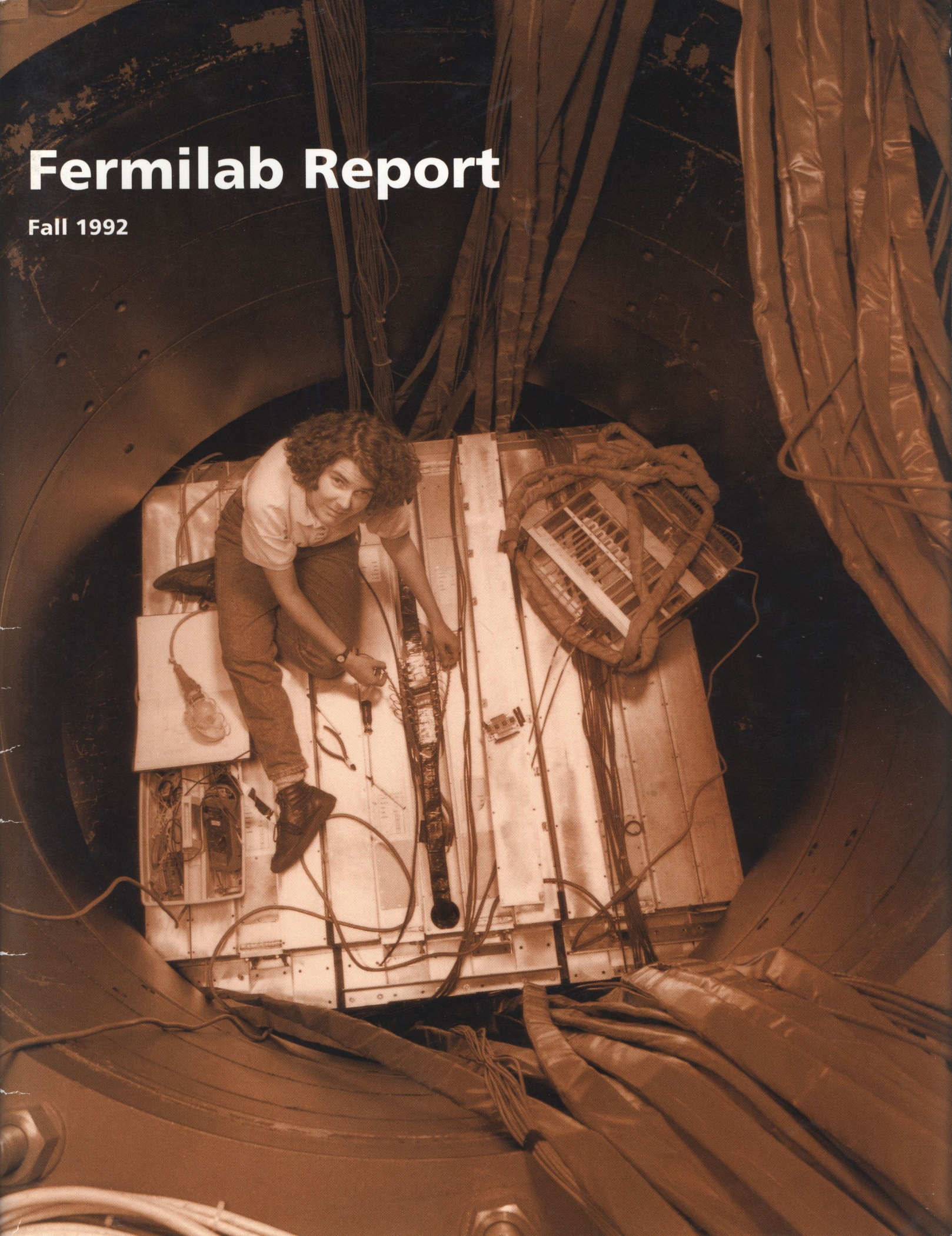
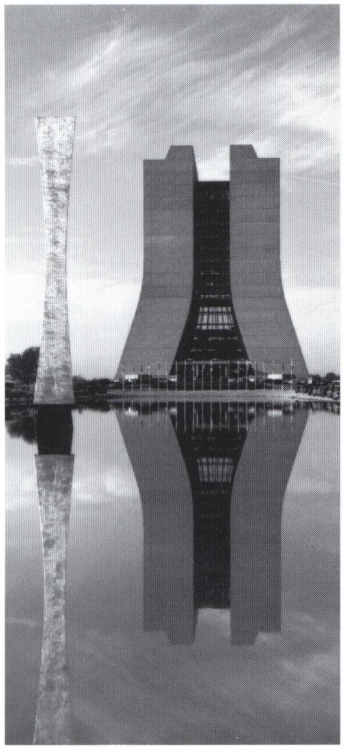
Fermilab Report

Fall 1992





Fermilab

Fermi National Accelerator Laboratory, popularly known as Fermilab, is one of the world's foremost laboratories dedicated to research in high energy physics. The Laboratory is operated by Universities Research Association, Inc. under a contract with the U. S. Department of Energy.

Since its founding in 1967, Fermilab's mission has remained unchanged: to understand the fundamental particles of matter and the forces acting between them. The principal scientific tool at Fermilab is the Tevatron—the world's first superconducting accelerator and currently the highest energy collider in the world. Protons and antiprotons travel at nearly the speed of light in the Tevatron's tunnel which is four miles in circumference.

Fermilab Report

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1992 Report and Recommendations

Physics Advisory Committee Meeting June 20-26, 1992

The Fermilab Physics Advisory Committee meets three or four times per year to advise the director about the Laboratory's scientific program and specific experimental proposals. Specific proposals are presented in open sessions to the committee, then discussed in closed session where questions and recommendations are formulated.

A one-week-long June meeting is held in Aspen, Colorado. At that extended meeting, the emphasis is on more general issues and long-range plans. The issues of particular importance at this year's meeting were the upgrades to the CDF and DØ detectors. The PAC reviewed the status of planning of the upgrades, provided the director with reports on the progress and made recommendations. These recommendations were accepted by the director and transmitted to the collaborations.

In addition, several specific proposals were discussed, and following the PAC's recommendations, the director has approved E811 (Orear) - $\bar{p}p$ Elastic Scattering, and E815 (Shaevitz) - Precision Measurements of Neutrino Neutral Current Interactions Using a Sign-Selected Beam.

As has been its custom since 1976, the committee made a number of comments of a general nature to the Laboratory director. The text follows:

General Comments and Recommendations

This has been a challenging year for Fermilab and the PAC commends the Laboratory for its responses to these challenges. The Laboratory is to be congratulated for the highly successful completion of the 1991-1992 fixed-target run and the start of the long-awaited collider run with both CDF and DØ operational. The committee appreciates the intense effort made by the Laboratory to achieve the switch-over between the fixed-target and collider operations and successfully respond to the need for a renewed appreciation of environmental, safety and health issues.

The PAC heard a status report from the Accelerator Division. It was a pleasure to hear that the newly installed Tevatron separators are

working and that the low-β systems have been fully implemented. The PAC endorses the Accelerator Division's goal of reaching a luminosity of $5 \times 10^{30} cm^{-2} sec^{-1}$ by August 1. The good progress being made on the Linac Upgrade and preparations for the Main Injector was noted. The PAC believes that the Laboratory's program for upgrading the accelerator facilities will lead to a strong physics program throughout the 1990s.

The PAC is excited about the prospects for the collider run and notes with pleasure what appears to be a very successful startup of the newly commissioned DØ detector, and the recommissioning of the CDF detector with the newly installed Silicon Vertex Detector. This run should be marked by record integrated luminosity, precision measurement of Standard Model parameters, improved measurements on *b* quarks, searches for new phenomena, and, hopefully, the discovery of the top quark. The PAC reaffirms that high-p_t physics is the highest priority part of the Laboratory's program.

At this meeting, several aspects of the planned upgrades to CDF and DØ for the next collider run (Run II) and beyond were discussed. In particular, the PAC reviewed the progress of the DØ and CDF collaborations in developing upgrades to their tracking systems capable of meeting the challenges and exploiting the opportunities expected from improvements in the performance of the Tevatron before and after the completion of the Main Injector. The Laboratory is to be commended for facilitating common R&D programs for silicon strip detectors and front-end electronics for CDF and DØ. The PAC encourages the collaborations to continue to work closely with the Laboratory to assure the success of the collider program.

In addition to maintaining and expanding the capabilities for pursuing high-p_t physics, the planned upgrades to DØ and CDF will naturally lead to increased capabilities for the study of *b* quarks. A rich program is possible, including the study of production dynamics, the spectroscopy of states, exclusive decay rates and dynamics, mixing of B_s mesons, rare decays, and tests of CP invariance. However, it remains to be demonstrated whether either detector can evolve to meet the challenge of making definitive measurements of CP violation in *B* decays or whether it will require an entirely new detector. The PAC remains convinced that *B* physics should play an important role in the future of the Laboratory.

The Laboratory is strongly encouraged to renew its efforts to facilitate the development of a strategy for a comprehensive long-range program for dedicated *B* physics at the Laboratory. The PAC endorses the Laboratory's support of a series of workshops (in conjunction with the SSC Laboratory) leading to a call for proposals for a detector capable of observing CP violation in the *B* system. The Laboratory is urged to support R&D efforts on advanced technologies relevant to the pursuit of *B* physics (e.g. vertex detectors, vertex triggering techniques, particle ID, etc.). The creation of a Laboratory facility for the development of silicon detectors is recognized as an important first step.

The PAC reaffirms the importance of the *K*-physics program of the Laboratory and of planned searches for rare and CP-violating *K*-decays, of which a measurement of ε'/ε to the 10^{-4} level remains as one of the central targets of high energy physics in the 90s.

The PAC also reaffirms the importance of the study of possible neutrino oscillations to the Laboratory program. The discovery of neutrino oscillations would imply a violation of lepton numbers, and would have implications comparable to the discoveries of P and CP violation. This physics is likely to be an important part of the future Laboratory program because of the very high neutrino fluxes made possible by the Main Injector.

The Laboratory is encouraged to resume its planning process to develop an integrated plan for both short- and long-baseline experiments, including design and costing. The NUMI report, the Report of the Neutrino Physics Review Panel, and the November '91 workshop were important steps in this direction; however progress has been very slow since their completion. The PAC urges the Laboratory to resume the planning necessary for a possible future program in this important area of physics.

The PAC received the report "Acceleration of Polarized Protons to 120 and 150 GeV in the Fermilab Main Injector." The SPIN Collaboration is commended for the effort that went into the study of the polarization possibilities at the Main Injector and into the preparation of their very useful report. The report makes a strong case for the technical

feasibility of polarized beams in the Main Injector. In order to consider fully the possible advantages of polarization at Fermilab, it is hoped that a similarly thorough study can be carried out to consider the corresponding issues of technical feasibility at the Tevatron, which are only briefly mentioned in the current report. The PAC hopes that the obvious technical strength of the SPIN Collaboration will play a role in this study. The possibility of using spin as another tool to test our understanding of the Standard Model and to look in detail for deviations is quite attractive and should be studied thoroughly, perhaps in a workshop.

The PAC took note of the progress that has been made in the analyses of data collected by thirteen experiments in the last fixed-target run. New results are expected in jet and particle production, deep inelastic muon scattering, prompt photon physics, charm decays, charmonium studies, *b* quark production and decays, a test of CPT in the *K* system, the search for and study of rare *K* decays, and measurements of hyperon decays and magnetic moments. The PAC anticipates considering the makeup of the program for the next fixed-target run during the December 1992 meeting. ■

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By studying the space-time development of a high-energy muo-produced hadron shower, we are trying to answer two fundamental questions about the nature of the quark.

Using High-Energy Muons to Probe Nucleons and Nuclei

Results from Fermilab E665

by Jorge G. Morfín for the E665 Collaboration

From its initial meetings in the early 80s, the Fermilab E665 Collaboration planned the Tevatron muon experiment with the goal in mind of studying partons within the environment of both a single nucleon as well as various nuclei in the expanded kinematic range made available by the Tevatron.

The first step towards this end was the design and construction of the Tevatron muon beam[1]. The beamline consists of 26 separate enclosures over a total length of 2500 meters making it the longest line at Fermilab and one of the longest in the world. The yield with 10^{12} 800 GeV protons on target is 10^7 muons with <E> of 490 GeV. The second step was to configure the E665 spectrometer[2] to handle the increased energy range of the secondaries. The resultant layout is shown in Figure 1 and is based on two large superconducting dipoles, the CERN Vertex Magnet and the Chicago Cyclotron Magnet. The array of targets which in the latest runs could be varied pulse-to-pulse, included H_2, D_2, C, Ca, Pb, and Xe. Tracking is accomplished with multi-wire proportional counters, drift chambers and, originally, a vertex streamer chamber which was subsequently replaced by a vertex drift chamber array. For particle identification, there are two threshold Cerenkov counters as well as a large ring imaging Cerenkov (RICH) counter.

Notation

In discussing the phenomena of muon scattering, there are standard kinematic variables used to characterize the interaction. If the incoming muon has energy E while the scattered muon has energy E' and scattering angle θ then the amount of 4-momentum transferred to the struck quark is:

$$Q^2 = 4EE' \sin^2 \theta/2 = -q^2$$

The transferred energy is

$$\upsilon = E - E'$$

with relative energy transfer

$$y = \upsilon / E$$

The ratio of the 4-momentum transferred to the energy transferred is a measure of the fraction of the total nucleon momentum carried by the struck quark, as first formulated by Bjorken;

$$x_{Bj} = Q^2 / 2M\upsilon.$$

The hadronic shower is described by the effective mass of the shower

$$W^2 = M^2 + 2M\upsilon - Q^2,$$

and individual hadrons within the

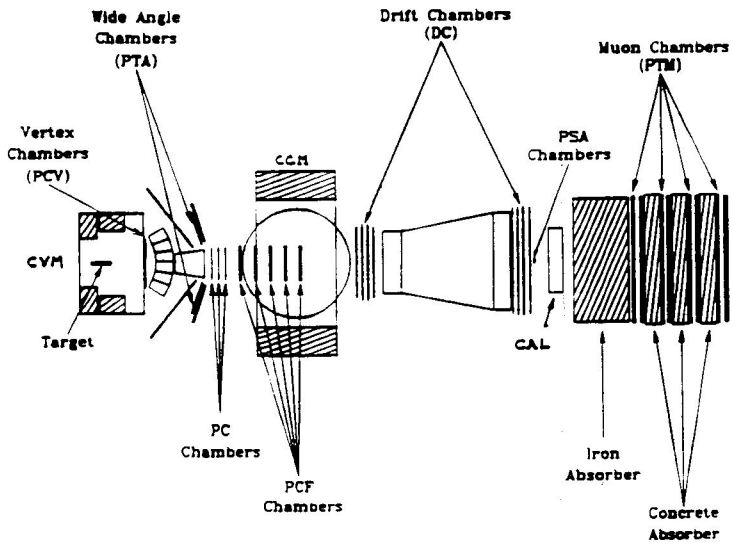


Figure 1. Plan view of the E665 Detector.

shower are characterized by the ratio of the hadron's energy to the total energy transferred to the hadron system

$$z = p / p_{max} = E_h / \upsilon.$$

Recent Physics Results

Although the physics studied in the E665 experiment is wide ranging[3], the topics which will be covered in this brief summary can be divided into two major categories: comparisons of production rates between xenon and deuterium targets and multi-jet phenomena.

