June 1988 SSC Monthly Report

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PROJECT SUMMARY

CENTRAL DESIGN GROUP (CDG)

Task Force on Radiation-Hardened Electronics

In the continuing study of radiation levels and effects at the SSC, high-energy physicists, engineers, and industry representatives experienced in the design and fabrication of radiation-hardened electronics systems met June 27–28 at the Central Design Group.

Presentations were made on the perceived electronics needs for experiments at the SSC, emphasizing areas in which radiation hardening is believed to be an important issue. Electronics systems for silicon tracking devices, drift chambers, calorimetry, and more general data acquisition systems were described. Capabilities for designing and producing radiation-hardened circuitry and systems in a variety of technologies applicable to the SSC were discussed in some detail.

Clearly, substantial expertise exists that may be brought to bear upon the electronics issues anticipated for the SSC. Because much of the existing capability is aimed at a radiation environment that is somewhat different than that expected at the SSC, in some cases (e.g., low-noise analog circuitry) the prevailing opinion was that additional R&D will be required to determine the feasibility of radiation-hardened technologies for certain SSC applications. Considerable interest in exploring further efforts on radiation-hardened electronics for the SSC was evinced.

Magnet Program

At the Magnet Systems Integration meeting (June 17 at BNL), test results from long and short magnets were reported. Plans for the disassembly of DD0010 were discussed.

Preparation for the Magnet Industrialization Program continued in anticipation of the program's initiation next month.

The group studying the interface between the cryostat and the tunnel held a second meeting at the CDG. The first edition of the CDG Cable Database will be released for review shortly.

Mathematical analysis studies focused on the distribution of stresses in the coil during operation and on a comparison of the C358A and NC-9 cross sections. Steps were taken toward verifying the NC-9 finite-element model and preparing a code for studying quench behavior.

Design studies for magnetic measurement hardware continued, and initial coil insulation tests in helium gas were carried out.

Plans were laid for the construction of three online cable measuring machines.

Studies on the program of Bayesian analysis of magnet accelerated life tests and of the fault-tree analysis for the magnet cold mass system continued.

BROOKHAVEN NATIONAL LABORATORY (BNL)

Recollaring of DD0015 with compensated collar packs was completed.

Production continued of 1.8-m R&D coils, using the single cure procedure.

Testing of DSS11 was completed. Its excellent performance continued, and it exhibited no retraining following a thermal cycle.

Warm field measurements were made on DD0013.

FERMI NATIONAL ACCELERATOR LABORATORY (FNAL)

DD0012 has been completely tested. Following the thermal cycle, the magnet demonstrated the same outstanding performance at 4.6 K as after the initial cooldown. Erratic performance at 2.8 K and currents around 7600 A suggests some mechanical limitation at high stress levels.

Magnet DD0014 is mounted on test stand 4 and is nearly ready for cooldown. Magnet DD0011 will replace DD0012 on test stand 5.

The assembly of magnet DD0013 is under way and is expected to be completed in late July.

Procurement of cryostat materials and subassemblies is taking place in anticipation of magnet assembly activity in early FY 89.

The dipole pilot production facility is taking shape on the floor of the Industrial Center Building. Procurement of parts for the curing, collaring, and yoking presses has resumed after a six-month budget-related hiatus.

LAWRENCE BERKELEY LABORATORY (LBL)

The prototype production cabling machine, which is being built at Dour Metal in Belgium, was tested successfully at the Dour plant. Cable was made to SSC outer-layer specifications at the maximum design operating speed of 30 feet per minute. The cable met SSC mechanical and dimensional specifications; cable critical-current measurements are in progress at BNL. The machine will be packaged and shipped to the New England Electric Wire plant in New Hampshire, and it should be operational by September.

Superconductor wire intended for use in long magnets DD0017 and DD0018 was completed by IGC (inner layer) and Supercon (outer layer). However, the production cabling runs originally planned for late June were delayed pending strand quality investigations; preliminary results indicated that some of the IGC wire has poor mechanical properties and may have to be rejected. Trial lengths of cable were made from the Supercon wire, and samples were sent to BNL for critical current measurements. The production run will be made when these tests are completed.

Magnet D15A-5 was disassembled and then reassembled with all the original parts, except for new sheet insulation, as D15A-5R1. The training quenches of the rebuilt magnet were in the outer layer; the original magnet had training quenches in both layers. The difference in training behavior shows that there may be sensitivity to small, undetected variations in assembly procedures. A second reassembly, designated D15A-5R2, will have a higher outer-coil prestress and will be tested in July.

Model D15A-6 assembly was completed June 23. Final inner- and outer-coil prestresses were 8300 and 6400, respectively. This magnet incorporates a new conductor in which proximity coupling of the 5 μm filaments is prevented by doping the copper matrix between the filaments with manganese. The complete test period will extend into most of July. The first and third quenches were in the outer layer at 5737 A and at 6671 A, respectively. The plateau quench at 4.3 K was in the inner layer at 6890 A.

Parts are completed for a third test coil with internally supported straight ends. A conceptual design was made of a flared-end winding with acceptable multipoles.

CDG REPORT

MAGNET PROGRAM

MSI Meeting

The MSI meeting was held at BNL on June 17. Discussions began with a review of test results for DD0010 and of the plan for its disassembly at BNL. When it is reassembled, the effort will concentrate on making the magnet similar to DD0012. (That is, axial collar-yoke shims and other features found in DD0012 will be provided.) The magnet was returned to BNL in its cryostat, which is intended to serve as a horizontal dewar for future single magnet tests at BNL.

Voltage-tap and strain-gauge results for both DD0010 and DD0012 were discussed in considerable detail. A report on the excellent training performance of DSS11 followed.

Magnet DD0014 was reported to be on test stand 4, and it is expected to be ready for testing in early July; DD0011 was partially cryostated; DD0013's cryostating was predicated on completion of DD0011; DD0015 awaited skin welding. Coil winding for DD0016 is scheduled for August, timed to have test results in hand from several short magnets prior to the long magnet's final assembly. Among the various new features in this long magnet will be a method of yoke support *without* shims.

Azimuthal stresses were discussed from various perspectives: data comparisons (DSS6, 10, 11, and DD0010, 12), simplified models, detailed ANSYS modeling, and the utility of the Fuji paper technique in stress measurements.

BNL's short-sample cable test procedure was reviewed; the ensuing discussion focused on the desirability of small R&D billets to resolve outstanding questions pertaining to filament size and Cu:SC ratio. BNL is considering two possible cable test facility improvements: lower temperature (~3 K) and/or higher fields (~8 T with a CBA yoke and SSC cable). LBL is also considering a high-field (~7 T) possibility, in this case a 1-m SSC dipole model with iron collars.

The next MSI meeting will be held at BNL in August.

Industrialization

Work continued on planning and development documentation for the Magnet Industrialization Program; it is expected that the Commerce Business Daily announcement initiating the program will be published next month. Preliminary plans were also made for developing commercial activities in FY89 that are not currently a part of the formal magnet program. This could possibly include procurement of industrial cable measuring and taping machines.

Systems Integration

The second cryostat-tunnel interface meeting involving FNAL and the CDG was held at the CDG on June 2. Discussions included methods for installing, supporting, and aligning the magnets in the tunnel. A first draft of a magnet installation procedure was developed. A preferred stand configuration was selected as the basis for engineering studies at FNAL. For the purpose of this exercise, the beam-to-beam centerline spacing will be permitted to increase from 700 mm to as much as 800 mm, so that the impact of this dimension on the support stand and interconnect design can be studied.

At a separate meeting held at FNAL, details of the design of the cold mass interconnect were studied. The impact of the design of the quench protection system on this area was also reviewed.

Cable Database

Design work continued on the CDG superconductor database. The first release will be a combination of data from LBL tables, BNL electrical tests, and manufacturers' test data. Nomenclature and formats will be adjusted following a review by the originators of the data and by the end users. The Timeline program is now being used to obtain LBL superconductor ordering information.

Magnet Division personnel began to acquaint themselves with the Accelerator Division's new Sybase database system on a Sun workstation. They also established a VAX link for BNL personnel to learn about the system.

Mathematical Analysis

Work continued on finite-element models of the collared coil. The model of the NC-9 dipole shows an uneven stress distribution in the coils after preloading. In an effort to understand this distribution, models of an isolated coil and of a homogeneous cylinder were analyzed. This study showed that rather small perturbations in the coil dimensions at the midplane produce unexpectedly large variations in the stress distribution at the midplane.

Preliminary analysis of the loss in preload at the coil poles under magnet excitation indicates that the loss is not at all uniform across the pole. In particular, the analysis indicates that for the inner coil the loss at the inner radius is several times greater than at the outer radius. To gain a better understanding of the preload loss, work is continuing in this area.

In a step toward verification of the current finite-element model of the NC-9 dipole, the horizontal stiffness of the collared coil assembly was calculated with the model. The calculated results compared quite well with experimentally determined values. A detailed report is being prepared.

A report was prepared documenting the variation in calculated midplane and pole stresses in the C358A model due to assembly and cooldown. The qualitative behavior is very similar to that noted previously for the NC-9 dipole model. The quantitative behavior is somewhat different, due to the difference in stiffness between aluminum and steel collars. This report is being reviewed.

The computer code QUENCH has existed for many years, and it has been modified and extended by numerous authors, often in ways that are not well documented. Consequently, the code does not conform to modern standards of software construction and is inadequately referenced and thus difficult to read. (Perhaps it is more correct to say that the versions of the code available to us have these failings.) These problems have surfaced because the code needs to be modified significantly in order to more adequately model quenches in SSC dipoles. The principal changes will be (i) to alter the velocity calculations to reflect experimental experience and (ii) to model the effect of the strip heaters in initiating a distributed quench front beginning in the outer coils. The goal is to produce a code that can be used on-line during magnet quench testing to predict maximum coil temperature (MIITs) and voltages. As a first step in performing these modifications, however, it was found necessary to clean up the existing code. This step has been accomplished: complicated nests of GOTO statements were replaced by subroutine calls, comments were added, sections of obsolete code were removed, and several errors were corrected.

Magnetic Measurements

Design studies of hardware for performing field-quality measurements continue. The intention is to develop modular systems in which a drive mechanism is capable of transporting a variety of measurement heads. Two types of driving systems are under consideration: in one, the drive stops each time a measurement is performed; in the other, the motion is continuous. Work is also proceeding on a measurement head that incorporates multiple Hall probes suitable for room-temperature harmonic measurements.

Insulation Tests

High-voltage testing of an NC-9 collared-coil end assembly began, using the test chamber described in the March Monthly Report. The principal effort has been to develop the techniques required for connecting and potting the high-voltage leads to the individual coil turns. As stated in the May report, the chamber allows high-voltage testing of turn-to-turn, mid-plane, layer-to-layer, and coil-to-ground insulation of collared coil end assemblies in 1 atm of helium gas.

Cable Measuring Machines

A decision was made to fabricate and assemble three more magnet cable measuring machines under the direction of the CDG. These machines will be similar to the four existing measuring machines assembled at FNAL. A drawing package has been received from FNAL; it is being reviewed for completeness prior to being sent to a vendor for parts fabrication. The first machine will be assembled in the LBL shops; the following two will be assembled by industry.

Magnet Reliability/Availability Studies

Studies have continued on the program of Bayesian analysis of magnet accelerated life tests (ALT). Two reports were filed: one on the necessary model dependence of any formulation of probabilities analysis of ALT results, and one on the implications of the existence of model-dependent sufficient statistics for certain ALT objectives. An important practical consequence of the latter was a mathematical proof of the impossibility of improving estimates of failure rates inferred from ALTs by manipulations of the ALT sampling protocols. A report was also filed on the role of a stable form of the probability density, or "natural conjugate prior," for Bayesian analysis of magnet ALT results. Besides affording natural quantifiers for augmentable ALT probability densities, these results will dictate, to a large degree, the storage mode for ALT statistical databases. Work continues on analysis of the maximum additional information obtainable from a new experiment or modification or continuation of a current experiment. Absolute and relative information-theory measures of different test parameters and observables are quantified. This quantification will be important, for example, in determining the point beyond which it is inefficient to continue ALT for different given objectives.

