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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, R-1 #40

COST (In Millions)	FY 2003	FY2004	FY2005	FY 2006	FY 2007	FY 2008	FY 2009
Total Program Element (PE) Cost	158.847	186.748	218.151	205.378	234.063	225.293	194.381
Electronic Module Technology MT-04	21.457	17.028	17.972	18.102	19.872	20.749	20.719
Centers of Excellence MT-07	4.756	4.000	4.000	0.000	0.000	0.000	0.000
Advanced Lithography MT-10	33.767	33.100	24.520	0.000	0.000	0.000	0.000
MEMS and Integrated Micro-systems Technology MT-12	27.887	26.069	45.462	48.719	52.521	33.000	3.000
Mixed Technology Integration MT-15	70.980	106.551	126.197	138.557	161.670	171.544	170.662

(U) Mission Description:

(U) The Advanced Electronics Technology program element is budgeted in the Advanced Technology Development Budget Activity because it seeks to design and demonstrate state-of-the-art manufacturing and process technologies for the production of various electronics and microelectronic devices, sensor systems, actuators and gear drives that have military applications and potential commercial utility. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements.

(U) The Electronic Module Technology project is a broad initiative to decrease the cost and increase the performance of weapon systems through the insertion of electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. Included in this project is the Semiconductor Ultraviolet Optical Sources (SUVOS), the Photonic Analog/Digital A/D Conversion, and the Chemical Engineering in Microsystems (CHEM) initiatives.

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(U) Advanced Lithography technology has enabled the dramatic growth of integrated circuit capability. Advances have led to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability. Further improvements require microcircuits with smaller features to meet the operational speed, power, weight and volume constraints.

(U) The Microelectromechanical Systems (MEMS) and Integrated Microsystems Technology project is a broad and cross-disciplinary initiative to develop an enabling technology that merges computation and power generation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical and electro-chemical-mechanical systems. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards and physiological states.

(U) The goal of the Mixed Technology Integration project is to revolutionize the integration of mixed technologies at the micrometer/nanometer scale. This will produce low-cost, lightweight, low-power 3-D microsystems that improve battlefield awareness and the operational performance of military platforms. This project will leverage industrial manufacturing infrastructure to produce mixed-technology microsystems that will revolutionize the way warfighters see, hear, taste, smell, touch and control environments.

(U) The Centers of Excellence project finances demonstration, training and deployment of advanced manufacturing technology at Marshall University.

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(U) Program Change Summary: *(In Millions)*

	FY 2003	FY 2004	FY2005
Previous President's Budget	158.987	174.150	172.151
Current President's Budget	158.847	186.748	218.151
Total Adjustments	-0.140	12.598	46.000
Congressional program reductions	0.000	-2.002	
Congressional increases	0.000	14.600	
Reprogrammings	0.300	0.000	
SBIR/STTR transfer	-0.440	0.000	

(U) Change Summary Explanation:

FY 2003	Decrease reflects minor reprogrammings offset by the SBIR transfer.
FY 2004	Increase reflects congressional adds for advanced lithography programs, crystal materials for electro-optic imaging and communication and 3D imaging, offset by congressional undistributed reductions.
FY 2005	Increase reflects project expansion of MT-12 and MT-15 for Sustainable Micropower Sources, Chip Scale Gas Analyzers and mixed technology programs.

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COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Electronic Module Technology MT-04	21.457	17.028	17.972	18.102	19.872	20.749	20.719

(U) **Mission Description:**

(U) The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards, and emerging technologies such as high density multichip modules. The project has three major objectives: (l) shorten the overall design, manufacture, test and insertion cycle for advanced electronic subsystems; (2) advance the state-of-the-art in electronic interconnection and physical packaging technology to allow circuits to operate close to their intrinsic maximum speed with less overhead in terms of volume, weight and cost; and (3) provide a robust manufacturing infrastructure for electronic modules.

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Semiconductor Ultraviolet Optical Sources (SUVOS)	21.457	17.028	12.972

(U) The Semiconductor Ultraviolet Optical Sources (SUVOS) program will develop photonic wide band gap materials for optical emission in the ultraviolet for bio sensing, and covert communications applications. This program will develop high conductivity *p*-type (positive charge carrier) material and highly efficient active region material suitable for ultraviolet emission, and exploit these results to enable the development of heterojunction bipolar transistors (HBT). The program will demonstrate short-wavelength semiconductor ultraviolet optical sources operating at wavelengths as short as 280 nm. Compared to conventional technologies, this program will achieve: 50x reduction of power requirements, 100x reduction of size and weight. This program will enable microsystems for biological agent detection, and covert non-line-of-sight (NLOS) tactical communications.

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(U) Program Plans:

- Demonstrate *p*-type (positive charge carrier) doping in high aluminum concentration nitride materials at concentrations sufficient for minority carrier injection devices.
- Demonstrate minority carrier devices (e.g. light emitting diodes (LED), laser diodes, heterojunction bipolar transistors).
- Develop and demonstrate 340 nm laser diodes and LEDs.
- Develop and demonstrate <280 nm laser diodes and LEDs.
- Demonstrate prototype microsystems based on SUVOS devices.

	FY 2003	FY 2004	FY 2005
Chemical Engineering in Microsystems (CHEMS)	0.000	0.000	5.000

(U) The CHEMS program will develop and demonstrate hardware and process control strategies for implementing practical and specific manipulation of the dynamics of matter at the molecular and atomic scale, ultimately leading to breakthrough capabilities in biochemical sensing and in high-value material synthesis and processing. The key technical capability developed in this program will be mechanisms for real-time control of ultrafast laser pulses for use as agile sensors, actuators, chaperones, and reagents for control of material system processes at the nanoscale.

(U) Program Plans:

- Develop controlled adaptive laser pulses signature suitable for Mass Spectroscopic and Raman Spectroscopic read-out.
- Demonstrate adaptive laser pulse use in detection of low vapor pressure simulant in gas phase and soil at a concentration 10 times lower than currently feasible.
- Demonstrate adaptive control of laser excited signature to enhance detection in the presence of interferents including diesel vapor, jet fuel, and aqueous film forming foam, pesticides and burning oil.
- Demonstrate excitation of molecules with shaped tailored light pulse at a distance of 100 meters for feasibility of retroemission of excited molecules for stand off detection.
- Demonstrate optical fractionation protocols for removing micrometer-scale impurities from biological samples of DoD interest, and for separation of bacteria (B. subtilis) from viruses as a step towards developing a new class of ultra-compact cytometers, potentially ideal for field-based analysis.

