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## WE.10 Integrated Beam Control for Ground-Based Laser Antisatellite System

**Objectives.** Develop and demonstrate ground-based laser (GBL) integrated beam control technologies to support a system development decision for a GBL antisatellite (ASAT) system. This effort uses the 3.5-m telescope at AFRL's Starfire Optical Range and will demonstrate, at full scale but very low power, all beam control functions associated with an end-to-end satellite engagement. The major functions include initial optical acquisition of the target satellite and coarse tracking using passive sensors, flood illumination of the satellite with an illuminator laser, handoff to precision active tracking, atmospheric compensation using adaptive optics and laser beacon sensing, designation of the desired aimpoint on the satellite target, laser beam propagation to the selected aimpoint, and aimpoint maintenance for the required engagement time. Primary metrics for this demonstration are atmospheric compensation performance, residual satellite tracking error, and laser beam pointing accuracy for aimpoint stabilization. Specific performance goals are classified, but they generally involve an improvement by factors of two to four over currently demonstrated capabilities at the subsystem level, and the simultaneous demonstration of improved performance for all subsystems in integrated testing. A series of increasingly complex integrated beam control field tests will culminate in a final demonstration in FY01. Low-power integrated beam control results will be extrapolated to high power through detailed simulation and performance analysis. (Additional details are classified.)

**Payoffs.** This DTO effort will demonstrate the enabling technology for a ground-based ASAT system, a significant technology for space control. It will also provide substantial capability for related applications in high-resolution imaging, power beaming, and laser communications as well as for tactical and strategic missions, such as the airborne laser (DTO D.10, Airborne Laser Technology for Theater Missile Defense). In addition, there has been a significant transfer of technology to the astronomy community.

**Challenges.** The principal technology issues are the development of (1) scaled adaptive optics, laser beacon concepts and hardware, and control systems to meet atmospheric compensation performance goals for full-scale (3.5–4.0 m) apertures using laser beacon sensing of distortions due to atmospheric turbulence; (2) laser illuminators and track sensors and processors to meet requirements for 24-hour active tracking of satellites to the required precision; and (3) aimpoint designation and maintenance techniques to meet requirements for laser beam pointing.

### Milestones/Metrics.

FY2000: Full-aperture Rayleigh-guide star imaging.

FY2001: Final demonstration using higher (up to 1,200 km) LEO satellites during night and day.

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### WE.10 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603605F	3647	9.8	9.8	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>9.8</b>	<b>9.8</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.13 Counteractive Protection Systems

**Objectives.** Develop and demonstrate techniques and technologies to allow antitank guided weapons (ATGWs) to defeat threat tanks equipped with Active Protection Systems (APSs). Approaches for Counteractive Protection Systems (CAPSs) include jamming or deception of the APS sensors, firing the ATGW warhead before it can be damaged, and preventing fragment damage to warhead or related components. Specific CAPS techniques may work together or separately to achieve these objectives. Technology areas where advances are being pursued include small, high-performance RF components, conformal antennas, and long-standoff, shaped-charge warheads for use in missile system applications to defeat both current and future threat APS.

**Payoffs.** Successful development of CAPS technology will enable the warfighter to defeat APS-equipped tanks with lightweight mobile ATGWs, which can be deployed to a theater much more rapidly than tanks or other heavy armored vehicles. APSs which are fielded or under development by potential adversaries, can defeat many antitank guided missiles. CAPS-capable ATGWs, either man-portable or on lightweight vehicles or aircraft, will be able to defeat these threat APSs, eliminating the need for heavy armor in rapid deployment and small engagement scenarios. In larger engagements, the need for heavy armor will be much reduced.

**Challenges.** Technical challenges that must be met for successful CAPS development include conformal RF antennas for directing energy forward without aerodynamic or guidance sensor interference, RF components and modules that operate efficiently over a wide range of frequencies, and advanced warhead technology capable of defeating threat armor from outside the engagement range of current and future APS munitions.

### Milestones/Metrics.

FY2000: Static test long-standoff, shaped-charge warhead that defeats 75% of frontal armor from range of more than 90% of munition engagements.

FY2001: Complete third-generation RF CAPS brassboard and demonstrate functionality for defeating future APS sensors.

FY2002: Complete flight prototypes of third-generation RF countermeasure and complete third-generation APS testbed radar.

FY2003: Demonstrate third-generation RF countermeasure in missile flight tests, defeating current and future APS sensors in more than 90% of engagements.

#### Customer POC

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**WE.13 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0603313A	550	1.9	5.5	5.5	2.5	0.0	0.0
	<b>DTO Total</b>	<b>1.9</b>	<b>5.5</b>	<b>5.5</b>	<b>2.5</b>	<b>0.0</b>	<b>0.0</b>

## WE.18 Direct Fire Lethality ATD

**Objectives.** Enhance and expand the lethal battlespace of the Abrams tank with an advanced kinetic energy (KE) cartridge capable of defeating explosive reactive armor (ERA) with increased accuracy.

**Payoffs.** This DTO will provide the advanced technology necessary to maintain the Abrams tank as the most lethal tank in the world. The DTO supports the evolving Force XXI doctrine, which requires the expansion of the maneuver commander's battlespace, and DoD downsizing and cost-reduction philosophies by upgrading existing weapon platforms with affordable, high-payoff lethal weapon system technologies. The DTO will increase armor penetration against future armors by up to 70% over the M829A2 and system accuracy by up to 70% stationary.

**Challenges.** Technical barriers for the advanced KE cartridge include novel penetrator aerodynamics, novel penetrator axial/radial dispersions, integrated novel penetrator reliability, axial thruster ignition/timing reliability, and radial thruster accelerometer/control logic function and integration.

### Milestones/Metrics.

FY2000: Demonstrate radial thruster capability to correct for multiple jump errors in achieving 30% to 70% increase in system accuracy, and demonstrate novel penetrator lethality up to 70% greater than the M829A2.

FY2001: Demonstrate 120-mm KE cartridge to defeat 2005-ERA protected threat with up to 70% increase in lethality over M829A2, and 30%–70% increase in system accuracy under stationary conditions over the M829A2/M1A2.

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### WE.18 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603004A	232	6.3	6.5	0.0	0.0	0.0	0.0
0603004A	43A	2.0	2.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>8.4</b>	<b>8.5</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.21 Fiber-Optic, Gyro-Based Navigation Systems

**Objectives.** Develop and demonstrate technologies for affordable and robust guidance, navigation, and control, including a high-level hybridization of a fiber-optic gyro and etched-silicon accelerometer-based inertial measurement unit (IMU) on a silicon wafer.

**Payoffs.** This DTO will meet warfighter needs for aircraft and affordable smart weapons that can maintain precision navigation during Global Positioning System (GPS) blackouts, and will provide enough accuracy to enable the weapon to maintain the circular error probability (CEP) specification. The hybridization will allow for high-accuracy performance at a price appropriate for tactical weapons such as joint standoff weapon (JSOW) and joint direct attack munition (JDAM); the cost goal is one-half of the baseline IMU price and provides superior performance. The GGP program ends in FY00 using FY99 funds. Current achievements include a navigation-grade (50- to 150-mg accel bias) silicon accelerometer, navigation-grade (less than 0.01 deg/hr gyro bias) interferometric fiber-optic gyroscope (IFOG), and a miniature all-in-view GPS receiver. Integration into a tightly integrated GPS/INS system is ongoing and will complete in FY00.

**Challenges.** Specific challenges include obtaining navigation-grade performance (1 nmi/hr) with (1) silicon accelerometer over the full military environment (-54° to +85°C); (2) IFOG employing fiber (approximately 1,000 m); (3) polarizing polymer waveguides (the degree to which these waveguides polarize the light is directly proportional to the ultimate navigation performance); (4) interface of the light source and detectors to the polymer waveguides; (5) phase modulator constant versus optical loss tradeoff; (6) level of integration (processes for each fabrication step must be devised so as to not adversely impact previous steps); and (7) heat management, temperature, and gradient-sensitive elements in the fiber-optic-guided optical circuit that are thermally shorted or isolated without adversely impacting the package cost or size.

### Milestones/Metrics.

FY2000: Demonstrate an integrated flightworthy IMU/GPS system that meets the JSOW cost and operational effectiveness analysis requirement of no GPS aiding. Transition to program office.

