



Test and Evaluation/Science and Technology (T&E/S&T) Program

Directed Energy Test (DET) Broad Area Announcement (BAA) Overview

**T&E/S&T Program
Industry/Academia Days
12-14 February 2008**



DET Overview



Directed Energy Weapons, classified in HEL or HPM domains, use the electromagnetic spectrum (light & radio energy) to attack targets at the speed of light

High Energy Laser (HEL)

Produce coherent, powerful, monochromatic, focused light beams that heat the target body

Airborne Laser
(ABL)



Advanced Tactical Laser
(ATL)



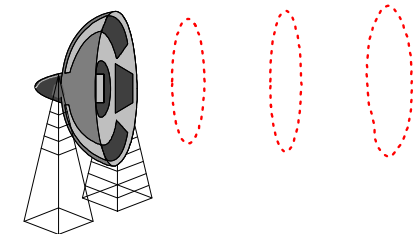
High Power Microwave (HPM)

Produce wide beams in bursts of high frequency radio energy that disable or damage electronics

Active Denial System
(ADS)



Threat Source



HPM Source



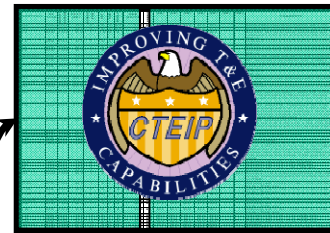
DET Roadmap



DE Weapons/Threats



DETEC Domain



ENGR DEV FUTURE DEV

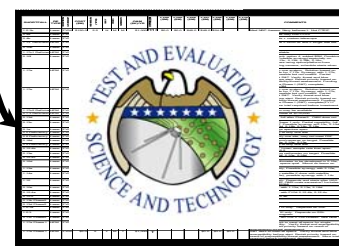
Risk Reduction /P3I

Tech Enablers



AoA Candidates

DET S&T Domain



TECH ADV

DETEC Tri-Service Study

Strategic Plan for DoD T&E Resources

- DE Stakeholders:**
- MRTFB/DOD Labs
 - Weapon Sys Dev
 - Industry/Academia
 - Intel Community

**DET S&T WG
DETEC IPT**

AoA – Analysis of Alternatives
 MRTFB – Major Range & Test Facility Base
 P3I – Pre-planned Product Improvement



DET

List of HEL BAA Topics



- **HEL Target Surface Temperature Measurement (TSTM) Risk Reduction**
 - HEL Multiple Waveband Thermal Sensor
 - HEL Temperature Determination Tool
- **HEL Irradiance on Target Measurement Array**
- **HEL Lethality Laser Risk Reduction**
- **HEL Atmospheric Characterization for Beam Propagation**
- **Other Technologies**



DET

List of HPM BAA Topics



- **HPM Human Surrogate for Explosive Testing**
- **HPM Non-intrusive W-band Skin Measurements**
 - **HPM W-band Skin Heating Rate Measurement**
 - **HPM W-band Electric Fields at Skin**
- **HPM Terahertz (THz) Sensor Array**
- **Non-intrusive Measurement of Currents Induced within HPM Targets**
- **HPM Non-intrusive Effects Determination**
- **Other Technologies**



DET HEL TSTM Risk Reduction: HEL Multiple Thermal Waveband Sensor



HEL Multiple Thermal Waveband Sensor

- **Description:**
 - Seeks prototype remote sensing capability for non-intrusive measurement of emitted thermal radiance for dynamic profiling of HEL target front surface temperature
- **T&E Need:**
 - Provide dynamic temperature maps of laser-heated, bare and painted target surfaces for HEL-target coupling effectiveness
- **S&T Challenge:**
 - Design and development of multi-band remote thermal sensor to provide the thermal radiance data needed by future temperature retrieval/determination tools (i.e. HEL Temperature Determination Tool)



DET HEL TSTM Risk Reduction: HEL Temperature Determination Tool



HEL Temperature Determination Tool

- **Description:**
 - Seeks robust, prototype analytical tool/techniques to determine target surface temperature using radiances measured in multiple wavebands (4 or more) in support of HEL engagement scenarios
- **T&E Need:**
 - Provide dynamic temperature maps of laser-heated, painted metal target surfaces for HEL-target coupling effectiveness
- **S&T Challenge:**
 - Develop temperature determination tool/technique to profile front surface temperature of HEL targets without incomplete knowledge of emissivity and its change with temperature and wavelength for temperatures up to metal melting points



