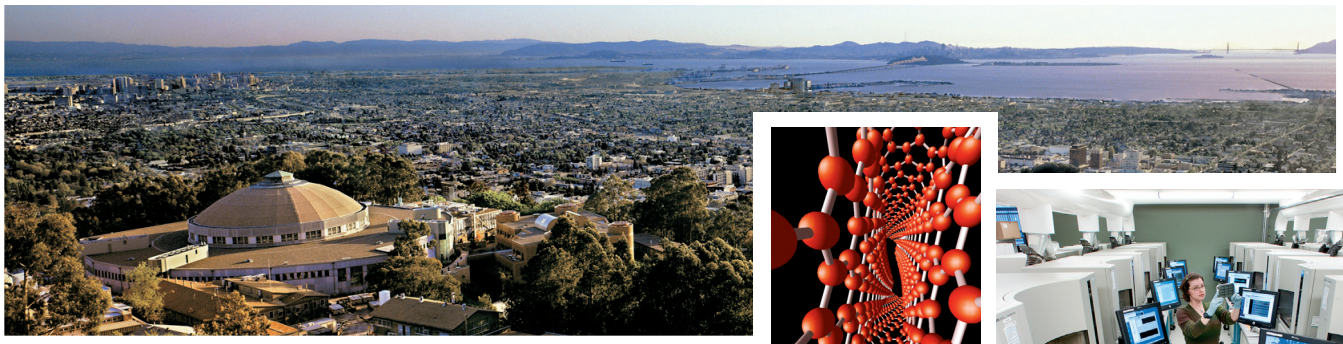
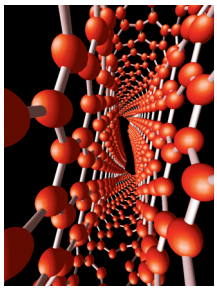
LAWRENCE BERKELEY NATIONAL LABORATORY





ABOUT BERKELEY LAB

The Lawrence Berkeley National Laboratory (Berkeley Lab) was founded in 1931 by Ernest O. Lawrence, who won the Nobel Prize in physics in 1939 for his invention of the cyclotron, which led to a Golden Age of particle physics and revolutionary discoveries about sub-atomic matter and the nature of the universe. Lawrence believed in a multidisciplinary team approach to science, and his laboratory is generally regarded as the birthplace of "big science."

Today, Berkeley Lab performs research across a broad spectrum of program areas, including nanoscience and advanced materials, life and physical biosciences, computing, energy and earth sciences, and high-energy physics and cosmology. Its scientific excellence has been recognized by a profusion of awards and honors. Eleven Nobel laureates, a dozen National Medal of Science winners and more members of the National Academy of Sciences than any other national laboratory have called Berkeley Lab their home.

Berkeley Lab is managed by the University of California (UC) for the Office of Science in the U.S. Department of Energy (DOE). It is located on a 200 acre site in the hills above the UC Berkeley campus, has a staff of approximately 4,000 employees and an annual budget of more than $520 million. Berkeley Lab enjoys a shared history and relationship with UC that is unique among the DOE national laboratories. More than 250 Lab scientists hold joint appointments with UC Berkeley and other UC campuses, and nearly 800 students, graduate and undergraduate, are employed each year.

As a San Francisco Bay Area institute, Berkeley Lab is also proximate to a host of other federal laboratories, universities and private sector R&D firms. This has provided outstanding opportunities for academic and industrial scientific partnerships. Current industrial collaborations include building the next generation of semiconductors and computer chips, and developing synthetic biology techniques for energy and biomedical applications.

MAJOR USER FACILITIES AND RESEARCH CENTERS INCLUDE:

The Molecular Foundry (TMF) — The only DOE Nanoscale Science Research Center on the West Coast, TMF research encompasses inorganic materials, including nanocrystals, nanotubes and lithographically patterned structures; and organic materials, including polymers, DNA and proteins. This research utilizes

both "top-down" fabrications, in which existing structures and objects are made smaller; and "bottom-up" fabrications, in which atoms and molecules are connected together to make larger structures and objects.

