fermilab report

Fermi National Accelerator Laboratory Monthly Report November 1985

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THE COVER: *View of the construction of the DØ Experimental Area taken on October 24, 1985. The walls forming the back of the Assembly Hall are visible at the top. The accelerator tunnel has almost been uncovered in preparation for its removal and the excavation of the Collision Hall. The existing service buildings will remain. A report on the Detector begins on page 5.* *(Fermilab photograph 85-800-10)*

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DEDICATION OF THE FERMILAB PROTON-ANTIPROTON COLLIDER

Fermilab's Proton-Antiproton Collider complex was formally dedicated at ceremonies in Ramsey Auditorium on October 11, 1985.

In 1981, the Department of Energy (DOE) successfully petitioned Congress to authorize the construction of an antiproton source and collision facilities. The project was designated Tevatron I. The Fermilab design, based on CERN's experience and on several years of R&D at Fermilab, was modified as the result of new ideas and new technological possibilities. The scheme was carefully reviewed by DOE, and approval for construction came in May of 1982. Under Tevatron I Project Manager John Peoples, the Proton-Antiproton Collider had all components in place by June of 1985.

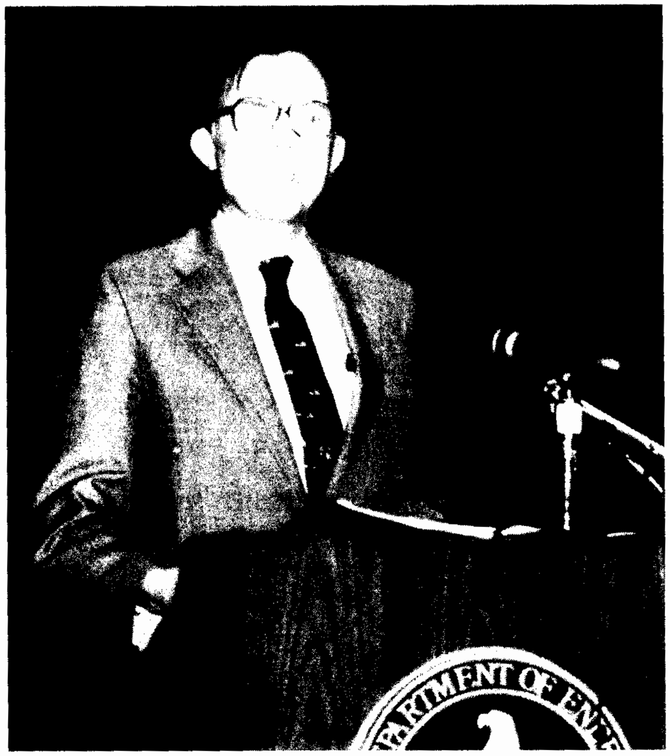
As reported in the October issue of **fermilab report**, at 3:30 a.m., Sunday, October 13, two days subsequent to the dedication ceremony, 1.6 TeV $\bar{p}p$ collisions were observed by the Vertex Time Projection Chamber in the Collider Detector at Fermilab (CDF).

The dedication ceremony was attended by members of the Antiproton Source, Accelerator, and CDF groups. Addressing the assemblage were guest speakers James R. Thompson, Governor of the

Secretary of Energy John S. Herrington's comments receive an appreciative response from (left to right) Harry Woolf, Chairman of the Board, Universities Research Association, Inc.; John Peoples, Tevatron I Project Manager; Fermilab Director Leon M. Lederman; Helen T. Edwards, Deputy Head of the Fermilab Accelerator Division; Illinois Governor James R. Thompson; and Richard A. Lundy, Fermilab Associate Director.

(Fermilab photograph 85-781-6)

State of Illinois; Lewis M. Branscomb, Vice President for Research, IBM; Norman Hackerman, President Emeritus, Rice University; John S. Herrington, Secretary of Energy; and Fermilab Director Leon M. Lederman. Chairman for the ceremony was Harry Woolf, Director, Institute for Advanced Study, and Chairman of the Board, Universities Research Association, Inc.



Lewis Branscomb, Vice President for Research, IBM, congratulated the Fermilab staff and their colleagues for the "hard and smart work behind today's dedication."

(Fermilab photograph 85-782-21)

Norman Hackerman, President Emeritus, Rice University, noted that "there is just and proper cause for celebration at the opening of this Proton-Antiproton Collider..."

(Fermilab photograph 85-782-23)

Touring the Proton-Antiproton rings are (left to right) Alvin Trivelpiece, Director, Energy Research, Department of Energy; Secretary of Energy John Herrington; Alvin Tollestrup, Co-manager, CDF; John Peoples, Project Manager, Tevatron I; Fermilab Director Leon Lederman; Ernest Malamud, Installation Leader, Tevatron I; and David Devane, press secretary for Secretary of Energy Herrington.