DET



HEL Irradiance on Target Measurement Array

HEL Irradiance on Target Measurement Array

- **Description:**
 - Seeks non-intrusive prototype capability to directly measure HEL irradiance incident at points on airborne towed or flight targets without significantly altering body aerodynamics and HEL power on target as alternative, risk reduction approach to other remote and onboard sensors investigated by DET S&T
- **T&E Need:**
 - Provide dynamic HEL irradiance map of HEL beam spot to support weapon system diagnostics
- **S&T Challenge:**
 - Design and development of HEL irradiance sensor array that does not affect laser-target interaction or flight dynamics while withstanding direct HEL irradiation



DET

HEL Lethality Laser Risk Reduction



HEL Lethality Laser Risk Reduction

- **Description:**
 - Seeks risk reduction to develop the high risk, high payoff technology enablers to support near-infrared (NIR: $\sim 1\mu\text{m}$) HEL development at the 100kW to 200kW power levels for short range lethality ground tests
- **T&E Need:**
 - Near-IR HEL to support ground-based lethality tests at short ranges
- **S&T Challenge:**
 - Identification of high risk areas for near-IR HEL lethality laser development, design of risk reduction activities, and implementation of activities to support follow-on full-power laser under DETEC procurement



DET

HEL Atmospheric Characterization



HEL Atmospheric Characterization for Beam Propagation

- **Description:**
 - Seeks prototype capability to measure all pertinent atmospheric properties affecting HEL beam slant path propagation on outdoor test ranges in near space and time (i.e. aerosols/molecules absorption and scattering, turbulence, etc...)
- **T&E Need:**
 - Measurement of atmospheric properties which may cause degradations to HEL beam path propagation
- **S&T Challenge:**
 - Development of slant range measurement profiling technique to quantify atmospheric properties near (in space and time) HEL beam propagation paths



DET

HPM Human Surrogate for Explosive Testing



HPM Human Surrogate for Explosive Testing

- **Description:**
 - Seeks prototype surrogate body which replicates electromagnetic properties of human body in ultra-high frequency (UHF) range to support HPM energy investigation of explosive devices worn by humans
- **T&E Need:**
 - Determine HPM countermeasure effectiveness against explosive devices worn on human body with it disturbing the electromagnetic environment
- **S&T Challenge:**
 - Identify and develop easily repairable/inexpensive human body surrogate that replicates electromagnetic properties during HPM irradiation testing



DET

HPM Non-Intrusive W-band Skin Measurements

HPM W-band Skin Heating Rate Measurement



HPM W-band Skin Heating Rate Measurement

- **Description:**
 - Seeks non-intrusive, prototype capability to directly measure absolute skin temperature rise rate (heating), on the body skin surface and under clothing during HPM W-band irradiation in operational environment
- **T&E Need:**
 - Provide human body absolute skin temperature rise rate measurements to support human response modeling and test safety during HPM W-band irradiation
- **S&T Challenge:**
 - Develop direct, non-intrusive temperature rise rate measurement sensors throughout body skin surface without perturbing electromagnetic environment, skin temperature, and physical response during HPM W-band irradiation



DET

HPM Non-Intrusive W-band Skin Measurements

HPM W-band Electric Fields at Skin



HPM W-band Electric Fields at Skin

- **Description:**
 - Seeks non-intrusive, prototype sensing capability to directly measure HPM W-band electric fields at the body skin surface and under clothing during exposure to HPM W-band irradiation in operational environment
- **T&E Need:**
 - Provide skin electric field measurements to support human response models and HPM W-band system effectiveness determination in operational environment
- **S&T Challenge:**
 - Develop direct, non-intrusive HPM W-band electric field measurement sensors throughout body without perturbing electromagnetic environment, heating, and physical response during HPM W-band irradiation



