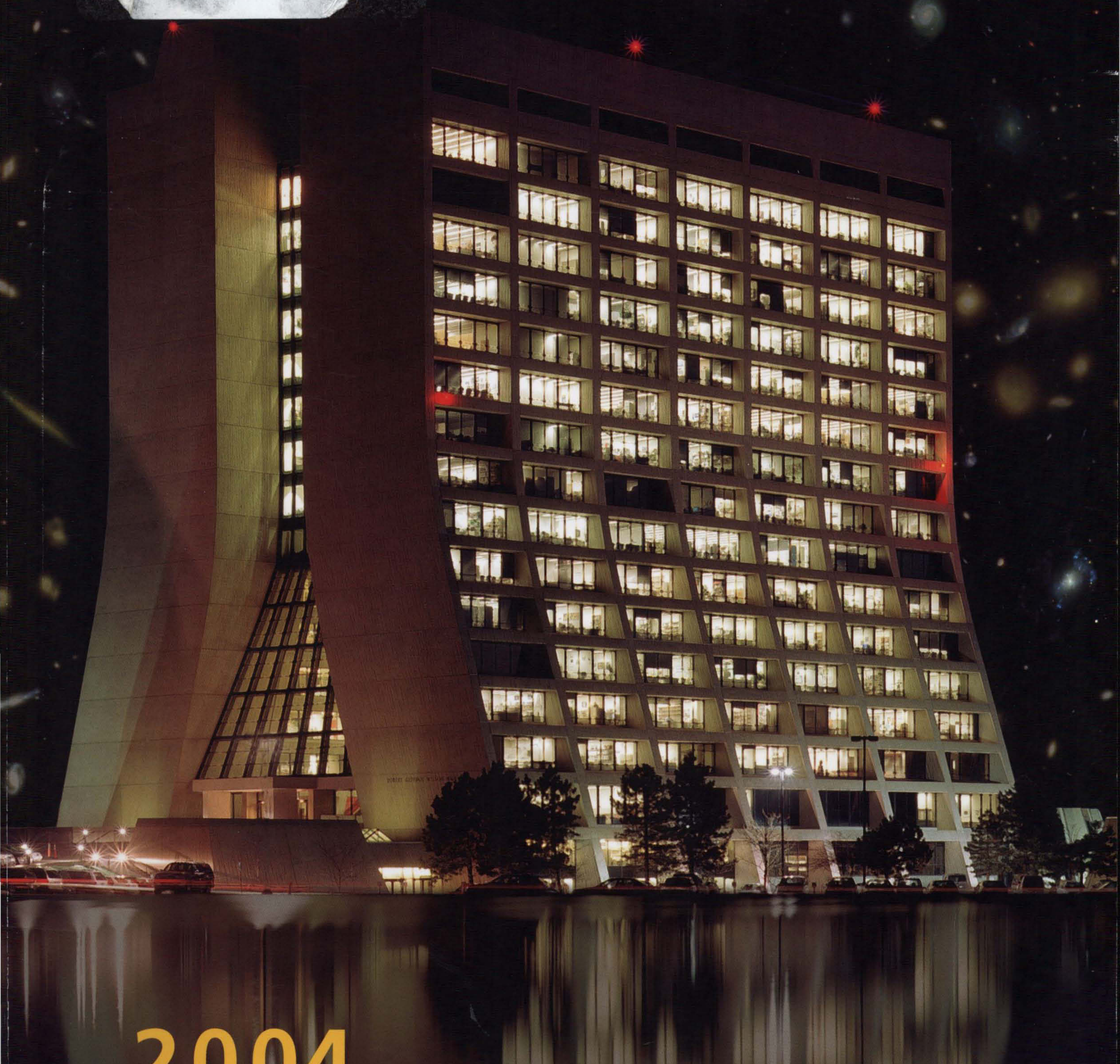
Universities Research Association, Inc.

ANNUAL REPORT



2004

THE INFINITE VOYAGE OF SCIENTIFIC DISCOVERY

URA

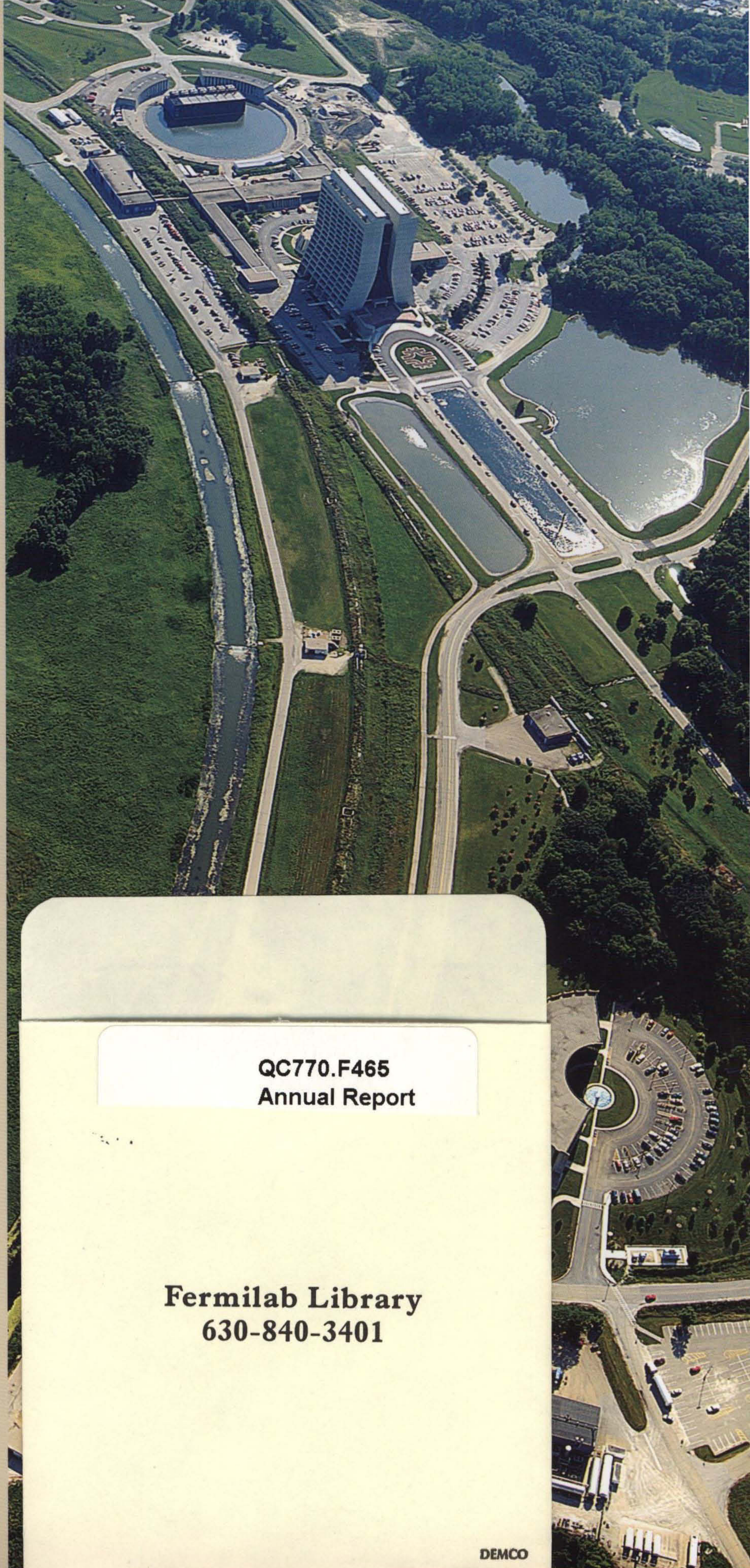
URA: Serving Universities and the Nation through Science

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 (left). The semi-circular Feynman Computing Center is seen in the bottom portion of the photo.

Brenna Flaugher (right), a scientist on the CDF experiment working late in her office, is one of hundreds of other physicists from 35 states and 29 countries that use the particle accelerators at Fermi National Accelerator Laboratory in Illinois for forefront research in particle physics.



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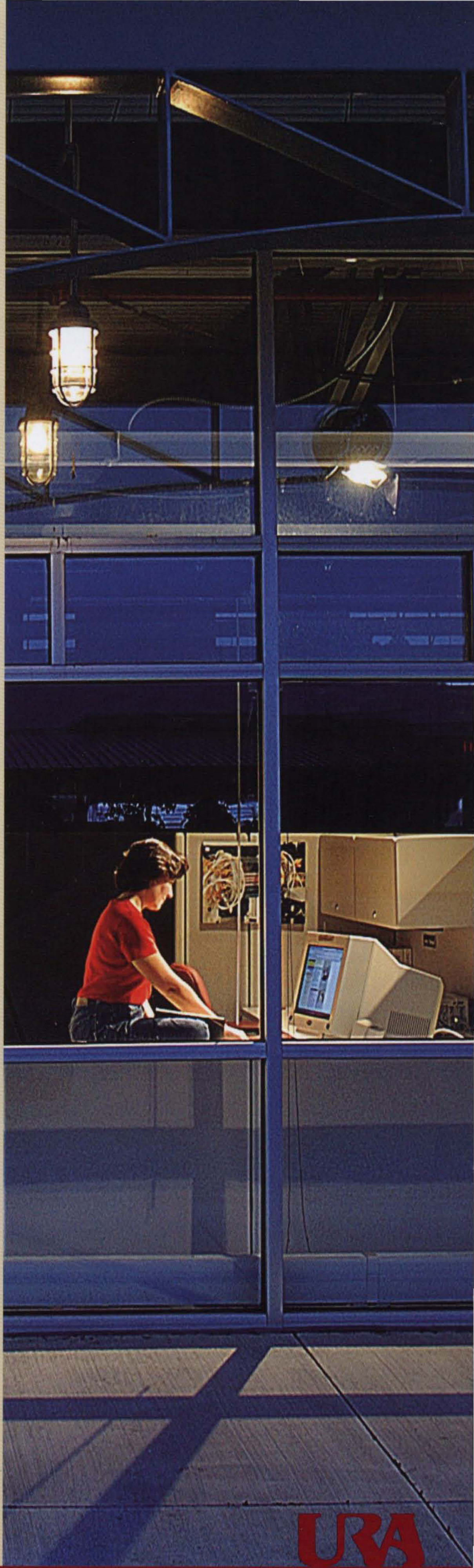
URA is a private not-for-profit corporation. A consortium of research universities, it serves as a contractor to the Federal government for the operation of major scientific facilities. This volume—updated annually with new financial and organizational data—provides the historical context for URA's structure 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 the 6th annual URA thesis award to Florencia Canelli, who received her Ph.D. from the University of Rochester. Canelli, who is from Argentina, is now a postdoc at UCLA, working on the CDF experiment at Fermilab.

