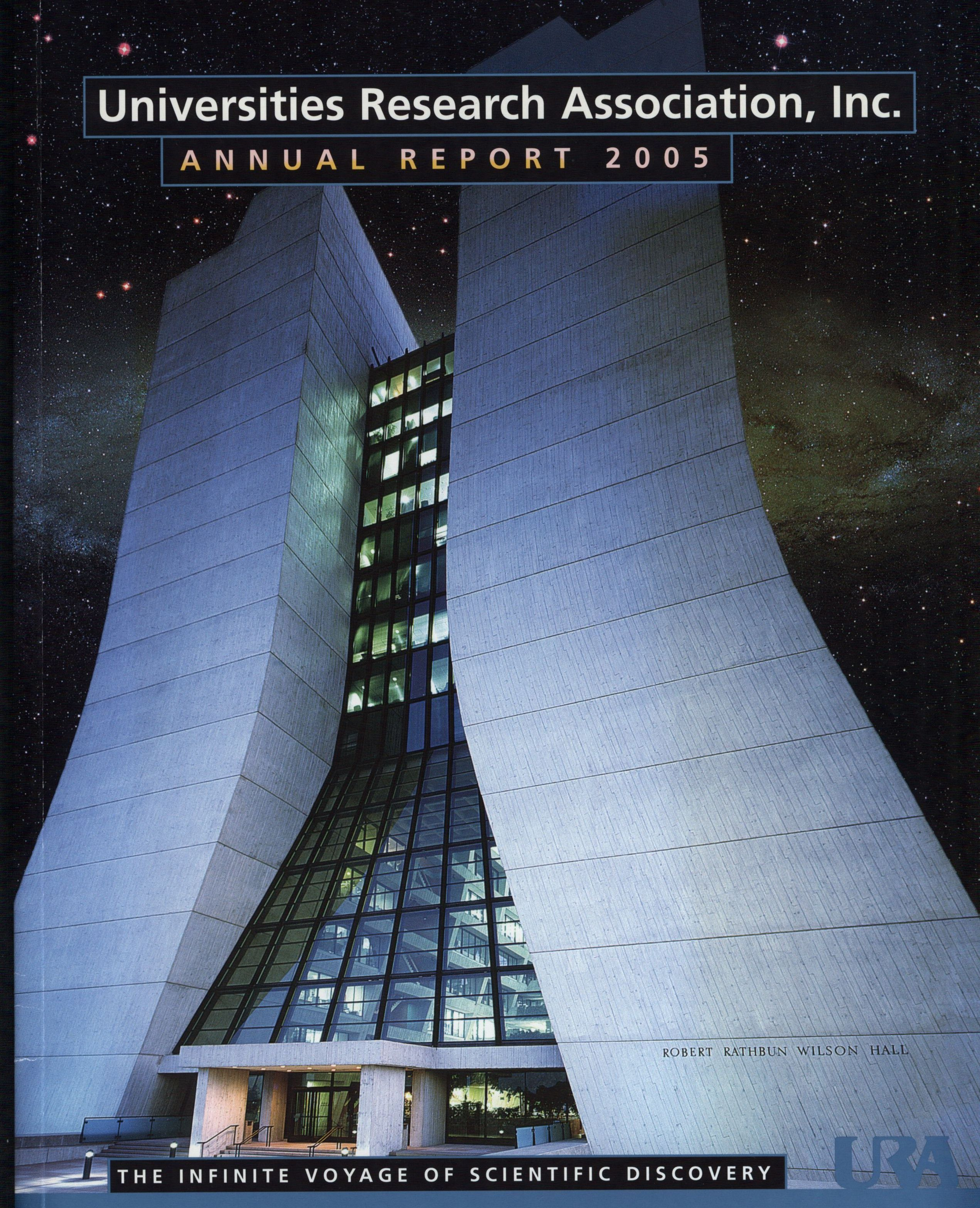
Universities Research Association, Inc.

ANNUAL REPORT 2005



THE INFINITE VOYAGE OF SCIENTIFIC DISCOVERY

URA

URA: Serving Universities and the Nation through Science

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."

In this aerial view of Fermilab, the 16-story Wilson Hall (seen at the top portion of photo) stands on the Illinois prairie adjacent to the 4-mile Tevatron accelerator ring (right). The blue Central Utility Building is seen in the cooling pond surrounded by the smaller circular ring that houses the Booster accelerator.

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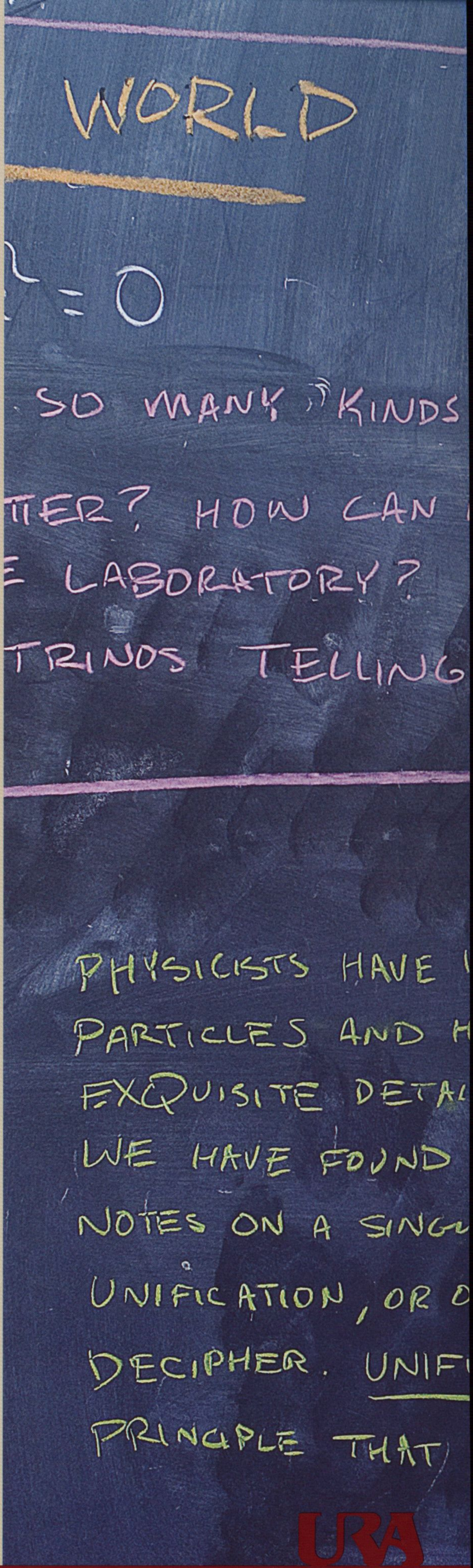

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URA is a private not-for-profit corporation. A consortium of research universities, it serves as a contractor to the Federal government for the operation of major scientific facilities. This volume—updated annually with new financial and organizational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

PHOTO CREDITS: Fred Ullrich, Reidar Hahn and Debra Guzman of Fermilab Visual Media Services

MESSAGE FROM THE URA PRESIDENT

URA President Fred Bernthal (right) presented Michael Witherell, retiring Director of Fermilab, with a Resolution of the Board of Trustees of Universities Research Association, Inc. honoring Mike for his six-year term as director of the lab.

The year 2005 has been pivotal in many respects for Fermilab, and for URA and its 90 member universities. Perhaps the single most important task of any organization such as ours is the selection of new leadership. So when Mike Witherell announced his intent to step down as Fermilab Director, a Search Committee, Chaired by Neal Lane, former Science Advisor to President Clinton and former Director of NSF, was promptly formed. Dr. Lane and his Committee did an outstanding, extraordinarily careful and diligent job, and in November 2004 URA was able to announce the selection of Piermaria Oddone, then Deputy Director of the Lawrence Berkeley National Laboratory, to be the next Fermilab Director.

This timely completion of the search process allowed Pier and his longtime friend and colleague, Mike, several months to consult and work closely together at Fermilab, to ensure an especially smooth and productive transition, and on July 1 Pier assumed his new post. We wish to thank Mike for his outstanding service as Director, and for leaving Fermilab a strong and vibrant Laboratory, prepared to meet the challenges that lie ahead. Our new Director presides over a Tevatron that regularly set new performance records in the closing months of 2005, a world-leading program in neutrino physics, and a burgeoning agenda in experimental particle astrophysics—all this as he and Fermilab lay the groundwork to host a new International Linear Collider (ILC) we hope may commence construction in northern Illinois within the next decade.

Fermilab remains the world leader at the high energy frontier of particle physics and associated sciences for most of the remainder of this decade, and the Laboratory is already reaping outstanding physics returns from its second multi-year discovery campaign, "Collider Run II." The Lab continued to meet or exceed its own aggressive "design" objective for beam delivered to the CDF and DZero experiments in 2005, and that performance was substantially enhanced by the successful demonstration of electron cooling of the antiproton beam—itself a technological tour de force in the field of accelerator physics. Meanwhile, Fermilab's scientific and management talent continues to lead U.S. participation in preparation for the expected 2007 startup of the Large Hadron Collider at CERN in Europe. And in 2005 Barry Barish of Caltech, working from his office at Fermilab, assumed the leadership of the Global Design Effort to research and plan for the ILC, a next-generation electron-positron linear collider.

The deep underground experimental hall of the Neutrinos from the Main Injector (NUMI) facility is now in operation at Fermilab, along with its sibling long-baseline MINOS detector at the former Soudan iron mine in northern Minnesota. With the MiniBooNE experiment soon to reveal its much-anticipated results, and with plans for the new "NOνA" experiment in northern Minnesota, Fermilab is the world center for accelerator-based neutrino physics. The Soudan mine is also host to a laboratory leading the search for enigmatic Cold Dark Matter in the universe. This and other undertakings in the realm of astrophysics and cosmology constitute a major new theme for Fermilab and its Particle Astrophysics Center.

The Sloan Digital Sky Survey collaboration has produced simply spectacular data of truly cosmic significance, and in Mendoza Province Argentina, the formal dedication of the 15-nation Pierre Auger Cosmic Ray Observatory collaboration was held last fall, as construction nears conclusion. Auger has already acquired the world's largest data-set on ultra-high-energy cosmic rays on the order of 10^{20}eV—some 100 million times greater than the energy produced by Fermilab's Tevatron. Under the outstanding leadership of Project Manager Paul Mantsch of Fermilab, Auger is on track (and under budget)

The URA paradigm for university-government-laboratory partnership

for completion in early 2007, and plans are being laid for subsequent construction of the complementary northern hemisphere array, to be sited in southeastern Colorado.

In the midst of these scientific successes, Fermilab continues to carry out its vitally important educational mission by producing the best of America's next generation of scientists and leaders. This year work carried out in particle physics and astrophysics programs at Fermilab resulted in some 145 Ph.D. theses. Each year, URA highlights this important measure of research productivity and vitality by awarding the URA Outstanding Ph.D. Thesis Prize. Similarly, URA sponsors the annual Alvin Tollestrup award for outstanding Postdoctoral research.

The Annual Meeting of the URA Council of Presidents (our "shareholders") was held in early February, 2005, with Gregory Geoffroy, President of Iowa State University, presiding and concluding his year as Council Chair. URA governance business was again combined with the now traditional Policy Forum, this year featuring addresses by John Marburger, former Chairman of the URA Board of Trustees and now Science Advisor to President Bush; Congressman David Hobson, Chair of the House Subcommittee on Energy and Water Development Appropriations; and DOE Office of Science Deputy Director, Jim Decker. Some 70 URA member universities were again represented at this year's meeting.

URA continues to benefit from the voluntary service of numerous distinguished individuals, who provide leadership on our Board of Trustees, on the Fermilab Board of Overseers, and in related oversight activities. We are pleased and grateful that Joe B. Wyatt, Chancellor Emeritus of Vanderbilt University, continues as Chair of our Trustees; Robert Galvin, former Chairman and CEO of Motorola provides his wise counsel to URA as Vice-Chair of the Trustees; Emanuel Fthenakis, former Chairman and CEO of Fairchild Industries, confers his considerable experience and expertise as Chair of our Audit Committee; and Don Hartill, Professor of Physics at Cornell University continues as Chair of the Fermilab Board of Overseers. Gerry Dugan, Professor of Physics at Cornell University, chaired the URA Visiting Committee's annual programmatic review of Fermilab, and Linda Wilson, retired DOE site manager at the Nevada Test Site, again led a similar review of Fermilab's administrative and operations support functions.

URA President Fred Bernthal (left) presented the 7th annual URA Thesis Award to Konstantin Anikeev of MIT and CDF during the Annual Users' Meeting held at Fermilab. Reinhard Schwienhorst of Michigan State University and DZero received the Alvin Tollestrup Award for postdoctoral research. Alvin Tollestrup presented the award during the same meeting. Both awards are funded by Universities Research Association, Inc.

This is just a sampling of the extraordinary talent that assembles voluntarily from around the country and the world to assist URA and our funding agencies in their undertakings, thereby reaffirming the benefits that derive from the URA partnership between our national laboratories and our nation's research universities. This paradigm of university-government-laboratory partnership has been frequently emulated at other agencies, to the considerable benefit of the research enterprise.

As new chapters in the history of URA's scientific endeavors are written, our activities and plans remain grounded in the original URA Articles of Incorporation, key excerpts of which appear on the inside cover of this report. In keeping with that charter, URA remains ready to respond to other appropriate opportunities to serve the U.S. and international research community. We look forward to another exciting year of service to our university community and to the American people, as we continue the infinite voyage of scientific discovery.

