

# Explosives Division Basic Research Overview

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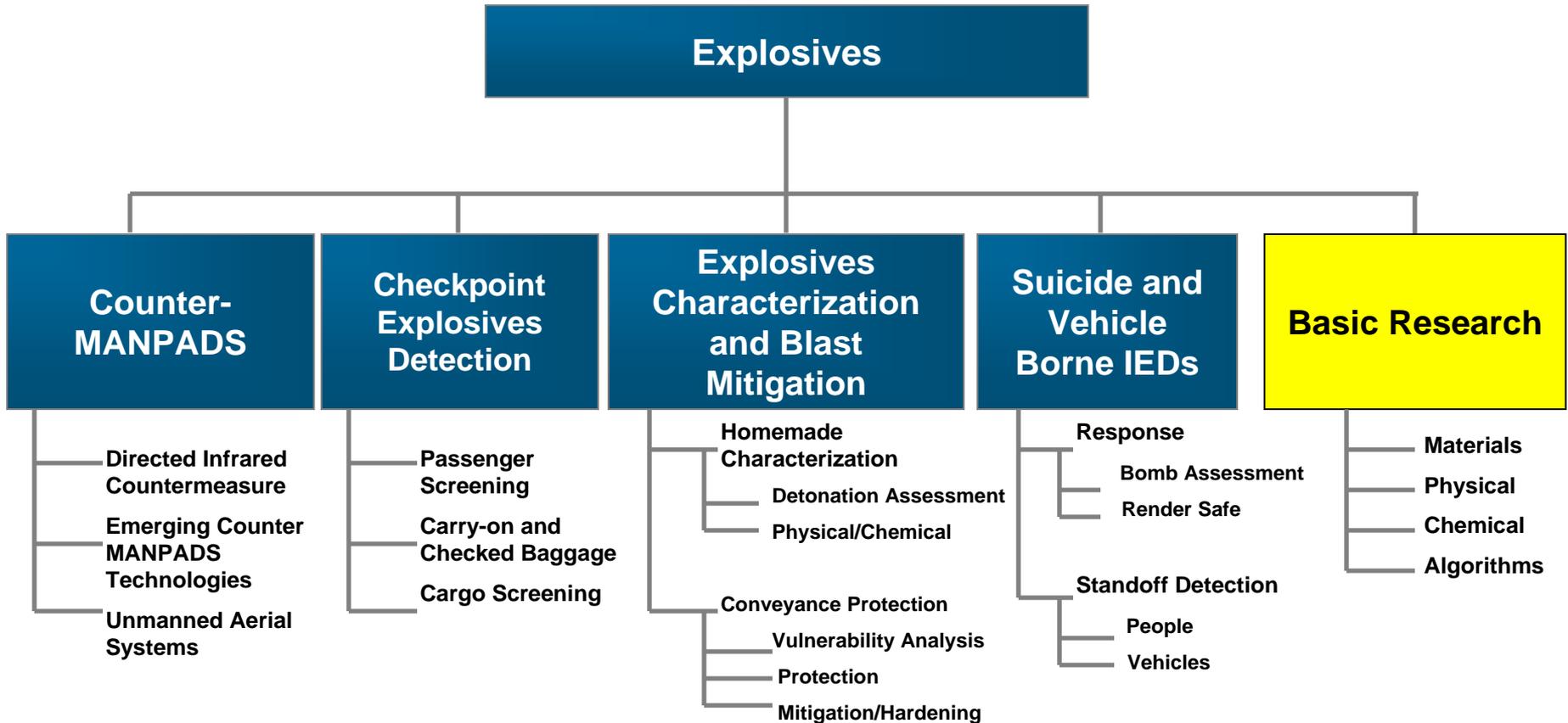


## Homeland Security



# Division Organization

Managed by the DHS Science and Technology Directorate, the Explosives Division delivers on its mission through five thrust areas.

