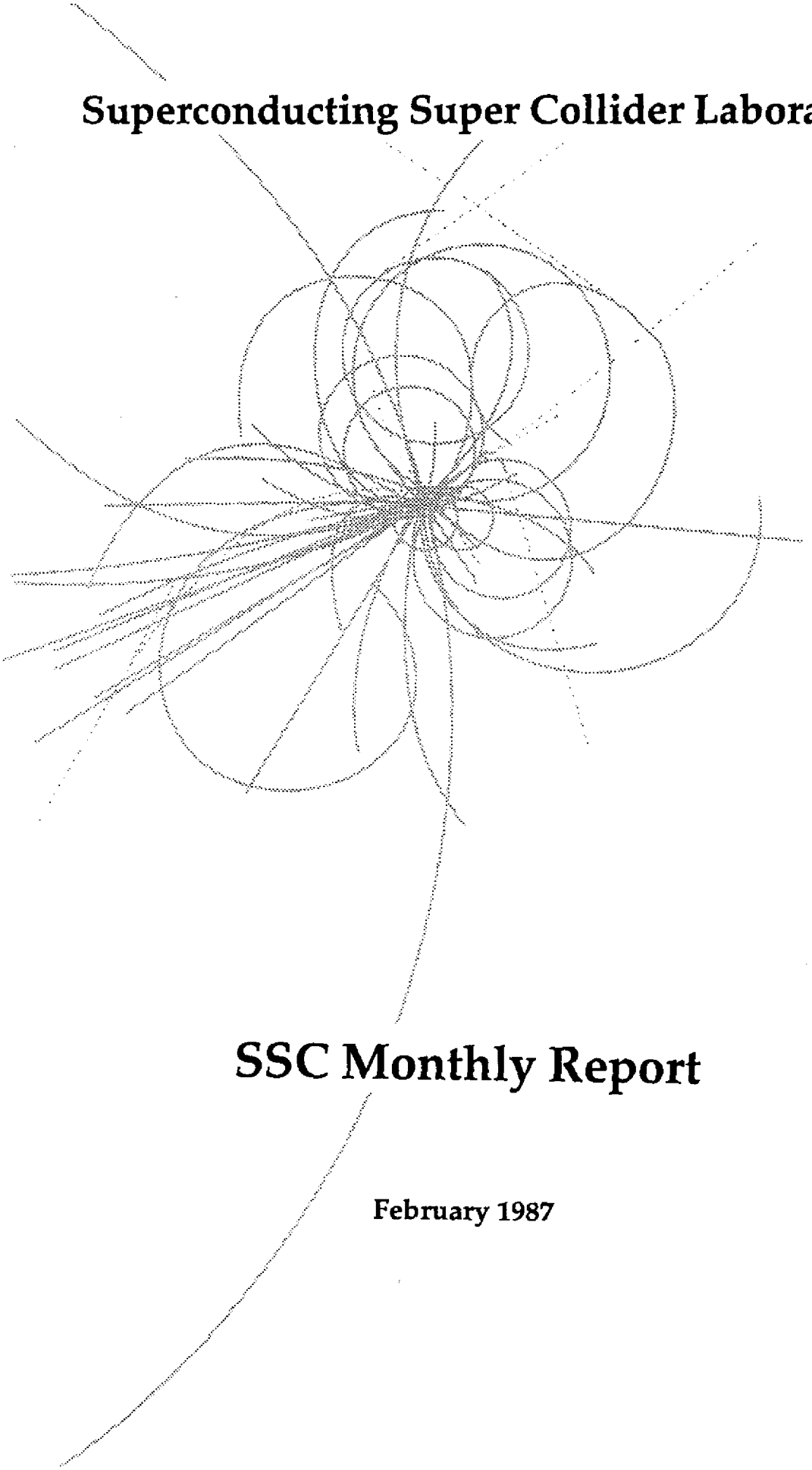
SSC-121

SSC-121

Superconducting Super Collider Laboratory



SSC Monthly Report

February 1987

SSC MONTHLY REPORT

FEBRUARY 1987

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SSC MONTHLY REPORT SSC-121

February 1987

Project Summary

Central Design Group (CDG)

- The Magnet Program Advisory Panel (MPAP) met at TAC on February 18.

- A Magnet Systems Integration Meeting was held at Fermilab on February 4. An agenda is given on page 3.

Brookhaven National Laboratory (BNL)

- Activities during February included the shipments of SLN013, a 4.5 m "dog-bone ended" dipole, and long dipole cold mass CM0004, a 16.6 m "straight ended" assembly, to Fermilab for tests.

- SLN013 has recently been retested at BNL in the vertical dewar, and it performed as well as when tested almost a year earlier.

- CM0004 was sent to Fermilab for use in alignment studies.

- Other activities this month centered on the assembly of D000X, the hybrid magnet, and DSS1, the first short (1.8 m) model dipole based on coil cross section G358A.

Fermi National Accelerator Laboratory (FNAL)

- The testing program for D0002 has been completed. During February quench testing was carried out with the magnet in several coolant conditions including superfluid and liquid helium at 4.6 K and superfluid helium at 3.5 K. The quenching current remained erratic. Quenches seemed to always originate at the magnet ends. The highest current obtained with the magnet at 3.5 K was 6950 A. These studies have not yet yielded a complete understanding of the magnet performance.

- The last of the 4-1/2 meter dog bone coils was received from BNL and is being assembled into a complete magnet (SD13). This assembly effort is about half finished and the magnet is expected to be mounted on the test stand before the end of March. The objective of this exercise is to operate a coil in a cryostat cooled with forced flow helium that has previously been successfully tested vertically in boiling helium.

- The improved cold mass connection-slide is being refined and tested. In this new design, the skin of the cold mass assembly is the bearing surface for the slide assembly. Several approaches are being pursued for making the cold mass skin suitably smooth and precise for that purpose. Progress has been sufficiently good that the new slide slide assembly will probably be incorporated into Long Magnet Model D000W.

- Progress is also being made to reduce the number of feet on the vacuum vessel from five to two.

Lawrence Berkeley Laboratory (LBL)

- Dipole model D-14B-9 was tested and exhibited excellent behavior; the first quench exceeded 6.6 T and the second quench reached the plateau level above 6.8 T. At 1.8 K, the magnet achieved 9.1 T.

- Magnet D-14B-10 is nearing completion and D-14B-11 has been started.

- The inner cable was produced for BNL long model LLN-000Z and 1.8 m models DSS 4-6.

- Improvements being made to the R&D cabling machine include installation of the Fermilab in-line measuring system and magnetic hysteresis-type brakes for tension control.

- Parts are being made to evaluate various tapers used in the tapered-key collars following the earlier encouraging test results using 3 degrees.

B. Project Report

I. Central Design Group

Magnet Program

The Magnet System Integration Meeting was held at Fermilab on Feb. 4. A meeting agenda is given below:

			Minutes
1.	Report on Further Measurements of D0002	FNAL	60
2.	Further Analysis of D0001 and D0002	Ad Lib	60
3.	Review Protocol for Remaining D0002 tests	FNAL	60
4.	Status Report on Addition of Cold Pump to MTF	FNAL	30
5.	Status Reports on MAGTEST Schedule		
	Discuss test objectives, technical	BNL	20
	issues, instrumentation and schedule	FNAL	20
	problems, if any	LBL	20
6.	Discussion of Intended Mole Improvements at BNL	BNL	30
7.	Discussion, with Data Presentation of the Relationship between Cu/SC Ratio and Training Behavior	BNL and other inspired parties	60
8.	Status of Evaluation of Coil Motion and Magnet End Design	BNL	30

The D0002 magnet tests still show an erratic quench behavior. The evaluation of the data indicates that most quenches originate close to the feed end. Protocol again was reviewed. Pressure and temperature will be varied to determine sensitivity of the magnet quench behavior to the controlled thermodynamic conditions. The laboratories reported the schedule status of the new magnet fabrication and test program. An overall delay of two weeks was reported for D000X due to the late part deliveries and priority conflicts at BNL.

Data were presented by BNL to support the contention that conductors with higher Cu:SC ratios exhibit better training characteristics.

A draft report on results from the TACO-NIKE analysis was circulated among the members of the Magnet Division. The received comments suggested additional cases to be analyzed. This analysis was completed and a revised draft was submitted for review. The analysis is in good agreement with LBL measurements.

A progress report on dynamic analysis of the dipole magnet assembly response to seismic and transportation loading is in progress. Several observations were noted concerning the overall dynamic behavior of the magnet system. A complete report is expected by mid-March.

Several preliminary analyses and reports have addressed the quality of estimates for the availability of the SSC magnet system that can be inferred from the accelerated life test protocol previously suggested. Preliminary consideration has been given to what sample sizes and testing periods might be required in order to make reliable estimates and decisions. A Bayesian analysis has been outlined which allows and encourages incorporation of successive increments of relevant information and refinements. Two levels of testing are being considered involving sample sizes of 5-10-20 or 100 magnets and testing periods of a few months or 1-2 years.

The next stages of this program will involve: 1) more detailed examination of the modeling used in the preliminary analysis; 2) carrying sample size and test-period questions beyond zeroth order; 3) addressing the information theory value of various possible directions of first-and-higherorder analyses and testing procedures that might be undertaken, 4) accessing and relating the failure and reliability data obtainable from the Tevatron.

Discussions have been started with Richard E. Barlow and associates toward embarking upon a program of system-level and component-level failure mode analyses leading to a logic/fault tree analysis. Close interactions seem very promising and necessary.

A CDG central drawing file was set up for SSC magnet-related drawings. Copies of all SSC magnet drawings produced at BNL, Fermilab, and LBL will be stored and cataloged using the facilities of the LBL mechanical engineering department. As new drawings are produced at the above laboratories, copies

will be sent to the CDG central file. When changes are made to existing drawings, a copy of the revised drawing will be transmitted to the CDG file where the old drawing will be replaced by the revised drawing.

An integrated Dipole Magnet R&D Schedule for FY88, including Gantt and PERT charts, was developed. The FY87 Superconductor Procurement Schedule was updated.

The procurement, modification, and calibration of two resistance type linear position transducers that will be installed on the ends of D000X and used to record any coil motion during cool down and operation were completed. The transducers were calibrated at room, liquid nitrogen, and liquid helium temperature. The change in resistance per unit of travel is about factor of three greater at helium temperature than at room temperature.