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
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University of California-Santa Barbara
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
Illinois Institute of Technology
University of Illinois
at Urbana-Champaign
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

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Louisiana State University
Tulane University

MARYLAND
Johns Hopkins University
University of Maryland-College Park

MASSACHUSETTS
Boston University
Harvard University
Massachusetts Institute of Technology
University of Massachusetts-Amherst
Northeastern University
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Michigan State University
University of Michigan
Wayne State University

MINNESOTA
University of Minnesota

MISSOURI
Washington University in St. Louis

NEBRASKA
University of Nebraska-Lincoln

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-
Chapel Hill

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*

Fermilab users from around the world work with the Laboratory's employees to advance the frontiers of particle physics

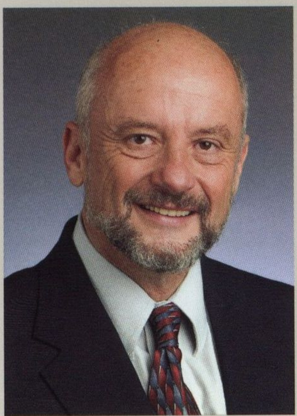
URA

FERMILAB

OVERVIEW

Fermi National Accelerator Laboratory, 30 miles west of Chicago, is a U.S. Department of Energy national laboratory with the primary mission to provide the facilities and resources necessary for advancing the understanding of the fundamental nature of matter and energy, and to provide leadership and resources for qualified experimenters to conduct basic research at the leading edge of high-energy physics and related disciplines.

Fermilab is the home of the Tevatron, the world's highest-energy particle accelerator. Particle beams circle through a ring of magnets four miles in circumference to generate collisions that produce experimental conditions equivalent to those that existed in the first quadrillionth of a second after the birth of the universe. Large detectors record and analyze these high-energy particle collisions to unveil the forces and particles that have governed the evolution of the universe since the Big Bang.



Fermilab Director Piermaria Oddone

Fermilab also has the world's most powerful proton beam for creating neutrinos, ghost-like particles that can cross the entire Earth without leaving a trace. The huge number of neutrinos produced at Fermilab allows scientists to conduct experiments that explore the role these particles have played in the formation of the universe. The detectors for both collider and neutrino experiments are built and operated by large teams of visiting scientists and Laboratory staff.

The Center for Particle Astrophysics at Fermilab includes groups investigating cosmic rays, supernovae, dark energy and other phenomena. Together with the collider and neutrino experiments, these research projects place Fermilab at the frontier of global particle physics and particle astrophysics research.

Fermilab currently provides research facilities for nearly 3,000 particle physicists and their students, from 259 institutions in 37 states (plus the Commonwealth of Puerto Rico) and 31 foreign countries. The U.S. scientists' research is usually supported by DOE and the National Science Foundation, and in some cases by university funds.

EVOLUTION OF THE LABORATORY

Today, the Fermilab accelerator complex consists of a chain of five machines that accelerate particles in sequence to increasing energy. Fermilab began operations in the early 1970s with a single beam of protons directed at fixed-target detectors. The Laboratory has upgraded its capabilities over the years to advance the exploration of the fundamental building blocks of matter. The 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 for the first time in 1983, and the leaders of its design and construction team received the National Medal of Technology in 1989.

Another vital upgrade enabled the Tevatron to become a collider, accelerating antiprotons as well as protons to TeV energies, in beams traveling in opposite directions, to produce collisions at selected 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 subatomic particles that emerge from proton-antiproton collisions. The collaborations that use these detectors announced in March 1995 the discovery of the top quark, a fundamental particle with an electric charge two-thirds that of the electron, and a mass nearly equal to that of one atom of gold. In late 1997, the Laboratory ended Tevatron Collider Run I in order to make major improvements to the Fermilab accelerator complex and the two big collider detectors for Run II. Meanwhile, the last run of the Tevatron fixed-target program was completed in

Fermilab's Wilson Hall is a landmark for both the local neighborhood and the high-energy physics community

The Wilson Hall high-rise southern view. Designed by founding Director Robert Wilson, the Mobius Strip sculpture is mounted in the midst of a circular pool atop Ramsey Auditorium. It is built of 3 x 5 inch pieces of stainless steel which were welded on a tubular form eight feet in diameter. (Photo credit Peter Ginter)

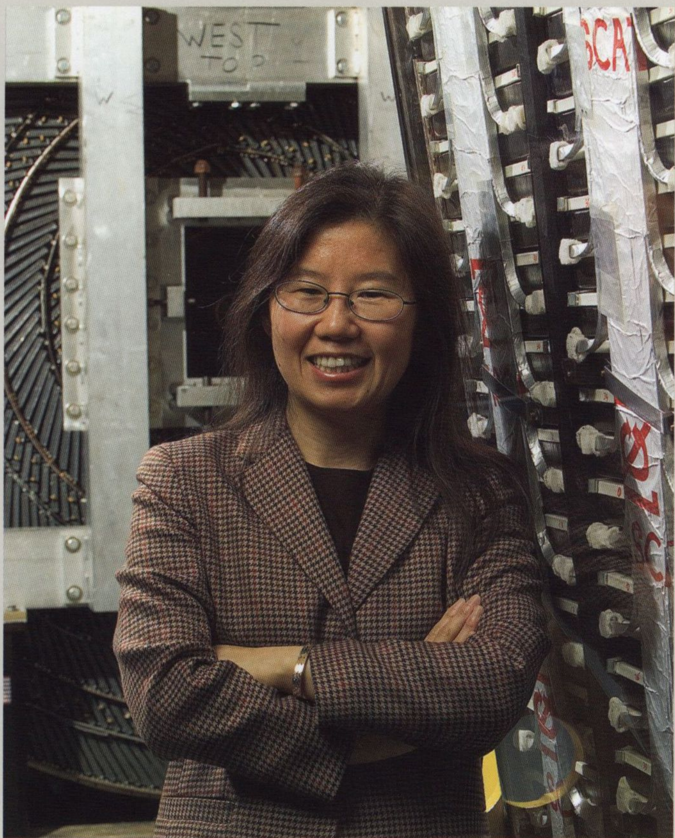
Major improvements in the accelerator complex have led to an increase of the collision energy and to a much higher collision rate

early 2000, the same year one of the collaborations announced the discovery of the predicted, but hitherto unobserved, tau neutrino, thereby completing the discovery of the members of all the three families of elementary particles.

Major improvements in the accelerator complex since the end of Run I have led to an increase of the Tevatron collision energy to nearly 2 TeV and to a much higher collision rate. The two-mile Main Injector, completed in 1999, has increased the rate of antiproton production for Run II. The Recycler, a storage ring located in the Main Injector tunnel that began operation in 2005, has eliminated a bottleneck in the accelerator chain and allows for large bunches of antiprotons to be injected into the Tevatron collider. The Recycler's successful operation involves reducing the size of the antiproton beams. The smaller and denser the antiproton beams, the larger the collision rate with the proton beams. Increasing the density of the beam is achieved via cooling, and one way to cool the beam is to bathe it in "cold" electrons. This technique has been successfully used in relatively low-energy nuclear physics machines. In the Recycler, the technique is being applied for the first time to higher energy, 8 billion electron volt (8 GeV) beams, pushing electron cooling to new performance limits.

Fermilab's two collider detectors have reinvented themselves for the new, higher-event-rate environment of Collider Run II. The CDF and DZero collaborations began to overhaul their respective detectors after the end of Collider Run I, and then proceeded with a major rebuilding program. Foremost among the challenging schedule issues for both collaborations was delivery of specialized silicon sensors and readout chips for particle tracking. Collider Run II began in 2001, and scientists from U.S. universities and others around the world resumed using these more sophisticated, more technically agile and more powerful detectors to record data in the barrage of high-energy collisions created by the Tevatron. All of the accelerator improvements for Collider Run II combined could provide proton-antiproton collision data up to sixty times that of the entire Collider Run I. Work continues on improving the performance of all systems of the accelerator complex to achieve the Run II goals by 2009.

The Laboratory's current fixed-target program consists of two forefront neutrino experiments: MINOS, which receives 120 GeV protons from the Main Injector; and MiniBooNE, which receives 8 GeV protons from the Booster, the proton injector accelerator for the Main Injector. A proposed third neutrino experiment, called NOvA, has received approval from the Fermilab directorate. Experiment collaborations continue to analyze data and uncover new scientific results from current and preceding collider and fixed target runs.



Young-Kee Kim, Professor of Physics at the University of Chicago acts as cospokesperson for the CDF collider experiment at Fermilab. Kim recently received South Korea's prestigious Ho-Am Award for her contributions to the understanding of the top quark, W boson and gluon.

Former CDF cospoksperson and user Luciano Ristor of INFN Pisa (Italy) stands by the upgradec CDF detector near the collision hall.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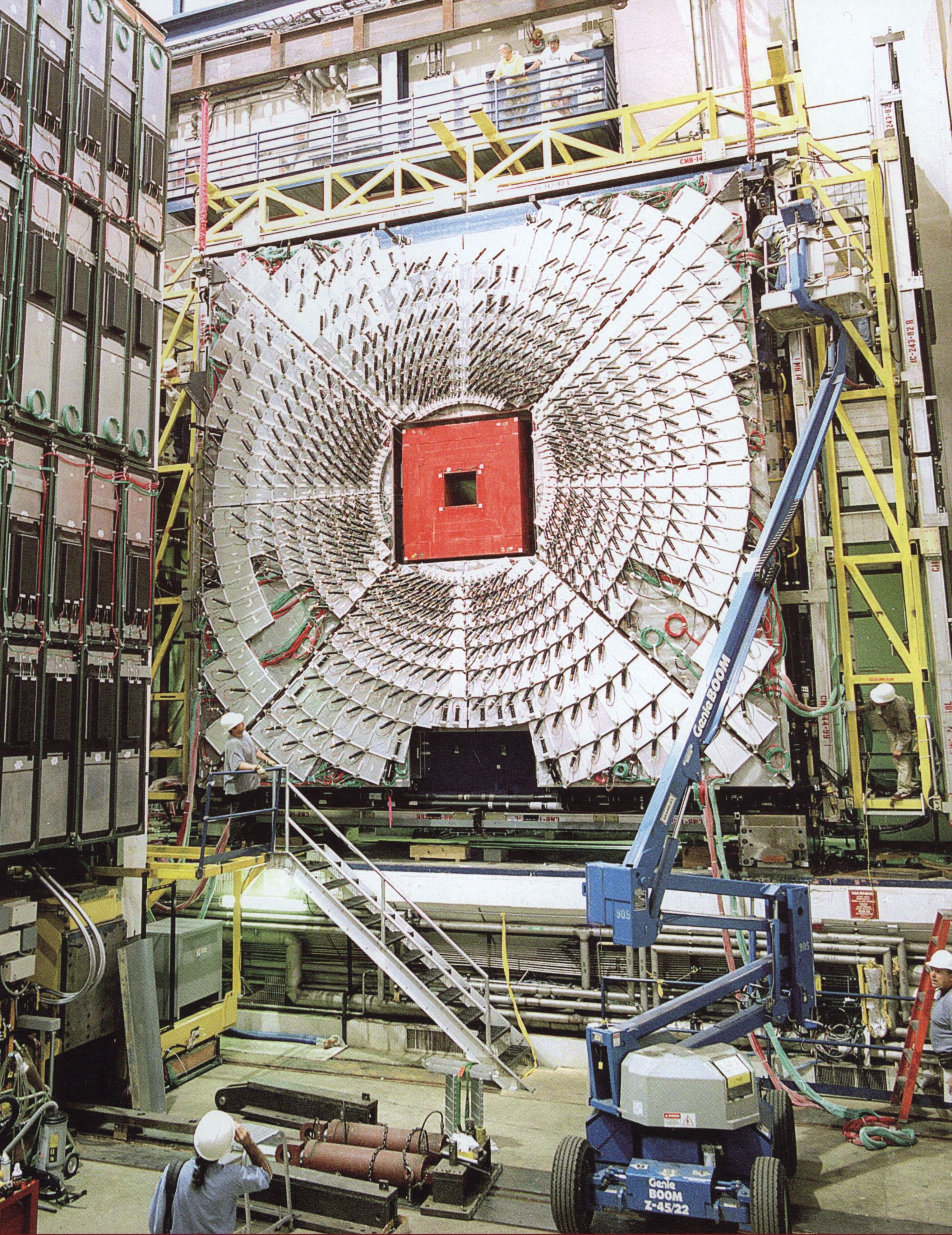
CAUTION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With Collider Run II well underway, the CDF and DZero detectors are both taking data with high efficiency

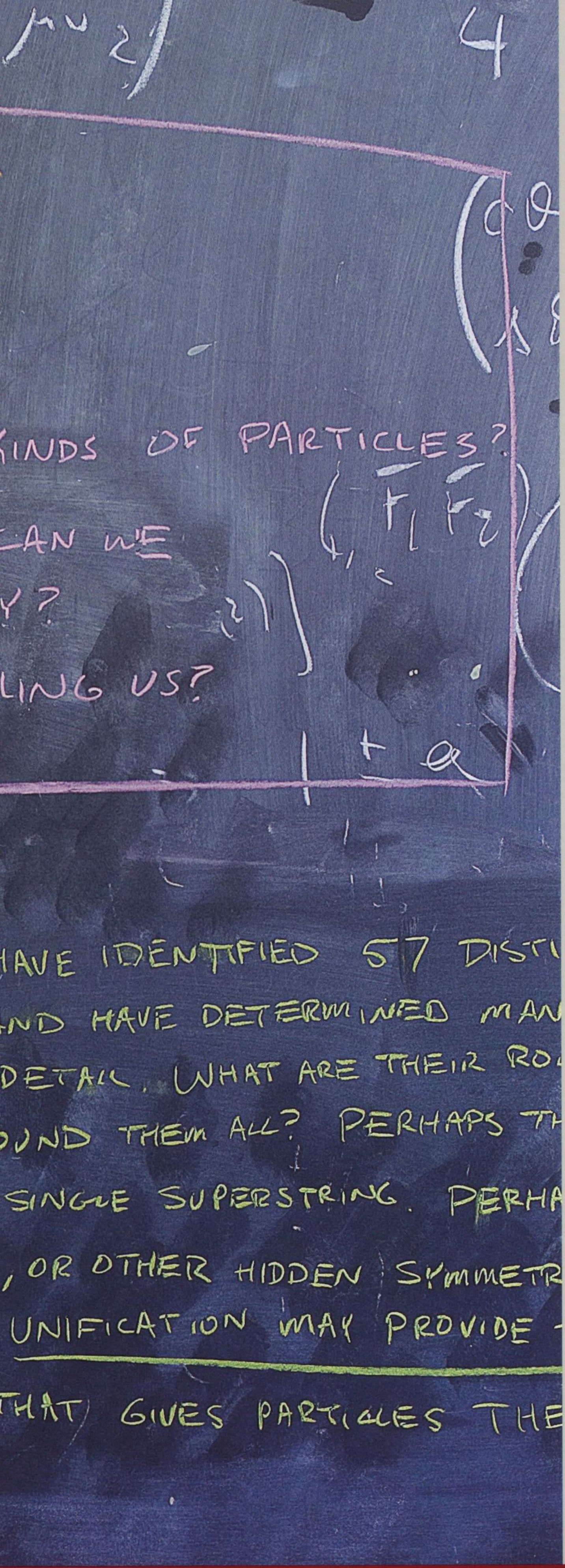
The control room of the DZero experiment during Run II of the Tevatron Collider. (Photo credit Peter Ginter)

Fermilab is moving ahead in its collaborations in non-accelerator projects at the forefront of research in astrophysics: the Cryogenic Dark Matter Search; the Pierre Auger (Cosmic Ray) Observatory Project; and the Sloan Digital Sky Survey. The Laboratory is also in collaborations for two proposed projects: the Super Nova Acceleration Probe (SNAP) and the Dark Energy Survey.