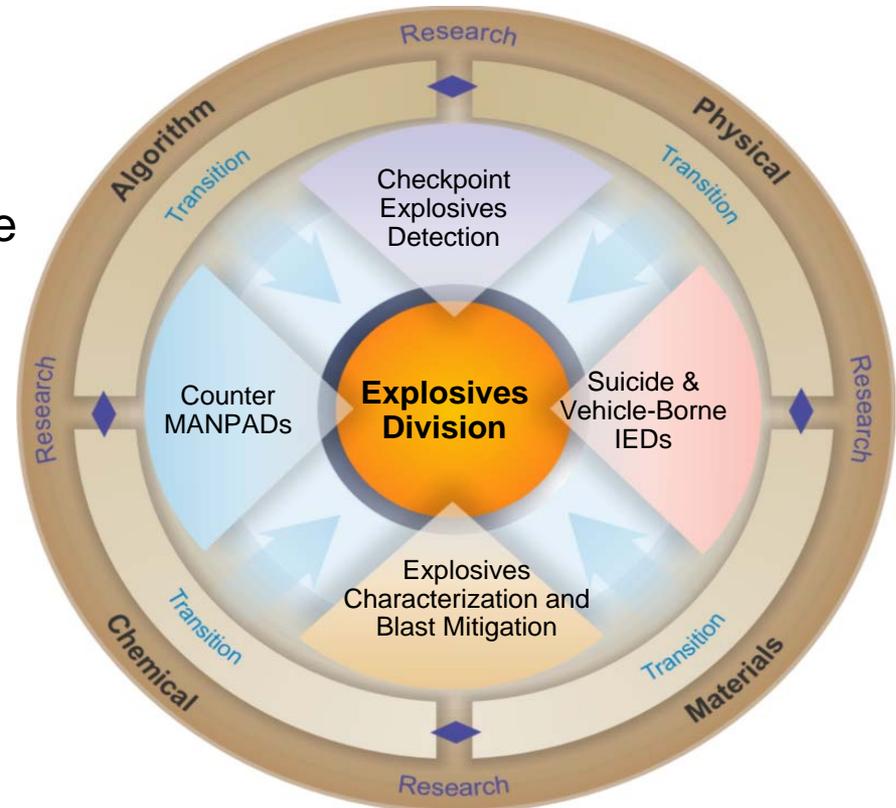


# Explosives Division

Mission: To develop technical capabilities to detect, interdict, mitigate, and respond to the effects of non-nuclear explosives terrorism and accidents.

## Customers:

- Transportation Security Administration
- National Protection & Program Directorate
- US Secret Service
- Customs and Border Protection
- US Coast Guard
- Federal, state and local first responders



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# Counter-MANPADS

- Developing and demonstrating Counter-MANPADS mitigation technologies to the commercial airlines industry
- Ensuring that the resulting systems will minimally impact on the air carriers, airport operations, maintenance and support activities
- Currently three programs underway:
  - DIRCM (in Phase III)
  - Evaluating Emerging Counter-MANPADS Technologies (ECMT)
  - High-altitude unmanned aircraft systems





# Checkpoint Explosives Detection

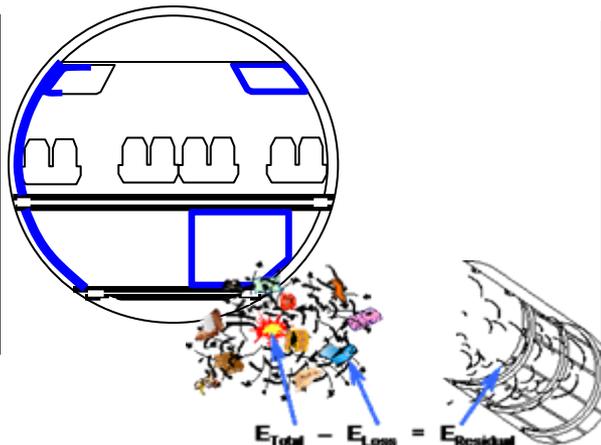
- Working to develop technologies to screen passengers, carry-on and checked luggage, and cargo
- Increasing detection capability, including for liquid explosives
- Improving screening system throughput, capacity, reliability and effectiveness while minimizing false alarm rates, cost and labor
- Working to decrease passenger retention time while reducing intrusive searches of passengers