DET

HPM Terahertz Sensor Array



HPM Terahertz (THz) Sensor Array

- **Description:**
 - Seeks prototype sensor array detection capability to measure HPM THz localized electric field emissions due to HPM THz irradiation for detection of explosive materials
- **T&E Need:**
 - Support determination of emission response of militarily interesting explosive materials when exposed to HPM THz energy by characterizing the THz beam at the target
- **S&T Challenge:**
 - Measurement of THz frequencies electric fields at target ranges with sufficient sensitivity response and resolution



DET



Non-intrusive HPM Induced Current Measurement

Non-intrusive Measurement of Currents Induced within HPM Targets

- **Description:**
 - Seeks prototype non-intrusive sensing capability to measure currents induced in wires, pins, and other connecting parts of HPM target electronics without significantly changing the currents
- **T&E Need:**
 - Determine cause of induced HPM effects by measuring currents induced by HPM fields within affected electronics
- **S&T Challenge:**
 - Non-intrusively quantify induced HPM currents without changing the magnitude of the currents measured on the chip, pin, or attached wires



DET



Non-intrusive HPM Effects Determination

Non-intrusive HPM Effects Determination

- **Description:**
 - Seeks non-intrusive prototype capability to identify target electronics failure sources and location during HPM irradiation when target cannot be disassembled
- **T&E Need:**
 - Determine cause of induced HPM effects by identifying physical electronic breaks/locations in HPM target equipment/electronics when it cannot be disassembled (i.e. electronics imbedded in epoxy) to evaluate HPM system effectiveness
- **S&T Challenge:**
 - Non-intrusive identification technologies to determine physical and/or electronic cause of failure and location when HPM target electronics/wires cannot be disassembled (i.e. dangerous, delicate, epoxy imbedded)



DET

Other Technologies



Other Technologies

- **Description:**
 - **Seeks potential technology development opportunities not identified in previous topic areas, but may be beneficial and critical to development of technologies to support DE T&E needs for rapid transition into infrastructure development**



DET

Draft FY09 BAA Schedule



Activity	Govt FY 2008									Govt FY 2009		
	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
FY09 Project and Study Selection												
EA's Draft BAA Topic Areas	■											
Industry/Academia Days		◆										
PMO Topic Area Approval			▲									
EA's Issue Solicitations			◆									
Offeror White Paper Submissions					◆							
EA WG's White Paper Review					▲							
PMO/EA Coordinate Selected White Papers / Develop Clarifications						▲						
Letter RFP Issued to Selected Offerors						◆						
Offeror Proposal Submissions								◆				
EA WG's Proposal Review & Recommendations to PMO								▲				
PMO Proposal Recommendations Review & Decisions									▲			
Clarifications, Negotiations & Contract Awards										▲		

BAA – Broad Agency Announcement
 PMO – Program Management Office

EA – Executing Agent
 RFP – Request for Proposal

WG – Working Group
 FY – Fiscal Year

T&E/S&T Program Industry / Academia Days 12-14 February 2008



DET Budget



	FY09	FY10	FY11	FY12	FY13	Total
DET (\$K) - est.	14,462	15,741	16,245	16,271	16,583	79,301



DET Summary



- **DET S&T efforts fill T&E gaps while progressively mitigating technology risk for transition to DE TEC and DoD test ranges/facilities**
 - Technology solution proposed must be comprised of innovative high risk, high payoff approach for S&T funding consideration
 - Transition potential & technical feasibility high drivers during two-phased BAA review period
- **FY09 BAA topic areas leverage Tri-Service Study Update to mitigate potential DE TEC II capability developments**
- **DET S&T team encourages feedback for current and future BAA solicitations to support emerging DE test requirements**

www.detecteam.org



DET Questions?



