SSC-135

Superconducting Super Collider Laboratory

SSC-135

SSC Monthly Report

June 1987

June 1987 SSC Monthly Report SSC-135

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PROJECT SUMMARY

CENTRAL DESIGN GROUP (CDG)

A Magnet System Integration meeting was held at LBL June 2–3.

The Cold Mass Design Review was conducted by CDG on June 29.

The magnet Accelerated Life Test design review panel met at BNL on June 25.

A short workshop on SSC cryogenics at Fermilab June 11–12 was chaired by Mike McAshan, CDG. A wrap-up paper will be issued in August.

Encouraging initial test results of the third long magnet were reported. D000X reached fields above the design value required for SSC operation.

Improvements to computer models of magnet behavior have been made. June work shows the importance of friction in coil unloading, and there were encouraging indications that coils maintain prestress longer than had been thought during the energizing cycle.

An investigation of magnet system stresses that would be induced on a typical soft soil site is in progress.

The Accelerator Systems group devoted much effort to data collection and analysis. The work comprised: continuation of data taking by the Photodesorption experiment at BNL; completion of data taking by the Neutron Flux Measurement Experiment in the Tevatron Tunnel at FNAL; and analysis of test data from FNAL on the third long magnet, D000X.

Useful information on tunnel costs, advance rates, and muck-handling techniques was obtained from a visit to a hydroelectric tunneling site. Attention was also given to shaft design and construction issues, and to a proposal to investigate reducing tunneling costs and time by using innovative contracting practices.

BROOKHAVEN NATIONAL LABORATORY (BNL)

Collaring of 1.8 m-long DSS4, precursor to long dipole DD0010, was completed this month.

All coils were wound and cured for DSS5 and DSSS6 — both magnets nominally identical to DSS4. In addition, all coils were wound and partially cured for DSSS9, precursor to long dipole DD0011.

Modifications to coil-curing form blocks were essentially completed.

Three dipoles were tested. DSS2 was retested with excellent results after having its coil ends potted with alumina-filled epoxy. DSSS7 was also tested; it exhibited satisfactory training performance and mainly satisfactory field quality. Finally, tests of LBL 1 m dipole at BNL have indicated that training performance in single-phase helium is not significantly different from that in liquid helium.

FERMI NATIONAL ACCELERATOR LABORATORY (FNAL)

Measurements on SSC dipole D000X were completed and the magnet has been warmed. The magnet trained smoothly to an apparent critical current plateau at 6800 A. The pressure, temperature, and voltage data during quenching are being analyzed to determine quench origin, quench velocity, peak pressures, and so forth.

Cryostat improvements for the B series dipoles are being tested. The cold mass connection slide has been tested extensively at room temperature on a full size cold mass and will shortly be tested on a smaller scale at 80 K.

LAWRENCE BERKELEY LABORATORY (LBL)

Inner layer cable was made at LBL for magnet DD0010 and delivered to BNL.

LBL staff spent a week at NEEW to commission the in-line measuring machine, to evaluate the capability of NEEW to produce cable to SSC specifications, and to complete transfer of LBL technology to NEEW Co. Both inner and outer cables were made successfully, and measuring equipment performed satisfactorily.

The tests on LBL 1 m model D14B11 were completed at BNL and the magnet returned to LBL for retesting.

The second 1 m model with tapered keys, D15A2, was tested and showed more training than D15A1. The increased training is perhaps associated with an intermittent turn-turn short. There

was also a training loss associated with cycling to room temperature. Measured field uniformity agreed with predictions. A third model, D15A3, is under construction.

DSS9 coils were produced at BNL with LBL components (wedges, end parts, etc.) and with participation of LBL staff. Parts and tooling for long model DD0011 are being designed and fabricated.

TEXAS ACCELERATOR CENTER (TAC)

Tests on diodes at TAC and preparations at the Texas A&M reactor are complete; a run is scheduled for the week of July 20.

The latest report on the quench diodes, "Results of Neutron Irradiation of Power Diodes at 80 K," (Paper 1292) analyzes five types of power diodes to determine their relative response to neutron radiation at cryogenic temperatures for currents up to 1 kA. The critical parameters influencing radiation resistance were also examined.

CDG REPORT

MAGNET PROGRAM

MSI Meeting

This month the Magnet System Integration meeting was held at LBL June 2–3. The agenda for the meeting was as follows:

June 2

SSC program plans	CDG	45 minutes
Tooling status	BNL	90
1. Curing press		
a. Modifications of existing tooling		
b. Dimensional tolerances achieved		
c. Design of new curing press		
2. Winding machine design upgrade status	BNL	40
D000X rest results	FNAL	30
D15A1 construction & test results	LBL	45
Collaring development at BNL	BNL	30
DSS2 status	BNL	15
DSS4/DDD010 status	BNL	40
DSS5/DD011 status	LBL/BNL	40
DDS8 status	BNL	15
D000Z status	BNL	20

June 3

D000Z cryostat status	FNAL	40
B11 status	BNL	15
D15A2 status	LBL	15
Conductor and cable R&D status	LBL	40
QA1 test results	LBL	15
Configuration management	CDG	30

The discussions at LBL began with a brief review of the revised 3-phase magnet Industrialization Plan and of the tooling status at BNL. As discussed in last month's report, the curing press is being modified to ensure acceptable tolerances on coil size variation; at the same time, several new, alternative curing press designs are under consideration. BNL's program on spot-welded collars shows promise for reducing springback and also offers certain manufacturing advantages. LBL's equally promising program on tapered keys is focusing renewed attention on aluminum collars and on the the need for systematic data on creep and relaxation phenomena.

As usual, the discussion focused on the status of magnets in various stages of assembly or testing. Long dipole D000X was reported to be undergoing final preparations for testing, with tests expected to be under way in the second week of June. (As discussed below, the magnet performed very well indeed.) Collaring experience with D15A1, the first short magnet with tapered keys, was good: the magnet achieved high final prestress with little springback. Training performance was also good, with the magnet reaching a quench plateau of ~7 kA at 4.3 K and ~9 kA at 1.8 K. The second dipole of this type, D15A2, was successfully collared; yoke insertion was expected on or about June 11. DSS2, the second 1.8 m dipole, exhibited a somewhat unstable quench plateau of ~6.5 kA at 4.5 K and nearly 8 kA at 2.6 K. This magnet will be retested, having subsequently been disassembled and its ends pressure-potted with alumina-filled epoxy — a promising new technique. DSS4 will be a precursor to long dipole DD0010, as will DSS7. DSS8, also in the pipeline, constitutes primarily an insulation test utilizing 9.5 mil Kapton instead of the standard 1 mil Kapton. DSS5 will be a precursor to long magnet DD0011. The next long magnet after D000X, D000Z, was in the final assembly stage at BNL at the time of the MSIM. DD0010 and DD0011 will be the end-points of the present two-pronged R&D program. DD0010 will incorporate BNL model magnet features verified in the relevant short model test vehicles; DD0011 will incorporate alternative LBL features. The principal features of DD0011 are expected to be aluminum collars with tapered keys, aluminum end clamps, and two-point collar support. A few preliminary quenches were reported for LBL 1 m dipole B11 in its test at BNL, but final cryogenic preparations have delayed the full-blown test. Finally, the first 1 m (LBL) quadrupole model QA1 (also utilizing tapered keys) showed considerable training; nevertheless, it achieved a respectable gradient: 270 T/m at 4.3 K.

The discussions closed with a review of conductor and cable status: possibilities of converting to higher Cu:SC ratio; evidence that interfilamentary copper is less effective in stabilizing performance than copper in the wire core or jacket ; good progress in optimizing inner-outer J_c, piece lengths and quality control; the reduction of the proximity effect between NbTi filaments by adding manganese to the copper matrix.

General progress

During June, magnet D000X was tested intensively. Test results indicate that its performance was superior to that of the two previous long magnets. It reached a quench plateau of approximately 6800 A with twelve training quenches, a plateau that agreed closely with the estimated short sample current. The origins of the quenches were near the coil end. Based on these results, and on results from DSS2, it was decided to modify the ends of D000Z, by pressure-potting them with alumina-filled epoxy. The D000Z magnet also is expected to have improved prestress. The prestress of D000X was approximately 50 percent less than the desired level.

The Cold Mass (DD0011) Design Review was conducted by CDG on June 29. The main features of DD0011 assembly are aluminum collars and tapered keys. This design is intended to

replicate successfully tested 1 m models designed and fabricated by LBL. Both of these features are intended to reduce excessive assembly pressure and maintain the ability to achieve high coil prestress. Review panel members have submitted 45 action items. Tentative conclusions were:

- No major show stoppers were uncovered.
- Avoidance of collar fracture needs to be kept in mind in deciding between aluminum and stainless steel collars.
- Many design issues have been raised that will need prompt attention.
- Utility of aluminum collar design will greatly depend on satisfactory resolution of multipole issues.
- Economics of aluminum collars will depend strongly on the acceptability of 7075–T6; whether 7075-T6 can meet design requirements is not yet certain.
- Instrumentation and measurements in areas other than training and multipoles did not receive sufficient attention.
- In spite of considerable analysis, issues raised indicate preliminary nature of the design.

The magnet Accelerated Life Test design review panel convened at BNL on June 25, 1987. The agenda is shown below:

Opening remarks – V. Karpenko, Chairman
Scope and Background – D. Brown
Magcool history & performance – J. Sondericker
Tour of Magcool facility – Sondericker, Rogers, Ganetis
Magnet connections & restraints – E. Rogers
Magnet Electrical & Ramp Rate – G. Ganetis
Heat load estimate – D. Brown

Cryogenic system, Phase I – D. Brown
Cryogenic system Phase II – K.C. Wu
Cooldown & warm-up – K.C. Wu

Testing format & duration – D. Brown
Review design parameters – D. Brown
Options for future study – D. Brown
Committee executive session

This was a preliminary design review. (A final design review is scheduled for September.) Its object was to evaluate the capability of the proposed facility to meet the Magnet Accelerated Life test objectives.

Hardware design is well advanced; fabrication of parts has begun. The design of new software and instrumentation has not yet started. The Review Panel generally accepted that the facility proposed for the life test, the method of implementing the test, the schedule, and the budget conformed to requirements in most areas.

The review panel's comments can be summarized as follows:

- As the proposed test is designed to reveal weaknesses in the construction of the magnets, it is prudent to anticipate that there may be magnet failure during the test. Therefore, the arrangement should be such that any magnet that fails can be replaced with only minimal disturbance to the rest of the setup. For example, it should not be necessary to disconnect or move any other magnets or auxiliary equipment in order to remove the offending magnet. It is suggested that consideration be given to moving the magnets laterally, and also to designing fixtures to facilitate replacement.

- The design of the leads should be modified so that they do not limit the range of the tests. For example, it may be advantageous to increase the current to 7.8 kA if the temperature is reduced.

- It is vital for the validity of the test results that auxiliary systems (e.g., quench protection circuits, warmup heaters) perform in a way that is closely analogous to the final SSC system. The CDG should provide clear specifications for these systems and future review panels should monitor their implementation closely.

- The period of seven months specified to complete the life cycle tests on one set of magnets has implications for other aspects of the magnet production schedule. An issue that will need further discussion is how to streamline the running schedule to fit into this period without falling below the test specifications.

Work continues on computer models of magnet training. Motion of the conductor and wedges is now modeled in greater detail: the model now includes 45 slide lines, 442 nodes, 175 elements, 278 slave nodes, and 258 master nodes. Lorentz forces are modeled from 576 separate load inputs, with an additional 12 displacement inputs. Numerical cyclic noise has been eliminated by reducing the time interval from 0.05 sec to 0.02 sec. Color graphic outputs represent line interface pressure, displacement, stress, and strain at specific intervals. The program shows separation between coil and collar and the hinge effect for low prestress.