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### WE.21 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603217N	R0447	2.0	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>2.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.22 High-Power Microwave C<sup>2</sup>W/IW Technology

**Objectives.** Develop and demonstrate high-power microwave (HPM) technology to disrupt and degrade electronics in communication and information systems to support command and control warfare/information warfare (C<sup>2</sup>W/IW) missions. Delivery systems such as standoff missiles, unmanned aerial vehicles, and ground vehicles will be evaluated. Technology for air-delivered submunitions will be developed building on solid-state and gas switches delivered in FY99. Initial efforts will focus on demonstrating effectiveness using ground-mobile or compact devices delivered in FY99. Subsequently, environmental and deployment requirements will be addressed in an air-delivered munition to be demonstrated in FY02. Current technology, on a ground-based platform, was used in a demonstration against a representative command post for an HPM IW ACTD (DTO H.11) in FY99. (Specific program, system design, and system effectiveness details are classified.)

**Payoffs.** Adversaries will be denied the use of electronic information collection, processing, and communications equipment through application of wideband sources. HPM technology will provide a means of electronic attack that is nonlethal and causes little or no collateral damage. Only electronic systems will be effected by the device(s). By the use of wideband source technology, guided by valid laboratory experimentation, limited prior target intelligence will be required. The device will provide persistent disruption of operations for the duration of pulsing with the added advantage of confusion and psychological effects in addition to the direct effect.

**Challenges.** The challenges of this DTO include (1) understanding efficacy of available sources to cause desired effects in target equipment, (2) improving coupling data and models to predict penetration of various buildings, (3) developing more accurate simulation, prediction, and measures of effectiveness codes, and (4) developing source components to meet radiated field requirements.

### Milestones/Metrics.

FY2000: Demonstrate brassboard compact device (over 70% effective). For aerial delivery, develop low-power submunition RF payload.

FY2001: Demonstrate compact device (over 80% effective). Ground-based demonstration of air-delivered submunition RF payload (over 70% effective).

FY2002: Demonstrate air-delivered submunition (80% effective).

FY2003: Complete design, packaging, and transition of compact and air-delivered devices.

#### Customer POC

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### WE.22 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602601F	5797	1.8	0.0	0.0	0.0	0.0	0.0
0602605F	4867	0.0	2.0	1.0	0.0	0.0	0.0
0603605F	3152	2.8	3.3	3.5	3.6	0.0	0.0
	<b>DTO Total</b>	<b>4.6</b>	<b>5.3</b>	<b>4.5</b>	<b>3.6</b>	<b>0.0</b>	<b>0.0</b>

**WE.29 Antitorpedo Torpedo ATD**

**Objectives.** Demonstrate, by FY00, antitorpedo torpedo (ATT) homing and fuzing that can be incorporated into existing and planned torpedo and submarine regional warfare systems. The effort is to embed ATT homing and fuzing technology developed in the 6.2 program into a prototype guidance system; and to demonstrate performance against torpedo targets in CM and ship wakes and against maneuvering targets. This technology will be developed and demonstrated based on common hardware and software compatible with existing and future U.S. torpedo systems (i.e., 21-in, 12.75-in, and 6.25-in diameters).

**Payoffs.** Surface ships and submarines need a hard-kill torpedo defense capability to ensure their survivability in future conflicts. Fewer ships will be operating in littoral waters and will encounter an emerging threat posed by the proliferation of quiet-capable, diesel-electric submarines armed with modern lethal weapons. Many of these encounters will be close in and will demand quick reaction. Closest points of approach (CPAs) that met or exceeded the Program Executive Office (Undersea Warfare) (PEO/USW) requirements (number is classified) in one-on-one engagements against a maneuvering threat and engagements in the wake environment were demonstrated.

**Challenges.** The technologies to be demonstrated include high-range-resolution, high-repetition waveforms; high-pulse-rate signal and image processing; adaptive CM processing; integrated homing and fuzing; acoustic intercept receiver; data fusion; and torpedo defense-specific tactics. Success of the DTO will be measured against the CPAs required to destroy antisubmarine warfare and antisurface ship warfare threat torpedoes. Demonstration of these CPAs will include operation against threat torpedoes in realistic surface ship and submarine environments. The challenges are close-in, quick-reaction encounters; high-speed, highly maneuvering targets; development of high-range-resolution, high-repetition-rate waveforms; homing and fuzing in the presence of countermeasures and ship wakes; and development of torpedo-defense-specific tactics.

**Milestones/Metrics.**

FY2000: Conduct in-water demonstration of full capability in realistic warfighting scenarios with system effectiveness that meets or exceeds PEO (USW) requirements (number is classified).

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**WE.29 S&T Funding (\$ millions)**

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603792N	R1889	5.0	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>5.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.32 Broadband Torpedo Sonar Demonstration

**Objectives.** Demonstrate, by FY01, a broadband torpedo guidance system for harsh shallow-water and advanced CM environments. Specifically, the goal is to demonstrate a 40% improvement in torpedo effectiveness in harsh shallow-water environments, and 100% improvement in torpedo effectiveness in countered environments. Performance improvements are sought in the areas of detection and classification, broadband sensing and processing, CM resistance, homing, terminal homing, and intelligence tactical control for torpedoes operating against diesel-electric submarines and advanced CM devices in shallow water.

**Payoffs.** The torpedo guidance system developed and demonstrated in this DTO will provide significant and cost-effective enhancements to warfighting capabilities. The demonstrations will show detection ranges increased by a factor of two, and false-alarm probabilities reduced by a factor of two relative to existing narrowband systems. The improvement of system performance (i.e., improvement of torpedo effectiveness) will be inserted into future upgrades of the MK48/advanced capability (ADCAP) heavyweight torpedo. Specifically, the ADCAP is being upgraded with the Common Broadband Advanced Sonar System (CBASS), which will provide a broadband capability to the weapon and is scheduled to be operational in FY03. Technologies developed and demonstrated in this DTO will transition to the CBASS, and have potential for transition for sonar processing in the new lightweight torpedo (MK54) and for surface ships and submarines.

**Challenges.** The technical challenges are to develop transducer elements and arrays with 5X the bandwidth of current weapon systems; develop algorithms, signal processing, and tactical processing to take advantage of the increased bandwidth; develop broadband techniques to increase detection ranges by a factor of two; develop broadband techniques to reduce false-alarm probabilities by a factor of two; and develop covert detection and homing technologies.

### Milestones/Metrics.

FY2000: Test and evaluate intelligent architecture for countermeasure resistance for 50% improvement in torpedo effectiveness in countered environments. (The baseline system capability is classified.)

FY2001: Conduct major in-water testing to demonstrate torpedo effectiveness improvements of 40% in shallow water environments and 100% in countered environments.

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### WE.32 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602633N	00000	3.1	3.2	0.0	0.0	0.0	0.0
0603747N	R2267	2.7	2.7	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>5.8</b>	<b>5.9</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

**WE.33 Electrothermal-Chemical Armaments for Direct Fire**

**Objectives.** Improve the lethality of direct-fire ground systems by providing the technology to significantly increase available muzzle energy. A well-established technique to improve penetration is to increase energy delivered to the target. One option is to provide a larger-caliber cannon. However, this approach is not supported by the user as the increased-caliber weapon requires significant vehicle modifications. Electrothermal-chemical (ETC) propulsion offers the possibility of providing increased lethality without increasing gun size. As such, the battlefield advantage of direct fire would be maintained without major changes in the cannon or ammunition envelope. The program will demonstrate the technical feasibility of ETC propulsion for near-term (2005–2010) direct-fire weapon systems. By the end of FY00, the program will begin examination of ETC for medium-caliber applications and identify ETC tailored propellants (low vulnerability with high energy). By the end of FY01, the program will test propellant candidates for ETC and demonstrate a medium-caliber ETC igniter. By the end of FY02, the program will demonstrate a 25% increase in muzzle kinetic energy for a medium-caliber ETC gun.

**Payoffs.** ETC will enhance the lethality of direct-fire cannons by providing a significant increase in muzzle energy within the existing weapon envelope. The ETC cartridge is essentially identical in mass and geometry to current ammunition, thus, no changes to ammunition storage or handling are required.

**Challenges.** Technical barriers for ETC include insensitive high-energy, high-density propellant formulations and geometries; design of plasma generators for effective coupling of electrical energy into propellants; and control of propellant temperature performance effects.

**Milestones/Metrics.**

FY2000: Begin examination of ETC for medium-caliber applications; identify ETC-tailored propellants (low vulnerability with high energy).

FY2001: Test propellant candidates for ETC; demonstrate a medium-caliber ETC igniter.

FY2002: Demonstrate a 25% increase in muzzle kinetic energy for a medium-caliber ETC gun.

