SPEAR 3

Quarterly Progress Report

Stanford Synchrotron Radiation Laboratory

April through June 2001

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A. SPEAR 3 PROJECT SUMMARY

1. Technical Progress

Magnet System - The project has received three shipments of magnets from IHEP. A total of 55 dipole, quadrupole and sextupole magnets out of 218 have arrived. All main magnets will arrive by December. The additional mechanical and electrical checks of the magnets at SSRL have been successful. Only minor mechanical problems were found and corrected. The prototype corrector magnet is being assembled at IHEP and should be delivered in August. The production correctors will all arrive by June 2002.

Assembly of the QFC prototype raft with magnets and vacuum chamber has been completed. The raft is located in building 750, where the assembly of all girders will take place. Procedures were developed for mounting each magnet, splitting the magnets to install the vacuum chamber and sliding in the dipole magnet. The assembly process went smoothly and the procurement for the production rafts is underway.

Vacuum System -The first article BM-2 chamber was completed this quarter and installed on the prototype girder. Welding of the chamber was delayed due to the overhaul and cleaning of the e-beam welder in order to improve performance and reliability. The chamber design tolerances were met except for the horizontal curvature. The welding parameters will be modified and additional welding passes will be used to reduce the distortion during the production phase. All QFC chamber plates were received in April and QFC production started in June with completion scheduled in September. The production plan is to complete 1-1/2 chambers per week using mulitple shifts as necessary. The BM-1 prototype chamber will be welded after the QFC production.

RF System - The four cavities being fabricated are experiencing delays because of resource conflicts at the manufacturer. The machining and e-beam welding delay has caused a two-month slip in the delivery schedule. The manufacturer has contracted out some of the work to make up the schedule. The first cavity will now be delivered in October instead of August.

The klystron received in April was loaned to the B-factory for testing and operation. After about 800 hours of operation, the klystron failed. It was sent back to the manufacturer for repair. Another klystron is being delivered in July and will be tested. The klystron failure is a concern for both the B-factory and SPEAR 3. Several options are being evaluated to address this problem. The cavity and klystron issues will not impact the overall project schedule and is not on the critial path because installation of these components is about a year and a half away.

Power Supply - The dipole magnet power supply transformer was factory-tested and delivered in early June. Engineering analysis continued on the suitability of the B-factory style power supply for SPEAR 3. The power supply will be tested in the SPEAR booster building during the current shutdown to determine needed upgrades to satisfy SPEAR 3 requirements. Many of the remaining power supplies are in various stages of the procurement cycle.

Facilities - The annual shutdown started on July 5 and will continue to October 12. Several SPEAR 3 construction activities are scheduled. The West Pit shielding work was awarded in June. This work will complete the straight section shielding walls and install the associated concrete roof shielding. The contract was 15% above cost estimates. The contract cable tray structural supports, concrete footings, trench work for the HV RF cables, and cable tray installation was also awarded.

Instrumentation and Controls - Progress in design and implementation of instrumentation and control systems for the SPEAR 3 project continued. Most effort was devoted to specifying and scheduling Computer Control System software tasks, designing Control System hardware components, deciding on the Beam Position Monitor (BPM) processing system plan, and beginning the detailed design of the Machine Protection System. The design effort for the Injection Timing System was renewed, and the design of the Quadrupole Modulation System commenced.

Accelerator Physics - The accelerator physics group conducted a complete review of the Synchrotron Light Monitor. In parallel software developments were made to provide timing features with MATLAB. SPEAR 2 accelerator physics shifts successfully demonstrated the software on-line. Also, as a test for SPEAR 3, beam was successfully accelerated in the Booster to 3 Gev.

ES&H - Efforts have focused on shutdown activities including shielding modifications and Personnel Protection System changes. The Earthquake Safety Committee and Electrical Safety Committee have approved cable tray supports and the general plan for cable plant installation.

2. Cost Reporting

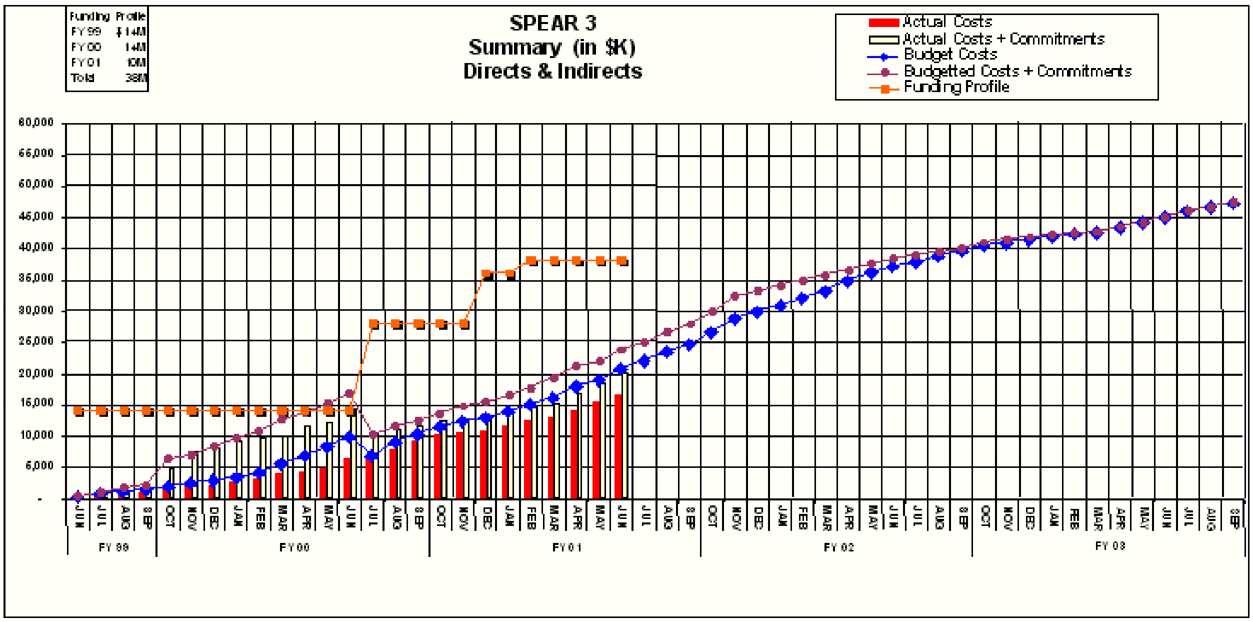
The total project costs and commitments through June of this quarter are provided in Table A1. The integrated costs and commitments per month are given in Fig. A1.

Table A1
Costs and Obligations
(through June 2001)

	K$	
	Direct	Direct & Indirects
Costs	14,471	16,491
Commitments	3,650	3,960
Total	18,121	20,451

Table A2 provides the project performance data with associated cost and schedule variances at WBS Level 2. Monthly plots of this data for FY 2001 are provided in Figure A2 together with BCWS projections through September 2001.

The current project schedule, from which the schedule variances (SV) are determined in Table A2, will be updated in the next Quarterly Report. The updated schedule will more accurately reflect the rebaselining effort of last year and will significantly reduce the variance for Magnets and Supports. Revisions for RF System and Cable Plant will be based on the latest detailed technical plans together with revised staffing plans. These changes which have been in progress do not impact any critical paths or milestones and will reduce the current SV by more than 50%.



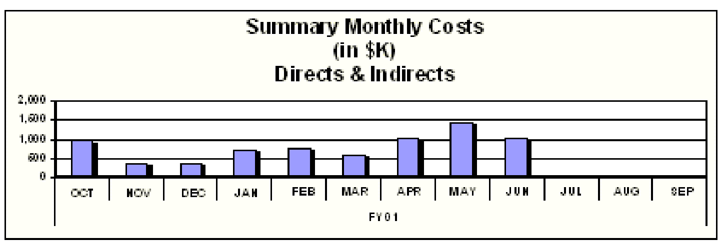


Figure A1

Table A2

Cost/Schedule Status Report - DIRECTS, INDIRECTS AND ESCALATION				
	Contract Type/No:	Project Name/No: Spear3 Revised Baseline	Report Period: Status thru 6/30/01	Signature: Title/Date: 7/27/01
(1) Original Contract Target Cost	(2) Negotiated Contract Changes	(3) Current Target Cost (1) + (2)	(4) Estimated Cost of Authorized Unpriced Work	(5) Contract Budget Base (3) + (4)
53,107	4,888	57,995	0	57,995