As reported in May, a parallel analysis effort devoted to refining structural models of existing cold mass configurations is under way. Work in June indicates the importance of friction in coil unloading. G-10, invar, and copper wedges were modeled with both high and low friction. For soft material, high friction is beneficial; low friction does not hold the wedges in place. Conversely, metal wedges are satisfactory under low friction, but with high friction they produce large forces. More realistic results were obtained by using a coil model where E varied as a function of both stress and temperature. The outcome indicates that coils maintain prestress during the energizing cycle for longer than had been thought, due to the relatively larger strains

with varying modulus of the coil. It is hoped that the model's increasing complexity will account for the "ratcheting effect" observed in the strain gauge data.

EQE's dynamic analysis of new cold mass configurations continues. Detailed finite element models of the center and outboard cradles have been developed. Full stiffness matrices, representing their force-displacement behavior, have been constructed and incorporated in the model of the magnet system. The existing cold mass models were modified to reflect the current configuration (support post locations and cradle) and to incorporate the updated design of the vacuum vessel. A dynamic model of the vacuum vessel itself was developed and incorporated into the magnet system analysis of transportation and seismic shocks. An additional piggy-back model was developed and is being analyzed.

Response spectrum analyses on the single and piggy-back models were performed for design ground response spectra of U.S. NRC Regulatory Guide 1.60, anchored to a peak ground acceleration of 0.3 g. The new model incorporates the vacuum vessel and the change in support post locations. It also more accurately represents the stiffness of the center and outboard cradles. As a result, the magnet system's dynamic characteristics also changed. The fundamental axial frequency increased from ~4 Hz to ~12 Hz, the fundamental lateral frequency decreased from ~11 Hz to ~9 Hz, and the fundamental vertical frequency remained high (> 25 Hz).

As expected, the frequency shift for the axial direction decreased the stresses in the support posts to within levels allowed by the design. For lateral motion, however, the support posts remain over stressed by approximately 30 percent. The piggy-back configuration leads to slightly higher stresses for the upper magnet system due to the flexibility of the connecting ring between the upper and lower vacuum vessels.

An investigation is under way of stresses that could be induced in the magnet system on a typical soft soil site. Three recorded earthquake motions (six horizontal component time histories) were obtained from D. L. Bernreuter (LLNL) and taken as representative of a soft soil site (V_s = 1000 fps). Mean and mean-plus-one-standard deviation response spectra were generated and response spectrum analyses performed for the single and piggy-back configurations of the magnet system. For both configurations, stresses throughout the system are within allowable values for these response spectra scaled to 0.3 g. In fact, for this definition, the surface design motion could be scaled to 0.36 g and stresses still maintained within allowable values. A second phase of this site specific investigation will assume the magnet system resides in a tunnel thirty feet beneath the surface. It is well recognized that earthquake ground motions typically decrease with depth in the soil. The decrease is being quantified and will be considered in evaluating the magnet system.

Work continues on a comprehensive data bank of material properties and material requirements. Discussions with National Bureau of Standards personnel focused on developing an agreement for a test program. The program would measure material properties of test specimens with proper loading conditions for both beam tube-flange welds and the proposed aluminum magnet collars. A report is being prepared on a study of the vacuum vessel material, A537 steel.

A preliminary examination of all the E778 data taken in May has been very encouraging. Part A of the experiment, which studies the "bare" Tevatron in the absence of intentional nonlinearities, has been satisfactorily concluded. Data from Part B, which studies turn-by-turn behavior in the presence of special sextupole excitation, are in good agreement with tracking results. Agreement is partially a result of discovering a missing factor of two in the definition of the sextupole strength in the tracking simulations, and of realizing that data taken at the highest sextupole excitation, 50 A, were tainted by large fractional beam losses. Analysis is now concentrated on 15 and 30 A data, (equivalent to 30 and 60 A in the "old" units) and it was realized that the analysis can be helped by more data at 15 and 30 A. Part C of E778, measuring the dynamic aperture by beam "heating," has been completed, except for some reservations about an apparent longitudinal growth of the beam.

Part D, which measures the effects of resonances, does not yet have sufficient turn-by-turn data for satisfactory analysis. Some of the data are satisfactory; some suffer from systematic glitches that are now understood; and some data are absent, due to the loss of two shifts during the May run when a main ring magnet failed. For these reasons, we are preparing a request for more experimental shifts, to be submitted shortly to the Fermilab Advisory Program Committee. There is no reason at present to doubt that the experiment will be successful.

Multiparticle tracking of E778 data was the focus of operations simulation work this month. The work will assist interpretation of experimental results; it also underscores the need for further refining data simulation. Accordingly, a multiparticle capability has been incorporated into the TEAPOT simulation program, and beam position monitor files have been generated for various Tevatron running conditions. Interactive tracking, Fourier analysis, and plotting have all been improved on the SUN workstations and were imported to the VAX.

A renewed study has begun to examine the ultimate future luminosity improvements possible in the SSC from reasonable extensions to present technology. Possible methods of improving the luminosity above the current 1×1^{33} $cm^{-2}s^{-1}$ include further reductions in the value of $\beta*$ or the beam emittance; increases in the beam current, number of bunches, or number of particles per bunch; and changes in operating energies. The study examines two issues:

- How much any of the individual parameters can be extended from the CDR design without either violating some fundamental quantity (such as the beam-beam tune shift limit, the maximum conceivable quadrupole gradient, beam instability limits), or exceeding the cryogenic capabilities in the CDR.

- How much any of those improvements will increase the integrated luminosity given in the CDR.

For each possible improvement or set of improvements, a nearly optimal operating cycle (length of time between refills) is first determined. It is based on projected beam losses (from collisions, vacuum, etc.), beam blow-ups (caused by intrabeam scattering, emittance growth, etc.), and emittance reduction from synchrotron radiation. Using this operating cycle, the total integrated luminosity over a typical year is then computed. The final results will include tables of the possible ranges of individual and combined parameter improvements, and the relative initial and long-term integrated luminosities for various improvements will be compared with the CDR design. Preliminary results of this study will be reported in the July workshop on detectors in Berkeley.

Further analysis of the Simpson's Rule correction scheme for systematic multipoles (D. Neuffer, SSC-N-339) suggests the possibility of eliminating the distributed bore-tube correction windings. The scheme lumps correcting elements in the middle of each half cell and near each quadrupole in the arc cell; it has been found to be effective in correcting tune shifts that are a linear function of multipole strengths due to systematic octupole, decapole, and higher multipoles. The scheme also improves systematic sextupole error correction: a sextupole coefficient (b_2) of 6 units can be corrected over the phase-space aperture required at injection.

Encouraging results were obtained from tests of practically (not quite symmetrically) placed correctors in the presence of many, simultaneous, severe errors. With a closed orbit of about 2 mm (rms), random a_1 and b_1 of 0.7, units and systematic b_2, b_3, and b_4 of 5.0, 0.4 , and 0.6 units, respectively, the correction effectiveness was diminished only slightly. In some cases, fine tuning the correctors away from the Simpson's Rule ratios produced even further improvement.

ACCELERATOR SYSTEMS

The photodesorption experiment

Two data runs of the photodesorption experiment were taken at the NSLS at BNL. The object of both runs was to investigate the rise in pressure observed in the experiment as integrated synchrotron radiation dose increases. The first run determined that the rise was indeed due to synchrotron radiation. The second run investigated whether this pressure rise will eventually lessen due to "clean up" of the beam tube with time.

A meeting was held at SRC, Stoughton, Wisconsin, to initiate an experiment to measure the number of molecules emitted by a beam tube surface per incident photon as a function of temperature down to 4.2 K. This experiment would help in interpreting the results of the photodesorption experiment at NSLS.

The neutron flux measurements

Neutron flux measurements in the Tevatron tunnel terminated with the end of the colliding-beam cycle in late May. Although the running time available to the experiment totaled only about 12 hours, most goals of the experiment were met. Spectra from beam gas collisions show a broad peak near 700 keV, somewhat higher than for the zero-pressure beam loss spectra. The Oak Ridge simulations (SSC-110) predict an identical spectrum and an integrated longitudinal rate about 30 to 45 percent lower than the measured rate.

Cryogenic systems

A short workshop on SSC cryogenics was held at Fermilab on June 11 and 12. The dates were chosen to coordinate with the International Cryogenic Engineering Conference held at St. Charles, Illinois, the following week; it was thus possible to have representation from seven laboratories and eight major industrial suppliers of cryogenic equipment worldwide.

The major topic of the workshop was a thorough discussion of refrigeration plants for the SSC. The CDG presented for comment recent work on an advanced conceptual design for the plants, and results on system modeling using this concept. Two working groups were formed to discuss and criticize this plant concept and to discuss developing specifications for a refrigeration plant of the type needed for the SSC. The first of these groups produced useful comment and ideas for improvement of the design concept and for further modeling work. The second group focused attention on refrigeration plant and system controls integration as a difficult area in plant specification.

A short wrap-up paper from the workshop will be issued early in August.

Analysis of magnet test data

Tests of the third long magnet, D000X, began at FNAL in June. The initial results are encouraging: D000X reached fields above the design value required for SSC operation; its plateau current appears to be at or above the short sample limit. Analysis of the quench data indicates that quenches are initiated predominantly in the end regions of the magnet. This information has helped to instigate modifications to the ends of the next long magnet under construction. D000X has significantly more instrumentation than the previous long magnets, including thermometers along the beam tube, extensiometers, and additional strain gauges. Analyses of these data are in progress.

RTK effort

It was decided to lease an Interpro 32C work station from RTK for use at CDG. Initially this will provide stand-alone two- and three-dimensional drafting capability. Files will be compatible with the Intergraph system used by most AE firms. RTK will provide maintenance and software support for the system, as well as providing training for CDG personnel. The system is designed for later access via phone lines or Decnet link to the Intergraph mainframe system at Kaiser Engineering. This will allow file interchange between CDG and RTK, as well as CDG access to the considerable library of application programs on the Kaiser main frame.

Don Scapuzzi arranged for a visit to a tunneling project near Murphys, California, in the Sierras, where long tunnels are being bored in the granite for a hydroelectric project. The tunnels are in the size range of interest for the SSC. Much useful information was gathered on advance rates, muck-handling techniques, tunnel costs, crew sizes, and so forth.

The trip was preceded by a one-day seminar on shaft excavation techniques conducted by Scapuzzi. It is clear that careful design and scheduling of shaft excavation is vital to reducing the machine's cost and construction time.

Considerable effort was expended during the month on site activities for DOE.

CDG effort

Work continued on the design of interaction region halls for the report of the Task Force on Limitations in preparation for the Detector Workshop in July. Tom O'Rourke from Cornell, a member of the CDG's Underground Technology Advisory Panel, spent a day with us to review the parts of the report related to geotechnology.

Jim Sanford and Tim Toohig participated in the DOE review of the Report of the Task Force on Environmental Radiation Considerations.

Derek Shuman, with the cooperation of Dave Johnson and the engineering support group at RTK, succeeded in taking a lattice output file and entering it into the database at RTK. This opens the possibility of combining mapping files from the USGS with the land template generated for the ISP and then inserting the lattice file directly.

Gilbert Drouet (CERN) and Derek Shuman attended a workshop at Fermilab in which the revised SSC refrigerator design was presented. The size and configuration of the refrigerator components are driving factors in the size and layout of the Service Area shafts. Shuman also discussed with Fermilab staff members the handling requirements for getting the magnets and other components down the shafts.