- **Minh Vuong**
- **DET Executing Agent**
- **U.S. Army PEO STRI**
- **12350 Research Parkway**
- **Orlando, FL 32826**
- **Minh.Vuong@us.army.mil**
- **(407)384-5248**

- **Amit Kapadia**
- **DET Deputy Executing Agent**
- **U.S. Army PEO STRI**
- **12350 Research Parkway**
- **Orlando, FL 32826**
- **Amit.Kapadia@us.army.mil**
- **(407)384-3815**



DET Back-Ups





DET

Project Summary (1 of 4)



Project Name / Contract Type	Contractor	Contract Type / Award Amount	Period of Performance	Comments	Transition
Quantum Well Infrared Photodetector (QWIP)	NASA Jet Propulsion Laboratory <i>Pasadena, CA</i>	Cost Phase 3: \$891K Total: \$1,571K	Phase 3 end: Aug 08	Develops IR camera to discern multiple laser wavelengths on target	WSMR; supports DETEC HEL ATIM risk reduction
Di-Electric Field Probes (DEFP)	IPITEK <i>Carlsbad, CA</i>	CPFF Phase 1: \$436K Phase 2: \$735K Total: \$1,171K	Phase 1 end: Mar 06 Phase 2 end: Oct 07	Non-intrusive waveguide HPM sensors	Follow-on P ³ I insertion into DET S&T Advanced Polymer Optical Sensor (APOS)
T&E Adaptive Optics System (TAOS)	WSMR <i>WSMR, NM</i>	Cost Phase 1: \$260K Phase 2: \$1,561K Total: \$1,821K	Phase 1 end: Mar 06 Phase 2 end: Oct 08	Prototype passive AO system	WSMR; supports DETEC HEL ATIM risk reduction
Range Profiles of Turbulence (RPOT)	Georgia Tech <i>Atlanta, GA</i>	CPFF Phase 1: \$373K Phase 2: \$1,390K Total: \$1,763K	Phase 1 end: Jun 05 Phase 2 end: Dec 07	Instrumentation to measure atmospheric turbulence	HELSTF; supports vertical and horizontal range profiling of atmospheric turbulence



DET

Project Summary (2 of 4)



Project Name / Contract Type	Contractor	Contract Type / Award Amount	Period of Performance	Description	Transition
Bistatic Optical Imaging Sensor (BOIS)	Photon Research Associates <i>San Diego, CA</i>	CPFF Phase 1: \$543K Phase 2: \$1,063K Phase 3: \$230K Total: \$1,836K	Phase 1 end: Nov 06 Phase 2 end: Jul 08 Phase 3 end: Oct 08	Develops 2-D hyper spectral imager using integral field spectrography technology	WSMR; supports DETEC HEL ATIM risk reduction as remote imager
Reflectance & Dynamic Fusion Models (RDFM)	Tau Tech. <i>ABQ, NM</i>	CPFF Phase 1: \$322K Phase 2: \$326K Total: \$648K	Phase 1 end: Apr 07 Phase 2 end: Apr 08	M&S tool to register 2D imagery onto 3D targets and calculate irradiance	DETEC LSI; supports post-processing analysis of HEL ATIM capability
Holographic Target Board (HTB)	Georgia Tech <i>Atlanta, GA</i>	CPFF Phase 1: \$62K Phase 2: \$310K Phase 2AB: \$187K Phase 3: \$328K Total: \$887K	Phase 1 end: Sep 06 Phase 2 end: Dec 07 Phase 2AB end: May 08 Phase 3 end: Apr 09	Holographic target board to characterize incident HEL beam parameters	HELSTF and AFRL to support lethality tests
Multiple Waveband Temperature Sensor (MWTS)	NASA Jet Propulsion Laboratory <i>Pasadena, CA</i>	Cost Phase 1: \$275K Phase 2: \$600K Phase 3: \$600K Total: \$1,475K	Phase 1 end: Jan 07 Phase 2 end: Jan 08 Phase 3 end: Jan 09	Four IR waveband temperature sensor	WSMR; supports DETEC HEL TSTM AoA as remote imager



DET

Project Summary (3 of 4)



