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TECHNOLOGY TRANSFER ACCOMPLISHMENTS, FY 1986

April 1987

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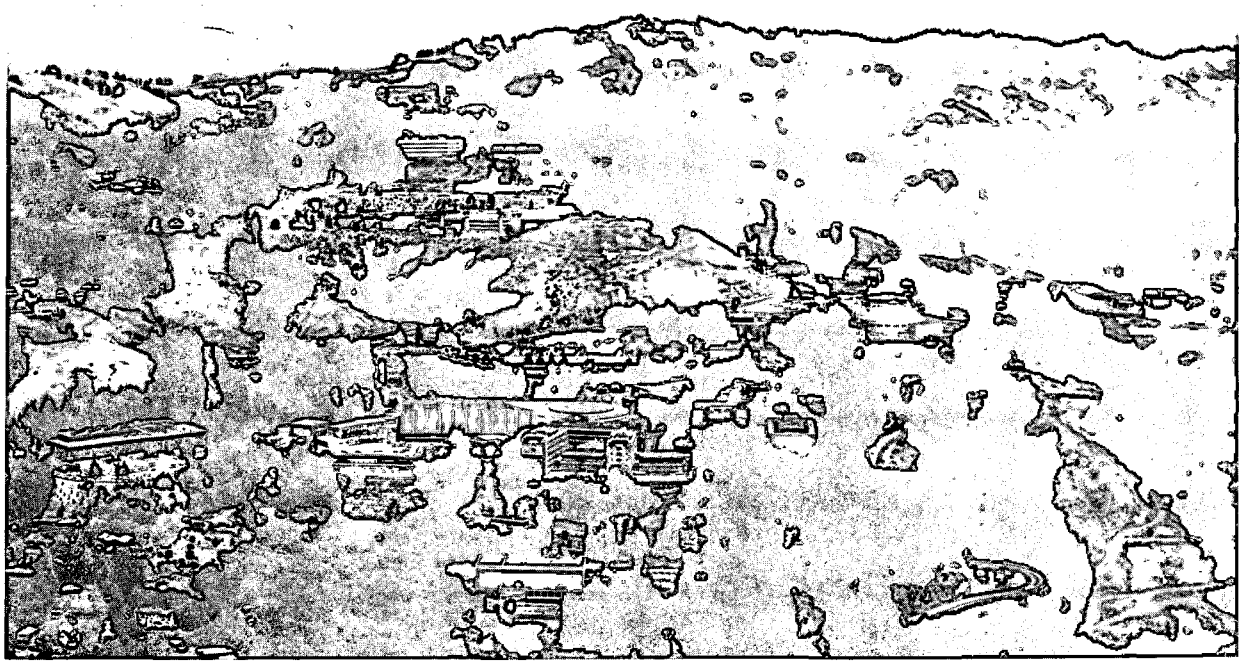

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FY 1986

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Lawrence Berkeley Laboratory
University of California
Berkeley, California

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TECHNOLOGY TRANSFER ACCOMPLISHMENTS

Lawrence Berkeley Laboratory

FY 1986

This is a list of technology transfer activities that either occurred or were first noted during FY 1986. A few items are updated descriptions of ongoing activities first noted in previous years. The name of the principal LBL researcher or contact person appears after each item.

MATERIALS SCIENCE

1. Surface Analytical Tool

We have developed a new surface analytical tool based on the highly surface-specific optical second harmonic generation process. The technique has many advantages over the conventional surface tool, and is applicable to essentially all interfaces accessible by light. The technique has been adapted or is being considered for several uses, including the study of surface melting and metal surfaces; measuring optical nonlinearities of molecules for the development of organic nonlinear optical materials; studying processing and reactions on semiconductor surfaces; developing the technique as a possible reader for a three-dimensional optical memory device; and in using the technique to study Langmuir-Blodgett films.

Some of the firms involved include AT&T Bell Laboratories, IBM Research Center, Exxon Research and Engineering Co., 3M Central Research Laboratories, and du Pont Experimental Station.

(Y.R. Shen)

2. Raman Spectroscopy

Instrumentation and computer code for Raman spectroscopy, based on a new imaging photomultiplier detector, are being developed for detecting extremely low numbers of molecular species. The results of this research are being used by engineers at surface science laboratories for new commercial instrumentation. Commercial products are available incorporating results from this effort.

(K. Veirs)

3. Materials Information System for Science and Technology (MIST)

The Materials Information System for Science and Technology (MIST) is a prototype computer system being developed at LBL that provides access to scientific information on material properties, including text, numeric data, tabular summaries, graphic representations, and bibliographic citations. It has been chosen by the National Material Property Data Network as a prototype vehicle for providing critically evaluated

material property data to U.S. research laboratories and industry. Its information management concepts promise to dramatically increase technical productivity in general by providing rapid and flexible access to a very broad range of codified scientific knowledge, identifying significant gaps in that knowledge, and expediting dissemination of new results. MIST project participants are working closely with national and international groups such as the American Society for Testing and Materials, and CODATA to identify and develop standard nomenclature and quality indicators for properties, independent variables, etc., as well as a materials data interchange format. Many of these groups are looking to MIST to provide some of the initial de facto standards regarding data elements, quality indicators, and interchange formats.

(C. Quong)

4. Ion Implantation in Semiconductors

Ions from the LBL SuperHILAC were used by the University of California Department of Electrical Engineering and by Boeing in ion-implantation experiments aimed at improving industrial semiconductor-doping techniques.

(J. Alonso)

5. Gallium Arsenide Schottky Barrier

Cooperative research is being conducted to determine the mechanism of Schottky barrier formation on gallium arsenide (GaAs) and to explain Fermi-level pinning independent of metal work function. Three metals are being investigated: gold, aluminum, and silver.

To decrease the number of variables (e.g., oxygen and carbon) that can pin Fermi level, samples are prepared in very clean conditions using in situ evaporation on UHV-cleaved GaAs (Stanford University) and in a molecular beam epitaxy chamber (IBM, Yorktown Heights). These samples, after being characterized electrically at Stanford University, are characterized structurally by high resolution and analytical electron microscopy at LBL.

A big step forward has already been achieved during our study. Arsenic accumulation near the metal/GaAs interface was observed in all three studied cases. This suggests an ion-rich defect responsible for Fermi level pinning. The Stanford group observed the change from rectifying to ohmic behavior upon annealing. This was proved by our study to be connected with the presence of elongated gold crystalites (gallium rich) on the periphery of the observed diodes. Work continues.

(J. Washburn/Z. Liliental-Weber)

6. Heavy Ion Rutherford Backscattering Spectrometry

The advantages of heavy ion Rutherford backscattering spectrometry (HIRBS) for material analysis over conventional RBS using hydrogen or helium atoms include improved mass resolution for the analysis of high atomic number samples and in certain applications, increased accessible

depth, and a smaller minimum detectable limit for impurity concentrations. This technique has recently been applied at the 88-Inch Cyclotron to examination of the characteristics of ohmic and Shottky barrier contacts on gallium arsenide (GaAs) and other semiconductor substrates and work is being done on applications involving other problems, such as optical coatings on glass. Hewlett-Packard, Siemans, and AT&T Bell Laboratories provided samples for analysis.

