Annual Report
on
Technology Transfer and Related Technology Partnering Activities
at the
National Laboratories and Other Facilities

Fiscal Year 2005

Prepared by:

Office of Policy and International Affairs
U.S. Department of Energy

In Coordination With:

National Laboratory Technology Partnerships Working Group
Technology Transfer Working Group

U.S. Department of Energy

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FOREWORD

On behalf of the U.S. Department of Energy (DOE), I am pleased to present this *Annual Report on Technology Transfer and Related Technology Partnering Activities at the National Laboratories and Other Facilities for Fiscal Year (FY) 2005*. The *Report* is prepared in accordance with the requirements of the Technology Transfer and Commercialization Act of 2000 [15USC 3710(f)1].

In FY 2005, DOE and its laboratories and facilities negotiated and executed 11,102 technology transfer-related transactions. These transactions include 644 new or active cooperative research and development agreements (CRADAs); 1,922 work-for-others projects involving non-Federal entities (NFE); 5,677 licenses of intellectual property; and 2,859 user facility agreements. In addition, DOE disclosed 1,776 inventions; filed 812 patent applications; was issued 467 patents; and logged more than 307,000 downloads of its copyrighted open-source software. Associated with these activities, DOE's laboratories and facilities reported $178 million in NFE work-for-others, $35 million of "funds-in" for CRADAs, $27.4 million in licensing income and nearly $12.4 million in earned royalties.

These activities evidence a robust technical enterprise, enabled by DOE outreach and technology partnering. While these activities are intended to facilitate research and innovation and encourage the development and transfer of emerging technologies, they also contribute to DOE missions and strengthen the technical competencies of DOE's laboratories and facilities. The extent of this work is a reflection, as well, of the continued confidence in DOE on the part of thousands of private partners who work with DOE in these ways. This *Report* describes these activities and outlines DOE's procedures for ensuring appropriate management and oversight of their conduct, in accord with prevailing policy and authorities.

This year's *Report* presents a special feature on User Facilities. In addition, Appendix B provides 22 examples of recent and successful technology partnerships and their outcomes. These outcomes span a broad range of research areas and DOE missions. Highlights include new technologies for homeland security, energy supply and efficiency, occupational safety, and medicine and health.

Finally, I would like to acknowledge the valued role played by the many professional practitioners of technology transfer throughout the DOE complex. I encourage them and their management to continue this excellent work. The resulting contributions add significantly to our Nation's economic competitiveness and to DOE's mission accomplishment.

Karen Harbert
Assistant Secretary
Office of Policy and International Affairs

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CHAPTER 1

OVERVIEW AND HIGHLIGHTS

The transfer of Federally-developed technologies and capabilities to non-Federal technology partners, including private firms, has been an aim of Government policy since the passage by Congress of enabling technology transfer legislation in 1980.[1] In 1989, the National Competitiveness Technology Transfer Act [2] strengthened this aim by establishing technology transfer as a mission of Federal R&D agencies, including the Department of Energy (DOE). DOE has since encouraged its laboratories and production facilities to enter into technology partnering activities with non-Federal entities as appropriate to each entity's mission, using a variety of mechanisms, including cooperative research and development agreements (CRADAs), and to patent and license intellectual property that may arise from DOE research and development (R&D).

Today, technology partnering is an active and significant component of DOE's overall mission, particularly in areas associated with its scientific, engineering and related technical activities. As authorized by DOE through provisions in its management and operating (M&O) contracts, technology transfer is now carried out at all 12 of DOE's national laboratories and at 10 other DOE research and production facilities (for a list, see page 4).

For DOE, technology partnering is important to the vibrancy of DOE's technical competencies at its research laboratories and facilities. To accomplish it mission, DOE cannot afford to home-grow or replicate all the required skills inside its own fences; rather it must have access to the rapidly evolving technical expertise and commercial technology of selected non-Federal entities, by transferring know-how and technology from the private sector to the Federal sector. Also, contractors of DOE laboratories and facilities create and own intellectual property, which encourages the commercialization and diffusion of technologies benefiting society. Private companies often have more experience in getting this goal accomplished successfully. For these reasons, it is beneficial, if not essential, for DOE to find efficient and effective ways to partner with such firms.

At the same time, private firms and other non-Federal entities have found that DOE's research laboratories and facilities can provide valuable and often unique problem solving capabilities. The firms are also interested in building long-term relationships that pay dividends over time. Technology partnering can enable and facilitate productive leveraging of different motivations, benefiting both DOE and its partners, in addition to furthering Federal missions and national priorities.

Technology Partnering Goals

In 2003, DOE reissued its Order 482.1 that governs technology partnering at its laboratories and facilities. In concert with the relevant statutes in this area, DOE Order 482.1 establishes technology transfer as a mission of DOE and its facilities and sets the policy context in which partnering is to take place, requiring of its practitioners, for example, a public purpose (i.e., a

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[1]Bayh-Dole (P.L. 96-517, as amended by P.L. 98-620) and Stevenson-Wydler (P.L. 96-480)
[2] P.L. 99-502

DOE mission). It established procedures to ensure fairness of opportunity, protect the national security, promote the economic interests of the United States, prevent inappropriate competition with the private sector, and provide a variety of means to respond to the private sector concerns and interests about technology partnering activities. The DOE Order assigns roles and responsibilities to various DOE organizational elements for the oversight, management and administration of DOE facility technology partnering activities. The DOE Order also sets forth a series of broad purposes for such activities. These are:

- Facilitate the efficient and expeditious development, transfer, and exploitation of Federally owned or originated technology to non-DOE entities for public benefit and to enhance the accomplishment of DOE missions;

- Leverage DOE resources, through its programs and facilities, through partnering; and

- Ensure fairness of opportunity, protect the national security, promote the economic interests of the United States, prevent inappropriate competition with the private sector, and provide a variety of means to respond to private-sector concerns and interests about facility technology partnering activities.

Technology Partnering Activities

Technology partnering can mean many things – technical assistance to solve a specific problem, use of unique facilities, licensing of patents and software, exchange of personnel, and cooperative research agreements. The most appropriate mechanism will depend on the objective of each partner. The most commonly used technology transfer mechanisms are described below:

- *Intellectual Property*. Identifying and protecting intellectual property made, created, or acquired at or by a DOE facility. This includes new invention disclosures, creation and filings of patent applications, issue of patents, copyright assertion, trademark creation, and associated monitoring and reporting. In FY 2005 there were 1,776 invention disclosures, 812 patent applications filed, and 467 patents issued.

- *Cooperative Research and Development Agreements*. Performing work for non-Federal sponsors under DOE Order 483.1. Negotiating all aspects of and entering into Cooperative Research and Development Agreements (CRADAs), performed under the National Competitiveness Technology Transfer Act of 1989. Such agreements focus on mutually beneficial collaborative research. They may involve resource commitments by each partner for its own use, or resource commitments from the non-Federal partner to the Federal partner, but no resource commitments from the Federal partner to the non-Federal partner. In FY 2005 there were 644 active CRADAs.

- *Licensing*. Negotiating and entering into license agreements and bailments that provide rights in intellectual property made, created, or acquired at or by a DOE facility, which is controlled or owned by the contractor for that facility. A license transfers *less* than ownership rights to intellectual property, such as a patent or copyright, to permit its use by the licensee. Licenses may be exclusive, or limited to a specific field of use, or limited to a specific geographical area. Royalties and income may be associated with the licensing. In FY 2005 there were 5,677 active licenses.

- *Work-for-Others*. Performing work for non-Federal sponsors under DOE Order 481.1C. WFO agreements permit reimbursable work, mostly research and development, to be carried out at DOE laboratories or facilities. This work is usually categorized into that for Federal agencies and non-Federal entities (NFE). It is the NFE work that is of interest to technology partnering in this report. All work conducted under WFO agreements is provided on a 100 percent reimbursable basis. Intellectual property rights generally belong to the NFE, but may be negotiated. In FY 2005 there were 1,922 Work-for-Others (WFO) agreements with non-Federal organizations.

- *User Facilities*. User Facilities are advanced scientific facilities, equipment, software, and the expertise that are available at DOE laboratories for use by the technical and scientific community. The facilities are intended to serve the research needs of the in-house laboratory scientific staff while encouraging participation by industry and universities. The research capabilities of the facility are essentially unique within the U.S. and it is of sufficient monetary value and/or sophistication that widespread duplication is unlikely. In FY 2005 there were 2,859 active user facility agreements.

- *Technical Consulting*. Technical consulting usually takes the form of technical assistance to small businesses, undertaken in response to an inquiry or request for such assistance from an individual or organization seeking knowledge, understanding or solutions to a problem, or means to improve a process or product. The extent of such consulting is often limited to a relatively low level of overall effort.

- *Personnel Exchanges*. These arrangements allow facility staff to work in a partner's technical facilities, or the partner's staff to work in the government laboratory, in order to enhance technical capabilities and/or support research in certain areas. Costs are typically borne by the sponsoring organization. IP arrangements may be negotiated as part of these exchanges.

Laboratories and Facilities Engaged in Technology Partnering

DOE authorizes some of its laboratories and facilities to conduct such technology partnering activities. Most of these laboratories and facilities have established formal technology transfer programs. Many also have staff dedicated to the facilitation of the administrative and negotiating processes involved in entering into agreements with non-Federal partners. This Report presents trends and analyses of the technology transfer activities at the aggregate level for DOE. It does not show individual facility data.[3]

[3] Considerable differences exist among the DOE laboratories and facilities. These differences consist of two main determinants: amount of R&D funding and type of R&D activity. Laboratories and facilities receive R&D funding from DOE's Cognizant Secretarial Officers (CSOs). Each CSO exercises primary oversight, management, and administrative responsibility for technology partnering activities at the laboratories and facilities under his or her respective cognizance.

The laboratories and facilities authorized by DOE to carry out technology transfer activities are listed below. These 22 entities constitute the scope of data included in this Report.

- Albany Research Center
- Ames Laboratory
- Argonne National Laboratory
- Brookhaven National Laboratory
- Fermi National Accelerator Laboratory
- Idaho National Laboratory
- Kansas City Plant
- Lawrence Berkeley National Laboratory
- Los Alamos National Laboratory
- Lawrence Livermore National Laboratory
- National Energy Technology Laboratory
- National Renewable Energy Laboratory
- Nevada Test Site
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory
- Pantex Plant
- Princeton Plasma Physics Laboratory
- Sandia National Laboratories
- Savannah River National Laboratory
- Stanford Linear Accelerator Center
- Thomas Jefferson National Accelerator Facility
- Y-12 National Security Complex

Summary of Transactions

In FY 2005, there were 11,102 technology transfer-related transactions negotiated and executed by DOE and its laboratories and facilities. These include 2,859 user facility agreements, 1,922 work-for-others projects involving non-Federal entities, 5,677 licenses of intellectual property, and 644 new or active cooperative research and development agreements (CRADAs). In addition, DOE disclosed 1,776 inventions, filed 812 patent applications, and was issued 467 patents.

As part of these activities, DOE reported $27.4 million in licensing income, of which $12.4 million was earned royalties. A summary of FY 2005 technology partnering activities for the DOE's laboratories and facilities is presented in Table 1. Technology transfer data for the past five years is provided in Appendix A.

Successful Accomplishments

There are numerous examples of technology partnerships that reflect the successful transfer of technologies out of the laboratory and into the marketplace. For FY 2005, 22 representative accomplishments are presented in Appendix B for FY 2005.

Table 1: Summary of FY 2005 Technology Partnering Activities at DOE National Laboratories and Facilities

Technology Transfer Data Element	FY 2005
Transactions and Activities	
CRADAs, total active in the FY	644
New inventions disclosed	1,776
Patents applications filed	812
Patents issued	467
Total Licenses; Active in the FY	5,677
• Invention Licenses	1,535
• Other IP (copyright, material transfer, other) Licenses	4,142
Licenses that are income-bearing	2,549
Work-for-Others Agreements, Non-Federal Entities, Active in FY	1,922
User Facility Agreements, Active in FY	2,859
Reported Income (Thousands of Dollars)	
Total Licensing Income Received	$ 27,382
• Invention (Patent) Licenses	$ 24,226
• Other Licenses	$ 3,156
Total Royalty Income Earned	$ 12,443

Organization, Management and Oversight

DOE exercises oversight, management and administration of its technology partnering activities at its national laboratories and facilities in two ways. First, DOE's secretarial officers and heads of associated field organizations, guided by the applicable statutes and DOE Orders, set policy, establish procedure and provide oversight and accountability for all technology partnering activities at the laboratories and facilities under their cognizance. Second, DOE's "matrixed" organizations, known as working groups, assist in this effort by meeting regularly to coordinate, communicate and integrate these policies and practices into daily activity across all of the DOE sites. These working groups also provide support to, and enable consistency across, all of the DOE mission areas and program offices. These working groups also address, as appropriate, issues or concerns as may arise.

There are two DOE working groups. For DOE Headquarters and its operations and field offices, the Technology Transfer Working Group (TTWG) is composed of Federal employees appointed to represent their respective organizations. For the DOE laboratories and facilities, the Technology Partnerships Working Group (TPWG) is composed of employees from DOE headquarters and operations and field offices and DOE laboratories and facilities.

DOE Technology Transfer Working Group

At DOE Headquarters, the Technology Transfer Working Group (TTWG) is comprised of about 35 Federal employees engaged in the oversight of technology partnering or transfer activities within their R&D programs elements at DOE Headquarters, or the administrative elements at the DOE Operations offices. The TTWG provides an agency wide forum for exchange of information on current activities and a focal point, when needed, for the review, development, and integration of technology transfer policies. The TTWG serves to inform DOE headquarters and its program offices about ongoing activities and emerging issues.

