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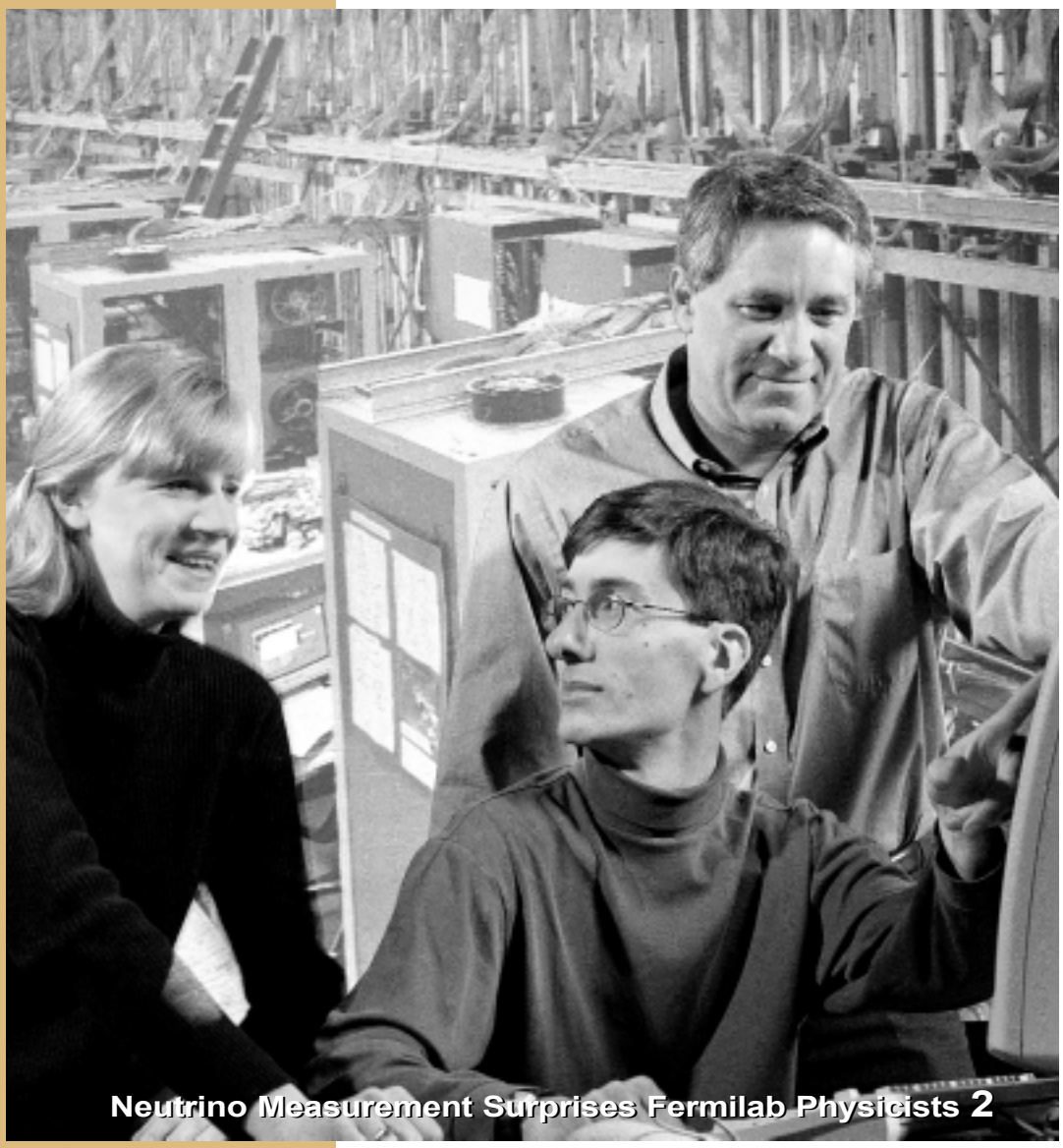

Neutrino Measurement Surprises Fermilab Physicists 2

Photo by Reidar Hahn

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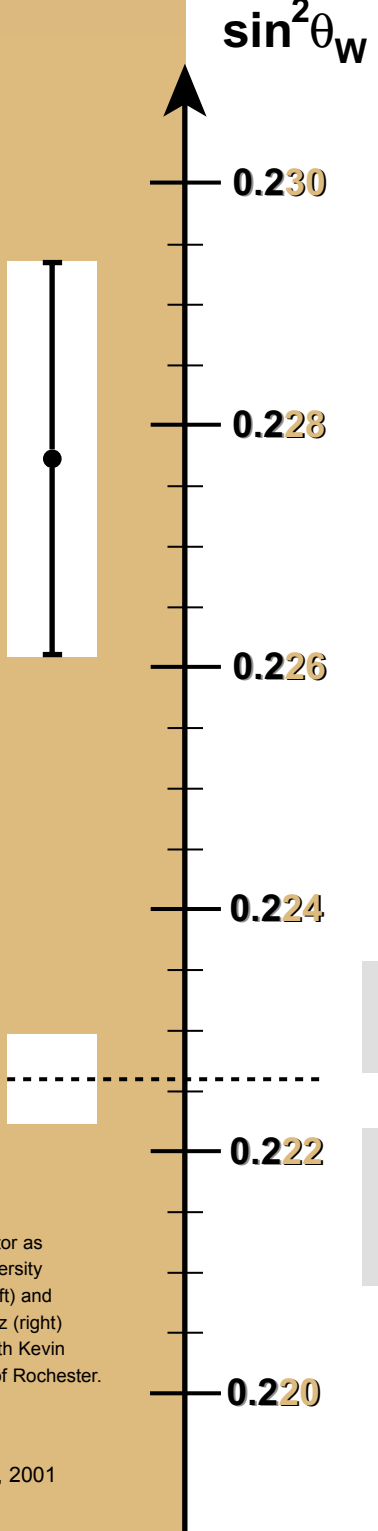
INSIDE:

Neutrino Measurement SURPRISES

Fermilab Physicists

by Judy Jackson



Precise measurements for other particles, including force-carrying bosons, quarks, electrons and muons, led to predictions for $\sin^2\theta_W$ for neutrinos. NuTeV experimenters, however, found a result that differed significantly from the predicted value.

COVER: With the NuTeV detector as background, Northwestern University graduate student Sam Zeller (left) and Fermilab physicist Mike Shaevitz (right) review the new NuTeV result with Kevin McFarland from the University of Rochester.

Scientists at Fermilab have found a surprising discrepancy between predictions for the behavior of neutrinos and the way the subatomic particles actually behave. Although the difference is tiny, it is the kind of inconsistency that makes the hair stand up on the back of a physicist's neck, because of its potentially far-reaching implications.

Experimenters at Fermilab's NuTeV (Neutrinos at the Tevatron) experiment measured the ratio of two types of particles—neutrinos and muons—emerging from high-energy collisions of neutrinos with target nuclei. The results of generations of particle experiments with other particles have yielded precise predictions for the value of this ratio, which characterizes the interactions of particles with the weak force, one of the four fundamental forces of nature. For other elementary particles, including the quarks and electrons of ordinary matter, the predictions seem to hold true. But, to the NuTeV experimenters' surprise, when they looked at neutrinos with comparable precision, neutrinos did not appear to fall into line with expectations.

