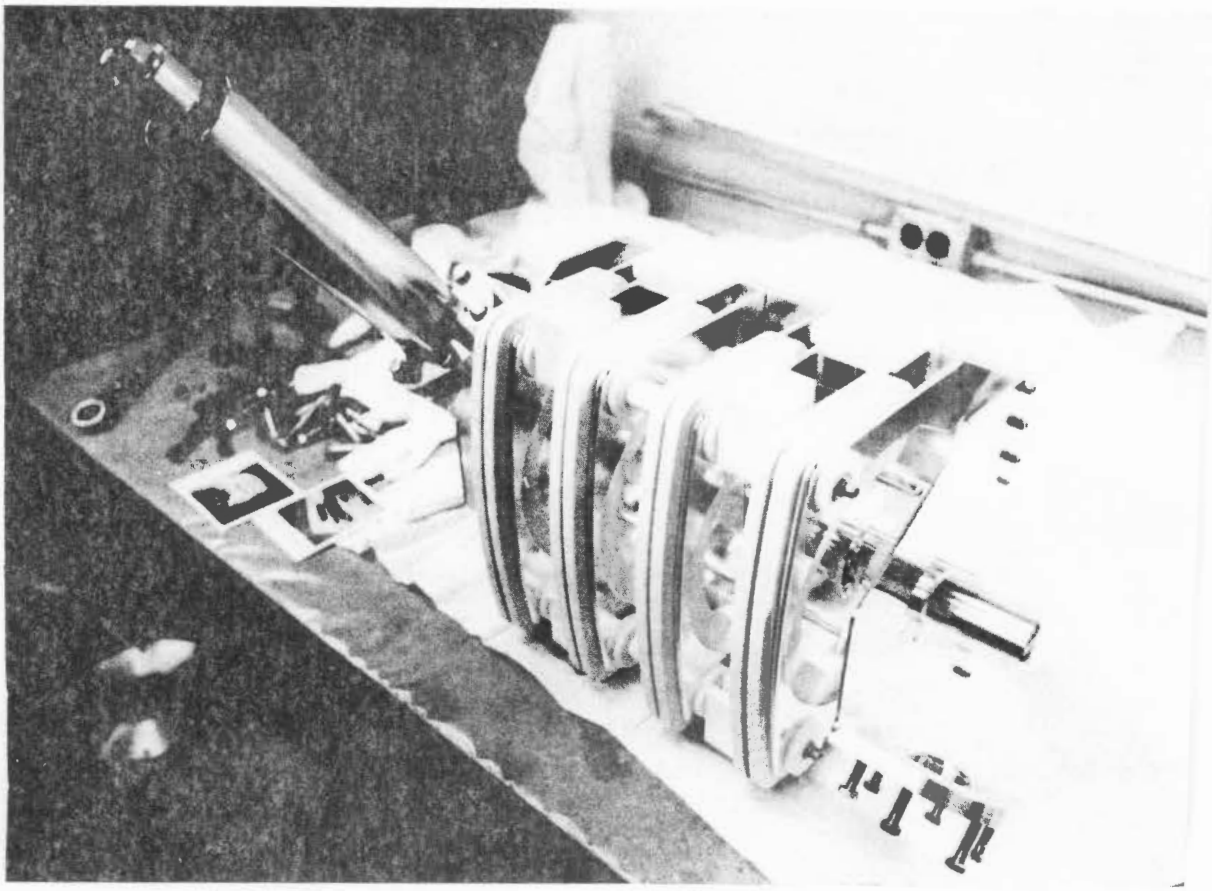
fermilab report

Fermi National Accelerator Laboratory Monthly Report

June 1984



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F. T. Cole, R. Donaldson, and L. Voyvodic, Editors

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THE COVER: Prototype kicker module for Tevatron I.
(Photograph by Fermilab Photo Unit)

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FERMILAB INDUSTRIAL AFFILIATES FOURTH ANNUAL MEETING

Richard Carrigan

The fourth annual meeting of the Fermilab Industrial Affiliates took place May 24 and 25. The central theme was "Industry and Large Scientific Projects - Particle Accelerators and Projections into the Future." The Superconducting Super Collider was taken as a prime example. This project may well be one of the most ambitious basic research projects in history.

Construction of a super accelerator will involve industrial participation on a scale unfamiliar to particle physics. It will require participation of many companies ranging from corporate giants to small machine shops. New innovative approaches will be needed to cement these relationships. In the words of George Keyworth, the Scientific Advisor to the President, at the Saver Dedication, "We have to realize that SSC won't be just another national big-science facility...The SSC design challenge is far more than just choosing between niobium-titanium or niobium-tin. That may be a necessary part of the job, but, as IBM or AT&T or Apple would be quick to tell us, big challenges demand big leaps in thinking...Ultimately, like Apollo, it's going to require cooperation and integration between the scientists who intend to use it and the technologists--many from industry and from unaccustomed disciplines--who will be full partners in this effort."

The highlight of the meeting was a Round Table on Industrial Participation in Large Scale Science Projects. The Round Table explored how deeply industry could or would opt to participate in projects like the super accelerator. It is important to determine how industry will react to the challenge of involvement in a project which is vital to scientific research but whose follow-on benefits are not clear. In the particular case of the super accelerator, manufacture of 10,000 large superconducting magnets will raise new problems of precision, quality assurance, and reliability. Whereas industry would not be expected to lose money, unusual requirements on close interaction with the designers throughout production may be required. The super accelerator project will have high visibility and serious technical challenges. All of this cannot carry excessive cost penalties.