The TTWG meets monthly via a teleconference. Its agenda and meeting exhibits are prepared in advance and transmitted electronically to all TTWG members. The Director of the Office of Science and Technology Policy, in DOE's Office of Policy and International Affairs, chairs the TTWG. The TTWG is co-chaired by the Assistant General Counsel for Technology Transfer and Intellectual Property, in DOE's Office of General Counsel. In addition to the 35 Federal members of the TTWG, a number of leading technology transfer managers and practitioners of the DOE laboratories and facilities, including those elected to the TPWG executive committee, are regularly invited to participate. Through these means, the TTWG builds, maintains and regularly exercises a network of communications among professionals in the Headquarters and the field.

DOE Technology Partnerships Working Group

The field-led DOE Technology Partnerships Working Group (TPWG) is comprised of more than 300 DOE-complex technology partnering practitioners. An executive committee comprised of six annually elected members, three from DOE operations and field offices, and three from DOE laboratories or facilities, lead the TPWG. The executive committee meets periodically to set and revise an annual program of activities believed to be useful to TPWG members. The executive committee also participates in the TTWG teleconferences.

The TPWG serves to address common needs of technology partnering offices and professionals across the DOE complex and facilitates in the sharing of best practices. It also provides services to the TTWG. It identifies field personnel who can contribute to ad hoc groups addressing current issues or planning activities, and ensures completion. The TPWG organizes periodic training and information exchange sessions on technology partnering. It serves as the coordinating body for gathering and compiling data to meet the needs of the DOE Annual Report. With guidance from the TTWG, the TPWG helped organize the agenda and acquires speakers for the DOE Annual Meeting on Technology Partnering. In May 2005, the TPWG combined their meeting with the Federal Laboratory Consortium on Technology Transfer in Orlando, Florida.

Federal Multi-Agency Coordination and Liaison Activities

In addition, DOE is active in a number of interagency and liaison activities. The Director of DOE's Office of Science and Technology Policy, is designated as the DOE representative to the Federal Interagency Working Group on Technology Transfer, led by the Technology Administration, U.S. Department of Commerce. The IWG meets monthly and is attended by agency representatives and patent counsels from 17 Federal agencies. The IWG serves as an interagency forum for the exchange of information, as a means to raise and address issues and concerns and for coordination across the Federal agencies.

Federal Laboratory Consortium on Technology Transfer

The Federal Laboratory Consortium for Technology Transfer (FLC) is formally chartered by U.S. Congress to facilitate technology transfer in the United States. Its membership draws from more than 225 Federal laboratories, including DOE's 22 technology transfer laboratories and facilities. In DOE, the Director of DOE's Office of Science and Technology Policy, and chair of DOE's TTWG, is the designated "agency representative" to the FLC. As required by statute, in FY 2005, DOE contributed funds (about $417,000), along with funds from other research and development agencies (totaling about $2,463,000), to the operations and management of the FLC. The FLC is supported by a contract between the National Institute of Standards and Technology, U.S. Department of Commerce, and the Universal Technical Resource Services, Inc., of Cherry Hill, New Jersey.

The DOE-designated agency representative of the Office of Policy and International Affairs participated in several FLC Board Meetings and the FLC annual meeting in Orlando, Florida in May 2005. The representative also coordinated the update and certification of voting membership lists from DOE laboratories (one voting member each).

DOE Technology Transfer Website

DOE maintains a technology transfer website, as part of the Secretary of Energy's e-government initiative. The website provides the public with information on DOE's technology transfer policies, procedures, and activities. It enables public access to information regarding technologies available for licensing from the DOE Laboratories and Facilities, and serves as a comprehensive reference for technology transfer activities. The website can be found at http://techtransfer.energy.gov/. In FY 2005, there were 1,772 visits to the website.

Alternative Dispute Resolution

DOE's Office of Dispute Resolution, in DOE's Office of General Counsel, provides assistance to DOE national laboratories and facilities regarding the use of alternative dispute resolution as a means to resolve formal disputes that otherwise would require investigations or litigation. The Office assists by providing partnering, processes for acknowledging and addressing differing professional opinions, and ombuds to mediate complaints involving intellectual property, contract, environment, grants, or whistleblower issues. Because non-Federal partners are often not familiar with Federal statutes and rules governing technology partnering, there is opportunity for confusion and misplaced expectations. It is important for DOE to communicate clearly and to be sensitive to potential complaints and disputes.

In FY 2005, ombuds at DOE's national laboratories and facilities were involved in five potential disputes involving CRADAs, patents, licenses, WFO or other issues. Three of these issues were resolved, one was withdrawn, and one is still pending.[4]

[4] Data provided by DOE's Office of Dispute Resolution, Feb 2, 2006.

The overall rate of incidence of disputes is considered low, in light of the total number of partnering arrangements of one kind or another initiated or continued each year between a DOE laboratory or facility and a non-Federal partner. Every such arrangement may be seen as an active engagement with a partner, and an opportunity for a dispute if not handled properly. In FY 2005, there were 11,102 such active arrangements, either new or continuing.

Open Source Software

In this year's report, the number of downloads from open source software is being reported for the first time by some DOE national laboratories. Four DOE laboratories reported over 307,000 downloads of open source software in FY 2005. Of these, about 205,000 downloads were reported from Argonne National Laboratory.

Multi-Year Trends in Key Indicators

In order to understand better the dynamics of technology transfer and technology partnering activities across the DOE complex, it is useful to examine a number of multi-year trends of a few key indicators. The data sources vary, and span various periods, reflecting data availability. Indicators selected for presentation are: (a) CRADAs; (b) invention disclosures, patent applications, and patents issued; (c) active licenses; (d) income from licenses; (e) work-for-others agreements involving only non-Federal entities (WFO from other Federal agencies are excluded); and (f) user facilities agreements.

Cooperative Research and Development Agreements

Cooperative research and development agreements (CRADAs) are used by DOE authorized laboratories and facilities to partner with industry and other non-Federal entities. Congress authorized the CRADA mechanism in 1986 to encourage the Federal laboratories to participate in R&D partnering.

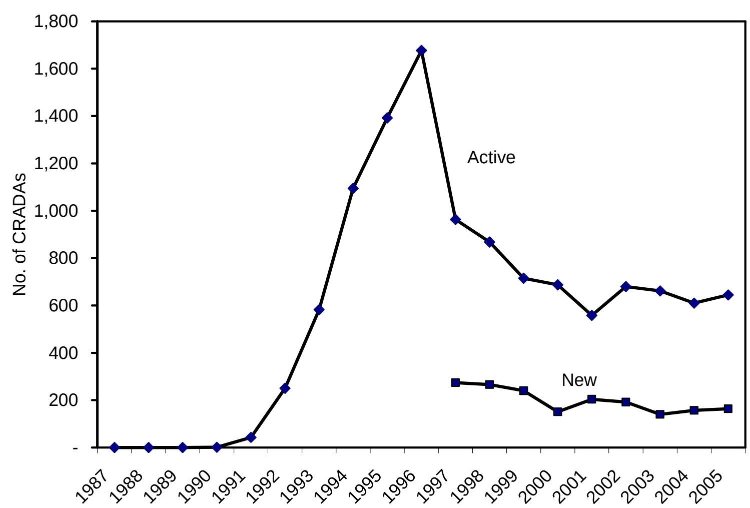

Figure 1: Cooperative Research and Development Agreements (CRADAs)

Figure 1 indicates that the number of active CRADAs peaked to just over 1,600 in FY 1996. After FY 1996, the number of CRADAs decreased by nearly 60 percent, to 558 in FY 2001. In FY 2005, the number of active CRADAs was 644 and the number of new CRADAs was 164. The trends in active and new CRADAs have remained steady over the past six years.

There was an initial growth in CRADAs from the early 1990s until 1996, followed by decline since 1996. This pattern reflects a similar track of dedicated CRADA funding to support activities on the DOE-side of such partnerships. Early in this history, Congress, through the Technology Partnership Program (TPP) and the Laboratory Technology Research (LTR) Program, provided dedicated funding for CRADAs. The combined TPP and LTR funding peaked at $261 million in FY 1995, and had declined to zero in FY 2004.

Inventions and Patents

Figure 2 shows invention disclosures, patent applications, and patents issued. All three indicators continue to show fluctuation from year-to-year. Invention disclosures increased over the past six years, while patent applications have remained steady. Patents issued have shown a decline over the past two years. It is too soon to tell whether this reflects a longer term trend or a single occurrence.

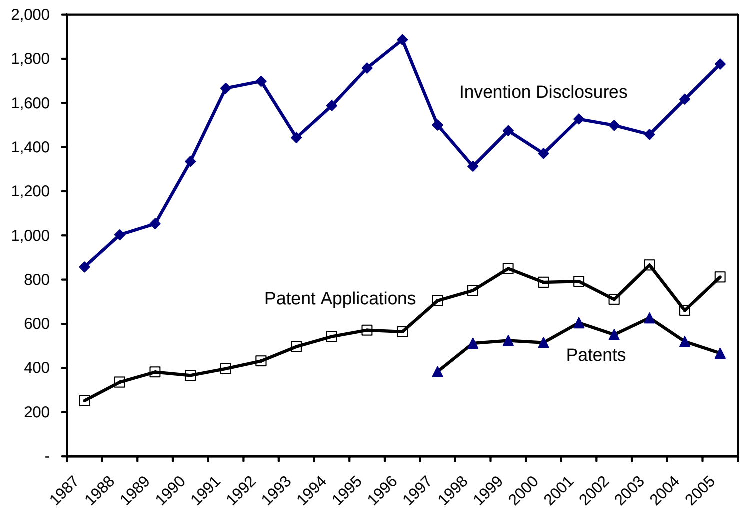

Figure 2: Invention Disclosure and Patenting

Licensing of Intellectual Property

Figure 3 presents data from 1999 through 2005 for the total number of active licenses; these are divided into two classes: patent (invention) licenses and other licenses. There were a total of 5,677 licenses for inventions and other intellectual property in FY 2005. Other licenses include copyrighted software (does not include open source software licenses, which is also copyrighted software), biological materials and other forms of intellectual property. The "other IP" licenses are now the largest category of licenses, with 4,142 in FY 2005.

Copyright licenses make up the bulk of "other IP" licenses and are continuing to grow, signaling new and growing areas for future licensing activity across the DOE complex. The number of patent (invention) licenses, increased over the previous year, totaling 1,535 in FY 2005, up 134 patent licenses from FY 2004.

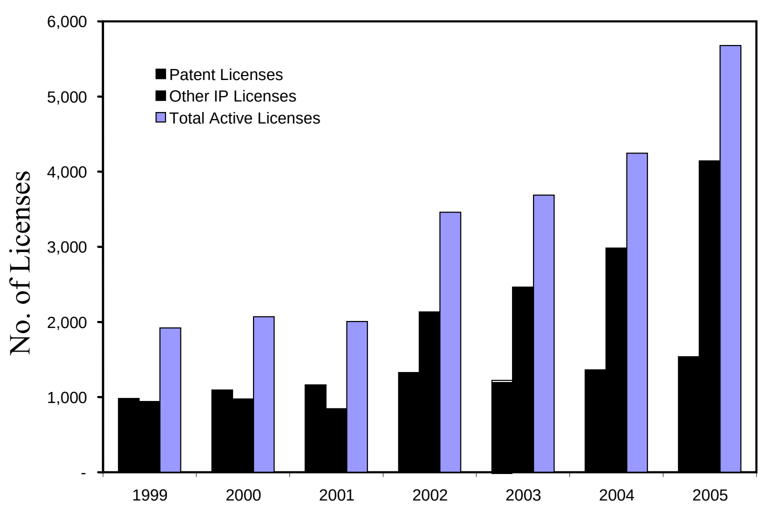

Figure 3: Licensing of Intellectual Property

Figure 4 shows the overall upward trend in income from licensing of inventions. In FY 2005 licensing income exceeded $27 million, down slightly from FY 2004. From FY 1996 to 2004, this trend has been increasing at an average rate of $2.6 million per year. DOE's policies guide, and the negotiated M&O contracts specify, the uses to which this income may be applied.

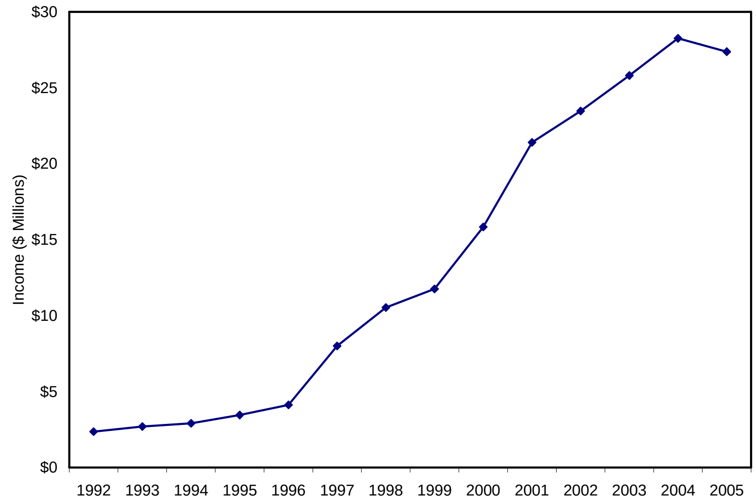

Figure 4: Income from Invention Licenses

Other Technology Partnering Agreements

Figure 5 displays trends in Work-for-Others agreements with non-Federal entities (NFEs). While historical data are not available for all DOE laboratories and facilities, data are available for 12 laboratories from a recent GAO report.[5] As Figure 5 shows, technology partnering at these 12 laboratories and facilities grew rapidly, with an accompanying influx of funds from businesses and other non-Federal entities for this purpose. Work-for-Others agreements with NFEs at these laboratories grew four-fold over ten years, from 1992 through 2001. For the larger set of 22 DOE laboratories and facilities covered in this year's *Report*, the total number of Work-for-Others-NFE agreements numbered 1,922 in FY 2005. This level of activity has remained steady over the past four years.

