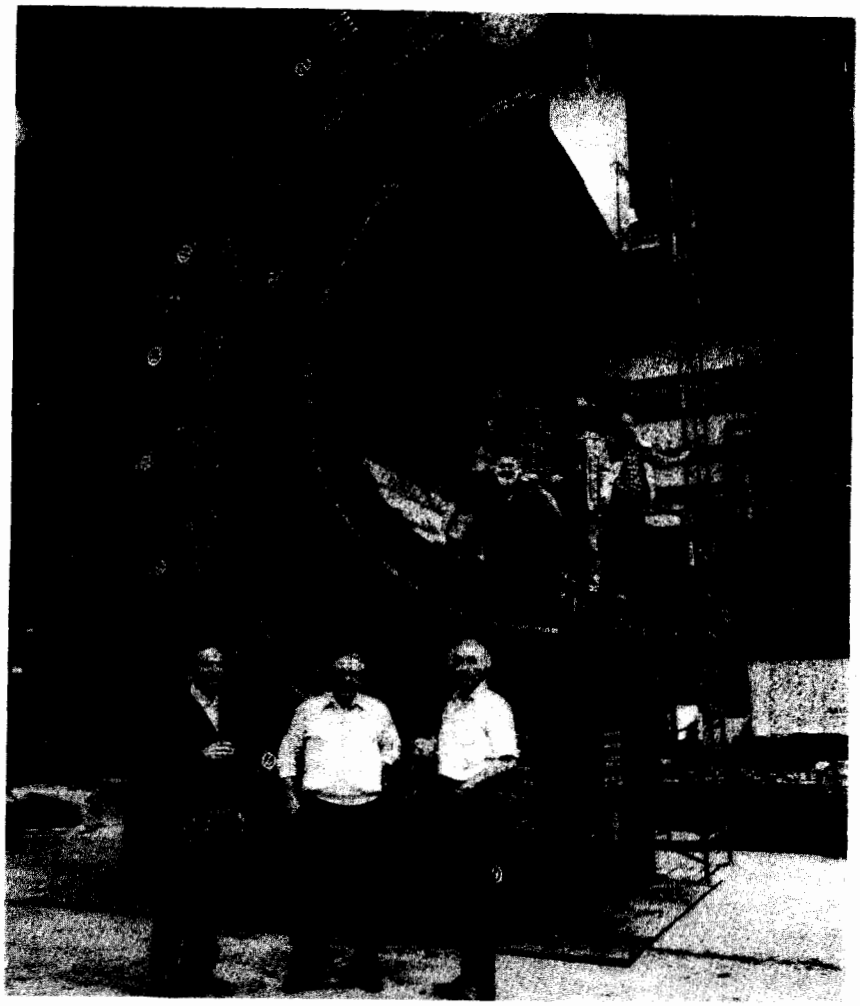
fermilab report

Fermi National Accelerator Laboratory Monthly Report

December 1982



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

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FERMILAB-82/9 **Fermi National Accelerator Laboratory** 0090.01

THE COVER: The massive central hadron calorimeter of the Collider Detector taking shape. The people toasting the assembly of the first half in Bldg. 366 at Argonne National Laboratory are (left to right) Art Garfinkel and Charles Schanke of Purdue University and Hans Kautzky of Fermilab. Jim Craig, Mike Sherwood, and Ralph Harshman, all of Purdue, with Jim Catalenello of Fermilab are inside the arch of the calorimeter.

(Photograph by Fermilab Photo Unit)

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PHYSICS ADVISORY COMMITTEE RECOMMENDATIONS

The Fermilab Physics Advisory Committee met on November 11-13, 1982. Following are the Committee's general recommendations to the Laboratory Director.

Priorities

The Committee reaffirms the high priority of three of the new beams, namely the Prompt Neutrino Beam, the Muon Beam, and the Broad Band Photon Beam. The construction of the M8 beam and the Polarized Proton Beam is ranked lower in priority. The M8 beam is given higher priority than the Polarized Proton Beam.

Saver Run

The Committee endorses the Fall '83 running schedule presented by the Laboratory. It recommends that the Laboratory adhere to the proposed 400-GeV run, as the means of completing the remaining 400-GeV experiments which cannot be run at higher energies without substantial Laboratory effort. It recommends that the run be limited to three months. After that period the Energy Saver should be operated at the maximum energy consistent with reliable performance and the physics program. In order to prepare for operation at energies greater than 400 GeV, the Committee recommends that the Laboratory dedicate significant time to explore operation at higher energy during the first three months of operation.

