internal isolator and integrate the gyro, accelerometer, and microprocessor functions in a single IMU to improve signal isolation. Perform test and evaluation on the early Phase 3 IMUs. In addition, the vibration isolation system will be redesigned for the modified mass and diameter. The 20,000 g launch challenge will require board stiffness redesign with emphasis on high yield and low cost for the IMU. In FY07, perform test and evaluation on the final Phase 3 IMU deliverables.	7603	10000	14600	5180

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- High-G Microelectromechanical Systems (MEMS) Deeply Integrated Guidance and Navigation Unit (DIGNU). In FY05, perform test and evaluation of the DIGNU1s developed under FY04 Congressional add. The DIGNU1s will be tested to meet the following parameters: gyro bias less than 75 deg/hr, volume less than 28 cubic inches, accel. Bias less than 9 millig and gun-hardened to 10,000 gs. Field tests will be performed on the DIGNU1s to test GPS/INS performance. In FY06, will mature the deep integration algorithms. Performance issues identified during live field tests will be addressed in redesign to improve performance. Missile flight tests will be supported with both Phase 2 DIGNUs and will also perform laboratory test and evaluation of the DIGNU2s. The DIGNU2s will be tested to meet the following parameters: gyro bias less than 20 deg/hr, volume less than 12 cubic inches, accel. bias less than 4 millig and gun-hardened to 15,500 gs. Will perform field tests on the DIGNU2 to determine GPS/INS/anti-jam capability; mature and further miniaturize internal anti-jam capability; test application platform interface software and finalize commonality requirements between the units from the two contractors; test G-operational requirements and expanded temperature range requirements for the DIGNU2 products. In FY07, will perform field tests and laboratory characterization on DIGNU3s including anti-jam capability; further miniaturize the anti-jam module, modify and retest any issues identified during testing of DIGNU2 and perform test and evaluation on the DIGNU3s. The DIGNU3s will be tested to meet the following parameters: gyro bias less than 1 deg/hr, volume less than 5 cubic inches, accel. bias less than 1 millig, greater than 90 db J/S and gun-hardened to 20,000 gs.	0	4000	5400	4820
- High-g MEMS/IMU Technology Development Acceleration – In FY04, this one-year Congressional add developed and substantiated an IMU "deeply integrated" with a Selective Availability Anti-Spoofing Module (SAASM) Global Positioning Systems (GPS) military receiver incorporating a single microprocessor architecture and incorporating integrated hardware and software anti-jam capability. Additionally, this add made manufacturing and process improvements to reduce cost, and reduce process, manufacturing, and testing variability to facilitate the production of the final MEMS IMU and deeply integrated GPS navigational unit design. No additional funding is required.	8189	0	0	0
- Low Cost Guidance Navigational Unit - This one-year Congressional add enhanced an existing guidance navigations unit design that will lower cost and power. In addition, anti-jam technology was prototyped, tested, and evaluated. No additional funding is required.	940	0	0	0

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Smaller, Lighter, Cheaper (SLC) Tactical Missiles. - SLC focuses technology to reduce the cost and logistics burden of precision munitions. Through innovative application of technology in concert with more efficient production and integration processes, this program's goal is to reduce the cost per kill of precision guided missiles. In FY05, perform assessment of current and future precision guided missile capabilities and gaps. Match innovative component technology and/or new weapon concepts to both reduce the cost per kill for precision weapons and, where needed, to fill gaps with a new capability. Reach consensus within the Army on key areas for focus, gaps to be filled, and the appropriate balance between cost and performance. Initiate requests for information from industry on identified topics. In FY06, initiate efforts with industry to design identified components for reduced cost per kill (e.g. seekers, warheads, guidance electronics). Construct simulation modules of each subsystem to facilitate design tradeoffs and verification. Where feasible, demonstrate the tradeoffs between cost and performance in force-on-force simulations. Address manufacturability and produceability issues from the start of design. In FY07, begin testing of subsystem componentry with laboratory testing, captive-carry, and/or warhead arena testing; prepare plans for full subsystem testing; continue to refine subsystem simulation modules which can be incorporated into weapon system simulations for evaluation of new subsystems on various system performances. Update cost models to enable production cost prediction of new designs.	0	500	1500	5900