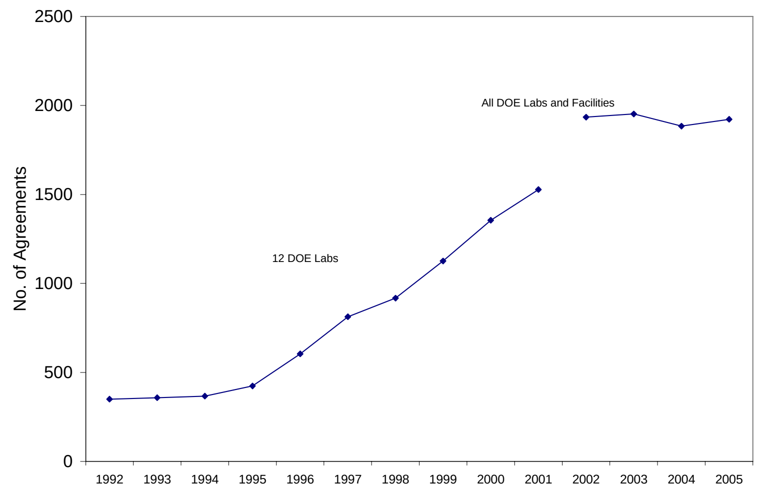

Figure 5: Work-for-Others Agreements, NFE

[5] U.S. General Accounting Office (2002), *Technology Transfer – Several Factors Have Led to a Decline In Partnerships at DOE's Laboratories,* GAO-02-465.

Figure 6 shows data on the number of partnering or project agreements negotiated at DOE scientific user facilities. These agreements provide access to unique DOE research equipment and facilities, and are regarded as another measure of technology partnering activity. In FY 2005, there were 2,859 active user facility agreements, down somewhat from the previous year. This figure shows a decline over the past two years.

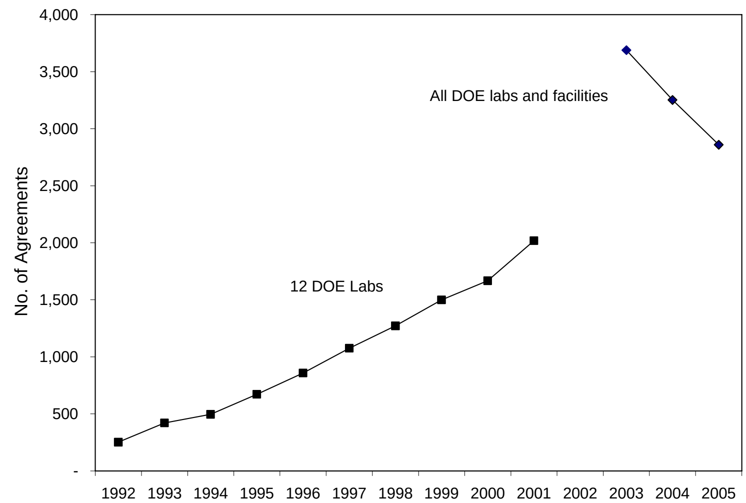

Figure 6: User Facility Agreements

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CHAPTER 2

USER FACILITIES: CONTRIBUTING TO THE DOE MISSION AND TO THE NATIONAL INNOVATION SYSTEM

Throughout its history, the Department of Energy has designed, constructed, and operated many of the Nation's most advanced, large-scale research and development user facilities that are important to the Nation's science and technology enterprise. These state-of-the-art facilities are shared with the science and technology community worldwide and contain sophisticated laboratory technologies and instrumentation.

Located at DOE's national laboratories and universities around the country, these user facilities include the world's first linear collider, synchrotron light sources, the superconducting Tevatron high-energy particle accelerator, the Relativistic Heavy Ion Collider, neutron scattering facilities, supercomputers, high-speed computer networks, and more.

In Congressional testimony in July 2003, Dr. Herman A. Grunder, Director of the Argonne National Laboratory, explained the importance of the DOE user facilities:

> "These user facilities provide resources …that speed up experiments by orders of magnitude and open up otherwise inaccessible facets of nature to scientific inquiry. Many of the important discoveries made in the physical sciences in the second half of the twentieth century were made at – or were made possible by – user facilities. Moreover, most of these user facilities, which are justified and built to serve one scientific field in the physical sciences, have made significant contributions to knowledge and technology in many other fields, including biology and medicine."

Today, for example, the Department is building the Spallation Neutron Source (SNS) in Oak Ridge, Tennessee. When the SNS is completed in the summer of 2006, it may yield such advances as lubricants for tomorrow's more efficient car engines, superconducting wires and strong magnets that will lower power costs, and strong, lighter materials for improved products.

DOE's user facilities are shared with the science community worldwide and contain some technologies and instrumentation that are available nowhere else. More than 18,000 researchers from universities, other government agencies, private industry and foreign entities use the DOE facilities each year. The scientists are both growing in number and diversity, and even start up new companies.

In Fiscal Year 2005, DOE established the Nanoscale Science Research Centers for specialized research in nanotechnology with unique instrumentation and expertise. Acknowledging the need for researchers to efficiently conduct their work, a new and innovative DOE user agreement was developed with associated patent waivers for work in this Center.

In this section, collaborative R&D and technology transfer within user facilities are examined as a means to "promote scientific and technological innovation…" and to "protect our national and economic security by providing world-class scientific research capacity and advancing scientific knowledge." [6]

User Facilities Defined

The DOE User Facilities Program originated in the 1970s under the auspices of the Department's Office of Energy Research. In the 1980's, DOE moved to meet a growing concern regarding the inadequacy of university-based research instrumentation and equipment by expanding the use of government facilities. Academic institutions were granted the right to use certain parts of the laboratories that were designated as user facilities.

User Facilities are advanced scientific facilities, equipment, software, and the expertise that are available at DOE laboratories for use by the technical and scientific community. The facilities are intended to serve the research needs of the in-house laboratory scientific staff while encouraging participation by industry and universities. The research capabilities of the facility are essentially unique within the U.S. and it is of sufficient monetary value and/or sophistication that widespread duplication is unlikely. DOE's Office of Science (formerly the Office of Energy Research) oversees a number of designated user facilities, and the National Nuclear Security Administration (NNSA) has oversight on a number of its designated Technology Deployment Centers/User Facilities. A list of these facilities is provided in Table 2. Both of these types of designated user facilities have been authorized to utilize special intellectual property provisions in their user agreements. Besides these designated user facilities, some of DOE's national laboratories also operate other facilities that are in support of the laboratory's mission. These laboratories frequently make these facilities available to users for research.

The *Advanced Photon Source (APS),* a user facility at Argonne National Laboratory, is the Nation's largest facility and one of the most brilliant x-ray beams for research. Since the APS began operating in 1995, well over 7000 scientists have conducted experiments at the APS. In 2005 alone, approximately 3200 scientists conducted more than 9500 individual experiments.

Originally conceived as a machine primarily for research in materials science, the APS now has become a leading facility for research in virtually every scientific discipline, since APS x-rays can be used to probe the structure and dynamics of all types of materials. These capabilities enable scientists to examine the structure and function of all kind of materials including, biological, geological and environmental materials at the atomic and nanoscale level.

The major pharmaceutical companies in the United States conduct research at the APS. Abbot Laboratories, for example, has developed a pharmaceutical known as Kaletra®. This drug is a protease inhibitor that is one of the world's most prescribed drugs for AIDS. Since its approval by the Food and Drug Administration in 2000, Kaletra® has had a tremendous positive impact on the progression of the disease in AIDS patients infected with HIV virus. In 2002, Kaletra® became the most-prescribed drug in its class for AIDS therapy. Kaletra® is referred to as a drug

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[6] The Department of Energy's Strategic Plan describes its mission and goals. The overarching mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex. It's scientific goal is "to protect our national and economic security by providing world-class scientific research capacity and advancing scientific knowledge."

that helped turn a situation where patients were dying from AIDS to a situation where patients are living with AIDS.

Important applied research is also conducted at user facilities. The *High Temperature Materials Laboratory (HTML)* at Oak Ridge National Laboratory (ORNL**)** is for use in the development of advanced materials. Sponsored by DOE's Office of Transportation Technologies in the Office of Energy Efficiency and Renewable Energy, it is designed to support the development of advanced materials such as ceramics, metal- and ceramic-matrix composites, lightweight materials (aluminum and magnesium alloys and steel) and electronics. The HTML provides researchers from U.S. industries, universities, and governmental agencies with access to a skilled staff and to a number of sophisticated, often one-of-a-kind devices for materials characterization. In HTML's 18 years, there have been over 1450 user projects representing 598 proposals from industry, 799 from academia, and 53 from other federal institutions.

Research at the HTML has yielded important contributions in developing advanced materials for use in industry. Ford Motor Company, for example, has used infrared analysis for improved modeling of brake rotors, and a fiber based infrared camera system for monitoring the behavior of rotors in test stands. Another company, IQ Technologies, has used unique x-ray and neutron residual stress measurements for determining the impact of a new quenching technique that can be used to improve stress corrosion cracking resistance in steel. The University of Florida has also used the HTML for high temperature x-ray diffraction to identify reactions occurring during thermal processing of multi-component photovoltaic thin films.

Applications to use DOE user facilities are accepted from all qualified scientists irrespective of their organizational association. DOE's standard terms for entering into agreements for use of the facilities is described in the next section.

Requirements for Conducting Research at User Facilities

Research conducted at user facilities must be suitable for the facility, of documented programmatic interest to DOE, and of high scientific quality. Generally, the use of DOE User Facilities for proprietary research is permitted if a similar, commercial facility is not available on an independent, convenient and timely basis, and at a reasonable charge. For proprietary use, users are charged on a full cost recovery basis. For non-proprietary research there is generally no charge for the use of an instrument or facility as long as the research results are to be published in the scientific literature. An exception to this rule is that fees may be assessed for services beyond the normal, designated use of the facility or for support services if the facility is not directly supported by DOE.

A patent waiver is a determination made under the authority set forth at 10 CFR 784 whereby the Government waives rights in new inventions made under research and development arrangements with DOE. A class waiver is one in which the Government relinquishes rights to a class of entities such as users. To facilitate access to user facilities DOE has granted several class patent waivers governing patent rights made under user agreements. One class waiver applies to all persons and organizations qualified and selected to conduct research using the unique equipment at user facilities. The policy permits individuals and organizations performing research to keep title to inventions created under the user agreement. The Government receives a comprehensive right of free use, a right to publish the results of the research, and, in the event of deliberate non-use, a right to compel licensing.

Another class waiver (Proprietary User Waiver) covers privately sponsored research work using the unique equipment in DOE Office of Science Designated User Facilities that is outside DOE's programmatic mission responsibilities and where the sponsor is providing full cost reimbursement for the work. The Proprietary User Waiver will not collaborate with laboratory personnel and will use equipment only. Under this class waiver, laboratory personnel may provide technical assistance in operating the equipment, but such assistance will not rise to the level of scientific collaboration. According to the standardized agreements based on this waiver, the user owns its inventions while using the Laboratory's equipment, but has no special right to negotiate a license to any Laboratory invention, and may, subject to certain limitations, have its data treated as proprietary. DOE does not retain a government-use license in the inventions, march-in rights, or rights in the user's data produced at the Laboratory unless: (a) the user is a foreign entity, (b) the data is incorporated in the facility; or (c) the data is related to public health or safety.

The Nanoscale Science Research Centers: An Innovative Solution Towards Collaborative Work

In Fiscal 2005 DOE established a program of Nanoscale Science Research Centers, composed of five user centers across the country, for specialized research in nanotechnology. Each of the five Centers, being constructed, has unique instrumentation and expertise. Acknowledging the need for researchers to efficiently conduct their work, a new and innovative DOE user agreement was developed with an associated new class patent waiver for work in these new facilities.

Nanomaterials – typically on the scale of billionths of a meter or 10,000 times smaller than a human hair – offer different chemical and physical properties than bulk materials, and have the potential to form the basis of new technologies. Understanding these properties may allow researchers to design materials with properties tailored to specific needs such as strong, lightweight materials, new lubricants and more efficient solar energy cells. By building structures one atom at a time, the materials may have enhanced mechanical, optical, electrical or catalytic properties.

Research in nanoscale science will benefit all of the DOE missions – advancing the energy, economic and national security of the United States, promoting scientific and technological innovation and ensuring environmental cleanup of the national nuclear weapons complex. Indeed, many of the missions can be accomplished only by achieving the level of understanding and control that nanoscale science will make possible.

To support the synthesis, processing, fabrication and analysis in nanoscale science, the DOE's Office of Science is developing, constructing and operating five new Nanoscale Science Research Centers (NSRCs). When complete, these five NSRCs will provide the Nation with resources unmatched anywhere else in the world.

The five NSRCs are:

- Center for Nanoscale Materials at Argonne National Laboratory

- Center for Functional Nanomaterials at Brookhaven National Laboratory
- Molecular Foundry at Lawrence Berkeley National Laboratory
- Center for Integrated Nanotechnologies at Los Alamos National Laboratory and Sandia National Laboratories
- Center for Nanophase Materials Sciences at Oak Ridge National Laboratory

The NSRCs are part of DOE's contribution to the National Nanotechnology Initiative[7], a federal R&D program established to coordinate the multi-agency efforts in nanoscale science, engineering, and technology. The NSRCs are designed to be the Nation's premier user centers for interdisciplinary research at the nanoscale, serving as the basis for a national program that encompasses new science, new tools and new computing capabilities. Each NSRC will focus on a different area of nanoscale research, such as materials derived from or inspired by nature; hard and crystalline materials, including the structure of macromolecules; magnetic and soft materials, including polymers and ordered structures in fluids; and nanotechnology integration.