DO

The Committee reaffirms its previous recommendation that the Laboratory call for new proposals for $\bar{p}p$ experiments in the DO and EO straight sections.

Review of the Collider Detector at Fermilab

The Director convened an excellent group of highly qualified people to review the progress and status of the Collider Detector at Fermilab. The PAC recommends that in the future the same group monitor the status of the project at appropriate intervals. The participation of several PAC members in the CDF review will substantially aid the PAC in keeping informed about this project.

The PAC requests that the Director transmit the CDF committee reports to the PAC prior to meetings at which Colliding Beam experiments are to be considered. The PAC plans to use the milestones specified in the preliminary CDF review to monitor the construction and commissioning of the CDF.

The committee is pleased by the fact that better contact has been established with the CERN SPS collider groups via a senior member of the CDF collaboration participating in the UA1 experiment.

Recommendation on Future Plans

The Committee unanimously views the creation of a collider facility with $\sqrt{s}$ of 20 TeV or higher as the prime candidate for the accelerator which would lead U. S. high-energy physics in the 1990's and beyond. Accordingly, we urge the Laboratory to continue research and development on inexpensive magnets as a high priority project.

In view of the present uncertainties concerning the possibility of building such a machine and the time schedule for construction, the Committee feels that the U. S. may require an "intermediate" accelerator for the 1990's, as envisioned by the Trilling Panel. A strong candidate for this machine would utilize a dedicated proton storage ring based on Saver magnets of the highest possible energy within the limits of the site boundary and the fiscal constraints specified by the Trilling Panel. The Committee is impressed with the following advantages of such a facility at Fermilab.

1. As a $p\bar{p}$ collider it provides significantly higher integrated luminosity for the study of hadron-hadron collisions at multi-TeV center-of-mass energies.

2. It permits a cost-effective high-energy electron-proton collider.

3. It enhances the fixed-target program at Fermilab.

4. It allows the option of a second ring for multi-TeV pp collisions at high luminosity.

Thus, the Committee recommends that the Laboratory prepare a suitable proposal for consideration by the Woods Hole Panel. The Committee further recommends that the Laboratory take suitable steps to inform the high-energy physics community of its plans and to involve them in the preparation of this proposal to the maximum extent possible.

LEDERMAN'S SHOULDER, WEINBERG'S NOSE, AND OTHER LESSONS FROM THE PAST*

H. David Politzer
California Institute of Technology

Planning for discovery is both absolutely necessary and fundamentally silly. We can't know what will be. However, we can look back. The unexpected has come sometimes at the highest energy frontier, such as scaling at SLAC, and sometimes in a careful look over old ground, such as CP violation or the heavy vector meson of Christenson et al. Whatever the current theoretical beliefs, our future plans should not stifle the possibility of discovery. This is where, I think, DO has a role to play.

Three issues came to mind regarding DO experiments: 1) far more money and luminosity are available at BO; 2) the CERN collider is already running; and 3) most theorists regard 2 TeV as a factor of 10^{13} too low to do anything really interesting. But before being discouraged one should consider: 1) The BO detector is a mammoth, all-purpose compromise, designed to see what is expected. It will either extend the Monte Carlo calculations one more decade (especially after they have been tuned to the CERN data) or discover the obvious. 2) Regarding the specialized detectors that should go into DO, data coming from CERN can only help in optimizing designs and suggesting new directions. The Crystal Ball is an outstanding example of the power of a highly specialized detector, and it only benefited from information provided by nominally competitive experiments. And 3) we have never in the past proven to be nearly as smart as we thought, so why should now be different?

These are certainly exciting times in theoretical physics. Buoyed by the successes of the "standard" model, we have tried to apply the same ideas to an ever wider range of phenomena. But as we attempt to answer certain questions, yet others come embarrassingly into sharper focus.

Gravity and early cosmology have become active areas of particle physics research. Yet the quantum mechanics of gravity itself remains a mystery. The explosive new scenarios for the Big Bang address several old puzzles regarding what was thought to be an excessive homogeneity of the observed universe. However, they rest heavily on the effects of what Einstein called the cosmological constant. All theoretical estimates of this constant are larger than the observed upper limit by a factor of 10^{120}. The only plausible resolution of this dilemma that I have heard so

*Synopsis of a talk presented at the DO Workshop, Fermilab, November 19, 1982

far relies mostly on the fact that we really don't know what we're talking about.

