

Nondestructive Characterization



Lawrence Livermore National Laboratory

Our world-class facilities, cutting-edge technologies, and top research staff combine to provide unequalled capabilities in the nondestructive evaluation of materials and systems made of the lightest aerogels to the densest, heaviest elements, across all length scales—from macro to nano.

As a premier national laboratory, LLNL's nondestructive characterization (NDC) capabilities and staff are second to none, and our methods for solving difficult problems are proven. We research, design, and build novel systems and methods for government, industry, and academia to understand and help solve their NDC problems. Our staff works with customers to analyze their requirements and understand their needs, then uses a systems approach to apply the appropriate solutions from our broad suite of NDC capabilities.

Facilities and Technologies

LLNL maintains numerous dedicated NDC facilities on site, housing x-ray, ultrasonic, computed tomography (CT), particle, and other devices—and we are ISO 9000 certified. Our state-of-the-art and customized systems include:

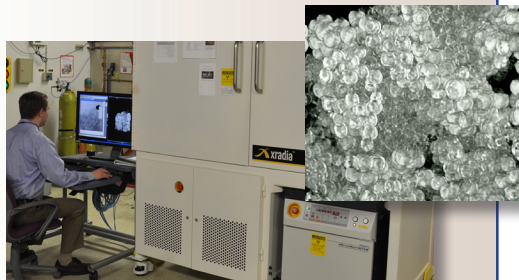
- LLNL-built 125- to 225-keV micro-focus radiography/CT system with 2- to 35-cm field of view, 1 to 20x magnification, and 20- to 400- μ m spatial resolution
- LLNL-built 80- to 450-keV radiography/CT system with 0.5- to 35-cm field of view, 1 to 2x magnification, and 0.1- to 400- μ m spatial resolution
- LLNL-built CoLOSSIS 9-MeV radiography/CT system with 35-cm field of view and 400- μ m spatial resolution
- Zeiss Xradia 510 Versa 30- to 160-keV microscale radiography/CT system with 1- to 50-mm field of view, 0.4x to 20x magnification, and 0.9- to 20- μ m spatial resolution, and in-situ stage for mechanical and thermal loading of samples
- Xradia UltraXRM-L200 8.04-keV nanoscale radiography/CT system with 65- and 16- μ m field of view, 200 and 800x magnification, and 150- and 50-nm spatial resolution
- LLNL's high-energy (6/9 MeV) linear- and area-array radiography detectors systems can image objects as large as 10 m and as small as 30 cm at 8-mm and 200- μ m spatial resolution, respectively
- Access to Advanced Light Source x-ray 8.3.2 beamline at Berkeley
- LLNL's explosive facilities to NDC explosives from a few grams up to 160 kg
- Category 3 nuclear facility to NDC Special Nuclear Materials (SNM)
- Mistras 6-axis UT immersion scanning system with contour-following capabilities and adjustable working volume to 102 cm \times 68 cm \times 132 cm
- Mistras 3-axis UT immersion scanning system with adjustable working volume to 117 cm \times 71 cm \times 56 cm

Capabilities

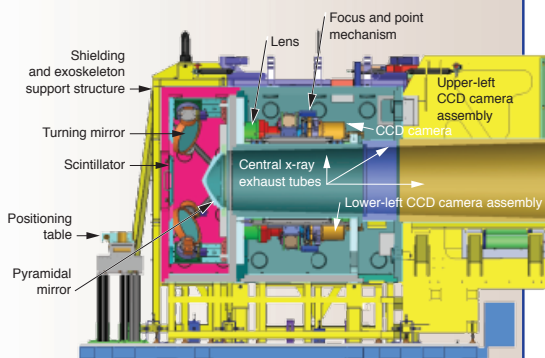
LLNL is the recognized leader in x-ray NDC within the Department of Energy complex of laboratories. Support of our nation's nuclear weapon Stockpile Stewardship mission has been the catalyst for creating unmatched capabilities in the NDC of explosives and special nuclear materials (SNM). Our NDC staff includes engineers, physicists, chemists, computer scientists, analysts, and American Society for Nondestructive Testing (ASNT) level III certified technicians. Their areas of expertise include x-ray,



Photo of the 6- and 9-MeV radiography/CT facility. (Inset) 9-MeV CT cross section of a NASA composite ablator 2.6 m o.d.

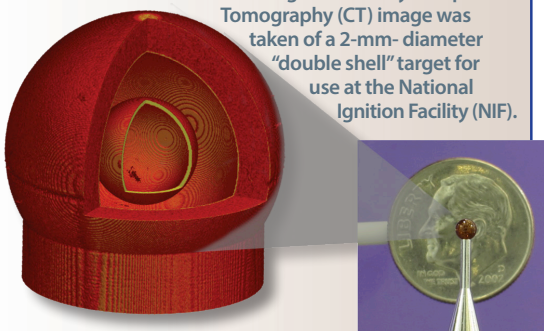


50- to 150-nm spatial resolution CT system (UltraXRM). (Inset) 3D rendered image of copper foam (many 1- μ m hollow 100-nm wall thickness copper beads).



A cutaway view of the LLNL-built Confined Large Optical Scintillator Screen and Imaging System (CoLOSSIS), which collects 3D digital x-ray images of industrial objects and test components.

