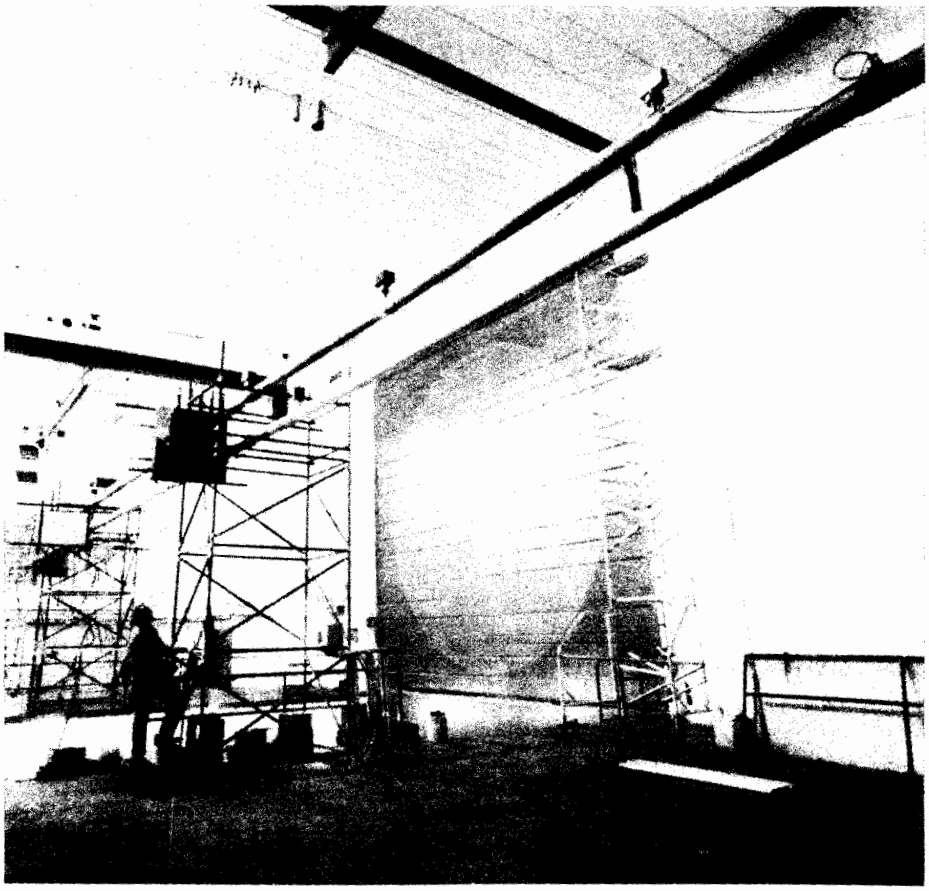
# fermilab report

Fermi National Accelerator Laboratory Monthly Report December 1983



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THE COVER: The Main Ring (upper) and Tevatron (lower) beam pipes passing through the Collider Detector Experimental Area at B0. The Main Ring beam pipe will be moved up out of the way of the Collider Detector when the Overpass is built.
(Photograph by Fermilab Photo Unit)

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# THE ENERGY SAVER

Interesting and important results are being produced in beam studies. First, an intensity of more than $1.1\times10^{13}$ protons has been accelerated in the Energy Saver, reaching toward our traditional Main-Ring intensity.

Second, beam-storage studies have been carried out looking toward storage of protons and antiproton beams in Tevatron I. The studies were carried out at 400 GeV and the measured proton-beam lifetime was many hours, but the quality was not good enough for colliding beams and needs work.

Installation work in the new Muon Lab. The analyzing magnet is the old Chicago Cyclotron built by Fermi and his coworkers.
(Photograph by Fermilab Photo Unit)

# FERMILAB CENTRAL COMPUTING STRATEGY FOR THE MID-80's

Al Brenner

## Introduction

The intent of this paper is to outline in broad terms the overall directions and plans which are being laid for the evolution of the Central Computing Facility at Fermilab. No detailed time schedule is given because of the number of factors which make that very difficult. The computing industry and the availability of computing components and the styles and packages in which they come are becoming more and more diverse at a very rapid rate. Also, the integration of these rapidly changing technologies and approaches into an ongoing dynamic operational situation is very complex. Finally, the whole activity is paced almost entirely by the level of funding and staffing that one can apply to this problem.

