SPEAR 3

Quarterly Progress Report

Stanford Synchrotron Radiation Laboratory

October through December
2001

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A. SPEAR 3 PROJECT SUMMARY

1. Technical Progress

In the magnet area, the production of all major components (dipoles, quadrupoles, and sextupoles) has been completed on schedule. This results from a highly successful collaboration with our colleagues at the Institute of High Energy Physics (IHEP) in Beijing. The production of corrector magnets is still in progress with completion scheduled for May 2002.

The production of support rafts for the magnets has continued this quarter. Apart from electrical connections, two QFC rafts were assembled with magnets and vacuum chambers. Full scale assembly of all QFC rafts will take place next quarter.

The associated vacuum chambers for the QFC rafts are in production. Deeper e-beam welds and outside gussets were used to eliminate small leaks in the first units. Full QFC raft production will begin in late January. The main box structure for the more complex BM1 chamber has been successfully welded. Progress has been made also on the design of the matching cell chambers near the two SPEAR straight sections as well as the West straight section which will include the new RF cavities.

Regarding power supplies, the chopper modules for the dipole units are being assembled with their controllers and the specifications for the associated bulk supply are in progress. The six large supplies for Quadrupole and Sextupole strings were released for fabrication. The same company was selected to design and manufacture the 82 intermediate supplies. Another manufacturer was contracted to design and build the 150 units of the bipolar power supply for the corrector magnets.

There are significant problems in the RF area. The first two of four RF cavities being fabricated for SPEAR 3 have developed leaks in the cooling channels. These channels are machined in the outer surface and filled with a plastic material. Approximately 3 mm of electro-plated copper coats the outer surface to seal the channels after which the plastic material is removed. The process was successful in the production of 26 cavities for the PEP-II project. PEP-II (which has ordered 6 additional cavities under the same current contract) and SPEAR 3 are working with the manufacturer to understand and solve the problem.

The 1.2 Megawatt Klystron for SPEAR 3 as well as other units delivered to PEP-II has failed. Plans are underway to see if the tubes under warranty can be repaired by the current manufacturer. In addition, 3 tubes are being repaired by a local company and SLAC while four new tubes will be fabricated by SLAC. PEP-II currently uses 8 tubes with a planned expansion to 10 units; SPEAR 3 requires 1 tube.

Work continued on all SPEAR 3 instrumentation and control systems during the last quarter. Effort was devoted to further specifying Computer Control System software tasks and developing the first EPICS IOC application. Detailed design of the fast corrector controllers continued. The BPM processing plan was finalized and the processor procurement was initiated. The RF/Timing Signal Generator system was ordered. Components for the Vacuum Machine Protection System were specified, a design review for the Orbit Interlock System was arranged and the Temperature Monitoring System was specified.

The main cable plant effort currently underway is to identify all cable requirements for power, monitoring, and Instrumentation and Controls. Orders will be placed soon in order to install as much as possible outside the ring shielding in the coming FY 2002 regular shutdown. Final connections will, of course, have to be made in the tunnel in the FY 2003 shutdown during which all SPEAR 3 components are installed.

Design plans are underway to complete the Klystron building near the West straight section. The concrete pad was completed in the last shutdown and the goal is to complete the building enclosure in March 2002. Other design plans in progress include the completion of the transition shielding to the East straight section and the new concrete roof over this area. This work is planned for the regular 2002 shutdown period and will complete all shielding modifications planned for SPEAR 3.

Efforts are also underway to plan and establish the details of the major SPEAR 3 installation in FY 2003. The work involves the complete removal of SPEAR 2, building a new reinforced concrete floor for the tunnel, and the installation of SPEAR 3. Details of the effort are being assembled and scheduled for all technical systems and associated support systems.

The SPEAR 3 Accelerator Physics Group has addressed many important tasks during this quarter. In particular, field coupling in the corrector magnets, testing of the slow orbit correction system, studies of the new beam line 4 and 7 wigglers and preparations for the on-line control application software were carried out. Progress is also reported in collaboration with the Radiation Physics Group on injection safety and Synchrotron Light Monitor Safety. Efforts have also started to develop the SPEAR 3 turn-on and pre-operational plans that will follow the major SPEAR 3 installation.