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Missile Guidance Systems and Seeker Technology - In FY04, performed laboratory tests of infrared counter-countermeasures (CCM) guidance algorithms, devised hardening techniques and algorithms for infrared (IR) seekers to defeat laser CCM; and enhanced MEMS angular rate sensors with vibration feedback for signal. Validated electrical design for guidance computer and mechanical/electrical interface requirements for prototype Integrated Guidance Units (IGU's). Conducted feasibility analyses electronics substrate technologies capable of reducing electronics size, weight, and cost and developed technology roadmap. In FY05, mature controlled arrays of MEMS sensors to provide full dynamic performance ranges, design geometry transformations for rapid retraining of automatic target recognition (ATR) systems, evaluate IR CCM guidance algorithms in a seeker; mature concepts for advanced uncooled IR seeker and sensor hardware; design, mature, and test advanced optics, signal processing, guidance and control techniques and conduct captive carry tests of prototype uncooled seeker. Build a prototype IGU based on proven design. In FY06, will integrate uncooled IR prototype hardware with advanced guidance and control signal processing techniques; will demonstrate RF and optical phase shifters for phased arrays for tactical seekers via laboratory tests. Will perform lab test of damaging laser IRCM threats optical components. Will spiral in stackable substrates and chip scale packaging into the Block 1 IGU. Build and test and compare to baseline IGU design. In FY07, will evaluate uncooled IR concepts and demonstrate prototype configurations, fabricate and test a passive phased sub-array from optical phase shifters and initiate transition of the technology. Will integrate damaging IRCM algorithms and optics in a seeker and perform hardware-in-the-loop testing. Will spiral in die stacking and die thinning into the Block 2 IGU and build, test and compare to baseline IGU design.	7670	9640	10859	13988

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- High Fidelity System Level Simulations and Aerodynamics - The use of advanced simulation and aerodynamics tools promises to reduce size, lighten the weight, and reduce cost in missile systems. In FY04, completed the design for a method of rapid IR passive signature prediction using the Multi-Service Electro-optics Signature (MuSES) code and investigated techniques for modeling target signatures as perceived by Laser Detection and Ranging (LADAR) sensors and S-band radar; characterized supersonic/hypersonic aerodynamic missile controls and power-on base drag; investigated NLOS-LS missile geometry and thrust level prediction methodologies. In FY05, will develop and extend the techniques for modeling target signatures and backgrounds as perceived by LADAR sensors; will complete initial software design for real-time improved control of simulation facilities. Will characterize aerodynamics for non-cylindrical and non-typical missile configurations. Implement new power-on base drag methods in simulation. In FY06, will apply LADAR target signature modeling to specific targets and backgrounds; will complete the design of real-time simulation control software. Will extend aerodynamic predictive techniques by validation with detailed measurements. In FY07, will integrate LADAR, passive IR and visible scene generation techniques on personal computer (PC) hardware; will integrate real-time simulation facility software control to all types of facilities. Will refine aerodynamic prediction methods to maximize benefits from advances in computational power and capabilities. Investigate novel aerodynamic control methods unique to smaller, lighter, more affordable missiles.	2030	2710	3280	4191

