

Lawrence Livermore National Laboratory

Science and Technology on a Mission

Consortium for Verification Technology Workshop

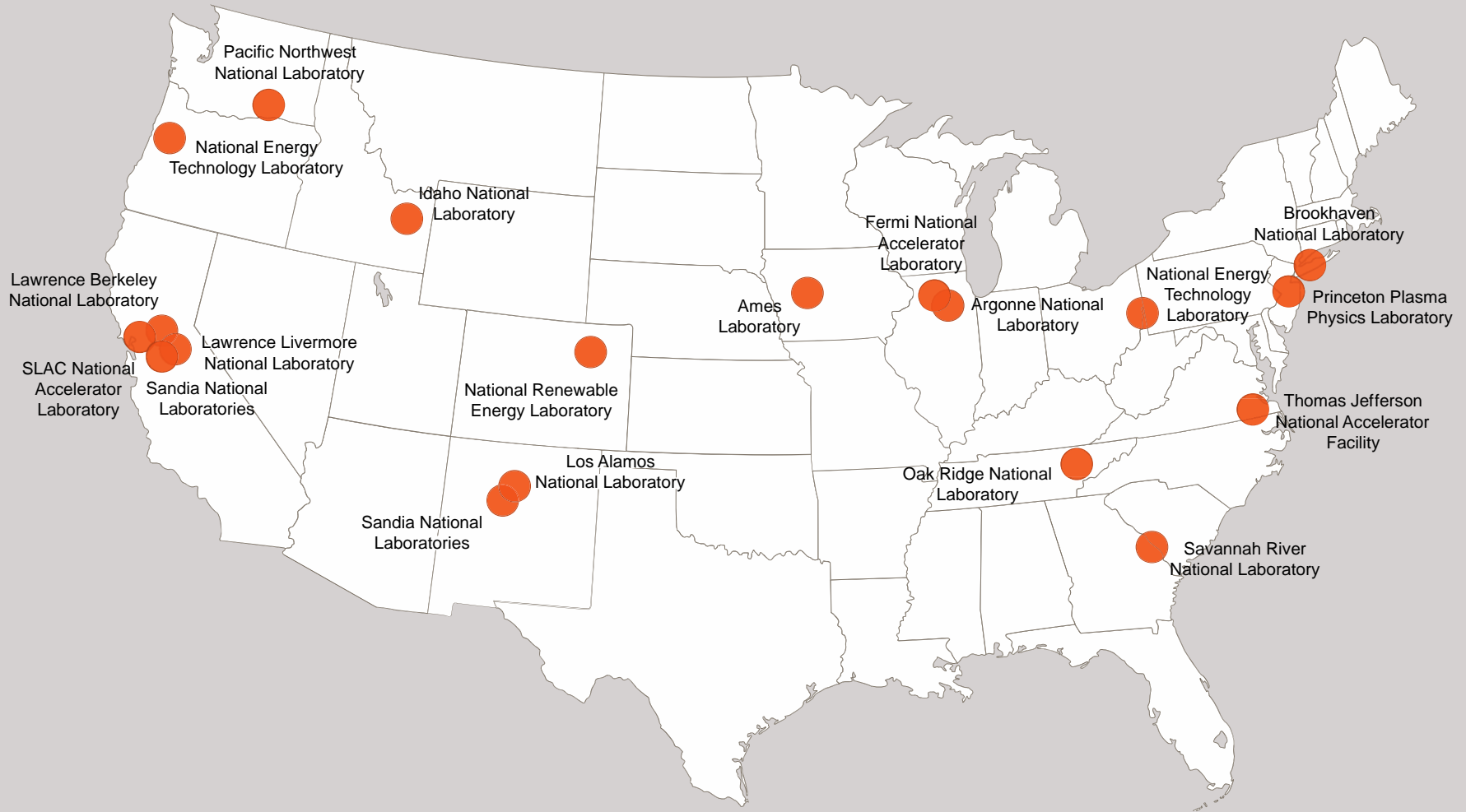
Scot S. Olivier

Lawrence Livermore National Laboratory

October 20, 2016



LLNL is one of 17 Department of Energy national laboratories



LLNL is a multidisciplinary national security laboratory



- Established in 1952
- Approximately 6,000 employees
- 1 square mile, 684 facilities
- Annual federal budget: ~ \$1.5B

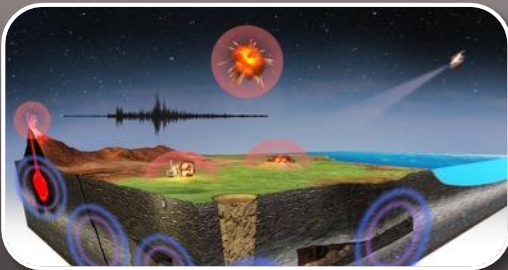
Experimental Test Site
(11 sq. mile site near Tracy, CA)