(J. Jaklevic)

7. Atomic Vapor Laser Isotope Separation

The atomic vapor laser isotope separation (AVLIS) process under development at Lawrence Livermore National Laboratory is significantly affected by oxidation of the liquid uranium process fluid by water and oxygen in the background gas. Formation of an oxide skin on the metal changes the emissivity of the metal, its sputtering yield, work function, and other parameters critical to satisfactory operation of the separation module. The probability of reaction of H_2O and O_2 with liquid uranium was measured in the modulated molecular beam machine at LBL. The very high reaction probability measured in the experiments (about 50% of the incident molecules react) means that care must be taken in design of the AVLIS process cells to minimize oxidizing gases in the background vacuum.

(D. Olander)

8. Flicker Noise as a Tool for Studying Defects in Metals

A new technique has been developed for studying defects in metals, in which the electrical flicker (1/f) noise is measured. By irradiating metal films with 500-keV electrons in one of the electron microscopes in LBL's National Center for Electron Microscopy, we have been able to show that the level of noise is a strong function of the defect density. The noise level drops after the films have been annealed, in a manner quite different from the change in resistivity. This method is now being developed collaboratively with workers at Argonne National Laboratory as a tool for studying the behavior of defects in metals.

(J. Clarke)

9. Monte Carlo Numerical Optimization Program

A Monte Carlo numerical optimization program based on thermodynamic concepts developed for the case of continuous multidimensional parameter spaces is being used by researchers at the Exxon Research and Engineering Company.

(S.G. Louie)

10. Nuclear Magnetic Resonance Spectroscopy and Imaging

Nuclear magnetic resonance techniques make use of the magnetism of spinning nuclei in a material to provide information that is useful in both medical studies and in materials science. In medical studies, NMR

imaging can picture processes as complex as the flow of blood through the heart. In materials science, NMR spectroscopy gives information about the composition, structure, and dynamics at the molecular scale. New techniques, including zero-field NMR, have been developed at LBL that extend the usefulness of the instrument. As a result, NMR technology is moving to divergent areas of academic and industrial research, such as geochemistry of molten and glassy silicates, studies of clustering in defects in amorphous silicon, structure and dynamics of organometallic hydrides, studies on the microscopic scale of fundamental questions in thermodynamics (as when order disappears from a system), and studies of nonlinear spin dynamics and chaotic maps for selective excitation of spectroscopic systems. In industrial research, NMR technology is being used by Exxon for characterization of catalysts and aluminosilicates, by Mobil Oil in studies of structures in heterogeneous and amorphous materials, and by Monsanto Company for investigation of collective molecular motion and diffusion in polymers.

(A. Pines)

11. Advanced Structural Materials

The Advanced Structural Materials Program in CAM* identified unexpected low temperature properties in Alcoa Alloy 2090, which has become a candidate material for the fuel tank for the NASA National Aerospace Plane and is therefore of great interest to companies such as Boeing and Lockheed.

(J.W. Morris)

12. Adherence of Metal Films to Substrates

The CAM Ceramics/Metal Interfaces Program provided guidance to two different IBM laboratories (one in Yorktown Heights, New York and one in San Jose, California) on methods of measuring the adherence of metal films to substrates.

(R. Fisher)

13. Iron in Gallium Arsenide

The CAM Electronic Materials Program performed measurements of the iron concentration in gallium arsenide crystals from Rockwell International using the electron paramagnetic resonance technique. The information was used to assess the effects of iron contamination on electrical properties of semi-insulating gallium arsenide.

(E. Haller)

14. Crystal Growth

Experience and information concerning optimization of the electrodynamic moving gradient crystal growth technique collected in the CAM

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*Center for Advanced Materials

Electronic Materials Program is transferred on a continuous basis to M/A COM and Cryscon, which use the same technique.

(E. Haller)

15. Liquid Crystals

The CAM Polymers Program staff collaborated with scientists at Raychem on research in the area of nuclear magnetic resonance in liquid crystal polymers.

(J. Reimer)

16. Formability of Sheet Steel

The CAM Advanced Structural Materials Program has collaborated with General Motors Technical Center and the Los Alamos National Laboratory on the metallurgical considerations that govern the formability of sheet steel. The project supports General Motors' activities in advanced manufacturing.

(J.W. Morris)

17. Solder Fatigue

In collaboration with IBM and Western Digital Inc., the CAM Advanced Structural Materials Program has conducted research on the sources of fatigue in lead-tin solder contacts and on metallurgical techniques to improve resistance to solder fatigue.

(J.W. Morris)

18. Instrumentation

Work on second harmonic generation in the CAM Instrumentation Progam is performed in collaboration with the Corporate Research Science Laboratories of Exxon Research and Engineering Company in Annandale, New Jersey.

(J. Clarke)

19. Polymers

A joint research publication on drawn filaments resulted from collaboration between staff scientists of the CAM Polymers Program and scientists from Dow Chemical.

(B.D. Freeman)

20. Reliability of Wire Bonds

The CAM Ceramics/Metal Interfaces Program worked in collaboration with scientists from Intel in Chandler, Arizona to define the origins of problems with the reliability of wire bonds.

(R. Fisher)

21. Mechanical Properties of Gallium Arsenide

Measurements of mechanical properties of gallium arsenide doped with isoelectronic (In) and electrically active (Si) impurities are conducted in collaboration with Hewlett Packard's Optoelectronic Division. The purpose of these investigations is to understand the physical mechanism of dislocation formation and to optimize the doping strategy for the growth of dislocation-free gallium arsenide.

(E. Haller)

22. Defect Distribution in Large Crystals

In collaboration with M/A COM Advanced Semiconductor Operations, measurements of carbon and native defect distribution in large diameter crystals are carried out using Fourier transform infrared spectroscopy. These measurements are essential for evaluation of homogeneity of the crystals.

(E. Haller)

23. Zeolite Synthesis

The CAM Catalysis Program is studying the silicate and aluminosilicate species involved in zeolite synthesis under a contract with W.R. Grace and Co.

(A. Bell)

24. Low Density Aluminum Alloys

The CAM Advanced Structural Materials Program is studying low density aluminum alloys for cryogenic applications under a contract with Lockheed.

(J.W. Morris)

25. Extended Visits of Industrial Scientists to CAM

a. Dr. Ted Oyama from Catalytica Associates has joined the CAM Catalysis Program as an industrial fellow. His salary will continue to be paid by Catalytica Associates for the two year appointment, during which he will be working on partial oxidation of organic molecules on vanadium and vanadium oxide catalyst surfaces.

(G. Somorjai)

b. The CAM Electronic Materials Program was joined by an industrial fellow from Bell Communications Research working with CAM scientists for two years on electron microscopy of gallium arsenide metal interfaces and reactions.

(E. Haller)

c. Two scientists from Exxon spent several months in 1986 working with CAM Catalysis Program staff scientists on a project involving low temperature organo-metallic catalysis.

(P. Vollhardt)

26. CAM Scientists on Extended Visits to Industry

a. CAM researcher David Soong spent a portion of his sabbatical leave at the IBM Research Laboratories in San Jose. He worked with IBM scientists on polymer applications in microelectronics packaging.