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- Demonstrate optical high throughput sorting of condensed DNA by size, using commercially available DNA samples as models for developing the necessary protocols. This project will provide a proving ground for a new breakthough approach to single-step multi-stage fractionation.

(U) **<u>Other Program Funding Summary Cost:</u>**

- Not Applicable.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-07

COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Centers of Excellence MT-07	4.756	4.000	4.000	0.000	0.000	0.000	0.000

(U) **Mission Description:**

(U) This project provides funding for the Robert C. Byrd Institute for Advanced Flexible Manufacturing at Marshall University. The Byrd Institute provides both a teaching factory and initiatives to local area industries to utilize computer-integrated manufacturing technologies and managerial techniques to improve manufacturing productivity and competitiveness. Training includes technologies to significantly reduce unit production and life cycle costs and to improve product quality.

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Advanced Flexible Manufacturing	3.808	4.000	4.000

(U) Program Plan:
- Continue the assessment of the Institute for Advanced Flexible Manufacturing's performance and transition from DoD to state/private support.

	FY 2003	FY 2004	FY 2005
Defense Techlink Rural Technology Transfer Project	0.948	0.000	0.000

(U) Program Accomplishments:
- Provided funding for the Defense Techlink Rural Technology Transfer Project.

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(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Advanced Lithography MT-10	33.767	33.100	24.520	0.000	0.000	0.000	0.000

(U) **Mission Description:**

(U) Microelectronics is a key to improved weapon system performance. Lithography technology has enabled the dramatic growth in microelectronics capability over the past three decades. The improved capabilities in semiconductor technology have contributed to significant system gains in speed, reliability, cost, power consumption and weight. Advanced microelectronics technology has been essential for computing and signal processing in virtually all military systems including command, control, communications and intelligence; electronic warfare; and beam forming for radar and sonar. Further improvements in areas such as target recognition, autonomous guided missiles and digital battlefield applications require microcircuits with smaller features to meet the operational speed, power, weight and volume constraints of these systems. Current microelectronics fabrication utilizes feature sizes of 0.13 microns. The Advanced Lithography program has emphasized longer-term research with expected high payoff in the fabrication of semiconductor devices with 0.05 micron or less feature sizes. These efforts will develop technology for sub 0.05 micron features.

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Advanced Lithography	23.517	23.500	24.520

(U) The goal of the Advanced Lithography program is to reduce technical barriers to the development of advanced lithographic technologies for the fabrication of a broad range of microelectronic devices and structures. Innovative research in pattern generation and transfer, imaging materials, new process and metrology will provide alternatives beyond current evolutionary trends. Maskless approaches will address the low volume needs of military systems. The program will investigate technologies for the creation of highly complex patterns at sub 0.05 µm resolution over field areas in excess of 1000 mm^2. Applications with larger geometries will be explored for innovative devices and structures beyond microelectronics, including photonics and bio-arrays. These accomplishments will allow industry to fabricate prototype tools and new high-performance devices for use in advance military systems and commercial markets.

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(U) The Advanced lithography program will also explore developments of key tool components, materials, and processing to accelerate the availability of emerging lithography technologies at 50nm and below. Efforts will include maskless approaches, imprint technologies, and innovative projection technologies. Developments in support technologies, common to several of the above, will include mask technology, resists, and metrology. The lithography program developments feature innovative designs and architectures, and new materials and processing beyond the evolutionary trends in the industry.

(U) Program Plans:

- Demonstrate key components of maskless wafer writer.
- Demonstrate proof of concept tool for multibeam maskless lithography.
- Deliver commercial imprint lithography tool with overlay of 50nm.
- Demonstrate prototype tool for fabrication of devices with 50nm features.
- Demonstrate key components for maskwriter for sub 0.05 micron features.
- Demonstrate Extreme Ultra-Violet (EUV) source of 35 watts.

	FY 2003	FY 2004	FY 2005
Laser Plasma X-Ray Source	2.467	3.400	0.000

(U) Program Plans:

- Continue development of laser plasma x-ray source technology.

	FY 2003	FY 2004	FY 2005
Advanced Lithography Demonstration	3.797	3.400	0.000

(U) Program Plans:

- Continue development of point source lithography.

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	FY 2003	FY 2004	FY 2005
Advanced Lithography X-Ray Thin Film Development	3.986	2.800	0.000

(U) Program Plans:

- Continue development of X-Ray mask lithography thin film.

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
MEMS and Integrated Micro-systems Technology MT-12	27.887	26.069	45.462	48.719	52.521	33.000	3.000

(U) **Mission Description:**

(U) The Microelectromechanical Systems (MEMS) program is a broad, cross-disciplinary initiative to develop an enabling technology that merges computation and power generation with sensing and actuation to realize a new technology for both perceiving and controlling weapons systems and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS applies the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical and electro-chemical-mechanical systems. The MEMS program addresses issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. These issues include microscale power and actuation systems as well as microscale components that survive harsh environments. The microfluidic molecular systems program will develop automated microsystems that integrate biochemical fluid handling capability along with electronics, optoelectronics and chip-based reaction and detection modules to perform tailored analysis sequences to monitor environmental conditions, health hazards and physiological states.

(U) The MEMS program has three principal objectives: the realization of advanced devices and systems concepts; the development and insertion of MEMS into DoD systems; and the creation of support and access technologies to catalyze a MEMS technology infrastructure. These three objectives cut across a number of focus application areas to create revolutionary military capabilities, make high-end functionality affordable to low-end systems and extend the operational performance and lifetimes of existing weapons platforms. The major technical focus areas for the MEMS program are: 1) inertial measurement; 2) fluid sensing and control; 3) electromagnetic and optical beam steering; 4) mass data storage; 5) chemical reactions on chip; 6) electromechanical signal processing; 7) active structural control; 8) analytical instruments; and 9) distributed networks of sensors and actuators.

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(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Micro Power Generation	10.824	8.101	0.000

(U) Compact portable power sources capable of generating power in the range of a few hundred milliwatts to one watt are critical to providing power for untethered sensors and other chip-scale microsystems. This program will replace today's technologies relying on primary and rechargeable batteries, which severely limit mission endurance and capabilities, by extending microelectronic machine technology to develop micro-power generators based on mechanical actuation and thermal-electric power generation. Operating with traditional fuels, these micropower generators will be capable of generating sustained power in the desired range for use with remote, field-deployed microsensors and microactuators. The program will also explore innovative micro-scale, integratable power sources to provide high density energy sources.