Space-Time Evolution of the Hadronization Process[4]

By studying the space-time development of a high-energy muo-produced hadron shower, we are trying to answer two fundamental questions about the nature of the quark. First, what is the **quark**-nucleon cross section? Second, when does the struck quark start fragmenting into hadrons? It will become obvious that a study of nuclear effects is crucial for answering the above two questions. Experimentally, we are trying to determine what happens between the time a muon is detected as scattering within the experimental target and a shower of hadrons emerges. The process can be divided into three stages:

1. The muon transfers a fraction of its energy to a parton.
2. The parton travels through the nuclear medium and hadronizes.
3. The hadrons continue through the target material and emerge.

Stage 1 covers such topics as the hadronic nature[5] of the virtual photon which mediates the muonic interactions and the measurement of the nucleon structure function[6]. These results tell us the probability with which the photon will interact with a quark of a given flavor and what fraction of the total nucleon's momentum will be carried by the quark. Stage 3 has been studied for many years and is covered well by references[7] dealing with the passage of a particle through matter. It is stage 2 which will be the focus of the present investigation. Naturally, stage 3 phenomena also includes hard final state scatters which would take us back to stage 2, etc.

The significance of a space-time analysis of high-energy processes as well as the basic ideas were summarized by Bjorken[8] in several reports from the mid 70s. He pointed out the importance of long time intervals and large distances which had been emphasized earlier by Landau and colleagues[9]. At the time, the emission of hard hadrons was postulated to be a tail effect of a bremsstrahlung-type process of soft hadron emission. In this case, the distance required for the hadron to form in the lab is simply the time/distance for the quark to fragment to the hadron in the quark rest frame—a distance of $\approx 1/m_h$ — boosted by its Lorentz factor (E_h/m_h) into the lab. This hypothesis was consistent with the observed[10] absence of intranuclear cascading of high energy hadrons since, if $E_h/m_h^2 >$ nuclear size, the hadron is formed outside of the nuclear matter.

The main thrust of this phase of the experiment was to study the ratios of multiplicity distributions of hadrons produced in the scattering of muons off of nuclei with different radii. Examined was the ratio of differential multiplicity distributions

$$R_{A_1/A_2}(z) = \left(\frac{1}{N_\mu}\frac{dn}{dz}\right)_{A_1} \Big/ \left(\frac{1}{N_\mu}\frac{dn}{dz}\right)_{A_2}$$

and, to emphasize any nuclear effects on the leading hadrons, the ratio of integrated z distributions

$$\bar{R}_{A_1/A_2}(z_{min}) = \int_{z_{min}}^{1.0} dz \left(\frac{1}{N_\mu}\frac{dn}{dz}\right)_{A_1} \Big/ \int_{z_{min}}^{1.0} dz \left(\frac{1}{N_\mu}\frac{dn}{dz}\right)_{A_2}$$

Charged particles with $x_F > 0$ from a sample of 10,000 Xe and 10,000 D_2 events with:

$x_{Bj} > 0.003$ $\quad Q^2 > 2\ GeV^2/c^2$
$\nu > 20$ GeV $\quad y < 0.8$

were studied.

The results of the analysis are shown in Figure 2 which shows the ν dependence of $\bar{R}_{Xe/D2}$ and the ratio of $<p_t^2>_{Xe/D2}$ in the integrated z distributions. The conclusions of this study can be summarized as follows:

1. There is a depletion of (18 ± 8)% in leading hadrons (z > 0.4) when comparing xenon to deuterium at low ν.
2. There is a hint that $< p_t^2 >$ might be larger in xenon than in deuterium at low ν, again consistent with the concept that the depletion of leading hadrons is caused by rescattering within the nucleus.
3. For $\nu > 50$ GeV, the xenon and deuterium z and p_t^2 distribution are essentially equal, consistent with the hypothesis that hadronization takes place outside the nucleus.

These preliminary results are consistent with the hypothesis that there is a finite hadronization length and it is proportional to ν, the energy transferred to the parton.

Leading Hadron Production[11] and Nuclear Shadowing at very low x_{Bj}[12]

When one observes the cross section ratio of a heavy nucleus to either hydrogen or deuterium, there are various effects, evidenced by excursions from unity in the ratio, as one proceeds from high to low x_{Bj}. There is a rise in the region ($.6 < x_{Bj} < 1.0$), a depletion in the region ($.2 < x_{Bj} < .6$), a "bump" in the region ($.1 < x_{Bj} < .2$) and finally, a depletion for the very low x region ($x_{Bj} < .05$). These excursions are due to Fermi motion, the so-called EMC effect, anti-shadowing and shadowing respectively.

It is this last phenomena, shadowing, that is of interest to us here. In hadron-nucleus interactions shadowing has long been observed[13] and is assumed to be due to the nature of the interaction, which is strong, so that scattering will occur near the surface of the target nucleus. The upstream part of the nucleus "shadows" the downstream part so that the cross section varies as a function of the surface area and not the volume of the nucleus i.e., $A^{2/3}$ rather than $A^{1.0}$. This would imply that the per-nucleon cross section on nuclear targets would be smaller than that of the free nucleon.

In muon scattering, the 4-momentum is transferred from the muon to the quark (nucleus) via a virtual photon in an ostensibly non-strong interaction so that one would not expect shadowing to occur as in hadron nucleus interactions. However, shadowing has been observed both in earlier muo-production experiments and in real photon absorption as well. The data from the lowest measured x_{Bj} and Q^2 tended toward the photoproduction data although no evidence for saturation had been observed. Shadowing via real and virtual photoabsorption has historically been described as Vector Meson Dominance[14], the photon transforms into a virtual meson with the same quantum numbers as the photon. In this model, one would expect a rather strong dependence of the

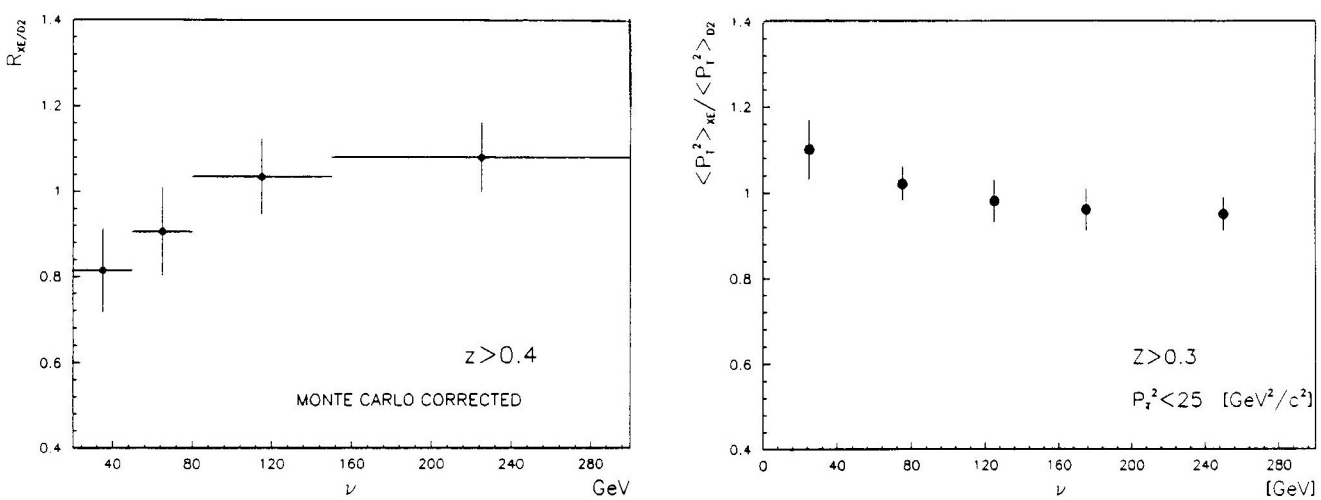


Figure 2. $\bar{R}$ and the ratio of average p_t^2 as a function of ν for a z > 0.4 cut.

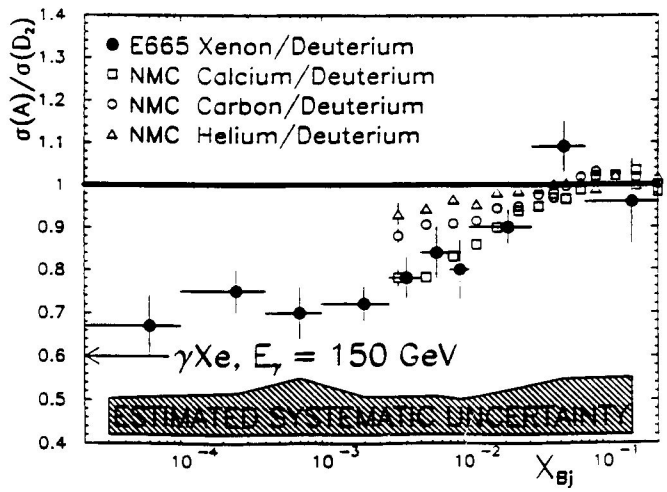


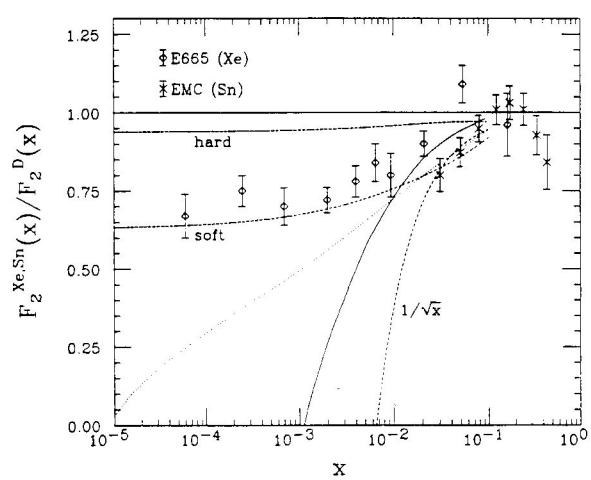
Figure 3. The ratio of xenon to deuterium cross sections as a function of x_{Bj}.

phenomena on Q^2. There have also been attempts to describe the shadowing phenomena in the framework of Quantum Chromodynamics with the use of "recombination" functions[15] which demonstrate how partons from neighboring nuclei recombine. The effect becomes more noticeable as x_{Bj} becomes smaller, since smaller x_{Bj} implies smaller quark momentum with corresponding imprecise spatial localization. When the localization becomes large with respect to nuclear size, the partons can overlap with partons in neighboring nuclei and recombine. This results in a net depletion of the small x_{Bj} partons in nucleons of a nucleus compared to free nucleons.

E665 has measured[16] the ratio of muons scattered off a pressurized xenon gas (8.5 g/cm^2, length = 113 cm) target to those from a liquid deuterium (15.5 g/cm^2, length = 115 cm) target. Figure 3 shows these measured points as well as the results from the NMC[17] shadowing experiment and a projected photoproduction value based on the results of reference 18. For x_{Bj} below 0.003 the xenon/deuterium ratio is constant at 0.72 ± 0.03 (stat) ± 0.07 (syst) indicating saturation of shadowing at very low x_{Bj}. Theoretically, this behavior can be reproduced using recombination models. As an example, Kumono[19] has demonstrated that the most important shadowing effect in his recombination model comes from modifications in the gluon distribution. By combining his calculations with various MRS[20] input gluon distributions he finds agreement with our results, as shown in Figure 4, only if he uses the MRS "soft" gluon with $xG(x) \propto (1-x)^6$.

In addition to manifesting itself in the ratio of cross sections, shadowing could conceivably alter the distribution of observed hadrons. Experiments in hadron-nucleus scattering that have observed shadowing in the ratio of cross sections have also observed[10] a correlated attenuation of the final state hadrons. To investigate the differences in the hadron shower between interactions in the shadowing and non-shadowing regimes, two kinematic regions were chosen. The first is defined by $x_{Bj} < 0.005$, $Q^2 < 1$ GeV^2/c^2 while the non-shadowing region is $x_{Bj} > 0.03$, $Q^2 > 2$ GeV^2/c^2. As can be seen from Figure 3, these are reasonable regions to compare. In contrast to the previous (space-time evolution) study of forward hadron production, a higher cut in energy transferred to the quark, $\nu >$ 50 GeV, was required. The sample analyzed was approximately 20,000 deuterium and 17,000 xenon tracks. Comparisons were made between

Figure 4. The predicitions of a recombination model[19] combined with MRS gluon distributions and compared to E665 results.