Supersymmetries have stirred much excitement because they are the only purely group-theoretic way to relate particles of different spin. Undaunted by the fact that none of the particles we know are so related, theorists posit a supergap: the splitting in mass between particles we know and their superpartners. Popular supergaps are on the scale of GeV, TeV, or 10^{19} GeV. Not coincidentally, these are the natural scales of strong, weak, and gravitational interactions, respectively. The paucity of alternative suggestions reflects our ignorance of intermediate scales rather than their impossibility.

The suggestion of unification of strong, weak, and electromagnetic forces not only stimulated the current round of proton decay and neutrino mass experiments; it also implied one spectacularly successful prediction: it gave the Weinberg angle right on the nose. I regard this as a stunning triumph.

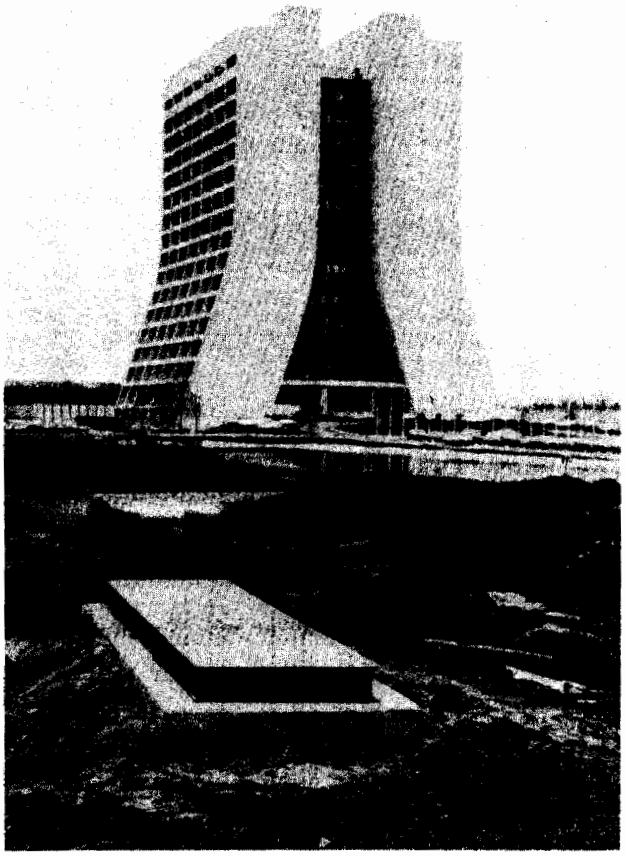
We have known for decades that something interesting must happen around a TeV because of the unitarity bound on weak interactions. While much has been learned in the past decade about the structure of the weak currents, we are still ignorant of the details of how their forces are transmitted over the relevant range of 10^{-16} cm. Alternatives to the Weinberg-Salam model are based on the observation that all other short-range forces we know are short ranged precisely because of the composite nature of the participants. So physics at 2 TeV may well reveal composite quarks and composite would-be W bosons. An indication that there is something to the weak interactions that we just don't understand is the existence of the approximate symmetry that makes $m_W/m_Z \cos\theta_W$ nearly 1. Exact symmetries are simply symmetries, but approximate symmetries have always been a clue to something interesting happening on a deeper level.

In the realm of pure hadron physics, if we had a basic understanding of at least some aspect of QCD, then experiments of confusing complexity would be pointless. But, in all honesty, our confidence in QCD is not based on any successful application of the theory to understand how something works. Rather, all we know directly from theory alone is that the QCD interaction strength vanishes at short distances. QCD is unique in this aspect and is, therefore, the only plausible explanation for some of the successes of the parton model. Virtually all other applications of QCD rest heavily on phenomenological inputs that we gleaned from experiment, with theorists having only the faintest glimmer of how these observed properties might follow from the basic equations. The reason it has proved so hard to "test" QCD is that our predictions are so shoddy. But even if one were convinced of the correctness of QCD, more experiments are needed to help us figure out how it works--to search for new phenomena and to understand how other gauge theories might work.