2. Cost Reporting

The total project costs and commitments through December 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 December 2001)

	K$	
	Direct	Direct & Indirects
Costs	21,302	24,016
Commitments	2,907	3,154
Total	24,209	27,170

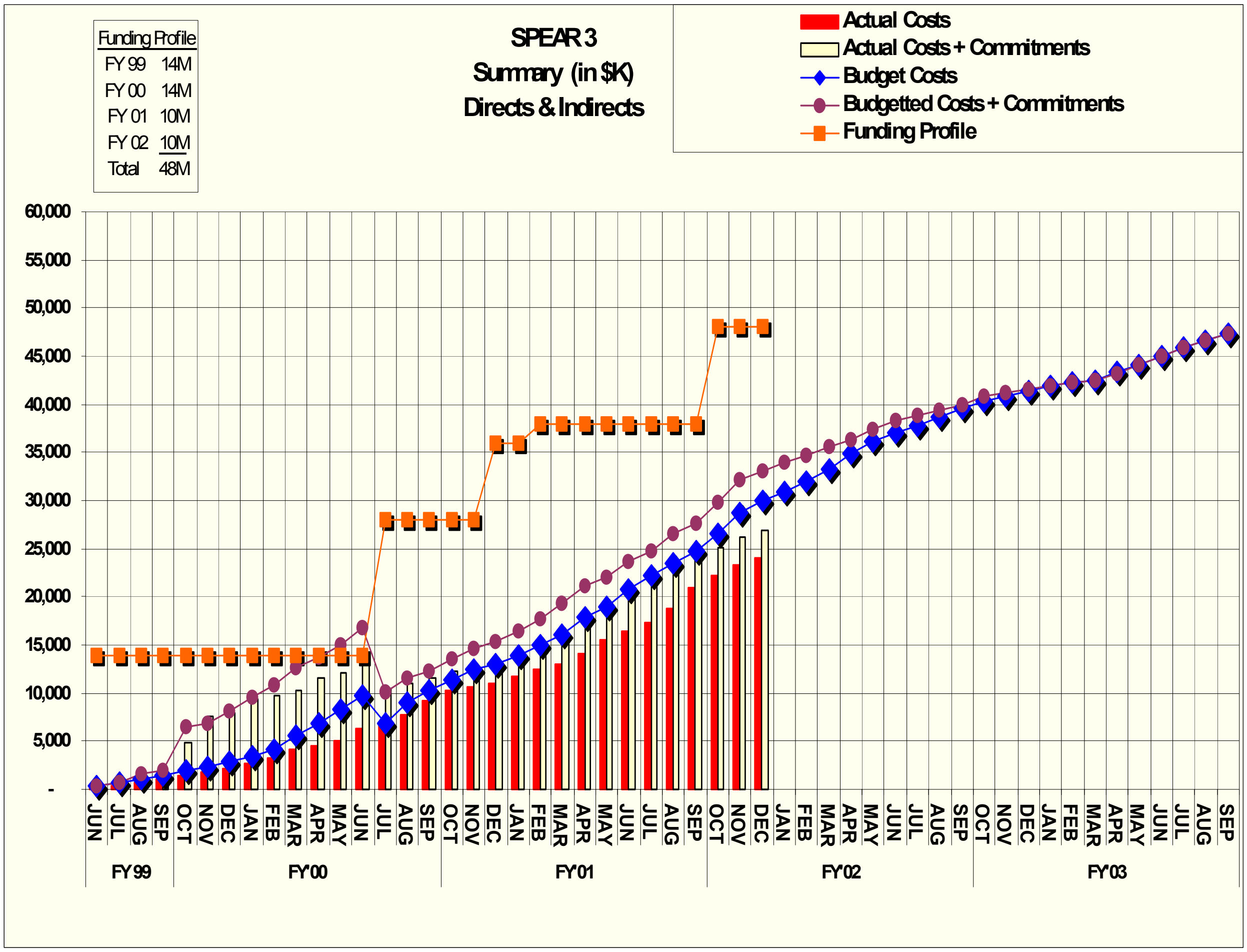


Figure A1

Table A2 provides the project performance data with associated cost and schedule variances at WBS Level 2. Monthly plots of the total project variances are provided in Figure A2.