"We looked at a quantity that physicists call 'sine squared theta W,'" said NuTeV physicist Sam Zeller, a graduate student from Northwestern University. "It tells us the strength of the interaction of neutrinos with the Z boson, one of the carriers of the weak force. The predicted value was 0.2227. The value we found was 0.2277, a difference of 0.0050.

Photo by Fred Ullrich

Members of the NuTeV collaboration, shown here in 1996 with their detector. NuTeV includes scientists from the University of Cincinnati, Columbia University, Fermilab, Kansas State University, Northwestern University, the University of Oregon, the University of Pittsburgh and the University of Rochester.

"It might not sound like much, but the room full of physicists fell silent when we first revealed the result."

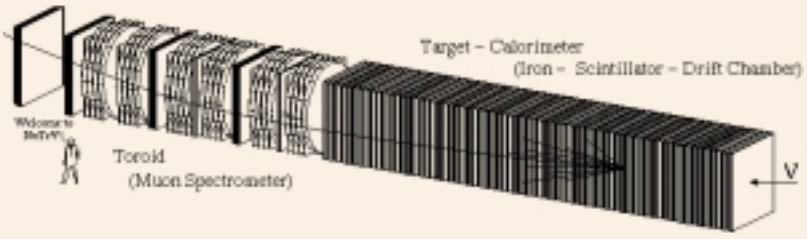
The NuTeV result gets physicists' attention because it doesn't quite fit the Standard Model, the very precise theoretical picture that physicists have developed to explain fundamental particles and forces and their interactions. In particle physics, such "misfit" results are often the harbinger of new particles, new forces and new ways of seeing nature. The experimenters reported a three-sigma discrepancy in $\sin^2\theta_W$, which translates to a 99.75 percent probability that the neutrinos are not behaving like other particles.

"Our picture of matter has held true for thirty years of experimental results," said Fermilab Associate Director Michael Shaevitz, a NuTeV co-spokesperson. "With the NuTeV result, it's possible we may have stumbled across a crack in the model. As yet, we don't know the explanation, but we believe it may foreshadow discoveries just ahead at accelerator laboratories."

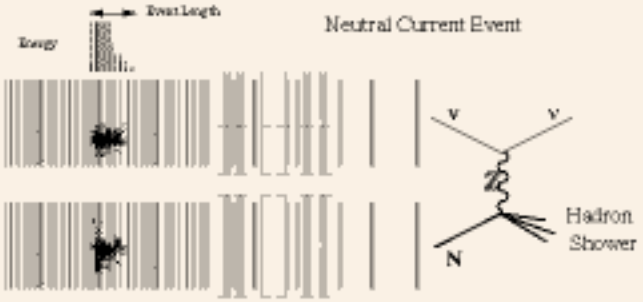
NuTeV collaborator Kevin McFarland, assistant professor of physics at the University of Rochester, emphasized that the NuTeV measurement would not be so striking if the experiment had not achieved an extraordinary level of precision, unprecedented for a neutrino experiment of its kind.

The Measurement

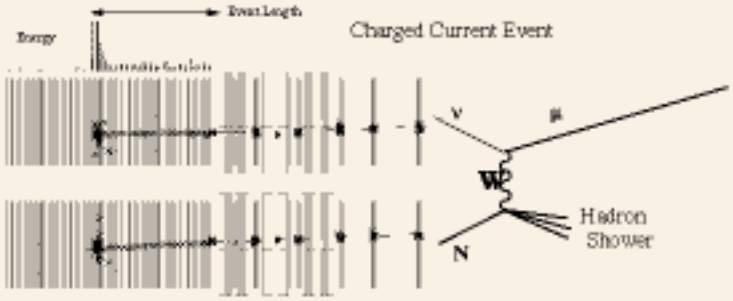
The NuTeV detector was a 700-ton sandwich with over a hundred slices of alternating steel and particle detectors. Even with 700 tons of target material to hit, only one in a billion neutrinos in the NuTeV beam interacted as it went from the first to the last slice.



Neutral Current Event
(A neutrino collides with a nucleus and stays a neutrino.)



Charged Current Event
(A neutrino collides with a nucleus and turns into a muon.)



The NuTeV detector can see neutrinos because, on their way through the sandwich, they slam into a nucleus and break it apart. After the collision, the neutrino may stay a neutrino or turn into a muon. A muon is a heavy cousin to the electron. The surface of the earth is constantly bathed in muons that rain down from cosmic rays. Experimenters can easily observe muons, but hardly ever see neutrinos.

When NuTeV experimenters see a nucleus break up, they know a neutrino has interacted. If they see a particle leaving the scene, it's a muon. If they see nothing leaving, they know that a neutrino has come and gone. Experimenters count the number of times that the neutrino stays a neutrino and the number of times it changes into a muon. The ratio of these numbers is very accurately predicted from our theories of the universe, which have been verified to a part per thousand accuracy in the interactions of particles other than neutrinos.

"Because we examined the interactions of millions of neutrinos and antineutrinos, their antimatter counterparts," McFarland said, "we determined that there is only a one in four hundred chance that our measurement is consistent with the prediction. Unless this is a statistical fluke—and we don't think it is—it looks as if neutrinos may really behave differently from other fundamental particles. Further, experimenters using the Large Electron Positron at CERN, the European Particle Physics Laboratory, recently measured this same neutrino interaction in a different particle reaction. They saw the same discrepancy we found, although with less precision. The consistency between these two very different measurements is striking."

The elusive neutrinos carry no electric charge and "feel" only the weak force, which is a hundred times weaker than the electromagnetic force. As a result, neutrinos rarely interact with each other or with other particles, making them extremely hard to detect. Physicists designed the NuTeV experiment in order to observe the interactions of millions of the highest-energy, highest-intensity neutrinos ever produced. Starting with a proton beam from Fermilab's Tevatron, the world's highest-energy particle accelerator, experimenters created a beam of neutrinos directed at a giant particle detector. The detector itself was a 700-ton sandwich of alternating slices of steel and detector. As the beam passed from the first to the last slice, one in a billion neutrinos collided with a target nucleus, breaking it apart.

After the collision with a nucleus, the neutrino could either remain a neutrino or turn into a muon, a particle that is a heavier cousin of the electron. When NuTeV experimenters saw a nucleus break up, they knew a neutrino had interacted. If they saw a particle leaving the scene of the collision, they knew it was a muon. If they saw nothing leaving, they knew a neutrino (invisible to the detector's "eye") had come and gone. The NuTeV scientists measured the ratio of muons to neutrinos and compared it with the predicted values, which other experiments have verified to a part per thousand accuracy. A painstaking years-long analysis of the NuTeV data revealed the unexpected discrepancy.