(Fermilab photograph 85-780-20)

UPDATE ON THE DØ EXPERIMENT

Peter F. M. Koehler

Introduction

The DØ Detector represents the second large facility which is being built to study $\bar{p}p$ collisions in the new energy region opened up by the Fermilab Tevatron Collider. It is the first of the second-generation detectors, having been designed on the basis of the results from the S$\bar{p}$pS collider at CERN.

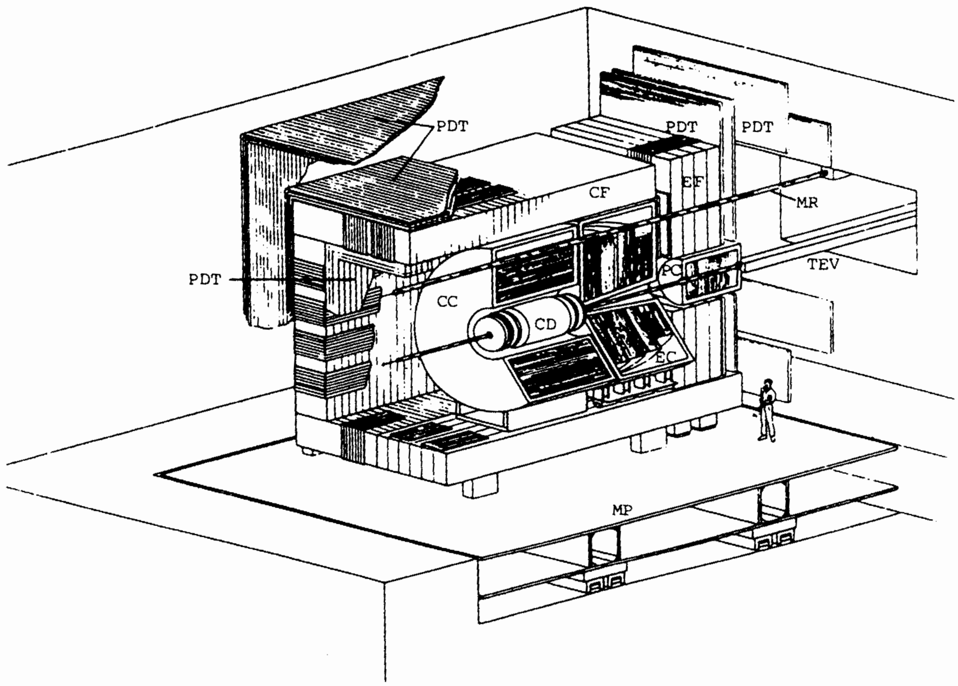
The DØ Detector will complement the Collider Detector at Fermilab (CDF) in a number of important ways. The DØ experiment will stress the measurement of the primary entities emerging from short-distance hadron collisions: leptons (both muons and electrons), parton jets, and missing transverse energy ($\not{E}_t$) which signals the production of non-interacting particles. The choice to do without a central magnetic field has rendered the detector design compact and free from gaps in the calorimeter coverage, with room to accommodate a muon detection system over the full solid angle. The ability to place the calorimeters relatively close to the beams has made it possible to choose the uranium-liquid argon technique with its superior energy resolution, segmentation, ease of calibration, and resistance to radiation damage.

The primary physics goals of the DØ experiment include precision studies of the W and Z bosons, where it should be possible to detect departures from the standard model predictions at the level of higher order corrections, and the search for new states or phenomena in the mass region above the W and Z. These searches should be aided by the DØ Detector's superior capability to detect leptons, jets, and missing $\not{E}_t$, because the cleanest signatures of most postulated heavy objects (new quarks, bosons, leptons, or supersymmetric particles) incorporate these objects. The evanescent hints in the CERN S$\bar{p}$pS experiments over the past year (monojets, top quarks, dimuon signals, high p_t W anomalies) have clearly demonstrated the utility of these capabilities. The CERN program has also shown once again the necessity of pursuing studies in new kinematic regimes with two independent experiments which compete with, confirm, and lead one another to an understanding of qualitatively new phenomena.

When Paul Grannis, the scientific spokesman for the DØ experiment, last reported in this publication (**fermilab report**; January 1, 1984), the design of the detector was just beginning to come together. The project has progressed substantially during the past 22 months in terms of the technical design, the R&D on particular detector components, the size of the collaboration committed to carry out this experiment, and the estimates of the resources and time required to implement the detector. Furthermore, the construction of the DØ Experimental Area is now well under way and has just entered its critical phase with the demolition of the accelerator tunnel at long straight section DØ. Thus, this is a good time to provide a comprehensive update on the DØ experiment.

Overview of the DØ Detector

A cut-away view of the detector is shown below. Its three major detector systems are: the central detectors, the calorimeters, and the muon system.