New Agreements for NSRCs

The emergence of NSRCs has led to the need for developing new class waivers for user facilities. The work of users performed at the NSRCs will be more collaborative in nature than the work of users that takes place at the other user facilities and will provide a venue for users and laboratory scientists to work together to design, run, and analyze the results of experiments. Such collaboration will advance DOE's programmatic interests, as well as those of the laboratory and users. Many of these collaborations will be directed towards pre-competitive, noncommercial areas of research interest.

The current user facility agreements instruments, however, did not address adequately pre-competitive noncommercial collaborative endeavors. Instruments such as the User Facilities Class Waiver (non-proprietary class Waiver) and the Class Waiver for Proprietary Users of Energy Research Designated User Facilities (proprietary user waiver), described above, do not address pre-competitive noncommercial collaborative work as they are designed for use of equipment only. Similarly, a Work for Others agreement (WFO) is not intended for collaborative work and Cooperative Research and Development Agreements (CRADAs) allow for collaborative work, but is directed towards more commercial collaborations and thus a CRADA may not meet the needs of all collaborative users.[8] To address the need for a new kind of agreement, DOE issued a Nanoscale Science Research Center Class Waiver (NSRC Waiver) and accompanying Pre-Competitive NSRC User Agreement. These documents are intended to be used pursuant to the Memorandum of Understanding for Implementation of a Standardized Approach to User Agreements at the NSRCs.

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[7] The 21st Century Nanotechnology Research and Development Act, 15 U.S.C. 7501 *et seq.* was signed into law on December 3, 2003 and provides for the establishment of a network of advanced technology user facilities and centers for nanotechnology research and development (R&D) that are supported, in whole or in part, by Federal funds. This legislation codifies programs and activities supported by the National Nanotechnology Initiative.

[8] See pages 2 and 3 for definitions of agreements.

Under the Memorandum of Understanding, the NSRC Waiver is offered to users who intend to collaborate with laboratory scientists and use the NSRC equipment. Users will have a general scope of work directed toward pre-competitive research that advances the state of the art in the user's area of interest, rather than toward producing a specific commercial product. Users are required to publish their results in the open scientific literature and they will not require the data protection available in a CRADA.

The Pre-Competitive NSRC User Agreement has standardized terms and conditions and thus avoids the sometimes lengthy negotiations of a CRADA. Inventions jointly made by the user and Laboratory personnel will be jointly owned. The user may elect title to its inventions while using the NSRC. DOE retains a royalty-free, nonexclusive license to each invention made under the agreement, and data first-produced at the NSRC as a result of the collaboration will be made publicly available.

Some users may select different types of instruments according to their needs. Some users may first collaborate under the NSRC waiver and, as result of that initial pre-competitive collaboration. CRADAs may also be used in those cases where the users are primarily commercial in nature (*e.g.,* users who are providing full cost recovery or require data protection) and may evolve out of a pre-competitive collaboration.

Conclusion

DOE's user facility program has had a long history of providing valuable tools to the research community. DOE's unique equipment and expertise along with innovative approaches to user agreements are critical in DOE's implementation of its technology transfer mission. A high level of collaboration among the research community and the DOE national laboratories in the use of world-class scientific equipment and supercomputers, facilities, and multidisciplinary teams of scientists increases their collective contribution to DOE's mission and the Nation, making the national laboratory system more valuable as a whole than as the sum of its parts.

Table 2: Designated User Facilities at DOE Laboratories and Facilities

National Laboratory or Facility	Office of Science Designated User Facilities	NNSA Designated Technology Deployment Centers/User Facilities
Ames Laboratory	Materials Preparation Center	
Argonne National Laboratory	Advanced Photon Source Argonne Tandem-Linac Accelerator System Electron Microscopy Center for Materials Research Intense Pulsed Neutron Source Argonne Wakefield Accelerator Center for Nanoscale Materials	
Brookhaven National Laboratory	Relativistic Heavy Ion Collider National Synchrotron Light Source Scanning Transmission Electron Microscope Facility Accelerator Test Facility Center for Functional Nanomaterials	
Fermi National Accelerator Laboratory	1,000 GeV Superconducting Accelerator System Colliding Beam Experimental Areas Neutrinos at the Main Injector MiniBooNE Beamline and Experimental Areas National Environmental Research Park	
Idaho National Laboratory	National Environmental Research Park	
Lawrence Berkeley National Laboratory	Advanced Light Source National Center for Electron Microscopy National Energy Research Scientific Computing Center Joint Genome Institute – Production Genomics Facility (Joint Facility with LLNL, LANL, ORNL, and PNNL) Molecular Foundry	
Los Alamos National Laboratory	Manuel Lujan Jr. Neutron Scattering Center National Flow Cytometry Resource National Environmental Research Park Center for Integrated Nanotechnologies (Jointly with Sandia National Laboratories)	Accelerator Radio-Frequency Advanced Free Electron Laser Facility Amorphous Alloys Laboratory Antenna and Pulse Power Outdoor Test Range Facility Clean Laboratory and Mass Spectrometry Facility Combustion-Driven Supersonic Flow Facility Detonation Systems Facilities Energetic Neutral Beam Facility Explosives Pulse Power Facility Geostationary-Orbit Trapped Radiation Environment Facility High-Speed Electronic Laboratory Ion Beam Materials Science Laboratory Laser-Induced Breakdown Spectroscopy Research Facility Library Without Walls

National Laboratory or Facility	Office of Science Designated User Facilities	NNSA Designated Technology Deployment Centers/User Facilities
Los Alamos National Laboratory (con't)		Los Alamos Elastic Lidar Facility Los Alamos Radioisotopes and Analytical Resource Materials Science Laboratory Nondestructive Assay Instrumentation Evaluation Facility Personal Protective Equipment Environmental Test Facility Plasma Processing Research Facility Polymers and Coatings Laboratory Radiochemistry User Facility Resonant Ultrasound Spectroscopy Facility Separation Science and Technology Center Subpicosecond High-Brightness Accelerator Facility Superconductivity Technology Center Supercritical Fluids Experimental Facility Trident Laser Laboratory Tritium Science and Fabrication Facility Weapons Neutron Research Facility
Nevada Test Site	National Environmental Research Park	
Oak Ridge National Laboratory	High Flux Isotope Reactor Holifield Radioactive Ion Beam Facility Spallation Neutron Source (under construction) Center for Nanophase Materials Science Leadership Computing Facility Shared Research Equipment Program Center for Comparative and Functional Genomics Radiochemical Engineering Development Center Materials Processing Laboratories	
Pacific Northwest National Laboratory	Environmental Molecular Sciences Laboratory National Environmental Research Park	
Sandia National Laboratories	Combustion Research Facility (Livermore, CA) Center for Integrated Nanotechnologies (Jointly with Los Alamos National Laboratory)	National Solar Thermal Test Facility Nuclear Facilities Resource Center Explosive Components Facility Materials and Process Diagnostic Facility Ion Beam Materials Research Laboratory Radiation Detector Test Facility Shock Technology and Applied Research Facility Primary Standards Laboratory Validation and Qualification Sciences Experimental Complex Facility Mechanical Testing and Evaluation Facility Manufacturing Technologies Center Center for Security Systems Electronics Technologies User Facility Pulsed Power and System Validation Facility Plasma Materials Test Facility Advanced Power Source Research,

National Laboratory or Facility	Office of Science Designated User Facilities	NNSA Designated Technology Deployment Centers/User Facilities
Sandia National Laboratories (con't)		Engineering, and Evaluation Facility Geomechanics Laboratory Photovoltaic Laboratory Facility Engineering Sciences Experimental Facilities Sandia Orpheus Site
Savannah River National Laboratory	National Environment Research Park	
Stanford Linear Accelerator Center	Linear Accelerator Center Stanford Synchrotron Radiation Laboratory Linac Coherent Light Source (under construction) B-Factory	
Thomas Jefferson National Accelerator Facility	Continuous Electron Beam Accelerator Facility	

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APPENDIX A

TECHNOLOGY TRANSFER INDICATORS FOR FISCAL YEARS 2001-2005

The Technology Transfer Commercialization Act of 2000 (P.L. 106-404) requires each Federal agency that operates or directs Federal laboratories (or engages in patenting or licensing of Federally owned inventions) to provide the Office of Management and Budget (OMB) with an annual report on its technology transfer plans and recent achievements. A copy is also provided to the Technology Administration Office of the Department of Commerce. The Secretary of Commerce then prepares an overall Federal assessment for the President and Congress based on the program information in these agency reports. Specific data requirements to be reported each year are established by the Department of Commerce.

In accordance with the OMB's reporting guidelines, DOE's technology transfer data for fiscal years 2001-2005 are shown in Table 2 below and continues on the following pages.

Table 3: Department of Energy's Technology Transfer Activities, Fiscal Years 2001-2005

	Fiscal Year				
	FY 2001	**FY 2002**	**FY 2003**	**FY2004**	**FY 2005**
■ **Collaborative Relationships for Research & Development**					
● **CRADAs**, total active in the FY[1]	558	680	661	610	644
- New, executed in the FY	204	192	140	157	164
▪ Traditional CRADAs,[2] total active in the FY	--	--	Nr	Nr	Nr
- New, executed in the FY	--	--	Nr	Nr	Nr
▪ Non-traditional CRADAs, total active in FY	--	--	Nr	Nr	Nr
- New, executed in the FY	--	--	Nr	Nr	Nr
● **Other collaborative R&D relationships**					
▪ (specify as relevant), total active in the FY					
- New, executed in the FY					
■ **Invention Disclosure and Patenting**					
● New inventions disclosed in the FY	1,527	1,498	1,469	1,617	1,776
● Patent applications filed in the FY	792	711	866	661	812
● Patents issued in the FY	605	551	627	520	467

(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC 3710a).
(2) CRADAs involving collaborative research and development by a federal laboratory and non-federal partners.

	Fiscal Year				
	FY 2001	FY 2002	FY 2003	FY2004	FY 2005
■ **Licensing**					
Profile of Active Licenses					
● **All licenses**, number total active in the FY	1,162	3,459	3,687	4,345	5,677
▫ New, executed in the FY	226	694	711	616	750
▪ **Invention licenses**, total active in the FY	1,162	1,327	1,223	1,362	1,535
▫ New, executed in the FY	226	206	172	168	198
- Patent licenses, total active in FY	1,162	1,327	1,223	1,362	1,535
▫ New, executed in the FY	226	206	172	168	198
- Material transfer, total active in FY	0	0	0	0	0
▫ New, executed in the FY	0	0	0	0	0
- Other invention licenses, total active in FY	--	--	--	--	--
▫ New, executed in the FY	--	--	--	--	--
▪ **Other IP licenses**, total active in the FY	843	2,132	2,464	2,983	4,142
▫ New, executed in the FY	--	488	539	449	553
- Copyright licenses (fee bearing)	--	1,525	1,823	2,136	3,042
▫ New, executed in the FY	--	332	348	217	289
- Material transfer (non-inv.), total active in FY	--	581	604	794	999
▫ New, executed in the FY	--	153	180	208	229
- Other (bailment agreements, trademarks, etc.)		26	37	53	101
▫ New, executed in the FY		3	11	24	35
● **All income bearing licenses**, number	1,012	2,523	2,523	3,236	2,549
▫ Exclusive	174	301	246	255	248
▫ Partially exclusive	112	136	235	638	287
▫ Non-exclusive	726	2,086	2,042	2,343	2,014
▪ **Invention licenses**, income bearing	--	1,123	1,056	1,151	1,148
▫ Exclusive	--	263	215	223	223
▫ Partially exclusive	--	123	196	189	244
▫ Non-exclusive	--	737	645	739	681
- Patent licenses, income bearing	--	1,123	1,056	1,151	1,148
▫ Exclusive	--	263	215	223	223
▫ Partially exclusive	--	123	196	189	244
▫ Non-exclusive	--	737	645	739	681

	Fiscal Year				
	FY 2001	FY 2002	FY 2003	FY2004	FY 2005
▪ **Other IP licenses**, income bearing	--	1,400	1,467	2,085	1,402
▫ Exclusive	--	38	31	32	26
▫ Partially exclusive	--	13	39	449	43
▫ Non-exclusive	--	1,349	1,397	1,604	1,333
- Copyright licenses (fee bearing)	--	1,173	1,352	1,993	1,233
▫ Exclusive	--	29	25	30	25
▫ Partially exclusive	--	7	35	448	39
▫ Non-exclusive	--	1,137	1,292	1,515	1,169
▪ **Other IP licenses**		227	115	92	169
▫ Exclusive		9	6	2	1
▫ Partially exclusive		6	4	1	4
▫ Non-exclusive		212	105	89	164
● **All royalty bearing licenses**, number	1,012	2,523	2,522	3,236	2,549
▪ **Invention licenses**, royalty bearing, number	--	1,123	1,055	1,083	1,148
- Patent licenses, royalty bearing	--	--	--	--	--
▪ **Other IP licenses**, royalty bearing	--	1,400	1,467	2,085	1,397
- Copyright licenses (fee bearing)			--	--	--
Licensing Management					
● Elapsed execution time, licenses granted in FY					
▪ Invention licenses					
▫ average (or median)	--	127	133	62	104
▫ minimum	--	8	8	0.5	1
▫ maximum	--	471	745	1,777	1,750
- Patent licenses					
▫ average (or median)	--	127	133	62	102
▫ minimum	--	8	8	0.5	1
▫ maximum	--	471	745	1,777	1,750
● Number of licenses terminated for cause in FY					
▪ Invention licenses					
- Patent licenses	60	77	35	31	21

