S&T Stakeholders Conference

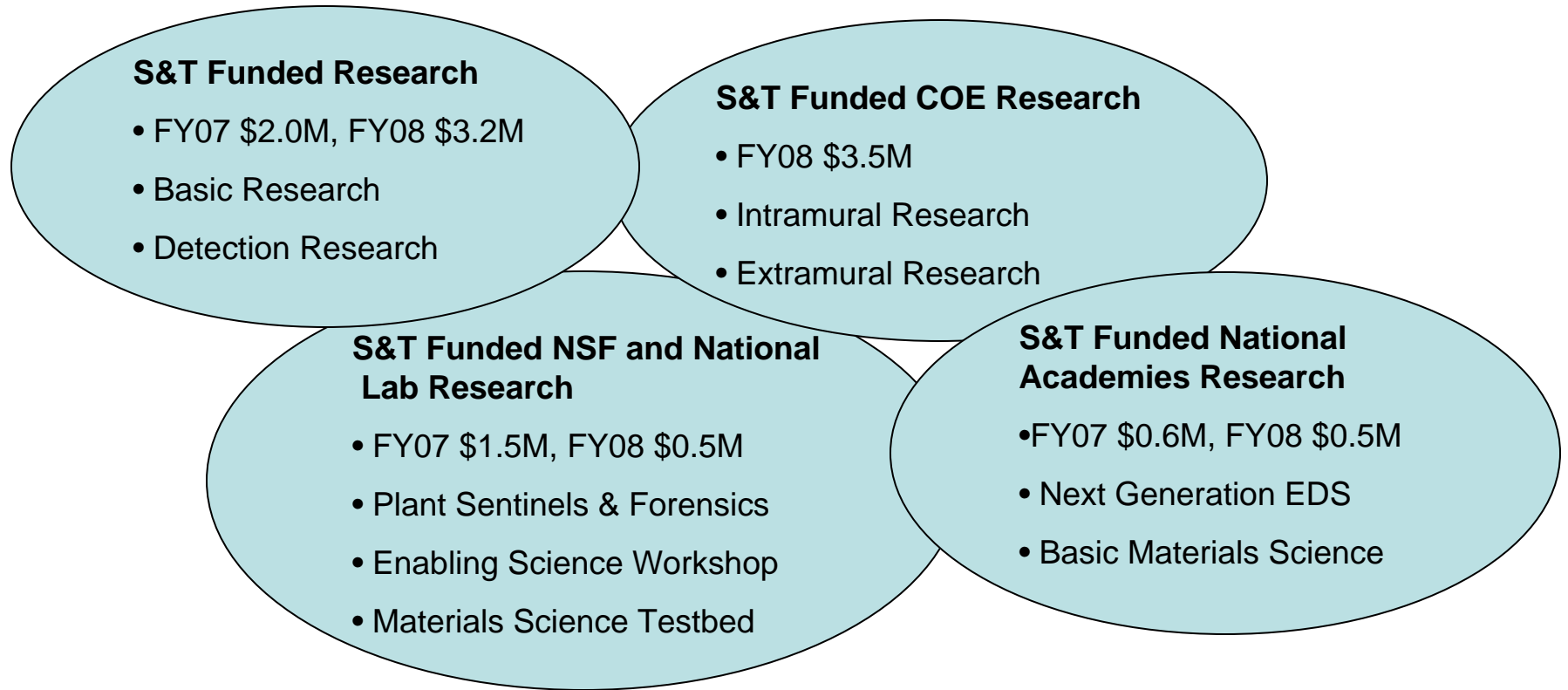## Explosives Division Basic Research Program

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PARTNERING FOR A SAFER NATION

Research Program Structure

S&T Funded Research

- FY07 $2.0M, FY08 $3.2M
- Basic Research
- Detection Research

S&T Funded COE Research

- FY08 $3.5M
- Intramural Research
- Extramural Research

S&T Funded NSF and National Lab Research

- FY07 $1.5M, FY08 $0.5M
- Plant Sentinels & Forensics
- Enabling Science Workshop
- Materials Science Testbed

