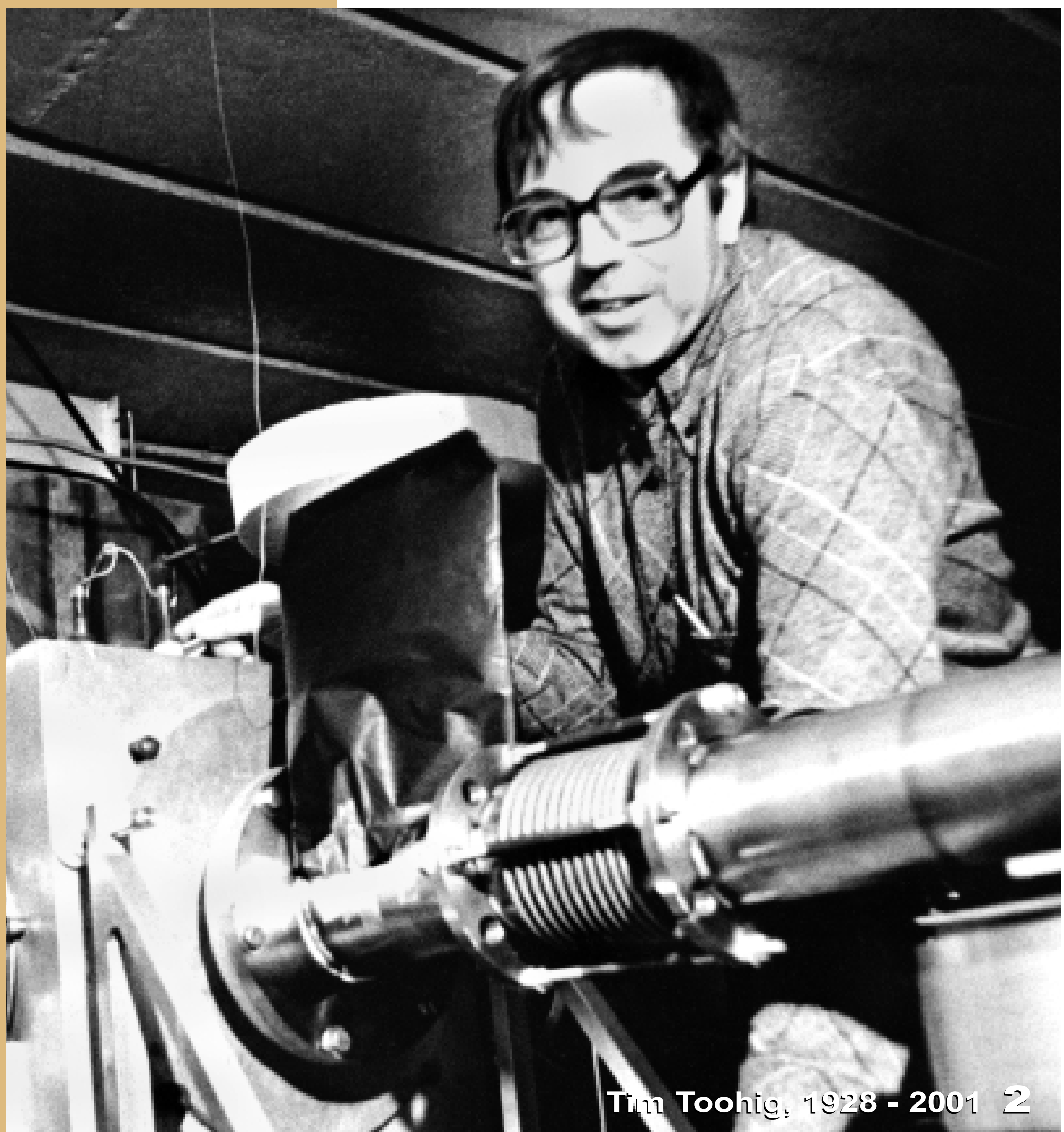
FERMI NEWS

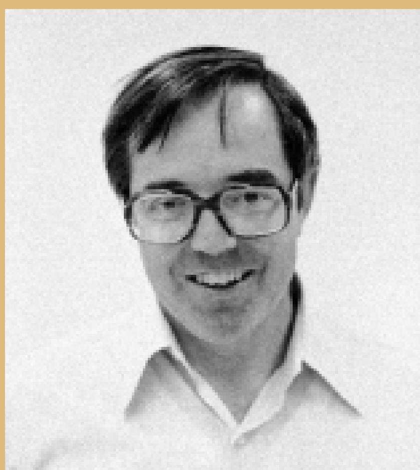
FERMILAB A U.S. DEPARTMENT OF ENERGY LABORATORY



Fermilab photo

Volume 24
Friday, October 19, 2001
Number 17

INSIDE:



Tim Toohig
1928-2001

Cover: Tim Toohig made integral contributions to three generations of colliders: the Tevatron at Fermilab, the never-completed Superconducting Super Collider, and the Large Hadron Collider under construction at CERN, the European Particle Physics Laboratory in Geneva, Switzerland. He also made many visits to Russia (then the Soviet Union) during the Cold War era. In this photo, he works on accelerator components at the Joint Institute for Nuclear Research in Dubna, Russia in 1980.

'Father Tim' Saw Spirituality in Science, Touched the Hearts and Minds of Scientists

by Mike Perricone

Tim Toohig lit a candle wherever he went. He shone the light wherever he thought it was needed, though not always by invitation.

"He was beloved by everybody, yet he kowtowed to nobody," said Fermilab physicist Joe Lach, a friend since 1965. "He said things the way he saw them, and what he said was usually right."

Physicist Tim Toohig—Father Timothy Toohig, S.J.—played a leading role in establishing both scientific and humanitarian standards in the early days of Fermilab. He made indispensable contributions to the design and construction of the Tevatron, then brought his scientific and leadership skills to the Superconducting Super Collider project. At the height of the Cold War, he participated in accelerator experiments in the Soviet Union. In his latest assignment at the U.S. Department of Energy, he made an imprint on yet another generation of high-energy physics forefront machines by serving as Program Manager for the $531 million U.S. involvement in the Large Hadron Collider at CERN, the European Particle Physics Laboratory.

Toohig was attending an LHC Program Advisory Committee meeting at Stanford Linear Accelerator Center on the day he died, September 25, 2001. The cause of death was not determined, although a stroke was suspected. In the evening following the PAC meeting, Toohig collapsed while speaking with colleague Tom Eliioff in the parking lot. He was taken by ambulance to Stanford Hospital, where he appeared alert and talkative. He passed away later that evening. He was 73.

Toohig received his doctorate in physics from Johns Hopkins University in 1962. He was ordained into the priesthood in 1965. Throughout a career spanning four decades, his spiritual guidance was as valued as his scientific knowledge. Toohig presided at memorial services at Fermilab for founding Director Robert R. Wilson in May, 2000, and Wilson had once described him as "spiritual counselor for the project" of building the laboratory. Lach related that Toohig had officiated at the funeral services for his wife, Barbara, and was preparing to preside at the wedding of his daughter, whom he had baptized when she was an infant.

"We had dinner together just a few weeks ago at *Chez Léon* [at Fermilab]," Lach said. "Tim hadn't met my daughter's fiancé, and he wanted to get to know him before officiating at the marriage."

Toohig was fond of breaking bread with friends and coworkers, as on this 1983 visit to Russia.

"Father Tim" to his extended family throughout the high-energy physics community, Toohig saw no conflict between his pursuit of scientific and spiritual knowledge. While serving at the Department of Energy, he also held a research position at Boston College. He was, in fact, representative of the Jesuit outlook since the order's founding in 1540 by Ignatius Loyola, who considered the acquisition of knowledge a spiritual task. Toohig's scientific papers (including a 1994 article, "Reassigning Blame for the SSCS Demise," in *Physics Today*) are featured in an exhibit, "Jesuits and the Sciences," compiled by the Science Library of Loyola University of Chicago, and available on the Web (http://www.luc.edu/libraries/science/jesuits/index.html).

