April 1988 SSC Monthly Report

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PROJECT SUMMARY

CENTRAL DESIGN GROUP (CDG)

Magnet Program

No MSI meeting was held during April.

A Magnet-to-Tunnel Interface Meeting was held at the CDG on April 21–22.

The Magnet R&D plan for FY89, particularly the number of long magnets to be constructed, is being revised to match funding predictions.

Finite element structural analysis continued with good results, both for the NC9 and the C358A coil cross sections.

Planning continued for cold testing of long magnets at FNAL in FY89 and beyond. A meeting was held at FNAL where necessary equipment modifications were reviewed.

The Magnet Industrialization Program Phase I Evaluation Board held its first meeting in Chicago on April 5. The Board reviewed and accepted the principal criteria for evaluating submittals from industry in response to a solicitation that will be published when approved by the DOE.

Good progress was made on the development of a centralized superconducting wire and cable database.

Low-temperature testing of DD0010 commenced on April 5 and continued until April 13, interrupted by a voltage tap short in the power leads. A large volume of strain gauge measurements and other data were obtained. Thirteen spontaneous quenches were recorded. While these tests took place on test stand 4, preparations for testing DD0012 went forward on stand 5; the magnet was cold and ready for testing on April 30.

Accelerator Physics

The Accelerator Physics Division's efforts for April included an examination of the land specifications for the SSC and the relative positioning of the magnet lattice within the specified areas, a tracking study of the effects of folding the lattice, operational simulations of the SSC with systematic dipole errors, and a consideration of multipole corrector strengths.

Accelerator Systems

Work started on developing a lattice database using Sybase. So far, the effort has been to understand what the machine people want from the lattice database. Work continued on trying to understand the data management needs of Fermilab's MTF. Some FORTRAN-accessible code has been written to facilitate the transfer of data between the VAX and the SUN.

Some minor modifications were suggested to Air Products on the flow sheet for the SSC dynamic simulation. Two were accepted by Air Products; the third is being negotiated. Coding of the interactive version of the program was completed and is being debugged.

Work continued on an analysis of heat transport due to helium convection in the magnet. The conductivity results of General Dynamics were reproduced using their values for the Kapton thermal conductivity. Preliminary analysis indicates that the model that they used for convection heat flow was not correct. It appears that this problem is more difficult than first thought, because of the flow regime; an experiment may be the best way to obtain an answer.

Work has started on a mechanical design of a diode holder for quench protection diodes. For this work we are using the analysis program "MacElastic," running on a Macintosh. It appears that the clamping force has to be applied close to the symmetry axis of the diode to get uniform clamping.

A paper from the experiment at SRC on photodesorption has been submitted to *Journal of Vacuum Science and Technology A*. The redesign of the sample holder for future runs of that experiment is proceeding at LBL.

Conventional Systems

A workshop was held on the noise levels to be expected around the remote service areas of the collider ring. Primary emphasis was on the helium compressors, but additional sources, like the cooling towers, were identified.

A meeting was held to discuss the magnet cryostat installation procedures, survey and alignment, and tunnel transport. Assignments for further study were made.

Studies of the load profile that will be seen by the electric utility supplying power to the SSC were carried out under contract by RTK.

The presence of C. Laughton, a visitor from the LEP project, provided an opportunity to revisit tunnel profiles, shafts, and other aspects of the underground construction. A number of alternatives were developed that promise increased utility and reduced construction schedules and

costs. These were discussed with representatives of the Robbins Co., principal U.S. tunnel-boring machine designers and manufacturers, in a visit to their plant in Kent, Washington. A report was made to the CDG in a Friday morning design seminar.

Version 1 of the final draft of the Safety Review Document was reviewed by CDG.

Project Planning and Management

Budget requirements for FY90 were determined and incorporated into the Field Task Proposal/Agreement to be submitted to the DOE.

Modification of project management software continued, as did work on the CDG personnel data base. The usual software support was provided to the CDG.

BROOKHAVEN NATIONAL LABORATORY (BNL)

Long magnet DD0015 has been disassembled in preparation for recollaring. Spot-welded collars were modified to compensate for the original twist, caused by an unbalanced moment in the first set of spot-welded collars. Modified collars have been received from the vendor, and new collar packs await magnet reassembly.

Long magnet DD0011 was shipped to Fermilab on April 11, following warm measurements and checkout. The next cold mass in this series, DD0013, was successfully assembled and leak checked.

Short magnet DSS11 was collared, using the new compensated packs. Inner and outer coils for DSS12 were assembled.

Modifications of long-coil curing press number 1 were completed. Engineering continues on the new 1.8-m curing press.

Discussions with the CDG concerning the feasibility of testing single long SSC magnets at BNL, using the MAGCOOL facility, have prompted a review of the plans for future utilization of MAGCOOL (including its role in the Accelerated Life Test).

FERMI NATIONAL ACCELERATOR LABORATORY (FNAL)

Testing of magnet DD0010 was terminated after ten quenches, as the result of a shorted instrumentation wire. The magnet was warmed up and opened, and the problem was corrected. In spite of this fault, the cooldown and testing of DD0010 demonstrated the viability of using

large numbers of sensors, particularly voltage taps, to diagnose the behavior of full-length SSC dipoles. The magnet will be retested to determine the effects of a thermal cycle.

Following the warmup of DD0010, attention turned to magnet DD0012, mounted on stand 5. Magnet DD0012 was cooled in 60 percent of the time of previous magnets—the result of refined procedures. The usual strain-gauge runs were made in cycles up to 5500 A. The spontaneous quenches were all at the conductor short sample limit of approximately 6500 A.

Both magnets DD0014 and DD0011 use the new-style cryostat. Introduction of the cryostat feature has slowed the assembly process. Magnet DD0014 requires alignment, connection of cryostat diagnostic instrumentation, and electrical checkout. Assembly of DD0011 is now under way.

LAWRENCE BERKELEY LABORATORY (LBL)

Two cabling runs were completed during April at New England Electric Wire (NEEW) to test a modification to the NEEW cablers prior to the SSC production cable runs. Earlier trials at NEEW indicated a variability in cable degradation that was not present in the same material when cabled at LBL. This degradation had been traced to a mandrel attachment that permitted the mandrel to rotate and pinch the strands as they entered the Turkshead rolls. Both the 23-strand cabler and the 30-strand cabler were modified during March to hold the mandrel rigid, as at LBL. The run on the 23-strand cabler involved personnel from LBL, Oxford Superconducting Technology, and NEEW. Measurements at BNL on a sample showed a critical current degradation due to cabling of only 3 percent, comparable to that obtained at LBL and a substantial improvement over the 10-15 percent experienced previously at NEEW.

A similar run was made on the 30-strand cabler with personnel from LBL, Supercon, and NEEW participating. The run went smoothly, and samples examined by etching away the copper matrix looked acceptable. Samples have been sent to BNL for critical current measurements, but the results are not yet available. Apparently, the only remaining problem in cable made at NEEW is the residual twist. At LBL, our variable planetary system removes the residual twist; the present machines at NEEW do not have this capability, although the new machine being made by Dour Metal does. If acceptable, the industrial wire vendors will be directed to proceed to make production cable at NEEW on present machines until the new machine is operational.

A key test was completed on April 27 at Dour Metal, in the presence of R. Scanlan. The main rotor was accelerated to its full operating speed in both directions; the components functioned

properly. Final assembly is proceeding; acceptance tests will be performed in mid-June. Details of this trip are documented in SSC-MAG-200.

D-15A-5 is scheduled for retest, after recollaring, in May. D15A-6, the first magnet with manganese-copper matrix to suppress filament-to-filament coupling, is being wound.

Collaring of 17-m model DD0013 was completed at BNL on April 7; final prestresses as assembled are 8000 psi (inner) and 7100 psi (outer). The details of collaring forces, pressures, and dimensions are given in SSC-MAG-192. The magnet was inserted into the yoke on April 19-20.

Test windings are being made, assembled, and sectioned to evaluate the detailed shape of the end parts for the "constant perimeter" straight end design; parts for model D15B-1, the first magnet assembly using this end design, were ordered. Tooling for flared-end coils was ordered.

Exploratory tests were started to evaluate techniques for constructing dipole magnets with a built-in bore liner.

CDG REPORT

MAGNET PROGRAM

Meetings

No Magnet Systems Integration meeting was held during April, as activities were centered on the long magnet test and analysis programs.

A Magnet-to-Tunnel Interface meeting was held at the CDG on April 21–22. The first topic was the 70-cm vertical separation of the beam centerlines. The assumption—later supported by Accelerator Physics studies—that this distance could be increased led to a discussion of the advantages that could be gained in the cryostat design by progressively increasing this spacing. The main advantages of such an increased spacing would be simplification of the vacuum vessel interconnect and tooling and the possibility of supporting the magnets independently rather than "piggyback" style, as currently planned.

A proposal for a modified tunnel cross section that would greatly improve access to the magnets and have only a minor cost impact was reviewed. It will be considered in further engineering studies to be carried out at FNAL.

Survey, alignment, and installation procedures were also discussed. Following a proposal from R. Neimann at FNAL, the draft of an "Installation Traveler" will be generated. This draft outline will eventually develop into a detailed installation procedure specification.

The next meeting in this series is scheduled for June 2 at the CDG.

R&D Plan

The magnet research and development plan, formulated on the assumption that sufficient funds would be available for an appropriate R&D and construction program in FY89, is now being revised to match predictions of the funds that may be available. The number of long magnets to be built has been reduced from 28 to 16, and the rest of the program is being adjusted commensurately.

Analysis

Work continues on finite-element models of the collared coil. For the NC9 cross section it was discovered that coil stresses are affected by the detailed distribution of force around the key. Previously, it had been noticed that coil stress distribution depended upon seemingly unimportant details of load application. It is now found that proper modeling of the tapered key produces coil stress distributions that are almost independent of load application details. Further, it had been previously reported that the calculated collar deflection did not agree with experimental

observation. Closer scrutiny of the results, however, reveals that theory and experiment are, in fact, in close agreement.

Debugging continues on the C358A model, which has now been successfully run through cooldown and magnet energization. One form of this model contains the distorted beam tube present in magnet DD0010. Calculations predict shifts in coil stress, due to the distorted tube, of the order of 200 psi; this should have negligible effect on magnet performance.

Magnetic Measurements

Planning for cold magnetic measurements to be performed on long magnets, beginning in FY89, is proceeding. A meeting was held at FNAL to discuss necessary equipment modification. The most cost-effective solution is to refit both ends of the test stands with an annular beam-tube feed through. This solution will permit a mole to be operated from either end of the magnet. It will still be necessary to produce a new warm finger for the measurements and to have mole C available. This design has a smaller diameter than previously, thus providing better thermal insulation between the warm finger and the beam tube. In further preparation for magnetic measurements, comparisons of previous warm/cold results continue. Also, a report was prepared on an alternate tilt-meter concept utilizing Hall probes; such a device has been implemented at DESY.