Solving global security challenges for the nation

Multidisciplinary science, technology, and engineering

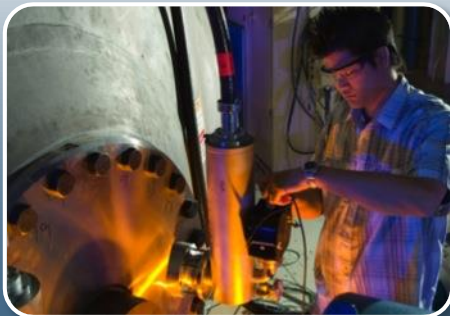
Nuclear Security



International and Domestic Security



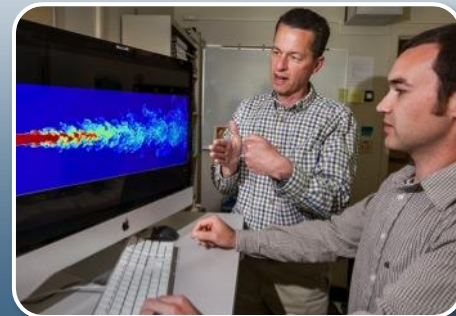
Energy and Environmental Security



Science



Engineering



Computing

Nuclear security and the Stockpile Stewardship Program

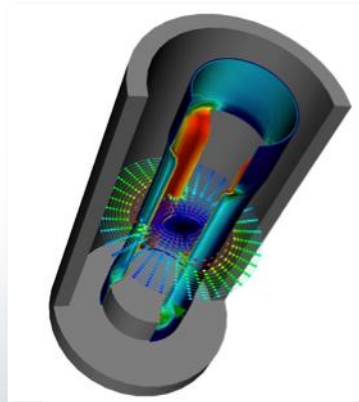
Maintaining the nuclear deterrent without explosive testing

Annual Assessment



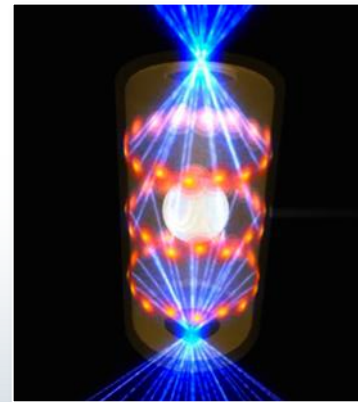
Annually assess the safety, security, and reliability of the stockpile

Life Extension



Extend the life of stockpile warheads, adapting safety and security features to evolving requirements

Science Resolution



Resolve the remaining weapons physics grand challenges

Responsive Tools



Deliver tools to respond to nuclear incidents, limit nuclear proliferation, and counter nuclear terrorism

Science-based stockpile stewardship is based on testing predictions with experiments

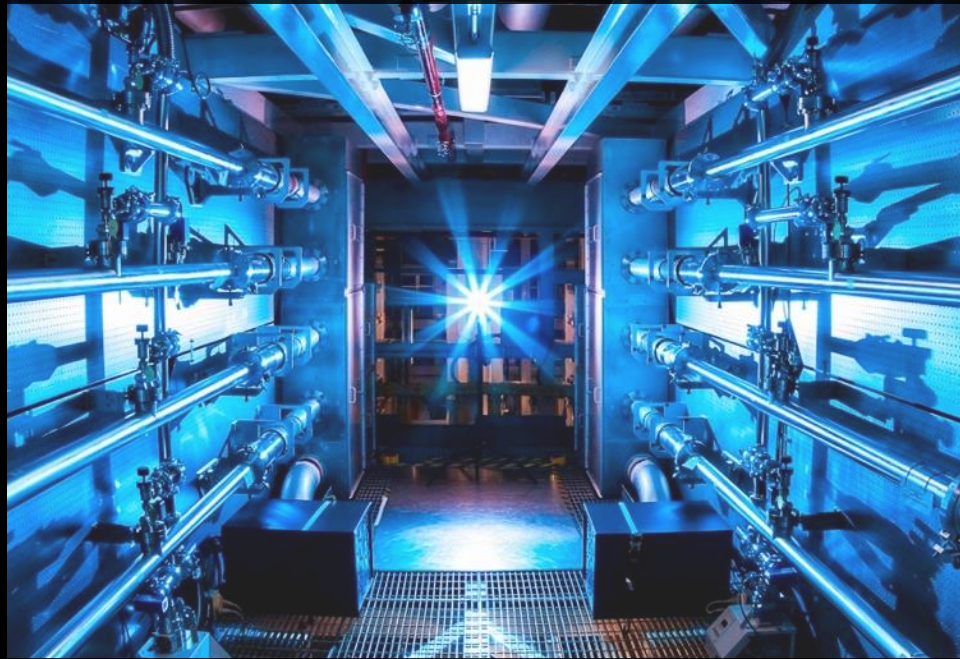
High-performance computing,
modeling, and simulation