An expanded version of the Magnet System Requirements (SRS) was prepared. The SRS was distributed internally for comments.

During February, a SSC "data bank" effort was started. The purposes of this effort are 1) to maintain a comprehensive index of SSC materials; and 2) to collect and evaluate data from various sources for a data repository of mechanical and thermal properties of SSC materials. This effort also includes special searches and evaluation of material properties and of environmental conditions to help achieve cost-effective designs. For example, the specification for the vacuum vessel material will have an important impact on costs; and, therefore, requires an objective evaluation of available information for (i) the NDT (nil ductility temperature) for candidate materials such as A537, A36, AISI 1010, and AISI 1020 steels and for (ii) the minimum transportation environmental temperature for the vacuum vessel.

Conventional Systems

The principal activity during the month was again on the Siting Parameters Document (SPD). RTK examined the SPD once again in the light of queries from DOE. They also responded to an example schedule prepared by the CDG for the siting activities work. A cost estimate was prepared for DOE to cover the environmental studies connected with site evaluation. As part of continuing support work for the CDG, they obtained a DEM tape from USGS which contains the information for a USGS standard quadrant map in digital form. This was successfully loaded into the Kaiser Engineering Intergraph CAD system to study the effectiveness of this approach for future A/E work on a real site. It looks very promising.

Perspective drawings were in preparation to illustrate and understand the impact of the SSC on a locality. Intensive studies were carried out under the direction of G. Drouet utilizing the LBL CAD system to illuminate radiation issues and required dimensions reflected in the SPD.

A new schedule was prepared for the work leading up to the beginning of construction.

Preparations continued for the Task Force on Collision Hall Limitations scheduled for 23-26 March. Forums on handling of heavy equipment discussed SLC experimental halls and detector assembly and movement and movement of massive equipment up to several thousand ton units across country for oil field work at Prudhoe Bay and reactor vessel installation.

K. Goebel of the Radiation Protection Division at CERN consulted with the CDG on environmental radiation questions and facilitated a visit of G. R. Stevenson of his division to work with a Task Force on Environmental Radiation under J. D. Jackson charged with preparing an in-depth report on that subject in support of the SPD.

Drafts of the SPD were submitted to DOE on February 10 and, following further revision, on February 27.

J. Sanford participated in several intensive meetings at DOE Chicago Operations. The preparation of the required environmental impact statement for the SSC site was exhaustively explored. The latest version of the SPD was examined in detail with the requirements for preparing an environmental impact statement and passed with flying colors.

T. Toohig attended the mid-year meeting of the Health Physics Society in Reno where the conference theme was "Health Physics of Radiation Generating Machines." The meeting was well attended by radiation protection professionals from Japan, Western Europe, and the Soviet Union, as well as the U.S., providing a good opportunity for discussions of SSC needs.

II. Laboratory Programs

A. BNL.

1. Model Magnets

Assembly of SDD1 took place this month. Initial collaring studies with the new cross section and spot-welded collars revealed data that were significantly different from expectations. Previous data (long cold masses 1-4 and a C358A "cookie" assembly) indicated that for the correct prestress using as-designed shims, the coil sizes beyond nominal should be +8 mils for the inner coil and +6 mils for the outer. The achieved values, measured in the curing fixture for the inner and outer coils fabricated to date, are +9.5 mils "inner" and +5 mils "outer"--close to the desired values. During curing, prestress required to achieve these sizes proved exceptionally high, namely 16-18 kpsi inner and 14-16 kpsi outer. It is suspected that these high pressures were caused by the 10% overlap of the Kapton that was implemented to avoid regions of single-Kapton thickness when the long coil program was started. When these coils were collared, the actual shim size for the required prestress was 10 mils inner and 21 mils outer, compared to design values of 21 and 26 mils, respectively. This necessitates that the shims are undersized by 11 and 5 mils for the inner and outer coils relative to the C358A design.

The spot-welded collars are significantly stiffer than those used in the past; hence a new criterion has to be established. In examining the results of the extra 10% overlap, two deleterious effects are seen: larger coil size and ~25% lower coil modulus as measured on the long coils. These two factors have led us to re-examine the necessity for the 10% extra Kapton overlap. Based on the unlikely event of a turn-to-turn short, BNL intends to return to the previous 50% overlap. This will bring the coil sizes closer to design and achieve the design goal of compensating the sextupole term properly.

With regard to the hybrid magnet, four collar assemblies were made, but each led to electrical problems. The first two were related to high prestress breaking down the midplane cap at the lead end. The next one was related to a turn-to-turn failure due to chafing of the midplane lead. The most recent failure is a midplane short which at the moment has not been located. All parts are available for this magnet, and all of the instrumentation has been added. This includes the 15 bore tube resistors for temperature determinations, 8 additional voltage taps on the inner coil post turn in addition to the normal 5 taps on the leads, the 6 spot heaters, coil end strain gauges and extensiometers, as well as the normal strain gauges for prestress.

With regard to the C358A long magnet program, two outer coils were completed; cable with 1.6:1 Cu to Sc ratio has been received, insulated, wound into an inner coil, and cured. All of these coils have the additional 10% overlap, so harmonics will be similar to those of the first three DSS magnets that were previously discussed.

CM0004 was sent to Fermilab for alignment studies. Prior to it being shipped, twist studies were performed. A report on the results is being prepared.

In the area of trim coil and bore tube activities, samples of trim coil material were exposed to 20 μA of 193 MeV protons in the BLIP facility. Damage to various materials was observed. A report is being prepared. Various companies have been contacted for producing samples of alternative radiation-resistant trim coil materials. A copper-plated section of beam tube has been welded into the center of the 17 m tube for CM0007. Work has started at Armco and Trent Tube on production of FY 1987 beam tubes. Four DSI beam tubes have been completed. Three plating vendors have agreed to submit proposals for a beam tube plating facility at their plant; their proposals are

expected shortly. A purchase request has been written for copper-plated tube samples for investigating contact-plating techniques. Finally, photodesorption measurements were performed at the NSLS on samples of coextruded aluminum beam tube produced in Japan. A copper-plated Nitronic 40 beam tube is also being prepared for tests at the NSLS.

Mole BII has been wired and assembled and is awaiting tests. Work has started on the design of a single tether mole, Mole C. A meeting was held at the BEI Co. in Little Rock, Arkansas, to determine if an encoder small enough to be accommodated in Mole C can be built; it was concluded that BEI can, indeed, fabricate the encoder. A detailed proposal is forthcoming.

2. Tooling and Facilities

Coils. Two outer 17 m coils (358 A cross section) have been wound and cured. Following that, the outer coil production tooling was re-converted to the production of 1.8 m DSS coils. Presently technicians are engaged in curing the first 17 m inner coil (again with 358 A cross section).

Collar/Yoke. Additional parts have been received from the vendor for the welding fixture for the 17 m yoke support shell assembly.

Magnet Test Facility. The basic design of the "turn-around" cans for the string test facility was completed in the design room. Additional work was completed on the drive mechanism for the 1.8 m vertical test set-up.

3. Superconductor

Wire Procurement. The RHIC wire loaned to LBL for use in the SSC Program is scheduled to be returned by March 27.

Cable Procurement. The outer cable for LLN-007 (D-000Z) has been received from LBL and has been tested and insulated.

As reported last month, a change in the 17 m SSC dipole program and the 1.8 m DSS program requires the fabrication of inner cable using wire with a Cu/S = 1.6. This cable was fabricated during the month of February with A. Bertsche representing BNL at LBL to witness and assist in the cabling of this new material. This cable is presently on site with the cable for LLN-007 tested and insulated. The cable for the DSS program is being tested and will be insulated the first week in March.

As reported last month, a Request for Quotation for 13,200 ft of cable (720 lb) has been released with replies expected by the end of February. The quotations have now been received, reviewed, and a vendor selected. The order has been placed.

Tooling. A Wire Springback Test Device has been received by BNL along with its manufacturing drawings. These drawings, along with those of LBL's Wire Sharp Bend Test Device, have been converted into BNL drawings with BNL numbers. If the need arises, Brookhaven can have additional devices manufactured. The drawings for a Wire Sharp Bend Test Device will be released to shops shortly. The Cable Twist Measuring Device, mentioned in last month's report, has been completed by the design group and will be released to the shops shortly. As reported, this device measures residual twist in a cable over a measured length under a defined tension.

Miscellaneous. As reported last month, a number of tests were made on the Wrapping Line to find ways of improving its speed, safety, and reliability. Improvements in Kapton/fiberglass application and cable guidance are being tried. The required parts modification has started.

As reported last month, a fault has been found in the design of the Wrapping Line Short Detector. Due to wear and fatigue of the brass brushes, it is possible to contaminate the cable. To completely eliminate this

possibility, a modification is in progress which will eliminate the brass brush while assuring complete short detection. Drawings for this modification are in the shops. Meanwhile, a temporary modification to the Short Detector has been made to eliminate the possibility of contamination, and, therefore, the quality of the cable is no longer threatened.

During the month of February, testing commenced on both Kapton and fiberglass insulation to determine their exact thickness and variation in thickness. A report will be made as soon as an adequate number of measurements have been made.

4. Tests and Measurements

The mole measuring probe was checked in the reference dipole several times. It was found that the field angle zero had not changed since the calibration done last November just before the mole was shipped to Fermilab.

5. Electrical Systems

The effort continues to be concentrated on the powering and instrumentation system for the Horizontal Test Facility.

B. FNAL.

1. Cryostat Development

Cold mass connection-slide development continues. A section of the D0004 cold mass skin has been removed and preparations are underway to replace it with a corresponding section of controlled thickness skin. Following the "reskinning" development activity, controlled thickness skin sections will be applied at the five support points. The localized "reskinning" will permit the integrated evaluation of the single element cold mass connection-slide installed at five points.

Parallel studies of local machining of the cold mass skin at support points continues.

Also underway is the procurement of controlled thickness, full-length cold mass skins. Discussions are in progress with a vendor to supply the sheet material for forming these skins. It is planned to incorporate the new cold mass connection-slide into Long Magnet Model D000W.

Material procurement continues for the improved support post and for the alternative anchor concept. Material is estimated to be available for component evaluations in April.