Toohig worked with the U.S. National Committee on Tunneling Technology in preparing a proposal to DOE. The proposed project would investigate the possibilities for reducing costs and

improving schedules for the SSC tunnel by using innovative contracting practices. Savings on the order of 30 percent have been realized on other major projects by applying those practices. The proposal will be presented to DOE for FY1988.

Toohig also gave an invited paper to the members of the Institute of Shaft Drilling Technology at their annual meeting in Las Vegas. The SSC project continues to excite great interest in the various facets of the underground technology industry.

BNL REPORT

MODEL MAGNETS

Collaring of 1.8 m dipole DSS4 was completed this month. This dipole is a precursor to long dipole DD0010; it incorporates C358A cross section, Cu:SC = 1.6:1, and strengthened (potted) ends. In addition, all coils were wound and cured for DSS5 and DSS6, both magnets nominally identical to DSS4. Finally, all coils were wound and some coils cured for DSS9, precursor to long dipole DD0011 (these magnets incorporating LBL design features, including cross section NC-9). Collars for DSS9 are on order at LBL, and the collaring press is undergoing necessary modifications at BNL.

In view of the good performance of DSS2 after its coil ends were pressure-impregnated with alumina-filled epoxy (below) it has been decided to disassemble long dipole D000Z and treat its ends in the same manner. This operation was under way at the close of the month.

A revised design for the outer coil strain gauge assembly was completed and ordered, with delivery expected by July 7. A strain gauge calibration fixture is now in the production stage.

In the trim coil area, new substrate materials have been slit, punched, and delivered to Multiwire. These substrates are proving to be superior in quality to those of earlier materials. Samples of Supercon multifilamentary wire have been found to have significantly higher ductility than earlier wires of this type. At the same time, additional batches of monofilament wire are on order. The program on radiation-resistant substrates is making good progress: all samples have now been irradiated and await inspection in the Hot Lab. Multiwire/PCK has developed a substrate that incorporates all the radiation-resistant options identified; it does not exhibit excessively high outgassing rates upon heating. Work is under way at DuPont, PCK, Multiwire, and Sheldahl to produce these substrates on an industrial scale.

Samples of seamless beam tubes have been produced by Armco and are being inspected at BNL. Meetings of the plating review committee have been held, and review criteria for technical issues established. Among other things, research has started on methods for inspecting plated tubes. Work on welding samples of plated tubes continues as well; in particular, investigation of laser welding techniques has begun.

TOOLING AND FACILITIES

Coils

Reworking the outer coil-curing formblocks was completed this month. It included regrinding side bars, filling cut-outs, and assembling the formblocks. The inner formblocks were also

completed, but they are not yet fully assembled. Top-hats are still out for grinding, expected back in early July. The long coil winder is scheduled for completion in mid-July.

Drawings for a second curing press have been released to the shops.

Magnet test facility

The documentation package for Mole BII was completed and is being checked. A tube for the Mole calibration fixture was completed. A design layout of a Mole support system has also been completed, and contracts and various vendors for the system have been initialized.

The engineering effort for the Accelerated Life Test focused on the turnaround can this month. The impact of modifying the cryostat support system from one utilizing five support points to two supports is under study. A conceptual design study has begun of cryostat handling devices for removing a magnet assembly from the trench while one or more magnets remain in place on the ground floor, above.

TESTS AND MEASUREMENTS

June saw three dipoles tested. DSS2 was retested after its ends were reinforced with alumina-filled epoxy, as noted earlier. The training curve exhibited marked improvement over its earlier version: better stability, higher fields, little de-training. The plateau at 4.5 K was slightly below 6.7 T; at 2.9 K fields slightly below 7.5 T were achieved.

Tests of DSS7 were confined to pool boiling at 4.5 K; again, a plateau of approximately 6.7 T was achieved. The field quality for DSS7 was generally satisfactory.

The third magnet tested was LBL 1 m dipole B11. Its quench results indicate that training in single-phase helium is not significantly different from that in liquid, and I_Q does not differ significantly for the two thermodynamic conditions.

FNAL REPORT

CRYOSTAT DEVELOPMENT

Evaluations of the performance of the single-element cold mass connection slide, using the D004 cold mass, continue. Measurements of performance with five supports positioned in a straight line have been completed. Measurements of performance with five supports aligned for a 3 mm sagitta are under way, with 700 of the prescribed 1000 test cycles completed. Preliminary measurement results indicate a negligible difference between straight line and sagitta alignments in apparent coefficient of friction and support post deflections. The support post loads and deflections are acceptable.

Test apparatus construction is nearing completion for the evaluation of the performance of the cold mass connection slide in vacuum at 80 K. Testing will commence in July. The initial configuration, and the welded and machined connection slide with Teflon loaded, sintered bronze slide pads, will be tested.

Material for controlled thickness cold mass skins has been provided to a vendor for forming. It is estimated that two sets of formed skins will be completed in July. The possibility of incorporating controlled thickness cold mass skins for the delayed D000Z cold mass will be discussed with BNL.

The improved support posts (heavy wall construction with graphite composite inner tube) have undergone the initial phase of structural testing. An improved support post is being instrumented for heat leak measurements and will be installed in the Heat Leak Test Facility.

The graphite composite tie rods for the improved anchor system have been completed and rods will undergo tensile and compressive testing. The coefficient of thermal expansion for a tie rod assembly will be measured to liquid nitrogen temperatures. Following component testing, the four tie rod assemblies will be installed in the D0004 test apparatus for evaluation. Tests include the measurement of the load-sharing characteristics of the anchor system, and the response of the system to cooldown with liquid nitrogen.

Detailed stress analysis of the two-footed vacuum system continues.

Work continues on specification of reflective material suitable for dimpled blankets. Development work has been initiated for the fabrication of insulation blankets by sewing.

Shield improvements are being worked on.

Interactions continue with the consulting firm studying the dynamic structural response of the cryostat. Currently under investigation are the responses of the two-footed versus the five-footed vacuum vessel and rigid versus pivoted center anchor connection.

The cryostat thermal model is essentially complete, and test runs are being made to evaluate the model's validity. Preliminary results are expected in July.

D000X was cooled to 4 K in about 60 hours; in addition to the normal readout of temperatures, pressures, and coil strains, data were taken during cooldown from strain gauges and extensiometers on the end ring, which measure the difference in contraction between the coil and the shell. The data indicated that the coil shrinks on the order of 0.025 inches more at each end than does the shell. An apparent error in the calibration of the coil strain gauges prohibited measurements to be made of the coil pre-load at 4 K.

The magnet was initially operated in 1.5 atm, 4.3 K subcooled liquid. It required 12 quenches to reach a plateau quench current of about 6800 A. The training quenches all originated near the lead (feed) end (although there is evidence that the longitudinal position varied somewhat) in both upper inner and lower inner quarter coils at varying azimuth. Eight quenches were taken on plateau; the average quench current was 6809 A, with a high of 6846 A and a low of 6757 A. About half the spread in quench current can be explained by the 50 mK variation in magnet temperature from quench to quench. These (presumably) short-sample quenches occurred in the body as well as near both ends. All but one were in the upper inner coil, and again the azimuthal position of the quench varied.

Cooling was then switched to high pressure supercritical fluid at 4 atm, 4.3 K. A series of spot-heater quenches were induced at currents from 3000 A to 6650 A with the strip heaters disabled. The MIITs were highest at 3000 A (9.4) and dropped below 7 at the highest current. The peak voltage to ground observed at any voltage tap and the peak resistive voltage both grew roughly like I^2, reaching maxima of about 350 V and 1900 V, respectively, for the short sample quenches that followed the spot heater quenches.

Six spontaneous quenches were taken in supercritical fluid; the average quench current was 6741 A with a range from 6659 A to 6814 A. Much, but not all, of the spread can be explained by quench-to-quench temperature variation. Contrary to the results from D0002 and SD13, there is no evidence for a systematically lower quench current in supercritical fluid than in liquid. The observed shift in the average quench current is -68 ± 28 A; the predicted shift from the slightly higher average temperature in the supercritical case is -48 ± 23 A.

Six spontaneous quenches were taken at 4 atm, 3.3 K; only a very small increase in current was observed. The first low-temperature quench was below the 4.3 K plateau; the remaining five varied from 6930 A to 7038 A with only a weak upward trend. By contrast, the predicted short sample limit at 3.3 K is around 7700 A. The first five quenches occurred near the lead end; the last was at the return end. Four were in the lower inner coil and two in the upper inner coil, again at varying azimuth.

Coil strain gauge, end ring strain gauge, and extensiometer data were taken in liquid at currents up to 6360 A. One of the inner coil strain gauges (bottom) shows unloading at about 5000

A, similar to D00002; the top shows unloading near 3000 A. Further study of these results is under way.

STRING TEST

The half cell test power supply system is now complete. It has been operated up to a level of 3000 A into a short circuit, under program control from the SECAR ramp generator, using the ACNET applications program for defining the waveform. Everything is ready to connect the power supply to the two dipoles in place at the test site. Wiring the dipoles should start in early July.

Detailed electrical parameter measurements on the first two dipoles, D0001 and D0002, are in progress. Those measurements will test the values extrapolated in the past. The initial experience will help develop a technique for making measurements on subsequent dipoles. The parameter measurements will also be useful for further studies of the transmission line nature of the magnet load, and they will provide an estimate of the short time constant eddy current effects.

LONG MAGNET FABRICATION

D000Z

Subassemblies are being developed in anticipation of receiving the cold mass in the latter part of July.

Wire measuring machine

The third (and last) machine is being prepared to measure insulated cable in Fermilab's cable insulating line. Parts damaged during commissioning tests have been replaced. It is hoped that measurements will be possible by the end of July.

LBL REPORT

SUPERCONDUCTOR AND CABLE

Inner layer cable for use in DD0010 at BNL and D14A-3 at LBL was made from IGC Billet 5955-2 during the week of June 8. A shipment of 3735 feet was dispatched to BNL on June 12, and 300 feet were retained at LBL. Electrical property measurements are being made at BNL and will be reported in July.

During the week of June 15–19, representatives from LBL (Roy Hannaford and Hugh Higley) worked with personnel at NEEW in fabricating SSC inner and outer layer cable. In addition, Al Bertsche and Brian Vogt from BNL observed cabling in preparation for making RHIC cable. This run was to investigate the in-line measuring machine that was recently delivered to NEEW by FNAL, to evaluate the capability of the NEEW machinery to make cable to SSC specifications, and to help in the initial setup for a cable run by Supercon as part of the SSC R&D program.

To compare results with those obtained at LBL, the measuring machine calibration blocks used at LBL were installed for the run at NEEW. The calibration and performance test of the measuring machine went smoothly, and the first run was begun on a 23-strand inner layer cable (SC 363), using strand from IGC Billet 5209-5. The cable mid-thickness values measured with the 10-stack fixture and with the in-line measuring machine were in good agreement; the cable width and keystone angle were measured at 6 second intervals (every 6–12 seconds, depending on line speed) and the measurements were within the specified range.

One mishap occurred 1155 feet into the inner layer cable run: the tip of the mandrel broke and the cable was consequently lost at that point. This mandrel had been damaged during an earlier run and had been straightened and flame hardened. In the future, mandrels will not be repaired but will be replaced when damaged, so this type of mishap should not recur.

An additional line stoppage occurred during the outer layer cable run due to a problem associated with the microswitch on the measuring machine. This problem was easily corrected.