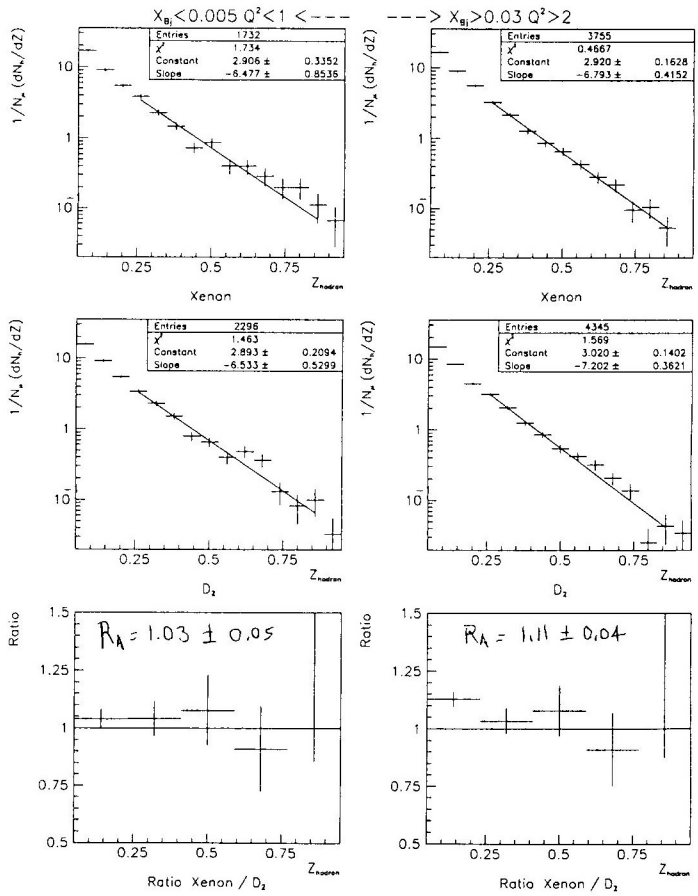


Figure 5. z distributions of D_2 and Xe in the shadowing and non-shadowing region.

the ratio of z distributions of hadrons from the xenon sample to hadrons from the deuterium sample in the two kinematic regions. If there is an effect in the hadronic jet correlated to the clear evidence for shadowing seen in the cross sections, there should be a difference in the ratios in the two kinematic regions. Figure 5 shows the ratio of z distributions in xenon and deuterium for all particles as well as the fastest in the shadowing region and the non-shadowing region. It is obvious that there is no substantial difference between the distributions from two regions. The conclusion to be drawn from this high ν analysis of the z distributions of the final state hadrons is that they show no evidence for a target dependence even in the shadowing region where significant effects are observed in the ratio of total cross sections.

Looking at the implications of our comparisons of rates between xenon and deuterium, we can draw the following overall conclusions:

1. The saturation of nuclear shadowing has been demonstrated.
2. Quarks which have absorbed energies of less than ≈50 GeV either produce hadrons within a nuclear radius or are attenuated.
3. At higher energy transfer there is no measurable difference in the distributions of fast hadrons produced in the shadowing region compared to those produced in the non-shadowing region. This is consistent with a small quark-nuclear cross section.

Rates and Characteristics of 3-Jet Events[21]

The Tevatron Muon Collaboration has recently completed the first measurement[22] of multi-jet rates produced in deep-inelastic lepton scattering. The simple Quark Parton Model predicts a backward jet and only one forward jet. Leading order QCD corrections[23] introduce additional sources of multi-forward jet phenomena; gluon bremsstrahlung and photon-gluon fusion. The rates of 3-jet events are a function of $\alpha_s(Q^2)$, the running strong coupling constant, and the parton distribution functions.

After the standard cuts to enhance the deep-inelastic sample:

$\nu > 40$ GeV $\quad 0.05 < y < 0.95$

$x_{Bj} > 0.003 \quad Q^2 > 4\ \mathrm{GeV}^2/c^2$

there were a total of 12,600 events with an average multiplicity of 5.4 particles. Only forward going particles in the CM system with lab energy greater than 2 GeV were used in the subsequent analysis.

The method employed to define jets was the JADE algorithm[24] which uses the scaled invariant mass of pairs of particles in the virtual photon-proton CM system;

$$y_{ij} = \frac{M_{ij}^2}{s^2},$$

$$M_{ij}^2 = 2\, E_i\, E_j\, (1 - \cos \varnothing_{ij})$$

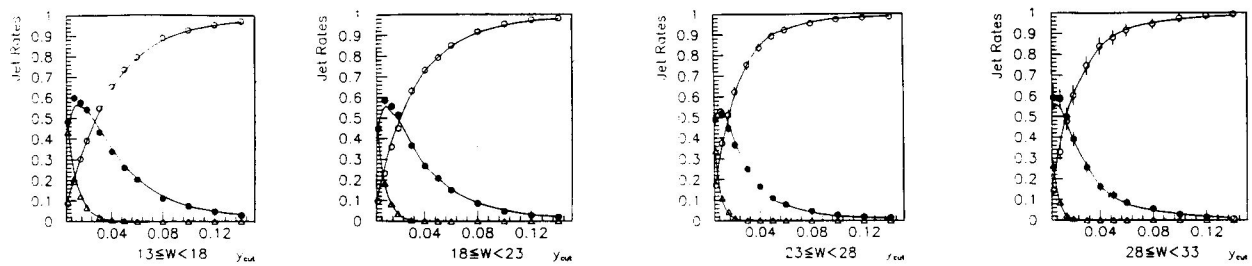


Figure 6. Corrected Rates of (forward) 1-jet (O), 2-jet (•) and 3-jet (Δ) production as a function of y_{cut} for various W bins.

with all charged particles assumed to be pions and neutral particles to be photons. If the y_{ij} is less than a chosen y_{cut}, the particles i and j are combined into a single psuedo-particle with 4-moment equal to the sum of the 4-momenta of particles i and j. This procedure is repeated until y_{ij} is greater than y_{cut}. The resulting psuedo-particles are called "jets".

The LUND[25] (LEPTO 5.2 and JETSET 6.3) Monte Carlo with Morfín-Tung[26] parton distributions was used to generate physics events which were then passed through a GEANT[27] based simulation of the detector to correct the data for resolution, reconstruction efficiency and geometrical acceptance. To check the sensitivity of the 3-jet rate to the physics generator employed, both a leading order QCD matrix element method and a QCD parton shower method were used to generate events.

Figure 6 shows the rate of 1, 2 and 3 forward jet events as a function of y_{cut} and for different ranges of the hadronic invariant mass W. Note that as y_{cut} increases, more and more (pseudo-) particles must be combined to survive the cut and, eventually, only "1 forward-jet" events are left. For a given y_{cut} the change in the observed rate of 2 forward-jet events as a function of W can be compared with Monte Carlo predictions. Leading order PQCD[28] predicts that the two forward-jet rate falls as W increases when the JADE algorithm is used to define jets. This is true whether one uses the matrix element (ME) or the parton shower (PS) methods, as can be seen in Figure 7 which displays this rate as a function of W for a value of y_{cut} = 0.04. The experimental points, corrected with the matrix element based Monte Carlo, are in excellent agreement with both the matrix element and the parton shower predictions. Figure 7 also displays the simple quark parton model predictions (no QCD), using the LUND Monte Carlo, which are in strong disagreement with the measured points.

The Future of E665 and the Tevatron Muon Collaboration

E665 completed data taking with the last fixed-target run and the spectrometer is presently being dismantled. However, there is much work still to be done by the collaboration. We are currently publishing results based on the earliest run and are in the process of analyzing an additional 150M triggers from more recent runs. To date, the experiment has produced 15 Ph.D.s with at least another 14 candidates expected to cover such topics as:

- Extraction of G(x) from photon gluon fusion (3-jet) events,
- The ratio of n/p cross sections particularly at small x_{Bj},

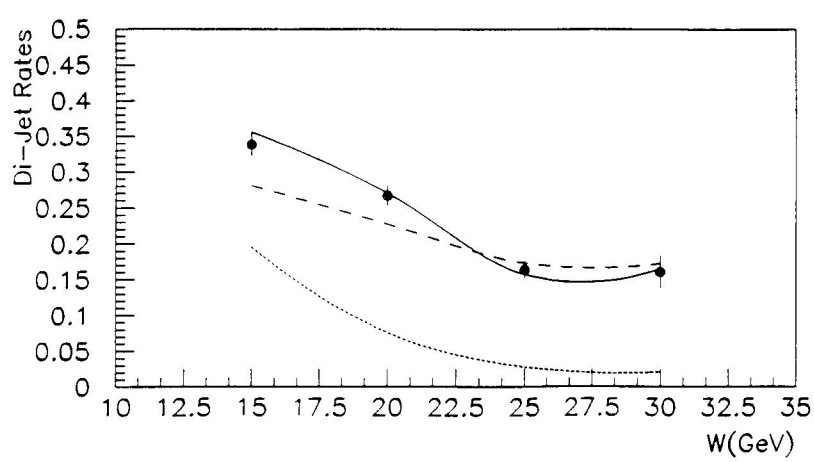


Figure 7. Corrected 2-jet rates vs W compared to LUND ME (solid), LUND PS (dashed) and without QCD (dotted) predictions.

- A measurement of α_s from the p_t^2 distribution of jets,
- The intrinsic k_t of partons within the proton,
- Strange particle production,
- Bose-Einstein correlations,
- The A dependence of leading particle production,
- The A dependence of fragmentation,
- Strangeness correlations,
- The ν dependence of fragmentation (with increased statistics),
- A study of slow neutrons,
- A measurement of the absolute structure function F_2 from H_2 and D_2. ■

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Photo page 4: Three members of the E665 collaboration reflected in the mirror of the Ring Imaging Cerenkov Counter (RICH).

The Contributor

Jorge Morfin joined the staff at Fermilab in November 1980 to work on the design and construction of the Tevatron Muon Beam and the E665 spectrometer as part of the Tevatron muon collaboration. He took part in the E594 neutrino experiment. He has helped organize and edit the Proceedings of Snowmass Summer Studies as well as several Fermilab topical workshops. Most recently, Morfin helped form the Coordinated Theoretical-Experimental QCD (CTEQ) Collaboration and organized the First CTEQ Summer School held in June of this year. He has been a member of the SLAC Nuclear PAC and was just invited to serve on the SLAC EPAC. He is also helping the Research Division integrate ES&H activities into the evolution of new experiments directly from the proposal stage.

Morfin has had a long-standing interest in aiding the development of physics research and education in third-world countries and just completed a term as the elected chair of the International Physics Group of the American Physical Society. He was subsequently appointed to the Committee on International Scientific Affairs of the A.P.S. He is a member of the Fermilab Auditorium Committee and chairs the Fermilab Minority Internship Committee. ■

The Accelerator Division looks forward with confidence to face the projected increased intenstity for the future fixed-target runs.

The 1991 Fixed-Target Run

by Craig Moore

The scheduled hiatus in the fixed-target program was extended due to the Laboratory-wide shielding review. After careful study, the main remediations were the additions of earth shielding and a number of interlocked radiation detectors.

A few perturbations had to be dealt with during the start up of the fixed-target run. The radiation shielding added to the Main Ring near the BØ overpass caused the magnets to settle as much as four millimeters. The newly installed radiation monitors tripped due to a lack of weather proofing and shut down operations unnecssarily. Another change was the installation of new quadrupoles in the Tevatron with a concomitant change in the machine parameters that adversely affected extraction for a while.

Nevertheless, we were able to start the fixed-target program on schedule with the requisite intensity, and the average weekly efficiency for this run was 73 percent, the same as for the 1990 fixed-target run. These efficiencies mean that these two runs were the smoothest in Laboratory history, in terms of hours of beam delivered to the experiments. The weekly averages are shown in figure 1 on page 13. Note there were several weeks with low efficiency. The first of these (week 4) was due to our attempt to replicate a Southwestern delicacy, fried snake. A curious snake got the shock of this life when he investigated one of our high-power cubicles. We have attempted to critter proof the rest of our cubicles and so far we have succeeded. Week 10 does not stand out especially, even though we had a fire in a transformer near the G2 service building. The fire did not impact the program due to a great effort by the whole Laboratory complex akin to the old-time response to a barn burning. The technical objective was to keep the Switchyard cryo systems in a state of readiness even though there was no conventional electrical power or computer controls. Approximately two days of running were saved by the valiant efforts of many groups, including Facilities Engineering Services Section, the Accelerator Electrical Engineering Support department, the Switchyard group, the Accelerator Cryo group, and especially, the Accelerator Operations group. Some of the old-time spirit was displayed, and it is a pleasure to remember the occasion.

Weeks 18 and 19 show the effects of the one instance of a Tevatron dipole failure. A very important contribution to the smoothness of the present running was the systematic implementation of improved lead restraints for the Tevatron dipoles. Since this one failure contributed to two weeks of inefficient running, one can estimate from the efficiency graph how multiple failures must have affected previous runs, and if one examines the graph of HEP hours which compares the two most recent runs with the immediately preceding, one can see the effect graphically.

As mentioned above, the two most recent runs have had exceptional stability and smoothness in terms of the hours of beam delivered to the experiments. However, the experimenters also desire smooth running on shorter time scales, i.e., spill quality. This run had occasional episodes of intensity-dependent instability in the spill that were not due to a simple cause such as ripple in a power supply. The extent of the problem for experimenters ranged from negligible to bothersome depending on the details of the experimental apparatus. In addition, not knowing the cause of the instability was a source of concern for the upcoming collider run, and especially for future fixed-target runs with the expected higher intensity from the scheduled upgrades. Finally, near the end of the run, the problem was isolated in the rf system by Pat Colestock and Gerry Jackson.

Summarizing, in the last fixed-target run, the accelerator delivered over 2E18 protons to the experiments in a smooth and steady manner and the Accelerator Division looks forward with confidence to face the projected increased intensity for the future fixed-target runs. ■

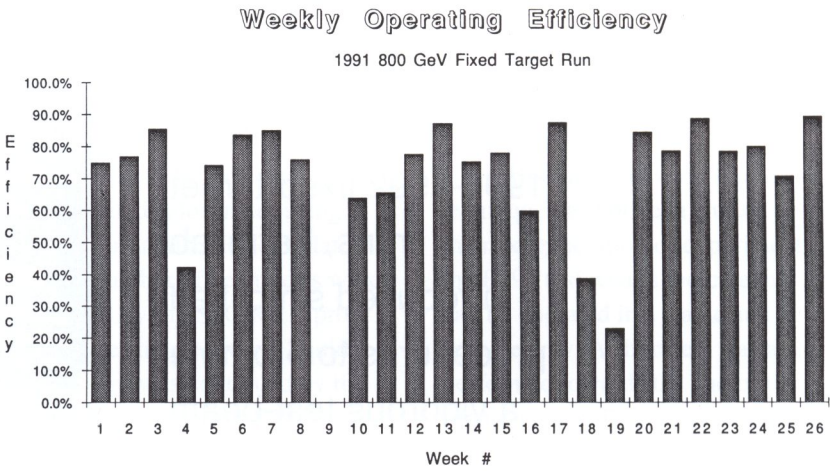


Figure 1.