The Table, chaired by Dick Lundy, included participants from a cross section of industries with expertise in technologies needed for a super accelerator. Among the participants were Dr. Ray Beuligman, program director of energy systems at Convair/General Dynamics; Mr. Dick Rodenizer, manager of systems and product engineering for medical systems at General Electric; Dr. C. H. Dustmann of Brown-Boveri in Germany, now working on superconducting magnets for HERA; Dr. John Hulm of Westinghouse, one of the developers of modern superconducting wire and a member

of the Board of Overseers for the SSC; Mr. Carl Rosner, chairman and chief executive officer of Intermagnetics General; Mr. Ryusei Saito, chief engineer in the nuclear fusion division of Hitachi, now working on the CDF coil; and Dr. Ed Temple, head of the U. S. Department of Energy working group on the SSC. The diverse perspectives of the participants led to a lively exchange of views. In particular, the discussion illuminated a range of industrial viewpoints across the U. S., Germany, and Japan. On Thursday, the meeting concentrated on the super accelerator and the experience gained with the Fermilab Energy Saver. Leon Lederman led in with a talk on the possibilities for physics in the 1990's that mandate an accelerator much more powerful than the Tevatron. Rich Orr discussed the operating experience with the Saver. Lundy then laid out the challenges of a super accelerator. Mr. Paul Gilbert of Parsons Brinckerhoff in San Francisco (the firm overseeing conventional construction for the SLAC SLC) reviewed the architectural-engineering requirements. Claus Rode outlined the characteristics of the large scale cryogenic systems that would be needed for the SSC. Dixon Bogert discussed controls and Mel Shochet, of the University of Chicago, speculated on the detectors that will be reuqired. Tom Nash covered future directions needed for computers.

The banquet speaker was Martin Cooper, retired vice president and director of research at Motorola, and one of the principals in the development of the cellular telephone concept. He now heads his own firm, Cellular Business Concepts.

The Fermilab Industrial Affiliates was established in 1980 in order to improve university-industry research communications and to foster technology transfer from Fermilab. The annual meeting provides an opportunity for research directors and senior technical personnel from the Affiliates and other companies, some from overseas, to visit Fermilab. By now, Fermilab Affiliates includes more than thirty institutions including many research-oriented companies in the Fortune 500 list as well as several vigorous young organizations established by Fermilab (user and staff) alumni.

Participation in the meeting included more than eighty people from outside Fermilab. More than forty U. S. companies and six foreign concerns were represented. There were also several participants from the Department of Energy and the press.

The attendees were uniformly pleased with the meeting. The wide spectrum of Affiliated interests emphasized the need to report on new Fermilab technology. Often others can see new, valuable ways to exploit technology developed for a very particular need here at the Laboratory.

Round Table at Fermilab Industrial Affiliates meeting. From left to right are Dick Lundy, chairman; Ray Beuligman, Convair/ General Dynamics; C. H. Dustmann, Brown-Boveri; John Hulm, Westinghouse, speaking; Dick Rodenizer, General Electric; Carl Rosner, Intermagnetic General; Ryusei Saito, Hitachi; and Ed Temple, DOE.

(Photograph by Fermilab Photo Unit)

Marty Cooper, the Affiliates after-dinner speaker, brings a smile to Leon Lederman and John Hulm, possibly when he told a famous quality control joke that Dick Lundy had decided not to use.

(Photograph by Fermilab Photo Unit)

A group of Japanese industrial representatives interested in high-energy physics technology at the recent Affiliates meeting. Clockwise from center back are H. Tanaka, Furukawa; M. Ikeda, Furukawa; S. Ito, Toshiba; N. Yamaguchi, Mitsubishi; R. Saito, Hitachi; M. Amano, IHI; and Taiji Yamanouchi, Fermilab.
(Photograph by Fermilab Photo Unit)

An informal discussion at the Affiliates meeting. Both the men in the center, Eric Siskind, NYCB Real Time Computing, and (right) Mel Schwartz, Digital Pathways, are alumni of particle physics and presidents of their own companies.
(Photograph by Fermilab Photo Unit)

Two of the principals in the development of the Fermilab Energy Saver superconducting wire, Bruce Zeitlin of Intermagnetics General and Bill Fowler, Fermilab, at the Affiliates meeting.

(Photograph by Jan Fox)

C. H. Dustmann of Brown/Boveri in Germany and Claus Rode of Fermilab in an informal moment at the Affiliates meeting.

(Photograph by Fermilab Photo Unit)

E-609--STUDY OF HIGH p_T EVENTS

Walter Selove
University of Pennsylvania

M. W. Arenton, W. R. Ditzler, T. H. Fields, Argonne National Laboratory; M. Harrison, Fermilab; A. Kanofsky, Lehigh University; R. Gustafson, University of Michigan; L. Cormell, M. Dris, J. Fleischman, E. Gardella, C. Hitzman, W. Kononenko, B. Robinson, G. Theodosiou, B. Yost, University of Pennsylvania; M. Corcoran, K. Johns, M. Marcin, H. E. Miettinen, R. C. Moore, C. Naudet, J. Rice, J. Roberts, Rice University; H. F. Chen, A. R. Erwin, M. A. Hasan, C. E. Kuehn, K. S. Nelson, M. A. Thompson, University of Wisconsin

Introduction

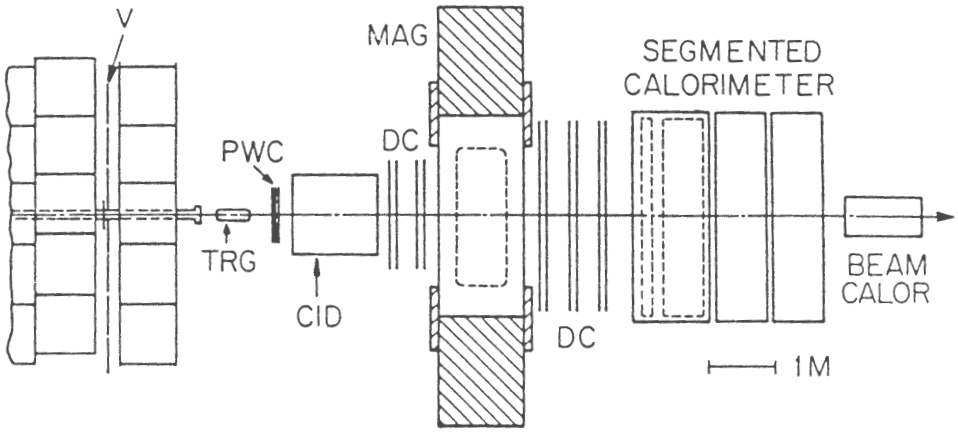
The existence of hadron jets at high p_T was first predicted by Bjorken in 1972. Bj reasoned that the partons observed in deep inelastic scattering could produce interactions at high p_T in hadronic collisions giving rise to jets of particles at large angles with respect to the beam. He suggested that the study of these collisions in a calorimeter would provide valuable information concerning the interactions of the partons and the structure of hadrons. Since that time the theory of QCD (quantum chromodynamics) has been developed. This theory of strong interactions can be used to predict the expected jet cross-sections and the evolution of the hadron structure functions. Several experiments have now reported the observation of jets at the ISR and the SPS Collider. We report here the first measurements of jets at Fermilab energies.

