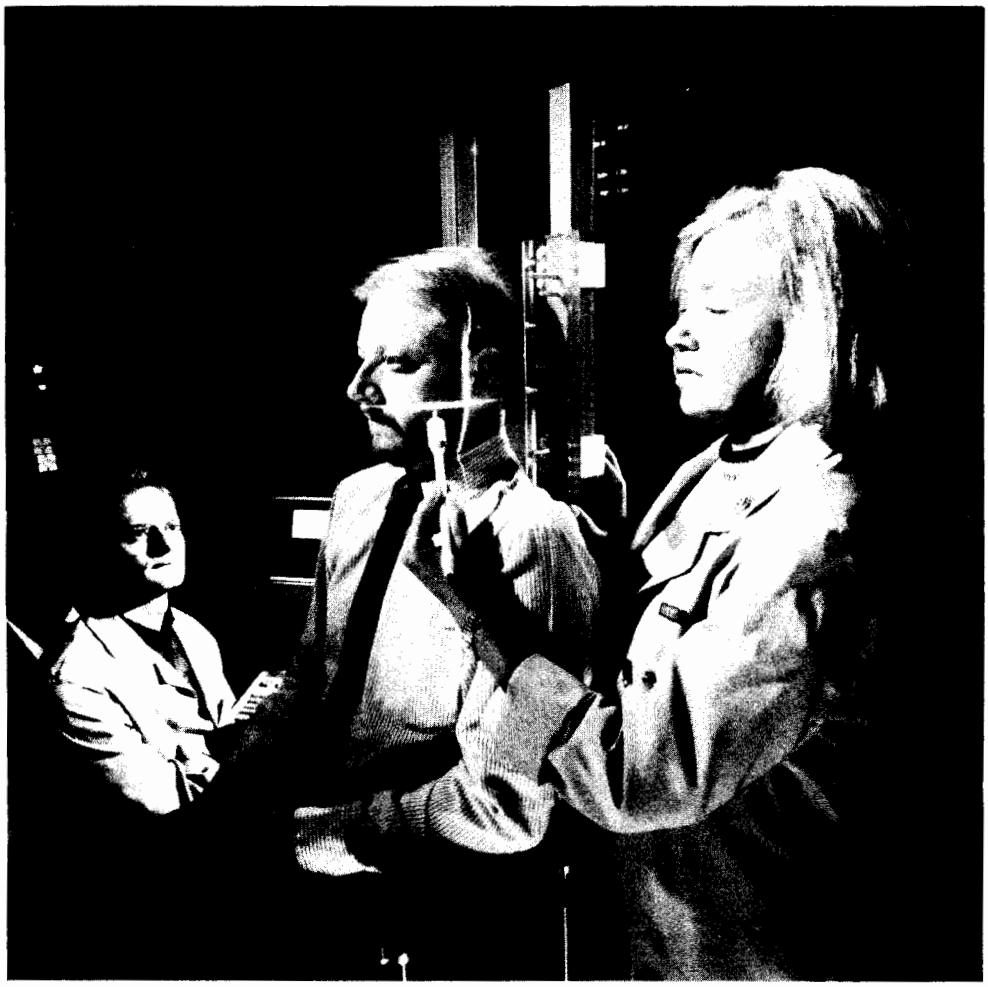
# fermilab report

November/December
1989



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**89/11** **Fermi National Accelerator Laboratory**

**On the cover:** *Barbara Bennett and Brian Pientak of Fermilab's Neutron Therapy Facility test the operation of a new magnetic contouring device. Donald Shea, shown on the left, developed its software. The pencil-like probe senses a magnetic field generated by a source and the position of the pencil point is displayed in 3D coordinates on the screen. The wand traces out a contour of a patient which is then utilized in calculating the dose distribution. The intersecting beam of laser light defines the central plane for the entry of the neutron beam.* *See story on page 1.*

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# NEUTRON THERAPY - A PROGRESS REPORT

*by* Arlene Lennox

Radiation has been used to treat certain forms of cancer since Roentgen's discovery of x-rays in 1895. Radiation sources commonly used in hospitals today include cobalt and electron linacs which produce photons by bombarding tungsten with electron beams having energies from 4 to 25 MeV. Clinical research has shown that certain tumors cannot be controlled by photon treatment. Radiation oncologists classify these tumors as "radioresistant" tumors. Unlike photon therapy, neutron therapy induces irreparable changes in the chromosome structure independent of the metabolic or biochemical state of the cells. For the past 25 years there has been an international clinical research effort to determine whether neutrons could be used to control otherwise radioresistant tumors.

Funded by the National Cancer Institute, Fermilab's Neutron Therapy Facility (NTF) began treating patients having radioresistant, inoperable tumors in 1976. The neutron beam was produced by bombarding beryllium with 66-MeV protons from the Linac. A freight elevator located about halfway down the Linac Gallery was converted into a treatment room so that the part of a patient's body to be treated could be aligned relative to the Linac beam. At that time NTF had the highest energy neutron therapy beam in the world. Other facilities were typically using cyclotron-produced proton or deuterium beams with energies around 15 MeV. As the international group of researchers compared clinical results over a period of years it became clear that better local control, with fewer side effects, was achieved with the higher energy beams [1]. Consequently, facilities having lower energy machines either stopped treating patients or upgraded to higher energy accelerators. In 1988, the National Accelerator Center in South Africa began treating patients using a 66-MeV proton beam from a separated-sector cyclotron. As of this writing, Catholic University of Louvain is using a 65-MeV proton beam, Clatterbridge Hospital in England has a 62-MeV beam, and the University of Washington in Seattle is using a 50-MeV proton beam. Several European facilities are in the process of upgrading to 65 MeV. Fermilab's work has set the standard for other facilities worldwide!