Industrialization

The Magnet Industrialization Program Phase I Evaluation Board held its first meeting in Chicago on April 5. Phase I of the program, known as Technology Orientation, involves the transfer to industry of the magnet fabrication technology that has been developed by the participating laboratories. It is intended that this process will enable industry to make well-founded bids for the later procurement phases of the program.

It will be the responsibility of the Evaluation Board to evaluate the submittals that are received in response to a solicitation that will be published when approved by the DOE.

The Evaluation Board will also be responsible for reviewing the applications for participation in Phase I and for making recommendations for acceptance to the head of the CDG Magnet Division, who will serve as the selecting official. At their first meeting the Board reviewed and accepted the principal evaluation criteria and assigned equal weight to all criteria. These criteria will be published as a part of the initial announcement. For their internal use, the Board also developed procedures for evaluating the proposals. To aid evaluation, each vendor will be required to complete a detailed application form as part of a submittal.

Superconducting Wire and Cable Database

Work continues on the development of a centralized database in which all wire and cable data will be stored. A compact summary sheet of the information in the database is now available. The database format for test data from measurements carried out at BNL has now been established. A convenient method of inputing the data is being developed in collaboration with the BNL group.

Tests of Magnet DD0010

The cooldown of Magnet 10 started on March 21 and required 2.5 days. The following week the 250 channels of the data acquisition system were checked, and the hardware problems were corrected. A Hipot of the 132 voltage tap cables was performed.

The test itself started on April 5 with strain gauge runs. In a strain gauge run, the current is ramped to a given value and then ramped down to zero. Strain gauge measurements were taken every 500 or 1000 A up to 3500, 4000, 4500, and 5000 A. The first quench occurred on April 8, at 5368 A, during a strain gauge run.

Between April 8 and April 13, 15 spontaneous quenches were recorded. For these tests, the current was ramped straight to 5000 A (16 A/s), and then up to quench (6 A/s). The magnet appeared to train very slowly. The highest current reached was 6102 A (quench 15), roughly 90 percent of the short sample value. All the quenches occurred in turn 13 of the inner coils (counting from the midplane), the first turn of the second block adjacent to the wedge. Ten of the quenches were in the upper coil (9 in the left side, 1 in the right side), and four were in the lower coil (2 in the left side and 2 in the right side, "left" and "right" sides defined by facing the magnet at the feed end). Longitudinally, the quenches are scattered throughout the straight section of the magnet.

On April 13, a short was found on one of the voltage taps connected to the power leads and the test was suspended. Warm-up started on April 15, and the magnet was opened on April 21. A visual inspection showed that the insulation of two voltage tap wires was damaged in such a way as to result in a short when the magnet was cold.

Preparation of Magnet DD0012

During the cold test of DD0010 on test stand 4, DD0012 was being prepared for testing on test stand 5. The internal wiring checkout was completed successfully on April 8. After the last-minute addition of some instrumentation at the feed end, the single phase bellows was welded on April 15. The external wiring checkout required two weeks, and cooldown started on April 29. This time, a fast cooldown mode was tested for the first time. No problems were encountered. It required only 1.5 days to reach 4.4 K; the magnet was cold and ready for testing on April 30.

General

CDG Magnet Division personnel continued their direct support of the magnet test program at FNAL, preparing magnet DD0012 for testing and continuing to support the FNAL cold tests of DD0010 (as reported above). Preliminary analysis of the strain gauge and voltage tap data from DD0010 was performed, and the results were distributed.

On April 12 a meeting was held to coordinate the activities of the Magnet Captains. Each magnet to be tested has a Captain, assigned to ensure that all details of the test program for that particular magnet are properly planned and executed.

Preliminary designs for lumped correctors, as a potential substitute for the distributed boretube correctors, were investigated.

ACCELERATOR PHYSICS

Improved Fitting of the Site Parameters Footprint by a 90° Lattice

In order to specify the SSC land requirements for the *Invitation for Site Proposals for the SSC*, a land-usage "footprint" was developed in early 1987, based upon an early version of the 90° cell lattice. This footprint detailed the land requirements for the arcs and cluster areas, and it also specified the location of several small parcels of land to be used for entrance and exit shafts and above-ground support buildings. The footprint, as developed, closely followed the early lattice.

Relative coordinates of the site footprint have been digitized in a grid system to facilitate the positioning of a lattice within the footprint. The desired positions of entrance and exit shafts relative to an advanced design 90° lattice were calculated and compared with the coordinates of the designated land areas. The two sets of coordinates agreed, to within the known specifications.

The mechanism has now been installed for future evaluation of proposed changes in either the location of certain land areas or in the desired positions of shafts.

Folded-Lattice Study

A tracking study has been made to determine the effects of placing a single, simple fold in the present 90° lattice. Such a fold has been described in the CDR. The fold was chosen to be symmetrically placed around the lattice's semi-major axis and to have an upward fold angle of 0.16°. This yields an elevation change of some 30 meters. As the actual lattice design is slightly non-symmetric about its semi-major axis, the effects of the fold produce a small amount of horizontal-vertical coupling in the major planes of the fold. Relative to the non-folded lattice, the projections of the beta and dispersion functions onto the local horizontal and vertical planes have

$\Delta\beta/\beta = 14.3\%$ and $\eta_y = 65$ mm inside the small hinges of the fold, and $\Delta\beta/\beta = 1\%$ and $\eta_y = 6$ mm outside of the fold.

Random multipole errors a_2, b_2 through a_8, b_8 were then turned on in the dipoles, and particle tracking was done to determine the linear and dynamic apertures of the machine with and without the fold. The results of five different random seeds are shown below.

	Linear Aperture (mm)	Dynamic Aperture (mm)
No Fold	8.17 ± 1.98	11.44 ± 1.46
Fold	8.26 ± 1.92	11.24 ± 0.94

Further tracking studies of the lattice including the random multipoles a_0, b_0, a_1, and b_1 are under way.

Operational Simulation

Work continued in April on the operational simulation of the SSC, focussing on the effects of systematic multipole errors in the dipoles. The random error in tune measurement was increased to 0.001 from the previously used value of 0.0005, which necessitated many iterations of the correction procedure. The procedure converged satisfactorily. Closed orbit errors were introduced, in order to produce horizontal and vertical rms orbit deviations of 1 mm, and gave little or no degradation in the performance of the correction procedure. Systematic b_6 errors, which had been neglected in earlier studies, were added. When the correction algorithm was applied, the b_3 correctors were required to correct both the systematic b_3 errors and the tune shifts caused by b_6. This correction procedure yielded satisfactory results.

Much effort was put into converting the operational simulation program from the Suntools window system to the X window system. This conversion requires translating all the graphics routines. Once the conversion is complete, the program will be far more portable, as X is available for the VAX, Apollo, IBM-PC, Macintosh, and HP workstations, whereas Suntools runs only on Sun workstations. Also, the new program will be more flexible, allowing the user to create, open, and close windows comparing various sets of data.

Suggested Multipole Corrector Strengths

Two approaches are being considered to compensate for the systematic and random multipole errors of the dipole magnets. One approach is the bore tube correction scheme that has one set of multipole correctors per dipole, as discussed in the CDR. The other approach is a lumped scheme, with 2 or 3 sets of correctors per half cell. In either case, a set consists of a sextupole,

an octupole, and a decapole corrector. Recently, a hybrid scheme, in which a corrector set is attached to one end of each dipole, was proposed. This gives a lumped scheme with 6 sets per half cell.

The corrector strengths needed to compensate for the envisioned multipole errors are the same for the bore tube or the magnet-end schemes. These strength specifications were reviewed. (Specification for the lumped schemes will be done next.) A suggestion was made that the sextupole corrector strength contains the provision of correcting the multipole b_2 errors by binning at 20 TeV. The suggested corrector strengths per corrector set are $b_2 = 0.089$, $b_3 = 0.0022$, and $b_4 = 0.0044$ tesla-meters at 1 cm radius.

CONVENTIONAL SYSTEMS

Compressor Noise Workshop

On April 14 an all-day workshop was held at the CDG to study the possible noise sources in the collider service areas and means of mitigating the problems. Participants were from the CDG Accelerator Systems and Conventional Systems Division, BNL, LBL, LLNL, Air Products Co., and the Architect/Engineer Joint Venture, RTK. Based on experience with the RHIC refrigerator at BNL, MFTF at Livermore, HERA, LBL, and industrial facilities, sound levels up to 100 dbs can be expected in the immediate vicinity of the service area compressors, but these can be reduced to ambient levels using normal industrial practices. Problems still remain for maintenance personnel working within the sound absorbing structures. Additional noise sources identified were the cooling towers required for the area heat exchangers, and escaping nitrogen gas, especially in connection with truck deliveries to liquid storage dewars.

Tunnel/Cryostat Interface Meeting

On April 21 a meeting was held at the CDG to discuss magnet cryostat installation, survey, and alignment in the tunnel. Participants were from Fermilab and the CDG Magnet, Accelerator Systems, and Conventional Systems divisions. The Conventional Systems Division presented the result of some design studies to allow the possibility of personnel access between the magnets and the outer wall of the tunnel for purposes of installation and inspection. The need for clearance between the cryostats and between the lower cryostat and the tunnel floor was also explored. The space required to clear an automatic welding head makes it possible to install a stand for the upper magnet, making it independent of the lower one. Several stand design possibilities were discussed. Various tasks were assigned at the end of the meeting, which will be performed and then reported at a subsequent meeting.

Tunnel and Shaft Design Studies

Taking advantage of the presence of C. Laughton, a geotechnical engineer visiting from the LEP project for two months, studies were initiated on possible modifications to the design of the tunnel cross section and of the various shafts around the collider tunnel. A tunnel cross section was developed based on over-excavating the 10-foot diameter of the tunnel down to the base, rather than filling in some of the tunnel with concrete to provide a floor. The additional volume of rock excavated is less than the amount of concrete that would be needed to fill in the base. At the same time, space is provided for access behind the magnet strings, as noted above, and the volume of air for ventilation is increased. Alternative designs were also developed for the electronics niches, which are in the tunnel ceiling in the CDR. They and the power alcoves would be moved to the outside wall of the tunnel behind the magnet strings. This design seems to offer savings in construction time and costs and, at the same time, to improve the safety of the tunnel transport system.

