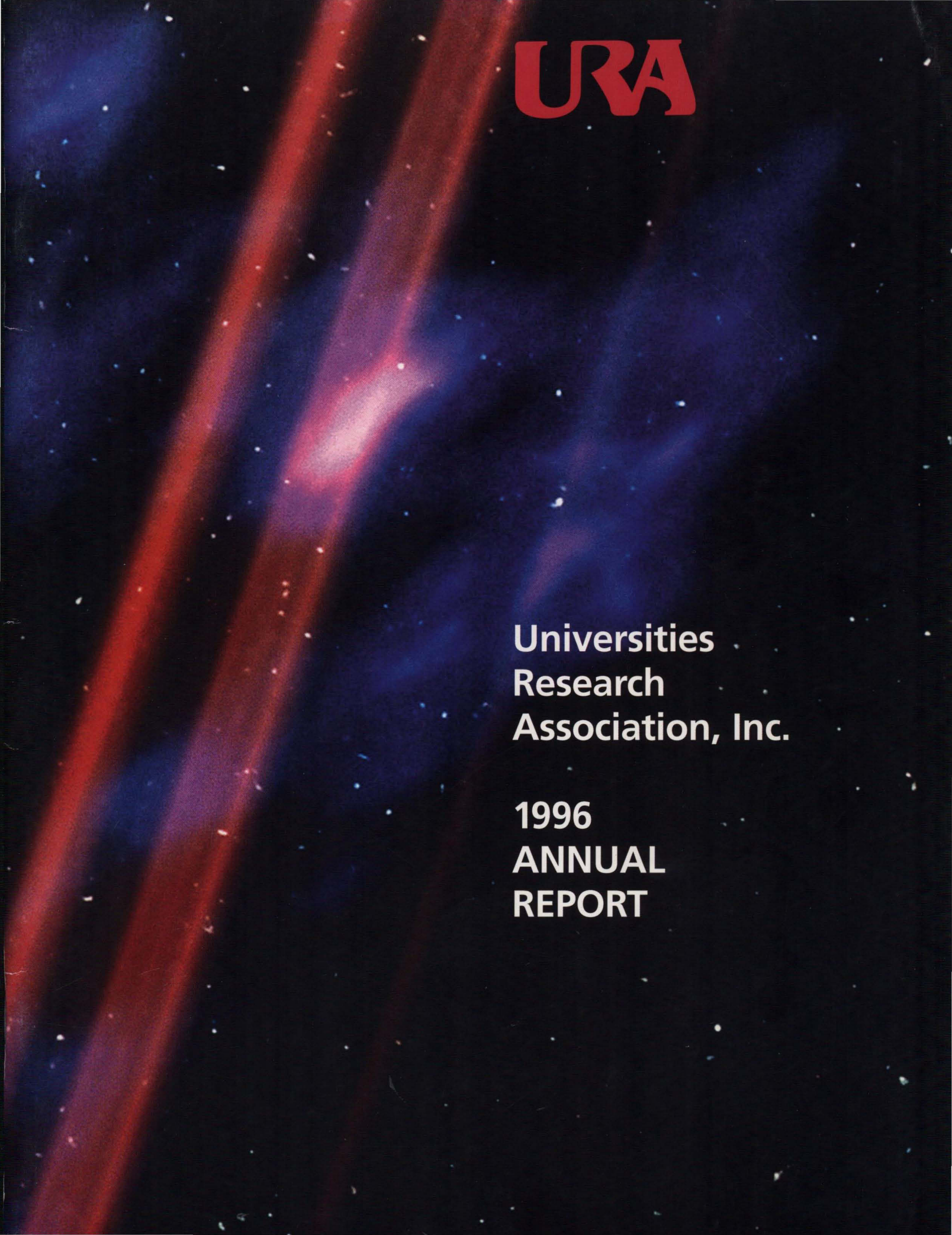

Universities Research Association, Inc.

1996 ANNUAL REPORT

URA Serves University Scientists

URA is "an entity in and by means of which universities and other research organizations may cooperate with one another, with the Government of the United States, and with other organizations, toward the support and use of laboratories, machines, and other research facilities, and toward the development of knowledge in the physical and biological sciences."
It was created "...for research, development and education in the physical and biological sciences, including all aspects of the field of high-energy physics, nuclear energy, and their engineering and other applications; and to educate and train technical, research and student personnel in said sciences."

Universities Research Association, Inc.

Annual Report 1996

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URA is a private not-for-profit corporation. A consortium of research universities, it serves as a contractor to the federal government for the operation of major scientific facilities. This volume – updated annually with new financial and organizational data – provides the historical context for the consortium's structure and mission, as well as highlights of its contributions to science, technology, industry, and education.

Message from URA President Fred Bernthal

For URA and its 86 member universities, 1996 was a year for focus on the future of the URA corporation and our undertakings in particle physics, and at the interface of particle physics and astrophysics. Part of the future laid out in 1996 has its foundation in URA's beginnings, as we reached agreement with DOE on a new five-year extension to the management and operating contract for Fermilab. At the same time, on behalf of several member universities, URA last fall submitted proposals to the Department of Energy and the National Science Foundation, requesting funding for the Pierre Auger Observatory Project to study the mysterious origins and character of the very highest energy cosmic rays. Meanwhile, the last handful of employees at the former Superconducting Super Collider (SSC) Laboratory quietly departed the Texas site.

URA continues to benefit from the leadership of those many distinguished individuals who voluntarily serve on the Board of Trustees, the Fermilab Board of Overseers, and in related oversight activities. Agnar Pytte, President of Case Western Reserve University, completed his second term on the Board of Trustees, and his third year as Chair; Robert Galvin, Chair of the Executive Committee of Motorola, continues to provide his wise counsel and leadership to Congress, to DOE, and to URA as Vice-Chair of the Trustees; Gordon Gee, President of The Ohio State University, served as Chair of the Council of Presidents this year, and John McTague, Vice President of Ford Motor Company and former Science Advisor to the President, completed his second year as Chair of the Fermilab Board of Overseers. Finally, Prof. Gary Feldman of Harvard University chaired this year's outside review of Fermilab by the URA Visiting Committee.

The extraordinary talent that assembles voluntarily from around the country and the world to constitute URA and assist its undertakings attests to the continuing benefits to be derived by the community of research scholars, and by DOE as agent for the American people, from this form of partnership between national laboratories and our nation's research universities.

The extraordinary talent that assembles voluntarily from around the country and the world to constitute URA and assist its undertakings attests to the continuing benefits to be derived by the community of research scholars, and by DOE as agent for the American people, from this form of partnership between national laboratories and our nation's research universities. The URA paradigm for university-government-laboratory partnership has by now been frequently emulated, not only in DOE's activities, but in other agencies as well.

That partnership was revalidated for URA in 1996 as our negotiating team, under the experienced leadership of Prof. Maurice Glicksman of Brown University, reached agreement on another five-year extension of the URA contract for the operation of Fermilab. This contract, the first to be negotiated under terms of DOE's proposed new contract reform regulations, contains provisions for performance measures and requires URA to assume certain new liabilities. While the assumption of those new risks comes at some additional cost, we believe the terms of this new contract provide a workable framework for URA to continue its partnership with DOE.

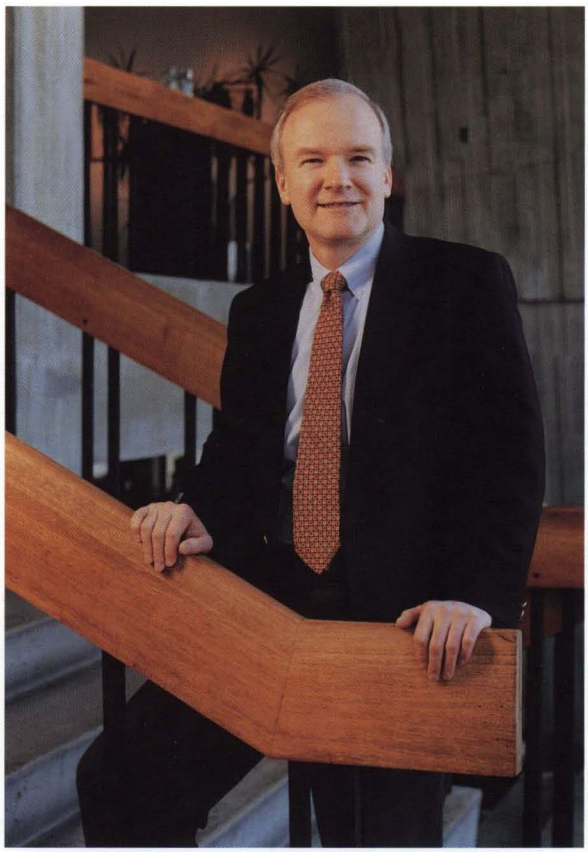
The 1996 Council of Presidents Annual Meeting – URA's "shareholders" meeting – continued our recent practice of combining Council business with a Policy Forum. The program this year featured addresses by then Chair of the House Science Committee, Congressman Robert Walker; the Chair of that Committee's Basic Research Subcommittee, Congressman Steven Schiff; President Clinton's Science Advisor, John Gibbons; DOE Office of Energy Research Director Martha Krebs; and NSF Director Neal Lane. Nearly 70 member universities were represented by their presidents or senior representatives at the 1996 meeting.

The University of California-Davis, the University of Florida, Kansas State University, the University of New Mexico, New Mexico State University, and the University of Pisa, Italy were all elected to full membership in URA in 1996, and an application is pending from another U.S. university.