(D. Soong)

27. Advisory Boards for CAM

a. Each of the CAM programs has an advisory board composed primarily of scientists from the private sector. Each board meets annually to discuss the work accomplished by the program and to suggest areas of research which will benefit industry. The companies represented include AT&T Bell Laboratories, Atlantic Richfield, Alcoa, Boeing, Celanese, Dow Chemical U.S.A., DuPont, Exxon Research and Engineering, Intel, Kaiser Aluminum and Chemical Corp, Lockheed, Northrop, Union Carbide, U.S. Steel, Westinghouse, and Xerox.

(H. Heinemann)

28. Short Term Visits to CAM by Industrial Scientists

a. Scientists from the private sector have visited CAM programs to learn about its programs or to collaborate with staff scientists for up to a week. The organizations represented include Alcan International, Ashland Chemical Company, Air Products and Chemicals, Inc., Chevron Research Company, Ethyl Corporation, Hewlett Packard, Mobil Research and Development Corporation, Morgan Semiconductor, P.Q. Corporation, Siemens Optoelectronics, Shell Development Company Stauffer Chemical, and Union Oil.

(H. Heinemann)

b. Gerd Binnig of IBM spent several days working with CAM Instrumentation Program scientists on the scanning tunneling microscope.

(J. Clarke)

c. The CAM Catalysis Program holds a weekly Catalysis and Surface Science Seminar. About half of the speakers are from industry and the other half represent academic institutions. The seminars, attended by LBL staff, university students, and industrial scientists, provide an opportunity for the participants

to keep abreast of new developments at CAM and in industry.

(H. Heinemann)

29. Visits to Industry by CAM Scientists

a. Polymers Program leader Morton Denn made numerous visits to industrial sites to discuss current research. Among the companies visited were Owens Corning Fiberglass, Alcoa, and Tennessee Eastman.

(M. Denn)

b. Staff members from the CAM Electronic Materials Program visited numerous industrial research laboratories in the U.S. (Hewlett Packard, M/A COM, Chevron Research Company), Japan (NTT Laboratories, Fujitsu Laboratories, and Optoelectronics Joint Research Laboratories) and Europe (Siemens Research Laboratories).

(E. Haller)

30. Industry Support of CAM

Industry Support for Student

a. IBM provides a graduate student fellowship for the scanning tunneling microscope program in the CAM Instrumentation Program.

(J. Clarke)

b. Western Digital Corporation and AT&T each support the work of a graduate researcher in the Advanced Structural Materials Program.

(W. Morris)

Gifts and Loans to CAM programs

c. The CAM Advanced Structural Materials Program conducts research on advanced aluminum lithium alloys. Alcoa, which manufactures the alloys, has contributed $50,000 to this effort.

(J.W. Morris)

d. The Polymers Program received a $25,000 gift from DuPont for research on liquid crystal polymers.

(M. Denn)

e. A $5,000 gift from Chevron continues to support the weekly Catalysis and Surface Science Seminar during the fall and winter terms.

(H. Heinemann)

f. The CAM Catalysis Program received a gift of equipment components from Perkin Elmer valued at over $300,000. These components greatly enhance the capabilities of the ESCA and SIMS analytical systems. These state-of-the-art instruments will be housed in the new Surface Science Catalysis Laboratory building.

(G. Somorjai)

g. Chevron Research Company donated a Fourier transform infrared spectrophotometer to the CAM Catalysis Program. This instrument is valued at approximately $50,000 and is used to study the vibrational properties of absorbed molecules on the surfaces of catalysts.

(G. Somorjai)

h. Rheometrics, Incorporated provided the CAM Polymers with components of a constant stress rheometer. This instrument will be used in research on liquid crystal polymers.

(M. Denn/D. Soong/M. Williams)

i. The CAM Electronic Materials Program uses x-ray equipment and a microindenter on loan from Hewlett Packard Central Research Laboratory.

j. Noncommercial polymers are supplied to the CAM Polymers Program by Celanese, Eastman Chemicals, Raychem, and DuPont for research on the relationship between the structure and properties of polymers and the methods used in processing them.

(M. Denn)

k. Several companies provide gallium arsenide crystals to the CAM Electronic Materials Program for analysis using the advanced characterization techniques. The participating companies include Hewlett Packard, Optical Electronics Division, and M/A COM (Lowell, Massachusetts). Some of the gallium arsenide grown in the Electronic Materials Program was synthesized in the Hewlett Packard Optoelectronics Division Laboratory.

(E. Haller)

j. Both Alcoa and Boeing have contributed samples of alloys to the CAM Advanced Structural Materials Program's research on advanced aluminum lithium alloys.

(W. Morris)

k. Celanese currently does materials characterization measurements on liquid crystal polymers for the CAM Polymers Program.

(M. Denn)

NUCLEAR INSTRUMENTATION AND CHARACTERIZATION

1. Large Area Position Sensitive Charged Particle Detectors

This work is a joint effort by LBL and Xerox Research Center, Palo Alto to develop large area position sensitive detectors for high energy physics, nuclear science and medical imaging. Work so far has consisted of measuring the signals produced in 2, 5, 10, and 15 micron layers of hydrogenated amorphous silicon (a-Si:H) using alpha particles and low energy protons on a-Si:H samples prepared at Xerox Park. Present measurements indicate that stacking layers 5 microns thick to produce a total thickness of 60–100 microns can be used to detect minimum ionizing singly charged particles. Research continues at Xerox to produce a-Si:H with lower densities of dangling bonds and enable the use of thicker layers (15–20 microns) as the basic elements of a stacked detector.

(V. Perez-Mendez)

2. Neutral-Beam Source/U.S. Common Long Pulse

A neutral-beam source, the U.S. Common Long Pulse Source, has been developed at LBL for use in the major U.S. fusion program facilities. (This source won an I-R 100 award in 1985, and a plasma probe developed for use with it won an additional I-R 100 award in 1986.) Neutralized positive-ion beams from sources now being manufactured by RCA will serve as the primary source of energy for heating the plasma in fusion experiments planned at the Princeton Plasma Physics Laboratory and GA Technologies. During the past year, LBL continued to consult with RCA and tested the first production units.

(J. Paterson/W. Cooper III)

3. Metal-Vapor Vacuum Arc Ion Source/MEVVA

Development and technology transfer of the metal-vapor vacuum arc (MEVVA) ion source--a concept invented here--continued in 1986. Because of the high ion intensities available from this source, it has possible applications in several areas, including particle accelerator development, ion implantation, heavy-ion fusion, secondary-ion mass spectrometry, surface analysis, and atomic physics. MEVVA sources are now in use at Lawrence Livermore National Laboratory, Sandia National Laboratory-Livermore, Cornell University, Texas A&M University, Los Alamos National Laboratory, Gesellschaft fur Schwerionenforschung (Germany), and Sydney University (Australia).

(I. Brown)

4. Superconducting Cable with High Critical Current

Transfer of superconductor and superconducting cable technology continued in 1986. We continued to collaborate with researchers at the University of Wisconsin and at Teledyne Wah Chang-Albany in developing high-homogeneity niobium-titanium alloys. In addition, we have worked with Intermagnetics General Corporation, Supercon, Inc., and Oxford

Superconducting Technology in producing wire, especially fine-filament wire, from the niobium-titanium alloy manufactured by Teledyne. During the past year, record current-carrying capacities were achieved in industrially produced wire. Also, superconducting cable-winding technology developed here is being transferred to New England Electric Wire and to manufacturers of cable-winding machines (Mossberg Industries and Cable du Dour, Belgium). Construction of the Superconducting Super Collider will mean $250 million in business for suppliers of superconducting material and cable.