This rendering of a 3D x-ray Computed Tomography (CT) image was taken of a 2-mm-diameter "double shell" target for use at the National Ignition Facility (NIF).



acoustic, thermal, particle, and surface NDC techniques; software, algorithm, and hardware development; and modeling and simulation. Specific staff and technical capabilities include:

- Military, commercial, and homemade explosives
- NDC research and techniques (e.g., x-ray, acoustic, thermal, mm-wave, optical, and neutrons)
- Modeling and simulation (straight ray, e.g., HADES, and Monte Carlo, e.g., MCNP, GEANT, COMSOL, and Imagine3D)
- Data analysis, signal and image processing
- Image reconstruction algorithms and software
- Statistical and model-based analysis
- System-independent dual-energy material property characterization
- Systems software and hardware design, development, and assembly
- Automatic defect or threat detection/recognition
- Novel x-ray and particle sources and detectors
- Fast image processing and reconstruction on the world's largest supercomputers
- Special nuclear and radiological materials

Project Showcase: Livermore Explosive Detection Program

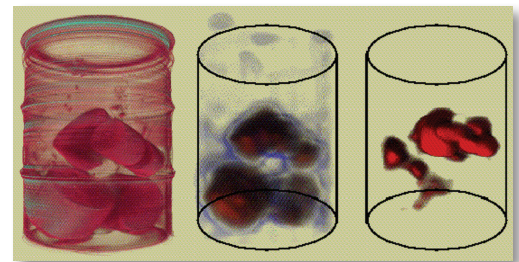
Livermore experts are working with the Department of Homeland Security (DHS) and other government agencies and private industry to strengthen existing airport explosives detection systems (EDS) and commercialize new technologies. The Livermore Explosives Detection Program seeks to enhance detectors' sensitivity to an expanding range of explosive threats without increasing the number of false alarms.

Sponsors

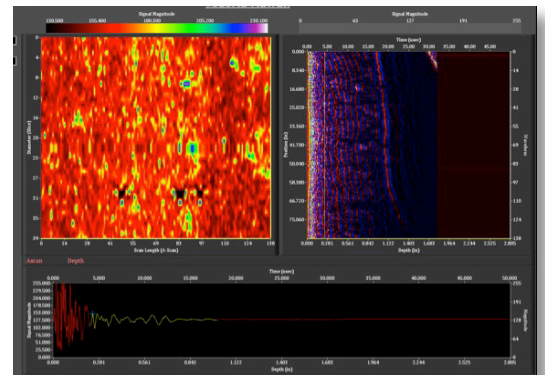
DOE/NNSA/EM
Department of Homeland Security
S&T Directorate
Transportation Security Administration
Countering Weapons of Mass Destruction
Department of Defense
Army Research Laboratory
Defense Threat Research Agency
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Academic Alliances

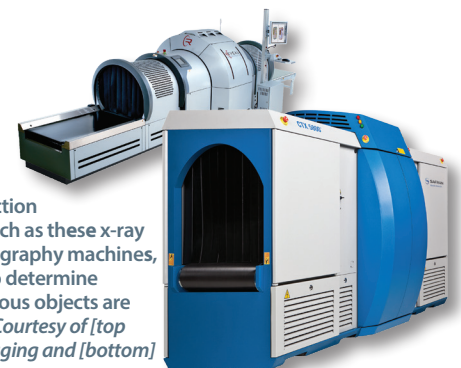
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University of California, San Diego
University of Huddersfield
University of Notre Dame



An R&D 100 award-winning technique precisely and accurately measures radioactivity inside 55-gallon waste barrels by combining (left to right) x-ray, gamma-ray, and single-photon emission CT data.



Ultrasonic surface scan shows details of a composite warhead.



Explosives detection technologies, such as these x-ray computed tomography machines, scan baggage to determine whether dangerous objects are hidden inside. (Courtesy of [top right] Reveal Imaging and [bottom] Safran Morpho.)

Capability Leaders



Harry E. Martz, Jr., Ph.D.
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Harry is the Director for the Nondestructive Characterization Institute, which has pioneered ways to use x rays and other forms of radiation and particles (protons and neutrons) for noninvasive imaging of everything from warhead components to bridge decks to breast tumors. He holds a Ph.D. in Nuclear Physics/Chemistry from Florida State University. He received an R&D 100 Award for radiation waste barrel assay. He was a member of several National Academies of Science committees and currently chairs an NAS committee on airport passenger screening systems.



Joe Tringe, Ph.D.
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Joe is the Group Leader for Nondestructive Evaluation, which provides advanced non-destructive characterization technical solutions for numerous laboratory programs and work for others. He is the author of 35 peer-reviewed publications and five U.S. patents. He holds a Ph.D. in Materials Engineering from Stanford University.



Steve Glenn, Ph.D.
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Steve concentrates on DNDO-related programs within NCI. Prior, he was a systems engineer and instrumentation specialist for NIF x-ray imaging diagnostics, a software developer and manager for NIF's control system, and an algorithm engineer for the NIF optics inspection and shot data analysis teams. Steve received his Ph. D. in Physics from the University of California, Davis.



Larry McMichael, Ph.D.
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Larry is a Group Leader for Structural & Applied Mechanics as well as an Associate Program Leader for Explosives Detection & Transportation Security. He is responsible for managing multidisciplinary teams that integrate high explosive and hydrodynamic experiments with high-fidelity modeling and simulation. Larry received his Ph.D. in Structural Mechanics from UC Davis.