(U) Program Plans:
- Demonstrate capabilities in fuel processing, energy conversion to electricity, and thermal and exhaust management.
- Demonstrate MEMS micro heat engines utilizing micropower sources.
- Demonstrate integration of various power-generation components with microsensors and microactuators.
- Demonstrate stand alone, remotely distributed microsensors and actuators with built-in power supply and wireless communication.
- Establish design paradigm-shifts that occur when implementing novel power sources at the micro-scale using MEMS technology.

	FY 2003	FY 2004	FY 2005
Bio-Fluidic Chips (BioFlips)	10.211	0.000	0.000

(U) The Bio-Fluidic Chips program funded the development of totally integrated microfluidic chips to enable ubiquitous yet unobtrusive assessment of the warfighter's body fluids. These microchips integrated detection, diagnostics and treatment in one chip-scale system.

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(U) Program Accomplishments:
- Demonstrated optimization of sub-systems and components for integration into prototype systems. Sub-systems included: 1) on-chip sample preparation and processing (on-chip flow/concentration regulators, biosignal amplification, on-chip pressure sources, on chip separation/mixing, reagents storage/reconstitution); 2) sample collection (body fluid extractors, concentrators); and 3) antidote synthesis (genetic and antibodies) subsystems.
- Identified partners in the DoD and other federal agencies for testing prototype systems.
- Performed preliminary testing of prototype systems for re-evaluation of sub-system functionality.
- Modified sub-systems based on preliminary testing of prototype systems.
- Finalized testing of prototype systems to optimize integrated performance.
- Demonstrated prototype BioFlip systems in DoD laboratories.

	FY 2003	FY 2004	FY 2005
Harsh Environment Robust Micromechanical Technology (HERMIT)	3.910	7.100	10.190

(U) The Harsh Environment Robust Micromechanical Technology (HERMIT) Program aims to demonstrate micromechanical devices that can operate under harsh conditions—e.g., under large temperature excursions, large power throughputs, high g-forces, corrosive substances, etc.—while maintaining unprecedented performance, stability, and lifetime. Although HERMIT realizations of micromechanical RF switches are of particular interest, where sizable power throughputs and impacting operation constitute harsh operational environments, implementations for vibrating resonator reference tanks, gyroscopes, and accelerometers are also of interest. Among the HERMIT implementation approaches deemed likely to succeed are two of most interest: (1) wafer-level encapsulation or packaging strategies based on MEMS technology that isolate a micromechanical device from its surroundings while maintaining a desired environment via passive or active control; or (2) material and design engineering strategies that render a micromechanical device impervious to its environment, with or without a package (if possible). A key approach in this program that should allow orders of magnitude power savings is to selectively control only the needed micro-scale environment or volume via MEMS-enabled isolation technologies. The success of this program should enable a myriad of strategic capabilities, including lower cost, more complex phased array antennas for radar applications; tiny frequency references with long- and short-term stabilities that greatly extend the portability of ultra-secure communications; and micro-scale inertial measurement units with bias stabilities approaching navigation-grade.

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(U) Program Plans:

- Establish the feasibility of encapsulating micromechanical devices under low-cost, wafer-level packages with minimal out-gassing or leaking and with minimal impact on device performance.
- Demonstrate engineered materials and/or surface treatments that render a micromechanical device impervious to its surroundings or operating environment.
- Demonstrate essential elements (e.g., thermistors, heaters, getters, etc.) needed for low power control of the operating environment surrounding a micromechanical device.
- Demonstrate micromechanical devices (e.g., RF switches, vibrating resonators, etc.) fully integrated together with environment isolating measures (including circuits, if any) that maintain unprecedented performance, stability, and reliability, even under harsh environments.

	FY 2003	FY 2004	FY 2005
Chip-Scale Gas Analyzers	0.000	5.000	10.000

(U) The Chip-Scale Gas Analyzer Program will utilize the latest MEMS technologies to implement separation-based analyzers (e.g., gas chromatographs, mass spectrometers, poly-chromator-like devices) at the micro-scale to greatly enhance the selectivity of sensors to specific species, and thus, enable extremely reliable, remote detection of chemical/biological agents. The use of MEMS technology should also increase analysis speed and make possible the operation of such complex analyzer systems at extremely low power levels—perhaps low enough for operation as autonomous, wireless sensors. The many challenges in this program include the exploration and realization of micro-scale preconcentrator approaches, stacked gas columns, multiple sensor arrays, ionizers, vacuum pumps, and vacuum packaging. The success of this program will yield sensors substantially more selective than conventional sensors, again, making them particularly suitable for detection and identification of airborne toxins.

(U) Program Plans:

- Establish design trade-offs in (column) length vs. species separation efficiency for micro-scale gas chromatographs, mass spectrometers, resonator-based separation mechanisms, etc.

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- Demonstrate MEMS-enabled, micro-scale preconcentrators and explore the degree to which they enhance separation efficiency and species detectability.
- Demonstrate MEMS-enabled, micro-scale separation columns, ionizers, electromagnetic field generators, vacuum pumps, gas sensor arrays, calibration sources, all needed for separation-based analyzers.
- Demonstrate advanced methods for making micromechanical sensor elements species sensitive (e.g., combinations of absorption spectroscopy and resonators coated with species-and-light sensitive films).
- Implement fully functional, MEMS-enabled gas separation analyzers with power consumptions small enough for autonomous, remote operation and with control electronics integrated directly.

	FY 2003	FY 2004	FY 2005
MEMS Exchange	0.000	3.868	6.344

(U) This program seeks to provide flexible access to complex Microelectromechanical Systems (MEMS) fabrication technology in a wide variety of materials and to a broad multi-disciplinary user base via the MEMS Exchange service. A major goal of the effort is to ensure self-sustained operation of MEMS Exchange after the end of the program by adding several process modules to the existing repertoire and increasing the number of processes run per year so as to raise revenues to the point of self-sufficiency. Among the future payoffs of this program is the establishment of an accessible infrastructure for low or medium volume production of MEMS-enabled products for DoD applications.

(U) Program Plans:

- Demonstrate online software capable of error checking and optimizing process flows input by users so as to reduce the turn-around time per run and increase success rate.
- Insert a MEMS process module into the MEMS Exchange repertoire and make it available for use.
- Double the number of runs processed per year, to achieve a goal rate of 500 runs per year.
- Provide a modular merging process that combines modules together with transistor integrated circuits.
- Insert MEMS technology into three DoD applications using MEMS Exchange as the fabrication vehicle.