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**WE.33 S&T Funding (\$ millions)**

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602618A	H75	2.5	2.0	1.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>2.5</b>	<b>2.0</b>	<b>1.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

### **WE.34 Objective Crew-Served Weapon ATD**

**Objectives.** Develop the Objective Crew-Served Weapon (OCSW) System—a lightweight, two-man-portable, single replacement system for select 40-mm MK19 grenade machine guns, .50-caliber M2 heavy machine guns, and medium machine guns. It will provide decisively violent and suppressive target effects out to 2,000 meters, including a high probability of incapacitation and suppression against protected personnel (body armor and in defilade) and a high potential to damage light- and lightly armored material vehicles. The OCSW will exploit lightweight, high-strength design and materials; modular optoelectronic full-solution fire control (leveraged from the Objective Individual Combat Weapon (OICW) ATD program); miniature electronic time-set fuzing; and high-explosive, air-bursting munitions.

**Payoffs.** The OCSW provides for a high probability of incapacitation and suppression against individual and group protected targets. The system also provides an all new capability to defeat defilade targets, which current systems have little or no capability of defeating. The OCSW system will be lightweight and two-man portable, allowing for dismounted crew-served weapon application and mounted vehicular application.

**Challenges.** Technical challenges for the OCSW program include efficient munition fragmentation, electronic miniaturization (fire control and fuze), overall system weight (including durability and reliability), and system integration. There are no significant technical barriers in the OCSW program.

#### **Milestones/Metrics.**

FY2000: Demonstrate from a lightweight (less than 50 lb) weapon (gun, pintle, T&E, and tripod); fully integrated fuze functions of airburst, point detonation and self-destruct; and rapid-fire (burst mode) fuze set of high-explosive precision airburst munition.

FY2001: Demonstrate a weapon-launched airburst munition using integrated crew-served fire control (leveraged from OICW ATD; STO III.I.1), Land Warrior (LW) interoperability as a threshold, Force XXI LW interoperability as a goal, and thermal module interoperability utilizing 1,000-m thermal module from OICW as a threshold. Leverage other uncooled thermal module to assess 2,000-m capability as a goal.

FY2002: Demonstrate overall system performance including greater probability of hit, incapacitation, and suppression out to 2,000 m (when compared to the current MK19 and M2 machine guns) with a system weight reduction of greater than 50%. Demonstrate the technological maturity and operational utility of the OCSW in safety and technical feasibility tests and live-fire troop testing.

**Customer POC**

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**WE.34 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602623A	H21	3.5	3.0	2.2	0.0	0.0	0.0
0603607A	627	8.5	4.5	2.7	0.0	0.0	0.0
0603640M	R2223	0.5	0.5	2.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>12.5</b>	<b>7.9</b>	<b>6.9</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.35 Air Superiority Missile Technology

**Objectives.** Through design and ground tests, demonstrate reaction jet flight control technologies that will significantly enhance air-to-air effectiveness in all phases of air combat. Reaction jet control technologies will permit the development of an offensive sphere around the launch aircraft to allow successful beyond- and within-visual-range target intercepts without regard to target off-boresight angle or orientation. Technologies will also facilitate unprecedented multimission kinematic/maneuvering performance for future multirole missile concepts.

**Payoffs.** This DTO will demonstrate reaction jet control technologies that will allow for a dramatically expanded weapon engagement zone, providing future pilots with the ability to engage multiple targets throughout all phases of air combat regardless of initial engagement geometry. These technologies will provide unprecedented missile maneuverability without degrading beyond-visual-range performance. Laboratory manned-air-combat analyses have shown that this radically new missile kinematic capability will allow pilots to engage and defeat targets from defensive postures that significantly increase Blue survival. Integration of this technology is projected to add less than 5% to the overall unit production cost of an advanced medium-range air-to-air missile (AMRAAM)-type weapon resulting in an extremely favorable cost-benefit relationship.

**Challenges.** Technical barriers involve developing reaction jet control implementations consistent with inventory AMRAAM rocket motors; form, fit, and function; hot-gas valve materials and reaction jet response times less than 10 ms to full thrust; stable flight of modified AMRAAM at 90-deg or more angle of attack; and compact packaging of all new technologies within the length and weight constraints of the F-22 weapons bay.

### Milestones/Metrics.

FY2000: Extensive developmental ground-test firings of reaction jets on inventory AMRAAM P<sup>3</sup>I rocket motors. Extensive high-angle-of-attack wind tunnel tests of test vehicle configuration.

FY2001: Flight test worthy hardware fabrication/ground tests.

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### WE.35 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602602F	2068	2.0	2.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>2.0</b>	<b>2.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.39 Tactical Missile Propulsion

**Objectives.** Enhance the warfighter's overall capability and survivability by pursuing robust propulsion technologies that will increase weapon systems' kinematic performance and utility. This DTO is an updated revision to DTO SP.13.06, Tactical Rocket Propulsion AT, which has been terminated. It has become a Weapons DTO because missile propulsion is a weapons-related technology. The needs, goals, and payoffs for tactical missile technology are best determined by the weapon's technical operational community. Rocket propulsion technologies are divided into four technology areas: propellants, control systems, combustion and energy conversion devices, and propellant management devices. Objectives within each technology area are based on the DoD Integrated High-Payoff Rocket Propulsion Technology (IHRPT) time-phased goals and include technologies that will result in increased propellant energy, increased motor volumetric loading, decreased component weight and volume, and increased component efficiency without sacrificing system safety or increasing cost.

**Payoffs.** By achieving the time-phased goals of the IHRPT program, warfighter capability will be enhanced through increased launch range, decreased time to target, increased average velocity, increased F- and A-pole, larger engagement envelopes and no-escape zones, and increased weapon lethality. Specific goals for years 2000, 2005, and 2010 for rocket propulsion are increases in delivered energy of, respectively, 3%, 7%, and 15%; increases in motor mass fraction of 2%, 5%, and 10% for motors without thrust vector control or thrust management; and mass fraction increases of 10%, 20%, and 30% for motors with thrust vector control or thrust management—all while meeting safety requirements and maintaining cost.

**Challenges.** Challenges for rocket propulsion are high-energy propellant ingredients and formulations that are insensitive-munitions-compatible, affordable, lightweight, high-strength, and high-pressure case materials; thrust management devices and no-/low-erosion nozzle materials; and high-power, compact, efficient thrust-vector control devices.

### Milestones/Metrics.

FY2000: Increase delivered energy by 3%; increase mass fraction by 2% (motors without thrust vector control (TVC)); and increase mass fraction by 5% (motors with TVC).

FY2003: Increase delivered energy by nearly 6%; increase mass fraction by nearly 4% (motors without TVC); and increase mass fraction by nearly 9% (motors with TVC).

#### Customer POC

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#### USD(A&T) POC

Dr. George ULLRICH  
OSD/DUSD

**\*WE.39 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602111N	00000	3.0	3.0	3.0	3.0	0.0	0.0
0602203F	4847	0.0	3.0	0.0	0.0	0.0	0.0
0602601F	1011	3.0	0.0	0.0	0.0	0.0	0.0
0603217N	R0447	2.0	3.0	3.0	3.0	0.0	0.0
0603302F	6339	0.3	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>8.3</b>	<b>9.0</b>	<b>6.0</b>	<b>6.0</b>	<b>0.0</b>	<b>0.0</b>

\*The decision with regard to out year funding for propulsion was made late in the Budget Review.  
 Out year DTO funding for this effort will be determined during the next planning and programming cycle.

**WE.41     Multimission Space-Based Laser**

**Objectives.** Develop and demonstrate space-based laser (SBL) technologies to support a system development decision for a multimission SBL that would first perform national missile defense, and then other missions including theater missile defense, space control, etc. Previously demonstrated technologies—a megawatt-class HF-chemical-laser lightweight 4-m segmented telescope and hierarchical outgoing wave-front beam control technologies—were successfully integrated and demonstrated in the Alpha/LAMP Integration (ALI) experiment. Efforts in FY99 focused on experiment of definition, identification, and development of technologies (e.g., high-efficiency laser nozzles) that could enable launch of an operational-class SBL on existing launch vehicles. Alternative high-energy laser (HEL) concepts were also analyzed. These SBL technologies will be incorporated in a ground Integrated Payload Technology Demonstration in FY06, followed by an Integrated Flight Experiment (IFX) by FY12. The IFX effort is now underway with the FY99 contract award to SBL Joint Venture Team (Boeing, Lockheed Martin, and TRW) with total system authority. The High-Altitude Balloon Experiment (HABE) began ground field testing in FY 99 and intends to demonstrate in FY01, at low power in the target environment, a complete acquisition, tracking, and pointing suite scalable to SBL operational requirements.