This year has been marked by outstanding success in a wide array of challenging undertakings and exciting new physics for URA and its 90 member universities. Now in his sixth year at the helm of our flagship enterprise, Fermilab Director Michael Witherell continues to preside over an array of construction projects and planned experiments among the most bold and most challenging of any of the DOE national laboratories.

Fermilab will remain 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 has begun reaping physics returns from its second multi-year discovery campaign, "Collider Run II." The Lab achieved a banner year in exceeding its own more aggressive "design" objective for integrated beam "luminosity." Characteristically, this achievement at the frontier of accelerator technology did not come easily, and indeed, more challenges lie ahead. Fermilab's scientific, technical, 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. Looking still farther ahead, Fermilab has joined in an international effort to research and plan a next-generation electron-positron linear collider, in the hope that such a facility might eventually be sited at Fermilab.

With civil construction complete, and first beam in the underground experimental hall of the *Neutrinos from the Main Injector* (NUMI) facility, and with the *MiniBooNE* experiment well on its way to completing its data run, Fermilab has emerged as a world center for neutrino physics. The former Soudan iron mine in northern Minnesota, site of the long-baseline MINOS neutrino detector, is also host to a new laboratory which this year began taking initial data in a search for the enigmatic "Cold Dark Matter" in the universe. This and other undertakings in the realm of cosmology have now been more formally recognized as a major theme of the Laboratory with the establishment this year of a new Particle Astrophysics Center at Fermilab, with Dr. Edward "Rocky" Kolb as its first Director. The *Sloan Digital Sky Survey* collaboration has already produced spectacular data of truly cosmic significance, and in Mendoza Province, Argentina, the *Pierre Auger Cosmic Ray Observatory* is nearing the half-way mark in construction and is already acquiring world-class data on cosmic rays in the 10^{20}eV energy regime. Despite continuing funding difficulties, under Project Manager Paul Mantsch of Fermilab, Auger is on track for completion in early 2006, and plans are being laid for subsequent construction of a northern hemisphere array to be sited in Colorado or Utah.

Sometimes taken for granted is the educational mission of Fermilab, which continues to produce the best of America's next generation of scientists and leaders. This year, work carried out at Fermilab led to some 70 Ph.D. theses. We acknowledge this important measure of productivity and vitality by recognizing one individual each year with a URA

The URA paradigm for university-government-laboratory partnership

Ph.D. Thesis Prize, and URA also now sponsors the annual Alvin Tollestrup award for outstanding Postdoctoral research. Details on all of these undertakings can be found in the body of this report.

In the fall of 2003, Mike Witherell announced his intent to step down as Director after six years, on July 1, 2005. A Search Committee Chaired by Dr. Neal Lane, former Science Advisor to President Clinton and former Director of NSF, was formed last spring. In November, URA announced Dr. Pier Oddone, currently Deputy Director of the Lawrence Berkeley National Laboratory, as the next Fermilab Director. We are indebted to Dr. Lane and the entire Search Committee for the outstanding and thorough job they did in carrying out this vitally important task. Dr. Witherell plans to return to U.C. Santa Barbara as Vice Chancellor for Research. We wish Mike, and of course Pier, every success in their next career steps!

The Annual Meeting of the URA Council of Presidents (our "shareholders") was held in late January 2004, with Shirley Tilghman, President of Princeton University, presiding and concluding her year as Chair of the Council. Council business was again combined with the 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; departing NSF Director Rita Colwell; and DOE Deputy Director of the Office of Science, Jim Decker. Once again, some 70 URA member universities were represented at this year's meeting.

URA continues to benefit from the help of many distinguished individuals, who voluntarily 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 to serve as Chair of our Trustees; Robert Galvin, former Chairman and CEO of Motorola continues 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. Steve Peggs of Brookhaven National Laboratory chaired the URA Visiting Committee's annual programmatic review of Fermilab, and Linda Wilson, retired DOE site manager at the Nevada Test Site, led a similar review of Fermilab's administrative and operations support functions.

This is just a small sample of the extraordinary talent that assembles voluntarily from around the country and the world to assist URA and our funding agencies in their undertakings, and thereby reaffirms 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
University of California-San Diego
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

LOUISIANA
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
Tufts University

MICHIGAN
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

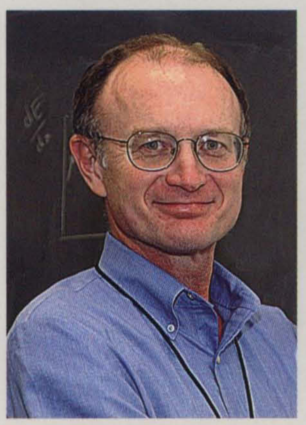
**Associate member institution*

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

FERMILAB

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

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 experimental conditions equivalent to those that existed in the first quadrillionth of a second after the birth of the universe. This capability to recreate the energy levels of the Big Bang places Fermilab at the frontier of global particle physics research, providing leadership and resources for qualified experimenters to conduct basic research at the leading edge of high-energy physics and related disciplines.



Fermilab Director Michael Witherell

The Fermilab accelerator complex is currently composed of a chain of five machines that accelerate particles in sequence to increasing energy. The core of the Laboratory's experimental particle physics program involves large detectors that receive the particle beams in experimental halls at locations within, or adjacent to, the accelerator complex. The detectors are built and operated by large teams of visiting scientists and by Laboratory staff.

Fermilab currently provides research facilities for about 2,500 particle physicists and their students, from 214 institutions in 35 states (plus the Commonwealth of Puerto Rico) and 29 foreign countries. Typically, the U.S. scientists' research is supported by DOE and the National Science Foundation, and in some cases by university funds.

EVOLUTION OF THE LABORATORY

Fermilab began operations in the early 1970s with a single beam of protons directed at fixed-target detectors and has upgraded its capabilities over the years to take successive steps into the interior of the atomic nucleus. The Laboratory's first major upgrade was the development of the Tevatron, the world's first superconducting synchrotron, with beam energies of approximately one TeV or one trillion electron volts. It operated initially in 1983, and in 1989 the National Medal of Technology was awarded to the leaders of its design and construction team. Another vital upgrade enabled the Tevatron to become a collider, accelerating antiprotons as well as protons to 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. Meanwhile, the last run of the Tevatron fixed-target program was completed in early 2000.

The Main Injector, completed in 1999, is the 120 billion electron Volt (GeV) accelerator that serves as an injector to the Tevatron and the driver for the production of the antiprotons collected by the Antiproton Source. With its increased beam intensity, the Main Injector allows Fermilab to increase the rate of antiproton production for Collider Run II. There have also been improvements

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

A row of colorful storage tanks which contain the helium required for operation of the superconducting magnets of the Tevatron collider, with the Wilson Hall high-rise in the background.

Fermilab's two collider detectors have reinvented themselves for the new, higher event rate environment of Collider Run II

in the rest of the accelerator complex since the end of Collider Run I. For example, technical modifications have been made to the Tevatron to allow 36 bunches of protons and antiprotons to collide, rather than the six bunches of the last collider run. The Laboratory continues to work on other systems for improving performance of the accelerator complex to achieve Run II goals.

The Recycler, a storage ring located in the Main Injector tunnel, is expected to increase further the number of antiprotons available for colliding beams. The Recycler's successful operation also involves reducing the width of antiproton beams. The smaller and denser the antiproton beams, the larger the collision rate with the proton beams.

DZero collaboration physicists Ryan Hooper and Julie Torborg inspect the Visible Light Photon Counter components underneath the DZero Detector.

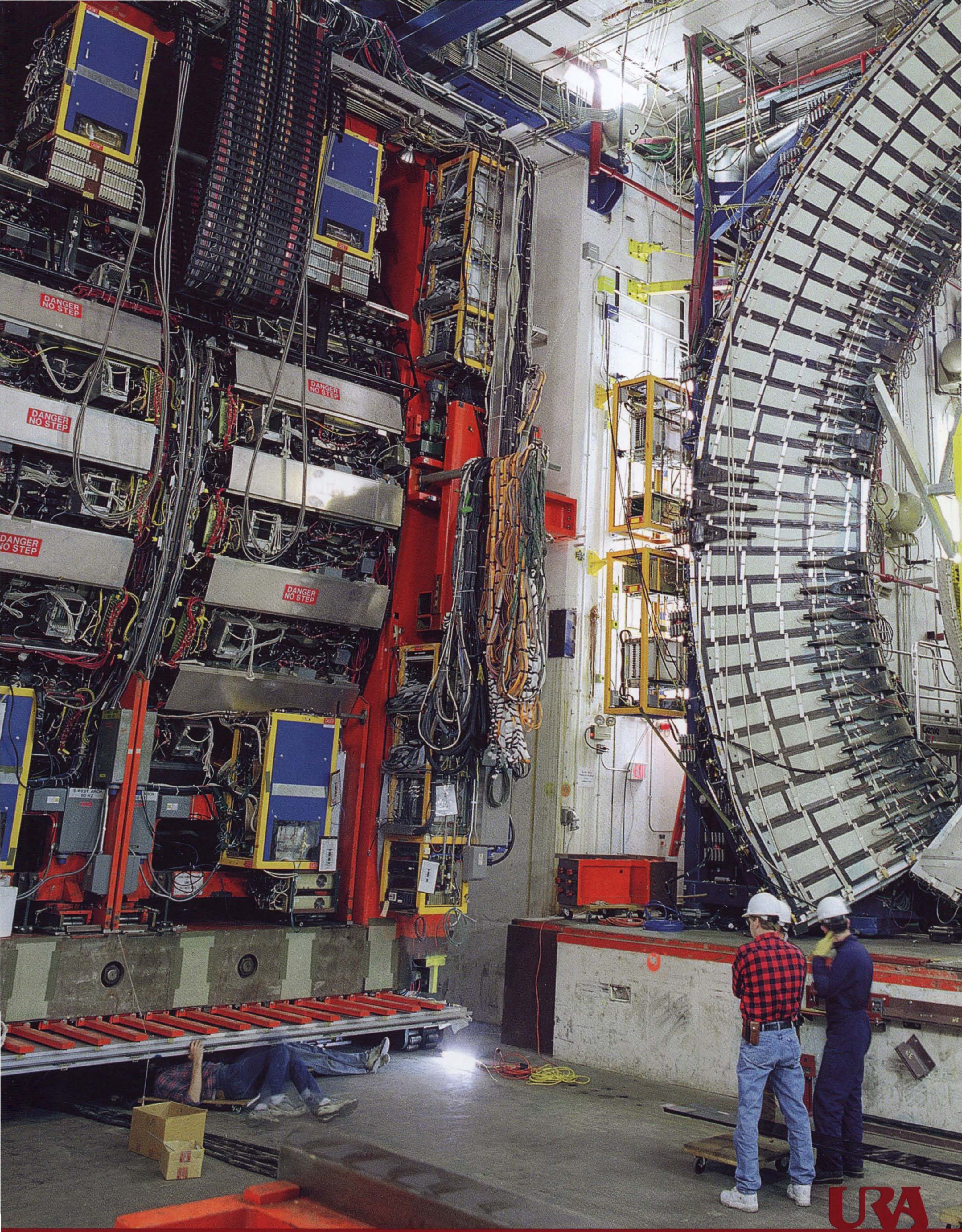
Increasing the density of the beam is called cooling, and one way to cool a beam is to bathe it in "cold" electrons. This technique has been successfully used in relatively low-energy nuclear physics machines. In the Recycler the technique will be applied for the first time to higher energy (8 GeV) beams, pushing the state of the art for electron cooling. The Recycler with electron cooling is on schedule to be ready for operation in 2005.