Performance Data								
	Cumulative to Date					At Completion		
WBS[2]	Budgeted Cost		Actual Cost Work Performed	Variance		Budgeted	Latest Revised Estimate	Variance
	Work Scheduled	Work Performed		Schedule	Cost			
1.1 Magnets and Supports	4,914	4,106	3,771	-808	335	8,873	8,873	0
1.2 Vacuum System	3,510	3,216	3,446	-293	-229	10,926	10,926	0
1.3 Power Supply System	722	502	309	-220	193	3,292	3,292	0
1.4 RF System	2,615	1,882	2,022	-733	-140	4,157	4,157	0
1.5 Instruments Control & Protection Systems	1,072	887	814	-185	72	3,694	3,694	0
1.6 Cable Plant	818	307	415	-510	-107	2,329	2,329	0
1.7 Beamline Front Ends	169	257	144	87	113	1,056	1,056	0
1.8 Facilities	1,539	1,386	1,559	-153	-173	2,656	2,656	0
1.9 Installation and Alignment	0	0	0	0	0	3,167	3,167	0
1.0 Mgmt, Support, & Accelerator Physics	1,919	1,919	1,901	0	18	4,037	4,037	0
Gen. and Admin.	2,403	2,403	2,110	0	292	5,819	5,819	0
Undist. Budget						0	0	0
Sub Total	19,681	16,865	16,491	-2,816	374	50,006	50,006	0
Management Resrv.						7,989	7,989	0
Total	19,681	16,865	16,491	-2,816	374	57,995	57,995	0

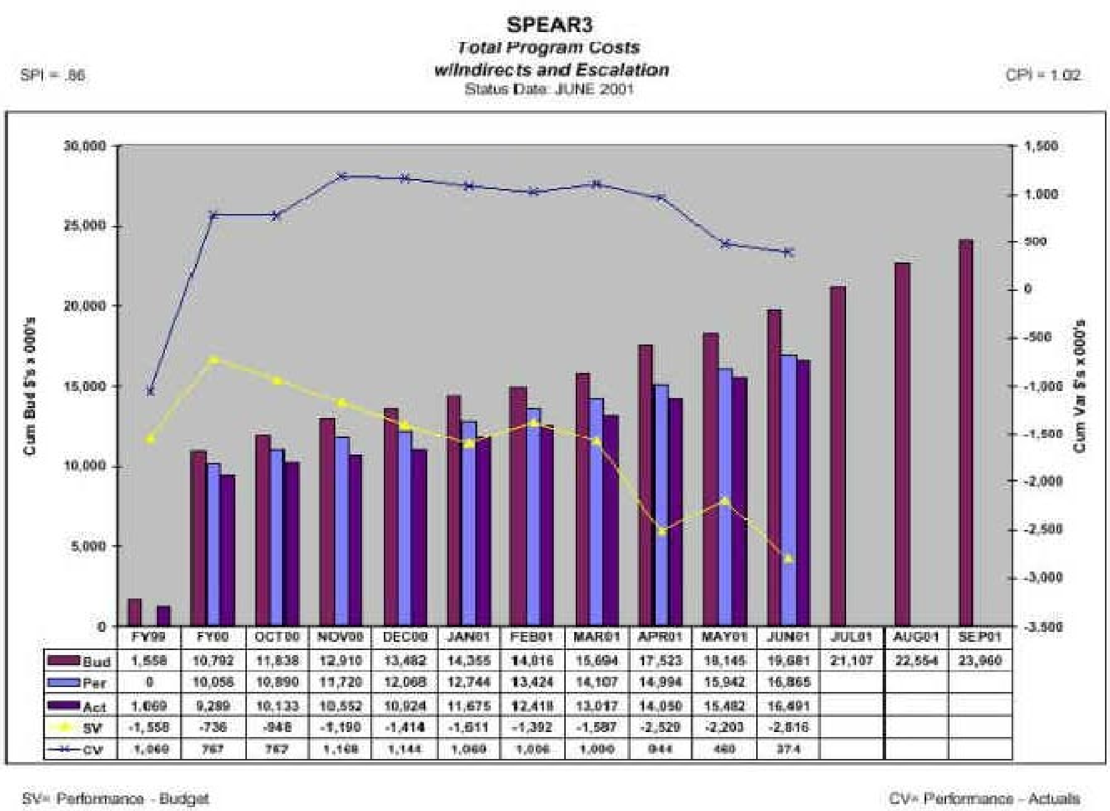


Figure A2

B. Detailed Reports

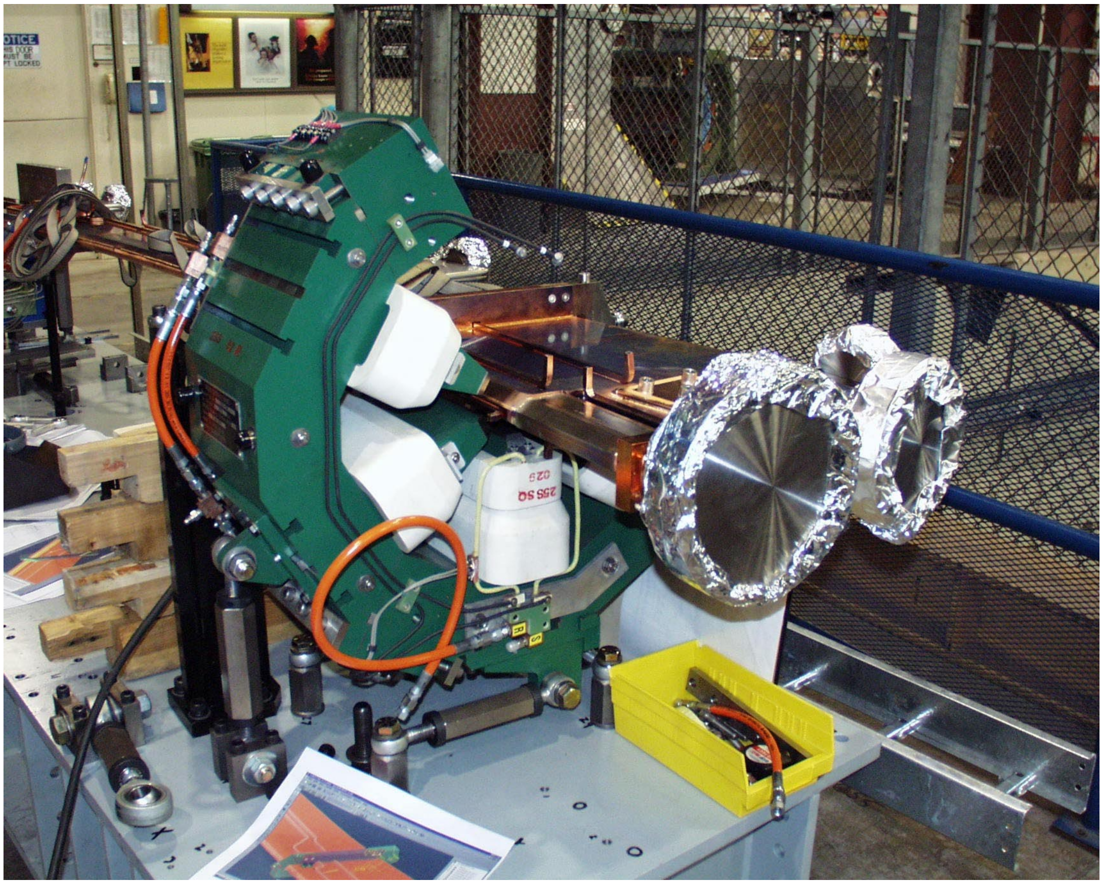
1.1 Magnets and Supports

Support System

The assembly of the SPEAR3 prototype raft with production magnets and vacuum chamber has been completed. Shown in the picture below are (L to R) the 34Q, 15Q, 145D, and 25S magnets installed and aligned onto the support raft. The raft itself, as will be the case in the SPEAR tunnel, is mounted onto two support stands that are secured and grouted to the concrete floor with a fixed support on the left and a flexible support on the right end.

Prototype Raft Assembly

Assembly of the prototype raft went very smoothly. Procedures were developed for mounting of the quadrupoles and sextupole and subsequent splitting of the magnets to allow for the vacuum chamber installation. After this process, the 15,000 lb dipole is carefully slid over the vacuum chamber using a dipole slider fixture. All components are aligned and the raft is then ready to be removed from the assembly stand. With the successful assembly of the raft, we have released for production the magnet support struts and support rafts as well as additional alignment support stands to prepare for production assembly.



Sextupole magnet on raft, split to allow installation of vacuum chamber

Magnets

Three shipments of production magnets have been received from IHEP for a total of 15 Dipoles, 26 Quadrupoles, and 14 Sextupoles. Magnet shipments are scheduled each month with completion scheduled for December 2001. The H/V Corrector magnets will be in a final shipment scheduled for June 2002.