The 45-member NuTeV collaboration—small on the scale of today's particle physics experiments—operated for 15 months in 1996 and 1997. Rochester's McFarland presented the measurement at an October 26 seminar at Fermilab. The collaboration has submitted the

SURPRISES Fermilab Physicists

results to Physical Review Letters for publication. The collaboration included physicists from the University of Cincinnati, Columbia University, Fermilab, Kansas State University, Northwestern University, the University of Oregon, the University of Pittsburgh and the University of Rochester. The research was supported by the National Science Foundation, the U.S. Department of Energy and the Alfred P. Sloan Foundation.

"This wouldn't be the first time that neutrinos have surprised us," said Northwestern's Zeller, noting recent evidence for a small mass in the ghostly particles found by the millions in every gallon of space in the universe. "Their pervasive presence in the world around us means that even very subtle properties of neutrinos have profound implications for the way the universe works."

On the Web:

NuTeV Electroweak Page
www.pas.rochester.edu/~ksmcf/NuTeV/

Photo by Reidar Hahn

Fermilab physicist and NuTeV cospokesman Bob Bernstein with the NuTev detector, a 700-ton sandwich of steel, scintillator and drift chambers.

The Central Utility Building, surrounded by the Booster ring, is vital to both cooling of accelerator equipment and controlling the temperature of buildings such as Wilson Hall. With the help of the Utility Incentive Program, Fermilab has modernized the 30-year-old CUB infrastructure in an energy-efficient way.

READY for Years to Come

New Equipment Saves Energy and Money

by Kurt Riesselmann

Thirty years is a long life for any piece of equipment. Hot water heaters fail before reaching that age. Furnaces are ready for the junkyard even sooner. And your refrigerator? Well, little chance that it will last that long.

Fermilab turned 30 a few years ago. Founded in 1967, the lab has dealt with its share of failing equipment for both its experiments and office buildings.

Aging cooling and heating equipment are among the elements that have caused problems at Fermilab. The electrical feeders, now delivering an average power supply of 45 megawatts, are another example. In the past few years, the lab has recorded about 30 feeder faults per year. Each incident costs the lab about thirty to fifty thousand dollars to fix and each one has the potential to interrupt the lab's scientific program.

"The lab has lasted more than thirty years," said Randy Ortgiesen, head of the Infrastructure Management Group of Fermilab's Facilities Engineering Services Section. "During this time, our science program has significantly progressed, but the infrastructure hasn't. We cannot do another thirty years of science without improving the infrastructure. "

Photo by Reidar Hahn

In 1999, Steve Krstulovich, here standing inside the Central Utility Building, received a DOE award for initiating "energy efficiency projects with alternative financing mechanisms." Since then he and his colleagues have significantly expanded the UIP program at Fermilab.

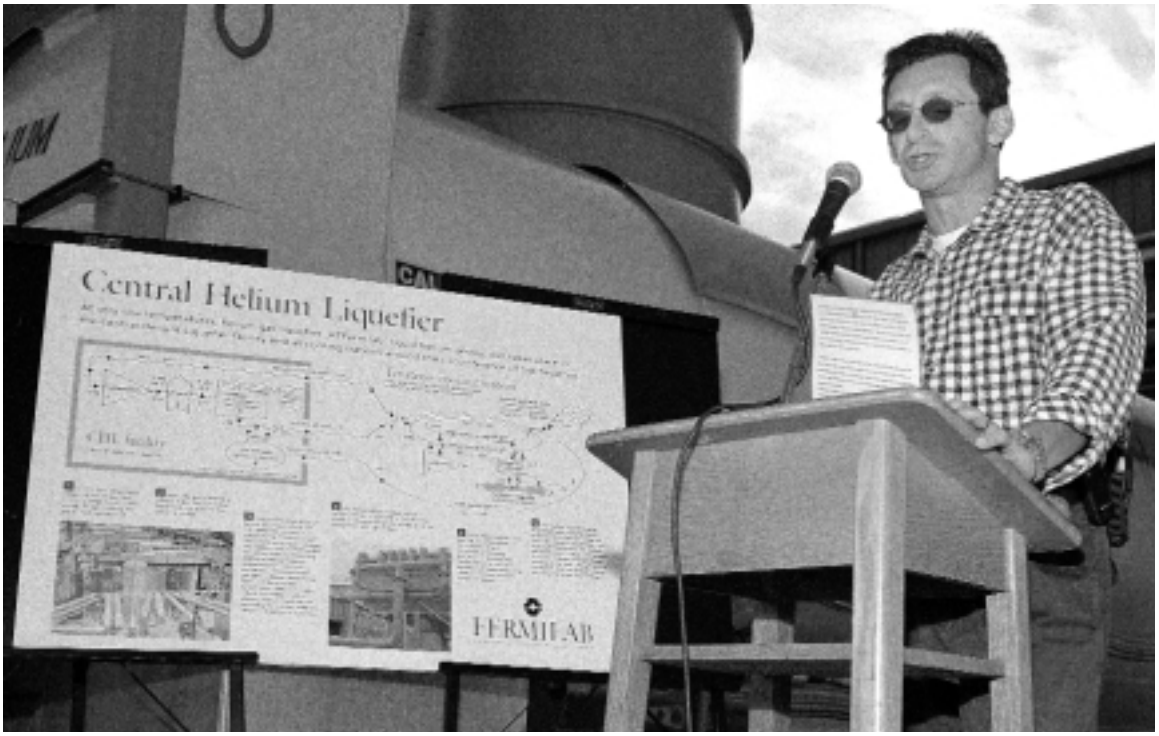


Photo by Reidar Hahn

At the dedication ceremony for "Compressor C" project leader Mike Geynisman summarized the energy savings that the new system will achieve. The compressor will save about one megawatt, enough to power 200 homes around the clock.

Innovative Funding Strategy

Fermilab officials recognized the increasing number of problems many years ago, but tight budgets provided little money to tackle the problems. Comprehensive plans like upgrading the Central Utility Building, which promised significant savings in lowered electrical bills, remained on hold as the lab struggled to find initial funding. A solution arose when FESS engineer Steve Krstulovich discovered the Utility Incentive Program. With the help of Associate Director George Robertson, who had experience with similar programs before joining Fermilab, he implemented UIP at Fermilab.

"UIP presents an alternative funding vehicle for energy efficiency programs and can rebuild critical infrastructure," explained Krstulovich, who manages the UIP program at Fermilab. "It allows labs to work with their utility companies to identify projects that will pay for themselves in less than ten years."

Under the UIP program, utility companies provide the initial funding. Reduced utility bills and other saved costs then allow laboratories to pay for the projects over a 10-year period or less. After this period the labs begin to realize real savings since most of the new equipment has 20- to 30-year life cycles.

Using established DOE protocols, UIP participants validate and verify the savings of each project, taking into account changes in lab operations, building functions, number of employees and other elements.

Early on, David Nevin, head of FESS, saw the positive impact that UIP could have. Working with the local DOE office and the lab directorate, he assembled a site-wide audit of all infrastructure needs at Fermilab. Based on the results, he developed the first reinvestment plans.

Managers of DOE's Federal Energy Management Program provided support for UIP at Fermilab. With help from DOE's Fermi Area Office, they have reviewed each UIP project proposal and contract.