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# Explosives Characterization and Blast Mitigation

- Developing and implementing projects that identify conventional and enhanced explosives threats and mitigate their potential damage
- Leveraging the testing from federal law enforcement, the national labs and others. Pairing this information with that from S&T tests
- Providing key DHS stakeholders with information to inform development and updating of procedures and concepts of operation
- Conducting vulnerability analysis to inform projects examining ways to mitigate damage from explosive threats



# Suicide and Vehicle Borne IEDs

- Developing new or improving existing technical capabilities to **detect**, **defeat**, and **mitigate** the effects of Suicide Bomber (SB) and Vehicle Borne (VB) IEDs for federal, state and local responders

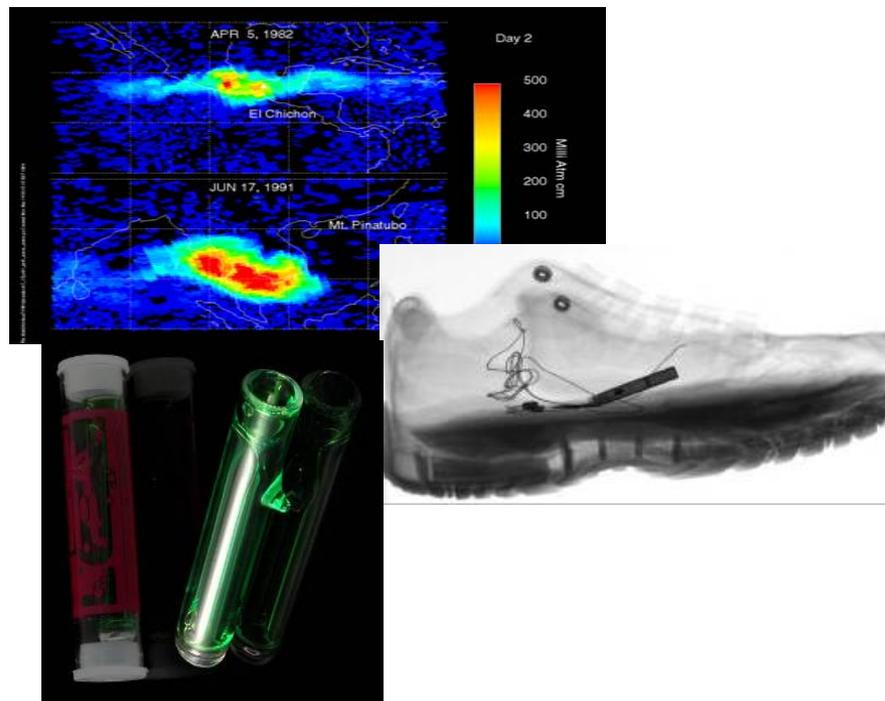


- Technologies should assess, diagnose and render safe SB or VBIEDs
- Developing portable, non-obtrusive detection technologies with no chokepoints and decreased false alarm rates
- Integrated layered approach and a standardized/common display system



# Basic Research

- Working to ensure that Explosives Division programs are balanced between:
  - Producing technologies that can be transitioned to meet customer needs, and
  - Advancing state of the art science related to explosives countermeasure and prevention



