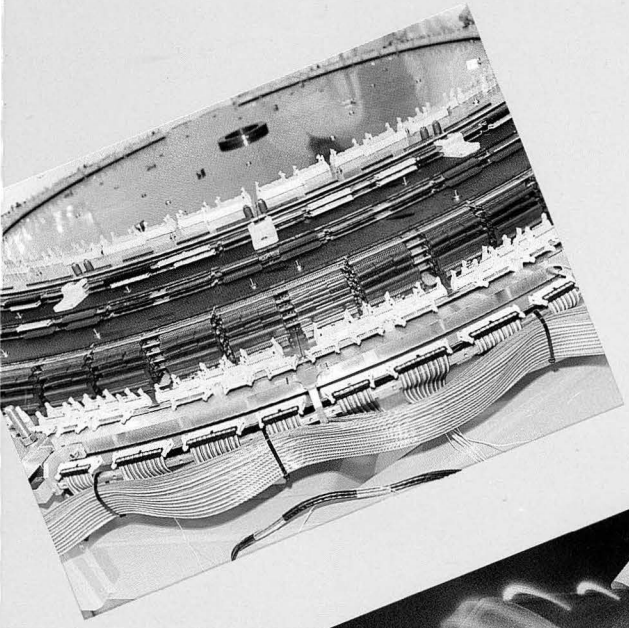
DISCLAIMER

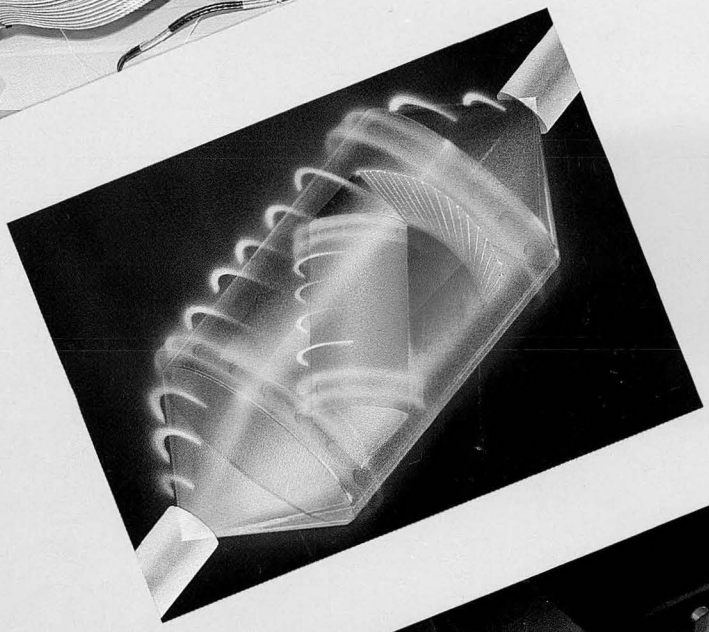
This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

TECHNOLOGY TRANSFER
AT
LAWRENCE BERKELEY LABORATORY

TAKING A CLOSER LOOK



RESEARCH



RESOURCES

EXPERTISE

For Reference

Not to be taken from this room

PUB-671
Copy 1
Bldg. 50 Library.

Cover Photos:

Top photo—The LBL-designed end-cap uranium-liquid argon electromagnetic calorimeter for the D0 detector, a second-generation hadron collider detector. Its primary aim is the precision study of high-mass, large-transverse-momentum phenomena, with particular emphasis on jets (clusters of produced particles), leptons (electrons and muons), and the "missing" transverse momentum indicative of penetrating particles, such as neutrinos.

Center photo—Schematic view of a "double rotation" sample holder. The design allows increased resolution in the nuclear magnetic resonance spectroscopy of a number of solid materials. Rotating the sample in the inner chamber, which in turn rotates in the outer chamber, will allow high-resolution study of nonspherical nuclei.

Bottom photo—The Nicolet P3 x-ray defractometer. This instrument measures the intensity of x-ray diffraction from crystal specimens. LBL researcher Sung-Hou Kim is optically aligning a crystal specimen to begin collecting data. X-ray diffraction measurement of crystals helps to determine the three-dimensional atomic structure of proteins, such as the cancer-causing protein *ras* oncoprotein, and other molecules.

Prepared by the Technology Transfer Office
Design concept, writer: Bruce Davies

Produced by the Information Resources Department
Design and layout: Marilee Bailey
Editor: Dick Johnson
Printing coordination: Jimmy Lovato
Photography (unless otherwise indicated): LBL Photo Lab

Contents

Taking a Closer Look 1

Profile—Lawrence Berkeley Laboratory 3

Technology Transfer Means Business 4

Choosing Your Technology Transfer Vehicle 6

Major Program Areas 8

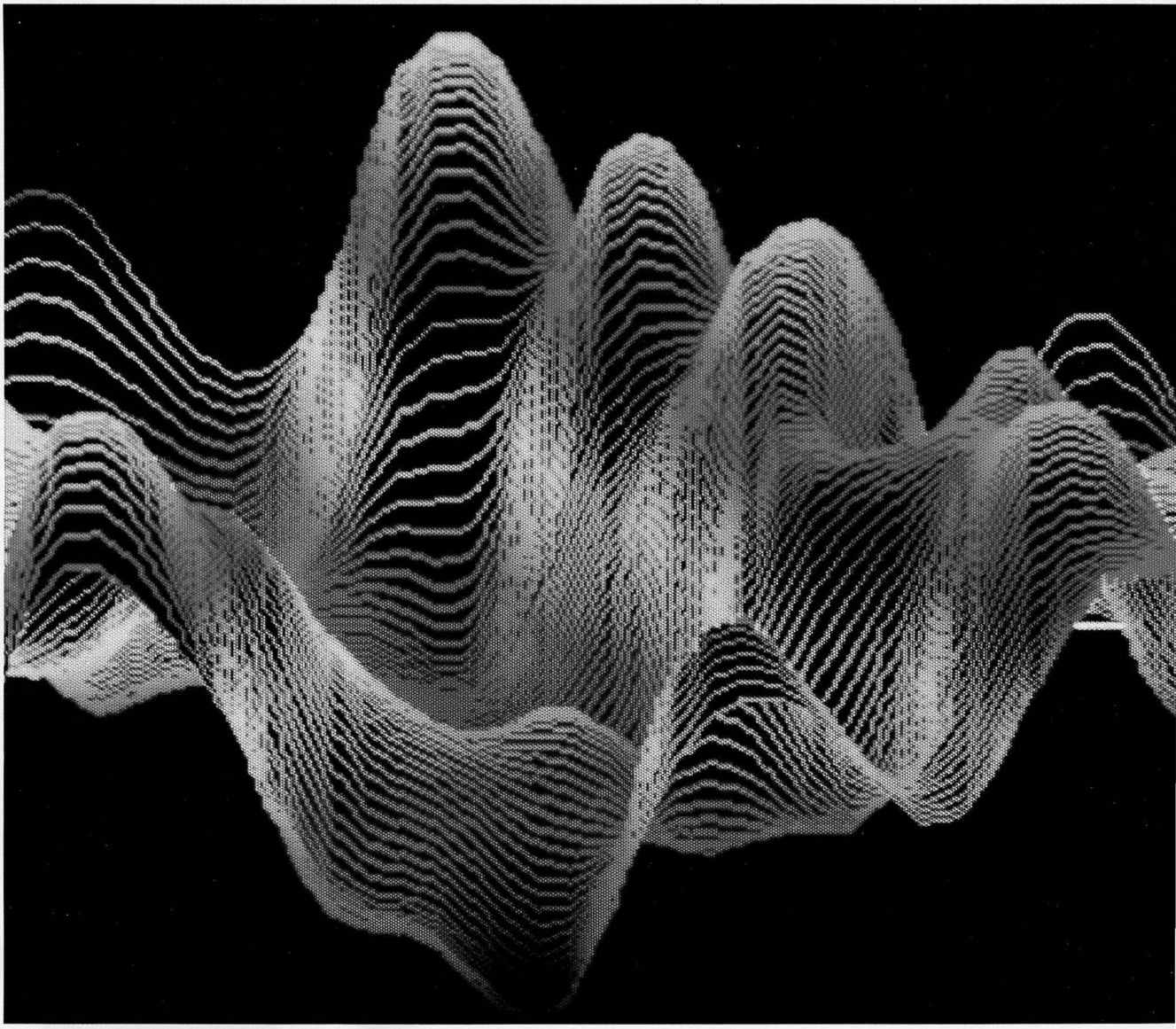
- Energy Sciences 10
- General Sciences 12
- Life Sciences 14
- Scientific and Technical Resources 16

Research Centers 18

User Facilities Available to Industry 22

Key to LBL Buildings 24

LBL Map 25



The first direct image of the helical structure of unaltered DNA was obtained through a scanning tunneling microscope at LBL's Center for Advanced Materials. The average distance between twists (shown as elevated contours in this isometric projection) is 35 Å (vertical axis is 4 × horizontal axis).

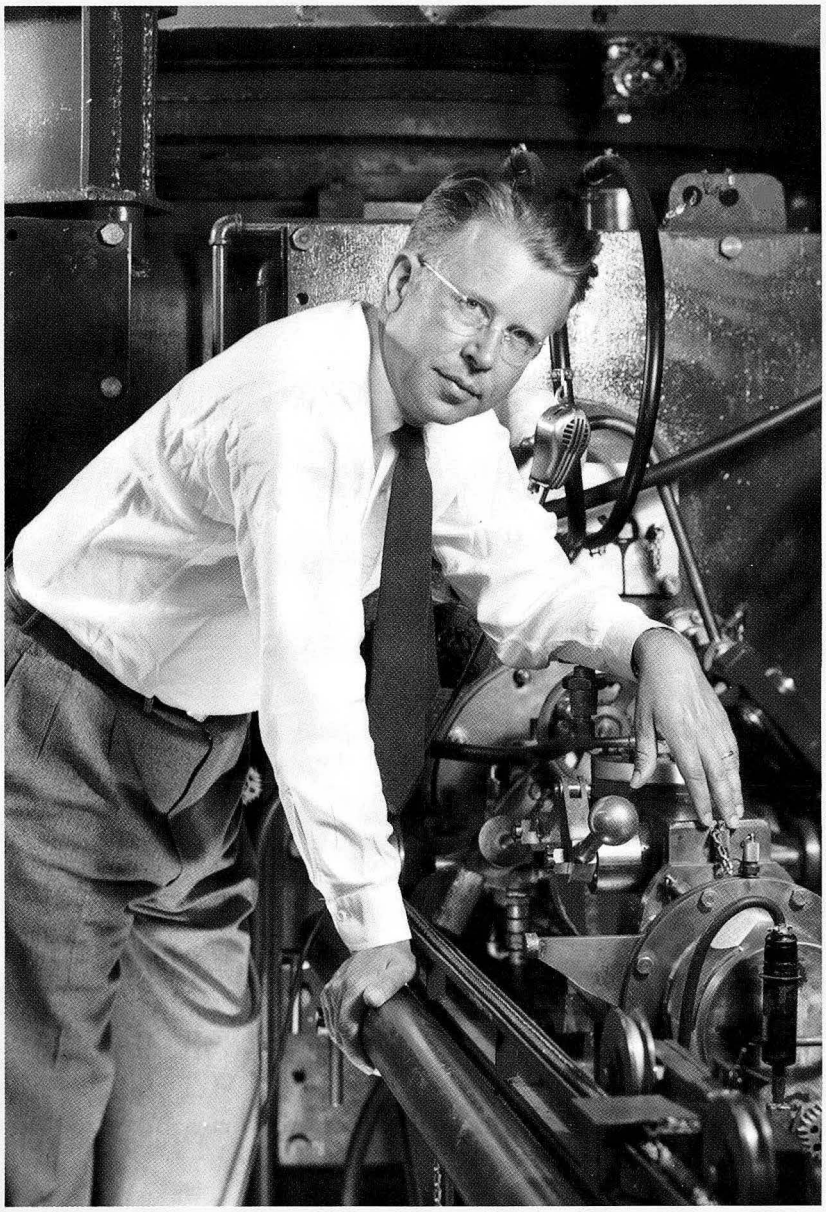
Taking A Closer Look

◆ In a rapidly expanding international marketplace, emerging technology drives the world's economy. The challenge to commercialize new technology will play out in fields such as advanced materials, biotechnology, and electronics, with the winner reaping worldwide economic rewards. Therefore, the value of technology transfer between national laboratories and the industrial community is more important in maintaining America's competitive edge than ever before.