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	FY 2003	FY 2004	FY 2005
Micromechanical Computation and Data Storage	0.000	2.000	5.700

(U) The Micromechanical Computation and Data Storage Program aims to harness the low loss and low thermodynamic noise floor inherent in mechanical structures to (1) attain computational and signal processing circuits with unprecedented robustness and record low power consumption; and (2) to realize archival data storage devices with better than 1000Gb/in^2 densities. The key to attaining such performance is the recognition that mechanical structures are circuit elements in their own right, each with the capability to filter signals via their resonance properties, switch signals via mechanical actuation, and distort/shape/amplify signals via their nonlinearities, all at bandwidths rivaling those of transistors when implemented on the nano-mechanical scale. When connected into larger circuit networks, such mechanical elements can then be structured to perform increasingly complex functions, including filtering, mixing, amplification, and A/D or D/A conversion, all with dynamic ranges and power usages potentially better than exhibited by transistor-based counterparts. For data storage, the key approach in this program that allows it to break the 100Gb/in^2 thermodynamic barrier presently constraining conventional magnetic storage approaches is the use of MEMS technology to store, access, and erase data as tiny pits, phase changes, or even molecular changes (e.g., in a DNA chain). One possible rendition might use a MEMS based probe to manipulate the bits. A successful program in micromechanical computation and data storage would not only make single-chip (electrical or mechanical) computers possible, but would also enable circuits that can be powered by means other than electrical energy (e.g. direct chemical energy is possible), and that are practically immune to Electro-Magnetic Interface (EMI) and robust against radiation.

(U) Program Plans:

- Demonstrate mechanical circuit elements capable of manipulating a set of signal types (e.g., mechanical, electrical, acoustic) in various domains (e.g., frequency, time).
- Establish the feasibility of writing, reading, and erasing data using alternative storage mechanisms with higher thermodynamic density limits (> 1000Gb/in^2); (e.g., structural change-based (pits), phase change-based, DNA-chain-change based).
- Demonstrate methods for improving the data rate of data storage devices based upon the above techniques (e.g., by using MEMS-enabled massively parallel construction) while maintaining high read/write reliability.
- Design and demonstrate mechanical circuit networks capable of performing needed computational or signal processing functions (e.g., addition, multiplication, mixing, amplification, A/D conversion) with extremely low power consumption, and with immunity to EMI or radiation interference.

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	FY 2003	FY 2004	FY 2005
Low Power Micro Cryogenic Coolers	0.000	0.000	5.228

(U) The Low Power Micro Cryogenic Cooler program will attain superior performance in micro-scale devices (e.g. Low Noise Amplifier (LNA's) IR detectors, RF front-ends, superconducting circuits) by cooling selected portions to cryogenic temperatures. The key approach in this program that should allow orders of magnitude power savings, is to selectively cool only the needed volume/device via MEMS-enabled isolation technologies. Such an approach will benefit a large number of applications where performance is determined predominately by only a few devices in a system, e.g., communications where the front-end filter and LNA often set the noise figure; and sensors, where the transducer and input transistor in the sense amplifier often set the resolution. MEMS technology will also be instrumental for achieving micro-scale mechanical pumps, valves, heat exchangers, and compressors, all needed to realize a complete cryogenic refrigeration system on a chip.

(U) Program Plans:

- Obtain high thermal isolation using MEMS technology, despite high surface-to-volume ratios of micro-scale elements.
- Demonstrate micro-scale compressors with sufficient efficiency for low power operation.
- Demonstrate heat exchangers, Joule-Thompson plugs, valves, pumps, all needed for cryo-cooler implementation.
- Integrate micro cooler components together with sufficiently isolated devices to-be-cooled to yield a single chip system.

	FY 2003	FY 2004	FY 2005
Sustainable Micro-Power Sources	0.000	0.000	8.000

(U) The Sustainable Micro Power Sources program will harness ultra-high density nuclear fuels, or readily available bio-fuels (e.g., carbohydrates: glucose, sucrose, perhaps obtained directly from a soldier's MRE, or from tree sap), to attain long-lived, on-demand power sources for soldier electronics and for distributed autonomous sensors. In the nuclear area, two approaches are of primary interest: (1) accelerator-activated alpha-emitting radioisotopes with plasma-based charge collectors; and (2) beta-emitting charge-collecting mechanical devices that reciprocate with charge build-up. On the bio-side, fuel cells using enzymatic or microbial catalysts to break down carbohydrate fuels into hydrogen ions and electrons to be used to power a circuit load are of high interest. Extensions of this concept to allow photosynthesis of glucose fuels are also of

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interest, as they could make possible ultra-long term power sources. In making available either long-lived nuclear sources, or MRE- or plant-fueled bio-fuel cells, the success of a Sustainable Micro Power Sources program should make available "electricity-on-demand" for various soldier electronics and for long-term autonomous sensors (e.g., cognitive arthropods).

(U) Program Plans:
- Establish the feasibility of techniques for engineering and generating enzymatic and microbial catalysts for bio fuel cells (e.g., directed evolution).
- Establish techniques for suppression of neutron and gamma emission in compact alpha emitter nuclear power generators (a safety issue) and verify methods for suppression of radiation-induced damage in nuclear energy converter mechanisms.
- Demonstrate efficient nuclear-to-electrical or mechanical energy conversion using MEMS-based mechanisms that minimize the loss of energy carriers.
- Demonstrate micro bio-fuel processors capable of removing unwanted species in fuel mixtures generated from available food.
- Demonstrate fuel flexible bio fuel cells, some of which may employ photosynthesis for sustainable power output lifetimes.

	FY 2003	FY 2004	FY 2005
MEMS Micro-Actuator Technology	1.423	0.000	0.000

(U) Program Accomplishments:
- Initiated novel design concepts of MEMS Micro-Actuators.

	FY 2003	FY 2004	FY 2005
MEMS Deep Silicon Etching Technology	1.519	0.000	0.000

(U) Program Accomplishments:
- Continued MEMS Deep Etching program in conjunction with Army Research Laboratory.