As 1996 came to a close, the book was in turn closed on the unfortunate and brief history of the Superconducting Super Collider Laboratory, with the last URA and URA-contractor employees departing the Texas site. Under the leadership of Gen. George Robertson, URA performed the shutdown well within the amount originally budgeted for that purpose, and with an outplacement effort that by any measure was a model for helping smooth the transition to new jobs for our dedicated employees.

Fermilab continues to perform and thrive as the URA flagship enterprise under the leadership of Director John Peoples. Construction of the Main Injector is on time and on budget, with the bonus addition of a novel antiproton recycler ring achieved within the original budget. The Tevatron completed its highly successful collider "Run I" in February of 1996. In the second half of 1997, following completion of a fixed-target run, the process of bringing the Main Injector on-line begins. Scheduling and budget issues that had threatened the timely availability of the upgraded DZero and CDF collider detectors have been resolved. Tevatron collider "Run II", with the Main Injector in place, is scheduled to begin in the summer of 1999. Meanwhile, Fermilab is also leading U.S. development of hardware for participation in the European Large Hadron Collider (LHC) Project at CERN, in concert with U.S. scientists who wish to work at the new high-energy frontier of particle physics early in the next century. And the Fermilab site itself still combines the qualities of environmental field laboratory, public park, and showcase of nature.

The proposed Neutrinos at the Main Injector (NUMI) project at Fermilab, an experiment designed to probe whether these elusive particles have measurable mass, was in 1996 formally recommended for funding by DOE's High Energy Physics Advisory Committee. When this $120 million project is fully funded, neutrinos produced at Fermilab will be seen by a detector to be located deep underground in the former Soudan iron mine in northern Minnesota, a site that also holds broader potential as a center for other research in particle astrophysics.



URA President Frederick M. Bernthal

In November of 1996, URA submitted identical proposals to the Department of Energy and to the National Science Foundation, requesting $30 million on behalf of U.S. participants in the Pierre Auger Observatory Project, led by Nobel-laureate Professor James Cronin of the University of Chicago. This $100 million project plans to study cosmic rays of energy 10^{20}eV, some 10^{8} times the energy which Fermilab is capable of producing! The effort now involves scientists from 18 countries, and we are hopeful that a decision to fund will be reached before the end of 1997.

As these new chapters in the history of URA's scientific programs are being written, our activities remain grounded in the original URA Articles of Incorporation, key excerpts from which appear on the inside cover of this report. We look forward to another successful year of service to our university community, as it continues the vital enterprise of exploration on behalf of the American people, and their international partners in scientific research.

Member Universities

Alabama
- University of Alabama-Tuscaloosa

Arizona
- Arizona State University
- University of Arizona

California
- California Institute of Technology
- University of California-Berkeley
- University of California-Davis
- University of California-Irvine
- University of California-Los Angeles
- University of California-Riverside
- University of California-San Diego
- San Francisco State University*
- Stanford University

Colorado
- University of Colorado-Boulder

Connecticut
- Yale University

Florida
- Florida State University
- University of Florida

Hawaii
- University of Hawaii-Manoa

Illinois
- University of Chicago
- University of Illinois-Champaign/Urbana
- Northern Illinois University*
- Northwestern University

Indiana
- Indiana University
- University of Notre Dame
- Purdue University

Iowa
- Iowa State University
- University of Iowa

Kansas
- Kansas State University

Louisiana
- Louisiana State University
- Tulane University

Maryland
- Johns Hopkins University
- University of Maryland

Massachusetts
- Boston University
- Harvard University
- University of Massachusetts
- Massachusetts Institute of Technology
- Northeastern University
- Tufts University

Michigan
- Michigan State University
- University of Michigan

Minnesota
- University of Minnesota

Missouri
- Washington University

New Jersey
- Princeton University
- Rutgers University

New Mexico
- New Mexico State University
- University of New Mexico

New York
- Columbia University
- Cornell University
- University of Rochester
- Rockefeller University
- State University of New York-Buffalo
- State University of New York-Stony Brook
- Syracuse University

North Carolina
- Duke University
- University of North Carolina

Ohio
- Case Western Reserve University
- Ohio State University

Oklahoma
- University of Oklahoma

Oregon
- University of Oregon

Pennsylvania
- Carnegie Mellon University
- Pennsylvania State University
- University of Pennsylvania
- University of Pittsburgh

Rhode Island
- Brown University

South Carolina
- University of South Carolina

Tennessee
- University of Tennessee-Knoxville
- Vanderbilt University

Texas
- University of Houston
- University of North Texas
- Prairie View A&M University*
- Rice University
- Southern Methodist University*
- Texas A&M University
- Texas Tech University
- University of Texas-Arlington
- University of Texas-Austin
- University of Texas-Dallas

Utah
- University of Utah

Virginia
- Virginia Polytechnic Institute
- University of Virginia
- College of William and Mary

Washington
- University of Washington

Wisconsin
- University of Wisconsin-Madison

Canada
- McGill University
- University of Toronto

Italy
- University of Pisa

Japan
- Waseda University

**Associate member institution*

More than 2,300 scientists from nearly 200 universities and institutions around the world use Fermilab's facilities to conduct high-energy physics research and expand the world's knowledge of the fundamental constituents of nature. The DZero detector has been operated since 1992 by a collaboration now totaling 49 institutions in the U.S. and 9 foreign countries, with over 450 Ph.D. physicists and graduate students. Some of those users are seen here in this collaboration portrait of Fermilab's DZero experiment.

Fermilab

URA

Fermi National Accelerator Laboratory, 30 miles west of Chicago, is a Department of Energy national laboratory with the primary mission of advancing the understanding of the fundamental nature of matter and energy.

Circling through rings of magnets four miles in circumference, particle beams generate experimental conditions equivalent to those in the first quadrillionth of a second after the birth of the universe. This capability to recreate the energy levels of the Big Bang places Fermilab at the frontier of global physics research, providing leadership and resources for qualified experimenters to conduct basic research at the leading edge of high-energy physics and related disciplines. Fermilab operates the world's highest-energy particle accelerator, the Tevatron, which can operate as a proton-antiproton collider or as a source of high-energy beams for fixed-target experiments.

Fermilab provides research facilities for about 2,300 particle physicists, from 98 institutions in 36 states and 90 foreign institutions in 20 countries. Typically, the U.S. scientists' research is supported by DOE and the National Science Foundation, and in some cases by university funds.

Fermilab is a Department of Energy national laboratory with the primary mission of advancing the understanding of the fundamental nature of matter and energy.

Fermilab began in the early 1970s with a single beam of protons directed at a fixed target and has upgraded its capabilities over the years to take successive steps into the interior of the atomic nucleus. The Laboratory's first major upgrade was the development of the Tevatron, the world's first superconducting synchrotron, with beam energies of approximately one TeV or one trillion electron volts. It operated initially in 1983, and in 1989 the National Medal of Technology was awarded to the leaders of its design and construction team. Another vital upgrade enabled the Tevatron to become a collider, accelerating antiprotons as well as protons to trillion electron-volt energies, in beams traveling in opposite directions, to produce collisions at a selected number of interaction regions. The first proton-antiproton collisions were achieved in 1985, and now two 5,000-ton detectors, CDF and DZero, track and record the sub-atomic fragments that emerge from proton-antiproton collisions. The collaborations that use these detectors announced the discovery of the top quark in March 1995.

Highlights from 1996

The successful Tevatron Collider Run I, which led to the discovery of the top quark, ended in late February 1996. During the first half of the year, Fermilab made the transition from collider to fixed-target operations, in which high-intensity beams of protons from the Tevatron are used to create an array of secondary particle beams directed to seven fixed-target experiments and two test beam set-ups. Fermilab expects that data from these experiments will:

- allow the first direct observation of the fundamental particle called the tau neutrino;
- provide new insight on the mysterious asymmetry between matter and antimatter;
- explore the inner structure of the proton;
- investigate the properties of charmed quarks, an exotic form of matter that has not existed since the instant after the Big Bang.

Much of the year was spent in partnership with the Laboratory's fixed-target users, getting the beamlines and experiments ready for Fermilab's last 800 GeV fixed-target run. This effort which consumed a major part of Laboratory resources, is succeeding brilliantly. The run is expected to continue until September 1997, when nearly all of

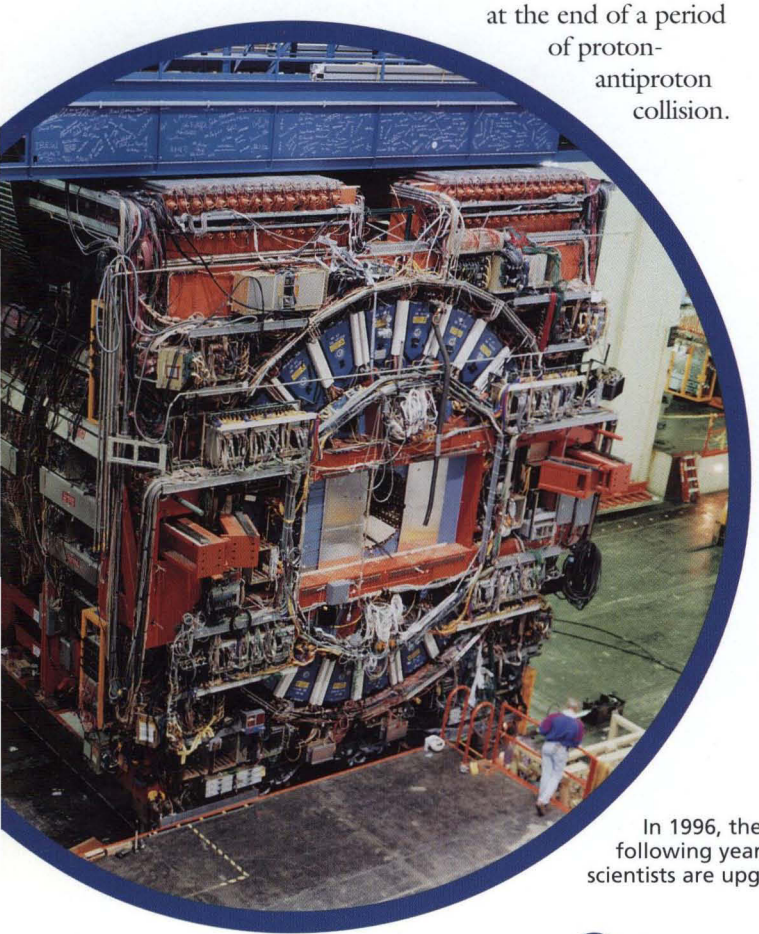
Fermilab's Wilson Hall is a landmark for both the local community and for high-energy physics in the United States. The Main Injector, Fermilab's newest accelerator now under construction, is at the top of the photograph.

the fixed-target experiments will have achieved most of their goals. When the fixed-target run ends, Fermilab will shift its efforts to completing the Main Injector project and the upgrades of the two collider detectors CDF and DZero.