During the last decade, corresponding to the operational life of the Laboratory, the computing industry has moved along briskly, but in a relatively monolithic direction. Now, however, the level and style of interaction possible, and also the mechanisms of accomplishing number crunching procedures, are in the process of a major diversification. This gives rise to enormous opportunities for improving our future computing capabilities, but carries with it the heavy burden of bringing all this together into a unified system. The Report of the **ad hoc** Committee on Future Computing Needs for Fermilab (the Ballam Committee Report) summarized in an accompanying article, has recognized these opportunities and burdens and has recommended that the Laboratory assign more resources to support these computing activities then it has heretofore. The rate at which the program outlined here will come to pass is strongly dependent upon our ability to carry out the recommendations of that Report.

## The Current State of Affairs

The Fermilab Central Computing Facility currently consists of a complex of three Cyber 175 computers which were installed at the end of 1978. They are currently quite saturated, although normal priority production jobs typically do turn around overnight. Interactive (terminal - CRT) jobs are responsive, but are limited in both memory allocation and in CP time for each user session. The latter is hardly a constraint, but the former is becoming a more and more serious limitation to the user community.

About 90% of the CP time is utilized by the experimental physics community setting up for and analyzing data. The remaining 10% is mostly utilized for accelerator design, structural analysis, magnet design, and other engineering functions. A small fraction currently is utilized by the theoretical physics community. A substantial number of non-physics users also utilize the facility and constitute a third or more of the interactive population. Their use of CP time, however, is negligible. These include most of the secretaries at the Laboratory and a small number of people doing computer-aided design (CAD) work.

All users on the site with direct hard-wired connections to the computing facility, as well as those off-site accessing the facilities via common carrier lines, have access to the computers under management control of the Computing Department, as well as a few other computers. This is accomplished with a very modern MICOM port-selector "cross-bar" switch which gives good flexibility to the user community. Bandwidths up to 9600 baud are possible. Thus, from any given terminal, access is possible to any of the connected computers, or with a dial-out capability over common carrier lines, to any of a limited number of allowed facilities outside the Laboratory.

Currently, there is no direct connection to ARPANET or to any of the value-added networks. ARPANET is accessible when required through a connection to Argonne. Currently, about a dozen user groups are connnected over dedicated common carrier lines, usually at 9.6 Kb, to the Fermilab MICOM data switch. By the end of this year, we will be connected into the BITNET network.

We have recently committed and started installing a broadband multiple T1 (1.54 MHz) system connecting Wilson Hall and the general B0/Industrial Area complex. There will also be installed in that complex a satellite MICOM port selector. That will give us broadband communications for a number of different lines between the B0/Industrial complex and Wilson Hall. Furthermore, that connection will be extended farther out to the other three experimental areas during the next year. Some of these connections will be used for machine-to-machine communications; in the first instance between the CDF data-acquisition and off-line VAX's.

Projections for the immediate future in terms of raw computing power required are as difficult as ever to make, but for the near-term early Tevatron period, the techniques we have used heretofore should continue to work. Thus, we project a need for a factor or two more computing than we have right now before the end of calendar '85. By that time, TeV I will start operating and the projections further into the future are very much more difficult to make. Without doubt, the growth slope will start increasing at that point. Thus, by the end of 1986 we will be in a very serious overload condition and will again require major additional equipment.

Our system is nicely backed-up for archival purposes with the Automatic Tape Library (ATL). This system is fully operational and is an enormous aid in terms of storing and retrieving files with a minimum of hassle for the operations group and with minimum delay for the user. The ATL in this environment is very effective. It is able to contain at current rates one year's worth of active disk files.

For interactive terminals, which are quite uniform across the Laboratory, we have a large number of dumb ADM-3A terminals. A substantial number of these have graphics-board extensions. The terminals have been very effective, inexpensive, and stable. New competition has come into play in the last year or so with somewhat more-powerful terminals. We have slowly moved in that direction as well. We have also been searching for an appropriate terminal on which to allow for output previewing. We will make a decision on that terminal in the near future.

With respect to the question of upgrading our facilities to take advantage of modern interactive graphics techniques, over the years we have developed our own internal global device-independent graphics system (DIGS) similar to what most of the laboratories have done, each in its own individual style. For interactive graphics, we mostly use 4010 protocols and we support a number of different terminals using 4010 graphics mode, including Retrographics Corporation enhancements to the dumb ADM-3A terminals that we use. These have found widespread and satisfactory use, at a very good price, across the whole Laboratory. The device independent graphics system also allows us to handle a variety of on-line graphics devices, including a number of Calcomp drum plotters and two high-quality Benson Varian medium speed electrostatic plotters. The latter, in particular, have been very successful in supplying high-quality graphics output with very good turn around.