In his March, 2000 talk at Fermilab ("Physics Research: Searching for God") during the Symposium on the Nature of Science, Toohig noted these parallels: "Both religion and science contain a powerful sense that there is more there than we currently understand. In science, this is what leads us, for example, to build new accelerators, as a way to reach beyond what we know, toward discoveries that we believe lie beyond."

During the talk, he reached back to the early 1960s, when he was a graduate student at Johns Hopkins. He was in a group working on the Berkeley Bevatron experiment that discovered the eta meson, a critical step on the path toward establishing the existence of quarks. Toohig and his fellow grad students ran their data during the night shift at NASA's Goddard Space Flight Center, watching those old line printers crank out the results of their calculations. With each result they knew they were seeing something new.

"It was a fantastic feeling, better than winning a football game," he recalled. "I couldn't help relating it to experiences in prayer, to the very special moments I'm sure we all have had in our lives, times of real trouble or very special moments when there's this tremendous sense of interior joy and excitement. It could only be described as a deep spiritual experience. With time, I've learned that such experiences are really what physics research is all about, and that's why we do it. The reward is that joy."

Toohig is survived by two brothers and five sisters, and a large extended family of physicists who felt a significant portion of their rewards from working with Father Tim.

"I counted on him, trusted him, and will miss him more than I can say," said Rich Orr, Fermilab's first assistant director. "The world is a darker place without him."

Fermilab photos

Toohig (left) and Dick Carrigan (center) with a Russian colleague during a 1983 visit to the Institute for High-Energy Physics in Protvino.

Tim Toohig
1928-2001

"...tireless worker...
...source of strength...
...spiritual counsel...
...great friend...
...we will miss him..."

Dick Carrigan

Tim made very significant contributions to the Tevatron and to the SSC.From a personal standpoint, Tim and I shared an interest in a special little area of physics, particle channeling, for a number of years. This collaboration had many interesting elements, partly because Tim was a priest and on our visits to the Soviet Union, the Soviets were interested in showing him signs of religious freedom in the USSR. Their efforts included a memorable visit to Armenia and the seat of the Armenian church. Beyond that, Tim had a tremendous personal impact outside physics—Tim officiated when Drasko Jovanovich's daughter was married, Tim served at Barb Lach's funeral, Tim counseled Bob Wilson after his first stroke. We will miss him.

Robert R. Wilson (1987)

It was not roses, roses, all the way. Tragedy began to strike as our numbers grew—disease, even death. Nowhere in the annals of physics are such things mentioned, nor had my previous experience prepared me to cope with them. Yet coping was part of the job. I soon found that Tim Toohig, a cracking good physicist at the Lab, as well as a Jesuit priest, would appear on such occasions full of compassionate sympathy and understanding. Despite a difference in our religious beliefs, we became close friends and the difference narrowed as my respect for Tim grew. He became the spiritual counsel for the project.

(1987 essay, "Starting Fermilab: Personal Viewpoints of a Laboratory Director")

Helen Edwards

Tim has had friends and colleagues who respect, admire and love him both as a man and as a scientist wherever he has gone. Tim was a tireless worker at trying to cut through the difficult problems that come up with civil construction, radiation and safety. He was invaluable in his search for the most economical and sensible solutions, and for working with firms to get them to understand just what was needed rather than using expensive overkill solutions. He was a tremendous asset to any project and to project leaders. He had that rare talent of independent thought and logic. He would challenge the bureaucratic system to solve technical or political problems.

But more importantly Tim was truly a man of God in a scientific world. Time and again he would be called upon to say words of comfort and healing at some sad occasion. He did this with wonderful thought and grace. He was able to communicate with meaning to people from a whole spectrum of religious and scientific backgrounds. This was a most unusual gift. He was a genuinely good and remarkable man and a great friend to so many of us.

Nikolai Mokhov

Tim was the first person I met in the Fermilab Accelerator Division when I arrived in this country as a visiting scientist in 1979. We had a very productive several months working together on the first external beam abort system. Ever since then, despite the difference in ages, we were very good friends, and our friendship was strengthening with the years. I remember his article "The View from The Volga" published by *Physics Today* in the spring of 1980. It was a very difficult time in the relations between the USA and the USSR, and not everybody liked the positive tone of that article. During my succeeding visits to Fermilab, we worked together on some aspects of the SSC project. In 1992, I moved to SSCL and we worked together a lot, publishing several joint papers. He was so depressed by the SSCL collapse.

In the '80s, Tim was twice my guest at IHEP (Protvino). I remember our disputes on scientific, political and religious issues. He spoke Russian rather well but with a terrible Boston accent. My wife and two sons loved "Uncle Tim" so much, and they were so depressed when they learned the sad news. Tim was an outstanding personality, a great reliable friend, one of the nicest men I knew in my life. I will miss him greatly.

Rich Orr

We went through many tough times in the early days in the Neutrino Lab. Tim was our leader and our rock. He always knew what we had to do to make a pile of dirt and concrete into a real laboratory. The physicists, technicians, and engineers in the section performed miracles under his leadership. (I always assumed divine intervention.)

Tim was also a major part of the leadership of the Tevatron Project. Again, he was a source of strength, advice and ideas when we needed them most. A lot of the infrastructure still being used in the Tevatron complex is due to Tim's creativity and drive. I counted on him, trusted him and will miss him more than I can say. The world is a darker place without him.

John Peoples

I first met Tim in the very late sixties at Fermilab. We worked together building the experimental areas, he in the neutrino area and I in the proton area. He was a wonderful fellow scientist with whom I cooked the books of the research division and got things done like the left bend. We came together at times of joy—weddings; and at times of sorrow—funerals. His deep faith in God and humanity always helped us through the difficult times. I always looked forward to seeing him come back to Fermilab. I will miss him.

Chris Quigg

Father Tim lived the gospel of love; he spread joy and hope and a feeling of belonging to everyone he met. Asked how he was, Tim would respond, beaming like a cherub, "The sun is shining, God's in his heaven, and all's right with the world." Whatever the state of your own little world seemed to be, you couldn't help beaming back.

Tim loved being Irish, he loved being a Jesuit, and he loved acting out the stereotypical richness of both traditions. When contractors, bureaucrats, or colleagues tried to put self-interest ahead of doing what was right, Tim would hammer them coming and going. "Being a Jesuit priest, if I see people playing games, I can get righteous; being Irish, I can shoot 'em in the knees."

Tim also loved being a physicist and a believer, and he loved the challenge of being both. Scientific knowledge, he liked so say, is incompatible with a lazy faith. "If you're going to be a believer, the props are gone. You really have to come face to face with the question of God. It's more scary on one hand and richer on the other hand."

On the Web:

SLAC In Memoriam
http://www.slac.stanford.edu/slac/announce/misc/toohig.html

Tim Toohig's lecture, "Physics Research: Searching for God" (Symposium on the Nature of Science)
http://vmsstreamer1.fnal.gov/Lectures/NatureOfScience/Toohig/index.htm

Jesuits and the Sciences
http://www.luc.edu/libraries/science/jesuits/

Peter Rosen

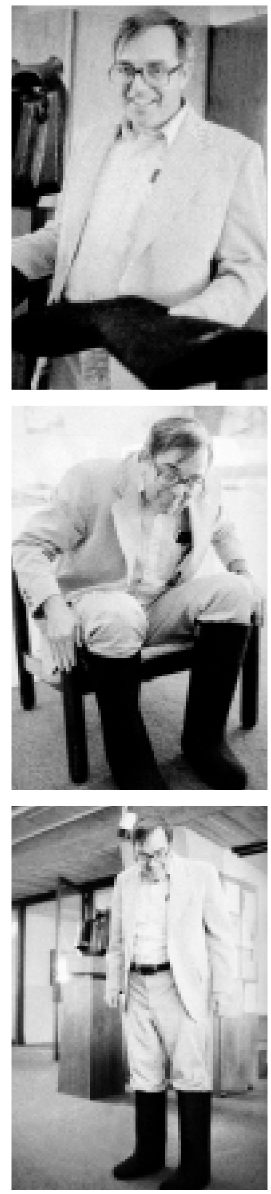
Tim was the nicest and most sincere person you could imagine. He loved the field of particle physics and gave it his all. It is fitting that he died with his boots on. We can take consolation by always remembering him as an active, hands-on physicist who served the field of high energy physics with great devotion and distinction. We will miss him greatly.