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(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Mixed Technology Integration MT-15	70.980	106.551	126.197	138.557	161.670	171.544	170.662

(U) **Mission Description:**

(U) The goal of the Mixed-Technology Integration project is to leverage advanced microelectronics manufacturing infrastructure and DARPA component technologies developed in other projects to produce mixed-technology microsystems that will revolutionize the way individuals see, hear, taste, smell, touch and control their environment at a distance. These 'wristwatch size', low-cost, lightweight and low power microsystems will improve the battlefield awareness and security of the warfighter and the operational performance of military platforms. At the present time, systems are fabricated by assembling a number of mixed-technology components: Microelectromechanical Systems (MEMS), microphotonics, microfluidics and millimeterwave/microwave. Each technology usually requires a different level of integration, occupies a separate silicon chip and requires off-chip wiring, fastening and packaging to form a module. The chip assembly and packaging processes produce a high cost, high power, large volume and lower performance system. This program is focused on the monolithic integration of mixed technologies to form batch-fabricated, mixed technology microsystems 'on-a-single-chip' or an integrated and interconnected 'stack-of-chips'.

(U) The field of microelectronics incorporates micrometer/nanometer scale integration and is the most highly integrated, low-cost and high-impact technology to date. Microelectronics technology has produced the microcomputer-chip that enabled or supported the revolutions in computers, networking and communication. This program extends the microelectronics paradigm to include the integration of heterogeneous or mixed technologies. This new paradigm will create a new class of 'matchbook-size', highly integrated device and microsystem architectures. Examples of component-microsystems include low-power, small-volume, lightweight, microsensors, microrobots and microcommunication systems that will improve and expand the performance of the warfighter, military platforms, munitions and UAVs.

(U) The program includes the integration of mixed materials on generic substrates including glass, polymers and silicon. The program is design and process intensive, using 'standard' processes and developing new semiconductor-like processes and technologies that support the integration of mixed-technologies at the micrometer/nanometer scale. The program includes the development of micrometer/nanometer scale isolation, contacts, interconnects and 'multiple-chip-scale' packaging for electronic, mechanical, fluidic, photonic and rf/mmwave/microwave technologies. For example, a mixed-technology microsystem using integrated microfluidics, MEMS, microphotonics, microelectronics and microwave components could provide a highly integrated, portable analytical instrument to monitor the battlefield environment, the physical condition of a warfighter, the identity of warfighters (friend or foe) or the combat readiness of equipment. The ability to integrate mixed technologies onto a single substrate will drive down the size, weight, volume and cost of weapon systems while increasing their performance and reliability.

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
RF Lightwave Integrated Circuits (RFLICS)	8.478	4.769	0.000

(U) The Radio Frequency (RF) Lightwave Integrated Circuits (RFLICS) program is demonstrating enhanced performance capabilities of RF systems enabled by integration of lightwave and RF technologies to route, control, and process analog RF signals in the 0.5 – 50 Ghz range.

(U) Program Plans:

- Study fundamental limits to RF communications links and perform system study.
- Define critical technical challenges to increasing link margin by improving component linearity.
- Establish program metrics for optimum RF link demonstration.
- Initiate component development and heteogeneous integration demonstrations.

	FY 2003	FY 2004	FY 2005
Nano Mechanical Array Signal Processor (NMASP)	18.106	16.014	2.000

(U) The Nano Mechanical Array Signal Processors (NMASP) will create arrays of precision; nano mechanical structures for radio frequency signal processing that will greatly reduce the size and power consumption of various communication systems.

(U) Program Plans:

- Demonstrate fabrication techniques to control surface morphology, geometry, and material properties at the sub-micron scale.

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- Demonstrate temperature stability and electrical tenability of individual nano resonators suitable for UHF communication.
- Initiate development of nano mechanical array signal processors that will enable ultra miniaturized (wristwatch or hearing aid in size) and ultra low power UHF communicators/GPS receivers.
- Demonstrate several alternatives to achieve uniform arrays of up to 1024 nano resonators with geometrical control and material uniformity at ±20%, and to ±1% with trimming and tuning.
- Demonstrate interconnection and isolation (multiplexed, serial, or random access) of individual resonators.

	FY 2003	FY 2004	FY 2005
Digital Control of Analog Circuits RF Front Ends	12.987	16.732	13.102

(U) Digital Control of Analog Circuits will demonstrate analog/RF electronic components with the ability to self-assess and adapt in real time (sub microseconds), by self-tuning its impedance-matched networks, extending the operational performance of analog components to the intrinsic semiconductor device limits. This technology will result in a new generation of analog, microwave and millimeter wave components with >150X improvements in power-bandwidth, linearity-efficiency products.

(U) Program Plans:

- Demonstrate real-time active self-assessment and monitoring of RF/analog functions using nano-CMOS digital and mixed-signal technologies to achieve stability, signal agility, and multifunctionality.
- Design processes to fabricate arrays of molecular flow control devices including interconnect microfluidics and electronics.
- Develop techniques and algorithms to monitor active device status.
- Demonstrate MEMs tunable device optimization (<1 microsecond, 10:1 tuning ratio).
- Fabricate tunable MEMs control Integrated Circuits (ICS).
- Fabricate self-assessment control Integrated Circuits (ICS).
- Demonstrate device and algorithm concepts for intelligent self-assessment of analog functions.
- Demonstrate device concepts for 10^{5} microsecond actuation time of impedance matched networks.
- Complete design concept for adaptable RF components.
- Demonstrate concept of digital assessment of analog device.

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- Demonstrate reconfigurable network concept for 10^5 microsecond actuation time of impedance matched networks.
- Validate concept of adaptable RF components by demonstrate digital control of analog circuits.
- Identify component requirements.
- Initiate Phase III – component demonstration.

	FY 2003	FY 2004	FY 2005
Chip Scale Wavelength Division Multiplexing (WDM)	16.935	18.763	15.500

(U) The goal of the Chip Scale Wavelength Division Multiplexing (WDM) program is to develop new materials, components and sub-systems for use in wavelength division multiplexing based optical communications, delivering high capacity, mission adaptable networks for use in data intensive military weapons systems.

(U) Program Plans:

- Conduct modeling, simulation and analysis of artificial dielectrics and new materials for ultra-compact Wavelength Division Multiplexing (WDM) components.
- Conduct experimental efforts in the growth and fabrication of these new materials and determine suitable processing procedures.
- Plan construction of WDM components.
- Design, fabricate and test novel WDM components using the new materials and processing technology.
- Determine fiberoptic and planar waveguide interconnection requirements.
- Evaluate the suitability of the new components for use in prototype modules.
- Down-select to the most promising approaches and begin prototype module assembly.
- Construct testbeds capable of fully measuring and characterizing the new technologies implemented in the chip-scale WDM components.
- Evaluate the performance characteristics of the prototype modules and determine the highest payoff dual use development paths.
- Evaluate and demonstrate network with device testing.
- Demonstrate network with completed modules.