The vacuum system variances in both cost and schedule result largely from the problems in establishing production at the e-beam welder as well as design issues. These issues are largely resolved and a CCB action will be taken in the next quarter.

The RF system schedule will continue to slip due to the problems noted above in Section A. The issues for both Klystrons and Cavities are being addressed by staff from both PEP-II and SPEAR 3 programs.

The new Cable Plant group, together with other technical group members, is in the process of establishing the total new electrical cable requirements and associated costs. Also cable routes and installation schedules are revised from the estimates of over two years ago. When finalized next quarter, an appropriate CCB action is projected.

Cost/Schedule Status Report									
	Contract Type/No:		Project Name/No: SPEAR3 Rebaseline ($58M)		Report Period: 11/30/01 12/31/01		Signature: Title/Date: 1/30/02		
(1) Original Contract Target Cost	(2) Negotiated Contract Changes		(3) Current Target Cost (1) + (2)		(4) Estimated Cost of Authorized Unpriced Work 0		(5) Contract Budget Base (3) + (4) 57,995		
Performance Data									
	Cumulative to Date					At Completion			
WBS[2]	Budgeted Cost		Actual Cost	Variance					
	Work Scheduled	Work Performed	Work Performed	Schedule	Cost	Budgeted	Latest Revised Estimate	Variance	
1.1 Magnets and Supports	6,592	6,588	5,749	-4	840	8,873	8,873	0	
1.2 Vacuum System	5,997	4,863	5,304	-1,134	-441	10,926	10,926	0	
1.3 Power Supply System	1,302	1,122	713	-180	409	3,514	3,514	0	
1.4 RF System	3,320	3,008	2,760	-311	249	4,624	4,624	0	
1.5 Instruments Control & Protectior	1,648	1,140	1,123	-508	17	3,633	3,633	0	
1.6 Cable Plant	1,439	639	735	-801	-96	2,354	2,354	0	
1.7 Beamline Front Ends	487	275	220	-212	56	1,056	1,056	0	
1.8 Facilities	2,818	2,004	2,178	-814	-174	3,210	3,210	0	
1.9 Installation and Alignment	0	0	0	0	0	3,224	3,224	0	
1.0 Mgmt, Support, & Accelerator Pl	2,347	2,347	2,426	0	-79	4,037	4,037	0	
Gen. and Admin.	3,199	3,199	2,951	0	247	5,907	5,907	0	
Undist. Budget						0	0	0	
Sub Total	29,149	25,186	24,157	-3,963	1,029	51,358	51,358	0	
Management Resrv.						6,637	6,637	0	
Total	29,149	25,186	24,157	-3,963	1,029	57,995	57,995	0	