(R. Scanlon)

5. Hardened Microelectronic Circuitry for Space Systems

New and evolving electronic instrumentation is continually being tested in heavy-ion beams at the 88-Inch Cyclotron in an effort to "harden" microelectronic devices and circuitry against adverse effects caused by cosmic-ray bombardment in outer space with the goal of creating autonomous space craft, systems that will function unerringly for long periods of time without human intervention. Instrumentation and techniques that push the limits of current technology are being developed to make such difficult measurements as the charge collection rate in picoseconds of micron-sized surfaces in order to examine the response under simulated space conditions of very high speed integrated circuits (VHSIC), of microprocessors, and of other intricate components in use and under development in both government and industry. Aerospace Corporation and Jet Propulsion Laboratory are making these tests with the support and collaboration of the Air Force Space Division, the Air Force Space Technology Center, the Naval Research Laboratory, Sandia National Laboratory and NASA:Goddard, and with the participation of numerous industrial laboratories.

(R. Stokstad)

6. Nuclear Structure and Decay Data

The Isotopes Project of the Nuclear Sciences Division provides evaluated nuclear structure and decay data for the worldwide nuclear physics community in coordination with other data centers via an international network. These reference data provide energies and intensities of radiation from radioactive isotopes, data that are essential for the medical use of these isotopes and are invaluable sources of information for scientists probing new areas of research. In addition to its mass-chain evaluation, the group produced the Table of Radioactive Isotopes, a comprehensive volume of decay data intended primarily for applied users of nuclear data, which was published in 1986. The same data are also available via an on-line computer database.

(E. Browne/R. Firestone)

7. High-Resolution Gamma-Ray Detector

The Nuclear Sciences Division high resolution array for gamma-ray studies of nuclei at high spin has introduced the use of bismuth-germanate (BGO) anti-Compton shields for high-resolution germanium gamma-ray detectors. The enhanced shielding capability of this material allows a larger number of smaller shields to be placed close to the

target, enlarging the solid angle seen by the detectors and increasing the statistics for higher coincidences. Multi-coincidence measurements are needed to increase the effective resolution of discrete transition, as well as to study energy correlations in the continuum. The detector has already given results in which quadruple coincidences can be obtained with as good statistics and higher resolution in the time that double coincidences were obtained formerly; completion of the central BGO ball will allow even better resolution. Use of the technology has already begun at other research institutions.

(F. Stephens/R. Diamond)

8. Quadrupole Charged Particle Accelerator

A contract was negotiated and signed with General Atomic for development of a radio-frequency quadrupole accelerator. Preliminary work was carried out as part of a collaborative engineering study.

(J. Alonso)

9. Accelerators/Design Software for Storage Rings

An accelerator physics design code, ZAP, was developed to aid in the design and optimization of storage rings. In the past year, the code has been used in the study of several commercial designs for compact synchrotron radiation sources, which are expected to play a key role in the industrial development of high-density microchips for computers. Analyses have been performed for Scanditronix (Sweden), Oxford Instruments (Great Britain), and COSY MicroTec (Germany), all of whom are proposing compact synchrotrons for use by U.S. industry. If these sources prove to be sufficiently reliable and inexpensive, they are expected to give rise to a chip production capability worth $100 billion by the 1990s. ZAP will also be used to study designs for third-generation synchrotron light sources in Italy, Germany, and the U.S.

(M. Zisman/S. Chattopadhyay)

10. Software for Neutral Beam Engineering Test Facility

Control and diagnostic software originally developed for the Department of Energy's Neutral Beam Engineering Test Facility was transferred successfully to the Joint European Torus (JET) project, despite the rather different architectures and computers involved. The program included controlling the neutral beam timing system and recreating a graphical and quantitative picture of the beam from input temperature data. JET funded this transfer.

(V. Jacobson/E. Theil)

11. The Center for X-Ray Optics

As part of a continuing collaboration with the IBM Thomas J. Watson Research Center, The Center for X-Ray Optics shared in the development of a high-resolution x-ray lens (known as a Fresnel zone plate) capable of resolving feature sizes as small as 700 angstroms. These lenses are

being tested at the National Synchrotron Light Source by researchers from the State University of New York at Stony Brook and will be used in the coming year in holographic experiments there. The optics center also continued its Affiliate Membership Program, extended to industrial researchers who share its interests and participate in its development efforts. Current members include employees of IBM, AT&T Bell Laboratories, and Zygo Corporation.

(Y. Vladimirsky/D.T. Attwood)

12. Pulse Delay Unit

To eliminate the need for attaching external delay cables to pulse circuit hardware, a unit was designed for use with standard NIM (Nuclear Instrumentation Module) electronics that provides a choice of time delays in a single-width quad-configured module. Called the Quad Nanosecond Delay, delays between input and output connectors can be added in 4-nanosecond increments by front panel switches up to a maximum of 60 nanoseconds with an accuracy of about 1%. The design details and artwork have been transferred to Tennelec.

(R.J. McDonald)

COMPUTERS

1. Socio-Economic Environmental Demographic Information System

LBL's Socio-Economic Environmental Demographic Information System (SEEDIS) consists of a major collection of databases for various geographic levels and time periods and a set of interactive information management and analysis tools for fields such as environmental epidemiology, energy and resource planning, and environment impact studies.

a. SEEDIS is the basis for a collaborative effort between the California Department of Health Services and LBL to undertake a multipronged analysis of birth defects and spontaneous abortions in Santa Clara County with respect to environmental pollution. Of particular importance will be the use of the recently developed density equalizing transformation algorithm in identifying clustering.

b. Another use of this unique information resource is being made by Dr. Sally Glaser, a postdoctoral fellow in epidemiology at Stanford University. Her research is concerned with possible geographic clustering of Hodgkin's disease.

c. LBL has developed methods to provide short term forcasts of various socio-ecomomic and demographic variables for arbitrary combinations of census geography. These methods, together with the SEEDIS database, form the labor market projections model that has been used by over 20 states for human resource planning at the state and substate level.

(C. Quong)

2. Computer Aided Design

A graphics translator has been written that provides full transfer of schematics created under Case Technology schematics capture software into Hewlett-Packard Engineering Graphics Software database. Case Technology is promoting this translator to their users that have a mixed base of IBM and HP workstations.

(G. Obegi/A. Wichard/J. Millaud)

3. Software/Project Cost Estimates

Source code and documentation for project cost estimates on the Artemis System were developed at LBL. This system was originally used to support the Superconducting Super Collider Reference Design Study and is being used at Parsons Brinkerhof, New York.

(J. Zelver)

4. Software/Data Transfers

This project involved source code and documentation to effect data transfers between the Aretemis System and Time Line software on a PC. The code is being used by McDonnell Douglas at locations in California and Florida.

(J. Zelver)

5. Software/Data Communications

A project originally devoted to unifying LBL's data communication paths resulted in Dbridge, a software network package that allows the Arpanet protocol TCP/IP to run over Decnet. Dbridge is now used at Caltech, CERN, and many other universities and laboratories. It is in the public domain and is formally supported by at least one commercial software house (Wollongong).