◆ At Lawrence Berkeley Laboratory (LBL), we want to work with U.S. industry to meet this challenge. LBL will continue to emphasize research excellence while actively seeking and establishing working relationships with industry across the U.S.

◆ Our commitment to research innovation is the foundation for new high-potential technology applications.

◆ On the following pages we invite you to take a closer look at the many opportunities and ways to establish working relationships with LBL. The Laboratory encourages your inquiries: these may lead to an active alliance that delivers innovative solutions that create new technologies, products, and systems of value to society.



LBL founder Ernest O. Lawrence

LAWRENCE BERKELEY LABORATORY

◆ LBL is a major multiprogram national laboratory managed by the University of California for the U.S. Department of Energy (DOE). LBL has more than 3,000 employees, of which 950 are scientists, theoreticians, and engineers. With an annual budget of approximately $230 million, LBL conducts a wide range of research activities, many that address the long-term needs of American industry and have the potential for a positive impact on U.S. competitiveness.

◆ The oldest of the nine DOE national laboratories, LBL is located next to one of the world's great universities—the University of California at Berkeley. This environment attracts some of the world's best and most creative investigators. Principal research programs include materials science and chemistry, earth sciences, biology and medicine, conservation and renewable energy, high-energy and nuclear physics, as well as engineering, mathematics, and computer sciences. Using multidisciplinary approaches to conduct research, teams of LBL scientists, theorists, engineers, and technicians employ state-of-the-art equipment to tackle and solve complex technological problems.

◆ LBL's role is to serve the nation and its scientific, educational, and business communities through research and development in the energy, life, and general sciences; to develop and operate unique national experimental facilities for use by qualified investigators; to educate and train future scientists and engineers; and to develop productive relationships between LBL research programs and industry.

Technology Transfer Means Business

Lawrence Berkeley Laboratory invites you to take a closer look at the many R&D approaches and opportunities available to private industry.

LBL Welcomes Your Inquiries

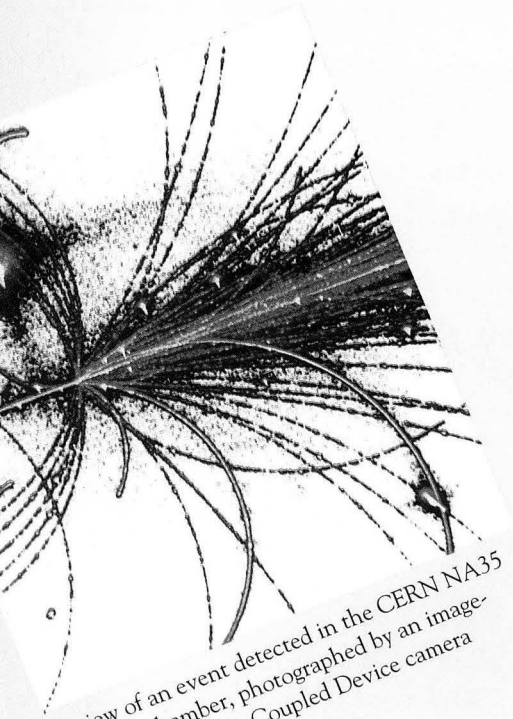
The research areas and administrative structure described in this publication provide general guidelines. LBL's interdisciplinary science approach offers many technology transfer options. DOE policy encourages private-sector use of government-developed technologies. LBL welcomes your inquiries to explore areas of research, technology, and collaboration.

Forging Stronger Ties

As a national laboratory, one mission of LBL is to make research results available to the nation's private sector for rapid commercialization. Private industrialists and entrepreneurs broaden the potential benefit and commercial value of laboratory research. They help translate new discoveries into commercially usable products and processes. Working together, the national laboratories and U.S. industry can help strengthen America's competitiveness in the world marketplace—together, we mean business.

Making Technology Transfer Accessible

To help make effective the transfer of technology from LBL to industry, LBL has streamlined its technology transfer operations. The following offices interact to help move technology and ideas to the marketplace and to handle research proposals and contracts with outside sponsors.



A view of an event detected in the CERN NA35 streamer chamber, photographed by an image-intensified Charge-Coupled Device camera developed at LBL.

Technology Transfer Office

The role of the Technology Transfer Office is to make technology and expertise developed at LBL available to industry.

Technology transfer depends on communication between those generating knowledge and those able to put it to use. The Technology Transfer Office acts as a focal point to foster productive relationships between LBL research programs and the private sector. If you have questions regarding research areas of interest or wish to have an answer regarding working relationships with LBL, start with the Technology Transfer Office. Call or visit the Technology Transfer Office to

- **Pinpoint research areas of common interest**
- **Negotiate rights to LBL's intellectual property**
- **Discuss current patent and copyright licensing opportunities**
- **Set up meetings with specific investigators; arrange LBL tours**
- **Learn the names of people in charge of sponsorships, collaborative projects, and staff-exchange programs**

Office of Sponsored Research Administration (OSRA)

OSRA is the administrative liaison for sponsored research and research collaborations between LBL scientists and the private sector.

If your company would like to use LBL facilities or have work performed by or jointly with LBL investigators, contact OSRA. OSRA's experienced staff coordinates proposal submissions and contract negotiations. Call or visit OSRA to inquire about

- **Research performed by LBL scientists under sponsorship by industry**
- **Use of LBL User Facilities by industry personnel**
- **Collaborative research—sharing of LBL and industry costs, facilities, equipment, or research capabilities**
- **Industry support of LBL researchers through gifts, grants, or fellowships**
- **Proposal submissions**
- **Contract negotiations**

Patent Department

The function of the Patent Department is to protect LBL inventions, technology, and software.

Staffed by professional patent attorneys, the Patent Department performs the legal work of LBL in matters relating to LBL inventions. It also performs an advisory and service role for the Technology Transfer Office and the Office of Sponsored Research Administration. To carry out its function, the Patent Department

- **Pursues patents, evaluates patentability of LBL inventions**
- **Creates, files, and prosecutes patent applications**
- **Registers copyrights with the U.S. Copyright Office**
- **Approves all intellectual property-rights clauses in sponsorship contracts and licensing agreements**
- **Interacts with DOE to expedite transfer of patent rights to the private sector**

Choosing Your Technology Transfer Vehicle

LBL's research produces innovative technologies and inventions, many with commercial value. LBL's resources, expertise, and project-oriented teams can help make your company's R&D effort more effective. From acquiring written information on a special project to establishing research collaborations or licensing available technology, there are many ways to work with Lawrence Berkeley Laboratory—many ways to leverage your research activities.

Licensing New Technology

LBL's work produces innovative and inventive discoveries, many of which have commercial value and are available for licensing. To discuss licensing possibilities, ideas for new technology applications, markets, or products—*contact the Technology Transfer Office*.

Sponsored Research

A company may sponsor LBL scientists to perform specific research compatible with LBL's research in the company's field of interest. The unique equipment and specialized staff expertise at LBL provide research opportunities that would not otherwise be available. *Discuss research concepts with scientific staff. To coordinate efforts—contact* OSRA.

Visitor/Staff Exchanges

University and industrial scientists may visit LBL to conduct research. Each year DOE sponsors a Laboratory-Industry Exchange Program, offering opportunities for researchers from industry and DOE laboratories to work in areas of mutual interest and benefit at one another's sites. *For more information about this program—contact the Technology Transfer Office or Research Division. For visits or staff exchanges that require a contractual relationship—contact* OSRA.

Collaborative Research and Development Agreements (CRADA)

Some of the most innovative technology transfer at LBL today involves collaborative projects with industry. In collaborative research arrangements, DOE and industry jointly sponsor a research project. Costs, personnel, facilities, equipment, or research capabilities may be shared for mutual benefit. This provides industry with an excellent way to leverage research activities. *Discuss technical points with scientific staff. Contact OSRA for proposal, contractual, and administrative matters. Discuss intellectual property arrangements with the Technology Transfer Office.*

GETTING STARTED

If you have not worked with LBL, these basic steps will help you choose the technology transfer vehicle that will work best for your company.

Identify a need

- A company identifies a problem it needs solved or identifies a general subject area in which it wants to broaden its expertise.

Make contact

- LBL's Technology Transfer Office offers help in determining access to LBL technology.
- A direct relationship is developed with the scientist or division.
- OSRA offers the company guidance on contractual approaches.

Initiate discussion

- A dialogue between the company and LBL technical managers is initiated.
- Contractual and administrative terms are discussed with OSRA.
- Intellectual property matters are discussed with the Technology Transfer Office.

Choose a vehicle

- A choice is made regarding a technology transfer method that will produce the desired results.
- Administration of industrially sponsored research and research collaboration projects are finalized with OSRA.