R&D continues on options for future accelerators, with the focus now on the proposed International Linear Collider (ILC) and an 8 GeV Proton Driver. Both machines would rely on superconducting acceleration structures. In an international collaboration, Fermilab is building the R&D facilities necessary to develop and test these components, and the Laboratory is preparing for a potential U.S. bid to host the ILC in Illinois.

In addition, the Laboratory is the center of U.S. activity in preparing for the scientific program at the Large Hadron Collider (LHC), now under construction at CERN, the European Laboratory for Particle Physics in Geneva, Switzerland. The LHC, which will collide particles at seven times the energy of the Tevatron, is currently scheduled to begin operations in 2007, and at that time, the high-energy frontier in particle physics will shift to Europe. The LHC Physics Center at Fermilab plans to provide U.S. physicists with a remote control room for the CMS experiment, as well as the computing resources for physics analysis.

he DZero detector being upgraded for Collider Run II. he increased dataset, higher collider energy and improved etector capabilities are enabling the DZero collaboration o explore physics beyond the Standard Model.



The Frontiers of Particle Physics, Astrophysics and Cosmology

The advances in scientists' understanding of the physical universe through progress in the interrelated fields of particle physics, astrophysics and cosmology over the past few decades are remarkable. Of the 18 fundamental subatomic particles that have been observed thus far, three have been discovered at Fermilab: the bottom quark in 1977, the top quark in 1995, and the tau neutrino in 2000. Yet these 18 particles make up less than five percent of the entire mass and energy of the universe. Experiments have shown that the total matter-energy content of the universe must include invisible dark matter that holds the universe together, and a mysterious dark energy that pushes the universe apart. The prospects for new fundamental discoveries in the next decade are as great as at any time in the history of these fields. New experiments and observations will be able to answer profound questions, some of which are related to discoveries within the last few years, and others which have been central to these fields for decades. In its report entitled "Quantum Universe, The Revolution in 21st Century Particle Physics," a Department of Energy/National Science Foundation advisory committee formulated the following nine interrelated questions that define the research agenda ahead.

1. Are there undiscovered principles of nature: new symmetries, new physical laws?

The fundamental particles discovered so far reflect the underlying symmetries that make up the known physical laws of nature. Yet the quantum ideas that so successfully describe the familiar forms of matter in our environment fail when applied at the cosmic scale of the universe. Solving the problem requires the appearance of new forces and new particles signaling the discovery of new symmetries. The theory of "supersymmetry" predicts that for every known particle there also exits a "superpartner" particle. The experimental discovery of supersymmetry is an immediate challenge in particle physics.

Physicists Anna Pla-Dalmau and Debbie Harris examine plastic extrusion for the MINERνA neutrino experiment.

2. How can we solve the mystery of dark energy?

Two independent discoveries imply the presence of a new form of energy that accounts for over two-thirds of the energy content of the universe. This dark energy that permeates empty space and accelerates the expansion of the universe must have a quantum explanation. Dark energy might be related to the so-called Higgs field, a force that fills space and gives particles their mass. The discovery of supersymmetry would provide crucial evidence for this possible connection.

3. Are there extra dimensions of space?

In trying to understand the quantum nature of gravity, physicists have developed "string theory," which implies the existence of supersymmetry and predicts seven undiscovered dimensions of space that give rise to much of the apparent complexity of particle physics. The discovery of these extra dimensions would change our understanding of the birth and evolution of the universe and reshape our concept of gravity.

4. Do all of the forces in nature become one?

At the most fundamental level all forces and particles in the universe might be manifestations of a single grand unified force, as envisioned by Albert Einstein. We already know that remarkably similar mathematical laws and principles describe all the known forces except gravity. A grand unified force would relate all of the elementary particles and predict new ways that one kind of particle can transform into another.

5. Why are there so many kinds of elementary particles?

There are three families of particles with dramatically different masses. Patterns and variations in the families of these particles suggest undiscovered principles that tie together the "quarks" and "leptons" of the "Standard Model" of particle physics. Detailed studies of quarks and leptons at accelerator experiments will provide the clearest insight into these principles.

6. What is dark matter, and how can we make it in the laboratory?

Most of the matter in the universe is unknown dark matter, probably heavy particles produced at the very beginning of the universe, in the "Big Bang." The leading candidates for dark matter are as yet unobserved particles whose existence is predicted by theories that go beyond the Standard Model. In particular, the theory of supersymmetry predicts new families of particles interacting very weakly with ordinary matter.

7. What are neutrinos telling us?

Among the particles that make up the Standard Model, neutrinos are the most mysterious. Neutrinos are both ubiquitous and elusive, interacting so weakly with other particles that they travel through the universe almost unimpeded by matter. Detailed studies of the neutrino's tiny mass relative to the other particles, and how they change from one type to another as they travel may lead to the discovery of new phenomena.

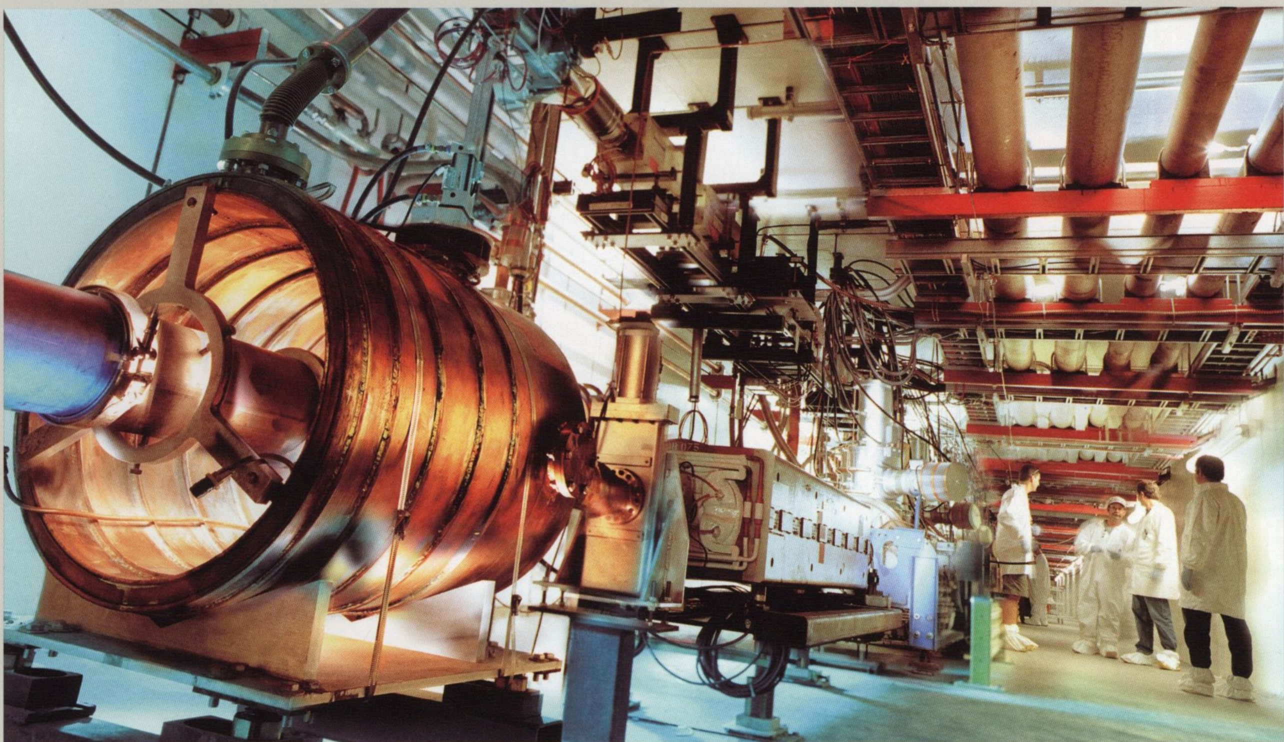
8. How did the universe come to be?

According to modern theories of cosmic evolution, the universe began with a singular explosion (the Big Bang), followed by an extremely rapid burst of expansion, termed "inflation." To understand inflation requires breakthroughs in our understanding of physics, of quantum gravity, and of an ultimate unified theory. Following inflation, the universe passed through a series of transitions to allow the formation of stars, galaxies, and life on earth. Although the physical conditions during inflation are too high in energy to reproduce on earth, some of the conditions of the later cosmic transitions could be recreated for study in high-energy accelerator experiments.

9. What happened to the antimatter?

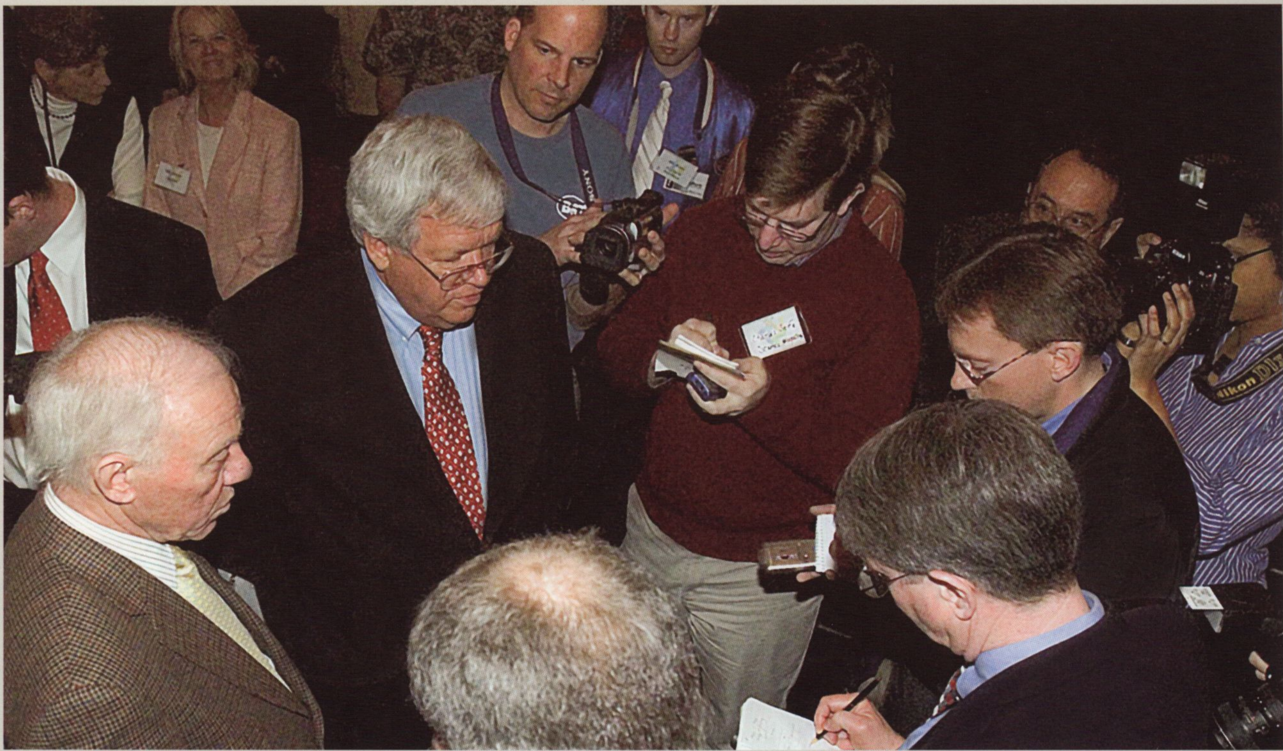
Experiments show that for every fundamental particle there exists an antiparticle, a particle that has identical mass and other properties, but has still other properties which are reversed, such as electrical charge. When a particle and an antiparticle interact, they annihilate each other, producing lighter particles and the release of energy in the form of massless photons. Current cosmological theories imply that the big bang and its immediate aftermath almost certainly produced particles and antiparticles in equal numbers. However, observations to date indicate that the universe is composed almost entirely of matter. A tiny imbalance between the particles and antiparticles must have developed early in the universe, or else most of them would have annihilated leaving only photons and neutrinos. Subtle asymmetries between matter and antimatter, some of which have been observed in the laboratory, must be responsible for this fortuitous imbalance.