Sequoia

has achieved the #1 ranking on the Graph 500, Green 500, and Top 500 lists and set a record by simulating 504 billion events per second.

Experimental challenge
and validation



National Ignition Facility

explores the extremes of energy, temperature, and pressure that occur in stars, supernovae, and nuclear explosions.

Domestic and International Security

Defending against advanced and asymmetric threats

Chemical/Biological Counterterrorism



- Rapid detection and characterization of emerging and unknown threats
- Rapid development of new medical countermeasures
- Threat assessment and risk analysis

Intelligence



- Persistent surveillance
- Space situational awareness
- End-to-end exploitation
- Integrated WMD analysis

Explosives Security



- Explosive detection development
- Aviation security
- Infrastructure protection

Cyber Security

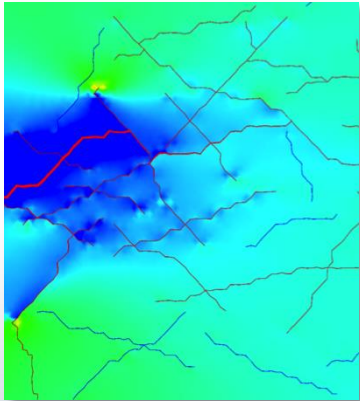


- Network mapping
- Behavioral-based situational awareness
- Predictive analysis of actions and effects

Energy and Environmental Security

Addressing critical climate and energy infrastructure issues

Natural Gas Future



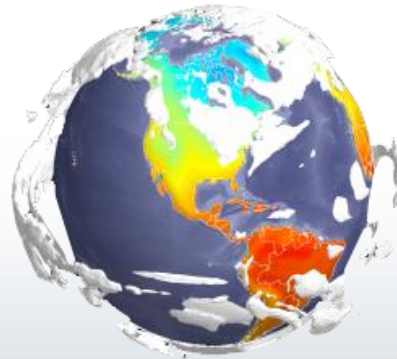
- Eliminate seismic risk and ensure safe operations
- Increase production/minimize water use
- Natural gas transportation fuels

Renewable Energy Solutions



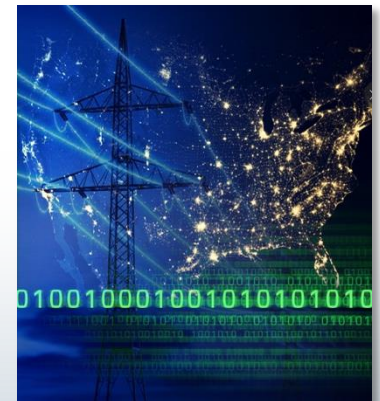
- Innovative materials
- Reduce uncertainty in wind power forecasts
- Biofuel combustion chemistry

Climate Change Adaptation



- Robust probabilistic climate projections
- Water production and management technology
- Infrastructure security

Smart Grid Systems



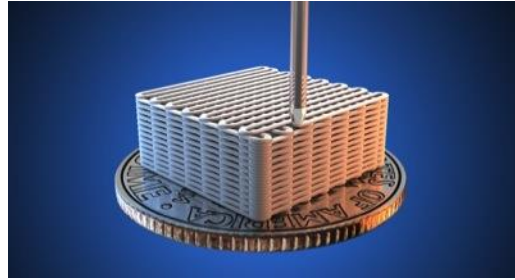
- Reliable grid and infrastructure systems
- Real-time grid operational awareness
- Grid cyber and physical security