C. Laughton undertook a study of the construction and design of shafts for the collider ring tunnel and the experimental areas. Very interesting concept designs were developed, based on optimizing the use of mechanical methods of mining. These give promise of improved cost and schedules for construction and result in shaft configurations more suited to the final installation of equipment. A key factor in these design studies has been the CAD work of T. Chang and D. Shuman, on assignment from the LBL Mechanical Engineering Department.

On April 26, C. Laughton and T. Toohig visited the Robbins Co., in Kent, Washington, the principal U.S. manufacturer of tunnel-boring machines and related excavation equipment, to discuss the feasibility of possible design modifications. Along with discussions of the possible approaches to the additional excavation for the modified tunnel profile, the current performance of tunnel-boring machines was discussed. Since the CDR, the advance rates for the tunnel-boring machines appear to have increased substantially, making the integral design of the tunnel-boring machines and spoils handling systems imperative. On April 29, a design seminar was given at CDG on the results of the visit.

RTK Work

Several meetings were held with L. Norman and R. Pellat of RTK concerning RTK's assignment to develop the load profile that would be seen by electric utility suppliers from operation of the SSC complex. Phase I of this task is to develop the load profile during a 24-hour period of normal physics operations. Substantial progress was made, and it is expected that the completed report will be delivered to the CDG about May 15.

The CAD capabilities of the Conventional Systems Division continue to be developed. A 56 K baud line was put into service to connect the CDG Interpro 32C Intergraph workstation to the mainframe system at Kaiser Engineering in Oakland. This gives the Conventional Systems Division access to the large library of applications programs for conventional systems design that

are on the Kaiser system. The system is already proving helpful in studies of the relationships between various collider lattices and the land footprint used in DOE's Invitation for Site Proposals.

Magnet Quality Assurance Facility

Design work continued in conjunction with the Magnet Systems Division to develop the requirements for setting up an Magnet Quality Assurance Facility very early at the site to "proof test" magnets produced in the magnet industrialization program. D. Shuman has developed several layouts in collaboration with M. McAshan.

Safety Review Document

A preliminary version of the final draft of the Safety Review Document was distributed for comment within the CDG. This version incorporates helpful comments received from CDG and DOE Chicago Operations Office on the first draft of the document. It will be forwarded to DOE for comment following incorporation of the additional comments received.

PROJECT PLANNING AND MANAGEMENT

Evaluation of the new version of the project management program (Open Plan 3.0) and the customized version of this code continued. A new set of SSC user instructions has been developed, and minor changes to the code are being implemented. With version 3.0 established, efforts will be directed toward designing appropriate changes to meet specific SSC needs.

The "Tops" repeater for the Macintosh network was installed in April to facilitate computer systems interconnections. Work is in progress to remove the final bugs.

Discussions were held within the CDG with regard to R&D plans for FY89 and FY90. The results were used to determine the budget requirements for FY90. The plans were incorporated into a final version of the Field Task Proposal/Agreement that will be submitted to the DOE. As the R&D request is closely coupled with the SSC construction plan, various scenarios for "construction" were considered for FY89 and FY90. A revised total construction plan that better reflects the current fiscal probabilities for the first two years will be studied.

Work continued on the CDG personnel database towards the goal of more precision in the tracking of personnel costs and expenses. One aspect, the database for linking travel expenses to the calendar, has been accomplished.

Proposals to upgrade the CDG overall Local Area Network (LAN) are under study, as the software for the existing system will be discontinued in the near future.

BNL REPORT

MODEL MAGNETS

Long Magnet DD0011, which incorporates LBL design features, was shipped to Fermilab on April 11. The second long magnet in this series, DD0013, was finally successfully assembled jointly by LBL and BNL technicians. The shell was welded and the assembly leak was checked.

All collaring tests were completed that pertain to the collar pack twist problem recently uncovered. A Magnet Division Note on the subject was released. Meanwhile, DD0015, the long magnet in which the twist problem first surfaced, has been disassembled in preparation for recollaring with a fresh set of collar packs. The new collar packs will be modified to compensate for the twist, which arose from an unbalanced moment in the original spot-welded collars. All Kapton coil insulation was removed from the DD0015 coils and replaced with new material. (Three-mil Kapton was substituted for the original 2-mil Kapton at the inner coil post and on the midplane.) Coil stress profile tests are under way. Moreover, a sufficient quantity of "opposite-weld" orientation collars has been received from the vendor, and new collar packs have been assembled.

Short magnet DSS11 was successfully collared using the new compensated packs. The magnet is presently attached and wired to the "top hat" in preparation for testing.

The inner and outer coils for DSS12 were assembled together.

Modifications have been made to the inner and outer end saddles to ensure a better fit, and design work is continuing on the new wedge tips for the next cross section iteration, C358D. The redesign of the interconnect region has resumed; primarily, it entails a new flexible joint and a single diode assembly.

In the trim coil R&D area, three coils were assembled and two were tested. The first quench was as high as 30 A; the short sample (approximately 90 A) was reached in less than eight training quenches. The samples did not de-train as a result of current reversal, but some de-training from thermal cycling has not yet been eliminated. Early coils that were sectioned show evidence of substrate flow, probably caused by elevated curing temperatures.

New, hardened trim-coil tooling has been designed and will be released to the shops in the near future. A decision has been made to attempt winding trim coils with a higher SC:Cu ratio and lower critical currents. BNL has requested Multiwire to prepare substrate samples with an improved glass-filled adhesive. The purpose is to strengthen the wire bond and adhesive fracture strength at liquid-helium temperature.

An informal collaboration agreement has been reached between BNL and DuPont, according to which DuPont will furnish Kapton samples to be tested at BNL. (Kapton film samples have already been irradiated at BNL's BLIP Facility.) In addition, Rogers, DuPont, and

Immitech will supply bulk samples of moldable polyimide-impregnated glass composites for mechanical, cryogenic, and radiation evaluation at BNL.

Silvex is nearing completion of the bore-tube plating facility. BNL could see the first plated tube sometime in June.

TOOLING AND FACILITIES

Coils

Modifications of long-coil curing press number 1 were completed, and the press is now operable. Minor difficulties with piping and the oil system were encountered on initial startup; all have been corrected. Design work was completed on the safety hoods for both long presses, and similar work is under way for 1.8-m hoods. Engineering continues on the new 1.8-m curing press.

Collars

The press section of the preproduction collaring press has been leveled and grouted. The compression plate and ram plate are in place, and all components are installed.

Test Facilities

The design work on all gas bypass parts for Mole C is completed. Central Shops is doing an excellent job manufacturing the intricate parts of the tether connector. Design work has commenced on the coil form and dewar components.

A firm in Switzerland has agreed to fabricate the miniature gear drive components for Mole C out of non-magnetic material.

Engineering work is continuing on the liquid-helium-cooled warm bore tube for Fermilab's MTF. Meanwhile, a similar design is being evaluated for the Accelerated Life Test, adapted to accept BNL's present end pots.

SUPERCONDUCTOR

Cable Procurement

The inner cables for DD0016 have been insulated and are ready for winding. The outer cables will be wrapped in early May.

Tooling

Both the cable twist measuring device and the cable width measuring device are now operational in Building 924.

Some parts for the set of cable guide rollers for registering the wires during the wrapping procedure have been completed and are being assembled.

A jury-rigged modification to the wrapping line has been successfully tested; it permits the wrapping of cable at three times the present speed of four feet per minute. Spooling restrictions, however, permit safe operation at only twice the present speed. (The spooling restrictions will be reviewed.)

Miscellaneous

A corrected sample of woven glass has been received from the vendor and is presently being tested.

The production run of fiberglass from Hexcel has been slit and is onsite receiving final inspection.

An investigation is under way to increase the amount of fiberglass per spool, so that fewer wrapping line shut-downs are required for glass splicing. Splicing must be minimized in order to take advantage of the expected increase in wrapping speed of the insulating line. With this in mind, Bertsche visited the fiberglass slitter (Standard Films Products, Inc.) in April, to inspect the slitter's limitations and to pursue the possibility of having the glass spooled, similar to Kapton.

TESTS AND MEASUREMENTS

Warm magnetic measurements were made on the 17-m dipole DD0011 before it was shipped to Fermilab. The multipoles were generally small, with the exception of the normal quadrupole term. This term also showed a significant variation along the magnet axis. The average dipole angle with respect to the vertical was large (65 mrad).

CRYOGENICS

Discussions with the CDG concerning the feasibility of testing single SSC magnets at BNL using the MAGCOOL facility, in a program that is in parallel with the Accelerated Life Test (ALT), caused us to review the plans for future utilization of MAGCOOL. The SSC Single Magnet Test (SMT) program, if pursued at BNL, would require dedication of two of the five test bays to SMT.

On the basis of this review, it was decided to move the ALT quench dewar from its position on the main floor level to a position in the trench parallel to the ALT trench. This permits the ALT to occupy only one MAGCOOL bay, so that any future possible space conflict will be circumvented. Drawings of the ALT piping are being modified to reflect this change.

Construction of the vacuum-jacketed piping for the 20 K heat shield supply and return lines is under way. This job is estimated to be 5 percent complete.

FNAL REPORT

DIPOLE CRYOSTAT

Work continued on the construction and instrumentation of long magnet model DD0014. The internal assembly of the magnet was completed. All temperature, strain, and acceleration sensors necessary for the planned cryogenic and structural evaluations of the cryostat were installed.

Insulation development continued during the construction of long magnet model DD0014. Improved handling and securing procedures were used to install insulation produced by Proud Mary. Similar development efforts are planned for the next several model magnets.

Assembly of shields by spot welding was evaluated during the construction of long magnet model DD0014. Significant initial operating problems were experienced with the spot welder, due to deficiencies in its construction. These problems were corrected, and subsequent spot welding experience was encouraging. Spot welding will continue to be evaluated.

The initial two-footed vacuum vessel was employed for long magnet model DD0014. Fabrication of the vessel went well, and the post fabrication cross-section alignment measurements were encouraging. Fabrication studies and alignment evaluations will continue.

Discussions of the iteration C cryostat design were held at the CDG. A major objective of the discussions was to obtain an agreement on the size and location of the various cryogenic lines within the cryostat. Design guidelines were agreed upon. Fermilab will develop a "draft" cross section for the iteration C design.

Discussions of magnet installations were held at the CDG. The discussions involved the magnet builder, mover, aligner, and operator. Changes to the magnet design that can occur are the magnet vertical centerline to centerline spacing, the use of stands to support upper magnets, etc. Installation procedures will be drafted.

Work continues on preparation for Industrialization. Documentation is being prepared in the format prescribed by the CDG. Preparations are under way to develop the Fermilab on-site program for Phase I: Technology Orientation.

Measurements for the evaluation of the mechanical stiffness of a BNL yoke pack were completed. The measurements include the deflection of the yoke assembly in air at 300 K and in liquid nitrogen. The results of the measurements will be provided to BNL for evaluation.