Project Name / Contract Type	Contractor	Contract Type / Award Amount	Period of Performance	Description	Transition
Dielectric Antenna Electro-Optical Sensor (DAEOS)	UCLA <i>Los Angeles, CA</i>	CPFF Phase 1: \$265K Phase 2: \$605K Total: \$870K	Phase 1 end: May 07 Phase 2 end: Aug 08	Electro-optical microdisk sensor embedded within dielectric resonator antenna	P ³ I insertion into DETEC HPM SS
Compact Three Axis Sensor (CTAS)	Naval Research Lab <i>Washington DC</i>	CPFF Phase 1: \$422K Phase 2: \$402K Total: \$824K	Phase 1 end: Nov 07 Phase 2 end: Nov 08	Non-intrusive electro-optical sensor capable of measuring 3 axis electric fields	P ³ I insertion into DETEC HPM SS
Laser Protected Antenna (LPA)	SAIC <i>ABQ, NM</i>	CPFF Phase 1: \$325K Phase 2: \$663K Total: \$998K	Phase 1 end: Nov 07 Phase 2 end: Nov 08	Verified shielding techniques on WSMR flight termination system antenna for HEL tests	WSMR; supports DETEC HEL TSP handbook
Scanning Target Board (STB)	SARA <i>Cypress, CA</i>	CPFF Phase 1: \$855K Phase 2: \$261K Total: \$1,116K	Phase 1 end: Jan 08 Phase 2 end: Jun 08	Compact multi-layered patch antenna W-band HPM target board	AFRL; support HPM W-band source characterization



DET

Project Summary (4 of 4)



Project Name / Contract Type	Contractor	Contract Type / Award Amount	Period of Performance	Description	Transition
Temperature & Irradiance Sensor Matrix (TISM)	AEgis <i>Huntsville, AL</i>	CPFF Phase 1: \$766K Phase 2: \$742K Phase 3: \$1,170K Total: \$2,678K	Phase 1 end: Feb 08 Phase 2 end: Feb 09 Phase 3 end: Feb 10	Conformal array of photoconductive sensors produced using ink-jet printing	DETEC LSI; supports DETEC HEL ATIM AoA as onboard sensor
Probe-based Irradiance Profiler (PIP)	Northrop Grumman (NG) <i>Brooks City Base, TX</i>	CPFF Phase 1: \$834K Total: \$834K	Phase 1 end: Mar 08	Breadboard system using probe beam and camera to determine irradiance	DETEC LSI; supports DETEC HEL ATIM AoA as offboard sensor
Magneto-Optical Field Sensor (MOFS)	Opteos, Inc. <i>Ann Arbor, MI</i>	CPFF Phase 1: \$443K Phase 2: \$444K Total: \$887K	Phase 1 end: Mar 08 Phase 2 end: Mar 09	Non-intrusive magnetic field sensor based on the Faraday effect	P ³ I insertion into DETEC HPM SS



DET

Reference Acronym Listing



- 46th TW – 46th Test Wing (Air Force)
- ABL – Airborne Laser
- ADS – Active Denial System
- AFRL/DELE – Air Force Research Laboratory/Directed Energy Laser Energy
- AoA – Analysis of Alternatives
- ATIM - Airborne Target Irradiance/Imagery Measurement
- ATL – Advanced Tactical Laser
- ARL/SLAD – Army Research Laboratory/Survivability, Lethality Analysis Directorate
- BAA – Broad Agency Announcement
- BDRF - Bi-directional Reflectance Distribution Function
- BOIS- Bistatic Optical Imaging Sensor
- CTAS - Compact Three Axis Sensor
- CPFF – Cost Plus Fixed Fee
- DEFP - Dielectric Electromagnetic Field Sensors
- DET – Directed Energy Test
- DETEC – Directed Energy Test & Evaluation Capability
- DOD – Department of Defense
- EO - Electro-optical
- HEL - High Energy Laser -
- HELSTF – High Energy Laser Systems Test Facility
- HTB - Holographic Target Board
- HPM - High Power Microwave
- HSI - Hyperspectral Imager
- Intel – Intelligence
- IPT – Integrated Process/Product Team
- MRTFB – Major Range & Test Facility Base
- NAVAIR – Naval Air Systems Command
- NAVSEA – Naval Sea Systems Command
- P3I –Pre-planned Product Improvement
- Pax - Patuxent River Naval Air Station
- PTR - Photo-Thermal Refractive
- RDFM - Reflectance & Dynamic Fusion Models
- RPOT - Range Profiles of Turbulence
- QWIP - Quantum Well Infrared Photodetector
- S&T – Science & Technology
- STB - Scanning Target Board
- SS - Sensor Suite
- T-SS – Tri-Service Study
- T&E – Test and Evaluation
- TRL – Technology Readiness Level
- WG – Working Group
- WSMR – White Sands Missile Range