Gifts and Graduate Support

Gifts to LBL are received in the form of equipment, research materials, and funds. Gifts may be undesignated or may be designated for a particular research area or research group. A fellowship may be given to support a graduate student's research. If a company is interested in acquiring expertise in a particular area, a specific student may be supported with the intention of bringing the student into the company after graduation. This is an efficient way to transfer technological expertise from LBL. *To coordinate gifts and fellowship support—contact OSRA.*

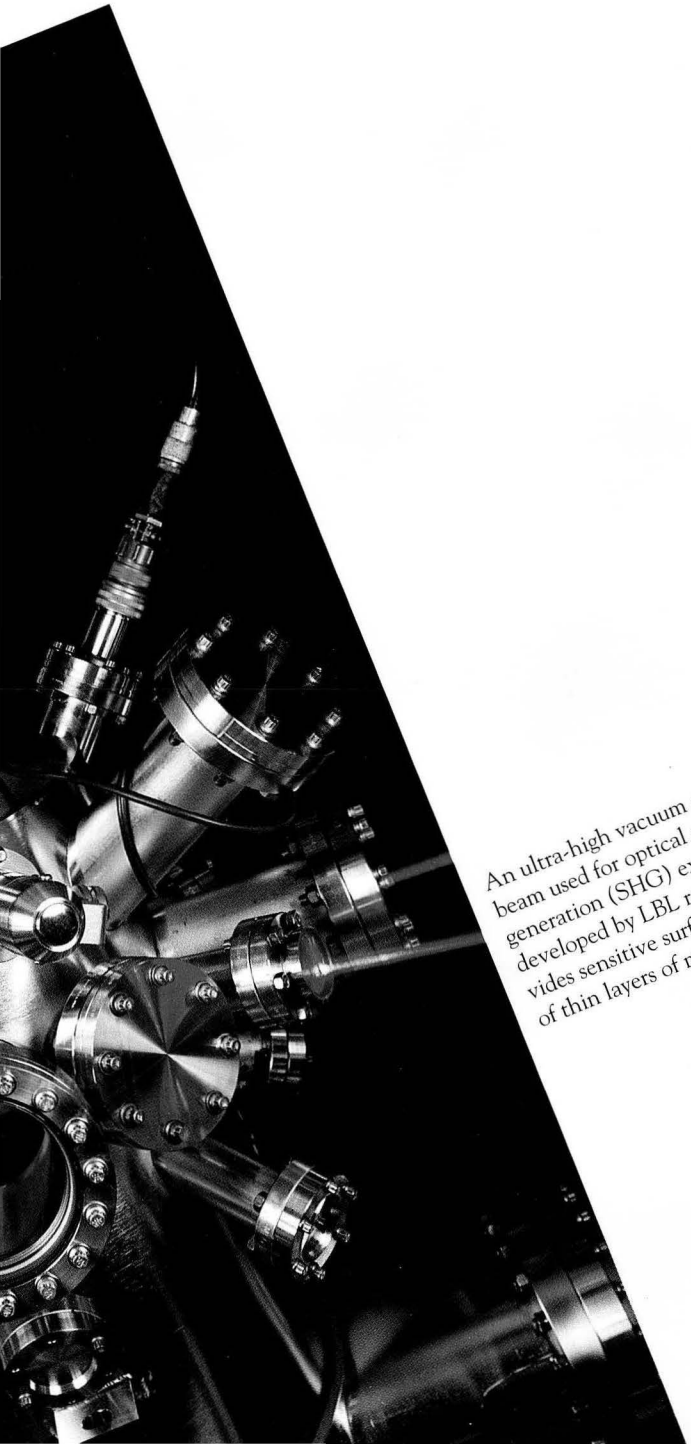
User Facilities

Certain facilities at LBL and other DOE laboratories are considered "National User Facilities" offering unique opportunities. *User Facility arrangements are administered through OSRA.*

User Facilities are discussed in further detail on page 22.

Major Program Areas

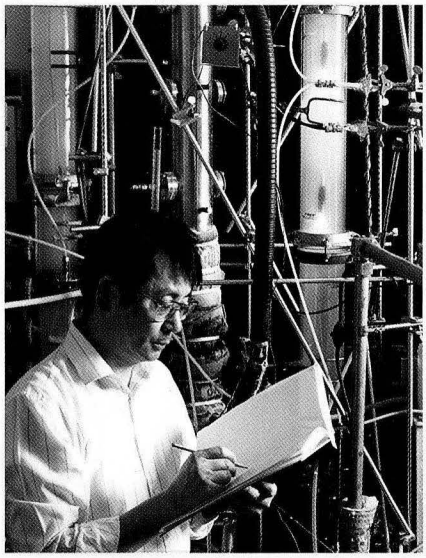
Research activities at LBL are concentrated in three major program areas: Energy Sciences, General Sciences, and Life Sciences. Each program area consists of three research divisions. Program areas are supported by a technical resource division. The following section offers brief descriptions of the divisions and their areas of expertise. Comprehensive overviews of research performed at each division are available from LBL. Lawrence Berkeley Laboratory welcomes both requests for information and proposals to conduct research.



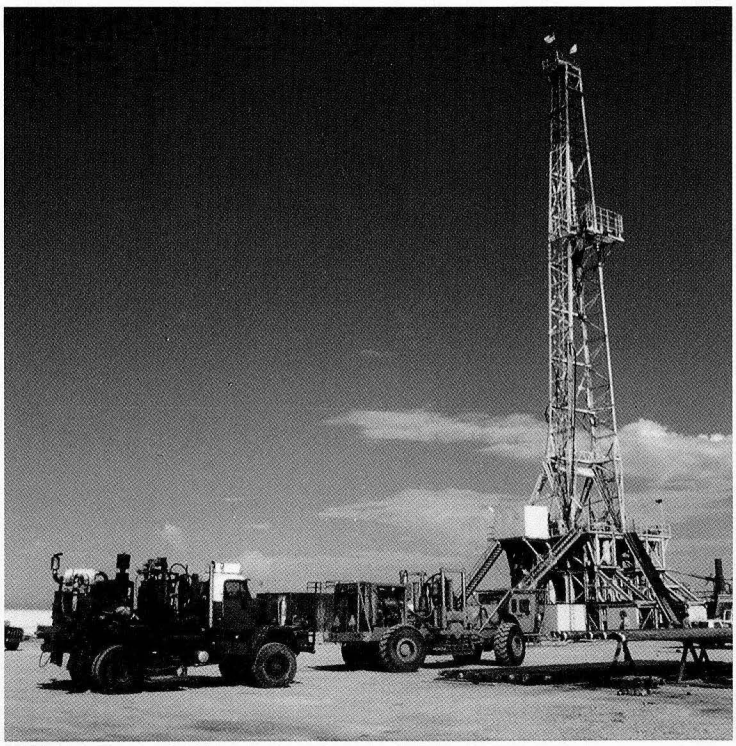
An ultra-high vacuum chamber and laser beam used for optical second-harmonic-generation (SHG) experiments. As developed by LBL researchers, SHG provides sensitive surface-structure analysis of thin layers of materials on surfaces.

ENERGY SCIENCES

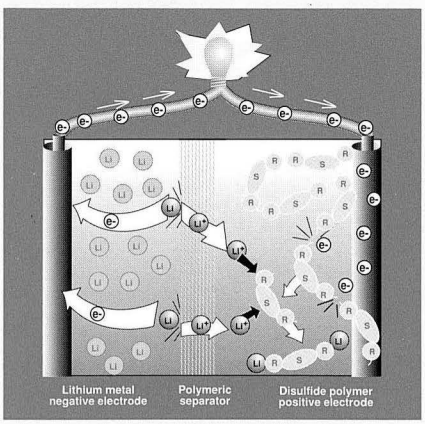
Energy Sciences research at LBL encompasses a wide spectrum of energy sciences and technology that includes programs in materials science, chemistry, physics, geology, and engineering. Energy resources, energy conservation, waste disposal, and the impact of energy technology on the environment are explored.



Applied Science. Researcher Ted Chang works at a bench-scale scrubber whose technology could cost-effectively remove more than 90% of the SO_2 and NO_X emitted (as flue gases) from coal-fired power plants.



Earth Sciences. Vertical seismic profile survey underway at the Salton Sea Scientific Drilling Project drill site. The two large vehicles are compressional (*P*) and shear (*S*) wave vibrators used to generate seismic wave signals.



Materials Sciences. LBL researchers invented a novel all-solid-state rechargeable battery. It uses a new class of polymer cathodes based on redox polymerization and depolymerization. LBL's solid-state lithium battery technology has been licensed to a U.S. company.

Applied Science Division

Research conducted in Applied Science covers a broad spectrum of areas, with emphasis on providing environmentally acceptable energy options for the future. These include fuels from non-petroleum sources, advanced batteries, conversion of solar energy, and improvements in energy end-use efficiency. The research on energy conservation in buildings, energy-efficient lighting, indoor air quality, solar heating and cooling, and acid rain continues to produce results that enlighten and inform both the private sector and the scientific community.

Research Areas

- Building energy efficiency
- Indoor air quality
- Environmental effects of technology
- Energy storage and distribution
- Combustion chemistry and cleanup
- Solar energy for heating/cooling systems for buildings
- Analyses of national and international energy demand and policy

Research Centers

- Center for Building Science
- California Institute for Energy Efficiency
- Center for Atmospheric and Biospheric Effects of Technology
- Berkeley Electrochemical Research Center

User Facilities

- Sky Simulator for Architectural Daylighting Design
- Mobile Window Thermal Test Facility

Earth Sciences Division

Investigators in Earth Sciences study the underground environment to accumulate knowledge essential for safe disposal of radioactive and toxic chemical wastes, to exploit geothermal energy, and to develop petroleum and strategic-mineral resources. Comprehensive research is conducted on the effects of high temperature and pressure on geological materials; the structure and dynamics of the Earth's deep crust and the influence of crustal processes on energy resources; and the behavior of fractured rock formations encountered in mining, geothermal, petroleum-extraction, or waste-disposal activities.

Research Areas

- Structure and behavior of the continental lithosphere
- Geophysical remote-imaging methods
- Chemical and physical transport in geologic systems
- Isotope geochemistry

Research Centers

- Center for Isotope Geochemistry

User Facilities

- Center for Computational Seismology

Materials and Chemical Sciences Divisions

Investigators in Materials and Chemical Sciences conduct both experimental and theoretical research in a wide range of topics, including high-temperature superconductors, semiconductors, composites, ceramics, light alloys, polymers, and magnetic and optical materials. Growth areas in materials science investigation include the study of electronic, structural, and other properties of thin films, surfaces, interfaces, and bulk materials; developing the science of wear, fracture, and failure modes; and extending the understanding of catalysts, novel processing, and production techniques such as enzymatic synthesis.