A summary of international clinical results for long-term local control of radioresistant, inoperable tumors is shown in Table 1. Though the treatment is not 100% effective it should be noted that, at least presently, there is no better treat-

*The author is with the Fermilab Neutron Therapy Facility.*

ment for these tumor types. In addition, an eight-year study has shown significant improvement in long-term survival of patients receiving neutron therapy for advanced carcinoma of the prostate [2]. The results of this study are not included in Table 1 because advanced prostate cancer does respond to photon therapy in some cases.

**Table 1**

*Control rates for neutron therapy of radioresistant, inoperable tumors (international experience through 1987)*

| Tumor Type | Control Rate |
|---|---|
| Salivary gland tumors | 71% |
| Sarcoma of bone | 66% |
| Soft tissue sarcomas | 50% |
| Melanoma | 71% |
| Recto-sigmoid cancers | 33% |
| Bladder cancers | 48% |

In 1985, after we had treated 1300 patients, officials at the National Cancer Institute decided that the efficacy of neutron therapy had been established and that research funds would be better spent in other areas, such as developing and testing new chemotherapeutic drugs. Hence, they did not renew our research grant. Both the Laboratory and the physicians working at NTF were committed to keeping this mode of treatment available for patients. The physicians formed a partnership, the Midwest Institute for Neutron Therapy, which operated the facility on a fee-for-service basis under a contract with the Universities Research Association (URA). Once again, NTF took the lead in moving neutron therapy from an experimental modality to being the treatment of choice for certain radio-resistant tumors. Convincing Medicare and the other medical insurers to cover the cost of treatment was a non-trivial project, but we have succeeded and have made the way easier for other facilities that are now beginning to offer neutron therapy on a fee-for-service basis. A further proof that this once-experimental treatment is becoming accepted in the medical community is the fact that Rush-Presbyterian-St. Luke's Medical Center has agreed to collaborate with URA in operating the facility. Over 500 patients have been treated since the grant was terminated. We continue to see about 500 follow-up patients each year at no additional cost to the patient.

Though other facilities are beginning to approach Fermilab's capability of providing relatively high proton energies for neutron therapy, our facility has the highest dose rate because we can take advantage of the high proton current available in the Fermilab Linac. Facilities using cyclotrons are limited by practi-

cal problems such as higher power requirements and higher radiation levels. A high dose rate is important because it minimizes the amount of time a patient must remain immobilized during treatment and increases the number of patients that can be treated each day. From a financial point of view it is important because proton accelerators used for neutron therapy can also be used to produce short-lived, medically useful radioisotopes. Facilities using cyclotrons for therapy and isotope production have found that the two uses interfere with each other. Some are in the process of purchasing a second cyclotron to satisfy the requirements of both activities. Our experience in using the Linac for both high-energy physics and neutron therapy by means of a fast switching magnet, coupled with new technology that can dramatically reduce the size of a 66-MeV proton linac, has led to the proposal that new neutron therapy facilities should use a linac, rather than a cyclotron, as the proton source [3]. Once again, Fermilab is taking the lead: this time by finding a way to make neutron therapy practical and cost effective in a hospital setting.

**References**

[1] T. Griffin, T. Pajak, G. Laramore, L. Davis, Analysis of Neutron Radiotherapy Treatment Complications, Bull. Cancer(Paris), 1986, Vol 73, 5, pp. 582-586.

[2] K. J. Russell, G. E. Laramore, J. M. Krall, F. J. Thomas, M. H. Maor, F. R. Hendrickson, J. N. Krieger, and T. W. Griffin, Eight Years Experience With Neutron Radiotherapy in the Treatment of Stages C and D Prostate Cancer: Updated Results of the RTOG 7704 Randomized Clinical Trial, The Prostate, Vol 11, 1987, pp. 183-193.

[3] A. J. Lennox, F. R. Hendrickson, D. A. Swenson, R. A. Winje, and D. E. Young, Proton Linac for Hospital-Based Fast Neutron Therapy and Radioisotope Production, Proceedings of the International Heavy Particle Workshop, Villigen, Switzerland, Sept., 1989 and Fermilab TM-1622.

# THE FERMILAB WILSON FELLOWSHIP PROGRAM

*by* Rolland P. Johnson

Over the last 12 years, the Wilson Fellowship has attracted some of the best young researchers in high energy and accelerator physics to Fermilab. The award was created by Leon Lederman to honor Fermilab's first director, Robert R. Wilson and it is typically awarded to one or two individuals per year. The award is for three years, extendable for another two, and has a stipend that is meant to be competitive with the best university assistant professorship pay scales. Additional funds are available for travel, publications, and computing.