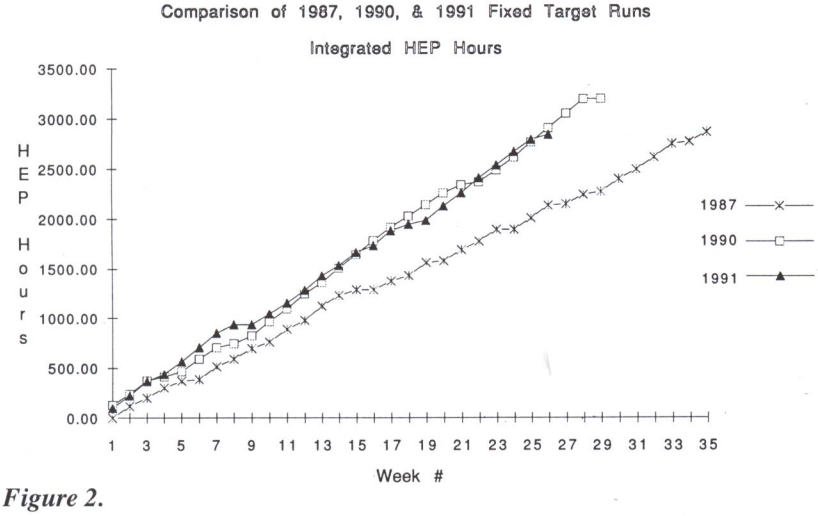
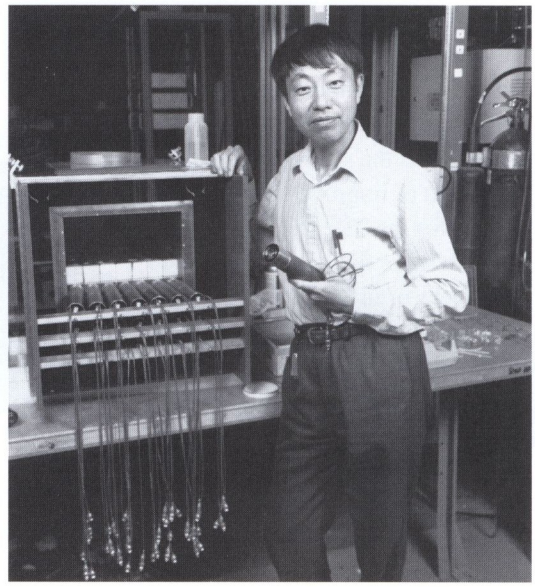


Figure 2.

The Contributor

Craig Moore joined the Radiation Physics group at Fermilab in 1973 where he participated in experiments which studied hadronic cascades in shielding. In 1976, he joined the Accelerator Division and built the beam line from the Linac to the Cooling Ring. After joining the Main Ring group, he was involved in beam dynamics studies including alignment and closed orbit control questions which led to his involvement in the Tevatron alignment, the initial alignment of the CDF detector and the alignment of the two Main Ring overpasses. In 1989, he joined the Switchyard and was department head and fixed-target run coordinator during the two recent fixed-target runs. During the shielding hiatus between the two runs, he returned to Radiation Physics and was heavily involved in the Switchyard shielding assessment and served on the Accelerator Division Shielding Assessment Committee. ■

For the completed 1990-1992 fixed-target runs, Fermilab introduced simplified procedures to promote a vigorous test-beam program.



Beam Tests at Fermilab during the 1990-1992 Fixed-Target Runs

by Carlos Hojvat

Experimental Elementary Particle Physics faces the challenge of developing detectors capable of operating at the high-event rates expected at the Superconducting Super Collider Laboratory. Beam tests of new technologies and of specific designs are an important step in the design of the new detectors.

For the completed 1990-1992 fixed-target runs, Fermilab introduced simplified procedures to promote a vigorous test-beam program. In addition, the Research Division appointed Carlos Hojvat, associate head of the Research Facilities Department, as test-beams coordinator for non-Fermilab beam tests. The role of the coordinator is to assist Fermilab's Program Planning Office in dealing with the many requests for test-beam time, to suggest beamlines and floor space assignments and to facilitate the realization of the tests. The coordinator is to evaluate future requirements and to develop the necessary plans to make facilities available for this purpose. An important requirement is that the test-beam activities must be compatible with Fermilab's extensive research program.

During the 1990-1992 runs, Romesh Sood, the assistant head of the Research Facilities Department, also participated actively in implementing the test-beam program.

Test-beam requests can be approved by the Program Planning Office through simplified procedures and are designated with the prefix "T." The prefix "E" refers to more extensive requests approved through the same procedure as proposals for actual experiments.

Experiments at the Fermilab Collider, CDF and DØ, carried out intense beam tests and calibration programs during the 1990-1992 runs, in parallel with the rest of the test-beams. Experiment E781, to run during the next fixed-target run, conducted prototype tests in the Proton Center Beamline. The activities of these three groups are not reported here.

For the immediate future, Fermilab and the experimental groups proposing the SDC and GEM detectors for the SSC Laboratory are in the process of understanding the requirements for the beam testing of SSC detector prototypes and systems during the next fixed-target run at Fermilab.

The 1990-1992 Program

A total of 22 different proposals for test-beams were completed during this period. These were installed on nine different beamlines and locations throughout Fermilab. In most cases, several tests shared beam time in the same beamline with local scheduling meetings taking place weekly to organize the data taking. The beam tests that took place during this runs are listed in Table 1.

One of the larger efforts was E790 (Spokesperson: F. Sciulli, Columbia University), calorimeter calibration for the ZEUS Experiment at the HERA collider in Germany. It was installed in the Neutrino Test Beamline upgraded for better momentum resolution for this run. The study of a prototype calorimeter module was followed by the calibration of the production modules with both hadrons and electrons. The modules weighing approximately 10 tons each, form a compensated calorimeter using depleted uranium and scintillator.

A number of beam tests were supported by the SSC/R&D program. The study of warm liquid calorimetry was continued by the WALIC collaboration E795 (Spokesperson: M. Pripstein, Lawrence Berkeley Laboratory) in the Meson Test Beamline. This beamline was shared with the CDF test and calibration set up. The tetramethyl pentane (TMP) liquid was contained in thin stainless steel containers interspersed with absorbers in a "hanging file" setup to form a calorimeter module. This arrangement allowed for rapid changes of the ratio between active and passive media, as well as of the material used.

Although the warm liquid technique has not been chosen by the next generation of experiments, the E795 test results indicate that it can be operated in a stable and reliable way. A short test was also performed towards the end of the running using TMP in a "swimming pool" configuration that involved the passive material being immersed in a container filled with the liquid.

Solid state pixel detectors were tested by T852 (Spokesperson: E. Arens, University of California, Berkeley Space Sciences Laboratory) and the dE/dx of muons measured by T855 (Spokesperson: G. Kalbfleisch, University of

Exp. #	Loc.	Description	Spokesperson	Affiliation		#
T840	MP	Scintillator Fiber Calorimetry	A. Para	Fermilab	(SSCL)	1
T841P	MP	Tiles Calorimetry-Hanging File	L. Price	ANL	(SSCL)	2
T844	MP	Test for Balloon Experiment	S. P. Swordy	U of Chicago		3
E784	MT	BCD Test Beam	N. Lockyer	U of Pennsylvania		4
E795	MT	TMP Warm Liquid Calorimetry	M. Pripstein	LBL	(SSCL)	5
T841T	MT	Tiles Calorimetry-Hanging File	L. Price	ANL	(SSCL)	6
T816	NM	Muon Tracking Studies	H. Lubatti	U of Washington	(SSCL)	7
T817	NM	Silicon Detector Tracking	J. Alexander	Cornell University		8
T819	NM	Muon Tracking Prototype	L. S. Osborne	MIT	(SSCL)	9
T839	NM	Scintillating Fiber Tracking	S. Margulies	U of Illinois/Chicago	(SSCL)	10
T852	NM	Pixel Detector Test	E. Arens	U of California/BSSL	(SSCL)	11
T855	NM	dE/dx of Muons 150/650 GeV	G. Kalbfleisch	U of Oklahoma	(SSCL)	12
T856	NM	Integrated Pixel Detector	S. Parker	U of Hawaii		13
E790	NT	Calorimeter Calibration, ZEUS	F. Sciulli	Columbia University	(HERA)	14
T848	NT	Electromagnetic Calorimeter Test	N. Giokaris	Rockefeller University	(SSCL)	15
T849	NT	BaF EM Calorimetry Test	H. Kobrak	U of California/San Diego	(SSCL)	16
T821	NW	Neutron Spectrum	K. Johns	U of Arizona	(SSCL)	17
T797	PE	Fast Gas Calorimetry	R. Thun	U of Michigan	(SSCL)	18
T798	PE	Pre-Shower/ Synchrotron Rad.	P. Cushman	Yale University	(SSCL)	19
T807	PE	Liquid Cerenkov Radiators	S. Tiege	Rutgers University		20
T842	PB	EM Calorimeter-Neutral Dump	D. Underwood	ANL		21
T851	C0	Radiation Damage to Fibers	S. Margulies	U of Illinois/Chicago	(SSCL)	22

Table 1. Research Division Completed Beam Tests during the 1990-1992 Fixed-Target Runs.

Oklahoma), both in the New Muon Beamline.

In the Neutrino Test Beamline, T848 (Spokesperson: N. Giokaris, Rockefeller University) conducted tests of a prototype high-pressure gas chamber as a candidate for radiation hard forward calorimetry.

In the Neutrino West Beamline, T821 (Spokesperson: K. Johns, University of Arizona) conducted measurements of the neutron spectra caused by the interaction of hadrons within calorimeters.

Two beam tests were performed in the Proton East Beamline. T797 (Spokesperson: R. Thun, University of Michigan) conducted studies of fast calorimetry using gas chambers as the active media and T798 (Spokespersons: P. Cushman, Yale University and R. Rusack, Rockefeller University) studied a prototype scintillating fiber shower maximum detector and the possibility of identifying electrons by the associated synchrotron radiation in the magnetic fields to be present in the proposed SSC detectors.

The Meson Polarized Beamline also hosted a series of SSC/R&D scintillating fiber calorimeter tests under T840 (Spokesperson: A. Para, Fermilab). A variety of prototypes built using different techniques were tested, e.g., low-temperature lead alloy cast around fibers, two-color optical fibers for longitudinal segmentation, etc.

The Meson Test Beamline was also occupied by the E784 BCD Test Beam (Bottom Collider Detector, Spokesperson: N. Lockyer, University of Pennsylvania). Prototypes for a RICH counter with CsI photocathodes and freon radiator, silicon vertex detectors and straw tracking chambers were studied.

l to r, J. Zimmerman, L. Demortier, D. Khazins, G. Fanourakis, S. Cihangir and N. Giokaris (spokesperson) surround the high-pressure gas chambers of the T848 apparatus before installation in the NT beam line.

A number of SSC/SDC supported beam test activities also took place. Hadronic and electromagnetic prototypes built with the fiber and tile technique were tested in the Meson Polarized Beamline by the T841P collaboration (Spokesperson: L. Price, Argonne National Laboratory). This test included studies of shower maximum detectors. A subset of the same group, T841T in the Meson Test Beamline, conducted tests with the same tile and fiber technique in a "hanging file" configuration to optimize the ratio between the amounts of active versus passive material and the type of passive material employed.

Studies of gas chambers and Cerenkov counters for muon tracking were conducted by T816 (Spokesperson: H. Lubatti, University of Washington) in the New Muon Beamline. Prototype devices for scintillating fiber tracking were also tested in the New Muon Beamline by T839 (Spokesperson: S. Margulies, University of Illinois/Chicago) including a short test of the first available VLPC's (Visual Light Photon Counters) solid state photon detectors.

Several groups associated with the SSC/GEM collaboration conducted beam tests. T849 (Spokesperson: H. Kobrak, University of California/San Diego) conducted tests of a prototype BaF calorimeter with triode photomultipliers in the Neutrino Test Beamline following the completion of E790.

Gas chambers for muon tracking were tested by T819 (Spokesperson: L.S. Osborne, M.I.T.) in the New Muon Beamline. Some tests associated with this group were done in conjunction with

T840, mentioned elsewhere.

A number of independent efforts were conducted with muons in the New Muon Beamline behind the E665 experiment. T817 (Spokesperson: J. Alexander, Cornell University) conducted tracking studies with silicon detectors to be used at the Cornell electron-positron collider. T856 (Spokesperson: S. Parker, University of Hawaii) tested a new form of integrated pixel detector. A study of liquid Cerenkov radiators was conducted in the Proton East Beamline by T807 (Spokesperson: S. Tiege, Rutgers University).

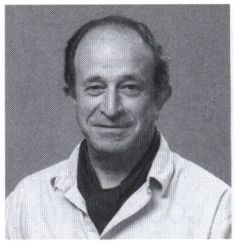
Two studies of radiation damage to fibers and scintillators were conducted. T842 (Spokesperson: D. Underwood, Argonne National Laboratory) exposed a number of electromagnetic modules composed of scintillator and lead to the radiation from the neutral beam dump in the Proton Broad Band Beamline. T851 (Spokesperson: S. Margulies, University of Illinois/ Chicago) exposed scintillating fibers held in different gaseous atmospheres to the tunnel radiation at CØ.

Under the denomination T844, (Spokesperson: S.P. Swordy, University of Chicago) an electromagnetic calorimeter module to be used in a balloon flight was calibrated in the Meson Polarized Beamline. A preliminary test of a liquid scintillator capillary module also took place in the same beamline.

Acknowledgments

The approval, design, installation, safety reviews, and operation of a large number of experiments required significant effort from the Research Division technical support and operation groups at Fermilab. Their contribution to the success of the test-beam program during the recently completed 1990-1992 fixed-target runs is gratefully acknowledged. Spokespersons and experimental groups in beamlines where beam tests were conducted were helpful and cooperated graciously with newly found colleagues. ■

The contributor



Carlos Hojvat joined Fermilab in 1977. He is presently associate head of the Research Facilities Department of the Research Division and is responsible for the Technical Support Group. Hojvat is also the Fermilab Coordinator of test-beams, working closely with the Fermilab Program Planning Office. He is associated with the now completed E735 collider experiment. On October 1, 1992, he was appointed to a new position with Program Planning in the Fermilab Directorate. ■

Photo page 14: Wei Zhongying standing next to a partially completed array of BaF detectors for beam test T849. The completed array was tested in the NT beam line.

