DEFENSE THREAT REDUCTION AGENCY
SBIR FY08.1 Proposal Submission

The mission of the Defense Threat Reduction Agency (DTRA) is to safeguard the United States and its allies from weapons of mass destruction (chemical, biological, radiological, nuclear and high-yield explosives) by providing capabilities to reduce, eliminate and counter the threat and mitigate its effects. This mission includes research and development activities organized into chemical/biological, nuclear, WMD counter-force, and systems engineering technology portfolios. From these activities, DTRA administers two SBIR programs. One is affiliated with the Chemical-Biological Defense Program and appears as a separate component under this solicitation. The other is drawn from the nuclear, WMD counter-force, and systems engineering portfolios and is described herein. Communications for this program should be directed to:

Defense Threat Reduction Agency
ATTN: Lt Col John Kelley, SBIR Program Manager
8725 John J. Kingman Drive, MSC 6201
Fort Belvoir, VA 22060-6201
E-mail: dtrasbir@dtra.mil

Use of e-mail is encouraged.

The DTRA SBIR program complements the agency's principal technology programs to detect/locate/track WMD; interdict or neutralize adversary WMD capabilities; protect against and restore following WMD use; attribute parties responsible for WMD attacks; and provide situational awareness and decision support to key leaders. SBIR topics reflect the current strategic priorities where small businesses are believed to have capabilities to address challenging technical issues. DTRA supports efforts to advance manufacturing technology through SBIR, where the challenges of such technology are inherent to technical issues of interest to the agency.

PROPOSAL PREPARATION AND SUBMISSION

Proposals (consisting of coversheets, technical proposal, cost proposal, and company commercialization report) will be accepted only by electronic submission at http://www.dodsbir.net/submission/. Paragraph 3.0 of the solicitation (http://www.dodsbir.net/solicitation/) provides the proposal preparation instructions. Consideration is limited to those proposals that do not exceed $100,000 and six months of performance. The period of performance may be extended up to six additional months following award, but such extensions may delay consideration for Phase II proposal invitation. Proposals may define and address a subset of the overall topic scope. Proposals applicable to more than one DTRA topic must be submitted under each topic.

PROPOSAL REVIEW

During the proposal review process employees from BRTRC, Inc. and Northrop Grumman Information Technology (NGIT) will provide administrative support for proposal handling and will have access to proposal information on an administrative basis only. Organizational conflict of interest provisions apply to these entities and their contracts include specifications for non-disclosure of proprietary information. All proposers to DTRA topics consent to the disclosure of their information to BRTRC and NGIT employees under these conditions.

BRTRC Inc
8260 Willow Oaks Corporate Drive, Suite 800
Fairfax, VA 22031-4506

Northrop Grumman Information Technology (NGIT)
6940 South Kings Highway, Suite 210
Alexandria, VA 22310

DTRA will evaluate Phase I proposals using the criteria specified in paragraph 4.2 of the solicitation with technical merit being most important, followed by principal investigator qualifications, and commercialization potential. Topic Points of Contact (TPOC) lead the evaluation of all proposals submitted in their topics.

SELECTION DECISION AND NOTIFICATION

DTRA has a single source selection authority (SSA) for all proposals received under one solicitation. The SSA either selects or rejects Phase I proposals based upon the strengths and weaknesses identified in proposal review plus other considerations including limitation of funds and balanced investment across all the DTRA topics in the solicitation. Balanced investment includes the degree to which offers support a manufacturing technology challenge. To balance investment across topics, a lower rated proposal in one topic could be selected over a higher rated proposal in a different topic. DTRA reserves the right to select all, some, or none of the proposals in a particular topic.

Following the SSA decision, the contracting officer will release notification e-mails through DTRA's SBIR evaluation system for each accepted or rejected offer. E-mails will be sent to the addresses provided for the Principal Investigator and Corporate Official. Offerors may request a debriefing of the evaluation of their proposal. Debriefings would be viewable at https:\\www.dtrasbir.net\debriefing\ and require password access. Debriefings are provided to help improve the offeror's potential response to future solicitations. Debriefings do not represent an opportunity to revise or rebut the SSA decision.