Both mishaps are start-up problems, and neither should recur in production runs.

Samples of each cable were sent to BNL for electrical testing; however, the BNL test facility was down for cryogenic repairs, so I_c measurements will not be available for about 3 weeks. The only non-standard condition noted is the residual twist in the cable. This condition cannot be corrected on the NEEW equipment, since the cablers are the fixed planetary type (the LBL cabler has variable planetary capability). The combination of 2 twists per inch in the strand and fixed planetary gives a residual twist of about 110° per 3 feet in both inner and outer cable, in the de-cabling direction. As a result of experience at HERA and at BNL, BNL staff have recommended a maximum allowable twist of 90° in the tightening direction and 0° in the de-cabling direction. Consequently, we should be prepared to accept this type of cable from the NEEW

machine until the new SSC prototype production cabling machine with variable planetary capability, scheduled for delivery in January, is in operation at NEEW. Alternatively, we can examine the twist requirement to see if it can be temporarily relaxed.

DIPOLE MODELS

The LBL magnet D14B11 tests at BNL were completed in June, and the magnet has been returned to LBL for further testing. The magnet was trained at BNL at 60 psi and 18 psi cryostat pressures. The data are being analyzed.

Dipole D15A2 is the second of LBL's tapered key SSC model magnets. A higher prestress in the outer layers was the major difference from the previous D15A1 assembly. An intermittent short was observed during testing, and at 4.3 K, the operating field (6700 A) was not reached until the ninth quench. The training at 1.8 K, to 8780 A, was almost identical to that in D15A1. After thermal cycling to room temperature and 4.3 K, there was a memory loss. The plateau value of 6800 A was not reached until the fourth quench after warm-up.

Measured multipoles of D15A2 (NC9 cross section) were compared with calculations. Multipoles b_2, b_6, and b_8 all agree with predicted values for the coil as built. Measured b_2 is +7.3 units (cold). The predicted b_2 is +6.3 units. The effect of iron saturation on b_2 is in close agreement with calculations and with D15A1 ($\Delta b_2 \sim -1.5$ units at 6.6 T).

The coils for model D15A3 have been wound and cured. These contain NC9 copper wedges and elliptically shaped end-spacers.

Wedges have been produced and insulated for the 17 m model (DD0011) to be constructed at BNL. The design and fabrication at LBL of parts and tooling for DD0011 is continuing.

Coils for DSS9 (DD0011 precursor) were wound and cured at BNL with participation of LBL personnel. Coil gauge blocks are being fabricated at LBL to enable measurement of these coils in the BNL compression gauge.

A thorough analysis of dimensions of LBL magnet coils during curing, inspection, and assembly in collars under prestress was completed and should enable more accurate control of coil dimensions regardless of wedge design, curing fixture configuration, etc.

A comprehensive FEA 2-D model of the tapered key collar/coil package has been started. This model contains plastic insulation layers over each conductor layer. It also contains a fine mesh and radii at the collar keyways for better stress concentration calculation. This model will eventually be able to predict coil prestress changes at cooldown, as well as coil stress states under Lorentz body forces for nonlinear, nonreversible coil properties.

TAC REPORT

MAGNETS

Results of experiments that monitored the diodes' forward and reverse characteristics as a function of exposure showed a strong dependence on diode type. Theoretical simulations indicated that the primary damage mechanism was a reduction in excess carrier lifetime. The simulations also provided simple design curves that relate base thickness to maximum acceptable neutron fluence as a function of allowable forward voltage drop.

PROJECT COST DATA

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TABLE C-1

CENTRAL DESIGN GROUP - SUPERCOLLIDER

JUNE 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.1	ADMINISTRATION	59	175	11	245	1759	3066
1.2	PROGRAM PLANNING & MANAGEMENT	33	4	18	55	395	550
1.3	ACCELERATOR R & D	129	128	100	357	2013	2594
1.4	CONVENTIONAL SYSTEMS DEVELOP.	33	17	20	70	439	650
	PROGRAM COSTS	253	324	149	726	4605	6860
1.41	RTK COSTS		30		30	267	320
	CDG/RTK COSTS	253	354	149	757	4873	7180
	COMMITMENTS					726	
	CHANGE IN COMMITMENTS (Delta)					245	

TABLE C-2

BROOKHAVEN NATIONAL LABORATORY - SUPERCOLLIDER

JUNE 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
2.1	LONG MAGNET FABRICATION	0	47.9	23	70.9	576	521
2.2	MAGNET DESIGN	7.3	2.7	4.8	14.7	149	202
2.3	TOOLING & FIXTURES	18.4	18.9	17.9	55.2	380	435
2.4	BEAM TUBE DEVELOPMENT	3.5	1	2.2	6.8	59	100
2.5	TRIM COIL DEVELOPMENT	5.8	2.3	3.9	12	126	167
2.6	MAGNET MEASUREMENTS	2.3	1	1.6	4.9	38	50
2.7	INDUSTRIALIZATION	35	26.8	29.8	91.6	651	1859
2.8	WINDER & CURING PRESS	11	88.9	48	147.9	177	1600
2.9	ACC. LIFE TEST (CRYO)	6.6	16.4	11.1	34	34	700
	PROGRAM COSTS	89.9	205.9	142.3	438	2189	5634
	COMMITMENTS					953	
	CHANGE IN COMMITMENTS (Delta)					57	
	EQUIPMENT					0	200

TABLE C-3

FERMI NATIONAL ACCELERATOR LABORATORY - SUPERCOLLIDER

JUNE 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
3.1	GENERAL	0	4.9	1.6	6.5	48	120
3.2	LONG MAGNET FABRICATION	0.8	83.2	27.2	111.2	553.4	515
3.3	MAGNETIC MEASUREMENTS	60.2	47.2	34.8	142.2	973.2	1315
3.4	COLD MASS FABRICATION	3.4	7.1	3.4	13.9	20.2	650
3.5	DIPOLE TOOLING R & D	11.6	0.5	3.9	16	16	490
3.6	CRYO SYSTEM	0	46.1	14.9	61	178	155
	PROGRAM COSTS	76	189	85.8	350.8	1788.8	3245
	COMMITMENTS					173.7	
	CHANGE IN COMMITMENTS (Delta)					-89	
	EQUIPMENT					264.2	400

TABLE C-4

LAWRENCE BERKELEY LABORATORY - SUPERCOLLIDER

JUNE 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET*
4.1	GENERAL	12	0	6	18	116	179
4.2	SUPERCONDUCTOR	8	0	4	11	196	984
4.3	QUADRUPOLE DEVELOPMENT	0	0	0	0	374	400
4.4	MODEL MAGNET	15	4	9	27	640	442
4.5	ACCELERATOR R & D	1	19	9	29	42	85
	PROGRAM COSTS	36	23	28	85	1368	2090
4.5	ACCELERATOR THEORY	28	2	14	43	401	600
	LBL/THEORY COSTS	64	25	42	128	1769	2690
	COMMITMENTS					258	
	CHANGE IN COMMITMENTS (Delta)					127	
	EQUIPMENT						200

* Due to shifts in the program and priority changes, budget figures are being revised for FY87.

TABLE C-5

TEXAS ACCELERATOR CENTER - SUPERCOLLIDER

JUNE 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
5.1	DIODE QUENCH PROT.	5.9	2.4	13.1	0	474.5	439
5.2	CORRECTION ELEMENTS	0.3	0	0.1	0	236.1	214
5.3	ACCELERATOR PHYSICS	3.7	8.1	5.3	0	176.9	63.5
5.4	TAMU NUCLEAR REACTOR	0	0	0	0	23.1	84
5.5	DIODE IRRADIATION STUDY	61.1	15	25.3	101.4	101.4	275
	PROGRAM COSTS	71.0	25.5	43.8	101.4	1012.0	1075.5
	COMMITMENTS					10.6	
	CHANGE IN COMMITMENTS (Delta)					-6.7	

TABLE C-6

PROGRAM SUMMARY - SUPERCOLLIDER

JUNE 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.	CDG PROGRAM	253	324	149	726	4605	6860.0
1.41	RTK PROGRAM	0	30	0	30	267	320.0
2.	BNL SSC PROGRAM	90	206	142	438	2189	5634.0
3.	FNAL SSC PROGRAM	76	189	86	351	1789	3245.0
4.	LBL SSC PROGRAM	64.0	25.0	42.0	128.0	1769.0	2690.0
5.	TAC SSC PROGRAM	71	26	44	101	1012	1075.5
6.	UNDISTRIBUTED FUNDS						175.5
	TOTAL SSC PROGRAM COSTS	554	800	463	1775	11631	20000
	COMMITMENTS					2121	
	CHANGE IN COMMITMENTS (Delta)					333	
	EQUIPMENT					264	800

TABLE C-7

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	574.3	574.3	417.5	417.5	596.5	596.5	179.0	179.0
NOV	574.3	1148.7	495.5	913.0	571.5	1168.0	255.0	76.0
DEC	574.3	1723.0	322.0	1235.0	266.0	1434.0	199.0	-56.0
JAN	574.3	2297.3	269.0	1504.0	309.0	1743.0	239.0	40.0
FEB	574.3	2871.7	540.0	2044.0	583.0	2326.0	282.0	43.0
MAR	574.3	3446.0	655.0	2699.0	685.0	3011.0	312.0	30.0
APR	574.3	4020.3	714.0	3413.0	941.0	3952.0	539.0	227.0
MAY	631.9	4652.3	702.0	4115.0	644.0	4596.0	481.0	-58.0
JUN	631.9	5284.2	757.0	4872.0	1002.0	5598.0	726.0	245.0
JUL	598.6	5882.8						
AUG	598.6	6481.4						
SEP	598.6	7080.0						

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	277.8	277.8	133.9	133.9	396.9	396.9	263.0	263.0
NOV	277.8	555.7	177.1	311.0	150.1	547.0	236.0	-27.0
DEC	277.8	833.5	158.6	469.6	198.6	745.6	276.0	40.0
JAN	277.8	1111.3	185.9	655.5	242.9	988.5	333.0	57.0
FEB	277.8	1389.2	155.3	810.8	264.3	1252.8	442.0	109.0
MAR	277.8	1667.0	301.1	1111.9	244.1	1496.9	385.0	-57.0
APR	277.8	1944.8	315.5	1427.4	564.5	2061.4	634.0	249.0
MAY	737.8	2682.7	325.5	1752.9	587.5	2648.9	896.0	262.0
JUN	737.8	3420.5	438.0	2190.9	495.0	3143.9	953.0	57.0
JUL	737.8	4158.3						
AUG	737.8	4896.2						
SEP	737.8	5634.0						

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	229.6	229.6	143.1	143.1	143.1	143.1	0.0	0.0
NOV	229.6	459.2	136.0	279.1	231.3	374.4	95.3	95.3
DEC	229.6	688.8	160.2	439.3	124.5	498.9	59.6	-35.7
JAN	229.6	918.3	83.1	522.4	74.7	573.6	51.2	-8.4
FEB	229.6	1147.9	162.0	684.4	183.5	757.1	72.7	21.5
MAR	229.6	1377.5	239.7	924.1	389.8	1146.9	222.8	150.1
APR	229.6	1607.1	216.6	1140.7	242.2	1389.1	248.4	25.6
MAY	327.6	1934.7	297.3	1438.0	311.6	1700.7	262.7	14.3
JUN	327.6	2262.3	350.8	1788.8	261.8	1962.5	173.7	-89.0
JUL	327.6	2589.8						
AUG	327.6	2917.4						
SEP	327.6	3245.0						