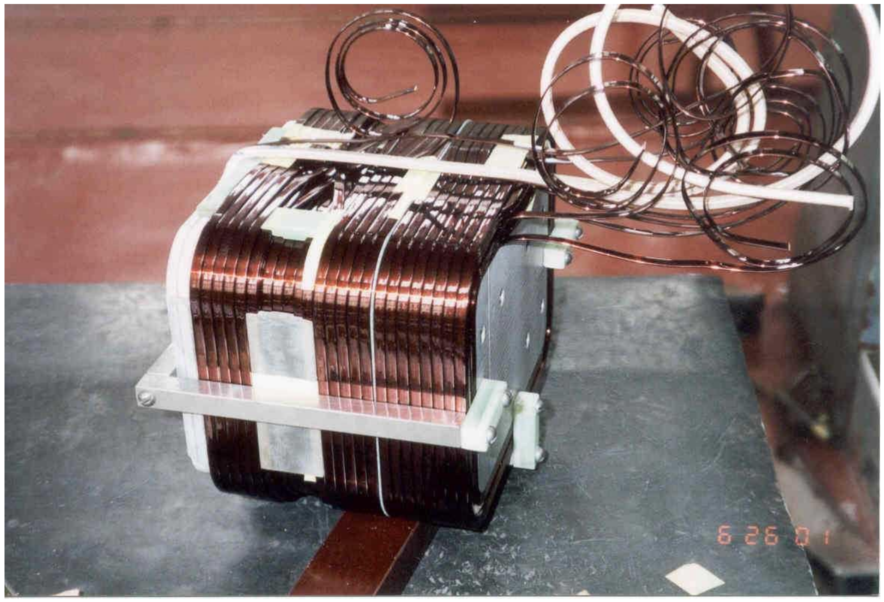
The production magnets are in the process of mechanical and electrical checkouts after which they will be sent to magnetic measurements and alignment. Some problems have been found in the bus connections of the magnets during the mechanical inspections. In some cases the silver plating was not adhering to the copper bus and in other cases the bus connections were not flat yielding a less then perfect contact. Solutions to these problems have been discussed with our IHEP colleagues and subsequent shipments will include these corrections.

At this point in the magnet production, IHEP has the following magnet completion percentage:

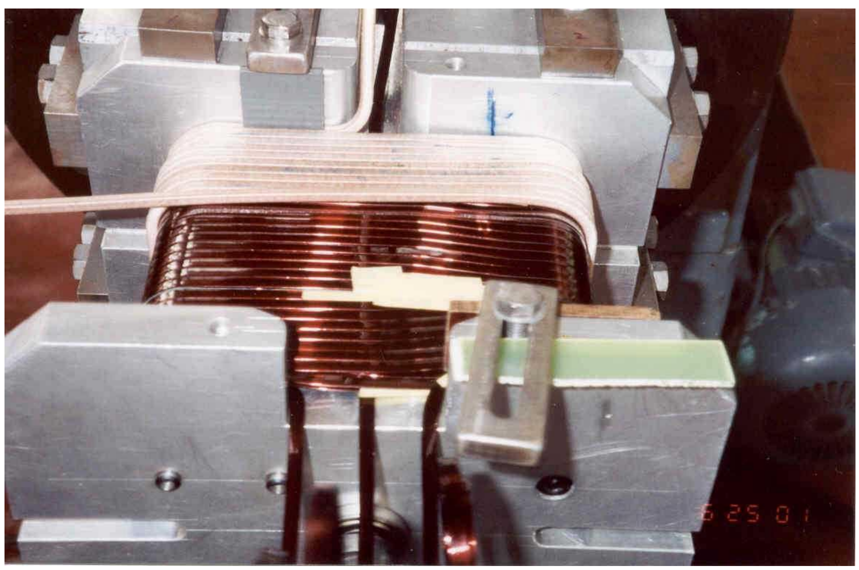
Magnet Type	Qty Required	Percent Complete
145D	30	83
109D	10	10
21S	46	4
25S	30	100
15Q	30	100
34Q	46	59
50Q	20	0
60Q	6	0

Completed Production Quadrupole magnets waiting shipment from IHEP

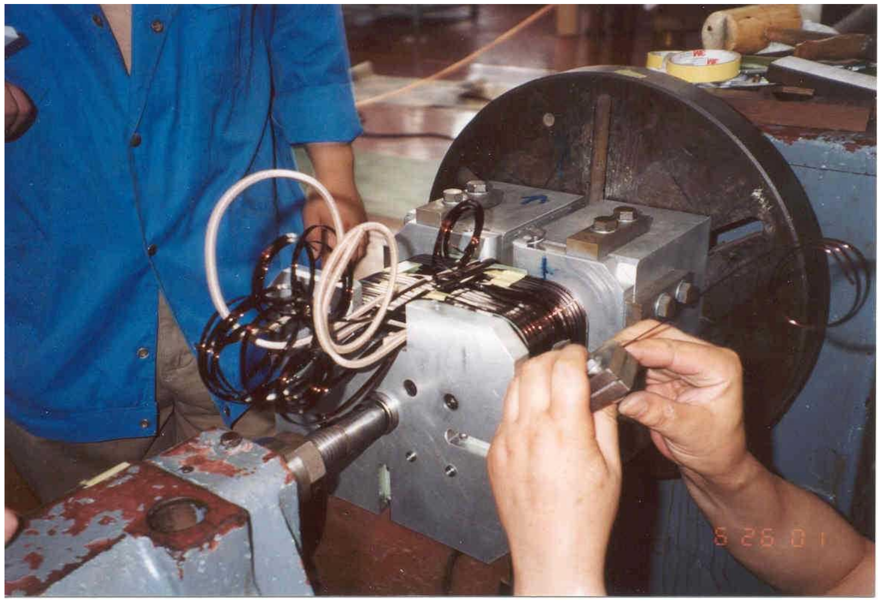
Nanyang Li, SPEAR3 magnet engineer, traveled to IHEP in June to review the production magnets and to assist IHEP in the winding of the complicated coil for the prototype H/V Corrector magnet. This visit was successful and necessary to address the items that were found during inspections. Shipment #4 was delayed a few weeks to incorporate these changes. The H/V Corrector coil was wound successfully after new tooling and fixtures were fabricated to keep each layer in its correct location during each wrap.



Wound H/V Corrector Coil – Vertical line shows division between H and V coils



Water cooling circuit wound around first layers of H/V coil



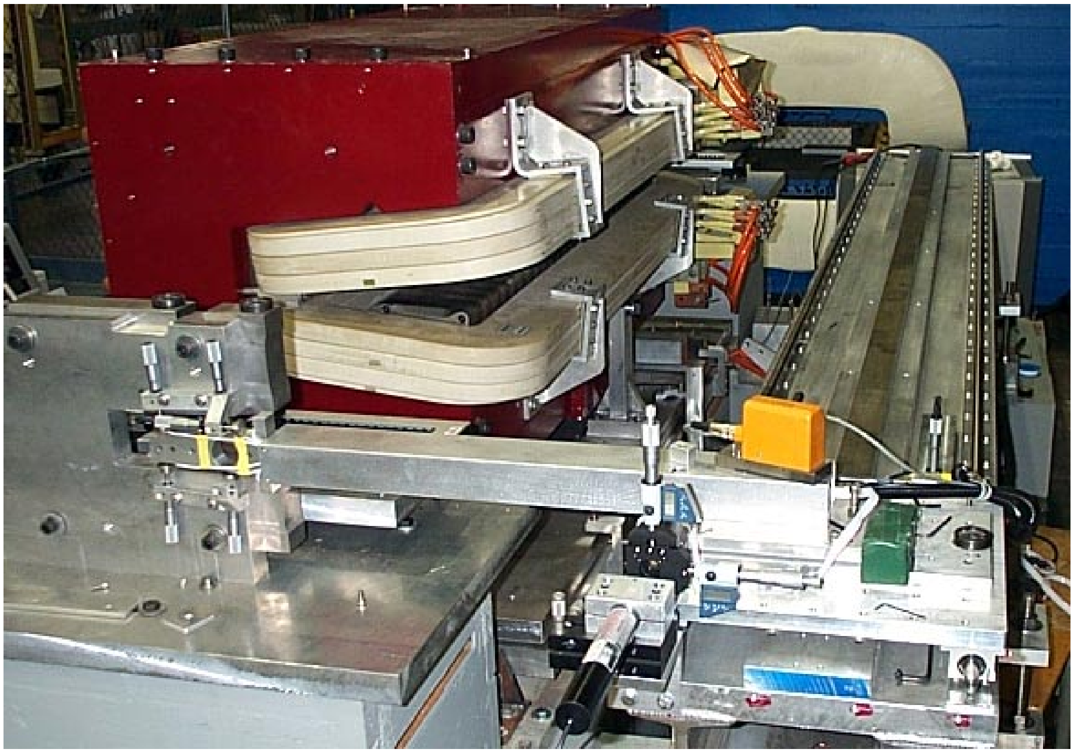
Winding fixtures for the H/V Corrector Coils at IHEP

Magnetic measurements

Gradient Magnet Alignment, Magnetic Measurement and Fiducialization

Each gradient magnet is installed on an alignment/measurement/fiducialization test stand. The test stand consists of the following main components:

- A kinematic support system capable of precision adjustment of the magnet position.
- A capacitive pickup system mounted on a precision rail.
- A reference "garage" establishing the magnet mechanical datum axis.
- A wire system on a precision stage connected to a voltage integrator/data acquisition system.
- A measurement coil/data acquisition system which measures the error field by in the absence of the fundamental dipole and quadrupole fields.


