fermilab report

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87/9 **Fermi National Accelerator Laboratory** **0090.01**

On the cover: Deputy Director Philip V. Livdahl retired from Fermilab in September of 1987. Livdahl, who has been a vital force in Fermilab's progress over the past 20 years, will be devoting his full attentions to the Loma Linda medical accelerator project. See page 26.

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Correction: In the July/August issue of *Fermilab Report*, on page 25, the name of Leonid Sagalovsky (University of Illinois - Champaign-Urbana) was inadvertently omitted from the list of students in the Joint University-Fermilab Doctoral Program in Accelerator Physics.

Operational Experience with a High-Speed Video Data Acquisition System in Fermilab Experiment 687*

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B. Baumbaugh and R. Ruchti
Notre Dame University

Introduction

The development of high-resolution scintillating glass active targets has created the need for specialized data-acquisition systems. The data produced by these targets is in the form of an image which is the projection of the interaction vertex upon the face of the active target. Image data of this type presents several problems which must be addressed. The images contain large volumes of data which must be stored and processed, requiring high speeds if significant numbers of images are to be recorded. To be useful for high-energy physics (HEP), the system must also be triggerable. The use of film for this type of target is practical only for testing since film cameras can, at best, run only a few frames per second in triggered mode. With these requirements in mind, the Video Data Acquisition System (VDAS) was developed.

The prototype VDAS was used to study Comet Halley to look for very short duration events which are masked by usual observational techniques.

VDAS is flexible enough to accommodate virtually any video format, standard or non-standard, and fast enough to be useful in HEP. VDAS is capable of digitizing an image at 30 million pixels per second and can store many images in its internal first-in/first-out (FIFO) buffer which can run at 100 megabytes per second. The first VDAS has been installed in the Wide Band Photon Hall at Fermilab as part of E-687, and will soon be taking data.

**A slightly different version of this article was presented at the IEEE Nuclear Science Symposium, San Francisco, California, October 21-23, 1987 and is available as Fermilab preprint 87/199.*

Experiment 687

Experiment 687 is designed to study the photo-production of charm and beauty states. This is accomplished by use of a large multiparticle spectrometer and elaborate tracking system. The experiment will use tagged photons interacting in a glass or plastic scintillating-fiber target for the primary vertex. The active target will study short-lived decays and aid in identification of decay products.

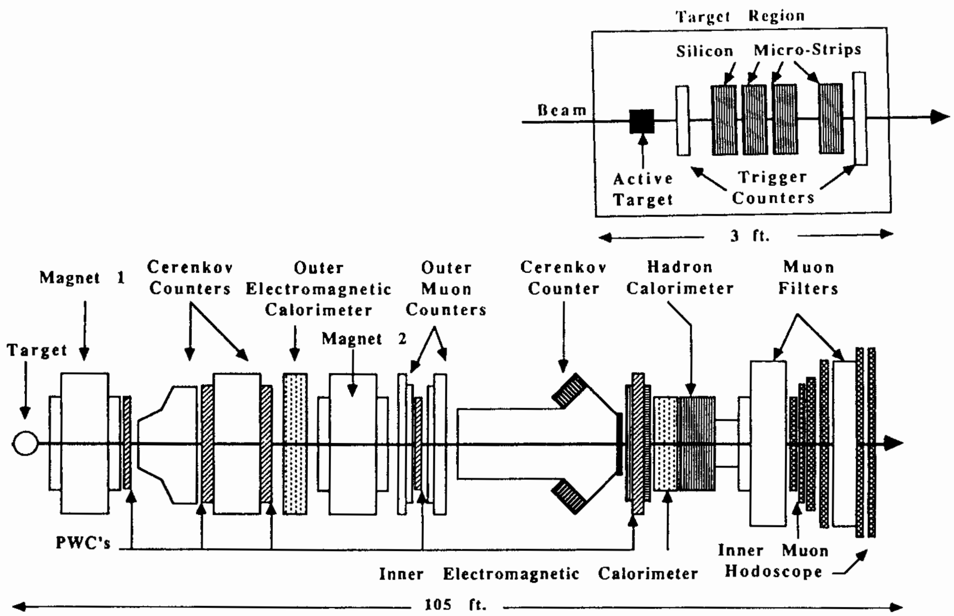


Figure 1. E-687 spectrometer configuration. The target region is shown in detail.

The E-687 spectrometer (Fig. 1) divides its job into, roughly, two regimes: an inner or forward portion for low-angle tracks and an outer portion for high-angle tracks. In both regimes, electromagnetic calorimetry and muon detection systems are provided, with hadron calorimetry for the inner region only. The tracking system consists of 20 planes of proportional wire chambers together with a 12-plane silicon microstrip detector for additional tracking in the vertex region. The spectrometer employs two analyzing magnets (of opposite polarity) with vertical bend planes, three Cerenkov detectors for particle identification, beam calorimetry devices (not shown) as well as miscellaneous scintillation counters and hodoscopes.

The spectrometer will provide the tracking and particle identification for all particles produced in the interaction. However, the tracking capability is not precise enough to detect particle decays which happen very close to the primary interaction vertex. For this reason, the target used will be an active or instrumented one. The spectrometer can record data faster than the active target, so only a subset of the spectrometer data will also have interaction vertex image data. The trigger will be set up so that the most interesting candidate events will gate the imaging system.

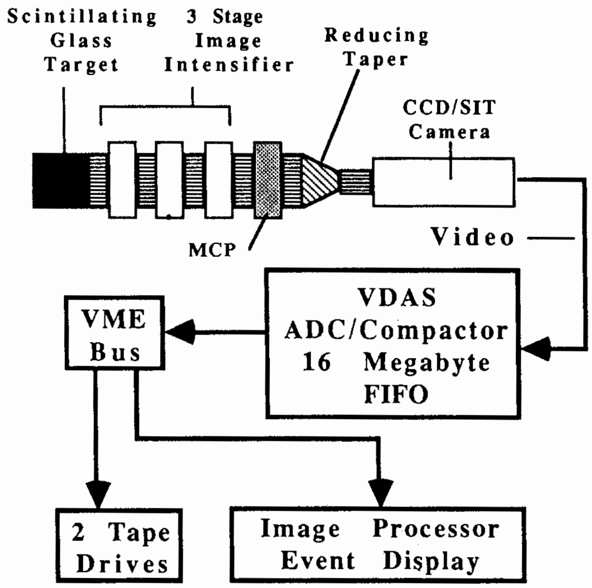


Figure 2. The active target, VDAS, and image data recording systems.

The active target system (Fig. 2) consists of a scintillating fiber target, a multiple-stage image intensifier, camera, the VDAS, and data recording system. There is also a crude image processing and display system for event viewing.

The active target system is made up of approximately 1 million GS1 Cerium glass fibers fused into a cube 20 millimeters on a side. Although this target is glass, plastic fibers could also be used to manufacture a target. A target constructed of these plastic fibers would have inherent advantages in a photon beam as plastic has a longer radiation length than glass.

The image produced by the target is a two-dimensional projection of the interaction region. This image has extremely low light levels, essentially single photon counting. This requires the use of a multi-stage image intensifier/ expander of the GEN-1 type, with a gain of approximately 100,000 to produce light levels usable for the camera. The image is expanded prior to intensification and reduced afterward to minimize the spot size effects of the image intensifiers.

The system also includes a fast local trigger and gated micro-channel plate stage in the intensifier so that only selected events are allowed to be gated onto the photo-sensitive face of the imaging device. The time delay needed for trigger decisions is provided by the phosphor decay time in each of the intensifier stages. These phosphors are chosen to match the beam rates of the experiment and the projected trigger rates.

The first data-taking run will use a silicon intensified target, or SIT, Vidicon camera as the primary imaging device. The electrostatically deflected SIT has the advantage of being triggerable; the camera can start a read-out cycle at any time, unlike a magnetically deflected camera in which the deflection coils are part of an oscillator. The electrostatic deflection allows the SIT to scan at a higher rate, as there is little energy stored in deflection circuits. The SIT also has reasonably high resolution, effectively 768 by 512 pixels.

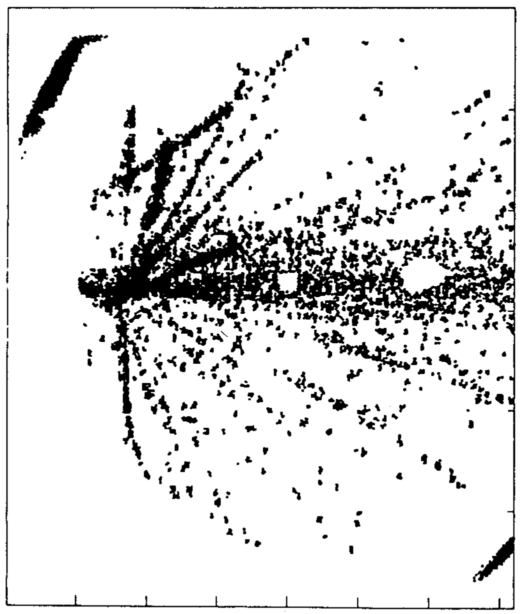


Figure 3. A 350-GeV pion captured by VDAS on 1/18/88. The event is one of 145,000 recorded in the first use of VDAS linked to the spectrometer in E-687. Note the low percentage of pixels which are of interest. This type of image lends itself to image compression with good results.

The Video Data Acquisition System

The video image is converted to digital data, with 6-bit resolution, using the VDAS system developed at Fermilab. A recent sample interaction is shown in Fig. 3. Typical images have only 10 to 20% of the pixels above threshold.

In order to increase the number of images which the system can store, the data is compacted in real time and stored locally in a large high-speed FIFO. By automatically inserting horizontal and vertical sync markers, as well as event tagging data, in the data stream, VDAS is able to reconstruct the image data. The analog-to-digital converter and data compactor have been tested at speeds of up to 30 million pixels per second, which is as fast as our test image signal could run. It is hoped that this speed can be increased to 100 million pixels per second in the near future. The image pixel density is programmable for any size up to 4096 by 4096 pixels.

The current FIFO is configured as 16 megabytes and has been tested at 100 megabytes per second. The data is read from the FIFO by a VME-based system and written to two streaming tape drives. The beam spill structure at Fermilab, 20 seconds of beam and 40 seconds off, dictates the FIFO size. The size of the FIFO is adjusted so that the tape drives run continuously and the FIFO buffers enough to keep the tapes busy during the 40 seconds between spills. The FIFO is a stand-alone device and can be used for buffering data from any source.