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Smart, Stealthy, Smokeless Missile Propulsion and Smart Structures and Enhanced Lethality – In FY04, completed deep throttling booster design and fabricated hardware, conducted functional demonstration of critical components, and began Computational Fluid Dynamics (CFD) model validation. Completed MOUT wall perforation testing and analysis. Demonstrated increased warhead effectiveness in MOUT room structure through use of Metal Augmented Charge (MAC) fill sleeve. Demonstrated controlled fragmentation of the Multi-Purpose Warhead design without degradation to the shaped charge performance. In FY05, complete design, fabricate and demonstrate self-regulating spring assembly or squib actuation in variable area nozzle (VAN) brassboard hardware. Perform tandem warhead integration and performance testing of advanced compact shaped charge with fragmenting body design. Testing warhead Insensitive Munitions design features and additional thermobaric fills. Investigate various fragmentation methods, materials and penetration studies against various classes of targets. Develop Lethality Design Tool Set to characterize system effectiveness against various targets. In FY06, will design, fabricate and static test integrated spring assembly actuator and VAN concept in a system configuration. Will mature integration of compact shaped charge warhead with enhanced fragmentation design features into a tandem system concept. Demonstrate the addition of thermobaric explosive to enhanced lethality of warhead sub-system. In FY07, will complete testing of VAN and update design concepts. Complete subsystem integration test in order to demonstrate projected increase in performance and decrease in sensitivity of the motor. Will demonstrate a combined effects compact warhead integrated into a tandem warhead missile system against a target set. Investigate the integration of scalable warhead concepts in missile systems.	3270	4154	5085	6490
- Insensitive Munitions Research - In FY04 initiated a focused insensitive munitions (IM) research effort on meeting the IM requirements for missiles and conducted formulation studies with less sensitive propulsion chemical formulations. In FY05 complete formulation research and identify controlled motor case venting techniques and candidate materials for lightweight barriers. In FY06 will conduct ballistic/aging studies on new less shock sensitive minimum smoke formulations and new formulations; and will evaluate lightweight barrier concepts, demonstrate motor case venting concept. In FY07, will evaluate existing and new energetic ingredients for insensitive munition beneficial characteristics; conduct formulations studies for emerging oxidizers, thermal additives, and nitramine replacements; and apply emerging materials/concepts to canister/case design.	994	1100	1100	1300

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Defense Against Rockets, Artillery and Mortars (RAM) - Inteceptor Development. - In FY04, performed interceptor concept exploration and identified critical supporting component technologies. In FY05, mature interceptor concepts, establish interceptor best technical approach(es), and develop a draft interceptor specification. In FY06, will begin the design and development critical supporting component interceptor technologies, including lethal mechanism, propulsion and low cost guidance and control mechanisms. In FY07, will complete the component fabrication and bench and field-testing of critical lethality, propulsion, and guidance and control technologies.	1000	1000	1800	6500
- Defense Against Rockets, Artillery and Mortars (RAM) - Fire Control and Systems Architecture - Investigates fire control components and the integration of the fire control and interceptor technologies into a robust system architecture. In FY04, performed fire control and systems architecture concept exploration and identified critical supporting component technologies. In FY05, mature fire control sensor, acquisition and tracking concepts; establish the best technical approach(es); develop a draft fire control specification; develop draft system architectures integrating the fire control and interceptor technologies; and demonstrate the operational utility of the system architectures through constructive and force-on-force simulations. In FY06, will begin the development and demonstration of critical supporting component fire control technologies, including acquisition and tracking sensors and decision algorithms. In FY07, will fabricate and bench and field test critical acquisition and tracking sensor components and decision algorithm technologies.	700	1000	1200	5500
- Close-In Active Protection System (CIAPS): In FY04, completed preliminary design for on-board target sensor, and purchased long-lead components for fabrication of science and technology prototype radar sensor for tactical wheeled vehicles. Transitioned this technology to PE 603313A Project D550.	4924	0	0	0
Totals	37320	34104	44824	53869

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	**0602303A - MISSILE TECHNOLOGY**	**G02**

COST (In Thousands)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
G02	ARMY HYPERSONICS APPLIED RESEARCH	7891	8749	17700	11932	0	0	0	0