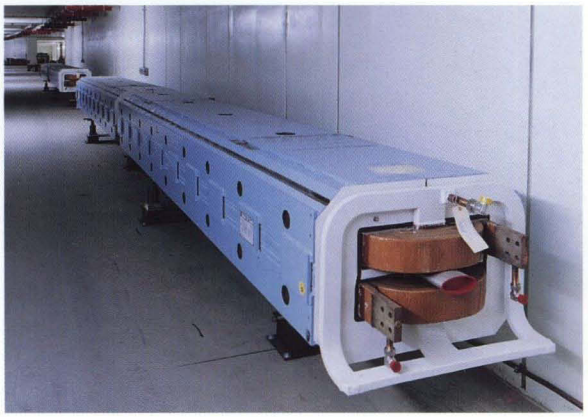
In keeping with Fermilab's mission to provide facilities for frontier research in high-energy physics, the Laboratory continued its projects to improve accelerators, detectors and supporting facilities during 1996.

Fermilab's Main Injector is a new accelerator, designed to replace the Main Ring, the Laboratory's 26-year old original accelerator. When the Main Injector begins operating in 1999, it will increase the collider luminosity (a measure of the proton-antiproton collision rate) of the Tevatron by a factor of about five, through increased beam intensity and improved beam dynamics, and will allow Fermilab to conduct collider and fixed-target operations simultaneously. The Main Injector was about 60 percent complete at the end of 1996 and remains on-budget and on-schedule.

A second luminosity-enhancement project, the Recycler Ring, developed during 1995, will double the luminosity that could be achieved by the Main Injector alone. The Recycler, now approved by DOE, will allow Fermilab to reuse the antiprotons that remain in the Tevatron at the end of a period of proton-antiproton collision.



In 1996, the CDF detector emerged from its collision hall, following years of extraordinary scientific operation. University scientists are upgrading the physics tool for the next collider run.



New magnets in the Main Injector tunnel.

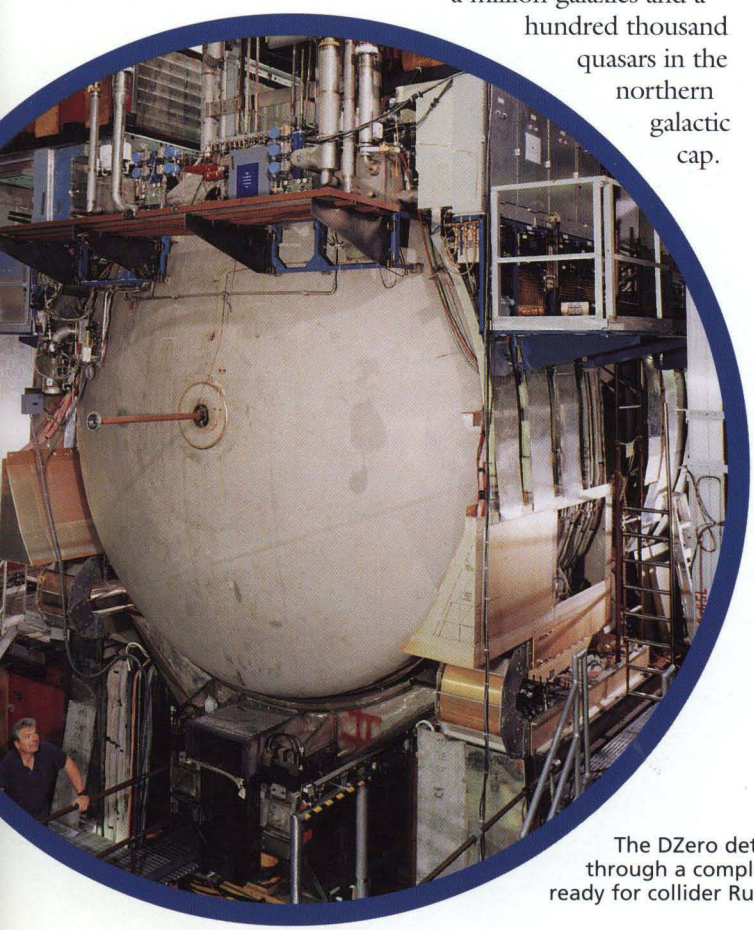
The Main Injector and the other improvements will provide experiments using collider detectors CDF and DZero more beam than they have ever had before. In Collider Run II with the Main Injector, scheduled to begin in 1999, these experiments will be recording at 10 times the rate of particle collisions as they did in Collider Run I. The two collider detectors must be rebuilt from the inside out, so that they will be able to take advantage of the great increase in the number of high-energy particle collisions that will occur. During 1996, both CDF and DZero collider detector collaborations prepared for very rigorous DOE reviews, which they came through with flying colors. The CDF and DZero upgrades are now well-established projects with approved plans, schedules and funding.

DOE has also given its approval for the NuMI project – Neutrinos at the Main Injector. Fermilab will provide a high-intensity neutrino beam for experiments that will explore the question whether neutrinos are, in fact, massless or actually have a small mass. Fermilab will use the Main Injector to create a beam of muon neutrinos aimed through the earth to a detector deep underground in the former Soudan iron mine in northern Minnesota. If the detector should reveal that some of the muon neutrinos have changed "flavor" to become tau neutrinos during their 700-kilometer journey from Fermilab to Minnesota, that change would show that neutrinos do indeed have mass. If they do, the implications of such a discovery will be profound. Fermilab proposes to begin design and engineering work for the beamline in late 1997. If the funding in subsequent years continues on the proposed schedule, the Laboratory expects that the NuMI experiments will begin operating in the year 2002.

Astrophysics

Experiments in particle astrophysics offer exciting opportunities to increase scientists' understanding of the universe. All of the proposals for extending the domain of validity of the Standard Model of particle interactions predict new particles. If these particles are stable, then large numbers of them will have survived the moment of creation and will still be present. Should that be the case, they could make up a significant fraction of the mass of the universe. Searches for these massive particles are underway. Fermilab has recently joined the Cold Dark Matter Search of the University of California-Berkeley, Stanford and Case Western Reserve Collaboration. These collaborators have developed very sensitive detectors that can detect the recoils of germanium or silicon nuclei if they collide with one of these massive particles. Because the performance of the detectors has met expectations, the collaborators are planning a much larger experiment, deep underground in the same Soudan Mine in northern Minnesota where the NuMI project will locate its detector.

Fermilab is also engaged in a project that aims to find out how matter, both dark and luminous, is distributed. This project, the Sloan Digital Sky Survey, will measure the location and red shift of a million galaxies and a hundred thousand quasars in the northern galactic cap.



The DZero detector is also going through a complex upgrade to get ready for collider Run II.

Fermilab participates in astrophysics projects, such as the Sloan Digital Sky Survey located in New Mexico.

Fermilab's contribution to this project is the construction of the data acquisition system and the software and hardware to process the expected 10 to 20 terabytes of data that will be accumulated during the roughly five-year span of the survey. The other partners, University of Chicago, Johns Hopkins University, Princeton University, Tokyo University, the U.S. Naval Observatory and the University of Washington, are building a 2.5 meter telescope and the associated instruments located at Apache Point, New Mexico. The construction of all of the equipment is well along, and it is hoped that first light will pass through the telescope into the camera and then to the data acquisition system in the fall of 1997. After first light, there will still be much more to do to make the 2.5 meter telescope and its instruments a functional tool for the five year survey. The information from observations of this type, in conjunction with information from satellite observatories of the microwave background, may shed light on physics at energy scales of 10^{16} GeV.

Another astrophysics project, the Pierre Auger Observatory, will try to find the mysterious source of very high energy cosmic rays. As a member of the Auger collaboration, Fermilab is participating actively in this very exciting international project, which a number of the scientific staff have joined. *(See Future Enterprises.)*

Experimental astrophysics has become a modest but important part of Fermilab's program, because it provides another approach in the search for an understanding of the unanswered questions posed by particle physics.

International Cooperation

High-energy physics is among the most international fields of science and can serve as a model for the emerging internationalization of many disciplines. For example, at Fermilab's two collider detectors, CDF and DZero, scientists and students from Brazil, Canada, China, Columbia, France, India, Italy, Japan, Korea, Mexico, Poland, Russia, Taiwan and the U.S. work in collaboration on experiments. The Laboratory's advisory committees typically draw members from universities and research facilities around the world, a practice which is also becoming more common in other fields of science.