Michael Witherell

Tim was a member of the group that built this laboratory and therefore was part of its historic past. More importantly, he was a trusted friend who had a lasting influence on the lives of many people at Fermilab and throughout our scientific community. He presided at their marriages, baptized their babies, and comforted them in difficult times. Even in the most difficult meetings his presence improved the civility of all those in the room. I will remember him with great affection and respect.

Victor Yarba

Tim had been in Russia during 1978-1980 as a visiting scientist at Dubna (JINR), doing an experiment at IHEP-Protvino. I met him at that time in Protvino. He was a remarkable American visiting scientist with an outstanding unusually excellent personality. I am sure he did a lot to improve relations between Americans and Russians during the Cold War. He became a best friend of mine and of many, many Russians who were lucky enough to meet him.



Fermilab photos

Toohig examines and tries the fit of a pair of boots presented to him in preparing for his 1979-80 visit to Dubna as a visiting scientist.

A Case of Identity

Kerberos goal: Free exchange of SCIENCE on SECURE computers

by Mike Perricone

"Who steals my purse
steals trash…
But he that filches
from me my good name
Robs me of that
which not enriches him,
And makes
me poor indeed."

—Shakespeare, "Othello,"
Act III, Scene 3

Question for our time: Who are you, and can you prove it?

Issue for our time: Achieving a balance between freedom and security.

Increasingly, the computing solution for these questions in these times is Kerberos, a system of "strong authentication" for computer users invented at the Massachusetts Institute of Technology, and already operating at many universities and several Department of Energy national laboratories. The list includes Fermilab, which adopted Kerberos for the CDF and DZero experiment collaboration computers during the past year, with a goal of extending the protection to the entire site by the end of 2001.

But the team responsible for adapting and implementing Kerberos at Fermilab is emphatic about the balance point between freedom and security.

"If we do something a little differently and there's a real security benefit, that's OK," said Matt Crawford, who is managing the installation. "But if it means people can't work together, then that's not OK. The primary goal is to allow the work of science."

Irwin Gaines agreed.

"Fermilab must maintain an open collaborative environment, otherwise there is no science," said Gaines, who has led tutorial workshops introducing lab employees to the ins and outs of the coming system. "Kerberos is a way to make sure we know who uses Fermilab computers. It's a procedure that makes sense for our environment."

Kerberos strives for the best balance between security and freedom by addressing the question of identity, and attempting to prevent identity theft. Kerberos establishes proof of identity ("user authentication") through cryptographic calculations at local computers, with a central server validating the proof. Kerberos aims to keep passwords from being transferred over networks, where they are vulnerable to "sniffers:" programs that watch for passwords going by, and harvest them for identity theft. Unfortunately, sniffers are everywhere.

"The nature of the Internet has changed," Gaines said. "The number of people breaking into computers—not just Fermilab computers, but computers all over the world—has grown exponentially. A person who has stolen an identity can then log into a computer and assume that identity. Because Fermilab computers are used by people all over the world, users have to log in from a remote site. If they're typing a password over the network, that password can be grabbed off the network at any point."

Since an individual identity is precious, Gaines has cautioned his workshop audiences to "treat your Kerberos password as a sacred object. Don't write it down on a sticky and attach it to your computer screen. Don't write it down,

Photo by Jenny Mullins

Irwin Gaines conducts a workshop on the implementation of the Kerberos computer security system at Fermilab.

anywhere." In addition, a Kerberos password must be different from any other password that an employee uses.

Kerberos acts as a gatekeeper for access to certain high-priority services, while leaving lower priority services alone. There will be two access routes, via software or cryptocard. The first route involves installing software on a desktop computer so a user can prove a Kerberos identity locally. The desktop will exchange information with the Key Distribution Center, which issues a key or ticket good for a computer anywhere in the lab. The alternate route involves a cryptocard, which produces a one-time password. A user without a Kerberos identity will be given a cryptocard challenge which, if passed, issues a one-time, one-use password.

"So even if it's seen," Gaines said, "it does no good because it's instantly obsolete."

Crawford, who Gaines said originated much of the plan, also created the innovation of having the cryptocard challenge available site wide. The cryptocard allows access from any computer on site, any home computer, any traveling computer—as long as the user brings the cryptocard along.

The Kerberos team, which has been operating for more than a year and a half, includes Randy Reitz and Frank Nagy of the Computing Department. Tom Nash and Computing Division Head Matthias Kasemann act jointly as Computer Security Executive, reporting directly to Fermilab Director Michael Witherell. Dane Skow is head of the Fermilab Computer Security team, and deputy to Nash and Kasemann. Crawford is Fermilab Computer Security Coordinator and project manager. Gaines is deputy FCSC for the general security domain and for training and education, while Donna Dyxon is deputy FCSC for government and DOE liaison.

The lab also has what Gaines described as a "volunteer fire department," the Fermilab Computer Incident Response Team. Volunteers from many areas of the lab take turns being on call to "put out fires," providing the first line of defense against unauthorized access. Don Petravic is about to replace Skow as head of FCIRT.

Crawford admitted that Kerberos won't plug every hole, but pointed to its widespread acceptance through its adoption by vendors including Microsoft, Sun, Cisco, IBM and many others. In addition, the goal for the security system is to maintain openness and minimize disruptions in communicating scientific information.

"It's like putting all our eggs in one carefully-designed well-secured basket," Crawford said. "Any system bugs or intruders can break one egg, but we're pretty sure they can't get the whole basket."

On the Web:

Kerberos at Fermilab
www.fnal.gov/docs/strongauth/

Run II WELL UNDER CONTROL

by Kurt Riesselmann

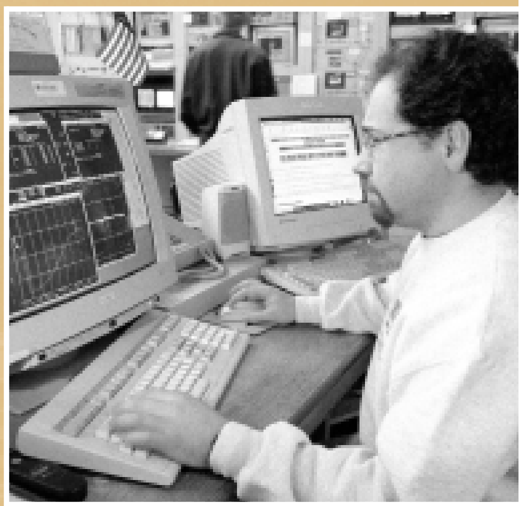


Photo by Fred Ulrich

Salah Chaurize, one of five operations crew chiefs, working in the Main Control Room.

On March 1, Collider Run II began at Fermilab. It is a six-year enterprise to produce a record number of proton-antiproton collisions using the world's most powerful particle accelerator, the Tevatron.

"This machine doesn't have an on/off switch," said Mike Martens, who just assumed the 24-hour-7-days-a-week responsibility as Run II coordinator. "Every time we start a run, we have to tune the machines, slowly increasing the luminosity."