**Payoffs.** SBL provides the nation with a highly effective, continuous global boost-phase intercept option for both national and theater missile defense. An SBL system could defend against missiles without putting the lives of U.S. military personnel at risk. With its long range and speed of light defense, it accomplishes boost-phase intercept at the earliest possible moment, offering the highest probability that intercepted missile fragments (possibly containing active nuclear, biological, or chemical nuclear materials) will fall within the attacker's territory, not on defended assets. This system can provide many ancillary capabilities including space control, air defense, global surveillance, and target detection and designation for other systems.

**Challenges.** The primary technical challenge (at the component level) for an operational system is the development of a large (10-m class), erectable beam-expansion telescope. Equally challenging is the development and integration of a complete system to include lightweight components mated to a suitable spacecraft structure.

**Milestones/Metrics.**

FY2000: Complete HEL through space affordability and architecture study to identify most promising HEL concepts.

FY2001: Complete SBL IFX system requirements review. Conduct end-to-end tracking and fire control demonstration on HABE at 26-km altitude. Demonstrate pointing error budget in timeline equivalent to operational engagement.

FY2002: Integrated test unit (ITU) Preliminary Design Review (PDR)

FY2003: IFX PDR.

FY2004: ITU Critical Design Review

FY2005: Beam control element test plan complete

**Customer POC**

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**WE.41 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0603173C	1360	73.2	0.0	0.0	0.0	0.0	0.0
0603174C	1360	0.0	74.5	74.5	74.4	74.3	74.3
0603876F	4779	64.0	63.2	63.1	63.0	63.6	64.0
	<b>DTO Total</b>	<b>137.2</b>	<b>137.7</b>	<b>137.6</b>	<b>137.4</b>	<b>137.9</b>	<b>138.3</b>

**WE.42 Laser Aircraft Self-Protect Missile Countermeasures**

**Objectives.** Demonstrate a robust, multifunctional laser countermeasure (LCM) effective against both current-generation reticle scanning (RS) and next-generation imaging IR (I<sup>2</sup>R) missile threats. The multifunctional LCM will utilize novel, progressive effects in order to counter RS and I<sup>2</sup>R missile threats. Among the novel effects to be investigated are ultra-fast laser-material interactions. The laser development and beam control activities associated with this program will focus on low-cost, reliable technologies. This development program will emphasize technologies applicable as P<sup>3</sup>I upgrades to existing systems in order to counter next-generation threats. This program is a coordinated Army, Navy, and Air Force effort.

**Payoffs.** Deceptive jamming countermeasures for conventional SAM and AAM threats are not expected to be effective against most emerging I<sup>2</sup>R missile threats. Upgrades to existing countermeasures systems will be required. The LCM program offers the potential of a robust, multifunctional countermeasure for both current and next-generation missile threats. Advanced concepts such as ultra-fast lasers and highly efficient, room-temperature, mid-IR, solid-state lasers make the LCM a more progressive solution to robust countermeasures. The P<sup>3</sup>I nature of the program will allow for very low-cost “drop-in” components to upgrade existing countermeasures systems.

**Challenges.** The LCM program will require identification of optimum laser characteristics including pulse format, average power, and wavelength for a progressive multifunctional countermeasure mission. The program will need to develop novel technologies that have the potential of being P<sup>3</sup>I upgrades to existing systems.

**Milestones/Metrics.**

FY2000: Laboratory demonstration of optimal laser characteristics for countering I<sup>2</sup>R arrays.

FY2001: Laboratory demonstration of the multifunctional LCM concept against a surrogate missile threat.

FY2002: Static field demonstration of the LCM concept utilizing static pointer/tracker optics and surrogate missile threat.

FY2003: Demonstration of the LCM concept utilizing a packaged laser/beam-control system.

FY2004: Demonstration of the LCM concept utilizing a dynamic laser/beam-control system.

FY2005: Demonstration of an LCM system suitable for P<sup>3</sup>I to existing system.

**Customer POC**

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HQ AMC/XPR

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**WE.42 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602601F	3326	4.6	0.0	0.0	0.0	0.0	0.0
0602605F	4866	0.0	1.7	3.6	3.0	1.0	1.0
0603605F	3151	2.7	2.0	3.9	4.4	3.0	3.0
	<b>DTO Total</b>	<b>7.3</b>	<b>3.7</b>	<b>7.5</b>	<b>7.4</b>	<b>4.0</b>	<b>4.0</b>

## **WE.43    Advanced Multiband Infrared Countermeasures Laser Source Solution Technology**

**Objectives.** Develop and demonstrate a multiband, mid-IR semiconductor laser system. The focus of the multiband infrared countermeasure (IRCM) laser source solution effort is to allow fixed- and rotary-wing IRCM programs, such as the DoD tri-service Advanced Threat IRCM (ATIRCM) program, to more effectively jam current generation threats. This laser program is a coordinated Army, Navy, and Air Force effort to develop and demonstrate semiconductor laser technology capable of countering IR-guided missile threats.

**Payoffs.** Countermeasures against the current threat of advanced IR-guided surface-to-air and air-to-air missiles will require laser sources to provide the precisely directed high-intensity beams of coherent mid-IR jamming energy. Current incoherent IR jamming sources (lamps) are relatively large, heavy, and inefficient and do not provide adequate emission in the Band IV spectral region to counter advanced threats. Many laser sources now under development offer higher jamming intensities, but require relatively inefficient optical conversion into some of the required mid-IR bands. In addition, these laser sources are relatively large and heavy, and their input power requirements are still too excessive for installation in tactical fixed-wing aircraft and smaller rotary-wing aircraft. However, semiconductor laser technologies offer the potential of very high electrical efficiency and brightness, and lightweight and compact packaging. This potential for ultra-compact, efficient MIR semiconductor lasers is being exploited in this DTO. The DTO has developed, demonstrated, and delivered high-brightness 2- $\mu\text{m}$  semiconductor lasers for IRCM applications. The same technology is being applied to semiconductor materials for near-term application to the Army ATIRCM Technology program. The 4- $\mu\text{m}$  sources were delivered January 2000. During FY00, higher brightness issues will be addressed.

**Challenges.** The principal technology issues are development of high-brightness, high-operating-temperature Band IV semiconductor lasers. Specific performance goals are to improve the brightness by a factor of three over current-generation Band I and Band IV semiconductor lasers using less than 500 watts of aircraft prime power.

### **Milestones/Metrics.**

FY2000: Demonstrate high-brightness (200–400 kW per steradian per  $\text{cm}^2$ ) multiband semiconductor lasers emitting 2-W peak/0.5-W average power per band. Emphasis will be placed on electrical efficiency, brightness, size, and weight.

#### **Customer POC**

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Dr. George ULLRICH  
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### **WE.43 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602601F	3326	0.5	0.0	0.0	0.0	0.0	0.0
0603605F	3151	3.0	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>3.5</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.45 Sea Mines

**Objectives.** Demonstrate a new littoral minefield concept through the integration of distributed multi-influence sensor fusion, lightweight hybrid torpedo, and mine/minefield remote control technologies. Demonstrated capabilities include passive distributed acoustic and EM sensors for detecting slow, quiet surface ships and submarines to ranges of 700 m with minimum false alarms; sensor fusion algorithms for enhanced target localization and classification; active acoustic sensors for target verification and tracking; two-way communications for full remote control of mines/minefield; and autonomous distributed minefield control. This DTO will also develop and demonstrate improved nonacoustic (advanced) sensors; multisensor fusion; and very shallow-water, extended-range communication for remote control to support development of a controllable, nonsweepable universal fixed mine to provide for a more logistically supportable state-of-the-art mine inventory to cover the full range of mine requirements from very shallow to shallow-intermediate depths.

**Payoffs.** This DTO will allow a commander to completely monitor and control a designated ocean battlespace. The Navy's current medium-water-depth mine (MK56) is 1950's technology that has very limited detection range, requires extensive numbers of mines (and delivery sorties) to achieve a significant level of effectiveness, and is being retired from service. 1960's deep-water mines (MK60 Captor) lose effectiveness in the shallow waters of the littoral, are not optimized to counter diesel-electric submarines, and cannot target surface ships. New underwater communications technologies connecting distributed autonomous sensor nodes will allow large-area coverage with fewer numbers of mines, and enhance tactical flexibility.

**Challenges.** Technical barriers include low-power, long-range underwater detection of quiet targets; automated classification of targets; multi-influence sensor fusion and real-time target decision algorithms; shallow/very shallow underwater communications at tactically significant ranges; autonomous minefield control and coordination protocols; safe, reliable, small, high-energy, long-life batteries; and minefield data management.