	Fiscal Year				
	FY 2001	FY 2002	FY 2003	FY2004	FY 2005
License Income					
● **Total income**, all licenses active in FY (thousands)	$21,403	$23,477	$25,805	$27,252	$27,382
▪ **Invention licenses**	$18,922	$21,253	$23,670	$23,321	$24,226
- Patent licenses	--	$21,253	$23,670	$23,670	$24,226
▪ **Other IP licenses**, total active in the FY	$1,870	$2,223	$2,136	$3,931	$3,156
- Copyright licenses	--	$1,870	$2,101	$2,678	$3,140
● **Total Earned Royalty Income** (ERI)	$7,832	$5,609	$6,612	$10,882	$12,443
▫ Median ERI	--	$4	$3	$4	$4
▫ Minimum ERI	$0.002	$0.023	$0.003	$0.004	$.004
▫ Maximum ERI	$1,585	$794	$913	$2,600	$1,752
▫ ERI from top 1% of licenses	$2,699	$1550	$1,478	$3,977	$3,486
▫ ERI from top 5% of licenses	$5,272	$3,696	$3,789	$8,837	$8,933
▫ ERI from top 20% of licenses	$7,163	$4,571	$5,962	$12,743	$11,152
▪ **Invention licenses**					
▫ Median ERI	--	$6	$5	$5	$5
▫ Minimum ERI	--	$0.025	$0.003	$0.006	$.005
▫ Maximum ERI	--	$794	913	$2,600	$1,752
▫ ERI from top 1% of licenses	--	$794	1,478	$3,977	$3,486
▫ ERI from top 5% of licenses	--	$3,419	$3,197	$7,299	$7,571
▫ ERI from top 20% of licenses	--	$5,068	$5,363	$10,729	$10,270
- Patent licenses					
▫ Median ERI	--	$6	$5	$5	$5
▫ Minimum ERI	--	$0.025	$0.003	$0.006	$.005
▫ Maximum ERI	--	$794	$913	$2,600	$1,752
▫ ERI from top 1% of licenses	--	$794	$1,478	$3,977	$3,486
▫ ERI from top 5% of licenses	--	$3,419	$3,197	$7,299	$7,571
▫ ERI from top 20% of licenses	--	$5,068	$5,363	$10,729	$10,270
▪ **Other IP licenses**					
▫ Median ERI	--	$1	$1	$2	$4
▫ Minimum ERI	--	$0.023	$0.010	$0.004	$0.004
▫ Maximum ERI	--	$69	$168	$197	$233
▫ ERI from top 1% of licenses	--	$69	$168	$197	$333
▫ ERI from top 5% of licenses	--	$115	$316	$498	$502
▫ ERI from top 20% of licenses	--	$197	$480	$660	$707

	Fiscal Year				
	FY 2001	FY 2002	FY 2003	FY2004	FY 2005
- Copyright licenses					
▫ Median ERI	--	$2	$1	$2	4
▫ Minimum ERI	--	$0.023	$0.010	$0.004	$.004
▫ Maximum ERI	--	$69	$168	$197	$233
▫ ERI from top 1% of licenses	--	$69	$168	$197	$333
▫ ERI from top 5% of licenses	--	$100	$272	$498	$502
▫ ERI from top 20% of licenses	--	$187	$480	$659	$707
Disposition of License Income					
● Income distributed (thousands)					
▪ Invention licenses, total distributed	$16,356	$16,423	$19,540	$18,622	$23,711
- To inventors	$5,942	$6,386	$5,624	$4,398	$5,267
-To other	$10,414	$10,036	$13,916	$14,224	$18,444
- Patent licenses, total distributed	$16,356	$16,423	$19,540	$18,622	$23,711
- To inventors	$5,942	$6,386	$5,624	$4,398	$5,267
-To other	$10,414	$10,036	$13,916	$14,224	$18,444
Other Technology Transfer Indicators (Relevant to DOE, but Not Required of all Agencies)					
Work-for-Others Agreements	--	1,934	1,952	1,884	2,431
User Facility Agreements	--	--	3,688	3,252	2,859

Notes:
-- Data were not requested.
Nr Data are not reported by DOE

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APPENDIX B
SELECTED ACCOMPLISHMENTS

There are many examples of technology transfer and industry partnering activities that reflect successful programs at DOE national laboratories and facilities. The following are examples of 22 successes, presented below to illustrate the range and nature of DOE technology transfer activities across the DOE complex. A brief description of each of these examples follows the list below.

- Alliance Reduces Risk of Deepwater Oil Well Catastrophes
- Brachy Therapy for the Treatment of Prostate Cancer
- Charge Coupled Device for Real-time Study of Neural Networks
- Combating Bioterrorism with Bio-Explosive Destruction Systems
- Faster, More Efficient Biorefining with Thermostable Endoglucanase (E1)
- Hybrid Solar Lighting
- Inter-Institutional Patent Bundling Agreement
- LANDSCAN 2003™: A Versatile Dataset for Global Population Mapping
- Laser-Peening System for Metal Life Extension
- MESA Reduces Drug Development Failures and Increases Efficiency
- Monitoring Combustion Behavior in Gas
- NanoFoil® Solders are Cool and Environmentally Friendly
- New Globus Venture Accelerates the Evolution of the Grid in Industry
- Oxygen Monitoring Made Simple
- Protecting Homeland Security with RAMSAFE® Software
- Reducing Infections with Bacterin-Coated Implants
- Separating Organic Material into Value-Added Chemicals
- Slowing the Progress of AIDS with Kaletra®
- Sounds of Old Recordings Restored with Optical Technology
- Structural Genomics Pipeline
- Underground Radio – Reach the Right People at the Right Time – In time
- University Alliance Initiative for Licensing Microelectromechanical (MEMS) Technologies

Alliance Reduces Risk of Deepwater Oil Well Catastrophes

Los Alamos National Laboratory (LANL) has developed expertise in radio frequency (RF) sensor technologies as part of its national security mission. Now LANL is using this expertise to partner with oil companies to support the Department of Energy's (DOE) energy mission. In recent decades, most new U.S. oil production has come from increasingly deep-water off-shore resources. As wells are drilled deeper underwater, the technological challenge due to high pressure and the extreme environment increases. The results of the LANL-Chevron partnership has the potential to save every deep-sea oil well from catastrophic failure — increasing the accessibility of domestic reserves and reducing U.S. dependence on imported oil. This technology also will result in savings of hundreds of millions of dollars for oil explorers and producers in the United States.

The partnership — called the Alliance for Advanced Energy Solutions — formally began in 2004 with a CRADA between LANL and Chevron to further develop and commercialize LANL's patented RF sensor innovations. Chevron is using the Alliance to collaborate with Los Alamos and to brainstorm solutions to problems in its day-to-day operations.

The Alliance is initially focusing on advanced well systems and solutions, giving Chevron the chance to test and incorporate cutting-edge approaches to oil well drilling. Researchers have focused on downhole wireless communications and noninvasive acoustic sensors for surface and downhole applications. These technologies help detect and mitigate trapped annular pressure problems that have led to well failures.

Los Alamos industry partner ChevronTexaco and its partner, Transocean Inc., achieved an industry record when Transocean's drill ship Discoverer Deep Seas began drilling operations at Tonga, the deepest well ever drilled in the U.S. Gulf of Mexico, at a total vertical depth of 31,824 feet.

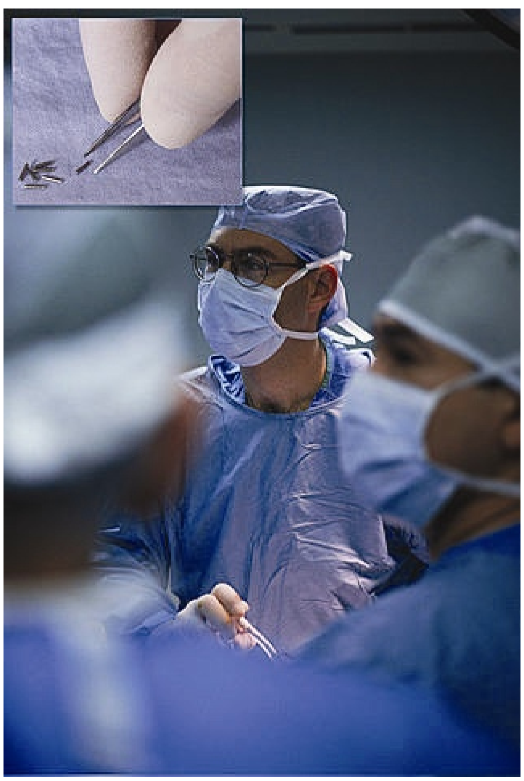
Photo courtesy of ChevronTexaco

Brachy Therapy for the Treatment of Prostate Cancer

Pacific Northwest National Laboratory (PNNL) has developed expertise in separating and purifying radioactive materials as part of its national security and environmental cleanup mission. Through a series of cooperative research agreements initiated in 2000, researchers at PNNL and IsoRay of Richland, Washington have worked to develop a new technology to treat prostate cancer. Through this collaboration, PNNL gained experience with a new medical isotope, and IsoRay personnel received valuable training in radiological operations and an understanding of the support and infrastructure required to operate a radiological facility.

The technology developed is for brachytherapy — also called internal radiation therapy — in which a protected radiation source is placed directly within or near a tumor site. This PNNL-IsoRay technology uses a new procedure to separate and purify cesium-131 and enclose it in small "seed" container. The seed emits x-rays that damage the genetic material of the cancer cells, making it impossible for these cells to continue to grow and divide.

In May 2004, PNNL and IsoRay began work to produce seeds. PNNL provided staff, specialized expertise, hot cells, and radiochemistry and analytical labs to assist IsoRay in achieving its business goals. In July 2005, IsoRay Medical, Inc. became a wholly owned subsidiary of a public company, IsoRay, Inc. As a public company, IsoRay will be better equipped to fund market expansion, including the approved use of its cesium-131 seeds in the treatment of breast, liver, lung, pancreatic, and other cancers.



To treat prostate cancer, IsoRay, Inc. developed an advanced form of radiation-emitting seeds that are implanted in confined tumors. The Richland startup company received a variety of assistance from Pacific Northwest National Laboratory.

Charge Coupled Device (CCD) for Real-time Study of Neural Networks

A multidisciplinary team of scientists and engineers from Lawrence Berkeley National Laboratory (LBNL) has developed a technique for growing large arrays of networked neurons in a way that will enable scientists to better understand how neurons in the human system communicate. This could lead to development of neural networks consisting of millions of living, interconnected nerve cells that can be used to test drugs and sense neurotoxins. The LBNL technique grows these arrays in virtually any pattern desired. This technique is unique due to the large size of the arrays and the fact that they are grown on the surface of a light-sensitive integrated circuit called a charge-coupled device (CCD). The result is a biological-electrical interface device called the Neural Matrix CCD which will enable scientists to isolate and identify neuronal networking in which neurons preferentially connect to some neurons and not others.

This technique is a large improvement over earlier techniques which produced neural networks consisting of fewer than a hundred neurons. These earlier methods couldn't be scaled up to detect adequately the precise location and history of nerve activity in large neuronal arrays. In contrast, the new LBNL technology is able to pattern the growth of up to a million neurons and to stimulate and monitor the activity of the individual neurons in these networks by using the CCD as an electrostatic pickup device; recording the signals from individual nerve cells, in real time, and mapping them within the neural network.

While most other neuron patterning and monitoring techniques are invasive, in the Neural Matrix CCD method, the nerve cells remain undisturbed during monitoring. This means that second messenger molecules and critical intracellular substances such as energy carrying adenosine triphosphate (ATP) remain unaffected. As more is learned about the growth of neural networks, the Neural Matrix CCD may become the basis for devices that can interface with patients' biological systems, helping those affected by neurological diseases such as multiple sclerosis, Alzheimer's, or Parkinson's. These implants might also be able to restore mental function lost due to brain injury or disease and repair spinal cord or nerve damage. By knowing what drugs or stimulation protocols most effectively stimulate synaptic connections, the technology could be used to promote nerve regeneration.

Further development of the Neural Matrix CCD is now under way in collaboration with Cellular Bioengineering Incorporated (CBI), a small business located in Honolulu, Hawaii. This research is being funded by the Center of Excellence for Research in Ocean Sciences (CEROS), a program of the Defense Advanced Research Projects Agency (DARPA).

The letters CBI were formed by patterned neuron growth using the LBNL Neural Matrix CCD. The line width of the lettering is 100 microns. The individual dots forming the letters are neurons. "CBI" stands for Cellular Bioengineering Incorporated, the company that is currently collaborating with Berkeley Lab to further develop the technology for neurotoxin detection.

Combating Bioterrorism with Bio-Explosive Destruction Systems

Researchers at Sandia National Laboratories have developed an instrument to explosively destroy and disarm bioweapons. This technology, called the Bio-Explosive Destruction System (BioEDS), extends the use of Sandia's existing Explosive Destruction System (EDS) to enable it to be used against bio-weapons. The original EDS was developed as an alternative to open burn/open detonation, which was inappropriate for use near population centers. The EDS system is currently patented by the United States Army.

The 8-ton Bio-EDS apparatus neutralizes dangerous biochemical agents including anthrax and sarin gas-infused weapons by first explosively opening the casing and deactivating explosives, then neutralizing harmful agents. This novel system includes: a system of linear and conical charges to open the weapon; a rotating vessel which contains the blast and also serves as the container for the neutralizing process; a chemical storage and feed system; and a waste handling system.