In the spirit of providing the most desirable position available, there are no constraints on the research that a Wilson Fellow may pursue. Fellows are encouraged to spend all of their time on their research and there are no required laboratory duties to distract from this effort. Fellows in experimental high-energy physics generally have been required to have substantial postdoctoral experience before consideration as a Wilson Fellow candidate. As a recognition of Robert Wilson's contributions to particle accelerators and as an inducement for people to enter the field, Wilson Fellow candidates for accelerator physics research may have less postdoctoral experience.

Selection of the Fellows is made by the Laboratory Director, based on the advice of the Wilson Fellows Committee. The present Committee is composed of Gene Fisk, Irwin Gaines, Dan Green, Rol Johnson (Chair), Drasko Jovanovic, Paul Mantsch, and John Marriner.

There are presently 11 Wilson Fellows. They are listed below with the date of their appointment:

Bob Hsiung (Wilson Fellow, May 1989) received his Ph.D. from Columbia based on Fermilab Experiment 605. As a Fermilab research associate he worked on E-731, a measurement of CP violation parameters $\varepsilon'/\varepsilon$ in neutral kaon decays. As a Wilson Fellow, Bob is involved in E-773, an extension of E-731, to test CPT invariance in the neutral kaon system by measuring the phase difference between the CP-violating decay parameters $\eta_{+-}$ and $\eta_{00}$. He is also involved in a search for the direct CP-violating rare decay of $KL \rightarrow \pi^0 e^+ e^-$ and in E-789.

Jay Hauser (January 1989) received his Ph.D. from Cal Tech on weak decays of D mesons using the Mark III detector at SLAC. As an Enrico Fermi Fellow at the

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*The author is with the Fermilab Accelerator Division.*

University of Chicago he participated in the Collider Detector at Fermilab (CDF) experiment where he was heavily involved in the development of the trigger processor. As a Wilson Fellow, Jay has continued with CDF, where, among other things, he has been analyzing the asymmetry of W boson decays.

Gerry Jackson, (October 1988), did his Ph.D. work at Cornell where he worked improving the luminosity of the CESR $e^+e^-$ collider. Before becoming a Wilson Fellow, he worked at Fermilab as a research associate on the Main Ring and Tevatron, and, in particular, on the rf manipulations needed for collider operation. Concurrent with his Wilson Fellowship, Gerry is the Associate Head of the Injector Department for Instrumentation. His research as a Wilson Fellow is the design and installation of a bunched beam stochastic cooling system in the Tevatron. He also is supervising two Ph.D. students on beam instabilities in the Antiproton Accumulator, Main Ring, and Tevatron, and preparing an accelerator-physics course at Northwestern with Jamie Rosenzweig.

Heidi Schellman (June 1988) did her Ph.D. at the University of California, Berkeley, working on the Mark II (PEP) detector at SLAC. Following that she worked for the University of Chicago on Fermilab Experiment 744/770, a neutrino scattering experiment to measure proton structure functions and their variation with $Q^2$. As a Wilson Fellow she is working on Fermilab Experiment 665, again a measurement of structure functions, but using the Tevatron muon beam instead of neutrinos. She is working primarily on hardware for the next run, including a vertex "jet" tracking chamber.

Jamie Rosenzweig (June 1988) did his Ph.D. at the University of Wisconsin on experimental and theoretical investigations in plasma wake-field acceleration. He has used the Argonne Advanced Accelerator Test Facility to first demonstrate plasma wake-field acceleration and then to study the dynamics of intense beams in more detail. He also investigated the optics of plasma lenses and their uses in the final focus of linear colliders. As a Wilson Fellow, Jamie has continued working on these subjects as well as space charge effects on proton beams, ion trapping by antiproton beams, longitudinal beam dynamics, and stochastic cooling.

Bruce Denby (June 1988) received his Ph.D. from the University of California, Santa Barabara, based on his work in experimental high-energy physics in charm photoproduction experiment E-516 at Fermilab. He subsequently worked on the UA1 experiment at the CERN SPS, and on Delphi at LEP. In 1987, while working at the Linear Accelerator Laboratory in Orsay, France, he became interested in neural networks, and became excited about the possibility of applying these techniques to triggering in a high-energy physics experiment. This excitement has carried through to his current position as a Wilson Fellow at Fermilab, where

he is currently investigating, among other neural net applications, two types of beauty triggers, one based on finding electrons within jets in a calorimeter, and the other based on the recognition of secondary vertices in a vertex detector.

Taku Yamanaka (January 1988) received his Ph.D at the University of Tokyo working on studies of charged kaon decays. As a Fermilab research associate, he has worked on Fermilab Experiment 731, a CP violation experiment, where he was especially interested in the data acquisition and trigger. As a Wilson Fellow, he has continued on the Monte Carlo simulation of E-731, a very crucial part of the analysis. Besides E-731, Taku and Wah from the University of Chicago proposed a new experiment for the group to measure the branching ratio of $K_L \rightarrow \pi^0 e^+e^-$ with a sensitivity of one part in $10^{11}$. The experiment has been approved (E-799), and preparations for the upcoming run are being made.

John Huth (Nov 87) received his Ph.D. from the University of California, Berkeley, based on a search for free quarks with the PEP-4 TPC Collaboration at SLAC. He subsequently worked at LBL on the development of a novel concept, the radial drift chamber. John came to Fermilab as a research associate where he joined the CDF experiment. As a Wilson Fellow, he has continued work on CDF where his main interests have been jet studies and detector upgrades.