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 are expected to provide proton-antiproton collision data sixty times that of Collider Run I.

The Laboratory is running its current fixed-target program, consisting of two forefront neutrino experiments, with 120 GeV protons from the Main Injector and with 8 GeV protons from the Booster, the injector accelerator for the Main Injector.

Experiment collaborations continue to analyze data and uncover new scientific results from current and preceding collider and fixed target runs. R&D continues on options for future accelerators, with the focus now on the proposed International Linear Collider and an 8 GeV Proton Driver. The Laboratory

The upgraded CDF detector being prepared for roll back into the collision hall in 2001. Muon chambers are seen to the right, inside the collision hall.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The Fermilab program is addressing important issues with new experiments

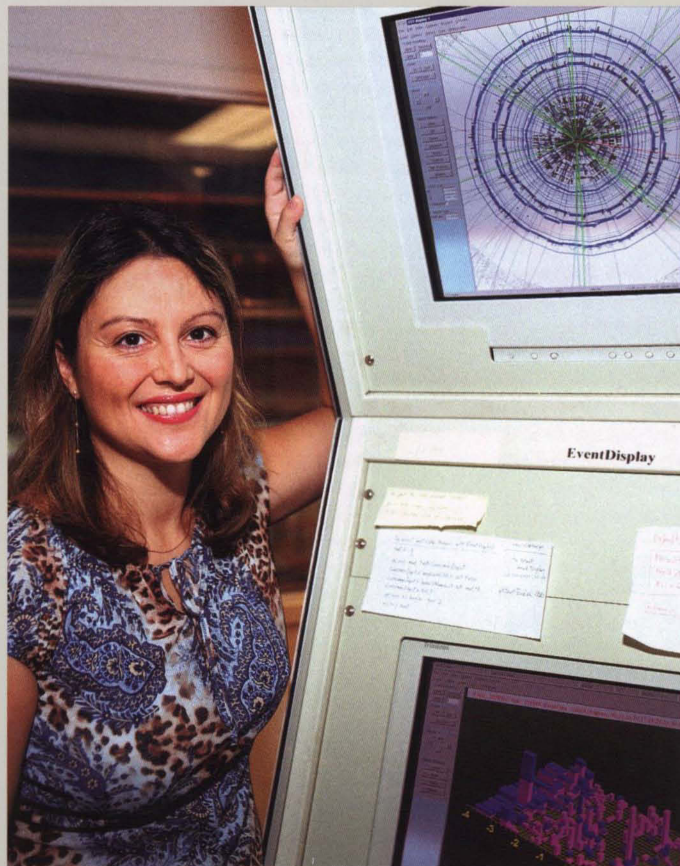
is moving ahead in its collaborations in three non-accelerator projects at the forefront of research in astrophysics: the Cryogenic Dark Matter Search; the Pierre Auger (Cosmic Ray) Observatory Project; and the Sloan Digital Sky Survey.

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 is currently scheduled to begin operations in 2007, and at that time, the high-energy frontier in particle physics will shift to Europe.

THE FERMILAB RESEARCH PROGRAM AND THE FIELDS OF PARTICLE PHYSICS, ASTROPHYSICS AND COSMOLOGY

The remarkable 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 well known and widely celebrated. The good news about the future is that 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 have arisen only within the last few years, and others of which have been central to these fields for decades. Observational data indicate 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. 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.

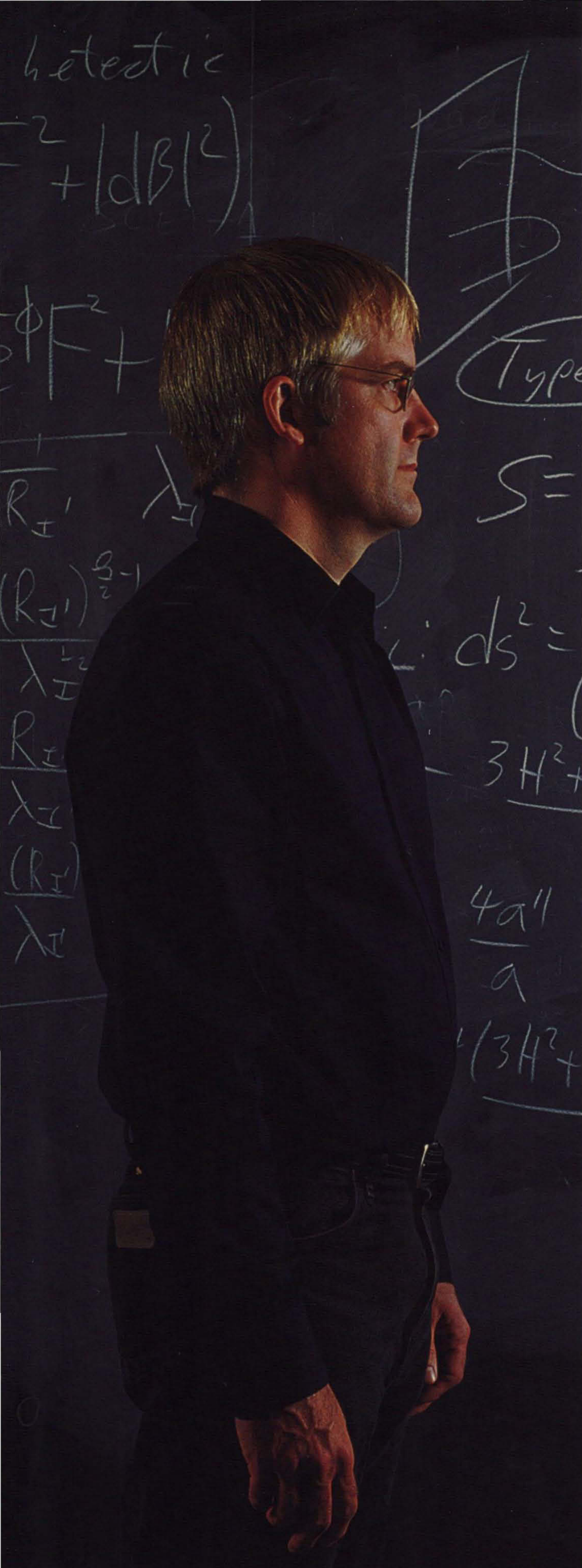
The upgraded DZero detector being prepared for roll back into the collision hall in 2001. The increased dataset, higher collider energy and improved detector capabilities are enabling the DZero collaboration to explore physics beyond the Standard Model.



"To me, it's like the work of a detective," said Italian INFN physicist Patrizia Azzi as she monitors a detector event display. "It's never the same." Azzi co-chairs a group of scientists in the CDF collaboration studying the top quark at Fermilab.

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

The fundamental particles exist because of underlying symmetries that make up the known physical laws of nature. The quantum ideas that so successfully describe 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 exists a superpartner particle. The discovery of supersymmetry is an immediate experimental challenge in particle physics.



Quantum Universe,

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?

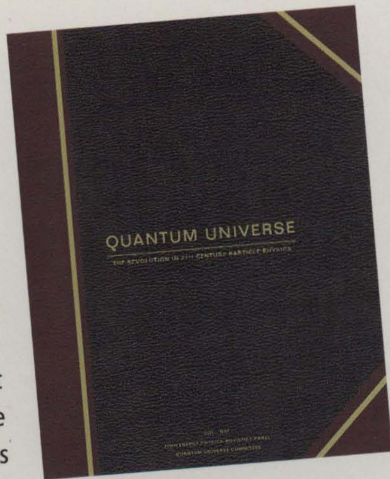
There are three families of particles with dramatically different masses. Patterns and variations in the families of these particles suggest undiscovered principles that tie together the "quarks" and "leptons" of the "Standard Model" of particle physics. Detailed studies of quarks and leptons at accelerator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

Fermilab theorist Joe Lykken, a member of the DOE / NSF Quantum Universe Committee. Photo credit: Chicago Tribune Magazine

The Revolution in 21st Century Particle Physics

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 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.