S&T Funded National Academies Research

- FY07 $0.6M, FY08 $0.5M
- Next Generation EDS
- Basic Materials Science

The Explosives Research Program has four main inter-related avenues to conduct basic research

Research Program Structure

- What is the research program designed to accomplish?
  - Empower novel thinking through challenges in National Labs, Universities and Industry.
  - Conduct basic and transformational research to discover altogether new ways to narrow capability gaps and to solve long-standing, unsolved limitations in the performance of present technologies.
  - Fund the education and development of the rising, increasingly culturally diverse generation of homeland security technical professionals.
  - Provide forums in which eminent scientists, engineers and professors working in Explosives Research and Transportation Security related fields may interact with DHS and its constituent organizations, laboratories, universities and other government agencies. ("All our minds are better than any of our minds." W. Wilson)

- What is the research program *__NOT__* designed to accomplish?
  - Attempt to solve immediate operational security problems such as "reducing false alarm rate for CT detection technology by 50%"
  - Transition technology at a high technical readiness level to meet a specific customer requirement *__NOW!__* E.g. Assessing performance of a "prototype hand-held screening system developed by ABC Company"

Homeland Security

Research Program Structure

S&T Funded Research

- Basic Research Programs
  - Algorithms & Analysis of Raw Images, Liquid & HME Characterization, Material Science, Fundamental Particle Physics
- Detection Research Programs
  - Checkpoint Explosive Detection, Suicide & Vehicle Borne IED, Trace Detection

S&T Funded NSF and National Laboratory Research

- NSF
  - Plant Sentinels and Forensics
- Enabling Science Workshops and Technology Roadmaps
  - Physics Approaches, Nano-science, Alternative Signatures, Bioscience
- Infrastructure Materials Science Testbed
  - Develop a Materials Science Testbed to reduce the uncertainty associated with the failure of heterogeneous aged construction materials under blast loading

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Research Program Structure

S&T Funded Center of Excellence (COE) Research

- COE Intramural Research
  - Chemical Characterization, Detection, Unconventional Approaches, Detection, Mitigation
- COE Extramural Research
  - Counter-IED, Materials, Image Processing, Advanced Sampling, Mitigation

S&T Funded National Academies Research

- Next Generation EDS
  - NRC Board on Manufacturing and Engineering Design (BMED) will make recommendations on how to reduce the false positive rate without increasing the false negative rate
- Basic Materials Science
  - Conduct basic materials research in support of critical infrastructure protection

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S&T Funded National Lab Research

The DOE National Labs have assisted in transformative breakthroughs in explosives detection. Examples of these partnerships include:

- 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. All workshops conducted in Dec 05 – Jan 06.

- Lawrence Livermore (LLNL) hosted "Physics Approaches" workshop. Panel topic areas included laser spectroscopy, mass spectroscopy, GHz/THz imaging and spectroscopy, nuclear methods, solid-state devices, and HE signatures.

- Sandia (SNL) hosted "Nanoscience and nanotechnology" workshop. Panel topics areas included preconcentration and separation, detectors, nano/bio interface, and nanofabrication.

- Los Alamos (LANL) hosted "Alternate Signatures and Systems" workshop. Panel topic areas included remote detection of electronics, remote assessment of intent, and integration of data from orthogonal sensors.

- Oak Ridge (ORNL) hosted "Bioscience and Biotechnology" workshop. Panel topic areas included artificial nose technology, catalytic enzymes, bioreporters, immunoassay sensors, and insect sensors.