The fixed-target control system known as EPICURE can be viewed as a network of cooperating processors.

EPICURE Control System

by Therese Watts

What is Epicure

The fixed-target control system known as EPICURE, Experimental Physics Interactive Controls User Resource Enhancement, was commissioned into operational status for the fixed-target run that began in February of 1990. EPICURE consists of multiple layers of interfaces for communication between logical tasks. This approach provides the capability of upgrading specific portions of the system often without impact or dependency on the surrounding layers. This provides a great deal of flexibility and many potential directions for future expansion. EPICURE can be viewed as a network of cooperating processors.

Accessibility/User Base

EPICURE is accessible via any DECnet node and can be installed on any VMS-based VAX on DECnet. This means that EPICURE users can be located essentially anywhere and have access to the entire control system. The core computing for the operational EPICURE system is comprised of a VAX/VMS cluster known as DISNEY. The DISNEY cluster supports 38 workstation nodes and 250 user accounts. Terminal service to EPICURE is available in 98 percent of the service buildings throughout the beamline area. Wherever you are in the beamlines, EPICURE service is never far away.

Once a user logs into DISNEY, many EPICURE programs are readily accessible by simply typing the word MENU. This will invoke the MENU program which provides a menu of program choices from which the user can easily invoke an EPICURE program.[1] Users can create their own menus to tailor the EPICURE interface to particular needs.

System services are made accessible to the application programmer through User Task Interface (UTI) routines. These routines provide a straightforward means for accessing EPICURE services via any Fortran or C application, thus allowing any EPICURE user to write powerful application programs. The tools required to write programs tailored to specific experimental needs are readily available. We encourage beamline physicists to take advantage of these tools.[2] The UTIs that currently exist include interfaces to the alarm system, database, data acquisition, data setting, screen

management, device scaling, network, timer system, event queue handling, file and data format conversion services. EPICURE library help information and example programs are readily accessible on-line. Detailed written documentation exists for all EPICURE products.[3, 4, 5]

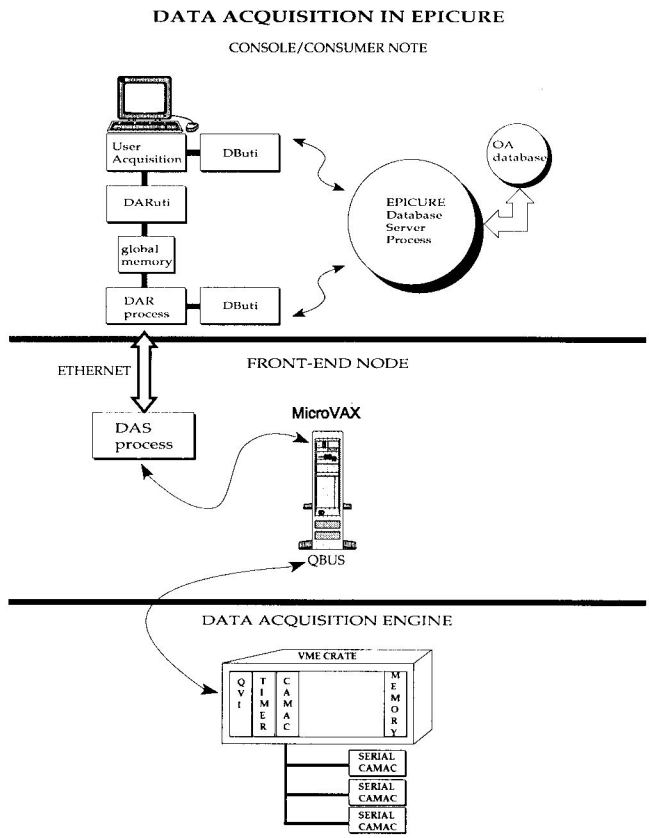
Consistent View

The EPICURE system has combined into a single view data from CAMAC, cryogenics and the interlock systems. Information from any of these systems is available through the PAGE application which supports readback, setting, status and control for all of these systems, alleviating the need for many special application programs.

The PAGE application allows the user to select the periodic rate or clock event time at which each device should be updated, and allows each user to set up private page views.[6] PAGE is a powerful application made possible in large part by the underlying EPICURE database and front-end device support routines. The designers of EPICURE focused on the goal of making all experimental devices readily accessible by PAGE and have achieved this goal. In EPICURE, you speak to all devices using the same interface routines.

Alarm information is likewise available for any monitored device through the alarm display application ALMDISP.[7] Any device can be setup to be monitored using the application program ALCON.[8] Site Operations controls device monitoring setup.

Any user can view the device monitor setup using the "Monitored Alarms Report" program.[9] All 'set' operations in EPICURE have privilege and protection schemes associated with them. Issuance of privilege is administered by Site Operations.



The EPICURE database editor, DBEDIT, allows any user to view all database information present about a device and gives Site Operations and other authorized users the ability to quickly modify or rename existing devices, enter new devices, or delete obsolete devices. Device creation is based on templates or existing devices.[10] Device change history is tracked and can be viewed using the DBHist application.[11] The EPICURE database currently supports 282 unique templates, 14,943 normal device entries and 112 synthetic device entries. Synthetic devices are values synthesized from multiple readbacks from physical hardware. The value of a synthetic device is the function of several other device values (component devices) and constants.[12]

Diagnostic programs such as TOOLKIT give a user an overview of the status of crates throughout an entire beamline and allow a user to zoom in on a particular crate to discover what modules are present and what data base entries are associated with each piece of physical hardware.[13]

Many other essential application programs such as Preserve - Save and Restore, SEM/Device Logging, SWICPIC, Swic Scanner Setup, and Beam Allocation were programmed by Site Operations. SOD and RD/Controls worked

closely together to make the EPICURE system a success. Close cooperation between these groups was fostered throughout the project. Prior to the run, operators worked daily with us on data base entry, programming and documentation. They also frequently worked with us during the run to resolve problems or lay future plans.

The EPICURE environment supports DEC workstations and VT2xx and VT3xx type terminals. Workstation users do their work in multiple active windows. Mouse control is implemented and pull-down and pop-up menus are often provided resulting in few operator motions being required to select an action. A standard look and feel is provided to interactive application programs by the use of Epicure Screen Management library routines.

EPICURE Hardware

Some of the oldest and most trouble-prone hardware in the beamline areas has been and continues to be replaced. These old modules are being replaced with new modules that include intelligence. These replacements have greatly improved system reliability and capability. New modules that have been commissioned include new Crate Controllers and Link Repeaters, C1151 ramping power supply controllers, C1011 RD/MADCs, C1045 Motor Controller Interface, C116 Safety System Interface, C1003 Teslameter Interface, C1013 Cryogenic Thermometer Interface, C1015 Zip-Tracker DTM Interface, C1111 Actuator Controller, C1113 Compressor Controller, and the C1170 CIA Crate Interface.

All Epicure Hardware is built to recognize TEV clock events, although the beamline areas are not yet running on TEV clock.

Intelligent EPICURE Hardware modules all come complete with in-house debugger software! This improves our capabilities to identify and respond to module problems. Additional personal computer-based debugger tools exist that allow technicians to capture detailed device information while working in the field.

EPICURE Data Acquisition System

The front-end systems that drive data acquisition are comprised of a VAX 3200 that interfaces from Qbus to VMEbus via the Qbus to VME Interface (QV I) module. Each Camac VME front-end system, known as the Data Acquisition Engine (DAE), currently consists of two 386-based processors and each CRYO VME front-end system consists of one 386-based processor. Within these VME processors resides the code to read data request packets to decide at which time data should be collected, schedule the periodic collection of data, send out the proper requests to acquire the data and format the return data packets. Data is then handed over the QVI to the Data Acquisition Server (DAS) process that resides on the VAX front-end. These replies will then be delivered to the requesting Data Acquisition Requestor (DAR) process. A DAR process runs on each EPICURE console node.

The CAMAC front-end systems are configured to support full fail-over. This means if one front-end fails to function, the remaining front-ends take on the task of acquiring its data requests. This increases system reliability, as no part of the CAMAC beamline is ever dependent on any one front-end to function. This past run has proven these systems to be very reliable!

What Remains to be Accomplished

While the system essentials are now in place, many tasks remain to be done. The EPICURE Control System was designed so that it could evolve and future needs could be met by upgrades and enhancements rather than replacement. This section will describe some of the tasks we are currently undertaking or plan to begin work on soon.

Organizational Tools

While programs written within RD/Controls are under code management control (CMS), we currently have no means to capture and centralize user-written applications. We believe that centralization of these resources would allow us to collect, performance test, rework, maintain and document a pool of experimenter resource programs that could be shared and used for the benefit of many. Through a pool of managed programs, we could improve the users' accessibility to work already done to solve common problems and realize quality improvements in the software program. At the very least, such a pool would provide a central pool of the source code and build procedures for all EPICURE-related programs. I hope we can organize a cooperative effort with beamline physicists and operations to bring this item to fruition.

Software Futures

No interactive data base report generator is currently available in EPICURE, but work is currently underway on this project.[14] Users will be able to request interactive data base reports custom-tailored to their needs. We expect many aspects of this program to be complete by the end of this year. EPICURE currently supports a set of canned reports that are updated on a daily basis.

Much interest is being expressed on the part of beamline physicists to automate the tuning of beam. Design discussions are just now getting underway between RD/Controls and beamline physicists to define the process that would be required and set a direction to put in place the support and applications required to meet this ambitious goal.

No generalized EPICURE product exists to support long-term global data logging. Such information is required for experimenters to view trends and analyze device relationships by invoking history plots. Such an application is desirable.

It is necessary that EPICURE move to support new windowing platforms. We intend to move towards support of the EPICURE environment using MOTIF. This change in the windowing system will effect screen management. New developer workstations are required to allow us to reach this goal.

While the EPICURE alarm system is fully commissioned for device support, alarm event support remains to be done. Additionally, only the highest level alarm monitor routines have been implemented to date. It is desireable that we work to implement low-level alarm monitor processes as planned for in the original design.[15] Plans also exist for integrating knowledge of device alarms into the PAGE application.

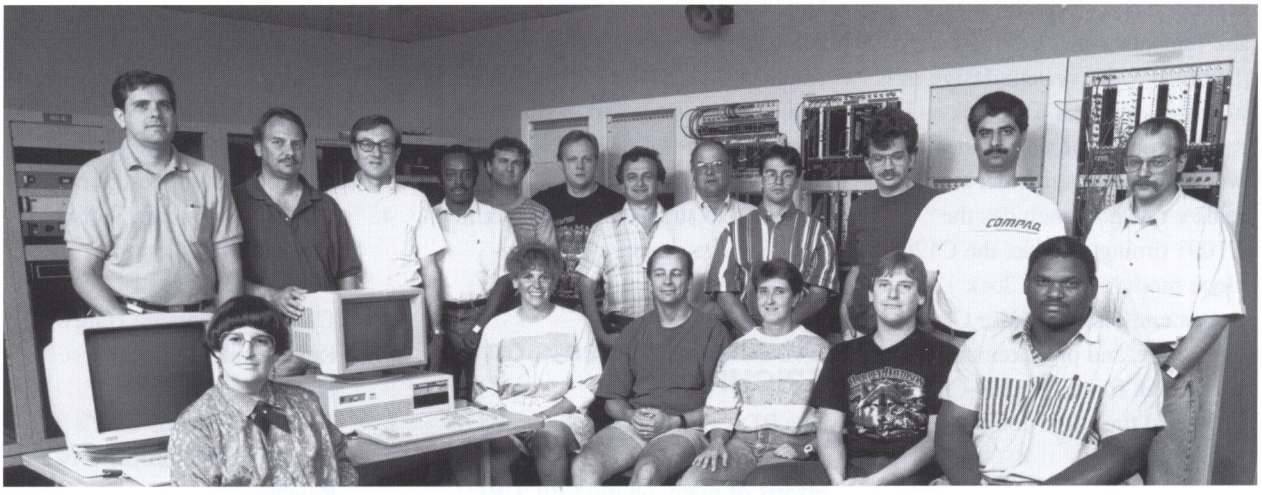
Many support applications are required for new hardware modules such as the C1080, a new cryogenics interface module which requires PID loop, linked logic, and download support applications, and the C1200, a new Experimental Area TEV clock generation module which requires a TEV clock support page for both internal and external modes of operation.

It is desireable that EPICURE begin to introduce greater use of graphical displays into application programs. CRYO users are especially interested in having these capabilities. Few graphical applications within EPICURE have been accomplished to date, but the capabilities for graphical development are certainly present.

While both fast-and slow-time plot applications exist, many plot features remain to be added.

Hardware Futures

Although much progress has been made on the upgrade of early 70s vintage hardware, many cards of this era remain in the beamlines. Even integrated circuits don't last forever, and failing boards often can't be repaired due to obsolete parts. We need to continue to aggressively pursue the upgrade



l to r (back) Allen Forni, Al Legan, Robert West, Johnny Green, Monty Emmons, Terry Kiper, Mark Kozlovsky, Terry O'Brien, David Kline, John DeVoy, Kal Dabous, Ed Dambik. (front) Debra Baddorf, Therese Watts, Brian Kramper, Cyndee Chopp, Mike Kuplic, Larry English, (missing) Jerry Dychakowsky.

programs that are now well underway and continue to work towards upgrade of trouble-prone modules.

With the addition of intelligent modules in the beamline areas, we now need local intelligence coordinators and fast data transfer networks. These goals could be realized by support of an in-house LAN. These improvements would result in better overall system performance, improved acquisition rates and the possibility of implementing intelligent feedback control at the house level. One area in which this is essential is the readback of SWICS. Without this capability, automation of beam tuning will be an exercise in frustration for all. Hardware work that has been underway to address these needs include the C1010 Intelligent MADC Controller, the C1032 SWIC Interface Module, ARCnet bridges and hubs, and the C1080 Multibus Interface.

We need to continue work towards conversion of the beamline to TEV clock, so that both the Research and Accelerator Division use one lab-wide clock system.[16] The EPICURE system design has always assumed TEV clock as its main timing source. Hardware work that has been underway to realize this goal includes the C1091 timing module, the C1200 clock module, TEV Clock Repeaters, TEV to Phase Clock Converter, and procurement of a Fiber Link from the TEV Clock Source in the MAC room to the beamlines.