Studies of a two-footed vacuum vessel to establish the optimum location, on a deflection basis, of both internal and external support locations have been scoped.

The measurements of the performance of dimpled aluminized Mylar, without spacer, blankets between 300 and 80 K with degraded vacuum are nearing completion. Following these measurements the Suspension Heat Leak Dewar will be converted for insulation measurements between 80 and 20 K.

Discussions are being conducted with vendors relative to the manufacture of blankets joined by means of sewing.

The HLM II Audit response is being prepared.

Dynamic structural analysis of the cryostat assembly, by a consultant under contract with the CDG, is underway. Measurements are being made of interconnection region bellows to provide axial and lateral stiffness coefficients necessary for the dynamic analysis.

2. String Test

The ER refrigerator continues to be used for the CCI cold compressor test.

Low Temperature Operation. The CCI reciprocating cold compressor was tested with the new cold end installed. The new cold end incorporated larger intake and exhaust valves which was hoped to improve upon the original 20% efficiency.

The cold end was tested at ER for 30 hours over the following conditions.

Mass flow:	0 to 49 gs
Pressure ratios:	1.15 to 2.16
Inlet pressures:	1.19 to 0.55 ata
Adiabatic efficiencies:	40 to 63%

Following the tests, the cold compressor was moved to MTF for lowering the temperature of D0002.

3. Accelerator Studies

The "shielding manual" was completed and sent out for printing. Further calculations are being performed on the important case of the muon dose due to an accidental beam loss. The completed manual augmented by the muon dose calculations will be used in the preparation of the site parameters document.

Work continues on updating CASIM to study energy deposition in the multi-TeV regime.

4. Long Magnet Fabrication

SD13. The cold mass was received from BNL and set up for electrical and mechanical measurements. Nine of twenty-three strands of the inner coil leads were found broken just outside of the cold mass end. These were repaired by soldering the inner cable to the stabilizer lead.

The quench heaters have been rewired to have two separate heater circuits with two heaters wired in series in each set. Strip heaters in quadrants one and three, and quadrants two and four respectively are in series.

With the agreement of Peter Limon, the vertical plane has been measured using the probe as well as measuring the vertical plane mechanically at each fiducial system. These measurements added a few days to the predicted completion date.

All patching to the cold mass skin together with filling the bus passages in the yoke lamination with G-10 is complete. It is anticipated that the entire cold mass and beam tube assembly with the support system attached will be complete by March 4, 1987.

All of the material for the balance of the cryostat assembly is on hand, and a completion date of March 20 is anticipated.

D000X. Subassemblies are being made for the vacuum vessel.

5. Magnetic Measurements

Quench testing of dipole D0002 continued throughout the month. Four spontaneous quenches were taken at 4 atm, 4.6 K ("standard" SSC operating conditions). The quench current varied from 5680 A to 6040 A with one quench in the middle of the magnet and in the lower inner coil and three in the feed end in the upper inner coil. In addition, two spot heater induced quenches were taken at a current of 5500 A to calibrate the position dependence of the

timing of the pressure rise at the two ends of the magnet. The dependence of quench current on helium pressure was briefly explored by quenching the magnet twice at 2.3 atm, 4.6 K; the quench currents of 5730 A and 6090 A indicate no strong effect.

A search was made for a dependence of quench current on the time between one quench and the next. Such a dependence could arise, for example, if there were a localized "hot spot" resulting from the previous quench which took much longer than the rest of the magnet to cool. (If more than one quench was taken in a day, the standard procedure was to wait until about 30 minutes after all temperature sensors returned to their nominal values. Since the bulk of the helium flow goes through the iron yoke the thermometers, which are external to the magnet, would be insensitive to the presence of a small hot spot.) All quenches in 4 atm, 4.6 K supercritical fluid and in 1.5 atm 4.5 K liquid in which the previous quench was at a current greater than 5500 A were examined and no effect was observed.

Using a cold compressor borrowed from the Accelerator Department cryogenics group, the temperature of the magnet was dropped to 3.5 K by pumping on the shell side of the subcooler in the feed can. A set of 12 spontaneous quenches were taken under these conditions, with quench currents varying from 5830 A to 6950 A. Again, most of the quenches originated in the feed end and the upper inner coil, but two quenches started in the return end and two in the lower inner coil. Comparing the quench behavior in 4 atm supercritical helium at 3.5 K with that at 4.6 K shows, on the average, an increase in quench current of 550 A for a decrease in temperature of 1 K. This slope is compatible with data obtained by BNL on SLN013, although the average quench current for D0002 is about 600 A lower.

The trim coil was quenched in 2.3 atm, 4.6 K fluid with 4000 A, 5000 A and 5500 A in the main coil. After between zero and two training quenches at each main coil current, the trim coil quench current ranged from 13 A at 4000 A to 8 A at 5500 A. These quench currents are moderately lower than that observed in SLN013 (14 A at 5800 A), but are much higher that obtained in D0001. The interpretation of the results is made difficult, however, by the presence of voltage "glitches" whose origin has not been firmly established, but which seem to effect trim coil quenches.

Substantial time was spent studying these glitches, which are seen in the main coil (in the upper minus lower coil voltage difference) as well as in the trim coil. The glitches are approximately 20 msec wide and have an amplitude of several tens of millivolts in the main coil and several hundred millivolts in the trim coil. They are present whenever the current is changed in the main coil or the trim coil, independent of the state of current in the other coil. They are present when ramping the main coil current down through the "zero" resistance dump with the main power supply off. The spacing of the glitches in terms of current depends on the main and trim coil currents, the ramp rate, the magnet temperature, and the immediate history. These facts indicate that the source of the glitches is in the magnet, not the power supplies. There is no evident time correlation between the glitches and main coil quenches, but almost all trim coil quenches appear to start with a glitch. This suggests an origin in the trim coil. Proposed mechanisms include large flux jumps, eddy currents in the wire and a resistive turn-to-turn short. Whether this phenomenon results from a fault in this particular trim coil or is a feature of all all trim coils will be answered most clearly by testing another magnet.

C. LBL.

1. Superconductor and Cable

At the beginning of February, two shipments of wire from OST (BNL procurement, first shipment 2-4-87 and second shipment 2-9-87) were received. The incoming strand inspection was done between Feb. 5-11, 1987; this inspection revealed that four spools (15,240 ft) had a Cu/SC ratio of 1.7/1 and the remaining 18 spools (119,065 ft) had a Cu/SC ratio of 1.55/1. Discussions with the manufacturer revealed that the wire with the high Cu/SC ratio had not been given the shaving operation. This material was set aside and a cable run was prepared from the 1.55/1 ratio material. This wire was cabled on Feb. 12 to produce 3671 ft of inner layer cable for use in magnet LLN-000Z. The cable was shipped to BNL on Feb. 13 and received on Feb. 17. A second cable run using the 1.55/1 Cu/SC ratio wire was made on Feb. 18 and the cable sent to BNL on Feb. 20. This cable (1853 ft will be used in 1.8 m dipoles DSS 4-6. Critical current measurements have been made at BNL and indicate that this cable has a critical current value comparable to that in the cable furnished for dipoles DSS1-3.

Responses to the RFP for a Prototype Production Cabling Machine were received on Feb. 24 and are now being evaluated.

After the cable production runs were completed on Feb. 18, several new components were installed on the R&D cabling machine. These include the in-line cable measuring machine built by Fermilab and a new magnetic-hysteresis-type tensioning system. These new components are now being used to make cable for evaluation with the in-line measuring machine.

2. Quadrupoles

Arc Quad. The location and the maximum field at each turn was calculated ("SSC Arc-Quad End Design," S. Capsi and M. Helm, SSC-N-228, 1-28-87).

In the inner layer all the turns except the pole turn experience a field between 4.71 and 4.84 (T) at 6500 A. The peak field at the pole turn is 5.4 (T). The short sample field at this current is 6.02 (T). The turns in the second layer experience somewhat smaller values of B. The 10% increase in field at the pole turn compared with the other turns strongly suggests ways of improving the quad stability or even increasing its gradient (reinforcement at this turn).

The 3D magnetostatic code MAGNUS has been implemented on the LBL VAX, and the code has been used to model the quad end and to obtain some preliminary results.

The coil assembly is 85% complete. Pressure gauge pack assemblies have been completed. Calibration is underway.

IR Quad. A report ("IR Quad for SSC - First Cut," S. Caspi and M. Helm, LBID-1252, SSC-N-286, 1-12-87) on the magnetic design details of several options for a 42 mm bore quad was finished.

3. Dipoles

Dipole Models. Dipole model D14B-8 was retested from Feb. 2-6 after having been at room temperature for seven weeks. It displayed considerable training on its first testing in December, 1986, for reasons that are discussed in the December monthly report. After the thermal cycle, the magnet had very little training, exhibiting good "memory"; at 4.3 K, only one additional quench was required to reach the magnet's short sample limit: the first quench was at 95% of plateau value, and the second was at 100%. At 1.8 K, the first quench was at 96% of the plateau value, and the fourth quench was at 100%.

Dipole model D-14B-9 was tested from Feb. 17-21. This magnet is intended to be identical to D-14B-8. There is virtually no training in HeI at

4.3 K. The first quench, slightly above 6.6 tesla central field, is 97% of the plateau value. The plateau value, above 6.8 tesla, was reached on the second quench. The 1.8 K plateau value above 9.1 tesla at 9469 A is the highest we have yet achieved and only required five quenches. The magnetic field quality of this magnet is excellent.

Dipole model D-14B-10 has been collared and is being prepared for yoke installation. Model D-14B-11 inner layer coils have been completed.

An array of tapered key collars and keys have been modified to test the keying forces and procedure with a series of increasing taper angles. The first lot of custom biaxial strain gages were shipped from the vendor.