A. Mission Description and Budget Item Justification: This project funds applied research to research and investigate the critical technologies required to mature expendable hypersonic missiles. Focus areas include: hypersonic aerodynamic prediction tool development; scramjet engine component design; active and passive cooling mechanisms; turbulent mixing enhancement at low Reynolds numbers; computational fluid dynamic code development and validation and high yield, storable hydrogen fuel grains. Initial efforts will focus on concept maturation of Scramjet enabled missiles to enhance Army operational missions. Efforts will be conducted through detailed system and subcomponent simulation, design, maturation and test in laboratory settings. The cited work is consistent with Transformation Planning Guidance, the Army Science and Technology Master Plan (ASTMP) and the Army Modernization Plan, and the Defense Technology Area Plan (DTAP). Work is performed at the Aviation & Missile Research, Development, and Engineering Center, U.S. Army Aviation and Missile Command, Redstone Arsenal, AL.

Accomplishments/Planned Program	FY 2004	FY 2005	FY 2006	FY 2007
- Hypersonic System Trade Studies:- In FY04, initiated system trade studies to determine the system level technical requirements associated with various air and missile defense and deep attack operational scenarios. Performed analyses of alternatives on the various missile components such as seeker, guidance and control, aerodynamic design to assess the technological shortcomings associated with a hypersonic enabled system. Estimated Initial missile sizing and mass properties based on preliminary sub-component geometry. Developed preliminary propulsion and aerodynamic estimates for notional system concepts and utilized multi-degree of freedom flyout analysis to assess system capability. Constructive simulations were also utilized to assess capability of a hypersonic enabled system in various operational scenarios. In FY05, will complete system and component level trade studies to determine missile system technical requirements addressing stated objectives for future Army air and missile defense systems and to assess the operational enhancement expected from a hypersonic enabled system. Computational fluid dynamic and high fidelity mathematical simulation analysis will be utilized in these analyses. Continue constructive simulation efforts based on preliminary design trades to further explore advantages of the proposed systems in new operational scenarios of interest. In FY06 utilize missile system and subsystem trades studies to assess system operational performance as system and subsystem technology matures and to clearly identify technological shortcomings that need to be addressed to weaponize the hypersonic engine technology. In FY07, will continue assessment of system operational performance. Evolving operational scenarios will be explored using constructive and engineering level simulations to assess advantages of hypersonic enabled systems.	843	1450	2000	2000

Accomplishments/Planned Program (continued)	FY 2004	FY 2005	FY 2006	FY 2007
- Hypersonic Engine and Missile Component Design: - In FY04, initiated design efforts for primary engine flow-path components. Investigated two specific engine designs, an annular engine design and an inward turning design. Performed computational fluid dynamic analysis to assess the impact of varying key geometric parameters on each engine component. Investigated inward turning and annular engine inlet designs along with multiple combustor length-to-diameters ratios on both engine concepts. Also investigated several fuel injection designs along with mixing enhancement devices on both engine concepts; investigated detailed nozzle geometries to maximize engine performance capability. In FY05, continue computational fluid dynamic analyses and develop initial hypersonic engine and missile component designs. Formulate and evaluate design concepts for inlets, combustor, fuel injectors, fuel mixing enhancement, thermal protection systems and other missile component technologies. and evaluate using computational methods. Complete design concepts for engine flow path subcomponents. Conduct limited lab and ground testing of selected engine component designs to validate computational methods. In FY06, engine component technology will be further evaluated in experimental testing of preliminary design concepts to assess operational capability of the component designs and to validate computational methods. These efforts will consist of experimental model design, instrumentation of experimental models, fabrication of test hardware and extensive ground test investigations of selected missile components. In FY07, continue experimental investigations of component technology to optimize the component designs as understanding of component designs improves and technologies mature. Component technology will be transitioned during FY07 to 0603313 G03.	7048	7299	15700	9932
Totals	7891	8749	17700	11932