Research Areas

- Advanced ceramic, metallic, and polymeric materials for electronic, catalytic, and structural applications
- Superconductivity
- Instrumentation for surface science and analysis
- Microstructural analysis by electron microscopy
- Electronic structure of solids and interfaces
- Dynamics of chemical reaction
- Atomic structure of heavy ions

Research Centers

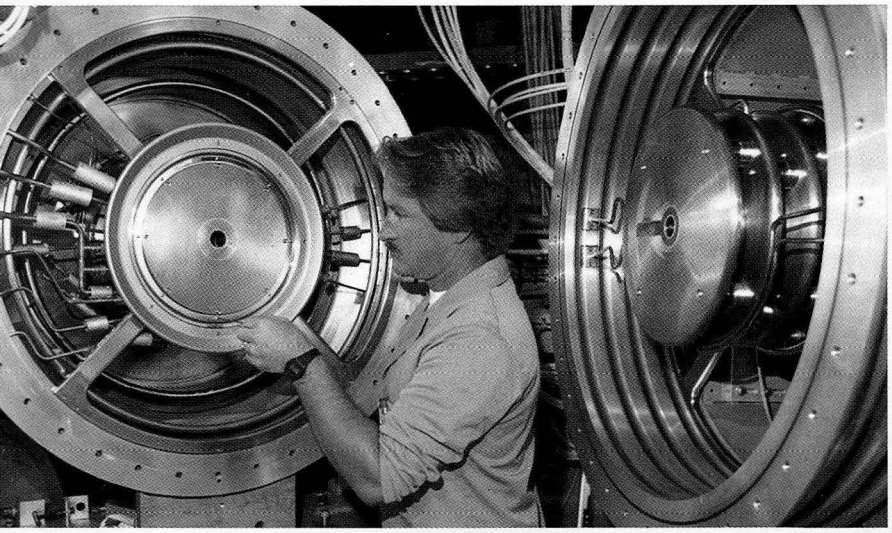
- Center for Advanced Materials
- Superconductivity Research Center for Thin-Film Applications

User Facilities

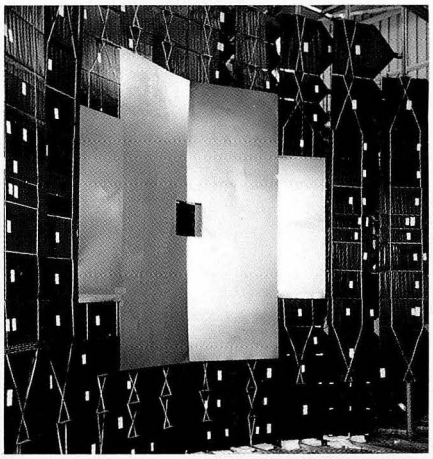
- National Center for Electron Microscopy
- 2.5-MeV Van de Graaff Facility

GENERAL SCIENCES

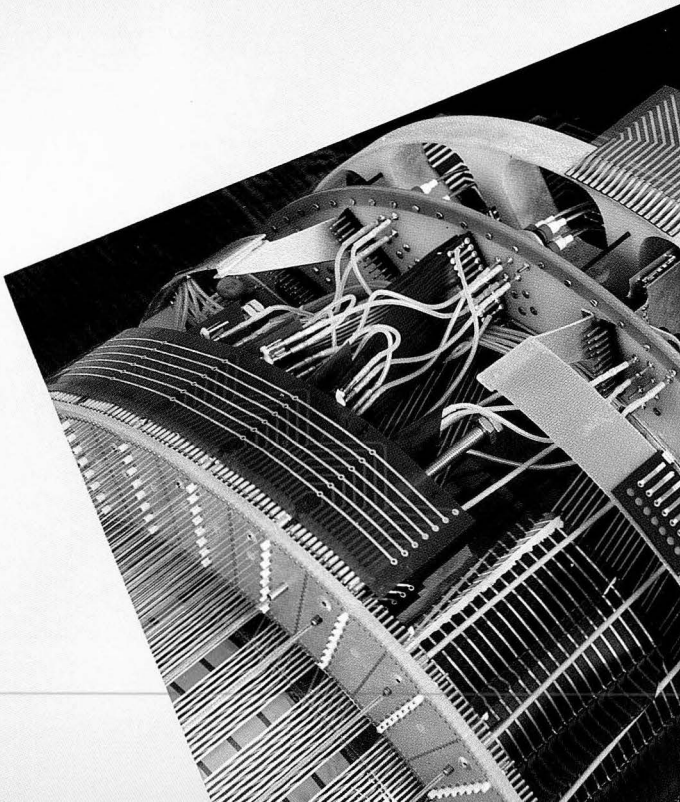
The General Sciences research programs build on LBL's historical work in high-energy physics, increasing our fundamental understanding of the nature of matter and providing a scientific and educational base for other fields.



Accelerator and Fusion Research. The constant-current, variable-voltage accelerator, developed by the Magnetic Fusion Energy Group, features electrostatic quadrupole focusing that reduces the risk of voltage breakdown.



Nuclear Science. Neutron detectors at the Bevalac. This array of plastic detectors was used by Kent State scientists to detect neutrons in coincidence with charged particles in a central heavy-ion collision.



Physics Division

The Division carries out research in experimental and theoretical particle physics, while developing new tools and techniques needed in the study of high-energy particle interactions. The Division's Particle Data Group provides the worldwide high-energy physics community with reference compilations of all existing particle data. The particle physics program has an active component in experimental and theoretical astrophysics, with emphasis on particle astrophysics at the boundary of particle physics and cosmology. In addition to the particle physics program, there is a smaller but highly significant research effort in applied mathematics.

Research Areas

- Experimental and theoretical particle physics
- Advanced detector development
- Particle data base for the high-energy physics community
- Astrophysics
- Applied mathematics

Nuclear Science Divison

The principal activity of the Division is the theoretical and experimental investigation of the interactions of heavy ions with target nuclei at various energies, both for their inherent scientific interest and for their use in the synthesis and study of new isotopes and chemical elements. This research program is carried out at LBL's accelerators and at other national and international accelerators. The Division operates the 88-Inch Cyclotron as a National User Facility. It fulfills an educational role with active graduate student and postdoctoral programs.

Research Areas

- Relativistic heavy-ion physics
- Nuclear structure
- Exotic nuclei
- Nuclear reactions
- Nuclear theory
- Nuclear astrophysics
- Nuclear chemistry
- Studies of transuranium elements
- Nuclear data evaluation
- Advanced instrumentation

User Facilities

- 88-Inch Cyclotron

Accelerator and Fusion Research Division

The advanced technology of beams—ions, electrons, and photons—is the focus of the Accelerator and Fusion Research Division. The Division is responsible for the operation of most of LBL's accelerators. Its scientists and engineers design new accelerators and devise new accelerator-technology applications ranging from fusion power to cancer treatment. Major efforts also include design and construction of the Advanced Light Source, a state-of-the-art synchrotron-radiation facility, and operation of the Bevalac, a large accelerator complex used for nuclear science and biomedical research.

Research Areas

- Accelerator design and operation
- Advanced accelerator technology development
- Accelerator and ion-source research for heavy-ion fusion and magnetic fusion
- X-ray optics
- Superconducting magnet design and fabrication
- Advanced Light Source design, construction, and operation

Research Centers

- Center for X-Ray Optics

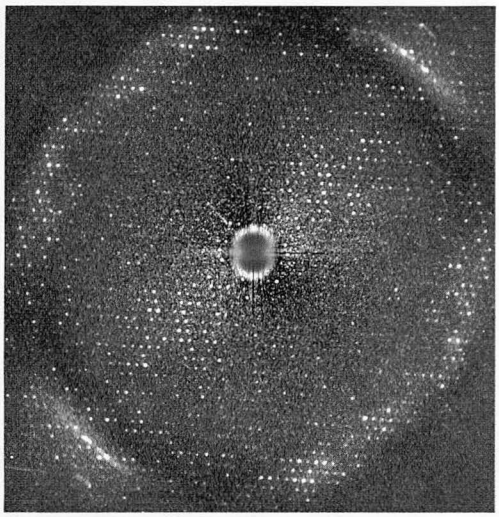
User Facilities

- Bevalac
- Advanced Light Source (first operation 1993)

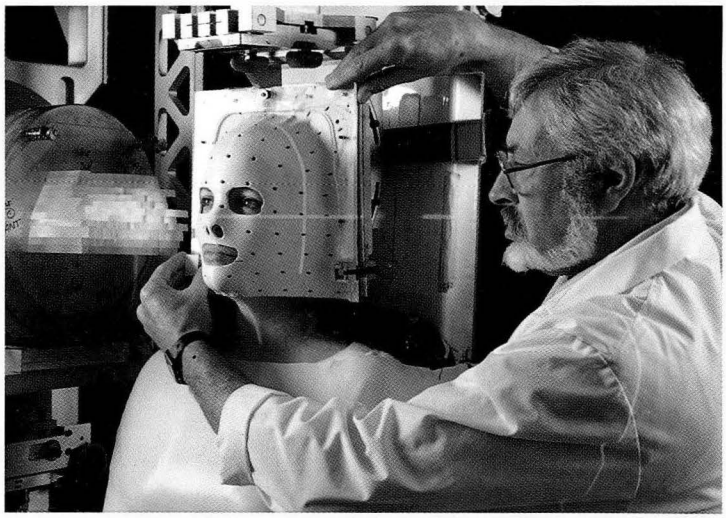
Physics. LBL's high-precision vertex chamber for the D0 detector at the Fermilab proton-antiproton collider.

LIFE SCIENCES

Through the development of biomedical instrumentation, studies of the intricate processes of gene expression, and expanding efforts to link biological structure and function, Life Sciences research plays an important role in understanding biological processes and controlling disease.



Cell and Molecular Biology. PhoE porin, a transmembrane channel found in the outer membranes of Gram-negative bacteria. It has been reconstituted into highly coherent two-dimensional crystals using a novel crystallization technique.



Research Medicine and Radiation Biophysics. LBL's patient-immobilization and beam-shaping system used in charged-particle radiation therapy.

Cell and Molecular Biology Division

The Division's goal is to develop a deeper understanding of factors that regulate gene replication and expression. This includes elucidating the biological effects of DNA-damaging agents, establishing the genetic basis of protection against DNA damage, identifying the health risks associated with such damage, and determining how tissue-specific genes interact with their environment. The Division also provides administrative support for the Human Genome Center.

Research Areas

- Differentiation, carcinogenesis, hematopoeisis
- Macromolecular structures
- Radiation biology and DNA repair

Chemical Biodynamics Division

Research work in Chemical Biodynamics contributes to the understanding of the relationship between structure and function in biological macromolecules. Projects include the study of the molecular mechanisms of photosynthesis and the involvement of structural modification of protein involved with oncogenesis. Nuclear magnetic resonance and x-ray crystallographic techniques are used to probe the molecular structure of complex biomolecules and to study the fundamental chemistry of electronically excited molecules.

Research Areas

- Genetics and mechanisms of photosynthesis
- Photochemistry and mechanisms of mutagenesis
- Structural and molecular biology of nucleic acids and proteins

User Facilities

- National Tritium Labeling Facility

Research Medicine and Radiation Biophysics Division

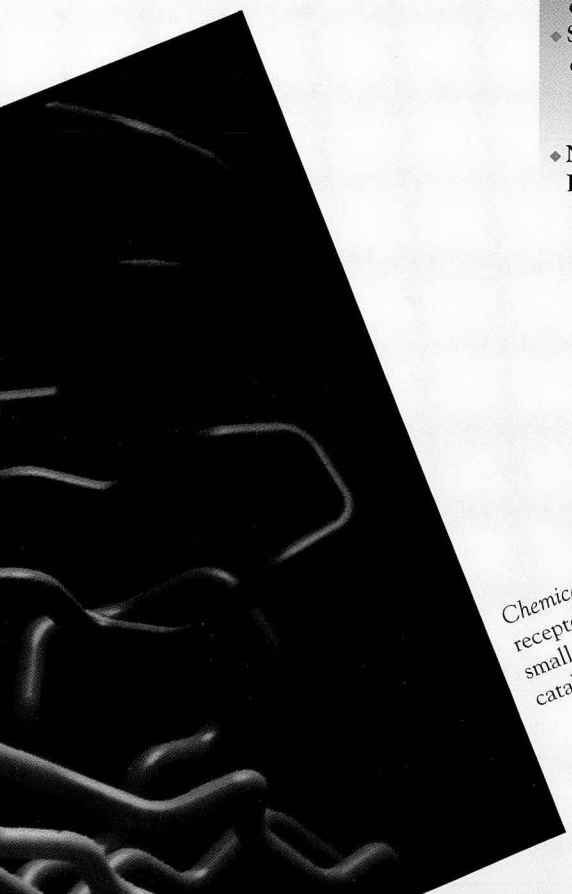
Leading research is focused on the diagnosis and treatment of disease. Principal activities center on the therapeutic use of heavy ions from the Bevalac and on the development of advanced tools for medical imaging, particularly nuclear magnetic resonance and positron-emission tomography and their applications in clinical research.