### Milestones/Metrics.

FY2000: Demonstrate integrated distributed sensor array and active acoustic sensor array in 50-m depth to achieve target detection and localization to +/-10% accuracy with near zero false alarms. Demonstrate two-way remote control from manned platforms to shallow-water mines with 99% reliability.

FY2001: Conduct integrated demonstration of critical technologies (remote control, target detection, and encapsulated torpedo launch and control) for a littoral sea mine that increases the area coverage by a factor of 40 over the existing MK-56 mine.

FY2002: Demonstrate at sea the capability to provide post-launch targeting updates to a mobile mine.

#### Customer POC

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**WE.45 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602315N	00000	2.8	2.9	2.9	0.0	0.0	0.0
0603782N	R2226	4.5	4.5	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>7.3</b>	<b>7.4</b>	<b>2.9</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## **WE.50 Compact Kinetic Energy Missile Technology**

**Objectives.** Develop and demonstrate advanced kinetic energy missile (KEM) technology necessary for the next-generation hypervelocity KE weapon. This program will demonstrate enhanced system lethality against advanced and active Future Compact Vehicle (FCV) threat armor target arrays with a reduced mass hypervelocity KEM (25–30 kg) testbed. Miniature guidance inertial measurement unit (IMU) technology will demonstrate high-g missile launch independent of launcher attitude and provide precision kill at target impact. A more efficient high-performance, nondetonable propulsion system will be developed and demonstrated to provide peak velocity (greater than Mach 6.5) at less than 500 m and deliver more than 10 MJ of penetrator energy on target over a range of 0.4–4 km. This DTO will incorporate novel lethal mechanism configurations to include chemical energy warhead to reduce the total energy requirement and increase zero-range lethality, and develop minimum-launch-signature, high-performance, nondetonable, minimum-smoke propulsion unit.

**Payoffs.** The technologies demonstrated will be transitioned to a hypervelocity weapon system for the next-generation KEM concept for the FCV. These technologies will yield a compact KEM testbed concept (~4 in length) that maintains line-of-sight antitank (LOSAT)-like lethality while reducing takeoff weight to 25%–30% of the LOSAT missile. The CKEM testbed concept maintains LOSAT lethality while reducing the LOSAT takeoff weight by 40%–50%. The technologies demonstrated will yield the opportunity to expand the engagement area and more than double the number of stowed kills for a given launch platform. Demonstration of the boost-phase IMU orientation capability coupled with the advanced guidance and control (G&C) capabilities increase existing horizontal field of regard by 50%–100% and may provide the capability for vertical launch or 360-deg (azimuth) by 90-deg (elevation) launcher orientation. Energy on target over the entire system range is more than three times the current muzzle energy of cannon-launched projectiles. The flight body testbed will provide the maneuvering capability necessary to destroy attacking rotary-wing aircraft. This program will enhance system lethality against future advanced and active FCV threat armor arrays and significantly increase launch platform survivability. Additionally, the ability to fire on the move makes the CKEM technology and testbed a prime candidate for the main weapon system on the FCV.

**Challenges.** The challenges in the CKEM program include (1) miniaturized guidance and continuous control actuation for Mach 6.5, 100-g lateral maneuver capability; (2) more efficient, high-performance, minimum-smoke, nondetonable propellant with a specific impulse of 250 and a burn time less than 0.6 s; (3) enhanced lethality from novel reduced-mass KE penetrator/missile performance; (4) application of high strength-to-density ratio composite in the propulsion unit; and (5) firing on the move.

### **Milestones/Metrics.**

FY2000: Demonstrate 25% increase in missile lethality with novel penetrators and quantify damage mechanisms other than perforation. Implement industry/government cooperative programs for component development in the areas of high-g guidance components and advanced propulsion.

FY2001: Joint government–industry operational environment component demonstrations for next-generation technology in advanced propulsion, enhanced lethality, and miniaturized high-g G&C components.

FY2002: Joint government–industry operational environment component demonstrations for next-generation technology in advanced propulsion, enhanced lethality, and miniaturized high-g G&C components. Validate through utilization of battlefield SMART. Build emulator proposed for FCV system with full 6 DOF.

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**WE.50 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602303A	214	10.7	19.1	10.3	0.0	0.0	0.0
0603313A	655	0.0	0.0	7.3	0.0	0.0	0.0
	<b>DTO Total</b>	<b>10.7</b>	<b>19.1</b>	<b>17.7</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.52 Best Buy ATD

**Objectives.** Develop and demonstrate a gun-fired, rocket-assisted, jointed, composite 5-in projectile with a high lift-to-drag ratio, and double the number of carried submunitions compared to the Extended-Range Gun Munition (ERGM, EX-171 from 72 to 143). The projectile will be delivered from sea-based guns to at least 50% further range (from 63–100 nmi), and will match or exceed expected shore performance of the 155-mm M198 gun-fired projectile.

**Payoffs.** Current naval gun projectiles in development do not meet OPNAV goals or naval surface fire support cost and operational analysis recommendations. The goals set forth are to use existing assets (Navy 5-inch gun) to support Marines’ operational maneuver from the sea for effective at-sea fire support at a minimum range of 75 nmi with 125 submunitions. A unit production cost (UPC) savings of over 50% is required, when based on an identical number of identical submunitions delivered to maximum range and when compared to the baseline ERGM program. In other words, Best Buy will deliver twice the number of submunitions, to a longer range, in a single round at under a 50% increase in UPC.

**Challenges.** Composite projectiles with fine length-to-diameter ratios (110:5 in) require significant design considerations if they are to be guided with control surfaces located in the nose, and if they are to survive the gun launch-loading environment. Technology for producing composites that are strong enough to carry launch loads, but flexible or elastic enough to survive off-axis accelerations induced on exiting the gun is not currently available. Long composite airframes need to be sized and designed with a mid-body joint that connects forward- and aft-burning rocket motor sections for a “burn-through-the-joint” motor to achieve required range and payload goals and be compatible with existing naval gun autoloaders. The joint must be structurally strong to survive and distribute launch loads through the thin composite airframe and strong enough to survive internal pressures produced by the burning rocket motor propellant in the forward rocket motor section, but lightweight enough to meet weight goals. Guidance and control systems are derived from the EX-171 ERGM program with minimal adaptation in the control algorithms for the flexibility of a long, fine structure. The system is additionally complicated by the need to maintain weight and physical dimension compatibility with the existing 5-inch MK45 Mod 4 gun autoloader system for multiple ramming operations, which mate the two separate airframe sections together in the gun barrel. Technical barriers for developing a multiple-ram, jointed airframe that is mated inside the gun barrel during Navy gun fire missions include gun launch survival of a jointed composite airframe; ignition and performance from a jointed, dual-pulse rocket motor from the same aft nozzle; controllable flight of a long, slender airframe from the existing IMU system after launch that achieves range goals; and delivery of a lethal payload within the required CEP of the EX-171.

### Milestones/Metrics.

FY2000: Flight testing of best-buy projectile demonstrating range and payload. Demonstration of submunition dispersal.

#### Customer POC

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#### Service/Agency POC

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ONR

#### USD(A&T) POC

Dr. George ULLRICH  
OSD/DUSD

### WE.52 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603792N	R1889	1.4	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>1.4</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

**WE.54 Reactive Material Warhead ATD**

**Objectives.** Demonstrate the ability of missile warheads to achieve catastrophic structural kills of cruise missile and manned aircraft targets by enhancing traditional KE defeat effects with fragment chemical energy that is released when fragments impact targets. The best candidate reactive material mixture will be incorporated into warhead prototypes, such that tests in a static arena environment against representative targets would demonstrate the potential catastrophic performance enhancement.

**Payoffs.** When launched into cruise missiles and manned aircraft, reactive materials have shown the potential capacity to react, creating significant overpressure, rupturing heat, and incendiary effects, thereby improving the damage over the KE-only effects normally found in inert metal fragments available in most current warheads. Used for ship self-defense and air superiority, reactive materials offer the potential of significantly improved catastrophic kills at current miss distances or sustained lethality at misses up to twice that of current systems. Candidate solid reactive materials have the capability to double the mission kill or catastrophic kill radius in missile warheads for ship self-defense and other air defense applications. It is expected that the addition of reactive materials will have only minor impact on system unit cost, but may provide major savings in the number of rounds required for target kill.

**Challenges.** Significant risk exists in the capability to explosively launch reactive materials, deliver them unreacted to the target, and trigger them to release lethal energy within the target. Additional challenges include packaging in a tactically effective configuration that has the ability to achieve effective fragment velocities and probability of hit on target.