## Research Programs Include:

Road Mapping & Assessment

Fundamental Particle Physics

National Science Foundation Supplemental

SENSIT/Ultra-Low Field Magnetic Resonance Imaging

Liquid & HME Characterization

Analysis of Raw Images and Algorithms

Manhattan II

Detection Technology/Materials



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# EXD Research Programs

- **Road Mapping & Assessment Program**
  - Cooperative effort with several DOE National Labs that build on previous Enabling Science workshops sponsored by S&T to identify basic research with promise for transformative breakthrough in explosives detection capability
- **Liquid & HME Characterization Program**
  - Ongoing effort with NEXESS Labs (LLNL, LANL, SNL) supporting HME detection program by supporting verification of lab testing results in finding and producing HME mixtures
  - Established multi-lab collaborative arrangement to provide technical expertise and rapid response for emergent threats and analysis
  - Long-term investment to address the research gaps in converting the positive results from HME characterization tests and technology assessments into screening equipment for airports and mass transit venues
- **National Academy of Science (NAS) Research**
  - Explosive detection research on “False Positives from EDS” using BMED committee to examine EDS technology



# EXD Research Programs (continued)

- **Analysis of Raw Images & Algorithms Program**
  - Ongoing effort with related to collection and analysis of novel threat data for research related to advanced algorithm development of explosives detection
  - Collect and consolidate images from commercial vendors and purchase additional images/data from CT, EDS, Trace and new emerging devices to include novel explosives and other technologies of future interest
  - Evaluation of images to determine relationship between image quality and false alarm rate, detection quality and image resolution over multiple types of fielded and new scanning systems
- **National Science Foundation (NSF) Research Program**
  - Support NSF ongoing basic research R&D program solicitation to industry and academia for program ideas that support innovative science that hold promise for improvements in explosives detection
  - Enables S&T to be part of process to identify and select innovative concepts and research proposals on “Explosives and related threats: Frontiers in Prediction and Detection”
  - Johns Hopkins Univ. research related to measurements of nitro-organic based explosives for forensic matching
  - Colorado State Univ. research related to developing gene circuits encoding traits that enable plants to detect and respond to explosives.



# EXD Research Programs (continued)

- **Manhattan II**
  - Performance Standard development that leverages DICOM/DICONDE for commercial CT devices (Battelle)
  - Advanced Algorithm Concept Studies and Experiments (TSWG BAA)
  - Non-Proprietary Image Database Development and Coordination (LLNL)
  - S&T BAA to support development of the performance Standard, identify enabling detection technologies, providing images/data, and support LCC Model development
- **SENSIT/Ultra-Low Field Magnetic Resonance Imaging**
  - Technology developed by LANL relies upon squids and physics insights first developed in connection with brain scanning for medical applications. This effort characterizes the development that would be necessary to undertake the technology cross-walk between medical and explosives detection applications.
- **Detection Technology/Materials**
  - LLNL will conduct advanced detection and materials technologies for development of a infrastructure materials science testbed.

# Advanced CTX Algorithm Research

## **Product Description:**

- Enhanced performance of deployed CTX equipment for checked bag screening.
- Develop innovative methods for image processing from raw data to ultimate screener displays which will correct for artifacts and also ensure the greatest possible ability to discriminate between threat targets and clutter in typical checked & hand-carried baggage
- TRL at Start: 6
- TRL at Transition: 8



## **Planned Demos/Deliverables/Transitions:**

- Evaluate CTX Algorithm Concepts–FY07
- Algorithm Demonstrations–FY08
- T&E of New System Capabilities–FY09
- Transition to TSA–Q2 FY10

## **Payoff:**

- **Supports Awareness, Prevention & Protection Goals**
  - Supports integrated next generation checked baggage systems & technologies
  - Improve detection capabilities & throughput
  - Reduce false alarms
  - Reduce operations & maintenance costs

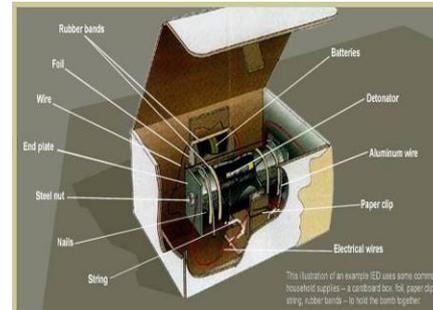
## **EHC Gap Indirectly Addressed:**

- System solution for detection in baggage (checked)
- Homemade or novel explosives detection