For selected offers, DTRA will initiate contracting actions which, if successfully completed, will result in contract award. DTRA Phase I awards are issued as fixed-price purchase orders with a 6-month period of performance that may be extended, as previously discussed. DTRA may complete Phase I awards without additional negotiations by the Contracting Officer or opportunity for revision for proposals that are reasonable and complete.

DTRA's projected funding levels support a steady state of 14 Phase I awards annually. Actual number of awards may vary.

CONTINUATION TO PHASE II

Only Phase II proposals provided in response to a written invitation from a DTRA contracting officer will be evaluated. DTRA invitations are issued based on the degree to which the offeror successfully proved feasibility of the concept in Phase I, program balance, and possible duplication of other research. Phase II invitations are issued when the majority of Phase I contracts from the preceding solicitation are complete, typically early spring. Phase I efforts which were delayed in award or extended after award will be considered for invitation the following year.

DTRA's projected funding levels support a steady state of 7 new Phase II awards annually to meet an objective of continuing approximately 50 percent of Phase I efforts to Phase II. Actual number of awards may vary.

OTHER CONSIDERATIONS

DTRA does not utilize a Phase II Enhancement process. While funds have not specifically been set aside for bridge funding between Phase I and Phase II, DTRA does not preclude FAST TRACK Phase II awards, and the potential offeror is advised to read carefully the conditions set out in this solicitation.

Notice of award will appear first in the Agency Web site at http://www.dtra.mil. Unsuccessful offerors may receive debriefing upon written request only. E-mail correspondence is considered to be written correspondence for this purpose and is encouraged.

DTRA SBIR 08.1 Topic Index

DTRA SBIR 08.1 Topic Descriptions

DTRA08-001 TITLE: Directed Mono-Energetic Gamma Source Generation and Detection

TECHNOLOGY AREAS: Sensors, Nuclear Technology

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Demonstrate capability to produce mono-energetic gamma rays for long-range detection of radiological/nuclear materials.

DESCRIPTION: The Defense Threat Reduction Agency (DTRA) seeks research proposals for investigation of mono-energetic, directed pulsed gamma ray sources which may be used for detecting special nuclear materials (SNM).

Currently, active gamma-ray interrogation for SNM makes use of Bremsstrahlung radiation based techniques. Bremsstrahlung beams have a broad energy spectrum and many of the generated gammas are of low energies. The use of sources of forward directed (i.e., focused) high energy, mono-energetic gamma rays would enable better propagation, and greater gamma intensity on target, at energies sufficiently high for inducing photo-fission in SNM, thus producing detectable signatures.

PHASE I: The successful Phase I project should address the feasibility of gamma ray sources for producing photo-fission in SNM to generate detectable gamma ray signatures. The gamma source should produce gamma energies in excess of 6 MeV and should have a negligible tail extending below the peak gamma energy.

PHASE II: The successful Phase II project will result in the development of a prototype device capable of being field-tested and demonstrated. At the conclusion of Phase II the performer will identify possible commercial collaborators for further development of the gamma source generators used for active interrogation.

PHASE III DUAL USE APPLICATIONS: The potential military application of this technology is focused on effective techniques for active interrogation using gamma rays.

REFERENCES:

1. Glenn Knoll, “Radiation Detection and Measurement”, 3rd Edition, New York: John Wiley and Son, 2000.

KEYWORDS: SNM, DETECTION, RADIATION, GAMMA, STANDOFF, ACTIVE INTERROGATION

DTRA08-002 TITLE: High-energy Neutron Interrogation for Special Nuclear Materials Detection

TECHNOLOGY AREAS: Sensors, Nuclear Technology

OBJECTIVE: Demonstrate capability to produce high-energy neutron beams for long-range detection of radiological/nuclear materials.