Luminosity is expert's lingo for the number of collisions produced per second. So far, Fermilab accelerator experts have achieved a peak rate of about 450,000 collisions per second (a luminosity of 7.5×10^{30} $cm^{-2}sec^{-1}$), a respectable start for Run II. By January, they want to increase the luminosity to 4×10^{31} ("four times ten to the thirty-one"), improving the previous record obtained during Run I, which ended in 1996, by about a factor of two.

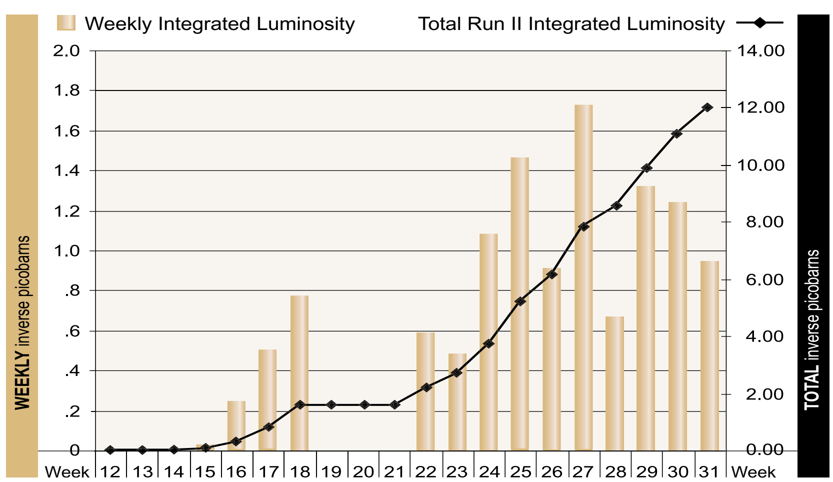
At present, scientists are using a six-week shutdown to improve accelerator operations and to put the final touches on the CDF and DZero detectors, large instruments that take "snapshots" of the collisions, revealing the nature of the tiniest building blocks of matter. In the past seven months, both CDF and DZero collaborations have tested their equipment, collected the first collision data and refined their computer controls. The planned shutdown, which began on October 8, gives them a chance to repair equipment and supplement existing electronics before the recording of "real" data will start around Thanksgiving.

On the Web:

Beams Division
www-bd.fnal.gov/

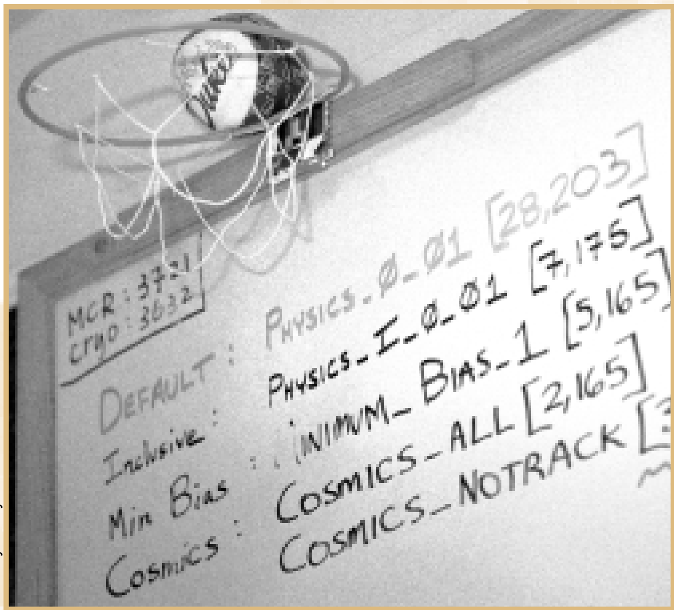
CDF collaboration
www-cdf.fnal.gov/

DZero collaboration
www-d0.fnal.gov/

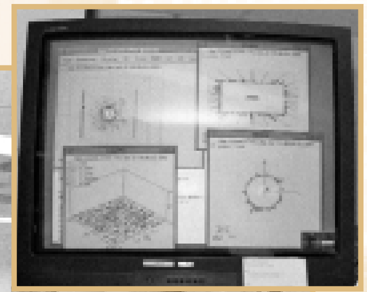


Run II started on March 1. Scientists have continuously increased the performance of the accelerators, achieving the first significant number of collisions in week 16. By the end of week 31, accelerator experts had produced 700 billion proton-antiproton collisions, equivalent to an integrated luminosity of 12 inverse picobarns (pb^{-1}). Scientists expect to accumulate 200 pb^{-1} by summer 2002.

Photo by Jenny Mullins



When the CDF control room is abuzz about particle collisions, scientists put their shootaround on hold.



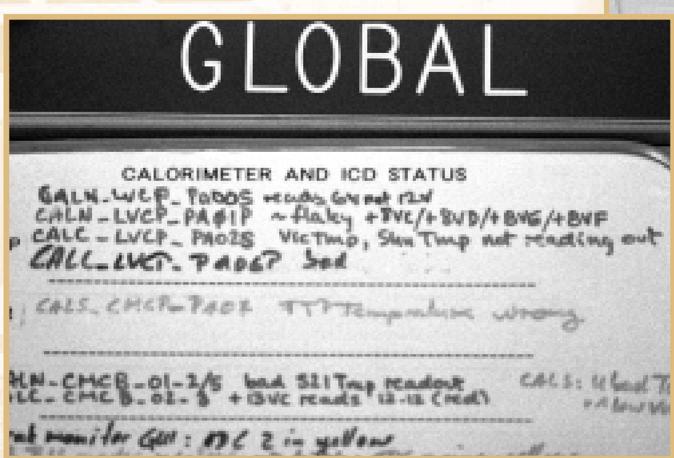
Photos by Reidar Hahn

From the DZero control room, scientists monitor various detector subsystems such as cooling equipment and data acquisition systems. Maintaining a high efficiency in recording particle collision events is the key to discovery.

Photo by Reidar Hahn

Caffeine anyone? When the Tevatron is in operation, scientists work in shifts to staff the detector control rooms 24 hours a day, 7 days a week.

Photo by Reidar Hahn



Keeping track of detector components.

Photo by Fred Ullrich

In the Main Control Room, operators have access to 90,000 read-outs and can control more than 40,000 devices related to the accelerators. Finding the optimal settings requires expertise and patience.

Scientists provide the answers

Why did you choose to become a particle physicist?

What does a particle physicist do?
Is the work dangerous?

What is antimatter? Can we use it as fuel for spaceships?

How do you accelerate particles? Can they go faster than the speed of light?

What happens when two particles collide at high energy?

How do you "see" particle collisions?

Why should I care about elementary particle physics? Will I ever benefit from this research?

by Kurt Riesselmann

You have heard about Fermilab, accelerators, quarks and the Big Bang. But how do all those things fit together?

If you only knew a scientist whom you could ask…

More than a year ago, physicist Peter Garbincius and some of his colleagues recognized the problem. They had seen many people visiting Fermilab, who—after seeing videos, reading posters and exploring displays—still had questions. Clearly these visitors needed to "Ask a Scientist," giving the new outreach program its name.

On Sunday, September 2, 2001 the Ask-a-Scientist program celebrated its first anniversary. Since the beginning of the program about 50 physicists have volunteered to spend two or more hours on a Sunday afternoon at the lab. In teams of two they have greeted visitors in Wilson Hall and answered questions ranging from particle physics to the occasional homework problem.

Since September 11, the program has been on hold as public access to the previously open Fermilab campus is severely restricted. No visitors are allowed to enter the site on weekends. Nevertheless, Garbincius and his colleagues are determined to keep the program alive. They have investigated possible alternative locations, and they plan to use the Web, a particle physics invention, to reach out to people far away. At present, real-time Ask-a-Scientist sessions on the Internet are under test.