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	150.0	150.0	64.0	64.0	80.0	80.0	16.0	16.0
NOV	250.0	400.0	97.0	161.0	97.0	177.0	16.0	0.0
DEC	350.0	750.0	527.0	688.0	547.0	724.0	36.0	20.0
JAN	250.0	1000.0	204.0	892.0	204.0	928.0	36.0	0.0
FEB	250.0	1250.0	182.0	1074.0	159.0	1087.0	13.0	-23.0
MAR	250.0	1500.0	231.0	1305.0	239.0	1326.0	21.0	8.0
APR	250.0	1750.0	184.0	1489.0	196.0	1522.0	33.0	12.0
MAY	200.0	1950.0	153.0	1642.0	251.0	1773.0	131.0	98.0
JUN	150.0	2100.0	129.0	1771.0	256.0	2029.0	258.0	127.0
JUL	130.0	2230.0						
AUG	135.0	2365.0						
SEP	325.0	2690.0						

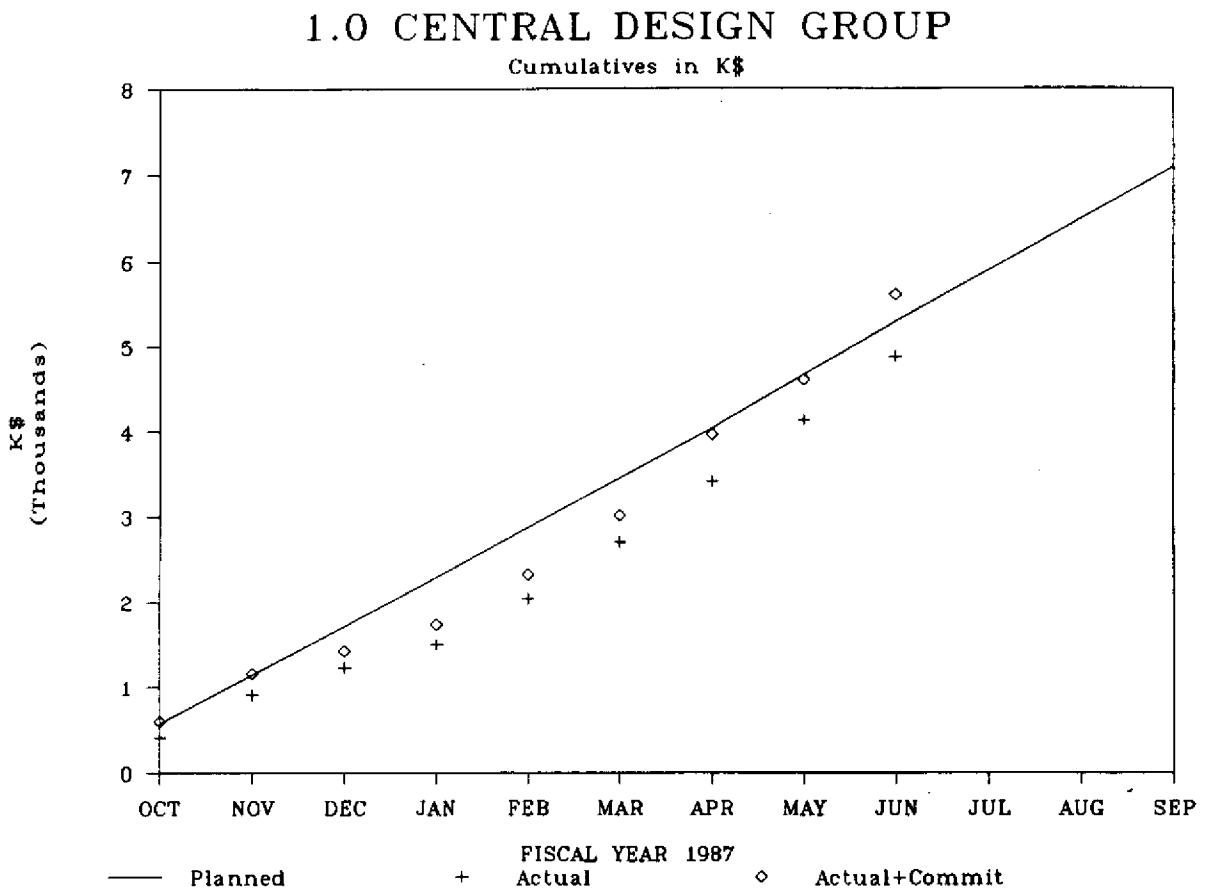
5.0 TEXAS ACCELERATOR CENTER - SUPERCOLLIDER

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	-100.0	100.0	108.9	108.9	219.3	219.3	110.4	110.4
NOV	100.0	200.0	106.0	214.9	56.0	275.3	60.4	-50.0
DEC	150.0	350.0	210.9	425.8	210.9	486.2	60.4	0.0
JAN	125.5	475.5	155.5	581.3	158.9	645.1	63.8	3.4
FEB	125.0	600.5	114.9	696.2	83.9	729.0	32.8	-31.0
MAR	100.0	700.5	76.5	772.7	71.7	800.7	28.0	-4.8
APR	100.0	800.5	99.4	872.1	92.0	892.7	20.6	-7.4
MAY	55.0	855.5	38.8	910.9	35.5	928.2	17.3	-3.3
JUN	55.0	910.5	101.4	1012.3	94.7	1022.9	10.6	-6.7
JUL	55.0	965.5						
AUG	55.0	1020.5						
SEP	54.5	1075.0						

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	1331.7	1331.7	867.4	867.4	1435.8	1435.8	568.4	568.4
NOV	1431.7	2763.5	1011.6	1879.0	1105.9	2541.7	662.7	94.3
DEC	1581.7	4345.2	1378.7	3257.7	1347.0	3888.7	631.0	-31.7
JAN	1457.2	5802.5	897.5	4155.2	989.5	4878.2	723.0	92.0
FEB	1456.7	7259.2	1154.2	5309.4	1273.7	6151.9	842.5	119.5
MAR	1431.7	8691.0	1503.3	6812.7	1629.6	7781.5	968.8	126.3
APR	1431.7	10122.7	1529.5	8342.2	2035.7	9817.2	1475.0	506.2
MAY	1952.4	12075.1	1516.6	9858.8	1829.6	11646.8	1788.0	313.0
JUN	1902.4	13977.4	1776.2	11635.0	2109.5	13756.3	2121.3	333.3
JUL	1849.0	15826.5						
AUG	1854.0	17680.5						
SEP	2043.5	19724.0						

UCLA, U. Wisc Funds: 200.0
Total FY87 Planned: 19924.0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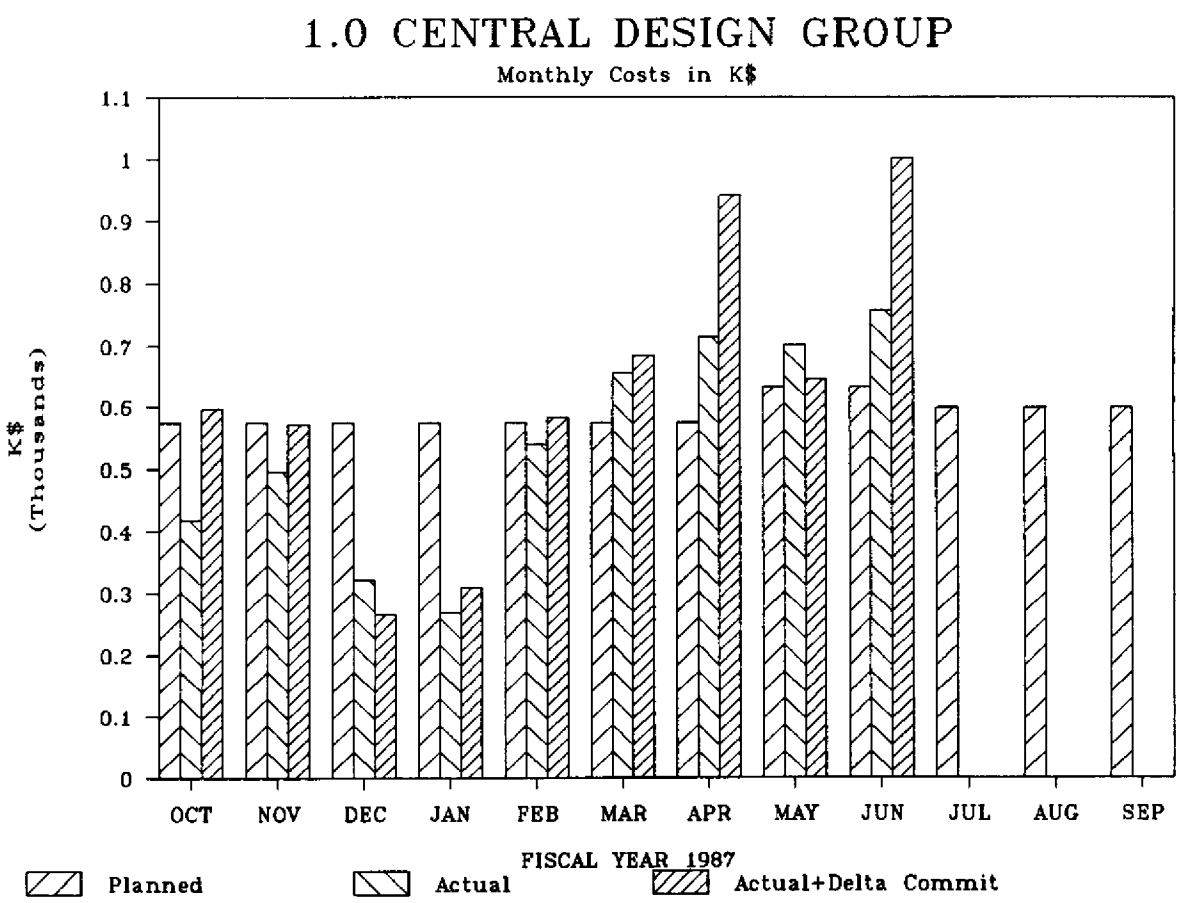
Cumulatives in K$
K$ (Thousands)
0
1
2
3
4
5
6
7
8
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Commit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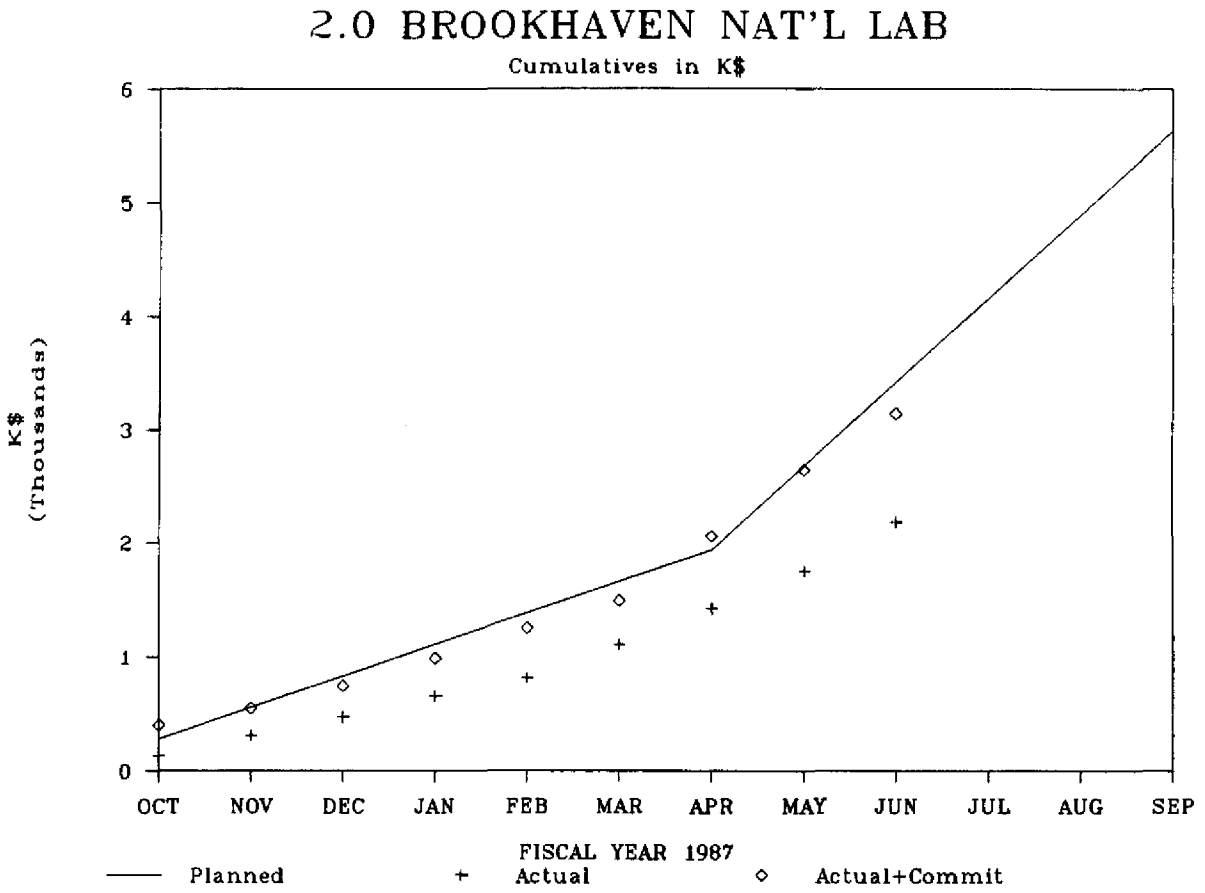
Monthly Costs in K$
K$ (Thousands)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 1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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 1987
Planned
Actual
Actual+Commit