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	FY 2003	FY 2004	FY 2005
Optical Code Division Multiple Access (CDMA)	0.000	7.306	6.767

(U) Optical CDMA represents a paradigm shift from the current Wavelength Division Multiplexing/Time Division Multiplexing (WDM/TDM) optical networks. Instead of assigning a wavelength and a time slot to a user, O-CDMA assigns a code to a user. The goal of this program is to demonstrate technology for an advanced O-CDMA communications system. Such a system potentially offers the benefit of multi-level security, low probability of interception, detection and jamming, decentralized network, and higher spectral efficiency.

(U) Program Plans:
- Demonstrate 10 simultaneous users at 10 Gb/s per user with a low bit error rate.
- Demonstrate scalability to 100 simultaneous users and cardinality of 1000.
- Demonstrate spectral efficiency scalable to 1 bit/s-Hz.

	FY 2003	FY 2004	FY 2005
Optical Phased Array of Phased Arrays (PAPA)	0.000	0.000	4.000

(U) The goal of this program is to demonstrate a fully scalable and modular architecture of phased sub-apertures capable of producing an arbitrarily large optical aperture that can be rapidly and non-mechanically steered over a wide field of regard with high precision.

(U) Program Plans:
- Develop sub-apertures to operate at wavelengths of 1.06 um, 1.55 um, 3-5 um, and 8-12 um.
- Demonstrate steering over a full 90 degree cone.
- Reduce parts counts, which will make certain laser systems affordable.
- Reduce weight, a particularly important goal for space-based applications.

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	FY 2003	FY 2004	FY 2005
Data in Optical Domain Network (DoD-Network)	0.000	10.235	10.600

(U) This program was formerly named Intelligent Optical Networks. Currently optical networks use photonics to transport data and electronics to process data. However, as the underlying bit rates of the optical networks are pushed beyond 40 giga-bits per second, there will be significant processing bottlenecks in these networks and these bottlenecks will severely limit the military's ability to rapidly transport time critical information. A potential solution to this problem is to develop photonic technology so optics can take over higher order network processing functions. This program will develop and demonstrate four key photonic technologies to meet these challenges: all-optical routing, all-optical data buffering (controllable and eventually random access,), optical logic and circuits, and all-optical (multi-wavelength) regenerators. These photonic technologies will lead to intelligent all-optical networks. The program will have two major areas of interest: The first will focus on developing new photonic technology that is essential if photonics is to play a significant role in higher order processing in optical networks. The second area will focus on developing novel architectures that will fully exploit the new photonic technology to bring new and increased functionalities to the optical networks.

(U) Program Plans:

- Develop a limited (4x4 or 8x8) optical packet switch.
- Develop means for address processing.
- Develop multi-wavelength optical regenerators.
- Develop flexible, room temperature optical buffers.
- Develop synchronization techniques for short pulses.
- Develop controllable picoseconds optical time delay.

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	FY 2003	FY 2004	FY 2005
Large Area Distributed Macroelectronics	0.000	5.500	7.400

(U) This program will develop large area multifunctional actuation and sensing systems using novel combinations of active and passive electronics and flexible, conformable, non-traditional materials and techniques. It will develop basic technologies and techniques for component attachment, electrical interconnections, multilayer routing and utilize existing novel materials and designs for actuation and sensing such as electroactive polymers to achieve active porosity and fibers for acoustic response. This program will demonstrate prototype systems that achieve order of magnitude improvements in performance and/or cost. Examples of applications include: control surfaces for an autonomous precision guided parafoil and controlled air boundary layers for reduction in drag for underwater vehicles; beam steered acoustic arrays with large aperatures to achieve order of magnitude improvements in angle of coverage and signal to noise ratios; early warning threat detection and localization using a large area inflatable structure with woven antennas and electronics for high bandwidth communications; and aircraft or UAV wing skins for chem/bio monitoring.

(U) Program Plans:
- Develop enhanced transistors compatible with low cost, large area fabrication.
- Develop methods to print active circuits on large area and flexible circuits.
- Develop techniques to wirelessly communicate between circuit blocks over a distributed electronics surface.
- Develop novel circuit/microarchitectures to enhance system performance for demanding electronic applications.
- Demonstrate examples of large area and/or flexible substrate distributed electronics to address difficult problems in sensor networks, physical security systems, or radar beam forming/steering.

	FY 2003	FY 2004	FY 2005
Microantenna Array Technology & Applications (MIATA)	0.000	8.000	9.000

(U) This program was formerly named Submillimeter Wave Imaging Technology. The goal of this program is to develop arrays of low-cost mircroantennas that can simultaneously sense both Millimeter Wave (MMW) and IR scenes along with compact MMW designator sources for

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passive and active imaging applications in the spectral region from W-band (94 Ghz) to the long wave infrared optical region. New micro- and nano-fabrication techniques of low cost antenna arrays provide a basis for revolutionary tactical military applications in the unexploited submillimeter to long wave optical spectral region. The military utility of this technology includes conventional passive imaging with compact devices at elevated temperatures, passive or active ballistic imaging through extreme weather and obscurants, polarization discrimination of manmade objects, rapid electronic spectral tuning for clutter discrimination, ultrawideband response (achieved using metal-insulator-metal tunneling structures for sensing/rectifying the antenna current), and may also include synthetic apertures, phased arrays, true time, and steered receiver beams.

(U) Program Plans:
- Achieve 95 GHZ: Noise Equivalent Temperature Detection (NETD) $\leq$ 20 Kelvin (K) in a 2x2 array.
- Achieve 8-12 um: NETD $\leq$ 0.1 K in a 8x8 array.
- Achieve 95 GHZ: NETD $\leq$ 2 K in a 8x8 array.
- Achieve 8-12 um: NETD $\leq$ 0.02 K in a 64x64 array.

	FY 2003	FY 2004	FY 2005
Ultra Wide Band Array Antenna	0.000	6.232	5.260

(U) The Ultra Wide Band Array Antenna effort will develop array antenna and beamforming technology to support steering from ten to one hundred independent beams with instantaneous bandwidths in excess of 100:1 from an array antenna. Frequency ranges of interest are: 20 MHz to 3 GHz, 100 MHz to 20 GHz and 500 MHz to 50 GHz.