DESCRIPTION: The Defense Threat Reduction Agency seeks proposals for the detection of special nuclear material (SNM) using directed beams of high-energy (>2 MeV) neutrons. Currently, SNM is detected at short ranges by measuring its naturally-occurring emitted radiation (e.g. alpha, beta, gamma, neutron). It is important to develop alternate technologies to detect SNM, which may be in complex or protected configurations such as multiply-shielded containers, at some distance from the interrogating radiation source. In general, neutron beam approaches involve creation of highly dispersive (usually isotropic or near isotropic) distributions of neutrons, of which only a small portion reach the targets of interest. Additionally, some of these approaches generate broad energy spectra in which a significant fraction of the beam is produced at lower energies, which are less useful for detecting and identifying SNM. The diffuse neutron beams are also more highly attenuated during propagation through air.

The successful production of forward-directed neutron beams with energies greater than 2 MeV would solve many of these problems and could provide sufficient neutrons to targets of interest to generate truly usable signatures for SNM.

PHASE I: The successful Phase I project should address the feasibility of producing directed beams of neutrons with energies at least of 2.0 MeV in sufficient quantities to stimulate fission in SNM at ranges of the order of 100 meters.

PHASE II: The successful Phase II project will result in the development of a prototype device capable of being field-tested and demonstrated. At the conclusion of Phase II the performer will identify possible commercial collaborators for further technical development.

PHASE III DUAL USE APPLICATIONS: The potential military application of this technology is to detect and identify SNM; possible ancillary fields include the environmental determination of radioactive materials.

REFERENCES:
1. “Radiation Shielding” by J. Kenneth Shultis and Richard E. Faw, American Nuclear Society, 2000.

2. “Fundamentals of Nuclear Science and Engineering” by J. Kenneth Shultis and Richard E. Faw, Marcel Dekker, Inc., 2002.

KEYWORDS: SNM, DETECTION, RADIATION, NEUTRON INTERACTIONS, HIGH-ENERGY NEUTRON BEAMS, FOCUSED NEUTRON BEAMS

DTRA08-003 TITLE: Characterization and Mitigation of Radiation Effects in Ultra-Deep Submicron Metal Oxide Semiconductor (< 90nm) and Compound Semiconductor Microelectronics Technologies

TECHNOLOGY AREAS: Sensors, Electronics, Space Platforms, Nuclear Technology

OBJECTIVE: The objectives of this task are to:
1. Characterization of both ionizing and displacement damage radiation effects in Metal Oxide Semiconductor (MOS) ultra-deep submicron (< 90nm) integrated circuits and compound semiconductor technologies and also to
2. Development and demonstration of minimally invasive methods to mitigate these radiation effects in ultra-deep submicron digital and analog/mixed-signal integrated circuits.

The successful outcome of this task will support the use of ultra-deep submicron integrated circuits in DoD satellite systems that will result in very significant savings in weight, power and reliability for systems that include Space Radar, Space Tracking and Surveillance Systems, TSAT and others. Each new generation of microelectronics results in performance benefits that include > 2X in integration density, > 4X in power savings and > 2X in operating speed making possible very significant improvements in system capabilities.

In addition, this task will also support the use of compound semiconductor technologies (e.g. Antimony Based Compound Semiconductors, Indium Phosphide, and others) in these systems and their introduction into advanced spacecraft and missile systems with similar savings in both power and weight and coupled with increased performance.

DESCRIPTION: Currently satellite systems are fabricated using a mix of commercial and radiation hardened circuits. However, the use of advanced commercial integrated circuits devices results in added complexity to mitigate radiation effects that can result in the mal-operation and/or destruction of devices. In many cases, the penalties in increased power, area, weight and added circuit complexity out-weigh any potential benefits and preclude the use of the advanced commercial technology. In addition, there has been an increase in the introduction of compound semiconductor technologies in these systems for specific high performance applications. Moreover, these technologies have demonstrated a sensitivity to radiation effects.

The present methods to mitigate radiation effects while proven to be effective at circuits geometries > 150nm have been shown to be less effective when applied to integrated circuit feature sizes below 100nm and many of these compound semiconductor technologies.

Thus, if minimally invasive methods such as the use of alternative materials, circuit enhancements, and other innovative approaches could be developed to reduce radiation effects sensitivity these devices could be used with little or no penalties.