Selected events are also loaded from the VME system to an LSI-11-based image processor for display and analysis. During the running period, this image processor is only used as a display device.

The spectrometer data is read into the experimental control VAX via several separate paths. The silicon micro-strips, calorimeters, and tracking chambers each has a data path which includes a LeCroy 1892 FIFO module.

The VDAS data path bypasses the VAX. The amount of data involved would overwhelm the experimental-data acquisition system, hence, the image data from VDAS is written to completely separate tapes.

The problem of reconstructing events is complicated by the multiple data paths, not only within the spectrometer data, but also by the completely separate path for the active target image data. To solve this problem, an Event Identification System (EIS) was designed and constructed. The system distributes a unique 64-bit ID to each data pathway consisting of a 16-bit run number, a 16-bit spill number, and a 32-bit event number within the spill. The master ID module resides in a CAMAC crate in the control system. The 64-bit ID number can be written and read via CAMAC for testing purposes. This 64-bit ID is distributed to the multiple data paths via a standard backplane and adapter modules which reside in a CAMAC-type crate.

In normal operation, the "run number" is set by the VAX. Setting the run number automatically clears the spill- and event-number counters. The master module has inputs for TTL or NIM spill and event triggers. The "spill" input increments the spill count and clears the event counters. The "event" input simply increments the event counter. In addition to the EIS, VDAS has its own event tagging system. VDAS records the run, spill, and event number as part of each image frame. VDAS also records an internal frame number and byte count as part of the image data. The frame number is also exported into the spectrometer's data path and is recorded along with the data on the VAX. In this way the separate data tapes can be sorted and recombined to form complete event records.

Event Analysis

During the current run, the active target system will be installed for seven shifts of beam and will record about 900,000 particle interaction images. A subset of these will be viewed in an unbiased way to observe the nature of the "average" interaction image. However, most of the events closely analyzed will be selected by examining the spectrometer data to determine interesting decay candidates. The goal is to select a few hundred interesting candidates using the spectrometer and then examine in detail the image data for those. These events will be used to fine tune the image-processing algorithms so as to improve the tracking capability of the imaging system.

The image processing and track finding for the mass of data produced in the experiment will require a new approach to data analysis. We are examining several possibilities to reduce the analysis time. These include a large multiprocessor array (the Advanced Computer Program at Fermilab) and a specialized image pipeline processor based upon a RISC chip set.

Future Upgrades for VDAS

The current VDAS has several minor limitations. The system is difficult to trouble-shoot because very wide data pathways within VDAS are accomplished via ribbon cables and the number of interconnections requires that the boards have ribbon-cable connectors filling both front and back edges of the boards. This means that the board set must first be assembled and then installed in a crate as a stack of boards. A single board cannot be removed for testing without disassembling the entire set. The FIFO, while electrically expandable to 256 megabytes, in practice is limited to 16 megabytes by cabling constraints.

Finally, the camera configurations and setup are programmed into VDAS by a number of DIP switches within VDAS itself. Therefore, in order to change camera configurations, resolutions, speeds, etc., the system must be partially disassembled. While these limitations are not unworkable, they are an inconvenience and we are in the process of re-packaging the system.

The new system will reside in a Euro-card-style crate 9U high and will have a custom backplane upon which will flow all the interconnects needed within the VDAS. This will completely eliminate the use of ribbon cable for internal connections and will allow the individual boards to be placed upon standard extender cards for trouble shooting and testing. A single crate will then house all of VDAS, as opposed to the current three-module setup. The single crate will contain enough space for at least 40 megabytes of FIFO and will support additional communication throughout the system. In addition, we will replace all user-selectable DIP switches with read/writeable registers so that the configuration of the system can be changed at will from the host computer. This will allow for the setup of several cameras and camera configuration tables so that a camera can be changed and the system reconfigured in virtually no time at all. This will make VDAS much more flexible and will eliminate the need to open up the system in order to make camera or resolution changes. The interface that will be used for this setup already exists and has, to this point, been used only for internal testing of the VDAS hardware.

Future Uses of VDAS

VDAS is being considered for use in other experiments, most notably by a streamer-chamber group at Fermilab which is proposing a system that might include 36 cameras in order to get the necessary resolution. The cameras would be multiplexed into six VDAS chassis. The system will be able to use a six-way multiplexer since the cycle time of the streamer chamber is relatively long.

We are also investigating the possibilities for using the system for beam-position measurements via synchrotron light in the Superconducting Super Collider and for ring-imaging Cerenkov counters.

Any application in which the data is in the form of an image could use VDAS; in applications currently using film, the use of a VDAS would eliminate many of the problems encountered in getting data to the computer. As noted in the introduction, VDAS was used for a unique study of Comet Halley, and there is the further possibility of using such a system to study astronomical events with millisecond time resolution.

The D0 Experiment Takes Shape

Paul D. Grannis

The landscape at Fermilab has been changing over the past year as many visible signs of the coming D0 experiment for the proton-antiproton Collider can be seen. Equipment, both large and small, has been arriving at Fermilab as the detector begins to take shape.

The D0 experiment is designed to exploit many of the physics signatures which have been found crucial in the very-high-energy world of hadronic collisions through the experiences of UA1, UA2, and more recently, CDF. To aid in finding new states of matter and rare phenomena, particular attention has been given to both electron and muon identification. Measurement of the missing transverse energy in events has been stressed in the design of the calorimetry; three uranium-liquid argon calorimeters provide high-resolution hermetic coverage for which the electron-to-hadron response ratio was measured to be 1.1 in prototype devices. The detector is made compact by eliminating the magnetic field in the tracking region. Lepton identification is enhanced in D0 by incorporating transition radiation detectors with the tracking chambers and by requiring large thicknesses (greater than 13 absorption lengths) for muons observed after the magnetized steel toroids.

One major focal point for the collaboration is the new D0 experimental hall where the physical outlines of the detector are emerging [see photograph on page 9]. After completing the platform upon which the detector moves, work is now in progress on building the muon toroidal field magnets which will encapsulate the experiment. Concurrently, the moving house for digitizing and trigger electronics has been completed, as has the cable bridge connecting platform to electronics house, and the cryogenic, power, gas, and water utilities.

Assembly operations for detector components are found at several sites around the Laboratory. Production of the large muon proportional drift tube panels is under way with one 2.5 m x 6.5 m module being completed each week. In a separate operation, laminated G-10 signal boards for calorimeter readout and the cathode strips for muon chambers are in full production. End calorimeter modules are being built and tested in a third area. A highly visible addition to the D0 experiment occurred in September when the cryostat for the central calorimeter was delivered. This doughnut-shaped vessel (5.2 m in diameter and 3 m long with an inner hole diameter of 1.5 m) has since been vacuum- and cold-tested and is now being prepared to accept its load of 64 individual calorimeter modules.

(Fermilab photograph 87-618-10)

The platform on which the D0 detector rests is shown in this photograph, together with the start of the side walls of the muon toroid magnets. Electronics are housed on the detectors, in the floor of the platform, and in a moving counting house whose cover is visible in the right of the picture. The cable bridge connecting platform and moving house is seen in the left foreground.

Institutions collaborating on the D0 experiment are equally busy building detectors, electronics, and software for shipment to Fermilab. The transition radiation detector construction is well advanced at Saclay. Brookhaven National Laboratory is turning out the central calorimeter modules. Lawrence Berkeley Laboratory (LBL) is preparing for the fabrication of the large electromagnetic sections of the two end calorimeters. Groups from Florida State, Florida, Michigan State, New York, Rochester, Stony Brook, and Yale universities are supplying many of the components for the major calorimeter assemblies. University groups from Indiana, Maryland, and Northern Illinois are contributing in a similar way to the muon chamber effort. Tracking chambers are emerging from LBL, Northwestern University, and Stony Brook. Electronics for signal shaping, digitization, and triggering are being built and tested in laboratories at Brown, Columbia, Michigan State, New York University, and Stony Brook. Global systems for high voltage and monitoring are being prepared by the University of California, Riverside, and Fermilab. A team from IHEP (Serpukhov) in the

U.S.S.R. has recently joined the collaboration and will provide both coarse-grained calorimetry and very forward muon detection.

With so much activity dispersed within the collaborating groups, it has become essential to establish a focus for integrating the parts of the detector into a working whole before the final installation in the D0 hall. To this end, a major effort has been under way in one of the beamlines of the TEVATRON during the current fixed-target run. Most of the D0 detector elements are being given a shakedown test in order to gain experience in operating the systems together - and to test each of the components in battle conditions. A succession of both central and end calorimeter modules are under test; detailed measurements are being made of the response to electrons and pions as a function of position, angle, and energy. Signals are collected through the full chain of cables, feedthroughs, preamplifiers, shapers, and digitizers being built for the full experiment. A parallel test involves sectors of each of the final tracking chambers together with their shaping amplifiers, flash digitization, and zero suppression electronics. Both of these detector groups run together under the control of the D0 trigger, microprocessor-farm data acquisition and event filter, and on-line programs; monitoring of voltages, temperatures, and argon quality is also done with the final D0 system.

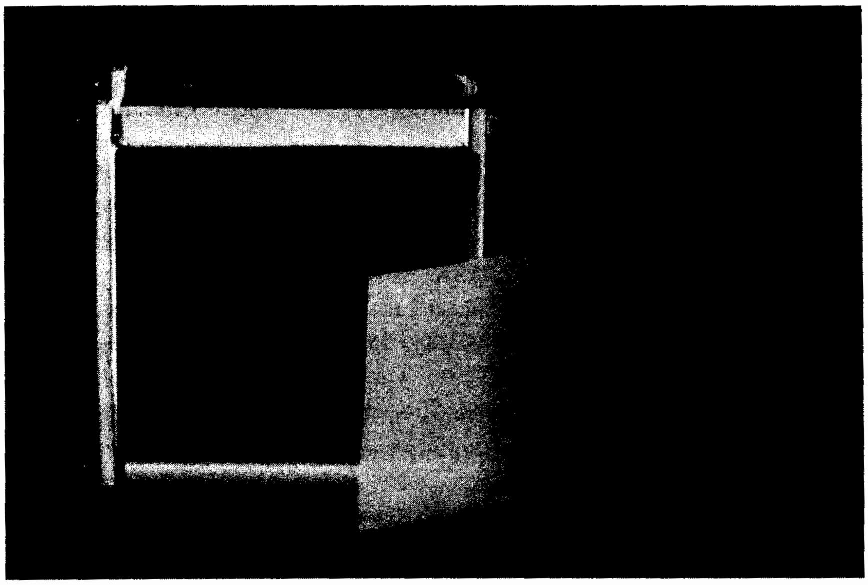
These tests have already given important verification that individual parts of the D0 detector perform to the specified levels. Even more crucial has been the chance to work with the ensemble of detectors and to work out the problems which arise from operating many sub-systems simultaneously. This test run has also forced the continuing evolution of the online and offline software to handle the challenge of controlling the experiment and informing the experimenters of the data quality. Finally, the test has brought together many of the physicists from different parts of the collaboration under conditions which simulate the future running at the Collider.