(U) Program Plans:
- Initiate component design and simulation - radiating element, low noise amplifier, beamformer.
- Extend initial designs to support 100:1 instantaneous bandwidth.
- Validate performance by simulation, begin component fab.
- Complete component fabrication, verify component performance, and demonstrate beamformer approach for 10 elements.
- Complete prototype integration and test - prove multi-octave, multi-beam performance.

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	FY 2003	FY 2004	FY 2005
Flexible Nanocomposite Organic Photovoltaic Cells	0.000	8.000	10.000

(U) The goal of the Flexible Nanocomposite Organic Photovoltaic (PV) Cells is to efficiently convert solar energy to electricity utilizing nanocomposite materials on flexible, lightweight substrates. Operational impact would be 200x increase in power/weight, longer operating time before resupply, increased sustainability, and greater mobility.

(U) Program Plans:

- Deliver 2 cm2 PV cell with increased efficiency from < 3% to 20%.
- Use plastic or fabric substrates in transparent electrode and heterojunction stability.

	FY 2003	FY 2004	FY 2005
Laser-Photoacoustic Spectroscopy (L-PAS)	0.000	0.000	7.068

(U) The goal of this program is to develop and demonstrate highly sensitive, compact, rapid, reliable, inexpensive, and low power consuming chemical agent sensors based on the principle of laser photoacoustic spectroscopy. The sensor will be capable of functioning to this level of performance for a wide variety of possible chemical agents, explosives, and narcotics in the presence of diverse background environments.

(U) Program Plans:

- Demonstrate working prototypes that have a sensitivity to <1ppb at a false alarm rate of better than 10^{-6}.
- Demonstrate a major improvement in performance (measured in terms of sensitivity) over the Joint Chemical Agent Detector (JCAD) system which is the next generation chemical sensor currently under development.

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	FY 2003	FY 2004	FY 2005
Broadband Covert Optical Device Technology	0.000	0.000	5.000

(U) This program will develop broadband laser sources and detector arrays in which each pixel is a high speed spectrometer. The laser sources will be diffraction limited output devices with linewidths greater than 50% of the central frequency ("octave lasers"). These sources will have outputs that span across the entire visible region, or across the entire Near Infrared Radiation/Short Wave Infrared (NIR/SWIR) band, and will be continuous wave devices. The receivers will be large area focal plane arrays in which each pixel is a high speed spectrometer, capable of nanosecond temporal resolution and simultaneous acquisition in ten to twenty distinct spectral bands across the spectral region of interest.

(U) Program Plans:

- Develop very broadband diffraction limited Continuous Wave (CW) optical sources.
- Develop matching detector focal plane arrays for multispectral imaging, in which each pixel is a multiband high bandwidth (speed) spectrometer with simultaneous detection in each band.
- Demonstrate optical coding/decoding by imprinting and interpreting high-speed pseudo-random noise (e.g.) signals on the ultra broadband carrier, for secure communications, designation, optical augmentation, and remote sensing.

	FY 2003	FY 2004	FY 2005
Hierarchical CAD Tools for Noise Tolerant Mixed Signal Electronic Circuits	0.000	0.000	5.000

(U) The program will develop hierarchical Computer Aided Design (CAD) tools to significantly improve the ability to design mixed signal circuits that are exposed to noise in harsh environments, e.g., complex electromagnetic environments with radiation effects due to incidence of high energy particles. Specifically, the program will develop and demonstrate a new generation of CAD tools and libraries with physics-based models of single event effects, total ionizing dose and prompt dose. The integrated CAD capability will incorporate (1) a novel "flow up" paradigm, where parameters, such as current leakage, doping profiles, charge trapping, fluence, linear energy transfer (LET), carrier transport, etc., will flow up from device and compact models into a behavioral circuit simulator and synthesis backbone and (2) synthesis tools to perform system wide radiation and electromagnetic interference trade-off analysis and optimization.

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(U) Program Plans:
- Develop fast parasitic extraction of SEE (Single Event Effects), TID (Total Ionizing Dose) and prompt dose effects and demonstrate parasitic aware routing, placement and layout tools.
- Demonstrate feasibility of using models to migrate designs between different technologies/processes quickly and efficiently.
- Develop models to demonstrate the automated synthesis, verification and optimization of noise-tolerant circuit architectures.
- Demonstrate the ability to predict optimal tradeoffs (between performance and radiation variables), achievable over the span of radiation aware design space.
- Implement model libraries for components and sub-blocks/circuits based on coupled electrical/radiation performance characteristics.
- Develop a plan to interface the models and libraries with either new or existing design environments (i.e., design flows) for electronic circuits.
- Conduct performance verification and validation studies (on a military relevant mixed signal circuit) to demonstrate the capabilities of the design tools.

	FY 2003	FY 2004	FY 2005
Ideal Radio Frequency (RF) Link	0.000	0.000	5.000

(U) The Ideal RF Link program seeks to exploit recent advances in analog transmit and receive technology with progress in ultra-high speed logic to simultaneously reduce the transceiver phase noise and reduce analog device non-linearities with digital correction techniques. In particular, the current performance of Silicon Germanium and Indium Phosphide bipolar device technology is now fast enough, with cut-off frequencies of > 350 GHz, that error correction techniques such as predistortion and feed forward correction can be considered for application to RF components. The effort will develop new circuit topologies and algorithms along with cross technology integrations schemes. The combination will increase the maximum signal data rate (increase the bits/sec/Hz) for DoD RF links.

(U) Program Plans:
- Study fundamental limits to RF communications links and perform system study.
- Define critical technical challenges to increasing link margin by improving component linearity.

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- Establish program metrics for optimum RF link demonstration.
- Initiate component development and heterogeneous integration demonstrations.

	FY 2003	FY 2004	FY 2005
Silicon RFICs with MEMS For Fully Programmable RF/mmwave Electronics	0.000	0.000	5.000

(U) This program will provide new systems capabilities for integrated RF microsystems by developing material and device processing technologies for integrating microelectromechanical RF structures (MEMS) with integrated RF/microwave/millimeterwave (MMWAVE) electronics to form reconfigurable, multi-functional active RF surfaces. The integration of massive numbers of minniaturized MEMS structures with advanced control and RF processing will enable fully programmable metallic and active RF processing surfaces which will be capable of rapid reconfiguration under electronic control to adapt their resonant and out-of-band characteristics, creating new classes of components that can rapidly and efficiently span electromagnetic bands with high signal-to-noise ratio and minimal losses. These highly integrated active RF elements will consist of efficient, low loss, low power, agile transceivers with high speed digital RF memories, precision analog/mixed signal circuits, and MEMS sensors and structures for actively reconfiguring the resonant structures and devices.