Physics

The principal objectives of E-609 were initially (1) to study di-jet cross sections and to compare them with theory, and to study (2) the possibility of parton identification in jets, using both charge and mass identification of the leading fragments in jets, (3) meson structure functions, and (4) high-p_T phenomena involving nuclear targets. By the time the first run took place in 1982, other large-solid-angle calorimeter studies of high-E_T events had been carried out at the SPS and at Fermilab. These experiments showed that a trigger using simply the total transverse energy E_T gave events that were mostly not of di-jet character, although some of the events detected did appear to be jet-like. We therefore made our first priority the study of how clearly di-jets could be seen, at Fermilab energies, and the investigation of the efficiency of different triggers for selecting such events in an unbiased way.

Apparatus

The principal part of the apparatus shown below was a highly segmented calorimeter array, with transverse segmenting into 132 "towers" pointing roughly at the target and



Layout of apparatus for E-609.

covering 9 srad at 400 GeV. Each tower consisted of 4 layers in depth; the first sample was a few radiation lengths thick, and the following 3 provided a total thickness of 6 to 8.2 absorption lengths. Sampling thickness was fitted to the lab energies expected for individual particles, and provided fine sampling for the 1 to 2 GeV particle energies that are significant at the outer angles, and at the same time coarser sampling, with small shower size and large total absorption thickness, for the 100 to 200 GeV particle energies encountered at the inner angles.

Triggering was accomplished with a very flexible triggering system which allowed simultaneous collection of data with many different kinds of high-p_T and high-E_T triggers.

The apparatus also included 15 wire-chamber planes, a large-aperture magnet, and a beam calorimeter. The magnet was operated with a small momentum kick, which allowed useful momentum and charge-sign measurements while not appreciably disturbing high-p_T triggering. The beam calorimeter allowed the study of possible novel processes, such as the Berger-Brodsky process in which a meson can be totally absorbed in a high-p_T collision, leaving no beam jet. (Data were taken in the 1982 run with incident mesons as well as protons; unfortunately, no meson beam was available in the 1983-84 run.)

A large solid-angle ring-imaging Cherenkov counter to identify outgoing particles was also installed for part of the 1982 run for test running. Initial results offered promise for

further operation, but unfortunately, a special image intensifier burned out shortly before the 1983-84 run.

Performance of Beam and Detector

Experiment 609 was approved in 1978 and was initially expected to run by late 1980 or early 1981. In fact, the first running was delayed by accelerator problems and was scheduled for January 1982. Because of severe problems in the M6 superconducting beam line, very little running was obtained in the 1982 run. A further run was therefore scheduled for 1983-84 and took place, with relatively little trouble, during the 400-GeV break-in period of the Saver.

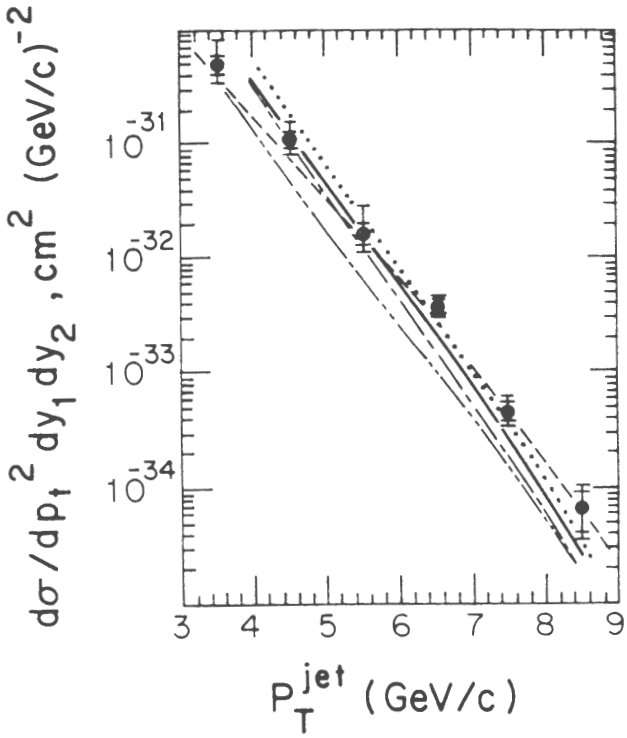
For the 1983-84 run, the electronics was put into defect-free condition, and additional extensive monitoring procedures were set up to make sure the 528-tube calorimeter system would operate smoothly and stably throughout the run--and it did. The new M-West beam line operated very smoothly, almost without trouble. Finally! The Saver operated on the whole quite well, though there were rather severe difficulties with beam-spill structure which were just beginning to be brought under control as the run approached its end. These spill problems may have been associated with the special pinhole collimator which is a part of the MT beam line. The beam optics for 400 GeV were highly improved over those of the 1982 beam. This permitted us to run at several times higher instantaneous intensity than we could have used in the earlier run. Since the spill time per minute was also several times higher than in the 1982 run, we were able to operate with 10 to 15 times as much flux per hour as in 1982. We also had 2 to 3 times as many good data hours, and thus in total obtained some 30 times as much integrated luminosity as in the 1982 run. This enabled us both to reach to substantially higher p_T than in the 1982 run and at the same time to allot considerably more time than in 1982 to running with nuclear targets.

Results So Far

Immediately following the 1982 run we were able to analyze the data to a sufficient degree to show in a model-independent way that a signal of di-jet like events could be seen at Fermilab energies, and we gave a report on these results at the Paris High-Energy Conference. The first dijet events from the CERN SPS Collider, which were visually spectacular, were also reported at the Paris Conference. In addition, the ISR experiment R807 also reported the calorimetric observation of jets.