C. PROJECT COST DATA

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TABLE C-1

CENTRAL DESIGN GROUP - SUPERCOLLIDER

FEBRUARY 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.1	ADMINISTRATION	85	79	80	244	727	3066
1.2	PROGRAM PLANNING & MANAGEMENT	25	1	12	38	183	550
1.3	ACCELERATOR R & D	100	110	-10	199	811	2516
1.4	CONVENTIONAL SYSTEMS DEVELOP.	19	16	0	35	185	650
	PROGRAM COSTS	229	205	82	516	1906	6782
1.41	RTK COSTS*		24		24	138	110
	CDG/RTK COSTS	229	230	82	540	2043	6892
	COMMITMENTS					282	
	CHANGE IN COMMITMENTS (Delta)					43	

*RTK OVERRUN IS COVERED BY FY86 CARRYOVER FUNDS IN AMOUNT OF 50 K$

TABLE C-2

BROOKHAVEN NATIONAL LABORATORY - SUPERCOLLIDER

FEBRUARY 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
2.1	LONG MAGNET FABRICATION	12.4	6.7	10.7	29.8	225	521
2.2	MAGNET DESIGN	5.9	1.3	4	11.2	63	202
2.3	TOOLING & FIXTURES	14.8	11.6	14.9	41.2	186	435
2.4	BEAM TUBE DEVELOPMENT	2.8	1.1	2.2	6.2	30	100
2.5	TRIM COIL DEVELOPMENT	4.7	2.2	3.9	10.8	67	167
2.6	MAGNET MEASUREMENTS	1.9	1.5	1.9	5.2	18	50
2.7	INDUSTRIALIZATION	28.3	4.3	18.3	50.9	220	1859
	PROGRAM COSTS	70.8	28.7	55.9	155.3	809	3334
	COMMITMENTS					442	
	CHANGE IN COMMITMENTS (Delta)					109	
	EQUIPMENT					0	200

TABLE C-3

FERMI NATIONAL ACCELERATOR LABORATORY - SUPERCOLLIDER

FEBRUARY 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
3.1	GENERAL	0.7	0.5	0.4	1.6	28.3	140
3.2	LONG MAGNET FABRICATION	23.5	12.4	12.7	48.6	188.1	750
3.3	MAGNETIC MEASUREMENTS	53.3	29.3	29.2	111.8	464.5	1315
3.4	INDUSTRIALIZATION	0	0	0	0	0	550
3.5	CRYOGENIC	0	0	0	0	3.5	
	PROGRAM COSTS	77.5	42.2	42.3	162	684.4	2755
	COMMITMENTS					72.7	
	CHANGE IN COMMITMENTS (Delta)					21.5	
	EQUIPMENT					182	400

TABLE C-4

LAWRENCE BERKELEY LABORATORY - SUPERCOLLIDER

FEBRUARY 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
4.1	GENERAL	7	0	4	11	59	180
4.2	SUPERCONDUCTOR	15	0	8	24	143	240
4.3	QUADRUPOLE DEVELOPMENT	29	4	16	49	282	300
4.4	MODEL MAGNET	40	0	19	59	362	559
4.5	ACCELERATOR R & D	0	0	0	0	0	84
	PROGRAM COSTS	92	4	47	143	846	1363
4.5	ACCELERATOR THEORY	25	1	13	39	227	600
	LBL/THEORY COSTS	117	5	60	182	1073	1963
	COMMITMENTS					13	
	CHANGE IN COMMITMENTS (Delta)					-23	
	EQUIPMENT						200

TABLE C-5

TEXAS ACCELERATOR CENTER - SUPERCOLLIDER

FEBRUARY 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
5.1	DIODE QUENCH PROT.	28.2	2.6	24.6	55.4	358.3	439
5.2	CORRECTION ELEMENTS	23.6	0	21.4	45	201	214
5.3	ACCELERATOR PHYSICS	2.1	0.5	11.9	14.5	127.2	63.5
5.4	TAMU NUCLEAR REACTOR	0	0	0	0	0.3	84
	PROGRAM COSTS	53.9	3.1	57.9	114.9	686.8	800.5
	FY86 COMMITMENTS	0	120.5	-4.1	116.4	142.2	107.8
	COMMITMENTS					32.8	
	CHANGE IN COMMITMENTS (Delta)					-31	

TABLE C-6

PROGRAM SUMMARY - SUPERCOLLIDER

FEBRUARY 1987 COST REPORT (K$)

	PROGRAM ELEMENT	LABOR	MAT'L & SERVICES	G & A	MONTH TOTAL	YEAR TO DATE	ANNUAL BUDGET
1.	CDG PROGRAM	229	205	82	516	1906	6782.0
1.41	ETE PROGRAM	0	24	0	24	138	110.0
2.	BNL SSC PROGRAM	71	29	56	155	809	3334.0
3.	FNAL SSC PROGRAM	78	42	42	162	684	2755.0
4.	LBL SSC PROGRAM	117.0	5.0	60.0	182.0	1073.0	1963.0
5.	TAC SSC PROGRAM	54	3	58	115	687	800.5
6.	UNDISTRIBUTED FUNDS						255.5
	TOTAL SSC PROGRAM COSTS	548	309	298	1154	5296	16000
	COMMITMENTS					843	
	CHANGE IN COMMITMENTS (Delta)					120	
	EQUIPMENT					182	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						
APR	574.3	4020.3						
MAY	574.3	4594.7						
JUN	574.3	5169.0						
JUL	574.3	5743.3						
AUG	574.3	6317.7						
SEP	574.3	6892.0						

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						
APR	277.8	1944.8						
MAY	277.8	2222.7						
JUN	277.8	2500.5						
JUL	277.8	2778.3						
AUG	277.8	3056.2						
SEP	277.8	3334.0						

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						
APR	229.6	1607.1						
MAY	229.6	1836.7						
JUN	229.6	2066.3						
JUL	229.6	2295.8						
AUG	229.6	2525.4						
SEP	229.6	2755.0						

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	163.6	163.6	64.0	64.0	80.0	80.0	16.0	16.0
NOV	163.6	327.2	97.0	161.0	97.0	177.0	16.0	0.0
DEC	163.6	490.8	527.0	688.0	547.0	724.0	36.0	20.0
JAN	163.6	654.3	204.0	892.0	204.0	928.0	36.0	0.0
FEB	163.6	817.9	182.0	1074.0	159.0	1087.0	13.0	-23.0
MAR	163.6	981.5						
APR	163.6	1145.1						
MAY	163.6	1308.7						
JUN	163.6	1472.3						
JUL	163.6	1635.8						
AUG	163.6	1799.4						
SEP	163.6	1963.0						

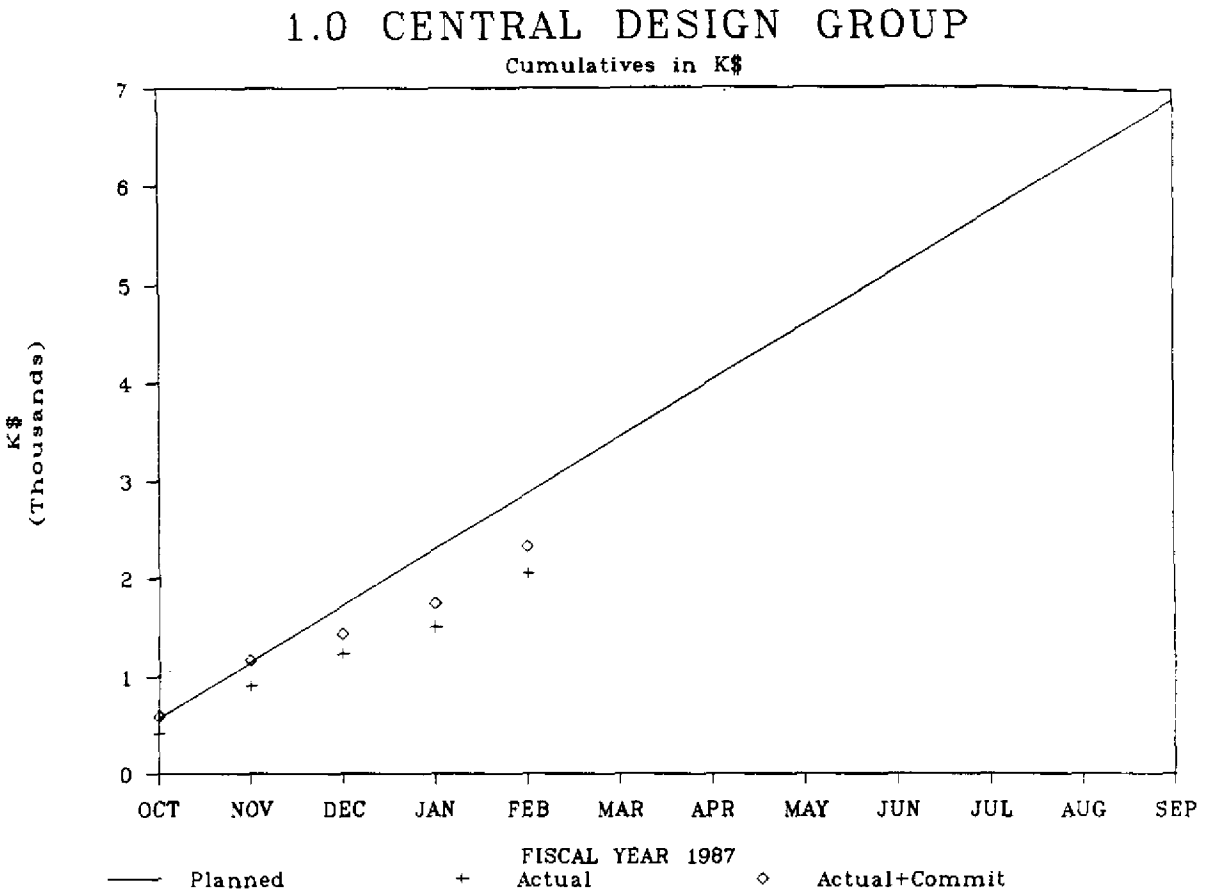
5.0 TEXAS ACCELERATOR CENTER - SUPERCOLLIDER

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	66.7	66.7	108.9	108.9	219.3	219.3	110.4	110.4
NOV	66.7	133.4	106.0	214.9	56.0	275.3	60.4	-50.0
DEC	66.7	200.1	201.1	416.0	201.1	476.4	60.4	0.0
JAN	66.7	266.8	155.5	571.5	158.9	635.3	63.8	3.4
FEB	66.7	333.5	116.4	687.9	85.4	720.7	32.8	-31.0
MAR	66.7	400.2						
APR	66.7	467.0						
MAY	66.7	533.7						
JUN	66.7	600.4						
JUL	66.7	667.1						
AUG	66.7	733.8						
SEP	66.7	800.5						