Recently, after a search for more than two years, we have chosen a low-cost, reasonably high resolution, high quality color graphic system. A number of these Envision terminals are on order and are beginning to be allocated to the user community. As part of this process, we are setting up a do-it-yourself transparency and slide making facility for the convenience of the users.

In other dimensions, we have made available simple database-management systems, likely to be convenient for the management of scientific as well as administrative data. We also are in the process of introducing new scientific high-quality printing terminals so that papers and letters can be output directly with an extended character set including Greek and mathematical symbols. Associated with this, we are also having developed a new dumb terminal which will present both Greek and mathematical symbols directly as typed.

## The Near-Term Plan

Conceptually, the plan at the time of the FY79 acquisition was to add "a fourth mainframe" during the FY83/84 time period to enhance the currently-installed system. All the necessary connections were provided at the time of that acquisition to make this possible. Since the "fourth mainframe" in the sense described did not exist as a marketplace item, earlier this year we broadly opened a competitive procurement to obtain enhancement at the same level, i.e., to at least twice that which we currently have installed to carry us through this early Tevatron period. Since a shortage of computing cycles was viewed as the greatest short-term (and indeed longer term) problem, the RFP procurement most strongly valued this aspect of the system. Bids were recieved from Amdahl, CDC, Cray, and IBM. A more detailed report on this computer acquisition appeared in the November 1983 issue of **Fermilab Report.**

CDC's bid for a dual CPU Cyber 875 system with 750K words of memory has been selected. The first CPU was delivered early in December. The remaining equipment and software is scheduled for delivery during the next 21 months. The total installed computing power in the Central Computing Facility at that time will be the equivalent of seven Cyber 175 CPU's. In addition to the CPU's and associated channels and controllers that are required, additional peripheral devices will come with the system. The installed disk capacity will double in size from about 15 gigabytes to a total of 30 gigabytes. Also, the high-speed printing capacity will be doubled. As part of this acquisition, during the next year a major upgrade of the operating system from NOS 1 to NOS 2 will also occur. With this change will come a number of added features giving rise to a more powerful operating environment for the user community.

The Cyber 875 will be connected to the existing Cyber and other local systems via a Network Systems Hyperchannel connection. We also have committed and will shortly install two quite large VAX 780 computers which will be configured in a cluster network themselves, as well as being separately connected to the Hyperchannel. This cluster will serve as an alternative front end to all systems. It is our intention to continue this expansion of options for alternate interactive mechanisms using the existing old architecture machines and the computers about to be acquired as the computing workhorse engines, behind these new interactive systems. Next year will see the addition of an IBM style alternative front end to the network.

We are planning to introduce Ethernet-type connections throughout Wilson Hall for general interconnectability via a gateway to the central local area network. The details of this connection are only conceptualized and are not yet detailed enough to proceed. It is only recently that Ethernet has stabilized and become a real product, supported by industry with real hardware and software.

With respect to graphics enhancements, we are watching very closely the status of the U.S. Standards Committee relative to both the GKS and Core (the U.S. nominal standard) protocols. We fully expect GKS or some minor variant of it to be adopted as the U.S. standard, and as soon as that happens, we will put major effort behind changing our local, unique DIGS standard to that one.

With the current explosion in the rate of introduction of new powerful desktop workstations, we are continuously tracking the availability in the marketplace in this arena. Clearly new ideas and new options are being introduced at a very rapid rate. Currently, our perception is that there is no obviously correct system to which Fermilab should commit. Furthermore, we fully expect to have our hands full making all the new items we have coming in with the current new acquisition work. It is our intention to continue to track the availablity and performance of workstations. Probably next year, when we have stablilized our new acquisition and integrated it into a total system and made it useful to the user community, we will turn our attention once again to the workstation question. We hope that new and stabilized workstation equipment will then be available, and we will evaluate seriously the choice of workstation(s) appropriate to the Fermilab needs.

As indicated earlier, we will continue to expand and increase the level of integration of a number of networking systems that we use. We will install an Ethernet system, enlarge the Hyperchannel network and connect BO/Industrial Area to the Central Laboratory via a T1 broad-band connection. The latter will then be expanded to other experimental area locations and also to the cross gallery.

We are also interested in expanding our support for engineering computing during this period. This includes an enhanced CAD capability, extended finite-element analysis tools, magnet-design programs, alternative word-processing capability, and more direct support of microcomputers.