The 1982 data have now been analyzed in detail to obtain di-jet cross sections at 400 GeV, using one trigger that showed itself to be particularly efficient at selecting di-jet events in an unbiased way while discriminating strongly against "soft"

events that have high E_T but no clusters of high-p_T particles. This is the "2-high" trigger, which requires that any 2 or more towers give p_T signals above a threshold, typically set at about 1.25 GeV/c. The cross-section results shown below are in strikingly good agreement with the calculations from pertubative QCD,



Dijet cross sections: data points from this experiment, curves from various QCD theoretical calculations.

especially considering the 7% uncertainty in energy scale. (The curves in the figure correspond to theoretical calculations using 5 different sets of structure functions proposed by various authors.)

Fixed-target high-p_T experiments allow the study of two types of reactions not presently accessible with colliding-beam machines, reactions using incident mesons, and reactions using nuclear targets. In the 1982 run we took data on both of these reactions. The 2-high trigger enables us to select jet-like events, even with nuclear targets, and to study their A-dependence, which proves to be substantially different from

that of non-jet-like high-E_T events. The preliminary nuclear target results appeared interesting enough that for the 1984 run we prepared and carried out a much more detailed set of measurements, using targets ranging from liquid helium to lead. When analyzed, these measurements may shed some light on the detailed nature of the space-time hadronization of scattered high-p_T partons, as well as on the nature of very high multiplicity events having large transverse energy and no jet structure.

The data taken in the 1982 run with mesons have also been under extensive analysis. We are now nearing the completion of analysis both on pion structure functions and on the search for the novel Berger-Brodsky type events.

The 1984 data were closely monitored, with continuous sampling by off-line analysis during data taking, and we believe they are of very good quality. The data have been put through the necessary analysis to reach the data-summary-tape stage, and DST's are being prepared. Eight graduate students have worked on E-609; one has finished his work and received his Ph.D.

Future Plans and Final Remarks

Intensive analysis of the E-609 data is in progress, by a number of members of the more advanced staff and by the students. On a longer time scale, many members of the collaboration are also at work on several new experiments. Most of the E-609 equipment will be used in the jet photoproduction experiment E-683, and many members of E-609 collaboration will participate in that experiment. Other members of the E-609 collaboration are at work on the $\bar{p}p$ collider experiments E-740 (D-0) and E-735 (search for quark-gluon-plasma effects), and on a large nucleon-decay experiment.

Like many other recent experiments at Fermilab, E-609 was delayed years beyond an optimum schedule. Some of the physics results that have come and will come from this experiment, like the di-jet cross sections, would have been a good deal more novel if they had come several years earlier, but are significant even with the delay. We expect that some of our forthcoming results will be unique and very interesting in spite of the delay.

Our experience in this experiment suggests that for efficient use of the accelerator and minimum experiment delays, in the coming years when collider and fixed-target running periods must both be provided, extensive pre-testing of beam lines, PREP electronics, detectors should be allowed for in the schedule. The Laboratory needs increased test-beam facilities for this purpose, as well as an increase in PREP and in on-line computer facilities.

We are glad to have had the opportunity to have a good run with the Saver. The Saver performance was very impressive, and

the support of the Laboratory, particularly through the newly organized Experimental Areas Department, was of crucial importance and great effectiveness. Our thanks to you all!

Snoopy, with the help of Alan Guth, particle theorist/cosmologist from MIT, ponders the Inflationary Universe.

Particle Experimentalist, Frank Sciulli, from Columbia University, gave a review on Neutrino Mass/Oscillation Experiments.

From east, west, north, and south they came: (foreground left to right) Larry Abbott, Brandeis University, Steve Ellis, University of Washington, and Pierre Sikivie, University of Florida.

Nobel Laureate Steven Weinberg from the University of Texas spoke about extra dimensions.

(Photographs by Fermilab Photo Unit)

A REPORT ON INNER SPACE/OUTER SPACE
A Conference on Physics at the Interface of Astrophysics/Cosmology and Particle Physics
Fermilab, May 2-5, 1984

Rocky Kolb and Michael Turner

During the first week of May, the theoretical astrophysics group at Fermilab hosted an international conference on science at the interface of particle physics and cosmology/astrophysics. The conference "Inner Space/Outer Space" was attended by a very diverse group of more than 200 physical scientists, including astronomers, astrophysicists, cosmologists, low-temperature physicists, and elementary particle theorists and experimentalists. The common interest which brings this diverse group together is the connection between physics on the smallest scale probed by man--the realm of elementary particle physics--and physics on the largest scale imaginable (the entire Universe)--the realm of cosmology.

In its infancy the Universe was a hot soup of quarks and leptons, closely resembling the conditions created in very high energy particle collisions.

One of the intriguing connections between particle physics and cosmology is the possibility that most of the mass in the Universe resides in a yet-to-be-detected sea of elementary particles which are relics of the earliest moments of the Universe. Marc Davis (UC Berkeley) gave an observer's view of the large scale structure in the Universe, and Jay Gallagher (Kitt Peak National Observatory) presented the evidence that there are more to galaxies than meet the eye--that is, that most of the mass in a galaxy is not in the form of stars. If the mass is not in the form of stars, it probably exists in a dark spherical halo, which is possibly comprised of the exotic relics mentioned above. Simon White (Arizona) summarized the results of numerical simulations of the formation of structure (i.e., galaxies, clusters, etc.) in model Universes with different types of elementary particles as the 'dark matter.' Based upon comparison of the simulations and the observations which were discussed by Davis, the preliminary conclusion is that the dark matter is probably not massive neutrinos, but might be more exotic particles such as axions or one of the particles from the supersymmetric zoo. On the final day of the conference, J.D. Bjorken (Fermilab) discussed the prospects for actually producing, at present or future accelerators, some of the more exotic (i.e., not yet known to exist) particles which have been suggested as candidates for the dark matter.

In the 15th century, Copernicus suggested that the earth is not at the center of the solar system. Bruno in the 16th century took the Copernican idea one step further when he wrote that there are "...innumerable suns, and an infinite number of earths

Conference organizers Michael Turner (left) and Rocky Kolb. "Among famous collaborators" they rank between Pauli and Heisenberg and Abbott and Costello.

revolve around those suns..." In the 20th century, we discovered that our solar system is not at the center of our own galaxy, and that our galaxy is but one of billions of galaxies in the Universe. At the Fermilab conference we heard about equally heretical theories in which the Universe we observed might well be only one among many, that there may be more than three spatial dimensions, and that the matter of which we are made (neutrons, protons, electrons) may not be the dominant form of matter in the Universe. It is just possible that one of these ultimate extensions of the Copernican principle will be confirmed by high-energy experiments at Fermilab or elsewhere. We all hope that the physicists and astronomers working in this field fare better than did Bruno (who was burned at the stake, February 17, 1600).