Research Areas

- Medical-imaging instrumentation
- Radiotherapy and radiosurgery
- Biochemical mechanisms of disease
- Atherosclerosis and aging

User Facilities

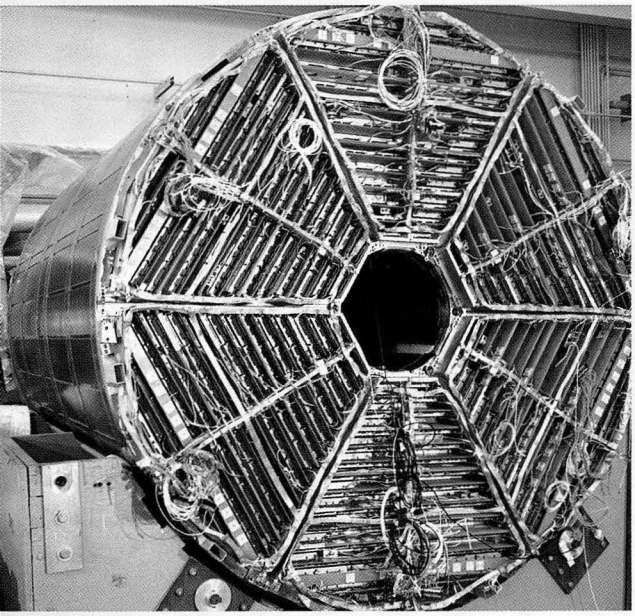
- Heavy Charged Particle Biomedical Facility



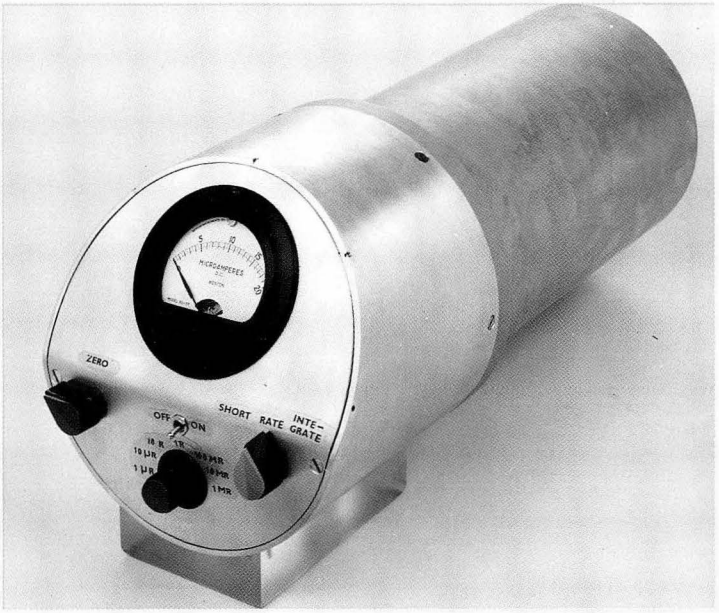
Chemical Biodynamics. Monoclonal antibodies provide a diverse class of receptors that will bind molecules ranging from nucleic acids to synthetic small molecules. LBL has developed a method to make these receptors catalyze chemical reactions.

SCIENTIFIC AND TECHNICAL RESOURCES

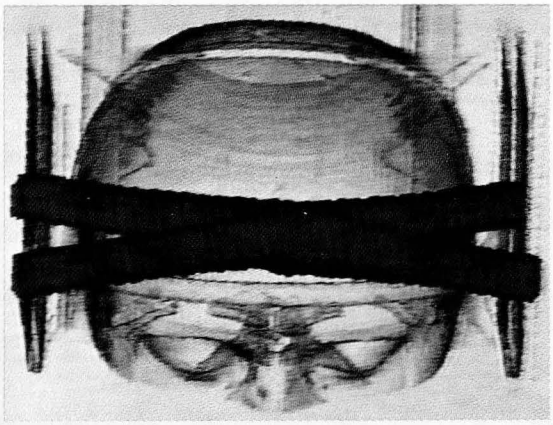
Scientific and Technical Resources supports LBL's nine research divisions. It provides engineering and computer science expertise to those divisions to accomplish the Lab's research goals. Its research programs yield innovative cutting-edge technology.



Engineering. The Time Projection Chamber (TPC), a particle detector invented at LBL that detects and identifies subatomic particles. The TPC reconstructs the three-dimensional ionization tracks of energetic subatomic particles over a time interval.



Occupational Health. This LBL-developed radiation detector measures the amount of ionizing radiation from such sources as radioisotopes, x-ray generators, charged-particle accelerators, and natural background.



Information and Computing Sciences. An example of LBL's visualization and graphics work. The image shows the integration of two data sets: a head of a child via x-ray computer topography, and the identification of a region of the brain to be treated. This work is being done with Research Medicine and Radiation Biophysics.

Engineering Division

Technological resources to support the research programs and the major research facilities of LBL are provided by Engineering. Many engineers and technicians are assigned outside the Division as team members to the various programs and research facilities, bringing the expertise of the engineering disciplines to bear on the objectives of the research or operations teams. Two offices, Electronics and Mechanical Engineering, administer the outside assignments of personnel, operate the central electronics and mechanical shops, and conduct basic research in the fields of nuclear instrumentation, semiconductor detectors, and magnet technologies.

Research and Support Areas

- Development of advanced research instrumentation systems
- Expert fabrication/technician shops
- Integrated CAD-E-M technologies
- Development of unique semiconductor and ionization-track detector systems

User Facilities

- Low-Background Counting Facility

Information and Computing Sciences Division

Information and Computing Sciences (ICS) operates computing and networking facilities, libraries, and technical publishing facilities to support LBL's scientific programs. ICS also conducts a program of computer science research and development in technologies appropriate for present and future scientific programs. This includes advanced software architectures, networking, data management, imaging, and visualization. An important aspect of the program is the evaluation of new hardware and software products and the integration of new technologies into scientific computing. ICS also provides application programs in several key areas, such as the Human Genome project and Biostatistics.

Research and Support Areas

- Advanced computing and information-management techniques
- Research into future-generation data-management techniques
- Development of new software architectures, distributed computing technology, and high-speed networking systems
- Biostatistic systems

Occupational Health Division

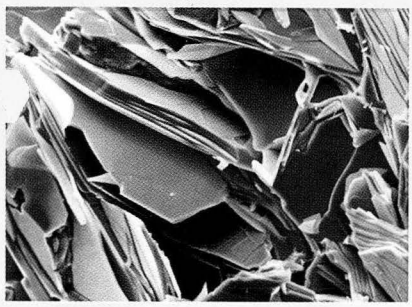
Occupational Health is responsible for making sure that LBL remains a safe and healthy work place. In addition to continuing advanced work in personal dosimetry, Occupational Health has invaluable experience with radiation-protection systems for particle accelerators and is playing a major role in the design of these systems for new accelerators.

Research and Support Areas

- Research safety associated with accelerator technology
- Radiation dosimetry and measurements
- Waste management
- Environmental surveillance
- Industrial hygiene
- Transportation and packaging of radioactive materials

Research Centers

Lawrence Berkeley Laboratory has established multidisciplinary research centers with the specific objective of fostering research with industry and educational institutions. LBL's research centers apply skills, expertise, and instrumentation in many subject areas to specific research problems. Many centers focus on problems of special interest to the private sector. Each research center offers a unique multidisciplinary approach to research areas of national interest, all of which have a potential for positive impact on the American economy.



Center for Advanced Materials. Scanning electron micrograph of a high-temperature superconductor made of bismuth-strontium-calcium-copper oxide.

Center for Advanced Materials

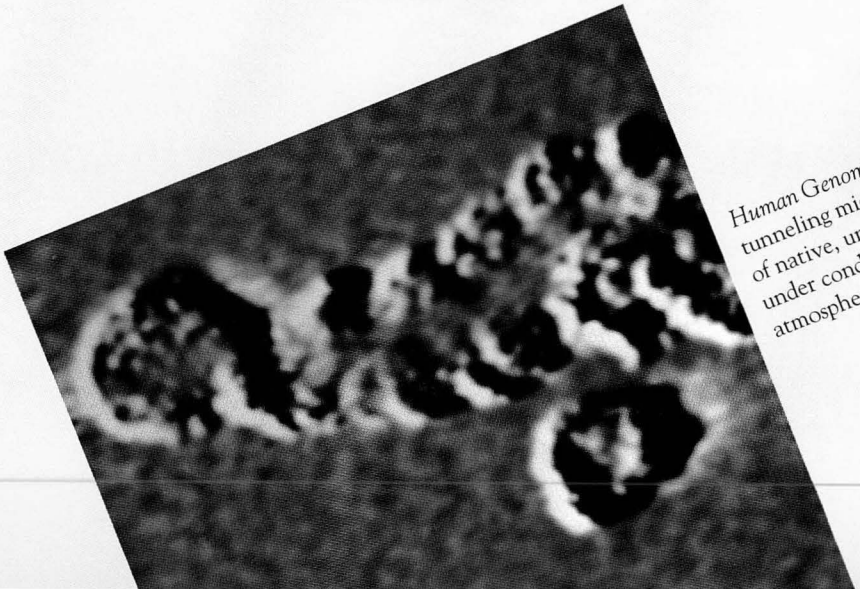
The Center for Advanced Materials (CAM) works in close partnership with industry and universities to perform fundamental materials science research in areas of prime importance to industry. CAM provides high-quality materials research that is directed toward the long-range needs of high-technology energy-related disciplines. The major areas of research activity in the Center for Advanced Materials are

- **High-T_c superconductivity**
- **Electronic materials**
- **Polymers and composites, including enzymatic synthesis**
- **High-performance metals**
- **Surface science and catalysis including instrumentation for surface science**
- **Ceramic science**

Human Genome Center

Activities at the Human Genome Center are concentrated in three areas: automation of existing physical mapping methods and development of new ones, evaluation and enhancement of existing sequencing technologies, and improvement of methods for interpreting and analyzing maps and sequence data. Current research endeavors within the three areas include

- **Constructing an ordered library for chromosome 21**
- **Improving YAC cloning methods**
- **Linking large DNA fragments and YACs by sequencing**
- **Improving pulsed-field gel electrophoresis**
- **Developing automated methods for image enhancement, image analysis, and map construction**



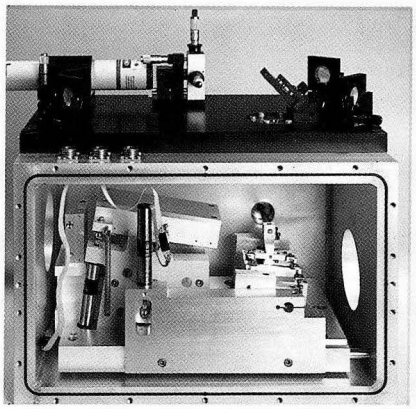
Human Genome Center. A scanning tunneling microscope (STM) image of native, unstained DNA molecules under conditions of normal atmospheric pressure.