## Longer-Range Expectations

The major problem with any medium-term solution now is that none of the normal architectural enhancements, neither IBM-like architectures nor any of the other extant architectures, is likely to bring with it at a cost that is even imaginably tractable the necessary computing that we will require, once the Tevatron starts functioning and producing data at the rates expected. Even assuming that we do everything we can to preprocess in real time as much of the data as possible, we will still need a factor over our current computing level exceeding 10 and possibly approaching 100 to handle the expected data rate as we approach the end of the decade. We will start needing more than the factor of two that we are currently installing as early as

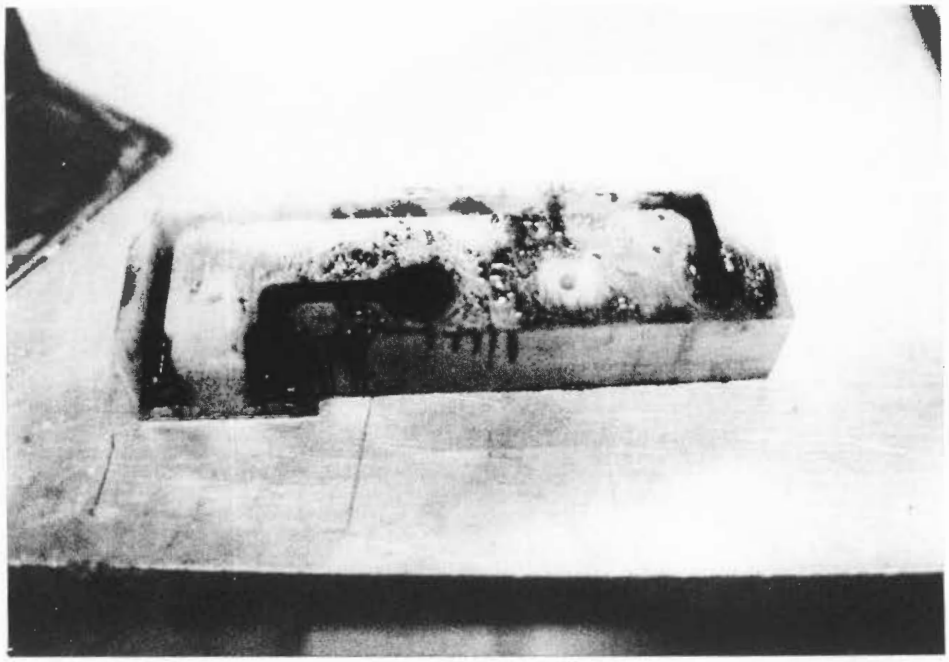
the end of 1985. No announced product is likely to be able to provide at reasonable cost the level of computing that we project as our need. On the other hand, there are a number of relevant activities currently in progress, with lots of interest on the part of government, laboratories, and universities. The message is being heard; the potential Japanese commercial encroachment also is having useful effect in inducing the various companies in this marketplace to come up with new products, some of which may be appropriate for the high-energy physics community.

Also, there are a number of activities being pursued in developing special-purpose processors, particularly cost effective for the needs of high-energy physics data-analysis computing. These include IBM emulators, the 3081/E being designed by SLAC and CERN and the 370E being designed by the Weizman Institute in collaboration with a number of European laboratories, the product of the Fermilab Advanced Computer Project (ACP) and a number of other university and industry-based projects. One or more of these will certainly play an important role in the solution to the Fermilab computing problem during the second half of the decade.

In our long-range Automatic Data Processing Plan, we have set aside $15M for major new architectural equipment in FY86/87. As indicated above, there is no collection of machines today that carries with it in a natural way the capability of computing at levels which we require. All indications are that the vector machines, even the dual-headed vector machines, i.e., the Cray X-MP, will not solve our problems. Neither do any of the IBM or IBM look-alikes, nor do any of the other available machines that function today. On the other hand, all the important manufacturers, e.g., Amdahl, CDC, Cray, Denelcor, IBM, and Trilogy as well as all three of the major Japanese companies, Fijitsu, Hitachi, and NEC, are committed to big new machines in the relevant time frame. In many cases, however, these are vector machines and what performance we would achieve with our job mix is totally unknown to us at this point. Nevertheless, we have been making known and our benchmarks have demonstrated our needs to these firms. In this way, we are trying to encourage all of the companies, especially the new ones like Denelcor, whose architecture appears to be better suited to our needs than that of any other machine, to pursue their efforts with new technology and, most importantly, with new architectural approaches.