CD	Central Detectors	EF	End Toroid
CC	Central Calorimeter	PDT	Proportional Drift Tubes
EC	Endcap Calorimeter	MP	Moving Platform
PC	Plug Calorimeter	MR	Main Ring Beamline
CF	Central Toroid	TEV	Tevatron Beamline

The central detectors consist of three sets of drift chambers (Inner Vertex, Central, and Forward) to provide space-point coordinates and dE/dx information, and a set of transition radiation detectors for distinguishing electrons from hadrons in the central angular region. The Inner Vertex Chamber is a high-resolution drift chamber capable of resolving tracks and determining decay vertices in the high-flux environment just outside the beam pipe.

The calorimeters are separated into three angular regions (Central, Endcaps, and Plugs). They employ depleted uranium as the absorber medium for its high density and its ability to equalize the response to electrons and hadrons ("compensation"). In the case of the Central and Endcap Calorimeters, the gaps between the absorber plates are filled with liquid argon as the ionization medium for its ease of calibration, stability, and radiation hardness; this choice also makes it possible to incorporate fine segmentation readout in all three coordinates. Gas chamber sampling is employed in the Plug Calorimeters. The choice of materials for the calorimeters makes it possible to achieve a total absorption thickness large enough to contain high-energy showers within a compact volume.

The calorimeters are enclosed by the muon system, which consists of three magnetized iron toroids which bend the muons, thus enabling their polarity and momentum to be determined, and which serve as additional absorber for the remnants of the hadron debris emerging from the calorimeters. The full thickness of the detector varies from 13 to 18 absorption lengths over its solid angle. The muon trajectories before and after the toroids are determined with planes of proportional drift tubes which give space-point coordinates at ten locations along a muon track.

The entire detector, which will weigh approximately 5500 tons, will be mounted on a support platform so that it can be moved expeditiously between the Assembly Hall portion of the DØ Experimental Area and the Collision Hall.

Sophisticated electronics systems are required for the DØ Detector to acquire and process the information derived from the 5400 channels of drift chamber sense wires and delay lines, 1500 transition radiation detector wires, 46,000 calorimeter channels, and 12,000 muon proportional drift tubes. Each signal must be amplified and shaped, with special attention paid to noise levels and timing; transmitted to digitizing electronics for time and amplitude measurements; examined by fast trigger systems to select interesting candidates; transferred to a microprocessor-based higher-level filtering system; and logged by a host computer to permanent data storage. In order to reduce the problem of large bundles of cables trailing behind the moving detector, the electronics will be located as close to the detector as possible, some inside the moving support platform and some in a 3-level counting house which will move with the detector.

Only the higher-level filtering and data logging systems will be located in the fixed counting areas of the DØ Experimental Area.

Details of the DØ Detector can be found in the "Design Report for the DØ Experiment at the Fermilab Antiproton-Proton Collider", which was last issued in October, 1984, and in the many DØ Notes written by members of the collaboration.

The DØ Collaboration

The DØ Detector is being designed and built by a collaboration which by now includes more than 110 physicists, plus technical support personnel and graduate students, from the following 17 institutions:

- Brookhaven National Laboratory
- Brown University
- Columbia University
- Fermilab
- Florida State University
- Indiana University
- Lawrence Berkeley Laboratory
- University of Maryland
- Michigan State University
- New York University
- Northwestern University
- University of Pennsylvania
- University of Rochester
- CEN/Saclay
- State University of New York/Stony Brook
- Virginia Polytechnic Institute and State University
- Yale University

It is likely that the collaboration will grow by the addition of a few more groups. Discussions are under way to delineate the specific responsibilities which the participants from the collaborating institutions will undertake towards the implementation of the DØ Detector.

Frequent meetings are an essential feature of having so many groups working together coherently. While the collaboration meets as a group only once a month, subgroups working on software and on subsystems of the detector get together more frequently. Furthermore, each of the last two summers the collaboration has held a weeklong workshop which has been very useful for working out design parameters and defining boundaries. In addition, the workshops gave all the members of this large and diverse collaboration a better sense of the detector as a whole and of its physics objectives.

Since Fermilab has the overall responsibility to the Department of Energy (DOE) for the DØ Detector project, the Experiments Support Department was established in the Accelerator Division on October 1, 1984, for the primary purpose of assisting the DØ collaboration with the implementation of this detector, both technically and administratively. The Experiments Support Department presently numbers 24 members and, in addition, draws heavily on assistance from several other departments in the Accelerator Division and from the Physics Department, the Research Division, and the Technical Support Section. The total Fermilab manpower effort in support of the DØ Project is presently at the level of 40 full-time-equivalent persons and is projected to more than double over the next two years.

Activity Highlights

During the past two years the DØ collaboration has concentrated on carrying out a program of R&D work on many aspects of the detector, firming up component designs, and preparing detailed cost estimates of the entire detector for review by DOE.