# HME Algorithm Research

## Product Description:

- Innovative algorithms and data analysis tools that improve performance and total cost of ownership of COTS detection systems.
- Supports development and rapid prototype of improved HME detection systems at checkpoints.
- The product will identify COTS and high leverage technologies to meet TSA transition goals.
- TRL at Start: 6
- TRL at Transition: 8



## Planned Demos/Deliverables/Transitions:

- Evaluate and Test COTS–FY07
- Technology & Algorithm Demonstrations–FY08
- T&E of New Technologies–FY09
- Transition to TSA–Q2 FY10

## Payoff:

- **Supports Awareness, Prevention & Protection Goals**
  - Improve detection capabilities & throughput
  - Reduce false alarms
  - Reduce operations & maintenance costs

## EHC Gap Indirectly Addressed:

- System solution for detection in baggage
- Identify individuals with hostile intent
- Homemade or novel explosives detection
- Novel explosives characterization

# Trace Research Project

## Product Description:

- Basic and Applied Research that advances the scientific understanding behind the deposition, removal and transport of explosive particles.
- This information is used to enhance the currently deployed trace detection equipment as well as provide crucial data necessary to develop the next generation trace detectors.
- TRL at Start: 2-3
- TRL at Transition: 6



## Planned Demos/Deliverables/Transitions:

- Studies–FY07
- New technology–FY08
- Integration into product–FY09
- Transition to TSA–Q1 FY10

## Payoff:

- **Supports Awareness, Prevention & Protection Goals**
  - Improve detection capabilities & throughput
  - Reduce false alarms
  - Reduce operations & maintenance costs

## EHC Gap Indirectly Addressed:

- System solution for detection in baggage
- Identify individuals with hostile intent
- Homemade or novel explosives detection
- Novel explosives characterization



# Blast Resistant Materials Project

## **Product Description:**

- Research that develops and transitions advanced materials for application in advanced aircraft design to reduce the effects of an explosive detonation.
- The main goals are to enhance the survivability of the aircraft to limit casualties and invest in materials to toughen barriers and building construction to withstand blast effects.
- TRL at Start: 4
- TRL at Transition: 6



## **Planned Demos/Deliverables/Transitions:**

- Studies–FY07
- New technology–FY08
- Integration into product–FY09
- Transition to TSA–Q1 FY10

## **Payoff:**

- **Supports Prevention & Protection Goals**
  - Improve protection of persons, conveyances, infrastructure
  - Reduce operations & maintenance costs

## **EHC Gap Indirectly Addressed:**

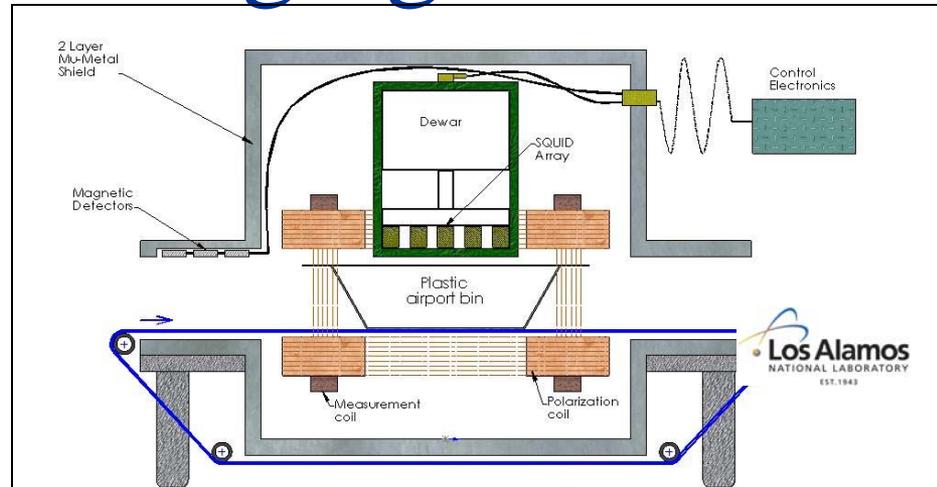
- Blast mitigation in the transit environment (hardening for transit, tunnels, structures)
- Assess, render safe, neutralize explosive threats
- Mitigation of standoff ballistic & guided projectiles in the transportation environment..