"Replacement of the chillers at the Central Utility Building was the first UIP project at Fermilab," recalled Ortgiesen. "It cost three and a half million dollars and has led to savings of almost one million dollars per year."

Thanks to UIP, engineers replaced old equipment and designed a more reliable and energy efficient system. They separated the old centralized cooling system into two segments: a "comfort system" to cool buildings and office space, and a "process system" to cool accelerator equipment. The system, which has a cooling capacity equivalent to that of about 1,500 homes, uses 40 percent less energy and is free of ozone-depleting chlorofluorocarbons (CFCs). If necessary, the new system allows for shifting cooling capacity from the comfort system to the process system, increasing cooling reliability and redundancy for accelerator operations.

READY for Years to Come

New Equipment Saves Energy and Money

Photo by Reidar Hahn

Nicor's Dan Dodge, Vice President for Business Development, joined Fermilab Director Michael Witherell for a ribbon-cutting ceremony on September 26 for the new energy-saving compressor at the Central Helium Liquefier facility.

Model for other projects

The chiller project, which gained Krstulovich a DOE award in 1999, worked so well that the lab decided to use the UIP approach site-wide. As a first step, Fermilab provided utility companies access to its facilities.

"The two utilities, Nicor and ComEd, spent six months at Fermilab reviewing our infrastructure," Krstulovich said. "They gave us a list of one hundred projects. Next, we encouraged them to think outside the box: 'Can we combine projects and eliminate work?' Eventually, we saved millions of dollars by doing several things at once. UIP has allowed us to invest 60 million dollars."

Fermilab has assumed a leadership role in successfully implementing the UIP program. Work at Fermilab accounts for more than one-third of the 170 million dollars spent on UIP projects at all DOE facilities. The Department of Energy has recognized the model character of Fermilab's approach by giving the lab the 2001 DOE Management Award for its Utility Incentive Program.

Key projects near completion

During the last three years the UIP program at Fermilab has made significant progress in providing reliable infrastructure that matches the demands of Collider Run II and other scientific projects.

"We have made improvements to three of the most vulnerable pieces of infrastructure at Fermilab: the electrical power feeders, the Central Utility Building and the Feynman Computing Center," Ortgiesen explained. "We have achieved significant energy savings, lowered the need for maintenance and repairs, and increased the robustness of the infrastructure for science. The UIP is at a peak right now."

The Central Utility Building, for example, will receive improvements worth 6.5 million dollars, on top of the chiller project. The additional upgrades include the installation of new cooling towers and complete rebuilding of the controls and electric systems. Work started in March and is expected to be complete by summer of 2002.

"We coordinated the work to make minimal impact on accelerator operations," said Ortgiesen. "A lot of work is scheduled during the present shutdown of the accelerators. We have up to seventy people working on the CUB during the shutdown."

The UIP program also included work at the Feynman Computing Center. The installation of a new power supply unit minimizes fluctuations in electrical voltage, protecting the Center's computer systems. The new unit also features a backup power generator, making the power supply virtually non-interruptible. Ortgiesen expects the project to be complete before the end of the year.

Keeping things cool

Major upgrades have also taken place at Fermilab's Central Helium Liquefier. The largest facility of its kind in the world, CHL produces liquid helium with a temperature of –452 degrees Fahrenheit to cool 1,000 superconducting magnets inside the Tevatron accelerator, the world's highest-energy particle accelerator. The CHL facility has seen upgrades worth more than four million dollars in the last four years to meet the increased cooling demands of Collider Run II. The latest project, the installation of a new compressor and cooling tower,

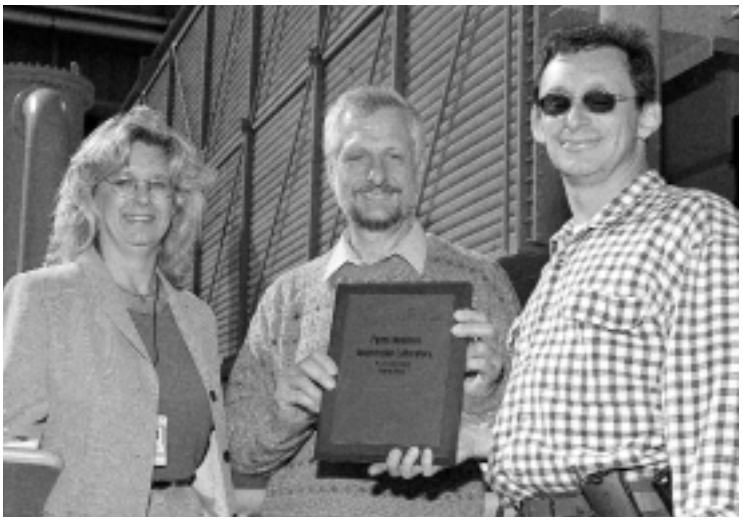


Photo by Reidar Hahn

Sharon Gill (left), director of the Chicago Regional FEMP Office, presented Fermilab's CHL facility with the DOE Energy Saver Showcase Award. Steve Krstulovich (center) and Michael Geynisman accepted the award on behalf of the laboratory.

critical elements of the CHL system, will allow operators to reduce power consumption by one megawatt.

"The energy we are saving is enough to power four middle schools or two hundred households around the clock," said Michael Geynisman. He led the one-million-dollar Compressor C project, which is expected to pay for itself within three years.

Geynisman was one of the speakers at a ribbon-cutting ceremony on September 26, marking the official dedication of the new compressor and tower. At the event, Fermilab director Michael Witherell praised the cooperation between the utility companies and the laboratory.

"This is a win-win situation," he said. "We rely on the local industry in many ways. Projects like this one provide our lab with high efficiency and high reliability as we are preparing for a long future ahead of us."

Geynisman praised the excellent cooperation between the utility company, DOE, various Fermilab divisions and the sub-contractors carrying out the installation. Despite unusually harsh winter conditions, workers completed the project within a very tight schedule.

The Department of Energy has recognized the CHL upgrade and its implementation as a model for other laboratories around the country. It named the Central Helium Liquefier an Energy Saver Showcase Facility. It is the second Showcase Award for Fermilab. The Feynman Computing Center received the award in 1996 for its innovative energy conservation design.

More work ahead

The UIP program has allowed the lab to address some of the most urgent needs.

"We have taken on the highest infrastructure vulnerabilities, but there is still a lot of work to be done," said Ortgiesen. "Unfortunately, the UIP program is not fixing everything. The industrial and domestic water systems, for example, offer limited saving opportunities and are difficult to bring into the program. "

The UIP program has allowed the bundling of projects to use savings related to one system to pay for other infrastructure improvements that are critical to future operations. This approach resulted in, for example, a robust power grid with new electrical feeders and added redundancy. Guest scientists have benefited from the UIP program as it has been used to replace old water pipes, providing higher-quality domestic water in the Fermilab village. Even the Wilson Hall kitchen, which is used to prepare meals for more than a thousand people every day, will see improvements. The first phase of a retrofit is currently under way.