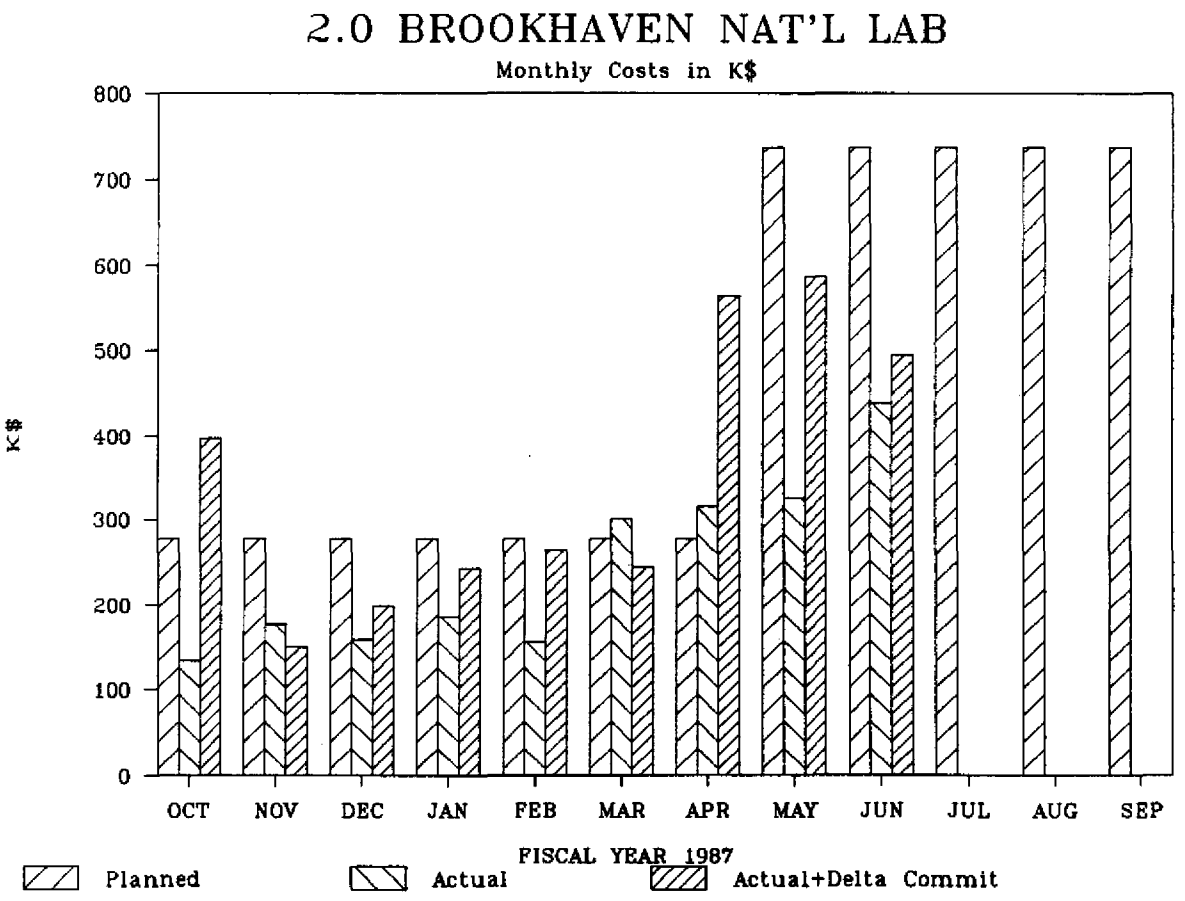
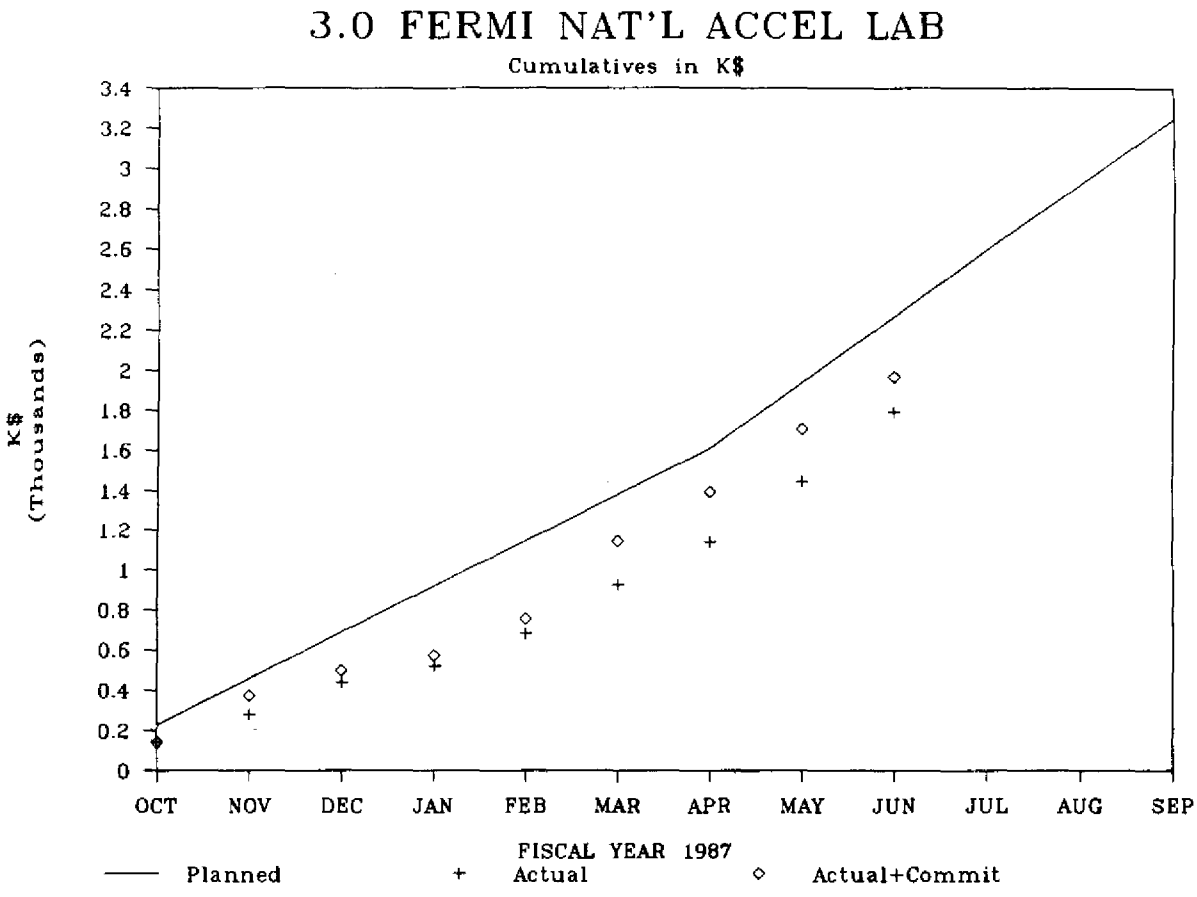

2.0 BROOKHAVEN NAT'L LAB
Monthly Costs in K$
K$
0
100
200
300
400
500
600
700
800
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 2


3.0 FERMI NAT'L ACCEL LAB
Cumulatives in K$
K$ (Thousands)
3.4
3.2
3
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
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Commit