Dipole mounted onto magnetic measurement stand at SLAC

Each magnet is fiducialized with a laser tracker system while the magnet is still mounted on the test stand. The results of the fiducial data are posted on a webpage for availability to anyone requiring the information.

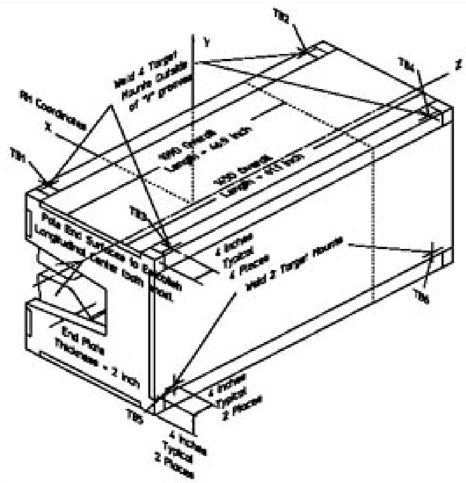
Gradient Dipole Magnet Checks	145D04

Date: 5/15/01

Magnet: 145D04

Operators: J. McDougal, H. Imfeld

Notes:



Magnetic Fiducial Coordinates: (inches)

Fiducial	Z	X	Y
TB1	-26.5554	3.4277	16.9994
TB2	26.5063	3.4346	17.0043
TB3	-26.5646	-22.4094	16.9971
TB4	26.5328	-22.4154	16.9963
TB5	-26.4866	-24.2482	-11.7594
TB6	26.4978	-24.2669	-11.6356

Offset: 0.0034 inches

Description:

Fiducial values based on the x-offset of the mechanical center line to the magnetic.

Web Page for Gradient Dipole measurement data

1.2 Vacuum System

The engineering efforts and manufacturing milestones during this quarter have been the following:

- QFC chamber halves for all the standard and matching cells received and inspected.
- Replacement copper material received for the BM-1 and BM-2 chambers.
- Machining of the BM-1 chamber halves started.
- QFC production piece parts received.
- BM-1 and BM-2 piece part fabrication and procurement underway.
- Completed the fabrication of the BM-2 prototype chamber.
- Completed the straightening tooling for the chamber halves.
- Completed the fabrication of the temporary clean room.
- Completed the brazing and assembly of the H2 absorber.
- Completed the preliminary design for the septum magnet/chamber support.
- Progress made on the design of the bellows module.
- SLM preliminary design review held.
- Started the HOM and magnetic tests for injection kicker prototype magnet/chamber.

Electron Beam Welding and Vacuum Facility

The electron beam welder was overhauled for approximately four weeks. The machine was thoroughly cleaned and modifications were made to the welder to improve performance and reliability. The time to clean the welder delayed our production schedule, but was necessary to ensure the quality and vacuum integrity of the chambers.

Figure 2.1: Clean straightening device/temporary clean room

Sample copper coupons are being used to monitor the cleanliness of the welder. During the next quarter the machine electronics will be re-calibrated.

Progress was made to our production facility by the completion of the temporary clean room (see Figure 2.1). This room was needed for straightening the vacuum chamber halves. The clean straightening device which was designed and built this quarter was installed in the new clean room and the first production plates were successfully straightened using the new device.

Standard Girder Chambers

BM2 First Article Chamber

The first article BM-2 chamber (Fig. 2.3) was completed this quarter and installed on the girder (see figures 2.5). During the construction of the BM-2 chamber many manufacturing concerns were resolved and new issues were encountered. The primary concern in fabricating the standard girder chamber was maintaining the profile of the slot. This is one of the most critical dimensions of the chamber because of the potential for mis-steered high power synchrotron radiation. A special device that utilizes a laser tracker for measuring the inner profile of the chamber is depicted in figure 2.2. Measurements were taken at each major weld step to monitor the changes in the slot profile. The completed chamber had a slot profile that met our design requirements. However, the curvature of the chamber exceeded our design requirements. Weld distortion in the horizontal plane was not anticipated, since the chamber is rigid in that direction and the design intentionally balanced the number of major welds to prevent distortion. The eddy current break welds, however, are not balanced and contributed to the distortion of the chamber. The plan is to modify the weld parameters to reduce the distortion of the chamber and use additional weld passes as needed.