PARTICLE PHYSICS HIGHLIGHTS OF 2004

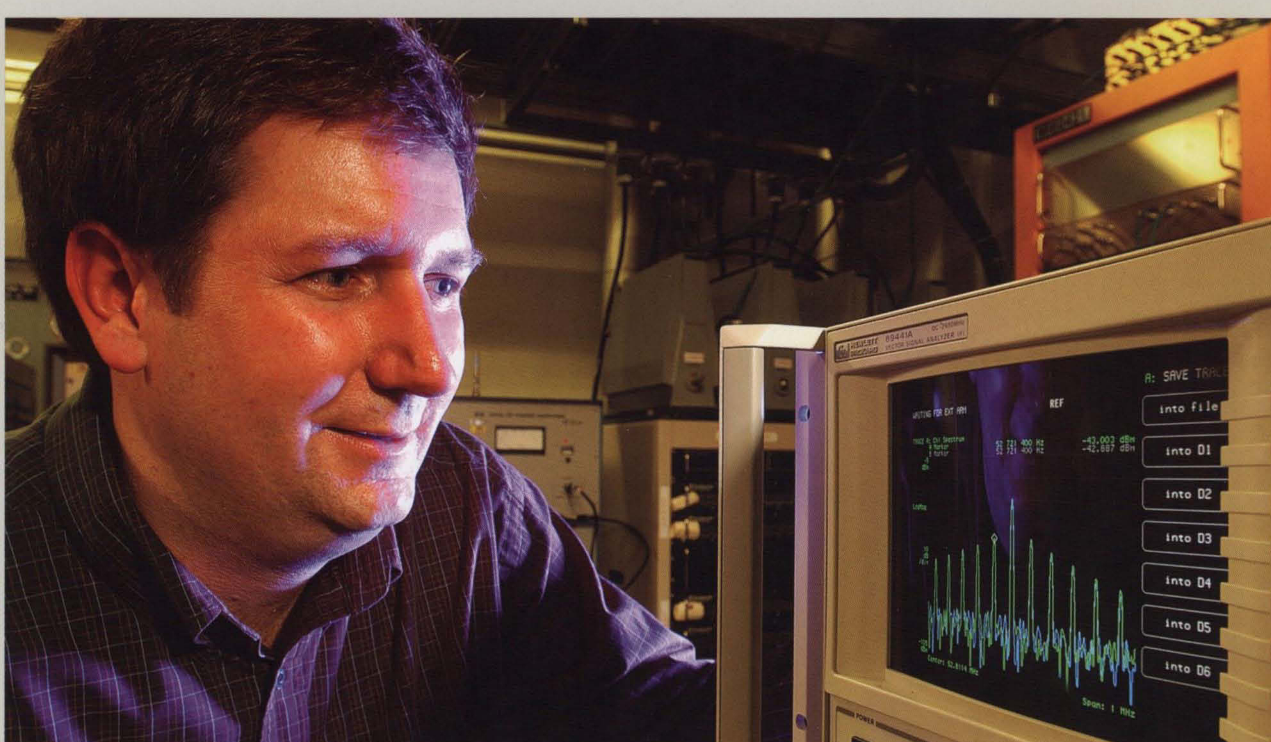
Fermilab's Tevatron Collider remains alone at the energy frontier until the LHC detector collaborations begin taking physics-quality data. The CDF and DZero collaborations have an excellent opportunity for new discoveries, such as the Higgs boson, the lightest supersymmetric particles, and evidence for 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 for operation of the new Collider complex, the Laboratory has been engaged in the technical challenge of steadily increasing Collider luminosity, a measure of the proton-antiproton collision rate. The steady luminosity improvements over the past two years are crucial for providing the 1000 physicists who make up the CDF and DZero collaborations with the quantity of data they require for new discoveries. In 2004 the Laboratory significantly exceeded its fiscal year design goal for Tevatron integrated luminosity, a measure of the number of collisions delivered to CDF and DZero.

During 2004 the various collaborations of experimenters and theorists at Fermilab produced over 140 publications. In addition, during 2003-04 some 70 Ph.D. candidates completed theses based on research they carried out at Fermilab. These students go on to exciting careers in particle physics, as well as in related fields such as astronomy, computer sciences, and engineering.

With Collider Run II well underway, the CDF and DZero detectors are both taking data with high efficiency. The detector collaborations continued to report more precise 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. At the 2004 International Conference on High Energy Physics in Beijing, the collaborations presented 133 conference papers, 23 parallel session talks and 3 plenary session talks.

Of great interest are ongoing analyses from the CDF and KTeV collaborations, as well as results from experiments at other accelerator laboratories around the world, on the very small asymmetry in the behavior of matter in certain particle interac-



Fermilab Engineer Joe Dey working on a system for enhancing performance of the Tevatron collider. Here Dey is viewing a display of certain beam characteristics in the Main Injector.

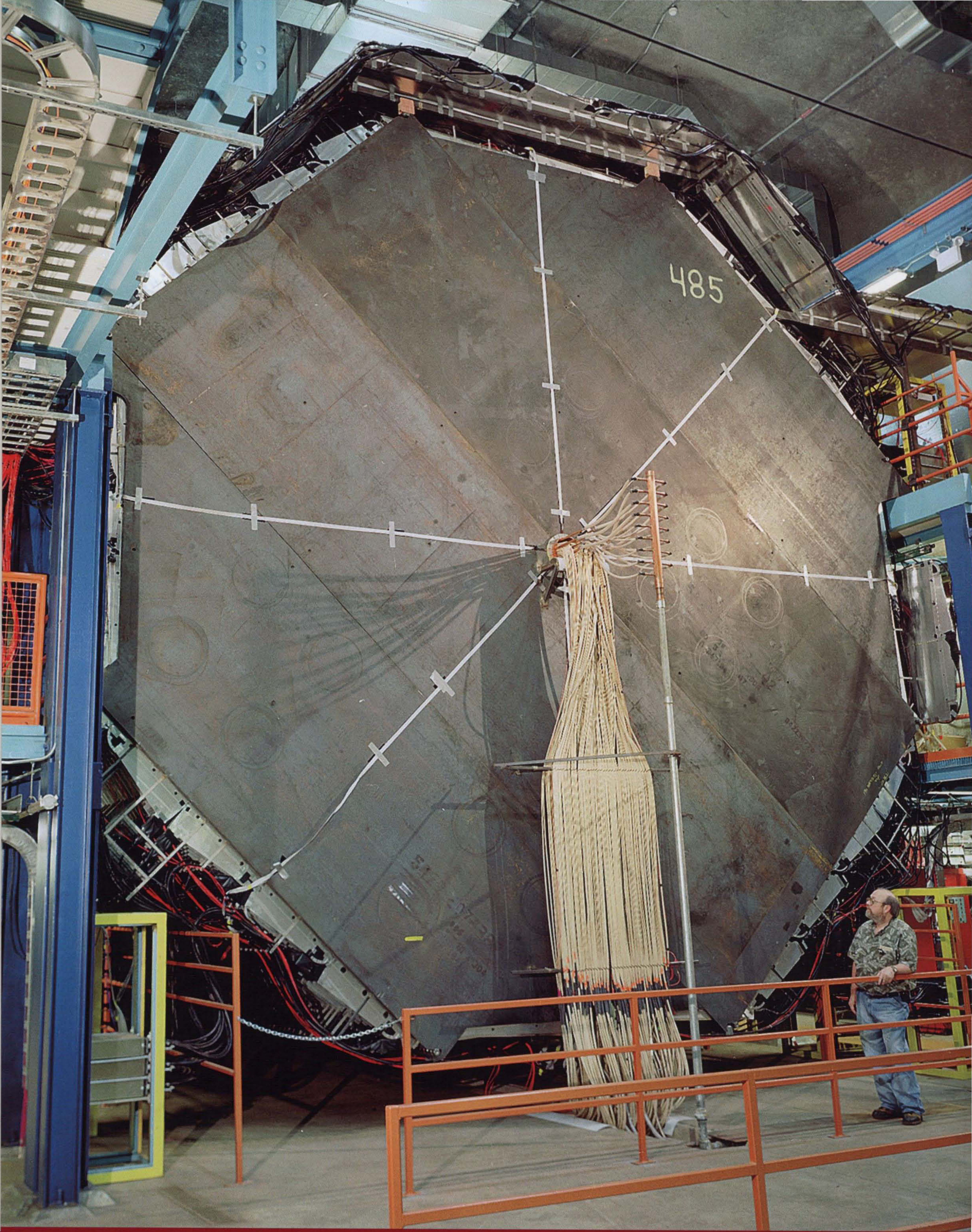
With Collider Run II well underway, the CDF and DZero detectors are both taking data with high efficiency

The MINOS installation and commissioning group in front of the Near Detector. The last plane (parallel flat surface module) was installed in the MINOS Near Detector in 2004. It took almost six months of complicated maneuvering to install all 282 individual parallel planes, and the whole process was completed with no safety incidents.

tions, namely meson decays that violate what is called charge-parity or time reversal symmetry. This phenomenon is key to understanding how matter came to predominate over antimatter in our universe, because without this asymmetry, there would be no stable aggregations of matter in the form of stars, planets and, ultimately, life. At Fermilab, planning continued for construction of the BTeV detector, the next generation of such experiments in the Tevatron Collider. In 2004, a series of successful Fermilab and DOE project reviews of BTeV had set the stage for final approval and construction funding in 2005. [However, early in 2005 DOE announced that due to budgetary constraints BTeV would be cancelled.]

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 new Fermilab experiments will explore in detail the phenomenon of neutrino mass through neutrino oscillations. Should these experiments, in conjunction with others around the world, confirm the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Fermilab experiments will explore the question of whether neutrinos do, in fact, have a small mass

existence of neutrino mass, the implications of such results would be profound. (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 antineutrinos to electron antineutrinos, and will provide a definitive answer to questions raised by evidence for such neutrino oscillations observed in an experiment at Los Alamos National Laboratory. 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 2004 the number of protons "on target" in a given week continued to increase, an important measure for collecting the data sample that the experiment requires, and the collaboration has made great progress in analyzing measurements.

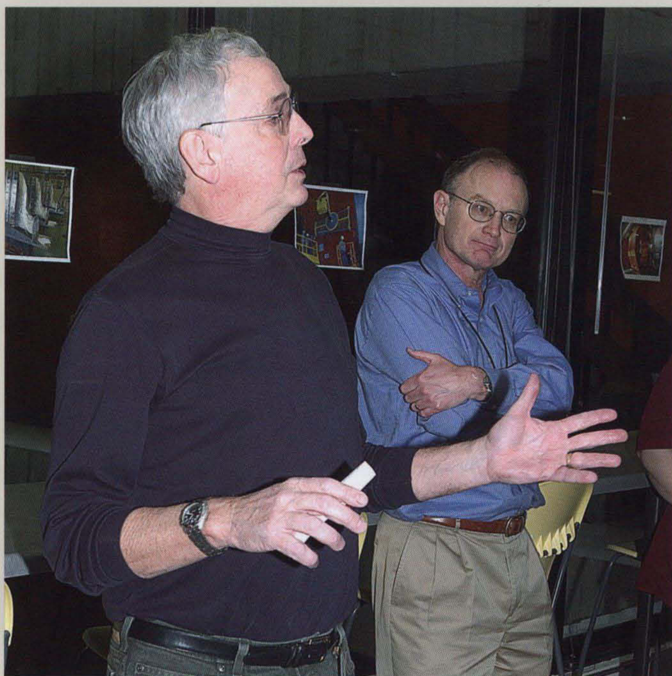
In project NuMI (Neutrinos at the Main Injector), with its associated experiment called Main Injector Oscillation Search (MINOS), Fermilab is nearly ready to use the Main Injector to create a high intensity beam of muon neutrinos aimed first at the "near" MINOS detector, and continuing through the earth 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. Design and engineering work for the NuMI beamline began in late 1997. Civil construction activities began in 1999, both on the Fermilab site and at Soudan.

*ne completed 100-foot-long MINOS far detector at the
oudan Underground Laboratory in Minnesota, consists of
86 massive octagonal planes, numbered 0 through 485
een in background).*

MiniBooNE cospokesperson Janet Conrad, Professor of Physics at Columbia University, holds one of the 1520 light sensors (called photomultiplier tubes) installed inside the MiniBooNE detector.