MAGNETIC MEASUREMENTS

Magnet DD0010 was warmed to room temperature, and the feed interconnect region was opened to allow inspection of the wiring. The cause of the short between voltage taps across the lower inner coil and between these taps and the beam pipe was found to be damaged insulation on the beam feed-through wires for these taps. The damage was at the point where these two wires

pass the beam-tube flange; it may have been caused when a tab was welded to the flange to allow electrical connection to be made to the beam tube. Inspection of the other wires in the interconnect region shows no evidence of any other damaged insulation. A complete continuity check was done on all voltage taps; tap 11B on the upper inner coil was found to be open. (Tap 15B has also been open since the coil was collared.) This explains the unusual behavior of the two signals associated with this tap. The damaged tap wires have been repaired, and the magnet is currently being prepared to be recooled.

Using a "new" cooling configuration, magnet DD0012 was cooled in 30 hours, approximately half the usual time, while still respecting the restriction on temperature difference between the two ends of the magnet. Following electrical checks at helium temperature, magnet testing began with a series of strain gauge runs, in which cryogenic and mechanical data were taken as a function of magnet excitation. Complete cycles to 4000 A, 4500 A, 5000 A, and 5500 A were taken before the first coil quench. A run was taken to 6300 A following the third quench. The strain gauge data indicate that the mechanical behavior of this magnet differs from DD0010 in the ways one would expect, given the different construction details. In particular, the coil stress is approximately 1000 psi higher at zero current and the stress decrease with excitation is about 30 percent less than on DD0010; coil stress is greater than 2500 psi at 6300 A. Force on the end plates builds up more rapidly on DD0012; the deflection of the end plate at 6300 A is only about 0.3 mils. The variation of longitudinal strain in the cold-mass skin indicates that the load is fully transmitted from the coil to the shell of DD0012 within several tens of inches of the end, compared to approximately 100 inches on DD0010.

Six spontaneous quenches were taken, all of them at the short sample limit of approximately 6500 A. Before the coil was quenched, however, four power lead "events," similar to those observed on magnets DD000Z and DD0010, occurred at progressively higher currents, with the first at 5000 A. Using the voltage taps installed on the leads, these events were found to occur in the throughbus. Quenches have been induced with each of four spot heaters at 6460 A and 5750 A, and with one spot heater at 3000 A, 4000 A, and 5000 A.

COLD-MASS TOOLING

Collaring of F2 was delayed by end insulation questions and by the potential for interference between the brass shoe and the collaring shims. These problems have been addressed, and collaring should take place on May 12 or May 13. The three different strain gauge packs have been tested and are awaiting collaring shim application. Photoelastic equipment, tooling, strain gauge electrical equipment and data recording equipment are set up and ready for the collaring operation.

Both F2 and F3 will be tested as magnets and will be assembled in the same way.

Magnet F4, the first FNAL-wound magnet, is scheduled to be collared and sectioned into cookies. Recent coil-end analysis by R. Bossert resulted in the decision to produce a low-stress end on at least one end of F4, using H. Fulton's existing CAD program. This area will be potted, sectioned, and analyzed.

Winding and curing of F4 was delayed by lack of end keys. These keys are being designed and should be released for manufacture by May 31.

LBL REPORT

SUPERCONDUCTOR AND CABLE

Two cabling runs were completed during April at New England Electric Wire (NEEW). These trials were made to test a modification to the NEEW cablers prior to the SSC production cable runs. Earlier trials at NEEW indicated a variability in cable degradation that was not present in the same material when cabled at LBL. This degradation had been traced to the mandrel attachment at NEEW, which permitted the mandrel to rotate and pinch the strands as the strands entered the Turkshead rolls. Both the 23-strand cabler and the 30-strand cabler were modified during March in order to hold the mandrel rigid, as is the case at LBL. The trial run on the 23-strand cabler was completed the week of April 4 and involved personnel from LBL, Oxford Superconducting Technology, and NEEW. The torsional stiffness of the new tooling was measured and found to be comparable to that measured previously at LBL. A total of 1645 feet of 23-strand cable was made to SSC specifications. A sample was sent to BNL for electrical measurements, which showed a critical current degradation due to cabling of only 3 percent. That amount which is comparable to that obtained at LBL and is a substantial improvement over the 10–15 percent degradation experienced previously at NEEW.

During the week of April 23, a similar run was made on the 30-strand cabler with participating personnel from LBL, Supercon, and NEEW. The run went smoothly, and samples examined by etching away the copper matrix looked acceptable. Samples were sent to BNL for critical current measurements, but the results are not yet available. The only known remaining problem at NEEW is the tendency of the cable to have a residual twist. This problem was corrected on cable made at LBL by using the variable planetary system to remove the residual twist; the present machines at NEEW do not have this capability, although the new machine being made by Dour Metal (Dour, Belgium) does. The residual twist condition has been described to the CDG and to the magnet winding groups at BNL, FNAL, and LBL; if it is agreed to be acceptable, the industrial wire vendors will be directed to proceed to make production cable at NEEW.

A key test on the new cabling machine being procured for the SSC project by LBL was completed on April 27 at Dour Metal in the presence of R. Scanlan. In this test, the main rotor was accelerated to its full operating speed of 120 rpm in both directions. The components functioned properly and no abnormal vibration modes were observed. Final assembly of the components is now under way. The acceptance tests will be performed in mid-June, after which the machine will be shipped to NEEW for installation. Details of this trip are documented in SSC-MAG-200.

MAGNET MODELS

Dipole Models

There were no magnet tests during April, 1988. Required maintenance work on the helium refrigerator was done, including the completion of a replacement piston assembly for the dry expander. Extensive work on the high current power supplies focussed on improving the current regulation.

A retest of dipole D-15A-5 is scheduled for May. This magnet is being recollared and retested to obtain information on the influence of recollaring on training behavior.

Model D-15A-6 inner coils are completed. We are waiting for delivery of wire for the outer coils. Coils for this magnet use the first R&D cable with a manganese-copper matrix surrounding the filaments. Since only one R&D billet was made (for inner material), about 25 pounds were drawn to 0.0255-inch diameter for use in an outer 30-strand cable.

Long Magnets

Collaring magnet DD0013 was completed on April 7. Final coil prestresses were 8,000 psi on the inner and 7,100 psi on the outer. A more complete record of forces, pressures, and dimensions is given in SSC-MAG-192. The collared coil was inserted into the yoke on April 19 and 20; this operation proceeded smoothly.

Bore Liner

Several exploratory bore liner experiments were completed. A bore liner was swagged into an assembled section of collared coils from an old dipole magnet. Several collared liner experiments were done using a presized liner (no swagging); coil stress and bore liner pressure data were taken. Final liner cushion thicknesses are still being chosen for each approach.

End Design

Tooling on which to wind flared ends for dipole coils was ordered. Computer programs to produce the contoured end parts are still being developed. A magnetic design that meets CDG requirements has tentatively been selected and should be finalized soon. Two constant perimeter end coils were wound and sectioned using the first injection-molded Lexan parts. Spacer shapes are being modified, and a third test coil will be wound, assembled with an outer coil, and sectioned to determine the quality of the cable support before building a complete magnet. New winding tooling was completed. Parts for the assembly of model D-15B-1 (the first constant perimeter end model) were ordered.

Coil Properties

The new 55,000 MTS tensile testing machine was installed and commissioned. Exploratory testing is beginning on samples of insulated cable.

PROJECT COST DATA

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TABLE C-1

CENTRAL DESIGN GROUP - SUPERCOLLIDER

APRIL 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.1	ADMINISTRATION	174.3	63.2	115.5	353.0	1856.5	3735.0
1.2	PROGRAM PLANNING & MANAGEMENT	27.5	6.8	14.1	48.5	341.0	574.0
1.3	ACCELERATOR R & D	345.6	127.9	200.5	674.0	2899.7	6112.0
1.4	CONVENTIONAL SYSTEMS DEVELOP.	33.5	2.4	14.9	50.8	278.1	824.0
	PROGRAM COSTS	580.9	200.3	345.1	1126.3	5375.3	11245.0
1.41	RTK COSTS	0.0	3.2	0.0	3.2	19.4	130.0
	CDG/RTK COSTS	580.9	203.5	345.1	1129.4	5394.7	11375.0
	COMMITMENTS					643.7	
	CHANGE IN COMMITMENTS (Delta)					269.3	
	EQUIPMENT COSTS					0.0	229.0

TABLE C-2

BROOKHAVEN NATIONAL LABORATORY - SUPERCOLLIDER

APRIL 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
2.1	LONG MAGNET FABRICATION	36.3	61.4	40.7	138.4	2073.0	3600.0
2.2	TOOLING & FIXTURES	28.2	3.5	13.2	44.9	1634.0	2200.0
2.3	SHORT MODEL MAGNETS	20.1	4.7	10.4	35.2	221.0	375.0
2.4	INDUSTRIALIZATION	8.1	0.0	3.4	11.5	103.0	175.0
2.5	ACC. LIFE TEST (CRYO)	24.2	1.2	10.6	36.0	446.0	650.0
	PROGRAM COSTS	116.9	70.8	78.3	266.0	4477.0	7000.0
	COMMITMENTS					1292.0	
	CHANGE IN COMMITMENTS (Delta)					0.0	
	EQUIPMENT COSTS	0.0	119.6	0.0	119.6	132.0	500.0
	EQUIPMENT OPEN COMMITMENTS					67.8	

TABLE C-3

FERMI NATIONAL ACCELERATOR LABORATORY - SUPERCOLLIDER

APRIL 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
3.1	GENERAL	0.0	3.2	1.1	4.3	61.2	220.0
3.2	LONG MAGNET FABRICATION	61.1	26.7	30.6	118.4	872.4	942.0
3.3	MAGNETIC MEASUREMENTS	86.7	43.9	45.5	176.1	1680.9	1363.0
3.4	COLD MASS FABRICATION	12.4	60.0	25.2	97.6	644.5	2241.0
3.5	INDUSTRIALIZATION	12.1	0.0	4.2	16.3	38.4	214.0
3.6	CELL TESTS	0.0	0.0	0.0	0.0	0.0	0.0
	PROGRAM COSTS	172.3	133.8	106.6	412.7	3297.4	4980.0
	COMMITMENTS					475.5	
	CHANGE IN COMMITMENTS (Delta)					-2.2	
	EQUIPMENT COSTS	0.0	0.4	0.0	0.4	78.1	271.0
	EQUIPMENT OPEN COMMITMENTS					-15.9	