The Fermilab program is addressing all nine of these important issues with new and proposed experiments. Over the next few years, the Tevatron collider remains at the center of the search for new physics at the highest energy available at any accelerator facility. For example, discovery of the predicted, but as yet unobserved, Higgs boson would lead to an understanding of what determines the masses of the elementary particles. Fermilab has also developed a world-leading neutrino program that will contribute essential information on the puzzling question of neutrino masses and oscillations. The Fermilab particle astrophysics program is exploring the questions of dark matter, dark energy, and mysterious high energy phenomena in the universe. Fermilab is actively engaged in planning and R&D for the future accelerators and experiments intended to address the above issues.



Inside the tunnel of the Main Injector accelerator at Fermilab. The Main Injector accelerates protons and antiprotons for injection into the Tevatron, the world's most powerful particle accelerator. (Photo credit Peter Ginter)

Programs and Activities, including Highlights of 2005



U.S. Speaker of the House Dennis Hastert (center), along with Congressman James Oberstar of Minnesota (left, front), answers reporters questions during the official dedication of NuMI that was held at Fermilab on March 4, 2005. House Speaker Hastert pressed a computer key that sent the neutrino beam to the far detector at Soudan. Full MINOS data-taking commenced in May 2005.

NEW DIRECTOR

Pier Oddone became Fermilab's fifth Laboratory Director on July 1, 2005. Immediately after stepping down from his previous position as Deputy Director of Lawrence Berkeley National Laboratory, Dr. Oddone was appointed to a consulting position at Fermilab on April 1, and began an intensive three-month Director transition period at the Laboratory. The overlap period with the last three months of Micheal Witherell's tenure as Director afforded Dr. Oddone the opportunity to participate as a member of the Laboratory's management team in a number of important strategic planning activities and external reviews of Fermilab.

PUBLICATIONS

During 2005 the various collaborations of experimenters and theorists at Fermilab produced over 180 publications and made over 240 conference presentations. The results included the most precise measurement of the top quark mass, observation of quantum oscillations between particles containing bottom quarks and their antiparticles, and new limits on the size of extra dimensions and the mass of new particles proposed by theoretical models such as supersymmetry. In addition, during 2004-05 some 90 Ph.D. candidates completed theses on accelerator-based research they carried out at Fermilab, and another 55 completed theses based on the Laboratory's astrophysics activities. These students go on to exciting careers in particle physics, in related fields such as astronomy, computer sciences, and engineering, as well as careers in industry and commerce.

SAFETY

Fermilab has an ambitious and effective program to continuously improve safety in the workplace. The Laboratory's major benchmark accident rates have been reduced by a factor of about eight over the last eight years, and are currently among the lowest in the DOE laboratory system. In 2005, Fermilab received two National Safety Council awards: the Excellence Achievement Award recognizes Fermilab for outstanding safety performance in 2004, and a Certificate of Merit honors Fermilab for outstanding safety practices during installation activities of the NuMI neutrino project.

Jasmine Ma, a summer student working on the MiniBooNE experiment, inspects one of the phototubes that detects light from neutrino interactions. (Photo credit Peter Ginter)

COLLIDER EXPERIMENTS

The CDF and DZero collaborations have an excellent opportunity for new discoveries, such as the Higgs boson, the lightest supersymmetric particles, and evidence for extra "dimensions" predicted by certain advanced theories. However, such discoveries require an aggressive program of further upgrades to the accelerator complex and the collider detectors over the next couple of years.

Since the March 2001 start-up of the collider complex for Run II, the Laboratory has been engaged in the technical challenge of steadily increasing collider luminosity, a measure of the proton-antiproton collision rate. The luminosity improvements over the past several years have been crucial for providing the 1,400 physicists who make up the CDF and DZero collaborations with the huge number of collisions they require for new discoveries. Since the beginning of 2005 the Laboratory has increased Tevatron peak luminosity by more than 50% and set a world record for the highest peak luminosity of any hadron collider. In addition the Laboratory exceeded the fiscal year design goal for integrated luminosity, a measure of the cumulative number of collisions delivered to CDF and DZero.

The upgraded CDF and DZero detectors are both taking data with high efficiency. The detector collaborations continue to report new measurements, both in support of leading theories and in the search for new phenomena beyond the current Standard Model. Some of these measurements provide the world's best limits on new phenomena. For example, in order to explain the relative weakness of gravity compared to the other three known forces, new theories have proposed that there are extra geometric dimensions beyond the normal three of everyday experience. The CDF collaboration has recently released a new result, based on data collected thus far, that places limits on the possible size of these extra dimensions. By mid-2005, the Collider collaborations had already submitted for publication some 60 papers on Run II research results. Fermilab's Tevatron collider program will represent the world's top research program at the energy frontier until the LHC detectors begin taking physics-quality data later this decade.

NEUTRINO EXPERIMENTS

Scientists have discovered three different types, or "flavors," of neutrinos: electron neutrinos, muon neutrinos, and tau neutrinos. The particles play an important role in stellar processes, such as the creation of energy in stars as well as supernova explosions. Experimental results obtained over the last five years have observed that the evasive neutrinos switch back and forth among their three different flavors while traveling through space and matter, suggesting that these particles have mass. Two current Fermilab experiments explore in detail the phenomenon of neutrino mass through neutrino oscillations. The results of these experiments concerning the properties of neutrinos, in conjunction with others around the world, could be profound because of the abundance of neutrinos in the universe. (Each cubic centimeter of the universe contains more than 100 neutrinos!)

The MiniBooNE experiment uses a proton beam from Fermilab's 8 GeV Booster to produce a neutrino beam. The MiniBooNE collaboration is searching for the change of muon neutrinos to electron neutrinos, and will provide a definitive answer to questions raised by evidence for such neutrino oscillations observed in an experiment at Los Alamos National Laboratory. The confirmation of the Los Alamos result would suggest the existence of a fourth type of neutrino and would revolutionize scientists understanding of the ghost-like particles.

Fermilab has also developed a world-leading neutrino program that will contribute essential information on the puzzling question of neutrino masses and oscillations

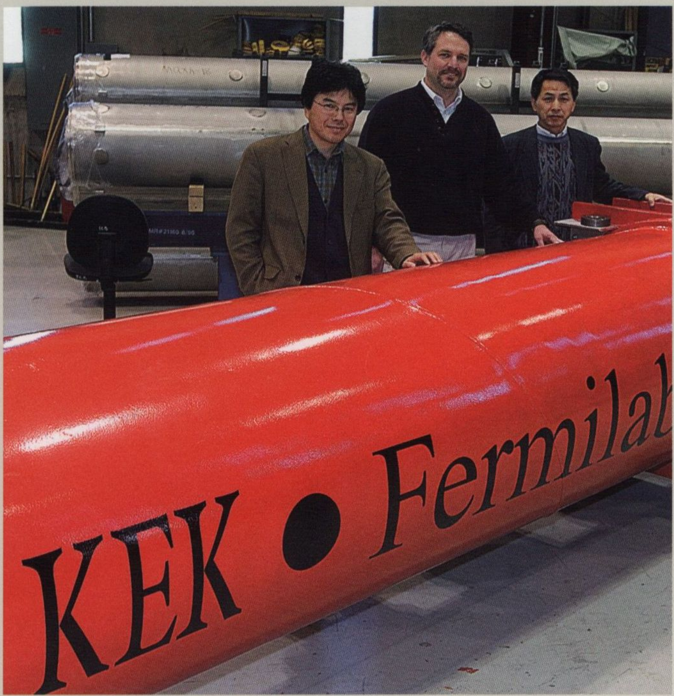
Construction of the MiniBooNE experiment began in October 1999, and the MiniBooNE collaboration has been taking physics data since late 2002. All beam and detector systems are working well. During 2005, the total number of protons "on target" for the production of neutrinos exceeded the established milestone, an important measure for collecting the data sample that the experiment requires. The collaboration has made great progress in analyzing measurements and anticipates presenting results in 2006.

In the NuMI (Neutrinos at the Main Injector) project, with its associated experiment called Main Injector Neutrino Oscillation Search (MINOS), Fermilab uses the Main Injector to create a high intensity beam of muon neutrinos aimed first at the "near" MINOS detector, and continuing straight through the earth to the "far" MINOS detector, located deep underground at the Soudan Underground Laboratory, in a former iron mine in northern Minnesota. The MINOS experiment will directly confirm muon neutrinos changing to tau neutrinos during their 730-kilometer journey from Fermilab to Minnesota. Civil construction, which included challenging underground excavation activities, began in 1999, both on the Fermilab site and at Soudan. The first beam of 120 GeV protons was successfully transferred from the Main Injector to the NuMI beamline in late 2004. The first neutrino event was recorded in the near detector in January 2005. The official dedication of NuMI was held at Fermilab on March 4, 2005, with U.S. Speaker of the House Dennis Hastert pressing a computer key that sent the neutrino beam to the far detector at Soudan. Full MINOS data-taking commenced in May 2005. In December 2005 the MINOS experiment reached an important milestone of 10^{20} protons on target for the production of neutrinos, a new world record for long baseline experiments. The civil construction component of the NuMI project has received the Outstanding Civil Engineering Achievement Award from the Illinois Section of the American Society of Civil Engineers.

In 2005, Fermilab granted first stage approval for NOvA, a proposed large neutrino detector that would be located about 810 kilometers from the Laboratory in Minnesota, on the surface and off-axis to the NuMI beam. NOvA would provide the most sensitive search for muon neutrino to electron neutrino oscillations and a unique capability to resolve the mass hierarchy among the different types of neutrinos. The Laboratory also granted similar approval for MINERvA, a small experiment to be located on-site in the NuMI beamline upstream from the MINOS near detector. MINERvA would measure neutrino cross sections, an important interaction property. Fermilab's plans to increase proton intensity for the production of neutrinos would extend the physics benefits significantly for these experiments.

Workers move a detector plane of the MINOS neutrino experiment into place to lower it underground for installation in the MINOS near detector. (Photo credit Peter Ginter)

The LHC will provide a unique and affordable opportunity for U.S. scientists to continue to work at the energy frontier



Fermilab scientist Jim Kerby (center) and two colleagues from the KEK Laboratory in Japan pose with a superconduting quadrupole magnet for the LHC. The magnet was jointly fabricated by Fermilab and KEK.

LARGE HADRON COLLIDER ACTIVITIES

As Collider Run II proceeds at Fermilab, the Laboratory also has a significant role in building the collider that will eventually overtake the Tevatron at the energy frontier. Through DOE and NSF, the United States is investing $531 million over eight years in the LHC accelerator at CERN and the two major LHC detectors. The U.S. is one of several non-CERN-member states, including Canada, Japan, India and Russia, contributing to the LHC.

When the LHC begins producing physics-quality data sometime in 2008, it will reach a beam energy seven times the energy of Fermilab's Tevatron. The LHC will provide a unique and affordable opportunity for U.S. scientists to continue to work at the energy frontier, and it will allow Fermilab to develop the technologies for building the accelerators that will someday surpass the LHC's capabilities.

Fermilab plays a major role in U.S. participation in the LHC. In the U.S. contribution to construction of the LHC accelerator, Fermilab leads a collaboration that includes Fermilab and the Brookhaven and Lawrence Berkeley National Laboratories. Most of the R&D for the advanced superconducting quadrupole magnets for the LHC's interaction regions has been done at Fermilab, and most of the fabrication of these quadrupoles is also taking place at Fermilab. The U.S. LHC accelerator project is nearly complete. To help commission the LHC and to carry out R&D to enhance LHC performance, Fermilab has been appointed the host laboratory for the U.S. LHC Accelerator Research Program (LARP), which was launched in February 2004.

DOE and NSF also asked Fermilab to oversee project management for the U.S. contribution to the international CMS detector, one of the LHC's two major detectors. Several years ago, the U.S. CMS collaboration asked Fermilab to serve both as one of its collaborating institutions and as its host laboratory, and Fermilab and URA agreed. In November 2005, the U.S. CMS collaboration celebrated the 97-percent completion milestone.

Fermilab has also been chosen to be the major U.S. regional computing center for CMS, one of the few such centers around the world. Planning is proceeding for Fermilab's role as host laboratory for the physics research phase of U.S. CMS once the LHC begins operations. Fermilab has established the LHC Physics Center (LPC) on the 11th floor of Wilson Hall to provide a research home for physicists from many institutions working on CMS physics analysis. Fermilab is studying the design of a remote LHC operations center, located at the Laboratory, to serve both LARP and LPC.