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	1312.0	1312.0	867.4	867.4	1435.8	1435.8	568.4	568.4
NOV	1312.0	2624.1	1011.6	1879.0	1105.9	2541.7	662.7	94.3
DEC	1312.0	3936.1	1368.9	3247.9	1337.2	3878.9	631.0	-31.7
JAN	1312.0	5248.2	897.5	4145.4	989.5	4868.4	723.0	92.0
FEB	1312.0	6560.2	1155.7	5301.1	1275.2	6143.6	842.5	119.5
MAR	1312.0	7872.2						
APR	1312.0	9184.3						
MAY	1312.0	10496.3						
JUN	1312.0	11808.4						
JUL	1312.0	13120.4						
AUG	1312.0	14432.5						
SEP	1312.0	15744.5						

Undistributed Funds: 255.5
Total FY87 Planned: 16000.0


1.0 CENTRAL DESIGN GROUP
Cumulatives in K$
K$ (Thousands)
0
1
2
3
4
5
6
7
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Commit

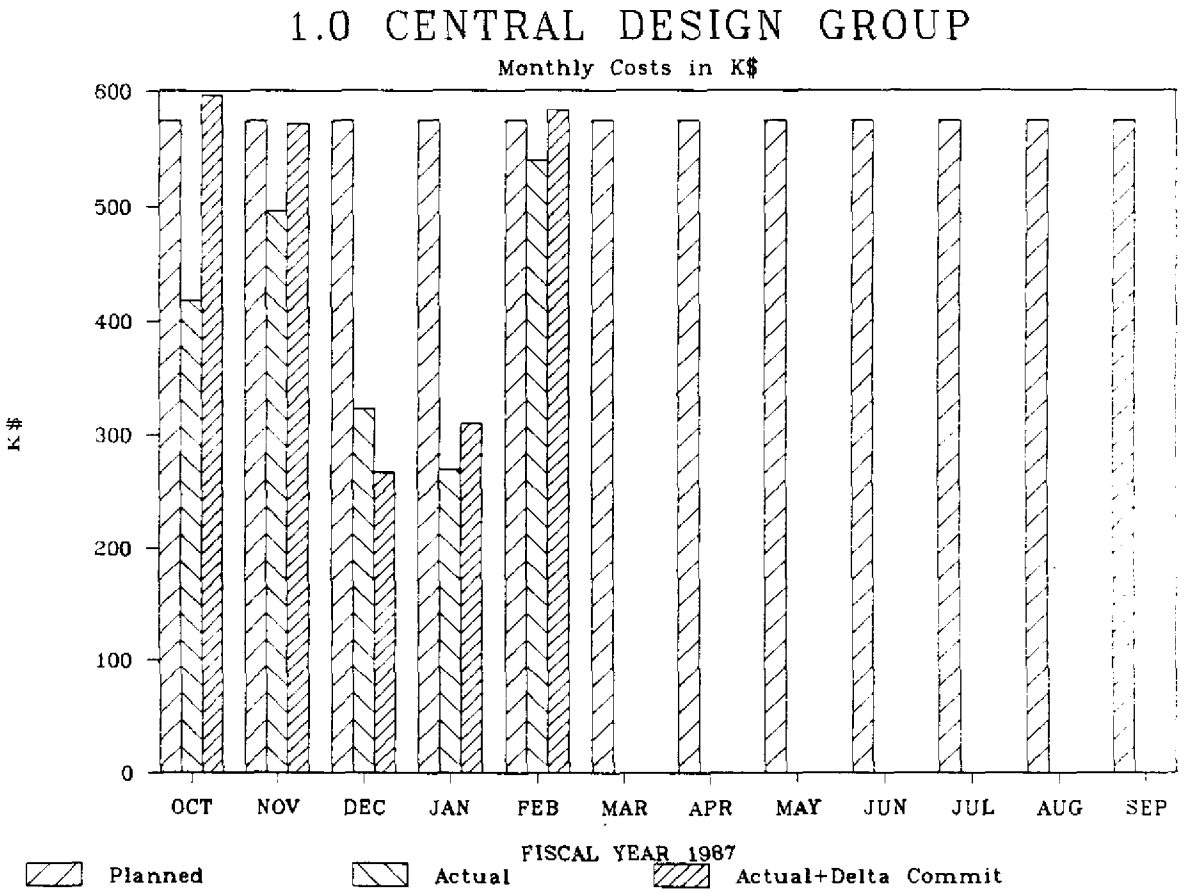
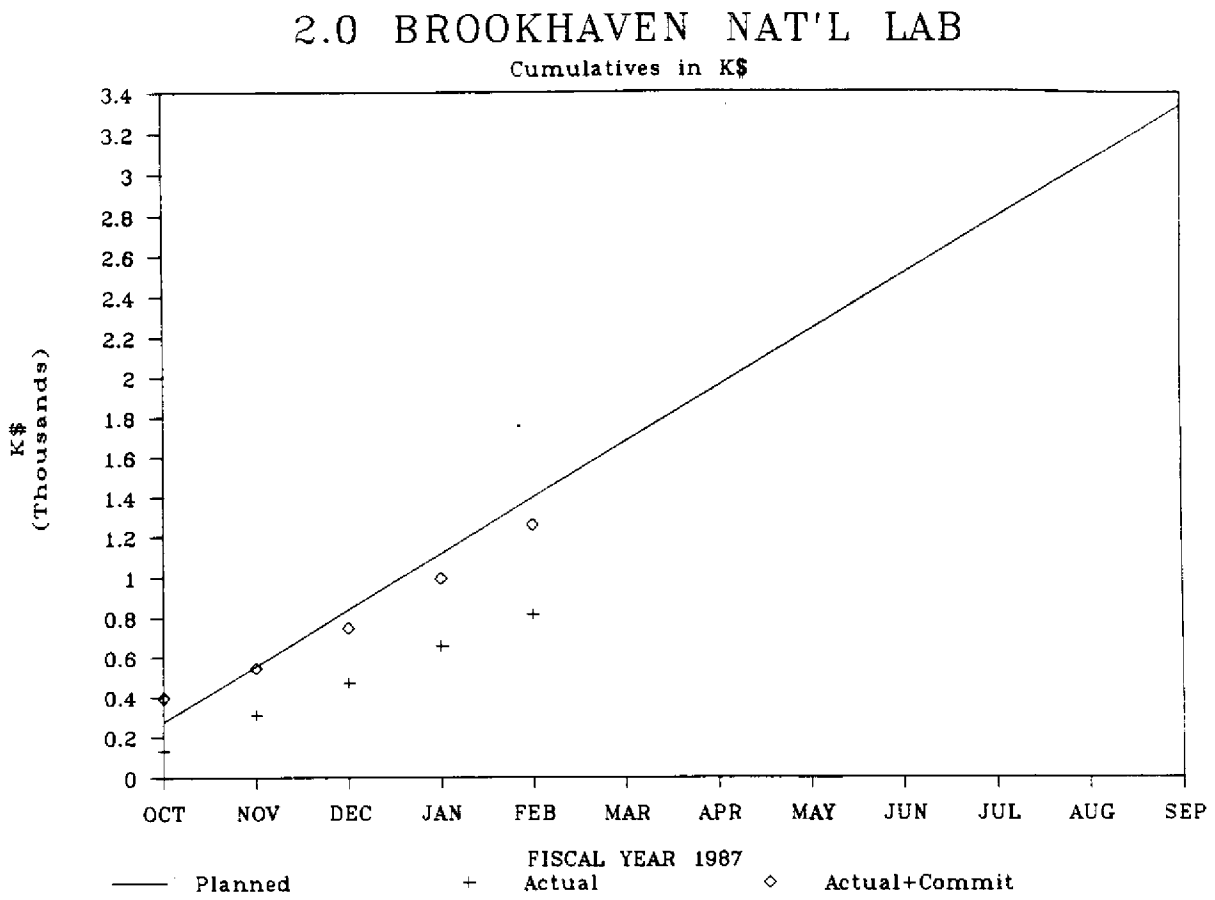

1.0 CENTRAL DESIGN GROUP
Monthly Costs in K$
K$
0
100
200
300
400
500
600
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 1


