FY11 DET S&T BAA TOPIC AREAS FOR TECHNOLOGY DEVELOPMENT

1. Non-intrusive Current Measurements in HPM Targets

The Directed Energy Test and Evaluation Capability (DETEC) Tri-Service Study (T-SS) Update (2007) identified a deficiency in the ability to measure currents generated within an high power microwave (HPM) target without changing the initiating HPM fields (typically 100 MHz to 12 GHz) in that target, the induced currents, and the resultant HPM effects. The HPM Sensor Suite is capable of acquiring such signals, but existing field probes are too intrusive. This topic specifically addresses methods to non-intrusively determine any of the currents generated by HPM in the vicinity of target electronics within a target platform or cavity.

Offerors may respond to either one or both of the following sub-topics. The first sub-topic seeks a non-intrusive approach to directly measure the currents generated in an HPM electronics target. The second sub-topic seeks an approach to employ existing, non-intrusive, small magnetic and electric field sensors already being developed by DET S&T.

a. Direct Non-intrusive Current Measurements in HPM Targets

The DET S&T program is seeking new sensors capable of directly measuring the currents inside an HPM target without perturbing the fields inside the target, or the currents those fields induce, from external HPM illumination. The dynamic range for the sensors should be from 1 mA to 100 A. Similar sensors (e.g., inductive couplers) have been used in the past but involve metallic couplers or probes that substantially interfere with the incident field, the target impedance, and/or the response to the original HPM illumination.

Offerors should describe their proposed approach and attempt to quantify the intrusiveness of the proposed sensor as it applies to both the internal HPM fields as well as the induced currents being measured.

b. Electromagnetic Model to Derive Induced Currents in HPM Targets Non-Intrusive Field Measurements

The DET S&T program is seeking a model and the associated E- and H-field sensor placement requirements (size, response time, sensitivity, sensor distance from target chip, number of probes required, etc.) necessary to identify HPM attack-generated currents. DET S&T investments will provide previously developed non-intrusive E-, H- or E- and H- field probes but no current probes. Unfortunately, no computer models or methodologies exist to show how these probes could be used for such a purpose. The user of the current model will have a Solid Works or similar Computer Aided Design description of the target platform and electronic bays. The approach should assume small and non-intrusive E- and H-field sensors accessed by fiber optic cables.

The offeror should provide a method to address a variety of potential targets (e.g., missile sensor compartments, personal computers, electronic equipment bays in vehicles, computer controlled distribution systems). The offeror should also propose one target platform and electronic device target to demonstrate the proposed prototype approach.

2. Pressurized Radome for Wideband Radio Frequency Source

DETEC is providing the HPM Wideband Threat System (WBTS) radio frequency (RF) source to the test ranges. The HPM WBTS Capability covers the frequency range from 200 MHz to 6000 MHz in nine frequency bands, each with a discrete helical antenna. The system emits such a high electric field that it is necessary for the installed helical antenna to be surrounded by sulfur hexafluoride (SF_6) gas to prevent arcing and atmospheric breakdown. This gas insulates the antenna to avoid air breakdown and is housed by two sizes of pressurized fiberglass. Over time and after repeated pressure/depressurization cycles, the existing domes have developed pinhole leaks that can pose a safety hazard.

The DET S&T challenge is to fabricate a structure that withstands many pressurization cycles and maximizes lifetime. Offerors should address both theoretical and fabrication techniques to meet the test and evaluation (T&E) requirements described below. To maximize the field on target, the dome must be as transmissive as possible. The domes connect to a stainless steel flange that allows the dome to be attached to the antenna backplane.

Table 1: Small and Large Dome Parameters

	small	large
Pressure (psi)*	170	50
Outside Diameter (in.)	31	38
Over Length (in.)	41	73
Flange Diameter (in.)	21	21
Operating frequency (MHz)	6000	200

* When installing the dome, a vacuum is applied to remove air before the SF_6 is added.

In addition, the proposed structure must work at altitudes from -60 to 7000 feet, at temperatures from -14 to 50 C^o, and from 8 to 95% relative humidity. They must withstand 20 knots of wind in operation and be able to withstand 50 knots of wind when not in use but still attached to the wideband source.

3. HPM Electronic Failure Analysis

The DETEC T-SS Update (2007) identified a deficiency in the ability to determine the specific cause of observed failures in electronic targets in an electronic attack. There is typically one of three potential results: 1) noise or disturbance that stops when the attack does, 2) electronics stop working and must be restarted to correct the problem (latch-up), and 3) damage to some portion of the electronics that cannot be corrected. Determining which specific part or function of the electronics is impacted by the HPM attack can be complex and laborious, considerably slowing down test execution. Furthermore, some test scenarios may deny access to the test location for considerable amounts of time eliminating human intervention in the HPM engagement area.

The DET S&T program is seeking solutions to determine the specific cause of failures resulting from HPM attack, preferably from a remote location. The primary focus is on the cause of failures where restarting the electronics corrects the problem (upset, or latch-up). Proposed solutions may be off board or onboard the target, but must operate in an HPM environment. Proposed solutions to identify specific causes of failure in the case of disturbance or methods to rapidly identify specific sources of damage are also desired.