To keep up with the expansion, Garbincius, who organizes the program, is looking for additional manpower.

"We would be happy for more scientists, including students or postdocs, to volunteer," he said. "If somebody hasn't done it before, we team them up with our senior people."

In the past, the program has remained a steady draw throughout the seasons.

"We averaged more than 20 visitors each session," said Garbincius. "Even on Super Bowl Sunday we didn't seem to have a significant drop in attendance."

Some physics questions just can't wait for an answer.

Photos by Reidar Hahn

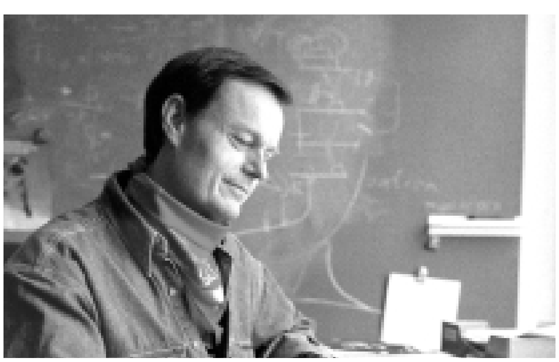
Members of the Ask-a-Scientist team volunteer their time on weekends to meet Fermilab visitors.
From left: Chandra Bhat, Leo Bellantoni, Boaz Klima, Jim MacLachlan, Fritz Dejongh, Pushpa Bhat, Alan Wehmann, Bob Tschirhart, Roger Dixon, Dave Harding, Sam Childress, Jim Hylen, Hank Glass, William Wester, Rajendran Raja, Hans Jöstlein, Jeff Appel, Dave Christian, Mike Syphers, Herman White, Peter Garbincius.
Additional volunteers are: Mike Albrow, Bruce Baller, Chuck Brown, Harry Cheung, David Finley, Mark Fischler, Gaston Gutierrez, Steve Holmes, Bob Hsiung, Catherine James, Paul Lebrun, Don Lincoln, John Marriner, Hugh Montgomery, Craig Moore, Jorge Morfin, Thornton Murphy, Vivian O'Dell, Adam Para, Stephen Pordes, Erik Ramberg, Heidi Schellman, Steve Wolbers, Victor Yarba.

"Why did you choose to become a particle physicist?"

Physicist Roger Dixon,
Cryogenic Dark Matter Search experiment:

The short answer is that I had an intense interest in astrophysics when I finished college, and I saw particle physics as the most attractive path to studying the topics in astrophysics that I was most interested in.

I had always been interested in the sky from the time I was a very small child. I spent most of my summers with my Grandfather on his ranch in the mountains of New Mexico. We looked at the sky together most every night and he would tell me all about the constellations and the mysteries of life. I was so enthralled just to be with him, I wanted to be like him in every way. He only had a second grade education, but he had quite a few patents including the first one for cruise control in an automobile. I think the gene pool got watered down a bit by the time it got to me. Anyway, the magic of those moments faded as the time approached for me to go to college. I thought I would study something practical like engineering, but once I began taking the physics and math that was required, the magic came back. And here I am.



Roger Dixon

"What does a particle physicist do? Is the work dangerous?"

Physicist Jeff Appel, E791 and BTeV experiment:

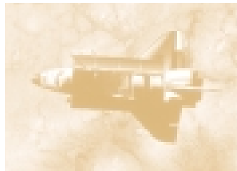
As in other branches of science, there are two types of particle physicists: experimental and theoretical. An experimental particle physicist designs and builds experiments to answer specific questions about the nature of the smallest components of matter and their interactions, and analyses the data that is collected in the experiments. This involves a host of disciplines and technologies, and working with engineers, technical support groups, and industry. We work together to design, build, and operate accelerators, particle detectors, and computing systems. A theoretical physicist helps interpret the results of a range of experiments, and helps frame the questions that the experimenters attempt to answer. For both experimentalists and theorists, the use of computers plays a major role these days, and we work in collaborations that stretch around the world.

At the moment, my own efforts as an experimentalist are focused on developing a new kind of particle detector, called a hybrid pixel detector, which will make certain kinds of experiments possible in the future - including the experiment I want to do!

Working at Fermilab is similar to working in a university laboratory or the research division of a high-tech company. We have no nuclear energy or weapons research program. Our main instruments are accelerators, much smaller versions of which you find at hospitals and inside television sets. Hence our work is no more dangerous than the work of an electrician or a nurse working with an x-ray machine.

Jeff Appel holding a prototype of the BTeV pixel detector

Scientists provide the answers



Steve Holmes

"What is antimatter? Can we use it as fuel for spaceships?"

Physicist Steve Holmes, Associate Director for Accelerators:

We and the world we see around us are made of matter. At the atomic scale this means protons, neutrons, and electrons. We know that for each of these matter particles there is a corresponding antimatter particle (or antiparticle for short). Antiparticles have exactly the same mass as their particle cousins, but exactly the opposite 'quantum numbers.' For example, the proton has positive charge, +1, and the antiproton has negative charge, -1.

If a particle and its antiparticle ever come into contact they annihilate into a tiny flash of pure energy. Fortunately, antimatter does not appear to occur naturally in any significant quantities—there are no anti-trees on earth, and we don't think there are anti-solar systems or anti-Milky Ways—so we don't have to spend a lot of time worrying about going poof.

Perhaps we could use antimatter as fuel for spaceships, but our resources wouldn't get us very far. NASA has calculated that it would take about a ton of antiprotons to propel a spaceship to the nearest star. This is about 1,000,000,000,000,000 times the amount of antiprotons that we produce at Fermilab in a year. So we would have to keep at it for an awful long time.

The interior of the linear accelerator at Fermilab. The copper structures get charged using alternating voltage to accelerate particles.

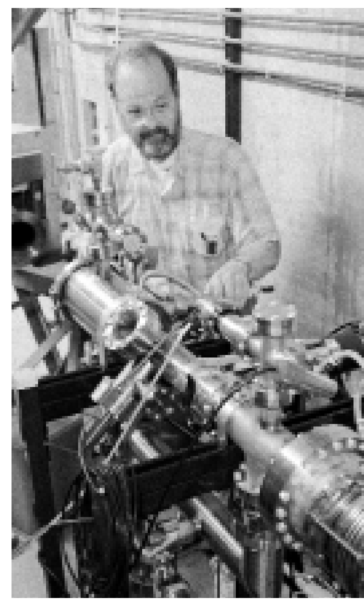
"How do you accelerate particles? Can they go faster than the speed of light?"

Physicist Jim MacLachlan, Beams Division:

We accelerate particles that carry electric charge. A proton, for example, has a positive charge. To accelerate the proton, you place a negative charge nearby: the proton will feel the force of the electric field and move toward the charge, speeding up along the way.

Particles that have low energy we can accelerate with a constant electric field. The acceleration occurs between electrodes with a high voltage across them. The Cockcroft-Walton accelerator at Fermilab is an example. It operates at a voltage of 750,000 volts. A charged particle traveling through this accelerator gains 750,000 electron volts (eV) in energy. Our most powerful accelerator, the Tevatron, takes particles to energies of nearly one trillion electron volts (1 TeV).

To achieve such a high energy, the economical way of supplying the electric field changes drastically. Instead of charging electrodes with a constant electric field, we use accelerators with an oscillating electric field, which is produced by an alternating voltage. Sending particles in bunches, synchronized with the oscillations of the field, the particles always feel forces pulling them forward as they travel through the accelerator.



Jim MacLachlan working on electron cooling equipment

Using larger and larger accelerators, the energy of a particle can be increased more or less indefinitely. However, all charged particles have mass. According to Einstein's theory of special relativity, their maximum velocity is always below the speed of light in vacuum. At 1 TeV, a proton has a velocity of 99.99996 percent of the speed of light. Though we can add more and more energy to such a proton, it will never reach or exceed the velocity of light. The additional energy effectively makes the proton "heavier," not faster.