2.0 BROOKHAVEN NAT'L 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

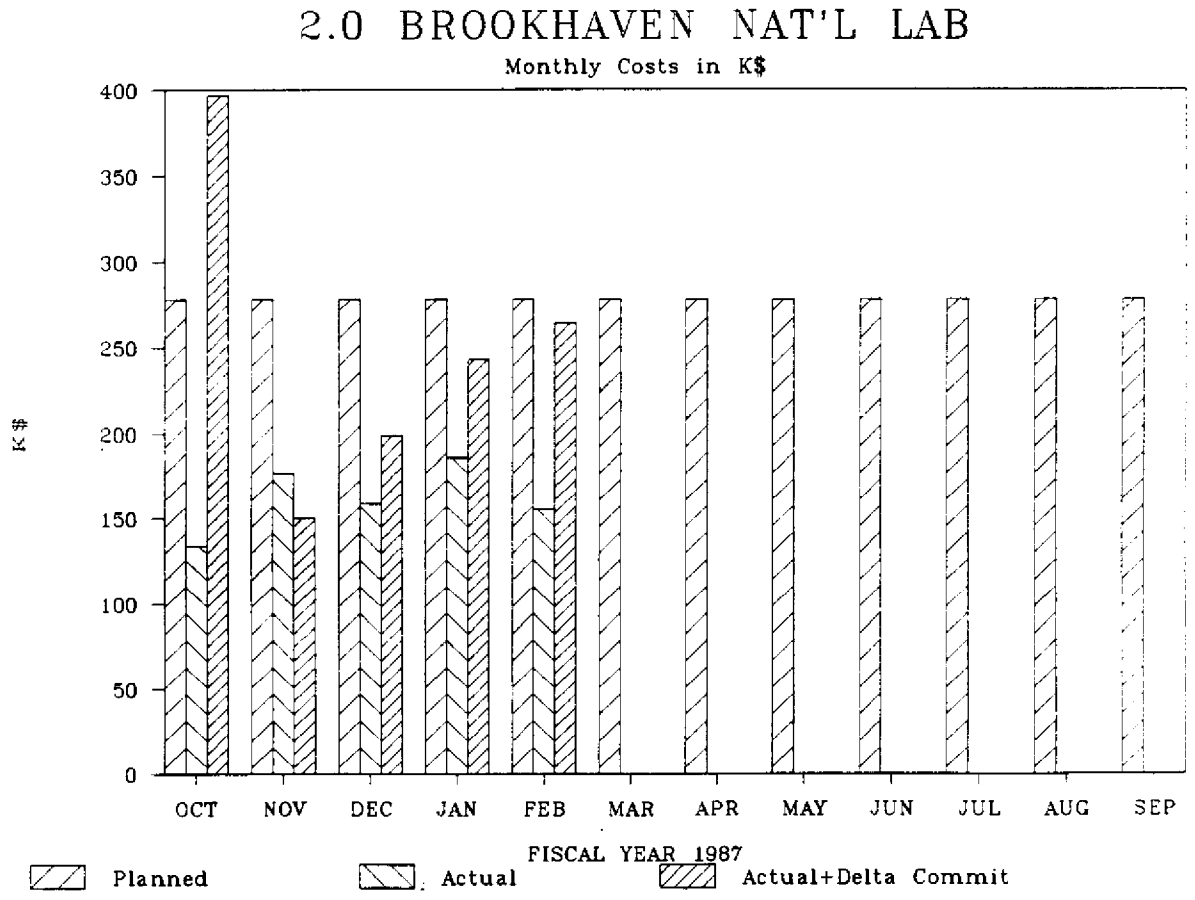
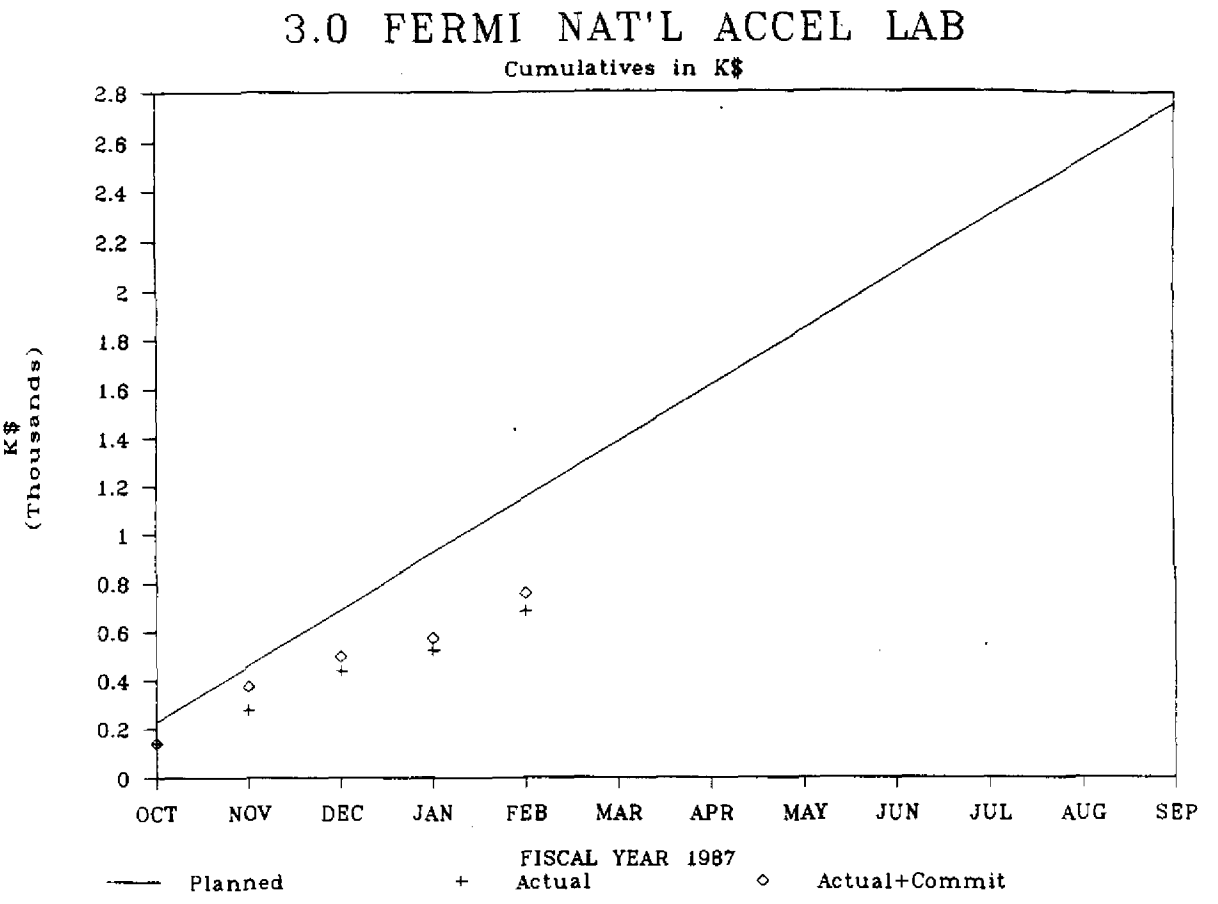

2.0 BROOKHAVEN NAT'L LAB
Monthly Costs in K$
K$
400
350
300
250
200
150
100
50
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 2


3.0 FERMI NAT'L ACCEL 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

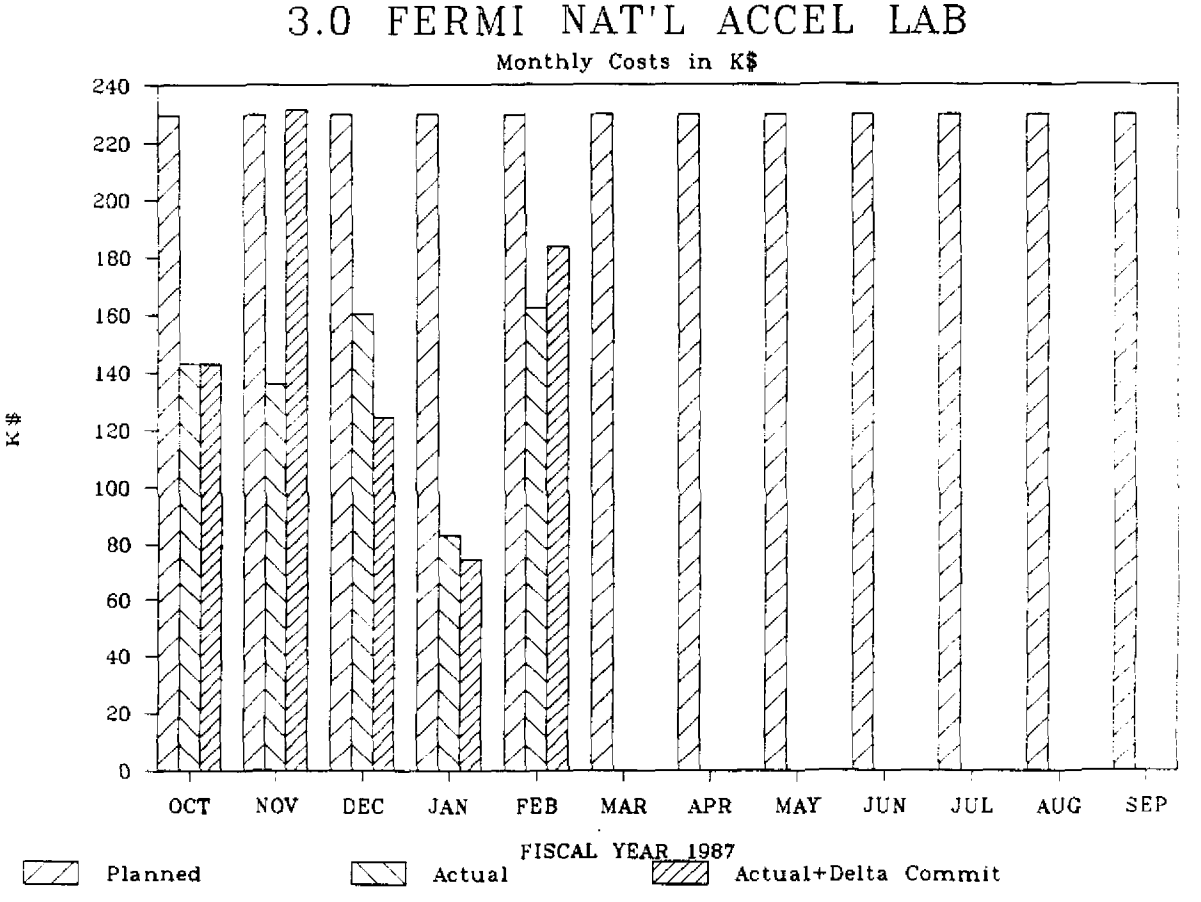
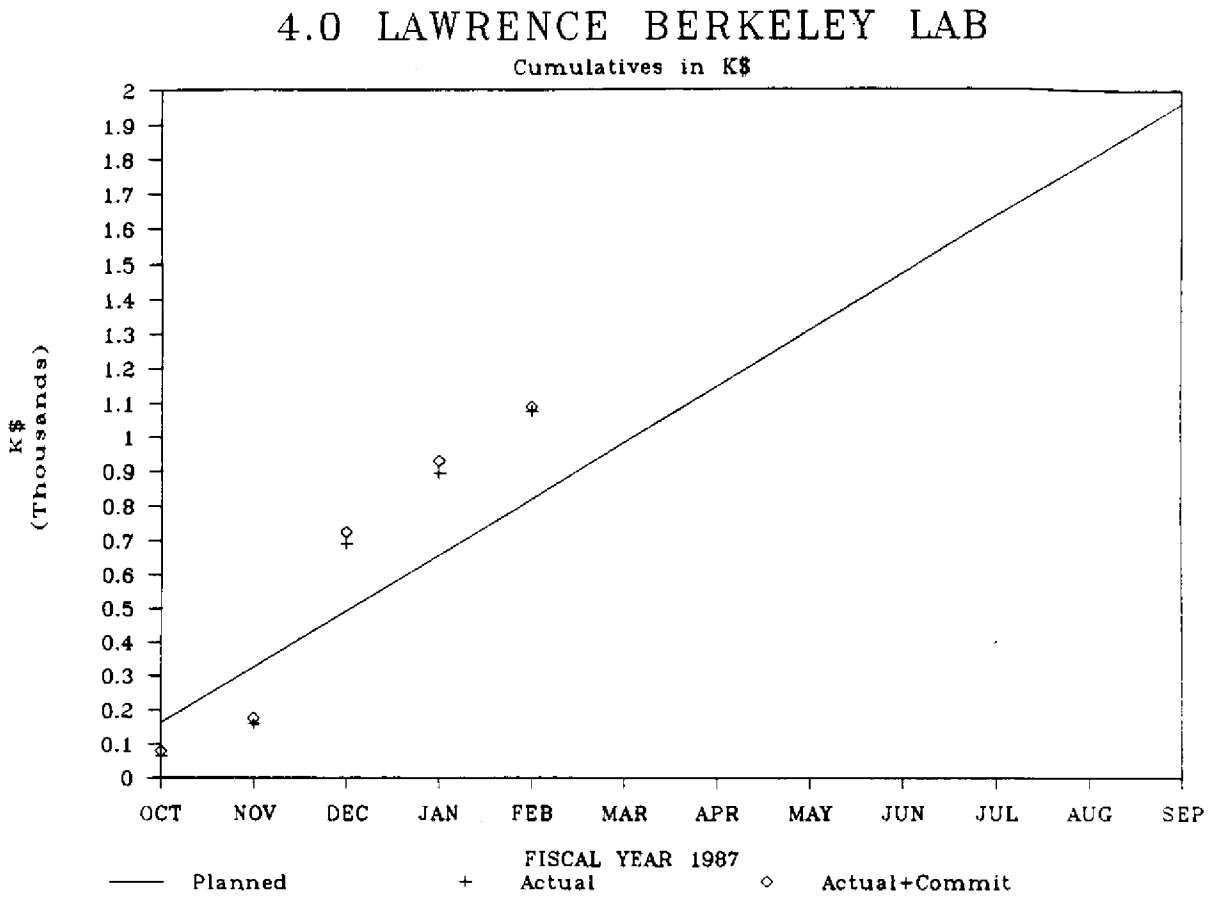