The fault-tree analysis for the magnet cold-mass system continues. A report was filed by the Operations Research Center group under R. E. Barlow. This group launched a new program on computerized analysis of decisional influence diagrams for superconducting cable statistics.

ACCELERATOR PHYSICS

Analytic Calculation of Smear

The horizontal rms smear S is a measure of the nonlinearity of a storage ring. For sextupole and octupole contributions, a first-order perturbation calculation has been carried out to give an analytic expression for S in terms of the Collins distortion functions. Preliminary computation indicates that this analytic formula reproduces the observed single-particle smear in Tevatron experiment E778. An analytic formula can also be written when all higher multipoles are included. If the multipoles are due to random errors only, it is shown that the rms smear is identically the same at every point around the ring. (Results will be reported in an SSC Note.)

Accelerator Physics Studies at Snowmass

A working group on SSC accelerator physics was organized at Snowmass for the DPF meeting on high-energy physics in the 1990s. Approximately 25 people expressed interest in working on various accelerator physics issues at the meeting. Several working groups were established on topics including high-energy test beams (>1 TeV), IR hall design specifications, long-term (>10000 turns) tracking, new predictions for the SSC total cross-sections, cost and efficiency of 1- versus 2-campus laboratories, and some specifications for polarized beams in the SSC. In the last week of the Snowmass workshop, a study will be initiated to look into the optimization of the linac chain design as part of the SSC injector.

Injector Booster Chain

A possible new design for the three boosters has been presented (L. K. Chen and M. A. Furman, SSC-164). The complex is matched so that the SSC filling factor is 94 percent; it is designed so that there is no transition crossing at any point of the injection chain. The optics are much improved from the CDR design; in particular, the dispersion function is substantially reduced: it is now zero or close to zero in the straight sections. The impedance thresholds for single-bunch instabilities are believed to be easily achievable. One significant change is a substantial increase of low-energy booster circumference (340 m from 250 m in the CDR); this implies an increased space-charge tune shift, which now is –0.2 at injection energy. However, single-particle tracking results — including the effects of the space-charge force, synchrotron oscillations, sextupoles and dipole errors — indicate that the dynamic aperture is sufficiently large.

Database

Work has begun on SYBASE, a relational database management system. It is hoped that this will provide the hub of a hub-and-spoke arrangement for the management of many different kinds of SSC data. The first databases to be installed under SYBASE are related to lattice description, design, and surveying. Tools are being developed to connect SYBASE to the outside world of the normal computing environment, so that these databases can be profitably used. In particular, it is necessary to be able to convert the internal database representation (tables) to a lattice description representation that can be input by tracking and lattice design programs (the standard format). Such a parser has already been demonstrated, in prototype form, during an evaluation of the INGRES database. A more rugged parser and its interface to SYBASE will soon be completed.

E778

Publication of results from the E778 experiment has begun: an article was submitted to *Physical Review Letters*, two papers were included in the proceedings of the Lugano workshop of the International Committee for Future Accelerators (ICFA), and two papers were presented at the Rome European Particle Accelerator Conference (EPAC). The main thrust of the *Physical Review Letters* article concerns the general nature of the resonance phenomena observed in E778. These phenomena are quantified by the strength and the decay rate of the copious persistent signal data taken in the February 1988 run. One of the ICFA papers surveys the successfully completed status of the smear data; the other presents a consistent theoretical Hamiltonian framework across the three different time scales of E778 phenomena. One of the EPAC papers surveys the smear analysis and the preliminary signal analysis; the other focuses on the dynamic aperture measurements. It should be noted that the persistent signal data have been only partially analyzed; there are more results to come from the continuing analysis.

ACCELERATOR SYSTEMS

Self-Describing Data Formats Workshop

A small workshop was held June 9–11 at the CDG to study the use of self-describing data formats (SDS). These will have wide-ranging use in the SSC control system, but the early emphasis is on magnet data from Fermilab MTF. The workshop had attendees from Fermilab, LBL, SLAC, Loma Linda Hospital, and the CDG. The general consensus seemed to be that SDS should be pursued vigorously. Fermilab attendees agreed to work it into the MTF data collection system. In the workshop, version-1 interfaces to "C" and FORTRAN were written. The will be circulated to the labs for test in July.

Working Group for RFP Studies

A working group was formed to start studies that will lead to writing an RFP for an R&D Magnet Test Laboratory. A very aggressive plan has been formulated to make this laboratory available as early as possible at or near the eventual SSC site. P. Vander Arend made a first pass at a cryogenic design and generated a flowsheet. J. Rasson used the static simulator Aspen/SP to start a systematic study of the flowsheet for optimization. Prior to establishing laboratory specifications, the refrigerator flowsheet will be integrated with the rest of the test laboratory to obtain state points for all the proposed operating modes.

Quench Protection Diodes

A paper by J. Ziegler and R. Carcagno, "Feasibility of Passive Quench Protection in the SSC," was submitted to the IEEE-sponsored MIDCON/88 technical conference on electronic and electrical technology. It was accepted as part of a session on "Power Engineering and Power Electronics." The conference is scheduled for August 30–September 1 in Dallas, Texas.

Integration of the bypass diodes with the rest of the machine began with an exchange of information among the people involved in different aspects of this work. On June 29, R. Carcagno participated in a meeting at Fermilab concerning the SSC Interconnect Region and presented an update on diode R&D. S. Plate (BNL) presented the latest design of the cold mass region, focusing on the expansion joints. The preliminary design of the interconnect region includes a diode holder attached to the end plate of the magnet. One problem with this design is that the heat sink is small compared with the optimum size proposed in SSC-N-432 (R=5 cm, L=4 cm).

General Dynamics Thermal Analyzer

The General Dynamics thermal analyzer program and its plotting program were installed in the LBL VAX 8650. Some software modifications were necessary, because the General Dynamics CYBER machine is a higher precision machine than the LBL VAX (64-bit compared with 32-bit). As a result, for the SSC cooldown model there was a lack of convergence error during program execution. All the SSC models provided by General Dynamics (cooldown, heat leak, and cold mass temperature under sychrotron radiation load), and a complete set of outputs and plotting files are now available.

APCI Dynamic Simulator

Air Products delivered two magnetic tapes with the following items:

(1) FORTRAN source for the SSC dynamic simulator,

(2) FORTRAN source for the thermodynamic routines (final version),

(3) Data files and VAX/VMS executable images for the three scenarios required by their contract: (a) startup from standby, (b) magnet "quench," (c) 4-K compressor trip, and

(4) Speakeasy data files containing the results.

The tapes were loaded into the VAX machine. Verification and analysis of results is in progress.

Air Products also delivered the following printed documents:

(1) Draft copy of the Task 3 report on the simulation results of the three SSC scenarios, and

(2) Draft copy of the user manual for the SSC dynamic simulator.

Heat Transport under Sychrotron Radiation

An analysis of ways to reduce the temperature rise in the coils is in progress. There are basically two approaches: to increase the solid thermal conductance in the cold mass, and to carry away heat from the beam tube region by helium convection (for example, including a helium transverse flow between lamination gaps, increasing the mass flow rate in the annular passage, using bore liners, etc.).

Redesigned Sample Holder for SRC Photodesorption versus Temperature Experiment

Part fabrication was 90 percent completed and assembly was started. Temperature-sensing resistors and a diode were received from Lake Shore Cryotronics. Sample holder testing should begin in mid-July.

Vacuum Considerations for an SSC Bore Tube with a 20-K Liner

SSC refrigeration requirements will be significantly reduced if the bore tube has a 20-K liner to intercept sychrotron radiation heat. However, because a 20-K liner will not cryopump hydrogen, the gas with the greatest effect on luminosity lifetime, the liner must have holes to allow the 4-K bore tube to cryopump the hydrogen. Holes in 5 to 10 percent of the liner will ensure an acceptable vacuum for initial and long-term SSC operation. (D. Bintinger reports these conclusions in SSC-N-527.)

CONVENTIONAL SYSTEMS

Magnet Installation/Tunnel Interface Meeting

A meeting was held on June 2 of representatives from the Magnet Division, Accelerator Systems Division, the Fermilab magnet program, and the Conventional Systems Division to continue discussions of installation requirements, as reported above. These meetings, led by R. Coombes, are proving helpful to all divisions.

The Conventional Systems Division is examining space and transport issues. RTK is working on a magnet transporter that would fit into the tunnel transport system. D. Shuman has developed ideas for lowering the magnets to tunnel level at the service areas. At the previous

meeting, questions were raised about the flatness of the invert surface. LEP's specification for flatness around the circumference of +0, –2 cm was improved on in the construction to hold the actual flatness to +0, –1 cm.

Safety Review Document

On June 7, Dr. R. Mayes and Dr. J. Nelson from the Environmental and Health group at Chicago Operations visited CDG to discuss the Safety Review Document.

Electrical Load Profile Studies

RTK has completed the characterization of the SSC electrical load profile for a fully operating SSC laboratory. Meetings were held at RTK on June 9 to begin the next phase of the characterization: the load profile during a long shutdown. For these purposes, the standby mode for the refrigerator system was defined by the Accelerator Systems Division as one refrigerator on each side of the ring operating at any time. To take into account power distribution practice, the Conventional Systems Division further refined this to be one refrigerator on each of the two separate grids feeding the site.

Tunneling Seminar

Professor P. Nelson of the University of Texas at Austin presented the history and current status of tunneling technology to the Hadrons and Cheese Seminar on June 10. The talk was very well received. At the request of the CDG, Professor Nelson was good enough to supply a set of tunneling slides for the CDG slide files.

Preparations for FY89 and FY90

A major effort for Spring 1989 is seen to be preparation of a Site Specific Conceptual Design (SSCD) to specialize the lattice for the chosen site. This concept design would then serve as the basis for initiating design with the AE/CM firm. In anticipation of that work C. Laughton, who played a leading role in tunnel work for LEP, has agreed to join the project along with A. Autin, an architect.

Concept Design: Background Studies

In preparation for the SSCD, a series of task orders with RTK is being developed to refine certain aspects of the conventional facilities for the SSC. At a meeting with RTK on July 21, a plan was outlined to model representative detectors from the 1987 Berkeley summer study, in order to refine collision hall requirements. A second program will involve modeling studies of

the tunnel cross-section and the transport system. (The magnet transporter, noted above, is one element of this broader study.)

Snowmass Presentation

T. Toohig made a presentation at the Snowmass summer study on planning for IRs. The goal was to convey to the community present thinking and schedules for IR construction, to elicit comments and, perhaps, some help in clarifying the designs. The community was responsive to the clarity and depth of the CDG plans.

R&D Magnet Test Laboratory Meetings

Several meetings were held of the interdivisional working group on the laboratory for testing production magnets at or near the site. A fast design and construction schedule, involving cooperative work among all divisions, is envisaged for this laboratory.

ISP Footprint

In preparation for adapting the definitive SSC lattice to the final site, J. Sanford devoted considerable effort to ordering the techniques required to translate the lattice given by the Accelerator Physics Division to a land footprint to be used at the chosen site.

PROJECT PLANNING AND MANAGEMENT

FY90 Program Plan

The SSC R&D program plan for FY90 was revised and distributed to the CDG group leaders for final approval. The FY90 plan, together with minor revisions to the FY89 plan, served as the basis for the Field Task Proposal/Agreement. The FTP/A was completed and submitted to the DOE on June 17.