Bob Bernstein (April 1987) received his Ph.D. from the University of Chicago for work done at Fermilab (E-617), a study direct of CP violation through a precision measurement of $\eta_{00}/\eta_{+-}$. He then joined the CCFR neutrino program at Fermilab (E-744/770) as a research assistant at Columbia University. As a Wilson Fellow, Bob has continued to work on the analysis of the neutrino experiment as well as on the design of a tagged neutrino facility. P-788 uses neutrinos from $K_L$ decay, where the neutrino species and momentum are determined event-by-event. Neutrino oscillation experiments and cross-section measurements would each improve by nearly an order-of-magnitude and $\sin^2 \theta_W$ could be determined in an entirely new way which would be nearly free of the systematic problems which have limited the old experiments, decreasing the error by a factor of three and making the errors on the radiative corrections competitive with future W and Z mass determinations from LEP.

Mike Crisler (April 1986) received his Ph.D. from Ohio State University for work on Fermilab Experiment 613, a measurement of the prompt neutrino flux produced by 400-GeV proton collisions in a beam dump. Mike then came to Fermilab as a research associate where he was involved in Experiment 711, a study of massive di-hadron production in proton-proton collisions. As a Wilson Fellow, Mike is presently Spokesperson for E-774, a beam-dump particle search.

Bill Foster (April 1984) earned his Ph.D. from Harvard University for work on the IMB underground search for proton decay. As a research associate at the

University of Michigan he was involved with hardware upgrades to the IMB detector. As a Wilson Fellow, he has worked on many aspects of the CDF experiment, including front-end electronics, VTPC, CTC, tracking processor for the trigger, event display, and top quark search in electromagnetic channels. Bill is presently Co-Leader of the CDF Data Acquisition Group.

**Previous Wilson Fellows**

There are nine Wilson Fellow alumni. They have all moved on to either university professorships or staff positions at a national laboratory. The previous fellows and their positions when last heard from are:

| Name | Appointment | Present Activity |
|---|---|---|
| Milind Purohit | April '86 | Asst. Prof., Princeton University, E-791 |
| Kam Biu Luk | August '85 | Asst. Prof., UC, Berkeley, E-789 |
| David Christian | Jan. '84 | Fermilab Assoc. Sci. detector VLSI, E-690 |
| Chris Sliwa | August '83 | Asst. Prof., Tufts, CDF |
| Petros Rapidis | June '82 | Fermilab Sci. I, Pbar Source, E-760 |
| Richard Kadel | June '82 | LBL Research Staff, CDF |
| David Neuffer | Oct. '80 | Los Alamos, Research Staff |
| Risto Orava | March '79 | Assoc. Prof., U. of Helsinki |
| John Cumalat | Oct. '77 | Assoc. Prof., U. of Colorado, E-791 |

Fermilab is quite proud to recognize the Wilson Fellows, present and past, as outstanding scientists, dedicated to learning nature's secrets. It is particularly satisfying to support these researchers at a time in their development when independence can be so important to creative endeavors.

**Michael Witherell has been awarded the 1990 W. K. H. Panofsky prize sponsored by the American Physical Society (APS). The** award results from Witherell's work on Fermilab Experiment 691. The citation from the APS cites him "[f]or his leadership in the organization of appropriate detector technology and of the analysis to succeed in the observation and measurement of an unprecedented number of charmed particles generated via the photproduction process. His research led to a new stage of precision studies of a large number of processes involving the production and decay of particles carrying the charm quark."

**The growing importance of computing Labwide was recognized recently with the creation of a new division at Fermilab devoted** solely to managing all computer-related activities that support the immediate and long term needs of high-energy physics. After months of hard work and planning, the new Division, formerly the Computing Department in the Research Division, began work October 1st in its new expanded capacity. The increasing role of computing tasks and the growing importance of interaction between users and the computing staff in a greatly enlarged computing environment provided the impetus for the Division's creation.

According to Tom Nash, Computing Division Head,"[The Division's] driving goal is to establish a major center of excellence in the operation and development of computing and data acquisition for high-energy physics. This is the key pillar of Fermilab's long-term future."

The Division's mission plan reflects this ambitious spirit. In this plan, the new body recommits itself to providing support to the HEP community while it continues to define potential solutions to computing and data acquisition problems. In addition, the continued search for possible HEP applications of new computing technology developed outside the Lab is reaffirmed. Besides stressing the need for continued progress in operational efficiency and computer development, the mission stresses the growing importance of user/staff communication in the new environment.

An expanded liaison group attached to the Division Office and under the direction of Joel Butler, Associate Division Head (Advanced Systems and R & D), was formed to provide consulting and direct support to experimenters and other computing clients. All Computing Consulting and Experiment Support Services (ACCESS) was initiated as a means of opening up a continuous two-way

dialogue between users and the computing staff, not only to ensure that experimenters have a means of communicating their needs to the Division, but also to allow for the Division to constantly provide the latest information on state-of-the-art systems and direction for clients' future computing requirements. In addition, the three Associate DivisionHeads will pay particular attention to keeping channels of communication open with members of the Division, and will strive to maintain a dialogue with those users labwide who have unique computing needs.

According to Nash, "Experimenters will find, as a result of this two-way communication, that they will, in effect, be running the Division."