3.0 FERMI NAT'L ACCEL LAB
Monthly Costs in K$
K$
240
220
200
180
160
140
120
100
80
60
40
20
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 3


4.0 LAWRENCE BERKELEY LAB
Cumulatives in K$
K$ (Thousands)
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+Commit

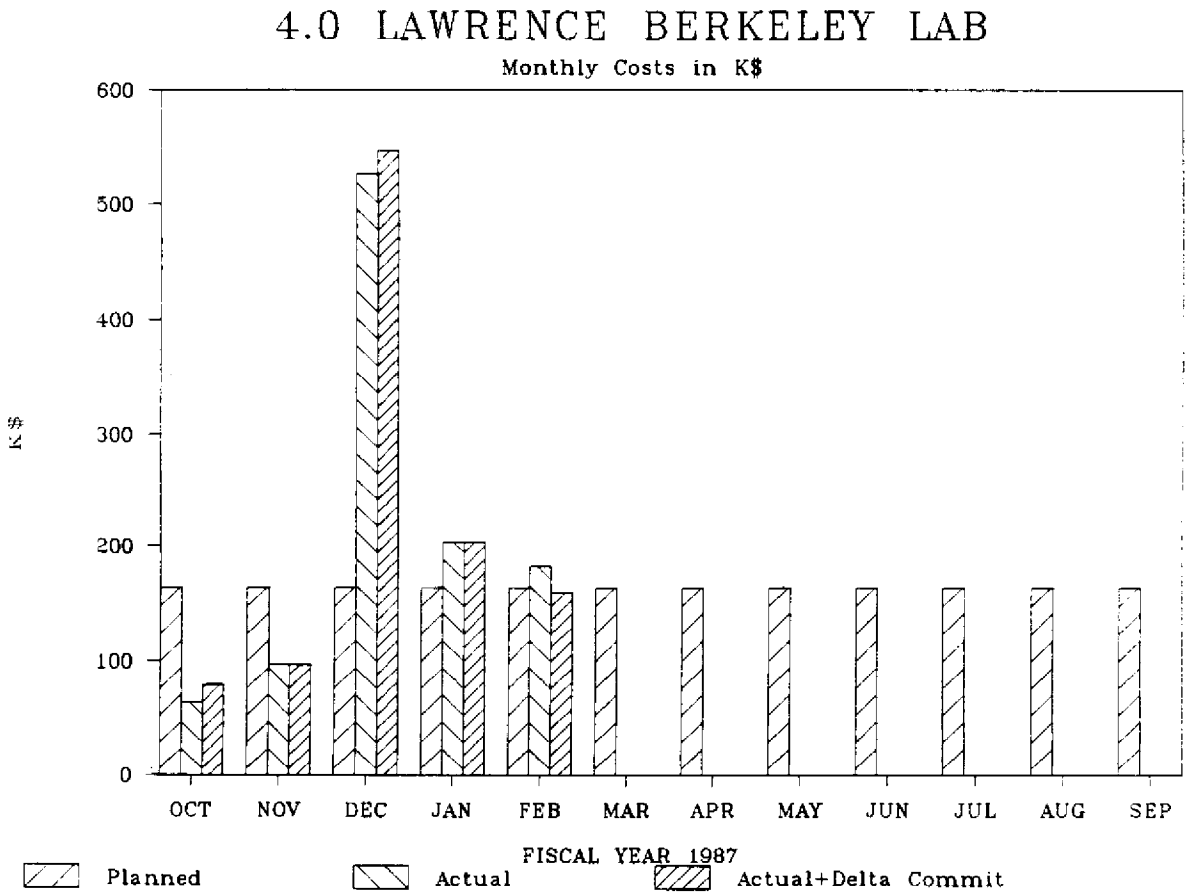
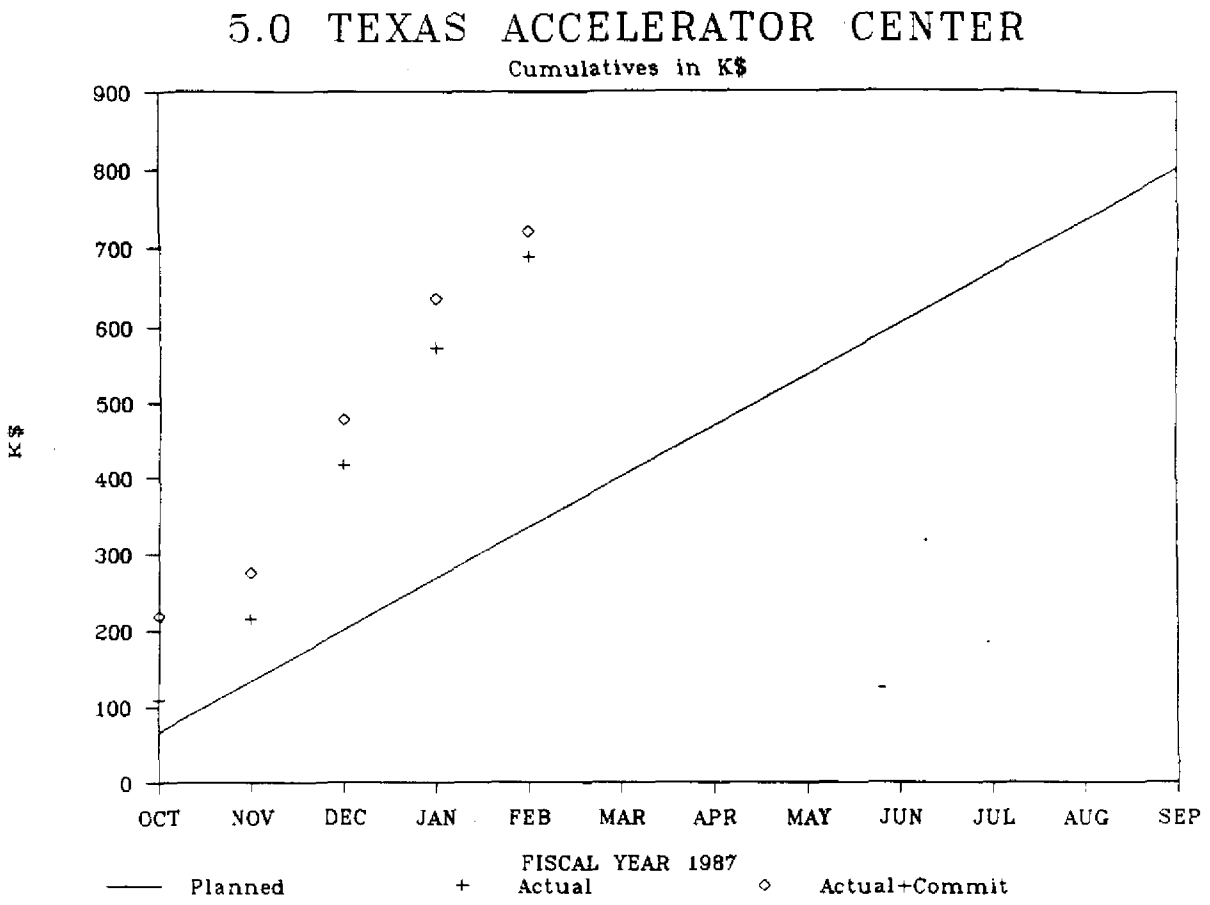

4.0 LAWRENCE BERKELEY LAB
Monthly Costs in K$
K$
600
500
400
300
200
100
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 4


5.0 TEXAS ACCELERATOR CENTER
Cumulatives in K$
K$
900
800
700
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+Commit