Construction Plans

On June 9, CDG staff met with DOE program personnel in Germantown to review SSC construction plans. Project plans were presented for the case of a total FY89 budget of $147 million. An outline plan was also considered for the case of a reduced FY89 budget of $100 million.

On June 21, PPM staff met with DOE representatives in Germantown and presented details of the FY90 construction plan to the DOE validation group. Costs, schedules, and manpower projections were reviewed. The magnet R&D plans and the projected program for magnet industrialization were also presented.

Networking and Software Support

A meeting was held in mid-June with the SSC accounting group, LBL's work station group, and representatives from Sympro and Novell to discuss the CDG's current and future networking needs. Telephone conferences were also held with Novell's technical engineering staff. Representatives of the Novell Engineering group will attend the next meeting, scheduled for July 7. The SSC1 LAN server has been configured to enable installation of the new "Platinum" accounting software from Advanced Business Microsystems (Sympro). The PCs of the accounting group have been adapted to accommodate the new software.

Efforts are continuing on the development of the latest version of Open Plan (3.0) in preparation for testing and implementation in specified areas of the FY89 program.

Support was provided to other SSC divisions in the following areas:

- SSC magnet R&D schedule (V-25) revision,
- Laboratory Program Agreements development,
- CDG personnel data base development,
- Exploration of large storage systems for magnet data together with search and retrieval capabilities,
- Installation of Microsoft "Windows" for the Administrative Services Group,
- Installation of "Time Line" up-grades to version 3.0,
- Development of "Time Line" schedules for conventional systems, and
- Development of a magnet installation schedule to assess equipment and manpower needs in the installation process.

BNL REPORT

MODEL MAGNETS

The collared coil assembly for DD0015 was completed with the new collar packs that incorporate standard and opposing weld orientations. Negligible longitudinal twist was measured after assembly. However, due to elastic deformation of the collars, the horizontal tab width grew beyond the specified limits at certain places, necessitating manual filing for a smooth fit to the DU channels.

Production continued of 1.8-m R&D coils, using a constant predetermined shim and the single cure procedure. During the ongoing single cure test runs, variations in the amount of "prepreg" materials were investigated. A method was developed for chemically removing material on wedge ends. This will reduce buildup at the wedge-wedge tip transition in coils for forthcoming magnets with the new C358D cross section.

Wedge tip design work was completed for the C358D cross section, and a start was made on adapting the coil compression gauge tooling to the new cross section. Some wedges for C358D were received; more are expected.

The purchase order was expedited for reworking existing rectangular-key collars to tapered-key collars. Phosphor bronze tapered keys for six 17-m dipoles (3000 keys) were received, inspected, and rejected. Replacements were promised by the vendor by August 1.

A visit was made to Remmele Engineering in St. Paul, Minnesota, in connection with precision shell fabrication. This vendor appears well qualified to undertake accurate machining of preformed full-length shells. Visits were made to FNAL for discussion of cryostat insulation tooling, in anticipation of a similar fixture at BNL, and for discussions on the proposed redesign of the interconnection region. The movable and fixed legs of the expansion joint have been reversed for a better fit in the available space. Further modifications, suggested at the FNAL meeting, are intended.

All parts of the strain-gauge compression fixture have been machined, and assembly of the complete unit is nearly complete. A hydraulic pump and accumulator were procured for operating the press. The strain-gauge temperature calibration system was completed and is now in use. An inner-coil "ten stack" creep fixture was designed, and the drawings were submitted to the shops.

Test trim coil number 12 was fabricated and prepared for testing. Substrate samples with varying amounts of glass were produced at Multiwire and delivered to BNL. Superconductor with varying Cu:SC ratios was also received from the vendor and forwarded for insulation. Rogers Corporation has produced a radiation-resistant polyimide that is ultrasonically bondable; samples are being sent to Multiwire for wiring tests. Sheldahl is presently producing substrates for FY89 long magnets. Key stock is being produced, bumper strips are being coated with

adhesive, wire is being wrapped with Kapton, preparations are under way for slitting and punching of substrates, and Multiwire wiring machinery is serviced and ready to go.

Various polyimide films were tested for their mechanical puncture properties. The results show that Du Pont XT and MT alumina-filled Kapton films are superior to other film products. No qualitative effects were apparent on examining samples of polyimide thermal plastic adhesive irradiated in BNL's BLIP facility.

Equipment, power supplies, and tubing to be copper plated were shipped to the Silvex Company. Anode material sent to BNL for welding was found to have several problems. In the interim, Silvex expects to proceed with the plating of initial samples using an improvised procedure.

TOOLING AND FACILITIES

Coils

The first set of drawings for 17-m curing-press safety hoods were released to the shops. Engineering continues on the new 1.8-m curing press.

Collars

Drawings for the lower platen extension of the collaring press were released to the shops. A start was made on the design of tapered-key insertion equipment for the preproduction curing press.

Shell

The carriage drive motor for the longitudinal shell-welding fixture is not strong enough to drive the carriages at a constant speed; it will be replaced with a motor of higher torque.

Test Facilities

Design work continues on various aspects of Mole C; many components are either in the Central Shops or being prepared by outside vendors. Design work has been completed for the gravity sensor and encoder assembly parts; this job is now in the Central Shops.

After discussions with FNAL, BNL agreed to order the required warm bore tubing. The warm bore tube design will be compatible with test facilities at either laboratory as well as at the Accelerated Life Test. A good start was made on the engineering of the tube assembly.

SUPERCONDUCTOR

Cable Procurement

New England Electric Wire requested the loan of BNL's RHIC turkshead roller assemblies for the manufacture of SSC outer cable, as their rollers had not yet arrived from Fenn. BNL's rollers were shipped by air to NEEW, to ensure that there would be no delay in delivery of cable to LBL.

Tooling

Modifications to the wrapping line to permit higher wrapping speed should be completed in July.

Tooling to produce fiber glass splices "in the field" is being investigated, following successful splicing tests at BNL.

Miscellaneous

Test results on a corrected glass sample indicate that there is no difference in "build up" between standard slit fiber glass and woven fiber glass. Further discussions of production and quality control issues are planned with the woven-glass vendor. One of the specifications for woven fiber glass will be the measurement of width under the same tension as when it is wrapped around the cable.

TESTS AND MEASUREMENTS

Testing of 1.8-m dipole DSS11 was completed. The magnet continued its excellent performance, exhibiting no retraining following a thermal cycle. A series of spot heater–induced quenches was also made.

Warm measurements were made on 17-m dipole DD0013. A preliminary analysis of the data indicates that the multipoles are less than a unit, with the exception of the skew quadrupole (about 4 units), the normal sextupole (–4 units), and the normal decapole (2 units).

FNAL REPORT

DIPOLE CRYOSTAT

Procedures for handling and securing insulation continue to be improved. They will be incorporated as appropriate into the long magnet models. Insulation blankets for five additional magnet models, beginning with DD0013, have been produced. The "Proud Mary" insulation fabrication facility will be decommissioned in July.

DD0014 was installed on the MTF test stand and will be cooled down in July. Critical cryostat parameters will be monitored during cooldown, steady state, and warmup. Modal analysis of DD0014 was rescheduled for September.

Long magnet model DD0011 was completed.

Subassembly preparations, including fabrication of support posts, anchor assemblies, and insulation blankets, are under way for long magnet DD0013.

Two designs for a vertical plane probe transporter are being developed in conjunction with GDSS. One design incorporates a self-propelled walker; the other uses a deployable boom. Models will be built and evaluated.

Plans are being developed for the procurement of components for FY89 long magnet cryostat kits. It is planned to procure components like support posts, vacuum vessels, etc., in final form for kit incorporation. Components for sixteen models will be procured.

Work continues on magnet design for installation. Initial studies were completed on the magnet vertical-centerline–to–centerline spacing and bottom-magnet–floor spacing. Effort is planned for magnet support stand design.

Preparation for industrialization continues. The draft of the Fermilab On-Site Program for Phase 1, Technology Orientation, was sent to the CDG.

MAGNETIC MEASUREMENTS

Tests of magnet DD0012 were completed. It was warmed to room temperature and will be removed from test stand 5, where DD0011 will be mounted.

On the second thermal cycle of DD0012, a total of 18 spontaneous quenches were taken: three at 4.4 K and 4 atm, six at 3.2 K and 4 atm, five at 2.8 K and 4 atm, and four at 4.3 K and 1.5 atm. One training quench at 4.4 K followed the warmup-cooldown cycle before the magnet returned to quenching at the short sample limit of approximately 6500 A. (There were no training quenches on the first cooldown.) At 3.2 K a single training quench at 7360 A was followed by four plateau quenches at approximately 7600 A. At 2.8 K, the quench currents were somewhat erratic, ranging between 7050 A and 7640 A. The cause of this behavior is unknown at present. Two more quenches were taken at 3.2 K, which were at the previous plateau current.

Four quenches were taken in sub-cooled liquid at 4.3 K and 1.5 atm. These quenches do not appear significantly different from the quenches in 4-atm supercritical fluid. Quenches were induced with spot heaters at each end of the magnet at 7400 A at 3.2 K and at 6460 A in sub-cooled liquid.

Strain-gauge data were taken up to 6360 A at 4.4 K and up to 7370 A at 3.2 K. At the highest current measured, the inner coil stresses range from 1400 psi to 2100 psi and are clearly falling more slowly than quadratically with increasing current. The total force of the coil on the end plate is 10500 pounds at 7360 A and is increasing a little faster than quadratically with increasing current.

Cooldown of magnet DD0014 is anticipated to begin in mid-July. The new electronics and readout equipment needed to read the extensive instrumentation on the cryostat have been installed. Several leaks in the magnet vacuum vessel were encountered in mounting and checking the magnet, principally in several of the special ports used to bring out the cryostat instrumentation signals.

LONG MAGNET FABRICATION

Component Magnets

Magnet DD0011 was completed on June 30.

Magnet DD0013 was received from BNL June 9. Vertical plane measurements were completed, and strain gauges were installed on the cold mass. Posts for the cradles are completed and await inspection. These parts will be available on July 12.

Optical surveying of the cold mass and assembly of the vacuum vessel is in process. All other subassemblies were completed, and the magnet should be complete by July 25.

Progress on Pilot Production Facility

Space has been cleared to allow the installation of press staging tables. One table will be used to assemble laminated tooling. The curing-press heat-plant heat exchanger is being connected to the building's air-conditioning system.

A load test was successfully conducted for an H-frame assembly of the collaring press.

Procurement of press and tooling components continues. A potential problem exists in the delivery time required for the press tie rods. The stress-proof steel selected for the tie rods would require a mill run, and delivery would take 22 weeks. Possible substitute materials are being investigated.

Coil-size data acquisition system specifications are being readied. Following a review of the data acquisition specification, procurement will proceed.

The center section of the winding table was received from BNL. The control panel and some miscellaneous parts are still to come.

F-Series Model Program

Magnet F2 has been assembled and welded into its skin. It should be ready for testing by July 18. Coil sizing of magnet F3 is completed, and collaring will be possible after the sizing curves are analyzed. Also required for F3 are inner and outer end saddles (provided by LBL), some collar packs, gauge packs (being assembled now), iron lamination packs, and some wedge and end-piece modifications.

G-10 inner return-end parts for magnet F-4 were released to the machine shop. Tool-pathing and drawing the parts have begun. A similar outer return-end part layout was started. All other winding and curing parts will be released in July; winding should be possible by the end of August.

Coil compression gauges for NC-9 inner and outer analysis have been released and are to be completed by July 18. Photoelastic stress analysis mockups for NC-9 collaring tooling are released and due by July 8.

Accelerator

A program to calculate energy deposition in arbitrary geometry and magnetic fields for SSC-type incident energies is now up and running. Work on energy deposition in a large, generic SSC detector was written and should soon be ready for distribution.