The organizing committee for the Inner Space/Outer Space Conference included Rocky Kolb, David Lindley, Keith Olive, Chris Quigg, David Schramm, David Seckel, and Michael Turner.

A REPORT ON RECENT DEVELOPMENTS IN COMPUTING, PROCESSOR, AND SOFTWARE RESEARCH FOR HIGH-ENERGY PHYSICS

A Symposium Held in Guanajuato, Mexico, May 8-11, 1984

Thomas Nash

The bottleneck of computing is a critical problem for most existing and pending high-energy physics experiments. Many groups recognize that finding highly cost effective, yet user-friendly solutions to the computing problem will be a contribution to physics of the highest importance.

Work is going on in many laboratories to meet this need. This work was discussed at "Recent Developments in Computing, Processor, and Software Research for High-Energy Physics," a four-day international symposium held in Guanajuato, Mexico, May 8-11, 1984. The symposium was the third in a series of meetings exploring activities in leading-edge computing technology in both processor and software research and their effects on high-energy physics. Topics covered included fixed-target on- and off-line reconstruction processors, lattice-gauge and general theoretical processors and computing; multiprocessor projects, e^+e^- colliders on- and off-line reconstruction processors, state of the art in university computer science and industry; software research, accelerator processors, and on and off-line reconstruction processors for proton-antiproton colliders.

The major emphasis at Guanajuato was on large projects, including the CERN/SLAC 3081/E emulator effort; the Fermilab Advanced Computer Program multi-microprocessor project; the LBL Midas Project; the Nevis Data Driven Processor; and the CERN UA1 multiprocessor upgrade. With the exception of the Nevis processor, all of these high priority efforts are focusing on multiprocessor environments with well-supported Fortran. The projects differ in the number of nodes, ranging from fewer higher performance processors in the 3081/E approach to hundreds of microprocessors with at least 1/2 Vax power each in the Fermilab ACP project. With reasonable confidence, one can expect that next summer there will be available computation for special purposes with the power of 50 Vax 11/780s for about the cost of one commercial system.

Many reports were given at the Symposium on low-level triggering systems for fixed-target and colliding-beam experiments. Though sophisticated and powerful, these systems did not show any tendency toward a uniformity of approach like that developing in the FORTRAN multiprocessors for high-level triggers and off-line computing.

Theorists and accelerator builders are also feeling the computing crunch and are interested in developing their own computers. At Cal Tech and Columbia, grids of microprocessors

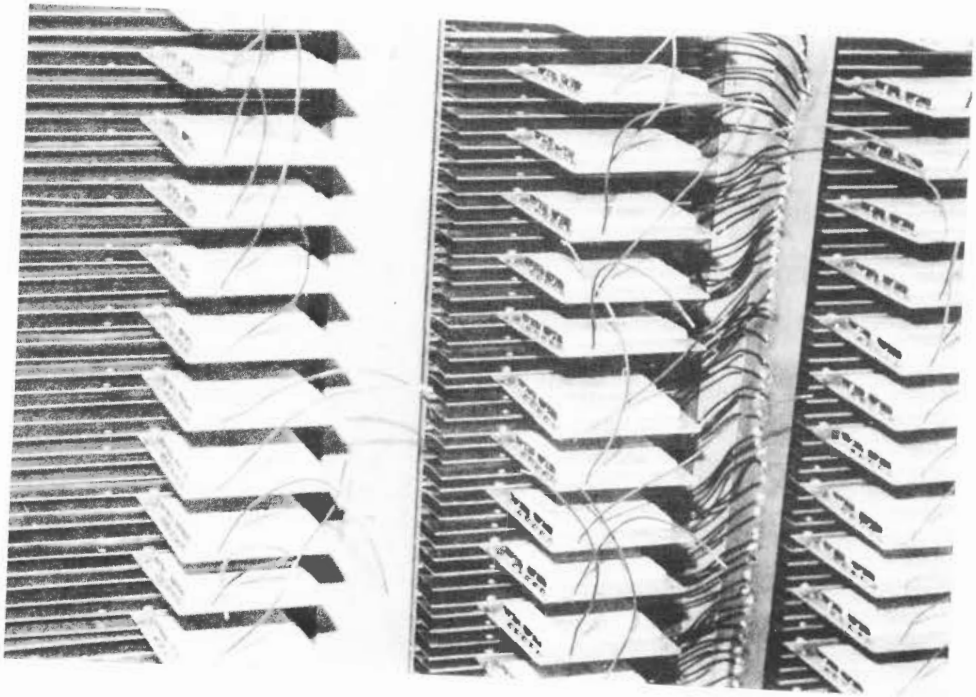
have been successfully assembled to attack the lattice gauge calculation. At Carnegie Mellon, even a QED calculation is being treated in this manner. At DESY, a multiprocessor system has been constructed for simulation of the HERA proton ring. This appears to be a forerunner of much future work on processors for accelerator calculations.

Many representatives of industry were present and were involved, along with a few stalwart physicist allies, in an intensive debate on the merits of commercial turn-key systems versus physicist-designed efforts. Industry is certainly feeling the pressure from the highly cost-effective multiprocessor-emulator efforts. The issue for industry is to what extent the activities in high-energy physics foreshadow a potential market outside this field.