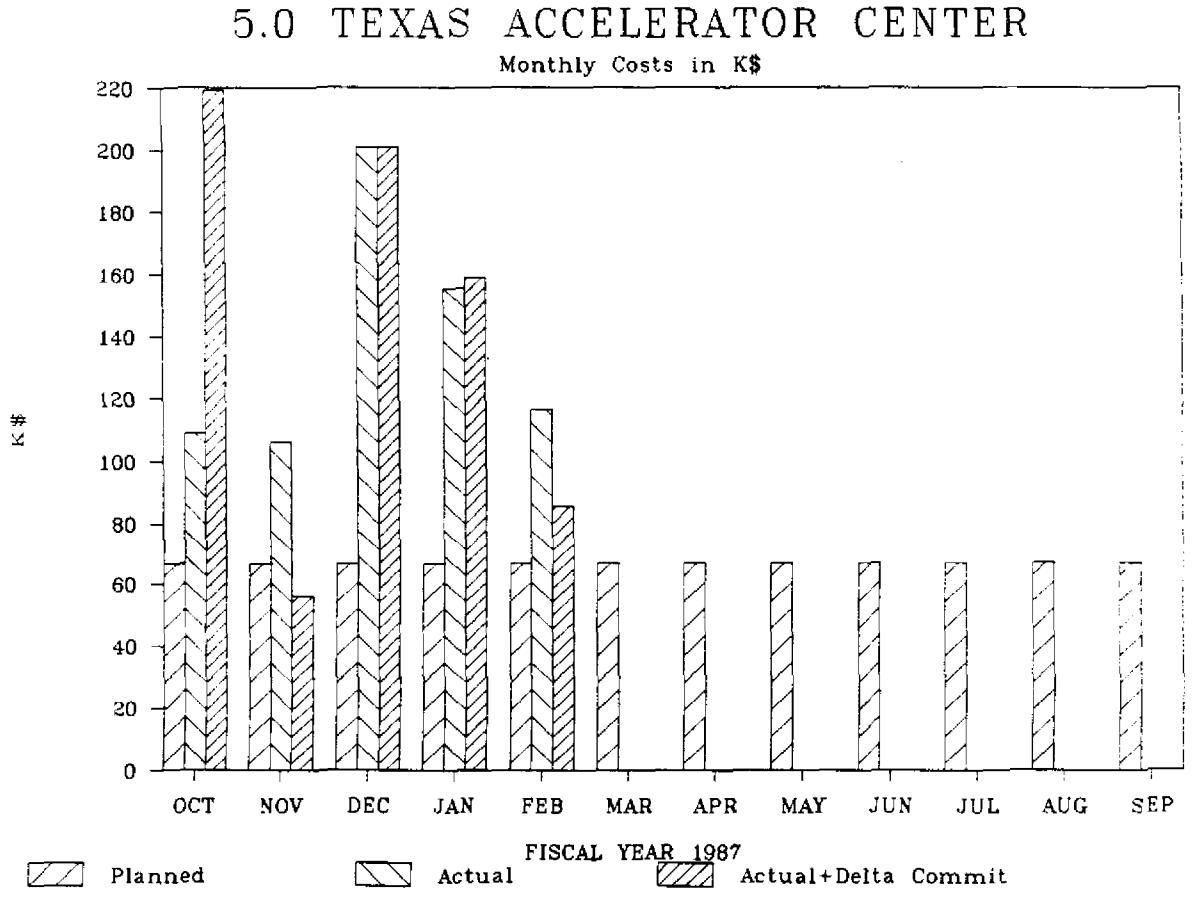
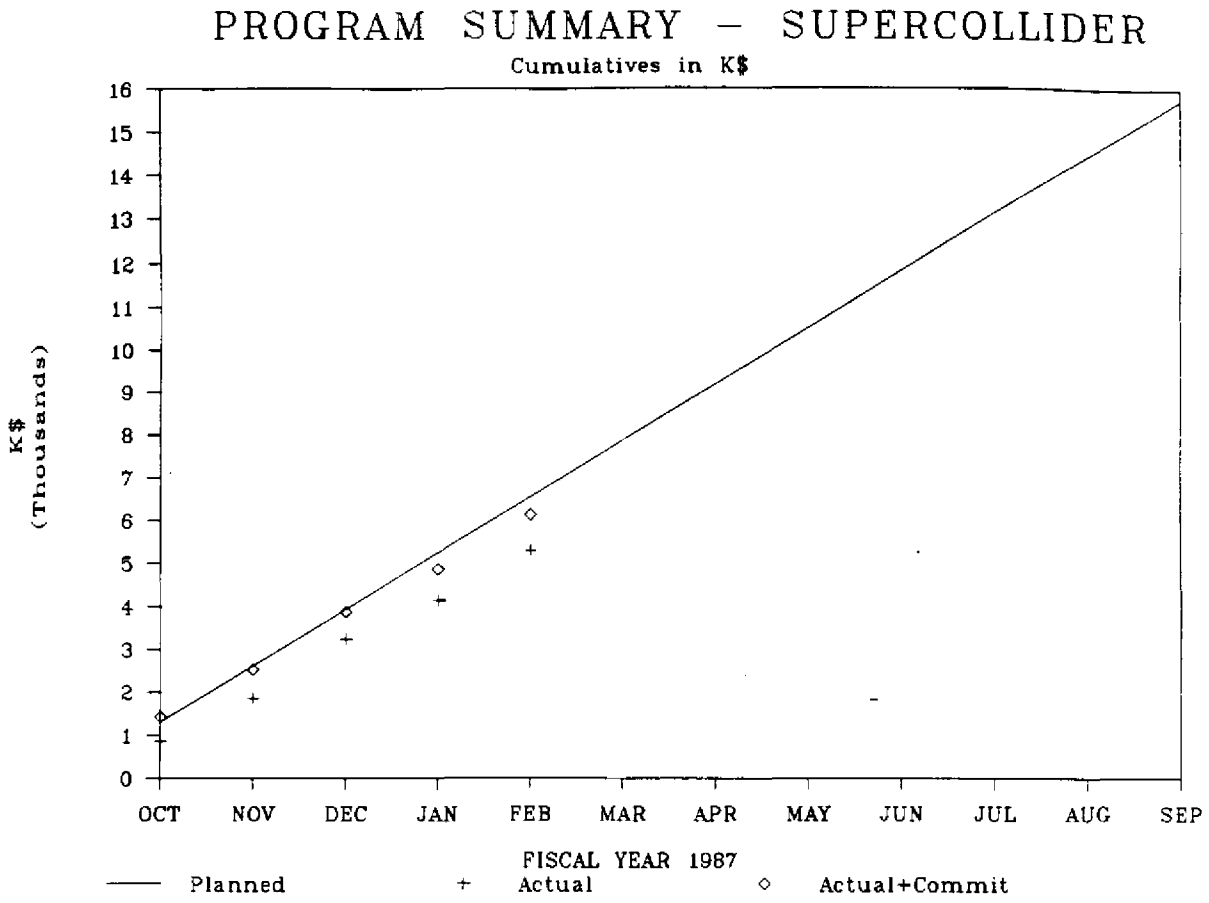

5.0 TEXAS ACCELERATOR CENTER
Monthly Costs in K$
K$
220
200
180
160
140
120
100
80
60
40
20
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 5


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

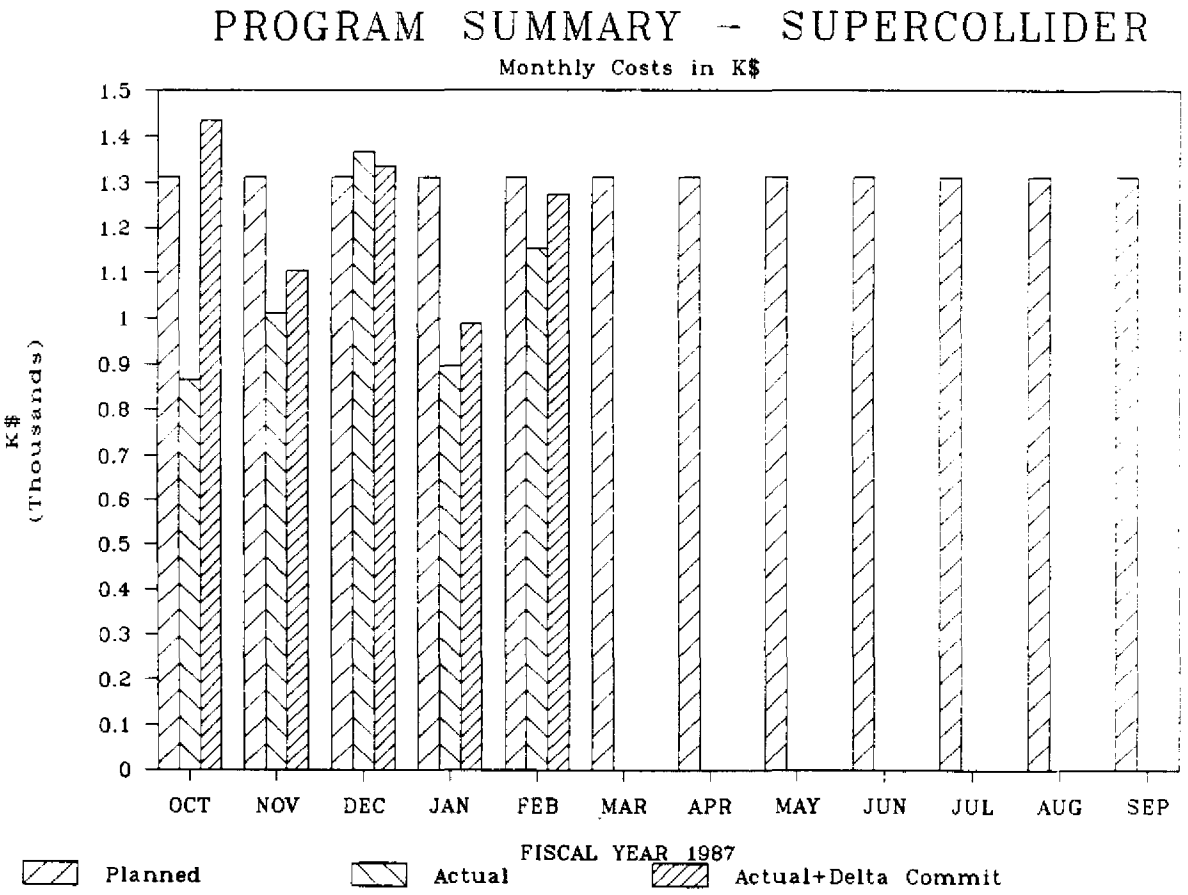

PROGRAM SUMMARY - SUPERCOLLIDER
Monthly Costs in K$
K$ (Thousands)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FISCAL YEAR 1987
Planned
Actual
Actual+Delta Commit

Fig. 6