S&T Core Competencies

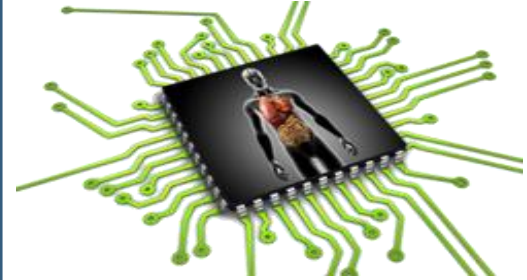
High-Energy-Density Science



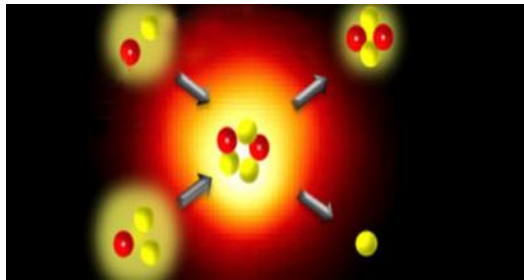
Advanced Materials and Manufacturing



Bioscience and Bioengineering



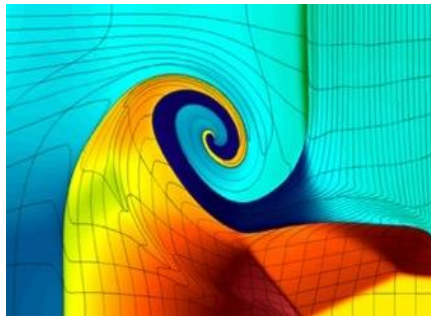
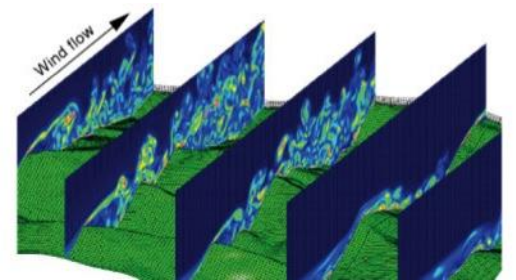
Nuclear, Chemical, and Isotopic S&T



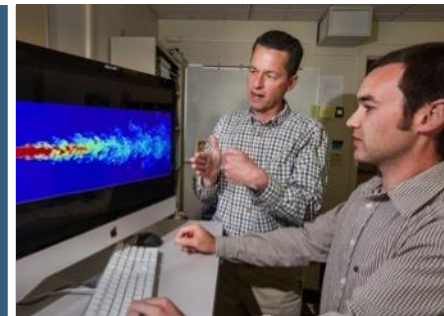
Lasers and Optical S&T



Earth and Atmospheric Science



High-Performance Computing, Simulation, and Data Science



The DOE Defense Nuclear Nonproliferation (DNN) Office of Research and Development (R&D) Supports a Broad Portfolio of Activities at LLNL

- **Mission:** Support U.S. national and nuclear security objectives in reducing global nuclear security threats through the innovation of unilateral and multi-lateral technical capabilities to detect, identify, and characterize: 1) foreign nuclear weapons programs, 2) illicit diversion of special nuclear materials, and 3) global nuclear detonations.
- **Proliferation Detection:** Develops technologies to detect foreign nuclear weapons development activities; to support nuclear arms control treaties verification and monitoring for compliance; and to support national nuclear security more broadly
- **Nuclear Detonation Detection:** Develops, demonstrates, and delivers advanced technologies and systems to operational monitoring agencies to fulfill U.S. requirements and policies to detect, identify, and precisely locate nuclear explosions

Office of Proliferation Detection (PD) Support for LLNL Activities

- **Nuclear Weaponization and Material Production Detection:** Supports the development of technology to target the detection and characterization of foreign weapons program activities, including materials and weapons production.
 - Detection and Characterization of Undeclared Irradiation Activities 13%
 - Remote Conversion
- **Nuclear Weapons and Material Security:** Supports the development of nuclear security and nuclear arms control treaty monitoring and verification tools and applications, and supports operational interdiction and nuclear security efforts across NNSA.
 - HELIOS 22
 - Nuclear CT and Incident Response R&D %
- **Nonproliferation Enabling Capabilities:** Supports the development of novel, cross-cutting technologies like simulations, algorithms and modeling applicable to multiple NNSA and the interagency missions.
 - Correlated Data in Fission Events 20
 - Tool to Improve Urban Search Planning %
 - Applications of Antineutrino Monitoring to Nonproliferation
 - Science-Guided Scintillator Discovery

Office of Nuclear Detonation Detection (NDD)

Support for LLNL Activities

- **Space-based Detection of Nuclear Detonations:** Develops and builds space sensors for the nation's operational nuclear test treaty monitoring and Integrated Threat Warning/Attack Assessment capabilities. 3%
 - USNDS Verification, Validation, and Accreditation and Engineering Support
- **Ground-based Detection of Nuclear Detonations:** Produces and updates the regional geophysical datasets and analytical understanding to enable operation of the nation's ground-based nuclear detonation monitoring networks; and provides technical expertise and leadership for development of next-generation seismic and radionuclide nuclear detonation detection technologies. 5%
 - Waveform Signal R&D for GNDD
 - Source Physics Experiment*
 - Underground Nuclear Explosion Signatures Experiment* *30%
 - Low-Yield Nuclear Explosion Monitoring* *PD
- **Nuclear Forensics:** Conducts R&D to advance analytic forensic capabilities related to nuclear detonations to improve the speed, accuracy, reliability, confidence, and specificity of nuclear forensics analysis. 7%
 - Post-Detonation Nuclear Forensics
 - Nuclear Forensics Testbed