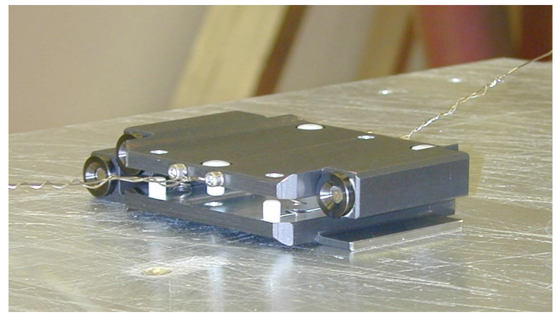


Figure 2.2: Profile Measuring Device

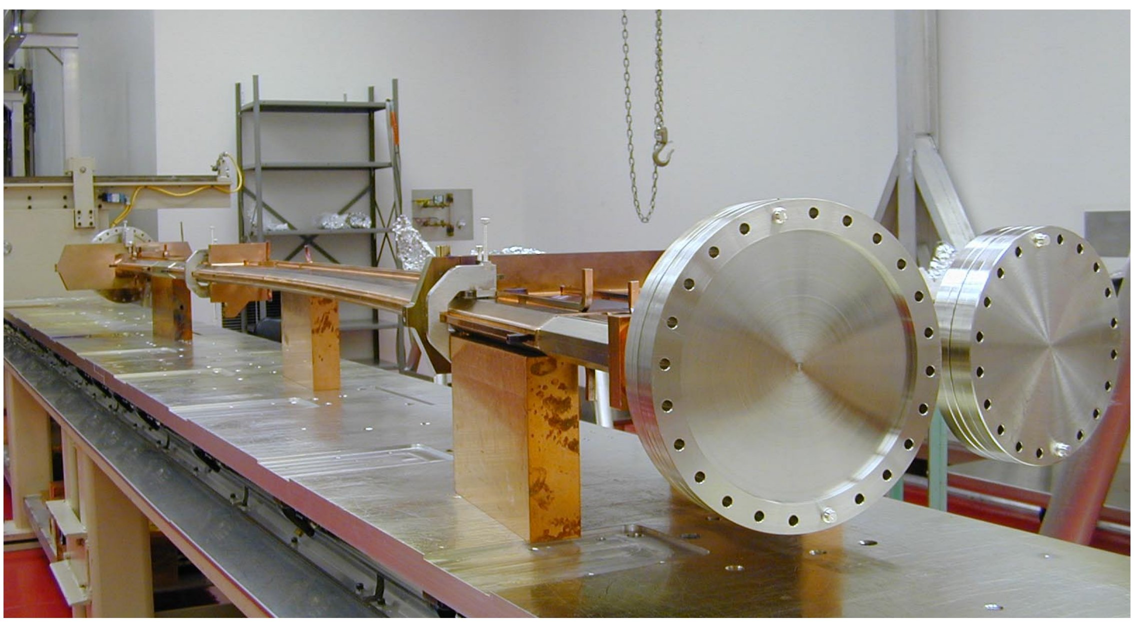


Figure 2.3: BM-2 Chamber

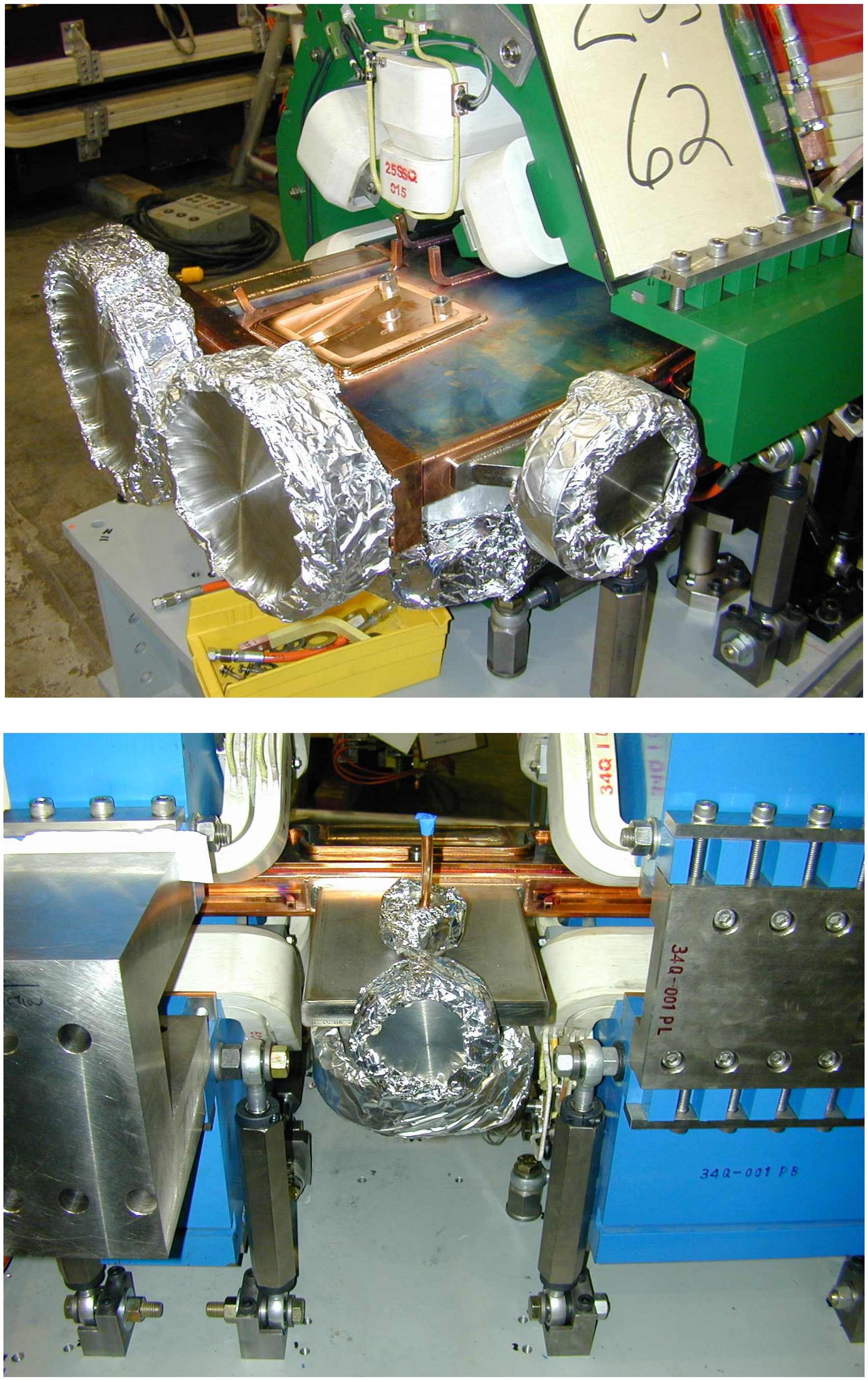


Figure 2.4: BM-2 Chamber installed on its raft

Another difficulty with the first articles chambers was the beam position monitor (BPM) welding. The primary design of the ceramic feedthru for the BPM used PEP-II technology. The major modification made to the design for SPEAR3 was in the weld flange. The PEP-II BPM weld flange was intentionally designed to keep the heat away from the ceramic-to-metal seal. The space constraints and BPM spacing requirement necessitated the reduction of the weld flange diameter, thus bringing the weld closer to the ceramic-to-metal seal. Prototype BPMs were purchased and test welds were made to verify that the reduction of the weld flange would not damage the seal. During the prototype testing no BPMs failed. However, the BM-2 chamber's BPMs failed at the ceramic-to-metal interface. Difficulties during welding were encountered, including problems with the weld parameters, as well as with the mechanical motion of the welder. The machine was repaired and new weld parameters and procedures were developed and successfully tested. The new weld parameters greatly reduce the amount of heat being deposited into the BPMs. Also, the weld is located at the very edge of the flange to increase the distance to the ceramic-to-metal seal. The BPM weld fixture provides heat sinking and also ensures that the weld does not encroach on the ceramic-to-metal seal. Six BPMs were successfully welded and passed stringent destructive testing. The testing is still in progress, but initial results indicate that the BPM seals meet our mechanical requirements after welding.

QFC Standard and Matching Chambers

The remaining QFC chamber halves and piece parts were received in April on schedule. Improvements to the QFC electron beam welding assembly tooling were made from the prototype experience. The first lot of QFC chambers is in fabrication (Fig. 2.5). Production programming for the QFC tooling is near completion and improvements on the production process is continuing. A senior technician from SLAC has been assigned to help facilitate

Figure 2.5: QFC Production

production flow and identify and resolve problems. The QFC standard chamber production should be complete by September. A second shift for assembling the chambers will be implemented to help expedite the production of chambers and decrease schedule delays.

The production QFC H2 absorber piece parts (Fig. 2.6) were also completed this quarter. The assembly, brazing and pressure testing were finished in June.

Figure 2.6: H2 Absorber Brazements and TSP Transition Brazements

BM-1 and BM-2 Standard Chambers

The copper material to finish all of the BM-1 and BM2 chambers were delivered this quarter. Fabrication of the production BM-1 chamber halves started and the first lot of four sets of chamber halves is near completion. Delivery of the first set will be in mid July on schedule. The BM-1 and BM-2 production piece part procurement started this quarter. The majority of BM-1 parts are on order as well as some of the BM-2 piece parts. Fabrication of these parts started this quarter and several deliveries have already been received. Piece part fabrication for the BM-1 chamber should be complete by early next quarter. During the first article BM-2 welding the production programming was finished. These programs will be modified for the BM-1 chamber and should help reduce the start-up time for production.

Standard Girder Vacuum Supports

Procurement for the Standard Girder Supports started after the successful integration of the BM-2 vacuum supports with the chamber and raft. Delivery of the support piece parts and assemblies are expected by the end of the year. The special low expansion supports are expected by the beginning of next year.

Injection System

The injection kicker magnet/chamber prototype was completed this quarter. Preliminary electrical tests were successful and the chamber is being measured for higher-order-modes (HOM). After the completion of the HOM tests, the electrical tests will resume. A decision to start the production is expected by the end of next quarter.

The preliminary design of the raft for the injection kicker and septum chamber and magnet was completed this quarter. A review for the raft will be held with the vacuum chamber after the magnet design is finalized.

Diagnostic System
A conceptual design review was held for the synchrotron light monitor this quarter. The primary mechanical and optics design requirements were approved. Work is continuing on the final design of the primary mirror and the special refractive optics. A conceptual design review for the light monitor is expected next quarter.

Straight Section Chambers, Bellows Modules
The RF chamber designs are completed and fabrication will start after the final HOM calculations are approved. Work on the bellows modules has been re-started this quarter. A final design review is expected next quarter.