Future Data Acquisition System

It is desirable to enhance the DAE component to include processors for receipt of fast data block transfers and alarm processing. Work is now starting on development of the fast data block transfer receiver module, known as the LISTENER. We anticipate that future front-end systems will consist of four processor modules, the current TIMER and CAMAC processors, enhanced by the LISTENER and an Alarm Processor. The processor board chosen for LISTENER development uses the RISC-based 960 processor.

Purchases are currently being made to start work on support of TURBO-channel for replacement of the QVI component of the front-end systems. The Qbus transfers are slow relative to other front-end data transfer capabilities, and therefore, we are hopeful that the TURBO channel will prove to be a suitable replacement that will result in increased acquisition rates.

Success of the C1080 Multibus Interface previously mentioned, would allow the CAMAC and CRYO front-ends to be identical. There would be only one type of EPICURE front-end system. This potentially would allow us to enhance the number of front-ends behind the system and available to participate in fail-over support. This would also mean less unique front-end code to support. CRYO would gain failover support, hence increased reliability for all.

Closing Comments on EPICURE

The RD/Controls group is proud of the success that was realized by the efforts of many on the EPICURE system through this past fixed-target run. RD/Controls has many ideas of how to continue to improve the system and hopes to have the opportunity to turn these ideas into reality. All group members have done a marvelous job in making and keeping the EPICURE Control System running smoothly through the entire fixed-target run.

The EPICURE system resulted from a good teamwork effort not only among the members of RD/Controls, but also with Site Operations, Cryo and beamline physicists. The success of the system would not be possible without the cooperation and commitment from all of these parties. We thank them for their help.

I would furthermore like to acknowledge and thank the past leadership in the RD/Controls group: Al Thomas, Walter Knopf and Frank Nagy, for laying a good foundation on which we all could build. ■

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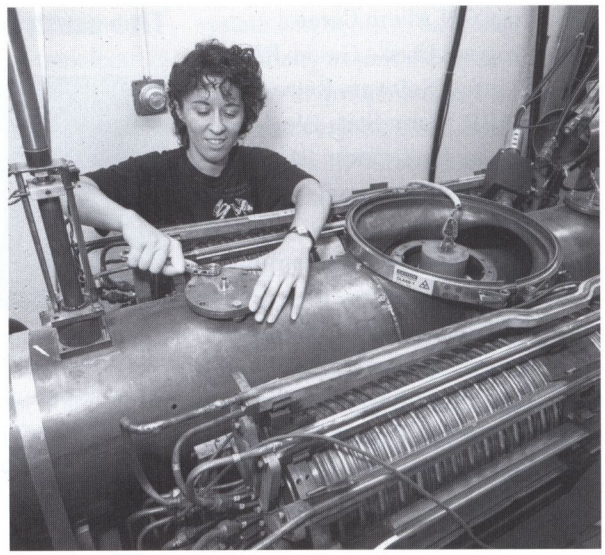
The contributor

Therese Watts is the group leader for the Research Division Electrical/ Electronics Department Controls Group. Her group is currently involved in a variety of hardware and software projects focused on providing: resource usage efficiency and consistency, increased data acquisition throughput, improved application functionality and development of applications to further automate beamline operation. Among these projects are: conversion of the fixed-target beamlines to TEV clock, replacement of the CRYO Multibus Interface and Data Acquisition Processor, front-end processor enhancements and LAN propagation to increase data acquisition collection, installation of LAN-based smart modules in service buildings, development of pc based diagnostics that use ARCnet data collection, development of an interactive data base report generation facility, support for the automation of family data base entry used for the definition of smart modules requiring multiple device entries in the database, definition and development of a data logger facility, addition of equation support to the existing 30 Hz plot application, definition and development of an automated tuning facility for the beamlines, definition and development of a MOTIF-based screen environment for use in EPICURE, and the development of the DAE-based Alarm Monitor Process. ■

As big science gets bigger, crucial tools such as accelerators outgrow their campus environments and migrate to national laboratories.



APGRA Program Trains Next Generation of Accelerator Physicists

by Summer Stevens

The larger accelerators grow, the smaller the number of physicists who can design, construct and operate them shrinks.

It's a sad irony, but it's true. As big science gets bigger, crucial tools such as accelerators outgrow their college campus environments and migrate to national laboratories. Discouraged by the lack of research equipment, graduate students at even the best universities turn to nuclear, molecular, solid state—anything but accelerator physics.

To help alleviate the shortage of accelerator physicists, Fermilab has established the Accelerator Physics Graduate Research Appointment (APGRA) Program. Promising graduate students from around the country who have fulfilled their classroom requirements journey to Fermilab to study with the most advanced accelerator equipment in the world. After working for two to four years and completing a thesis, students graduate with a Ph.D. in the uncrowded field of accelerator physics.

According to APGRA Executive Committee Chairman Gerald Jackson, the purpose of the APGRA program is to educate the next generation of accelerator physicists necessary to complete and run projects such as the Superconducting Super Collider, medical accelerators and synchrotron light sources.

"We're losing people, and very few are coming in," Jackson said, adding that Fermilab alone has lost approximately 20 accelerator physicists in the last few years. After Fermilab, Cornell University, which turns out one graduate every other year, is the only institution with a self-contained graduate program in accelerator physics.

Fermilab's program began in 1985 under former Director Leon Lederman. Mike Syphers, a former University of Illinois at Chicago student now at the SSC Laboratory, earned the first Fermilab degree in 1988. Since Syphers graduated, six more students have received their doctorates. Nine APGRA students are now at Fermilab, and all expect to graduate in the next two years.

The APGRA program seems to command great respect among the academic community. Most of the current students and graduates heard about the program through their professors and were encouraged to apply. Todd Satogata, who hopes to receive his Ph.D this year, took a class at Northwestern University

from Fermilab staff member Leo Michelotti, who encouraged Satogata to apply. Another professor brought his nuclear physics class, of which Satogata was a member, to Fermilab for a conference on deep-inelastic scattering. Satogata was impressed with what he saw, and decided to study at Fermilab. Satogata's Northwestern colleague, Linda Klamp, had an experience that was slightly less typical. She worked as an operator at Fermilab for eight years before deciding to pursue a Ph.D. When it came time to choose a research project, Klamp returned to the Laboratory. "It's worth staying here just to work with Pat Colestock," Klamp said. "He's got a lot of insight and good advice."

Colestock is Klamp's thesis advisor. Students receive their thesis advisors during the application and acceptance process, which begins with a declaration of interest from the student. Fermilab assistant director and APGRA administrator Roy Rubinstein then requests transcripts, letters of recommendation and a curriculum vitae. At this point, said Jackson, "we're looking for reasonable grades, some sign the person could get the job done. We look for what is looked for in any graduate student." Letters of recommendation carry great weight.

Rubinstein forwards each student's application materials to the APGRA Executive Committee, which currently consists of Fermilab Director John Peoples, Roy Rubinstein, Accelerator Division Head Steve Holmes and thesis advisors Pat Colestock, Glenn Goderre, Gerry Jackson and David McGinnis. If the executive committee chooses, the student is invited to Fermilab for interviews with the executive committee and any other Accelerator Division physicists who might be interested in advising an APGRA student. The committee evaluates the student's competence and enthusiasm.

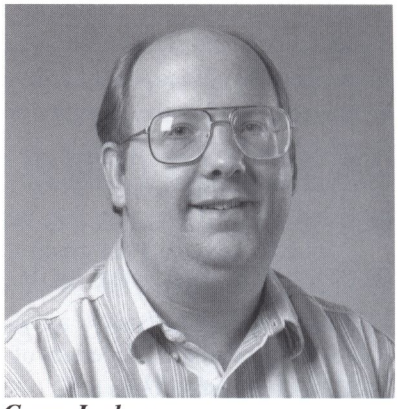
After an applicant passes the interview phase of the selection process, the physicist who is most interested in the student proposes a thesis topic. "The executive committee discusses the research topic," Jackson said. "It's a built-in means to make sure the research is relevant and beneficial to the Lab."

If the student agrees to the project and the student's university also agrees, he or she begins work with the interested physicist as the thesis advisor. Nine students are now working with advisors, and Jackson believes the APGRA program is close to capacity. "The availability of advisors is a limiting factor," he said.

The executive committee has chosen to concentrate not on quantity but on quality. Towards this end, the committee meets monthly to evaluate students' progress. "We make sure the students don't stay too long, and see that the work done is of a sufficient caliber to award a Ph.D.," Jackson said. In addition, the graduate students are required to give a seminar on their thesis topic once each year at an informal Users' Center gathering called the Sacherer Seminars.

In order to earn a doctorate degree, students must complete their thesis and defend it before the Fermilab committee and their university committee. The student's thesis advisor also serves as a member of the university committee.

Current students and graduates seem pleased with the APGRA



Gerry Jackson

program. "I think they do a pretty good job here," said Linda Klamp, who is preparing a thesis on nonlinear wave mixing in coasting beams. "There is a small number of dedicated people who take a lot of time with us. There is a lot of cooperation and willingness to teach among the physicists, and I feel like I have a lot of support from the Lab."

Katherine Harkay, a Purdue University student who hopes to graduate this fall, points out the utility of a program specifically geared to train accelerator physicists. "It's an important way to get young people into the field," she said. "It's nice to train people in accelerator physics from the beginning, because some of the techniques are specific. It's been a great opportunity for me." Harkay, whose thesis is titled "Booster Longitudinal Instability," echoed several other students when she emphasized that a joint university-Fermilab Ph.D. can take much less time than a traditional university doctorate.

"Compared to a university, you can't beat it," said Todd Satogata. "It's worked wonderfully for me. A national laboratory has resources you can't get at a university." Satogata's thesis data comes

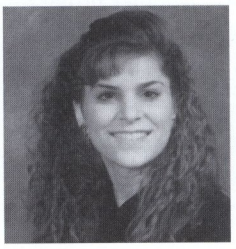
from E778 and concerns nonlinear dynamics coherent signals. He appreciates the enthusiasm of Lab employees and likes the diversity of the people and topics. "There's definitely a feeling of community," he added.

John Palkovic, a 1991 graduate of APGRA, enjoyed the Fermilab community as well. Palkovic attended the University of Wisconsin and went to the SSC Laboratory after graduation."I think Fermilab's a great lab," he said. "I liked just being in a community of high-energy physicists, and being able to discuss physics." Palkovic also said that the Village was "a great place to live."

Nikolitsa "Lia" Merminga, who received her APGRA Ph.D. in 1989, appreciated the real-world laboratory environment. "I got to see real people, real scientists, even Nobel laureates at work," she said. Merminga had journeyed to the University of Michigan from Greece, and switched her area of concentration to accelerator physics when particle theory became frustrating. Following her Ph.D., she joined SLAC, and now works at CEBAF.

The APGRA program is near capacity, but Fermilab is succeeding in its effort to educate a new cadre of accelerator physicists. Todd Satogata found the Lab "invigorating" and "awe-inspiring" when he considered the great minds that have developed theories and run experiments here. He and his APGRA colleagues are the next generation that will carry Fermilab and other accelerator physics projects into the 21st century. ■

The Contributor



Summer Stevens is a 1991 graduate of the University of Indiana with a degree in journalism. She is currently a second-year law student at DePaul University in Chicago, Illinois. Stevens worked for two summers as an intern in the Fermilab Publications Office.

Physics is very close to art in the sense that when you examine nature on a samll scale, you see a diversity in nature, you see symmetries in nature, you see forms in nature that are just utterly delightful.

Art Gallery, Arts Series Enhance Public Perception of Fermilab

By Summer Stevens

Imagine the excitement of journeying from your university physics department on the east or west coast, circa 1970, to a fascinating new accelerator facility nestled just outside the Second City. Picture the sophisticated equipment, the ambitious experiments, the potential inherent in a laboratory which has attracted many of the world's top physicists.

Now picture the laboratory's site. Acres and acres of prairie, surrounded by a few little towns in an area called Fox Valley. It's beautiful, but what is there to *do* on a Saturday night on a prairie? When the work week is over, and you and your family are seeking cultural stimulation, will you really feel like braving the traffic, the parking problems and the outrageous ticket prices to see a musical production, a dance concert or a lecture in Chicago?

You think of Fermilab physics, and you're thrilled. Then you think of your family and of the small-town atmosphere on weekend nights. And maybe, just maybe, you have second thoughts.

Fermilab's first director, Robert R. Wilson, didn't want any of the physicists he invited to the Laboratory in the early days to have second thoughts. An Easterner and sculptor accustomed to the cultural offerings provided by a university town, he recognized the possibility that metropolitan physicists might be wary of coming to a site relatively isolated from concert venues and performance stages. So Wilson, assisted by a group of dedicated volunteers, set out to make the budding Laboratory a cultural island in the Fox Valley area. Some twenty years later, it's evident that he succeeded.

Fermilab's second-floor crossover features an art gallery which has exhibited a wide variety of paintings, sculpture, photographs and prints. An auditorium which seats 800 has provided a showcase for orchestras, ballets and plays. The Fox Valley area now has a myriad of cultural offerings, and Fermilab helped steer the transformation of the area from small town to sophisticated suburb.

The auditorium becomes a showplace

"Physics is very close to art in the sense that when you examine nature on a small scale, you see a diversity in nature, you see symmetries in

nature, you see forms in nature that are just utterly delightful. Eventually, in the way that one looks at sculpture or art, people will also begin to look at those great simple facts."[1]—Robert R. Wilson

Shortly after the Central Laboratory, later named Wilson Hall, was completed, Wilson forwarded a memo to physicist Art Roberts, who, along with his pianist wife Janice, was active in the arts world. "It has been clear for some time that the new NAL auditorium has the potentiality of becoming an important asset to the Laboratory," Wilson wrote. "I refer not only to its use for obvious Laboratory purposes, such as meetings, colloquia and lectures, but also to its important potential use as a cultural asset both to the Laboratory and to the surrounding community.

"I also am aware that many other people have been struck by the same idea, and are already casting glances, calculating and/or envious, at our new and inviting facility," Wilson added. He went on to propose the formation of the very first Auditorium Committee. He asked eight Fermilab employees to serve on the committee, and the Auditorium Committee at Fermilab was born in 1974.