The D0 collaboration looks forward to joining the search for exciting new physics with a first run during the 1989 Collider cycle. This first round should see a portion of each of the detector systems installed; it will include the large-angle tracking and TRD, the central calorimeter, and a portion of the muon system, together with the trigger, multiple microprocessor event filter, online software, and the various support systems. The full detector is expected to be operating in the 1990 Collider cycle; with the experience gained in both test beam and first Collider runs, the experimenters look forward to a rapid start in making a large impact on our understanding of very-high-energy hadron collisions.

A Scintillating-Fiber and Tungsten Calorimeter for E-774

Mark Bodnarczuk

One aspect of Fermilab's efforts to develop state-of-the-art detectors is the Particle Detector Group (PDG) within the Research Division. The PDG is working in a number of R&D areas including the development of dopants for polystyrene fibers which may produce very radiation-hard scintillators that have good light output and short decay times. But this research work has present applications and has been used to develop a scintillating-fiber and tungsten calorimeter that will soon be part of the apparatus for experiment 774 which is located in the new Wide Band Photon Beamline.



Pictured is the calorimeter (left) and the actual fiber ribbon (right).

(Fermilab photograph 87-790-1)

The new scintillating-fiber and tungsten calorimeter were developed by PDG member Alan Bross. The calorimeter is very dense and uses newly developed doped polystyrene fiber ribbons as an active medium. The calorimeter is a 10 cm cubed stack of 3 mm-thick tungsten plates interspersed with 200-micron-sq scintillator fibers formed into ribbons. The sampling fraction of active medium to absorber is very low (about 5/10 of 1%) in this device in order to keep the calorimeter as short as possible and thus yield the highest sensitivity to short-lived particles. This is possible because the light fibers provide a high-quality light piping capability. Also, the use of "ribbon fibers" has a distinct advantage over other scintillating structures, namely scintillator "sheets." If one used a 200-micron scintillator sheet rather than ribbons composed of 200-micron-sq fibers, the sheet would cause tremendous losses in transmitting light from one end of the sheet to the other. The fiber ribbons are quite uniform, yielding a more uniform response.

Experiment 774 uses the new scintillating-fiber tungsten calorimeter as an active beam-dump calorimeter. The experiment places the calorimeter in a 400-GeV electron beam with the beam entering the calorimeter perpendicular to the plates from the left. As the beam interacts in the tungsten calorimeter plates, the scintillator fibers are excited by the secondaries of the electron shower and the resultant light is emitted up in the fiber direction and detected by an array of 3/4-in. phototubes.

The goal of E-774 is to search for light, neutral, short-lived particles that couple to the electron. Interest in the existence of such objects has recently been stimulated by the anomalous electron-positron pair production seen in heavy ion collisions at the GSI. These coincident electron-positron pairs occur with approximately equal lab energies, consistent with the production and subsequent decay of a neutral particle of mass 1.8 MeV/c. While the simplest models for this particle seem to be excluded by recent experiments, its existence has not yet been conclusively ruled out, and the debate over the 1.8-MeV particle has focused attention on a region of mass/lifetime where similar objects may exist and yet would not have been seen.

Although the main purpose of the Particle Detector Group is to develop state-of-the-art detector designs in anticipation of the next generation of multi-TeV colliders and fixed-target experiments, it is important to note that these technologies have applications in currently running experiments.

Software Support:
Preempting the Quick Question

Lauri Loebel

[Conservation of energy is as much a law of the successful research establishment as it is a law of physics itself. The wise laboratory finds people who find ways to stretch resources while maintaining programs and services. In this spirit, we present this somewhat tongue-in-cheek paper, one of three winners of the Best Paper competition at the 15th annual ACM-SIGUCCS User Services Conference held at Kansas City, Missouri., September 27-30, 1987. - Ed.]

Once Upon a Time...

Once upon a time, in those long ago and far away days when files were found in cabinets and "cut and paste" implied scissors and glue, the role of the computer consultant was very prestigious indeed. Computer users in the world of research were limited to a well-defined set of scientists who were content with GOTO's, card readers, and single precision number crunching. The consultant was that Guru of Last Resort, the Wizard who could be found in the wee hours before dawn, who could read a system dump as if it were his in mother tongue, and who was treated with the greatest of Humility and Respect. The prerequisites for this unofficial Position of Honour did not include such trivialities as listening, speaking, or writing skills; all that was required was a hefty appetite for stale popcorn and Twinkies, an office in the darkest corner of the basement, and a mind that counted in binary.

Welcome to the eighties, where consulting is the underpaid and overburdened (if officially recognized) Afterthought of the Computer Revolution. No longer shrouded in mystery and awe, the consultants of today are mere mortals who are expected to be easy-to-find during regular business hours, able to communicate with an increasingly diverse user community, and knowledgeable in areas that range far and wide from the technical programming of days gone by. In the continuing struggle to retain the feeling of professional challenge, it is frequently all too easy to "brush off" the quick question in favor of more interesting pursuits.

The author is a consultant with the Fermilab Computer Applications Group. The drawings were prepared by Mark Runyon.

At Fermi National Accelerator Laboratory we are attempting to do the impossible: provide a complete spectrum of consulting services which satisfy our users without disenchanting our staff. High-energy physicists from universities throughout the world use the computer facilities at Fermilab to perform all phases of their research - data acquisition, mathematical analysis, word processing, graphics display, and publishing, to name a few. We have an extremely small support group which must meet the needs of a large number of users, ranging in skill from novice to expert. We therefore strive to make our users self-sufficient through the use of well-publicized maintenance procedures, documentation systems, and product support standards. By these pre-emptive measures we attempt to have quick answers at hand for the truly quick questions, leaving us time for interesting problems.

Product Support Philosophy

The computing facilities at Fermilab consist of an intricate web of overlapping software packages, interface tools, and peripheral devices layered upon a conglomeration of mainframes, mini-processors, PC's, and workstations. Our product-support structure must be flexible enough to handle many widely varying types of hardware, software, and vendor requirements; yet it must also be rigid enough to be consistent and predictable for our users. Above all, it must effectively serve the growing needs of the high-energy physics community, within the constraints of tight federal budgets and staffing restrictions.

In the belief that an informed user is a satisfied and more productive user, our entire product-support structure has been designed to encourage users to go beyond their immediate question of "How?" to the deeper and more enlightening question of "Why?" Rather than trying to maintain an aura of mystery, we make our policies and standards available to the public. This provides us with the opportunity to receive valuable feedback from our user community. Users may go "browsing" through the product files in search of useful items without the need of a consultant. They are encouraged to read online HELP and associated documentation files, attend seminars and classes, investigate the Computing Department Library - in short, we try to keep all of our resources open to the public for their enrichment and education. By giving our users access to as much information as possible, we seek to avoid many of the redundant and time-consuming questions often faced by consultants in other environments.

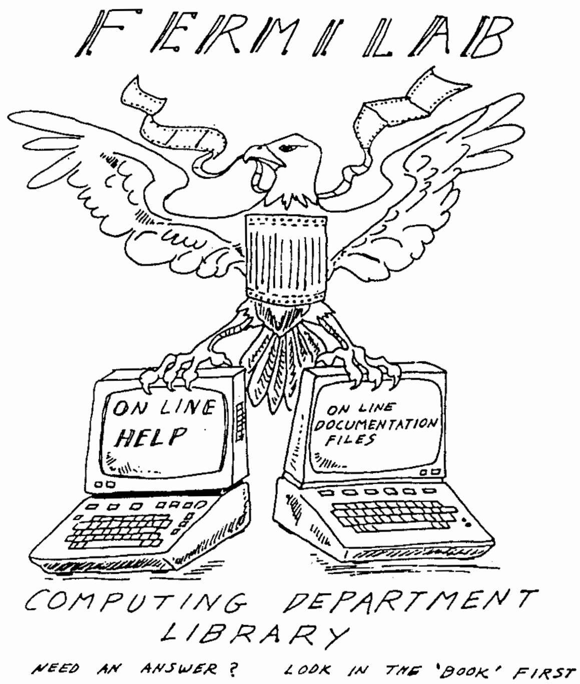
Product Maintenance

Our maintenance procedures reflect this attitude of "public awareness." Before a new release of *any* product is installed, we announce to our users (via electronic NOTICE and NEWS utilities) that a change is coming. We invite them (beg them, plead with them) to test the new version before actual installation so that the transition may be made smoothly. This policy has its disadvantages, including a plethora of announcements at login which inevitably scroll off the screen long before anybody has the chance to read them. It has, however, averted many traumatic consultation sessions through the anticipation of backwards incompatibility in all products.

Many of our users are located off-site and use our facilities only occasionally, so that merely announcing an impending upgrade at login is not sufficient. As part of our product maintenance standards, we keep a detailed history of all products, online whenever practical. When not in conflict with licensing agreements, we also make public the actual source codes. By allowing our users easy access to the entire suite of product files (rather than just the pieces required for use), we encourage them to try solving problems on their own before seeking a consultant for help.

Et Cetera

In the age of electronic information systems, there are still those people who need to see things in "black and white." Our Computing Department Library provides full documentation for all of our products, from vendor-supplied technical manuals to locally written user guides. We offer well-publicized training courses and demonstrations for many of our products, as well as regularly scheduled Computing Department seminars which cover a wide range of topics. In addition, we publish general and special-interest information releases which attempt to anticipate the needs of the user community in a timely fashion.



GRIPE

Another line of defense in our battle against the walk-in "quick question" is our use of the electronic mail facility. We encourage users to MAIL the questions to user GRIPE. This mailbox is checked daily by the consulting staff. We frequently find the same questions being asked by many users, so that a reply may often be drawn from a pool of (very polite and friendly) "stock" answers. This shields our consultants from the most trivial questions while satisfying our users with a quick response. When expert advice is required, the GRIPE may be forwarded to the most qualified persons (usually those who are on vacation) without the delay of physically locating them. Each GRIPE is tracked through to completion and logged for posterity. This provides us with an historical and educational picture of the user-support services at Fermilab, through which we can flag out-of-date documentation and other serious problems or concerns.

educational picture of the user-support services at Fermilab, through which we can flag out-of-date documentation and other serious problems or concerns.