Table A2

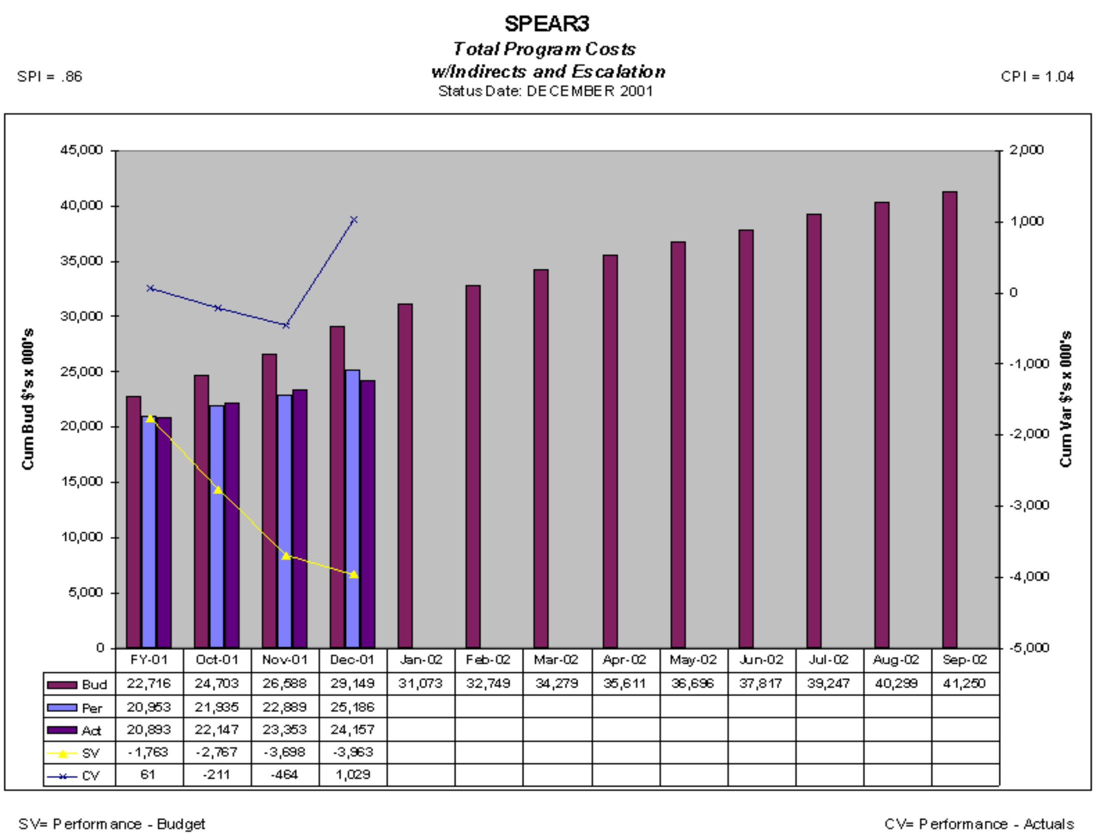


Figure A2

B. Detailed Reports

1.1 Magnets and Supports

Magnets

As of the end of this quarter we have received 100% of the main magnets from IHEP, which consists of 40 Dipoles, 102 Quadrupoles, and 76 Sextupoles. We have also received 8 production H/V Corrector magnets as well. This represents a major milestone in the successful collaboration between IHEP and the SPEAR3 magnet team. Congratulations are certainly in order to all on a job well done.

The remainder of the H/V Corrector magnets will arrive in 4 separate shipments to allow installation of the Corrector magnets onto their support rafts. The final shipment is scheduled to leave Beijing in late May 2002, ahead of the original schedule.

Magnetic Measurements & Fiducilization

Measurements and fiducialization of the magnets are proceeding on schedule. IHEP measurements have indicated that all magnets have met or exceeded the field quality and reproducibility requirements set forth in magnet specifications. Verification measurements at SLAC for the gradient magnets are proceeding. At this time all thirty of the 145D magnets are complete and measurements of the ten 109D magnets are beginning. Verification measurements at SLAC for the quadrupoles and sextupoles are in progress.

Further DC measurements of the H/V Corrector magnets have found a slight angular mis-match between the horizontal and vertical fields in the order of 10-15 milliradians. While this is correctable by adjusting the upper and lower coils relative to each other, the sensitivity of this movement is beyond the ability of the coil supports as they are currently designed. However, since the correction of the electron beam orbit will use both horizontal and vertical correctors combined, it is believed that these angular errors in the Corrector magnet will not prove problematic.