- Next step is to complete integrated "technology development roadmap" that will define key science efforts to achieve the research vision.
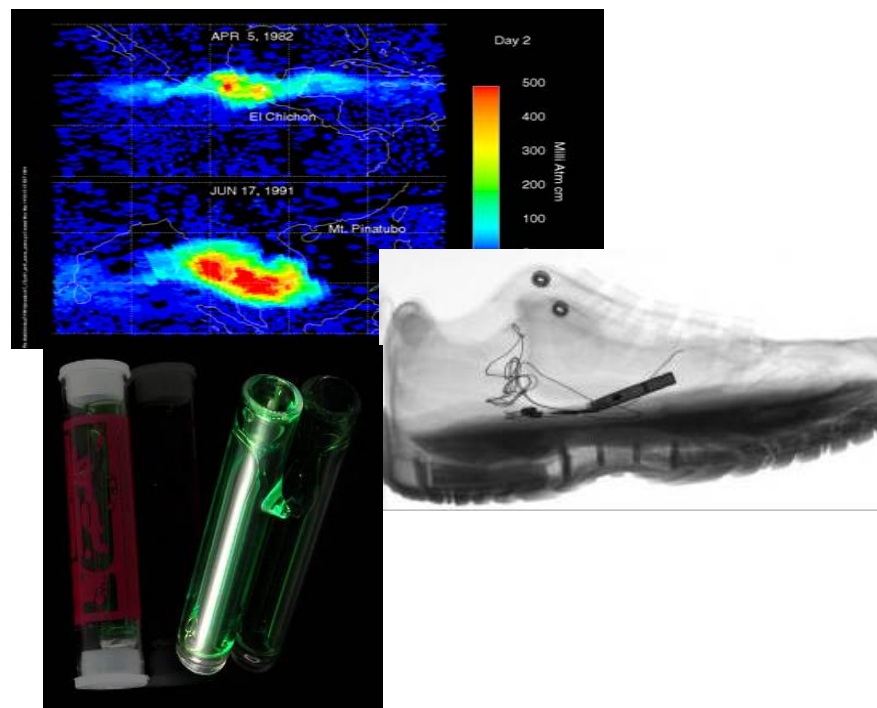
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S&T Explosives Basic Research & Detection Research

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

Basic Research Programs Include:

Road Mapping & Assessment	Liquid & HME Characterization
Fundamental Particle Physics	Analysis of Raw Images and Algorithms
National Science Foundation Supplemental	Detection Technology/Materials

Explosives Detection Research

There is an ever expanding list of threats to detect and identify

- S&T is attempting to determine the detectability of priority threats identified during the Homemade Explosives (HME) Characterization effort. The effort is being coordinated with TSA to focus on several liquid HME threat groups.

- Our ability to detect threats depends on providing characterization information to current vendors and National Laboratories to improve sensitivity and selectivity of existing equipment and also set future capabilities for new detection equipment.

- Finally, we need to be able to estimate the damage to key infrastructure caused by different threat weights and configurations.

Key research initiatives being undertaken by S&T include the Manhattan II Program for Next Generation Checked Baggage where we are trying to:

- Find the "best of the best" enabling technologies.
- Un-bundle constituent activity in security screening of checked bags.
- Match best detection technology with best image processing technology.
- Integrate best detection technology with best image processing via a consensus performance standard.

Detection Research

- 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

Detection Research Programs Include:

Checkpoint Explosives Detection
Suicide & Vehicle Borne IEDs
Trace Explosives Detection
Manhattan II
SENSIT/Ultra-Low Field Magnetic Resonance Imaging

Mitigation Research

- Blast mitigation in the transit environment includes hardening for transit, tunnels, structures.
- Research that develops and transitions advanced materials for application in critical infrastructure to reduce the effects of an explosive detonation.
- Develop guidelines on the mitigation of blast effects through structural engineering approaches, invest in materials to toughen barriers and building construction to withstand blast effects.
- Understand structural systems behavior under effects of common threats.
- Active blast suppression by automatic thermodynamic intervention during the explosion process.
- Blast deflection through both geometric and material combinations.

Thickness variable as a function of distance and threat requirements.

S&T Explosives Center of Excellence Research Programs

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Explosives COE Research:
Mobilizing the Academic Community

- We want to mobilize the academic community to help define the basic research priorities for explosives threats.