Therefore, the basic approach to accomplish this task would be to leverage commercial microelectronics at the < 90nm nodes and augment these technologies with radiation mitigation techniques that would have minimal impact on the electrical performance and manufacturability. This same approach also applies to the radiation hardening of the compound semiconductor technologies.

Additionally, the development of such methods requires the development of cost effective methods to model and simulate the radiation response of these < 90nm and compound semiconductor technologies. Without a robust modeling and simulation capability it would be both technically and economically unfeasible to develop these mitigation methods.

PHASE I:
• Identification of minimally invasive methods, including material approaches, to mitigate radiation effects in < 90nm microelectronics technologies including III-V and SiGe materials systems.
• Development of cost effective radiation effects modeling and simulation methods for < 90nm microelectronics and compound semiconductor digital and analog/mixed-signal microelectronics.

PHASE II:
• Electronic Design Automation tools (programs) that can;
  o Identify design sensitivities in complex integrated circuits
  o Design radiation insensitive integrated circuits
  o Perform trade studies to provide optimized integrated circuits WRT radiation and electrical performance
  o Analysis the radiation response of complex integrated circuits
• Technology Computer Aided Design (TCAD) tools that can:
  o Provide cost effective 3-D models to support the simulation of the radiation response of nanotechnology microelectronics.
  o Identify radiation sensitivities at the transistor level
• Mixed-Mode and Level Simulation systems that can effectively couple the radiation response at the transistor level to higher levels of circuit and subsystem integration (e.g. transistor response to small circuit to complex circuit to sub-system) to support the accurate radiation response simulation up to and including the sub-system level.
• Radiation effects Product Design Kits (PDK) that combine the electrical and radiation response design and modeling parameters for a specific technology. PDKs are provided by semiconductor manufacturers to their customers to support design activities. In general a semiconductor manufacturer will develop an electrical performance and design PDK that must be then augmented with radiation performance to support customer s that require the technology to be used in a radiation environment.

• Development and demonstration of < 90nm radiation effects modeling and simulation methods

PHASE III DUAL USE APPLICATIONS: Use of the mitigation, modeling and simulation methods developed through this effort to support the use of advanced microelectronics for terrestrial application such a very high performance microprocessor, advanced Servers, and very large cache memories.

REFERENCES:
1. IEEE Transactions on Nuclear Science; December 2005, Volume 52, Number 6, Session A Single Even Effects: Mechanisms and Modeling, pages 2104-2231

2. IEEE Transactions on Nuclear Science; December 2005, Volume 52, Number 6, Session F Single Even Effects: Devices and Integrated Circuits, pages 2421-2495

3. JEDEC 57, SEE Test and Characterization Guidelines and Test Method

4. Military Test Method 1019, Steady State Total Ionizing Dose

5. ASTM 1892 – Steady State Total Ionizing Effects Guideline

KEYWORDS: SINGLE-EVENT EFFECTS, SINGLE-EVENT UPSET, SINGLE-EVENT TRANSIENTS, TOTAL IONIZING DOSE, DISPLACEMENT DAMAGE

DTRA08-004 TITLE: Mass Spectrometer for Nuclear Forensics Analysis

TECHNOLOGY AREAS: Sensors, Nuclear Technology

OBJECTIVE: Develop a portable mass spectrometry (MS) capability suitable for deployment in austere environments and in radiologically contaminated areas. Demonstrate the capability to measure high mass elemental species (m/e > 200), such as special nuclear material (SNM) and transuranics, preferably to sub-amu resolution.

DESCRIPTION: The current method of measuring the amount of radioactive material present in a sample is accomplished by measuring its rate of radioactive decay. For long-lived isotopes, this measurement lacks precision for the short counting times required for operational response.

In recent years, MS has become a useful alternative to the radiation detection method for measuring longer-lived radionuclides. It provides a second and completely independent method of measurement to confirm results; it also gives the analyst a choice, because some measurements are easier or more reliable by one method than the other. The MS technique has been successfully used to measure radioactive species with half-lives greater than ten years.