Fermilab provides research facilities for about 2,300 particle physicists, from 98 institutions in 36 states and 90 foreign institutions in 20 countries.

Science Education

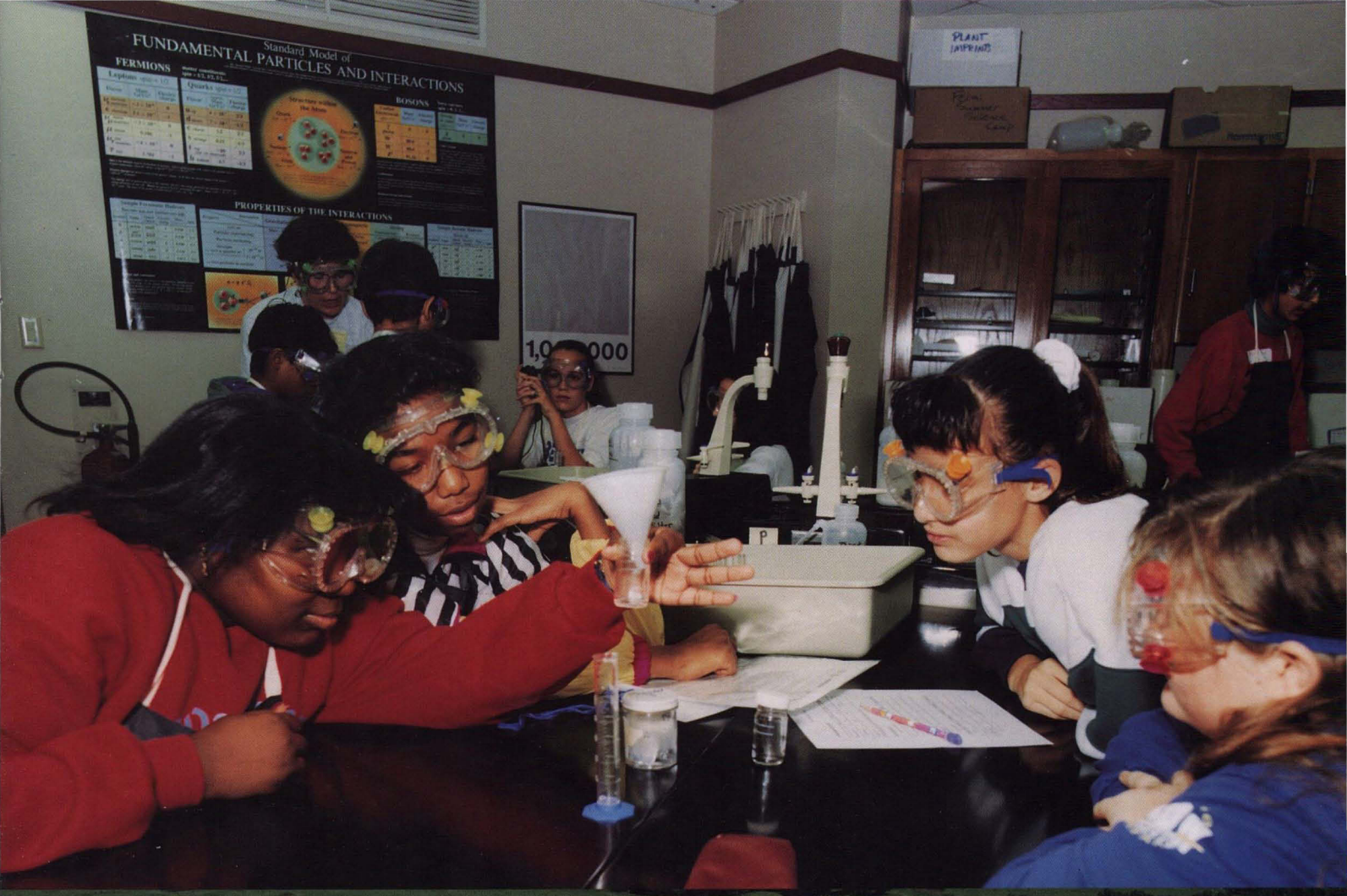
Fermilab's history of achievement in science education and teacher training programs is a tribute to physicists' love of learning and to students' responsiveness to real-world situations. Spearheaded by former Fermilab Director Leon Lederman, the education program gives special emphasis throughout to strengthening science education for under-represented groups.

The Leon M. Lederman Science Education Center, dedicated in 1992, drew attendance in 1996 of over 20,000 students and 6,000 teachers. The Center offers some 30 programs, teacher enhancement workshops and institutes, opportunities for research participation, development and distribution of instructional materials, a collection of teachers' resources, Laboratory tours, special events, class field trips, and science shows.

Funding limitations in fiscal year 1996, which curtailed spending for DOE education programs, had an impact on the Laboratory's education programs and on the Lederman Center in particular. In response, the URA Board of Trustees voted to provide an additional $150,000 from URA's accumulated management allowance to the Center to continue its programs. The programs are continuing in fiscal year 1997 with partial support from outside sources through Friends of Fermilab.

URA also provides financial support for graduate courses at Fermilab. Students must spend so long participating in experiments at the Laboratory that they often have difficulty taking needed classes at their home institutions.

Fermilab sponsors fellowships, participates in a Joint University-Fermilab Doctoral Program in Accelerator Physics and, in collaboration with other laboratories and U.S. universities, helps sponsor the U.S. Particle Accelerator School. The Laboratory also supports faculty members through a guest scientist program and as visitors to the Theory Group.



Fermilab has always had a strong commitment to science education. In the above photograph, students and teachers analyze water samples as part of an environmental field study at the Laboratory's Lederman Science Education Center, which is located to the West of Wilson Hall (at the bottom of the photograph below).

Environmental Activities

Contrary to the usual image of high-technology installations, Fermilab has been designated a National Environmental Research Park by DOE. The Laboratory maintains careful vigilance over restoration and preservation of the site's ecosystems. During 1996, the Laboratory prepared a long-range ecological management plan, which is now available to the public on the World Wide Web.

Over the years, with the support of the Nature Conservancy and hundreds of local volunteers, the Laboratory has begun the restoration of the native tallgrass prairie that once covered the Fermilab site. More than a thousand acres are currently under restoration, and annual prairie burns help to maintain the system's natural cycles. The Laboratory is home to a famous herd of buffalo.

Fermilab's partnership with the environment extends back to the earliest days of the Laboratory. Fermilab now has more than 1,000 acres of restored tall-grass prairie on its site.

The new 8 GeV beam transfer line, connecting the Booster accelerator to the Main Injector, employs advanced permanent magnet technology. Such advances at Fermilab can have applications beyond high-energy physics research.

Technology Transfer

While Fermilab is dedicated to basic physics research, the Laboratory is eager to share its science, technology, and know-how by working cooperatively with U.S. industry to encourage economic development. Fermilab has unique capabilities in designing and operating accelerators, managing very large cryogenic systems, developing and operating fast electronics, creating hardware architectures and software for massively parallel computing systems, and operating industrial-scale applications of superconducting technology. Sometimes advances in these technologies at the Laboratory have applications beyond high-energy physics research, and Fermilab can transfer new technology to industry to foster economic development.

Fermilab's Directorate-level Office of Research and Technology Applications (ORTA) facilitates the transfer of Laboratory technologies. Symposia, tours, and exhibits at the Laboratory encourage the exchange of information between Laboratory staff and industry specialists.

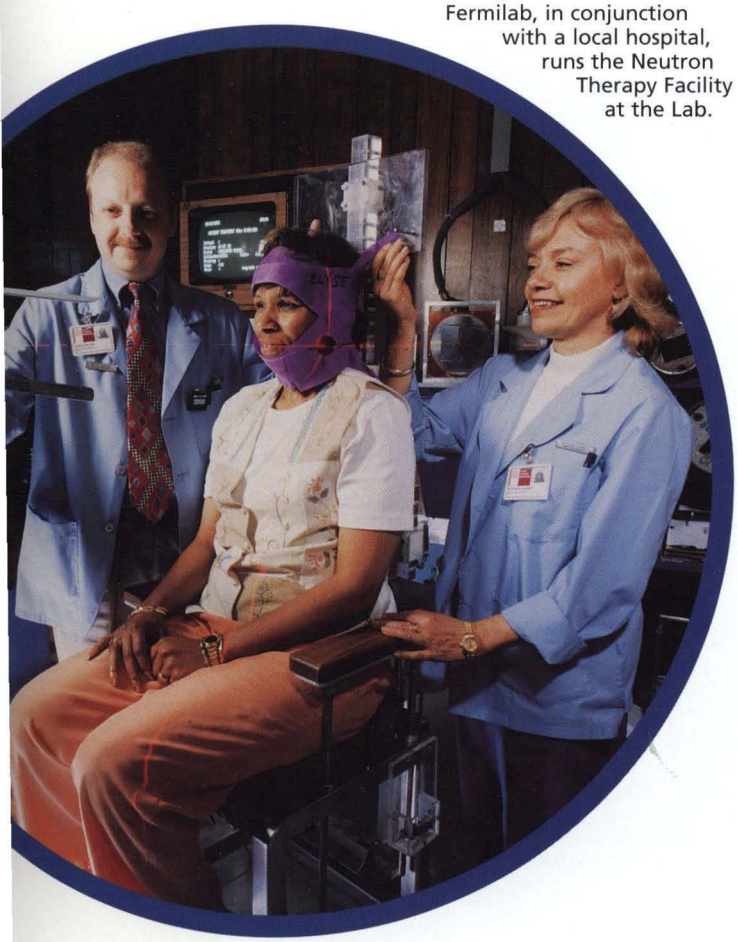
While most of Fermilab's research is inherently fundamental in character, nonetheless since 1980, Fermilab has received 13 R&D 100 Awards for significant technological developments. Almost 760 Fermilab innovations have been assessed for patent and market potential and catalogued. Nine licenses have been granted on intellectual property (patents or copyrights) developed at Fermilab. ORTA identifies and evaluates 15 to 20 technological innovations each year. Six CRADAs have been executed and others are under discussion.