During evaluation, each of the treatment processes used resulted in complete neutralization of the bacterial spores based on no bacterial growth in post-treatment incubations. Use of the Bio-EDS results in a liquid effluent that can be disposed of at any commercial hazardous waste facility. The system's safety and portability — it can be easily transported on a flatbed trailer, rail car, or airplane to any site — make it the ideal candidate for a wide range of emergency response situations requiring the neutralization of bombs, suspect vials, canisters, or other munitions. Sandia's Bio-Explosive Destruction System won an award for "Notable Technology Development" as part of the *2005 Federal Laboratories Consortium Mid-Continent Region Annual Awards*.

The Explosive Destruction System can be transported to sites where materiel may not be safe to store or transport.

Faster, More Efficient Biorefining with Thermostable Endoglucanase (E1)

The biomass industry is aimed at changing the way that many industrial chemicals are produced today through the promotion of the "biorefinery" concept. A biorefinery is a facility that integrates processes and equipment to produce fuels, power, and chemicals from organic materials, such as corn or wheat. The biorefinery concept is analogous to today's petroleum refineries, which produce multiple fuels and products from petroleum. Industrial biorefineries have been identified as the most promising route to the creation of a new domestic biomass industry.

NREL pursues enzyme development critical to market viability for biofuels, chemicals, and other products.

A new genus and species discovered by National Renewable Energy Laboratory (NREL) scientists has the potential to change the biomass industry. NREL packaged this exciting discovery into a cutting edge enzyme technology that has the potential to improve productivity for the biorefinery. This technology is known as Thermostable Endoglucanase (E1), which allows manufacturers to operate enzymatic processes at higher temperatures, resulting in reduced process time and commensurate cost savings for creating industrial chemicals. This platform technology is designed to utilize a renewable technology based on enzymes to convert organic materials into sugars, for further development of ethanol/fuel, as well as other chemicals, and products.

The primary use for enzyme technology worldwide is for the active biological component of detergents and cleaning products. Enzymes are also used in the textile industry, mainly in the finishing of fabrics and garments for manufacturing processes such eliminating sizing, bio-polishing, and bio-stoning. Enzymes are also used in the areas of recycling/reprocessing operations for cellulosic materials, as well as food and animal feed, pulp and paper, brewing, and grain feedstock processing. The worldwide market value for this technology is estimated to be $500 million and growing.

NREL secured a license agreement with Genencor International (Genencor) for the E1 suite of patents. NREL was pleased to partner with Genencor because they hold many patents and applications worldwide and have demonstrated results in successful biotechnology commercial applications. Genencor believes that the production of a wide array of industrial products through biotechnological methods is imminent. This new license agreement between NREL and Genencor is an opportunity for the biotechnology industry to begin production from plants and other renewable resources, and more importantly is cost competitive with, or even less expensive than those synthesized through traditional chemistry.

Hybrid Solar Lighting

Oak Ridge National Laboratory (ORNL) scientists have developed a sunlight-based lighting technology that can completely replace conventional lighting in commercial buildings. The patented technology was funded by the Department of Energy (DOE) and the Tennessee Valley Authority (TVA) in partnership with utility companies, state energy agencies, industry and universities. It is called “hybrid” because it packages together conventional lighting technology and fiber-optic transmitted sunlight with sensor actuators programmed to create a uniform level of lighting. The system’s electric lights dim in bright sun and intensify as clouds or darkness approach. This hybrid solar lighting technology provides a truly natural quality of light while saving money for building owners.

Sunlight Direct, an ORNL startup formed to commercialize hybrid solar lighting for use in commercial buildings, has manufactured a beta product. The HSL 3000 uses a roof-mounted 48-inch diameter collector and small fiber optics to transfer sunlight to top-floor hybrid fixtures. The first deployment of the HSL 3000 was at the American Museum of Science and Energy in Oak Ridge. ORNL cosponsored systems at the Sacramento Municipal Utility District headquarters and at a recently-opened Super Wal-Mart in McKinney, Texas. Sunlight Direct has sold another six beta systems to be installed at commercial buildings in Minneapolis, New York, San Diego, and other sites around the country. Recent increases in energy costs and solar lighting tax incentives in the Energy Policy Act of 2005 make the timing ideal for hybrid solar lighting and the company now plans a full product launch in 2007.

ORNL’s hybrid solar lighting system uses sunlight for lighting space.

Inter-Institutional Patent Bundling Agreement

Public and private sector entities seeking to commercialize technologies developed by multiple research institutions used to have to negotiate a separate license deal with each institution. But on February 25, 2005, Sandia National Laboratories and six other New Mexico research institutions signed the Inter-Institutional Agreement (IIA) which allows for the bundling of patents. This groundbreaking agreement provides rapid response and flexibility so that when commercialization opportunities arise, these institutions can quickly capitalize on each opportunity rather than spending time negotiating contracts. The IIA allows each institution to identify patents that are appropriate for the agreement and available for licensing while retaining the right to license their patents non-exclusively. These patents are included in a bundle and licensed via the IIA to interested companies. The IIA also allows owning institutions to add or remove their own intellectual property and may be modified to allow other research organizations to become signatories.

Sandia was joined in signing the agreement by Los Alamos National Laboratory (LANL), Science and Technology Corporation at the University of New Mexico (UNM), New Mexico State University, New Mexico Institute of Mining and Technology, The MIND Institute, and the National Center for Genome Resources. The agreement was negotiated by a multi-organization team of Sandia, LANL, and UNM's Science and Technology Corporation.

This agreement will expand the number of companies that license technologies resulting from an increasing number of multi-institutional research efforts. Previously many companies were discouraged from licensing such technologies because of the time and money involved in the previous requirement for multiple negotiations. The Mid-Continent Region of the Federal Laboratory Consortium awarded the Inter-Institutional Agreement its "Regional Partnership Award" for 2005.

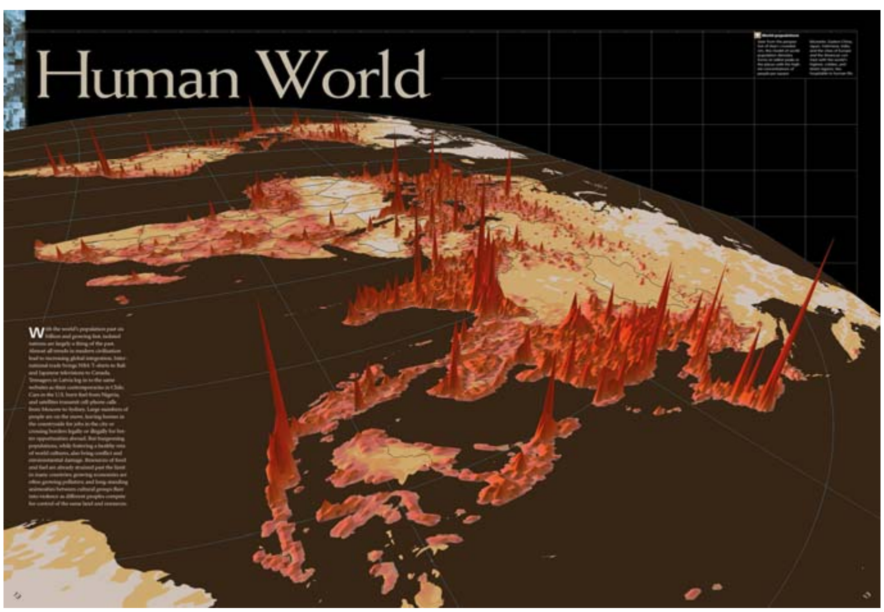
Seated left to right, Governor Bill Richardson (D-N.M.) and Senators Jeff Bingaman (D-N.M.),and Pete Domenici (R-N.M.) preside over the signing of the Inter-Institutional Agreement on the 25th anniversary of the Bayh-Dole Act, February 25, 2005.

LandScan 2003™: A Versatile Dataset for Global Population Mapping

Using data processing expertise gained from their work on the Department of Energy's (DOE) science and national security missions, scientists at Oak Ridge National Laboratory (ORNL) collected and organized a comprehensive global population dataset and linked it to geographic information science (GIS) data to create ORNL's LandScan 2003™ "High Resolution Global Population Data Set" (U.S. Copyright Registration No. TXu1-221-931).

Licenses for LandScan 2003™ are provided free of charge by UT-Battelle LLC to research institutions, U.S. Government agencies and United Nations organizations for research, humanitarian and U.S. Government uses. In 2005, it saw an unprecedented level of applications in these areas. For example, LandScan 2003™ was a critical component in disaster response planning during the recent Tsunami in Southeast Asia and Hurricane Katrina. The technology received widespread media coverage during these disaster recovery efforts, and ORNL's Geographic Information Systems (GIS) group continues to function in an "alert" mode whenever the situation demands, providing crucial population information as disasters and the accompanying relief efforts unfold.

Recently, ORNL's Office of Technology Transfer and Economic Development also sought to maximize more tangible returns. In 2005, 11 revenue-generating licenses were executed. High profile commercial users include *National Geographic*, *Time Magazine*, and the *New York Times*. The dataset also continues to be used by scientists and students in studies ranging from climate change effects to pollution monitoring and by a constituency ranging from high schools to the Max Planck Institute in Germany. In FY 2005, UT-Battelle granted 142 such licenses, resulting in a similar number of peer-reviewed research publications.



LandScan provides improved analysis of geographical distribution of populations such as densities of Asia's Pacific Rim.

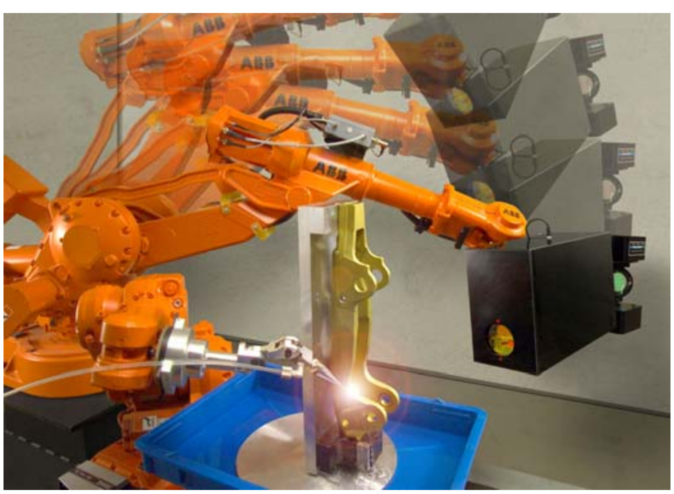
Laser-Peening System for Metal Life Extension

Lawrence Livermore National Laboratory (LLNL) laser fusion scientists realized that shockwaves from rapidly firing laser beam could be used for peening of metals. Peening is a technique to strengthen metal. Blacksmiths peen metal with hammer blows, but manufacturers peen by blasting metal with shot (shot peening). Because peening expands the surface of the cold metal, it relieves stresses and encourages strain hardening of the surface metal. In “laser peening,” laser beams travel into and compress the metal surface at a level four times deeper than conventional shot peening. This gives metal far greater fatigue strength by creating a layer of beneficial compressive stress

When applied to jet engine fan blades, laser peening enables the engines to be run longer and at higher temperatures leading to improvements in fuel efficiency. The technology is now used to peen the fan blades of the Trent 500 engines used in the A340 aircraft. In addition to permitting greater operating efficiency, the parts last longer so the time between periodic inspections and overhauls can safely be extended and maintenance costs, including aircraft down time, are lower.

Metal Improvement Company, Inc. (MIC) of Paramus, New Jersey, licensed the laser peening technology from LLNL and developed an advanced process through a Cooperative Research and Development Agreement. Over 40 new applications are being developed in aircraft, helicopters, Formula 1 race cars, and even in the semiconductor manufacturing industry.

MIC developed mobile laser peening systems for large and remote parts in the aerospace, oil, gas, and nuclear power industries. For example, MIC developed a robotic system that can move the laser beam and reach up to areas of aircraft or other structures by moving the laser rather than needing to move the part. In 1998, LLNL won a research and development (R&D) 100 Award and advanced applications of the technology won additional R&D 100 Awards in 2001 and 2003. Between May 2002, when MIC started manufacturing the technology at its facility in Livermore, and early 2005, MIC had created 30 new jobs in the Livermore area and an additional 30 jobs in the U.K. The number of production peening systems is being increased by 50 percent again during 2006 and more high quality technical jobs as well as lower skill support jobs are being added. Laser peening is gaining momentum as a tool to extend the useful life of highly stressed metal parts. In 2005, the Aerospace Branch of SAE International issued the first-ever standard for laser peening, AMS2546.

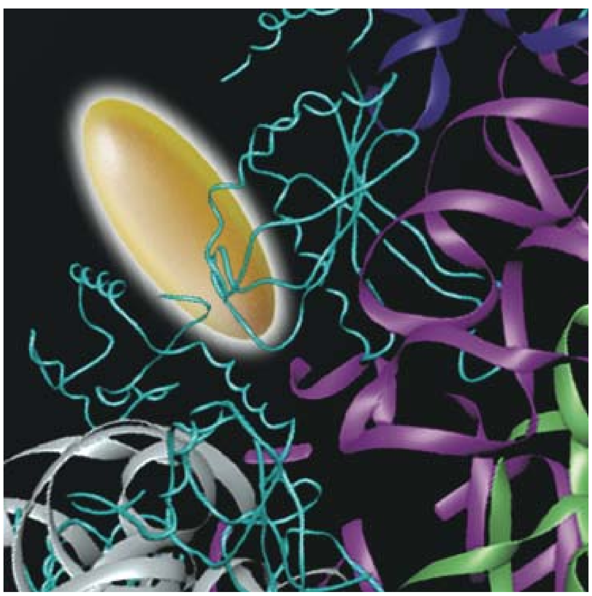


Moveable beam peening a T38 landing gear trunnion

MESA Reduces Drug Development Failures and Increases Efficiency

A Los Alamos National Laboratory scientist developed MESA (measuring enzyme substrate affinities) to serve the Department of Energy's (DOE) energy and science missions. But he realized this technique also could be used to measure potentially toxic protein-drug interactions more quickly and on a much larger scale than methods currently used by the pharmaceutical industry. To commercialize the pharmaceutical application of this technology, the scientist took entrepreneurial leave of absence from the Laboratory and founded Caldera Pharmaceuticals.