**Milestones/Metrics.**

FY2000: Determine fragment design parameters for hydrocode and experiments. Determine final material characteristics for composition mix/morphology/reaction rates. Assess initial performance and perform analyses to verify capability to increase level of damage to catastrophic kill at 2X standoff.

FY2001: Demonstrate explosive launch and reaction on target to verify stable flight paths and fragment flight distances (less than 10% of material reacts during flight) and reactions on target to verify capability to enhance damage level to catastrophic kill in appropriate encounters. Determine warhead/fragment design to weaponizable design (mechanical analysis and design layouts).

FY2002: Demonstrate repeatable explosive launch with prototype warheads for consistent fragment velocity, predictable fragment flight paths, reactions at target with appropriate release rates, and lethal damage. Demonstrate prototype warheads in performance and lethality arenas to verify enhanced lethality, verify catastrophic damage at 2X standoff, and verify 50% damage increase at current standoff. Conduct end-game performance analyses and validate 50% increase in missile system terminal effectiveness.

**Customer POC**

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**WE.54 S&T Funding (\$ millions)**

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603792N	R1889	4.4	4.7	5.2	0.0	0.0	0.0
	<b>DTO Total</b>	<b>4.4</b>	<b>4.7</b>	<b>5.2</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## **WE.55     Reduced-Size Torpedo Subsystem Demonstration**

**Objectives.** Develop and demonstrate, by 2003, torpedo subsystems in reduced sizes so that these subsystems or components would be applicable to various sizes of torpedoes and counterweapons (21-, 12.75-, and 6.25-in diameters). The technology developed would be compatible with existing and future U.S. torpedo systems and would be capable of insertion into existing operational weapon systems to provide improved warfighting capabilities.

**Payoffs.** The technology being developed offers payoffs in reduced cost of ownership due to the commonality of components among various sizes of weapons and counterweapons, and greatly reduced cost of support equipment and infrastructure of these systems. These technologies would permit the development of smaller weapons and counterweapons, which allows the deployment of a larger number of weapons or a greater weapon mix without an increase in platform size. Advanced directed-energy warhead technologies with the potential of achieving at least 2X the performance of current undersea warheads are under development. High-energy-density, high-power-density propulsion technologies with the potential of achieving at least 7X the performance of current advanced capability (ADCAP) propulsion system are under development.

**Challenges.** The major technical challenge is to develop and demonstrate smaller components without sacrificing performance. This requires the development of warhead concepts to focus the shock, thereby reducing losses due to spherical losses and permitting greater warhead performance in reduced size of microelectromechanical systems (MEMS)- based safe-and-arm (S&A) systems to a size typical of integrated circuits; and development of high-energy-density, high-power-density power plants.

### **Milestones/Metrics.**

FY2000: Demonstrate feasibility of advanced torpedo warhead concept with at least 2X performance improvement over current capability. Demonstrate full-scale energy source components for 21-in propulsion energy source.

FY2001: Demonstrate feasibility of warhead concepts for 35%–50% volume reduction over current warheads for half-length torpedo. Demonstrate integrated 21-in propulsion energy source with proof-of-concept combustor/turbine engine.

FY2002: Demonstrate MEMS-based S&A system with 90% volume reduction over current ADCAP S&A. Demonstrate integrated 21-in propulsion energy source with high-performance combustor/turbine engine.

FY2003: Demonstrate complete propulsion power plant in breadboard system test for transition to advanced technology development program.

#### **Customer POC**

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**WE.55 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602633N	00000	5.1	4.7	4.4	3.9	0.0	0.0
	<b>DTO Total</b>	<b>5.1</b>	<b>4.7</b>	<b>4.4</b>	<b>3.9</b>	<b>0.0</b>	<b>0.0</b>

## **WE.57 Lethality/Vulnerability Models for High-Value Fixed Targets**

**Objectives.** Verify and validate lethality/vulnerability (L/V) models for predicting weapon effects against high-value fixed targets. Current L/V tools that are used to assess the performance of conceptual and inventory weapons against high-value fixed targets have extremely large uncertainties. These models and tools are currently used to conduct studies and analyses in preparation for major acquisition milestones, thereby impacting critical decisions on advanced concepts and weapons technologies. Additionally, these models and tools are used by warfighters for pre-attack planning for and post-attack assessment of strikes against high-value fixed targets. Most recently, some of the models were used to support Operations Desert Fox, Desert Viper, and NATO Operation Allied Force.

**Payoffs.** This DTO will reduce the time, risk, and cost involved in correctly identifying, developing, and applying emerging weapon system technologies best capable of holding high-value fixed targets at risk. This DTO will also ensure the most effective use of existing weapon systems to defeat high-value fixed targets by identifying the best means of exploiting target vulnerabilities through aimpoint selection and tailored delivery strategy. This increased sortie effectiveness will reduce the need for retargeting, which will reduce the exposure of warfighters and airborne assets to hostile fire. Cost of operations will be reduced by accomplishing the mission with fewer aircraft sorties, expending fewer munitions, and losing fewer aircraft.

**Challenges.** Recent advances in weapon technology have driven L/V models far beyond the range for which validation data exist. The technical challenge is to develop high-quality weapon's effects data necessary for validating L/V models. This requires executing well-controlled tests or performing high-fidelity, physics-based analyses to obtain weapon effects data for current and developmental weapons against realistic target sets. Progress has started in this area. Since FY98, the size of the penetration database of inventory and developmental weapons into rock has increased by approximately 25% while the validation database for blast propagation models in complex structures has grown by roughly 15%. During FY99, much progress was made to reduce the uncertainty in the penetration database for validating L/V models.

### **Milestones/Metrics.**

FY2000: Reduce the prediction uncertainty for blast by 200% for blast damage from shock, and a corresponding amount for late-time quasistatic pressure; reduce the prediction uncertainty by 200% for blast/fragment loading WMD containers.

FY2001: Increase the validation database for synergistic effects of blast and fragments by 20%; reduce the prediction error by 30%; reduce the prediction error for blast/fragmentation damage to former-Soviet-bloc critical C<sup>3</sup>I components by 50%.

FY2002: Finalize the system-level validation plan for inventory and development weapons against high-value fixed targets; 200% reduction in the failure uncertainty for blast fragment loading against former-Soviet-bloc critical C<sup>3</sup>I components; 300% reduction in failure uncertainty for combined blast and fragment loading against reinforced concrete targets.

FY2003: Validate the system-level L/V models for fixed WMD targets using test data from a large-scale test; 200% reduction in overall system-level prediction error for WMD targets.

FY2004: Validate the system-level L/V models for fixed tunnel targets using test data from a large-scale tunnel defeat test. Reduce the modeling error for overall system level L/V analysis by 100% for tunnel targets.

FY2005: Develop and validate additional L/V models for damage from enhanced lethality weapons, such as high-temperature incendiaries.

**Customer POC**

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**WE.57 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602602F	2502	0.6	0.5	0.5	0.6	0.8	0.5
0602715BR	AC	5.9	0.0	0.0	0.0	0.0	0.0
0602715BR	BD	0.0	3.9	3.4	2.0	0.0	0.0
0602715BR	BF/CP	0.0	3.1	5.8	4.4	0.0	0.0
0603160BR	BK	0.0	0.0	0.0	0.0	11.0	10.0
	<b>DTO Total</b>	<b>6.5</b>	<b>7.5</b>	<b>9.7</b>	<b>7.0</b>	<b>11.8</b>	<b>10.5</b>

## **WE.58    Microelectromechanical Sensor Inertial Navigation System**

**Objectives.** Improve the silicon-based inertial sensors (gyros and accelerometers) and integrate them with navigation software into a low-power, small, lightweight, low-cost, tactical-grade inertial navigation system (INS). The microelectromechanical systems (MEMS) INS will be generic for insertion/embedding into military systems and in man-portable applications.

**Payoffs.** The MEMS INS technology developed under this program will fulfill the low-end guidance performance gap and emphasize even smaller, lighter, lower-cost, and lower-power attributes as compared with other tactical- and navigation-grade technologies. Due to the expected low cost, MEMS INS will be the ideal insertion candidate into low-cost, high-volume system and weapon applications. MEMS INS is transitionable to expendables/bombs, munitions (e.g., ERGM), and man-portable equipment. Field demonstrations will put these technology products into the hands of operators so they can exploit the unique guidance, navigation, and control attributes of MEMS INS. Current efforts include the fabrication and assembly of improved gyroscopes for tactical-grade application. In FY99, gyro bias performance of 1–10 deg/hr was demonstrated.