Accelerators in Medicine

In 1975, the National Cancer Institute awarded a grant for a facility at Fermilab to explore the effectiveness of fast neutrons versus x-rays in the management of certain types of cancer. Over 2,100 patients have received treatment at Fermilab's Neutron Therapy Facility, which provides the world's highest-energy neutron beam for therapeutic use. In 1995, management of the facility transferred to St. Joseph Hospital of Elgin, Illinois.

Beyond the borders of Illinois, the NTF has served as a model for more recently built neutron therapy facilities in Michigan, South Africa, and France. Fermilab also built a 250 million-electron-volt proton accelerator for the hospital of Loma Linda University Medical Center in California, which began treating patients in October, 1990.

As part of a collaboration with SAIC, the Biomedical Research Foundation of Northwest Louisiana, and the University of Washington, Fermilab is assembling a compact linear accelerator that will explore the use of helium-3 ion beams for the production of isotopes to be used in positron emission tomography (PET) scan imaging.



Fermilab, in conjunction with a local hospital, runs the Neutron Therapy Facility at the Lab.

Community Programs

Fermilab's role as a key element of the Illinois High Technology Corridor is complemented by its sponsorship of cultural activities to which the public is invited. Laboratory staff volunteer in supporting an arts series, physics colloquia, films, and an art gallery.

The Future

Fermilab has been asked by the Department of Energy to provide major oversight and scientific support for the construction of components for the Large Hadron Collider (LHC) at CERN, the European Particle Physics Laboratory. The LHC will provide experimenters the opportunity to analyze collisions with seven times the Tevatron's center-of-mass energy, at a collision rate 100 times greater. A decade from now, the LHC proton collider will address key questions in particle physics. The LHC will open a new energy domain, allowing scientists to formulate questions that they cannot conceive today. The LHC is essential for further progress in this field.

In February 1997, the Department of Energy and the National Science Foundation initialed a formal agreement whereby DOE proposed to commit $450 million of its high-energy physics budget over the seven-year construction period for construction of components for the LHC facility and two of the LHC detectors, ATLAS and CMS. NSF proposed to allocate $80 million. Congress must still agree to appropriate these funds over the next seven years.

The agreement with CERN will provide roughly one quarter of U.S. scientists engaged in experimental particle physics with opportunities to work at the high energy frontier of particle physics a decade from now. It will also allow accelerator builders in the U.S. to work at the forefront of accelerator technology. A three-laboratory consortium of Brookhaven National Laboratory, Fermilab, and Lawrence Berkeley National Laboratory will be responsible for many of the components for certain sections of the accelerator. The work will allow Fermilab to continue to rejuvenate its superconducting accelerator magnet program. Physicist Jim Strait of Fermilab has been selected as the Project Manager of this effort. In addition, the U.S. members of the CMS detector collaboration have selected Fermilab as their host U.S. laboratory.

Fermilab is now planning for the time after the LHC begins operating. This involves concentrated R&D on a future facility at Fermilab that helps to recapture U.S. leadership of high-energy physics.

One avenue that the Laboratory is exploring is a very large hadron collider. In 1996, a small group of people examined some of the unsolved technology issues for building a large proton-proton collider. Fermilab held a recent workshop on the physics opportunities of such a collider. Fermilab Director John Peoples expects that a low level of work will continue on a very large hadron collider, because its strongest and most effective proponents are currently very busy with the Main Injector, the Recycler and electron cooling projects.

In 1996, the small group that worked full time on concepts for future colliders at Fermilab gave their greatest effort to consideration of a muon collider, an accelerator that uses muons, the heavier, short-lived relatives of electrons, to create particle collisions. The work is still in progress, not only at Fermilab but also at UCLA and at Brookhaven, Lawrence Berkeley, and Argonne National Laboratories. It will require much more work to resolve whether a full calculation can demonstrate that a muon collider is feasible. To this end, Fermilab has established a muon collider group in the Beams Division. Fermilab Director Peoples has commissioned an 18-month intensive study to determine the feasibility of a 500 GeV center-of-mass muon collider.

Ernie Malamud (left), assistant director, talks shop with John Peoples, Fermilab's director.

Laboratory Director

In 1989, Dr. John Peoples, Jr. became Fermilab's third director. With a doctorate in physics from Columbia University in 1966, he headed the Proton Laboratory and the Research Division during his early years at Fermilab. He was Project Manager of the Antiproton Source, which made it possible for Fermilab to create proton-antiproton collisions. Dr. Peoples became Deputy Director in 1987.

During his service as Fermilab Director, Dr. Peoples was appointed to handle termination of the SSC, from late 1993 to mid-1994. In 1995, Dr. Peoples received a Distinguished Associate Award from the Department of Energy for his superior service in the SSC termination.

Fermilab's founding director, Robert R. Wilson, served from 1968 to 1978, and is currently a member of URA's Fermilab Board of Overseers. Dr. Wilson also provides continuing guidance for the aesthetics of buildings and grounds, including sculpture that he created. Leon M. Lederman, a 1988 Nobel Laureate, directed the Laboratory from 1979 to 1989 and is a member of the URA Board of Trustees. His recent contributions to science education are known worldwide.

The Laboratory recently presented employee recognition awards to Ruth Pordes, head of the Computing Division's Online Systems Department, and John Cooper (center), head of the Particle Physics Division. John Peoples, Fermilab's director, is at right.

Fermilab's Wilson Hall, at twilight, with the Acqua Alle Funi sculpture, designed by Robert Wilson, Fermilab's first director.

Future Enterprises

Cosmic rays are fast-moving particles from space that constantly bombard the earth from all directions. Most of the particles are either electrons or the nuclei of atoms. Of the nuclei, the majority are single protons—the nuclei of hydrogen atoms—but a few are much heavier, ranging up to the nuclei of lead atoms. Cosmic ray particles travel at nearly the speed of light, which means they have very high energy. Some of them, in fact, are the most energetic particles ever observed in nature. To discover the source of cosmic ray particles, scientists measure their energy and their direction as they arrive from space. To measure cosmic ray particles directly requires sending detectors to heights above most of the earth's atmosphere, using high-flying balloons and satellites. However, scientists can also detect cosmic rays indirectly on the surface of the earth by observing the showers of particles they produce in the air, as discovered by physicist Pierre Auger about sixty years ago.

The Pierre Auger Observatory Project is a broad-based international effort to make a detailed study of the highest energy cosmic rays (about 10^{20}eV, or 100 million times greater than the energy of the protons accelerated by Fermilab's Tevatron). The Project's co-leaders are Dr. James W. Cronin, Professor of Physics, University of Chicago and Dr. Alan A. Watson, Professor of Physics, University of Leeds in the United Kingdom. Thus far, members of the Pierre Auger collaboration come from Argentina, Armenia, Australia, Bolivia, Brazil, Chile, China, France, Germany, Greece, Japan, Mexico, Russia, Slovenia, Spain, United Kingdom, USA, and Vietnam. The U.S. collaboration comprises nine universities plus Fermilab, home of the Project Manager, Dr. Paul Mantsch.

The Pierre Auger Observatory Project is a broad-based international effort to make a detailed study of the highest energy cosmic rays

Because the highest energy cosmic rays are so rare, scientists must cast a huge net to capture even a few. The Pierre Auger Observatory would consist of two giant arrays, each consisting of 1600 particle detector stations spaced 1.5 kilometers apart and covering about 3000 square kilometers, an area about the size of the state of Rhode Island. In order to get a complete view of the heavens as seen from the earth, one array would be located in the northern hemisphere and one in the southern hemisphere. In November 1995, the collaboration selected a site in the Province of Mendoza, Argentina for the southern hemisphere array, and in September 1996 a site in Millard County, Utah for the northern hemisphere array. The total project cost estimate is approximately $100 million.

On behalf of the U.S. Project participants under Dr. Cronin's leadership, URA in November 1996 submitted unsolicited proposals to the National Science Foundation (NSF) and the Department of Energy (DOE), requesting a total of $30 million in funding to be shared between the two agencies. That proposal is currently undergoing merit review.

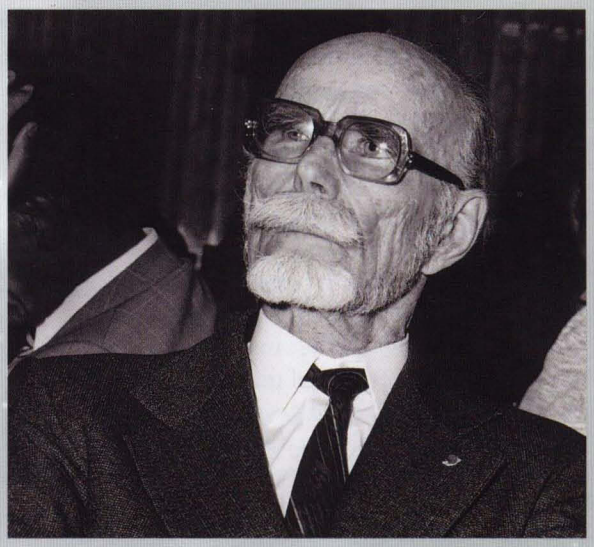
If the Project is funded, URA would serve as the sponsoring organization for the U.S. participants, and as such would oversee such tasks as site preparation, construction, and operations at the Utah site, as well as component R&D and production funded by the U.S. To implement that responsibility, URA would award subgrants or subcontracts, based upon Memoranda of Understanding (MOU) with the institutions participating in the Utah site activity.