An additional benefit of the GRIPE facility is that it encourages users to explore the problem - or at least explain it - before seeking the aid of a consultant. It is quick and painless to send a reply that says, "I need more information before I can begin to analyze the problem." In a face-to-face environment the consultant is frequently wracked by feelings of inadequacy and guilt in turning away an ill-prepared client. The act of writing the complaint forces our users to clarify and order their thoughts.

Consulting Guidelines

No matter how hard we try to make our users self-sufficient, there will always be those persistent few who choose not to meet the challenge, that handful of users who feel the need for personal contact with an "expert" for *every* problem they encounter. To our consultants, faced with the prospect of perpetuating this unproductive state of affairs, we offer the following guidelines:

1. Always ask the user which manuals for HELP files have been previously consulted. Emphasize the importance of these documentation aids. Don't be afraid to request some "homework" before providing additional personal service to the user who has made absolutely no attempt at self-help.

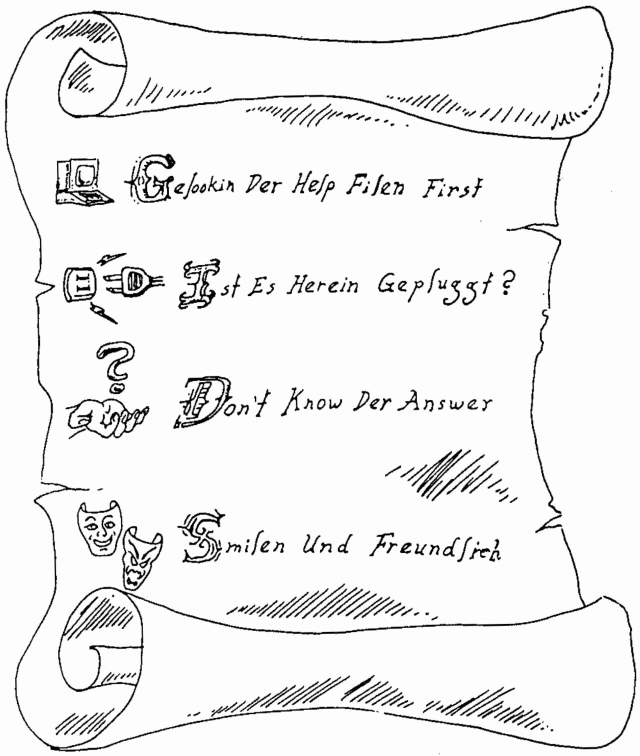
2. Don't be afraid to ask dumb questions ("Is it plugged in?"). Each user who walks away with the embarassingly obvious answer will be much more inclined to thoroughly investigate any subsequent problems before crying wolf.

3. Don't be afraid to say "I don't know." (Note that this will help to explode the myth of infallibility that still surrounds consultants!) Investigate the problem with the user, and treat the consulting session as an educational experience for both of you. Go through the steps in analyzing the problem aloud and explain your reasoning. By setting a good example you will encourage the users to believe that they can find the answer on their own.

4. Be friendly and pleasant at all times. While a generally surly attitude will dissuade many users from returning, you will be left with only those whose demeanor is worse than your own! On the other hand, a helpful and understanding attitude will convince most users that you are a wonderful person who benevolently put aside Many Important Things on their behalf. You will earn their gratitude and appreciation - and their respect for your time!

. . .Happily Ever After

In the rapidly evolving world of high-energy-physics computing, the importance of self-reliance has emerged as the central focus of our user-support services at Fermilab. In our efforts to provide an enriching and productive environment for users and staff alike, we have structured our product-support system in a manner that encourages our users to explore strange new features, to seek out



online HELP and product documentation files, to boldly go where every user should go before soliciting the aid of a consultant. It is our hope that through these pre-emptive measures we may take advantage of the capabilities of the computer itself in providing distributed and automated answers to the "quick question."

500,000 Miles Without an Overhaul

Thomas J. Peterson

A helium expansion engine, manufactured by Koch Process Systems, Inc., extensively modified by technicians in the Cryogenics Department of the Accelerator Division, and installed in the Fermilab Main Ring, has been operating for more than a year without an overhaul.

Liquid helium used to cool the superconducting magnets of the TEVATRON is produced by 24 satellite refrigerators in conjunction with the Central Helium Liquefier. Each satellite refrigerator has one "wet engine," a machine whose purpose is analogous to that of the expansion valve in a household refrigerator. It expands the coolant (helium in this case, rather than freon), which cools at it expands. The wet engine is much like any other piston-type engine in that high-pressure gas in its cylinders pushes on a piston which is connected to a crank and drive shaft.

The wet engine drives a small electric generator, but that is just an incidental benefit. What we really want is its exhaust, liquid helium (hence the name, "wet"). Even the helium entering the engine is so cold that all other gases except helium are frozen solid. Valves in these engines can be damaged by solid particles of frozen air if the helium is contaminated with air. Lubricants, of course, would also be frozen solid, so none can be used in the cold parts of a wet engine.

Each engine has two pistons and four valves, which typically go through about 120 cycles per minute, over a million cycles per week. Valves and piston seals must remain leak tight, but eventually, parts wear and fail and must be replaced.

Although expanders similar to these have been used for making liquid helium since the 1960s, reliability has always been a problem. Even in the late 1970s when prototype satellite refrigerators began operating, some similar engines did not last 48 hours without breaking. Six to twelve weeks before failure was typical.

But during the last Collider run, which ended in May of 1987, our 24 wet engines averaged more than 5000 hours (over six months) without failure. Most were overhauled as a part of scheduled maintenance, but a few were let go to see how long they last. One has now exceeded one year without major repairs.

The author, with the Fermilab Accelerator Division Cryogenics Department at the time of this writing, is currently with the Accelerator Division Mechanical Support Department.

A car averaging 50 miles per hour would have gone almost 500,000 miles in that time, with only oil changes and tune-ups.

The reasons for this success include design improvements made here at Fermilab, years of testing and data collection from operating engines to check performance of newly designed components, and skilled technicians assembling and maintaining these engines. A great many people have been involved in this effort, including people at the Bubble Chamber and others in Research Division Cryogenics as well as in the Accelerator Division. The purity of the helium in the cryogenic system is also a key factor affecting lifetime.

(Fermilab photograph 87-432-11)

Expansion-engine crew, Cryogenics Department, Accelerator Division. Left to right: Steve Dochwat, Jeff Spencer, Dan Freeman, Jim Thompson, Tom Peterson (now with the Mechanical Support Department), and Mark Gilmore. Not pictured: Joe Savignano and recent full-time expansion-engine people Ralph Afanador, Ann Eighorn, Carl Pallaver, Ernie Ramirez, and Ted Roberts.

Institutions and companies using similar helium liquefiers have called us for advice regarding these engines. Among these users who have contacted us are the University of Washington, Kansas State University, GA Technologies, and General Electric. We have cooperated with Koch Process Systems in communicating to them our experience, design changes, and suggestions. Helium liquefiers which Koch markets for magnetic resonance imaging devices include expansion engines which incorporate many features based on experience at Fermilab.

[The Friends of Fermilab, Inc., is a frequent and welcome guest to the pages of Fermilab Report *(see* Fermilab Report *November 1983, September 1985, February 1986, April/May 1986, October 1986, and July/August 1987). The following article, to be published in slightly different form in the proceedings of the Federal Laboratory Consortium semi-annual meeting (November 3-5, 1987, Sacramento, California), provides an overview of Friends programs, most of which were unique at the time of their inception. These programs have placed the Friends of Fermilab at the forefront of the effort to help build an educational foundation for this country's scientific future. - Ed.]*

Precollege Education Programs at Fermi National Accelerator Laboratory

Stanka Jovanovic
Friends of Fermilab, Inc.

Introduction

Most precollege science education programs at Fermilab are sponsored by the Friends of Fermilab,Inc., a not-for-profit corporation founded in the State of Illinois in 1983. The Friends of Fermilab's mission is "to provide support for endeavors extending Fermilab's mission of research in fundamental physics to its social responsibilities in science education." Today, the Friends sponsors a number of programs at Fermilab for elementary and secondary students and teachers. It has raised close to $1 million from private and public sources and continues to develop and conduct programs in direct response to the needs of the education community. Friends of Fermilab program reports and "how-to" manuals are shared with other institutions interested in implementing similar programs.

In this presentation we will describe the organization and the program development process based on Friends experience. The Summer Institute for Science Teachers (SIST) will then be used as an example of a model program. Finally, an overview of other Friends precollege programs at Fermilab will be given.

The author is President and Executive Director of Friends of Fermilab, Inc.

Organization and Program Development

During the past four years of its existence, Friends of Fermilab has developed a successful working format for program development and implementation. The process starts with the appointment of a program committee consisting of educators (teachers, school administrators), Fermilab physicists, and the program director for the Friends. The program committee conducts a Needs Assessment Workshop to identify the current needs in science education that could be addressed at Fermilab. Based on the goals set by the workshop, the Program Committee drafts a proposal for consideration and approval by the Friends of Fermilab's Board of Directors. The board, which consists of Fermilab, civic, business, and education community leaders, approves the proposed programs and proceeds to seek funds from private and public sources. When the funds become available, the program committee hires a project director who is fully responsible for the conduct, evaluation, dissemination, and writing of the program reports.

The involvement of master teachers from the inception of a program is the most important element in the success of Friends of Fermilab programs. The project director and most of the program staff are drawn from local schools. In many cases, the project director and the key staff personnel are teachers who participated in the needs assessment and therefore had a part in the program's design. Scientists from Fermilab and other laboratories and universities are the program lecturers and consultants with very little, if any, administrative responsibilities. Friends of Fermilab is responsible for management and prudent use of funds.

Another important element is a carefully developed program budget that provides the project director with well defined working parameters. Program funds are dedicated funds. This provides each program with complete budget autonomy and independence.

Curriculum development and participant selection are the responsibility of a committee of program staff members, teachers, and scientists. It is very important to recognize that teachers are most sensitive to what type of teacher or student will benefit most. The correct combination of the course content and participants assures a successful program.

Formal and informal evaluations of a program are conducted by the staff and the participants. The program reports are written by the project director. Subsequently, based on these reports, Friends staff develops how-to manuals for use by others. The curriculum materials developed by the program activities, if any, are also made available.