TABLE C-4

LAWRENCE BERKELEY LABORATORY - SUPERCOLLIDER

APRIL 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET*
4.1	GENERAL	7.5	0.0	3.6	11.1	64.7	190.0
4.2	SUPERCONDUCTOR	2.3	125.8	8.3	136.4	303.3	720.0
4.3	QUADRUPOLE DEVELOPMENT	0.0	0.0	0.0	0.0	0.0	100.0
4.4	COMP. DEVELOP. & TESTS	21.1	7.9	13.8	42.8	850.6	1175.0
4.5	INDUSTRIALIZATION	0.0	0.0	0.0	0.0	0.0	50.0
	MAGNET R & D TOTALS	30.9	133.7	25.7	190.3	1218.6	2235.0
4.6	ACCELERATOR PHYSICS R & D	16.5	-0.5	7.6	23.6	240.4	410.0
	LBL/THEORY COSTS	47.4	133.2	33.3	213.9	1459.0	2645.0
	COMMITMENTS					113.0	
	CHANGE IN COMMITMENTS (Delta)					-108.0	

TABLE C-5

PROGRAM SUMMARY - SUPERCOLLIDER

APRIL 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.	CDG PROGRAM	580.9	200.3	345.1	1126.3	5375.3	11245.0
1.41	RTK PROGRAM	0.0	3.2	0.0	3.2	19.4	130.0
2.	BNL SSC PROGRAM	116.9	70.8	78.3	266.0	4477.0	7000.0
3.	FNAL SSC PROGRAM	172.3	133.8	106.6	412.7	3297.4	4980.0
4.	LBL SSC PROGRAM	47.4	133.2	33.3	213.9	1459.0	2645.0
	TOTAL SSC PROGRAM COSTS	917.5	541.3	563.3	2022.0	14628.1	26000.0
	COMMITMENTS					2524.2	
	CHANGE IN COMMITMENTS (Delta)					159.1	
	EQUIPMENT COSTS					210.1	1000.0
	EQUIPMENT OPEN COMMITMENTS					51.9	

TABLE C-6

MONTHLY AND CUMULATIVE SUMMARY OF PLANNED AND ACTUAL COSTS AND COMMITTMENTS

1.0 CENTRAL DESIGN GROUP - SUPERCOLLIDER

DATE	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	947.9	947.9	33.4	33.4	496.4	496.4	463.0	463.0
NOV	947.9	1895.8	747.4	780.8	572.4	1068.8	288.0	-175.0
DEC	947.9	2843.8	1221.6	2002.4	1199.6	2268.4	266.0	-22.0
JAN	947.9	3791.7	549.0	2551.4	478.2	2746.6	195.2	-70.8
FEB	947.9	4739.6	781.8	3333.2	995.0	3741.6	408.3	213.1
MAR	947.9	5687.5	931.9	4265.1	898.0	4639.5	374.4	-33.9
APR	947.9	6635.4	1129.4	5394.6	1398.8	6038.3	643.7	269.3
MAY	947.9	7583.3						
JUN	947.9	8531.3						
JUL	947.9	9479.2						
AUG	947.9	10427.1						
SEP	947.9	11375.0						

2.0 BROOKHAVEN NAT'L LAB - SUPERCOLLIDER

DATE	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	583.3	583.3	498.0	498.0	2095.0	2095.0	1597.0	1597.0
NOV	583.3	1166.7	643.0	1141.0	995.0	3090.0	1949.0	352.0
DEC	583.3	1750.0	763.6	1904.6	632.6	3722.6	1818.0	-131.0
JAN	583.3	2333.3	894.9	2799.5	831.9	4554.5	1755.0	-63.0
FEB	583.3	2916.7	702.0	3501.5	516.0	5070.5	1569.0	-186.0
MAR	583.3	3500.0	708.7	4210.2	431.7	5502.2	1292.0	-277.0
APR	583.3	4083.3	265.8	4476.0	265.8	5768.0	1292.0	0.0
MAY	583.3	4666.7						
JUN	583.3	5250.0						
JUL	583.3	5833.3						
AUG	583.3	6416.7						
SEP	583.3	7000.0						

3.0 FERMI NAT'L ACCEL LAB - SUPERCOLLIDER

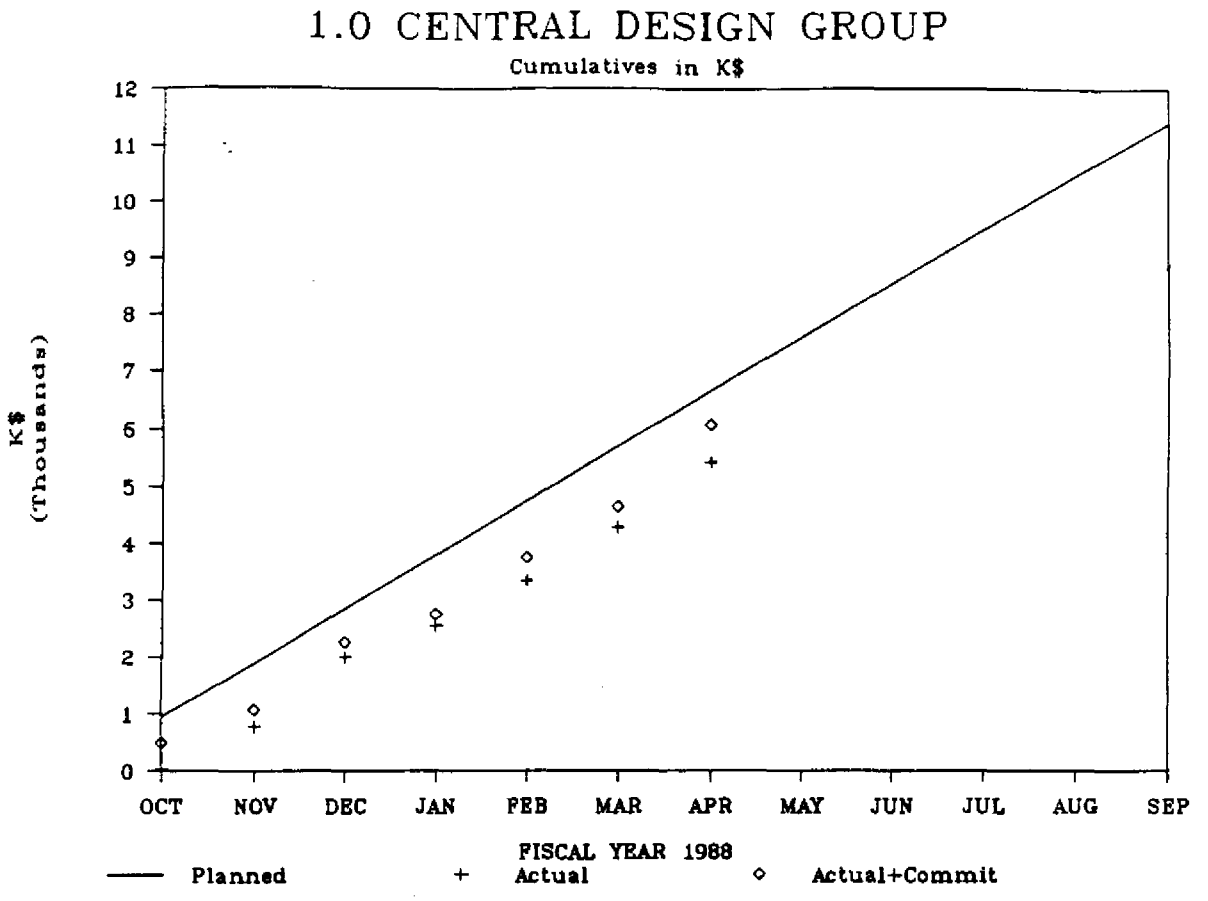
DATE	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	415.0	415.0	314.7	314.7	792.5	792.5	477.8	477.8
NOV	415.0	830.0	390.6	705.3	353.1	1145.6	440.3	-37.5
DEC	415.0	1245.0	694.7	1400.0	462.4	1608.0	208.0	-232.3
JAN	415.0	1660.0	307.3	1707.3	465.3	2073.3	366.0	158.0
FEB	415.0	2075.0	720.2	2427.5	722.5	2795.8	368.3	2.3
MAR	415.0	2490.0	457.2	2884.7	566.6	3362.4	477.7	109.4
APR	415.0	2905.0	412.7	3297.4	410.5	3772.9	475.5	-2.2
MAY	415.0	3320.0						
JUN	415.0	3735.0						
JUL	415.0	4150.0						
AUG	415.0	4565.0						
SEP	415.0	4980.0						

4.0 LAWRENCE BERKELEY LAB - SUPERCOLLIDER

DATE	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	220.4	220.4	230.5	230.5	662.5	662.5	432.0	432.0
NOV	220.4	440.8	191.1	421.6	191.1	853.6	432.0	0.0
DEC	220.4	661.3	135.9	557.5	135.9	989.5	432.0	0.0
JAN	220.4	881.7	263.3	820.8	175.3	1164.8	344.0	-88.0
FEB	220.4	1102.1	185.8	1006.6	135.8	1300.6	294.0	-50.0
MAR	220.4	1322.5	238.5	1245.1	165.5	1466.1	221.0	-73.0
APR	220.4	1542.9	213.9	1459.0	105.9	1572.0	113.0	-108.0
MAY	220.4	1763.3						
JUN	220.4	1983.8						
JUL	220.4	2204.2						
AUG	220.4	2424.6						
SEP	220.4	2645.0						