This technology should dramatically reduce the failure rate of animal and clinical trials for new drugs which typically cost about $200 million per drug. In addition, because MESA captures and categorizes all drug-protein interactions — including those that are potentially therapeutic as well as those that are potentially toxic — MESA could be used in the emerging field of personalized medicine to identify what treatment options are best for an individual. This will allow the most effective treatments to be tried first, saving lives and money. The company has now acquired $7 million in financing and plans to employ 100 people.



A fluorescing drug molecule (the glowing gold oval) binds to a protein (twisted and coiled thin teal "rope") within a "ribbon" representation of a bacterial ribosome, a frequent target for antibiotic drugs. This binding of the native drug to a protein molecule would be unambiguously detected by the MESA label-free measurement technology.

Monitoring Combustion Behavior in Gas

Researchers at National Energy Technology Laboratory (NETL) have developed a combustion control and diagnostics sensor (CCADS) that monitors combustion behavior in gas turbine combustors by analyzing the electrical properties of the flame. Prior to the invention of CCADS, a lack of durable combustion sensors for in-situ condition monitoring limited the ability of modern gas turbines to achieve stable ultra-low emissions performance over the entire operating range. It was developed and improved between 1999 and 2001 and two patents were issued for the invention.

The CCADS technique utilizes two electrically isolated electrodes installed on the fuel nozzle. The electrode closest to the combustion zone is called the "guard" electrode, and the upstream electrode is called the "sense" electrode. When an equal voltage is applied to both electrodes, current flows from the guard electrode through the flame. When the flame enters the upstream region of the fuel nozzle, (i.e., during auto-ignition and/or flashback) a significant ionization current is produced from the sense electrode. When the CCADS fuel nozzle is incorporated into the centerbody of a gas turbine fuel nozzle, it can sense flame flashback, combustion instabilities (including flame oscillations), and variations in fuel/air mixture composition and it reacts to stabilize the flame, thus extending engine life and reducing electricity costs and emissions of NOx and CO.

In 2002, NETL licensed the invention to Woodward Industrial Controls for commercial development. A CRADA was negotiated between NETL and Woodward to enable the two to work together to enhance the development. In 2005, NETL and Woodward executed a second CRADA to address research and development (R&D) issues for commercialization. This has advanced the technology to the point where Woodward is negotiating sales of CCADS to the major turbine manufacturers. Woodward was chosen to commercialize CCADS because it has the design and manufacturing expertise and market knowledge to make the technology a commercial success. Woodward provides services and subsystems to most major gas turbine original equipment manufacturers, and is the leading producer of nozzles for heavy frame engines (large turbines) worldwide.

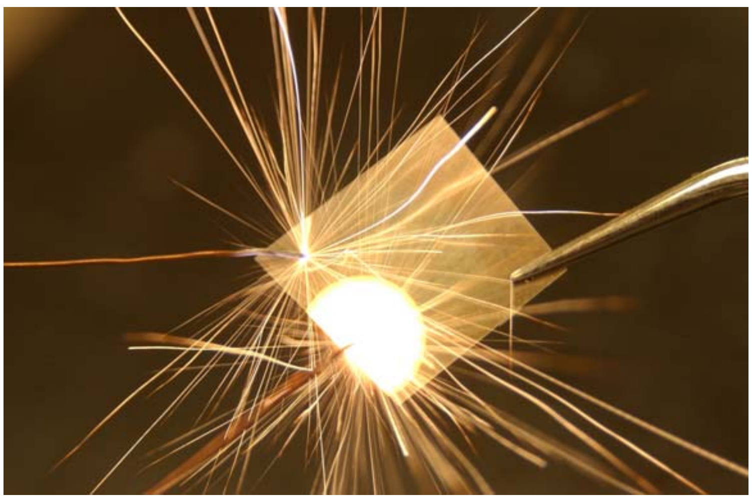
NETL researchers evaluate the operation of the combustion control and diagnostics sensor.

NanoFoil® Solders are Cool and Environmentally Friendly

A critical issue in computer and semiconductor design is developing effective methods to conduct heat away from a computer chip, without damaging or destroying the chip. A new class of material called *NanoFoil® does just that — creating a strong, thermally conductive bond between a heat sink and a chip with no damage to the chip. Nanofoil® can be used to bond metals, ceramics, semiconductors, and polymers. It will even bond dissimilar materials without causing them to crack. Developed jointly by Lawrence Livermore National Laboratory (LLNL), Johns Hopkins University, and Reactive NanoTechnologies, Inc. (RNT) of Hunt Valley, Maryland, NanoFoil® is now manufactured and sold exclusively by RNT.

NanoFoil® delivers just enough heat to melt a solder but not enough to damage a chip. When one end of the foil is pulsed with energy, NanoFoil's thousands of nanolayers of nickel and aluminum begin to chemically react and release heat into the surrounding solder material. This reaction front self-propagates across the foil so that the temperature of the reacted area increases to more than 1,500°C while the rest of the foil remains at room temperature. The bond produced can be customized for specific uses by controlling properties of this chemical reaction.

NanoFoil® can replace epoxies and solder in mounting components on circuit boards, eliminating the need for lead-based solders. Because it creates strong, large-area metallic joints between ceramic and metal, it also may be used to attach ceramic armor tiles to military tanks and trucks. Other potential applications include mounting magnetron sputtering targets; hermetically sealing devices such as photocells, capacitors, and sensors; and igniting solid propellants. NanoFoil® may also be developed for numerous other military applications. NanoFoil® was featured on the cover of the *Strategic Plan for the National Nanotechnology Initiative* published in December 2004 by the Executive Office of the President. More recently, RNT, LLNL, and Johns Hopkins University won a 2005 research and development (R&D) 100 Award for NanoFoil®.



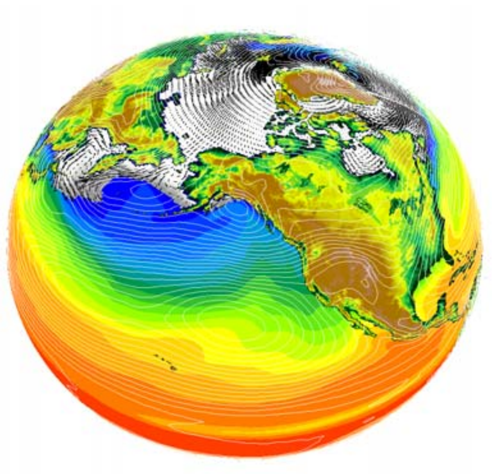
A NanoFoil® is pulsed with energy to ignite a reaction with the foil. Image courtesy of Reactive NanoTechnologies, Inc. (RNT).

*NanoFoil® is a registered trademark of Reactive NanoTechnologies, Inc. (RNT)

New Globus Venture Accelerates the Evolution of the Grid in Industry

Since 1996, the Globus Alliance — a joint effort initially of Argonne National Laboratory, the Information Sciences Institute of the University of Southern California, and several other institutions worldwide has developed the open-source Globus Toolkit software. This software is central to virtually every major deployment of "the Grid" — an interconnected computing environment that is transforming the nature of science and engineering research. The Grid lets users share computing power, databases, and other tools securely over the Internet. Now in its fourth major release, the Globus Toolkit has been widely adopted as a de facto standard infrastructure for the Grid. Since 2000, companies including DataSynapse, Fujitsu, Hewlett-Packard, IBM, NEC, Oracle, Platform, Sun, and United Devices have pursued Grid strategies based on the Globus Toolkit.

The Alliance recently started a new venture, Univa Corporation, to assist commercial customers in building and implementing Grid technology. In October 2005, IBM announced that it was adopting Univa technology as a core piece of its Grid computing offering. Univa was named by NetworkWorld as one of the top 10 startups to watch this year. Also championing open source Grid technologies in the enterprise is the recently created Globus Consortium. With the support of the Globus Alliance together with industry leaders IBM, Intel, HP, and Sun Microsystems, the Globus Consortium draws together the vast resources of IT industry vendors, enterprise IT groups, and a vital open source developer community to advance use of the Globus Toolkit in the enterprise.



Scientists in the Earth System Grid (ESG) are producing, archiving, and providing access to climate data that informs research on global climate change. This image displays data from ESG and shows sea ice extent (white/gray), sea ice motion, sea surface temperatures (colors), and atmospheric sea level pressure (contours). ESG uses Globus software for security, data movement, and system monitoring. (Image provided by the National Center for Atmospheric Research)

Oxygen Monitoring Made Simple

Scientists at Ames Laboratory's and Iowa State University's (ISU) Microelectronics Research Center conducting basic research on luminescent organic thin films and organic light-emitting devices, (OLED) have discovered a way to make integrated oxygen/OLED sensors. Because the sensor is structurally integrated with its ultrathin light source, an OLED, its size is greatly reduced, simplifying and reducing the cost of fabrication and lessening its energy consumption. Two ISU graduate students are fabricating the OLEDs for the new oxygen sensors, and the Ames Laboratory Electronics Shop is designing and fabricating a prototype electronics module, power supply, and photodetector assemblies.

A new spinoff company, Integrated Sensor Technologies, Inc (ISTI) has now licensed this technology and technology commercialization specialists ISU's Institute for Physical Research and Technology helped ISTI obtain research funding including a Small Business Innovative Research grant from the National Institutes of Health. ISTI is now studying potential markets for oxygen sensors in health care, environmental, biological, food packaging, health and safety, and aerospace applications.

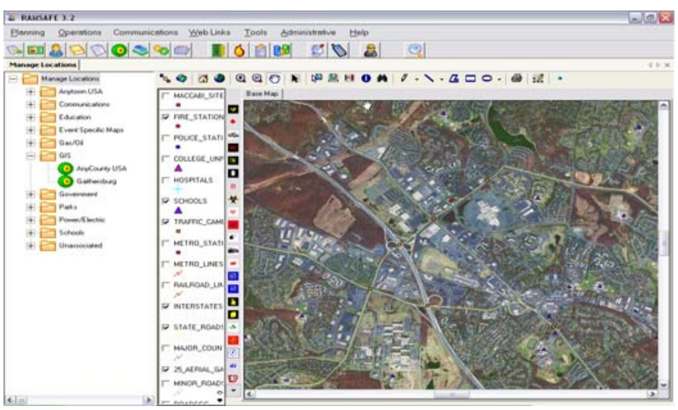
This brilliant blue organic light-emitting device, or OLED, is integral to a new oxygen sensor that is making its way from basic research at Ames Laboratory to marketable product at the new Ames company, ISTI. The novel sensor technology structurally integrates a photoluminescence-based oxygen sensing element with its OLED light source.

Protecting Homeland Security with RAMSAFE® Software System

A research partnership comprising the Y-12 National Security Complex, Oak Ridge National Laboratory, University of Tennessee Research Foundation, and MCH, a small software company, has developed a dynamic, easy-to-use software system designed to help cities and states better prepare, respond, and recover from emergency situations.

The RAMSAFE® software system integrates interagency collaboration tools, operational checklists and procedures, resource management, and visual intelligence in order to enable emergency responders to save time, save lives, and avoid hazards in the worst possible scenarios. It provides real-time logistical information and stores and organizes massive amounts of critical, emergency-event mitigating data: floor plans, photos, pre-incident plans, checklists, and other crucial information and feeds this data into a software system which provides forecasts of casualties and other impacts and recommends command-level responses. RAMSAFE's® Geographic Information Systems (GIS) capabilities enable specific time-phased resource requirements and its modeling capability provide online access to personnel and resource shortfall predictions that change as a situation unfolds.

Licensed to a new, start-up company, RAMSAFE® Technologies, Inc., the system has been installed and used in numerous cities beginning with the 2002 Utah Olympics. Since then it has been installed in at least 11 sites, most recently in New Orleans, to assist in the recovery from Hurricane Katrina. In 2004, Unisys Global Corporation (Unisys) completed an analysis of the 10 top software competitors serving the homeland security response market. Unisys selected RAMSAFE® to be the sole software used in Unisys' homeland security marketing efforts to first responders and emergency managers at all levels of government.



Example of RAMSAFE® system computer screen showing aerial view of location

Reducing Infections with Bacterin-Coated Implants

Pacific Northwest National Laboratory (PNNL) developed a bioactive mineral layer for use on bone implant surfaces. Bioactive calcium phosphate coatings for orthopedic implants can be produced from a water-based solution using a surface-induced mineralization process, known as SIM. The coating process can coat both rough and smooth implants without affecting the surface texture. Advances like SIM can eliminate the need for follow-up surgeries and stop the spread of infection, therefore, saving implant patients a great deal of pain, risk, and expense.

A biofilms specialist company, Bacterin, licensed the technology in 2003 and obtained approvals required by the Food and Drug Administration. This technology will play a major role in dramatically reducing post-surgical infections in implant recipients and wounded military personnel. It will also increase acceptance of artificial joints by the body. Preventing these infections promises billions of dollars of savings to the U.S. government in follow-up medical care. In addition, significant cost savings and reduced environmental impact will be realized in the manufacturing process, as the simplified water-based deposition process does not require use of multi-million dollar instruments and uses very few hazardous materials

Bacterin-coated implants are accepted as human bone rather than foreign objects, increasing surgical success rates while reducing infection.

