LOS ALAMOS NATIONAL LABORATORY

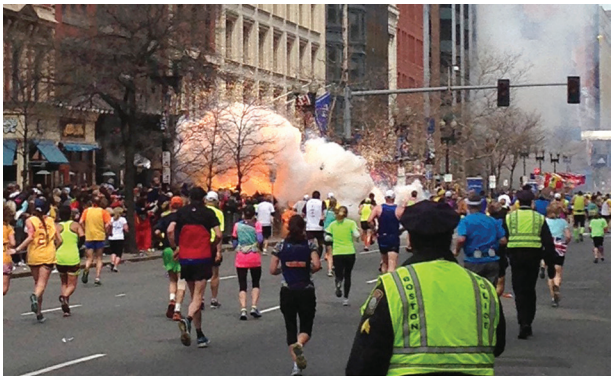
COLLABORATION FOR EXPLOSIVES DETECTION

TECHNOLOGIES THAT SAVE LIVES

SUMMARY

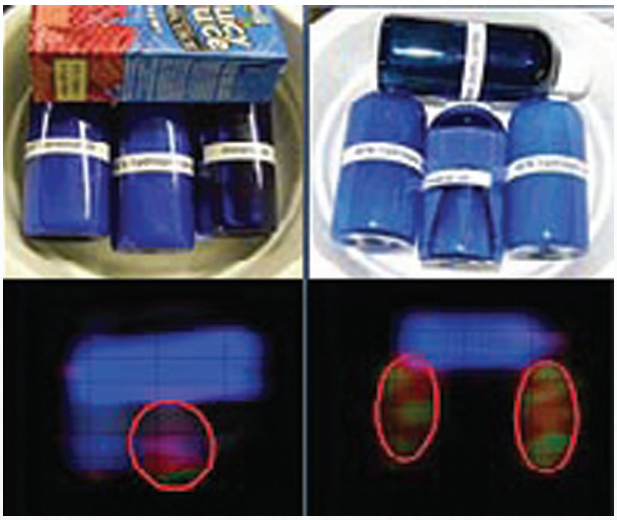
Los Alamos National Laboratory Collaboration for Explosives Detection (LACED) is a virtual gateway to world-class expertise and capabilities that counter all aspects of explosive threats, predominantly through enhanced detection capabilities.

Los Alamos National Laboratory (Los Alamos) has been a driving force in explosives science since its inception in 1943. The efforts to build the first nuclear weapons created exquisite requirements for high explosives that did not previously exist. These requirements necessitated improvements to the understanding and manipulation of high explosives performance and safety to an unprecedented degree. Continued progress in high explosives science requires an integrated approach, which is implemented at Los Alamos via comprehensive explosives capabilities that allow for innovative explosives detection solutions.



Boston Marathon bombing

Current efforts in explosives science cover many areas critical to national security, particularly the need for explosives threat countermeasures. LACED deploys these countermeasures through its four core capabilities: *1) Explosives Science, 2) Anticipate-Affect, 3) Detect,* and *4) Neutralize & Mitigate.*



Los Alamos' Magnetic Resonance Imaging (MagViz) technology

Solving future problems in explosives detection requires the ability to make, measure, and test explosives of interest. Capabilities at Los Alamos encompass the ability to safely synthesize, handle, detect, and ultimately neutralize the enormous variety of both conventional and homemade explosives. This range of capabilities and depth of expertise makes LACED a key strategic partner to push the boundaries of explosives science.

VISION

The vision of LACED is to create a collaboration of strategic public and private partners focused on the innovation and education of explosives detection technologies. LACED will leverage Los Alamos expertise, capabilities, and facilities to address global security threats by developing the next generation of technologies that save lives.

CAPABILITIES

EXPLOSIVES SCIENCE 1

Current efforts in explosives science cover many areas critical to national security. One particular area is the need for countermeasures against explosive threats.