LBL REPORT

SUPERCONDUCTOR AND CABLE

The prototype production cabling machine, which is being built at Dour Metal in Belgium, was tested successfully at the Dour plant. During this acceptance test, cable was made to SSC outer-layer specifications at the maximum design operating speed of 30 feet per minute. (Report SSC-MAG-208, by J. Royet, contains details.) The cable meets SSC mechanical and dimensional specifications; critical current measurements are in progress at BNL. After a few minor problems identified during the acceptance trials are corrected, the machine will be packaged and shipped to the New England Electric Wire plant in New Hampshire. A final series of tests will be performed by personnel from Dour, LBL, and NEEW. After these tests are complete, the machine will be available for fabrication of SSC cable. If shipping and customs clearance proceed smoothly, the cabling machine should be installed and operational by September.

Superconductor wire intended for use in long magnets DD0017 and DD0018 was completed by IGC (inner layer) and Supercon (outer layer). However, the production cabling runs originally planned for late June were delayed. The IGC run was postponed pending an evaluation of trial cables made at LBL and of wire breaks that occurred during wire manufacturing. Preliminary results indicated that some of the wire had poor mechanical properties and may have to be rejected. Detailed discussions of these results will take place at IGC on July 12 with R. Scanlan (LBL), D. Larbalestier (University of Wisconsin), and R. Remsbottom (University of Wisconsin).

Trial lengths of cable were made from the Supercon wire, and samples were sent to BNL for critical current measurements. The production run will be made when these tests are completed.

MAGNET MODELS

Dipole Models

D15A-5R1. Rebuilt dipole D15A-5, called D15A-5R1, was tested May 31–June 14. The room temperature thermal cycle occurred June 8-9. Magnet D15A-5 was originally tested March 11–18 and had somewhat poorer-than-average training, although very high plateau currents were reached (7140 A at 4.3 K and 9400 A at 1.8 K).

The magnet was rebuilt with new sheet insulation to see whether training can be undone by a reassembly operation. Would the rebuilt magnet retain the training, retrain as the original magnet, or train in a new pattern?

In this case, the rebuilt magnet trained in a somewhat different pattern. All the training quenches of the rebuilt magnet were in the outer layer; the original magnet had training quenches in both layers, predominantly in the inner layer. The magnets reached similar maximum currents. Our conclusion is that, in this case, the magnet's training memory was destroyed by rebuilding; however, the difference in training behavior shows that details may be sensitive to small undetected or uncontrolled variations in assembly procedures.

After testing, this model was disassembled and found to have an outer-coil pressure gauge reading incorrectly. Gauges have been repaired and are ready for collaring. This reassembly, designated D15A-5R2, will attempt to "fix" the outer layer training of the R1 test by assembling to a higher outer coil prestress of 8000 psi.

D15A-6. Model D15A-6 assembly was completed June 23. Final inner- and outer-coil prestresses were 8300 and 6400, respectively. This magnet incorporates a new conductor, in which proximity coupling of the 5-μm filaments is prevented by doping the copper matrix between the filaments with manganese. The complete test period will extend into most of July. The first and third quenches were in the outer layer at 5737 A and at 6671 A, respectively. The plateau quench at 4.3 K was in the inner layer at 6890 A.

End Design. N.C. machining of the third straight-end test coil is complete. The coil will be wound, impregnated with epoxy, and autopsied in mid-July.

Conceptual design of flared-end windings that produce acceptable integrated multipoles is finished. (A report should be available soon.) Several difficulties associated with the theory of three-dimensional iron and the reduction of three-dimensional magnetic problems into a more simple two-dimensional version have been resolved. In the future, it should be possible to compute end harmonics and fields from a three-dimensional end that includes axisymmetrical iron. The computations, however, will be carried out using two-dimensional codes.

Clamped-Collar Model. A modified clamping system was fabricated to clamp the iron yoke blocks firmly against the collars (either aluminum or iron) during assembly and operation. The model in which this will be incorporated has not been determined. We have punched magnetic iron collars for a proposed close-in iron system. (Stainless steel collars could be used as well.)

FNAL Style Curing Fixtures. New 1-m dipole coil-curing fixtures will be built at LBL. FNAL will provide the lamination assemblies, and the other machined parts will be fabricated at LBL according to FNAL drawings.

PROJECT COST DATA

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TABLE C-1

CENTRAL DESIGN GROUP - SUPERCOLLIDER

JUNE 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.1	ADMINISTRATION	46.2	82.5	67.0	195.6	2300.3	3600.5
1.2	PROGRAM PLANNING & MANAGEMENT	31.0	3.7	11.3	46.0	429.8	554.0
1.3	ACCELERATOR R & D	105.4	180.7	114.8	400.9	3821.7	5891.5
1.4	CONVENTIONAL SYSTEMS DEVELOP.	19.2	22.2	14.3	55.7	405.0	793.0
	PROGRAM COSTS	201.7	289.1	207.3	698.2	6956.8	10839.0
1.41	RTK COSTS	0.0	2.8	0.0	2.8	31.9	130.0
	CDG/RTK COSTS	201.7	291.9	207.3	701.0	6988.7	10969.0
	COMMITMENTS					490.4	
	CHANGE IN COMMITMENTS (Delta)					-31.7	
	EQUIPMENT COSTS					0.0	229.0

TABLE C-2

BROOKHAVEN NATIONAL LABORATORY - SUPERCOLLIDER

JUNE 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
2.1	LONG MAGNET FABRICATION	41.4	132.0	80.2	253.6	2417.3	3600.0
2.2	TOOLING & FIXTURES	26.4	11.8	17.6	55.8	1819.3	2271.0
2.3	SHORT MODEL MAGNETS	18.8	0.0	8.7	27.5	278.8	375.0
2.4	INDUSTRIALIZATION	7.5	0.0	3.5	11.0	125.4	175.0
2.5	ACC. LIFE TEST (CRYO)	15.1	3.7	8.7	27.5	499.3	650.0
	PROGRAM COSTS	109.2	147.5	118.7	375.4	5139.9	7071.0
	COMMITMENTS					634.0	
	CHANGE IN COMMITMENTS (Delta)					-44.0	
	EQUIPMENT COSTS	0.0	165.3	0.0	165.3	346.0	500.0
	EQUIPMENT OPEN COMMITMENTS					50.8	

TABLE C-3

FERMI NATIONAL ACCELERATOR LABORATORY - SUPERCOLLIDER

JUNE 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
3.1	GENERAL	0.0	6.3	2.5	8.8	79.6	220.0
3.2	LONG MAGNET FABRICATION	38.5	60.3	38.5	137.3	1116.1	1242.0
3.3	MAGNETIC MEASUREMENTS	59.5	19.6	30.8	109.9	1931.2	1363.0
3.4	COLD MASS FABRICATION	2.2	-155.1	-59.6	-212.5	512.8	2241.0
3.5	INDUSTRIALIZATION	3.3	1.3	1.8	6.4	65.0	214.0
3.6	CELL TESTS	0.0	0.0	0.0	0.0	0.0	0.0
	PROGRAM COSTS	103.5	-67.6	14.0	49.9	3704.7	5280.0
	COMMITMENTS					330.2	
	CHANGE IN COMMITMENTS (Delta)					-85.8	
	EQUIPMENT COSTS	0.0	0.0	0.0	0.0	79.9	271.0
	EQUIPMENT OPEN COMMITMENTS					-10.3	

TABLE C-4

LAWRENCE BERKELEY LABORATORY - SUPERCOLLIDER

JUNE 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET*
4.1	GENERAL	7.6	0.0	3.6	11.2	85.5	190.0
4.2	SUPERCONDUCTOR	1.9	129.9	22.8	154.6	461.7	750.0
4.3	QUADRUPOLE DEVELOPMENT	0.0	0.0	0.0	0.0	0.0	100.0
4.4	COMP. DEVELOP. & TESTS	21.5	2.3	11.3	35.1	944.7	1175.0
4.5	INDUSTRIALIZATION	0.0	0.0	0.0	0.0	0.0	50.0
	MAGNET R & D TOTALS	31.0	132.2	37.7	200.9	1491.9	2265.0
4.6	ACCELERATOR PHYSICS R & D	21.8	1.2	11.0	34.0	283.3	380.0
	LBL/THEORY COSTS	52.8	133.4	48.7	234.9	1775.2	2645.0
	COMMITMENTS					143.0	
	CHANGE IN COMMITMENTS (Delta)					-135.0	

TABLE C-5

PROGRAM SUMMARY - SUPERCOLLIDER

JUNE 1988 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.	CDG PROGRAM	201.7	289.1	207.3	698.2	6956.8	10839.0
1.41	RTK PROGRAM	0.0	2.8	0.0	2.8	31.9	130.0
2.	BNL SSC PROGRAM	109.2	147.5	118.7	375.4	5139.9	7071.0
3.	FNAL SSC PROGRAM	103.5	-67.6	14.0	49.9	3704.7	5280.0
4.	LBL SSC PROGRAM	52.8	133.4	48.7	234.9	1775.2	2645.0
	TOTAL SSC PROGRAM COSTS	467.2	505.2	388.7	1361.2	17608.5	25965.0
	COMMITMENTS					1597.6	
	CHANGE IN COMMITMENTS (Delta)					-296.5	
	EQUIPMENT COSTS					425.9	1000.0
	EQUIPMENT OPEN COMMITMENTS					40.5	

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	903.3	903.3	33.4	33.4	496.4	496.4	463.0	463.0
NOV	903.3	1806.5	747.4	780.8	572.4	1068.8	288.0	-175.0
DEC	903.3	2709.8	1221.6	2002.4	1199.6	2268.4	266.0	-22.0
JAN	903.3	3613.0	549.0	2551.4	478.2	2746.6	195.2	-70.8
FEB	903.3	4516.3	781.8	3333.2	995.0	3741.6	408.3	213.1
MAR	903.3	5419.5	931.9	4265.1	898.0	4639.5	374.4	-33.9
APR	903.3	6322.8	1129.4	5394.6	1398.8	6038.3	643.7	269.3
MAY	903.3	7226.0	893.1	6287.7	771.5	6809.8	522.1	-121.6
JUN	903.3	8129.3	701.0	6988.7	669.3	7479.1	490.4	-31.7
JUL	903.3	9032.5						
AUG	903.3	9935.8						
SEP	903.3	10839.0						

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	589.3	589.3	498.0	498.0	2095.0	2095.0	1597.0	1597.0
NOV	589.3	1178.5	643.0	1141.0	995.0	3090.0	1949.0	352.0
DEC	589.3	1767.8	763.6	1904.6	632.6	3722.6	1818.0	-131.0
JAN	589.3	2357.0	894.9	2799.5	831.9	4554.5	1755.0	-63.0
FEB	589.3	2946.3	702.0	3501.5	516.0	5070.5	1569.0	-186.0
MAR	589.3	3535.5	708.7	4210.2	431.7	5502.2	1292.0	-277.0
APR	589.3	4124.8	265.8	4476.0	265.8	5768.0	1292.0	0.0
MAY	589.3	4714.0	287.7	4763.7	-326.3	5441.7	678.0	-614.0
JUN	589.3	5303.3	375.4	5139.1	331.4	5773.1	634.0	-44.0
JUL	589.3	5892.5						
AUG	589.3	6481.8						
SEP	589.3	7071.0						