Native New Yorker Janice Roberts, who ran Fermilab's Guest Office in the late 1960s and early 1970s, took it upon herself to get the Auditorium Committee off the ground. "It was fun," Roberts said of the early days. "It was something that we were building. We wanted to create a concert series on a par with the quality of the Laboratory." Roberts said that because of her many connections in the art world, booking acts was easy. The current Lombard resident also explained that when Ramsey Auditorium came to be, there was no competition from surrounding towns because no venues existed.

"In the beginning, it was just one outstanding group after another," Roberts said. The original Fine Arts Quartet christened the Laboratory in 1972, before the committee formed, at the International High Energy Physics Conference.

One of the first tasks the Auditorium Committee undertook was to survey Fermilab employees and community residents about what sort of performances they would like to see. Musical theater was favored; rock and chamber music were not. But the Auditorium Committee brought a wide variety of performers to the Lab. Some highlights have been Maynard Ferguson, the Hubbard Street Dance Company, the St. Martin in the Fields Octet and James Cotton. Lab employees remember that when the Joffrey II performed and featured the young Ron Reagan, security was especially heavy. Jazz, choreographers' and percussion showcases have proved popular. Tickets cost only $3 in the beginning; the price has risen some but is still well below averages for Chicago performances.

Long-time Fermilab employees are almost unanimous in their opinion of which performance was the best. On July 10, 1975, the Bolshoi Ballet visited the Lab at the invitation of visiting scientists from the Soviet Union. Nine dancers performed over the lunch hour in what is possibly the only private Bolshoi performance ever.

Requests from Chicago-area performers began to pour in almost as soon as the auditorium was complete. One request that was summarily rejected was from directors of the Miss Illinois pageant in 1973. In turning down the request, Wilson wrote that "we are committed to a strong equal opportunity program, in which we deeply oppose discrimination of any kind. Happily, there is a solution: were you to permit a proper representation of men as contestants, say fifty percent, the problem would go away. Given the abominable fact that no man has won the contest since the pageant began, we would also insist on a bias in favor of a male Miss America."

The pageant was not held at Fermilab. But requests such as this one necessitated the creation of guidelines the Auditorium Committee could use in selecting performers for Ramsey Auditorium. In 1974, the committee decided that selected acts must demonstrate a professional level, or evidence of outstanding quality and background and that performances must be commensurate with Laboratory interests.

Nancy Carrigan, an artist and a long-time member of the auditorium committee, explained the selection process for participants in the Arts Series. "We get suggestions from knowledgeable people," she explained. "All members of the committee are knowledgeable in some area of the performing arts." The Laboratory has an arts coordinator, currently Janet McKay, who attends meetings of the Midwest Arts Council to seek out excellent acts, and she brings back suggestions. The committee listens to or views performance tapes, and usually at least one committee member tries to see the act live. The

committee then votes on which acts to invite to the Lab. "We try to book them at least a year ahead," Carrigan said.

Physicist Morris Binkley has been the head of the Auditorium Committee since 1990. "I had known Nancy Carrigan when I joined, and I had always been interested in going to performing arts events," he said. "It sounded like an interesting thing to do, and it was a nice diversion from physics." He said that the time commitment for a committee member was not prohibitive—"we have a good and effective arts coordinator." The coordinator is assisted by approximately 30 volunteers who handle lighting, management of the house, cleaning up and other duties.

Something to see on the second-floor crossover

"I believe that in sculpture and painting the purpose is understanding. It explains what we see. Usually, it simplifies. Sometimes it provides something we haven't seen before. And I believe that science is exactly the same."[2]—Robert R. Wilson

Perhaps physicists, after studying particles they can't see for hours on end, wish to see something beautiful when they're finished. For whatever reason, the art gallery on the second-floor crossover has been a major attraction among both Lab employees and visitors over the years.

Wilson's influence on the arts at Fermilab is perhaps most evident in the art gallery Three of his sculptures are part of the Lab's permanent collection, and he chose several of the other sculptures displayed in the gallery. The next two directors have continued to make the gallery a priority.

"Leon Lederman suggested to Dr. Wilson that this area have an art gallery," said Saundra Poces, a longtime volunteer who now manages the art gallery. "All three directors have had an interest in art." Janice Roberts was the first gallery manager.

The art gallery came into being sometime in the early 1970s. The first exhibit was "Science through the Ages," a collection of scientific books from the John Crerar Library. The next two exhibits, Kitaoji Rosanjin Ceramics and Japanese prints, were borrowed from the University of Chicago. Exhibits, now changed every eight weeks, have included the photographs of Ellen Carr Lederman, an Art Institute of Chicago faculty show and phscolograms, a combination of sculpture, photographs and holograms. Every two years, an employee show spotlights Lab workers' creations.

Saundra Poces is quick to point out that not all the gallery's exhibits fall into a narrow definition of art. The Chicago Shell Society loaned a collection of marine mollusk shells and the Field Museum's collection of minerals attracted attention. A Goethe Institute exhibit entitled "Frontiers of Chaos" presented contemporary math as art.

Some of the materials exhibited have been priceless. In spring 1980, the Art Institute provided a collection of fifth century Greek vases. Poces remembers the frightening task of unpacking and setting up the artifacts. "Certain of us touched them; others were afraid to," she said.

Every exhibit, according to Poces, harbors a story. A collection of East European photographers' work delivered to the Lab from the Jacques Baruch Gallery revealed a slight misunderstanding about the Lab's mission. According to Poces, the jarring, violent photographs deliberately sent pointed to a mistaken belief that the Lab was involved in weapons production.

A collection of minimalist sculptures from Virginio Ferrari prompted the Machine Shop to mount a metal box and slip it into the display area. Security guards called Poces and informed her that there were eight-one sculptures in the eighty-piece collection, and that they couldn't tell which one was bogus. Luckily Poces' trained eye was able to pick out the Machine Shop's creation.

Poces also remembers that the gallery helped inspire Lab employees who wished to become artists themselves. The Lab arranged for the Art Institute of Chicago to offer classes on site.

Although art classes are no longer held here, the gallery still features a wide variety of exhibits. Poces and a group of volunteers choose exhibits, usually but not always complete collections, borrowed from artists or galleries. One-artist shows are becoming more common, as are exhibits by women artists. Poces and the other volunteers arrange the works. A reception often marks the beginning of an exhibit, and for the next eight weeks Lab employees, tour groups and visitors to auditorium events enjoy strolls through the second-floor gallery.

Poces credits Wilson for the quality of the Laboratory's permanent collection. "He was very

artistic," she said. "He had a good eye." She credits volunteers for keeping the quality of the gallery high over the past twenty years.

These volunteers have helped bring about what Morris Binckley sees as a change in the community's perception of Fermilab. "The art series and art gallery gives people a chance to see that we (at Fermilab) are real people," he said.

Janice Roberts agreed. "I think it did a great deal for the public perception of the Laboratory." ■

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Lab notes

Fermilab hosts 12th annual FIA meeting

Experts from the worlds of high-energy physics, medicine and industry explored opportunities for collaboration and cooperation at the Twelfth Annual Fermilab Industrial Affiliates Meeting and Industry Briefing. Medical technology was the theme of the meeting, held May 28 and 29 at the Laboratory. Ninety-one representatives from industry and the medical profession attended lectures, toured the Laboratory and participated in panel discussions.

Director John Peoples opened the session with an explanation of the theme selected by Richard Carrigan, head of the Office of Research and Technology Application.

The Director than turned to medical technology, a theme proposed by Richard Carrigan (Directorate). "Dick suggested medical technology, because this is an area where we (physicists) contributed early on, with tools like synchotrons and x-ray machines." Now, though, physicists and physicians are beginning to see a common need for progress in computing, visualization methods and other research methodologies. "These things promise not only to transform the field of medical technology, but maybe even help us in particle physics," Peoples said.

A description of the mission of Fermilab closed People's introduction. "We're pushing elementary particle physics," he explained. He discussed the search for the top quark, but added "I suspect that won't be the end of elementary particle physics. At any rate, we're very excited about the prospects of making some very important discoveries."

Tom Nash, head of the Computing Division, chaired the first session, an overview of the opportunities for technology transfer involving the pharmaceutical industry. Calling technology transfer a "two-way street," Nash emphasized the benefits that accrue to both government laboratories and industry when information on technology, and specifically high-performance computing, is shared.

The first speaker, Gene Fluder, is a Senior Research Fellow at Merck Research Laboratories. He is responsible for planning and executing high-performance computing strategy at his company.

In his lecture on "Computational Drug Design," Fluder described the importance of discovering new drugs, and suggested that government laboratories might be helpful in finding new visualization methods and new ways of comparing structures.

Noel Jones, Senior Research Scientist and Group Leader of Macromolecular Structure Research at Lilly Research Laboratories of Eli Lilly & Company, followed with a talk titled "Applications of Synchrotron Radiation to Structure-Based Drug Design." Jones is the head of a nine-institution group preparing to do molecular analysis for structure-based drug design at the Argonne Advanced Photon Source now under construction. He detailed plans for research at the new accelerator as well as his work in protein crystallography.

The second afternoon session spotlighted "Medical Imaging—Breakthroughs and Challenges." Richard Carrigan began the session by suggesting areas where technology transfer with the medical profession might have applications. The list included accelerators, high-powered computing including

parallel processing devices and cryogenics and superconductivity. He then introduced Paul Lauterbur, the "founding father" of magnetic resonance imaging.

Lauterbur, who holds several academic and administrative positions at the University of Illinois, pointed out the long relationship between physicists and doctors in imaging technology. He pointed out the successes of magnetic resonance imaging, but stressed the need for future involvement by the particle physics community in order to further perfect this imaging modality.

Michel Ter Pogossian of Washington University and the Mallinckrodt Institute of Radiology then presented "The Genesis, Present Status and Future of Positron Emission Tomography." Positron Emission Tomography uses particles of antimatter to allow physicians to see the brain. Like Lauterbur, Ter Pogossian credited physicists for their transfer of technology to date and encouraged them to continue working with the medical community toward better imaging methods.

After these sessions, David Anderson, Fermilab Research Division, Larry Antonuk of the University of Michigan and David Levin of the University of Chicago led a panel discussion on "Initiatives for the Future." Antonuk is currently developing amorphous-silicon imaging arrays for radiotherapy and diagnostic applications, and Levin, a radiologist and physicist, is researching software designed to create three-dimensional images of brain structure and function.

The Thursday activities concluded with a social hour, banquet and after-dinner comments by Lee Rogers, chairman of radiology at Northwestern University Medical School. Rogers, president of the American College of Radiology, addressed the theme of laboratory-industry cooperation in medical technology, calling for a new paradigm of cooperative and collaborative research.

Friday morning commenced with an update on cooperative programs at the Lab. "One of the missions of this laboratory is to do technology transfer, and this is a mission across all of DOE for every installation," said John Venard, Fermilab licensing officer. "Our aim is to get broader utilization of the technologies that are developed here at the Laboratory in the course of doing the physics that is the main mission." Venard then listed several formal mechanisms for cooperative work.

Ken Thomas, president of the Brobeck Division of Maxwell Laboratories, detailed an example of such cooperation in "Accelerator Controls-a New Technology Transfer." His company has commissioned the first commercial electron synchrotron in the United States, and has recently completed a licensing agreement for a control system developed at Fermilab.

After a break, Frank Cole chaired a session on "Accelerators for Medicine." Cole, a former Fermilab employee who is now a member of Particle Accelerator Corporation (a private company), gave a brief history of radiation treatment for cancer, which began shortly after the invention of x-rays in the late 19th century. He also described the design and construction of the Loma Linda Medical Accelerator which was developed at Fermilab.

Charles Ankenbrandt, Fermilab Accelerator Division, spoke next on "Design Concepts for a Proton Therapy Facility." Ankenbrandt and his colleagues are beginning to consider plans for an innovative accelerator to be used for proton therapy. He credited Robert R. Wilson, Fermilab's first director, for his role as the original proponent of protons being used for cancer therapy.

The indications and demand for treatment at proton medical facilities headlined Michael Goitein's presentation. Goitein is currently involved in the development of the North East Proton Medical Facility at Massachusetts General Hospital (Harvard University). He pondered the possibilities for laboratory-industry collaboration in the development of interactive computer graphics and biophysical models for cancer treatment.

Arlene Lennox (Neutron Therapy Facility), concluded the Industrial Affiliates meeting with a presentation entitled "Medical Applications of Proton Linacs," explained to non-physicists the difference between cyclotrons, synchotrons and linear accelerators, then diagrammed and described Fermilab's own Neutron Therapy Facility. She summarized the options the medical and physics communities have in using proton linear accelerators for therapeutic and diagnostic purposes.

According to Richard Carrigan, Fermilab established the Industrial Affiliates in 1980 to improve university-industrial communications and foster

technology transfer from the Laboratory. "We're even suspicious that some of these partners might have better ideas than we have," Carrigan added. The annual meeting provides an opportunity for senior personnel from the affiliates, which now number 32, and other companies to learn about ways to communicate those ideas. ■

Richard Auskalnis Elected President of NAPM

Richard J. Auskalnis, head of the Purchasing Department, is the 1992/1993 president of the National Association of Purchasing Management, Inc. Auskalnis assumed his role as NAPM president at the close of NAPM's seventy-seventh Annual International Purchasing Conference, which was held May 3-6, 1992 in Orlando, Florida.

NAPM is a not-for-profit association which provides national and international leadership in purchasing and materials management research and education. The organization provides its more than 45,000 associated professionals in 172 affiliated bodies with opportunities to expand their professional skill and knowledge. It also seeks to stimulate public interest in and foster a better public understanding of purchasing and materials management concepts.

As president, Auskalnis is the chief executive officer and chair of the NAPM Board of Directors. He is responsible for general supervision of the executive affairs of this seventy-eight-year-old research and educational association that serves purchasing and materials management professionals from industrial, educational, distributional, governmental, institutional and service organizations.

"My theme throughout the year is 'Professionalism through Education.' This profession is changing. We can't afford to stand still, and we can't just do things the way they were always done," said Auskalnis. ■

Research Division Appointments

Roger Dixon has been appointed acting head of the Research Division. He replaces Peter Garbincius, who has accepted a new assignment in the Physics Section. Dixon has served as deputy head of the Research Division, head of Program Planning in the Director's Office, and head of the DØ Department. He was recently responsible for overseeing the installation and assembly of the new DØ detector.