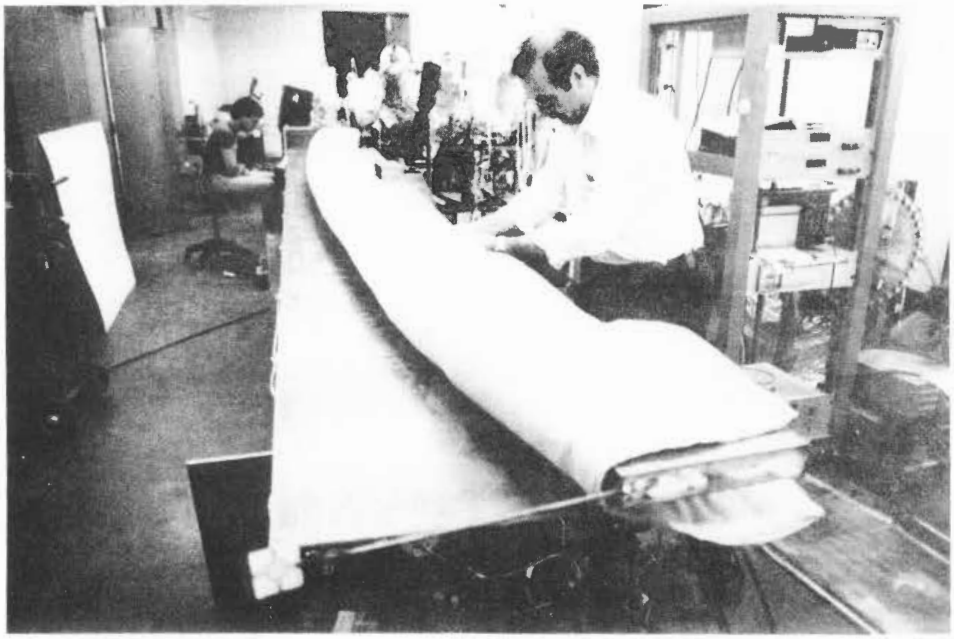
Finally, serious research in software aimed at improving physicist productivity was visible for the first time at such a conference. By far the most ambitious such activity is Cornell's Gibb's Project which is trying to develop a higher level than FORTRAN language environment. The idea is for physicists to write down their problems, mathematics and algorithms, in a readable book-like format using standard scientific notation and have this compiled automatically to FORTRAN.

The intensity of efforts in computing research for high-energy physics throughout the world was clearly felt at Guanajuato and the NIKHEF representative volunteered Amsterdam as a site for another meeting in a year.

Estudiantinas serenade attendees in the calles of Guanajuato during a traditional "callejoneada" at the Symposium on Recent Developments in Computing, Processor, and Software Research for High-Energy Physics, Guanajuato, Mexico, May 8-11, 1984.
(Photograph by Tom Nash)



Liquid Argon-Uranium Calorimeter for E-740.
(Photograph by Fermilab Photo Unit)



John Satti wrapping a prototype Accumulator vacuum-chamber section for brakeout tests.

(Photograph by Fermilab Photo Unit)

NORMAN RAMSEY RECEIVES IEEE MEDAL OF HONOR

Dr. Norman F. Ramsey, first president of Universities Research Association, received the 1984 Institute of Electrical and Electronic Engineers Medal of Honor, the IEEE's highest award, "for fundamental contributions to very high-accuracy time and frequency standards exemplified by the cesium atomic clock and hydrogen maser oscillator" at the 100th Anniversary Meeting of the IEEE in Boston last month.

Dr. Ramsey is Higgins Professor of Physics at Harvard University, where he has been working since 1947, and is a Visiting Professor at the University of Virginia, this year.

His experimental work has ranged from molecular beams to particle physics and has concentrated on precision measurements of the electric and magnetic properties of nucleons, nuclei, atoms, and molecules. An active participant in a number of professional societies, Dr. Ramsey was the founding president of Universities Research Association and served in that post for 15 years. He has been president of the American Physical Society, and is currently chairman of the American Institute of Physics' Board of Governors. He holds doctoral degrees from Columbia University and Oxford University.

MANUSCRIPTS AND NOTES PREPARED FROM APRIL 15 TO JUNE 7, 1984
AND LECTURES AND COLLOQUIA PRESENTED FROM MAY 6 TO JUNE 17, 1984

Copies of preprints with Fermilab publication numbers can be obtained from the Publications Office or Theoretical Physics Department, 3rd floor east, Wilson Hall. Copies of some articles listed are on the reference shelf in the Fermilab library.

Experimental Physics

M. L. Swartz et al. Experiment #326	The Atomic Mass Dependence of the Transverse Momentum Distribution of Massive Muon Pairs from 225 GeV/c π^- Nucleus Collisions (Submitted to Phys. Rev. Lett.)
M. L. Swartz Experiment #326	The Atomic Mass Dependence of Massive Muon Pair Production in 225 GeV/c π^--Nucleus Interactions (Ph.D. Thesis, The University of Chicago, March 1984)
C. Baltay et al. Experiment #380	Measurement of the Bjorken x and y Distributions in Neutral- and Charged Current ν_μ Interactions (Submitted to Phys. Rev. Lett.)
H. C. Ballagh et al. Experiment #546	Search for High Energy Tau Neutrino Interactions (Submitted to Phys. Rev. D)
M. D. Jones et al. Experiment #546	High Energy Neutrino Neutral-Current Interactions (Submitted to Neutrino '84)
C. C. Chang et al. Experiment #580	Diffractive Production of $K^0_S K^0_S \pi^+ \pi^- \pi^-$ in $\pi^- N$ Interactions at 200 GeV/c [Phys. Rev. **D29**, 1888 (1984)]
M. W. Arenton et al. Experiment #609	Measurement of the Di-Jet Cross Section in 400 GeV pp Collisions (Submitted to Phys. Rev. Lett.)
T. J. Chapin et al. Experiment #612	Diffraction Dissociation of Photons on Hydrogen (Submitted to Phys. Rev. D)
S. I. Baker et al. Experiment #660	First Operation with a Crystal Septum to Replace a Magnet in a Charged Particle Beam (FERMILAB-Pub-84/45-E; submitted to Nucl. Instrum. Methods)

S. I. Baker et al. Experiment #660	Deflection of Charged Particles in the Hundred GeV Regime Using Channeling in Bent Single Crystals [Phys. Lett. **137B**, 129 (1984)]

Theoretical Physics

S. Dawson et al.	Search for Supersymmetric Particles in Hadron-Hadron Collisions (FERMILAB-Pub-83/82-THY; submitted to Phys. Rev.)
J. F. Schonfeld	Statistical Mechanics of Colliding Beams (FERMILAB-Pub-83/93-THY; submitted to Ann. Phys.)
J. F. Schonfeld	Electron Storage Ring Distributions Near Linear Resonance (FERMILAB-Pub-83/95-THY; submitted to Ann. Phys.)
J. D. Bjorken et al.	Search for Neutral, Penetrating, Metastable Particles Produced in the SLAC Beam Dump (FERMILAB-Conf-84/33-T; presented at the 4th Moriond Workshop on Massive Neutrinos in Particle and Astrophysics, LaPlagne, France, January 15-21, 1984)
T. E. Clark and S. T. Love	Absence of Radiative Mass Shifts for Composite Goldstone Supermultiplets (FERMILAB-Pub-84/39-T; submitted to Phys. Lett.)
R. K. Ellis	Perturbative Corrections to Universality and Renormalization Group Behavior (FERMILAB-Conf-84/41-T; talk presented at the Workshop on Gauge Theory on a Lattice, Argonne National Laboratory, April 1984)

Astrophysics

E. W. Kolb et al.	More Dimensions (FERMILAB-Pub-84/37-AST; submitted to Phys. Rev. D)
E. W. Kolb and L. McLerran	The Structure of "Techni" Jets (FERMILAB-Pub-84/44-A; submitted to Phys. Rev.)