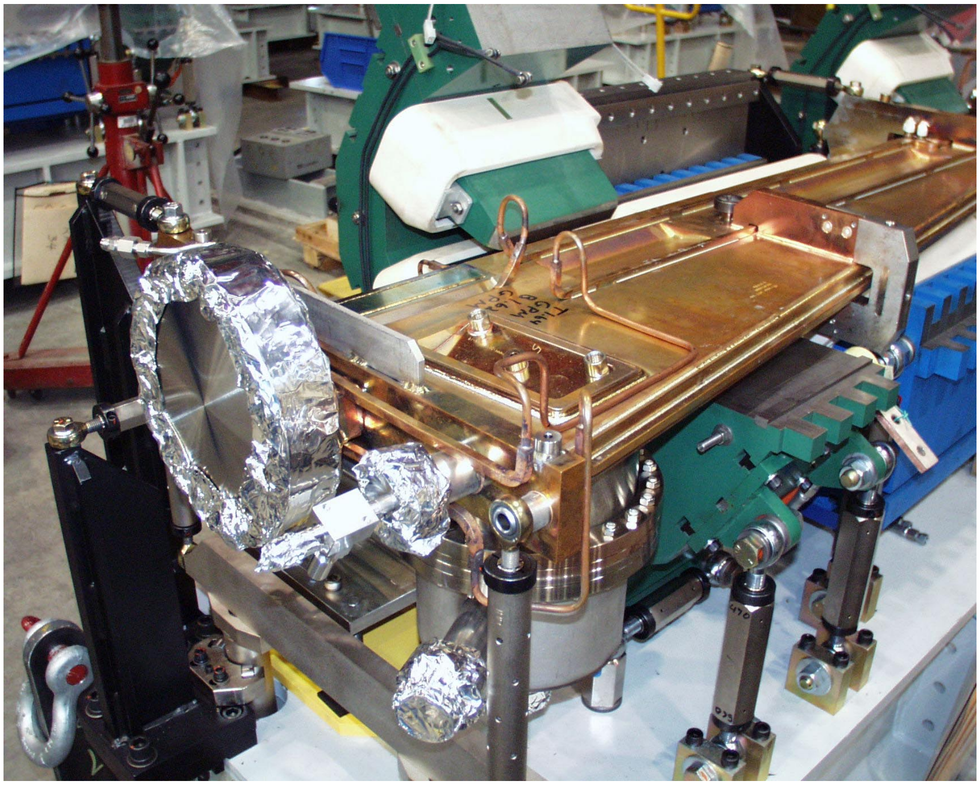
Supports System & Assembly

Fabrication of the middle support raft, 50Q, for a standard cell is complete and 18 rafts have been delivered to SLAC. The remainder of the support rafts will be delivered over the next 4 months.

The production raft assembly has begun at the SLAC B750 (SLC Hall) complex. This building has floor space and an overhead crane which is used to mount magnets and to move fully loaded rafts which will weigh approximately 26,000 pounds. As of the end of this quarter we have successfully assembled one 50Q raft complete with 2 Sextupoles, 1 Quadrupole, 1 Corrector and the QFC vacuum chamber. All elements were aligned and all tolerances and clearances met.

The raft assembly process is much like an automobile assembly line. There will be several stages during which approximately 6 to 8 rafts will be worked on simultaneously. This will include installation of magnet and vacuum chamber supports in one stage, critical alignment of components on alignment stands in the second stage, and completion of LCW and electrical pre-wiring in the final stage. The completed rafts will be moved to storage in other SLAC locations.

SPEAR 3 50Q Rafts in assembly stage



SPEAR3 QFC vacuum chamber being installed into split magnets on the 50Q raft

1.2 Vacuum System

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

- Assembly, welding and vacuum processing the standard and matching QFC chambers and BM1 standard chamber.
- First lot of BM-2 chamber halves received.
- BM-2 piece part fabrication near completion.
- Finalized and reviewed the septum chamber design.
- Finalizing the design and analysis of the bellows modules.
- Finalized the design of the primary vacuum chamber and aperture masking for the SLM.
- Completed the design and analysis of the cold finger and primary mirror for the SLM.
- Finalized the overall optics, tunnel, and building layouts for the SLM
- Completed the electrical testing of the injection kicker prototype magnet/chamber.
- Received the first lot of standard girder supports.
- Finalizing the design and analysis of the matching girder chambers.