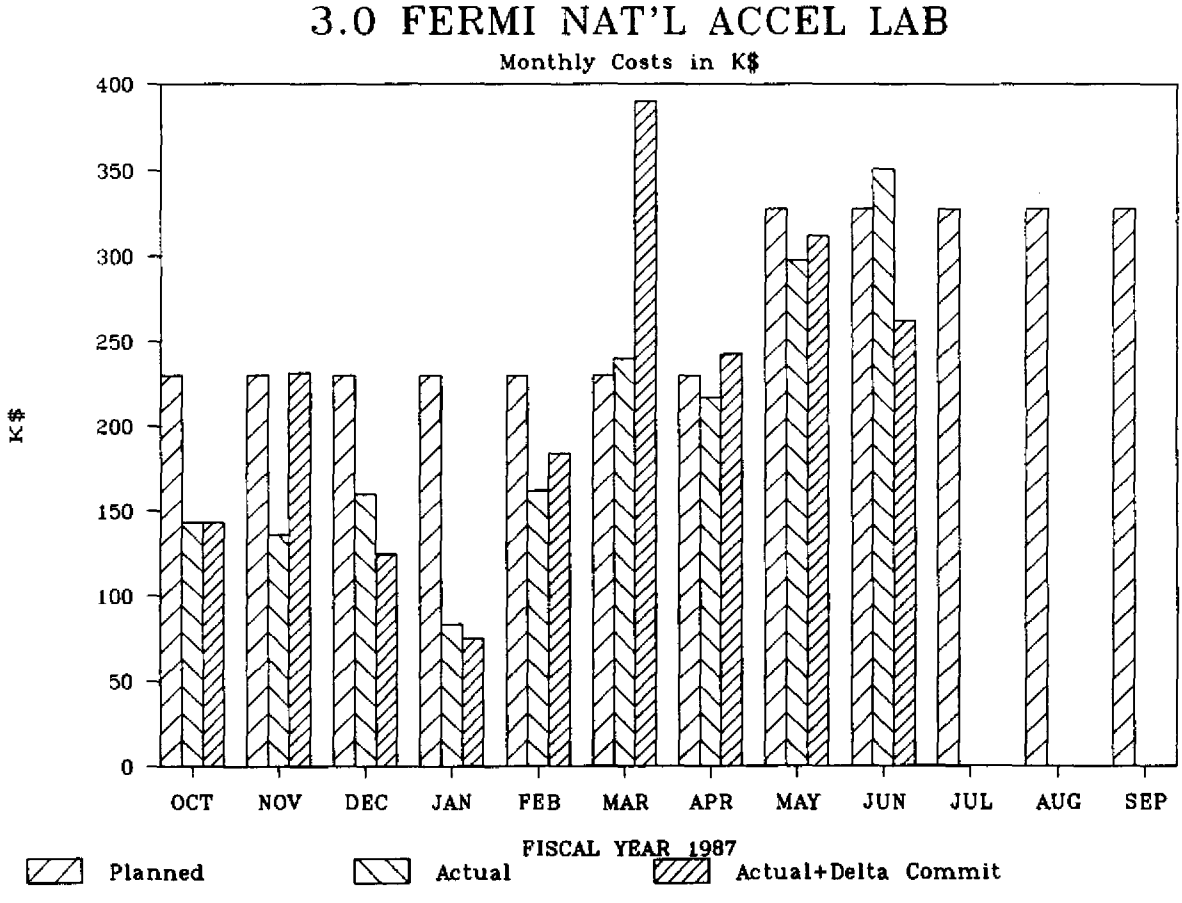
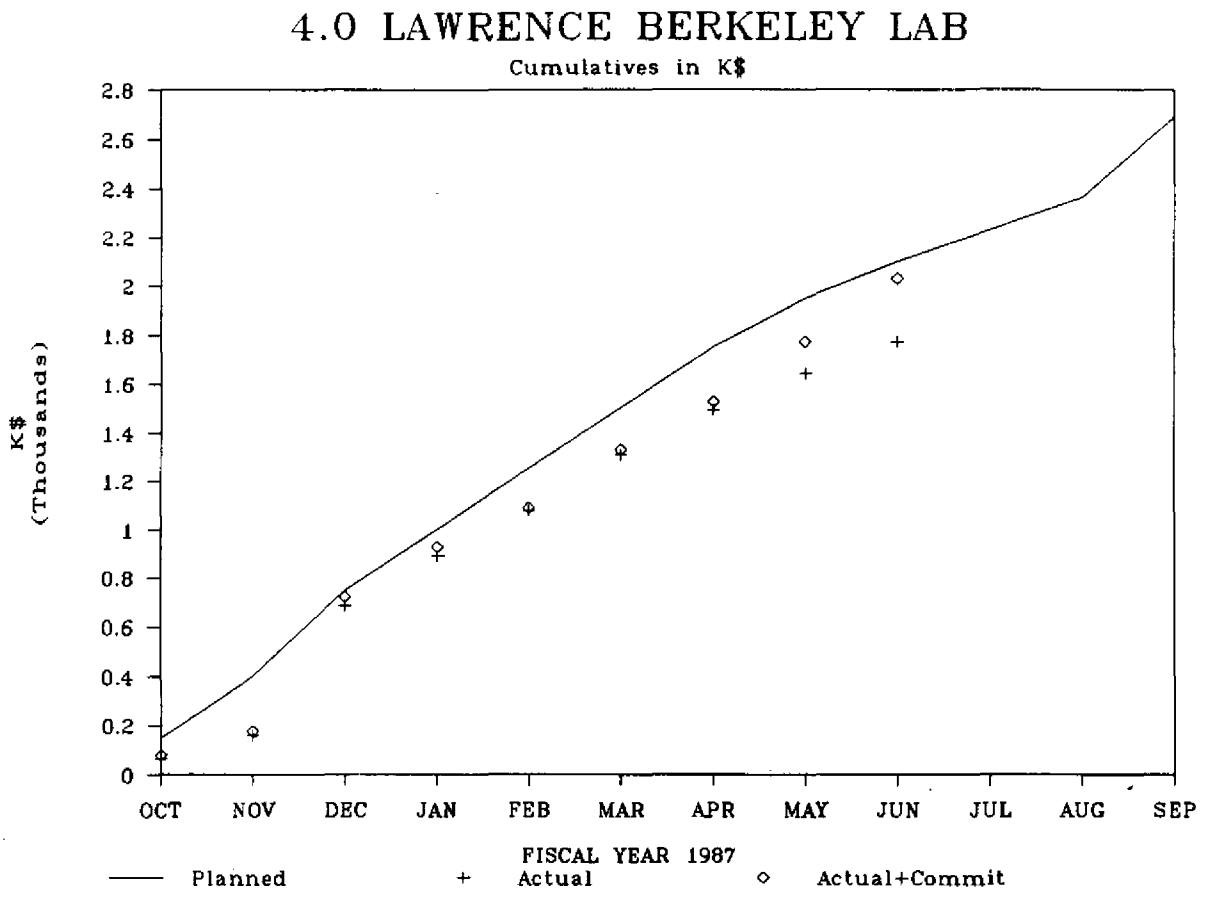

3.0 FERMI NAT'L ACCEL LAB
Monthly Costs in K$
K$
400
350
300
250
200
150
100
50
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 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
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Commit

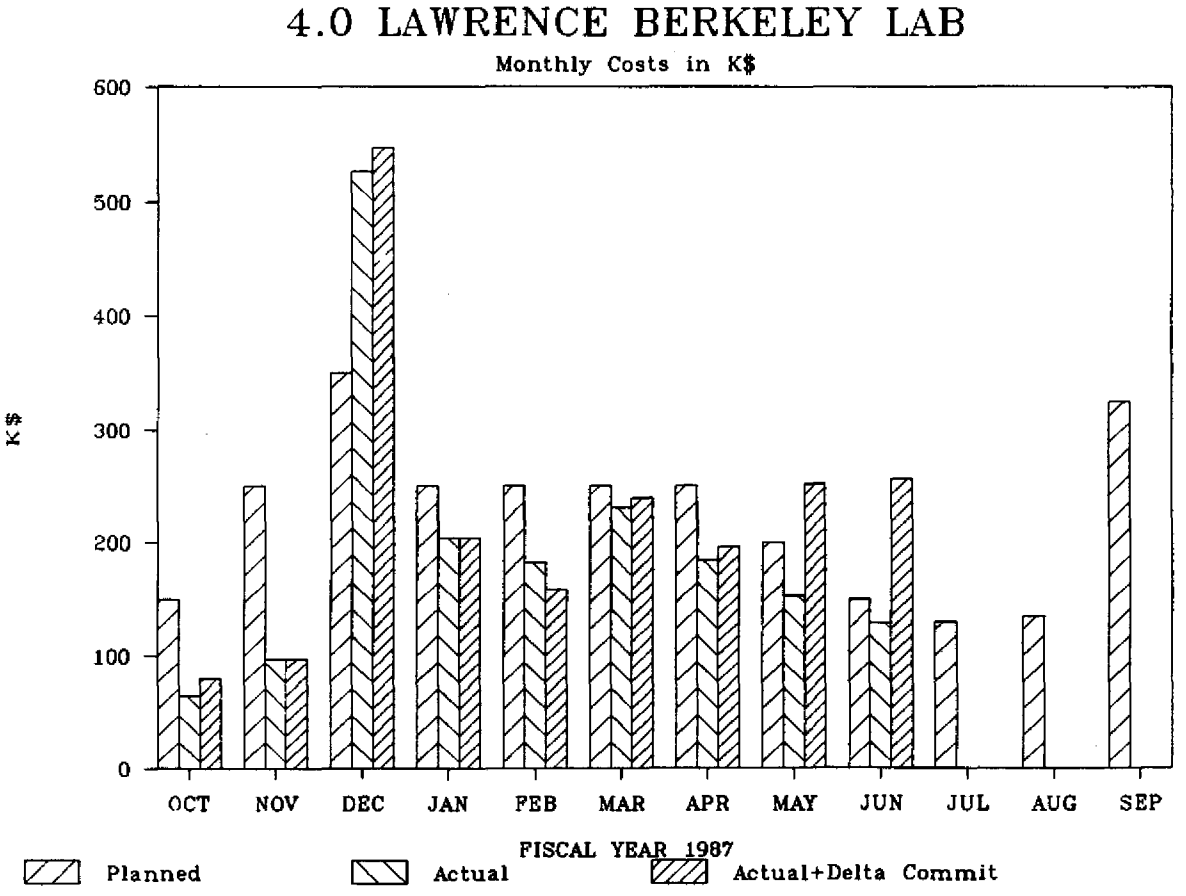
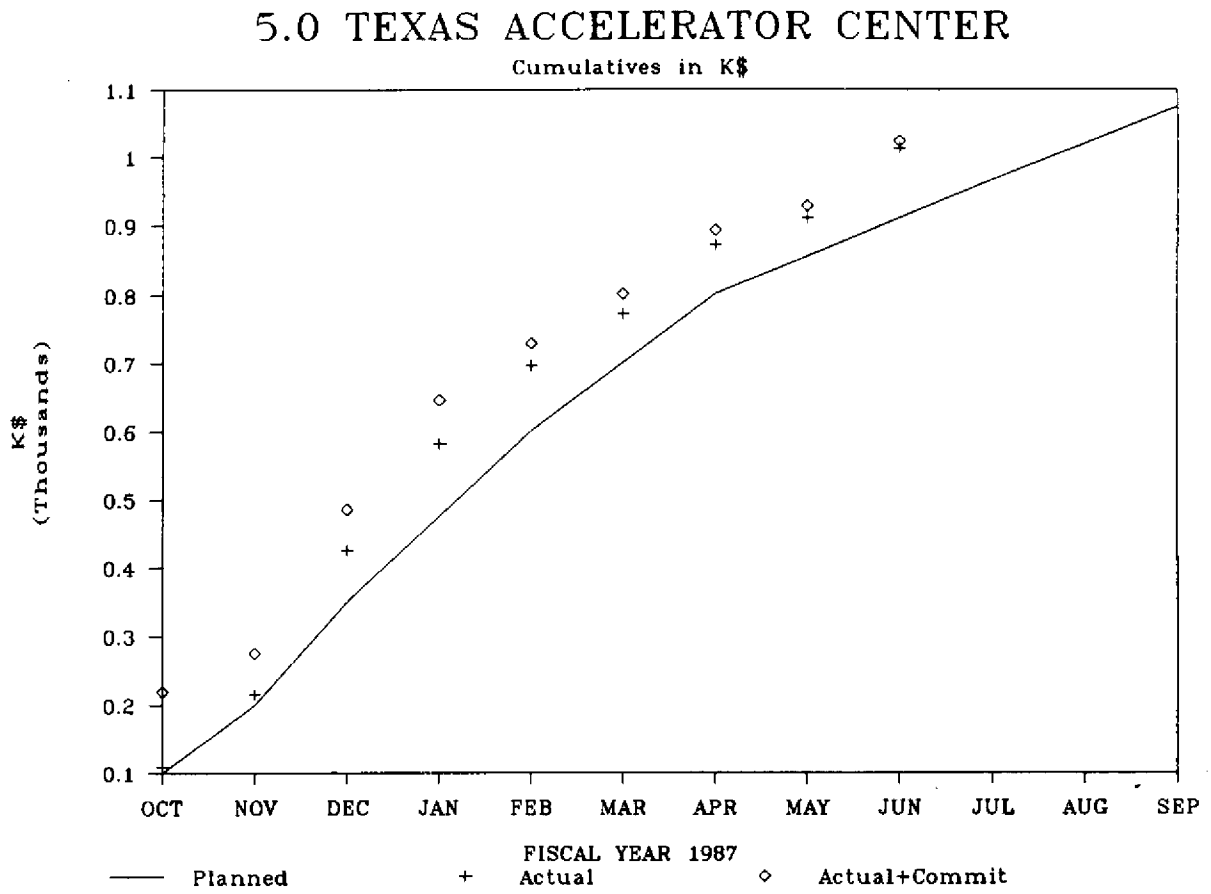