# Ultra-Low Field – Magnetic Resonance Imaging

## Product Description:

- **NEW START FY07**
- Airport and security portal scanner for detecting liquid explosives, solid explosives and explosive components in baggage and packages.
- Ultra-Low Field Magnetic Resonance Imaging (MRI) technology developed at Los Alamos Lab.
- Noninvasive (non-contact) technology can be safely used for screening individual passengers
- TRL at Start: 2/3; TRL at Transition: 6+



## Planned Demos/Deliverables/Transitions:

1. Liquid Explosive Detection Demonstration (Sep 2006)
2. Application Demonstration (Lab version) — FY07
3. Prototype System Demo — FY07 - FY08
4. First transition to TSA, Commercialization – FY08
5. Baggage Inspection — FY09
6. Solid Materials Evaluation – FY09 - FY10
7. Transition to TSA — FY10

## Payoffs:

- Supports existing requirement for standoff detection in a tiered security environment
- Reliable detection with high throughput (non-contact, non-invasive, no radiation, no residue required)
- Explosive material database can readily incorporate new threats as they arise without hardware modifications
- Easily adaptable to any portal screening (e.g. federal buildings)
- Basic science serving national security



# Manhattan II

## Product Description:

- Manhattan-II pursues new concepts and revolutionary technologies with potential for offering solutions that meet long-term checked baggage screening requirements for improved detection and stakeholder cost reduction
- TRL at start: 3
- TRL at transition: 7



## Demos/Deliverables/Transitions:

- Phase 0 Baseline Determination and Identification of Technology Gaps – FY06-FY07
- Phase I Novel Explosive Characterization and Data Collection – FY07-FY08
- Phase II Performance Standard Development – FY08-FY09
- Phase III Hardware and Software Optimization and System Integration – FY10-FY11

## Payoff:

- **Supports Awareness, Prevention & Protection Goals**
- Integrated next generation checked baggage systems & technologies
- Improved threat detection & passenger throughput
- Lower life-cycle costs

## IPT Supported:

- Explosives

## Customers:

- Civil Aviation Stakeholders (including traveling public)

## Capability Gaps Addressed:

- System solution for detection in baggage (checked)
- Homemade or novel explosives detection
- Novel explosives characterization



# Algorithm & Analysis of Raw Images

## **Product Description:**

- Collection and analysis of novel threat data for research related to advanced algorithm development of explosives detection.
- TRL at Start: 1/2
- TRL at Transition: 3/4



## **Planned Demos/Deliverables/Transitions:**

- Collect and consolidate images from commercial vendors and purchase additional images/data from CT, EDS, Trace and new emerging devices to include novel explosives and other technologies of future interest
- Evaluation and analysis of images to determine relationship between image quality and false alarm rate, detection quality and image resolution
- Raw Image Research Reports and Analysis for transition to other screening system programs

## **Payoff:**

- **Supports Awareness, Prevention & Protection Goals**
  - Supports future detection systems needs and capabilities

## **EHC Gap Indirectly Addressed:**

- System solution for improved detection capabilities
- Homemade or novel explosives detection

# Detection Technology & Material Science

## **Product Description:**

- Advanced detection and materials technologies for development of an infrastructure materials test bed.
- Invest in materials combinations which can toughen existing infrastructure.
- Characterize materials in basic infrastructure application to determine how they change over time and how they will withstand stress at end of life.
- TRL at Start: 1/2
- TRL at Transition: 3/4



## **Planned Demos/Deliverables/Transitions:**

- Employ latest advances in high performance materials development to provide a basis for enhanced aircraft survivability.
- Focus on blast resistant materials used in aircraft design to reduce effects of an explosive detonation
- Detection Technology and Materials Science Research Reports and Analysis for transition to other mitigation and protection programs