Separating Organic Material into Value-Added Chemicals

Researchers at the National Renewable Energy Laboratory (NREL) have created a technology and process to separate organic materials such as corn, wheat, cotton waste, and other lignocellulosic material, into pure streams of value-added chemicals. These pure streams are valuable because they can be used to produce chemical products for a variety of industries such as pulp and paper, chemical, food, and packaging. NREL's new method is superior to conventional chemical separation processes because it enables a variety of organic materials to be separated by a highly efficient, single-phase process that promises far lower cost and higher quality, extremely pure products such as cellulose, hemicellulose, and lignin. The NREL technology and process also gives the manufacturer greater flexibility in feedstocks that can be used and in the products produced.

Key applications for this technology, with markets approaching many billions of dollars in size, include the biomass to ethanol and cellulose production for the paper and pulp industry, chemical industry, and the packaging industry. NREL has secured a worldwide exclusive technology license between UTEK and Xethanol Corporation and is collaborating with Xethanol Corporation, as they develop and commercialize this new technology. Xethanol Corporation is focused on biomass-to-alcohol industry. Their mission is to convert biomass that is currently being abandoned or land filled into ethanol and other valuable co-products. Xethanol owns and operates an ethanol production facility at its Biomass Technology Center in Iowa that processes fermentable sugars derived from food biomass as its primary feedstock.

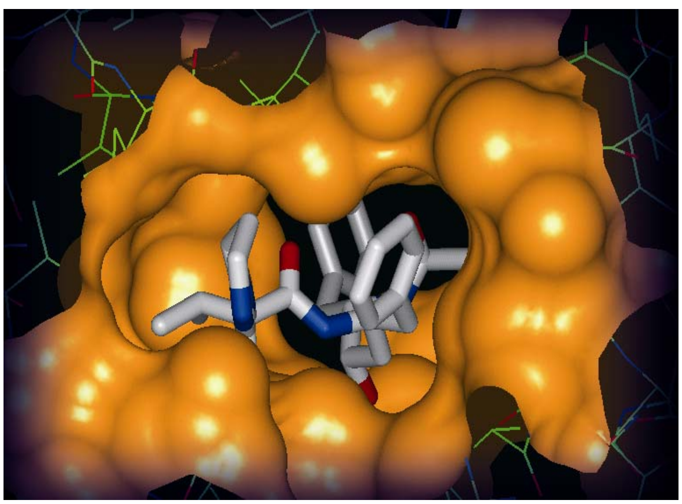
NREL researchers have developed a technology to produce ethanol and other products from the fibrous material in the corn stalks and husks or other agricultural or forestry residues.

Slowing the Progress of AIDS with Kaletra®

Scientists conducting X-ray crystallographic studies of the protein called human immunodeficiency virus (HIV) protease at the Department of Energy's (DOE) Advanced Photon Source (APS) at Argonne National Laboratory discovered the atomic details of how compounds interact with this protein. They then tested potential drugs for the treatment of acquired immune deficiency syndrome (AIDS) that interact with the 12 different kinds of proteins produced by HIV so as to interfere with virus reproduction. This work was carried out by researchers using an Industrial Macromolecular Crystallography Association Collaborative Access Team (IMCA-CAT) beamline at the APS and led to the determination of the crystallographic structure of the Abbott Laboratories' pharmaceutical known as Kaletra®.

Since its approval by the Food and Drug Administration in 2000, Kaletra® has had a tremendous positive impact on the progression of AIDS in patients infected with HIV. In the first six years of clinical trials, patients taking Kaletra® had an undetectable viral load (amount of virus in the blood) of less than 50 copies per milliliter, as measured by HIV RNA. In 2002, Kaletra® became the most-prescribed drug in its class for AIDS therapy. Kaletra® is referred to as a drug that helped turn a situation where patients were dying from AIDS to a situation where patients are living with AIDS.

IMCA-CAT is an organization charged by the Industrial Macromolecular Crystallography Association to design, build, and operate an experimental facility at the APS. IMCA is an association of leading pharmaceutical companies committed to the use of macromolecular crystallography as a tool in drug discovery and product development.

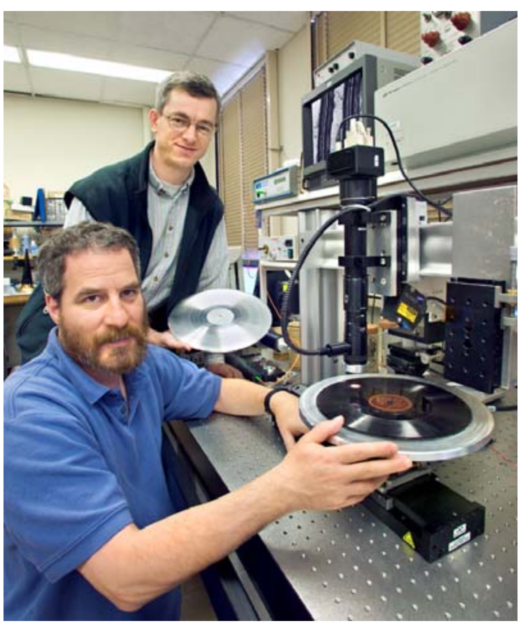


Close-up view of the drug binding site within HIV protease. A mathematically calculated surface (orange) shows the active site of the protein is a cavity inside the protein. The drug fits inside this cavity, much like a key fits into a lock. X-ray crystallography studies provided the scientific details of how the atoms of Kaletra® (carbon atoms are gray; nitrogens, blue; oxygens, red) interact with the viral protein.

Sounds of Old Recordings Restored with Optical Technology

An optical sound restoration system developed by Lawrence Berkeley National Laboratory (LBNL) scientists is the first technology to provide non-contact restoration of recording for all types of sound carriers. Now audio data more than a century-old can be recovered without any physical contact with fragile old recordings on a wide array of media including tin foil, wax and plastic cylinders, shellac and vinyl discs, acetate sheets, and plastic dictation belts. Depending on the medium to be restored, the technology produces either 2-dimensional or 3-dimensional optical digital images, creating a map of the entire groove profile of a disc or cylinder.

The physicists who invented the system developed their expertise in sensor arrays as part of the Department of Energy's (DOE) Science mission. They realized that that tracking particles in high energy physics experiments — which requires the ability to find and image the tracks made by elementary particles amid a jumble of noise — is similar to the problem of recovering old audio data. Through LBNL's Technology Transfer Department, these scientists received a $5,000 technology maturation grant to finish the first round of studies and publish their results. The scientists sent their publication describing the technology to the Library of Congress and other institutions. Their outreach resulted in over $600,000 in funding from The National Endowment for the Humanities, The Library of Congress, The National Archives and Records Administration, and DOE for audio restoration technology development and demonstration. LBNL is now working with the Library of Congress to build an optical restoration system for preserving our national audio treasures. The invention will also enable libraries and archives all over the world to digitize early recordings of music, news broadcasts, and live events. The home page for the LBNL system, http://www-cdf.lbl.gov/~av features digital recordings made using the technology, as well as presentations and papers.

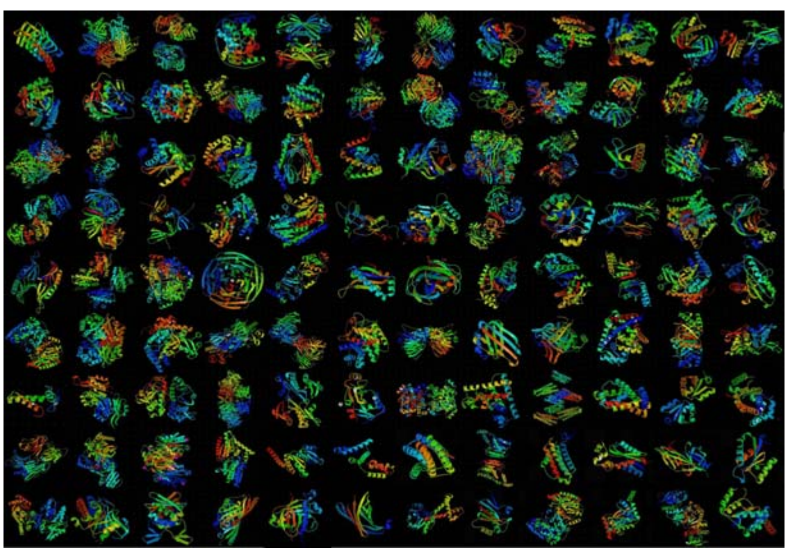


Scientists at LBNL load an album into the touchless Berkeley Lab sound restoration system. The scientists are working with the Library of Congress to further develop the system in order to preserve historically valuable recordings and digitize audio collections so that the public and scholars will have greater access to these treasures.

Structural Genomics Pipeline

Scientists at Argonne National Laboratory (ANL) carrying out the Department of Energy's (DOE) energy and science missions developed new techniques for organizing massive amounts of data for complex work such as computer reconstruction of high energy nuclear reactions. Now these scientists have joined biologists and computer scientists to study the macromolecular structure intrinsic to life. As little as a decade ago, production of a single protein structure was considered a sufficient challenge to be worthy of a Ph.D in genomics. Now, as a result of this interdisciplinary effort, it is often accomplished in a matter of a few weeks because scientists have automated every step in the process. Scientists at ANL's Advanced Photon Source have begun to automate cloning of genes; bacterial production of proteins, crystallization, collection and analysis of crystallographic data and interpretation of the x-ray patterns collected. ANL's work in "Structural Genomics" now involves an integrated set of technologies that encompasses the entire experimental pipeline that stretches from the sequence of a gene to the three-dimensional structure of the gene product.

After its launch of the Pilot Center of the Protein Structure Initiative of the National Institute of General Medical Sciences, ANL was named a Production Center for this Initiative. The Midwest Center for Structural Genomics now produces images of the molecular structure of as many as 20 proteins a month. The advances in technology needed to reach this level of efficiency have transformed the entire field of structural biology, and are now having huge impact on our understanding of cellular functions. The goal of Structural Genomics is no less than to establish a complete link between the reams of information being generated by genome projects to the three-dimensional structures of cells as a critical step towards fundamental understanding of the molecular basis of living systems. ANL's Center is the Structural Genomics pipeline to achieving this goal.



Protein structures solved by the MCSG at Argonne National Laboratory

Underground Radio — Reach the Right People at the Right Time — in Time

Underground Radio, developed by Los Alamos National Laboratory (LANL), is the first portable radio receiver able to support two-way voice communication through hundreds of meters of solid rock. Underground Radio achieves high sensitivity and low noise by using a detector made of high-temperature superconducting (HTS) material fashioned into a magnetic field sensor called a superconducting quantum interference device (SQUID). This quantum technology enables the signals to transmit through metal and debris with extremely high reliability.

With a bandwidth of several kilohertz — more than 1 order of magnitude larger than that of other through-the-earth radio systems — Underground Radio can also be used for voice communication. The HTS SQUID sensor can also be used to provide divers and small submersible craft with underwater communication capabilities or as a down hole magnetometer to for high-quality geophysical measurements. In fact, Underground Radio was originally developed by Los Alamos and Raton Technology Research Inc. for mineral exploration and development applications, an $8 billion U.S. industry. In 2004, Canadian-based Vital Alert signed a limited exclusive license with LANL Vital Alert plans to integrate the technology into products that for urban and rescue communications.

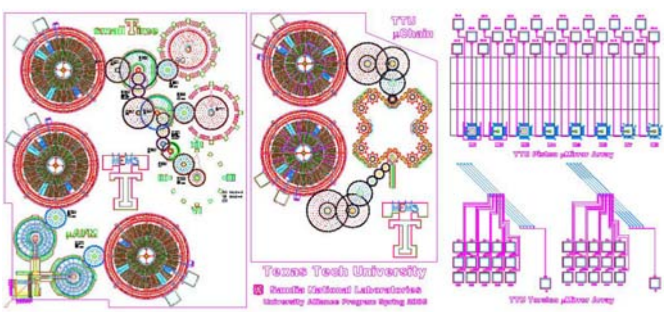
Scientists at LANL demonstrate the Underground Radio technology in a northern New Mexico mine. Canadian-based Vital Alert recently licensed the technology from Los Alamos.

University Alliance Initiative for Licensing Microelectromechanical (MEMS) Technologies

The University Alliance initiative is a licensing program developed at Sandia National Laboratories that allows U.S. educational institutions to access Sandia's MEMS capabilities. As part of the Initiative agreement, participating educational institutions receive MEMS teaching materials, SUMMiT™ design and visualization software, training for a school "superuser" and MEMS parts for test and evaluation. Since its creation in 2004, the University Alliance program has gained 10 licensees, and has 4 licenses pending.

University Alliance is part of Sandia's SAMPLES™ (Sandia Agile MEMS Prototyping Layout Tools, Education and Services) program, developed to facilitate MEMS education and access to Sandia's cutting-edge SUMMiT™ process technology. The SUMMiT™ fabrication process is a MEMS batch fabrication process that uses conventional integrated circuit processing tools to achieve high volume, low cost MEMS production. Sandia's SUMMiT™ fabrication processes allow the development and manufacture of complicated MEMS devices not otherwise achievable through surface micromachining processes, thereby enabling advancements for a variety of applications, including military hardware, optical switches, electronic imaging, telecommunications, and sensors, among others.

The University Alliance Program was honored as an industry "Best Practice" by the MEMS community members attending the MEMS 2005 Educational Workshop (Jan 2005) sponsored by the National Science Foundation and the Institute of Electrical and Electronics Engineers.



Texas Tech engineering students produced this winning design for the 2005 University Alliance Design Competition.