LACED offers a comprehensive explosives process. This process leverages entire technical divisions dedicated to explosives science. Los Alamos scientists combine advanced expertise and capabilities with modern facilities. These assets enable LACED to offer unmatched R&D partnering opportunities to perform critical work in explosives detection. Explosives science capabilities include:

- Analytical chemistry, including:
  - *Atomic Force Microscopy (AFM)*
  - *Differential Scanning Calorimetry (DSC)*
  - *Full suite of analytical instrumentation for explosives characterization*
  - *Gas chromatography*
  - *High-performance liquid chromatography*
  - *Neutron scattering*
  - *Nuclear Magnetic Resonance (NMR)*
  - *Optical microscopy*
  - *Particle sizing*
  - *Quality assurance*
  - *Scanning Electron Microscopy (SEM)*
  - *Trace detection*
  - *Thermo-gravimetric analysis*
  - *Thermal diffusivity*
  - *X-Ray Diffraction (XRD)*
- Micromechanical testing
- Performance testing of explosives from bench scale to demonstration scale
- Polymorphism
- Sensitivity testing
- Spectroscopy capabilities, including:
  - *UV / Visible*
  - *Vibrational*
- Surface / interface science
- Capabilities in synthesis / formulation of explosives, including:
  - *Green pathways*
  - *High-energy density energetics*
  - *High-performance propellants*
  - *Nano-energetics*
  - *New materials*
- Thermal analysis and thermal ignition testing

ANTICIPATE-AFFECT 2

What conditions lead an individual or group toward committing political violence? Is it possible to accurately forecast who will become radicalized or even estimate when they might resort to violence?

These and similar questions weigh heavily on the minds of security specialists and decision makers around the world. At Los Alamos, scientists are developing sophisticated modeling and research techniques to give them an advantage in their ability to anticipate and affect explosive-related threats or events. The idea is to help counter such threats before anything actually happens.

Modeling techniques incorporate socio-cultural data to understand what influences, characterizes, and enables human networks to carry out asymmetric acts. Further data mining enables Los Alamos scientists to collect and analyze data regarding social and cultural behavior. Los Alamos also plays a large role in training members of the military in explosives threat response.

The facilities and experienced personnel at Los Alamos provide a perfect environment for such essential training programs. Anticipate capabilities provide knowledge and models that enable U.S. forces to anticipate and affect explosive threats or events. Such capabilities include the following:

- Conducting socio-cultural modeling to better understand and identify what influences, characterizes, and enables human networks to carry out asymmetric acts
- Data mining and analytics to collect and evaluate social and cultural behavior
- Executing persistent surveillance
- Training in improvised explosive threats

CAPABILITIES

DETECT 3

Los Alamos scientists and engineers develop detection technologies for every conceivable type of explosive under a variety of scenarios. Detection methods range from trace and signature characterization to bulk detection and new methods that address homemade or esoteric explosives. Los Alamos has developed technologies that range from sensors designed to help warfighters detect Improvised Explosive Devices (known as IEDs) from afar to imaging techniques that find hidden explosives in liquids. Concurrently, scientists continue to make fundamental improvements to existing technologies. The following are just some of the areas that fall under the "detect" banner at Los Alamos:

- Advanced image analysis
  - *Anomalous change detection*
  - *Whole-body imaging*
- Exquisite surveillance technologies
- Fundamental improvements to existing technologies
- IED location-independent detection
- Remote selective trace detection of explosive vapors / residues
  - *Advanced swipe materials*
  - *Colorimetry*
  - *Deep ultraviolet Raman*
  - *Deep UV Raman*
  - *Electrochemistry*
  - *Gas chromatography*
  - *Ion mobility spectrometry*
  - *Mass spectrometry*
  - *ODD-Ex: Pulse shape optimized species-selective coherent Raman scattering*
- Standoff detection of physical and chemical signatures from manufacturing and concealed deployment
- Standoff high-selectivity spectroscopy of explosive vapors, residues, or bulk
- Standoff stimulation of signatures released from explosive bulks, with signature analysis
  - *Dielectric permittivity*
  - *Piezoelectric effects*
  - *Resonant ultrasound*
  - *Spectroscopic library development*