In addition to the proposed $30 million U.S. contribution, it is expected that $30 million will be obtained from South America and Mexico, and approximately $40 million from Europe and Asia. URA has also offered to assist the collaboration in its international activities.

URA

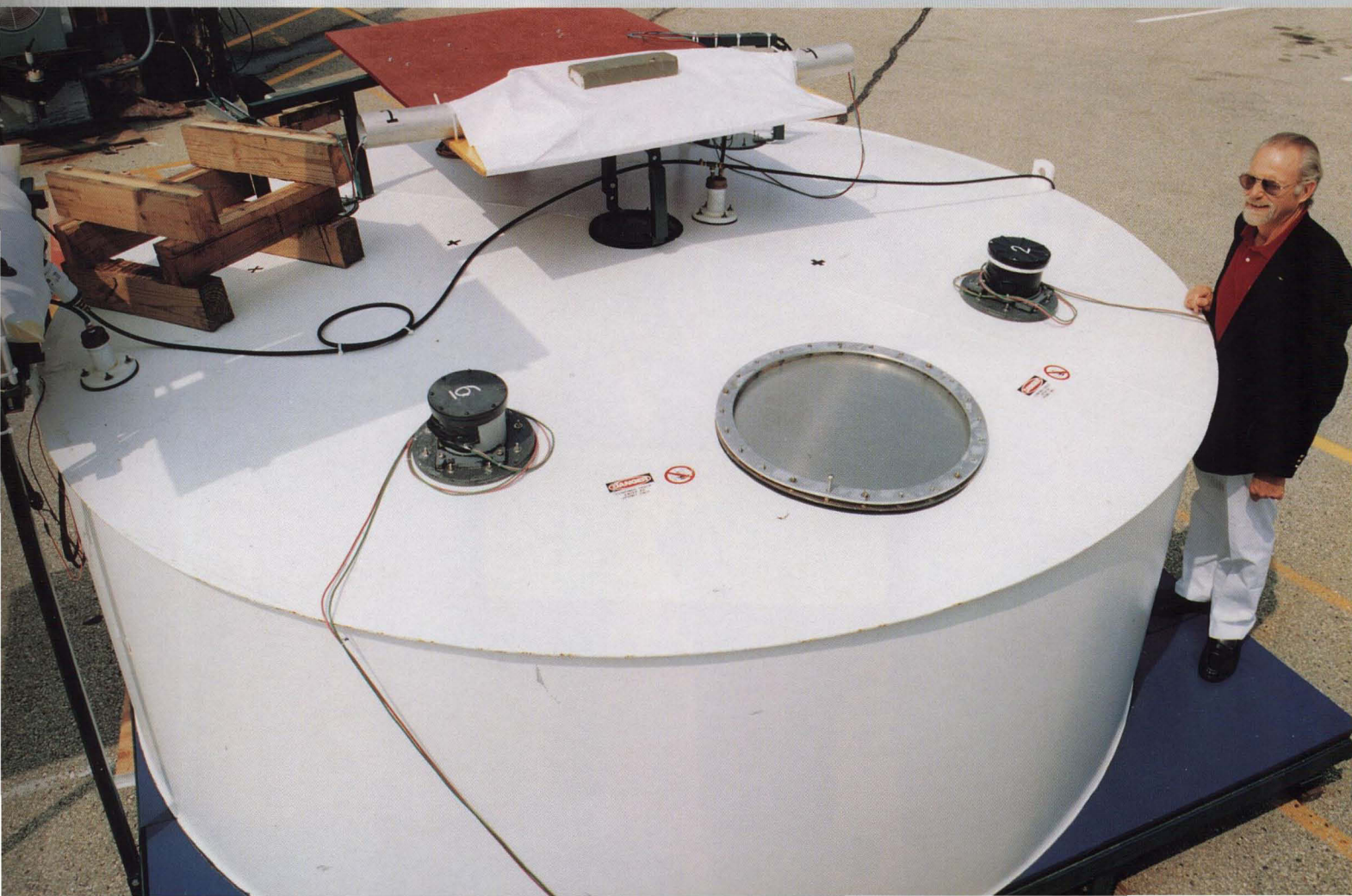
Other Activities

URA has a broad charter for the management of research and educational activities in the natural sciences. With the SSC termination now completed, the Corporation is engaged in long-range planning to explore potential new management responsibilities that would be of value to the university research community. For example, there have been preliminary discussions about URA assuming a management role for the Soudan Underground Laboratory in Northern Minnesota, with the goal of creating a national user facility for certain astrophysics experiments that require a deep underground environment.



Physicist Pierre Auger, who in 1938 discovered extensive air showers of secondary particles produced by cosmic rays.

Fermilab physicist Peter Mazur, below, with a prototype particle detector for the Pierre Auger Project. The project will build two giant observatories—each containing 1,600 of the detectors spaced 1.5 kilometers apart over an area of 3,000 square kilometers—to discover the unknown source of very high energy cosmic rays. Mazur and other Auger collaborators built the detector at Fermilab.



History 1965-1996

The creation of URA marked a milestone in government-university cooperation for the management of federal laboratories. Until 1965, individual universities and regional consortia had built and operated facilities under federal sponsorship. It was the unique character of particle physics research—which often involved collaborations among scientists from many institutions—that created the need to establish a truly national management organization. The federal government consulted with the National Academy of Sciences on how to accomplish this goal. The President of the Academy then convened the presidents of the U.S. universities engaged in particle physics, to consider management options for national facilities. Following that meeting, 25 attendees agreed to form a consortium leading to the incorporation of URA.

Fermilab's Founding Director, Robert R. Wilson.

This concept of fully national, and now increasingly international, cooperative efforts between the federal government and research universities was developed to address the needs of many fields of science. Since 1967 URA has been contractor to the Department of Energy and its predecessor agencies for the design, construction, management, and operation of Fermilab. URA's success in building and operating Fermilab led to its selection as contractor for the nation's next major particle accelerator, the SSC. After the project was canceled in 1993, URA managers and staff assisted with the termination activities, which were essentially concluded by the end of 1996.

Currently, the Fermilab program and its associated scientific and technological enterprises represent the core of URA's mission. As appropriate opportunities arise, the corporation will consider submitting proposals to the federal government, or elsewhere, for the management and operation of other facilities and programs in science and engineering.

It is about 5 p.m. Friday, April 16, 1971. Here in the Transfer Gallery of the Fermilab Main Ring Tunnel, Chairman Andronik Petrosyants, of the Soviet Atomic Energy Committee, (left) shakes hands with Glenn T. Seaborg, Chairman, U.S. Atomic Energy Commission. After a tour of the Laboratory site they have just reached the appropriate place where, within a few minutes, the final and 1,014th magnet in the Main Accelerator System will be placed by workmen. Also in this photo are (left to right): Ernest Malamud, Main Accelerator section leader; two members of the Soviet delegation; Petrosyants; Seaborg; a U.S. State Department interpreter; **Norman Ramsey,** URA president, and Harvard University physics professor; **Robert R. Wilson,** Laboratory Director; and Clarence Larson, Member of the U.S. Atomic Energy Commission.