Particularly noteworthy among the R&D efforts are studies of detector prototypes in test beams at Brookhaven (BNL), CERN, and Fermilab. In addition, the major activities included cosmic ray tests of the muon proportional drift tube prototypes, development of a data filtering system based on parallel microprocessors, and the development of Monte Carlo programs required to simulate events in the DØ Detector.

At BNL, a beam of pions and protons was used to test five prototype drift chamber cells in order to measure the dependence of the important performance parameters such as position resolution, two-track separation, and dE/dx discrimination on various design choices for the Central and Forward Drift Chambers and the associated electronics.

Prototypes of the Transition Radiation Detectors have been tested in a beam of pions and electrons at CERN in order to determine how the pion rejection efficiency depends on the choice of radiators (polypropylene foils, Li foils, or CH_2 fibers), X-ray detector gas (Xe-isobutane or Xe-CO_2), and signal counting method (total charge or cluster). It was found that the DØ design goal for pion rejection (30:1) can be obtained with multiple stacks of polypropylene foils and the use of cluster counting.

Extensive beam tests of a prototype uranium-liquid argon calorimeter were carried out at Fermilab. The primary aims were the measurement of the energy resolutions for electrons and pions between 10 and 150 GeV, a comparison of the calorimeter's response to electromagnetic and hadronic showers, determination of the position resolution, and studies of the total depth needed for adequate containment of hadronic showers. Two different arrangements of the calorimeter stack were tested in order to determine the dependence of the achievable resolutions on plate thickness. The results indicate that the ratio of the calorimeter's response to electromagnetic and hadronic showers of a given energy is approximately 1.1 over the full range of energies tested and that the resolutions are in agreement with the design goals for the DØ Detector. These tests have also provided us with a wealth of useful information on assembly techniques for uranium-liquid argon calorimeters and on the performance of the electronics employed to extract the low-level calorimeter signals.

The results from this R&D program, which needs to be pursued vigorously throughout FY 86 and beyond, are being used to make and refine design choices for the DØ Detector. They are also reflected in the most recent "bottoms-up" cost estimate which was prepared earlier this month and presented to a DOE Review Committee. In terms of FY 86 dollars, the base cost of the DØ Detector is estimated to be $36.1M; the addition of a 32% contingency brings the total estimated cost of the project to $47.8M. Thus the total estimated cost for the detector has not changed since the first detailed estimate was compiled a year ago.

Schedule and Milestones

The DØ collaboration is committed to the task of achieving a detector capable of its full physics potential as early as possible. Given our assessment of the scope of work ahead, and the technical resources available to us, we have developed a detailed implementation plan which aims to achieve hermetic coverage in all three detector systems (tracking, calorimetry, and muon detection) by late 1989 and complete the detector in 1990. The major milestones along the way are the following:

September 1986	Begin assembly of the support platform in the Assembly Hall portion of the DØ Experimental Area.
March 1987	Complete assembly of the support platform; begin assembly of muon toroid magnets.
November 1987	Complete toroids; Vertex Chamber, Central Transition Radiation Detectors, Central Drift Chambers, and first portion of muon Proportional Drift Tubes ready; begin installation of cables, electronics, and computers.
July 1988	Tracking and muon detection systems installed; Central and Plug Calorimeters complete, along with cryogenic support services. Ready for beam test of partial detector.

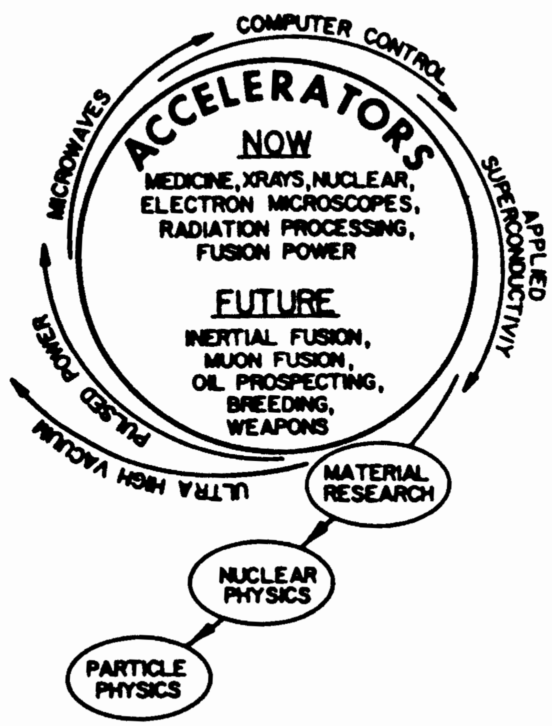
April 1989	Complete Endcap Calorimeters, fast trigger electronics. Continue installation of electronics, data acquisition system, computers.
October 1989	Detector ready for first data run with hermetic coverage in tracking, calorimetry, and muon detection.
July 1990	Fully instrumented detector complete.