We are seeking proposals to develop a portable MS system capable of measuring high mass elemental species (m/e > 200). Additional consideration will be given to proposals demonstrating sub-amu resolution and the ability to couple the instrument to an Automated Laboratory System.

PHASE I: The successful Phase I project should address the feasibility of producing a portable MS system capable of reliably measuring high-mass elemental species (m/e > 200). Sub-amu resolution is a secondary consideration.

PHASE II: The successful Phase II project will result in the development of a prototype MS system capable of being field-tested and demonstrated. The MS system will be integrated with an Automated Laboratory System, such as a programmable microwave digester (total dissolution), chemical separation, and concentration of the radionuclide. At the conclusion of Phase II the performer will identify possible commercial collaborators for further technical development.

PHASE III DUAL USE APPLICATIONS: The potential military application of this technology is to rapidly assess field samples for the presence of SNM, and to identify elemental composition; possible ancillary fields include the determination of the presence of radioactive materials in environmental samples.

REFERENCES:
1. Radioanalytical Chemistry, B. Kahn, editor, Springer, 2007.

2. Radioisotope Techniques, R. Overman and H. Clark, McGraw-Hill, 1960.

3. Radiochemistry, C. Keller, John Wiley & Sons, 1988.

4. Master Thesis, M.A.R. Walsh, Rensselaer Polytechnic Institute, "Production of Rare Earth Radioactive Isotopes for the Study of Rapid Ion Exchange", 1973.

5. Field Test of the Rapid Transuranic Monitoring Laboratory, Idaho National Laboratory, EGG-WTD-10935, December 1993.

KEYWORDS: Mass Spectrometer, Special Nuclear Material, transuranics, Automated Laboratory System

DTRA08-005 TITLE: Bulk Composite Materials for Detection of Gamma Radiation

TECHNOLOGY AREAS: Materials/Processes, Nuclear Technology

OBJECTIVE: Develop economical industrial-scale process for production of bulk gamma radiation detectors based on composite material(s) that have characteristics comparable to large single-crystal detectors.

DESCRIPTION: The current generations of moderate- and high-resolution detectors for gamma radiation are based on single crystals of semiconductor or scintillator material. Examples include high-purity germanium, cadmium-zinc telluride (CZT), mercuric iodide, thallium bromide, rare-earth halides, and cesium lithium yttrium chloride (CLYC). For wide band-gap semiconductors capable of operating at ambient temperature, achievable energy resolution for gamma detection is less than 1% FWHM at 662 keV. For single crystal scintillators, 3% energy resolution has been demonstrated. National security applications require large bulk crystals of similar energy resolution with sufficient stopping power for efficient near-real time detection of gamma energies up to 3 MeV. Large single crystals of many materials have proved difficult to produce consistently and reliably on an industrial scale, and consistent production of some crystals is possible only in small batches at relatively high cost.

Composite or nano-composite materials potentially offer attractive radiation-detection characteristics, such as high energy resolution and high stopping power for high gamma energies, without the need or high cost of producing large single crystals. Composite materials could potentially be produced in large sizes at lower cost, be configured in sizes and shapes appropriate for unique radiation-detection applications, and have durable physical properties that would enable radiation detectors to operate in the harsh environments encountered in military operations. In general, large batch production of composite materials requires small, even nano-scale sized materials with appropriate and consistent radiation-detection properties. These small particles must then be combined at relatively high density with a binder that makes feasible the efficient extraction of electronic charge or of light proportional to the amount of radiation energy deposited in the material. For many thin-film nano-materials, the available thickness of the product typically has insufficient stopping power for the higher energy gamma rays. Furthermore, layering thin-film devices to create thick detectors is not always feasible or economical. A detector made of composite materials should have attractive radiation detection properties comparable to detectors based on single crystals, including energy resolution, detection efficiency, response time, and stopping power. The economical scaling of nano- or micro-scale process to a large bulk material is also important.