Superconducting quadrupole magnets built at Fermilab's Technical Division. Designed and built at Fermilab, they are destined for the interaction regions of CERN's Large Hadron Collider in Geneva, Switzerland. These magnets are key components of the LHC, scheduled to begin operating in 2007. (Photo credit Peter Ginter)


Fermilab
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COMPUTING

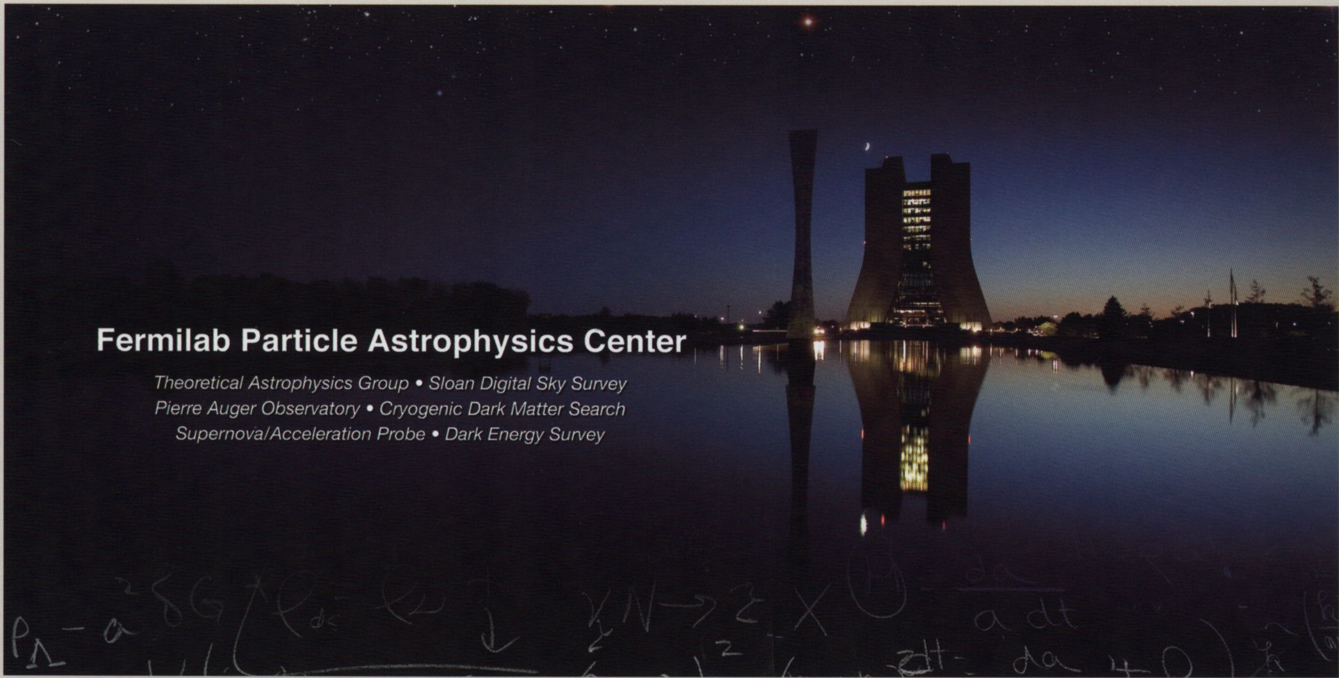
Fermilab is at the forefront of the development and use of ultra-fast data processing and data transfer technology. Run II at Fermilab is well underway with over a thousand participating physicists around the world. The upcoming LHC experiments at CERN involve collaborations larger than their predecessors, with more widely distributed analysis work. The data collected from experiments are becoming orders of magnitude more voluminous; petabytes (millions of gigabytes) per year are expected. To satisfy these and other emerging IT needs in the scientific, industrial, governmental and commercial arenas, grid computing has been conceived as an expansion of distributed computing. The term grid arose in the late 1990s to describe a computing infrastructure that allows dynamic, distributed collaborations to share resources. Grid computing involves the distribution of computing resources among geographically separated sites (creating a "grid" of resources), all of which are configured with specialized software for routing jobs, authenticating users, monitoring resources, and so on.

Fermilab is actively participating in the development and deployment of grid technology for high energy physics research. The Laboratory's Computing Division is involved in a variety of grid projects, some involving CDF and DZero Run II data handling and other current research projects at Fermilab, others looking forward to and preparing for physics that will be coming from the LHC at CERN in a few years. These grid projects are collaborations of scientific and computer professionals from a number of participating laboratories, universities and other organizations throughout the U.S., Europe and Asia. Fermilab is among the first users of DOE's UltraScience Net, a new network for high-speed and high-capacity science applications.

The Advanced Accelerator Modeling Team in the Computing Division, working in close collaboration with Laboratory's Accelerator Division, has developed Synergia, software that simulates the behavior of particles in an accelerator. The first version of this innovative software package was released to the general scientific community in 2005.

CPU's at the Feynman Computing Center provide the required data processing and analysis for Fermilab's experiments. (Photo credit Peter Ginter).

The Fermilab particle astrophysics program is exploring the questions of dark matter, dark energy, and mysterious high energy phenomena in the universe



A new poster denoting the major scientific activities of the Fermilab Particle Astrophysics Center.

ASTROPHYSICS

Fermilab's astrophysics program addresses fundamental scientific issues in the intersecting domains of particle physics and cosmology, the study of the origin and structure of the physical universe. The Fermilab Particle Astrophysics Center on the 6th and 7th floors of Wilson Hall was established in November 2004, unifying the Laboratory's existing and proposed experimental and theoretical astrophysics activities. The Center Director is renowned Fermilab and University of Chicago astrophysicist Edward "Rocky" Kolb.

All of the proposals for extending the 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 such particles of "cold dark matter" are underway. Fermilab is a member of the collaboration of twelve institutions in the Cryogenic Dark Matter Search (CDMS). These collaborators have developed very sensitive detectors that can detect the recoils of germanium or silicon nuclei if they collide with one of the massive dark matter particles. Several years ago the CDMS collaboration made public the most sensitive limits on the detection of such dark matter, on the basis of the preliminary experiment at a shallow underground site on the Stanford University campus.

Fermilab has the project management responsibility for building the larger and more sensitive experiment, CDMS II, in the same Soudan Underground Laboratory that also houses the far MINOS detector. Fermilab is playing a key role in the electronics, data acquisition, and cryogenics systems for CDMS II. The critical cryogenic system is now in operation, and the first two detector "towers" are taking data at Soudan. A third detector tower is undergoing final testing at Case Western Reserve University, and the remaining two towers are under construction at Stanford University. In 2005, the CDMS II collaboration published results from its first two tower run, with data at significantly greater sensitivity than ever

From left to right, new Fermilab Director Pier Oddone, retiring Lab Director Michael Witherell, Director of the new Fermilab Particle Astrophysics Center Edward "Rocky" Kolb, and Michael Turner of the University of Chicago cutting the cake during the Center's dedication celebration.

before in the realm of dark matter particles. Fermilab scientists are also involved in R&D work for the SuperCDMS, a phased enlargement of CDMS culminating in a detector system with roughly 1,000 times the sensitivity of the current one.

Fermilab has also been engaged in a collaboration that aims to find out how matter, both dark and luminous, is distributed. This project, the Sloan Digital Sky Survey (SDSS) has mapped in detail one-quarter of the entire sky, determining the positions, absolute brightnesses, and red shifts of nearly 200 million celestial objects, including more than a million galaxies and two hundred thousand quasars. The SDSS collaboration built and utilizes a 2.5-meter telescope and the associated instruments at Apache Point, New Mexico. Among Fermilab's many contributions to this project has been the construction of the data acquisition system and the software and hardware to process the expected 10 to 20 terabytes of data that were accumulated during the roughly five-year duration of the survey. On July 1, 2003, Richard Kron, a senior scientist in the Laboratory's Experimental Astrophysics Group, succeeded Fermilab Director Emeritus John Peoples as SDSS Director.

In July 2004, SDSS scientists announced that their extensive investigation of the distribution of material in the largest, most detailed map of the universe strongly confirms that 70% of the universe is composed of dark energy. In January 2005, a group of SDSS scientists announced results on the clustering of nearby galaxies, with important implications for the geometry of the universe. Later in 2005, SDSS published the collaboration's fourth data release, containing imaging data from 6670 square degrees of the sky and information on roughly 180 million objects. In June 2005, a follow-on survey, SDSS-II, was announced, with funding from the Alfred P. Sloan Foundation, NSF, and DOE. The SDSS-II collaboration has grown to include 23 member institutions around the world. SDSS-II has three components. The first, called LEGACY, will complete the SDSS survey of the extragalactic universe, obtaining images and distances of nearly a million galaxies and quasars over a continuous swath of sky in the Northern Hemisphere. The new funding inaugurates the second part of SDSS-II, the Sloan Extension for Galactic Understanding and Exploration (SEGUE), mapping the structure and stellar makeup of the Milky Way Galaxy, and gathering data on how the Milky Way formed and evolved. Identifying the oldest stars will help scientists understand how the elements of the periodic table were formed inside of stars. The third component of SDSS-II includes an intensive study of supernovae, sweeping the sky to find these remnants of gigantic explosions from dying stars. Scientists can precisely measure the distances of distant supernovae, using them to map the rate of expansion of the universe, a direct measurement of the effects of dark energy on the geometry of the universe as a whole.

Looking beyond SDSS, the Experimental Astrophysics Group has joined a collaboration of institutions in a space-based mission to probe the nature of dark energy and the accelerating expansion of the universe. The SuperNova Acceleration Probe (SNAP) satellite experiment, a proposal for the NASA-DOE Joint Dark Energy Mission, would detect and monitor several thousand "Type Ia" supernovae to determine the properties of dark energy. Scientists in the Experimental Astrophysics Group are also part of a collaboration that is proposing a five-year Dark Energy Survey to begin in 2009, using a new wide-field camera to be built for the existing 4-meter telescope at the Cerro Tololo Inter-American Observatory in Chile. Fermilab scientists are leading the construction of the camera and optics.

As a member of an international collaboration of 15 countries, Fermilab is playing a major role in the Pierre Auger Observatory Project, which will explore the properties and mysterious origins of very-high-energy cosmic rays. (*See Separate Section on Pierre Auger Observatory Project.*)

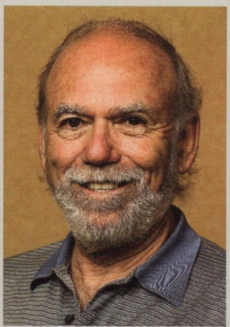
As the largest U.S. laboratory for particle physics, Fermilab would provide a strong base on which to build new facilities

FUTURE COLLIDER FACILITIES

While scientists await new discoveries at the high-energy frontier from Collider Run II at Fermilab, and later in the decade from the LHC at CERN, they must also plan how to advance the field in the future. For this it is necessary to perform R&D for the next generation of major accelerator facilities. Many in the community believe that Fermilab is the natural site for such a facility. As the largest U.S. laboratory for particle physics, Fermilab would provide a strong base of talent and infrastructure on which to build new facilities both on and near the present site.

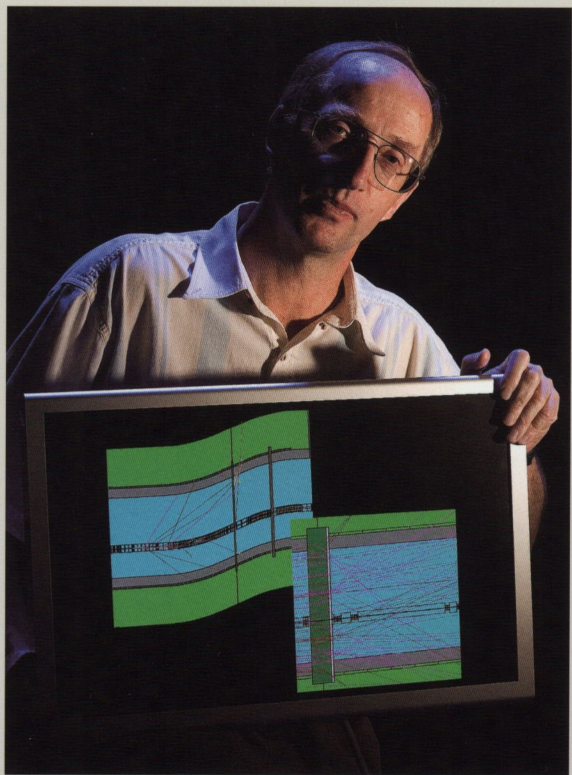
There is a consensus in the worldwide particle physics community that the next large facility should be an International Linear Collider (ILC). The ILC would create high-energy (500-1000 GeV) particle collisions between electrons and positrons, their antimatter counterparts. Together with the LHC, the ILC would provide a tool for scientists to address many of the 21st century questions about the fundamental nature of matter, energy, space and time, including dark matter, dark energy, and extra dimensions. From its inception, the ILC would be designed, funded, managed, and operated as an international scientific laboratory.

With the endorsement of the International Committee for Future Accelerators (ICFA) in 2004, the particle physics community has chosen an accelerator technology for the ILC, opening the way for the world community to unite and concentrate resources on the design of a linear collider using superconducting radiofrequency (rf) technology for the accelerating structures of the ILC. In 2005, ICFA established the international Global Design Effort (GDE). An international group of about 50 people forms the GDE team for the ILC, headed by Barry Barish, professor of physics at California Institute of Technology and former director of the LIGO laboratory, a major NSF-funded observatory for the detection of gravity waves. The GDE team sets the strategy and priorities for the work of hundreds of scientists and engineers at universities and laboratories around the world. The GDE goal is to produce an ILC Conceptual Design Report by the end of 2006 and an ILC Technical Design Report by the end of 2008. Physicists and policy-makers will use the reports to decide the future of the project. Fermilab is hosting members of the GDE team on the 13th floor of Wilson Hall and supports the ILC Website and communications.



Barry Barish, Director of the ILC Global Design Effort

Fermilab has assumed a leading role in building a proposed engineering test facility for major ILC linac systems, In 2005, DOE Office of Science officials indicated that if the U.S. were chosen by the international community to host the ILC, the collider would be sited near Fermilab. In response, Fermilab has initiated site studies for a proposed ILC located in Northern Illinois, for which Fermilab would be the host laboratory.



Fermilab accelerator physicist Nikolai Mokhov shows a display from a computational model of the ILC beamline.

Scientist in a clean room at Fermilab testing a superconducting rf structure for potential use in the International Linear Collider.