Excavation of underground NuMI enclosures on the Laboratory site, including the near detector hall, was completed in 2002. Outfitting of the enclosures, construction of the service buildings, and installation of beamline components and the MINOS near detector were all completed in 2004. Meanwhile, the MINOS far detector in the Soudan mine was completed in July 2003, and subsequently began official data-taking from neutrinos in the atmosphere. The entire project remains on the schedule and budget as re-baselined in 2001. A beam of 120 GeV protons was successfully transferred from the Main Injector to the NuMI beamline in late 2004, and full data-taking is scheduled to begin with both MINOS detectors when neutrino beam commissioning starts in early 2005.

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



U.S.CMS Project Manager Dan Green and Laboratory Director Mike Witherell at the Open House on the 11th floor of Wilson Hall to dedicate the offices of the LHC Physics Center (LPC). U.S. and Fermilab physicists are involved in experiments at the world's soon-to-be, highest-energy particle accelerator.

LARGE HADRON COLLIDER ACTIVITIES

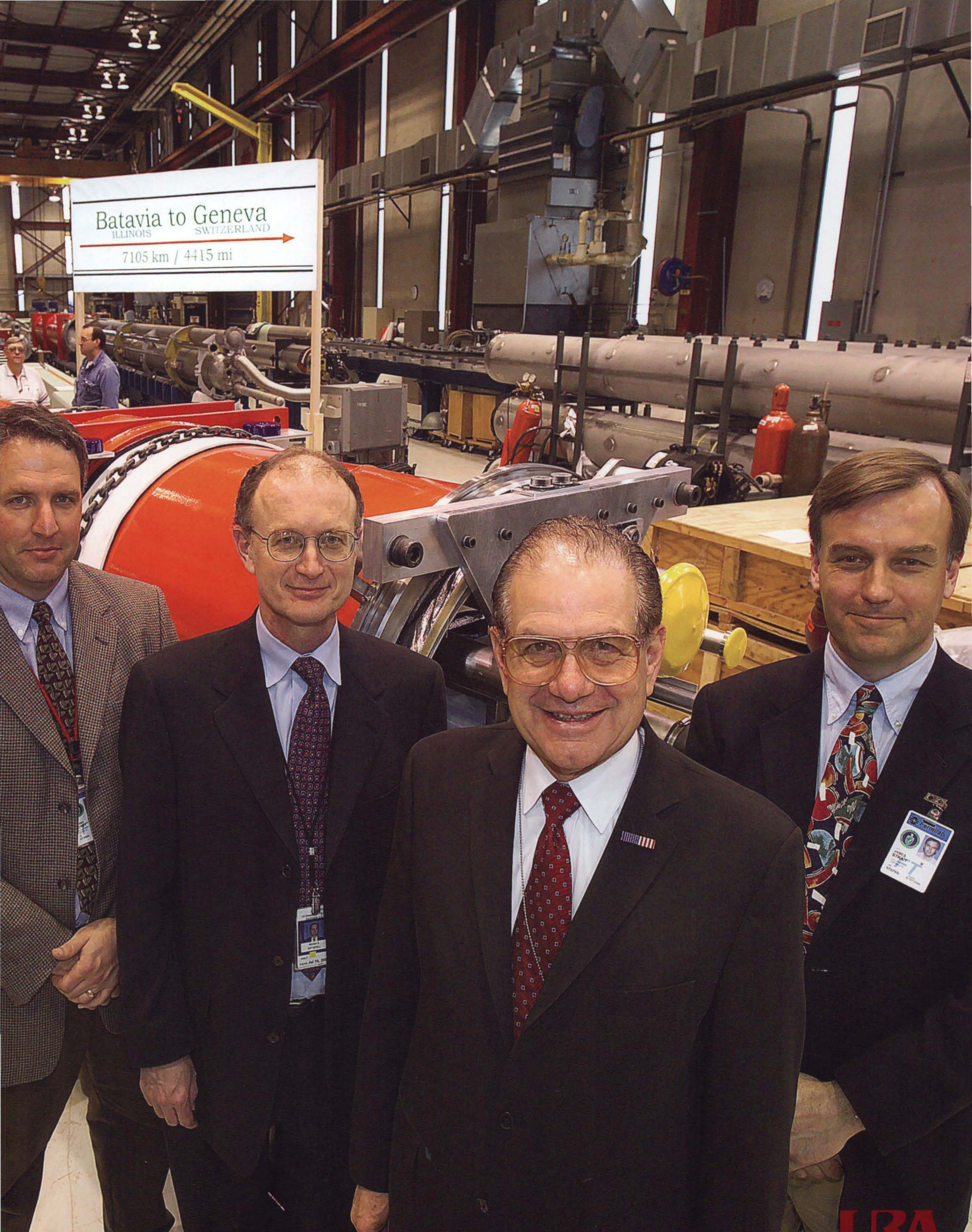
As Collider Run II proceeds at Fermilab, the Laboratory also has a significant role in building the collider that will eventually overtake the Tevatron at the energy frontier. Through DOE and NSF, the United States is investing $531 million over eight years in the LHC accelerator at CERN and the two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

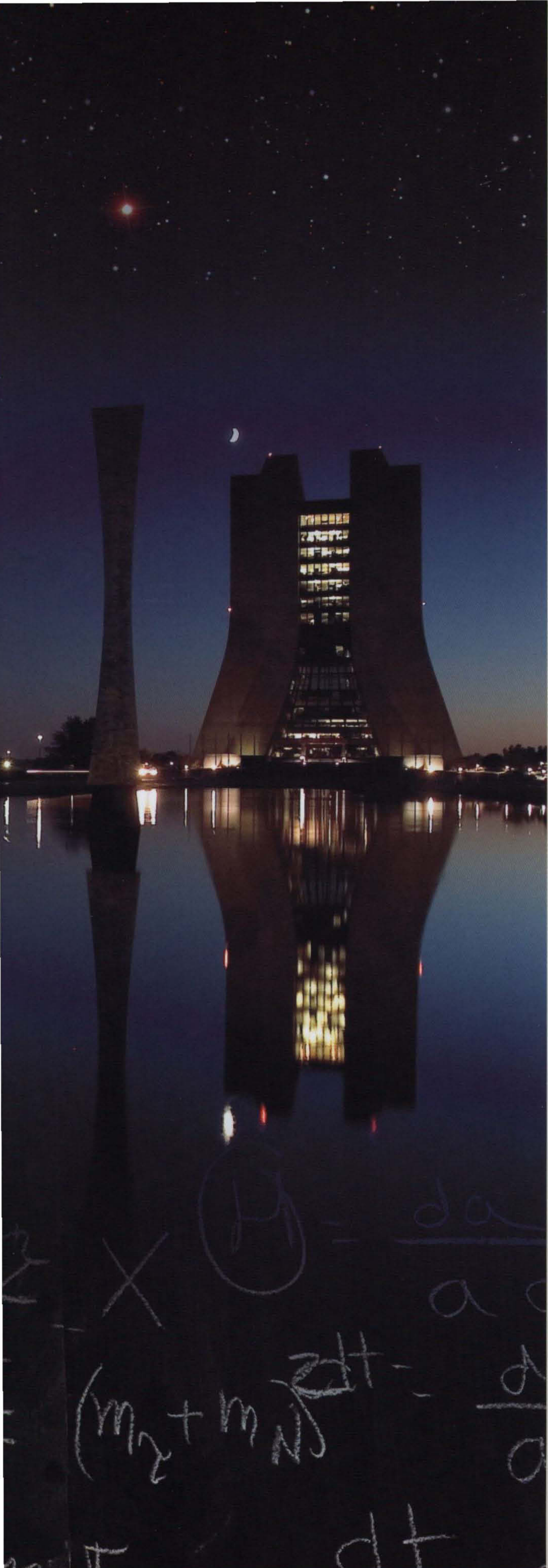
When the LHC begins producing physics quality data sometime in 2008, it will reach a beam energy seven times the energy of Fermilab's Tevatron. The LHC will provide a unique and affordable opportunity for U.S. scientists to continue to work at the energy frontier, and it will allow Fermilab to develop 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 magnets is also taking place at Fermilab. The U.S. LHC accelerator project is about 95% 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. The collaboration continued to make excellent progress in the past year, and the U.S. CMS construction project, now over 80% complete, continues to be on schedule and on budget. Fermilab has also been chosen to be the major U.S. CMS regional computing center, 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 is establishing the LHC Physics Center, which will include a virtual control room and physics analysis center on the 11th floor of Wilson Hall.

Fermilab-LHC Project Manager James Kerby (left), Fermilab Director Michael Witherell, US-LHC Project Manager James Strait, DOE Office of Science Director Raymond L. Orbach (front), with the first Fermilab-built superconducting focusing magnet, destined for the Large Hadron Collider at CERN, in Geneva, Switzerland. The first of a series of such magnets designed and built at Fermilab, the magnet is destined to play a key role in the operation of the LHC, due to begin operating in 2007.


Batavia to Geneva
ILLINOIS
SWITZERLAND
7105 km / 4415 mi



ASTROPHYSICS

All of the proposals for extending the domain of validity of the Standard Model of particle interactions predict new particles. If these particles are stable, then large numbers of them will have survived the moment of creation and will still be present. Should that be the case, they could make up a significant fraction of the mass of the universe. Searches for 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 these massive 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 houses the far MINOS detector. Fermilab is also 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 May 2004, the collaboration published CDMS II results from data at significantly greater sensitivity than ever before in the realm of dark matter particles.

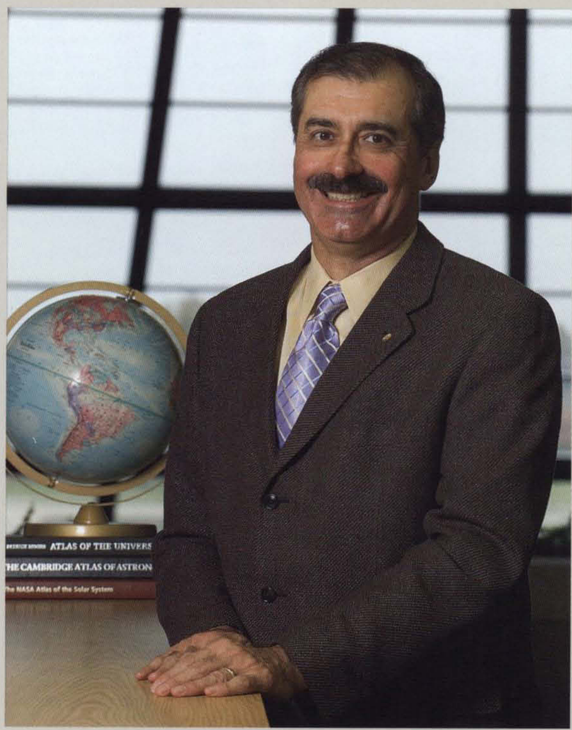
Fermilab is also engaged in a collaboration that aims to find out how matter, both dark and luminous, is distributed. This project, the Sloan Digital Sky Survey (SDSS) is mapping in detail one-quarter of the entire sky, determining the positions, absolute brightnesses, and red shifts of more than 100 million celestial objects, including more than a

Fermilab is home to about 50 astrophysicists. Research focuses on the nature of dark matter and dark energy; the evolution of the universe; and the role of neutrinos in our universe.