Summer Institute for Science Teachers: A Model Program

Most of the processes described above evolved through the experience of the Summer Institute for Science Teachers program. In response to Fermilab's interest in providing support for high-school science teachers, the Friends of Fermilab conducted its first Needs Assessment Workshop in 1982. Secondary schools, universities, community colleges, private industry, and research institutions were represented at the workshop. Discussions began in four small groups where individuals were asked to suggest objectives. Each group reached a consensus on five or six priorities which were presented to the entire group. After considerable discussion, the participants recommended five objectives. This advice was invaluable in developing the program. The five objectives, which are *not* ranked, include:

- Targeting successful and lively teaching techniques for existing materials, including laboratory preparation and techniques, and computer applications.

- Improving the teaching of problem-solving skills.

- Enhancing teachers' backgrounds in basic subject matter.

- Exposing teachers to current developments in scientific research, and basic objectives and problems in modern science.

- Strengthening the awareness and teaching of contemporary relations among science, technology, and society.

Based on these objectives, the Program Committee drafted the proposal that has successfully raised funds for five consecutive Summer Institutes for biology, chemistry, and physics teachers. In 1987 the institute was expanded to include a section for mathematics teachers. Using the proposal, and later the how-to manual, several other institutions conducted programs modeled after the Summer Institute.

High School and Junior High School Programs

Over the past four years, the Friends has sponsored, or co-sponsored with Fermilab, 15 education programs for elementary and secondary school students and teachers. Some of the programs are described here.

Beauty and Charm at Fermilab - An Introduction to Particle Physics

A week-long particle physics curriculum for the junior-high classroom was developed. Teachers attend workshops to become familiar with the curriculum, including several simple hands-on experiments that demonstrate concepts such as "How Small is Small?" and "How to Measure What We Cannot See." The teachers are provided with a "kit unit" which includes all the materials needed for the classroom experiments, a manual outlining the day-to-day conduct of the curriculum, and audio-visual materials to supplement the curriculum. After teaching the classroom unit, the teachers may accompany their students on a visit to Fermilab to tour working areas and meet with a Fermilab physicist.

DOE High School Honors Research Program in Particle Physics

The objective of this program, which is sponsored by the U. S. Department of Energy, is to expose gifted high school students to the research done at a world-class particle-physics laboratory. Participants join groups of physicists and graduate students doing particle-physics research. The program includes lectures by Fermilab staff physicists, lab tours, and tutorial sessions, as well as on-the-job experiences. Students spend two weeks working and studying at Fermilab. They are under the supervision of master high school physics teachers and are boarded at the Illinois Mathematics and Science Academy. Students in this program come from the 50 states, the District of Columbia, and six foreign countries.

Target: Science and Engineering - An Apprentice Research Program

Gifted minority high school students are nominated by their schools and selected by a committee composed of Fermilab Equal Opportunity Office personnel, Fermilab scientists, and area educators. The selected students, the majority of them from Chicago schools, spend six weeks in the program. Mornings are spent working side-by-side with a scientific, engineering, or technical mentor at Fermilab. During the afternoon, students attend classes taught by high school teachers and receive assistance in the preparation of an individual or group research project, which is generally based on some aspect of the morning work. The students receive a combination of salaries and a stipend for their participation in the program. The program is in its eighth year at Fermilab, and is co-sponsored by Fermilab and Friends of Fermilab.

Physics West and Chemistry West

Friends of Fermilab sponsors Physics West and Chemistry West, network organizations for area teachers. The objective of these programs is to prolong the beneficial effects of the SIST for institute "graduates" and other science teachers. Each group meets monthly in a local school or college in order to share skills, strategies, and materials for the high school science classroom.

These and other Friends programs have generated a variety of classroom materials such as Standard Model charts and the Big Bang poster (available from Friends of Fermilab, P.O. Box 500, Batavia, Il 60510, at $6.00 for both or $4.00 each; the charts are 2 ft x 3 ft in size) which are used by science teachers nation wide. The Friends of Fermilab is currently developing materials that can be directly incorporated into existing physics curricula. This program, "Topics in Modern Physics," is under the direction of six master physics teachers. The *Resource Manual*, including material on particle physics, symmetry, relativity, accelerators, detectors, and cosmology, will be tested in 50 classrooms across the country by participants in the 1986 Conference on the Teaching of Modern Physics which was held at Fermilab. Later, other teachers will be trained to merge the *Resource Manual* material with existing physics textbooks.

The vitality, versatility, and high quality of the precollege programs at Fermilab are due in large part to Fermilab scientists and their commitment to science education. Through Friends of Fermilab, the intellectual resources of Fermi National Accelerator Laboratory have been utilized to "extend Fermilab's mission of research in fundamental physics to its social responsibilities in science education."

Lab Notes

Deputy Director Philip V. Livdahl "Retires" to Loma Linda Project . . .

Fermilab Deputy Director Philip V. Livdahl retired from the Laboratory on September 17, 1987, after a career that found him deeply involved with every major advance the Laboratory has made. "During these last nine years in the Directorate, I've had the tremendous experience of working with a group of very talented, very dedicated, and very willing people; I'm going to miss them very much. And those sentiments extend to all the people I've worked with over my years here at Fermilab."

Joining the fledgling National Accelerator Laboratory in late 1967, Phil set about the task of constructing and making operational the Linac. With the Linac ready to go, a Main Ring was the next logical step, and in 1971 Phil became one third of the three-manager system (along with Dick Lundy and Rich Orr) set up by then-Director Robert R. Wilson to finish construction of the Main Ring and make it operational. With the Main Ring complete, the Lab reorganized, setting up an Accelerator Division and a Research Division to facilitate completion of the experimental areas. Phil became Deputy Head of the Accelerator Division for the next few years, and he began working with Don Edwards, Bill Fowler, the late Will Hanson, Hank Hinterberger, Paul Reardon, Bruce Strauss, Lee Teng, and Wilson as the basic group laying plans for the fabrication of superconducting magnets, the foundation for the Energy Doubler/Saver project.

In 1978, with the departure of Wilson, Livdahl became Acting Director. As Director Leon Lederman noted in his remarks on the occasion of Phil's retirement, "[When I became] Director Designate in the fall of 1978, I knew you were holding the Lab together, and that in itself was no small achievement."

"My years here have been fascinating," Phil said. "Looking back on it, one realizes that even the normal aggravations and frustrations were very rewarding in the end. One gets to work with extremely bright people who are all very much of a single purpose: to do what you've set out to do. To have had an opportunity to be a part of the process of making things happen here has truly been wonderful.

"And, of course, working with Leon these past nine years has always been the most rewarding of experiences for me. He's an ingenious and unbelievable person. His imagination and his ability to carry things through is really quite remarkable."

("Lab Notes" continued)

All of which is mere prelude. "The reason I've made this change now," said Phil, "is so that I can spend all of my time on the Loma Linda proton therapy accelerator. When we designed Fermilab's agreement with the Loma Linda Medical Center in California, we excluded from Laboratory responsibility anything outside of the accelerator itself. In trying to put together an organization to take care of the equipment requirements for the rest of the facility, the administration of the Medical Center asked me if I would take on that responsibility. I couldn't do that and continue in the Directorate, so I decided that for once in my life I was going to get down to one job."

Eventually, Phil's work on the medical accelerator will take him, and his wife Phyllis, to California, but at present he's sharing his time between Loma Linda and Fermilab while the proton accelerator undergoes prototyping at the Industrial Complex.

Again quoting from the Director's remarks at Phil's retirement: "How does one sum up your 20 years of service to Fermilab? You brought an unflappable steadiness to the team. . . Looking back, I really can't imagine what I, what the Laboratory, would have done without you."

New Large-Scale, General-Purpose, Scientific Computer Chosen . . .

A contract has been signed with Systemhouse, Inc., for delivery of a large-scale, general-purpose, scientific computer system for installation in the new Fermilab Central Computing Facility (see following story). The total system consists of an Amdahl 5890 600E CPU with four central processors and 192 Mbytes of main storage, 40 Gbytes of disk storage, 16 tape drives, eight cassette tape drives, four 1200-lpm impact line printers, four 20-page-per-minute laser printers, four DECnet gateway links, two Ethernet gateway links, 224 ASCII terminal ports, and 32 native terminal ports.

Delivery of the new system is scheduled for April 1988 (dependent upon completion of the new computer building) and will initially consist of an Amdahl 5890 300E (two CPU's, 96 Mbytes of main storage), all disk and tape, half the printer, DECnet and Ethernet capability, 144 ASCII ports, and all 32 native terminal ports. Remaining equipment will be delivered in FY89 or earlier, dependent upon available funds. *J. A. Appel*

Central Computing Facility Upgrade . . .

The central computing facilities at Fermilab are being upgraded in a multi-faceted project which includes a new building for central computing to house the new large-scale scientific computer (LSSC), expanded VAX cluster, and farms

*("**Lab Notes**" continued)*

of microprocessor-based parallel processing systems. The building which will house the LSSC and become the new home of Fermilab Central Computing Facilities is rapidly coming to completion and is visible for all to see. The overall cost of the project is $25 million with about $9 million of that cost for the new building. Construction of the 74,000 sq ft, three-story building is scheduled for completion in the spring of 1988.

The first floor will house computing hardware, a user's area, and tape vault which is capable of storing over 150,000 10-1/2-in. reel tapes. In addition to the present system of 10-1/2-in. reel 6250-bpi tapes which have become the "workhorse" of high-energy physics data accumulation, the acquisition package of the LSSC encouraged potential vendors to propose a complement of new data-storage systems which use more sophisticated technologies like tape cartridges and optical disks.

The second floor is dominated by the LSSC mainframes along with other CPU's, disk drives, and an area for maintenance. The third floor will house the Physics Research Equipment Pool and three groups of Computing Department personnel who are currently housed on the sixth and eleventh floors of Wilson Hall.

The Central Computing Upgrade Project represents a statement about the magnitude of the future computing needs of the Fermilab high-energy physics community, and is a major step towards meeting those needs. Now that fixed-target and colliding-beams experiments are accumulating higher and higher statistics data samples, the computing demand is impossible to meet with the existing computing systems. The fact that there is no room available in Wilson Hall to add more equipment further complicates the problem. The upgrade of the Central Computing Facilities, with both a new LSSC and new building to house the computing engine and personnel who service it, is a positive statement about the Department of Energy's and Fermilab's commitment to provide the resources required to do today's high-energy physics experiments. *M. Bodnarczuk*

Energy Design Award to Fermilab's Central Computing Facility . . .