In collaboration with other laboratories, universities and industry, Fermilab is progressing in the development of the electron source for a superconducting linac; design of a damping ring to "cool" the motion of electrons and positrons, so the beams can be tightly focused; development of simulation tools to study beam transport from the damping ring to the interaction point; and design, production and testing of a superconducting niobium accelerating cavity and its power input devices. In his role as Fermilab Director, Pier Oddone is a member of both the International Linear Collider Steering Committee (ILCSC) under ICFA, and the regional Linear Collider Group of the Americas (formerly the U.S. Linear Collider Steering Group)

FUTURE ACCELERATORS FOR NEUTRINO EXPERIMENTS

With interest high in neutrino physics, very intense neutrino sources are required for the next generation of experiments. Current accelerator sources at Fermilab produce secondary beams of neutrinos from collisions of high energy protons on stationary targets. To increase proton intensity, Fermilab has developed concepts for a new 8 GeV proton source facility, called the Proton Driver, to replace Fermilab's aging Linac and Booster accelerators. With its enhanced performance, the Proton Driver would solve the associated problems of decreasing Booster reliability and the need for increased proton intensity for simultaneous operation of the MiniBooNE and NuMI/MINOS neutrino experiments. In light of the selection of superconducting acceleration technology for the ILC, Fermilab has chosen to develop the same technology for the Proton Driver. Because of the synergistic overlap, the Laboratory is pursuing R&D for both the ILC and the Proton Driver in parallel. In collaboration with a number of other institutions involved in the development of superconducting rf technology, Fermilab is establishing an ILC Test Area and a Proton Test Area.

Muons, the short-lived and heavier relatives of electrons, can be used to produce much more intense beams of neutrinos. However, muon beams are large and diffuse, and they currently are too big to "fit" into an accelerator. Fermilab's MuCool project is part of the Neutrino Factory and Muon Collider collaboration, which includes particle and accelerator physicists from U.S., Japanese and European laboratories and universities. With the goal of creating compact muon beams, MuCool physicists will soon be testing accelerating capabilities of new rf cavities, developed by groups at Lawrence Berkeley National Laboratory and Thomas Jefferson National Accelerator Facility.

Fermilab is also collaborating with several regional universities that have initiated accelerator R&D efforts, including Illinois Institute of Technology, Northern Illinois University, Northwestern University, University of Chicago and University of Illinois at Urbana-Champaign. The Northern Illinois Center for Accelerator and Detector Development (NICADD) began operations in 2002 at Northern Illinois University's DeKalb campus. NICADD projects envisioned for collaboration with Fermilab include creation of a particle detector research facility, establishment of a separate facility for development of the next generation of linear colliders, and joint operation a laser-driven, electron beam research facility at Fermilab. Seven participating institutions are using the facility, with its superconducting rf technology, for experiments on plasma and laser acceleration techniques, and for several investigations that could have an impact on linear collider design considerations.

The Leon M. Lederman Science Education Center, dedicated in 1992, drew attendance in 2005 of over 25,000 students and 2,400 teachers in K-12 education programs

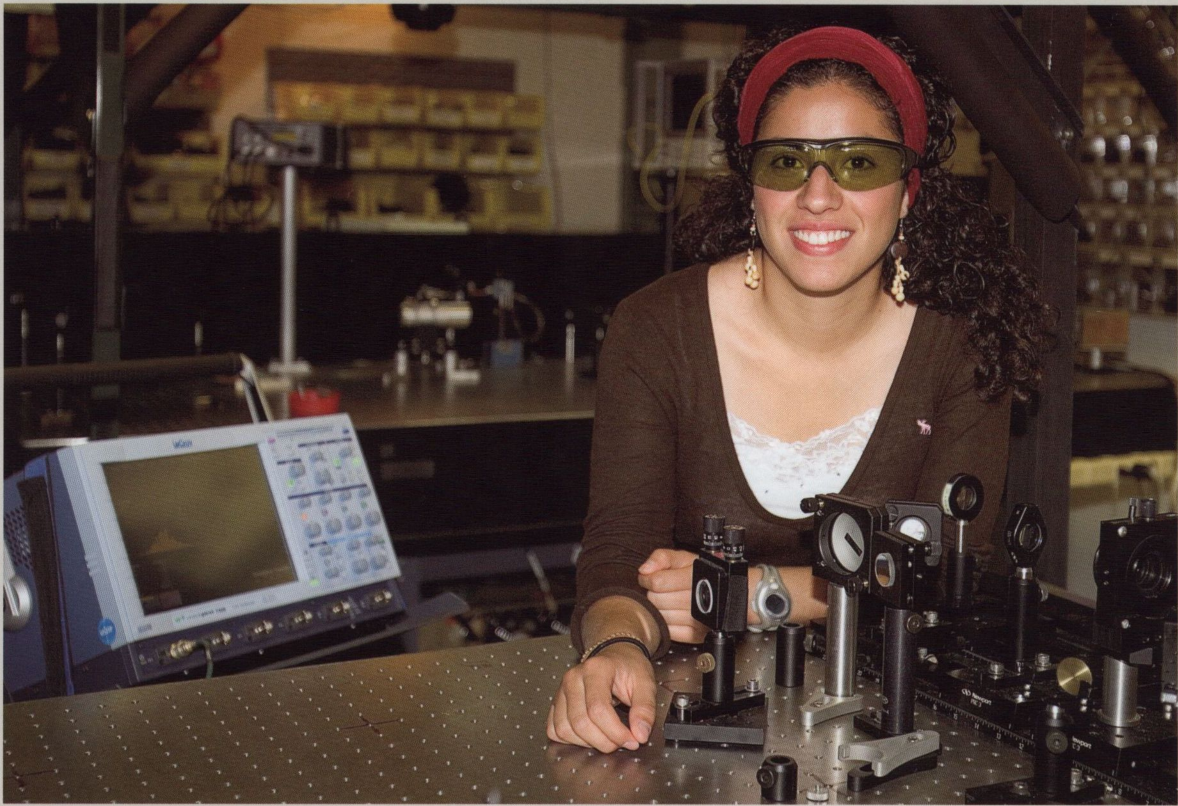
From left to right, Saturday Morning Physics leader Roger Dixon, Leon Lederman, Michael Witherell—and on the extreme right—Drasko Jovanovic, founder of the the program, together with students at the Saturday Morning Physics 25th Anniversary and Graduation.

EDUCATION, TRAINING AND FELLOWSHIP PROGRAMS

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 Fermilab Director Emeritus and Nobel laureate 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 2005 of over 25,000 students and 2,400 teachers in K-12 education programs. The Center offers some 32 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. The Center is a leader in QuarkNet, the DOE- and NSF-funded program that reaches 500 high school teachers across the country, bringing the world of particle physics to their students. In 2005, the Center's education webserver received nearly 17 million hits. Currently, 50 percent of the Center's funding, including QuarkNet, is provided by Fermilab, and 50 percent comes from other federal, state and private sources.

The Internships for Physics Majors (IMP) summer program is aimed at outstanding college physics students who desire an opportunity to experience a working scientific environment. The IMP program is open to students in the U.S. and abroad. Students also participate in the IMP program through DOE's Science Undergraduate Laboratory Internship program, which is open to all science undergraduates. TARGET is a program



SIST Student Michelle Alvarado. Fermilab has sponsored the SIST program for 35 years. SIST has the distinction of being the oldest operating program of its type in the U.S. and has served as a model for other laboratories and private industry.

for academically talented high school students who are members of minority groups and who have expressed an interest in science. TARGET students come to the Laboratory each morning in the summer to work with an advisor and then attend three classes every afternoon at nearby Naperville High School. The Summer Internships in Science and Technology (SIST) program provides summer internships at Fermilab in physics, engineering and computer science to an average of 20 undergraduate students per year from minority groups traditionally underrepresented in the fields of science and engineering. Fermilab has sponsored the SIST program for 35 years. SIST has the distinction of being the oldest operating program of its type in the U.S. and has served as a model for other laboratories and private industry.

Fermilab sponsors the Lederman, Peoples and Wilson postdoctoral fellowships at the Laboratory, and participates in a Joint University-Fermilab Doctoral Program in Accelerator Physics. In 2005, Fermilab initiated the John Bardeen Engineering Fellowship to bring to the Laboratory each year one or two of the most talented masters or doctoral recipients in engineering. In collaboration with other laboratories and U.S. universities, Fermilab serves as home of the U.S. Particle Accelerator School. The Laboratory also supports university faculty members in residence at the Laboratory through a guest scientist program.

URA sponsors two annual awards at the Laboratory. The Fermilab/URA Graduate Thesis Award honors the outstanding doctoral thesis written on research conducted at Fermilab or in collaboration with Fermilab scientists. The Tollestrup Award for Postdoctoral Research honors outstanding work conducted by a postdoctoral researcher at Fermilab or in collaboration with Fermilab scientists. URA also supports the awards for outstanding poster presentations at the annual New Perspectives Conference, organized each year by Fermilab's Graduate Student Association on behalf of young scientists at the undergraduate, graduate, and postdoctoral levels.

URA also provides financial support for graduate courses at Fermilab. Graduate students often have difficulty taking classes at their home institutions because they spend so much time at Fermilab participating in experiments. In 2005, Fermilab's Theoretical Physics Department began an academic lecture series aimed at graduate students and young postdocs.

Fermilab has been designated a National Environmental Research Park by the U.S. Department of Energy

ENVIRONMENTAL AND CONSERVATION ACTIVITIES

In addition to its research mission in high-energy physics, Fermilab has been designated a National Environmental Research Park by DOE. The Laboratory diligently oversees restoration and preservation of the site's ecosystems. Over the years, the Laboratory has restored more than a thousand acres of the native tallgrass prairie that once covered the Fermilab site. The prairie is actively managed, including annual prairie burns to help maintain the system's natural cycles. In 1998, Fermilab became a member of Chicago Wilderness, a consortium of nearly one hundred public and private landholders in the Chicago area committed to careful and responsible management of the remaining habitat in the region.

Fermilab is a leader in implementing energy conservation, recycling and waste reduction programs, and has won a number of awards over the past few years. The Laboratory received two 2003 Pollution Prevention and Environmental Stewardship Awards from the DOE Office of Science. The first award recognized the Laboratory for its implementation of the Fermilab Alternative Fuel Initiative. Through the use of 63 alternative fuel vehicles on site, the Laboratory reduced its use of petroleum fuel by 20 percent during FY2003, accomplishing the DOE's goal of fuel reduction two fiscal years ahead of schedule. The Laboratory received the second award for implementing a Scintillator Plastic Recycling Program. In June 2005, Fermilab won another DOE Stewardship award for its implementation of an Emergency Light Battery Removal and Relocation Program, a multi-year activity to remove emergency light batteries from over six miles of accelerator and fixed-target beamline enclosures. Although proper disposal of batteries is always important, the presence of the batteries in areas subject to radiation presented the Laboratory with a mixed-waste disposal problem. An Accelerator Division team replaced some emergency lighting systems with uninterruptible power supplies and relocated other batteries to areas not subject to radiation. As a result, one source of mixed-waste was eliminated and Laboratory safety was improved.

Fermilab recycles about 90,000 pounds of electronic equipment per year. Because such equipment often contains lead and other hazardous materials that make traditional disposal or recycling methods difficult and costly, the Laboratory has an "e-cycling" program, in which a contractor breaks down the equipment into components that can be individually recycled.

In May 2004, the U.S. Environmental Protection Agency presented Fermilab with a 2003 Conservation and Native Landscaping Award, citing the Laboratory's achievement in using native plants in the Main Injector Wetland Mitigation Project. In October 2004, Fermilab was one of 15 Illinois companies and organizations to receive a Governor's Pollution Prevention Award for implementing a new liquid nitrogen recovery system that reduces exhaust and conserves energy. Fermilab also received an FY2004 Federal Energy and Water Management Award for the Laboratory's Condensation Control on the Rings Project, which added dehumidifiers in the Tevatron enclosure.

Fermilab is a member of Chicago Wilderness, a consortium of nearly one hundred public and private landholders in the Chicago area committed to careful and responsible management of the remaining habitat in the region. Springtime brings the birth of infant American Bison to the Fermilab buffalo herd.

DOE Fermi Site Office Manager Joanna Livengood presents a Safety Award to Fermilab Director Mike Witherell.

ACCELERATORS IN MEDICINE

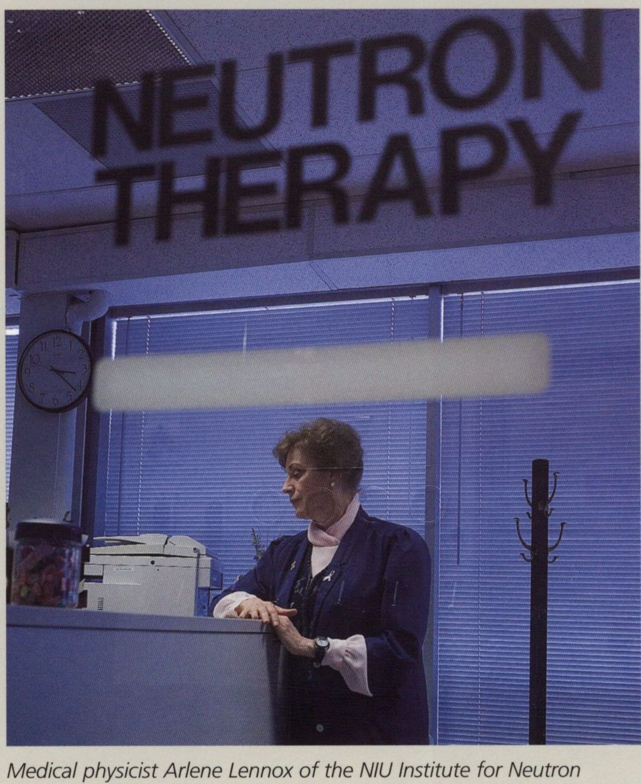
Between 1976 and 1985, the National Cancer Institute funded clinical trials at Fermilab to explore the effectiveness of fast neutrons versus photon therapy in the management of radioresistant tumors. Since then, working with hospitals in the Fermilab region, more than 3,100 patients with cancer have received treatment at Fermilab's Neutron Therapy Facility (NTF). About 25 percent of these patients reside outside Illinois, including individuals from Canada, Greece, Haiti, Mexico, Pakistan, and the Philippines. From 1995 to 2003, the NTF was operated under contract with Provena Saint Joseph Hospital of Elgin, Illinois. In December 2004, Northern Illinois University announced the formation of the NIU Institute for Neutron Therapy at Fermilab, partnering with the Laboratory to continue the NTF program of providing such therapy to patients and to conduct extensive research on this treatment.