PHASE I:
• Demonstrate consistent production of a composite material(s) in small batches
• Measure the radiation response of a sample of the proposed material for several gamma energies up to and including 662 keV
• Produce a detailed plan for volume production of the material into a bulk configuration of sufficient size to reliably stop 3 MeV gamma rays

PHASE II:
• Demonstrate consistent medium batch-scale production of composite material
• Demonstrate high-energy gamma detection characteristics of the bulk material comparable to single-crystal detectors
• Demonstrate capability for scaling to an industrial-scale process, including a full cost analysis supporting industrial scale process
• Deliver a prototype detector demonstrating marketable configurations for military applications
• Provide a planned commercialization path forward

PHASE III DUAL USE APPLICATIONS: Potential additional national security applications for a successful low-cost, bulk-composite radiation detector would include homeland security, forensics, and local state and federal responders to a possible radiation incident. Additional applications beyond national security could include medical imaging, physics experiments, and radiation contamination mapping.

REFERENCES:
1. Glenn Knoll, "Radiation Detection and Measurement", 3rd Edition, New York: John Wiley and Son, 2000

KEYWORDS: radiation detection, composite materials, gamma rays

DTRA08-006 TITLE: <u>Engineering Models for Damage to Structural Components Subjected to Internal Blast Loading</u>

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: Develop algorithms for fast-running engineering models relating damage levels of structural members to the blast environment resulting from detonation of high explosives inside a building. Validate models utilizing existing test data and synthetic data generated by high fidelity computational codes.

DESCRIPTION: DTRA develops tools for targeting and vulnerability assessments. These tools use fast-running models to calculate the blast environment from various weapons and the associated damage to buildings. Pressure-Impulse (P-I) diagrams and response surfaces generated from synthetic data are used extensively to quickly determine blast damage to structural components from external blast loads. However, these approaches are typically only applicable for blast load histories with a given assumed shape that is characteristic of external explosions (i.e., instantaneous rise to a peak pressure followed by an exponential decay). Separate fast-running algorithms are needed for structural components subject to internal explosions with more complicated shapes that consist of both shock and quasi-static pressure loads. In many cases, impulsive loads from primary debris should also be considered. It is anticipated that the new fast-running algorithms will be based on a combination of theoretical analysis and test data, where the theoretical analysis may be based on a simplified procedure such as single-degree-of-freedom (SDOF) or high fidelity computational fluid and structural codes.

PHASE I: Collect applicable data related to blast pressures from internal explosions and associated damage. Choose at least one structural component type (e.g., steel stud wall, concrete masonry unit wall, reinforced concrete wall, etc) to be considered for the Phase I study. Determine characteristics of internal blast waveforms using existing data and synthetic data generated from high-fidelity codes. Develop an appropriate fast-running structural damage methodology (e.g., modified P-I diagrams) for the structural member(s) chosen and for the variety of internal blast waveforms identified. Demonstrate that the methodology accurately replicates the damage state. Describe how the methodology could be applied to other structural component types and how synthetic data would be created for other components studied in Phase II where test data is lacking.

PHASE II: Develop fast-running algorithms for all component types in Component Explosive Damage Assessment Workbook (CEDAW) and compare results to applicable data and to theoretical analyses. This methodology should be compatible with available fast-running prediction methods for internal blast loads that are developed based on ongoing testing.

PHASE III DUAL USE APPLICATIONS: Prediction of structural damage from internal blast loads is important to weaponeering and physical security studies, as well as explosive safety and industrial accident studies. The fast-running algorithms can be used for all of these cases.

REFERENCES:
1. Baker, W. E., Cox, P. A., Westine, P. S., Kulesz, J. J., and Strehlow, R. A., Explosion Hazards and Evaluation, Elsevier Scientific Publishing Company, New York, NY, ISBN 0 444 42094 0, 1983.

2. Oswald, C.,J. "Component Explosive Damage Assessment Workbook (CEDAW)," Prepared by Baker Engineering and Risk Consultants for the U.S. Army Corps of Engineers Protective Design Center, Contract No. DACA45-01-D-0007-0013, May 2005.