The energy-efficient aspects of the new Fermilab Central Computing Facility, developed through Wayne Nestander's Construction Engineering Services Group (CES), represent the first of a new generation of "intelligent" buildings now being constructed on site. Recently honored at the DOE Annual Energy Awards Night for optimized energy conservation design, this facility is projected to save substantial amounts of money in operating costs during the life

*("**Lab Notes**" continued)*
of the building while using only 35% of the energy typical of similar facilities designed in the mid-seventies.

Design concepts were initially developed by Steve Krstulovich, CES Chief Mechanical Engineer, in a 1000-page computerized simulation analysis, and call

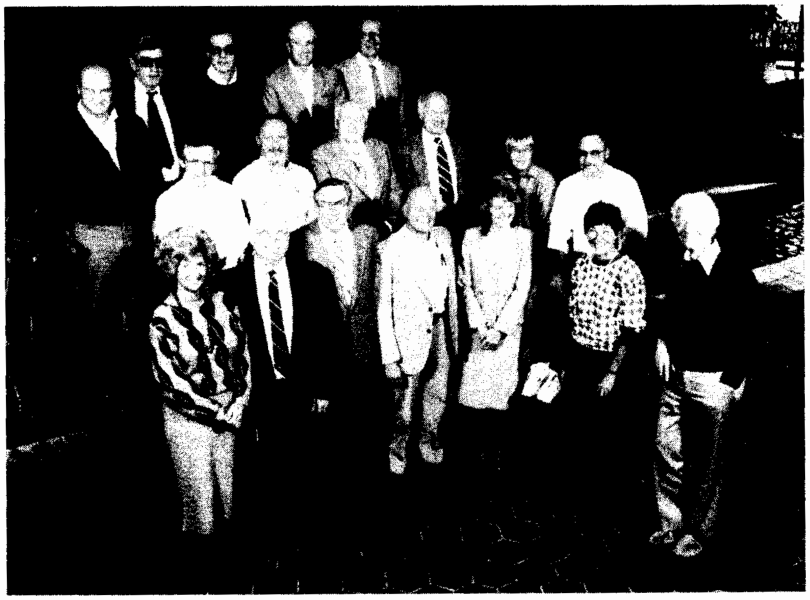
(Photograph courtesy of Argonne National Laboratory)

James Finks (third from right), Head of Fermilab's Business Services Section, accepts the Association of Energy Engineers Corporate Energy Management Award from Hilary J. Rauch, Manager, DOE/Chicago Operations. Also pictured are, from left, Norman Hansen, DOE/Batavia Area Office, Steve Krstulovich, Chief Mechanical Engineer, Fermilab Construction Engineering Services; Richard W. Brancato, Director, Federal Energy Management Program, DOE Washington HQ, and Bill Riches, Fermilab Energy Management Coordinator. The award was based on: 1) energy-efficient design for the new Central Computing Facility, 2) use of the DOE Mobile Energy Lab for energy studies support, and 3) cogeneration feasibility studies at Fermilab.

for driving the entire facility as a giant heat engine to reclaim and distribute energy while monitoring wind, weather, solar intensity, cooling ponds, and heat generation patterns throughout the building. Under Steve's direction, the CES Mechanical Department broke new ground in the use of advanced technology systems to actualize design concept goals. CES Mechanical Designer Merle Olson took the lead in conjunction with Designers John Bell, Jack Furlong, and

("Lab Notes" continued)
Bob Weldon in laying out the intricate mechanical systems, while CES Mechanical Engineer Al Schmitt worked out the sophisticated DDC computer control systems. Ultimately, Al's work should enable this computer to talk to maintenance and engineering offices over a network linking similar building computers throughout the site. Current plans include submitting this project for award to other professional energy conservation societies such as ASHRAE.

Fermilab Honors Employees for 20 Years of Service...



(Fermilab photograph 87-798-6)

Hale, hearty, and none the worse for the wear, the first group of Fermilab 20-year veterans gathered recently for the camera. They are (first row, l. to r.) Jean Plese (Directorate), Quentin Kerns (Accel. Div./Instrum.), Frank Cole (Loma Linda Proj.), Reid Rihel (Facil. Op. Eng.), Barb Kristen (Res. Div.), and Carolyn Hines (Comm.); (second row, l. to r.) Art Skraboly (Mech. Dept.), Gerry Tool (E/E Suppt.), Stan Snowdon (Accel. Div.), Don Young (Linac), Angela Gonzales (Directorate), and Jan Wildenradt (Accel. Div./Mech. Suppt.); (third row, l. to r.) Tony Frelo (Vis. Med. Serv.), Curt Owen (Loma Linda Proj.), Lincoln Read (Medical Accel.), Glenn Lee (Accel. Div./Mech. Suppt.), and Phil Livdahl (Loma Linda Proj.). Director Leon Lederman (at right) offered congratulations on behalf of the Laboratory. Chuck Marofske (Lab. Serv.) and Lee Teng (Medical Accel.), also 20-year veterans, are not pictured.

Manuscripts, Notes, Colloquia, Lectures, and Seminars

prepared or presented from September 19, 1987 to December 31, 1987. Copies of technical publications with Fermilab publication numbers can be obtained from the Fermilab Publications Office, Theoretical Physics Department, or Theoretical Astrophysics Group, 3rd floor, Wilson Hall. Copies of some articles listed are on the reference shelf in the Fermilab Library, 3rd-floor crossover, Wilson Hall.

Manuscripts and Notes

Experimental Physics Results

P. Coteus et al.
Experiment #400

Production of the Charmed Strange Baryon Ξ_c^+ by Neutrons (FERMILAB-Pub-87/146-E; submitted to Phys. Rev. Lett.)

P. Coteus et al.
Experiment #400

Charm Hadroproduction Results from Fermilab E-400 (FERMILAB-Conf-87/147-E; presented at the Topical Seminar on Heavy Flavors, San Miniato, Italy, May 25-29, 1987. Submitted to the Supplement Section of Nucl. Phys. B)

J. P. Cumalat et al.
Experiment #400

Observations of $D^0 \rightarrow K^0 \bar{K}^0$ (FERMILAB-Pub-87/192-E; submitted to Phys. Rev. Lett.)

J. P. Cumalat et al.
Experiment #400

Neutron Production of Charm Particles in Fermilab E-400 (FERMILAB-Conf-87/197-E; presented at the SLAC Summer Institute on Particle Physics, Stanford, California, August 10-21, 1987)

E. Anassontzis et al.
Experiment #537

High Mass Dimuon Production in $\bar{p}$N and π^-N Interactions at 125 GeV/c (FERMILAB-Pub-87/217-E; submitted to Phys. Rev. D)

S. Katsanevas et al.
Experiment #537

Nuclear Target Effects in J/ψ Production in 125 GeV/c Antiproton and π^- Interactions (FERMILAB-Pub-87/57-E; submitted to Phys. Rev. Lett.)

R. W. Joyner
Experiment #580

Diffractive Process in 200 GeV/c $\pi^- N \rightarrow \pi^- \pi^- \pi^+ N$ Interactions (Ph.D. Thesis, University of Notre Dame, Notre Dame, Indiana, 1987)

A. Mukherjee et al.
Experiment #594

Azimuthal Energy Flow in Deep-Inelastic Neutrino Scattering (FERMILAB-Pub-87/200-E; submitted to Phys. Rev. Lett.)

D. E. Jaffe
Experiment #605

High Transverse Momentum Hadron Production in 400 and 800 GeV/c Proton-Nucleon Collisions (Ph.D. Thesis, State University of New York at Stony Brook, New York, August 1987)

J. C. Anjos et al.
Experiment #691

A Study of the Semileptonic Decay Mode $D^0 \rightarrow K^- e^+ \nu_e$ (FERMILAB-Conf-87/142-E; contributed paper submitted to the 1987 International Symposium on Lepton and Photon Interactions at High Energies, Hamburg, Germany, July 27-31, 1987)

J. C. Anjos et al.
Experiment #691

A Search for Flavour Changing Neutral Current Processes in Decays of Charmed Mesons (FERMILAB-Conf-87/143-E; contributed paper submitted to the 1987 International Symposium on Lepton and Photon Interactions at High Energies, Hamburg, Germany, July 27-31, 1987)

J. C. Anjos et al.
Experiment #691

Measurement of the D_s^+ Decays and Cabibbo-Suppressed D^+ Decays FERMILAB-Pub-87/203-E; submitted to Phys. Rev. Lett.)

J. R. Rabb et al.
Experiment #691

Measurement of the D^0, D^+, and D_s^+ Lifetimes (FERMILAB-Pub-87/144-E; submitted to Phys. Rev. D)

W. J. Womersley et al.
Experiment #733

Hadron Showers in a Low-Density Fine-Grained Flash Chamber Calorimeter (FERMILAB-Pub-87/159-E; submitted to Nucl. Instrum. Methods A)

S. Aronson et al. Experiment #740	Hadron and Electron Response in a Uranium Liquid Argon Calorimeter from 10-50 GeV (FERMILAB-Pub-87/216-E; submitted to Nucl. Instrum. Methods A)
G. Ascoli et al. Experiment #741/CDF	CDF Central Muon Detector (FERMILAB-Pub-87/179-E; submitted to Nucl. Instrum. Methods A)
G. Ascoli et al. Experiment #741/CDF	A Leveling System for the CDF Central Muon Chambers (FERMILAB-Pub-87/180-E; submitted to Nucl. Instrum. Methods A)
F. Bedeschi et al. Experiment #741/CDF	Design and Construction of the CDF Central Tracking Chamber (FERMILAB-Pub-87/182-E; submitted to Nucl. Instrum. Methods A)
S. Bhadra et al. Experiment #741/CDF	The Design and Construction of the CDF Central Drift Tube Array (FERMILAB-Pub-87/184-E; submitted to Nucl. Instrum. Methods A)
K. Byrum et al. Experiment #741/CDF	The CDF Forward Muon System (FERMILAB-Pub-87/181-E; submitted to Nucl. Instrum. Methods A)
Y. Fukui et al. Experiment #741/CDF	CDF End Plug Electromagnetic Calorimeter Using Conductive Plastic Proportional Tubes (FERMILAB-Pub-87/173-E; submitted to Nucl. Instrum. Methods A)
L. Balka et al. Experiment #741/CDF	The CDF Central Electromagnetic Calorimeter (FERMILAB-Pub-87/172-E; submitted to Nucl. Instrum. Methods A)
F. Snider et al. Experiment #741/CDF	The CDF Vertex Time Projection Chamber System (FERMILAB-Pub-87/183-E; submitted to Nucl. Instrum. Methods A)
R. G. Wagner et al. Experiment #741/CDF	Cosmic Ray Test of the CDF Central Calorimeters (FERMILAB-Pub-87/176-E; subm'td to Nucl. Instrum. Methods A)