On October 16, Fermilab received a DOE Award in recognition of its outstanding energy management, citing its implementation of the Utility Incentive Program.

"By necessity, this will become the way to do business for other federal laboratories as well," Ortgiesen said. "The UIP program has provided a much-needed boost to our lab's infrastructure. It is a huge step in meeting the needs of the laboratory today and helps position the lab for involvement in future science opportunities."

Photo by Reidar Hahn

The recent installation of a new backup power supply at the Feynman Computing Center has made data acquisition and computer services more reliable.

On the Web:

FESS Infrastructure Management Group
www-fess.fnal.gov/IMG/IMGhome.htm

Federal Energy Management Program
www.eren.doe.gov/femp/

Federal Energy Saver Showcases
www.eren.doe.gov/femp/prodtech/fed_showcase.htm

The Central Utility Building Upgrade
www.eren.doe.gov/femp/utility/fermilab.html

FROGS Come A-Countin'

Survey offers environmental clues along with numbers

by Rod Walton
Fermilab Facilities Engineering Services Section

Walking around the Fermilab site in the evening in early Spring, you may have heard the chorus of spring peepers or chorus frogs. Later, on a warm summer night, a fat bullfrog may have serenaded you with his deep "jug-a-rum," or you may have heard his ugly cousin, the American toad with his long and loud trill. (Yes, "his" is the correct pronoun; only males call). Frogs and toads are ubiquitous at Fermilab, owing to our abundant ponds and wetland areas, but they are not particularly noticeable except through their calls. In fact, they aren't much more visible to prospective mates, which is why they call in the first place. Gathering in lakes, ponds and wetlands in the spring and early summer, males call relentlessly to attract females.

They also attract large numbers of amateur herpetologists, interested in documenting how many and what kinds of frogs there are in an area. Chicago Wilderness, a regional consortium of scientific and land management organizations in northeastern Illinois, has been conducting a survey of calling frogs for the past two years. A calling frog survey is a fairly simple endeavor. Volunteer participants only need to be able to identify the calls of the eleven or so species of frogs and toads that occur in the region. Then they go out on certain nights to listen for frogs and record their observations.

Bullfrog

Aside from satisfying the naturalist's inborn curiosity, this kind of basic data is crucial as a long term, regional baseline of frog distribution and abundance. Frogs are particularly susceptible to environmental stresses, because they typically live part of their lives in aquatic, and part in terrestrial habitats. Additionally, frogs exchange gases directly with the air through their skin, so they tend to have a maximum amount of surface area exposed to contaminants. Beginning in the early 1980's, biologists realized that amphibians like frogs are extremely sensitive to environmental stresses. Declines in amphibian numbers and increases in deformed anatomy have led scientists to investigate the affect of habitat loss, increased ultraviolet radiation (due to ozone depletion) and chemical pollution on frog populations. For example, Blanchard's cricket frog was the most common amphibian in Illinois in the 1960's. However, today it has nearly disappeared

On the Web:

Chicago Wilderness
www.chicagowilderness.org

Chicago Wilderness Calling Frog Survey
www.habitatproject.org/frogs/SurveyInfo.htm

Frogs of Fermilab
www-ed.fnal.gov/projects/frogs/

Photo by Reidar Hahn

Ecologist Rod Walton of FESS collects data for the frog survey.

from the northern third of Illinois, for as-yet-unknown reasons. To address the needs of amphibians in a region, naturalists first must know their distribution as the first step in assessing the population status of a given species.

Of the 11 species in the Chicago Wilderness area, only eight are commonly found at Fermilab. During three specified periods from spring into late summer, volunteers pack up clipboards, flashlights and thermometers and head to listening spots to hear how many and what species of frogs are there. Some of the areas are temporary vernal pools in the woods, while others are permanent large water bodies, like Lake Logo in the middle of the Tevatron ring. Air temperature, wind and cloud cover are all factors that can affect the calling frogs, so careful observations are made at each spot, then qualitative estimates of the numbers of individuals and species are recorded over a five-minute period. These data are then entered into the Chicago Wilderness Herpetological Atlas, which will show which species occur where in the region. This information is passed on to landowners and appropriate governmental agencies, such as county forest preserve districts, to aid in land management.

Fermilab is an almost perfect spot to conduct frog surveys because of its size and the nearly natural setting. Frog populations on this site are subjected to fewer of the stresses that are present in more congested urban and suburban settings, even in forest preserves and parks. Fermilab's frog populations are situated in a more nearly functional ecosystem, complete with a suite of predators, many types of acceptable habitat and abundant food.

Volunteering to help monitor Fermilab's frog population for Chicago Wilderness is easy. Contact Rod Walton at extension 2565 or rwalton@fnal.gov and sign up! Then, next spring, after a short training course, you can begin collecting data.

NSF Grant Triggers WIDE Computing Possibilities From BTeV

by Mike Perricone

Everybody talks about crashing computers, but nobody does anything about them.

Now, with a $4.98 million National Science Foundation grant in the area of Information Technology Research, Fermilab's B-physics at the Tevatron experiment (BTeV) just might help solve the puzzle of "Why don't things work as well as we'd like?"

That question represents the theme for educational outreach components of the effort to build a fault tolerance system into the BTeV trigger and data acquisition project. BTeV's goal is assembling as many as 10,000 parallel computers and making them work together dependably and consistently in the triggering and data-acquisition system—despite incorporating different kinds of computers with different tasks. The BTeV trigger will be challenged to reconstruct 15 million particle events per second, and to use that reconstruction data in deciding which events to keep for further analysis. It will be further challenged to perform the reconstructions around the clock —while spotting and correcting any problems that arise.

The idea of self-awareness or introspection in computers is not new. But the idea of achieving "fault tolerance" or self-correction at this level of complexity is both new and intriguing.

"People have written fault tolerant systems for smaller numbers of computers, on the order of hundreds," said BTeV cospokesperson Joel Butler. "But when you get to the ambitious level we're working at, with perhaps 10,000 computers, those ideas do not scale up. You can't just change the number of processors and have it all work out… In this very self-aware computing system, the software will be expected to solve problems from the level of the smallest processor in the system all the way up to the level of whether the whole thing is behaving as expected."

Imagine the possibilities.

"This is a very hot topic in electrical engineering and computer science right now, this concept of evolvability and fault tolerance " said BTeV collaborator Paul Sheldon of Vanderbilt University, the computing project's principal investigator. "With thousands of components, you'll always have something going wrong, somewhere. You want a system to be able to adapt to a fault because if it doesn't, you'll crash or miss something critically important. Fault tolerance is useful in complex systems such as weather monitoring. Or in vehicle navigation where you can literally crash. Think of the country's air traffic control system, which is really old and can't be easily upgraded.

Photo by Reidar Hahn

BTeV cospokesperson Joel Butler surveyed construction work on the CZero experimental hall in 1998.

On the Web:

National Science Foundation
www.nsf.org

The BTeV Trigger Movie
www-ppd.fnal.gov/btev-trigger-w/presentations/Animated_trigger/

We try these things in science first—to make them work without the agony. Technology like this eventually percolates down, and hopefully it will someday make your own computer crash less often."