Figure 2.1: QFC Chamber – Final bake out and water jumper assembly completed

Standard Girder Chambers

QFC Standard and Matching Chambers

The seventeen standard and matching chambers are nearly complete and will be fully assembled by the beginning of next quarter. Issues regarding the leaks have been resolved. Full 3-D analysis of the chamber and the weld joints were completed and interpreted along with experimental tests. A few design modifications were incorporated to increase the reliability of the chambers. Also, an ultrasonic testing procedure is being developed to verify the weld depth of the chambers. The first QFC chamber was successfully installed onto the raft and inside the magnets this quarter. Figure 2.1 show a completed QFC chamber.

BM-1 Standard Chambers

Production of the first BM-1 chamber began this quarter. The ramp up for the BM-1 production is being interleaved with the ramp down of the QFC work. The first set of cooling bars was completed in November. New EB programming was required for the BM1 box and the first box was welded by the end of the year. Initial measurements indicate that the profile of the box is within its tolerance band and that no hard plane bow was evident. Figure 2.2 and 2.3 shows the BM-1 chamber production.

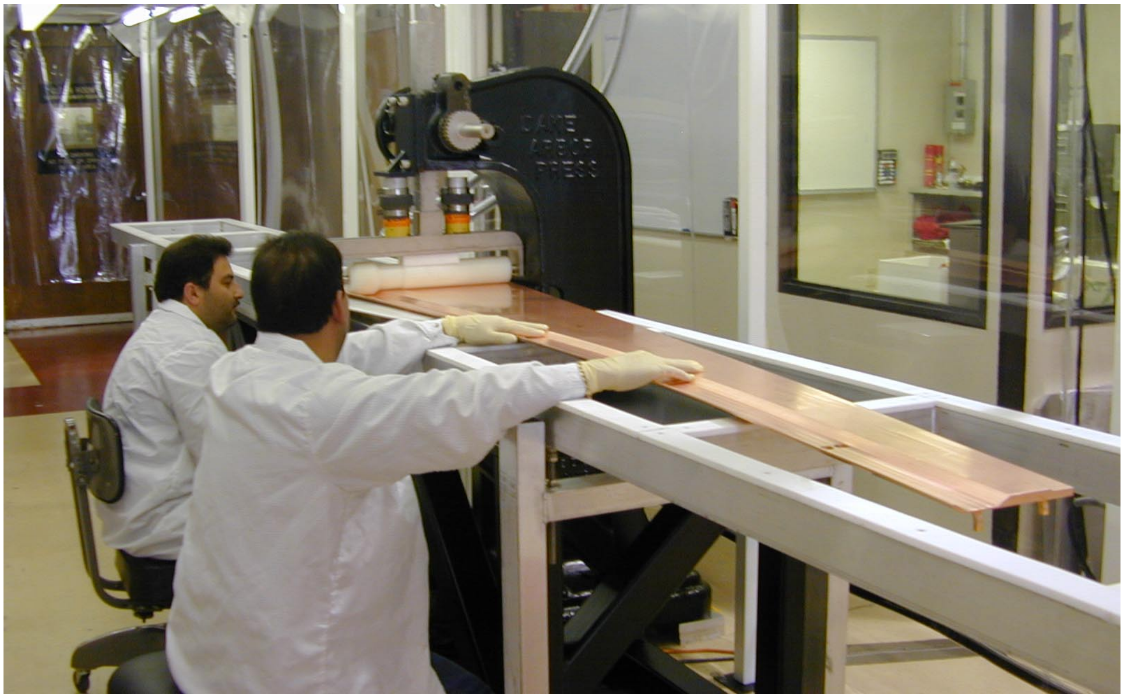


Figure 2.2: BM-1 Straightening

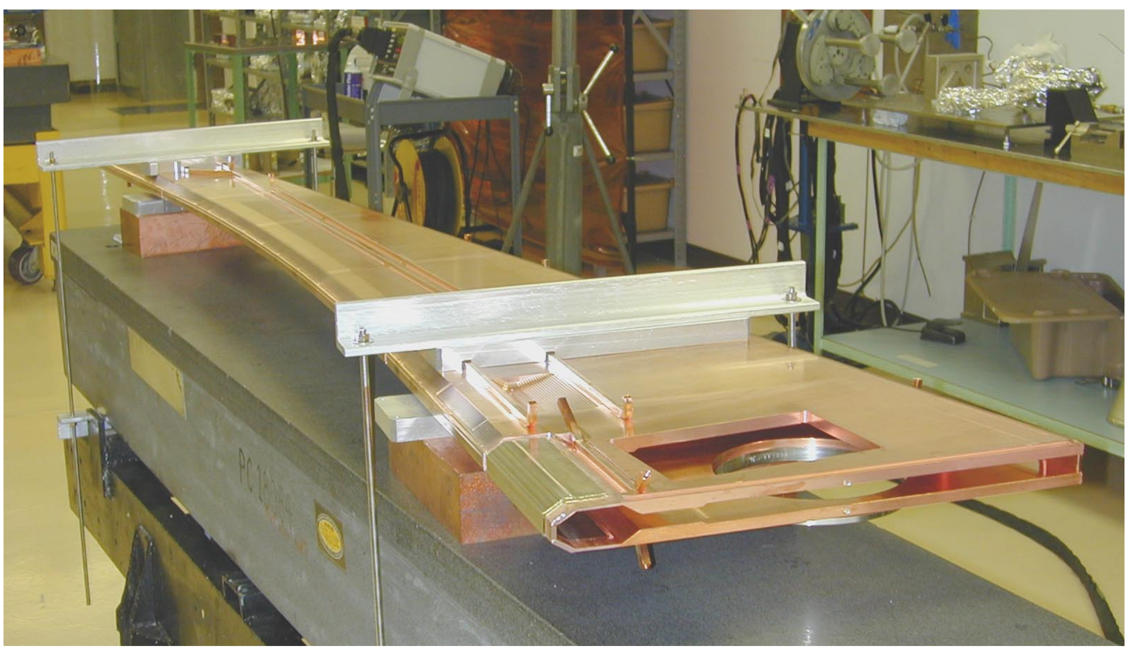


Figure 2.3: BM-1 welded box

BM-2 Standard Chambers

The first lot of BM-2 chamber halves were received in December on schedule. The majority of the piece parts have been received. Production tooling for the cooling bar and box weld should be complete by spring. BM-2 production is not scheduled to start until June of 2003

Electron Beam Welding and Vacuum Facility

Welding was stopped for 1.5 weeks for machine calibration and a diagnostic check out. This has improved the machine operation and the appearances of the welds.

Also a new electron beam welder was hired during this quarter. The new welder will start in January 2002 and a swing shift should be operational by mid February.