(V. Jacobson/E. Theil)

EDUCATION

1. Outreach Programs

As an integral part of our consortium agreements with Jackson State University in Mississippi and the Ana G. Mendez Educational Foundation in Puerto Rico, faculty from those institutions work with researchers at LBL with the goal of establishing joint, collaborative research projects. JSU and AGMEF faculty have worked on the projects listed below:

a. Optical guiding in a free electron laser and how this phenomenon effects the group velocity of an electromagnetic pulse.

(R. Johnson, JSU/A. Sessler, LBL)

b. Aerosol sampling to determine particulate composition of San Juan Metropolitan Area air. Measurements were conducted at LBL for 1) determination of black carbon by optical attenuation, 2) determination of total carbon by CO_2 coulometry, 3) elemental concentration by x-ray fluorescence, and 4) anion and cation concentrations by ion chromatography.

(F. Diaz and W. Medina, AGMEF/T. Novakov, LBL)

c. Radiation damage to DNA; including developing techniques for SV-40 viral DNA isolation.

(M. Irizarry, AGMEF/A. Chatterjee, LBL)

d. Effect of oxygen on enhancement of strand break in the gamma-ray radiated DNA of SV-40 Virus (including preparation of manuscript "Two dimensional electrophoresis for analysis of SV-40 viral DNA with polyacrylamide gel blocks in agarose gel."

(W-H Yang, JSU/A. Chatterjee, LBL)

e. Behavior of multidimensional file structure (grid file) under parallel disk allocation.

(P. Bhalla, JSU/E. Close, LBL)

f. Construction of electrochemical cell for in situ Raman spectroscopic studies of lithium electrodes to be conducted at JSU.

(H. Tachikawa, JSU/F. McLarnon, LBL)

g. Design alternatives for residential water heaters.

(W. Brewer, JSU/I. Turiel, LBL)

2. Science Education in Secondary Schools

A six-week summer program for San Francisco Bay Area teachers has been provided by LBL to help improve science education in secondary schools. The teachers spend about 80% of their time in an assigned research laboratory at LBL; the remainder is used to explore Laboratory resources, attend lectures and seminars, and develop science curricula.

(R. Otto)

3. Training in Energy Analysis for Asian Participants

A five-week program on building energy analysis tools for 16 middle-level researchers, government officials, and private sector participants from five Asian countries was conducted at LBL in July/August 1986. This training activity is part of a multi-year technology transfer project dealing with research, assessment, and policy analysis

on building energy conservation for Indonesia, the Philippines, Malaysia, Singapore, and Thailand.

(M. Levine)

EARTH AND ENVIRONMENTAL SCIENCE

1. Groundwater Contamination

Developed modeling codes and engineering techniques for evaluating contamination and clean-up of underground aquifers. Participated in University of California systemwide Toxic Substances Research and Teaching Program in the area of petroleum contamination of groundwater. Participated in workshop instruction in ERA's state-by-state program to transfer technical developments to state regulatory staff and industrial/consulting firms.

(I. Javandel)

2. Trace Elements Contamination

Studies are underway to characterize the chemical contamination in the Kesterson Reservoir ecosystem located in the Central Valley of California. The reservoir is a wildlife refuge in which deleterious effects from selenium and other trace elements from agricultural runoff water have been noted. Selenium transport and food-chain mechanisms are being determined using geochemical and biochemical analyses, field testing, hydrogeochemical experiments, and chemical-hydrologic modeling so that planned remedial measures may be evaluated. This work is progressing in collaboration with the U.S. Bureau of Reclamation, California Department of Water Resources, California Water Resources Control Board, and the U.S. Geological Survey.

(H. Wollenberg)

3. Continental Scientific Drilling

A continuously cored hole was drilled to 715 m near the town of Mammoth Lakes in the Long Valley, California caldera. The hole intersected high temperatures over 200°C at a depth of only 325 m, suggesting the presence of a viable geothermal resource and identifying the sector of the principal heat source of the caldera's hydrothermal system. Those activities are cooperatively supported by DOE's Office of Basic Energy Sciences; the California Energy Commission; Mono County, California; and the U.S. Geological Survey.

(H. Wollenberg)

4. Ambient Air Particulate Analysis

We are developing a nondestructive technique to analyze Teflon air filters for ambient air particulate species using infrared absorption and Fourier transform infrared spectroscopy (FTIR). The FTIR instrument has been modified for automated analysis of up to 20 filters to

facilitate analysis during large sampling programs. We are collaborating with EMSI Corporation in the analysis of filters collected during a California Air Resources program titled Carbonaceous Species Methods Comparison Study. We are among 30 laboratories participating in this study.

(M. Pollard)

LIFE SCIENCES

1. Scanning Electron Microscopy

We are developing a low-temperature scanning electron microscope in conjunction with an engineer from the Mechanical Engineering Department of the University of California, Berkeley and a private company that is developing a cryosurgical probe that we are utilizing in our experiments. The prototype probe has produced useful results. We have made design modification suggestions which are being incorporated in a second generation probe for our use.

(J. Bastacky/T.L. Hayes)

2. Lipoproteins/Ultracentrifuge

As a part of a Lipoprotein Program project we have studied, with the Gladstone Foundation, San Francisco, the hydrodynamic properties of apolipoprotein E3 by classical analytic ultracentrifuge sedimentation velocity, sedimentation equilibrium, and diffusion.

Intact apo E3 is a 279 amino-acid chain, molecular weight 35 kilodaltons, which in aqueous solution is a tetrameric polymer. Thrombin proteolytic carboxy terminal fragments of 10 and 12 kilodaltons of apo E3 have been studied and also exhibit tetrameric aggregation. Studies of the 22 kilodalton N terminal fragment indicate monomeric hydrodynamic behavior. Thus, the carboxy terminal fragments of this apolipoprotein may be capable for the first time of classical crystallization and purification, similar to many biologically well-characterized proteins.

(F. Lindgren)

3. Extracellular Matrix Components

The discovery that extracellular matrix components profoundly influence the expression of tissue-specific functions and increase the level of messenger-RNA for secretory proteins has attracted the attention of biotechnology companies such as Monsanto of St. Louis. These studies have drawn the attention of the industry to the importance of substrata on which the cells grow and have focused their efforts in optimizing the environment of the cell not only with defined media and hormones, but also with solid substrata.

(M. Bissell)

4. Regulation of Gene Expression

Our studies on mammary epithelial cells have relevance to other epithelial cell functions. Scientists at UpJohn Company have an interest in keratinocytes and biology of hair cells. They have been in touch with us regularly, and in December, 1986, I will take part in an exclusive symposium on biology of epithelial cell function in Kalamazoo. There are many other companies, including Genetech, Bioresponse, and Celus, that have expressed an interest in our work and to whom I will lecture.