This plan has received support from Fermilab and from DOE after review of the DØ Detector in May and November, 1985. Their combined efforts have been successful in achieving a significant improvement in the equipment allocation to this project during FY 86, which is the crucial year when the transition from design to fabrication must take place for all of the major systems. The collaboration now has its collective hands full to respond to this challenge. The recent successful test of the Antiproton Source, the acceleration and storage of protons and antiprotons in the Accelerator, and CDF's observation of the first $\bar{p}p$ collisions at 1.6 TeV has provided additional incentive and urgency to the work of the DØ collaboration. We feel that the full potential of the Fermilab Tevatron Collider program will only be realized when both of the large detectors are in place and taking data.

What Has Fermilab Done for Me Lately?
or
". . . but What Is the Practical Goal of Your Program?"

Reported by Richard A. Carrigan, Jr.

A superficial observer of a laboratory like Fermilab engaged in very basic research might jump to the conclusion that there were too few superconducting toothbrushes and quark power generators coming out of the program. A more insightful picture is that much of modern technology has been built upon the foundation provided by the direct antecedents of the basic research now under way at Fermilab. This situation is graphically illustrated with the trail of scientists, shown in the chart on the next page, that have led to our present level of high technology. The figure below illustrates the same sort of effects for accelerator science where a multitude of new and associated technologies, as well as new techniques for allied sciences, have flooded out of what was originally a search for tools for basic science investigations.



Intellectual Heroes of Basic Frontier Physics

Democritus	
Archimedes	
Ptolemy	
Copernicus	
Galileo	
Brae	
Newton	CLASSICAL MECHANICS
Ampere	
Faraday	
Maxwell	RADIO
Hertz	TELEVISION
Curie	
Thomson	
Rutherford	
Einstein	
Bohr	TRANSISTORS
Schrödinger	CHEMISTRY
Heisenberg	DNA
Pauli	
Fermi	ATOMIC POWER
Anderson	MEDICAL TRACERS
Yukawa	
Dirac	
Lawrence	ACCELERATORS
Lamb	
Schwinger	
Feynman	
Bardeen	
Yang	
Gell-Mann	
Salam	
Weinberg	COSMOLOGY
Glashow	
Cronin	
Fitch	
K. Wilson	

An anecdote related by George Zweig, co-inventor of the quark hypothesis, at the recent Fermilab Industrial Affiliates annual meeting shows how important basic research can be. During the latter part of the last century, Gustaf Hertz, a very prominent physicist of his day, and the discoverer of radio waves, tried in vain to find the particle we now know as the electron. In the process, he invented the cathode-ray tube. He published his null results in 1883. Because of his enormous reputation, no one pursued the matter for 15 years until J. J. Thomson came along. All of modern electronics including oscilloscopes and television flowed <u>directly</u> out of Thomson's discovery of the electron. What would our century have looked like if Hertz had found the electron 15 years earlier?

Last year, Fermilab Director Leon Lederman published an article entitled "The Value of Fundamental Science" in *Scientific American* that discussed many of the practical results that have come out of fundamental physics. This was part of a serious program on his part to make more widely known the substantial benefits accruing from basic research and the ways these benefits reach the public. This article grew out of an earlier *Viewpoint* article, a more detailed review of the same point. Lederman's *Scientific American* article speaks directly to the ways benefits flow out of fundamental science.

> "...the support of fundamental science - mathematics, astronomy, the physical and the biological sciences - yields profoundly significant benefits. They can be classified roughly according to the time it takes for them to be transferred to society. The most important benefits are cultural; the cultural benefits also require the longest and most complicated maturation process. Direct benefits, in which the object of scientific inquiry is put to some practical use, typically require about 30 years to be realized. For example, nuclear magnetic resonance (NMR) was discovered in the 1940's, and its commercialization as an imaging device in medicine began in the 1970's. The most rapidly realized social benefits are usually indirect, such as technology spin-off. They arise when some solution to a problem in a fundamental discipline is perceived to have application in an unrelated field."

With this in mind it is obvious that any report of current efforts to spin-out technology misses the main long-term benefits. If Katz-Moody algebras are to string theory what calculus was to classical mechanics, then the most important contribution of particle physics in the next millenium could be mathematics. Nevertheless, the more immediate spin-offs are also interesting.

The major thrust of the technology transfer program at Fermilab is the Fermilab Industrial Affiliates. The Affiliates organization is comprised of industrial concerns interested in the research and development work underway at the Laboratory. Affiliates receive a monthly tailored distribution of reports. An annual meeting gives the Affiliates an opportunity to visit the Laboratory and review ongoing work and future projects. The most recent meeting had as its major topic "Applications of Particle Physics, Out on the Limb of Speculation." This Round Table attracted outstanding participants--Sheldon Glashow of Harvard University, George Zweig of Los Alamos National Laboratory, two very interesting industrial scientists from the General Electric Company and Hughes Research Laboratory , and Stephen Jones, then at Idaho National Engineering Laboratory and now at Brigham Young University. Walter Sullivan of the *New York Times* served as moderator. An "Intense Briefing on Superconductivity" was held in February. This was well attended by interested industries in the cryogenics and superconductivity fields. That meeting helped to illuminate the practical side of large scale superconductivity.