1.3 Power Supplies

Unipolar Power Supplies
Dipole Power Supply

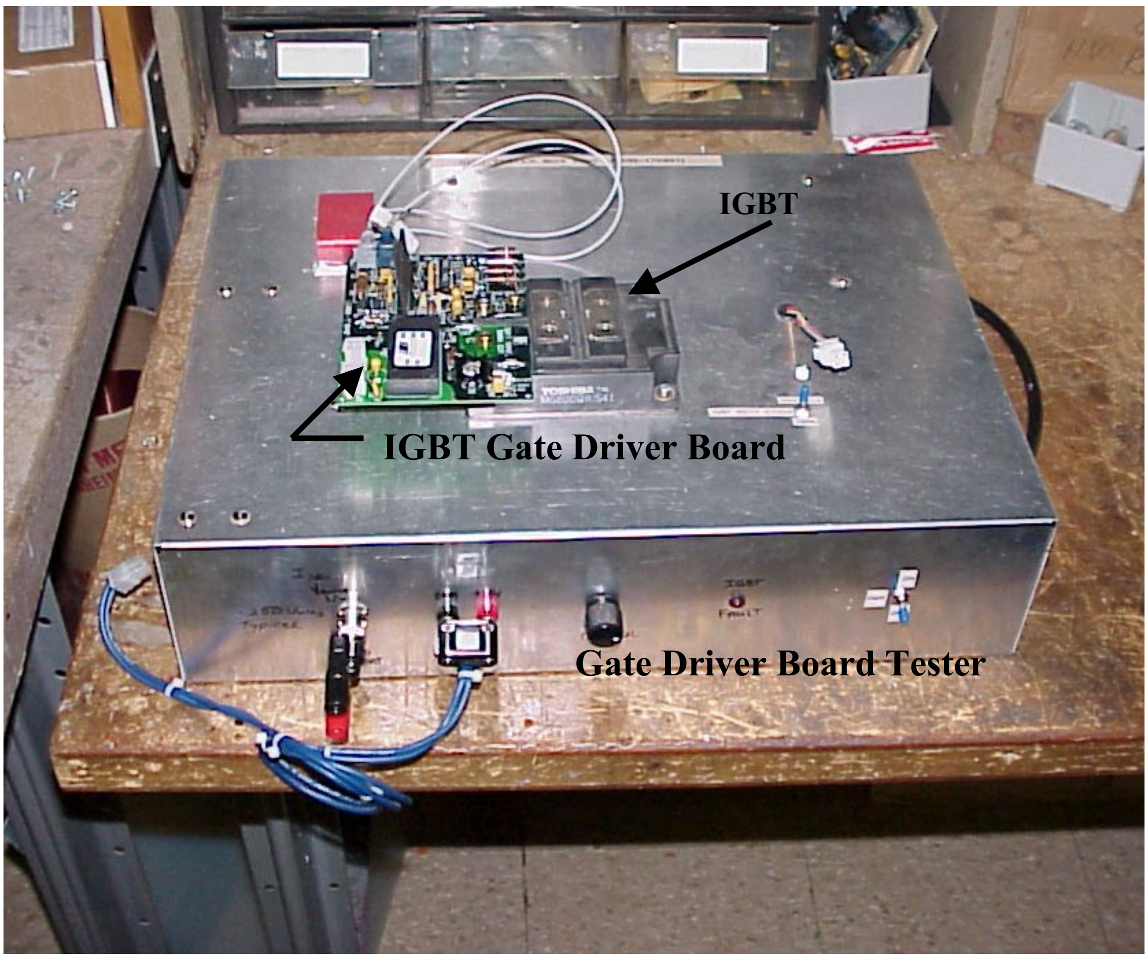
The 1200 kVA, 480 V: 600 V / 600 V Dipole Power Transformer was successfully factory-tested by Neeltran. The transformer arrived on site in early June and was placed into storage until it can be tested on-site. Below is a photograph of the transformer at the SLAC Receiving Department.

Neeltran Dipole Power Transformer

The engineering analysis of the suitability of PEP-II style chopper power system for the SPEAR 3 dipole power system has gone well. This analysis and some constrained chopper module testing into a dummy load indicates that the module ratings can be extended from the 500 V, 400 A PEP-II rating to the 600 V, 400 A rating required for the SPEAR 3 dipole power system.

A PEP-II chopper module and control system has been borrowed from the Power Conversion Department. They were moved into the SPEAR Booster Building. Early into the SPEAR summer shutdown, the module will be run to the required 600 V, 400 A using the White Circuit Bias Power Supply as a bulk power supply and using the Bias magnet string as the test load. If successful, this test will confirm the results and expectations from the engineering analysis and previous low-power testing. At the very least the test should provide an indication of the upgrades that might be needed to realize the chopper module extended rating.

All of the artwork needed to fabricate the printed circuit boards for the dipole power system controllers and module electronics have been received from Arnold Lange of the Lawrence Livermore National Laboratory. Subsequently, 12 insulated gate bipolar transistor (IGBT) gate driver boards were fabricated, stuffed with components and successfully tested. An IGBT gate driver board, mounted on an IGBT, along with the test chassis is shown in the figure below.



IGBT, IGBT Gate Driver Board and Tester

The printed circuit boards for the chopper module controllers have been fabricated and are being stuffed with components. The controller chassis metalwork is also being fabricated. The controller boards will be individually bench tested. Testing of the completed chassis will follow the bench tests.

Large Power Supplies
There are 6 large power supplies needed for SPEAR 3. These are freestanding power supplies with output ratings greater than 35 kW. The power supply service and ratings are tabulated below.

Service	Volts	Amperes	Kilowatts	Cooling
SD	600	225	135	Air/water
SF	600	225	135	Air/water
QD	700	100	70	Air
QF	700	100	70	Air
QFC	700	100	70	Air
QFC	700	100	70	Air

An RFP was issued to industry for the above-listed power supplies. A purchase order was issued to the successful bidder, IE Power, a Canadian firm. IE Power will design the power supplies using a buck regulator topology.

Intermediate Power Supplies
An intermediate power supply specification review was held on May 30, 2001. Reviewers felt that the specification adequately addressed project needs. On that basis, an RFP for 80 intermediate power supplies ranging in output from 2.5 kW to 15 kW was issued to industry. Proposals are due during the next reporting period.

Titanium Sublimation Pump (TSP) Power Systems
The previous scope of the SPEAR3 project assumed that the vacuum system would be locally and manually sublimated by powering individual Titanium Sublimation Pumps (TSPs) during downtimes. However, PEP-II beam operating experience has shown that a remotely controlled, switched distribution TSP power system is required to significantly reduce machine downtime and enhance availability by allowing sublimation during machine operation. A CCB to establish a budget for a distributed, switched TSP electric power system was initiated and approved. Work orders have been written to start the design of DC powered systems since AC power is unsatisfactory for powering the TSP filaments. A schedule for designing and implementing the TSP Power System is in progress.

Bipolar Power Supplies

Corrector Power Supplies
Fabrication of a crate of 8 bipolar corrector power supplies, built specifically to check that no mechanical inferences exist, is well underway. Completion is expected by mid-July. The 8 power supplies will be tested for heat dissipation and power supply cross talk. By the end of July and barring any unforeseen circumstances, Byra will be contracted to build the production units.

Quadrupole Modulation System (QMS)

The CCB to transfer budget from the I & C budget to WBS 1.3 was approved. Work orders were written and approved to have the SLAC Power Conversion Department design and fabricate the system. The design effort has started and informal discussions raised several issues pertaining to the maximum allowable continuous current in the trim coils (identified as 14 A) and equipment safety if a trim coil, or trim coil lead, should short to a main HV winding. Since the trim coils are wound on the same cores as the main coils there is also the issue of suppressing the high voltages that can be induced in the trim coils if the currents in the main coils are chopped.

Pulsed Power Supplies

Kicker Pulsers

As reported earlier, a 4-stack (intended for the K2 magnet) version of the SPEAR 3 kicker pulser has been fabricated. During this reporting period the 4-stack pulser was successfully tested to its design rating of 8 kV. However, some minor issues did surface. For example, IGBT turn-on and turn-off times were a bit slower than anticipated. A reduction of circuit inductance (physical re-configuration of cable and connectors) will be needed to shorten the IGBT current rise and fall times. The re-configuration will be accomplished in parallel with a rebuild of the 4-stack pulser to an 8-stack (for pulsing the K1 and K3 magnets to 15 kV).

The layout of the electronic enclosure for the pulser and its ancillary control and interlock circuitry has been defined as a task that must be started and completed during the next reporting period.

During a July 2, 2001 meeting with SPEAR 3 representatives, the Power Conversion Department asked for, and on the basis of successful test results, was authorized to begin the purchase of parts for the fabrication of the 3 injection pulsers.

BitBus Power Supply Controllers

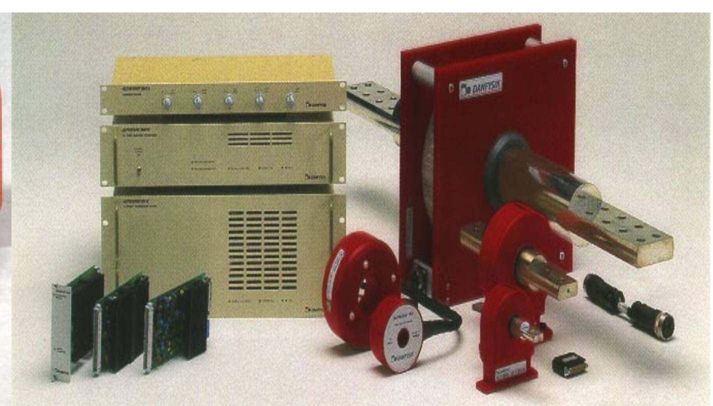
The SSRL Instrumentation and Controls Department completed a successful evaluation of a VME-to-BitBus adapter. This allows the use of the PEP-II style BitBus power supply controller to be used for SPEAR 3 unipolar power supply control, in conjunction with the VME controllers that will be ubiquitous in SPEAR 3. In light of the satisfactory results with the adapter, a work order was written to the SLAC Power Conversion Department to fabricate and test 80 controllers for SPEAR 3.