The PEP-II welding caused at least a two week delay during this quarter. More PEP-II work is anticipated this spring.

Matching BM-1 and BM-2 Chambers

The preliminary design of the matching chambers is complete. Analysis of the chambers will be complete early next quarter and a final design review will be held in February.

Injection System

The electrical and higher-order-mode testing are complete. The tests indicated that the design of the injection kicker meets its design goals. The production drawings for the 1.2 and 0.6 m kicker will be complete next quarter.

A review of the injection system was completed this quarter. The design of the septum chamber was approved and a decision to build a useable first article instead of a test article was made. The detail drawings are near completion pending a review of the integrated septum bellows. Also, the support design for the injection system was approved. Production of the injection kicker, septum chamber and transition chambers will start next quarter.

Diagnostics

The physics requirements for the SLM monitor were approved last quarter. The source fan was reduced from 5 mrad to 3.5 mrad. The overall layout of the optics was approved. Radiation studies are in progress to determine the safety of the future SLM hutch and the required shielding for the tunnel. A preliminary design of an electron-clearing magnet was analyzed and submitted to the Radiation Physics department. The clearing magnet is required to prevent the very unlikely scenario that the electron beam could be steered down the SLM beamline.

The conceptual design and layouts for all the components on the UHV side of the SLM are near completion. The preliminary support integration with the magnet group is complete. A final design review for the SLM vacuum system will be held next quarter.

Pumping System

The first lot of titanium sublimation pumps were completed this quarter. The remaining pumps should be completed by next quarter. The ion pump order for SPEAR 3 is in progress and the order will be placed next quarter.