NEUTRALIZE & MITIGATE 4

At Los Alamos, scientists are developing technologies designed to mitigate the detonation effects of IEDs and other types of explosives to protect personnel and equipment. Around since World War II, IEDs have become increasingly common. In Iraq, these devices caused 36.4 percent of American casualties. Insurgents not only used IEDs to target military personnel and vehicles, but also Iraqi police and civilian personnel, vehicles, and buildings.

Technologies under development at Los Alamos include armor / blast-mitigation systems, including solid mass resistance (such as concrete bunker and steel plate), foam energy absorption (soap froth and compression panels), fracture energy adsorption (ceramics and sandbags), and composite structures (multifunctional layered structures); and reversible barriers that can resist chemicals and fire and withstand attacks from vehicles, battering rams, and infantry. Research areas include the following:

- Airframe modeling
- Blast event shaping
- Detonation physics and chemistry
- Disruptive technologies
- Electromagnetic Energy (EME) coupling
- High-performance, multifunctional materials
- Shielding paradigms designed to protect personnel from:
  - *Blast*
  - *Fragmentation*
  - *Thermal*
- Threat scenario modeling

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TRAINING

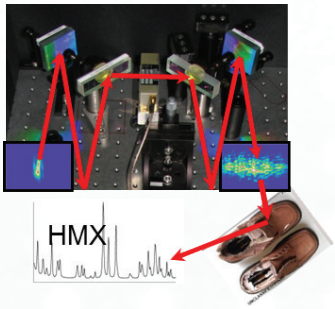
Los Alamos' decades of experience with all types of explosives enables scientists and engineers to provide realistic training scenarios that reinforce classroom knowledge to military troops from all branches. By special request, Los Alamos can provide specific training on any explosives topic. Training topics include:

- High Explosives Orientation
- Introduction to Explosives Science
- Homemade Explosives Training Class
- Advanced Homemade Explosives Training Class for Explosive Ordnance Disposal

Los Alamos also offers peer review of explosives courses, as well as instrument validation related to explosives work.

FACILITIES

LACED offers unsurpassed explosives detection capabilities and extensive analytical expertise. From bench-top to large-scale open air experimentation, a broad suite of diagnostic, modeling and simulation capabilities are employed to evaluate nuclear weapon response and performance, as well as a range of scenarios with broad applicability. These scenarios include homemade explosives assessment, lethality, vulnerability, disablement and defeat, aging and surveillance, shock / detonation wave physics, and blast effects. In the laboratory, our scientists shape the explosives detection field through foundational research, which includes trace analysis, compressive sensing, explosives synthesis and formulations, safety testing, explosives characterization, full diagnostic capabilities, and more. The explosives facilities at Los Alamos provide the full suite of capabilities to enable cutting-edge detection science, giving scientists the tools to develop and test their most innovative ideas.



Los Alamos' Optimal Dynamic Detection of Explosives (ODD-Ex) technology

EXPERTISE

LACED is built upon Los Alamos' unparalleled explosives detection capabilities derived from the expertise of award-winning scientists and state-of-the-art facilities. LACED is made up of 57 scientific experts across 18 divisions at Los Alamos. Spanning 11 unique fields of expertise, these scientists have published over 100 explosives detection-related publications.

GOVERNMENT AND INDUSTRIAL PARTNERING MECHANISMS

At LACED, we believe that technological know-how is best leveraged through top-tier industrial partners, federal agencies, and universities. LACED offers a variety of partnering mechanisms that allow access to federally developed technologies and R&D capabilities. Contact LACED for more information about partnering mechanisms.

CONTACT

For more information about LACED, please contact us at **LACED@lanl.gov** or visit our website at **LACED.lanl.gov**.