- We want to harness the knowledge in the academic community to help us answer the questions:
  - What is the threat we must be able to detect?
  - Can we detect those threats reliably and efficiently?
  - What is the damage potential for novel threats?
  - How do we validate modeling and simulation of explosives using Cheetah, Hydraulic codes, and finite element analysis of structures of interest, with carefully designed tests?
  - How do we prioritize and coordinate our research efforts to accomplish our objectives efficiently on the basis of solid science?

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Explosives COE Intramural Research

- S&T selected two co-leads for Explosives COE
  - Northeastern University (NU) as co-lead for Research and University of Rhode Island (URI) as co-lead for Education.
  - Design and execute multi-year plan for education and research missions.
- Chemical Characterization Research
  - Advance the understanding of explosive materials including synthesis, characterization, packaging and behavior.
- Detection Research
  - Investigate research applications for advanced explosives-related detection methods.
- Unconventional Approaches Research
  - Investigate research applications that will use unconventional approaches to identify and exploit novel ways to detect explosives.
- Detection Systems Research
  - Investigate research applications that will help ensure the effective integration between single and multi-sensor system approaches.
- Mitigation Research
  - Pursue research that has the potential to mitigate consequences of explosives-based terrorist incident (e.g. materials science research in cooperation with IG Division).

Explosives COE Extramural Research

- S&T supplemental funds to two co-leads for Explosives COE
  - Use their convening authority to identify best universities and academic institutions for extramural research. This research will be directed to major transcending issues challenging S&T and Technology policy matters.

- Counter-IED Research
  - Initiate a multi-year, multi-disciplinary effort to develop research strategy to identify fundamental sciences for IED detect and defeat capabilities.

- Materials Properties Research
  - Initiate a multi-year, multi-disciplinary effort to develop a basic materials properties research strategy to improve the protective and mitigation capabilities of critical infrastructure.

- Image Processing Research
  - Develop a research strategy to identify fundamental sciences to improve transportation screening capabilities for various detection technologies.

- Advance Sampling Research
  - Investigate the research applications that have the potential to be included in an advanced sampling strategy to improve transportation screening capabilities.