Council of Presidents

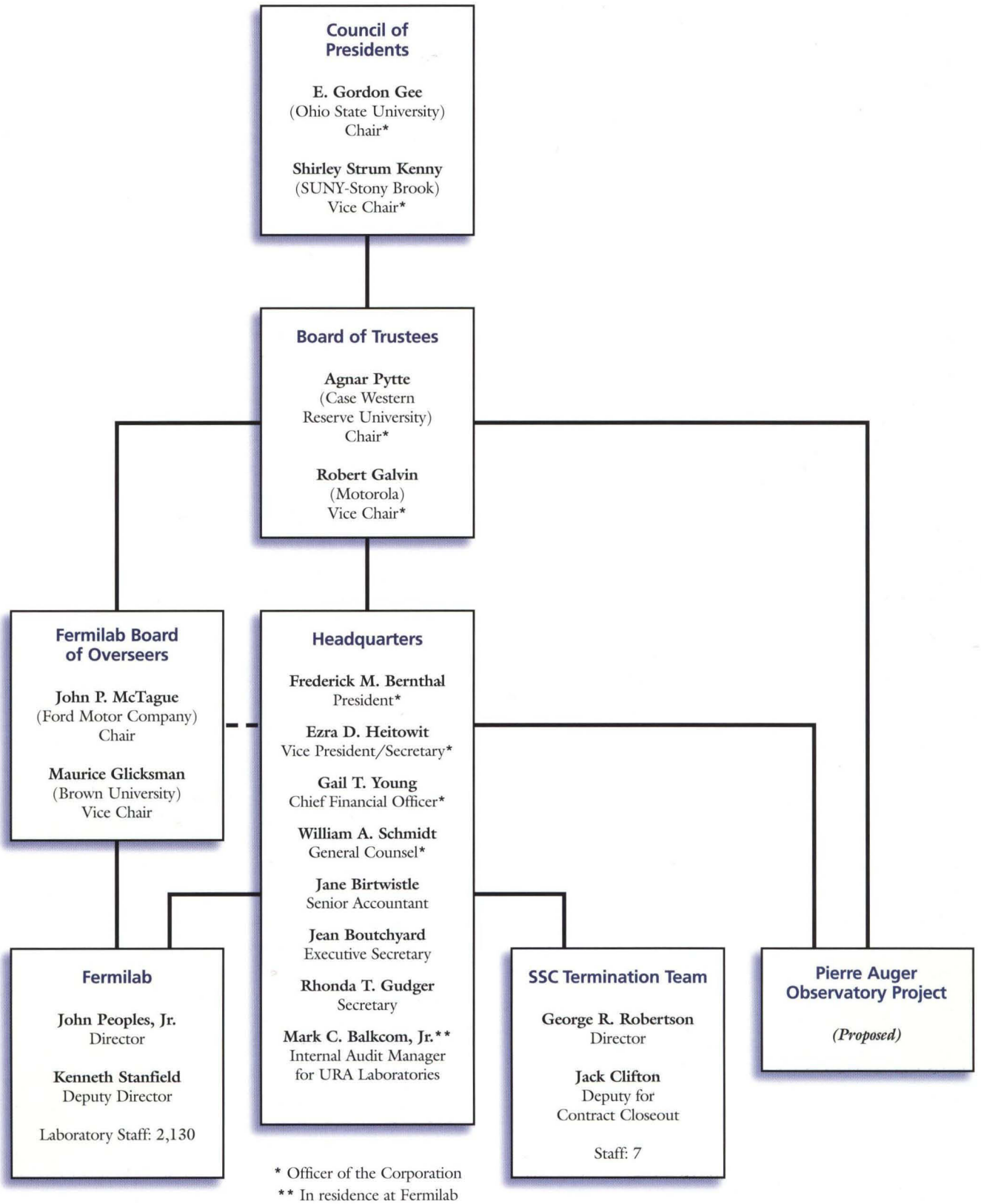
URA

University of Alabama ..... Andrew Sorensen
Arizona State University ..... Lattie F. Coor
University of Arizona ..... Manuel T. Pacheco
Boston University ..... Jon Westling
Brown University ..... Vartan Gregorian
California Institute of Technology ..... Thomas E. Everhart
University of California-Berkeley ..... Chang-lin Tien
University of California-Davis ..... Larry N. Vanderhoef
University of California-Irvine ..... Laurel L. Wilkening
University of California-Los Angeles ..... Charles E. Young
University of California-Riverside ..... Raymond L. Orbach
University of California-San Diego ..... Robert C. Dynes
Carnegie-Mellon University ..... Robert Mehrabian
Case Western Reserve University ..... Agnar Pytte
University of Chicago ..... Hugo Sonnenschein
University of Colorado-Boulder ..... Richard L. Byyny
Columbia University ..... George Rupp
Cornell University ..... Hunter R. Rawlings, III
Duke University ..... Nannerl Overholser Keohane
Florida State University ..... H. Talbot D'Alemberte
University of Florida ..... John Lombardi
Harvard University ..... Neil Rudenstine
University of Hawaii ..... Kenneth P. Mortimer
University of Houston ..... Glenn A. Goerke
University of Illinois ..... Michael Aiken
Indiana University ..... Myles Brand
Iowa State University ..... Martin Jischke
University of Iowa ..... Mary Sue Coleman
Johns Hopkins University ..... William R. Brody
Kansas State University ..... Jon Wefald
Louisiana State University ..... William L. Jenkins
McGill University ..... Bernard Shapiro
University of Massachusetts at Amherst ..... David K. Scott
University of Maryland ..... William E. Kirwan
Massachusetts Institute of Technology ..... Charles M. Vest
Michigan State University ..... E. Peter McPherson
University of Michigan ..... Homer A. Neal
University of Minnesota ..... Nils Hasselmo
University of New Mexico ..... Richard E. Peck
New Mexico State University ..... J. Michael Orenduff
SUNY - Buffalo ..... William R. Greiner
SUNY - Stony Brook ..... Shirley Strum Kenny
University of North Carolina ..... Michael Hooker
University of North Texas ..... Alfred F. Hurley
Northeastern University ..... Richard M. Freeland
Northwestern University ..... Henry S. Bienen
University of Notre Dame ..... Edward A. Malloy, C.S.C.
Ohio State University ..... E. Gordon Gee
University of Oklahoma ..... David L. Boren
University of Oregon ..... Dave Frohnmayer
Pennsylvania State University ..... Graham B. Spanier
University of Pennsylvania ..... Judith Rodin
University of Pisa ..... Luciano Modica
University of Pittsburgh ..... Mark Nordenberg
Princeton University ..... Harold T. Shapiro
Purdue University ..... Steven C. Beering
Rice University ..... Malcolm Gillis
University of Rochester ..... Thomas Jackson
Rockefeller University ..... Torsten Wiesel
Rutgers, The State University of New Jersey ... Francis L. Lawrence
University of South Carolina ..... John M. Palms
Stanford University ..... Gerhard Casper
Syracuse University ..... Kenneth A. Shaw
University of Tennessee at Knoxville ..... William Snyder
University of Texas at Arlington ..... Robert E. Witt
University of Texas at Austin ..... Robert M. Berdahl
University of Texas at Dallas ..... Franklyn G. Jenifer
Texas A&M University ..... Ray M. Bowen
Texas Tech University ..... Donald R. Haragan
University of Toronto ..... J. Robert S. Prichard
Tufts University ..... John DiBiaggio
Tulane University ..... Eamon Kelly
University of Utah ..... Arthur K. Smith
Vanderbilt University ..... Joe B. Wyatt
Virginia Polytechnic Institute ..... Paul E. Torgersen
University of Virginia ..... John T. Casteen, III
Waseda University ..... Takayasu Okushima
Washington University ..... Mark S. Wrighton
University of Washington ..... Richard L. McCormick
College of William and Mary ..... Timothy J. Sullivan
University of Wisconsin-Madison ..... David Ward
Yale University ..... Richard C. Levin

Associate Members

Northern Illinois University ..... John LaTourette
Prairie View University ..... Charles A. Hines
San Francisco State University ..... Robert A. Corrigan
Southern Methodist University ..... R. Gerald Turner

Universities Research Association, Inc.
1996 Organization Chart



* Officer of the Corporation
** In residence at Fermilab

Corporate Structure

Membership and Governance

As a non-profit corporation, URA acts under the direction of its governing body, the Council of Presidents of its 86 member universities. The Council is analogous to the shareholders of a public corporation. A Board of Trustees, elected by the Council, has the fiduciary responsibilities for the corporation and deals with corporate policy and planning issues. The Trustees appoint boards of overseers for each URA research enterprise. The headquarters office of URA in Washington, D.C. coordinates the activities of the Council and boards, and is currently responsible for oversight and governance of Fermilab and for corporate relations with the Federal government, industry, academe, and the general public.

The Fermilab Director is selected by the Board of Trustees with the approval of DOE. Daily operations are coordinated directly between Laboratory management and the DOE Chicago Operations Office or DOE headquarters. The total number of URA employees at corporate headquarters and at Fermilab is now about 2100.

URA member universities are divided among seven geographic regions within the United States to ensure that the boards reflected the organization's national character. URA has expanded these regions to include its international members. The Council of Presidents elects one trustee from each of the seven regions; each regional trustee is president or equivalent chief executive officer of a member institution in the region. There are up to eight at-large trustees. Similarly, there are seven regional members and up to eleven at-large members of a board of overseers.

URA board members over the years have included chief executive officers of major industrial corporations, corporate vice-presidents, and university presidents and vice-presidents. Boards have also included winners of major science prizes, including Nobel laureates, as well as directors of other major research laboratories. Regional group secretaries, who are faculty members at URA member universities, help to identify candidates for election to the boards of overseers.

In lieu of annual dues, URA may assess its member universities as special needs arise. Since the formation of the corporation in 1965, assessments have totaled $30,000 per member. Newly elected members are assessed the amount of the most recent prior assessment.

Headquarters Office

Corporate officers include leaders of the URA governing bodies (Council of Presidents and Board of Trustees) and executive officers at headquarters in Washington, D.C. Headquarters officers are the president, vice-president/secretary, chief financial officer, and general counsel.

Regional Group Secretaries

1. **Barry Barish**
   California Institute of Technology
2. **Lee Pondrom**
   University of Wisconsin
3. **Austin M. Gleeson**
   University of Texas-Austin
4. **Lawrence W. Jones**
   University of Michigan
5. **William D. Walker**
   Duke University
6. **Thomas Ferbel**
   University of Rochester
7. **Jack Sandweiss**
   Yale University

1996 URA Board of Trustees

Regional Trustees

Region		Term Expires
1	Thomas E. Everhart California Institute of Technology	1997
2	Nils Hasselmo University of Minnesota	1999
3	William B. Davis Louisiana State University	1998
4	Agnar Pytte Case Western Reserve University	1997
5	Joe B. Wyatt Vanderbilt University	1999
6	Harold T. Shapiro Princeton University	1998
7	Richard C. Levin Yale University	1997

Trustees At-Large

	Term Expires
Emanuel J. Fthenakis Fairchild Industries (ret.)	1998
Robert W. Galvin Motorola, Inc.	1999
Franklyn Jenifer University of Texas at Dallas	1999
Donald N. Langenberg University of Maryland System	1999
Leon M. Lederman Illinois Institute of Technology and Director Emeritus, Fermi National Accelerator Laboratory	1998
Walter E. Massey Morehouse College	1997
John P. McTague (ex officio) Ford Motor Company Chair, Fermilab Board of Overseers	
George P. Mitchell Mitchell Energy & Develop Corp.	1997
H. Guyford Stever National Academy of Engineering (ret.)	1998

URA

Board of Trustees Organization

Chair

Agnar Pytte
Case Western Reserve University

Vice Chair

Robert W. Galvin
Motorola, Inc.