However, if we take a route like the Denelcor route, the chances of there being a sophisticated operating system with all sorts of productivity-enhancing tools on it, is very small. The only way in which such a machine will end up being both a useful computing engine and a useful productivity tool for the user is by appropriately networking it with other machines. We are in the process of learning how to network various machines, as is the rest of the world just learning. We are sensitive to the availability of these different tools, and we believe that we will put together an appropriate mixture of productivity tools

connected to computing engines to handle the Fermilab computing needs as they grow.



Part of a burned-out spool piece (correction magnet assembly) removed from the Energy Saver.
(Photograph by Fermilab Photo Unit)

# THE AD HOC COMMITTEE ON FUTURE COMPUTER NEEDS AT FERMILAB

David Quarrie

## Introduction

This committee was formed at the request of the Director, as an ad-hoc group charged with reviewing Fermilab's computing needs for the next five to ten years and making recommendations as to possible means of satisfying them. An important by-product of this task is to increase the awareness of the general community to the current state of computing and to the direction in which it is moving. As a result, the report under preparation (for publication in December 1983) contains not only specific recommendations to the Director but also significant tutorial material. In this short discussion, I shall attempt to summarize our report and the procedure by which we arrived at our conclusions.

## Committee Membership and Procedure

The Committee consisted of the following members:

J. Ballam, SLAC, Chairman
J. Butler, Fermilab
K. King, Cornell
P. Kunz, SLAC
D. Linglin, CERN
G. Lynch, LBL
H. Newman, Caltech
R. Peierls, BNL
D. Quarrie, Fermilab
M. Schaevitz, Columbia

With representation from high-energy physics labs both in the USA and Europe, good comparisons between the situation here at Fermilab and elsewhere could be made, as well as good verification of some of the predicted requirements.

Presentations were made to the committee about the needs of present and future experiments at CERN (UA1, LEP-3) and SLAC (TPC) and the plans made by CDF in preparing to meet their needs. In addition, presentations were made on the plans of the Computer Department and the Advanced Computer Project. The committee conducted a survey of users (HEP experimentalists, theorists, and accelerator physicists and engineers) in order to estimate the computing load predicted to occur over the next few years.

## Results from Survey

The basic conclusion from the survey of users was that the raw computing power necessary will rise to approximately 7 Cyber-175 equivalents in 1984 and to 24 Cyber equivalents by 1987. These numbers have, of course, large uncertainties on them, but, even if only partially correct, do indicate that an enormous increase in the demands put upon the Computing Center is imminent. Several major factors contribute to this predicted increase:

(a) The advent of the Collider and the two experiments, CDF and D0. Together these two experiments are predicted to account for 65% of the total load by 1987. This number already assumes that the data rate has been considerably reduced from the enormous interaction rate before writing data onto magnetic tape. Sophisticated hardware and software trigger processors, themselves having comparable computing requirements, will be necessary to perform this function.

(b) Most fixed-target experiments have increased in complexity, having increased the number of detector channels and the trigger rate. In many cases the experiments are now second generation and are therefore, because of their nature, more complex.

(c) Enhancements to the beam lines will enable several previously mutually exclusive experiments to coexist.

(d) Extensive studies of the performance of the Antiproton Source and Collider will soon be necessary.

(e) Fermilab will be heavily involved in the design and construction of the new Multi-TeV pp collider. This machine will require a very intensive program of lattice calculations and magnet design in order to produce a technically feasible solution that satisfies budgetary constraints.

It is the general feeling of the committee members that such an enormous computing load will not be cost-effectively met by a "mainframe" in an adequate timescale and that by mid-1986 one could have a central processor that would handle approximately half this load. The remainder of the task will probably have to be performed using super-mini computers, single-board programmable microprocessors or emulators. Care must be taken to provide an adequate environment by which these diverse technologies may be integrated into a useable whole.

The survey mainly addressed "capacity" rather than "capability." Capacity may be thought of as the number of CPU cycles, disc drives, and tape drives. Capability is the number of special input and output devices, number of large jobs that can be run in parallel, variety of the types of work that can be performed such as interactive graphics, and the quality of interactive computing. The committee members feel that more emphasis should be given to addressing the aspects of computing associated with increasing the capability of the Fermilab Computing Center.

## Computing Tasks and the Computing Environment

In bringing a HEP experiment to a successful conclusion there are many diverse computing tasks that must be performed. Some of these, such as performing the main data reduction, stress the traditional batch role of a computer center. This also means that they are suitable for more unconventional, cost-effective means of solution such as multiple single-board microprocessors or emulators. Other tasks, such as program development and physics analysis, require a more high-level interactive environment.