0.0 PROGRAM SUMMARY - SUPERCOLLIDER

DATE	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	2166.7	2166.7	1076.6	1076.6	4046.4	4046.4	2969.8	2969.8
NOV	2166.7	4333.3	1972.1	3048.7	2111.6	6158.0	3109.3	139.5
DEC	2166.7	6500.0	2815.8	5864.5	2430.5	8588.5	2724.0	-385.3
JAN	2166.7	8666.7	2014.5	7879.0	1950.7	10539.2	2660.2	-63.8
FEB	2166.7	10833.3	2389.8	10268.8	2369.3	12908.5	2639.6	-20.6
MAR	2166.7	13000.0	2336.3	12605.1	2061.8	14970.2	2365.1	-274.5
APR	2166.7	15166.7	2021.8	14627.0	2181.0	17151.2	2524.2	159.1
MAY	2166.7	17333.3						
JUN	2166.7	19500.0						
JUL	2166.7	21666.7						
AUG	2166.7	23833.3						
SEP	2166.7	26000.0						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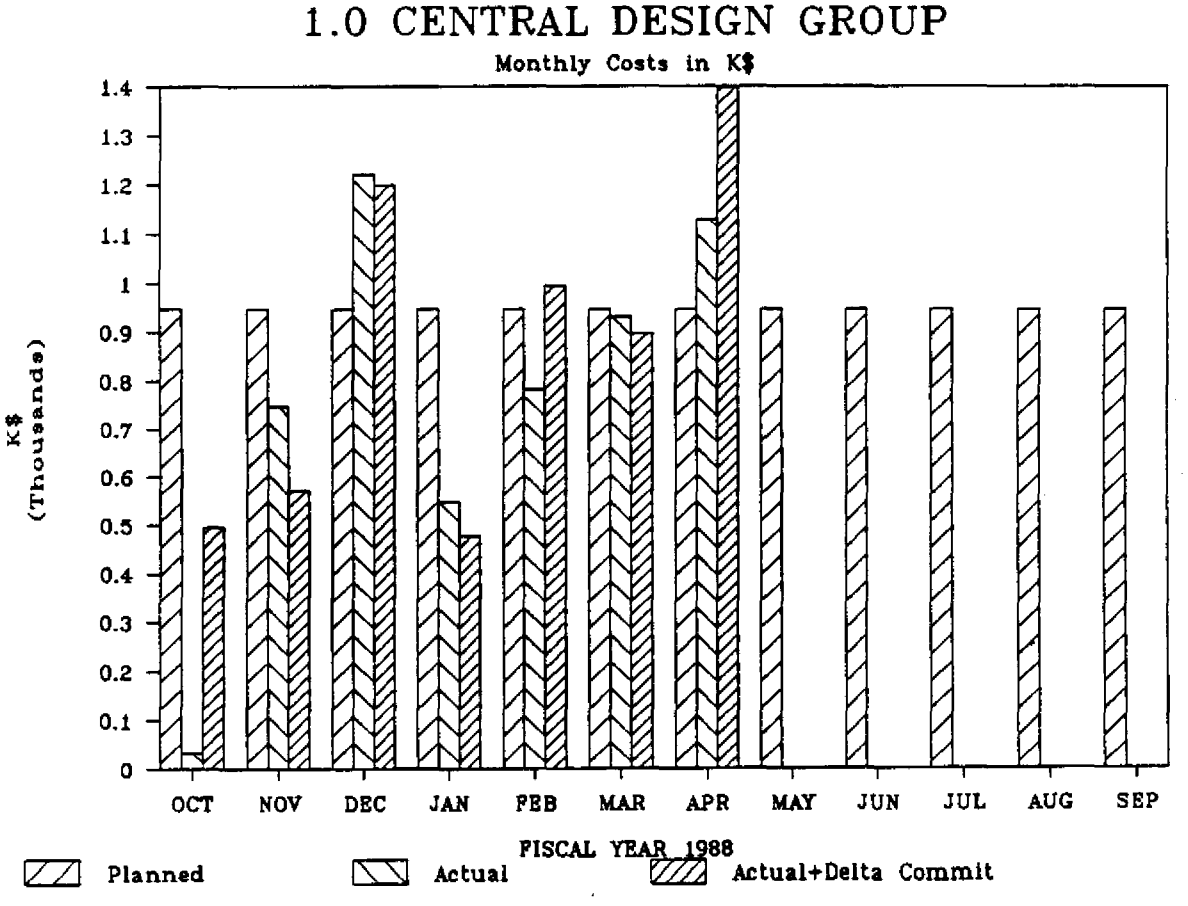
10
11
12
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit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0.4
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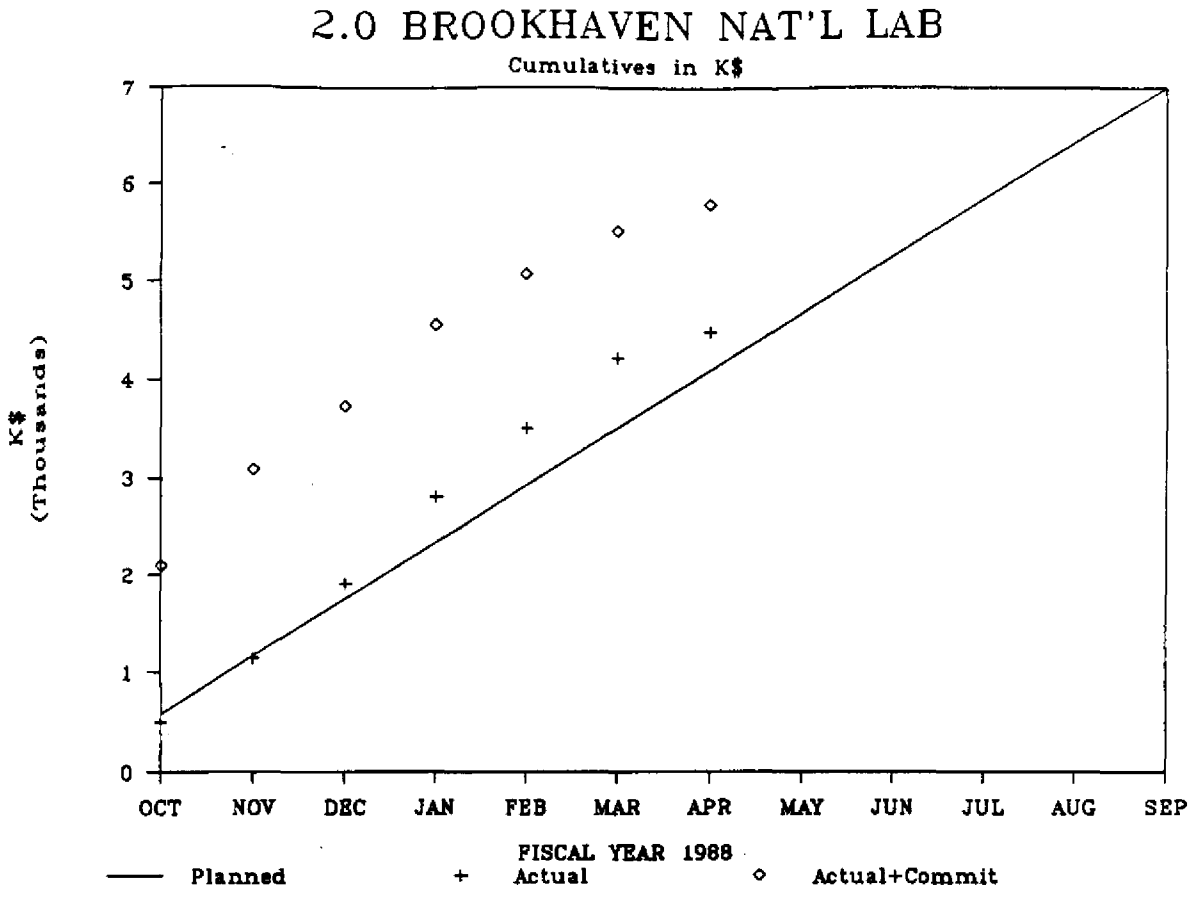
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 1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Cumulatives in K$
K$ (Thousands)
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1
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3
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OCT
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DEC
JAN
FEB
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MAY
JUN
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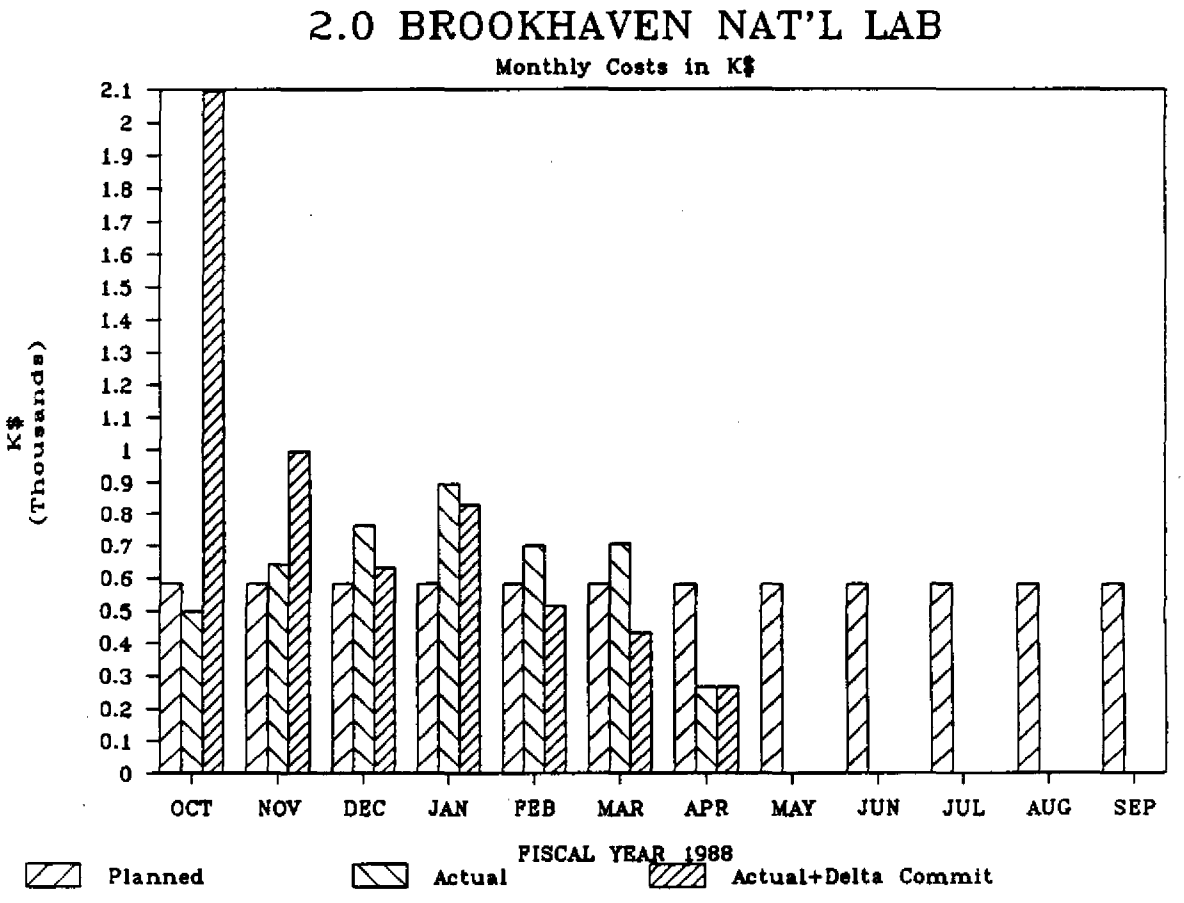
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit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Monthly Costs in K$
K$ (Thousands)
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0.9
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1.1
1.2
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1.5
1.6
1.7
1.8
1.9
2
2.1
OCT
NOV
DEC
JAN
FEB
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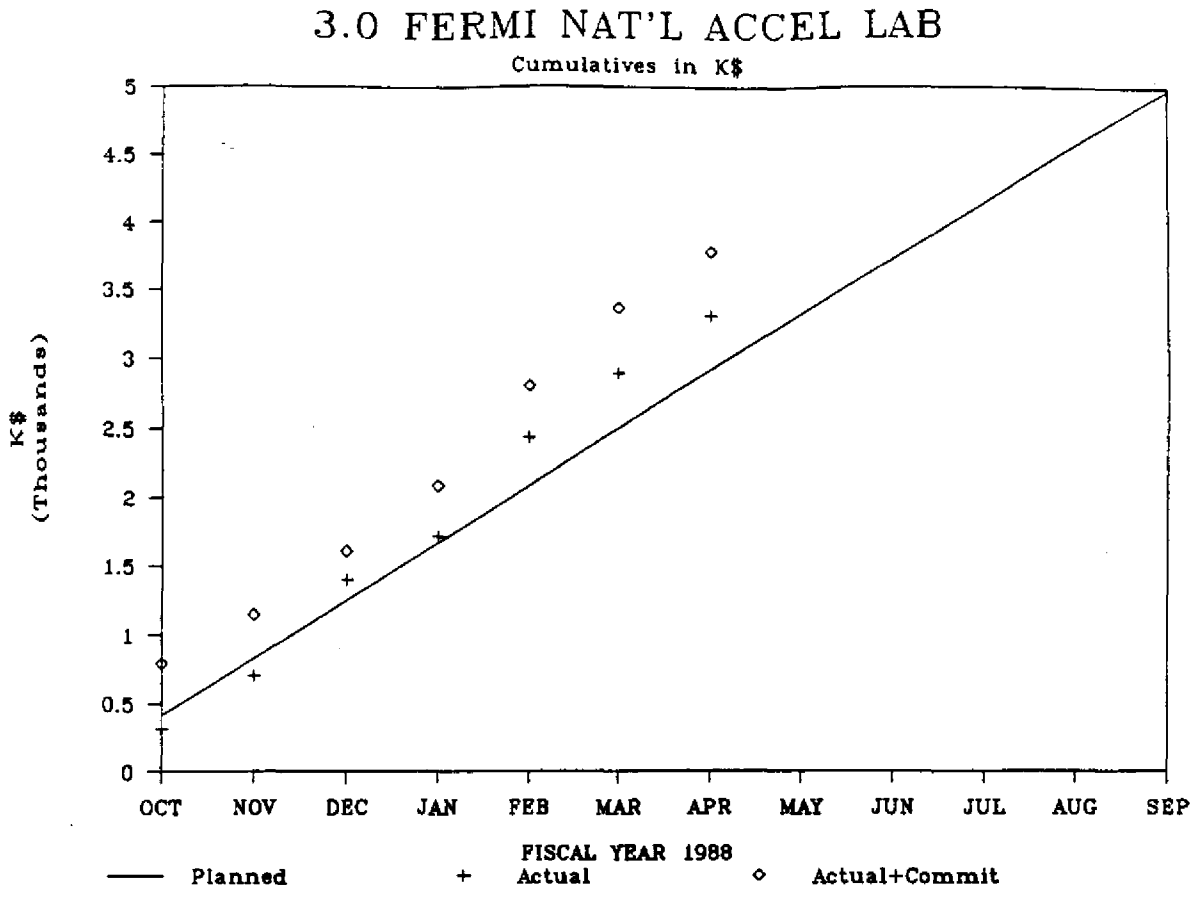
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 2