Executive Committee

Fred Bernthal
URA President, Chair

Emanuel J. Fthenakis
Fairchild Industries (ret.)

Robert W. Galvin
Motorola, Inc.

Leon M. Lederman
Illinois Institute of Technology

Agnar Pytte
Case Western Reserve University

Harold T. Shapiro
Princeton University

H. Guyford Stever
National Academy of Engineering (ret.)

Joe B. Wyatt
Vanderbilt University

Audit Committee

Emanuel J. Fthenakis
Fairchild Industries (ret.), Chair

Donald N. Langenberg
University of Maryland System

Percy Pierre (ex officio)
Michigan State University,
Fermilab Board of Overseers

H. Guyford Stever
National Academy of Engineering (ret.)

Nominating Committee

Joe B. Wyatt
Vanderbilt University, Chair

Fred Bernthal
URA President

Robert W. Galvin
Motorola, Inc.

1996-97 Fermilab Board of Overseers

Regional Overseers

Region		Term Expires
1	Roberto Peccei Univ. of California, Los Angeles	1997
2	John Kozak Iowa State University	1998
3	S. Peter Rosen* University of Texas, Arlington	1998
4	Percy Pierre Michigan State University	1999
5	Alexander Abashian Virginia Polytechnic Institute	1998
6	David Shirley Pennsylvania State University	1998
7	Jerome Friedman Massachusetts Institute of Technology	1999

Overseers At-Large

	Term Expires
E. William Colglazier National Academy of Sciences	1997
Harold Forsen National Academy of Engineering	1999
John Gage Sun Microsystems, Inc.	1999
Maurice Glicksman Brown University	1999
Gail Hanson Indiana University	1997
Ronald Kerber Whirlpool Corporation	1997
Peter Koehler University of Pittsburgh	1997
John McTague Ford Motor Company	1998
David Schramm University of Chicago	1997
Robert Wilson Cornell University (ret.)	1998
Jill Wittels Lockheed-Martin IR Imaging System	1999

URA

Fermilab Board of Overseers Organization

Chair

John McTague

Vice Chair

Maurice Glicksman

Executive Committee

John McTague, Chair
Maurice Glicksman
Peter Koehler
Roberto Peccei
Percy Pierre
S. Peter Rosen*
David Shirley
Robert Wilson

Administrative Committee

Peter Koehler, Chair
John Gage
Maurice Glicksman
Ronald Kerber
John McTague
Percy Pierre
Jill Wittels

Audit Committee

Percy Pierre, Chair
Peter Koehler
Jill Wittels

Environmental, Safety and Health Committee

David Shirley, Chair
E. William Colglazier
Harold Forsen
John Kozak

Nominating Committee

S. Peter Rosen,* Chair
Alexander Abashian
Harold Forsen

Physics Committee

Roberto Peccei, Chair
Alexander Abashian
Jerome Friedman
Gail Hanson
S. Peter Rosen*
David Schramm
Robert Wilson

* Resigned on January 27, 1997 to become Associate Director for High-Energy and Nuclear Physics, Office of Energy Research, U.S. Department of Energy.

External Committees

Fermilab Physics Advisory Committee

	Term Expires
Rollin Morrison, Chair UC/Santa Barbara	1997
Martin Breidenbach SLAC	1999
Leslie Camilleri CERN	2000
Howard Georgi Harvard University	1998
Nicholas Hadley University of Maryland	2001
John Huth Harvard University	1997
Tuneyoshi Kamae University of Tokyo	1998
Andreas Kronfeld Fermilab	2000
Kenneth Lane Boston University	1999
William Molzon UC/Irvine	1998
Ritchie Patterson Cornell University	1999
Michael Shaevitz Columbia University	1997
Taiji Yamanouchi Secretary	

URA

URA Visiting Committee for Fermilab

	Term Expires
Gary J. Feldman, Chair Harvard University	1998
Frederick J. Gilman Carnegie Mellon University	1998
Donald L. Hartill Cornell University	1999
Kay Kinoshita Virginia Polytechnic Institute and State University	1998
Robert B. Palmer Brookhaven National Laboratory	1999
Frank Sciulli Columbia University	1999
Paul J. Steinhardt University of Pennsylvania	1998
J. Anthony Tyson Lucent Technologies	1999
William J. Willis Columbia University	1998

From the Fermilab Board of Overseers

Gail Hanson Indiana University	1997
Roberto Peccei University of California-Los Angeles	1997

Finances

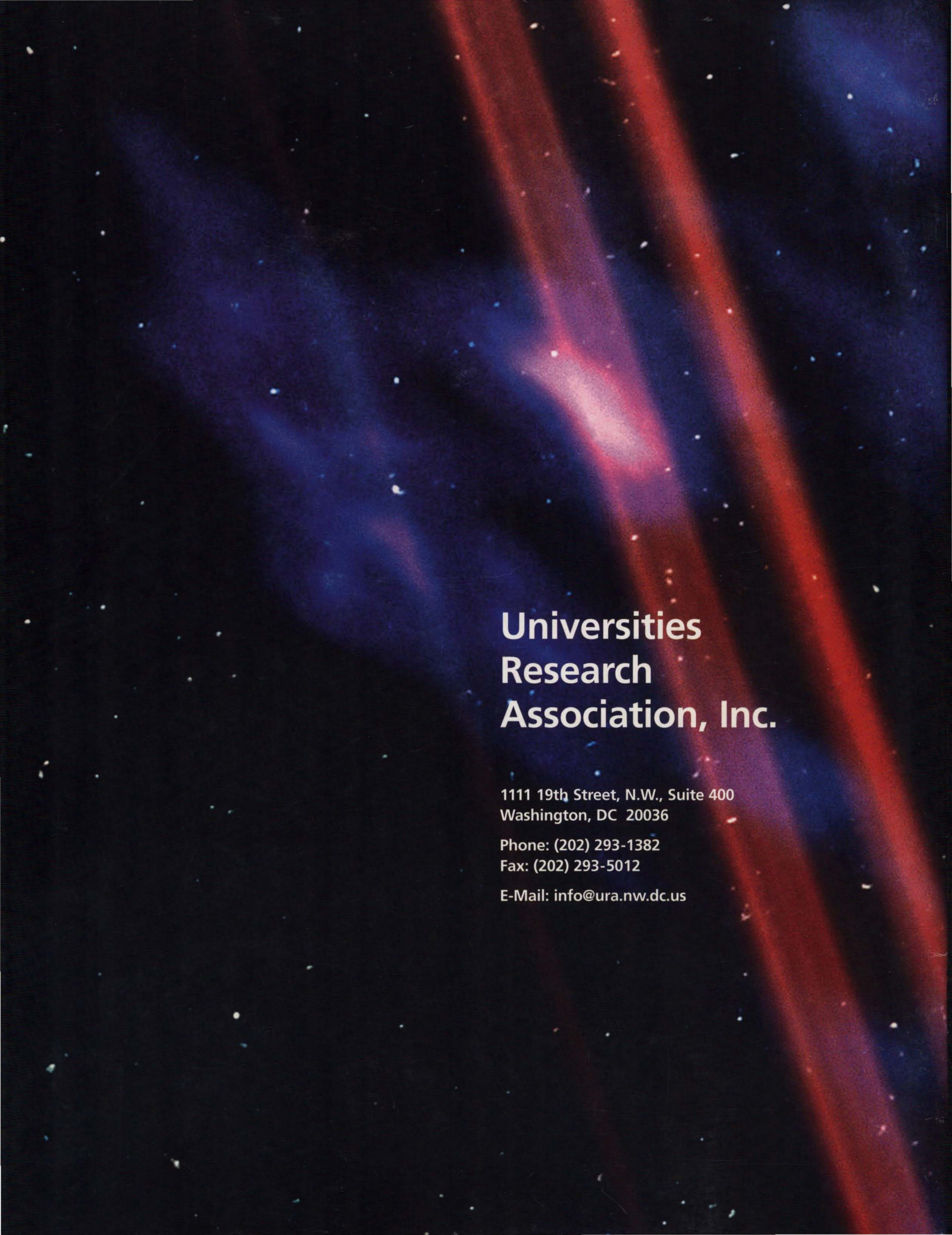
Universities Research Association, Inc.
Statements of Revenue and Expenses and Changes in Fund Balance
For the Year Ended September 30, 1996

REVENUE:

Government Contracts	$ 347,653,916
Contributions, Gifts and Grants	307,209
Other	3,125,797
Total Revenue	**$351,086,922**

EXPENSES:

Salaries, Wages, and Benefits	$ 126,790,340
Payroll Taxes	7,343,316
Subcontracts, Purchased Services and Supplies	12,823,689
Depreciation	51,117,944
Occupancy	18,122,636
Other Expenses	18,660,606
Total Expenses	**$234,858,531**
Excess of Revenue Over Expenses	**$116,228,390**
Net Assets/Fund Balance - Beginning of Year	**$ 27,521,480**
Other Changes in Net Assets/Fund Balance	**$179,255,410**
Net Assets/Fund Balance - End of Year	**$323,005,280**



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