(M. Bissell)

5. Molecular Biology Studies

There have been several studies in cooperation with researchers at other laboratories.

a. Micro Injection of Avian Embryos, with Steven Martin, Department of Zoology, University of California, Berkeley: Collaboration on the study of the interactions of Rous sarcoma virus with the avian embryo.

b. Molecular Biology Techniques and Mammary Cell Culture, with Prof. Judy Aggeler, Department of Anatomy, University of California, Davis.

c. Mammary Cell Culture and Molecular Biology Probes, with Prof. Zena Werb, Radiobiology Laboratory and Department of Anatomy, University of California, San Francisco. Dr. Werb and Dr. Unemori have collaborated with us on detection of proteolytic activities in milk and on cells in culture as a function of substrata.

d. Molecular Biology Probes and Antibodies, with Prof. Charles Daniel, Department of Biology, University of California, Santa Cruz. We have begun studies on the role of transferrin in mammary gland function.

e. Molecular Biology Techniques and Probes, with Prof. Chung Park, Department of Dairy Science, University of North Dakota. Dr. Park spent a six-month sabbatical at LBL last year learning molecular biology techniques and we continue to collaborate on messenger-RNA for extracellular matrix components in the mammary gland.

f. Cell Biology, Molecular Biology, with Profs. David Warhawsky and Roy Albert, Kettering Institute, University of Cincinnati Medical School, Ohio. We have just begun a long range collaboration with the Institute of Environmental Health at the University of Cincinnati Medical Center. We have also started a collaboration on the relation of carcinogenesis and differentiation with rat mammary cells with Dr. Warhawsky, who spent a nine-month sabbatical at LBL.

g. Cell and Molecular Biology Techniques and Materials, with Prof. Denise Chan, Jackson State University, Jackson,

Mississippi. We have an ongoing collaboration on the nature of fibronectin-degrading enzymes in malignant cells.

h. Molecular Probes and Antibodies, with Prof. Dan Medina, Department of Anatomy, Baylor College of Medicine, Houston, Texas. We are collaborating on characterization of mammary cell lines and on regulation of m-RNA for milk proteins.

i. Molecular Biology and Gene Expression with Dr. Helene Smith, Peralta Cancer Institute, Oakland, California. We have provided consultation on many projects related to human breast cancer for Peralta Institute and helped organize a meeting at Peralta entitled Cancer at the Cellular Level. A report on the conference has been jointly written.

j. Cell Biology, with Dr. John Wyke, Imperial Cancer Research Fund Laboratories, London, England. After a year's sabbatical at Dr. Wyke's laboratory, we have co-authored four articles and continue to collaborate and exchange ideas, materials, and scientists. Two scientists are now visiting LBL and two more are expected.

k. Biochemistry and Molecular Biology, with Prof. Nelly Auersperg, Department of Anatomy, University of British Columbia, Vancouver, B.C., Canada. We are collaborating on a project characterizing the expression of oncogene ras in cells in culture.

(M. Bissell)

6. Algorithms for Reconstruction Tomography

Algorithms for reconstruction tomography continue to be disseminated to various educational institutes and industrial firms via the manual known as RECLBL and associated computer tapes. There were approximately 60 calls for this integrated set of codes over the last year.

(T.F. Budinger/R.H. Huesman)

7. Nuclear Magnetic Resonance Safety

Magnetic resonance medical studies of patients depend on the assessment of hazards from the magnetic fields and rf currents. LBL is the research and publication center for evaluating safety of these procedures. During the last year, two workshops were held with various industrial firms to transfer the technical results on rf heating.

(T.F. Budinger)

8. Heavy Charged Particle Radiation Therapy

We are now in our eleventh year of receiving support from the National Cancer Institute and the Department of Energy for the study of heavy-charged-particle radiotherapy in the treatment of human cancer. As of August 1986, we had used charged particles in the treatment of 914

patients. Protocols are ongoing for the following tumor sites: localized squamous carcinoma of the esophagus; malignant glioma of the brain; locally advanced carcinoma of the pancreas, biliar tract, and stomach; selected advanced head and neck tumors; locally advanced soft tissue sarcomata; locally advanced carcinoma of the lung and prostate; and malignant melanoma of the eye. Patients entered in this study are treated with helium, carbon, neon, or silicon heavy charged particles. The majority of our patients are referred from members of the Northern California Oncology Group and the Radiation Therapy Oncology Group, which together provide the clinical trial support services for protocol design, patient accrual, statistical services, data collection, and analysis. The value of the treatments in FY 1986, measured by the community rates for comparable conventional services, was $1,025,000.

(J.R. Castro)

9. Erythropoietin Radioimmunoassay

Our radioimmunoassay for erythropoietin was used to study infants in high risk pregnancy in collaboration with Dr. Schwartz and Dr. Widness, Brown University, Providence, Rhode Island, and Dr. Teramo, Helsinki, Finland. During the past year, we have continued our study with respect to Ep in cord blood and amniotic fluid in high risk pregnancies, such as diabetic and hypertensive mothers. This study will be completed during the following year. We have found that amniotic fluid Ep correlates with cord plasma Ep both in healthy controls and diabetics at delivery without labor. In addition we observed a correlation between C-peptide and Ep both in cord plasma and in amniotic fluid which agrees with the hypothesis that fetal hyperinsulinemia could result in chronic fetal hypoxia. Whether amniotic fluid Ep determinations can be used as an antepartum indicator of chronic fetal hypoxia in high risk pregnancies needs further investigation and the development of a less time-consuming assay, such as a radioreceptor assay.

(G.K. Clemons)

10. Biological Potency and Acute Toxicity of New Organic Ligands

A National Institutes of Health supported program tests the biological potency and acute toxicity of new organic ligands "designed" specifically to bind the tetravalent actinides (e.g., Pu^{+4}) and iron (Fe^{+3}). Such ligands are the only practical way to remove these potentially toxic metals from the body, and have immediate usefulness in supplementing or augmenting the chelating agents now used to treat Pu^{+4} accident victims or persons who have accumulated toxic amounts of iron. They have potential usefulness in chemical separations and for waste treatment. Specific ligators for uranylion (UO_2^{2+}) are presently being designed. The results are of interest to the toxicology research community.

(P.W. Durbin)

11. Mutagenesis Studies in Yeast

This is a collaboration with Professor Robert Haynes of York University, Ontario, Canada on mutagenesis in yeast. We have participated in a symposium on problems of large scale fermentation in yeast.

(M. Esposito)

12. Lipoprotein Metabolism/VLDL

In collaboration with Dr. Patsy Wang-Iverson, Mt. Sinai Hospital, New York, we evaluated changes in biophysical properties of very low density lipoproteins (VLDL) incubated with macrophages. The question addressed was whether macrophages can metabolize and modify VLDL. Metabolism and modification of VLDL may be an early process leading to foam cell development in atherosclerosis. In our laboratory we examined incubation products (VLDL isolated after incubation with macrophages) by means of gradient gel electrophoresis and electron microscopy. Changes in physical parameters of VLDL were correlated with time of incubation with cells and degree of lipolysis. The physical-chemical approach taken has provided new information on processing of VLDL by macrophages.