Advanced Light Source (ALS) — The ALS is an electron synchrotron and storage ring designed to accelerate electrons to relativistic energies and extract from them beams of ultraviolet and x-ray light that are a hundred million times brighter than light from the most powerful x-ray tubes. This light can be focused to atomic-sized spots and is strobed, like a stop-action camera, flashing up to 500 million pulses per second, with each pulse lasting only a few trillionths of a second. ALS light is ideal for protein crystallography and nanofabrications.

National Energy Research Scientific Computing Center (NERSC) — One of the most powerful unclassified computing centers in the country, NERSC's array of supercomputers are capable of investigating problems of vast complexity, producing remarkably detailed models.

The Energy Sciences Network (ESnet) — A high-speed network serving thousands of DOE scientists and collaborators worldwide, ESnet is a recognized leader in high-bandwidth and reliable connections.

National Center for Electron Microscopy (NCEM) — Home to several of the world's most powerful electron microscopes, including the One Ångstrom Microscope, which broke the single angstrom resolution barrier, and the Transmission Electron Aberration-corrected Microscopes (TEAM 0.5 and 1.0), now being constructed, which will make it possible to see atoms individually positioned in space, and help scientists assemble nano-scale structures.

The Joint Genome Institute (JGI) — A multi-purpose genome sequencing and research center, JGI brings together the research capabilities of Berkeley Lab, Lawrence Livermore and Los Alamos National Laboratories. JGI's scientific mission encompasses comparative, functional, and evolutionary genomics, shedding light on many natural processes that support life on our planet.

Berkeley Center for Synthetic Biology (BCSB) — Berkeley Lab established the world's first synthetic biology department, and has now joined forces with the California Institute for Quantitative Biomedical Research (QB3) to create the BCSB. The goal is to design biological systems and components that can address problems which cannot be solved through naturally-occurring entities. This research holds enormous promise for human health, renewable energy and the environment. QB3 is a collaboration between the UC campuses of Berkeley, San Francisco and Santa Cruz.

Helios — This Berkeley Lab initiative unites proven scientific and engineering expertise in biophysics, biochemistry, electrochemistry, nanotechnology and environmental energy sciences to create or advance new solar-based energy technologies. Emphasis here is twofold: the development of efficient carbon-neutral biofuel technologies that could replace oil for transportation; and the development of materials and nanostructures that can be used in the production of new photovoltaic devices comparable in efficiency to today's solid-state solar cells, but far more durable and much cheaper to mass-produce.

Berkeley Electrochemical Research Council (BERC) — BERC performs and oversees research on advanced rechargeable batteries and fuel cells. The goal is to develop high-performance electrochemical technologies that are low cost, long lived and environmentally safe. BERC is a part of Berkeley Lab's Environmental Energy Technologies Division, whose nationally acclaimed programs have netted millions of dollars in energy savings.

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DHS Scholarship and Fellowship Program
2008 Summer Internships

Lawrence Berkeley National Laboratory

Project Title	Principal Investigator			DHS Research Area
	Name	Phone	Email	
High-Throughput Discovery of Scintillation Materials	Steven Derenzo	(510)486-4097	SEDerenzo@lbl.gov	During the past 12 years, we have synthesized thousands of doped and undoped samples, with a primary focus on heavy-atom, ultra-fast scintillation from semiconductor scintillators for time-of-flight positron tomography. We found that the limitation for further discovery is the slow pace of synthesis of powders and crystals and of their characterization and the lack of predictive data. This new project is designed to accelerate the discovery process by improving our understanding of scintillators and by automating the synthesis and characterization procedures that we have developed. We are constructing a facility to automate proven synthesis and characterization procedures for high-throughput screening. We will use available information and first-principles calculations of electronic structure properties to select families of candidate compounds. We will acquire single crystals or transparent ceramic samples of the most promising candidates identified by the high-throughput facility and test them as scintillator radiation detectors.