Fermilab is also engaged in a collaboration that aims to find out how matter, both dark and luminous, is distributed

million galaxies and a hundred thousand quasars. 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 will be accumulated during the roughly five-year duration of the survey. The SDSS collaboration, comprising twelve institutions, has built a 2.5-meter telescope and the associated instruments at Apache Point, New Mexico. 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 2004, with photometric and spectroscopic observations of the sky gathered over the past two years, SDSS released one of the largest astronomy catalogs ever compiled. In the past year, 163 papers based on SDSS data were published in refereed scientific journals. 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.

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 Super Nova 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 2008, using a new wide-field camera to be built for the existing 4-meter telescope at the Cerro Tololo Inter-American Observatory in Chile.

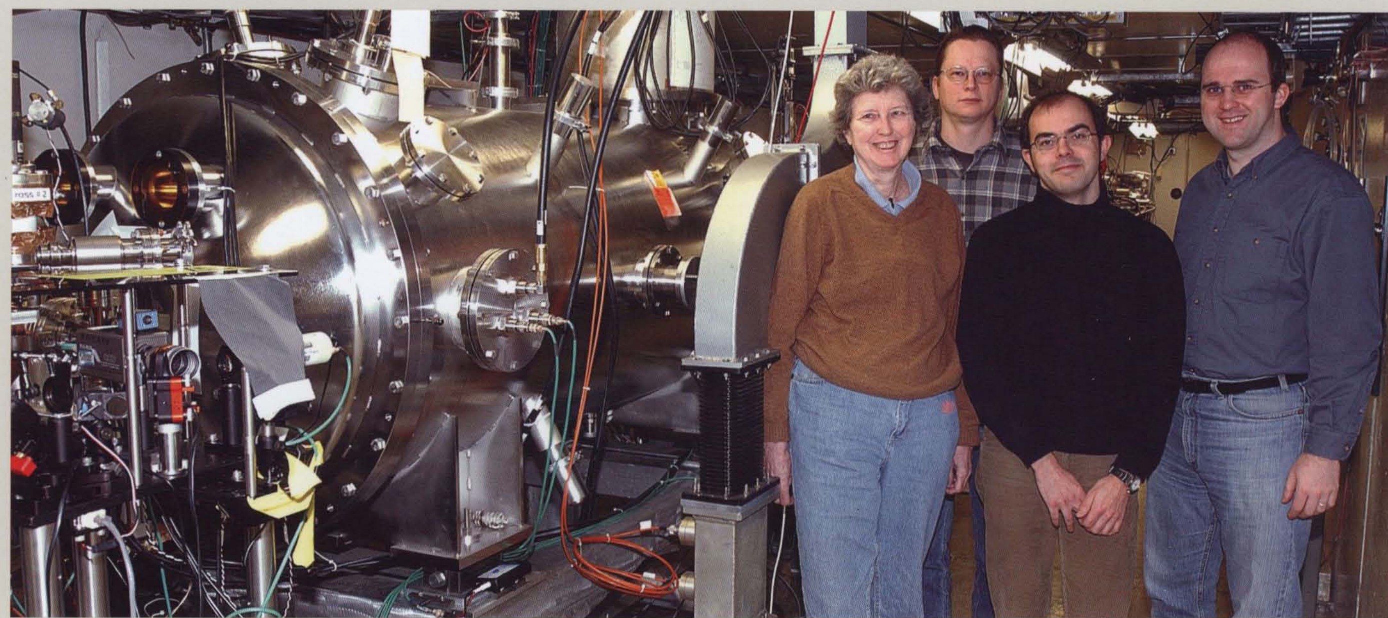


Renowned Fermilab and University of Chicago cosmologist Edward "Rocky" Kolb is Director of the new Fermilab Particle Astrophysics Center.

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.)*

On November 1, 2004, Laboratory Director Michael Witherell announced the establishment of the Fermilab Particle Astrophysics Center, and named renowned Fermilab and University of Chicago cosmologist Edward "Rocky" Kolb as Center Director. The Center functions as an intellectual focus for the Laboratory's existing and proposed particle astrophysics activities, bringing together the Theoretical and Experimental Astrophysics Groups.

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



In Fermilab's Photoinjector Lab (left to right), accelerator physicist Helen Edwards, Fermilab postdoc Kai Desler, and Peoples Fellows Philippe Piot and Markus Huening work on the design of a superconducting radio-frequency (rf) cavity for the TESLA accelerator at the DESY Laboratory in Germany. Superconducting rf cavities form the basis for the technology that was selected in 2004 for the proposed International Linear Collider.

FUTURE ACCELERATOR 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 now 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 anti-matter counterparts. 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. Fermilab Director Michael Witherell is a member of both the U.S. Linear Collider Steering Committee, and an ILC working group under the International Committee for Future Accelerators (ICFA).

For the past several years, Fermilab has been the only institution affiliated with both of the collaborations conducting R&D on competing accelerator technologies for the ILC. As part of its long-range planning, Fermilab has been actively considering a leading role in building an engineering test facility for major ILC linac systems, as well as promotion of a U.S. bid to host the ILC in Northern Illinois, with Fermilab as the host laboratory. In August 2004, an international panel of scientists recommended the superconducting radio-frequency (rf) technology for the accelerating structures of the ILC. This recommendation was immediately endorsed by the international particle physics community, and Fermilab has committed to concentrate its accelerator R&D efforts to provide U.S. leadership in this area.

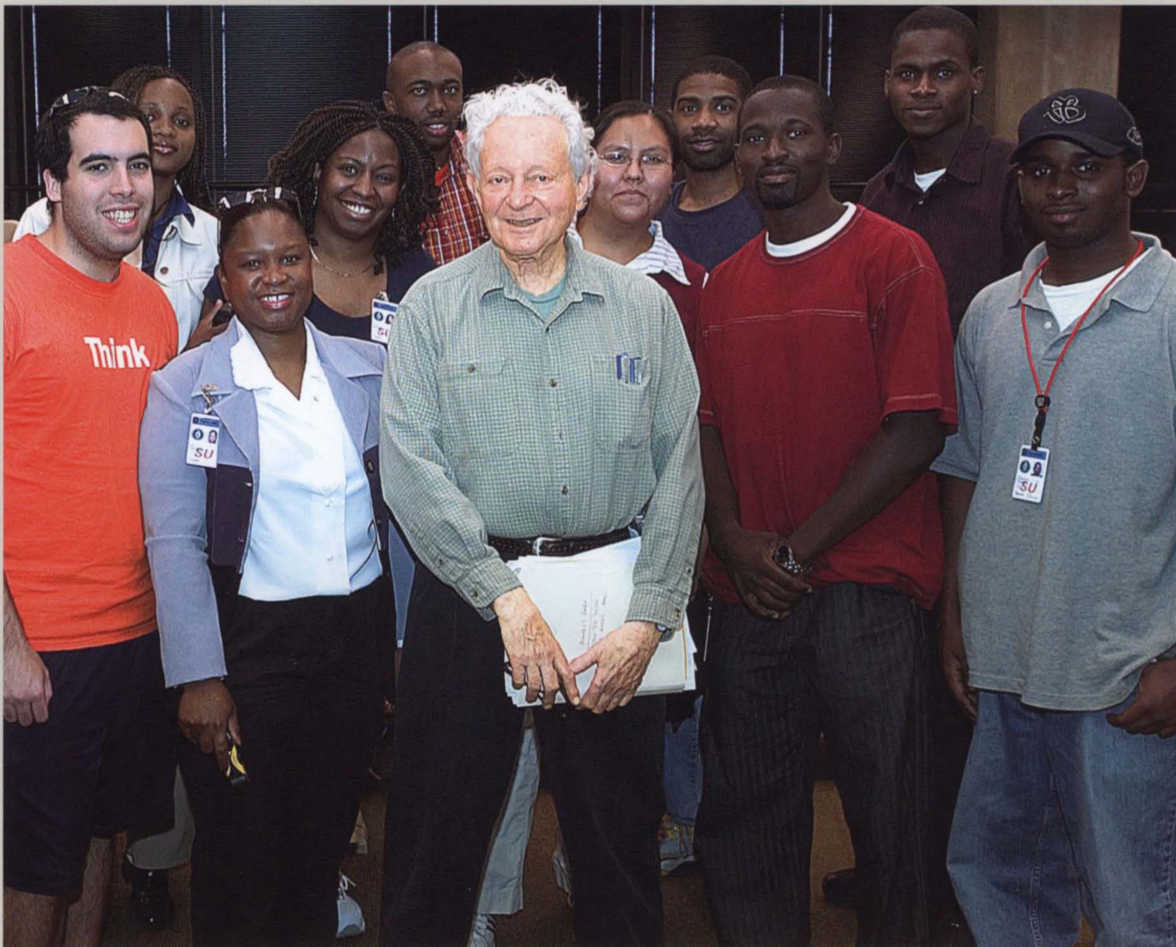
With interest high in neutrino physics, very intense neutrino sources are required for the next generation of experiments. Current accelerator sources at Fermilab produce secondary beams of neutrinos from collisions of high energy protons on stationary targets. To increase proton intensity, Fermilab has developed concepts for a new 8 GeV proton source facility, called the Proton Driver, to replace the 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 is focusing on the development of 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.

A much more intense neutrino source could be potentially formed using a muon storage ring. The collaboration analyzing this concept encompasses a number of laboratories and universities, with Fermilab and the Brookhaven and Lawrence Berkeley National Laboratories as lead laboratories. At this early stage, R&D is being performed on technical components for a muon cooling experiment to be located at Fermilab.

Fermilab is also collaborating with several regional universities that have initiated accelerator R&D efforts utilizing both State and Federal support. The Illinois Consortium for Accelerator Research (ICAR) consists of Illinois Institute of Technology, Northern Illinois University, Northwestern University, University of Chicago and University of Illinois, Urbana-Champaign. Supported at $2.5 million per year, the purpose of ICAR is to assist Fermilab with accelerator R&D for future facilities. 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 of the Fermilab/NICADD Photoinjector Laboratory (FNPL), a laser-driven, electron beam research facility at Fermilab. Seven participating institutions are using the FNPL, 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.