Center for Building Science

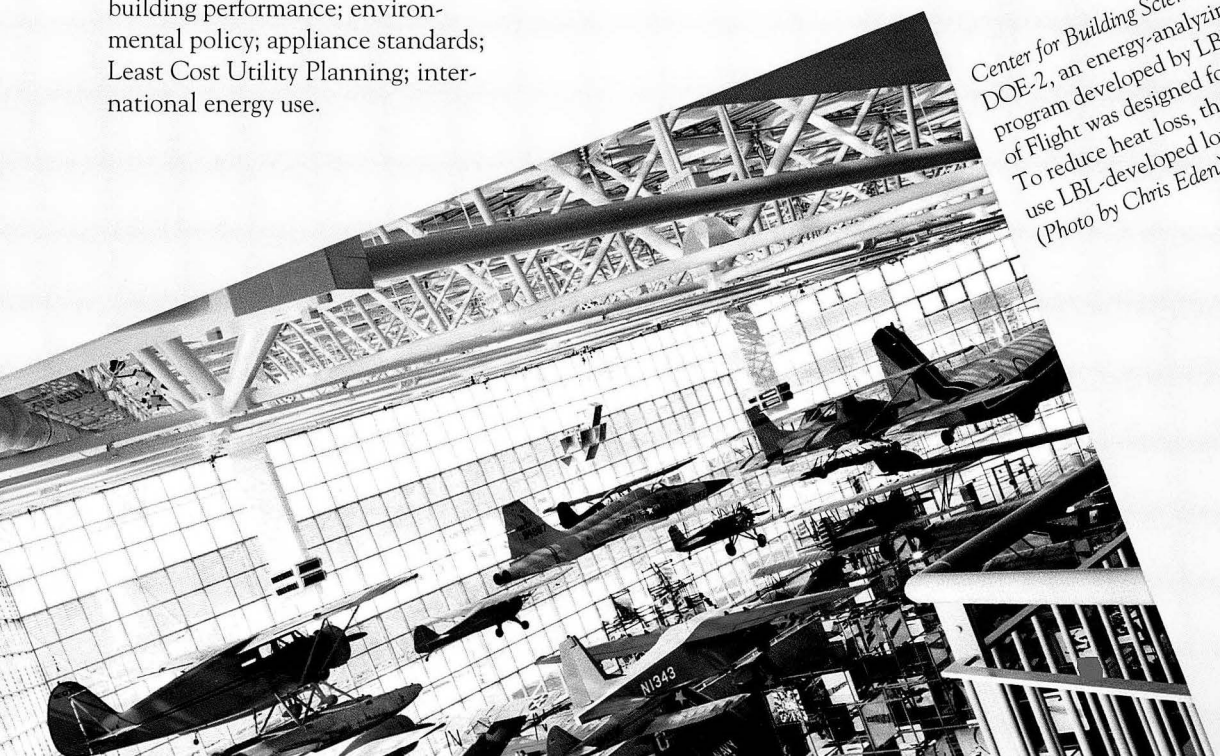
The Center for Building Science provides a cohesive working environment to perform joint research, to develop new research areas, and to transfer successful building R&D results to industry.
Windows, lighting, and daylighting: development of advanced, efficient lamps and controls; studies of human performance under varied lighting conditions; thin-film coatings and other approaches to advanced window design; window performance measurements and modeling.
Indoor air quality: pollutant characterization and control; ventilation and infiltration; building performance monitoring; exposure assessment; sampling and analysis methods; predictive models.
Systems and Analysis: DOE-2 whole-building energy analysis program and advanced simulation techniques; advanced HVAC systems; databases of measured building performance; environmental policy; appliance standards; Least Cost Utility Planning; international energy use.

Center for X-Ray Optics

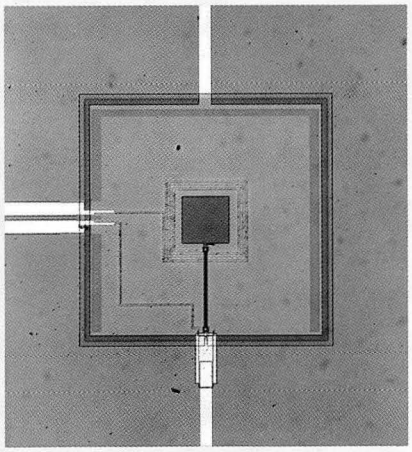
The Center develops means for generating, transporting, focusing, and detecting radiation with photon energies from approximately 10 eV to 10 keV. Continuing research programs include diffractive x-ray optics to develop x-ray lenses for scanning and imaging materials, reflective x-ray optics to develop high-reflectivity multilayer coatings for hard x-ray studies for materials and biological systems, monochromator and spectrometer development, high-brightness x-ray source development, and x-ray holography research. The Center conducts a wide range of research on the fundamental interactions of x-rays with matter and develops advanced beam lines at national synchrotron facilities, including the Advanced Light Source.



Center for X-Ray Optics. Designed at LBL, the High-Resolution Erect-Field Spectrometer/Monochromator analyzes electromagnetic radiation from the extreme ultraviolet and soft-x-ray regions.



Center for Building Science. Through use of DOE-2, an energy-analyzing computer program developed by LBL, Seattle's Museum of Flight was designed for energy efficiency. To reduce heat loss, the museum's glass walls use LBL-developed low-emissivity coating. (*Photo by Chris Eden*)



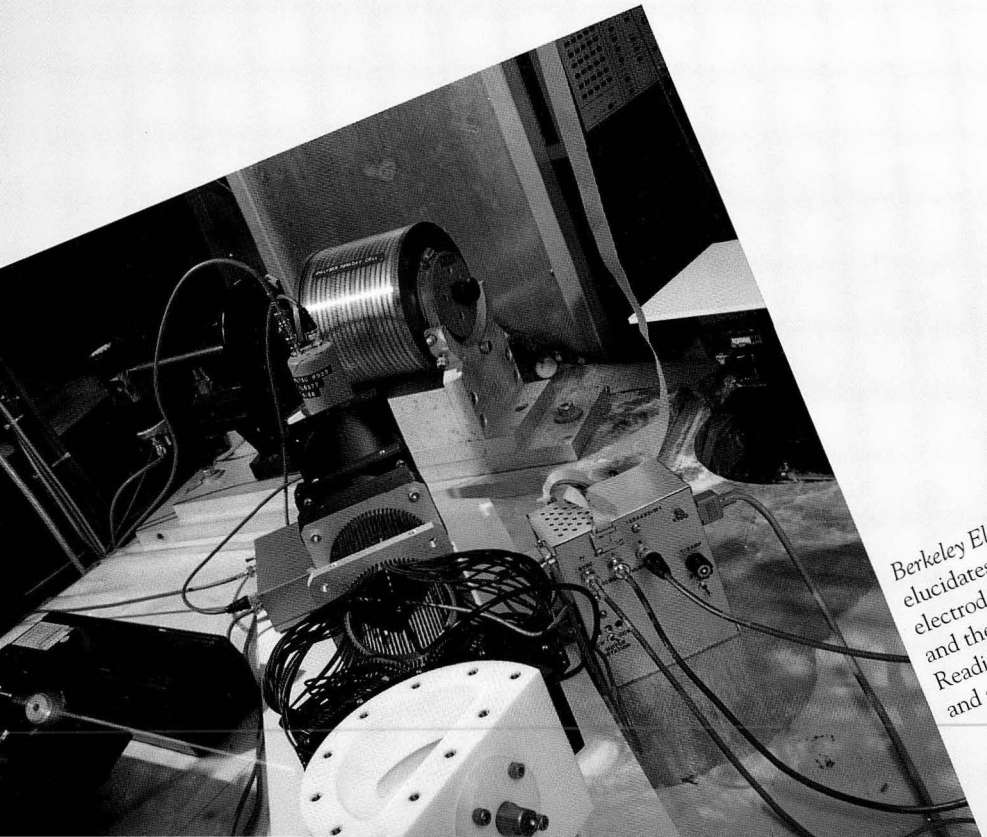
Superconductivity Research Center for Thin-Film Applications. A SQUID (Superconducting QUantum Interference Device), an ultrasensitive detector of magnetic fields.

Berkeley Electrochemical Research Center (BERC)

The Berkeley Electrochemical Research Center carries out collaborative interdisciplinary research in the areas of electrochemical energy conversion and electrochemical engineering. BERC is the Lead Center for the DOE's Technology Base Research Project for Electrochemical Energy Storage. The aim of this project is to advance the development of high-performance rechargeable batteries and fuel cells for applications such as electric vehicles and load leveling. Center efforts include exploratory R&D on new electrochemical systems; supporting research for advanced rechargeable batteries; and electrochemical research to improve electrochemical energy-conversion efficiency and fuel-cell technology.

Superconductivity Research Center for Thin-Film Applications

As a part of LBL's Center for Advanced Materials, the Superconductivity Research Center for Thin-Film Applications serves as a focal point for research and information on thin-film applications of high-temperature superconductors. The Center assists in coordinating research conducted in several LBL units, including CAM, the Applied Science Division, the Accelerator and Fusion Research Division, and the National Center for Electron Microscopy. Film-synthesis techniques include laser ablation, magnetron sputtering, and sol-gel chemical deposition. The goals of the thin-film program are to produce electronic sensors, including SQUIDs and bolometers, and to produce high-current conductors for electric power systems.



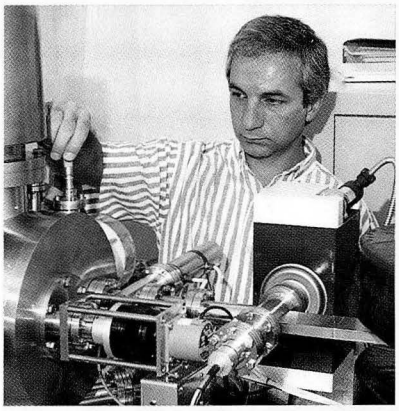
Berkeley Electrochemical Research Center. This novel cell elucidates the electrochemical reactions occurring at an electrode's surface. A laser beam is directed at the electrode, and the scattered light is then collected by optical fibers. Reading the fibers sequentially allows electrode particle sizes and spacings to be determined.