3.0 FERMI NAT'L ACCEL LAB - SUPERCOLLIDER

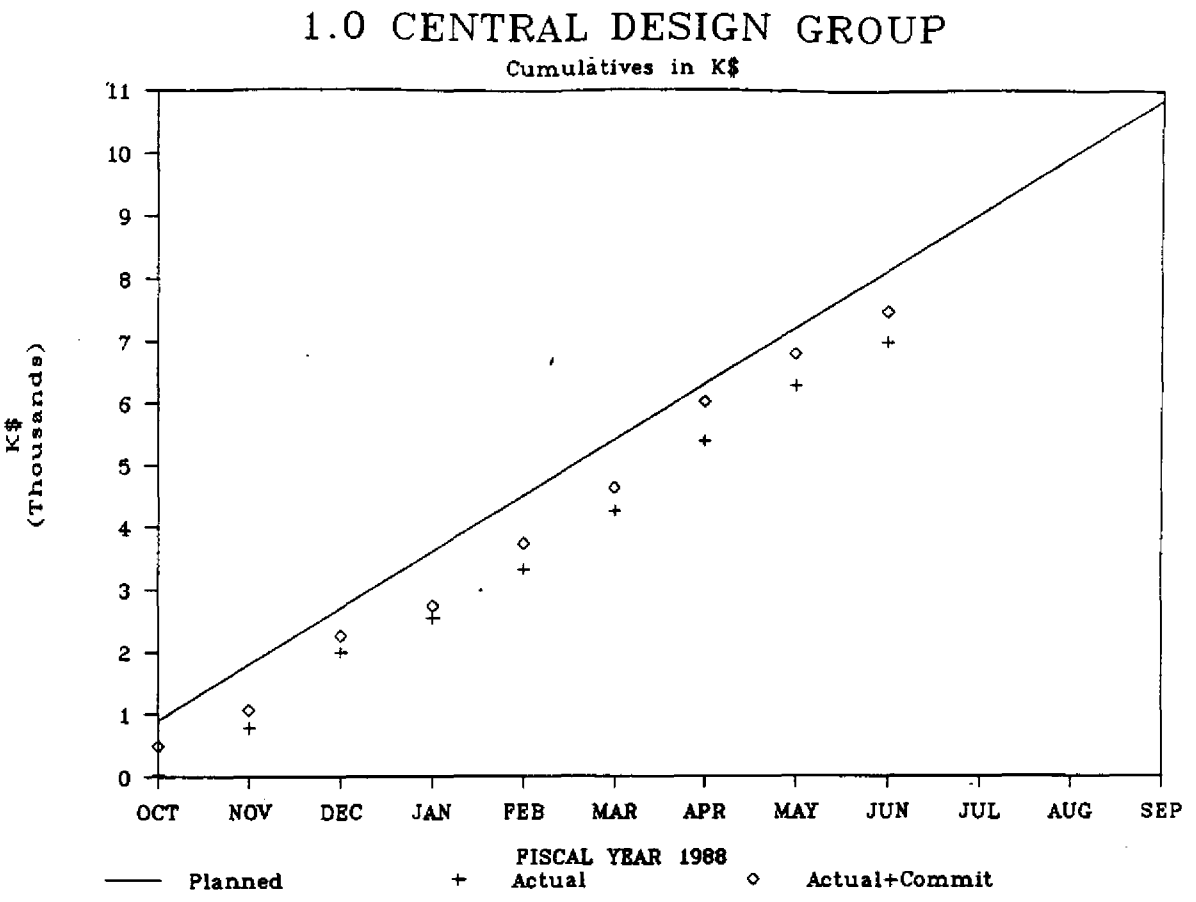
DATE	MONTHLY PLANNED COSTS	FY PLANNED CUMULAT	MONTHLY ACTUAL COSTS	FY ACTUALS CUMULAT	MO ACT+ DELTA COMMITS	CUM ACT + COMMITS	CURRENT COMMITS	DELTA COMMITS
OCT	440.0	440.0	314.7	314.7	792.5	792.5	477.8	477.8
NOV	440.0	880.0	390.6	705.3	353.1	1145.6	440.3	-37.5
DEC	440.0	1320.0	694.7	1400.0	462.4	1608.0	208.0	-232.3
JAN	440.0	1760.0	307.3	1707.3	465.3	2073.3	366.0	158.0
FEB	440.0	2200.0	720.2	2427.5	722.5	2795.8	368.3	2.3
MAR	440.0	2640.0	457.2	2884.7	566.6	3362.4	477.7	109.4
APR	440.0	3080.0	412.7	3297.4	410.5	3772.9	475.5	-2.2
MAY	440.0	3520.0	357.4	3654.8	297.9	4070.8	416.0	-59.5
JUN	440.0	3960.0	49.9	3704.7	-35.9	4034.9	330.2	-85.8
JUL	440.0	4400.0						
AUG	440.0	4840.0						
SEP	440.0	5280.0						

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	81.3	1540.3	246.3	1818.3	278.0	165.0
JUN	220.4	1983.8	234.9	1775.2	99.9	1918.2	143.0	-135.0
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	2152.9	2152.9	1076.6	1076.6	4046.4	4046.4	2969.8	2969.8
NOV	2152.9	4305.8	1972.1	3048.7	2111.6	6158.0	3109.3	139.5
DEC	2152.9	6458.8	2815.8	5864.5	2430.5	8588.5	2724.0	-385.3
JAN	2152.9	8611.7	2014.5	7879.0	1950.7	10539.2	2660.2	-63.8
FEB	2152.9	10764.6	2389.8	10268.8	2369.3	12908.5	2639.6	-20.6
MAR	2152.9	12917.5	2336.3	12605.1	2061.8	14970.2	2365.1	-274.5
APR	2152.9	15070.4	2021.8	14627.0	2181.0	17151.2	2524.2	159.1
MAY	2152.9	17223.3	1619.5	16246.5	989.4	18140.6	1894.1	-630.1
JUN	2152.9	19376.3	1361.2	17607.7	1064.7	19205.3	1597.6	-296.5
JUL	2152.9	21529.2						
AUG	2152.9	23682.1						
SEP	2152.9	25835.0						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K$ (Thousands)
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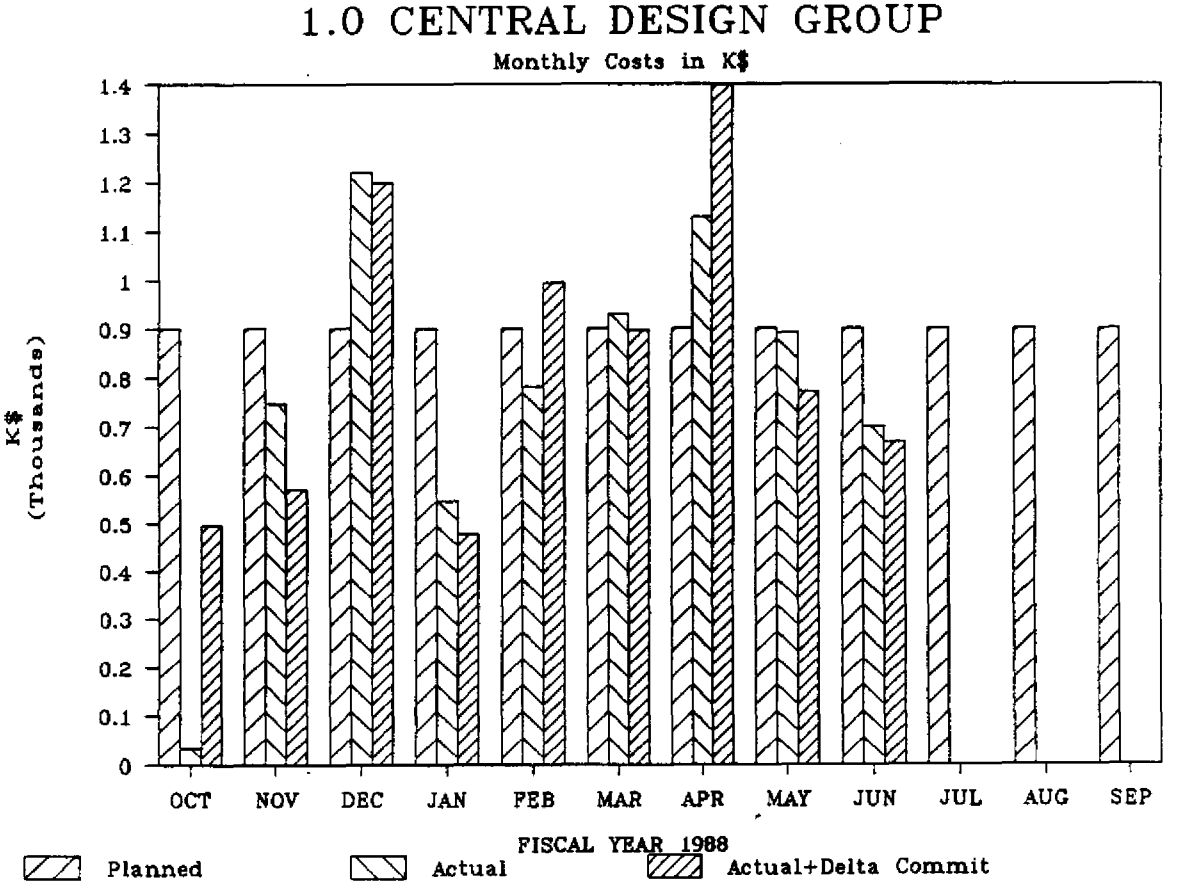
2
3
4
5
6
7
8
9
10
11
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit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Monthly Costs in K$
K$ (Thousands)
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0.2
0.3
0.4
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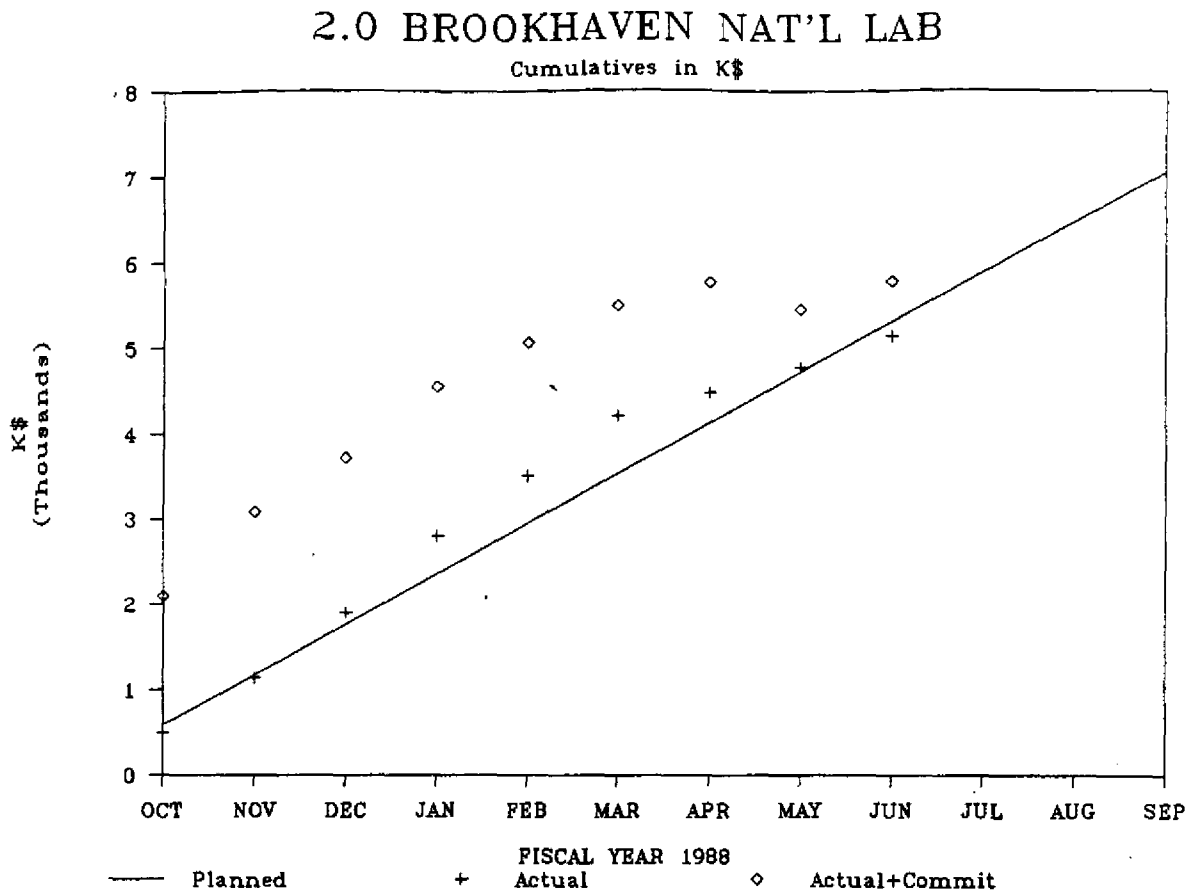
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 1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Cumulatives in K$
K$ (Thousands)
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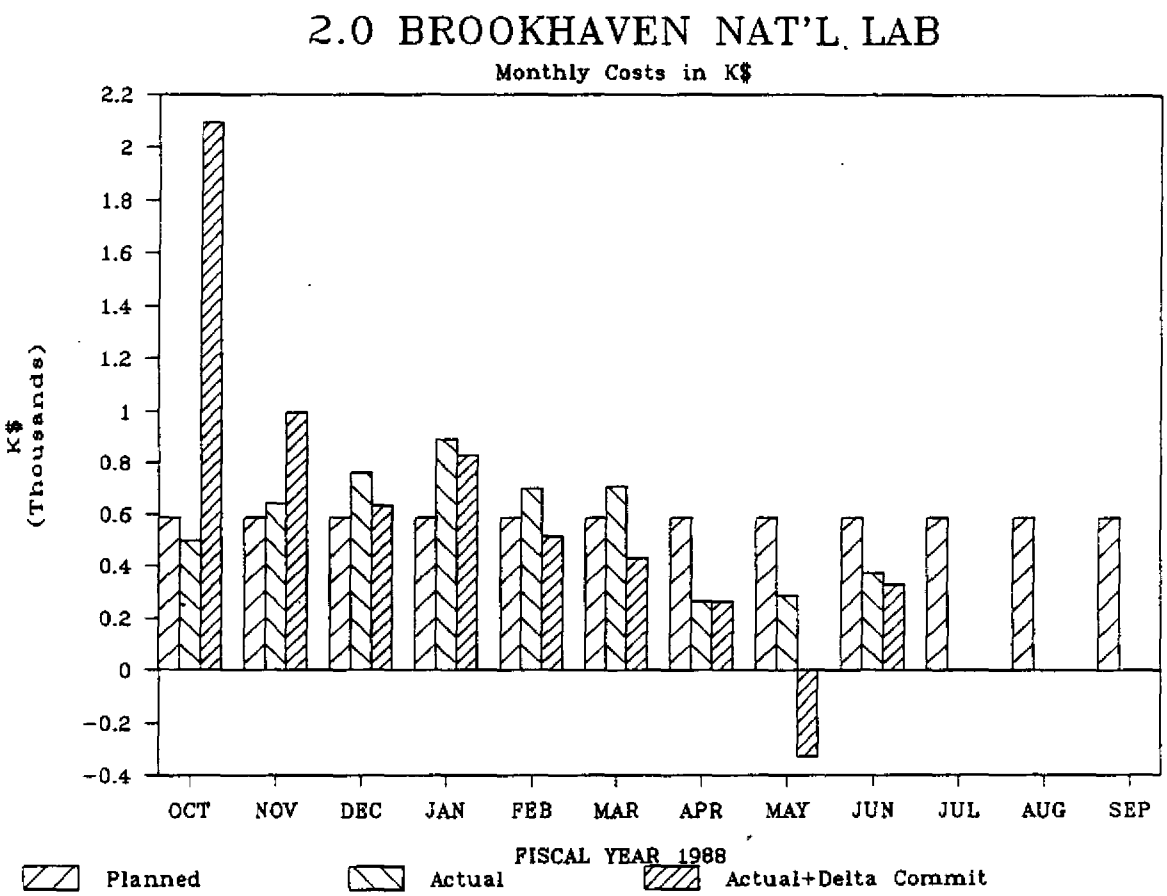
1
2
3
4
5
6
7
8
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit


2.0 BROOKHAVEN NAT'L LAB
Monthly Costs in K$
K$ (Thousands)
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2
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1.6
1.4
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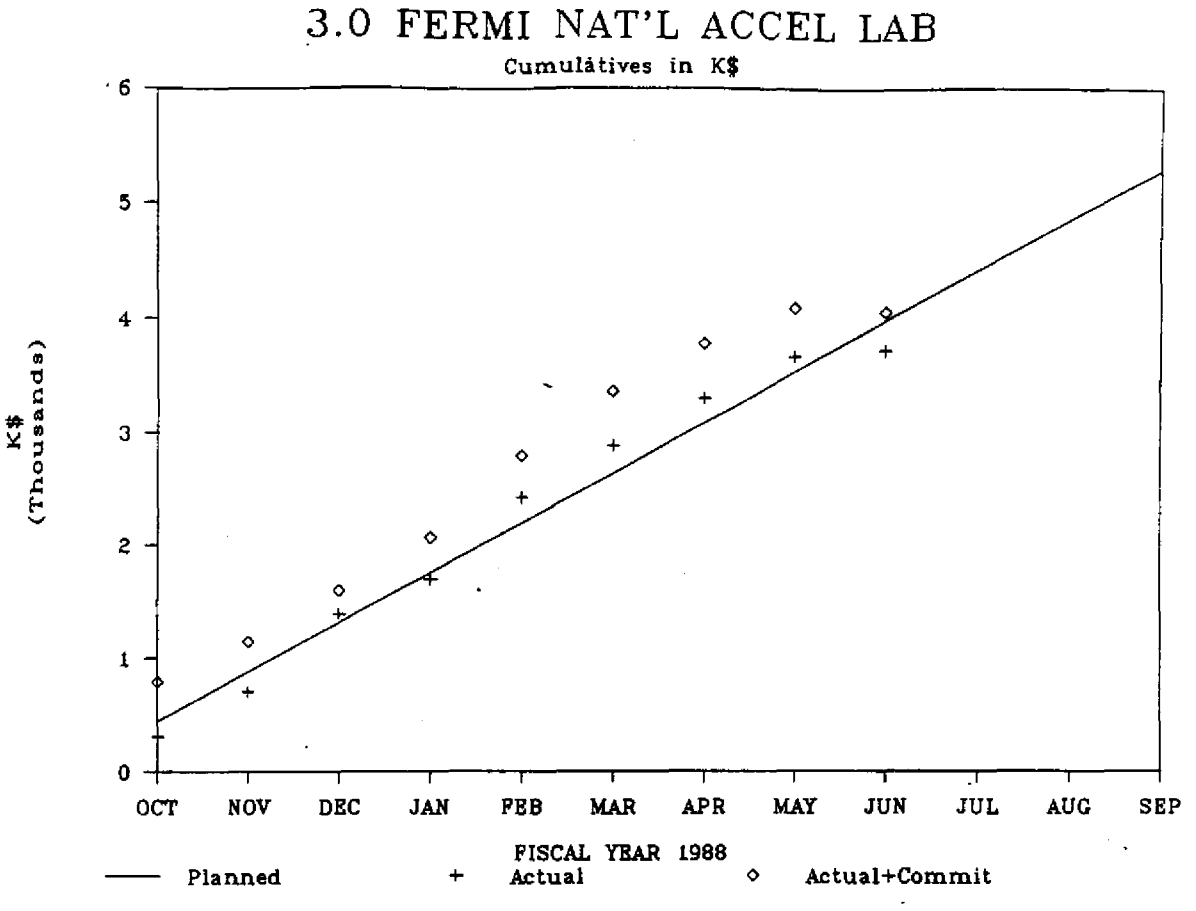
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 2


3.0 FERMI NAT'L ACCEL LAB
Cumulatives in K$
K$ (Thousands)
0
1
2
3
4
5
6
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Commit

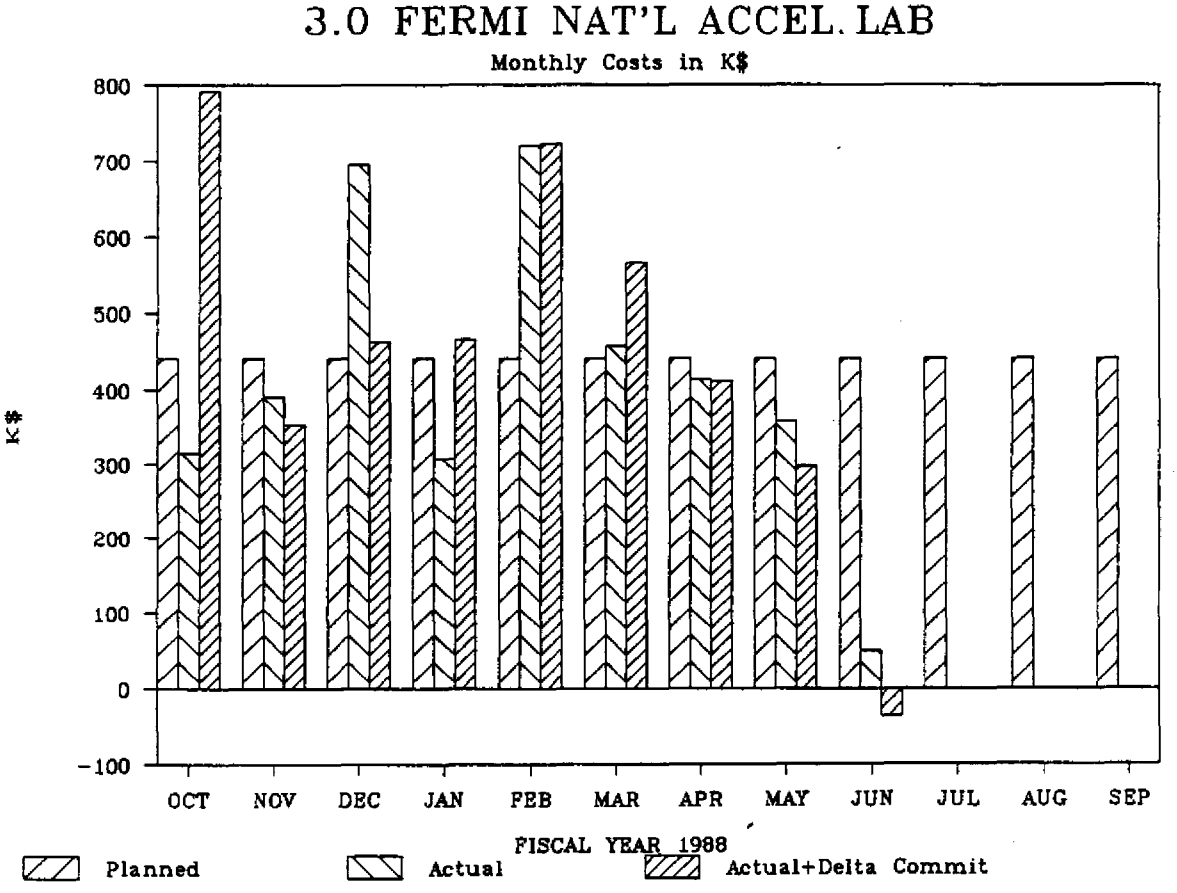
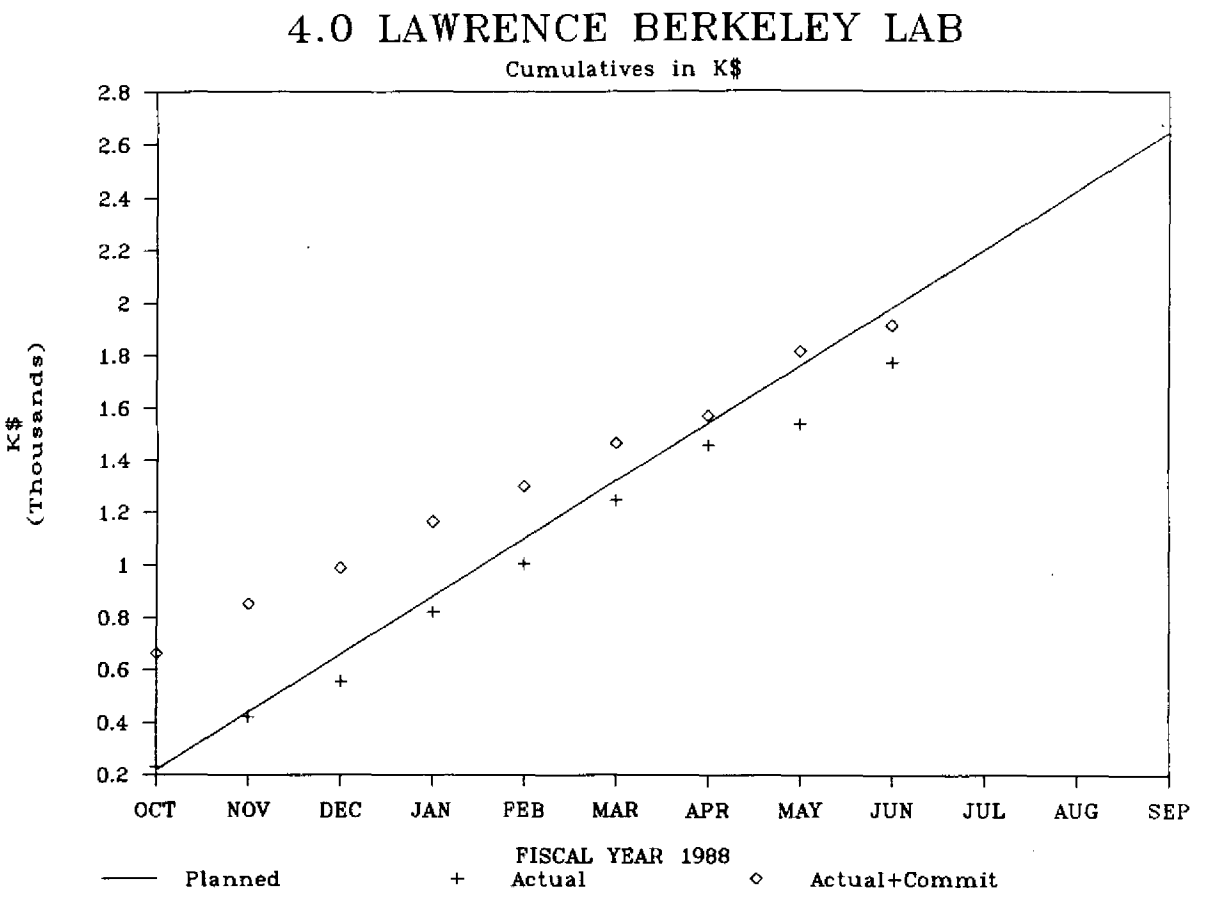