3. Wathugala, G. W., Hasselman, T. and Bogosian, D "FAST-RUNNING MODELS FOR PREDICTING REINFORCED CONCRETE WALL RESPONSE TO CASED MUNITIONS," Proceedings of the Thirtieth DoD Explosives Safety Seminar, 13-15 August 2002.

4. "A Manual for the Prediction of Blast and Fragment Loadings on Structures," prepared for United States Department of Energy, by Southwest Research Institute and Wilfred Baker Engineering, Inc., under contract with Mason & Hanger, and Battelle Pantex, Report No. DOE/TIC 11268, July 1992.

KEYWORDS: Internal blast, Shock, Quasi-Static Pressure, Structural Response

DTRA08-007 TITLE: <u>Measuring Dynamic-Pressure-Generated Gas Flow During Internal Detonations</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors, Weapons

OBJECTIVE: To develop a method or sensor(s) which can accurately measure or visually capture extremely high pressure, high velocity gas/debris flows in obscured or inaccessible environments.

DESCRIPTION: During an internal structure weapon detonation, the rapid expansion of gas products causes high velocity gas movements to occur within a multi-room structure. The gases flow from confined high pressure regions to areas of lower pressure. This phenomenon has been referred to as “dynamic pressure”. These gas flow “winds” can reach hundreds of miles per hour and can be lethal and/or damaging to personnel and equipment. If the flow was simply gases, the flow could be measured by current techniques, such as hot-wire anemometer, pitot-tube, stagnation gauges, or even video. Testing, however, has demonstrated that the flow is far from “clean”, but instead contains massive amounts of high temperature gas/particulate and debris. This hostile environment destroys sensors and produces zero visibility. A method and/or sensor is needed to capture gas flow data (mainly direction and velocity), through-out a test room (approximately 1000-6000 cubic ft with walls constructed from various materials), during the entire gas flow duration (about 1 second), in order to create/update/verify computer models. Possible methods/sensors could consist of an “internal” type solution such as a sensor(s) within the gas flow, or “external” such as special observation cameras, or “seeded/tagged” combustion/airborne products, or a combination of, but not limited to, any of these methods. The test facilities are very flexible in accommodating any sensor/apparatus installation, and are typically constructed with concrete walls that can be modified. Data collection will primarily occur outside of the detonation room (in hallways or other rooms), thus any sensors/devices used will be shielded from the direct blast.

PHASE I: Develop a feasible cost-effective approach (i.e. a proof of concept) for capturing the gas flow history during a detonation event (1 to 50 kg TNT equivalents) comprised of high temperature/velocity gases and particulates. Adequately show how this approach will survive the event, and capture the flow properties throughout the event. Explain the physics/mechanics utilized in the technique, and a plausible packaging and employment method that would be used.

PHASE II: Develop the brass-board hardware (i.e. a prototype) for capturing the gas flow history during a detonation event comprised of high temperature/velocity gases and particulates. Demonstrate the capability and survivability of this technique in a relevant environment. Provide fabrication-level engineering drawings of the recommended packaging of the device, and recommendations for manufacturing.

PHASE III DUAL USE APPLICATIONS: Gages able to withstand blast induced dynamic pressures could be of use in measuring the flow in applications where hot, turbulent, multi-phase, corrosive, or abrasive materials are being pumped, sprayed or propelled. Coating applications such as Flame Spray, Plasma Coating could use these gages to characterize the flow to improve the process and/or develop new materials, applications, etc or to provide flow information in a control circuit. These dynamic pressure gages could be of use in determining efficiencies and finding material flaws in Turbines. The intake and exhaust of turbine engines are exposed to particulate environments that can cause high wear to pressure sensors. This is especially true for operations in environments where dust, sand, and other particulate matter are abundant. This sort of gage would also be of substantial value for environmental measurement of flue gases. Since the static pressures in typical flue pipes is minimal the most accurate measure of flow is via dynamic pressure measurement thus a technique is needed that will provide this measurement in the hot gas environment.