California Institute for Energy Efficiency (CIEE)

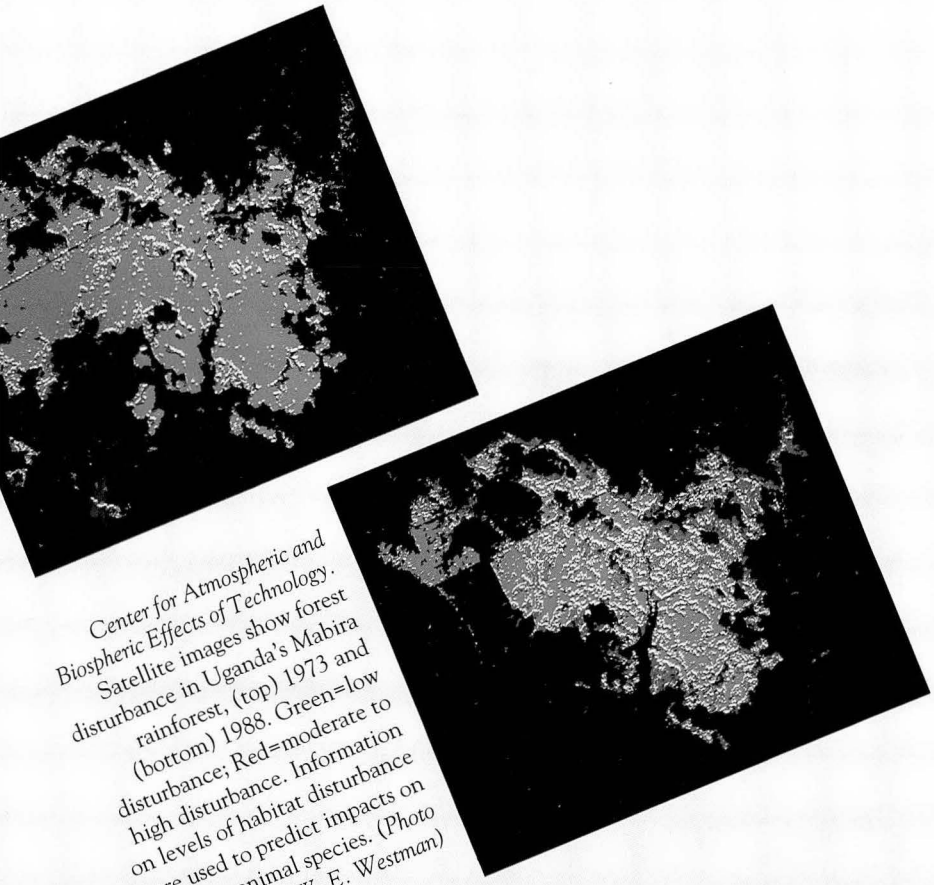
CIEE is a collaborative scientific effort among the state's utilities, research institutions, and government energy-related bodies. Research will be conducted in LBL's Applied Science Division and universities within California on techniques and technology to improve the efficiency of energy use in the state. Through research to eliminate energy waste, the Center will focus on alleviating such problems as urban smog, rising cost and demand for electricity, and global warming.

Center for Isotope Geochemistry

The Center for Isotope Geochemistry was established in the Earth Sciences Division. Assisting investigators around the world, Center scientists from LBL and UC Berkeley analyze geological materials and develop basic technologies and applications for precision measurement of geological isotopes. Isotope ratios can determine the age of sediments in petroleum-bearing rock formations, elucidate past climatic conditions, and provide fundamental insights into the dynamics of hydrological systems for geothermal and environmental applications.



Center for Isotope Geochemistry. LBL researcher Don DePaolo uses a mass spectrometer to obtain precise measurements of isotopic ratios—information that holds clues to the geologic history of Earth.



Center for Atmospheric and Biospheric Effects of Technology. Satellite images show forest disturbance in Uganda's Mabira rainforest, (top) 1973 and (bottom) 1988. Green=low disturbance; Red=moderate to high disturbance. Information on levels of habitat disturbance are used to predict impacts on resident animal species. (*Photo courtesy of Dr. W. E. Westman*)

Center for Atmospheric and Biospheric Effects of Technology (CABET)

Research within CABET focuses on the environmental effects of current and future innovations in technology. Emphasis is placed on studying the composition and behavior of direct emissions from particular technologies, as well as on developing the mechanisms for emission abatement. Also of interest to CABET are the health and ecological effects of these emissions as well as the global changes they may cause.

User Facilities Available To Industry

LBL offers a range of unique research facilities to qualified investigators from universities, industry, and government. User Facilities designated as "National User Facilities" have national Program Advisory Committees to review research proposals by qualified investigators. DOE allows proprietory work by industry under some circumstances. Many sponsored projects take advantage of User Facilities.

The Bevalac

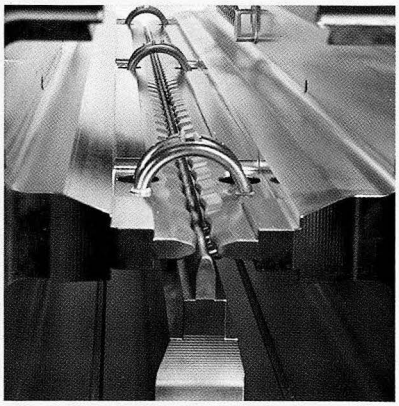
This facility consists of the Bevatron (a synchrotron) in tandem with a linear accelerator ion source: either the SuperHILAC or the Bevatron injector. The Bevalac provides ion beams from protons to uranium at energies up to 2.1 GeV per nucleon. This facility offers the widest range of ions at the highest heavy-ion energies in the world. Experiments are conducted in nuclear science and such applied fields as radiation damage in semiconductors, space effects (cosmic rays) on satellite instrumentation and astronauts, and a biomedical program that emphasizes both radiation treatment and basic research. Various technology spinoffs result from accelerator and experimental-systems development.

The 88-Inch Cyclotron

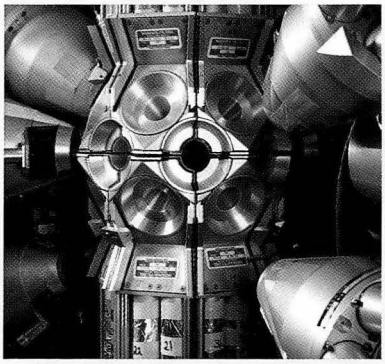
The accelerator provides light ions, polarized protons and deuterons, and intense and high-charge-state beams of heavy ions at energies as high as 55 MeV per nucleon. The cyclotron facility has experimental areas for conducting research in nuclear science, biomedicine, atomic physics, and radiation damage in semiconductors. A large complement of detectors located in the experimental areas includes a 21-element array of Compton-suppressed high-resolution germanium detectors for studies of nuclei at high spin, three large NaI gamma-ray spectrometers for a 60-element particle hodoscope of phoswich detectors, a high-resolution magnetic spectrometer, a time-of-flight spectrometer, and an on-line isotope separator for studying exotic nuclei.

The National Center For Electron Microscopy

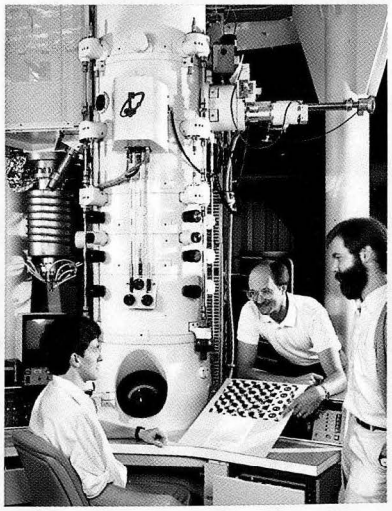
The Center operates two major transmission electron microscopes: The High Voltage Microscope ac-



The LBL-designed, self-aligning, radio-frequency quadrupole accelerator, shown with the top vane removed.



A view of the 21 Compton-shielded germanium x-ray detectors and the central bismuth germinate ball that make up the high-energy-resolution array.



The Atomic Resolution Microscope offers the highest resolution of any microscope in the world (1.6 Å).

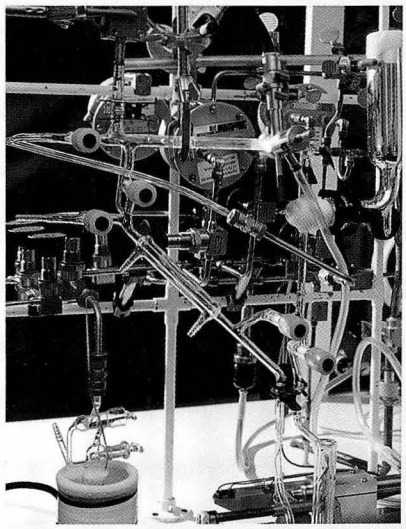
celerates electrons to energies of 1.5 MeV (the most powerful microscope of its kind in the U.S.); the Atomic Resolution Microscope operates in the 0.4 to 1.0 MeV range and offers the highest resolution in the world. The two microscopes allow materials scientists and biologists to study samples under the most realistic conditions possible and to distinguish individual atom columns even in closely packed metallic and ceramic structures. A third microscope, the Analytical Electron Microscope, operates at 0.2 MeV and provides state-of-the-art microanalytical capabilities.

The Advanced Light Source (ALS)

Scheduled for initial operation in 1993, the ALS will provide photon beams of unprecedented brightness and coherence and with 30-psec time structure. With it, materials scientists will tackle questions that can lead to new generations of semiconductor devices; chemists will be able to study chemical reactivity at a new level of precision, and biologists plan to watch processes unfold in living cells.

The National Tritium Labeling Facility (NTLF)

In this facility, compounds are labeled with tritium to serve as tracers in chemical and biomedical research. The tritium-labeled compounds are then used by researchers at their home laboratories. Labeling is accomplished by microwave discharge, catalytic tritio-hydrogenation, iodo displacements, and catalytic exchanges. A significant activity of the NTLF is the training of scientists in the safe handling and use of tritium.

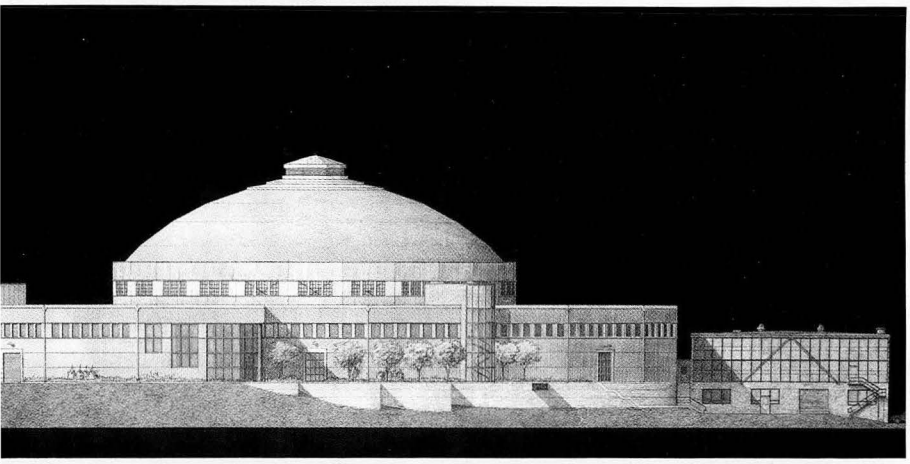


Tritium, shown glowing in the center of the photo in the excited state in a microwave excitation apparatus.

Other User Facilities

Other user facilities not designated as "National User Facilities" are made available to qualified scientists and engineers.