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Advanced Explosives and SNM Interrogation and Verification	Joe Kwan	(510)486-7631	JWKwan@lbl.gov	Over the past several decades, LBNL has developed several leading edge ion beam technologies for the DOE that are now being leveraged to address challenges in homeland security. These technologies include developments in plasmas and ion sources; formation, transport and targeting of high power ion beams; low energy acceleration using both electrostatic and radiofrequency means; and the use of sophisticated, state-of-the-art modeling and simulation codes. These capabilities are being applied in several areas of homeland security including the development of active interrogation tools to screen cargo containers and small packages for explosives, shielded SNM and other contraband. Various projects are underway using D-D, D-T, and T-T fusion reactions and other low-energy nuclear reactions, to develop compact, high-yield sources of neutrons and high-energy gamma rays. Both the yield and inherent flexibility of this family of interrogation tools provide a unique set of capabilities. Work on the advanced mobile, dual-mode interrogation system is being carried out in collaboration with S
Development of AlSb Ambient Temperature Radiation Detectors	Paul Luke and Edith Bourret	510-486-4962 and 510-486-5553	PNLuke@lbl.gov	The specific aim of the project is to develop AlSb, a III-V compound semiconductor, as the next generation material for ambient-temperature gamma-ray detectors. We are studying the effects of AlSb material properties and defects on detector performance to identify the relevant parameters that limit detector performance and to develop appropriate strategies to improve crystal growth. New crystal-growth capabilities will be implemented to produce materials with enhanced detection capability. Detector fabrication technologies will be developed and improved to minimize detector noise and maximize detector performance.

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Semiconductor Radiation Detector Materials: Accelerated High Throughput Screening and Database Development	Sam Mao	510-486-7038	ssmao@lbl.gov	The goal of this project is to use a high-throughput combinatorial materials discovery approach to screen and develop high performance semiconductor materials for radiation detectors. The tasks include upgrading LBNL's current material fabrication facility, optimizing laser-based growth conditions for high-Z semiconductors, and building a theoretical modeling platform to calculate transport properties of various semiconductor materials for radiation detection applications.
Limiting Factors in Scintillator Energy Resolution	Bill Moses	510-486-4432	wwmoses@lbl.gov	Scintillators are often used for high-efficiency detection and identification of radioactive materials. An essential part of the identification is good energy resolution, but the energy resolution of the best existing scintillators is a factor of two worse than the theoretical limit. This proposal seeks to improve the energy resolution of scintillators by two routes: (1) to better understand the fundamental mechanisms that affect energy resolution in scintillators, including experimental measurement of a fundamental scintillation property known as non-linearity, as well as computational exploration of the relationship between non-linearity and energy resolution; and (2) to accurately model the light collection in scintillation detectors. This includes experimental measurements of the reflection of scintillation light off the surface of scintillators, incorporating these data into computational models, and experimentally validating the models.

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Development of quasi-monoenergetic neutron beams for national security applications	Peggy McMahan	510-486-5980	p_mcmahan@lbl.gov	A neutron beamline has been built at the 88" Cyclotron which is being used for a variety of low-energy nuclear applications, ranging from cross section measurements for stockpile stewardship, astrophysics, AFCI and NIF to development of interrogation methods for homeland security to radiation effects in electronics and biological systems. Neutrons are being characterized over a variety of energies from 2 - 30 MeV for both thick and thin targets.
Development of neutron imaging detectors	Peggy McMahan	510-486-5980	p_mcmahan@lbl.gov	Imaging detectors for fast neutrons are under development to use in neutron irradiations at the 88" Cyclotron. These are based on new technology under development for thermal neutrons, incorporating a scintillating layer backed by Gaseous Electron Multipliers (GEM). Scintillating materials being explored for this application - which should be sensitive to neutrons but not to gamma rays - are ZnS and both single crystal and polymorphous diamonds.