Both the technology and the thinking will also percolate beyond Fermilab, beyond the four collaborating universities (Vanderbilt, the University of Illinois, Pittsburgh and Syracuse), and beyond the graduate students who will be working on the project.

Adapting the QuarkNet model established by Fermilab's Education Department, the BTeV trigger computing project aims to involve high school teachers. The QuarkNet method trains high school teachers to train other teachers, as well as connecting students through the World Wide Web to ongoing particle physics experiments. The BTeV educational adaptation would include exercises in the concepts of exception handling and fault tolerance—in other words, how to work around glitches without an entire structure coming apart, in day-to-day applications.

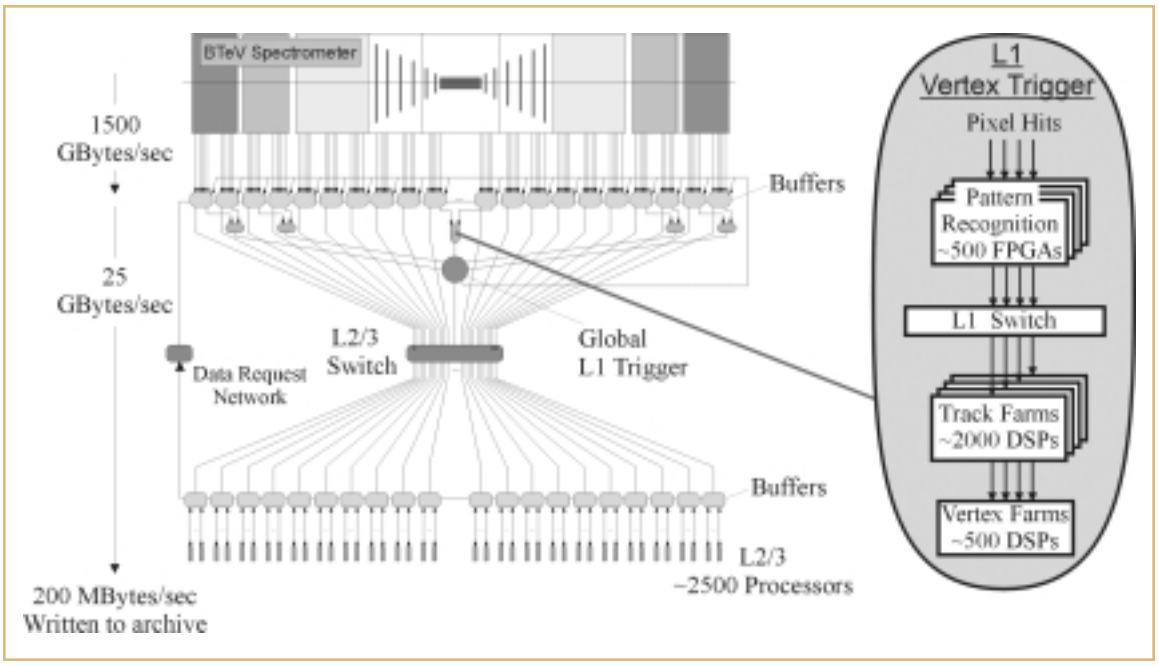
Finding the underlying connections of a system is a basic tenet of science: the need for a methodical way of thinking, of exploring the consequences when things go wrong, of devising plans to correct or work around those consequences.

The NSF grant includes funding for educational programs to teach this scientific approach.

"It's an important part of scientific literacy for the general public," said Marge Bardeen, head of Fermilab's Education Department. "Having been through an experience of how science works, people would gain a better understanding of basic research and see its value. They would gain a better understanding of how to make careful and responsible decisions about science, about funding and other issues. Also, we don't often teach science as an experimental, research-based, kid-centered discipline. We don't often teach science the way science is done. First, how do we help teachers understand how scientists work; and second, how do we figure out how to do that in a classroom? That's what QuarkNet tries to do, and that's what the BTeV group will try to do."

Photo by Reidar Hahn

Fermilab's Marge Bardeen, Education Department head.



Graphic courtesy of BTeV

This schematic of the BTeV Trigger and Data Acquisition System shows, on the left side, the detector, buffer memories and the Level 1, Level 2 and Level 3 clusters with their interconnects. The right side shows a blowup of the Level 1 Vertex trigger. The trigger system will reconstruct every bunch crossing of the Tevatron—bunch crossings occur at 7.6 million per second, or 132 nanoseconds apart. The data system will attempt to find all the tracks and all interaction vertices, looking for evidence that there is a decay downstream of the interaction vertex, which could come from a *b* particle. While the processors can work on events for a long time, the trigger system must make a decision at an average rate of once every 132 nanoseconds. It saves all the data from every crossing in a massive memory buffer (of a size on the order of a few terabytes), giving itself time to "think" about which events to keep and which to flush out of the memory. Field Programmable Gate Arrays find track segments in the pixel vertex detector. The track segments are switched through to a farm of Digital Signal Processors (similar to the chips in cell phones) for reconstructing particle trajectories, followed by a second farm of DSPs to reconstruct vertices.

NSF Grant Triggers WIDE Computing Possibilities From BTeV

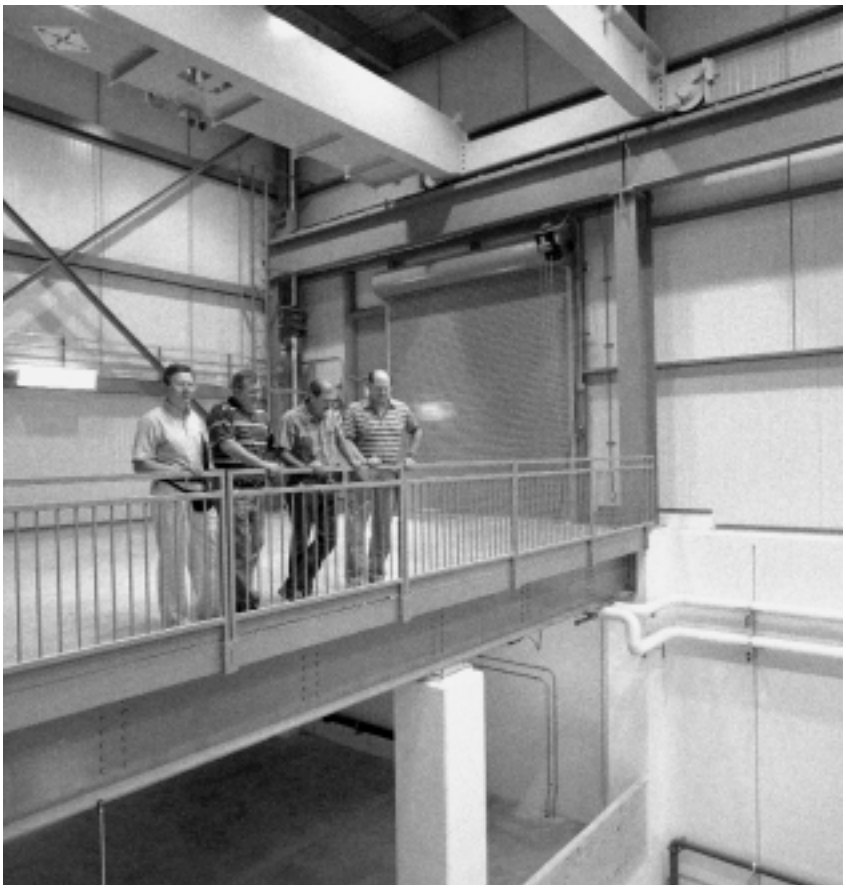


Photo by Reidar Hahn

Completed a year ago, the CZero experimental hall will be home to BTeV and other experiments. Looking over the finished product are (from left) CZero project manager Peter Garbincius, and engineers Tom Lackowski, Ron Foutch and Paul Lahn.