S. R. Hahn et al.
Experiment #741/CDF

Calibration Systems for the CDF Central Electromagnetic Calorimeter (FERMILAB-Pub-87/177-E; submitted to Nucl. Instrum. Methods A)

T. Devlin et al.
Experiment #741/CDF

Phototube Testing for CDF (FERMILAB-Pub-87/178-E; submitted to Nucl. Instrum. Methods A)

S. Bertolucci et al.
Experiment #741/CDF

The CDF Central and Endwall Hadron Calorimeter (FERMILAB-Pub-87/174-E; submitted to Nucl. Instrum. Methods A)

K. Yasuoka et al.
Experiment #741/CDF

Response Maps of the CDF Central Electromagnetic Calorimeter with Electrons (FERMILAB-Pub-87/175-E; submitted to Nucl. Instrum. Methods A)

F. S. Merritt et al.
Experiment #744

Measurement of the Same-Sign Dimuon Production in High-Energy Neutrino Interactions (FERMILAB-Conf-87/150-E; presented at the XVIII International Symposium on Multiparticle Dynamics, Tashkent, U.S.S.R., September 8-12, 1987)

General Particle Physics

A. E. Baumbaugh et al.

Operational Experience with a High-Speed Video Data Acquisition System in Fermilab E-687 (FERMILAB-Conf-87/199; presented at the IEEE Nuclear Science Symposium, San Francisco, California, October 21-23, 1987)

J. Freeman and
C. Newman-Holmes

Detector Dependent Contributions to Jet Resolution (FERMILAB-Conf-87/137; presented at the Workshop on Experiments, Detectors, and Experimental Areas for the Super Collider, Lawrence Berkeley Laboratory, Berkeley, California, July 7-17, 1987)

S. R. Mane	Calculation of Electron Polarization in High-Energy Storage Rings Including Nonlinear Spin-Orbit Coupling (FN-466)
S. R. Mane	Calculation of Electron Polarization in High-Energy Storage Rings Including Transverse Momentum Recoils (FN-467)
S. R. Mane	Equilibrium Polarization Formula for Electron Storage Rings Including Transverse Recoils in All Planes (FN-465)
A. V. Tollestrup	Report on the 1987 CDF Run (invited talk at the 7th International Conference on "Physics in Collisions," Tsukuba, Japan, August 25-27, 1987)
A. Van Ginneken	Elastic Scattering in Thick Targets and Edge Scattering (FERMILAB-Pub-87/141; submitted for journal publication)

Accelerator Physics

D. Beechy	A Programmable Finite State Module for Use with the Fermilab TEVATRON Clock (TM-1480; submitted to the Europhysics Conference on Control Systems for Experimental Physics, Villars-sur-Ollon, Switzerland, September 28-October 2, 1987)
R. A. Carrigan, Jr.	Channeling and Dechanneling at High Energy (FERMILAB-Conf-87/149; presented at the 12th International Conference on Atomic Collisions in Solids, Okayama, Japan, October 12-16, 1987)
J. D. Cossairt	Analysis of Exposure Due to Work on Activated Components (TM-1499 [SSC-N-409]; presented at the Meeting of the Task Force on Radioactivation at the SSC, SSC Central Design Group, Berkeley, California, October 1-2, 1987)

J. D. Cossairt — Estimates of the Radioactivity Produced in the Proposed SSC Beam Absorbers (TM-1501 [SSC-N-411]; presented at the Meeting of the Task Force on Radioactivation at the SSC, SSC Central Design Group, Berkeley, California, October 1-2, 1987)

J. D. Cossairt — Radioactivation Considerations for the HEB Test Beams and Beam Absorbers (TM-1498 [SSC-N-408]; presented at the Meeting of the Task Force on Radioactivation at the SSC, SSC Central Design Group, Berkeley, California, October 1-2, 1987)

J. D. Cossairt — Radioactivation in "Quiet" Sections of the SSC (TM-1500 [SSC-N-410]; presented at the Meeting of the Task Force on Radioactivation at the SSC, SSC Central Design Group, Berkeley, California, October 1-2, 1987)

J. D. Cossairt — Residual Radioactivity Measurements along the PB Target Pile (TM-1497 [SSC-N-407]; presented at the Meeting of the Task Force on Radioactivation at the SSC, SSC Central Design Group, Berkeley, California, October 1-2, 1987)

L. Coulson et al. — A Guide to Understanding the Radiation Environment of the Superconducting Super Collider (SSC) (FN-468 [SSC-N-147])

H. T. Edwards — The Fermilab TEVATRON Operation and Upgrade Plans (talk given at the International Committee on Future Accelerators held at Brookhaven National Laboratory, Upton, Long Island, New York, October 5-10, 1987)

S. D. Holmes — A Practical Guide to Modern High Energy Particle Accelerators (FERMILAB-Conf-87/160; lectures given at the

	Theoretical Advanced Summer Institute, Santa Fe, New Mexico, July 6-24, 1987)
M. Kuchnir and Ed. E. Schmidt	Measurements of Magnetic Field Alignment (TM-1493; presented at the 10th International Conference on Magnet Technology [MT-10], Boston, Massachusetts, September 21-25, 1987)
P. Lucas	Updated Overview of the TEVATRON Control System (TM-1489; submitted to the Europhysics Conference on Control Systems for Experimental Physics, Villars-sur-Ollon, Switzerland, September 28-October 2, 1987)
A. D. McInturff et al.	The Magnetic Properties of the SCL Intersection Region Superconducting Quadrupole Triplets (TM-1494; presented at the 10th International Conference on Magnet Technology [MT-10], Boston, Massachusetts, September 21-25, 1987)
K.-Y. Ng	Coupling Between Counter-Rotating Bunches (FN-462)
K.-Y. Ng	Impedance of Separators at Low Frequencies (FN-463)
K.-Y. Ng	Longitudinal Coupled-Bunch Instability in the Fermilab Booster (FN-464)
K. Seino et al.	Fermilab Accelerator Control System Analog Monitoring Facilities (TM-1488; submitted to the Europhysics Conference on Control Systems for Experimental Physics, Villars-sur-Ollon, Switzerland, September 28-October 2, 1987)
M. F. Shea et al.	The DZero Downloading and Control System (submitted to the Europhysics Conference on Control Systems for Experimental Physics, Villars-sur-Ollon, Switzerland, September 28-October 2, 1987)

S. Stahl and S. A. Bogacz	Coupled Bunch Instability in Fermilab Booster and Possible Cures - Longitudinal Phase-Space Simulation (FN-460; submitted to Phys. Rev. D)
J. Strait et al.	Tests of Prototype SSC Magnets (TM-1479 [SSC-N-387]; presented at the 10th International Conference on Magnet Technology [MT-10], Boston, Massachusetts, September 21-25, 1987)
L. C. Teng	Accelerator Projects, Worldwide (FN-461; presented at the General Meeting of the American Physical Society, Crystal City, Virginia, April 20-23, 1987)
L. Teng	Primer on Beam Dynamics in Synchrotrons (TM-1475; to be published in *Physics of High Energy Colliders*, A. Chao, H. Edwards, and M. Month, eds.)
J. R. Zagel and L. J. Chapman	User Friendly Far Front Ends (FERMILAB-Conf-87/162; submitted to the Europhysics Conference on Control Systems for Experimental Physics, Villars-sur-Ollon, Switzerland, September 28-October 2, 1987)

Theoretical Physics

C. H. Albright et al.	Testing the Fritzsch Quark Mass Matrices with the Invariant Function Approach (FERMILAB-Pub-87/135-T; submitted to Phys. Rev. Lett.)
D. Chang et al.	Induced Amplitudes $Z' \to Z\gamma$ and $Z' \to ZZ$ (FERMILAB-Pub-87/148-T; submitted to Phys. Lett. B)
P. Q. Hung	Non-Perturbative Unification à la Maiani-Parisi-Petronzio at Intermediate Energies (FERMILAB-Pub-87/156-T; submitted to Phys. Rev. D)

P. Q. Hung and S. Pokorski	Enhanced Higgs Boson Production at the TEVATRON (FERMILAB-Pub-87/211-T; submitted to Phys. Rev. Lett.)
H. Itoyama and T. R. Taylor	Small Cosmological Constant in String Models (FERMILAB-Conf-87/129-T; to appear in the Proceedings of the "International Europhysics Conference on High Energy Physics," Uppsala, Sweden, June 25-July 1, 1987)
P. Mackenzie et al.	ACPMAPS: The Fermilab Lattice Supercomputer Project (FERMILAB-Conf-87/214-T; talk given at the International Symposium "Field Theory on the Lattice," Seillac, France, September 28-October 2, 1987, P. Mackenzie presenter)
K. Meissner et al.	One-Loop Corrections to 4-Graviton Interaction in SST II and Heterotic String Theory (FERMILAB-Pub-87/165-T; submitted to Phys. Rev.)
Z. Kunszt	Higgs Search at Future Colliders (FERMILAB-Conf-87/138-T; to appear in the proceedings of the "International Europhysics Conference on High Energy Physics,", Uppsala, Sweden, June 25-July 1, 1987)
M. Mangano and S. J. Parke	Quark-Gluon Amplitudes in the Dual Expansion (FERMILAB-Pub-87/136-T; submitted to Nucl. Phys. B)
L. McLerran	A Chiral Symmetry Order Parameter, The Lattice, and Nucleosynthesis (FERMILAB-Pub-87/133-T; submitted to Phys. Rev. D)
M. H. Reno and D. Seckel	Primordial Nucleosynthesis: The Effects of Injecting Hadrons (FERMILAB-Pub-87/115-T [SCIPP-87/97]; submitted to Phys. Rev.)
T. R. Taylor	Model Building on Asymmetric Z_3 Orbifolds: Non-Supersymmetric Models

(FERMILAB-Pub-87/157-T; submitted to Nucl. Phys.)

H. B. Thacker et al. — The Three-Body Potential for Heavy Quark Baryons in Lattice QCD (FERMILAB-Conf-87/204-T; presented at the International Symposium on Field Theory of the Lattice, Scilloc, France, September 28-October 3, 1987)

Theoretical Astrophysics

D. P. Bennett and R. Bouchet — Cosmic Strings: A Problem or a Solution? (FERMILAB-Conf-87/164-A; talk presented at the NATO ASI, "The Post-Recombination Universe," Cambridge, England, July 27-August 7, 1987)

R. Brandenberger et al. — Galaxy and Structure Formation with Hot Dark Matter and Cosmic Strings (FERMILAB-Pub-87/126-A; submitted to Phys. Rev. Lett.)