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Visual Workflow Tools to Support Collaborative Hypothesis Generation and Evidence Chaining	Deb Agarwal	510-486-7078	DAAgarwal@lbl.gov	The Knowledge Discovery and Dissemination (KDD) community has a tool called BLACKBOOK that provides mechanisms for database mining and to represent results graphically. BLACKBOOK provides an excellent interface for investigation of relationships between entities and to search for patterns in these relationships. However, investigation of patterns and hypotheses is difficult and quickly becomes unwieldy with only these mechanisms available. A promising approach to representing and launching complex and cross-database queries is to specify them in terms of a workflow. Use of a workflow will allow the user to specify the order of the queries, refinements which should occur, decision points which require human intervention, and subsequent steps. Such a tool can also be used to capture some or all of the queries and refinements undertaken during the investigation. The primary challenges in this project are designing the data mining workflow primitives and logic as well as designing interfaces that fit with the BLACKBOOK user needs.
Functionalization of porous copolymers in microfluidic devices ac biological sensors	Frank Svec	(510)486-7964	FSvec@lbl.gov	Working in the the Organic Nanostructures Facility of LBNL's new Molecular Foundry the intern will work on preparation of porous copolymers in microfluidic devices using combinations of acrylate- and/or methacrylate-based mono- and divinylic monomers and UV initiated polymerization. Functionalization of these materials via radiation initiated grafting of reactive monomers. Immobilization of specific antibodies to create units for "fishing out" selected proteins from complex matrices prior to their detection. Ultimate application is seen in detection of biological WMDs.

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Discovery of selective chemical sensors via combinatorial chemistry	Ron Zuckermann		RNZuckermann@lbl.gov	Molecular Foundry to develop a general approach for the rapid discovery of specific, robust molecular recognition elements (MREs) for chemical and biological sensing. Currently MRE's are typically either highly specific but unstable (proteins or other biomolecules), or highly stable and relatively non-specific (polymers). We have developed a class of bio-inspired polymeric material (called peptoids) that are ideally suited to serve as robust MREs, and we are screening combinatorial libraries of them for binding to pesticide molecules.
Building filters as samplers for event characterization	Gary Andersen	(510)495-2795	GLAndersen@lbl.gov	Building ventilation systems filter the supply airstreams provided to occupants. The supply airstream is a mixture of incoming outdoor air and recirculated indoor air. Biological material trapped on these filters would likely offer the best clues for follow-up information in the event of an outdoor biological release. However, collecting the follow up information from existing filters of buildings, and interpreting that information is non-trivial. Commercial filters come in different types, with different particle collection efficiencies. These efficiencies change as the filters become loaded with deposited particles over the course of normal operation. The project will focus on developing the sampling and extraction methods for bioaerosols from loaded filters. The student will also assist in the study of isolating practical amounts of DNA from the loaded filters for further analysis.

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Understanding chem, bio and rad (CBR) threats to buildings and building occupants	Rich Sextro, Ashok Gadgil, and Mike Sohn	510-486-6295, 510-486-4651, and 510-486-7610	rgsextro@lbl.gov, ajgadgil@lbl.gov, and mdsohn@lbl.gov	People spend 80 to 90 percent of their time in buildings - residences, workplaces, schools, etc. Occupants of buildings may have increased vulnerability to the deliberate release of CBR materials indoors; alternatively, buildings may afford shelter from outdoor CBR events, thus reducing exposures to occupants who stay indoors. The projects conducted by the Air flow and Pollutant Transport group - part of the Indoor Environment Department - seek to understand air flow and contaminant transport within buildings - especially large scale facilities like transportation hubs. These projects include both experimental and modeling studies and are designed to improve protection of building occupants from CBR threats.