The BTeV trigger system (see graphics on page 13) distinguishes itself by essentially merging with the experiment, assuming the role of part of the apparatus. The trigger system will reconstruct every bunch crossing of the Tevatron—bunch crossings occur at 7.6 million per second, or 132 nano seconds apart. The data system will attempt to find all the tracks and interaction vertices, looking for evidence that there is a decay downstream of the interaction vertex that could come from a *b* particle. Then it thinks about which events to keep and which to discard.

"The trigger must work reliably and quickly, over a long period of time," said Fermilab physicist Erik Gottschalk, who has worked on designing the trigger system. "This process is not being done off-line. It's integral to the experiment itself instead of being a step removed, as it would if it were being handled off-line. If it fails, it affects the data. Everything counts on the trigger."

And that trigger will count on the fault-tolerance software developed with the help of the NSF grant, approximately $1 million per year for five years, already effective as of October 1. BTeV applied for the grant after a Fermilab technical review of the experiment proposal suggested strengthening the fault-tolerance aspects of the system. Collaborators reached out to people at their own institutions who were conducting this kind of research—the Institute for Software Integrated Systems at Vanderbilt, the Coordinated Sciences Lab at the University of Illinois, the Fault-Tolerant Real-Time Systems Group at Pittsburgh and a Computer Science group at Syracuse. Together, the experiment and university collaborators wrote a proposal that survived competition with thousands of other entries, emerging with a share of $156 million that NSF has targeted "to preserve America's position as the world leader of computer science and its applications."

NSF is especially interested in possible applications, scientific and commercial. The BTeV proposal points to a wide range of uses including medicine (data acquisition in positron emission tomography), astrophysics (the Pierre Auger Cosmic Ray Observatory and its 1,600 detector stations), vehicle navigation, weather monitoring and disaster warning systems, widely available Internet services—and others yet to be described. In fact, the collaboration intends to hold a series of workshops, inviting representatives from these areas of technology, to discuss these connections and expand the list.

Sheldon, as principal investigator of the project, coordinates the apportioning of resources. He points out that the funds are directed specifically to computer scientists.

"No physicists are actually being funded by this grant," he said. "The whole point was to bring in people from other disciplines."

Butler, whose experience dates back to early fixed-target experiments at Fermilab, is enthusiastic about expanding the formal connections between high-energy physics and computer science among several institutions.

"You would think it's the most natural of collaborations," Butler said, "high-energy physics with its complicated computer needs, and university computer scientists with their resources. But there really haven't been that many examples. It's exciting that NSF has opened up this possibility."

CALENDAR

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

Fermilab Arts Series Presents:

Trio Voronezh

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

Trained at the Conservatory in Voronezh, Russia, these three musicians play 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 diverse repertoire ranges from classical works of Bach, Tchaikovsky and Vivaldi to popular songs by Gershwin to Russian folk and gypsy dance music.

The Christmas Schooner

December 1, 2001
$17 ($9 ages 18 and under)

Experience the warmth, love, hardship and resilience of the Stossel family, German immigrants living in Chicago in the 19th century. This original musical tells the true story of a group of hardy souls who braved ferocious winter weather to deliver Christmas trees to the people of Chicago after the Great Chicago Fire. Not knowing if the ship could make it through the stormy weather, or if there was any desire for his cargo, the Captain was met at the dock by crowds of people waiting to purchase trees to carry on the tradition of Tannenbaum. Hailed by the Chicago Tribune as "one of the best of the alternative family shows in the Chicago area," this production, filled with great music and dance, is perfect for the entire family.

ONGOING

NALWO

Free English classes in the Users' Center for FNAL guests, visitors 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.

CORRECTION

In "Neutrons Against Cancer" (*FERMINEWS*, vol. 24, no. 15, pg 13) a photograph from the early days of the Neutron Therapy Facility incorrectly identified the person on the far right as designer Jim Edwards. The correct identification is Henry Van Leesten.

MILESTONES

BORN

■ Matthew Charles, on October 20, 2001, to Chuck (BD/Anti-Proton Source) and Rita Bair.

RETIRING

■ Eugene Dentino, ID 4527, PES-OP-Service/ Inv. Mgt. October 24.

■ Robert Peters, ID 238, BD-Accelerator Controls Dept, December 31.

DIED

■ Bob Hall (FESS-Services, ID 01346 N), on Oct. 28 following an illness. He was 55. Hall joined the lab in 1971, and was soon placed in charge of the newly organized Roads & Grounds Department located at Site 55. When the grass was cut, the snow was plowed or the roads and parking lots needed maintenance, Hall was the supervisor. He also handled many other responsibilities as they came up, such as agriculture lease agreements, and his efforts and skills helped the lab function as an open site for most of three decades.

LETTER TO THE EDITOR

I would like to thank everyone at Fermilab who made the September 28 Enrico Fermi celebration a resounding success. Those of us who attended the day and evening activities are most grateful that you proceeded as scheduled. It is imperative to enact security measures in times of national emergencies, such as the one now facing all Americans, and Fermilab successfully met that challenge. From one who has attended both cultural and lecture events for years, your efforts are deeply appreciated.

Allowing this celebration to take place is indeed a most meaningful message about what makes this country and its people so great: its relentless and unwavering pursuit of freedom. Fermilab is the image of this wonderful freedom all Americans hold dear. Thank you.

Nancy Nolley
Dubuque, IA

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, NOVEMBER 14
Mustard Maple Ham Steaks with Cider Madeira Sauce
Sweet Potatoes with Toasted Almonds
Pan Roasted Brussel Sprouts with Bacon
Pear Cardamon Pie

DINNER
THURSDAY, NOVEMBER 15
Booked

LUNCH
WEDNESDAY, NOVEMBER 21
Cheese Fondue
Field Greens with Walnuts
Cold Lemon Souffle

DINNER
THURSDAY, NOVEMBER 22
Closed for Thanksgiving

FERMI NEWS

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The deadline for the Friday, November 23, 2001, issue is Tuesday, November 13, 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.

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CLASSIFIEDS

FOR SALE

■ '98 Jeep Grand Cherokee, all-time 4x4, auto, a/c, power doors/locks, AM/FM CD and cassette, towing package. New tires August 2000, very clean. Asking $11,000. Call x6386, 815-899-2627 (home) or dkeiner@fnal.gov.