Although the size of major HEP experiments is increasing enormously, both in the number of electronic channels (100k-300k) and the number of physicists involved (100-250), the development of the software base falls to a relatively small number of people. Thus the quality of the computing environment plays an increasingly important role in determining whether an experiment will be ready on time. The particular aspects that are important here are the level of interactiveness for program development and the integration of different sections of the computing environment into a collective ensemble. Thus editing, file handling, job submission, interactive debugging, system monitoring, and code and database portability are the important areas rather than just raw computing power.

The committee has put forward a senario that has the following components:

(a) A large mainframe. This need not be a single processor, but should present a single system image to the user, such that he need not concern himself with which processor he is communicating with or on which one the jobs he submits will run. Essential features of such a "mainframe" are the provision of sufficient user-addressable memory (several megabytes) as well as sufficient physical memory to allow several such user jobs to run concurrently efficiently. It must have facilities for including the machine in a network, with particular emphasis on connection to VAX computers used as data-acquisition computers. Such a connection should provide adequate hardware and software support for transfer of both programs and databases.

(b) Banks or "farms" of special-purpose processors for "number crunching." Such farms can provide significant computing power for relatively stable production jobs. However, access must be flexible because it is highly unlikely that programs will remain completely stable throughout the life of an experiment. The emphasis here is on adequate software support to enable both programs and databases to be developed, downloaded, and verified.

(c) Distributed VAX computers. These exist primarily for data-acquisition purposes. Given the correct environment, such computers could form a considerable resource if they are stable for the lifetime of an experiment. This would enable them to be used, not only for data acquisition, but also for some off-line work and local development of special trigger processors etc. The emphasis here is on a sufficient level of networking.

(d) Personal work stations. These may take the form of specialized graphics devices, stand-alone computing systems, or integrated networking systems. State-of-the-art workstations are currently not available from the major manufacturers, although both IBM and DEC have just announced offerings approaching this level. They have the potential to revolutionize a major part of computing within HEP. Major portions of the physicist's data analysis, calculation, and document-preparation tasks could be entirely removed from the province of centralized computing.

(e) Home-institution computers. Most of these are VAXs and have the potential of providing considerable computing resources.

(f) Networks connecting the various elements of this computer ensemble. Crucial are both high-speed links between computers on-site, and also slower speed links to the outside world, so as to enable physicists from their home institutions easy access, not only to the main computer center, but also to their data-acquisition computer.

The effectiveness of such a computer system will depend very heavily on the software support in order to present to the user a uniform image. Important criteria are:

(a) Does the environment provide an efficient means for performing all the essential data-taking, reduction and analysis-related jobs?

(b) Are the hardware facilities fully utilized without unduly sacrificing convenience or quick availability?

(c) Are the facilities sufficiently centralized to allow efficient use of manpower? Conversely, if distributed, are the overall hardware and software maintenance tasks reasonable?

(d) Does the environment function as a flexible, integrated whole? Can the user choose a part of the total system best suited to a particular task efficiently and not be

subjected to excessive "overhead?" Will he have to prepare specially formatted input or output files, or have to transport large amounts of data across slow and unreliable links?

Implicit here is a high level of networking, both locally on the Fermilab site, and also efficient links to collaborating institutions, not only here in the USA, but also to Europe and Japan. Such networking should provide a high degree of transparency and provide the user with protocols for both computer-computer and terminal-computer interaction. When dealing with diverse machine architectures, the support hardware and software should attempt to minimize the "pain" to the sensible user in the number of restrictive rules that he must self-impose.

Implementing such a computer system will place great demands on the computer department since more effort will need to be expended in areas unconnected with the normal day-to-day activities. Study groups should be set up in order to evaluate alternatives in critical areas such as workstations and networks. Compatibility, both of programs and databases, across diverse machine architectures will become increasingly important and will entail detailed study.

## Recommendations

Several recommendations have been made by the committee as concluding remarks in its report to the Director. The main ones may be summarized:

1. Significant additional computing capacity and capability should be provided by 1986. A working group with representation from the principal computer-user community should be formed to begin immediately to develop the technical specifications. High priority should be assigned to providing a large user memory and software portability as well as a productive computing environment.