REFERENCES:
1. ADB292020 “(U) Experimental results for 1/3-Scale Dipole Tiger 1 and 11.6 Scale Tests 63, 64, and 65 in Support of the Collateral Effects Environment Program", ENGINEER RESEARCH AND DEVELOPMENT CENTER VICKSBURG MS GEOTECHNICAL AND STRUCTURES LAB, 2003, Graham, Paul W., Chiarito, Vincent P., Albritton, Gayle E.

2. ADM001466 “Twenty-Ninth DOD Explosives Safety Seminar Proceedings (CD-ROM)", Dec 2000

KEYWORDS: Mass-flow measurement, dynamic pressure measurement, multi-phase flow, internal detonation, particulate flow, entrained flow measurement

DTRA08-008 TITLE: <u>Agent Defeat using Proton Accelerator</u>

TECHNOLOGY AREAS: Sensors, Electronics, Nuclear Technology

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective of this research topic is develop a capability for a field deployable system that achieves defeat of bulk-stored bio-agent using high energy protons.

DESCRIPTION: Cancer treatment using high energy protons is driving a surge in the construction of proton accelerators as well as research into new technologies for reducing the machine size and the attendant operational burden. One attractive attribute of high energy protons is that they can be focused and stopped at a predetermined point inside the target, where they then deposit most of their energy. For cancer treatment this feature can target deeply buried tumors with minimal effect to surrounding healthy tissue. For agent defeat, this feature may similarly allow a focusing of energy upon pockets of bio-agent contained inside of storage containers or weapons. In the case of weapons, such focusing capability could offer tactical options of either disabling or avoiding the explosives and fuzes used by the weapon for agent dispersal, depending on the situation. Many research issues remain to be answered before new proton accelerator technology can be applied to the bulk agent defeat problem. For instance, what mechanisms produce the defeat of biological agents?   What effects do these proton mechanisms have upon other dangerous materials likely to be found in conjunction with the bio-agents, for instance, chemical agents and explosives?   Is DNA damage, believed to be the cause of destruction of cancer cells by proton beams, an effective way to deal with bulk bio-agent, and if not, is some other result of energy deposition by the protons effective?   What energy levels, flux density, beam dwell time and pulse rate are appropriate for WMD defeat?   What are the promising approaches for ways to further miniaturize proton accelerator devices that would be capable of producing beams at the appropriate energy and flux while also being field deployable?

PHASE I: Perform research and analysis of the generation of high-energy proton beams and the mechanisms of interaction between these high energy proton beams and various bio-agent systems. Develop technology concepts for generation and use of high energy protons to neutralize concentrated masses of bio-agents. Model the expected level of effective neutralization of bulk bio-agent held in typical bulk storage and in stored weapons. Develop a system concept and model or simulate its expected performance against bulk bio-agent under conditions as stored in either a production facility or within stored weapons.

PHASE II: Develop a prototype proton accelerator capable of delivering a beam of high-energy protons that can be focused upon and effectively destroy the bulk bio-agent stored in liquid water within steel storage drums as typically used in production facilities, and stored within the payload of a typical steel-cased warhead. Demonstrate and evaluate the prototype system against bulk-stored simulated bio-agent as in warehouse storage and in stored weapons, and measure it's effectiveness in terms of percent of agent killed, time required to kill the agent, maximum and minimum stand-off distance, and power requirements.

PHASE III: Perform systems integration and demonstration of a field-deployable proton-beam generator that will fully neutralize bulk bio-agent in warehouse and weapon storage conditions. The technology may be commercialized for its applications in cancer treatment, high energy physics research or non destructive testing.

REFERENCES:
1."Defense Threat Reduction Agency, 2003 Strategic Plan", http://www.dtra.mil/about/media/brochures/index.cfm

2. "National Military Strategy to Combat Weapons of Mass Destruction (WMS-CWMD)". Feb 2006, http://www.defenselink.mil/pdf/NMS-CWMD2006.pdf

3. "First Compact Proton Therapy Machine for Cancer Treatment Center", Steve Wampler, News Release, July 3, 2007, http://www.llnl.gov/pao/news/news_releases/2007/NR-07-06-06.html

KEYWORDS: Particle accelerator, proton accelerator, agent defeat, chemical, biological agent defeat, WMD defeat