Herman White with a particle detector made of plastic scintillating material, which detects charged particles as they pass through a counter.

"What happens when two particles collide at high energy?"

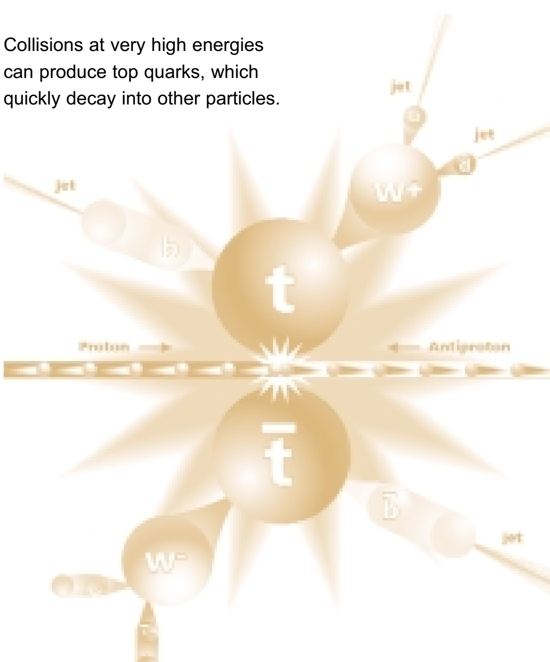
Physicist Herman White,
KTeV and CKM experiments:

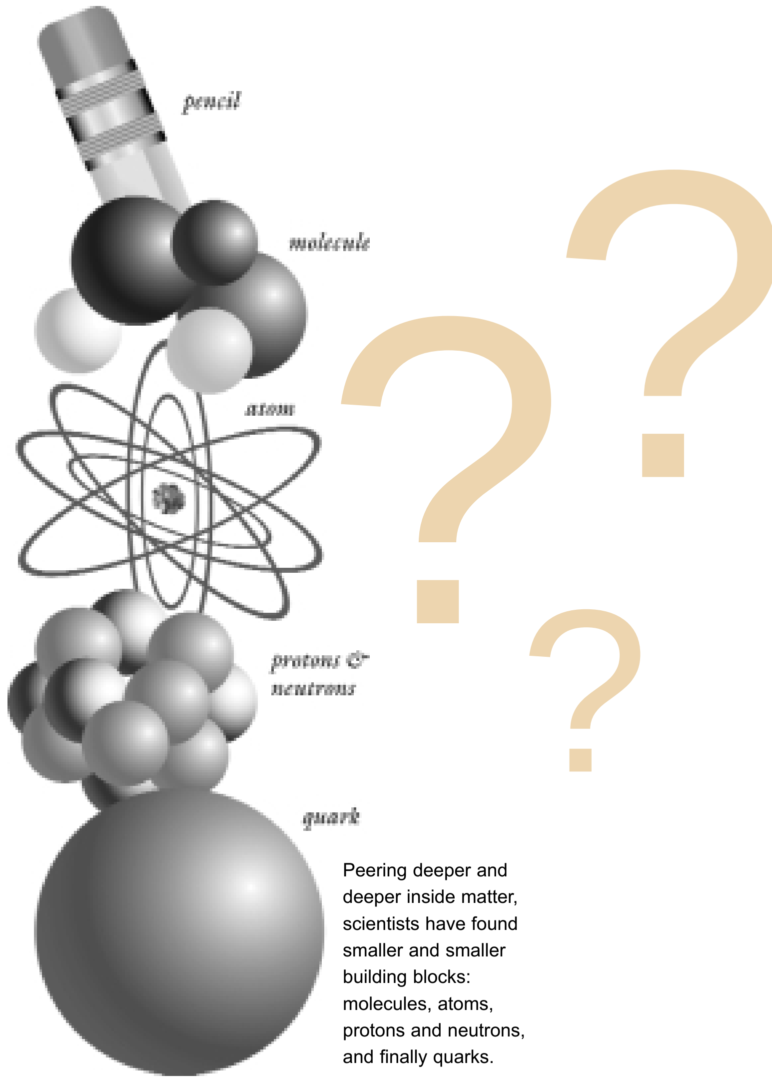
Through a collision we break the forces that bind together the internal components of a particle. Similar to cracking an egg, a collision reveals the inner structure of the particles involved.

By colliding beams of protons with their antiparticles (antiprotons), we are able to reveal the smallest building blocks of matter: quarks. At the very high collision energies reached at Fermilab, the quarks inside a proton are interacting with the quarks inside an antiproton. The violent collision not only annihilates proton and antiproton, but it rearranges their quarks to produce composed particles that do not usually exist. Unlike protons, these new particles only exist for a short period of time and then decay.

Carefully analyzing these particles and their properties, we can deduce the properties of matter at the smallest scale. Thus we learn a great deal about how quarks behave and the fundamental forces of nature.

Collisions at very high energies can produce top quarks, which quickly decay into other particles.





Peering deeper and deeper inside matter, scientists have found smaller and smaller building blocks: molecules, atoms, protons and neutrons, and finally quarks.

"How do you 'see' particle collisions?"

Physicist William Wester,
CDF experiment and ASIC testing lab:

When particles collide, all sorts of particles can get created and can fly out of the collision point. By detecting and making measurements of this emerging "debris," we are able to "see" the particle collisions, which would otherwise be invisible. Consider a collision at the center of the CDF or DZero detector in which top quarks are produced. Each top quark immediately decays into two other particles (a W boson and a b quark), which lead to "jets of particles" and many different particles flying out. The detectors, which we built, are like huge microscopes that surround the collision area. They yield electronic signals that allow us to determine position, path, energy, and sometimes the type of the outgoing particles. Our computer programs put this information together. By using the known laws of physics, we are able to combine groups of the "debris" particles back together to identify the original decay products of each top quark. We are thus able to "see" when a collision produced top quarks.

Photos by Reidar Hahn

William Wester inspecting a silicon wafer containing chips for the MINOS experiment

Scientists provide the answers

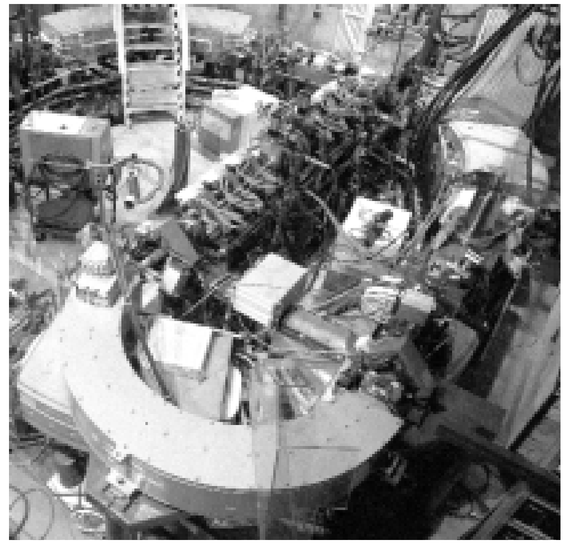


Photo by Fred Ullrich

The Loma Linda University Medical Center uses this proton accelerator, here shown at Fermilab in 1989, to treat cancer patients.

"Why should I care about elementary particle physics? Will I ever benefit from this research?"

Physicist Peter Garbincius, FOCUS experiment and future accelerator studies: I would like to address these questions on three levels: culture, benefits and spin-offs. These are some of the reasons that I think particle physics is both fun and important.