The Laboratory is also involved in the more traditional forms of technology transfer. Many technical articles are published and papers presented at meetings based on the work of the Laboratory. These papers represent a very effective means for transferring the work of the Laboratory. The field of particle physics is also an exporter of highly trained manpower to other technical areas. Staff and graduate students trained at Fermilab have gone on to such activities as telephone switching systems, oil exploration, and medical imaging where they have made direct use of Fermilab science and technology.

These technology transfer activities are superimposed on another traditional, on-going, and historically very effective natural process of technology transfer. This is the process whereby Fermilab specifications are met by vendors only after considerable effort, usually collaborative, between Laboratory and industry. The result is often a new product or a new skill which results in a new product. A prime example of this is the development of the superconducting cable that was used in the Tevatron. That cable solidified and aggregated the present superconducting cable industry. Similar illustrations hold for several important electronic products. It is this "standard" activity that probably accounts for an overall payback which is a significant fraction of the annual budget of all the basic research laboratories. An interesting analysis of this type of activity has been carried out recently at CERN. A similar study at Fermilab would strongly support the CERN picture.

A recent activity at Fermilab that shows this process in action is the Advanced Computer Project (ACP). That project is developing a special super computer that can analyze many experimental particle events in parallel. The system goals are to be able to process an enormous number of events at a modest cost in an environment that is user-friendly. One important element of this program has been to maintain close working relationships with microprocessor chip manufacturers and software developers. The thrust of the Fermilab program, in turn, acts back on the suppliers. To quote comments received from a person at a prominent corporation in the computer field, "I applaud your progress on the ACP microprocessor. You deserve credit for helping us all realize the benefits of multiprocessing systems."

Recently the Laboratory has also been serving as a lightning rod for interest in the possibility of developing a proton accelerator for medicine. Several meetings have been held here as a forum for the interested parties from medicine, industry, the universities, and the accelerator community. At this stage the dust has not yet settled but it has been vigorously stirred. Discussions have been underway with the State of Illinois about the possibility of a small center at Fermilab to facilitate commercialization.

These two activities represent broad areas with substantial potential. Progress has also been made in exploiting some of the individual inventions at the Laboratory. This year the Laboratory has started to use the Technology Commercialization Center at the University of Illinois-Chicago to assess some of these inventions. Currently a design class at the University is studying an interlocking component system devised here by Carl Lindenmeyer in the Physics Department for drift chamber fabrication. Interestingly, one of the applications they are considering is for decorative panels. Another Laboratory-developed modification on a Bendix coordinate measuring machine by Greg Kobliska and his colleagues in Technical Services was featured recently in the magazine *Quality*, the trade publication of the quality control industry.

This fall the Laboratory was awarded an IR-100 award for a magnetic wire position transducer developed by Hans Jöstlein. About 20% of these IR-100 awards went to DOE Laboratories this year. This is certainly a tribute to the enormous diversity of the Department of Energy's (DOE) program.

The Laboratory has redoubled its efforts to patent appropriate technologies. In the process a complete technology inventory has been put in place. It now contains more than 300 technology items in a computer data base. An application assessment along the lines of a standard DOE reporting form has been prepared for each of these. In the next year, hopefully, ways will be found to effectively exploit these innovations.

These developments discussed here arose directly out of the Laboratory's single mission of conducting research in fundamental physics. These technologies either have or could have wide practical use. On the other hand, new technology is not the primary purpose of the Laboratory. While science leads to technology, technology is not the aim of the Laboratory. Basic research is!

MANUSCRIPTS, NOTES, LECTURES, AND COLLOQUIA PREPARED OR PRESENTED FROM OCTOBER 14, 1985 TO NOVEMBER 17, 1985

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

S. Bhadra et al. Experiment #516	A Study of the Inclusive K_S^0, Λ, $\bar{\Lambda}$ Production in Diffractive γp Interactions (Submitted to Phys. Rev. Lett.)
S. Mikocki et al. Experiment #580	Inclusive Strange Particle Production in Single-Vee Events in 200 GeV/c $\pi^- N$ Interactions (FERMILAB-Pub-85/132-E; submitted to Phys. Rev. D)
C. Biino Experiment #615	An Apparatus to Measure the Structure of the Pion (Submitted to Nucl. Instrum. Methods)
T. F. Davenport et al. Experiment #623	Observation of Double Phi Meson Production in 400 GeV/c Proton-Nucleon Interactions (FERMILAB-Pub-85/141-E; submitted to Phys. Rev. D)
T. F. Davenport Experiment #623	Observation of Double Phi Meson Production in 400 GeV/c Proton-Nucleon Interactions (Ph.D Thesis, Florida State University, Tallahassee, Florida, December 1984)
H. Miyata Experiment #741	A Gas Calorimeter for High Energy Experiment and Study of High Energy Cascade Shower (Ph.D Thesis, University of Tsukuba, Japan, September 1984)