Communication with outside entities will also be emphasized. Jack Pfister, Associate Division Head, will be responsible for coordinating the research into developments in industry and academia that have relevant applications to HEP computing needs. His ongoing relations with industry, government, and other laboratories, as well the rest of the computing world, will continue to enhance the Division's own broad R&D base by providing a continuous flow of information on developments in the field.

The Computing Division now has five departments. Their current activities are as follows:

1) Central Computing Department (CCD), Peter Cooper, Head; Gerry Bellendir, Associate Head: Operation of Fermilab's major shared central computing resources, including the central Amdahl and IBM complexes, ACP I farms, the Cybers, and any future Unix-based centralized production systems.

2) Distributed Computing Department (DCD), Al Thomas, Head: Operation of local and wide-area networks and other communication. Operation of central farms configured for DST analysis and of the VAX clusters. Support for departmental clusters, workstations, networked PC's, and associated peripherals. Maintenance of VAX and Unix hardware and related software for these machines.

3 & 4) Data Acquisition Departments (DAD): Development and support of hardware and software tools for use in experiment DA systems.

DA Support Department, Vicki White, Head: Includes PREP. Presently responsible for online and data acquisition systems for the forthcoming fixed-target run.

DA Electronics Department, Ed Barsotti, Head: Presently participating in silicon detector readout development and study of a high-speed DAQ switch.

5) Computing R&D Department (CRD), Joe Biel, Head; Mark Fischler, Associate Head: Presently developing ACP II software, hardware, and the ACPMAPS lattice gauge processor. - *Phil Stebbings*

**In recognition of her years of devoted service to Fermilab, the interpretive trail through the restored prairie next to outbound** Pine Street will now be named for Margaret Pearson, the long-time Manager of the Public InformationOffice, who is currently on long-term disability status. In late December, the Prairie Committee unanimously recommended to the Directorate that this action be taken. When weather permits, a new plaque dedicating the Margaret Pearson Interpretive Trail will be placed at the trail head.

In the planning stages for three years, the trail was formally opened in June of 1989 in conjunction with the dedication of the entire Fermilab site as a National Environmental Research Park. Working with other members of the Fermilab community, Margaret has been instrumental in developing the reports and application documentation that assured the research park designation.

The prairie restoration project at Fermilab was first unveiled to the public in February of 1974 and Margaret Pearson was named a member of the first prairie committee. She is the only original member left on the committee.

The Margaret Pearson Interpretive Trail is a half-mile loop featuring a dozen signs designed to explain the various sights and sounds of the prairie. This loop is currently covered with wood chips but the hope is that it will ultimately be surfaced with a fine, packed gravel so as to be suitable for wheelchair traffic. In addition, there is a 1.2-mile outer loop which takes the more adventurous further out into the prairie.

Open to the public during all daylight hours, the trail gives visitors a unique opportunity to learn about the grasses, flowers, birds, and insects that populate the prairie. In its first season, the Margaret Pearson Interpretive Trail has seen extensive use from prairie experts, casual observers, family groups, and school groups.

With her literary flair, her love of nature, and her sound knowledge of the prairie ecosystem, Margaret is recognized as the prime mover in the realization of the trail.

Dr. Robert Betz, biology professor at Northeastern Illinois University and the chief professional advisor for the Fermilab prairie restoration project, credits the very existence of the interpretive trail to Margaret's dedication and determination. "Her persistent commitment to the whole concept of an interpretive trail is what kept us going," he said.

Finley Markley (TS), current chair of the Fermilab Prairie Committee, sees the naming of the trail in Margaret's honor as a fitting recognition of, and appropriate tribute to, her energy and enthusiasm for the now 15-year-old Fermilab prairie restoration project. - *Barbara Lach*

**Fermilab Director John Peoples delivered the keynote address at the 1989 Association of Energy Engineers (AEE) energy** awards banquet at Morraine Valley Community College in Palos Heights, Illinois. The event, which is also sponsored by the Greater Chicago Use Energy Wisely Committee and the Department of Energy (DOE), is held annually to recognize and honor individuals, institutions, and industries for their efforts and achievements in energy conservation and energy management. More than 100 energy professionals from the Chicagoland area were present to hear Peoples outline the Fermilab mission, its development of superconducting technology and the Tevatron, and his message of the importance of using energy wisely and efficiently in high-energy physics.

*Karl Klima (left), DOE-FEMP, Chicago Operations Office, and Edward G. Cumesty (center), Deputy Manager, DOE Chicago Operations Office, present the plaque honoring Fermilab's energy initiatives in 1989. Bill Riches, Fermilab Energy Conservation Coordinator, accepted the award on behalf of the Lab.*

Peoples emphasized that energy conservation at Fermilab was on-going, with DOE having funded $7 million in energy conservation retrofit projects over the past several years, which have resulted in an annual energy cost savings of $3 million. Currently, we have 11 retrofit and metering projects, totalling $1.5 million, which are in various stages of design or construction, and which are projected to produce an annual operating cost savings of $792,000. FY 1990 DOE funding in the amount of $810,000 was requested for six additional retrofits which will produce an energy cost savings of $310,000. FY 1991 funding has been requested for a $1 million retrofit project to convert the HVAC systems for the five Industrial Complex buildings from electricity to natural gas. DOE has also provided FY 1990 funding for four engineering feasibility studies which could produce future energy conservation retrofits.