Photo by Jenny Mullins

Peter Garbincius

Cultural aspect:

Mankind has always been driven to try to understand what the universe is all about. Such drives to explore and to understand seem to be at the core of what it is to be human. We want to know what are the building blocks, how they are put together, and how the more complex structures, such as atoms, molecules, cells, organisms, planets, stars, galaxies, and the universe itself, come about and work. In elementary particle physics, we focus on investigating the smallest, most basic structures and the forces that govern their interactions. This quest represents an extension of the series of unending questions, "What's this made of? What's inside of that?" questions asked by both little children and some of the greatest thinkers throughout history.

Benefits from nature:

Basic science, driven by the curiosity of its investigators, has proven its worth time and again by providing the understanding necessary to use nature to benefit mankind. For example, nobody was able to foresee the utility of early investigations of electricity, electromagnetic waves, light, radioactivity, quantum physics, relativity, atoms, or nuclei, but the fruits of those studies are a large part of our standard of living.

Over 150 years ago, Michael Faraday, when asked by his patrons in the British government as to the usefulness of his experiments on electricity replied prophetically, "I do not know, but I am sure that one day you will be able to tax it."

Due to the rapid progress of the physical sciences during the Twentieth Century, we may have come to expect instant returns on research investment. I'll grant that it may be more difficult to readily apply elementary particle physics because of the higher energies and larger machines involved, but who can imagine the possible benefits to future generations from the scientific understanding being gained today?

Technological spin-offs:

Although not our main goal or mission, the tools and technologies developed by the elementary particle physics community have had some spectacularly beneficial applications. Among others, they have led to computerized tomography (CAT scans), neutron (a Fermilab specialty) and proton cancer therapy, superconducting magnets for magnetic resonance imaging (MRI) and the world-wide-web (originally a communication tool for high-energy physicists).

These are my personal thoughts about why we study elementary particle physics. More aspects are given at www.fnal.gov/pub/inquiring/matter/whysupport/

On the Web:

More Q&As online:
www.fnal.gov/pub/inquiring/questions/

Frequently asked questions about Fermilab:
www.fnal.gov/pub/about/faqs/

More basic information on particle physics:
www.fnal.gov/pub/inquiring/matter/
www.particleadventure.org
www.nobel.se/physics/educational/matter/

Fermilab Arts Series Presents:
Trio Voronezh

Saturday, November 10, 2001 - $17 ($9 ages 18 and under)

Trained at the Conservatory in Voronezh, Russia, the trio plays traditional Russian folk instruments: a double-bass balalaika (the three-stringed Russian national instrument with a large triangular body), a domra (a three-stringed short necked ancestor of the mandolin), and a bajan (a chromatic-button accordion). The trio's repertoire ranges from classical works of Bach, Tchaikovsky and Vivaldi to popular songs by Gershwin to Russian folk and gypsy dance music.

Heightened security and cultural events:

Arts & Lecture Series - The general public can still order tickets over the phone (630/840.ARTS), by fax (630-840-5501), or via e-mail (audweb@fnal.gov, but please don't send your charge account number). Due to current security restrictions, outside patrons may not visit the Wilson Hall Atrium box office in person to purchase or pick up tickets in advance of performances. However, the Ramsey Auditorium box office will be open for picking up will-call tickets, and for purchasing tickets when available, on the evening of a performance starting at 7 pm. Employees can still purchase tickets at the Atrium box office for themselves or others. When attending Arts and Lecture series events, the general public may only use the Pine Street entrance on the west side of the site. Employees may use the Batavia Road entrance on the east side. However, those with non-employees in their cars must use the Pine Street entrance. Parking spaces near Wilson Hall and Ramsey Auditorium will be restricted, so patrons will have to walk a little farther to enter the building. There will be handicapped parking drop-off by the northwest, lower-level doors of Wilson Hall. All patrons including employees must exit the laboratory via Pine Street.

Film Society - The Film Society events have been postponed. For up-to-date information about our schedule, phone 630/840-8000.

Art Gallery - The gallery is temporarily closed to non-Fermilab guests.

Folk Dancing - Silk & Thistle Scottish Country Dancing has been moved to the North Aurora Activity Center and will continue to meet on Tuesdays at 7:30 p.m. International Folk Dancing at 8 p.m. on Thursdays has been moved to either the Batavia Park District's East Side Community Center or their Boat Club. For information call 630-584-0825 or 630-840-8194. Barn Dancing has moved to the Warrenville Community Center. For barn dancing info call 630-840-2061.

For the most up-to-date information, please check the Web at www.fnal.gov/culture.

CALENDAR

Website for Fermilab events: http://www.fnal.gov/faw/events.html

NOVEMBER 6, 2001

NALWO invites all Fermilab women (spouses, guests, users, visitors, employees) to a Special Coffee Morning featuring glorious pictures of several US National Parks; 10:30am to 12 Noon in the Music Room of the Users' Center. OFF-SITE NON-EMPLOYEES MUST CALL X3777 TO REGISTER. http://www.fnal.gov/orgs/nalwo/parkpix.html.

ONGOING
NALWO

Free English classes in the Users' Center for FNAL users and their spouses. The schedule is: Monday and Friday, 9:30 a.m. - 11:00 a.m. Separate classes for both beginners and advanced students.

MILESTONES

AWARDED

To Fermilab's Internal Audit Department: the 2001 Commitment to Quality Improvement Award, by the Institute of Internal Auditors. The international award recognizes "an ongoing commitment to improving the quality of internal auditing in the areas of professional excellence, quality of service and professional outreach." The semiannual award was inaugurated in 1999; Fermilab was one of only three internal auditing departments recognized in the June 2001 selections.

RETIRING

Paula Cashin (ID 07127, LS-Benefits), October 31, 2001

DIED

■ John J. McGrath, Director of Public Affairs at Argonne National Laboratory, on Oct. 4 at University of Chicago Hospitals. McGrath, 57, had been undergoing cancer treatment.

■ Thornton Murphy (BD-External Beamlines, ID 02125N), on Friday, Oct. 12 at his home in Batavia. On September 28, Murphy conducted the Fermilab Choir at the commemoration of the 100th anniversary of the birth of Enrico Fermi.

LUNCH SERVED FROM
11:30 A.M. TO 1 P.M.
$10/PERSON

DINNER SERVED AT 7 P.M.
$23/PERSON

Chez Léon MENU

FOR RESERVATIONS, CALL X4512
CAKES FOR SPECIAL OCCASIONS
DIETARY RESTRICTIONS
CONTACT TITA, X3524
HTTP://WWW.FNAL.GOV/FAW/EVENTS/MENUS.HTML

LUNCH
WEDNESDAY, OCTOBER 24

Tandoori Game Hens
Chickpea Salad
Grilled Curried Potatoes and Cauliflower
Crepes with Peaches

DINNER
THURSDAY, OCTOBER 25

Steamed Mussels in Saffron Wine Sauce
Grilled Duck Breast with Wild Mushrooms and Fig Sauce
Wild Rice with Currants and Pine Nuts

LUNCH
WEDNESDAY, OCTOBER 31 (HALLOWEEN)

Black Cat's Delight
Dirty Rice
Devil's Dream

DINNER
THURSDAY, NOVEMBER 1

Curried Pumpkin Soup
Braised Rabbit in Mustard Sauce
Potato Onion Gratin
Brussels Sprouts with Lemon and Bacon
Almond Cake with Citrus Syrup

FERMI NEWS

FERMILAB
A U.S. DEPARTMENT OF ENERGY LABORATORY

Ferminews is published by Fermilab's Office of Public Affairs.
Phone: 630-840-3351

Design and Illustration:
Performance Graphics

Photography:
Fermilab's Visual Media Services

Ferminews Archive at:
http://www.fnal.gov/pub/ferminews/

The deadline for the Friday, November 2, 2001, issue is Tuesday, October 23, 2001. Please send classified ads and story ideas by mail to the Public Affairs Office, MS 206, Fermilab, P.O. Box 500, Batavia, IL 60510, or by e-mail to ferminews@fnal.gov. Letters from readers are welcome. Please include your name and daytime phone number.