3.0 FERMI NAT'L ACCEL LAB
Cumulatives in K$
K$ (Thousands)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit

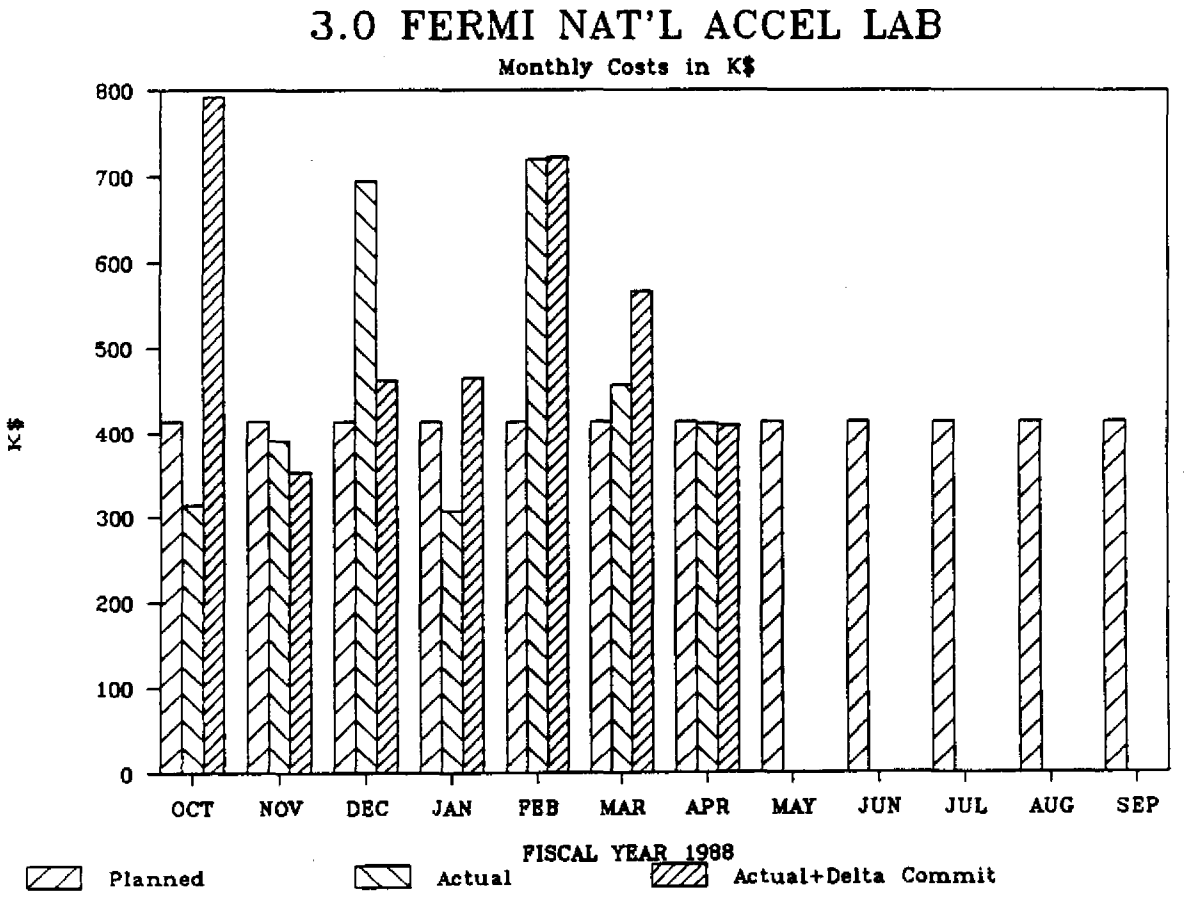
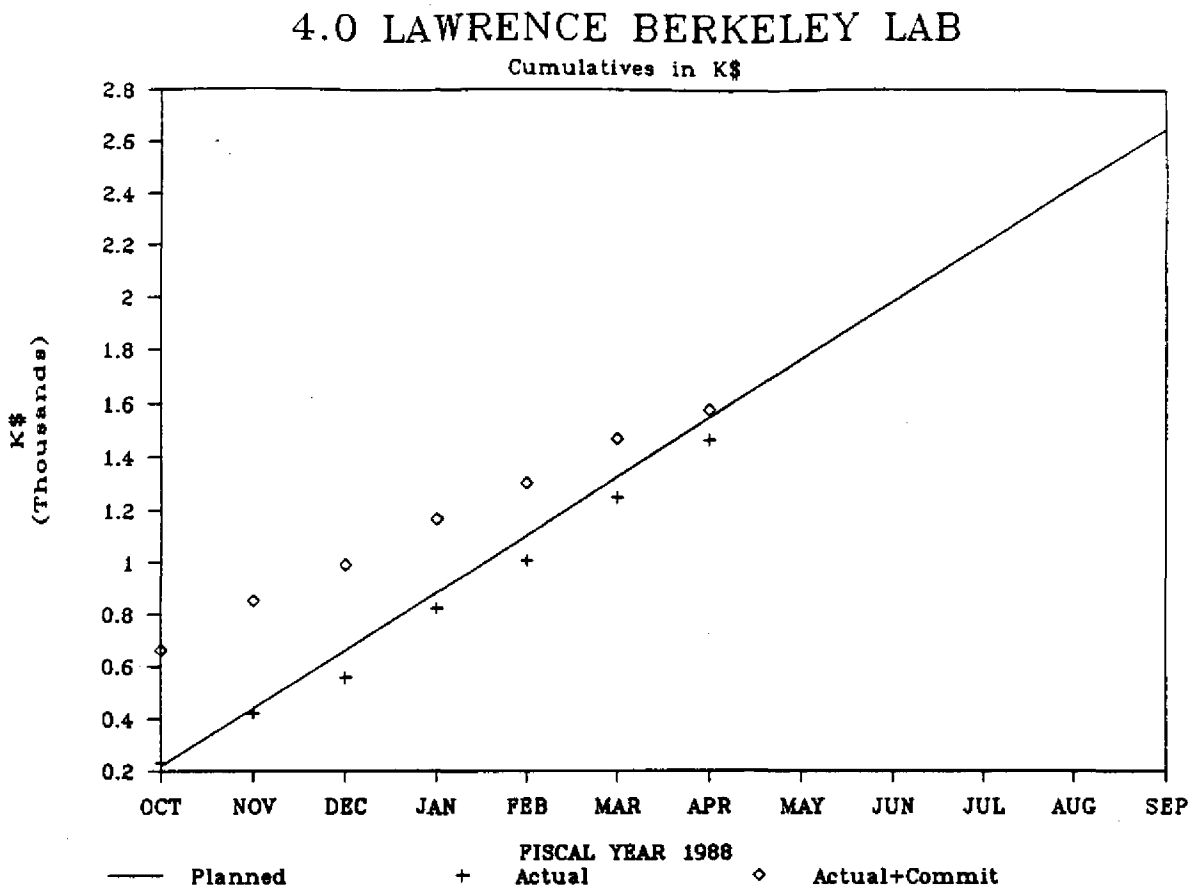

3.0 FERMI NAT'L ACCEL LAB
Monthly Costs in K$
K$
800
700
600
500
400
300
200
100
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 3