Peoples pointed out that several of the retrofit projects were the result of suggestions received through the Fermilab Employee Energy Conservation Awards Program, which offers cash awards of up to $5000 for suggestions which have been evaluated and recommended for adoption. He reported that in FY 1989, a total of $18,670 in employee cash awards was made in response to suggestions with projected annual electrical savings of 17,800 megawatt hours and

an annual net cost saving of $647,000.

Other Fermilab attendees at the banquet were Norman Hansen, DOE Batavia Area Office, and Bill Riches, Energy Conservation Coordinator. Riches was the recipient of the 1989 AEE Energy Manager of the Year Award in recognition of his energy conservation and energy management activities and achievements during the past year.

Riches reports that at the December 1989 meeting of the Employee Suggestion Awards Committee, 36 new energy conservation suggestions were reviewed and referred for evaluation and possible future cash awards. - *William Riches*

**Christopher T. Hill, of Fermilab's Theoretical Physics Department, has been elected to the status of Fellowship by the** American Physical Society (APS) "[f]or elucidating the mechanisms shaping the spectra of ultra-high energy cosmic rays and neutrinos, and for contributions to the understanding of nonleptonic weak interactions."

The APS designates for Fellowship "only those members who have contributed to the advancement of physics by independent, original research. . ."

*. . .prepared or presented from December 1, 1989, to January 15, 1990. Copies of Fermilab TM's, FN's, and preprints (exclusive of theoretical physics and theoretical astrophysics preprints) can be obtained from the Fermilab Publications Office, WH6NW, (708) 840-3278, or via (DECnet) FNAL::TECHPUBS or (BITnet) TECHPUBS@FNAL. For theoretical physics and astrophysics preprints, contact those departments directly. For papers with no Fermilab catalogue number, contact the author(s) directly.*

## Experimental Physics Results

*Experiment #740*

J. M. Butler et al., "Study of Fast Gases, Resolutions, and Contaminants in the D0 Muon System," (FERMILAB-Pub-89/222-E; submitted to Nucl. Instrum. Methods A)

*Experiment #741/CDF*

F. Abe et al., "Measurement of the Ratio $\sigma(W \rightarrow e\upsilon)/\sigma(Z \rightarrow e\,e)$ in $\bar{p}p$ Collisions at $\sqrt{s}$=1.8 TeV," (FERMILAB-Pub-89/245-E; submitted to Phys. Rev. Lett.)

F. Abe et al., "A Search for the Top Quark in the Reaction $\bar{p}p \rightarrow$ Electron + Jets at $\sqrt{s}$=1.8 TeV," (FERMILAB-Pub-89/212-E; submitted to Phys. Rev. Lett.)

R. D. St. Denis, "Dijet Angular Distributions in Proton-Antiproton Collisions at the Fermilab Tevatron," Ph.D. Thesis, Harvard University, Cambridge, Massachusetts, December 1988)

*Experiment #772*

R. Guo et al., "Improved Limit on Axion Production in 800-GeV Hadronic Showers," (FERMILAB-Pub-89/234-E; submitted to Phys. Rev. D)

## General Particle Physics

J. A. Appel et al., "Embedded $e^+e^-$ Pairs in Heavy Flavor Photoproduction," (FN-524; talk given by J. Busenitz at "Physics at Fermilab in the 1990's," Breckenridge, Colorado, August 15-24, 1989)

J. Busenitz, "Acceptances for Charm Photoproduction," (FN-523; talk given at "Physics at Fermilab in the 1990's," Breckenridge, Colorado, August 15-24, 1989)

D. R. Green and L. M. Lederman, "Fermilab Research Results 1978-1988," (FN-527)

F. A Harfoush and K.-Y. Ng, "On the Calculation of Wake Functions Using Mafia-T3 Code," (FN-521; presented by K.-Y. Ng at the Impedances and Bunch Instability Workshop, Argonne National Laboratory, Argonne, Illinois, October 31- November 1, 1989)

D. M. Kaplan, "Prospects for High-Luminosity Rare-B-Decay Experiments," (FN-526; presented at "Physics at Fermilab in the 1990's," Breckenridge, Colorado, August 15-24, 1989)

S. K. Mtingwa and A. V. Tollestrup,"Intrabeam Scattering Formulae for Asymptotic Beams with Unequal Horizontal and Vertical Emittances," (FERMILAB-Pub-89/224; submitted to Part. Acc.)

**Accelerator Physics**

S. A. Bogacz, "Main Injector - Coherent Instability Limits," (FN-519)

D. C. Carey, "Fluxes and Background from $\Sigma^+ \rightarrow$ Polarized Proton at Fermilab," (FERMILAB-Conf-89/216; presented at the III Workshop on High Energy Spin Physics, Protvino, U.S.S.R., September 5-7, 1989)

R. Goodwin et al., "Initial Operation and Current Status of the Fermilab DZero VMEBUS-Based Hardware Control and Monitor System," (FERMILAB-Conf 89/230; to be published in the proceedings of the International Conference on Accelerator and Large Experimental Physics Control Systems, Vancouver, British Columbia, Canada, October 30-November 3, 1989)

Hans Jöstlein, "Vacuum Technology Issues for the SSC," (TM-1631; talk presented at the Conference of the American Vacuum Society, Boston, Massachusetts, October 26, 1989. To be published in J. Vac. Sci. Tech.)