Racks And Accessories

Current Transductors

A successful review of the zero flux current transductor specifications was held on May 30, 2001. Subsequently, an RFP was issued to industry for 150 zero-flux current transductors, ranging in rating and type from 150 A, integrated head units, for the smallest power supplies, to 1000 A, separate head and electronics chassis, for the dipole power system. The industry bids are due during the next reporting period.

150 A to 600A Integrated Head Transductors



1000 A Current Transductors

Racks
Work has started on the drawings and specification for definition and purchase of intermediate power supply (and perhaps I & C) racks. The goal is to have these documents ready for review during the next reporting period.

Other Work
General
An update to the Magnet Power Supply Spreadsheet is underway to reflect the additional systems that have been incorporated into this WBS, as well as several other changes that have occurred over the past few months. The revised spreadsheet, an update to the AC one-line diagrams for the power supplies and revisions to the rack profile drawings will also be completed during the next reporting period. All the revised documents will be disseminated for inter-disciplinary coordination.

An update to the Power Supply installation schedule, WBS 1.9.3 is underway in response to SPEAR management's request and also to reflect the latest project information.

Magnet Testing
The second shipment of dipole, quadrupole and sextupole magnets that arrived from Beijing were satisfactorily electrically tested. For each magnet the tests consisted of high potential testing, DC resistance measurements of the main coils, trim windings and Klixon thermostats and B-field polarity measurements at each pole.

1.4 RF System

RF Cavities
Cavities being fabricated at Accel Intrumentation in Germany are experiencing delays due to machining and e-beam welding capacity conflicts. A delay in the expected delivery for the first cavity in August 2001 is expected. This is not a problem as cavity installation does not occur for two years beyond this date. Electro-forming is completed on all four cavities and cavity ports are now being machined at the sub-contractor.

The cavity rafts have been ordered and are expected in July. All twelve high order mode loads are completed. Regarding ceramic windows, a first successful braze was done in house at SLAC. This window is now being fine-tuned. Other components (tuners and coupling network) are waiting for completion of spring fingers and flanges.

Klystron
The 1.2 MW klystron was ordered March 17, 2000 from Marconi Applied Technologies was received and has been successfully tested. A high voltage power supply has been ordered from NWL with expected delivery in December 2001. The associated control circuits are being fabricated at SLAC.

Low-level RF
The low-level RF System design modifications are in process at the new Electronics & Software Engineering Department at SLAC.

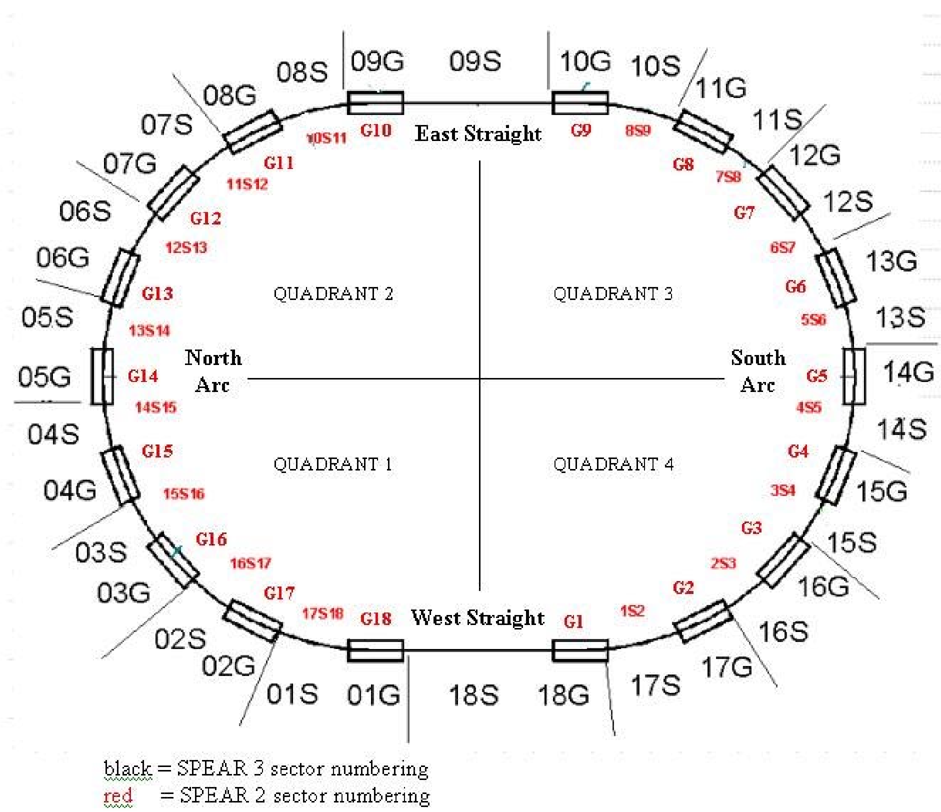
1.5 Instrumentation and Control Systems

Progress in design and implementation of instrumentation and control systems for the SPEAR 3 project continued. Most effort was devoted to specifying and scheduling Computer Control System software tasks, designing Control System hardware components, deciding on the Beam Position Monitor (BPM) processing system plan, and beginning the detailed design of the Machine Protection System. The design effort for the Injection Timing System was renewed, and the design of the Quadrupole Modulation System commenced.

Computer Control System

SPEAR 3 software tasks were defined in further detail and production schedules generated. The EPICS software development environment was installed on a Solaris computer. Together with the PC-based VxWorks real-time operating system development platform, the EPICS development system will be used to create the first IOC on a VME CPU during the Summer shutdown period. A decision will be made in the next quarter on whether the DM2K graphical user interface construction toolbox will be abandoned in favor of the more recent EDM toolbox favored by many other EPICS users. A design review for the complete computer control system plan is scheduled for August, 2001.

SPEAR 3 component nomenclature was defined, resulting in a decision to reverse the numbering sequence for ring components from the original counter-clockwise direction (positron direction for SPEAR 1 and 2) to the clockwise, electron beam direction. A database for ring components has been created, and the infrastructure for web-based information access has been constructed.



A preliminary design review of the 8-Channel Power Supply Controller was held in which the proposed design was validated. The controller system for each 8-channel power supply crate will be comprised of a commercial VME CPU, a digital interface board between VME and the crate backplane (deemed the "Frankenboard"), and a digitally controlled daughter board containing ADCs and DAC for each power supply module. The aggregate 20-bit DAC update and ADC readback rate over the crate backplane and Ethernet control LAN supporting 16 controllers will be 4 ks/s. A prototype controller is planned for completion by the end of CY 01.

Beam Monitoring Systems

Definition of Beam Position Monitor (BPM) electronics has focused onto a two-system approach, in order to meet the diverse requirements of closed orbit feedback and faster, first-turn response. A decision was reached to proceed with the specification and procurement of 60 commercially available narrowband, switched-button BPM processors. Two sample processors of this type, without modifications, were tested in SPEAR 2 over the last month with promising results. The production versions will be modified to accept an external LO input, to provide a wideband IF output, and to permit external control of the multiplexing switches. 54 of these processors will be installed in SPEAR 3. The remaining 36 BPMs will be equipped with wide band processors, including unswitched processors suitable for first-turn and turn-by-turn orbit measurement. These processors will employ the digital IF Receiver modules already received from Echotek. Work will begin on developing the wideband processors during the next quarter.

Cable harnesses that will connect BPM button assemblies to bulkhead panels on the accelerator support girders are in design. These harnesses must be installed on the vacuum chamber prior to installation in the magnet raft assemblies, which begins at the end of CY 01.

Tests to detect higher order modes sustained in SPEAR insertion device vacuum chambers were conducted with beam in SPEAR 2. It appears from these tests that travelling wave modes that could corrupt beam position detection are prohibited below ~700 MHz, far away from the 476 MHz processing frequency to be used for SPEAR 3.

Work has begun on the data acquisition and digital processing system that will be used for the commercial switched-button BPM processors. Information from many of these processors must be shared with the Orbit Interlock System. Two processing plans are being prepared for comparison: one that splits that analog signals from the BPM processor units for digitization by separate ADC system (one ADC system for orbit monitoring, the other for the Orbit Interlock), and one that uses a single ADC system and shared digitized signals. A decision on which plan to adopt will be made in the next quarter.

Quadrupole Modulation System

The design of the Quadrupole Modulation System was assigned to an engineer within the SLAC Power Conversion Group. The preliminary design of this system will be reviewed in mid-July.

Timing System

Work on specifying the LO/Clock, Booster-SPEAR Phase-Locked Loop, and injection timing systems has resumed. Preliminary designs for these will be reviewed in early July.