(U) Program Plans:
- Develop and demonstrate fabrication technologies for critical high performance electronics and micromachined components with very high quality factors and high performance radio-frequency characteristics compatible with integration into active radio frequency surfaces.
- Develop and demonstrate chip and device-scale electromagnetic isolation approaches.
- Complete development of scaled fabrication process for reducing power and insertion loss of integrated radio-frequency components.
- Complete measurements of radio-frequency parameters of integrated radio-frequency components and perform de-embedding analysis.
- Demonstrate integration technologies that result in the ability to combine high speed analog/mixed signal electronics with digital control devices and with micromachined devices to form active surfaces for agile radio-frequency microsystems.
- Develop control algorithms for controlling the active electronics and micromachined components across wide dynamic range and bandwidth for active radio-frequency surface applications.
- Complete far-field and power measurements of fully programmable radio-frequency active surface microsystem.

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	FY 2003	FY 2004	FY 2005
Liquid Electronics Power Source	0.000	0.000	5.000

(U) The Liquid Electronics Power Source program will develop a technology base for the development of modules and systems capable of efficiently converting radiation energy into electrical power in the hundreds of KW to MW range. By coupling experience in the chemistry, physics, materials and engineering communities, it is envisioned that a new class of electronics materials based on liquid semiconductors can be developed and engineered into unique structures, devices and modules to allow for efficient, direct conversion of radiation energy with relatively high specific power. Technologies will be developed in this program to overcome specific hurdles of converting radiation energy directly into electricity. Included in the technology development will be alphavoltaics, betravoltaics, direct fission conversion, thermoelectric, thermionics and themophotovoltaics.

(U) Program Plans:
- Control radiation and electron transport in novel chemical systems and engineered structures.
- Synthesize new compositions of matter leading to enhanced materials properties.
- Model cooperative or parasitic effects associated with scaling.
- Transfer radiation particles from sources to converters.
- Develop novel hybrid approaches to couple various conversion technologies.

	FY 2003	FY 2004	FY 2005
Intelligent Mixed-Signal Microsystems Technology (IMMST)	0.000	0.000	5.000

(U) The overall goal of the IMMST program is to significantly advance analog/digital (A/D) conversion technology for insertion into a wide variety of military platforms. A specific goal is a one hundred fold improvement in the data conversion metric (bandwidth X resolution/power). A promising approach is to develop and implement new high performance architectures that overcome the limitations of current mixed signal circuits by harnessing analog pre-processing functions with the enormous calculational power of the most aggressive digital CMOS technology. This

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program will seek new, innovative approaches to analog/digital (A/D) architectures for refinement and incorporation into Defense sensor systems. The resulting technology will impact many Defense communications, radar, and Signal Intelligent (SIGINT) systems.

(U) Program Plans:
- Identify application for adaptable A/D, components requirements, and technical challenges.
- Identify concepts for adaptable A/D functions.
- Demonstrate algorithms and circuits for architecture optimizers.
- Complete design concepts for adaptable A/D converter architectures.
- Demonstrate adaptability concepts in mixed signal circuits.

	FY 2003	FY 2004	FY 2005
Novel Crystal Components for Imaging and Communications	1.614	2.125	0.000

(U) The goal of this program was to develop novel imaging technologies utilizing infrared (IR) and crystal growth approaches.

(U) Program Plans:
- Continue the development of novel crystal components.

	FY 2003	FY 2004	FY 2005
Sterred Agile Laser Beams (STAB)	12.860	0.000	0.000

(U) The Steered Agile Laser Beams (STAB) program developed small, lightweight laser beam scanning technologies for the replacement of large, heavy gimbaled mirror systems. New solid state/micro-component technologies such as optical MEMs, patterned liquid crystals and diffractive micro-optics was used to build small, ultra-light, rapidly steered laser beam sub-systems.

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(U) Program Accomplishments:
- Analyzed system concepts that were used to develop design goals for assembled components.
- Fabricated individual laser beam steering components (lasers, diffractive optics, MEMS sub-assemblies, detectors, filters and integrated circuits).
- Resolved component interface issues in preparation for breadboard development.
- Evaluated competing laser beam steering component technologies and down-selected to the most promising approaches.
- Completed prototype design studies.
- Assembled and tested components suitable for use in prototype demonstration and evaluation.
- Assessed performance characteristics of the prototypes and made recommendations for future development.

	FY 2003	FY 2004	FY 2005
Electronic & Photonic Integrated Circuits on Silicon (EPIC)	0.000	0.000	5.500

(U) This program will develop two critical alternative photonic technologies based on silicon substrates. The first thrust addresses active photonic components based on silicon which do not rely on generating light within the material. While passive photonic components, such as waveguides, can be fabricated from silicon, silicon's indirect bandgap does not lend it to fabricating active photonic components based on the generation of photons (lasers, amplifiers etc.). The first alternative technology development will be optical amplifiers using Raman gain. Fiber amplifiers based on Raman gain currently play a major role in optical networks, and demonstrating this optical amplification in silicon will be a major step toward overcoming on chip losses in complex chip-scale optical components. The second alternative technology development will address optical transistor action, or switching, in silicon, (i.e., a three-terminal optical device, in which control photons at one terminal will make a large change in the photons transmitted between the other two terminals). Taken together, these two capabilities will create a new paradigm, in which silicon will provide a platform for monolithic integration of photonic and electronic functions.

(U) Program Plans:
- Demonstrate low-loss waveguides connecting optical gates and increased dynamic range for the logic gates.
- Demonstrate integrated processing functions such as adders and shift registers, requiring integration of 3-10 logic gates.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-15

	FY 2003	FY 2004	FY 2005
3-D Imaging Technology Development	0.000	2.125	0.000

(U) The 3-Dimensional Imaging Technology Development effort aims at developing new high speed imaging devices and array technology with high resolution three dimensional images of tactical targets at ranges of 7 to 10 kilometers, with increased identification range of tactical targets, especially from fast moving platforms.

(U) Program Plans:

- Demonstrate range imaging at the eye-safe wavelength of 1.54 micrometers with a minimum array size of 64 x 64.

	FY 2003	FY 2004	FY 2005
Mil-Tech Extension	0.000	0.750	0.000

(U) This effort aims to develop new technologies in military-industrial infrastructure.

(U) **<u>Other Program Funding Summary Cost:</u>**

- Not Applicable.