■ '97 Honda Civic DX 2dr, manual, 55K, well-maintained, clean. Alpine 6-CD changer, AM/FM. Tires and front brakes recently replaced. Asking for blue book value of $9,500. Contact ipal@fnal.gov.

■ '95 Hyundai Accent Green 84K miles, 5 speed, runs great $3,000. Juan Estrada (estrada@fnal.gov) x6625

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

■ '94 Minivan Mercury Villager "Nautica," white, auto., ABS, airbag, 3 doors, 7 leather seats, power steering, power windows, power seats, power locks, front and rear AC, roof rack, AM/FM/cassette/CD, runs great, very good condition, 102K mi, $7,500. E-mail montanet@fnal.gov x6486 or x4234.

■ '93 Nissan Sentra XE, sliver-gray, 2-dr, 5-spd, 116K miles, 6-CD changer/cassette, cruise control, PS, flip-up roof, runs great. $2,250 o.b.o. Call Onne, x2177 or 630-753-0487 or email opeters@fnal.gov.

■ '93 Cadillac Deville - 69, 150 ODO $6,600 o.b.o. White with maroon leather interior AM/FM/cassette, temperature control (shows degrees in settings) will show outside temp, 6-way auto seat adjust in front/and adjustable mirrors outside, power windows/locks, keyless entry, rearview dimmer, child safety locks on doors/windows, air bag on driver side, seat belts for six people. Very good condition. hardamon@fnal.gov, x3057.

■ '90 Honda Prelude 2.0 Si Coupe 2D, 4 cyl 2.0 liter, 5 speed, A/C, power steering, tilt wheel, cruise control, AM/FM stereo, cassette, moon roof, very good condition. Runs very well. Blue book value $4,625. Asking $3,700, negotiable.

■ '89 Plymouth Horizon. 4-door hatchback. Always reliable, solid car. 96K miles. $1,100 o.b.o. Call 708-645-1168.

■ '88 Honda Civic LX sedan 4D, 4 cyl 1.5. liter, automatic, A/C, power steering, tilt wheel, power windows, power door locks, AM/FM stereo, cassette, no rust, excellent condition. Mostly driven by my wife. Runs great. Blue book value $3,715. Asking $2,800, negotiable. Stephan Vandenbrink, 630-236-8584 or ssbrink@hotmail.com

■ '79 Dodge Van, 125K miles, good conditions, $500. Contact michgall@fnal.gov or call 212-751-0522

■ Sears VariDrive GT16, with 42″ rotary mower and 46″ dozer. Has all manuals. Needs valve job. Parts readily available from Sears. $50. Also: Briggs & Stratton professional battery jumpstart system. Comes with 1 KW, 110-volt outlet. $50. Call x3169 or 630-325-4608, or email waw@fnal.gov

■ 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 (included) $500, Edison Victrola turn of the century with 50-1/4″ 78 rpm records $500, 4 bookcases 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.

■ Prices reduced! Suzuki GT380 - 3 cylinder, 2 stroke, needs some work, $175. Treadmill, digital displays, works fine, $65. Young man's 18 speed mountain bike, Giant brand, $35. Kayak, Pyranha creek 280, with all accessories, many brand new, $450. Canning jars, quarts and pints, with screw tops, make an offer. Apple macintosh, 030 processor, monitor, modem, CD, lots of software, $90. Contact Scott at hawke@fnal.gov or 840-4083.

■ Cinder blocks (15) $5; commercial coffee grinder (new $600), $200 o.b.o.; countertop humidor, $650; 6-ft. folding metal tables, $15 each; folding metal chairs $2 each; Toledo electronic scale, $75. Greg x3011 or 630-557-2523

■ 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.

■ Kelvinator refrigerator, 5 yrs. old, 18.9 cu. ft., almond, wire racks, 2 crisper drawers, available December 8. $75 x8361.

FOR RENT

■ Beautiful 1 bedroom, appliances, fireplace, deck, next to train station. Security entrance, storage, all appliances. $700 per month, $700 deposit. 1062 College Ave. Wheaton, Illinois. Immediate occupancy. 630-871-6049, 630-840-3499.

■ BATAVIA: 2 BR , all appls, excellent location, 4.5 miles to Fermilab. Available Nov. 29. Call Lena x5005 or e-mail lena@fnal.gov.

■ Townhouse: Aurora - Near Stonebridge on Eola — New 3 Bed + den, 2 car Gar., Full Base., 2 Sty. LR w/FP, Naper. Sch., 15 Min. fr/Lab, 3 min. to Train/Interstate, Avail. 11/1/01, $1350/mo.+ Sec. Dep. 630-585-0559

HOUSES FOR SALE

■ 4-Bedroom house, Aurora's Far South East side. Great neighborhood, Close to schools and shopping. $150,000. Call 630-585-5284, or 630-675-7102 for appointment jill@fnal.gov.

■ Price reduction: Nice older home in Hinckley on over 1/2-acre. 3 bedroom, 2 bath, 2 car heated garage. Restored original woodwork in living room and formal dining room. Large eat-in kitchen with huge walk in pantry, appliances stay. Family room with wood burning stove. Basement with new high efficiency boiler and water heater. New roof this year and many other updates. Immediate possession. $149,999 Contact Scott at hawke@fnal.gov or 840-4083.

CLEANING SERVICE

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

LABNOTES

'FILL THE BOOT' collects $9,390 for NYC firefighters

On October 12, the Fermilab Fire Department joined fire departments across the nation to help the families of New York City firefighters who suffered losses in the tragic events of September 11. This "Fill the Boot" campaign collected $9,390.00 despite the rainy weather. All the money collected will go directly to the "The New York Firefighters 9-11 Disaster Relief Fund." The collection includes $52.36 from the children at the Fermilab day care center, and donations from school children from the Troy (IL) School District visiting Fermilab for a class field trip. Donations ranged from from loose change (totaling $347.58) to hundred-dollar bills, with personal checks of $50.00, $100.00, $250.00, and $1,000.00. Fermilab's firefighters have been deeply moved by these generous contributions and would like to thank the entire Fermilab community for their generous support.

Barn Dances Move Off Site

Due to limited Fermilab access, the Barn Dances have moved to the Warrenville Community Building, 3S240 Warren Rd. Dances are held on the second Sunday evening of each month from September through June at 6:30 PM, and on the third Sunday afternoon of each month from November through April at 2:00 PM. For more information, including a map and driving instructions to the new location, see our Web page at http://www.fnal.gov/orgs/folkclub or contact Dave Harding (x2971, harding@fnal.gov) or Lynn Garren (x2061, garren@fnal.gov).

FNALU Strong Authentication Reminder

On Tuesday, December 4, the FNALU cluster will be converted to strong authentication "strong mode." On that day, access will be restricted to Kerberos or CRYPTOCard authentication. Non-Kerberos authenticated ssh access with an AFS password will no longer be permitted. Please see www.fnal.gov/docs/strongauth/misc/fnalukerberos.html for more information.

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