Theoretical Physics

J. Traschen and C. T. Hill	Stability of DeSitter Space Coupled to a Quantum Field (FERMILAB-Pub-84/104-T; submitted to Nucl. Phys. B)
J. F. Schonfeld	Passive Correction of Orbit Distortion in Very Large Proton Storage Rings (FERMILAB-Pub-85/91-T; submitted to Phys. Rev. Lett.)

W. A. Bardeen and N. Deo	Comment on Spinor Anomalies (FERMI-LAB-Pub-85/109-T; submitted to Nucl. Phys.)
W. A. Bardeen	Gauge Anomalies, Gravitational Anomalies, and Superstrings (FERMILAB-Conf-85/110-T; talk presented at the INS International Symposium, Tokyo, Japan, August 12-14, 1985)
J. F. Schonfeld	A New Approach to Dynamic Aperture Problems (FERMILAB-Pub-85/112-T; submitted to Particle Accelerators)
S. J. Parke and T. R. Taylor	Gluonic Two Goes to Four (FERMILAB-Pub-85/118-T; submitted to Phys. Lett. B)
T. Sjöstrand	Multiple Parton-Parton Interactions in Hadronic Events (FERMILAB-Pub-85/119-T; presented to the Oregon Workshop on Super High Energy Physics, and Nucl. Phys. B)
I. Dunietz et al.	A Priori Definition of Maximal CP Violation (FERMILAB-Pub-85/124-T; submitted to Phys. Rev.)
C. N. Leung	Higgs Boson Spectrum from Infrared Fixed Point (FERMILAB-Conf-85/129-T; submitted to the DPF Meeting of the American Physical Society, Eugene, Oregon, August 12-15, 1985)
O. W. Greenberg	A New Level of Structure (FERMILAB-Pub-85/138-T; submitted to Physics Today)
K. Tanaka	Two Dimensional Liouville, sine-Gordon, and Non-Linear σ-Models (FERMILAB-Pub-85/161-T; submitted to Phys. Rev.)

Astrophysics

R. Holman and D. B. Reiss	Fermion Masses in $E_8 \times E_8$, Superstring Theories (FERMILAB-Pub-85/130-A; submitted to Phys. Rev. D)

E. W. Kolb	Searching for Cygnets (FERMILAB-Conf-85/134-A; talk presented at Physics in Collision, Autun, France, July 1985; Particles and the Universe, Thessaloniki, Greece, June 1985)
E. W. Kolb et al.	Time Variation of Fundamental Constants, Primordial Nucleosynthesis, and the Size of Extra Dimensions (FERMILAB-Pub-85/136-A; submitted to Phys. Rev.)
J. M. Bardeen et al.	The Statistics of Peaks of Gaussian Random Fields (FERMILAB-Pub-85/148-A; submitted to Astrophys. J.)
M. S. Turner	On the Cosmic and Local Mass Density of 'Invisible' Axions (FERMILAB-Pub-85/149-A; submitted to Phys. Rev. D)
M. S. Turner	The Inflationary Paradigm (FERMILAB-Conf-85/153-A; summary of three lectures on inflation given at the Cargese Summer School on Fundamental Physics and Cosmology (July 1984), the Les Houches Summer School on the Architecture of the Fundamental Interactions at Short Distances (July-August 1985), and the UK Theory Summer Institute (St. Andrews, August 1985). To be published in the Proceedings of the Cargese School on Fundamental Physics and Cosmology, eds. J. Audouze and J. Tran Thanh Van (Editions Frontieres, Gif-Sur-Yvette, France, 1985)
J. A. Stein-Schabes and M. Gleiser	Low Energy Superstring Cosmology: I (FERMILAB-Pub-85/157-A; submitted to Phys. Lett.)