Gene Fisk takes over Dixon's position as head of the DØ Department. Fisk has been the deputy spokesman for DØ since 1988. From 1986-1988 he was DØ Department head and from 1984-1986 served as deputy head of the Technical Support Section. ■

Accelerator Division Appointments

David Finley is the new deputy head of the Accelerator Division. At Fermilab, Finley has been head of the Switchyard, the Collider Program and the Tevatron Group. In 1990, he became head of the Main Accelerator Department, and a year later served as associate division head for administration and environment, safety and health. ■

Technical Support Section Appointments

Paul Mantsch has resigned his post as head of the Technical Support Section to accept a new assignment as project manager for the Solenoid Detector Collaboration Calorimeter. Mantsch joined the Fermilab staff in 1973 and has held several technical management positions at the Laboratory in addition to his participation in experiments.

Ray Hanft will succeed Mantsch as head of Technical Support until October, when Frank Turkot, who is on a one-year assignment to work on the ZEUS detector at DESY, returns to the Lab. Hanft has held the position of acting deputy head of Technical Support since November 1991.

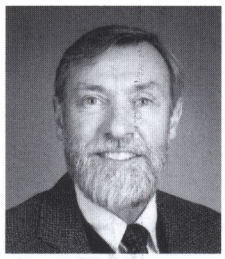
Jim Strait is the new deputy head of the Technical Support Section. He represents Technical Support as a member of the Environmental Safety & Health Policy Advisory Committee (ESHPAC) and will continue to supervise the activities of the Magnet R&D Group. ■

Gale Pewitt Cited by DOE

Gale Pewitt, project manager in the Technical Support Section, received

a United States Department of Energy Certificate of Appreciation in February 1992. Joseph Cipriano of the DOE/SSC Project Office presented the certificate, which was signed by DOE Energy Research Director William Happer.

The citation stated "Dr. Pewitt has developed and led a strongly focused team involving General Dynamics Corporation, the SSC Laboratory and Fermilab to the successful design, production and test of 50-mm Collider Dipole Magnets for the Accelerator Systems String Test. His personal initiative and resourcefulness were the foundation for achieving this milestone so critical to the construction of the Super Collider." ■


Gene Fisk

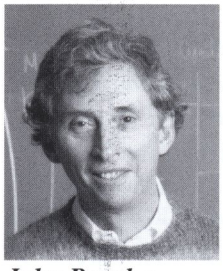
David Finley

Paul Mantsch

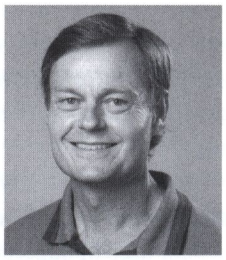
Ray Hanft

Jim Strait

Gale Pewitt


John Peoples

Richard Auskalnis


Roger Dixon

Director John Peoples Receives Appointments

Fermilab Director John Peoples has been appointed Chairman of the International Committee on Future Accelerators. Peoples will take office January 1, 1993, and will serve for a period of three years.

The American Physical Society (APS) has elected John Peoples Division of Physics of Beams (DPB) Councillor. As DPB Councillor, Peoples is a member of the APS DPB Executive Committee and a member of the APS Council. He took office January 1, 1992 and will serve a two-year term.

The American Association for the Advancement of Science (AAAS) Council has elected John Peoples to the rank of Fellow of the AAAS. A Fellow of the AAAS is "a member whose efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished." Peoples was honored specifically for his "contributions to experimental particle physics, particularly the role of electromagnetic interactions in high-energy processes, and for leadership in the development of accelerators." ■

URA Grants Technology Licensing Agreement

Universities Research Association, Inc. has granted nonexclusive commercial rights to a Fermilab-developed technology to Superconductivity, Inc. of Middleton, Wisconsin.

The URA/Superconductivity, Inc. licensing agreement, which became effective January 28, 1992, involves a piece of technology called a Cryogenic Support Member developed by Tom Nicol of the Technical Support Section's Engineering Department and Ralph Niemann and John Gonczy (now working in the Advanced Photon Source at Argonne National Laboratory.) The technology, which was patented in September 1987, evolved from superconducting

magnet research and development done at Fermilab in connection with the SSC.

The license gives Superconductivity, Inc. the right to incorporate the Fermilab-developed support member design into cryostats for the Superconducting Storage Device (SSD™) they manufacture and market. These devices improve the reliability of power supplies by providing a short-term energy source during voltage sags and power failures. Such sags can cause interruptions in the operation of electric motors and electronic devices leading to costly shutdowns of manufacturing processes of control systems. SSD™ are capable of providing as much as two megawatts of power to support critical equipment during short-term power system disturbances.

Superconductivity, Inc. was founded in 1988 to develop practical uses of superconductivity for solving power quality problems, and manufactured its first SSD™ in 1989. The founder of the company brought together a team of experts to develop this new product line which includes Dick Lundy, former associate director of technology at Fermilab.

According to John Venard, Fermilab licensing officer, this Sten Hanson (Physics Section) and Richard Kwarciany (Computing Division) for their contributions to the development of the *fastbus smart crate controller*. Alan Bross (Research Division) was credited as the inventor of the *radiation-hard 3-HF polysterene scintillating fiber*. Brian Hendricks' (Accelerator Division) and K. Casey Sieno's (Accelerator Division) innovative talents produced the *Main Ring vacuum readback interface*. Muzaffer Atac (Research Division) and William Foster (Research Division) invented *a simple method for fusing plastic fibers*. Alan Jones (formerly Accelerator Division, now SSCL) and Michael Shea (Accelerator Division) pooled their expertise to develop the *fairly quick VMEBUS digitizer*. Moyses Kuchnir (Technical Support Section) invented *a method for labeling calibrated sensing resistors*. Edward Barsotti, David Christian (Research Division), Carl Swoboda (Computing Division) and Ray Yarema (Research Division) invented a *fastbus-based ECL silicon strip detector readout system*. Gustavo Cancelo, Bruce Denby (Computing Division) and Sten Hansen were the architects of a *neural network trigger programming board and associated software*. Gerald Davis (Technical Support Section), Ralph Niemann (formerly Technical Support Section, now at Argonne National Laboratory) and Andrew Oleck (Technical Support Section) designed a *low beta quadropole cold mass connection slide*. Arie Lipski (Technical Support Section) and Finley Markley (Technical Support Section) invented a *cryogenics materials tester*. Charles Nila (Research Division) and Richard Schmidt (Research Division) combined their talents to devise a *helium expansion engine valve clearance adjuster*. David Anderson (Research Division) and Brian Kross (formerly Research Division, now at CEBAF) jointly developed a *cerium flouride scintillator material*. ■

Fermilab-Developed Software Entices License Agreement

On March 31, 1992, Universities Research Association, Inc. (URA) executed a Nonexclusive Software License Agreement with the Brobeck division of Maxwell Laboratories, Inc. (MLI) of Richmond, California. Brobeck Division (formerly Brobeck Corporation) has been designing and building innovative, reliable accelerators and beamline components since 1957.

The company was founded by William M. Brobeck after he left Lawrence Berkley Laboratory, where he worked closely with Ernest O. Lawrence in developing early cyclotrons. Brobeck machines are used around the world in research laboratories, hospitals and industry.

The software licensed to MLI is the package used to control the accelerators and primary beamlines of Fermilab. As a whole, this package is generally known as the Fermilab ACNET Accelerator Control System and includes programs and subprograms which provide system services, hardware diagnostics and support, software development and maintenance tools and database management and applications programs.

The license gives MLI the right to use and sell ACNET software and to sublicense its customers to use the system. It is a royalty-bearing license and the royalty revenue

generated will be shared between URA and the more than forty Fermilab employees who were authors of the software.

Bruce Chrisman, associate director for administration, who was actively involved in shaping Fermilab's future relationships with MLI said, "This recent license agreement with MLI is just one of the examples of Fermilab's and the Department of Energy's commitment to technology transfer."

As one of the few centers of accelerator expertise outside of the national laboratories, Brobeck Division plays an important role in the development of accelerator technology and in innovative applications. Maxwell Laboratories, Inc. believes that the major accelerator projects now under construction around the world represent just the beginning of an on-going period of vigorous development in accelerator technology and in innovative applications. Growing demand is expected for several Brobeck Division projects, including synchrotron light sources, linear accelerators, cyclotron light sources, proton synchrotrons, insertion devices, beam optics and photon beamlines.

One of Fermilab's missions is to be actively involved with the transfer of technology developed at this Laboratory to industry. Recent federal legislation has created new oppotunities for industry and federal laboratories cooperation. Partnership with companies such as MLI assists in this mission. ■

ORTA Honors Inventors

Fermilab honored the achievements of 26 Fermilab inventors with a reception held Wednesday, March 18 in the Lab's Wilson Hall.

During a brief and informal ceremony, innovators who had filed records of invention with the Office of Research and Technology Application between August 1, 1990 and July 31, 1991 received certificates and cash awards.

Dennis Theriot, associate director for technology, welcomed those in attendance and made the opening statements on behalf of the Directorate. He hailed the achievements of those being honored and credited them for the important role their pioneering spirits play in the field of high energy physics.

ORTA manager Richard Carrigan Jr, who has worked closely with all the inventors, hosted the event and congratulated the fine work of the honorees. Honored at the reception were:

Edward Barsotti (Computing Division), Mark Bowden (formerly Computing Division, now SSCL), Gustavo Cancelo (formerly Physics Section, now a professor at National University of La Plata, Argentina), Sten Hanson (Physics Section) and Richard Kwarciany (Computing Division) for their contributions to the development of the *fastbus smart crate controller*. Alan Bross (Research Division) was credited as the inventor of the *radiation-hard 3-HF polysterene scintillating fiber*. Brian Hendricks' (Accelerator Division) and K. Casey Sieno's (Accelerator Division) innovative talents produced the *Main Ring vacuum readback interface*. Muzaffer Atac (Research Division) and William Foster (Research Division) invented *a simple method for fusing plastic fibers*. Alan Jones (formerly Accelerator Division, now SSCL) and Michael Shea (Accelerator Division) pooled their expertise to develop the *fairly quick VMEBUS digitizer*. Moyses Kuchnir (Technical Support Section) invented *a method for labeling calibrated sensing resistors*. Edward Barsotti, David Christian (Research Division), Carl Swoboda (Computing Division) and Ray Yarema (Research Division) invented a *fastbus-based ECL silicon strip detector readout system*. Gustavo Cancelo, Bruce Denby (Computing Division) and Sten Hansen were the architects of a *neural network trigger programming board and associated software*. Gerald Davis (Technical Support Section), Ralph Niemann (formerly Technical Support Section, now at Argonne National Laboratory) and Andrew Oleck (Technical Support Section) designed a *low beta quadropole cold mass connection slide*. Arie Lipski (Technical Support Section) and Finley Markley (Technical Support Section) invented a *cryogenics materials tester*. Charles Nila (Research Division) and Richard Schmidt (Research Division) combined their talents to devise a *helium expansion engine valve clearance adjuster*. David Anderson (Research Division) and Brian Kross (formerly Research Division, now at CEBAF) jointly developed a *cerium flouride scintillator material*. ■

Dates to Remember

- *November 10-14, 1992* Particles & Fields 92: 7th Meeting of the Division of Particles and Fields of the APS (DPF92), Fermilab, Batavia, Illinois; Rajandran Raja/John Yoh, Fermilab, Co-Chair; Contact: C.M. Sazama, Fermilab, P.O. Box 500, Batavia, IL 60510-0500, Telefax: 708-840-3867, Email: SAZAMA@FNAL
- *December 4-6, 1992* Physics Advisory Committee Meeting
- *January 18, 1993* Deadline for receipt of material to be considered at the February PAC meeting
- *February 19-21, 1993* Physics Advisory Committee Meeting
- *March 22, 1993* Deadline for receipt of material to be considered at April PAC meeting
- *April 16-18, 1993 or April 23-25, 1993* Physics Advisory Committee Meeting
- *May 19, 1993* Deadline for receipt of material to be considered at the June PAC meeting
- *June 19-25, 1993* Physics Advisory Committee Meeting

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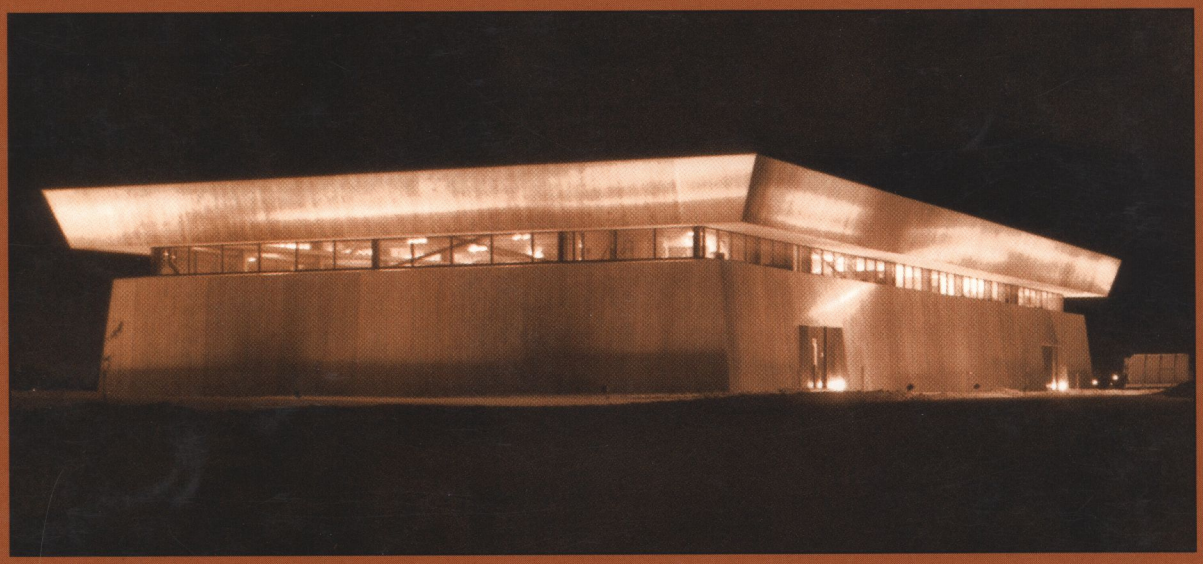
Cover photographs: (front) Heidi Schellman assembling the E665 Vertex Detector Chambers, (back) Evening view of the Fermilab New Muon Laboratory.



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