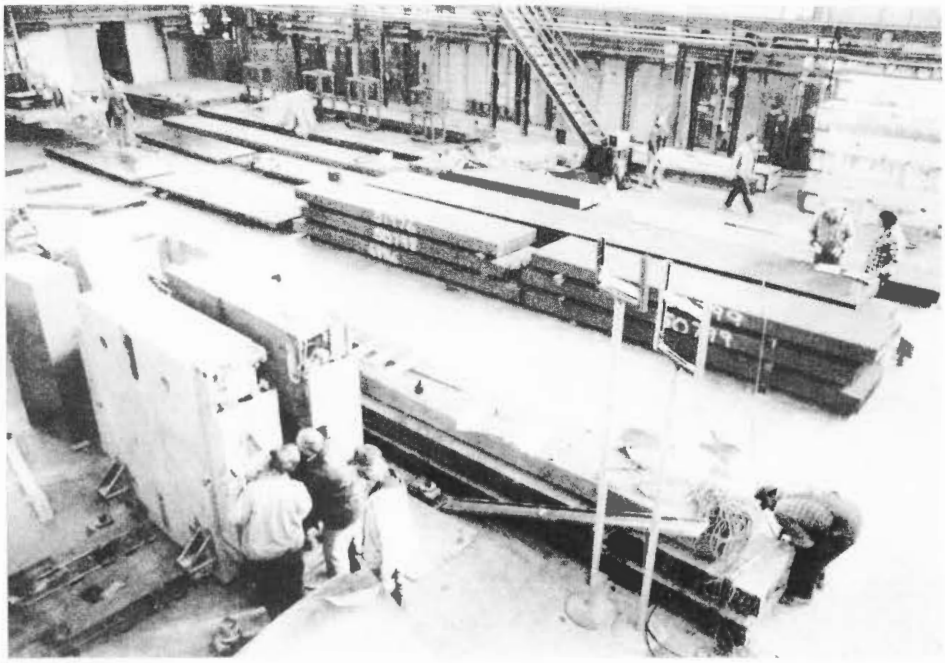
2. The Laboratory should move decisively to a more fully interactive environment.

3. A plan for networking both inside and outside the Laboratory should be developed over the next year.

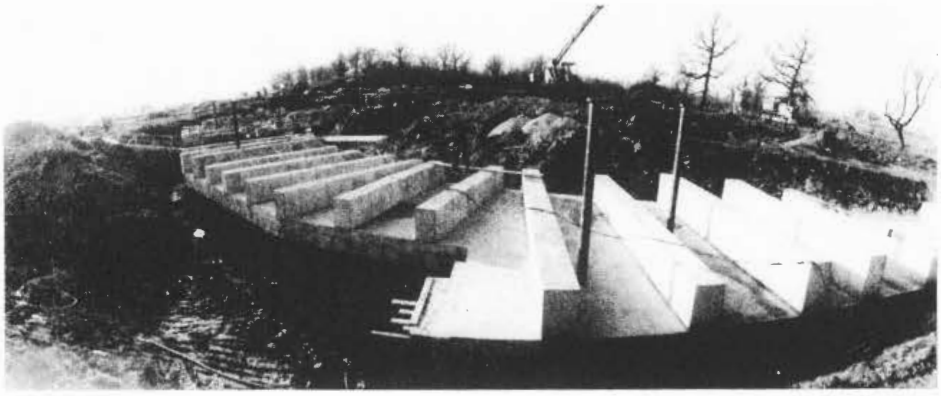
4. The Laboratory resources devoted to computing, including manpower, should be increased over the next few years. A reasonable increase would be 50% over the next two years, increasing thereafter to a level of about twice the present one.

5. A standing computer-coordinating group, with membership from all the principal computer-user constituents of the Laboratory, should be appointed. This group should regularly review all aspects of the computing environment, assist the Director in keeping the user community well informed, and define and manage working groups set up to pursue special development projects.

Several of these recommendations have already been, or are in the process of being acted on. Action on all areas identified in the report should have profound effects on both the amount of raw computing power available and also on the quality of life as a computer user.



Steel shielding being installed in the M3 beam line.
(Photograph by Fermilab Photo Unit)



Construction progress on the Antiproton Source Ring Tunnel.
(Photograph by Fermilab Photo Unit)

## TAIJI YAMANOUCHI AWARDED NISHINA MEMORIAL PRIZE

Taiji Yamanouchi, Fermilab Assistant Director and Head of the Program Planning Office, was selected to receive the 1983 Nishina Memorial Prize at a ceremony held in Tokyo on December 6. This prize is given to Japanese physicists who have performed distinguished work in the field of atomic and nuclear physics. Dr. Yamanouchi was awarded the prize for his accomplishments in high-energy physics research, including his contribution to the discovery of the upsilon particle in Fermilab experiment E-288.