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 MeV proton accelerator for the hospital of Loma Linda University Medical Center in California, which began treating patients in October 1990.

In 2005 Fermilab successfully implemented its Environmental Management System (EMS), a set of problem identification and solving tools. Fermilab's EMS is analogous to the Laboratory's successful Integrated Safety Management System (ISMS).

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 technologies developed at the Laboratory.



Medical physicist Arlene Lennox of the NIU Institute for Neutron Therapy at Fermilab.

Fermilab laboratory staff volunteer in sponsorship of cultural activities and conduct tours for visitors

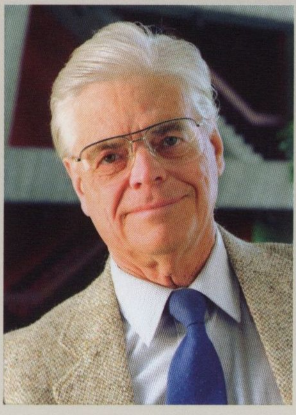
Fermilab physicist Gene Fisk (left), responds to questions from community visitors during one of the regular Ask-a-Scientist sessions at Fermilab.

COMMUNITY PROGRAMS

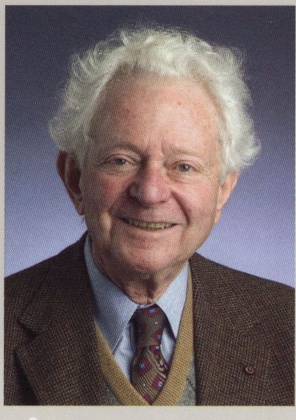
Fermilab's role as a key element of the Illinois High Technology Corridor is complemented by its sponsorship of cultural activities to which the public is invited. Laboratory staff members volunteer in supporting an arts series, physics colloquia, films and an art gallery. Fermilab also conducts public tours for visitors and briefings for local citizens on Laboratory initiatives. With the cooperation of DOE security officials, the Laboratory has been pleased to be able to continue most of its public events and guided tours in the wake of post-9/11 security concerns at Federal facilities. In January 2005, Fermilab implemented a new site security plan, which places principal security attention on a number of Property Protection Areas. For the remainder of the site, the Laboratory provides open access during normal business hours. As a result of the new security program, Fermilab maintains the strong connection with the surrounding communities that it has historically enjoyed.

In March 2004, the Laboratory formed the Fermilab Community Task Force on Public Participation to develop a set of mutual expectations for how Fermilab will interact with the community on issues that affect them both. The 20-member Task Force consists of individuals with diverse interests from the surrounding communities. The Laboratory asked the Task Force to provide recommendations on how the Laboratory and the community should work together on issues of mutual interest and concern. The Task Force submitted its final recommendations to Laboratory management in December 2004. Fermilab is using these recommendations to develop a comprehensive policy for public participation, incorporating community desires and concerns to the maximum extent possible. In November 2005, the Task Force's ILC Subcommittee met at the Laboratory to discuss goals and objectives for community involvement in the possible siting of the ILC in Northern Illinois, near Fermilab.

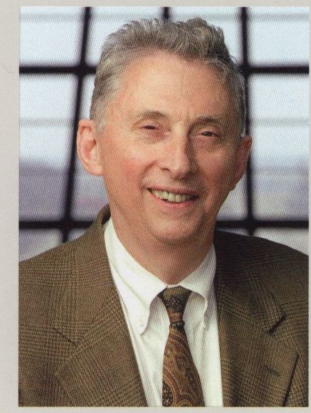
On July 1, 2005, Piermaria Oddone became Fermilab's fifth Director



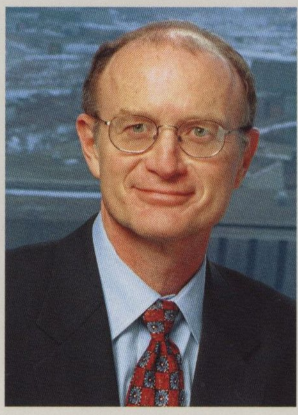
Fermilab Founding Director Robert R. Wilson, 1967-1977.



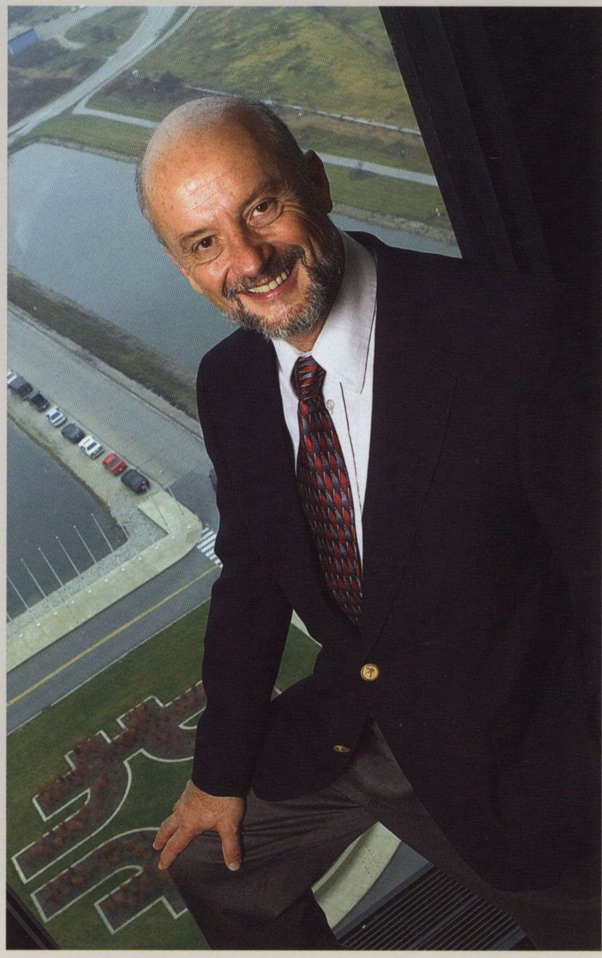
Second Director, Nobel Laureate Leon Lederman, 1977-1987.



John Peoples served as Fermilab's third Director, 1988-1999.



Retiring Lab Director, Michael Witherell, 1999-2005.



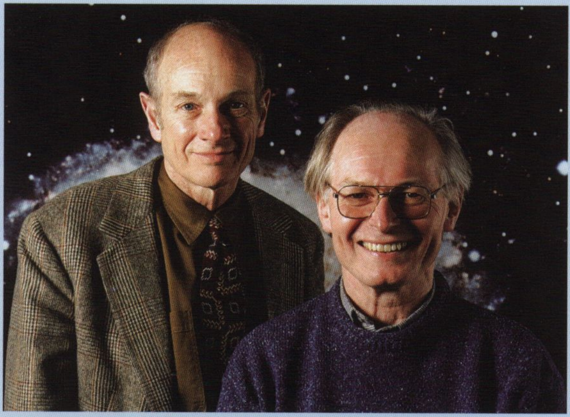
Piermaria Oddone shortly before URA's public announcement of the appointment of Dr. Oddone as the next Director of Fermilab, effective July 1, 2005, seen viewing the Laboratory site from the visitor area on the fifteenth floor of Wilson Hall.

LABORATORY DIRECTORS

On July 1, 2005, Piermaria Oddone became Fermilab's fifth Director. Dr. Oddone comes to Fermilab from Lawrence Berkeley National Laboratory, where he was Deputy Director for the previous fifteen years. Dr. Oddone succeeds Michael Witherell, who served with distinction as Director since July 1999. Dr. Witherell has returned to the University of California at Santa Barbara, where he now serves as Vice Chancellor for Research. John Peoples Jr. led the Laboratory from 1989 to 1999. Dr. Peoples is currently a senior scientist in Fermilab's Experimental Astrophysics Program, where he served from 1999 to 2003 as Director of the Sloan Digital Sky Survey. Leon M. Lederman, a 1988 Nobel laureate, directed the Laboratory from 1979 to 1989 and is a member of the URA Board of Trustees. Dr. Lederman is currently Resident Scholar at the Illinois Mathematics and Science Academy; his contributions to science education are known worldwide. Fermilab's founding Director, the late Robert R. Wilson, served from 1968 to 1978, and subsequently served as a member of URA's Fermilab Board of Overseers. Dr. Wilson provided enduring guidance for the aesthetics of buildings and grounds, including sculpture that he created.

For further information about Fermilab, visit the Laboratory's website at http://www.fnal.gov

PIERRE AUGER OBSERVATORY PROJECT



"These highest-energy cosmic rays are messengers from the extreme universe. They represent a great opportunity for discoveries," said Nobel Prize winner James Cronin (left), of the University of Chicago, who conceived the Auger experiment together with Alan Watson of the University of Leeds (UK). Watson added: "How does nature create the conditions to accelerate a tiny particle to such an energy? Tracking these ultrahigh-energy particles back to their sources will answer that question."

Cosmic rays are high-energy charged particles from space that constantly bombard the Earth from all directions. The majority of the particles are single protons—the nuclei of hydrogen atoms—but some are much heavier, ranging up to the nuclei of lead atoms. A small fraction of cosmic rays are the most energetic particles ever observed in nature. Direct measurement requires locating detectors above most of the Earth's atmosphere, using high-altitude balloons and orbiting satellites, which necessarily imposes limits on the weight of instrumentation required for the highest energy cosmic rays. About 60 years ago, French physicist Pierre Auger discovered that cosmic rays can also be detected indirectly on the surface of the Earth by observing the showers of secondary particles they produce when colliding with atmospheric molecules. Named in his honor, the Pierre Auger Observatory is a broad-based international effort to solve the mystery of the origins of the extremely rare, ultra-high-energy cosmic rays showering the earth at energies above 10^{19} electron volts (eV), or about 10 million times greater than the energy of the protons accelerated by Fermilab's Tevatron. These highest-energy cosmic rays can be considered messengers from the extreme universe, and thus represent great opportunity for discoveries. Tracking these particles back to their source will help explain how nature creates the conditions to accelerate them to such high energies.

The especially interesting cosmic rays, which have energies over 10^{20}eV (equivalent to the kinetic energy of a tennis ball traveling at 340 miles per hour, but packed into a single proton), have an estimated arrival rate of just 1 per square kilometer per century! To record a large number of these ultra-high energy cosmic rays events requires a very large observing area, roughly the size of the state of Rhode Island. The Pierre Auger Observatory is constructing an array of 1,600 surface detectors spaced about 1.5 kilometers apart and spread over 3,000 square kilometers in Argentina's Mendoza Province, just east of the Andes Mountains. For more accurate detection of cosmic ray events, the Observatory is the first to use a hybrid approach: a surface detector array to record the showers of particles produced when cosmic rays strike the earth's surface; and fluorescence detectors to record the atmospheric flares produced by particle showers, visible on dark clear nights. Each surface

One of four massive fluorescence detector buildings (in background) adjacent to a communications tower. This one at Los Leones overlooks its closest surface detector tank (in foreground). Some 1,600 surface detectors are being deployed for the Southern Auger array to record showers of particles produced when cosmic rays strike the earth's atmosphere.

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

detector, consisting of a tank filled with 3,000 gallons of ultra-pure de-ionized water and associated electronic equipment, can record the electromagnetic shock waves produced by cosmic ray shower particles traveling through the water. Surrounding the surface array is a set of 24 fluorescence telescopes, which on clear moonless nights observe the ultraviolet fluorescence produced as cosmic ray shower particles travel through the atmosphere.

The Auger Project was initiated in 1995 by James W. Cronin, Professor of Physics and Nobel Laureate at the University of Chicago. Currently, the Pierre Auger collaboration is led by Alan A. Watson, Professor of Physics at the University of Leeds in the United Kingdom, and by Giorgio Matthiae, Professor of Physics at the University of Rome. Thus far, the Auger collaboration includes over 370 scientists and engineers from Argentina, Australia, Brazil, Bolivia, Czech Republic, France, Germany, Italy, Mexico, Netherlands, Poland, Slovenia, Spain, United Kingdom, and the USA. The U.S. collaboration comprises scientists from 16 universities plus Fermilab, home of Auger Project Manager Paul Mantsch and Deputy Project Manager Carlos Hojvat.

In March 1999, an international agreement was signed in Argentina for the organization, management and funding of the Pierre Auger Observatory, and the southern hemisphere site was inaugurated at Malargue in Mendoza Province. In November 2000, construction was completed for the Detector Assembly Building at the Central Campus in Malargue and for the first fluorescence detector building. In December 2000, the project received a gift of $1 million from the University of Chicago for the construction of the Central Campus Office Building. An "Engineering Array," consisting of 32 surface detector stations and two fluorescence telescope units, was deployed in 2001. With data collected in 2002-2003,

James Cronin discusses cosmic ray science at the Dedication Celebration in November, 2005. Members of the Argentina Auger collaboration congregate in front of the Central Campus Office Building in Malargue, Argentina.

the Engineering Array demonstrated that the Observatory will perform better, and will have greater discovery potential, than originally expected. With the experience gained from the Engineering Array, construction of the entire southern hemisphere array is now underway, and is scheduled for completion in 2007. The construction cost for the southern hemisphere Auger Observatory is about $50 million.