4.0 LAWRENCE BERKELEY LAB
Cumulatives in K$
K$ (Thousands)
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit

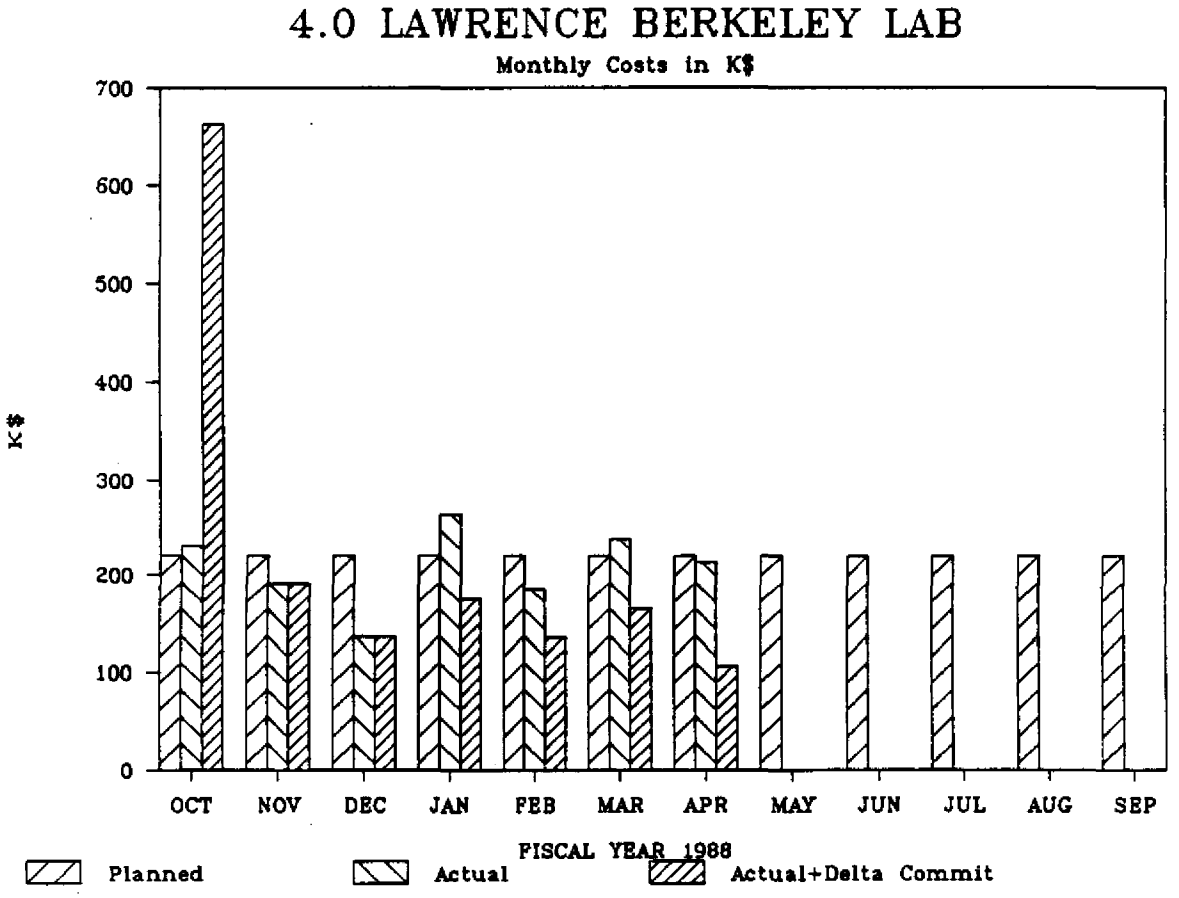
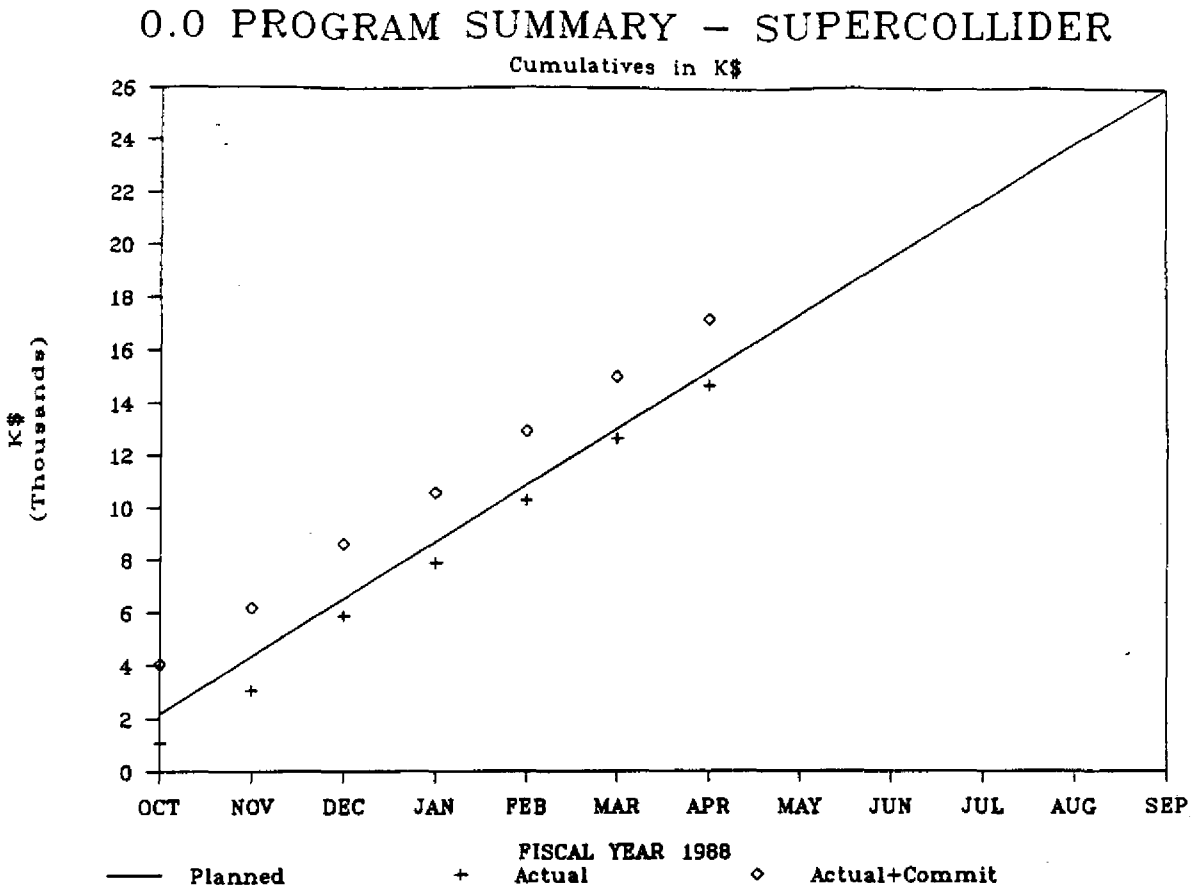

4.0 LAWRENCE BERKELEY LAB
Monthly Costs in K$
K$
700
600
500
400
300
200
100
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 4


0.0 PROGRAM SUMMARY – SUPERCOLLIDER
Cumulatives in K$
K$ (Thousands)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit

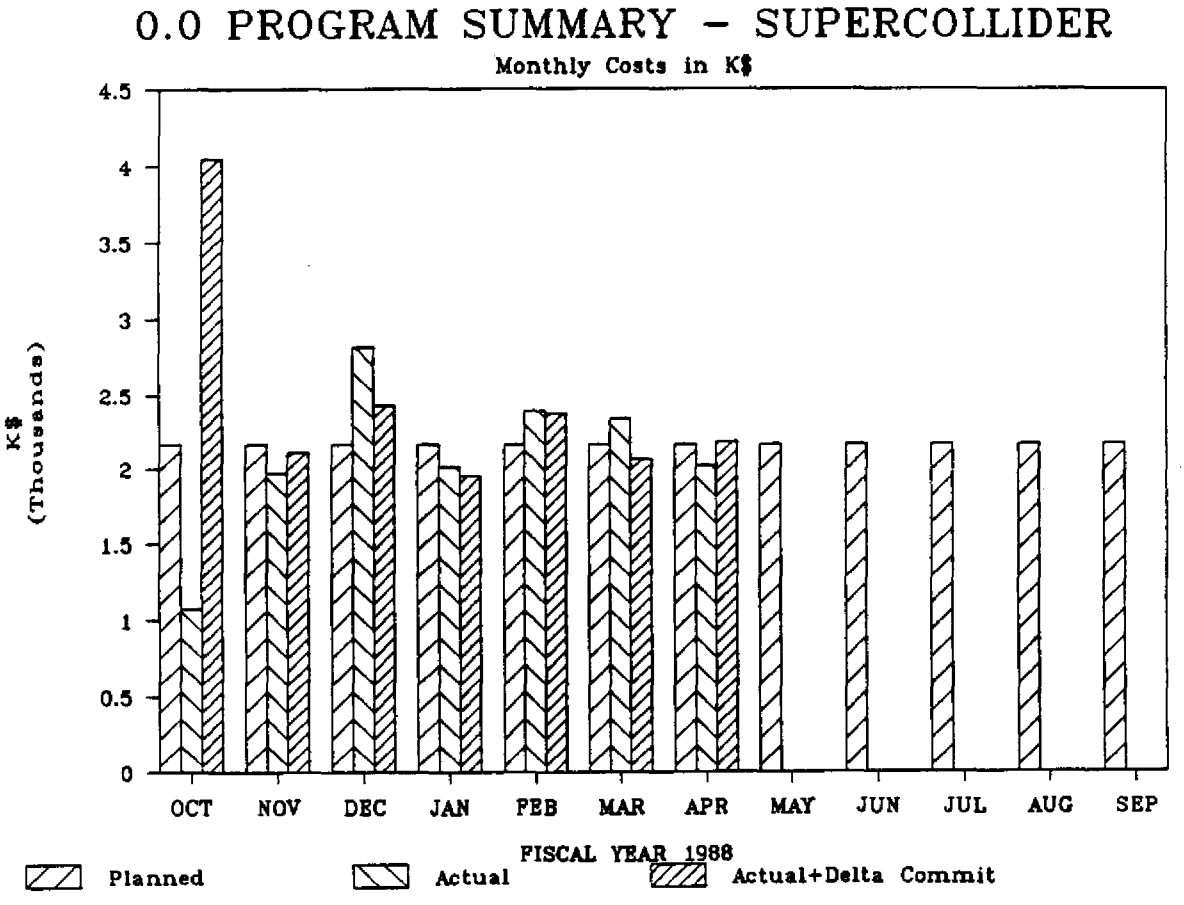

0.0 PROGRAM SUMMARY – SUPERCOLLIDER
Monthly Costs in K$
K$ (Thousands)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 5