(T.M. Forte)

13. Stereotactic Heavy-Ion Bragg Peak Radiosurgery

The program at Donner Pavilion has applied nuclear medicine research to the diagnosis and radiosurgical treatment of life-threatening intracranial vascular disorders that affect approximately one million Americans. Stereotactic heavy-ion Bragg peak radiosurgery, using narrow beams of heavy ions (helium), demonstrates superior biological and physical characteristics in brain over x and gamma rays and protons, viz., improved dose distribution in the Bragg peak, sharp lateral and distal borders, and less multiple scattering and range straggling for the same residual range in CNS tissue. Examination of CNS tissue response and alteration of cerebral blood-flow dynamics related to heavy-ion Bragg peak radiosurgery is being undertaken using three-dimensional treatment planning and quantitative imaging utilizing cerebral angiography, computerized tomography (CT), magnetic resonance imaging (MRI), cine-CT, xenon x-ray CT, and positron emission tomography (PET). Also under examination are the physical properties of narrow heavy-ion beams for improving methods of dose delivery and dose distribution and for establishing clinical RBE/LET and dose-response relationships for human CNS tissues. Based on the evaluation and treatment with stereotactically directed narrow beams of heavy ions of over 250 patients, with cerebral angiography and CT scanning, and with MRI radioisotope scanning of selected patients, plus extensive clinical and neuroradiological follow-up, it appears that heavy-ion radiosurgery obliterates intracranial arteriovenous malformations or protects against rebleeding with reduced morbidity and mortality.

(J.I. Fabrikant)

14. Lipoprotein Metabolism in Newborns

In a collaboration with the Neonatology Division, Children's Hospital, Oakland, California, the effects of intravenous fat feeding on plasma lipids and lipoprotein distributions in acutely ill newborns was studied. Nondenaturing gradient gel electrophoresis and lipid quantitation were carried out to determine whether intravenous fat feeding adversely affects plasma lipoproteins. Lipoprotein distributions, particularly in the high density lipoprotein (HDL) fraction, were correlated with plasma lipid levels and clinical data on neonates.

Data has revealed that certain infants, especially those with necrotizing enterocolitis and severe respiratory distress, have very abnormal HDL distributions that suggest abnormal liver metabolism. The use of intravenous fat feeding markedly improves the HDL distribution. This joint project has provided new insights in parental nutrition of very young, sick infants.

(T.M. Forte)

15. Carcinogenic Potency in Laboratory Animals

A computer tape of published database on carcinogenic potency in laboratory animals has been distributed to the U.S. Army, Health Designs, Inc., and the Chemical Industry Institute of Technology (CITT). It contains variables that describe experimental protocols as well as statistical results for approximately 7800 experiments on 765 chemicals.

(L. Gold)

16. Electromagnetic Energy Research

Research is being conducted to employ electromagnetic energy to facilitate the transfer of drugs from liposome vesicles into target cells. This work is progressing in collaboration with Liposome Technology Incorporated in Menlo Park, California.

(R.P. Liburdy)

17. Radiation Therapy Treatment Plan Optimization

An algorithm to estimate the normal tissue complication probability following a course of radiation therapy has been developed and distributed to Massachusetts General Hospital, Memorial Sloan-Kettering Cancer Institute, New York, and Washington University School of Medicine, St. Louis, Missouri.

(J.T. Lyman)

18. Yeast Genetics

Recently, the yeast Saccharomyces cerevisiae has become increasingly important for both basic research and the production of proteins by biotechnology firms. We have constructed and sent out numerous yeast strains and plasmids bearing yeast genes to both educational institutions and biotechnology industries. We have also collated and published

a new edition of the yeast genetic map in 1985 that should be of value to both research and industrial organizations.

(R.K. Mortimer/D. Schild/J. Game)

19. Normal Tissue Radiobiology

We provide educational and training opportunities for students from Jackson State University in Mississippi.

(A. Rodriguez)

20. Nuclear Magnetic Resonance Imaging Spectrometer

As part of an ongoing contract with IBM in the field of biomedical applications of nuclear magnetic resonance (NMR) imaging and spectroscopy, we have developed a software system for real-time control and data processing for an NMR imaging spectrometer. This work was reported at the fourth annual meeting of the Society of Magnetic Resonance in Medicine, and a publication with LBL and IBM authors is in preparation. In addition to the basic software, which is in its second release, LBL has provided macros for acquiring and processing multi-slice, multi-echo image data to the other sites. These macros take advantage of substantial performance increases attained during the past year. The work has been performed in association with the Bitter National Laboratory at MIT and the Brigham and Women's Hospital affiliated with Harvard Medical School.

(M.S. Roos)

21. Rapid Brain Scanning Radiopharmaceutical

A rapid brain scanning radiopharmaceutical for measurement of cerebral blood flow using positron emission tomography (PET) was first developed in 1982 and a patent was applied for in that year. The new agent, termed IDNNA, was designed so that it could be tagged with iodine-122, a positron emitter with a half-life of only 3.5 minutes. It is derived from a generator of 20-hour xenon-122, which can be produced by a centralized accelerator and shipped to distant PET laboratories, where the iodine-122 can be extracted for use every 20 minutes for 2 days. This makes PET imaging possible in laboratories without the cost of operating their own cyclotron. The radiation dose to the patient is low because of the short life of iodine-122, and the test can be repeated. In FY 1986, we have demonstrated the effectiveness of iodine-122 in human subjects, and initiated technology transfer of the radiopharmaceutical and the xenon-122 generator to several industrial firms. This new radiopharmaceutical technology is expected to have wide application in research and diagnosis of stroke, Alzheimer's disease, and other neurological illnesses.

(T. Sargent/C.A. Mathis/A.T. Shulgin)

22. Hematology

Collaborative research studies were done with Dr. A. Allisson, Synex Corp., Palo Alto, California, of the action of interleukin 1 (IL-1) upon the activity of the hormone erythropoietin, which regulates red blood cell formation.

(J.C. Schooley)

23. Anemia and Immunosuppression

Our recent discovery that malaria causes the depletion of the pluripotent stem cell, which is ultimately responsible for the production of all blood cells, has important ramifications for treatment and prevention of diseases that cause anemia and immunosuppression. We are currently collaborating with Chiron Corporation and Genetech, Inc., to investigate the application of these findings to several related infectious agents and the effects of lymphokines and stem cell stimulators on the nature and outcome of the disease process. Some of the materials under examination are recombination products of biotechnology.

(P.H. Silverman)

24. Modified Nucleotides

Synthesis and incorporation of modified nucleotides and deoxynucleotide triphosphate has been developed specifically for adducts resulting from directly acting alkylation agents, known to be mutagenic and carcinogenic in humans. The adducts have been used by Doctors L. Loeb and B. Preston of the University of Washington School of Medicine, Seattle, in studies of site-directed mutagenesis by O-alkyl products. The polymers incorporating these nucleotides have been used in collaboration with Doctors J. Swenberg and F. Richardson of CIIT Research, Triangle Park, North Carolina to develop a noninvasive assay for carcinogen exposure based on the ability to detect low levels of product in polymer or free nucleoside. The assay is successful even with polyclonal antibodies of low specificity. We are now hoping to enhance the sensitivity using monoclonal antibodies.

(B. Singer/S. Spengler)

25. Human Mammary Epithelial Cells

Cell cultures derived from normal and malignant human mammary epithelial tissues have been sent (frozen or growing) to various collaborators and investigators. These cells have been used to study normal human cellular physiology, genetics, and immunology, as well as the processes that occur during carcinogenesis.