J. B. Rosenzweig et al., "Demonstration of Electron Beam Self-Focusing in Plasma Wake-Fields," (FERMILAB-Pub-89/213; submitted to Physics of Fluids B)

A. Van Ginneken, "Non Ionizing Energy Deposition in Silicon for Radiation Damage Studies," (FN-522)

D. E. Young et al., "An 805 MHz Disk and Washer Accelerating Structure with Coaxial Coupler for the Fermilab Upgrade," (FERMILAB-Conf-89/197; presented at the XIV International Conference on High Energy Accelerators, Tsukuba, Japan, August 22-26, 1989)

**Theoretical Physics**

C. H. Albright, "Three-Family Mass Matrices Leading to a Very Massive Top Quark," (FERMILAB-Pub-89/258-T; submitted to Phys. Lett. B)

P. Aurenche et al., "Prompt Photon Production at Colliders," (FERMILAB-Pub 89/226-T; submitted to Phys. Rev.)

U. Baur and E. W. N. Glover, "Higgs Boson Production at Large Transverse Momentum in Hadronic Collisions," (FERMILAB-Pub-89/243-T; submitted to Nucl. Phys. B)

D. Chang et al., "Neutrino Magnetic Moment and Nonabelian Discrete Symmetry," (FERMILAB-Pub-89/240-T; submitted to Phys. Rev. Lett.)

R. S. Chivukula and M. Golden,"Observing the Techniomega at the SSC," (FERMILAB-Pub-89/256-T; Nucl. Phys. B)

E. Eichten and B. Hill, "Renormalization of Heavy-Light Bilinears and $f_B$ for Wilson Fermions," (FERMILAB-Pub-89/209-T; submitted to Phys. Lett. B)

E. W. N. Glover et al., "The Decay of the Z Boson into Four Massive Fermions," (FERMILAB-Pub-89/244-T; submitted to Z. Phys. C)

C. T. Hill and E. A. Paschos, "A Naturally Heavy Fourth Generation Neutrino," (FERMILAB-Pub-89/228-T; submitted to Phys. Lett. B)

O. F. Herna´ndez and B. R. Hill "The Static Approximation, Staggered Fermions and $f_{B,}$" (FERMILAB-Pub-89/210-T; submitted to Phys. Lett. B)

C.-S. Huang and D.-H. Zhang, "Ward Identities and Characters of Kac-Moody Algebras," (FERMILAB-Pub-89/241-T; submitted to Nucl. Phys. B)

A. D. Kennedy, 'The Theory of Hybrid Stochastic Algorithms," (FERMILAB-Conf-89/237-T; lectures given at the workshop on "Probabilistic Methods in Quantum Field Theory and Quantum Gravity," Cargese, France, August 21-27, 1989)

A. S. Kronfeld, "Improved Methods for Computing Masses from Numerical Simulations," (FERMILAB-Conf-89/242-T; talk presented at "LATTICE 89," Capri, Italy, September 18-21, 1989)

A. S. Kronfeld, "Status of Glueball Mass Calculations in Lattice Gauge Theory," (FERMILAB-Conf-89/232-T; talk presented at the 1989 International Symposium on Hadron Spectroscopy, Ajaccio, Corsica, France, September 23-27, 1989)

J. D. Lykken et al., "Anyonic Superconductivity," (FERMILAB-Pub-89/231-T; submitted to Phys. Rev. Lett.)

R. Martinez et al., "Supersymmetry, Foldy-Wouthuysen Transformation and Stability of the Dirac Sea," (FERMILAB-Pub-89/248-T; submitted to Mod. Phys. Lett.)

T. R. Morris, "The Quantum Equivalence of Nambu and Polyakov String Actions," (FERMILAB-Pub-89/251-T; submitted to Nucl. Phys. B)

H. Sato, "Noncommuting Wilson Lines from Orbifold Topology and Stringy Construction of Degenerate Orbifolds," (FERMILAB-Pub-89/238-T; submitted to Phys. Lett.)

**Theoretical Astrophysics**

A. Albrecht, "Small Scale Structure on Cosmic Strings," (FERMILAB-Conf-89/221-A; invited talk given at the Symposium on Formation and Evolution of Cosmic Strings, Cambridge, England, July 2-7, 1989)

D. Garfinkle and R. Gregor, "Corrections to the Thin Wall Approximation in General Relativity," (FERMILAB-Pub-89/225-A; submitted to Phys. Rev. D)

G. Goetz and D. Noetzold, "An Exact Solution for a Thick Domain Wall in General Relativity," (FERMILAB-Pub-89/235-A; submitted to Phys. Rev. D)

G. Goetz and D. Noetzold, "On Thick Domain Walls in General Relativity," (FERMILAB-Pub-89/236-A; submitted to Phys. Rev. D)

R. Gregory et al., "Cosmic Strings and Baryon Decay Catalysis," (FERMILAB-Conf-89/215-A; based on talks presented by R. Gregory and W. Perkins at the Symposium on Formation and Evolution of Cosmic Strings, Cambridge, England, July 2-7, 1989)

K. Griest and M. Kamionkowski, "Unitarity Limits on the Mass and Radius of Dark Matter Particles," (FERMILAB-Pub 89/205-A; submitted to Phys. Rev. Lett.)