4. Predictive Tool to Assist Testers Scope HPM Effects Parameter Space

Testing the vulnerability of U.S. weapons systems to HPM attack can be time consuming and expensive. Often test range personnel are presented with HPM test requirements that span such a large operating space (power on target, frequency, pulse-repetition frequency, pulse width, etc.) that testing a system in every conceivable configuration is impossible. Tools are required that will allow test personnel to quickly determine the most appropriate test parameters to assess the vulnerability of U.S. systems to HPM attack.

The DET S&T program is seeking a modeling and simulation tool that will assist test range personnel in determining the specific HPM parameters against which a U.S. weapons system should be tested (power on target, frequency, pulse-repetition frequency, pulse width, etc.). Given basic inputs from test range personnel, the code should identify the parameters of the HPM source to which a target will be most vulnerable. Given the allowed amount of time to execute the test, it should intelligently scope the test space and also allow for updates, or test modifications given results as the actual test progresses in near-real time.

5. Time-Out-of-Action Models for HPM Effect

An important HPM effect to consider when determining weapon effectiveness or target vulnerability is the length of time the target is disabled, which is called time-out-of action (TOA). The DET S&T progrm is seeking TOA models to assess the persistence of target down-times after an HPM engagement. Electronic targets of interest include, but are not limited to, computer networks, control systems, and telecommunications equipment. Offerors should address an approach to develop TOA models that when executed will provide target down-time suitable for inclusion in engagement models, such as the Extended Air Defense Simulation (EADSIM). It is recommended that offerors first identify test parameters and test procedures to obtain requisite TOA data before executing TOA tests that are sufficient to provide adequate data for TOA models and before creating the TOA model suitable for engagement modeling.

6. HPM Effects Simulator

Obtaining HPM effects test data is a critical aspect of developing time-out-of action (TOA) models for HPM engagements. Unfortunately, such HPM testing is restricted to only a few locations across the country and can be time consuming and expensive. There have been attempts to create HPM effects simulators that try to mimic the upset mechanisms on electronic targets of interest, but to date such activities cannot adequately model the subtle aspects of HPM electronic engagements.

Offerors should provide an approach to develop an HPM effects simulator that can be used as a test tool for developing HPM TOA models and can also be used as a training tool to prepare system operators for potential HPM electronic attack. Two classes of targets are of interest at this time—computer networks and industrial control systems. The simulator should have the same form, fit, and function of the actual electronic system it simulates so that test subjects can interact with the system directly in efforts to repair the effects caused by the simulated engagement. The simulation should allow for various levels of degradation to include disturbance (effect present after illumination but eventually recovers), upset (requires external intervention), and damage (requires hardware, software, or firmware replacement).

7. Reusable HEL Towed Target Boards

A critical T&E shortfall identified through the DETEC High Energy Laser (HEL) Airborne Target Irradiance and Imagery Measurement (ATIM) Capability is the requirement to measure the incident HEL irradiance delivered to an airborne target in flight. Time and space-resolved irradiance maps are a key metric of HEL system capability that can be furthered analyzed to determine HEL spot size, location on target, and jitter/drift, etc.

Currently, DE test ranges do not possess a capability to measure HEL beam irradiance on flight targets at threat irradiance levels. Remote imaging techniques of target laser scatter have yet to achieve radiometric accuracy due to large uncertainties in the dynamic surface target bi-directional reflectance distribution function (BRDF), an area in which DET S&T has investments. For this reason, direct (contact) detection techniques are also being pursued by DET S&T, but have yet to demonstrate survivability to direct multi-kW/cm^2 irradiance values, flight aerodynamic loads, and non-intrusiveness to HEL-target interaction and flight aerodynamics.

Additional parallel risk reduction direct detection technologies are sought to directly measure HEL irradiance incident at points on an airborne towed target with centimeter level resolution. Proposed measurement arrays must be compact and lightweight for installation onto towed cylindrical targets without significantly altering the body aerodynamics. The proposed technique should be scalable in terms of spatial resolution (measurement point separation) and area covered. Data from this measurement array may be collected by an internal recording system or telemetered to an external receiver.

Offerors responding to this topic should consider and demonstrate measurement array accuracy, sensor grid spacing, survivability at multi-kW/cm^2 for several seconds, and reusability/affordability.

8. HEL Dynamic Reflection Hazard Modeling

HEL irradiation of targets during outdoor testing may result in hazardous target reflections and impact the ability to conduct safe testing. Further, the reflectivity of the target may change dynamically during testing due to HEL heating and damaging of the target surface. A methodology and supporting analysis tools are needed to determine the region in which dynamic target reflections may exceed specified human ocular and sensor exposure limits. The analysis methodology should utilize a probabilistic risk assessment (PRA) approach, rather than only assuming the worst case (because the worst case for hazardous target reflections may be highly improbable).

Offerors responding to this topic should address the approach for developing the methodology and associated software tools for assessing three-dimensional dynamic reflection hazard zones for given HEL-target test scenarios. A realistic PRA approach is desired, as an overly conservative, worst case approach may result in hazard zones which are too large to control for HEL system of current and future interest. Unnecessarily large hazard zones could result in HEL testing not being permitted for some systems and test scenarios. On the other hand, underestimating the hazard zone extent could have dire consequences. The proposed approach should include testing concepts for verifying the dynamic hazard zone predictions from the model.

9. Other Technologies

DET S&T encourages potential technology development opportunities in areas that are not identified in previous topic areas, but may be beneficial and critical to the development of technologies to support directed energy T&E needs for rapid transition into infrastructure development.