In October 2004, a U.S. collaboration of major DOE and NSF-supported laboratories and universities presented to Dr. Witherell a preliminary proposal for the establishment of the Superconducting Module Test Facility (SMTF) at Fermilab. The goal of SMTF is to develop U.S. capabilities in high-gradient superconducting accelerating structures in support of the ILC and other accelerator projects of interest to U.S. laboratories. The collaboration encompasses institutions involved in the ILC, the proposed Rare Isotope Accelerator (RIA), the Fermilab Proton Driver, high-energy electron cooling, and various fourth-generation light sources.

Mechanical Support Group in Fermilab's Photoinjector Lab (left to right) Mike Heinz, Mike Rauchmiller and Wade Muranyi helping to build a superconducting rf cavity for use in a next generation particle detector.



Fermilab Director Emeritus and Nobel laureate Leon Lederman speaking with summer interns at the Laboratory.

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.

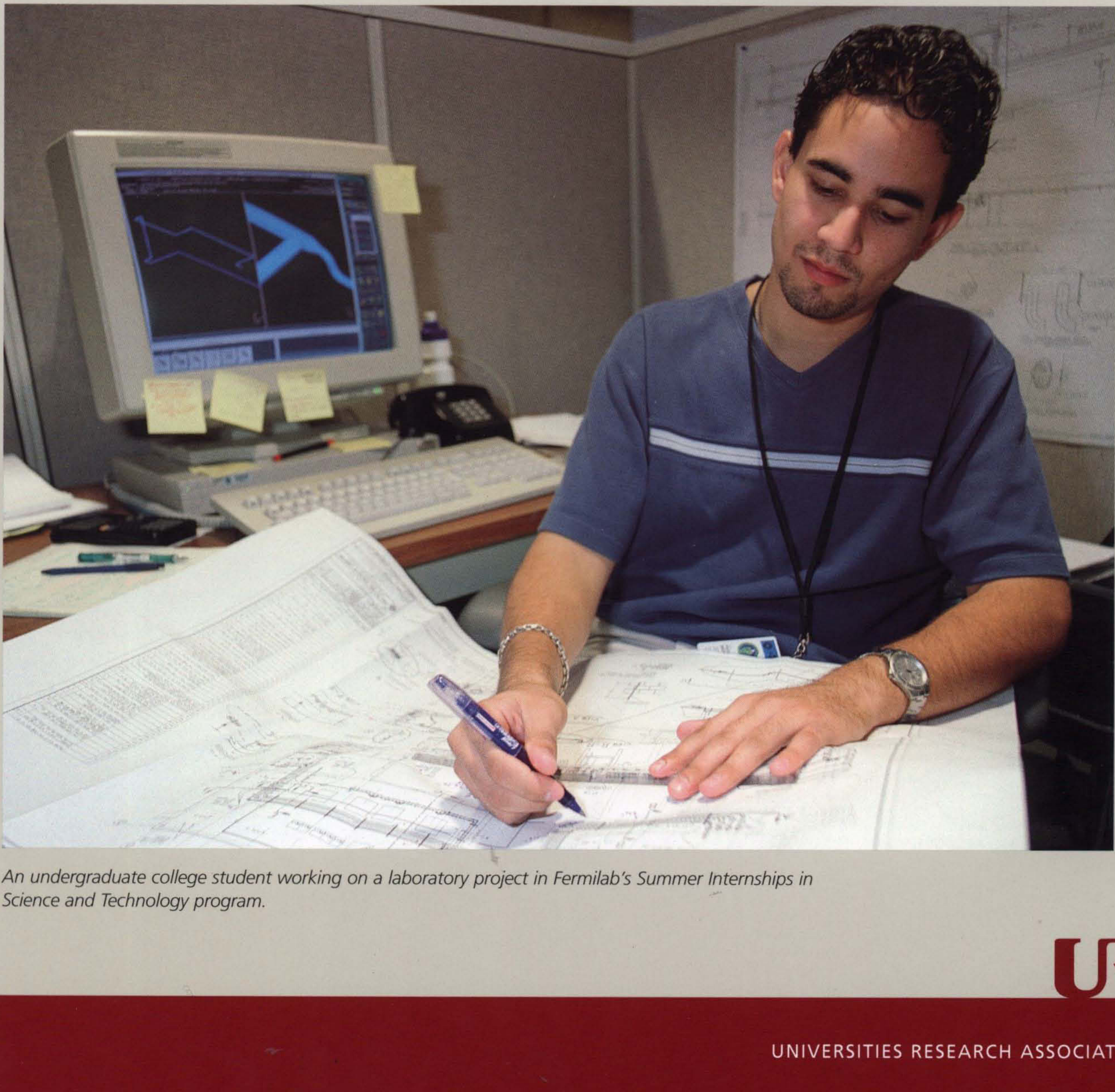
The Leon M. Lederman Science Education Center, dedicated in 1992, drew attendance in 2004 of over 18,000 students and 3,200 teachers in K-12 education programs. The Center offers some 31 programs: teacher enhancement workshops and institutes, opportunities for research participation, development and 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 2004, the Center's education webserver received nearly 112 million hits. Currently, 80 percent of the Center's funding is provided by Fermilab, and 20 percent comes from other federal, state and private sources.

The Internships for Physics Majors (IPM) summer program is aimed at outstanding college physics students who desire an opportunity to experience a working scientific environment. The IPM program is open to students in the U.S. and abroad. The Summer Internships in Science and Technology (SIST) program provides summer internships at

The Summer Internships in Science and Technology (SIST) program 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 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 over 30 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 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.



An undergraduate college student working on a laboratory project in Fermilab's Summer Internships in Science and Technology program.

Director Mike Witherell and DOE Fermilab Area Office Manager Jane Monhart accepted two safety awards from the National Safety Council on the behalf of the laboratory. "Fermilab's safety records have become a lasting legacy of the laboratory," Witherell said. "This is a great achievement, and we plan to keep doing it again and again." Monhart added, "I have all of the confidence that Fermilab has the will and the talent to keep doing better and better. Everyone at Fermilab should be proud."

Fermilab physicist Alvin Tollestrup (left) presents the 2004 Tollestrup Award for Postdoctoral Research to Nicole Bell, a scientist in the Fermilab Theoretical Astrophysics Group. The award is sponsored by Universities Research Association, Inc.

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 under-graduate, graduate, and postdoctoral levels.

Graduate students must devote so much time to participating in experiments at the Laboratory that they often have difficulty taking needed classes at their home institutions. Therefore, URA also provides financial support for graduate courses at Fermilab.

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

ENVIRONMENTAL AND CONSERVATION ACTIVITIES

In addition to its research 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.

In February 2004, the DOE Office of Science announced that Fermilab won two 2003 Pollution Prevention and Environmental Stewardship Awards. The first award recognizes 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 2003, Fermilab installed a plastic scintillator extrusion line to serve the needs of several Laboratory experiments. This line produces 3,000-6,000 pounds of waste per month. With the help of the Laboratory's Business Services Section, a commercial vendor was found that could accept 100 percent of the waste, reducing disposal costs and the need for landfill space.

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 has begun the process of implementing an Environmental Management System (EMS), a set of tools for problem identification and solving. Fermilab's EMS, which is analogous to the Laboratory's successful Integrated Safety Management System (ISMS), is on track to be in place by the end of 2005. In FY2004, Fermilab had one of the best safety records of any laboratory under the DOE Office of Science.

One of two Great Horned Owls returning safely to their nest in the Fermilab Village. 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.

Wyatt Merritt (left) co-leader of the SAMGrid project at Fermilab, with Michael Diesburg and Amber Boehnlein near DZero Computer Cluster at Feynman Computing Center. The SAM software was developed by the Fermilab Computing Division and the DZero experiment to allow processing of real collision data at remote sites. Taking advantage of additional off-site computing power helps further develop the Grid system and permits faster analysis of particle physics collision data.

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.

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. Working with hospitals in the Fermilab region, more than 3,100 patients over nearly three decades 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. The NTF was previously (1995-2003) 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.

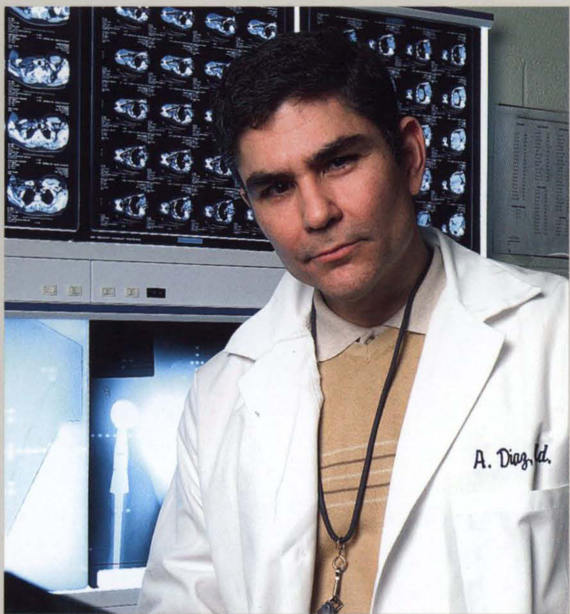
Fermilab laboratory staff volunteer in sponsorship of cultural activities and conduct tours for visitors

Fermilab's Community Task Force on a tour of the lab before it holds its first working meeting. The meeting included a presentation by Director Michael Witherell on the lab's budget and decision-making processes. The Community Task Force, with members drawn from the lab and from surrounding communities, will meet monthly. The group is charged with identifying issues of mutual concern to the lab and the community, and suggesting ways for the lab and community to interact on those issues.

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.

COMMUNITY PROGRAMS

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



Dr. Aidnag "A.Z." Diaz serves as the new Medical Director of the NIU Institute for Neutron Therapy at Fermilab. Diaz has stated that the main task of the NIU Institute is to give health centers in the region an extra tool to treat their patients.

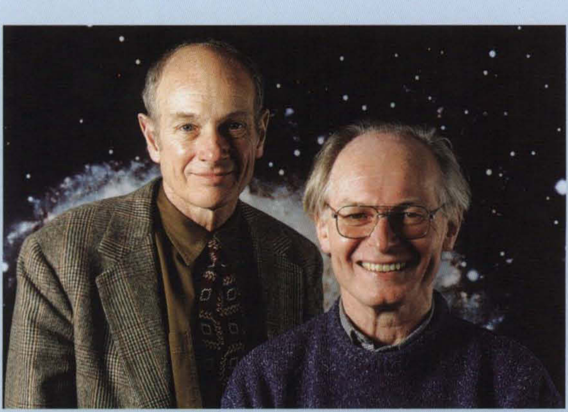
URA President Fred Bernthal (left) and current Fermilab Director Michael Witherell (center) chat with Piermaria Oddone shortly before URA's public announcement of the appointment of Dr. Oddone as the next Director of Fermilab, effective July 1, 2005.