In November 2005, Auger scientists held a celebration in Malargue to mark the progress on installation of the Observatory's detectors and presentation of first physics results. About 60% of the Auger surface array was operational, three fluorescence detector buildings, each with six telescopes, were operating routinely, and construction was initiated on the fourth fluorescence detector building. During 2005 the first Auger results were presented at the International Cosmic Ray Conference in India and at other scientific conferences. These presentations included: a new cosmic ray spectrum at the highest energies; the results of anisotropy and point source searches; and new limits on the photon content of the primaries, the cosmic ray particles that initially strike the earth's atmosphere. Within the scientific community, there is great interest in the mysterious origin of the ultra-high energy cosmic rays that the Observatory is analyzing. Theorists have developed a number of exotic theories for such origin, including the collapse of hypothetical objects, called "topological defects," left over from the Big Bang.

In order to get a complete view of the heavens as seen from the earth, the Auger collaboration is working to establish a northern hemisphere partner of the southern hemisphere Observatory, likely to be based in southeastern Colorado. With observatories in both hemispheres, the Auger collaboration will have the opportunity to view cosmic rays across the entire sky visible from earth.

Preparing some of the 1,600 surface detector tanks in the Assembly Building prior to deployment for the Southern Auger array.

In a grant to URA on behalf of the U.S. Project participants under Dr. Cronin's continuing leadership, the National Science Foundation and the Department of Energy are providing some $10 million toward the U.S. share for the construction of the southern hemisphere Observatory. URA serves as the sponsoring organization for the U.S. participants, and as such oversees those activities currently funded by the U.S., such as component R&D and production. In addition, DOE and NSF have designated URA to be the agent on behalf of the U.S. on the Project's international oversight board, currently chaired by URA President Fred Bernthal.

For further information about the Pierre Auger Observatory, visit its website at http://www.auger.org

FUTURE URA ENTERPRISES

URA has a broad charter for the management of research and educational activities in the natural sciences. The Corporation is always exploring potential new management responsibilities that would be of value to the university research community.

As part of this planning, URA will consider bids on management contracts for selected national research centers and facilities that serve a broad base of national and international users.

HISTORY 1965-2005

Robert R. Wilson, Founding Director of Fermilab, hand raised high, with his staff in October, 1969 at the Groundbreaking for the Main Ring 200 GeV accelerator. The legend goes that on this occasion Wilson actually tasted the dirt to confirm the fitness of the soil, as any farmer or cowboy might do.

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.

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, and U.S. participation in the Pierre Auger Observatory Project 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.

The creation of URA marked a milestone in government-university cooperation for the management of Federal laboratories

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San Francisco State University
Robert A. Corrigan

Southern Methodist University
R. Gerald Turner

2005 ORGANIZATION CHART
Universities Research Association, Inc.

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(California Institute of Technology)
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(Massachusetts Institute of Technology)
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Frederick M. Bernthal
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Vice President/Secretary

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William A. Schmidt
General Counsel

Fermilab

Michael Witherell
Director
Piermaria Oddone
effective July 1, 2005

Kenneth Stanfield
Deputy Director

Laboratory Staff: 2,020

Pierre Auger Observatory Project

James W. Cronin
(University of Chicago)
U.S. Principal Investigator

CORPORATE STRUCTURE

MEMBERSHIP AND GOVERNANCE

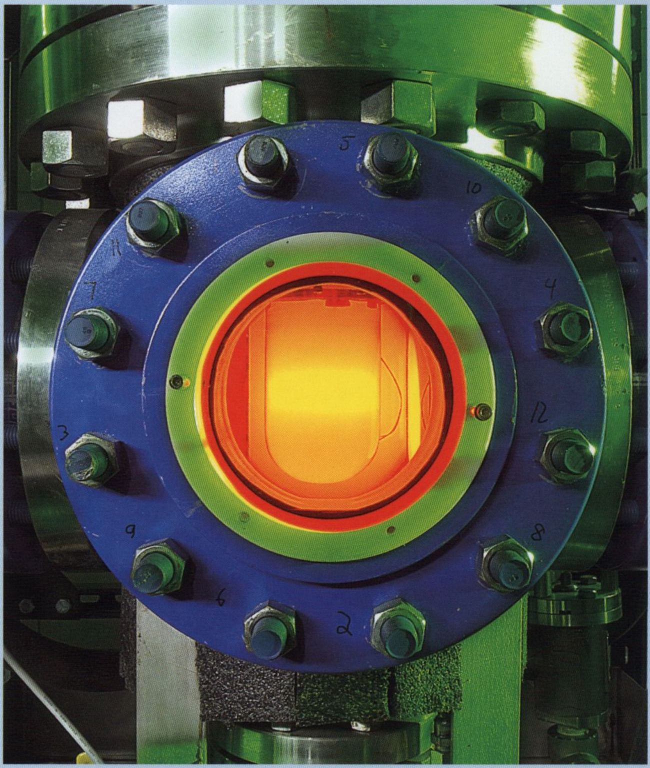
As a non-profit corporation, URA acts under the authority of its governing body, the Council of Presidents of its 90 member universities. The Council is analogous to the shareholders of a public corporation. A Board of Trustees, elected by the Council, has the fiduciary responsibilities for the corporation 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 responsible for oversight and governance of Fermilab and for corporate relations with the Federal government, industry, academe, and the general public. The Internal Audit Manager for Fermilab reports to the URA Headquarters Office.

The Fermilab Director is selected by the Board of Trustees with the approval of DOE. Daily operations are coordinated directly between Laboratory management and DOE's Fermi Site Office or the Office of Science at DOE headquarters. The total number of URA employees at corporate headquarters and at Fermilab is now about 2,030.

URA member universities are divided among seven geographic regions within the United States to ensure that the boards reflect 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 nine 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 university presidents, corporate chief executive officers, Nobel laureates, and 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 has assessed 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.



A dark matter detector that has been installed underground in the MINOS near detector hall.

HEADQUARTERS OFFICE

Corporate officers include leaders of the URA governing bodies (Council of Presidents and Board of Trustees), and executive officers at the URA headquarters in Washington, D.C., including the President, Vice President/Secretary, Chief Financial Officer/Treasurer, and General Counsel of URA.

REGIONAL GROUP SECRETARIES

1 **Kam-Biu Luk,** University of California, Berkeley
2 **Kenneth J. Heller,** University of Minnesota
3 **Sally C. Seidel,** University of New Mexico
4 **Randal C. Ruchti,** University of Notre Dame
5 **Paul D. Sheldon,** Vanderbilt University
6 **Bruce A. Barnett,** Johns Hopkins University
7 **Michael Tuts,** Columbia University

URA BOARD OF TRUSTEES

FERMILAB BOARD OF OVERSEERS

EXTERNAL COMMITTEES

URA VISITING COMMITTEE FOR FERMILAB

	Term Expires
Gerald Dugan, Chair Cornell University	2005
Daniela Bortoletto Purdue University	2006
Douglas Cowen Pennsylvania State University	2005
Albrecht Karle University of Wisconsin–Madison	2007
Matthias Neubert Cornell University	2007
Fulvia Pilat Brookhaven National Laboratory	2007
Natalie Roe Lawrence Berkeley National Laboratory	2008
Nobu Toge KEK Laboratory	2008
Nicholas Walker DESY Laboratory	2008

From the Fermilab Board of Overseers

Donald Hartill Cornell University	2005
Frank Sciulli Columbia University	2006
Thomas Weiler Vanderbilt University	2005

FERMILAB ACCELERATOR ADVISORY COMMITTEE

	Term Expires
John Corlett, Chair Lawrence Berkeley National Laboratory	2007
Swapan Chattopadhyay Thomas Jefferson National Accelerator Facility	2009
Gunther Geschonke CERN	2009
Georg Hoffstaetter Cornell University	2007
Kwang-Je Kim Argonne National Laboratory	2009
Jean-Pierre Koutchouk CERN	2005
Shin-ichi Kurokawa KEK	2007
Stephen Milton Argonne National Laboratory	2007
Michiko Minty DESY	2007
Hasan Padamsee Cornell University	2009

FERMILAB ACCELERATOR ADVISORY COMMITTEE *(cont.)*

	Term Expires
Stephen Peggs Brookhaven National Laboratory	2007
Thomas Roser Brookhaven National Laboratory	2005
Lucio Rossi CERN	2005
Ronald Ruth SLAC	2005
Hans Weise DESY	2009

FERMILAB PHYSICS ADVISORY COMMITTEE

	Term Expires
Andrew Lankford, Chair University of California–Irvine	2006
James Alexander Cornell University	2005
James Brau University of Oregon	2006
Sarah Eno University of Maryland	2009
Fabiola Gianotti CERN	2008
Rolf-Dieter Heuer DESY	2009
Steven Kahn SLAC	2008
Boris Kayser Fermilab	2008
Takahiko Kondo KEK	2006
Daniel Marlow Princeton University	2007
Robert McKeown California Institute of Technology	2008
Hitoshi Murayama University of California–Berkeley	2006
Heidi Schellman Northwestern University	2005
Dong Su SLAC	2007
Paul Tipton University of Rochester	2005
Scott Willenbrock University of Illinois at Urbana–Champaign	2007
Jeff Appel, Secretary Fermilab	

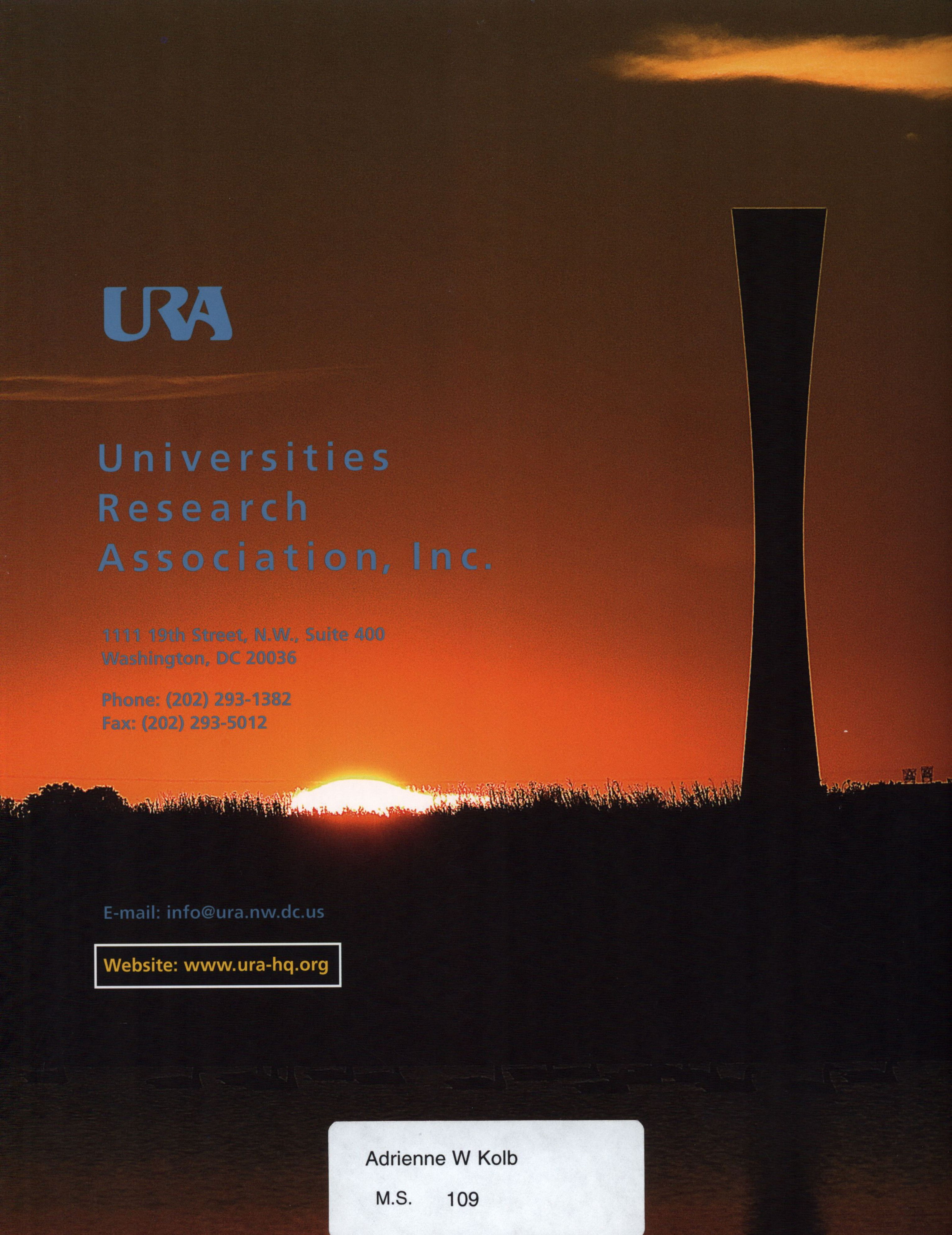
FINANCES

Universities Research Association, Inc.
SUMMARY OF REVENUES AND EXPENSES
Year Ended September 30, 2005

Total Revenue	**$ 315,754,077**
EXPENSES:	
Salaries, wages and benefits	$ 182,731,396
Subcontracts and purchased services	47,039,553
Materials and supplies	20,928,774
Electric power	18,075,966
Travel, relocation and other employee allowances	6,857,797
Inventory usage	2,939,350
Fermi National Accelerator Laboratory and Pierre Auger Project support	847,416
Scholarships	199,100
Other	734,215
Total Operating Expenses	**$ 280,353,567**
Cost of property, plant and equipment constructed for DOE	**$ 34,734,573**
Total Expenses	**$ 315,088,140**
Change in Net Assets	**$ 665,937**

The Feynman Computing Center, is a three-story semicircular structure of 74,000 square feet which houses the central computing facilities for the Laboratory. The building's pre-cast concrete backbones are supported on a steel frame, as is the north-facing glass facade. The pre-cast panels provide protection from the sun's heat and also duplicate the vertical lines of Ramsey Auditorium to the south. (Photo credit Peter Ginter).

Back cover photo: Aqua Ali Funi sculpture, designed by Founding Director Robert Wilson, seen in silhouette at sunrise.



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