- Center for Computational Seismology
- Sky Simulator for Architectural Daylighting Design
- Mobile Window Thermal Test Facility
- Low-Background Counting Facility
- Heavy Charged Particle Biomedical Facility
- 2.5-MeV Van de Graaff Facility



Advanced Light Source

Key To LBL Buildings

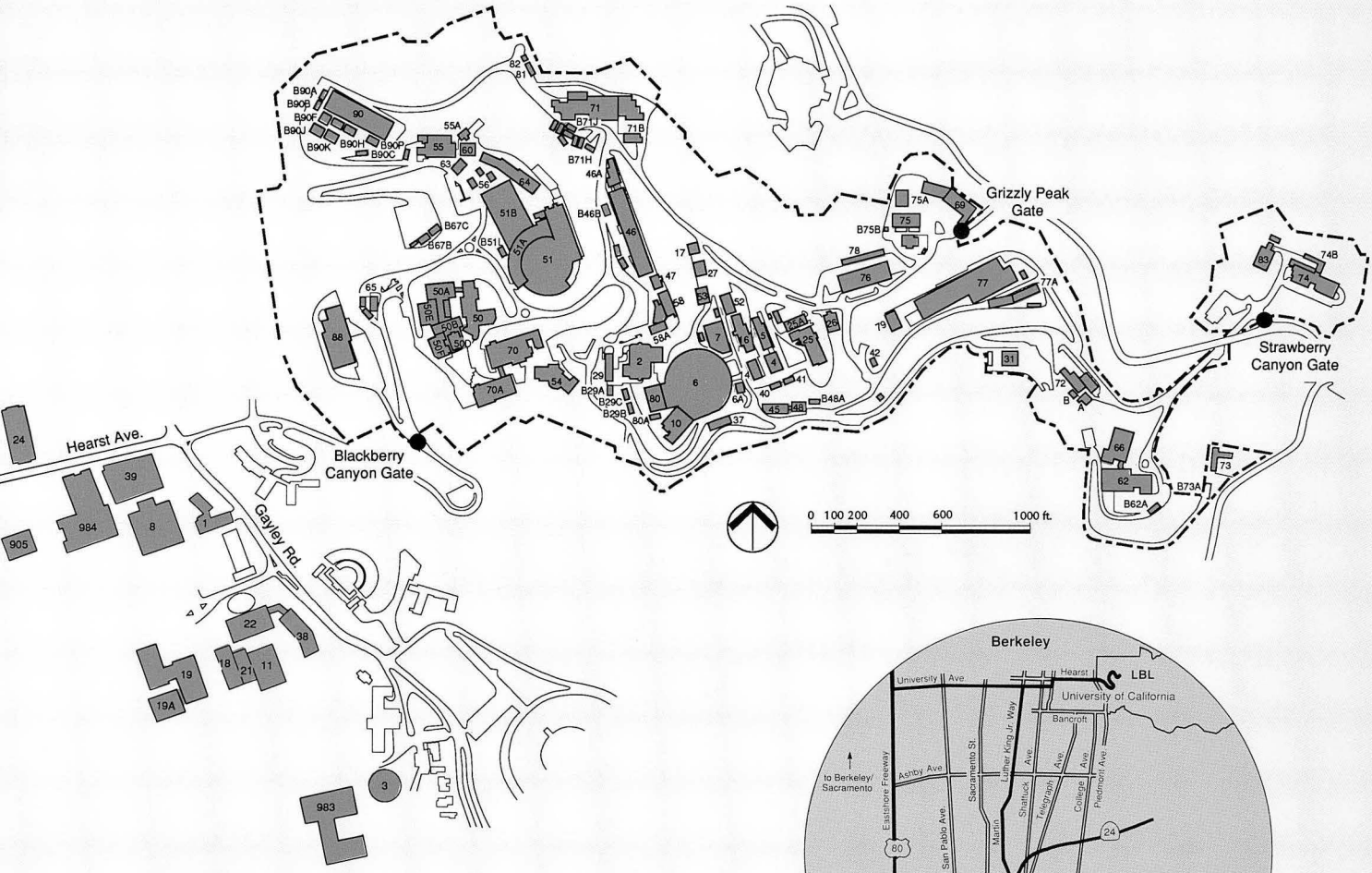
Bldg. No.	Occupants
2	Advanced Materials Laboratory, Center for X-ray Optics
4	Magnetic Fusion Energy
5	Magnetic Fusion Energy
6	Advanced Light Source
7	Stores, Electronics Shops
10	Cell & Molecular Biology, Photography
14	Accelerator & Fusion Research, Earth Sciences
16	Magnetic Fusion Energy Laboratory
17	Environmental Health & Safety, Applied Science Lab
25	Mechanical Technology
25A	Electronics Shop
26	Medical Services
27	High-Voltage Test Facility & Cable Shop
29	Electronics Engineering, Research Medicine, Radiation Biophysics Office
31	Chicken Creek Maintenance Building
40	Electronics Development Lab
41	Magnetic Measurements Lab
42	Salvage
44	Indoor Air Pollution Studies
45	Fire Apparatus
46	Advanced Light Source, Accelerator Development, Real Time Systems
46A	Real-Time Systems Section
47	Advanced Accelerator Study
48	Fire Station
50	Physics, Accelerator & Fusion Research, Nuclear Science
50A	Director's Office, Environment & Laboratory Development, Administration, Patents
50B	Physics, Computing Services, Information Resources
50C	Public Information, Physics
50D	Materials & Chemical Sciences, Nuclear Science
50E	Earth Sciences
50F	Technical Illustration, Computing Services
51	Bevalac/Bevatron
51A	Bevatron Experimental Area
51B	External Particle Beam
52	Magnetic Fusion Energy Laboratory
53	Super HILAC Development
54	Cafeteria
55	Research Medicine, Radiation Biophysics
55A	Nuclear Magnetic Resonance
56	Cryogenic Facility
58	Accelerator Research & Development
58A	Accelerator Research & Development
60	High Bay Laboratory
62	Materials & Chemical Sciences
63	Accelerator & Fusion Research
64	Accelerator & Fusion Research
65	Data Processing Service
66	Surface Science & Catalysis Laboratory
69	Materiel Management & Purchasing, Mailroom
70	Nuclear Science, Applied Science, Earth Sciences
70A	Nuclear Science, Materials & Chemical Sciences, Earth Sciences
71	Heavy Ion Linear Accelerator (HILAC)
71A	HILAC Rectifier
71B	HILAC Annex
72	National Center for Electron Microscopy
72A	High-Voltage Electron Microscope
72B	Atomic Resolution Microscope
72C	ARM Support Lab
73	Atmospheric Aerosol Research
74	Research Medicine, Radiation Biophysics, Cell & Molecular Biology Lab
75	Radioisotope Service, National Tritium Facility
76	Craft & Maintenance Shops
77	Mechanical Shops
77A	Ultra-High Vacuum Assembly
78	Craft Stores
79	Metal Stores
80	ALS Operations (future)
80A	Telephone Services
81	Liquid Gas Storage
83	Cell Biology Laboratory
88	88-Inch Cyclotron
90	Applied Science, Employment, Engineering, Personnel, Protective Services, Technology Transfer Office, Occupational Health, Center for Science & Engineering Education

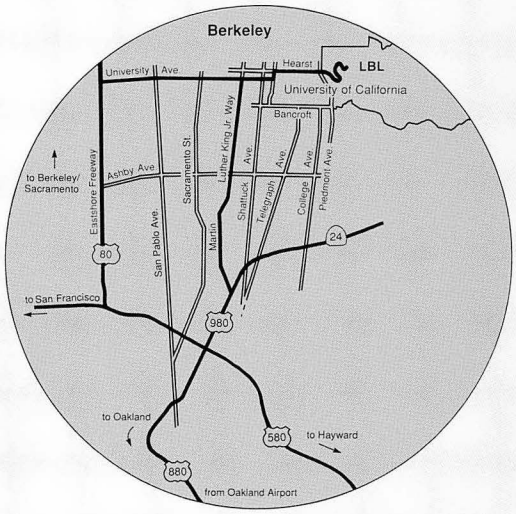
UC CAMPUS BUILDINGS
WHOLLY OR PARTIALLY OCCUPIED BY LBL

1	Donner Laboratory
3	Calvin Chemical Biodynamics Laboratory
8	Hearst Mining
18	Gilman Hall
19	LeConte Hall
19A	Birge Hall
21	Giauque Hall
22	Latimer Hall
24	Etcheverry Hall
38	Lewis Hall
39	Cory Hall
905	Hesse Hall
983	Wurster Hall
984	Davis Hall

Not shown:
Life Sciences Building
(near the western edge of the campus)

LBL Map





LBL to San Francisco airport
distance: 25 mi.
driving time: 1–2 hr.

LBL to Oakland airport
distance: 16.5 mi.
driving time: 1–1.5 hr.

LBL is adjacent to the UC Berkeley campus. There is shuttle bus service every 10 min. to the campus and to the downtown Berkeley BART station.

LBL to Interstate 80
distance: 3 mi.
driving time: 15 min.

Map indicates key streets only.

PERSONNEL DIRECTORY

The personnel listed here are direct contacts to Divisions, Centers, User Facilities, and Technology Transfer officials.

Technology Transfer Office
Pepi Ross
Director
Lawrence Berkeley Laboratory
Bldg. 90-1076
Berkeley, CA 94720
(415) 486-6467

Office of Sponsored Research Administration
Joe Acanfora
Department Head
Bldg. 936A
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-4126

RESEARCH DIVISIONS

Accelerator and Fusion Research
Jose Alonso
Assistant Division Director
Lawrence Berkeley Laboratory
Bldg. 50-149
Berkeley, CA 94720
(415) 486-5501

Chemical Sciences
Norman Phillips
Division Director
Bldg. 66
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-4896

Earth Sciences
Karl Olson
Deputy Division Director
Bldg. 50E
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-6129

Materials Sciences
Mark Alper
Associate Division Director
Bldg. 66
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-6581

Nuclear Science
Janis Dairiki

SCIENTIFIC AND TECHNICAL SUPPORT

Engineering
Lee Wagner
Assistant Division Director
Bldg. 90-1106
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-7466

Information and Computing Sciences
Sandy Merola
Deputy Division Director
Bldg. 50B-2239
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-7440

Occupational Health
Ralph Thomas
Division Director
Bldg. 90-1106
Lawrence Berkeley Laboratory
Berkeley, CA 94720
(415) 486-5514

LAWRENCE BERKELEY LABORATORY
Technology Transfer Office
Building 90 Room 1076
Berkeley, California 94720
(415) 486-6467

LAWRENCE BERKELEY LABORATORY

TECHNOLOGY TRANSFER APPROACHES AND OPPORTUNITIES

- SPONSORED RESEARCH

  Extramural project support

- COLLABORATIVE RESEARCH

  Joint project support

- LICENSING NEW TECHNOLOGY

- GIFTS

- NATIONAL USER FACILITIES

- VISITOR ARRANGEMENTS

  Industry and Laboratory Staff Exchanges

- EDUCATION AND TRAINING

  Industry-sponsored postdoctoral appointments

  LBL postdoctoral and graduate students

- CONFERENCES AND WORKSHOPS

Enhance the nation's competitive position—and yours—by working with Lawrence Berkeley Laboratory.