The list of what we don't understand is endless. We still debate the correctness of the Drell-Yan picture of hard hadron collisions and likewise the nature of high-energy elastic scattering. We do not understand how individual hadrons (save perhaps heavionia) are composed of quarks. Is there, for instance, any validity to a naive, non-relativistic constituent picture? Why do total cross sections rise as they do? How are individual hadrons produced and in what relative proportions?

Hadron jets at 2 TeV will be spectacular. In analyzing them, the uncertainties implicit in our "hadronization" models will definitely be somewhat less important than they are in current e^+e^- physics. But other uncertainties in the theory will come to the fore instead. Even for arbitrarily high energies, we do not know the structure of jets inside cones of some fixed (small) angle.

These are all subjects of active theoretical study, but any new information from the experimental side would be more than welcome. I firmly believe that anything that can be measured well is worth doing.



Completed construction for 1 TeV in the Switchyard area.
(Photograph by Fermilab Photo Unit)

MANUSCRIPTS, NOTES, LECTURES, AND COLLOQUIA PREPARED
OR PRESENTED FROM NOVEMBER 1, 1982 TO DECEMBER 19, 1982

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. A. Lefler Experiment #253	The Total Cross Section for $\nu_\mu e$ Elastic Scattering (Ph.D. Thesis, University of Maryland)
W. F. Baker et al. Experiment #290	Pion-Proton Backward Elastic Scattering Between 30 and 90 GeV/c (FERMILAB-Pub-82/78-EXP; submitted to Phys. Rev. D)
K. Goulianos Experiment #396	Diffractive Jets (Presented at the Europhysics Study Conference on Jet Structure from Quark and Lepton Interactions, Erice, Sicily, September 12-17, 1982)
M. Binkley et al. Experiment #401	ψ' Photoproduction at a Mean Energy of 150 GeV (FERMILAB-Pub-82/83-EXP; submitted to Phys. Rev. Lett.)
P. S. Cooper et al. Experiment #407	Σ^+ and Σ^- Production Polarizations (FERMILAB-Conf-82/84-EXP; submitted to the 5th International Symposium on High Energy Spin Physics, Brookhaven National Laboratory, September 16-22, 1982)
J. P. Marriner et al. Experiment #497	Magnetic Moments of the Σ^+ and Σ^- (FERMILAB-Conf-82/85-EXP; submitted to the 5th International Symposium on High Energy Spin Physics, Brookhaven National Laboratory, September 16-22, 1982)
B. Cox et al. Experiment #537	A Measurement of the Response of an SCG1-C Scintillation Glass Shower Detector to 2-17.5 GeV Positrons (FERMILAB-Conf-82/75-EXP; submitted to the National Science Symposium, Washington, D. C., October 20-22, 1982)

B. Cox et al. Experiment #537	High Energy Electromagnetic Shower Position Measurement by a Fine Grained Scintillation Hodoscope (FERMILAB-Conf-82/76-EXP; submitted to the National Science Symposium, Washington, D. C., October 20-22, 1982)
T. Y. Chen et al. Experiment #580	Resonance Production in Diffractive $\pi^- N \to K_S^0 K_S^0 \pi^- N'$ at 200 GeV/c (FERMILAB-Pub-82/94-EXP; submitted to Phys. Rev. Lett.)

Theoretical Physics

J. D. Bjorken and S. K. Mtingwa	Intrabeam Scattering (FERMILAB-Pub-82/47-THY; submitted to Particle Accelerators)
J. Oliensis and M. Fischler	Two Loop Calculations of M_b/M_τ and Heavy Fermion Masses in the SU(5) Model (FERMILAB-Pub-82/63-THY; submitted to Phys. Lett.)
H. B. Thacker	Integrability, Duality, Monodromy, and the Structure of Bethe's Ansatz (FERMILAB-Conf-82/67-THY; lectures given at l'Ecole d'Ete de Physique Theorique, Les Houches, France, "Recent Advances in Field Theory and Statistical Mechanics," August 2-September 10, 1982)
C. T. Hill	Monopolonium (FERMILAB-Pub-82/70-THY; submitted to Nucl. Phys. B)
S. Dawson and A. N. Schellekens	Monopole Catalysis of Proton Decay in SO(10) Grand Unified Models (FERMILAB-Pub-82/81-THY; submitted to Phys. Rev. D)

General

P. K. Malhotra and R. Orava	Measurement of Strange Quark Suppression in Hadronic Vacuum (FERMILAB-Pub-82/79; submitted to Zeit. Phys.)
P. K. Malhotra and R. Orava	A Determination of Intrinsic Transverse Momentum of Quarks (FERMILAB-Pub-82/80; submitted to Zeit. Phys.)