Protection Systems
As discussed in item 2 above, work has begun in designing the BPM data acquisition system that will be used for the Orbit Interlock system. The interlock processing algorithm is being more completely specified, and processing hardware options are being explored. A review of system configuration proposals is planned for the next quarter.

The design of the SPEAR 3 vacuum and magnet cooling protection systems are in progress. The family of programmable logic controllers that will be used for these systems has been chosen.

1.6 Cable Plant

These are the main tasks accomplished in this quarter:

The tray structural supports design for B118 and front of B118 were completed: The bid package for fabrication was produced and successfully awarded.

Tray structural supports in and out of B118 and outside the inner perimeter of the shielding wall were designed and presented to the Earthquake Safety Committee. The supports were analyzed and approved. The Cable Tray System was also reviewed and approved by the Electrical Safety Committee.

Cable Tray support concrete footings and a trench for HV RF cable outside B118 were designed, analyzed and approved by the Earthquake Safety Committee. This work was successfully bid and awarded.

The Cable Tray Installation Bid package in and out of B118: Drawings and specifications were produced, successfully bid, and awarded to a recognized Electrical Contractor.

Reconfiguration of magnet circuit layouts were initiated for the new clockwise nomenclature layout instead of the original counterclockwise one.

The layout of Power Supply racks in B118 were revised to allow for additional I&C and TSP racks.

The list of I&C and DC systems personnel responsible for specifying cable and connector info inherent in the design of cable systems was initiated.

Technical assistance in the demolition of existing utilities was provided in preparation for SPEAR3 installation.

1.8 Facilities

The Subcontract for the remaining shielding work in West Pit was awarded in June. There were two bids submitted for this work. The lowest bid was 15% above the engineering estimate. In order to minimize the construction duration, the roof in the West Pit area will be cast-in-place concrete instead of pre-cast concrete panels. The construction submittals are being reviewed. The start of construction is July 16 and the completion date is scheduled to be September 4, 2001. The remaining cast-in-place concrete shielding wall in East Pit and the roof shielding will be installed in the summer 2002.

2.0 Accelerator Physics

During the third quarter of FY2001, the SPEAR 3 accelerator physics group conducted a complete review of the Synchrotron Light Monitor from source to optical bench components. Each subsystem was scrutinized for physics performance and engineering feasibility. The result indicates the system will be both robust and provide accurate beam measurements. In parallel, software developments were made to provide timing features within MATLAB. The new capability allows programmers to monitor signals through Channel Access, measure response matrices with synchronous timing, and correct electron beam orbits in MATLAB without use of the inefficient 'PAUSE' command. Accelerator physics shifts were successfully carried out on SPEAR 2 to demonstrate the software on-line. Also in this quarter, five separate papers on SPEAR 3 accelerator systems were submitted to the 2001 Particle Accelerator Conference in Chicago. In a related development, beam was accelerated in the SSRL Booster Synchrotron to 3 GeV.

Synchrotron Light Monitor

A project review for the Synchrotron Light Monitor (SLM) was held on May 9. The review covered the SLM system from source point (entrance of BD1 on Girder 14, Raft 1) through the cold finger, M0 mirror, reflective Schwarzchild-mirror focusing system and wall penetration to the optical bench in the building 120 control room. Important parameters and working decisions include the following:

Photon Beam Source Point

Dipole Name: BD1, Sector 4 (20.3 cm into the dipole magnet)
Beam size sx = 182 mm , sy = 50.8 m m (K=1%)

Radiation Power Dump (Cold Finger)

Height: 10.2 mm
Taper: 45 deg
Vertical Window: +/- 0.6 mrad to +/- 3 mrad
Horizontal Window: +/- 5 mrad
Location: 8.5 m from source
Adjustment: fixed

Photon Beam Position Monitor

Type: differential 2-photodiode flourescence detector (ala BL11)
Window: Be + Al
Vacuum: UHV, He pocket

First Mirror (M0)

Location: 9.5 m from source, 9 degree incidence
Dimension: 15" long x 3-4" height x 2.5" thickness
Coating: Rhodium (in-house?)
Roughness: 10 Angstrom
Power Load: 360 W (0.37W/mm2) during mis-steer (PEP-II HER 40 W/mm2)
Support: kinematic 6-strut
Adjustment: +/- 2 mrad pitch control

Vacuum Window

Window: Fused silica from Insularot Seal
Window Power load: 1.56 W (0.41 W/mm2)
Window Transmission: 85% @ 186 nm

Image Magnification System

Type:dual-mirror Swarzchild (refractive system rejected)
Magnification: 2.76
Vacuum: rough or temperature controlled N2
Coating: Rh or Mo or Al with anti-oxidation coating
Support: Kinematic, remote longitudinal adjust
M1: r=1704.5 +/- 0.1% mm, 56 mm diameter
M2: r=298 +/- 0.1% mm, 11 mm diameter
Chromatic Aberrations: none
Tolerance: 0.1% on radii (CIV)

Optical Bench Components

CCD camera: ~2eV
Streak camera: ~6eV
Beam Splitter: KrF2 on fused silica

Software Developments

The MATLAB Channel Access toolbox (MCA) was extended to include database signal acquisition on a real-time basis. This feature resulted in two timing modules (1) 'timereval' which allows single-shot and clock-driven events and (2) 'scheduler' which allows the programmer to schedule a sequence of events to occur with variable delay. As opposed to the 'PAUSE' command in MATLAB, timereval and scheduler utilize the computer system timer in the Windows environment to return program control to MATLAB as time progresses. Both functions have been tested for monitoring process variables from the SPEAR EPICS server and incorporated in the orbit control application program for on-line testing. The timing functions and the MCA toolbox are under evaluation at SNS for accelerator applications in the EPICS environment. Both response matrix measurements and ~6 hour orbit control feedback tests were conducted on SPEAR 2 with the timing functions. A new version of the Accelerator Toolbox (AT1.1) was released at the time of the PAC2001 conference for public use.

Application Programs

Planning has begun to extend the orbit control software to include:
(1) quadrupole shunt capability
(2) pre-defined orbit bump capability
(3) interlock verification capability

By sharing software between programs, software development time will be minimized and software maintenance streamlined.

Booster Synchrotron to 3 GeV
The main Accelerator Systems Department at SSRL reached a major milestone by testing the SSRL Booster Synchrotron to 3 GeV beam energy. The work was the result of months of planning and power supply upgrade efforts. As quoted in an all-hands memo "The White circuit was ramped in four steps from 2.25 to 3 GeV, with expert tweaking by the SPEAR operator at each stage to restore good booster beam. By 1:00 PM, the booster was running with 200 mV of 3 GeV beam on the Q-meter. The BTS was then ramped to 3 GeV, with some steering in the booster required to maintain beam. Adjustment of the ejection kicker and ETG was sufficient to get 0.14 nA all the way to the BTS Faraday cup".

2001 Particle Accelerator Conference: SPEAR 3 Articles

SPEAR 3 Upgrade Project: A Status Report, J. Corbett, et al
Interactive Orbit Control in MATLAB, J. Corbett and A. Terebilo
Study of Low Beta-Y in SPEAR 3, Y. Nosochkov, J. Corbett and T. Rabedeau
SPEAR 3 Injection Kicker System, J. Sebek, et al
Accelerator Toolbox in MATLAB, A. Terebilo

2.1 ES&H

As we enter the FY2001 shutdown, much of the SPEAR3 related ES&H activities are focused on this years modifications to the existing accelerator and support infrastructure. The West Pit shielding project will be completed, which includes; reducing the existing PPS zone to just the accelerator ring, adding roof shielding, completing the wall shielding started last year and relocating PPS access control hardware. Results from the extensive reviews of the shielding and PPS changes by the Radiation Physics Department, Radiation Safety Committee and other ad hoc committees have been positive, which reflects on the hard work and early planning of many portions of these projects. An example of why such reviews are time consuming, is the need to review all changes to accommodate both SPEAR2 and SPEAR3 operating parameters. This process saves time later on.

The Preliminary Safety Assessment Document (PSAD) is complete, and at the time of writing under review by the local DOE site office and Oakland area office staff.

With respect to radiation physics objectives, we have finalized on the minimum roof thickness and boundary conditions for SPEAR3 operation and are presently finishing up on the lateral wall thickness shielding requirements. Fundamentally this is a complicated review, as it needs to take into consideration losses in the “C” shaped magnets that may have an adverse affect on dose rates outside of the shielding wall.

The Earthquake Safety Committee approved the design for the new cable tray and support structure, while the Electrical Safety Committee also reviewed the general plan for cable plant installation and were pleased with the installation plans.