General

F. Beck and M. Gormley	Computer Control of Large Accelerators (FERMILAB-Conf-84/43; lectures given at the 3rd Annual Summer School on High Energy Accelerators, BNL-Stony Brook, July 6-16, 1983)
D. Theriot	The Collider Detector (CDF) at Fermilab - An Overview (Invited talk, 4th Topical Workshop on Proton-Antiproton Collider Physics, Bern, Switzerland, March 5-8, 1984)
R. A. Carrigan, Jr. and W. P. Trower	Magnetic Monpoles [Nature **305**, 673 (1983)]
O. Fackler et al.	The Calculation of Molecular Final States and Their Effect on a Precision Neutrino Mass Experiment (Presented at the Fourth Moriond Workshop on Massive Neutrinos in Particle and Astrophysics, LaPlagne, France, January 15-21, 1984)
L. C. Teng	High Energy Hadron Colliders (TM-1259; presented at the INS-Kikuchi Winter School on Accelerators for Nuclear Physics, Japan, January 29-February 2, 1984)
R. W. Goodwin and M. F. Shea	Modern Control Techniques for Accelerators (TM-1261; submitted to the 10th International Conference on Cyclotrons and Their Applications, E. Lansing, Michigan, April 30-May 3, 1984)

Physics Notes

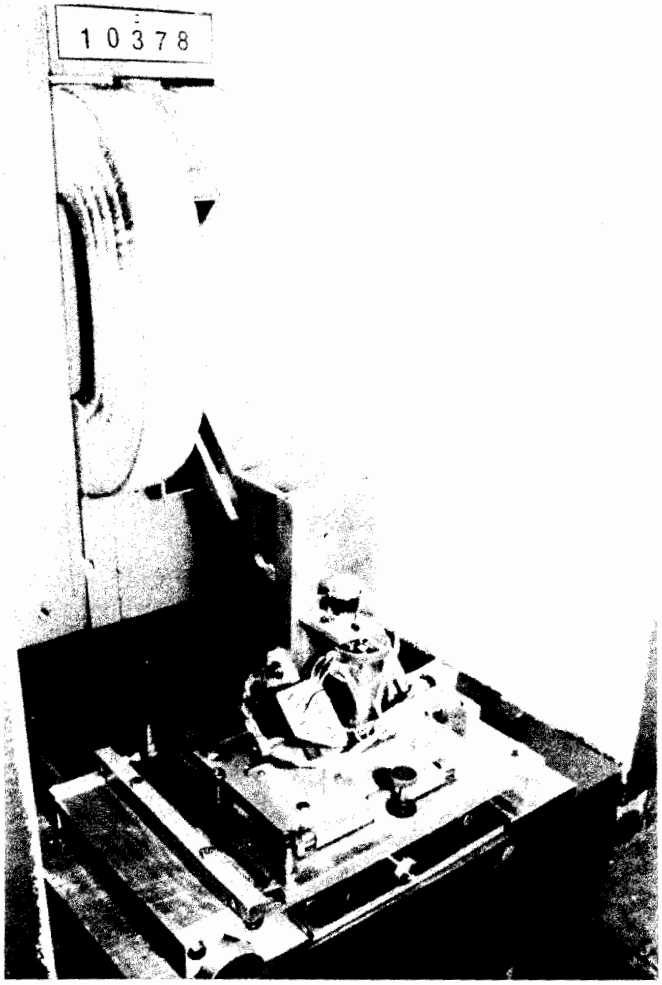
J. Morfin	Leptoproduction at an SSC Fixed Target Facility (FN-440; submitted to the SSC Fixed Target Workshop, The Woodlands, Texas, January 1984)

Colloquia, Lectures, and Seminars

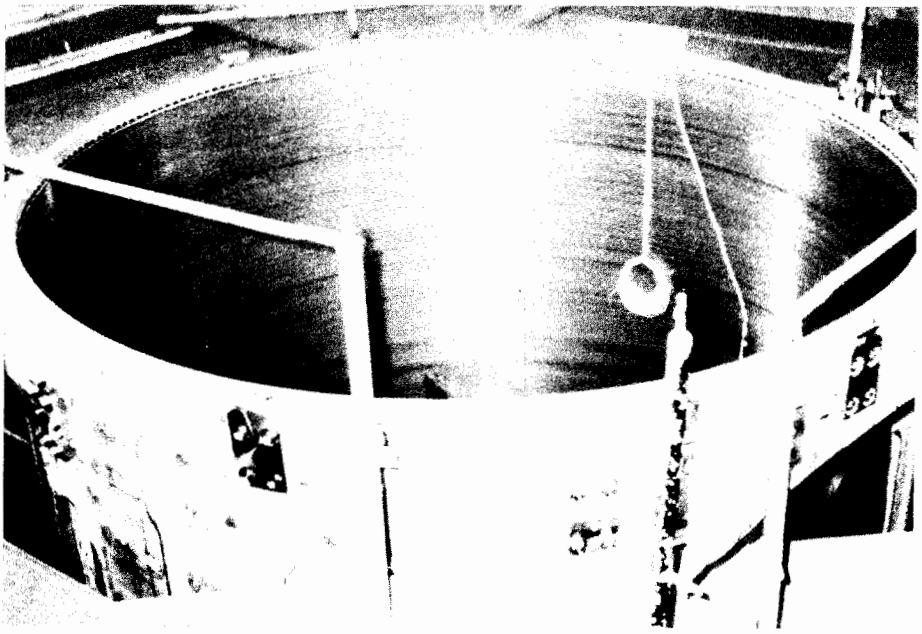
F. Cilyo	"POWERCON Conference Review" (Fermilab, April 20, 1984)