LABORATORY DIRECTORS

On November 19, 2004, URA announced the appointment of Piermaria Oddone as Fermilab's fifth Director, effective July 1, 2005. Dr. Oddone has been Deputy Director of the Lawrence Berkeley National Laboratory for the past fifteen years. Dr. Oddone succeeds Michael Witherell, who has served with distinction as Director since July 1999. After he steps down, Dr. Witherell will be returning to the University of California at Santa Barbara, where he has been appointed as the next Vice Chancellor for Research. As Fermilab Director, Dr. Witherell succeeded John Peoples Jr., who 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



James W. Cronin (left) of the University of Chicago and Alan A. Watson of the University of Leeds are co-founders of the Pierre Auger Observatory Project.

Cosmic rays are high-energy particles from space—usually protons or the nuclei of atoms—that constantly bombard the Earth from all directions. The majority 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.

The Pierre Auger Observatory Project is a broad-based international effort to make a detailed study of ultrahigh-energy cosmic rays, about 10^{20} eV, or 100 million times greater than the energy of the protons accelerated by Fermilab's Tevatron. The Project was initiated by Dr. James W. Cronin, Professor of Physics and Nobel laureate at the University of Chicago. Currently, the Pierre Auger collaboration is led by Dr. Alan A. Watson, Professor of Physics at the University of Leeds in the United Kingdom, and by Dr. Giorgio Matthiae, Professor of Physics at the University of Rome (who in 2004 succeeded Dr. Hans Bluemer, Director of the Institute for Nuclear Physics at Forschungszentrum Karlsruhe in Germany). Thus far, the collaboration includes over 250 scientists from Argentina, Australia, Brazil, Bolivia, Czech Republic, France, Germany, Italy, Mexico, Poland, Slovenia, Spain, United Kingdom, USA and Vietnam. The U.S. collaboration comprises nine universities plus Fermilab, home of Project Manager Dr. Paul Mantsch and Deputy Project Manager Dr. Carlos Hojvat.

Because the highest-energy cosmic rays are so rare, scientists must cast a huge net to capture even a few. The Pierre Auger Observatory is the first to combine two different methods for the detection of cosmic ray events in a hybrid approach: surface detector arrays to record the showers of particles produced when cosmic rays strike the earth's atmosphere; and fluorescence detectors to observe the atmospheric flares produced during the air

Some of the 1,600 surface detectors that are being prepared for deployment for the Southern Auger array to record showers of particles produced when cosmic rays strike the earth's atmosphere. The surface detectors are being spaced in the array about 1.5 kilometers apart.

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

showers on dark nights. When completed, the Observatory will include two giant surface arrays, each consisting of 1600 particle detector stations spaced 1.5 kilometers apart and covering about 3000 square kilometers, an area about the size of the state of Rhode Island, plus 24 fluorescence telescopes observing the atmosphere above the array. In order to get a complete view of the heavens as seen from the earth, one array will be located in the northern hemisphere and one in the southern hemisphere. In November 1995, the collaboration selected a site in the Province of Mendoza, Argentina for the southern hemisphere array. A site in the U.S. for the northern hemisphere array is currently under discussion. The total project cost is approximately $100 million.

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 array. This is planned to be followed by the northern hemisphere array.

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.

Members of the international Auger collaboration in front of the Central Campus Office Building in Malargue, Argentina.

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 the data collected in 2002-2003, the Engineering Array has shown 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.

At the end of 2004, the Auger surface array was more than 1/3 complete and 1/2 of the fluorescence detector telescopes were operating routinely. The observatory is measuring more than 500 air showers each day, with 600 of the 1600 surface detectors operational. The building for the third fluorescence detector station was dedicated on November 13, 2004, and construction of the fourth station is expected to begin in early 2005. First physics results from the Auger Observatory are expected to be reported in mid-2005

There is great interest in the mysterious origin of the ultra-high energy cosmic rays that the Observatory will be analyzing. Theorists have suggested such candidate sources as the black hole cores of quasars, ultra-magnetic neutron stars, and super-heavy dark matter clumps. As a measure of the scientific importance attached to the Observatory, a 2002 report of the National Research Council's Committee on the Physics of the Universe recommends "that the United States ensure the timely completion of the Southern Auger array."

The recently finished third (of four) fluorescence detector buildings at the southern hemisphere Auger site in the Province of Mendoza, Argentina. Behind the detector building is a communications mast that transmits data from the fluorescence and surface detectors to the data acquisition center on the Central Campus.

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 has been engaged in long-range planning to explore potential new management responsibilities that would be of value to the university research community. As part of this planning, URA has been considering bids on management contracts for selected national research centers and facilities that serve a broad base of national and international users.

HISTORY 1965-2004

Mary Cullen has been the Director's Aide for three Fermilab Directors: left, Mike Witherell (1999-present), Leon Lederman (1978-1989) and John Peoples (1989-1999). Cullen retired in 2004 after a long and distinguished service career at the Lab.

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.

At the 512 GeV party on July 8, 1983, founding Director Robert Wilson (1967-1978) celebrated the Tevatron, his vision turned reality. The Tevatron celebrated its 20th Anniversary in 2003.

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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2004 ORGANIZATION CHART
Universities Research Association, Inc.

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Michael Witherell
Director

Kenneth Stanfield
Deputy Director

Laboratory Staff: 2,100

Pierre Auger Observatory Project

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

CORPORATE STRUCTURE

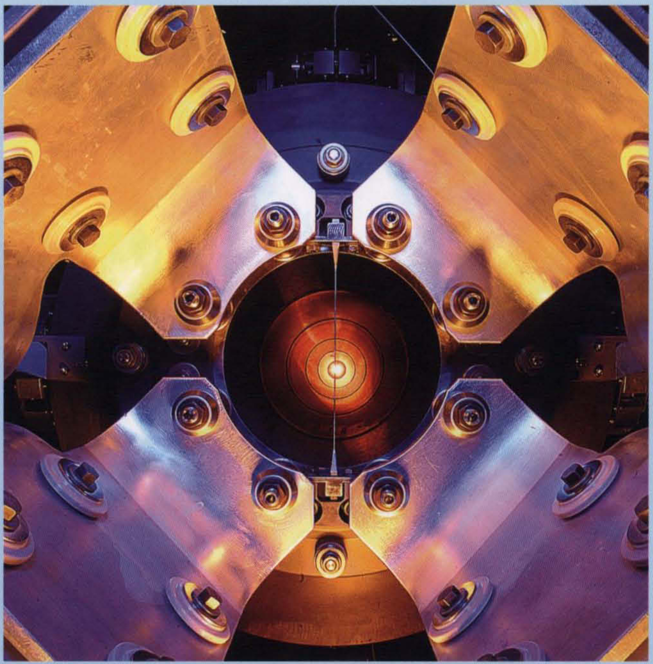
MEMBERSHIP AND GOVERNANCE

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 the DOE Chicago Operations Office or DOE headquarters. The total number of URA employees at corporate headquarters and at Fermilab is now about 2,120.

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.



Head on view of the NuMI Horn, a device for focusing particles that produce neutrinos for the MINOS experiment.

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

HEADQUARTERS OFFICE

Corporate officers include leaders of the URA governing bodies (Council of Presidents and Board of Trustees), and executive officers at 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

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FERMILAB BOARD OF OVERSEERS

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University of Nebraska-Lincoln

3 Jack Ritchie 2007
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Professor, University of Chicago

5 Thomas Weiler 2007
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Professor,
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Professor, University of Pittsburgh

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Honeywell Technology Partnerships

Alan Schriesheim 2006
Director Emeritus,
Argonne National Laboratory

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Douglas Cowen Pennsylvania State University	2005
Sally Dawson Brookhaven National Laboratory	2004
Gerald Dugan Cornell University	2005
Lawrence Gibbons Cornell University	2004
Yorikiyo Nagashima Osaka University	2004
Meenakshi Narain Boston University	2004
Rene Ong University of California, Los Angeles	2004

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	Term Expires
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Frank Sciulli Columbia University	2006
Thomas Weiler Vanderbilt University	2005

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John Corbett Lawrence Berkeley National Laboratory	2007
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Michiko Minty DESY	2007
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Lucio Rossi CERN	2005
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	Term Expires
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Fabiola Gianotti CERN	2008
Steven Kahn SLAC	2008
Boris Kayser Fermilab	2008
Takahiko Kondo KEK	2006
Andrew Lankford University of California-Irvine	2005
Joseph Lykken Fermilab	2004
Daniel Marlow Princeton University	2007
Robert McKeown California Institute of Technology	2008
Hitoshi Murayama University of California-Berkeley	2006
Natalie Roe Lawrence Berkeley National Laboratory	2004
Heidi Schellman Northwestern University	2005
Dong Su SLAC	2007
Paul Tipton University of Rochester	2005
Tejinder Virdee CERN	2004
Scott Willenbrock University of Illinois at Urbana-Champaign	2007
Jeff Appel Secretary (Fermilab)	

FINANCES

Universities Research Association, Inc.
STATEMENT OF ACTIVITIES
Year Ended September 30, 2004

Total Revenue	$ 317,785,264

EXPENSES:

Salaries, wages and benefits	$ 174,951,420
Subcontracts and purchased services	46,773,320
Materials and supplies	23,173,639
Electric power	14,769,698
Travel, relocation and other employee allowances	6,360,895
Inventory usage	4,048,189
Fermi National Accelerator Laboratory and Pierre Auger Project support	660,519
Scholarships	196,900
Other	676,813
Total Operating Expenses	$ 271,611,393
Cost of property, plant and equipment constructed for DOE	$ 46,059,255
Total Expenses	$ 317,670,648

Flags of nations representing Fermilab's international user community fly in view from the front of Wilson Hall. High-energy physics has long been a leader in international scientific collaboration. Future progress will require even greater international cooperation to build accelerators and detectors to reach new energy frontiers.

Back cover photo: "Tractricious" is a free-standing hyperboloid sculpture, located at the Industrial Center Building. It is made from unused stainless steel beam pipe. It stands 36 feet high and was designed by Fermilab Founding Director Robert Wilson with structural design accomplished by Tom Nicol of Fermilab's Technical Support section. Each stainless steel outer tube weighs 550 pounds, and the structure can withstand 80-mph winds.

URA

URA

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