General

M. Atac and T. Hessing	Radial Wire Drift Chambers for CDF Forward Tracking [CDF Note No. 359; invited paper presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

A. E. Baumbaugh et al. — A Real Time Data Compactor (Sparsifier) and 8 Megabyte High Speed FIFO for HEP [TM-1363; submitted to the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

F. Bedeschi et al. — A Silicon Vertex Detector for CDF [CDF Note No. 362; presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

A. Cohen et al. — Status of FASTBUS Software in the Computing Department at Fermilab (TM-1359; submitted to the CERN FASTBUS Software Workshop, Geneva, Switzerland, September 23-24, 1985)

G. Drake et al. — A Large Dynamic Range Charge Amplifier ADC for the Fermilab Collider Detector Facility [FERMILAB-Conf-85/155; presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

G. Drake et al. — The RABBIT System: Low Cost, High Reliability Front End Electronics Featuring 16 Bit Dynamic Range [FERMILAB-Conf-85/156; presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

D. Green — Future Detector Needs for High Energy Physics [FERMILAB-Conf-85/151; invited talk presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

M. Haldeman and S. Zimmerman — FASTBUS Rack Alarms and Limits [Invited paper presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

M. Haldeman et al. — FASTBUS Cooling [Invited paper presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

H. B. Jensen	The Collider Detector at Fermilab (CDF) [FERMILAB-Conf-85/150; invited talk presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]
L. C. Teng	Accelerating A Polarized Beam in the 1-Tev Booster - Summary Report of the Booster Working Group (Presented at the Workshop on Polarized Beams for the SSC, Ann Arbor, Michigan, June 1985)
S. Zimmerman	A FASTBUS Logic Analyzer Based on SLAC SNOOP Diagnostic Modules [Invited paper presented at the 1985 IEEE Nuclear Science Symposium (NPS), San Francisco, CA, Oct. 23-25, 1985]

Physics Notes

G. Chartrand and P. Demar	DECnet and the High Energy Physics Network (FN-425; published in DECUS SIGs Newsletters, September 1985, vol. 1, no. 1)

Colloquia, Lectures, and Seminars

R. A. Carrigan, Jr.	"Crystals as Beam Line Elements (Fermilab, October 17, 1985)
J. Misek	"The Booster to Debuncher Line - Mechanical Layout" (Fermilab, October 24, 1985)
R. Oberholtzer	"The Booster to Debuncher Line - Electrical Installation" (Fermilab, October 24, 1985)
D. Edwards	"Introduction to Accelerator Physics" (Fermilab, October 28, 30, and November 4, 1985)
R. Orr	"Accelerator Division Information Meeting" (Fermilab, October 29, 1985)
R. Shafer	"Performance of the Stochastic Cooling Systems During September-October Run" (Fermilab, October 31, 1985)

J. Peoples	"Comments on the DOE Review of October 29 and 30" (Fermilab, October 31, 1985)
J. Cieply	"Humanizing HALO" (Fermilab, October 31, 1985)
M. Mishina, G. Brandenburg, and M. Atac	"Gas Calorimetry Workshop" (Fermilab, October 31-November 1, 1985)
H. Itoyama	"Supersymmetry Anomalies" (Fermilab, November 5, 1985)
R. Pasquinelli	"The Stochastic Cooling System of TeV I" (Fermilab, November 5, 1985)
D. Bogert	"Introduction to the Accelerator Control System" (Fermilab, November 7, 1985)
D. Anderson	"Nuclear Medicine (PET, NMR, etc.)" (Fermilab, November 7, 1985)
L. M. Lederman	"Inner Space/Outer Space Revisited; The Super Accelerator" (Fermilab, November 8, 1985)
B. Cox et al.	"Workshop on Triggering, Data Acquisition, and Computing for High Energy/High Luminosity Hadron-Hadron Colliders" (Fermilab, November 11-14, 1985)
M. Syphers	"The New 8-GeV Beam Line" (Fermilab, November 12, 1985)

DATES TO REMEMBER

December 6, 1985	"Supersymmetry, Gravity, and Unification," by Bruno Zumino (Physics Department, University of California at Berkeley); third lecture of the Director's Special Colloquia on Topics in High-Energy Physics held at Fermilab, Ramsey Auditorium, 4:00 p.m.
December 7, 1985	Users Executive Committee meeting
December 10, 1985	"The Ongoing Search for Dark Matter Candidates," by Frank Wilczek (Institute for Theoretical Physics, Santa Barbara, California); fourth lecture of the Director's Special Colloquia on Topics in High-Energy Physics held at Fermilab, Ramsey Auditorium, 3:00 p.m.
December 12-13, 1985	Physics Advisory Committee meeting
January 15-24, 1986	Observable Standard Model Physics at the SSC: Monte Carlo Simulation and Detector Capabilities; for further information contact Sharon Wong (213) 825-3441 or Chuck Buchanan (213) 825-7466.
January 16-17, 1986	Workshop on Radiation Damage to Wire Chambers, Lawrence Berkeley Laboratory, Berkeley, California 94720; for more information contact John Kadyk, (415) 486-7189 or FTS 451-7189.
January 23, 1986	"Superstring Theory," by Edward Witten (Princeton University); fifth lecture of the Director's Special Colloquia on Topics in High-Energy Physics held at Fermilab, Ramsey Auditorium, 3:00 p.m.