R. Johnson	"First Results from Beam Storage with B0 Low-β Insertion" (Fermilab, May 8, 1984)
J. MacLachlan	"Description of the Low Level RF Systems for the Debuncher and Accumulator" (Fermilab, May 10, 1984)
M. Atac	"Radial Drift Chamber for the CDF" (Fermilab, May 10, 1984)
B. Ducar and J. Grimson	"Conference Report - Robotics and Remote Handling" (Fermilab, May 14, 1984)
D. Johnson	"Plans for Conventional Construction During the Summer Shutdown" (Fermilab, May 17, 1984)
E. Malamud	"Overview of the Installation Plan for the Accumulator and Debuncher" (Fermilab, May 17, 1984)
D. Young and R. Gluckstern	"Report on the 1984 Linear Accelerator Conference" (Fermilab, May 22, 1984)
J. Krider	"Instrumentation for the Target Station" (Fermilab, May 24, 1984)
G. Nicholls	"Update on the Status of the Bunch Coalescing System" (Fermilab, May 24, 1984)
J. Schonfeld	"Statistical Mechanics of Colliding Beams" (Fermilab, May 29, 1984)
P. Limon	"Report on SSC Reference Design Study at LBL" (Fermilab, May 29, 1984)
L. Bartoszek	"Shutter and Kicker Status" (Fermilab, May 31, 1984)
B. Hyslop	"Status of Traveling Wave Tube Amplifier Procurement" (Fermilab, May 31, 1984)
S. Majewski	"Thin Multiwire Chambers in the Highly Saturated Mode" (Fermilab, May 31, 1984)

S. Fuess	"An Experimental Comparison of the Neutral Current Interaction to the Charged Current Interaction (E-594)" (Fermilab, June 1, 1984)
P. Limon	"Report on SSC Reference Design Study at LBL (Part II)" (Fermilab, June 4, 1984)
J. Nicholls	"The Computers at Fermilab: What? Where? How?" (Fermilab, June 6, 1984)
B. Ducar	"TeV I Repeater System" (Fermilab, June 7, 1984)
D. McConnell	"Comments on the TeV I Database" (Fermilab, June 7, 1984)
L. M. Lederman	"High Energy Physics" (Fermilab, June 11, 1984)
F. Cole	"Julich and Argonne Neutron Generators" (Fermilab, June 12, 1984)
P. O. Mazur	"Superconducting Technology" (Fermilab, June 13, 1984)
J. Misek	"Update on the Status of the Plan to Fabricate Debuncher Cavities" (Fermilab, June 14, 1984)
J. Hangst	"Status of Pulsed Magnets" (Fermilab, June 14, 1984)
G. Lee	"Status of the Fabrication of Beam Tube Assemblies" (Fermilab, June 14, 1984)

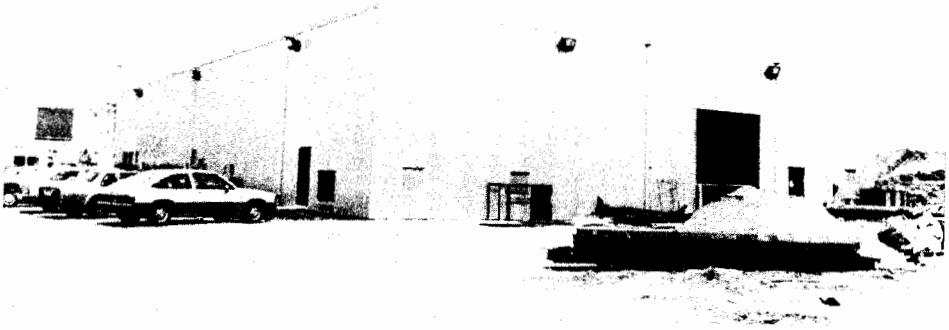


M Center target and magnet for E-731.
(Photograph by Fermilab Photo Unit)

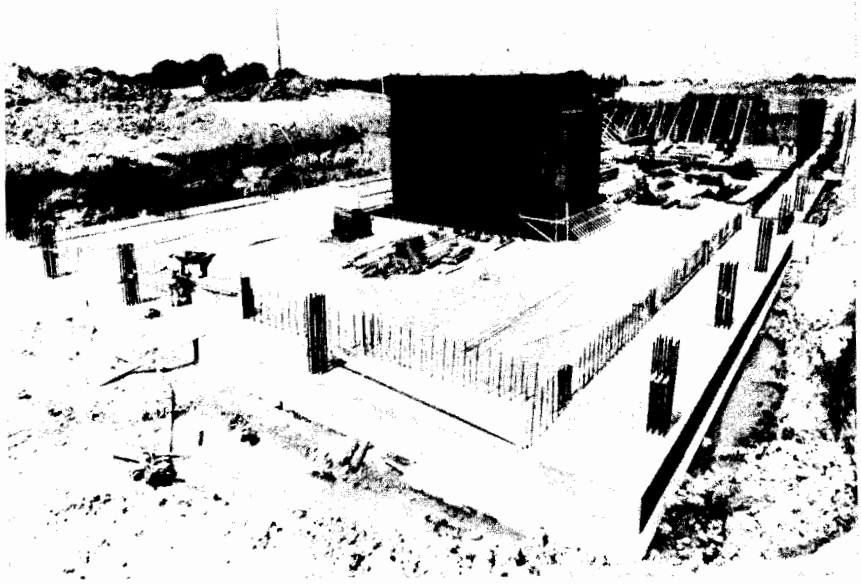


Superconducting solenoid for the Collider Detector being fabricated by Hitachi Company.

(Photograph by Fermilab Photo Unit)



The new Lab F at an advanced stage.
(Photograph by Fermilab Photo Unit)



Beginning of the Muon Lab.
(Photograph by Fermilab Photo Unit)

DATES TO REMEMBER

June 23-July 13, 1984	1984 Summer Study on the Design and Utilization of the Superconducting Super Collider, Snowmass, Colorado
August 13-24, 1984	U. S. Summer School on Particle Accelerators, Fermilab