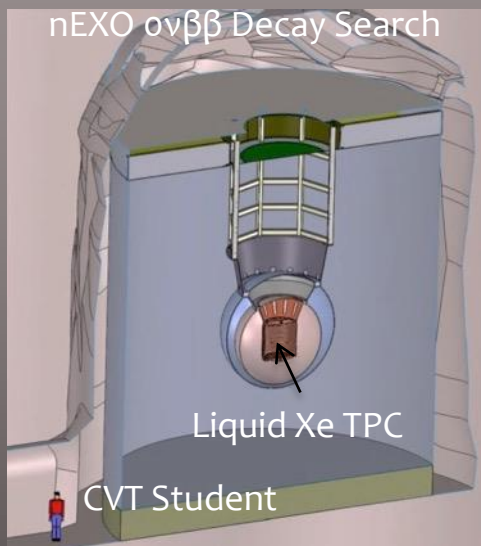
Summary of CVT research at LLNL

- CVT Graduate Fellows Anthony Christe and Julie Schnurr from University of Hawaii visited LLNL to work with researchers in the Geophysical Monitoring Group led by Seismologist Bill Walter
 - Christe worked with on aggregation and analysis of distributed sensor measurements
 - Schnurr worked on analysis of air blast data from explosions
- CVT Undergraduate Fellow Emily King worked as a summer intern at LLNL with Physicist Stephan Friedrich in the Rare Event Detection Group
 - King worked on testing of a metallic magnetic calorimeter for a high energy resolution gamma spectrometer
- LLNL Physicist Ramona Vogt received a CVT National Lab Scientist Fellowship to visit U. Michigan to collaborate on research on correlated fission events.

Additional Opportunities for Thesis Projects at LLNL

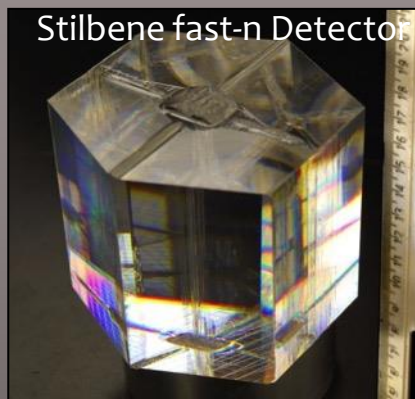
Science and security applications, undergraduate and graduate projects

Rare Event Detection



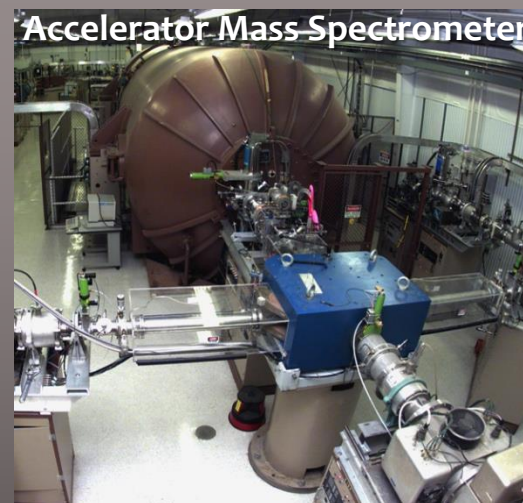
- Neutrino-less $\beta\beta$ decay
- Basic neutrino physics and neutrino reactor monitoring
- Dark matter (axions, WIMPs)

Fundamental Data



- Advanced detectors
- Precise beta decay
- Super-heavy elements
- Cross sections (for short $\tau_{1/2}$)
- Fission modeling

Nuclear Forensics



- Actinide bio-geochemistry
- Fission radiochemistry at NIF
- Ultra-trace mass spec.
- NMR for radiochemistry

Contacts for more information



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Lawrence Livermore National Laboratory Science and Technology on a Mission

“Pursuit of frontier science and technology – and a technical workforce qualified to advance the frontier - is absolutely required to be able to offer new solutions to evolving challenges faced by our sponsor, NNSA, as well as the broader national security enterprise, and to anticipate and respond to disruptive developments in S&T that hold the potential to effect national security.”

– WHG