K. Griest et al., "Supersymmetric Dark Matter above the $W$ Mass," (FERMILAB-Pub-89/239-A; submitted to Phys. Rev. D)

L. Kawano, "Evolution of Domain Walls in the Early Universe," (FERMILAB-Pub-89/208-A; submitted to Phys. Rev. D)

H. Kurki-Suonio et al., "Big Bang Nucleosynthesis and the Quark-Hadron Transition," (FERMILAB-Pub-89/252-A; submitted to Astrophys. J.)

M. T. Ressell and M. S. Turner, "The Grand Unified Photon Spectrum - A Coherent View of the Diffuse Extragalactic Background Radiation," (FERMILAB-Pub-89/214-A; to appear in Comments on Astrophys.)

D. N. Schramm, "The Age of the Universe: Concordance," (FERMILAB-Conf-89/253-A; talk delivered at the 5th IAP Astrophysics Meeting, "Astrophysical Ages and Dating Methods," Institut d'Astrophysique de Paris, Paris, France, June 26-29, 1989)

D. N. Schramm, "Cosmology and the Weak Interaction," (FERMILAB-Conf-89/255-A; talk delivered at the Wein 89 International Symposium on Weak and

Electromagnetic Interactions in Nuclei, Montreal, Quebec, Canada, May 15-19, 1989.

D. N. Schramm, "Nuclear Physics and Cosmology," (FERMILAB-Conf-89/254-A; talk delivered at the IUPAP International Nuclear Physics Conference, Sao Paulo, Brazil, August 20-26, 1989)

**Computing**

J. R. Biel, "General Purpose Computers in Real Time," (FERMILAB-Conf-89/217; presented at the ECFA Study Week on Instrumentation Technology for High Luminosity Hadron Colliders, Bellaterra, Barcelona, Spain, September 14-21, 1989)

M. Fischler et al., "Designing Machines for Lattice Physics and Algorithm Investigation," (FERMILAB-Conf-89/220; presented by M. Fischler at "LATTICE 89," Isola di Capri, Italy, September 18-21, 1989; to be published in Nucl. Phys. B, Proceedings Supplement Section)

**Other**

M. Bodnarczuk, "Defining a Doctrine for QA in Government Funded Basic Research," (FERMILAB-Pub-89/218; submitted to Quality Progress)

## COLLOQUIA, LECTURES, AND SEMINARS

*by Fermilab staff, at Fermilab, November-December 1989, unless otherwise noted.*

*November 1*

A. Olinto, "SN87A as a Laboratory for High Density Matter," at the Massachusetts Institute of Technology

*November 2*

B. Denby, "Neural Networks"

P. Griffin and D. Kosower, "One-Loop Gravity, Lies, and Video Tape"

*November 9*

P. Lucas, et al., "Tevatron Controls Upgrade, Status and Plans"

G. Tassotto, "Report on Brookhaven Instrumentation Workshop"

S. Chaudhuri, "Intrinsically Four-Dimensional String Models"

*November 16*

B. Webber, "Beam Diagnostics in the Loma Linda Accelerator"

J. Crisp, "Modelling of the Loma Linda rf Feedback Loops"

*November 21*
A. Olinto, "PSR87A and the E>O.S. for Neutron Stars," at Purdue University

*November 28*
C. Briegel, D. Bogert, P. Lucas, "Control System Design"

A. Olinto, (title to be announced), at Purdue University

*November 30*
S. Peggs, "Beyond the RF Bucket: Driven Pendula and Accelerators"

*December 1*
K. Thorne, "Hyperon Results from E-621 and the $\Delta I=1/2$ Rule"

*December 7*
S. Hsueh, "Summary of August E-760 Accumulator Deceleration Studies"

G. Hockney, "CANOPY: A Language for Lattice Gauge Theory"

*December 12*
D. Anderson, "A Short Report on the Calorimetry Conference in Sigtuna, Sweden; + CeF3: A Fast, Dense Scintillator; + PbF2: An Ultra-Compact Cherenkov Calorimeter"

M. Turner, "Axion Signatures," plenary talk at Signatures of Particle Dark Matter Workshop, Center for Particle Astrophysics, University of California, Berkeley

*December 14*
R. Noble, "Status of the Linac Upgrade"

A. Jonckheere, "D0GEANT and You"

*December 19*
B. Brown, "Iron-Free Magnets Using Superconducting Shields"

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## DATES TO REMEMBER

*April 9-13, 1990*
Conference on Computing in High Energy Physics; at Santa Fe, New Mexico.

*April 26-28, 1990*
Workshop on Hadron Structure Functions; at Fermilab. For information contact Cynthia Sazama, Fermilab, P.O. Box 500, MS 122, Batavia, IL 60510.

*May 18-19, 1990*
Fermilab Users' Annual Meeting; at Fermilab. For information contact Joy Perington, Fermilab Users' Office, (708) 840-3111 or USERSOFFICE@FNAL.

*June 25-July 13, 1990*
1990 Summer Study on High Energy Physics - Research Directions for the Decade; at Snowmass, Colorado. For information contact Robin Craven, Department of Physics, University of Wisconsin, Madison, Wisconsin 53706; office: (608) 263-2267, fax: (608) 263-0800; DECnet Wishep::Snowmass; BITnet Snowmass@Wishep.