4.0 LAWRENCE BERKELEY LAB
Monthly Costs in K$
K$
600
500
400
300
200
100
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 4


5.0 TEXAS ACCELERATOR CENTER
Cumulatives in K$
K$ (Thousands)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Commit

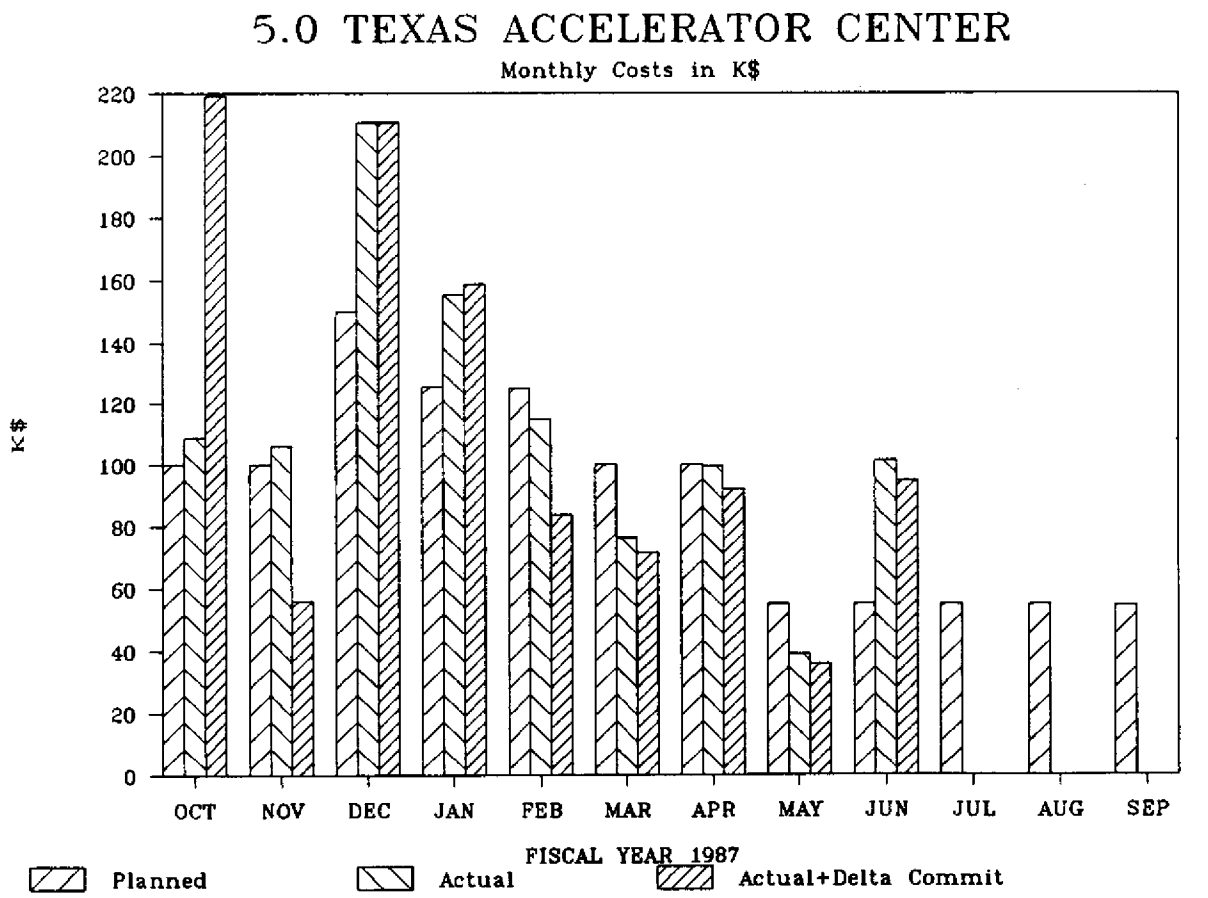
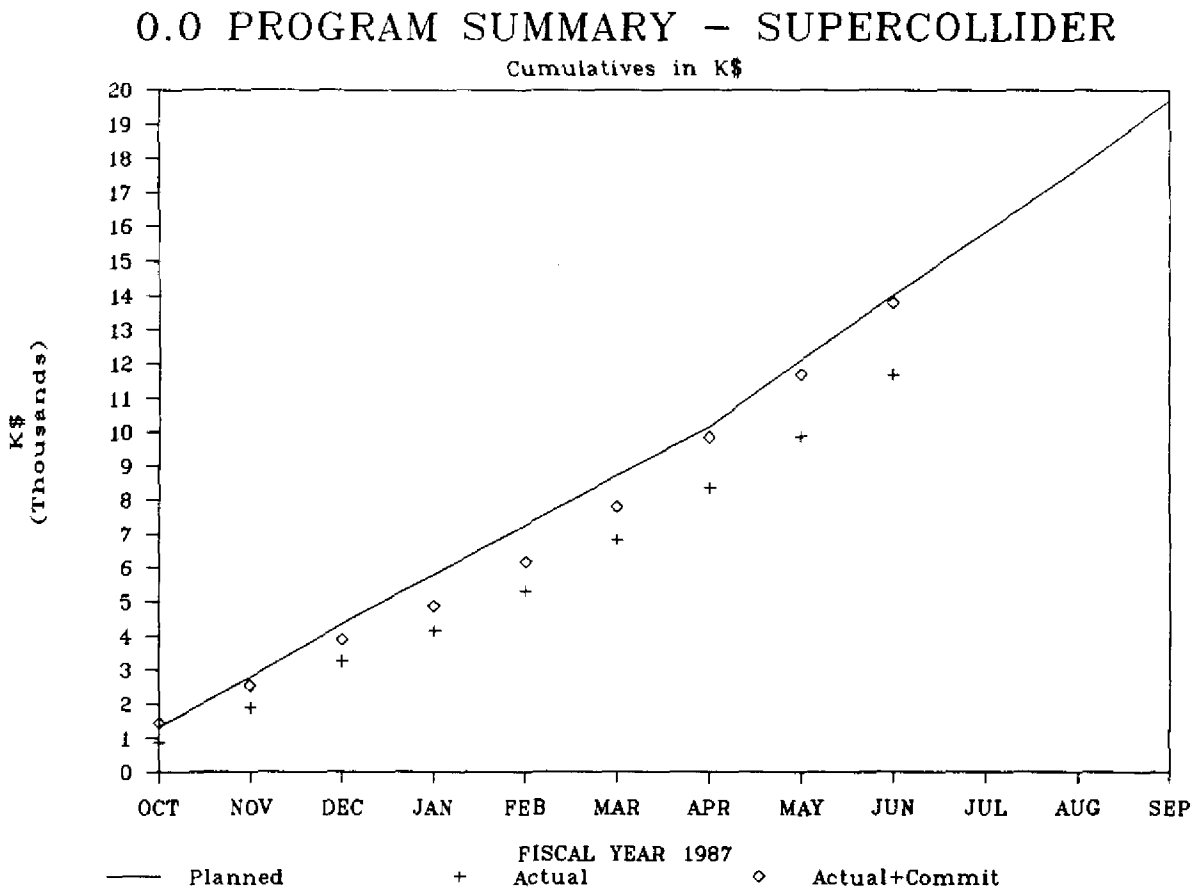

5.0 TEXAS ACCELERATOR CENTER
Monthly Costs in K$
K$
220
200
180
160
140
120
100
80
60
40
20
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 5


0.0 PROGRAM SUMMARY – SUPERCOLLIDER
Cumulatives in K$
K$ (Thousands)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Commit

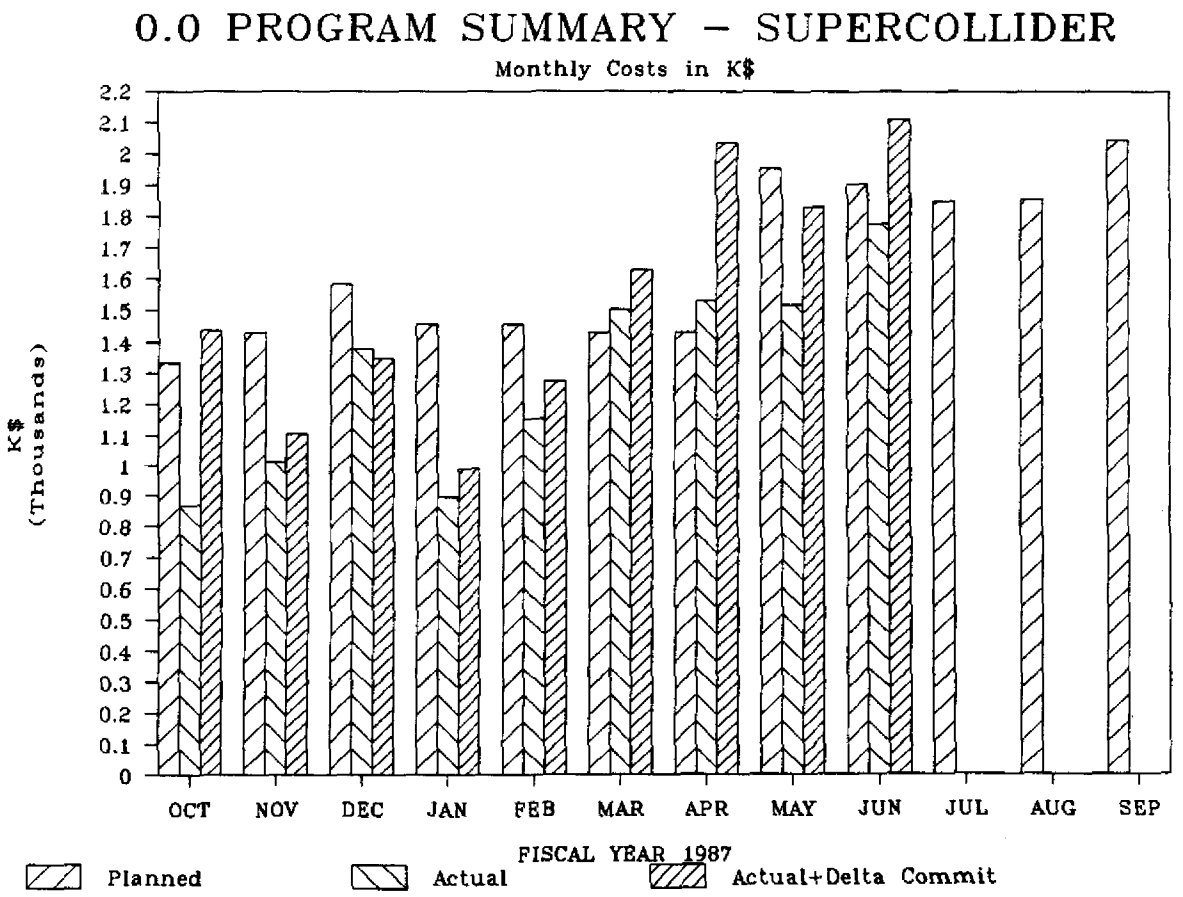

0.0 PROGRAM SUMMARY – SUPERCOLLIDER
Monthly Costs in K$
K$ (Thousands)
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 6