3.0 FERMI NAT'L ACCEL. LAB
Monthly Costs in K$
K$
800
700
600
500
400
300
200
100
0
-100
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

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

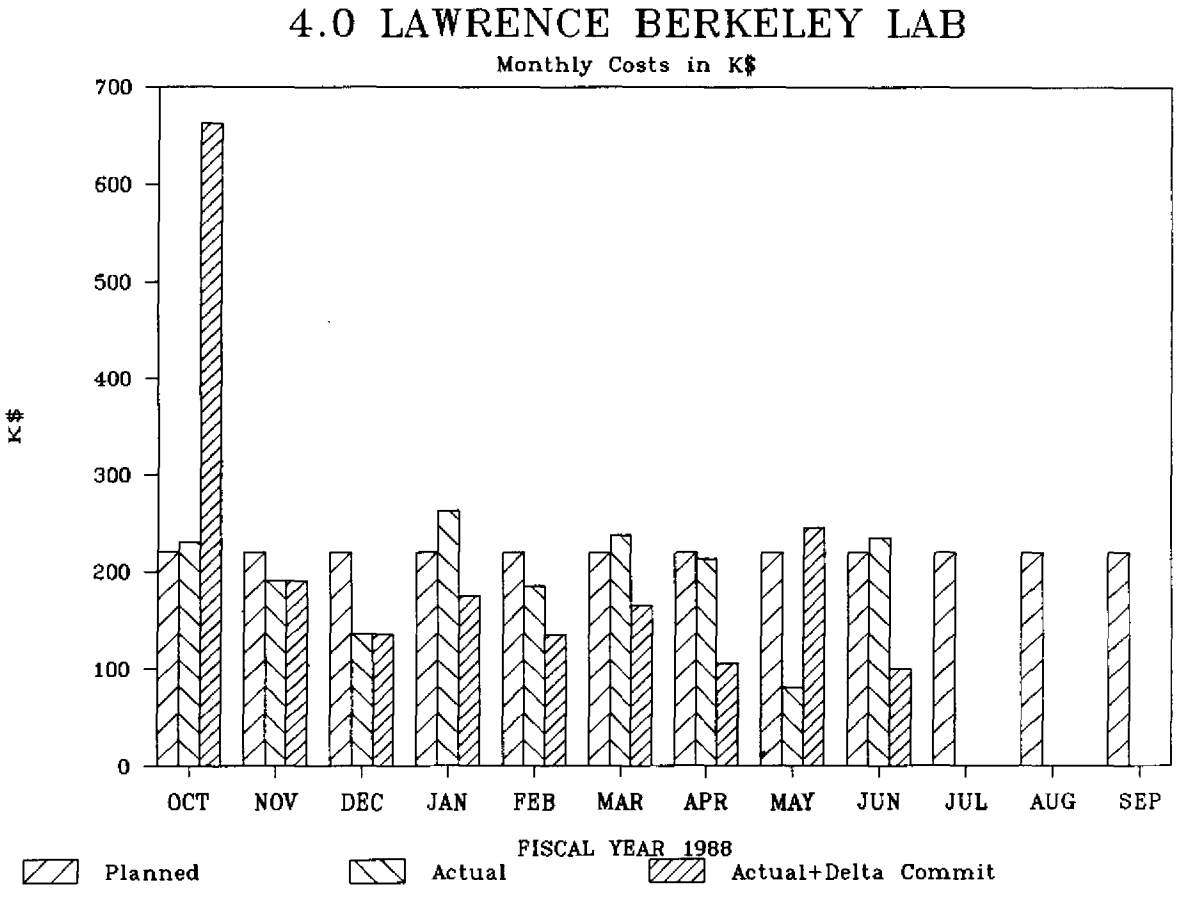
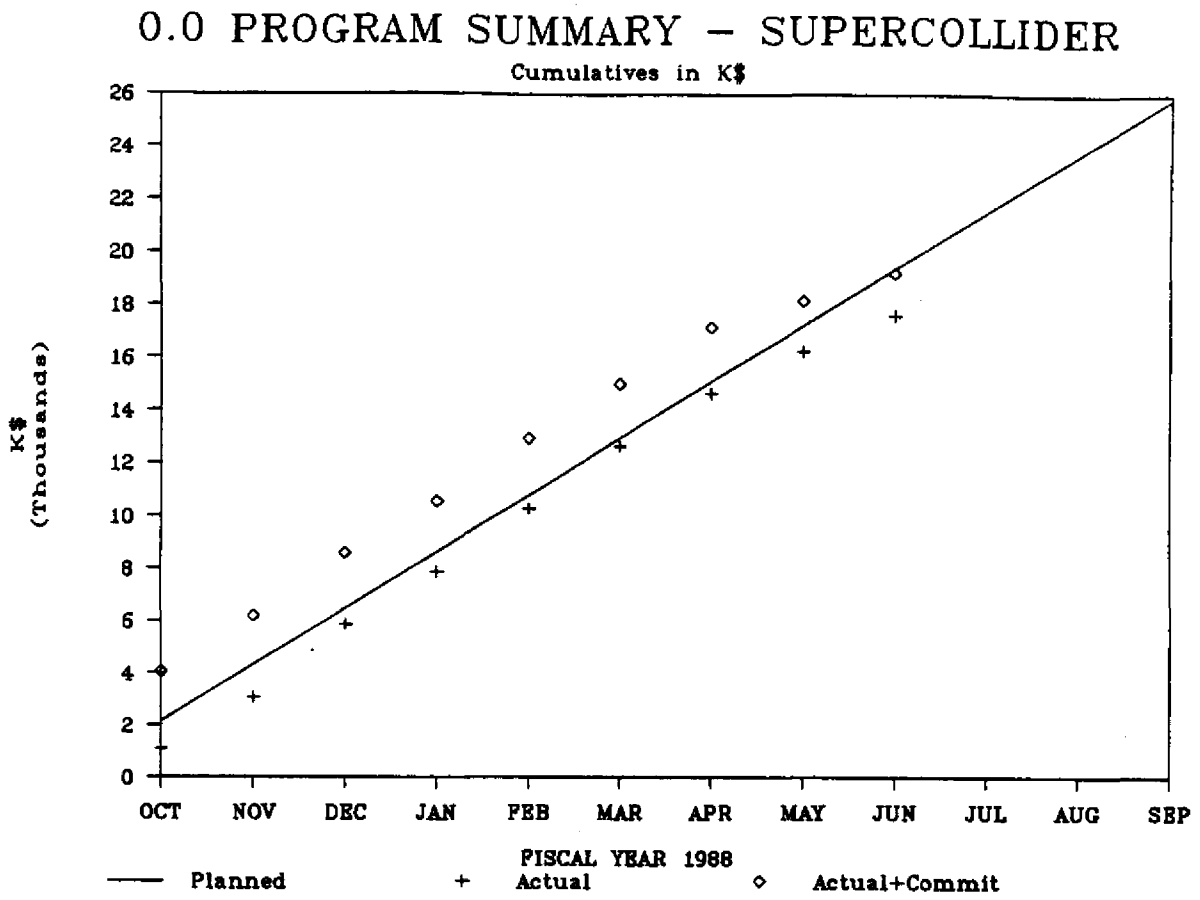

4.0 LAWRENCE BERKELEY LAB
Monthly Costs in K$
K$
700
600
500
400
300
200
100
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 4


0.0 PROGRAM SUMMARY – SUPERCOLLIDER
Cumulatives in K$
K$ (Thousands)
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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