## **Payoff:**

- **Supports Awareness, Prevention & Protection Goals**
  - Supports future detection systems needs and capabilities

## **EHC Gap Indirectly Addressed:**

- System solution for improved detection capabilities
- Homemade or novel explosives detection

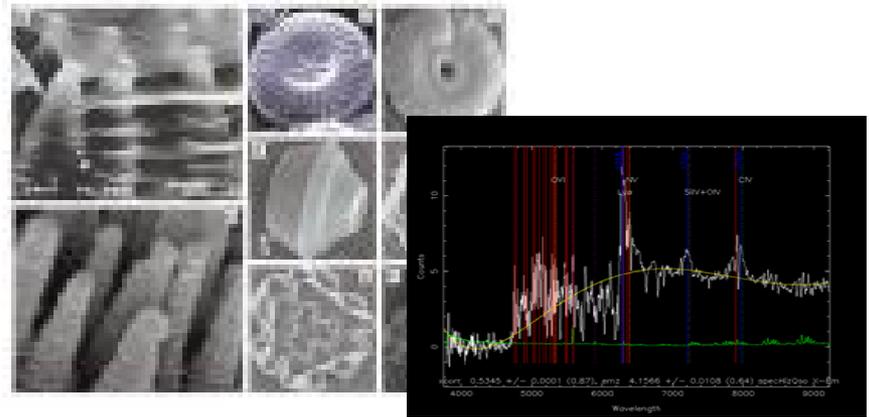


# Homeland Security

# Fundamental Particle Physics

## Product Description:

- Investigating fundamental science behind explosive particle behavior for insight into sampling technology
- Improved sampling technologies support resolution of current passenger screening puffer issues.
- Detection science investment to advance knowledge of reflective spectroscopic imaging for bulk, liquids and vapors.
- TRL at Start: 3/4
- TRL at Transition: 5/6



## Planned Demos/Deliverables/Transitions:

- Identify and exploit the unique physical properties of explosive threat materials to provide highly automated enhanced detection capability.
- Application demonstration and ConOps development for transition to other prototype detection system programs

## Payoff:

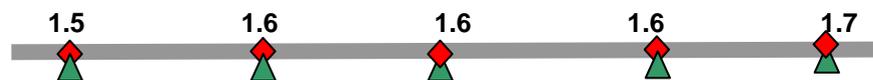
- **Supports Prevention, Protection & Response Goals**
  - Supports future detection system needs and capabilities

## EHC Gap Indirectly Addressed:

- System solution for improved detection capabilities
- Improved sampling and detection of Homemade or novel explosive threats

FY07      FY08      FY09      FY10      FY11      FY12      FY13

Total Funding (\$M)  
 Deliverables/Demos ◆  
 Transitions ▲  
 Performer: TBD



# Liquid and Home Made Explosive Characterization

## Product Description:

- Support the accumulation of information on the detonability of various mixtures and the performance of those which are detonable.
- Information will rely both upon explosives testing and utilization and verification of hydrodynamic codes as the LLNL CHEETAH code.
- Understand how unstable mixtures change over time.
- TRL at Start: 3/4
- TRL at Transition: 5/6



## Planned Demos/Deliverables/Transitions:

- Address the research gaps in converting the positive results from HME characterization tests and technology assessments into screening equipment for airports and mass transit venues.
- Detection Technology and Materials Science Research Reports and Analysis for transition to other mitigation and protection programs

## Payoff:

- **Supports Prevention, Protection & Response Goals**
  - Supports future detection system needs and capabilities

## EHC Gap Indirectly Addressed:

- System solution for improved detection capabilities
- Homemade or novel explosives detection

FY07      FY08      FY09      FY10      FY11      FY12      FY13

Total Funding (\$M)  
 Deliverables/Demos ◆  
 Transitions ▲  
 Performer: TBD