**Challenges.** Challenges include selecting and refining foundries and foundry processes, designing the mechanical subsystems, selecting and refining the navigation software, and performing INS simulations of the modeled sensors. Additional challenges include developing low-power, power-managed IMU electronics for long-life operations and low-cost, small-size, environmentally robust sensor packaging.

### **Milestones/Metrics.**

FY2000: Demonstrate and deliver tactical-grade (1-deg/hr gyro bias drift, 500-mg accelerometer bias) MEMS-based INSs for 1.0 W and 10 in<sup>3</sup> package.

#### **Customer POC**

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### **WE.58 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0603762E	SGT-01	6.8	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>6.8</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.60 High-Power Microwave Munitions

**Objectives.** Develop, demonstrate, and transition high-power microwave (HPM) technology to disrupt, degrade, and destroy electronic components of adversary weapon systems. More specifically, assess the effects of HPM radiation on applicable targets, develop and demonstrate applicable HPM warhead technologies, assess systems engineering and platform interface issues, and evaluate military effectiveness and utility. Evaluate targets including critical infrastructures, integrated air defense systems, command and control nodes, and other electronic targets of military value. This DTO will also evaluate candidate platforms applicable for this warhead technology with consideration to size, weight, and configuration. (Specific performance objectives are classified.)

**Payoffs.** Technology developed under this program will provide the user unprecedented options for effective attack of adversary targets and with reduced collateral damage. It will increase effectiveness of electronic attack missions by enabling attack of multiple mission-critical components over a larger area than is possible with conventional munitions and with little collateral damage to people and structures. Also, since multiple targets can be neutralized with each HPM warhead, mission costs should be reduced when compared with conventional munitions.

**Challenges.** The principal challenges for this program include packaging of an effective HPM system into the munition that provides military effectiveness, increasing our quantitative understanding of HPM effects on targets, and developing means to confirm these effects during military operations.

### Milestones/Metrics.

FY2000: Complete development of all subsystems and conduct a critical experiment (breadboard) of a pulsed-power unit integrated with an HPM source. Continue effects efforts to determine requirements for HPM munition targets, including increased emphasis on M&S for effects predictive capability.

FY2001: Based on a successful critical experiment, complete the design, development, and demonstration of each refined HPM subsystem. Downselect the munition platform for later brassboard integration. Continue M&S predictive capability and effects testing of applicable targets.

FY2002: Begin brassboard integration and demonstration efforts for the HPM system. Begin transition planning.

FY2003: Complete brassboard integration. Conduct an TD to validate effectiveness of a full-scale HPM munition aboveground and against appropriate targets. Conduct risk reduction to ensure successful technology transition. Transition the technology to AAC.

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### WE.60 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602601F	5797	1.8	0.0	0.0	0.0	0.0	0.0
0602605F	4867	0.0	1.7	2.8	2.9	0.0	0.0
0603605F	3152	3.1	3.6	3.6	3.7	0.0	0.0
	<b>DTO Total</b>	<b>4.9</b>	<b>5.3</b>	<b>6.4</b>	<b>6.6</b>	<b>0.0</b>	<b>0.0</b>

## **WE.61 Modernized Hellfire Guidance and Control/Seeker Technology Effort**

**Objectives.** Develop and demonstrate guidance and control (G&C), seeker, automatic target recognition (ATR), wide-band secure datalinks, and controllable propulsion technology necessary for the Modernized Hellfire EMD program starting in FY2003. The program will demonstrate one or more dual-mode seeker/G&C concepts that could fulfill the Modernized Hellfire requirements. In addition, controllable propulsion technology will be investigated through static tests. All technologies must be compatible with existing and future helicopter platforms. The program will provide captive flight seeker(s) for testing and analysis in FY2002, as well as statically tested propulsion systems.

**Payoffs.** The technologies demonstrated will be transitioned to a Modernized Hellfire EMD program in support of Army Beyond 2015 and, potentially, the Future Combat Vehicle (FCV) and Common Modular Missile. The technology will allow for expanded battlespace and fire-and-forget guidance with precision strike capability. This approach will reduce the number of different types of missiles required for a load-out. The battlefield tempo will be increased through a faster airframe and through the ability to engage targets “over the hill.” Technologies could benefit missile variants for advanced fire support systems, FCV, Common Modular Missile, and Army Beyond 2015.

**Challenges.** The challenges of this effort include (1) determining guidance/seeker concept best suited for Modernized Hellfire within schedule and cost, (2) designing and developing dual-mode seeker, and (3) packaging dual-mode seeker and G&C section within given volume and weight. The technologies under consideration are MMW/SAL, IIR/SAL, LADAR/SAL, and other dual-mode/G&C combinations. In addition, controllable propulsion systems are currently risky. Reducing the risk to enter EMD will require intensive effort. The ATR and datalinks pose challenges from processors for ATR and power/weight for the datalink.

### **Milestones/Metrics.**

FY2000: Start seeker/G&C/propulsion procurement and development.

FY2001: Bench test seeker/G&C/propulsion module.

FY2002: Seeker integrated captive flight tests; static test of propulsion system.

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### **WE.61 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0603313A	263	13.5	8.0	9.4	0.0	0.0	0.0
	<b>DTO Total</b>	<b>13.5</b>	<b>8.0</b>	<b>9.4</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## WE.62 High-Quantity Antimateriel Submunition Program

**Objectives.** Significantly increase the effectiveness, increase the capabilities, and reduce the size and cost of current and future missile systems. It is essential that the Army Beyond 2015 systems have the capability to detect, classify, and identify threat targets with smaller and smarter missile systems. The High-Quantity Antimateriel Submunition (HI-QUAMS) and planned ATD will demonstrate LADAR seeker miniaturization technology necessary for future Army powered small-diameter submunitions. This work is being done to support a TRADOC Futures Division and Force XXI identified need for a 5X-10X improvement in stowed kills for MLRS/ATACMS when attacking lightly armored, highly valued targets. To improve stowed kills, more submunitions need to be dispensed and they must be more effective. To store more submunitions in an MLRS, they must be smaller. To be more effective, they must be capable of accurately classifying targets in and out of clutter. The HI-QUAMS program has been coordinated with the Powered LOCAAS and the LADAR ATR efforts. HI-QUAMS will complement both of these programs by offering a LADAR seeker that is greatly reduced in size. The point of contact for the HI-QUAMS program is a member of the JSGCC LADAR working group and the Army munition LADAR working group. A considerable effort is being made to ensure no duplication of effort.

**Payoffs.** The HI-QUAMS seeker will demonstrate LADAR seeker miniaturization technology necessary for future Army powered submunitions and missile systems. Requirements dictate that there is a need for LADAR seekers that have approximately a 3-in diameter. The reduced size and weight will allow for a higher kill ratio for MLRS and ATACMS. The advanced state of the art of fiber-optic lasers, no-moving-parts scanners, diffractive optics, and integrated detector electronics are expected to provide the miniaturization pathway supporting Army requirements for a variety of missile applications. HI-QUAMS is currently designing and building a brassboard LADAR seeker that incorporates the use of a gimbal-less scanner, diffractive optics, detector and pulse-capture electronics integration, and compact high-power laser.

**Challenges.** The major technical challenge is the miniaturization of current LADAR seeker technology. A design that incorporates a gimbal-less scanner, diffractive optics, detector and pulse-capture electronics integration, and a compact high-power laser will allow for the successful demonstration of a 3-in submunition. The size and cost are the largest barriers to overcome. Classification accuracy is being demonstrated with LOCAAS and the STAR seeker. HI-QUAMS will demonstrate LADAR seeker miniaturization technology necessary for future Army powered submunitions.

### Milestones/Metrics.

FY2000: Final integration and testing of the seeker components will be completed, and a functional ladar brassboard will be built and demonstrated.

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**WE.62 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602303A	214	0.5	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>0.5</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

**WE.63 Direct-Attack Munition Affordable Seeker ATD**

**Objectives.** The Direct-Attack Munition Affordable Seeker (DAMASK) demonstrates critical technologies showing that image-guided bombs (IGBs) can replace laser-guided bombs (LGBs). DAMASK uses low-cost strapdown IR imaging seekers with a joint direct attack munition (JDAM) 2,000-lb MK84 bomb in both captive-carry and free-flight drop tests. Integrating an imaging seeker with the JDAM Global Positioning System/Inertial Navigation System (GPS/INS), DAMASK will achieve a 3-m CEP. Commercially available uncooled IR focal plane array (FPA) technology, low-cost IR optics and windows technology, injection molded composite construction, and signal processing hardware will provide affordable yet increased performance for GPS/INSs systems.