- Mitigation Research
  - Investigate research applications that have the potential to mitigate consequences of explosives-based terrorist incident.
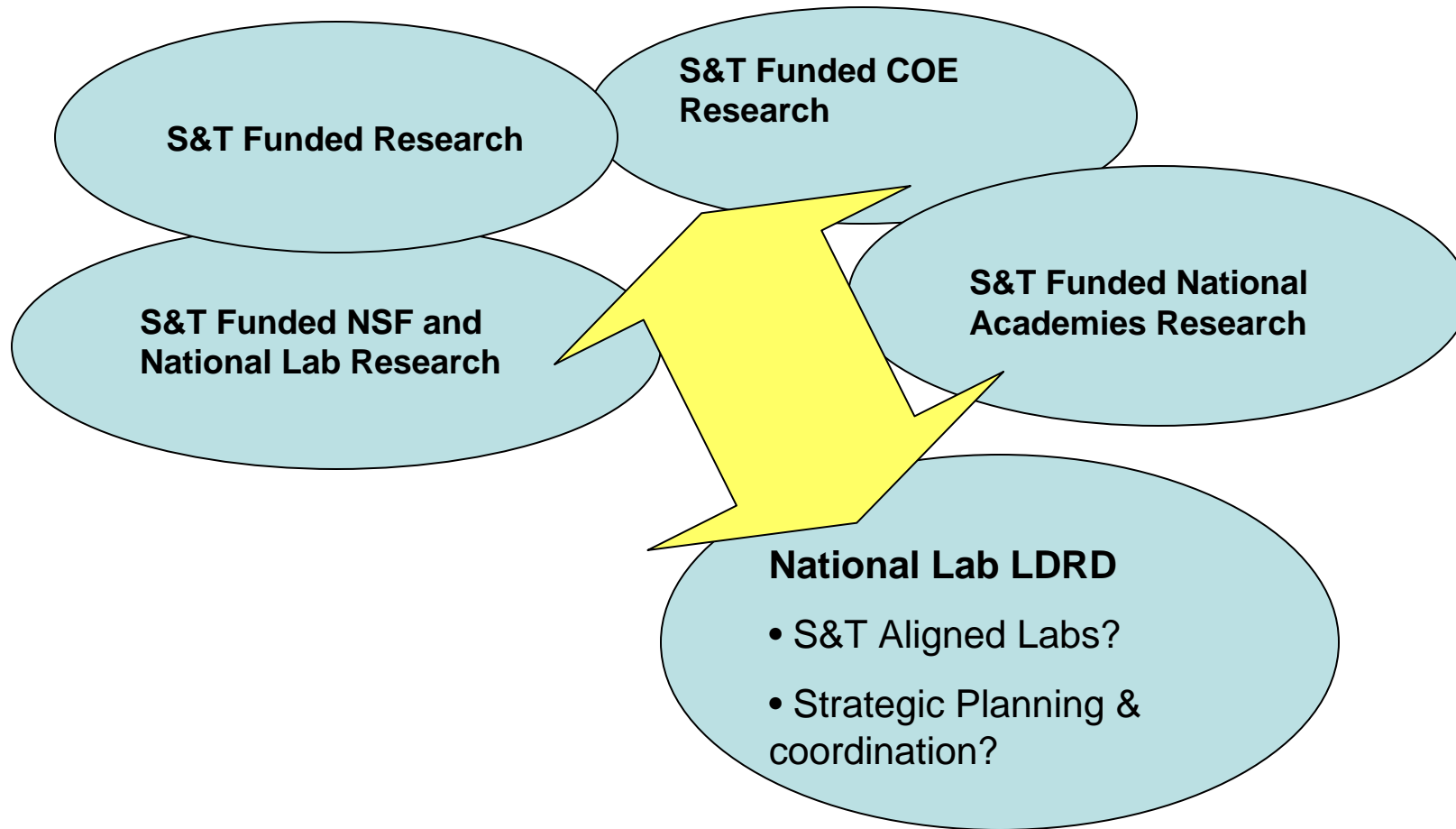
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S&T Explosives Research
and
DOE LDRD Programs

Research Program Structure

S&T Funded Research

S&T Funded COE Research

S&T Funded NSF and National Lab Research

S&T Funded National Academies Research

National Lab LDRD

- S&T Aligned Labs?

- Strategic Planning & coordination?

The Explosives Research Program is interested in investigating potential interface mechanisms with National Lab LDRD efforts

National Lab Research Discussions

- Discussion of multi-year Counter-IED basic research investment strategy
  - How does S&T develop a strategy or gather info for multiple approaches?
  - Labs could use existing tools to conduct risk analysis to support basic research investment strategy
  - Systematic approaches to analyze risk across the "kill chain" from Predict, Deter, Detect, Respond and Mitigate
- Discussion of how S&T research needs can and should influence LDRD
  - S&T influence subject matter for investments at various labs
  - Define right time for intervention in the "notional" LDRD 3-year life cycle
  - S&T input to LDRD process to stimulate interest and leverage results
- Discussion of coordination between Labs and S&T for DT&E vs. OT&E
  - Interface between research and transition programs
  - Interface with S&T customers, e.g. DHS Operational Directorates
  - Collection and analysis of T&E data to support customer transition needs
- Discussion of lab coordination with new Explosives COE
  - COE has responsibility to integrate basic research and education objectives
  - What is the interface between LDRD and University research funded by COE?

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National Lab Research Discussions

- Discussion of developing a forum for Material Science & Detection scientists
  - Need to develop taxonomy of material research ideas for both explosives detection and Infrastructure protection

- Discussion of technology assessment review process
  - Peer review is an integral part of the process for selection of ideas and monitoring progress.
  - How does S&T integrate peer review into both COE research ideas and other S&T funded research venues?
  - Selection of reviewers for BAA proposals should have requisite knowledge to evaluate breakthrough concepts and innovative research ideas
  - Commission review papers for status of key technologies to influence investment strategy
- Discussion of methodology to integrate orthogonal technologies