R. Orava	Jets, Models Versus Experimental Data I (FERMILAB-Conf-82/86; invited review talk in the Europhysics Study Conference on Jet Structure from Quark and Lepton Interactions, Erice, Sicily, September 12-17, 1982)
P. K. Malhotra	Transverse Momentum Spectra of Dimuons Produced in Hadronic Interactions and Comparison with QCD (FERMILAB-Conf-82/87; invited review talk given at the Workshop on Drell-Yan Processes, Fermilab, October 7-8, 1982)
R. P. Johnson and J. Marriner	Stochastic Stacking Without Filters (FERMILAB-Pub-82/92; to appear in the Proceedings of the Beam Cooling Workshop, Madison, Wisconsin, September, 1982)
D. N. Schramm	Nuclear Constraints on the Age of the Universe (FERMILAB-Conf-82/93; invited talk for the Joint Discussion on the Extragalactic Distance Scale at the IUE Meeting, Patras, Greece)

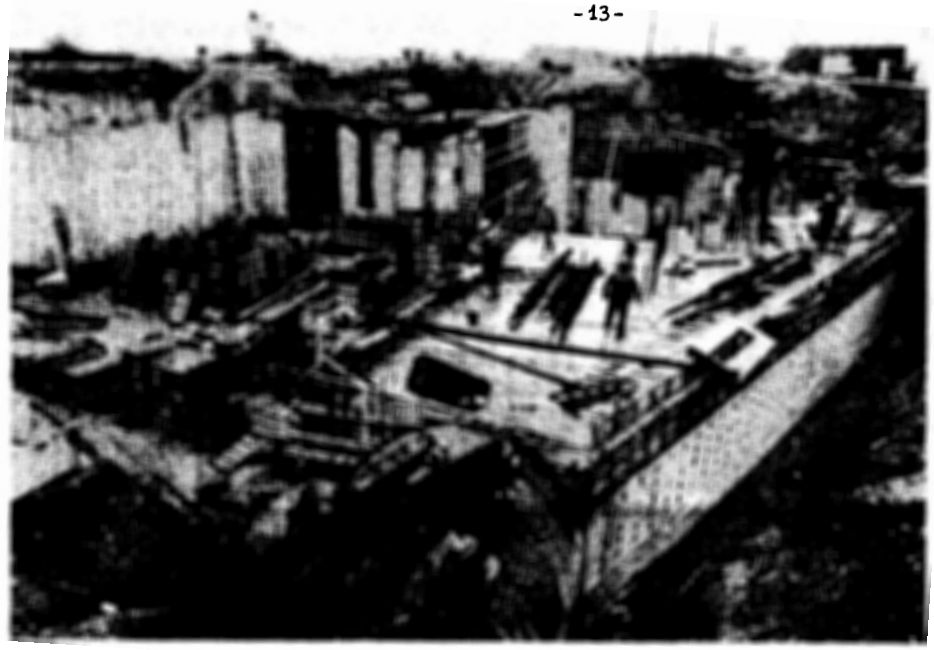
Physics Notes

L. Cohen and M. Awschalom	Fast Neutron Radiation Therapy (FN-342)
M. Atac et al.	Self-Quenching Streamers (FN-348)

Colloquia, Lectures, and Seminars

R. Orr	Accelerator Division Informations Meeting (Fermilab, November 2, December 7, 1982)
P. Rapidis	"Results from E-616: Neutrino Cross Sections and Nucleon Structure Functions" (Fermilab, November 12, 1982)
R. Huson	"20 TeV Machine" (Fermilab, November 30, 1982)
C. Hill	"Monopolonium" (Fermilab, December 2, 1982)

M. Kuchnir, A. McInturff, and F. Turkot — "Report on Applied Superconductivity Conference, Knoxville" (Fermilab, December 14, 1982)



Construction status of the Collider Detector [illegible]
November 23, 1982.