D. H. Coule and M. B. Mijić — Quantum Fluctuations and Eternal Inflation in the R^2 Model (FERMILAB-Pub-87/36-A [CALT-68-1447]; submitted to the International Journal for Modern Physics)

F. Grassi — Hadron-Quark Phase Transition in Dense Stars (FERMILAB-Conf-87/163-A; submitted to Zeitschrift fur Physik C: "Proceedings of the 1987 Quark Matter Conference," Schloss Nordkirchen, West Germany, August 23-29, 1987)

F. Grassi — Zero Temperature Quark Matter Equation of State (FERMILAB-Conf-87/167-A; to appear in the "Proceedings of the Workshop on Variational Calculations in Quantum Field Theory," Wangerooge, West Germany, September 1-4, 1987)

C. T. Hill et al.	Are Cosmic Strings Frustrated? (FERMILAB-Pub-87/193-A; submitted to Phys. Rev. D)
H. M. Hodges et al.	Superconducting Cosmic Strings and the Photofission of ^{4}He in the Early Universe (FERMILAB-Pub-87/153-A; submitted to Phys. Rev. Lett.)
E. W. Kolb et al.	How Reliable Are Neutrino Mass Limits Derived from SN1987A? (FERMILAB-Pub-87/74-A-Rev. Addendum and Erratum: submitted to Phys. Rev. D)
A. D. Linde	Inflation and Axion Cosmology (FERMILAB-Pub-87/198-A; submitted to Phys. Rev. Lett.)
M. Mijić and J. A. Stein-Schabes	A No Hair Theorem for R^2 Models (FERMILAB-Pub-87/151-A [CALT-68-1455]; submitted to Phys. Rev. Lett.)
A. V. Olinto	Quark Matter in Astrophysics and Cosmology (FERMILAB-Conf-87/168-A; submitted to Zeitschrift fur Physik C: "Proceedings of the 1987 Quark Matter Conference," Schloss Nordkirchen, West Germany, August 23-29, 1987)
D. N. Schramm	Big Bang Nucleosynthesis: Accelerator Tests and Can Ω_B Really Be Large (FERMILAB-Conf-87/166-A; prepared for the proceedings of the American Chemical Society Meeting in New Orleans, "Symposium on the Origin of the Elements," September 1, 1987)
D. N. Schramm	A Look at Supernova 1987A (FERMILAB-Conf-87/161-A; prepared for the "Proceedings of the International Symposium on Lepton and Photon Interactions at High Energies," Hamburg, Germany, July 27-31, 1987)
M. S. Turner	On the Magnitude of Baryon-to-Photon Ratio Inhomogeneities Resulting From a First Order Quark/Hadron Transition

	FERMILAB-Pub-87/155-A; submitted to Phys. Rev. D)
M. S. Turner	Axions from SN 1987a (FERMILAB-Pub-87/202-A; submitted to Phys. Rev. Lett.)
M. S. Turner and L. M. Widrow	Inflation-Produced, Large-Scale Magnetic Fields (FERMILAB-Pub-87/154-A; submitted to Phys. Rev. D)

Computing

L. Gustafsson	A VME to FASTBUS Interface Using a Finite State Machine Coprocessor (FERMILAB-Pub-87/145; submitted to Computer Standards and Interfaces)
N. Hughart and D. Ritchie	NULLJOB Product (FERMILAB-Conf-87/139; presented at the Fifth Conference on Real-Time Computer Applications in Nuclear, Particle, and Plasma Physics (IEEE), San Francisco, California, May 11-15, 1987)
L. Loebel	Software Support: Pre-Empting the Quick Question (TM-1481; submitted to the ACM SIGUCCS User Services Conference, Kansas City, Missouri, September 27-30, 1987)
D. R. Quarrie	Personal Computers in High Energy Physics (appeared in "Computer Physics Communications 45," [1987], 175-179, North-Holland, Amsterdam. Submitted to the proceedings of the International Conference on Computing in High Energy Physics, Asilomar, California, February 2-6, 1987)

Cryogenics

M. Kuchnir	Thermal Diffusivity of $YBa_2Cu_30_{7-\delta}$ at 84K (submitted to the Oak Ridge SIS

	[Superconductivity Information System] Electronic Bulletin Board, July 23, 1987)
K. McGuire et al.	Cryogenic Instrumentation of an SSC Magnet Test Stand (TM-1476 [SSC-N-386]; presented at the 1987 Cryogenic Engineering Conference/International Cryogenic Materials Conference, St Charles, Illinois, June 14-18, 1987)
T. J. Peterson and J. D. Fuerst	Tests of Cold Helium Compressors at Fermilab (TM-1485; presented at the Cryogenic Engineering Conference/ International Cryogenic Materials Conference, St. Charles, Illinois, June 14-18, 1987)
Q. S. Shu et al.	Crack Covering Patch Technique to Reduce the Heat Flux from 77K to 4.2K through Multilayer Insulation (presented at the 1987 Cryogenic Engineering Conference/International Cryogenic Materials Conference, St. Charles, Illinois, June 14-18, 1987 and submitted to Advances in Cryogenic Engineering)
J. C. Theilacker	Cryogenic Testing at the SSC String Test Facility (TM-1483; Presented at the Cryogenic Engineering Conference/International Cryogenic Materials Conference, St. Charles, Illinois, June 14-18, 1987)
J. C. Theilacker and C. H. Rode	An Investigation into Flow Regimes for Two-Phase Helium Flow (TM-1482; presented at the Cryogenic Engineering Conference/International Cryogenic Materials Conference, St. Charles, Illinois, June 14-18, 1987)

Other

D. F. Anderson and D. C. Lamb — Saturation Effects in Liquid Argon Doped with Methane (FERMILAB-Pub-87/134; submitted to Nucl. Instrum. Methods A)

K. R. Saroja et al. — An Update on Malignant Salivary Gland Tumors Treated with Neutrons at Fermilab (published in Int. J. Radiation Oncology Biol. Phys., Vol. 13, 1987, pp. 1319-1325)

Colloquia, Lectures, and Seminars

(All by Fermilab staff at Fermilab in 1987 unless otherwise noted)

September 22
S. Mane: "The Michigan/IUCF Siberian Snake Test"
T. Nicinski: "What is DEC-MMS and How To Use It?"

September 23
R. Stefanski: "Rap Session on Heavy Flavor Symposium at Stanford and B Workshop at SLAC, September 1-9, 1987"

September 24
R. Noble: "Plan to Improve the Low Energy End of the Linac (Cockcroft-Walton and Tank 1)"

September 25
A. Jonckheere: "D0 Calorimeter Monte Carlo"
Z. Kunszt, Fermilab/E.T.H. Zurich: "Multi-Jet Production at Hadron Colliders"

October 1
J. Palkovic and C. Schmidt: "Plan to Improve the Low Energy End of the Linac (Cockroft-Walton and Tank 1) II"

October 2
C. Brown, G. Dugan, H. Montgomery, J. Spalding, and R. Stefanski: "Report from the Conferences at Hamburg and Stanford"

October 6
P. Martin, D. Trbojevic, and R. Gerig: "Coalescing Improvements and Main Ring Vertical Dispersion Reduction"

October 8
V. Bharadwaj: "E-760 and the Need to Decelerate in the Accumulator"
W. Marsh: "DEC AUX - the Way to Decelerate"
T. Taylor: "Orbifolds Without Supersymmetry"

October 13
H. Johnstad: "ZEBRA Data Structures"
J. Strait: "SSC Magnet R&D Program"

October 20
D. Edwards: "Progress Report on E-778 - Test of SSC Aperture Criterion"

October 22
M. Lindner: "Nonlinear Evolution of Yukawa Coupling Matrices"

October 27
M. Harrison and A. Van Ginneken: "Beam Scraping in the TEVATRON: Principles and Observations"
D. Ritchie: "Conferencing by Computer - What, Why, When and How"

October 29
J. Crisp: "Main Ring Damper Problems"
G. Jackson: "New Ideas on Coalescing"

October 30
K. Ellis: "QCD at the Collider"

November 3
V. Bharadwaj: "Deceleration in the Accumulator"
H. Edwards: "FY88 R&D and Improvement Projects; Long-Term Luminosity Upgrade and the Need for More Intensity"

November 5
S. Holmes and J. Marriner: "Report on the New Rings Study Group"

November 6
J. Huth: "CDF Survey and Alignment"

November 10
F. Bartlett: "Structured Analysis Structured Design Principles and Tools"

November 12
C. Briegel and M. Shea: "Networks"
K. Cahill and A. Waller: "Consoles"

November 16
M. Gleiser: "Generalities on Non-Topological Solitons"

November 17
S. Holmes: "Plans for Improved Performance of the Fermilab Booster"
H. Johnstad and R. Thatcher: "Fortran 8X Who's for it, who's against it, and why"

November 19
K. P. Koepke: "Low-Beta Upgrade"
M. Syphers: "More on Main Ring Aperture and Life Time"

November 24
L. Hoddeson: "The Underground History of the Doubler"
L. Loebel: "CLI - The Command Language Interpreter - How to Make Your Programs Look Like DCL Commands"

December 3
G. Coutrakon: "The E-665 RICH Detector"
A. Moretti: "Disk-and-Washer Measurements and Computations (3D)"
R. Noble: "Coupled Cavity Accelerating Structures for the Linac Upgrade"

December 4
K. Ellis: "Production of Top and BottomQuarks at Collider Energies"

December 8
M. Harrison: "Fixed-Target Performance Limitations"
M. Leininger and G. Tool: "DOE CAD/CAM Conference Report"
M. Syphers: "Main Ring Performance at 8 and 20 GeV"

December 10
Continuation of Discussion on Control System Upgrades:
P. Lucas: "Introductory Remarks"
M. Glass: "Front Ends"
L. Chapman: "Distributed Systems"

December 17
A. Lennox: "Neutrons Against Cancer: The Clinical Experience at Fermilab"

December 18
P. Martin, G. Dugan: "D0 Main Ring Backgrounds"

Dates to Remember

March 11, 1988	Users Executive Committee Meeting, Washington, D. C.
May 11, 1988	Deadline for receipt of material to be considered at June 1988 Physics Advisory Committee Meeting
May 13-14, 1988	Users Annual Meeting
June 18-24, 1988	Physics Advisory Committee Meeting
June 20-24, 1988	7th Topical Workshop on Proton-Antiproton Collider Physics. For information contact: Fermilab Users Office, Phyllis Hale, (312) 840-3111 or BITNET USERSOFFICE @ FNAL