Some of the recipients include: Cetus Corporation; University of Wisconsin; University of California; Hybridtech, Inc.; National Cancer Institute; University of Texas; Veterans Hospital in New York; University of Wisconsin; National Institutes of Health; Cancer Institute (Amsterdam); Hana Biologics; Peralta Cancer Research Institute; Dana-

Farber Cancer Institute; Roche Institute of Molecular Biology; and Eli Lilly.

(M.S. Stampfer)

26. Portable 60-Hz Magnetic Field Dosimeter with Data Acquisition Capabilities

A portable dosimeter has been developed for monitoring human exposure to power-frequency magnetic fields encountered in households and occupational settings. The microprocessor-controlled dosimeter measures 60-Hz field intensities in the range of 20 microgauss to 600 milligauss using miniature 500-turn coil detectors along three orthogonal axes. A digitized resolution of 2.5 microgauss is achieved in the 20 microgauss to 10 milligauss field range, and 150 microgauss resolution in the 10 milligauss to 600 milligauss range. Automatic range switching is implemented for both signal processing and data acquisition. This dosimeter was developed with the support of the Electric Power Research Institute. The initial prototype dosimeter has been completed and subjected to performance tests in a calibrated 60-Hz magnet. The linearity of the detection system for 60-Hz fields is within 2%, and the harmonic signal rejection is greater than 45 dB.

(T.S. Tenforde)

27. Biomedical Research with Accelerated Heavy Ions at the Bevalac

Under development were: techniques for administering light and heavy-ion beams to produce therapeutic focal lesions in patients (e.g., with highly localized tumors of the retina, the pituitary, and adjacent to the spinal cord); techniques involving the production of radioactive beams, beam canning, etc.; novel techniques for measuring the dose and LET distributions of particle fields. A proposed accelerator, the LIBRA (Light Ion Biomedical Accelerator) would be built by LBL at a hospital.

(C.A. Tobias)

28. Research Medicine

A neon gas target system for the production of fluorine-18 by the $^{20}Ne(d,\alpha)^{18}F$ reaction and the chemical apparatus for the synthesis of [^{18}F]-2-Fluoro-2-deoxyglucose have been developed. The system that produced ^{18}F and synthesized the fluorodeoxyglucose utilized the 88-Inch cyclotron. The radiolabeled substrate was tested by measuring the metabolic rate for glucose in studies with the LBL Positron Emission Tomograph. The technology was then transferred to Crocker Nuclear Laboratory at University of California-Davis where it is being used to provide ^{18}F-fluorodeoxglucose to medical users at LBL, the University of California at San Francisco and Irvine, and Stanford University.

(Y. Yano/C.A. Mathis)

29. Charged Particle Detectors

We have supplied silicon lithium-drifted detectors for two unique programs:

a. The Stanford Angiography Detector is a 300-element detector that has been successfully employed in producing angiographs of the human heart. This detector forms the basis of an extensive program at Stanford Synchrotron Radiation Laboratory in the development of digital angiographs.

b. The Lockheed UARS Detectors are intended to be flown on UARS Satellite and are unique in the temperature range/noise performance requirements.

(J. Walton)

ENERGY TECHNOLOGIES

1. Simulation of Energy Use in Residential and Commercial Buildings

DOE-2 is an LBL-developed computer program for simulating the hour-by-hour energy use of residential and commercial buildings. It is widely used by the building research and design communities in the U.S. and over 20 other countries to evaluate energy efficient technologies and design. During FY 1986, approximately 130 copies of DOE-2.1C, the latest version of the program, were distributed by LBL and NTIS for implementation on mainframe computers in the public and private sectors. DOE-2 is also being made available by a private company in a version that will run on IBM-compatible personal computers. LBL continued distribution to approximately 200 subscribers of the DOE-1 USER NEWS, a quarterly newsletter which features documentation updates and corrections, articles of interest to program users, an explanation of program bugs and their fixes, and documentation ordering information.

(F. Winkelmann)

2. ASHRAE Standards

Scientists in the LBL Indoor Environment and Energy Analysis programs continue to play major roles in ASHRAE Standard activities.

a. David Grimsrud is Vice-Chair and Secretary of the committee revising Standard 62, Ventilation for Acceptable Indoor Air Quality. This revision has been released for public comment.

b. Max Sherman is Chair of the committee writing ASHRAE Standard 119, Air Leakage in Residential Buildings. The work on the standard has been completed and has been submitted to the ASHRAE Standard Committee.

c. William Fisk is a member of the committee writing a new Standard 129, Ventilation Efficiency in Buildings.

d. Steve Byrne, Joe Huang, and Ron Ritschard contributed both technical data and effort for the revision of ASHRAE Standard 90.2 for energy efficient design of residential buildings.

3. Radon Concentration in Residences

Bonneville Power Administration (BPA) and DOE's Office of Buildings and Community Systems co-funded an effort to reduce radon concentrations in 14 houses in the Spokane, Washington area. This effort, which was successfully completed in all houses, developed and perfected techniques that permitted reductions from initial concentrations ranging from 20 to 200 pCi/L to final concentrations less than 5 pCi/L in all cases.

(D. Grimsrud)

4. International Daylighting Conference

During FY 1986, LBL staff were involved in organizing the 2nd International Daylighting Conference held in Long Beach, Calif., November 3–6, 1986. LBL staff also participated as session leaders, invited speakers, and presenters of technical papers.

(S. Selkowitz)

5. Thermal Properties of Windows

WINDOW 2.0 Heat Transfer Program is a microcomputer program that calculates thermal properties of window systems. It was derived from research codes and is used by more than 50 glass, coatings, and window manufacturers.

(M. Rubin)

6. Skylight Handbook

Skylight Handbook, Energy Design Guidelines: Based on LBL research results, this handbook was compiled and written to help architects and engineers use skylights to reduce energy needs. An architectural firm assisted in the preparation of the manual; the American Architectural Manufacturers Association will publish and distribute the completed document.

(M. Wilde)

7. Removal of Trace-Metal Compounds from Heavy Crude Petroleums

LBL researchers have developed patented techniques which use polymer-supported metal-binding molecules, ligands, for the removal of trace-metal non-porphyrin compounds such as arsenic, vanadium, and nickel in heavy crude petroleums. These techniques are currently being evaluated by Chevron Chemical Company.

(R. Fish)

8. Lighting Impacts Research Program

On March 13, 1986, important new results from the Lighting Impacts Research Program were presented to 35 lighting engineers in a day-long seminar at the Nela Park, Ohio, headquarters of the General Electric Lighting Division.

(S. Berman)

9. Program for Energy Analysis of Residences

PEAR (Program for Energy Analysis of Residences), a simplified energy calculation tool for new residential buildings, was completed and distributed to a panel of 35 building professionals (architects, builders, engineers, planners, and utility officials) for their review and evaluation.

(R. Ritschard)

10. Home Energy Rating Tool

The Home Energy Rating Tool developed at LBL was evaluated by city building officials and utility planners in two California cities.

(R. Ritschard)

11. Energy Conservation in Public Housing

LBL authors wrote several articles on energy conservation in public housing for use by local housing authorities, including an article on lowering energy costs in the Maintenance and Modernization Supervisor, a publication read by several thousand public housing managers and maintenance personnel. Workshops were conducted in San Francisco on tenant responses to energy conservation.

(R. Ritschard, E. Vine, and C. Goldman)

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