Fermilab is operated by Universities Research Association, Inc., under contract with the U.S. Department of Energy.

SI NON VIS IMPRIMI NOLI PATI FIERI
FERMINEWS MCMLXXVIII

CLASSIFIEDS

FOR SALE

■ '97 Pontiac GrandAm-GT, (white), auto, air, all power, CD, mag wheels, really sharp, 60K, $9,000 o.b.o. Call Gerry, 630-892-5083.

■ '97 Dodge Neon Highline: 4-dr sedan, green, 4 cyl, PS, AT, AC, dual air bags, valet remote RF auto-start feature, Jensen CD/cassette stereo, 3-year or 32,000-mile bumper-to-bumper limited warranty, Carfax Clean Title History Guarantee, 59,500 miles. Excellent condition. Sale price range: $5,850 with extended warranty or $5,300 without warranty. Call Dave 630-464-8078 after 5:00 p.m. or find additional information on the web at: www.hort.ws/neon.htm.

■ '95 Plymouth Grand Voyager SE minivan, 120 K, good condition. $5,000 o.b.o. Call Sasha x4440 or 630-262-0987, email shemyakin@fnal.gov.

■ '94 Geo Prizm, auto, pwr steering, dual airbags, a/c, 74K miles, excellent condition. The car was actually made by Toyota. $3,900 o.b.o. Andrea x4494 romanino@fnal.gov.

■ '93 Honda Civic CX (red) 5-speed, cd, mag wheels w/ extra set of wheels and tires for winter, 112k, fantastic condition.$4,800 o.b.o. Call Gerry, 630-892-5083.

■ '92 Mercedes-Benz 300E, sportsline, silver, 123K miles, good condition. Auto, airbag, ABS. Very comfortable. Asking $8,800. meiqin@fnal.gov, call 630-719-9097 or x6765.

■ '90 Plymouth Voyager SE minivan. 94K miles. Hardly any rust. Very reliable. A/C, pwr. dr. locks, tilt, cruise, AM/FM/stereo cassette, maroon. $2,300 or best offer. Call Henry at X8630, page 0141 or e-mail ehenry10@earthlink.net.

■ '89 Plymouth Horizon. 4-door hatchback. Always reliable, burns no oil, solid car. Have maintenance records and mechanic's service manual. 96K miles. $1,500 o.b.o. Call 708-645-1168.

■ '86 Ford Ranger 4x4 super cab XLT pickup. V6 2.9 liter, auto., A/C, PS, tilt wheel, cruise control, AM/FM/cassette, sliding rear window, pickup shell/cap, bed liner, running boards. 147K miles. New water pump, EGR valve pipe, & distributor cap & rotor. Asking $800. Dale Miller x 3875, Dale@fnal.gov.

■ Four P215/60R14 raised-white-letter tires on Ford factory 5-lug aluminum mag wheels. Plenty of tread. Fits Ford Ranger. $125. Contact Mark Shoun, ext #2085, pager #0511 or email shoun@fnal.gov.

■ Car trailer. Steel ramp type deck. Dual axle, 8′ x 14′, 4,000 lbs. GVW, electric brakes with controller, tilt away fender, low mileage. $1,100. Marc, x4189

■ Stuff: Pair of JVC 15″ speakers-$50; SONY 7″ reel-to-reel tape recorder, with 80 tapes $75; 1959 stereo "Rock-Ola" Juke Box, holds, 100- 45 rpm records (records included) $500; Edison Victrola, turn of the century with 50 1/4″ 78 rpm records $500; 4 book cases various sizes $5 each; Royal wide carriage manual typewriter $20; FREE drafting table professional size; wardrobe $20; dry sink $25; 2 drawer wood filing cabinet $20. No reasonable offer refused. Call 630-897-3077 or Kay Campbell x3395.

■ GE electric washer/dryer set, $225, phubbard@fnal.gov, x6302

■ Sewing machine w/ 4-drawer desk, Brother Pacesetter model XL711 (c. 1972). Needs oiling. Includes many spools of thread, bobbins, needles, and more (sorry no instruction booklet), $75.

■ Yellow wave slide for child's play fort, used, $10. Contact Bob x4700, brooker@fnal.gov.

■ Gas stove $20; volleyball set $10; broadcast seeder $10; canning pot $5; Weber outside fireplace $10; 20# CO_2 tank $70; 3 stainless steel serving trays w/racks $10. Greg 630-557-2523 / ext. 3011.

■ Mustek-Paragon 600Pro Scanner Compatible with Macintosh or PC/AT - 300x600 dpi resolution Original box, instructions and floppys with the drive. $45 o.b.o. Alma 630-879-3809.

■ 2 nearly new (outgrown) Kelty Jr. Tioga backpacks with frames; suitable for ages 10 to 15 or small adult—$50 each; and 2 gently used Moonstone sleeping bags, excellent condition, full size, suitable to 28F—$50 each; contact Sue, x5059 or mendel@fnal.gov

■ Harley-Davidson leather jacket, size large, never used, paid $600, asking $300. call Bert X-3825.

■ Sofa and loveseat. $300 o.b.o. Call Susan at x3620 or smeduga@fnal.gov.

■ Cleaning Service, professional, insured, residential or commercial, reasonable rates. Teri's Cleaning Service, 630-820-0564.

■ Southwest Airlines round trip travel voucher. Transferable.Valid through Nov 3, 2001. Call ext. 6288 to make an offer.

FOR RENT

■ 2 rooms in a 4-BR, 2-BA townhouse. 10 minutes from Fermilab, short walk to West Chicago Metra, large living room and kitchen, furnished basement. $243.75/each + util. Sublease available for Nov. 1 to June 1, possible renewal. Call 876-8787 or email sondra@fnal.gov

SERVICES

■ Furniture refinishing and restoration. Pick-up and delivery service available. 815-695-5460.

WANTED

■ Tree seeds: Bur Oak, Red Oak, White Oak, Shagbark Hickory, Bitternut Hickory for Fermilab's Roads and Grounds Department to plant. The seeds should be separated by species, dried and kept cool. Drop seeds off at Road and Grounds or call Bob Lootens x3303 for a pickup. The donated seeds from last year are growing beautifully.

LABNOTES

Smoke Alarm Reminder: "Change your clock, change your batteries"

Fermilab Fire Chief Jack Steinhoff has this reminder: On October 27, when you turn back your clocks, take the time to install new batteries in your smoke detectors. Then push the test button to make sure the alarm sounds. A smoke detector cuts your risk in half if there's a fire in your home—but the smoke detector must be working. Batteries last about a year. Check your smoke detectors monthly, using the test button. Make it a family event, and discuss your escape plans. Use a wooden broom handle, if you can't reach the test button easily. Batteries are cheap, but your family is priceless.

August Mier Collection on Display

The August Mier collection of Native American weapons, tools and artifacts, previously displayed on the 15th floor of Wilson Hall, is currently on loan to the Lizzadro Museum of Lapidary Art in Elmhurst, Illinois. The Mier collection is part of a special exhibit, "Prehistoric Stone Weapons and Tools in Illinois," running through December 30. For more information, contact the Lizzadro Museum, Wilder Park, 220 Cottage Hill, Elmhurst, IL 60216; telephone 630-833-1616, or visit the Web at www.lizzadromuseum.org

http://www.fnal.gov/pub/ferminews/

F E R M I L A B
A U.S. DEPARTMENT OF ENERGY LABORATORY

Office of Public Affairs
P.O. Box 500, Batavia, IL 60510

First-Class Mail
U.S. Postage
PAID
Bartlett, IL
Permit No. 125