(Photograph by Fermilab Photo Unit)

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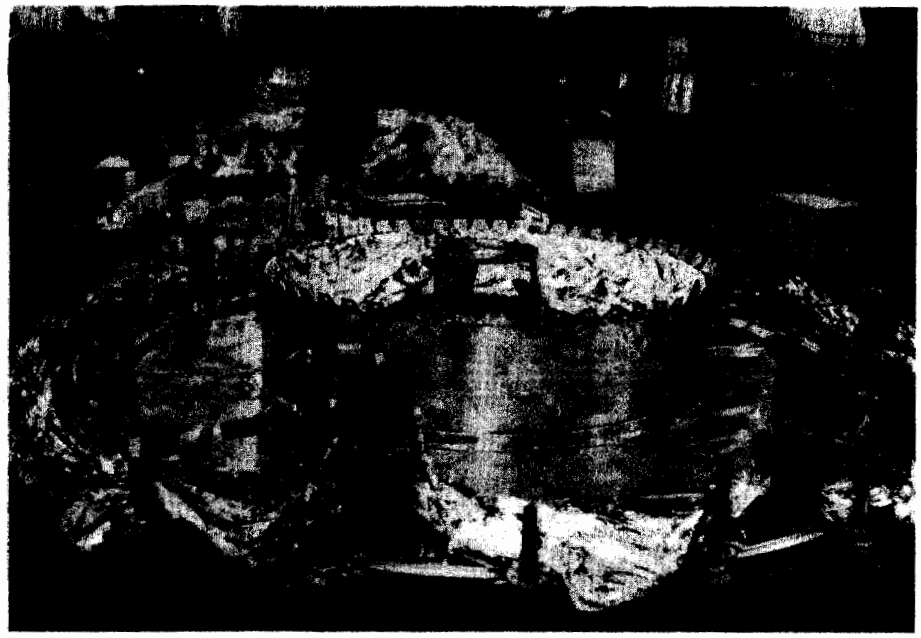
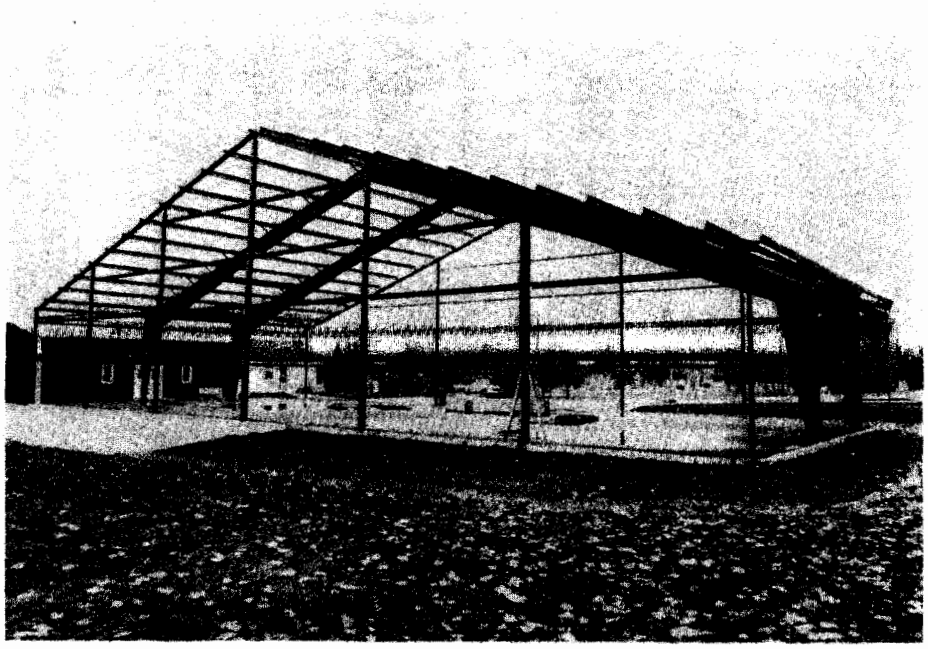


Progress on the superconducting 30-inch bubble chamber magnet.
(Photograph by Fermilab Photo Unit)

DATES TO REMEMBER

February 1, 1983	Deadline for new DO proposals and other submissions for consideration of the Physics Advisory Committee
April 7-8, 1983	PAC Proposal Presentation Meeting
June 18-24, 1983	PAC Extended Summer Meeting



The new gym being built in the Village for visiting users.
(Photograph by Fermilab Photo Unit)