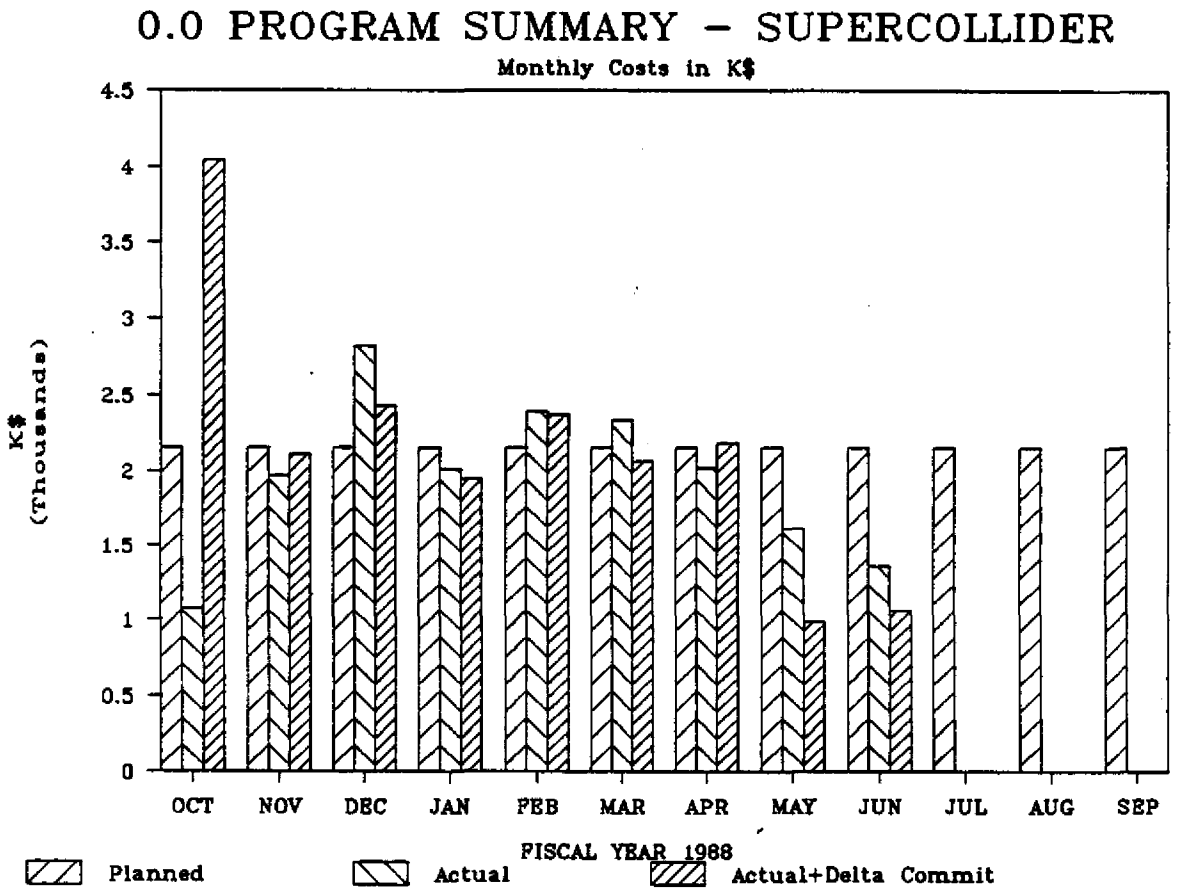
0.0 PROGRAM SUMMARY – SUPERCOLLIDER
Monthly Costs in K$
K$ (Thousands)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1988
Planned
Actual
Actual+Delta Commit

Figure 5

FNAL REPORT

DIPOLE CRYOSTAT

Procedures for handling and securing insulation continue to be improved. They will be incorporated as appropriate into the long magnet models. Insulation blankets for five additional magnet models, beginning with DD0013, have been produced. The "Proud Mary" insulation fabrication facility will be decommissioned in July.

DD0014 was installed on the MTF test stand and will be cooled down in July. Critical cryostat parameters will be monitored during cooldown, steady state, and warmup. Modal analysis of DD0014 was rescheduled for September.

Long magnet model DD0011 was completed.

Subassembly preparations, including fabrication of support posts, anchor assemblies, and insulation blankets, are under way for long magnet DD0013.

Two designs for a vertical plane probe transporter are being developed in conjunction with GDSS. One design incorporates a self-propelled walker; the other uses a deployable boom. Models will be built and evaluated.

Plans are being developed for the procurement of components for FY89 long magnet cryostat kits. It is planned to procure components like support posts, vacuum vessels, etc., in final form for kit incorporation. Components for sixteen models will be procured.

Work continues on magnet design for installation. Initial studies were completed on the magnet vertical-centerline–to–centerline spacing and bottom-magnet–floor spacing. Effort is planned for magnet support stand design.

Preparation for industrialization continues. The draft of the Fermilab On-Site Program for Phase 1, Technology Orientation, was sent to the CDG.

Magnetic Measurements

Tests of magnet DD0012 were completed. It was warmed to room temperature and will be removed from test stand 5, where DD0011 will be mounted.

On the second thermal cycle of DD0012, a total of 18 spontaneous quenches were taken: three at 4.4 K and 4 atm, six at 3.2 K and 4 atm, five at 2.8 K and 4 atm, and four at 4.3 K and 1.5 atm. One training quench at 4.4 K followed the warmup-cooldown cycle before the magnet returned to quenching at the short sample limit of approximately 6500 A. (There were no training quenches on the first cooldown.) At 3.2 K a single training quench at 7360 A was followed by four plateau quenches at approximately 7600 A. At 2.8 K, the quench currents were somewhat erratic, ranging between 7050 A and 7640 A. The cause of this behavior is unknown at present. Two more quenches were taken at 3.2 K, which were at the previous plateau current. Four quenches were taken in sub-cooled liquid at 4.3 K and 1.5 atm. These quenches do not

appear significantly different from the quenches in 4-atm supercritical fluid. Quenches were induced with spot heaters at each end of the magnet at 7400 A at 3.2 K and at 6460 A in sub-cooled liquid.

Strain-gauge data were taken up to 6360 A at 4.4 K and up to 7370 A at 3.2 K. At the highest current measured, the inner coil stresses range from 1400 psi to 2100 psi and are clearly falling more slowly than quadratically with increasing current. The total force of the coil on the end plate is 10500 pounds at 7360 A and is increasing a little faster than quadratically with increasing current.

Cooldown of magnet DD0014 is anticipated to begin in mid-July. The new electronics and readout equipment needed to read the extensive instrumentation on the cryostat have been installed. Several leaks in the magnet vacuum vessel were encountered in mounting and checking the magnet, principally in several of the special ports used to bring out the cryostat instrumentation signals.

LONG MAGNET FABRICATION

Component Magnets

Magnet DD0011 was completed on June 30.

Magnet DD0013 was received from BNL June 9. Vertical plane measurements were completed, and strain gauges were installed on the cold mass. Posts for the cradles are completed and await inspection. These parts will be available on July 12.

Optical surveying of the cold mass and assembly of the vacuum vessel is in process. All other subassemblies were completed, and the magnet should be complete by July 25.

Progress on Pilot Production Facility

Space has been cleared to allow the installation of press staging tables. One table will be used to assemble laminated tooling. The curing-press heat-plant heat exchanger is being connected to the building's air-conditioning system.

A load test was successfully conducted for an H-frame assembly of the collaring press.

Procurement of press and tooling components continues. A potential problem exists in the delivery time required for the press tie rods. The stress-proof steel selected for the tie rods would require a mill run, and delivery would take 22 weeks. Possible substitute materials are being investigated.

Coil-size data acquisition system specifications are being readied. Following a review of the data acquisition specification, procurement will proceed.

The center section of the winding table was received from BNL. The control panel and some miscellaneous parts are still to come.

F-Series Model Program

Magnet F2 has been assembled and welded into its skin. It should be ready for testing by July 18. Coil sizing of magnet F3 is completed, and collaring will be possible after the sizing curves are analyzed. Also required for F3 are inner and outer end saddles (provided by LBL), some collar packs, gauge packs (being assembled now), iron lamination packs, and some wedge and end-piece modifications.

G-10 inner return-end parts for magnet F-4 were released to the machine shop. Tool-pathing and drawing the parts have begun. A similar outer return-end part layout was started. All other winding and curing parts will be released in July; winding should be possible by the end of August.

Coil compression gauges for NC-9 inner and outer analysis have been released and are to be completed by July 18. Photoelastic stress analysis mockups for NC-9 collaring tooling are released and due by July 8.

Accelerator

A program to calculate energy deposition in arbitrary geometry and magnetic fields for SSC-type incident energies is now up and running. Work on energy deposition in a large, generic SSC detector was written and should soon be ready for distribution.

LBL REPORT

SUPERCONDUCTOR AND CABLE

The prototype production cabling machine, which is being built at Dour Metal in Belgium, was tested successfully at the Dour plant. During this acceptance test, cable was made to SSC outer-layer specifications at the maximum design operating speed of 30 feet per minute. (Report SSC-MAG-208, by J. Royet, contains details.) The cable meets SSC mechanical and dimensional specifications; critical current measurements are in progress at BNL. After a few minor problems identified during the acceptance trials are corrected, the machine will be packaged and shipped to the New England Electric Wire plant in New Hampshire. A final series of tests will be performed by personnel from Dour, LBL, and NEEW. After these tests are complete, the machine will be available for fabrication of SSC cable. If shipping and customs clearance proceed smoothly, the cabling machine should be installed and operational by September.

Superconductor wire intended for use in long magnets DD0017 and DD0018 was completed by IGC (inner layer) and Supercon (outer layer). However, the production cabling runs originally planned for late June were delayed. The IGC run was postponed pending an evaluation of trial cables made at LBL and of wire breaks that occurred during wire manufacturing. Preliminary results indicated that some of the wire had poor mechanical properties and may have to be rejected. Detailed discussions of these results will take place at IGC on July 12 with R. Scanlan (LBL), D. Larbalestier (University of Wisconsin), and R. Remsbottom (University of Wisconsin).

Trial lengths of cable were made from the Supercon wire, and samples were sent to BNL for critical current measurements. The production run will be made when these tests are completed.

MAGNET MODELS

Dipole Models

D15A-5R1. Rebuilt dipole D15A-5, called D15A-5R1, was tested May 31–June 14. The room temperature thermal cycle occurred June 8-9. Magnet D15A-5 was originally tested March 11–18 and had somewhat poorer-than-average training, although very high plateau currents were reached (7140 A at 4.3 K and 9400 A at 1.8 K).

The magnet was rebuilt with new sheet insulation to see whether training can be undone by a reassembly operation. Would the rebuilt magnet retain the training, retrain as the original magnet, or train in a new pattern?

In this case, the rebuilt magnet trained in a somewhat different pattern. All the training quenches of the rebuilt magnet were in the outer layer; the original magnet had training quenches in both layers, predominantly in the inner layer. The magnets reached similar maximum currents. Our conclusion is that, in this case, the magnet's training memory was destroyed by rebuilding; however, the difference in training behavior shows that details may be sensitive to small undetected or uncontrolled variations in assembly procedures.

After testing, this model was disassembled and found to have an outer-coil pressure gauge reading incorrectly. Gauges have been repaired and are ready for collaring. This reassembly, designated D15A-5R2, will attempt to "fix" the outer layer training of the R1 test by assembling to a higher outer coil prestress of 8000 psi.

D15A-6. Model D15A-6 assembly was completed June 23. Final inner- and outer-coil prestresses were 8300 and 6400, respectively. This magnet incorporates a new conductor, in which proximity coupling of the 5-μm filaments is prevented by doping the copper matrix between the filaments with manganese. The complete test period will extend into most of July. The first and third quenches were in the outer layer at 5737 A and at 6671 A, respectively. The plateau quench at 4.3 K was in the inner layer at 6890 A.

End Design. N.C. machining of the third straight-end test coil is complete. The coil will be wound, impregnated with epoxy, and autopsied in mid-July.

Conceptual design of flared-end windings that produce acceptable integrated multipoles is finished. (A report should be available soon.) Several difficulties associated with the theory of three-dimensional iron and the reduction of three-dimensional magnetic problems into a more simple two-dimensional version have been resolved. In the future, it should be possible to compute end harmonics and fields from a three-dimensional end that includes axisymmetrical iron. The computations, however, will be carried out using two-dimensional codes.

Clamped-Collar Model. A modified clamping system was fabricated to clamp the iron yoke blocks firmly against the collars (either aluminum or iron) during assembly and operation. The model in which this will be incorporated has not been determined. We have punched magnetic iron collars for a proposed close-in iron system. (Stainless steel collars could be used as well.)

FNAL Style Curing Fixtures. New 1-m dipole coil-curing fixtures will be built at LBL. FNAL will provide the lamination assemblies, and the other machined parts will be fabricated at LBL according to FNAL drawings.

PROJECT COST DATA

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