**Payoffs.** Baseline GPS/INS-guided weapons like the JDAM MK84 provide 13-m CEP accuracy. If GPS signals cannot be acquired, the error can grow to 30 m when released from the F/A-18 and other tactical aircraft. LGBs provide 3-m CEP, but require a clear line of sight to the target and designation until weapon impact. DAMASK provides 3-m precision in a launch-and-leave weapon system. The pilot does not need to see the target; instead the pilot releases in a launch window with JDAM. GPS/INS-guided weapons provide the capability to attack multiple targets from a single release point, and DAMASK improves this capability with 3-m accuracy. DAMASK will operate “through the weather” with a cloud deck of 1,500 m or above. DAMASK will support organic or offboard targeting (the concept of being able to designate the target using the aircraft's own SAR or FLIR imagers as a source of template imagery). The templates are generated automatically, the pilot needing only to select the target within the template image and then release the weapon. DAMASK also supports, but will not demonstrate, the ability to receive target templates from a command center through a datalink. For example, JSTARS can send images to a battlespace manager who can produce the template and send the data to a DAMASK-loaded F/A-18.

**Challenges.** DAMASK has challenges in three specific areas: the guidance integration, signal processing and template generation, and uncooled IR FPA selection. The DAMASK approaches the highest risk of integrating the IR seeker with the JDAM GPS/INS system through guidance law modification that supplements the accuracy of the GPS signal and flies the bomb to the target image. High-speed template matching signal processing algorithms are required from a low-cost signal processor (one currently under development is fabricated from off-the-shelf hardware to keep costs affordable). DAMASK uses a fully strapdown uncooled IR FPA seeker, eliminating expensive components found in gimbal seekers and the costs associated with cryogenics, scanners, and dewers found on traditional IR seekers.

**Milestones/Metrics.**

FY2000: Captive-carry testing from F/A-18; DAMASK free-flight drop tests/demonstration.

**Customer POC**

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**WE.63 S&T Funding (\$ millions)**

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603238N	R2145	5.1	0.0	0.0	0.0	0.0	0.0
	<b>DTO Total</b>	<b>5.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>

## **WE.64    Advanced Light Armament for Combat Vehicles**

**Objectives.** Design, develop, and demonstrate optimum ammunition components in bursting munitions and novel KE long rods (with nondepleted uranium emphasis) for 30- to 40-mm applications, which would provide enhanced antiarmor and antipersonnel effects for ground combat vehicles. Bursting ammunition enhancements will focus on development, test, and evaluation of advanced fuzing and warhead lethality. KE ammunition enhancements will focus on leveraging large-caliber novel penetrator concept evolution for defeat of applique-protected targets and increased behind-armor effects.

**Payoffs.** This DTO will provide more effective ammunition, utilizing fewer shots per kill and resulting in lower overall life-cycle costs and logistics burdens. The ability to defeat and suppress troops in defilade will be dramatically increased. Quantitative goals call for a 400% increase in the lethal area of a bursting high-explosive round, an increase in the number of stowed kills by 300%, and the ability to defeat future light-armor threats by increasing behind-armor lethal effects by 30%.

**Challenges.** Challenges include adapting air-bursting fuze technology to high-g environment (greater than 50,000 g), enabling fuze programming at high rates of fire, increasing bursting fragmentation efficiency and performance, and ensuring sufficient behind-armor effects with nondepleted uranium penetrator materials.

### **Milestones/Metrics.**

FY2000: Develop 30- to 35-mm novel KE penetrator concepts and demonstrate defeat of advanced threat targets and enhanced behind-armor effects. Complete bursting munitions fuze technology assessment and simulated high-g functional evaluation.

FY2001: Complete detailed design of integrated 30-mm bursting munitions warheads and fuzing; conduct full-up demonstration of 30-mm KE penetrator defeat capability against selected targets with 30% increase in behind-armor effect.

FY2002: Demonstrate fourfold increase in 30-mm bursting munitions projectile antipersonnel lethal area and complete integrated weapon/munitions fuse setting interface designs. Demonstrate 40-mm cased, telescoped, bursting projectile and KE cartridge defeat of Future Scout and Calvary System threat targets.

FY2003: Demonstrate integrated 30-mm and 40-mm Supershot bursting munitions projectile concepts, weapon/bursting munitions functionality, and 40-mm Supershot KE projectile package.

#### **Customer POC**

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COL Frank J. STONE, USA  
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#### **Service/Agency POC**

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**WE.64 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602624A	H19	0.8	0.7	0.5	0.0	0.0	0.0
0603004A	43A	0.0	1.9	1.8	2.5	0.0	0.0
	<b>DTO Total</b>	<b>0.8</b>	<b>2.6</b>	<b>2.3</b>	<b>2.5</b>	<b>0.0</b>	<b>0.0</b>

## **WE.65 High-Efficiency, Scalable Solid-State Lasers for Military Applications**

**Objectives.** Military directed-energy sensors and electronics and electronic warfare applications require scalable, mass-producible (low-cost), solid-state laser architectures or technologies leading to high-electrical efficiency (approaching 30%–40%) and packaging exhibiting high-power density (0.1–1 W/cm<sup>3</sup>). The joint service's implementation of high-efficiency, scalable lasers will provide an answer to the critical needs for a number of ground, air, and space missions. The objectives are to integrate fiber, solid-state laser, and high-brightness diode laser technologies along with a paradigm shift in mass-production and scaling concepts toward the development of next-generation electric laser device technology; significantly reduce the time and cost to implement fully capable laser systems; directly influence and leverage the commercial market where laser devices are to be developed within the next 3–5 years; and collaborate and coordinate a tri-service effort. This effort supports the AFRL Space Optics and Laser Technology Integrated Technology Transition Program (ITTP).

**Payoffs.** High-efficiency, scalable electric lasers provide unique solutions to military operations ensuring battlefield superiority throughout the next century. This battlefield superiority will be gained through investments into the development of new technology that integrates fibers with diode laser devices. The result will be modular laser devices of exceptional brightness and efficiency. Scalable architectures based on these modular building-block units will lead to directed-energy weapon (DEW) laser devices. Laser integration technology (LITE) investment areas include novel fibers, waveguides, and high-brightness diode lasers; ultra-compact packaging conducive to machine vision assembly and mass-producible manufacturing methods; and beam-combining techniques for power-scaling architectures. Low-cost laser and beam-control technologies will allow for a much wider range of applicable platforms. Immediate payoff will be realized through extremely high efficiencies (30%–40% wall plug) for critical air- or space-based applications; scalable technologies for DEW applications; cost reduction of 10X–20X through the development of laser mass-production technology; greatly increased reliability, compactness, and utility; and fast electronic beam steering and conformable mounting technology. Near-term applications of this technology include IR countermeasures sources, illuminators and imagers for unmanned aerial vehicles, and ultra-compact target designators.

**Challenges.** The challenge to provide a scalable, low-cost laser solution is met by a paradigm shift in electrically driven solid-state laser technology. A new, fully integrated fiber laser technology is to be introduced and implemented through a phased program with definitive milestones. Specific demonstrations of this new technology will accelerate this program through a transition from brassboards to the development of devices with full functional capabilities. Specific technological challenges will be found in the development of fully integrated, scalable architecture for high-power lasers; mass-production technology for integrated laser devices; high-power fiber and solid-state laser building blocks leading to high-power laser modules; and novel fast-steering technology for multiple target engagements (BRIGHT LITE).

### **Milestones/Metrics.**

FY2000: Demonstration of 100-W, packaged brassboard fiber laser (Mini-LITE) showcasing the newest advances in scalable semiconductor and fiber laser technology.

FY2002: Demonstration of 1-kW, packaged brassboard fiber laser module (Module-LITE) showcasing the building-block technology of future directed-energy, megawatt-class electric lasers. Demonstrate wavelength-versatile integrated laser/NLO at 5-W power levels.

FY2005: Demonstration of 10-kW, packaged brassboard fiber laser system (Kilo-LITE) showcasing a directed-energy, megawatt-class scalable electric laser. Demonstrate wavelength-versatile integrated laser/NLO and beam steering at 50-W power levels.

**Customer POC**

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**WE.65 S&T Funding (\$ millions)**

<b>PE</b>	<b>Project</b>	<b>FY00</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>	<b>FY05</b>
0602601F	3326	3.7	0.0	0.0	0.0	0.0	0.0
0602605F	4866	0.0	3.8	5.0	3.9	4.3	4.4
0603605F	3151	1.4	1.6	1.6	3.3	6.1	6.2
	<b>DTO Total</b>	<b>5.1</b>	<b>5.4</b>	<b>6.6</b>	<b>7.2</b>	<b>10.4</b>	<b>10.6</b>