Dr. Yoshio Nishina was a prominent Japanese physicist who is well-known for the Klein-Nishina formula on electron-photon interactions, and also is recognized as being the founder of modern Japanese physics in the 1920's.

Taiji Yamanouchi

A delegation from the People's Republic of China visiting Fermilab on November 21.

(Photograph by Fermilab Photo Unit)

MANUSCRIPTS, NOTES, LECTURES, AND COLLOQUIA PREPARED
OR PRESENTED FROM NOVEMBER 21, 1983 TO DECEMBER 11, 1983

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

**Experimental Physics**

| | |
|---|---|
| K. Sliwa et al.<br>Experiment #516 | A Study of $D^*$ Production in High-Energy $\gamma p$ Interactions (FERMILAB-Pub-83/96-EXP; submitted to Phys. Lett.) |
| B. H. Denby et al.<br>Experiment #516 | Inelastic and Elastic Photoproduction of $J/\psi$ (3097) (FERMILAB-Pub-83/98-EXP; submitted to Phys. Rev. Lett.) |
| C. C. Chang et al.<br>Experiment #580 | Diffractive Production of $K^0_S K^0_S \pi^+ \pi^- \pi^-$ in $\pi^- N$ Interactions at 200 GeV/c (FERMILAB-Pub-83/99-EXP; submitted to Phys. Rev. D) |
| R. Blair et al.<br>Experiment #616 | Monitoring and Calibration System for Neutrino Flux Measurement in a High-Energy Dichromatic Beam (FERMILAB-Pub-83/26-EXP; submitted to Nucl. Instrum. Methods) |
| S. I. Baker et al.<br>Experiment #660 | Deflection of Charged Particles in the Hundred GeV Regime Using Channeling in Bent Single Crystals (FERMILAB-Pub-83/100-EXP; submitted to Phys. Lett.) |

**Theoretical Physics**

| | |
|---|---|
| J. H. Kuhn | How to Measure the Polarization of Top Quarks (FERMILAB-Pub-83/79-THY; submitted to Nucl. Phys. B) |
| H. J. Lipkin and I. Cohen | Is the Iota a Giant Quarkonium Resonance? (FERMILAB-Pub-83/86-THY; submitted to Phys. Lett. B) |

## Astrophysics

| | |
|---|---|
| D. N. Schramm | Cosmology and GUTS: The Matter of the Universe (FERMILAB-Conf-83/83-AST; delivered at the COSPAR meetings, Bulgaria, October 1983) |
| E. W. Kolb and R. Slansky | Dimensional Reduction in the Early Universe: Where Have the Massive Particles Gone? (FERMILAB-83/88-AST; submitted to Astrophysics J.) |
| D. N. Schramm and K. A. Olive | Quark-Hadron and Chiral Transitions and Their Relation to the Early Universe (FERMILAB-Conf-83/92-AST; submitted to the Quark Matter Conference, State University of New York) |

## Physics Notes

| | |
|---|---|
| L. Michelotti | Catstrophe and Maxwell Surfaces of the Half Integer Resonance Excited by Quadrupoles and Octupoles (FN-393) |
| J. D. Cossairt and L. V. Coulson | Neutron Skyshine Measurements at Fermilab (FN-394; submitted to Health Physics) |

## Colloquia, Lectures, and Seminars

| | |
|---|---|
| D. E. Johnson | "The Tevatron I Project" (Michigan State University, November 8, 1983) |
| A. Sen | "Supersymmetric SU(6) as a Solution to the Fine Tuning and the Strong CP Problems" (Fermilab, November 22, 1983) |
| K. Koepke | "Low-$\beta$ Insertion at B0" (Fermilab, November 22, 1983) |
| R. Johnson | "Beam Storage in the Tevatron - First Result" (Fermilab, November 29, 1983) |
| H. Jöstlein | "The Vacuum System of the Tevatron - A Superconducting Accelerator" (Fermilab, November 30, 1983) |

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| R. Orr | "Accelerator Division Informations Meeting" (Fermilab, December 6, 1983) |
| D. Seckel | "Wall-Dominated Inflation" (Fermilab, December 8, 1983) |
| M. Kuchnir | "Chicago-Fermilab-Michigan Monopole Search" (Fermilab, December 9, 1983) |

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## DATES TO REMEMBER

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| June 16-22, 1984 | Extended Summer Meeting of the Physics Advisory Committee |
| May 2-4, 1984 | "Inner Space-Outer Space," Workshop on High-Energy Physics, Astrophysics, and Cosmology |