1.3 Power Supplies

Unipolar Power Supplies

Dipole Power Supply

The SLAC Power Conversion Department (PCD) received all the module electronic components for the chopper modules. PCD will issue a work order to the SLAC fabrication shops to have the chopper module metal parts fabricated and to assemble the modules. Four chopper modules are needed (2 positive and 2 negative), but 6 modules will be built so that 1 spare module of each polarity will be available.

Three chopper module controllers have been fabricated. Two controllers are needed for system operation; the third unit is a spare. The 3 controllers will be bench tested during the next reporting period.

A bulk power supply will be needed to power the chopper modules. Work has begun to specify the requirements of this power supply. The bulk power supply is somewhat conventional, except that it needs a well-designed low-pass, inductor-capacitor LC filter. PSPICE runs will be made to assist in choosing the LC values to provide proper filtering and highest achievable power factor. An overall system diagram of the dipole power system is currently in process. The diagram will tie all the pieces together and highlight any loose ends.

Large Power Supplies

IE Power is the designer/manufacturer of the 6 Large Power Supplies that will power the QD, QF, QFC, SD and SF. They submitted a Large Power Supply design package, which was reviewed and deemed acceptable by SLAC personnel. The 6 power supplies were released for fabrication.

Intermediate Power Supplies

IE Power was selected to design and manufacture the 82 Intermediate Power Supplies based on technical responsiveness, lowest cost and acceptable schedule. IE Power has submitted the required design package, which is currently undergoing SLAC review.

A Change Control Board request was filed and approved to add 2 additional intermediate power supplies for the B7H and B8V magnet systems. The change was needed to cover the increase in magnet resistance that occurred from the initial magnet design that was in place when the purchase order was placed to the final approved design.

Titanium Sublimation Pump (TSP) Power System

The IDOM that will be needed to control the TSP switch circuits is on order. The 4 switch chassis are also on order.

The power supplies that will power the TSPs are included in the Intermediate Power Supply order.
The Amphenol connector that will mate with the connector on each TSP has been identified, purchased and received in time to support wiring of the TSPs on the magnet rafts. Electrical Interconnect (EI) diagrams for the TSP system are complete.

Bipolar Power Supplies

Corrector Power Supplies

Bira Systems, Incorporated has been contracted to fabricate and perform functional bench testing of 150 bipolar power supplies that will be needed to power the SPEAR 3 horizontal and vertical correctors, insertion device trims and the quadrupole modulation trims. Bira has fabricated 10 power supply printed circuit boards (PCBs). One of these boards has been sent to SLAC for examination. If the artwork is correct, Bira will be asked to stuff the 10 PCBs and to functionally test them. Upon successful completion of the 10 functional tests, Bira will proceed with fabrication of the 140 power supply balance.

Quadrupole Modulation System (QMS)

A November 14, 2001 design review successfully addressed the primary issues of the QMS power system:

- Equipment will be safe in the unlikely event of a trim coil, or trim coil bus bar, shorting to a main HV winding.

- There is the real possibility of opening a QMS power relay while the QMS magnet is energized. For this situation, ESD will specify and provide metal oxide varistors (MOVs) for connection across each QMS magnet. The MOVs will suppress the induced high voltages in the trim coils if the currents in the main coils are chopped.

- SSRL hopes to be able to modulate a QMS magnet at 10 A, (RMS) and 10 Hz. Information presented at the design review showed that the mains will probably experience voltage compliance problems at these settings. Furthermore, since the BitBus controller is set for precision and stability, its bandwidth is typically on the order of 1 Hz.

The information presented at the design review show no voltage compliance problems at modulation combinations of 1A, 10Hz or 10A, 1Hz.

A system is being setup onsite to test the effects of QMS modulation on the main current. During the tests the BitBus controller bandwidth will be varied to see what can be achieved in terms of bandwidth and stability. The modulation parameters should be better known after the tests.

Pulsed Power Supplies

Kicker Pulsers

A 10-stack IGBT pulser was fabricated and tested with the prototype kicker magnet. The tests of the integrated kicker system have been successful. Some additional testing will occur during the next reporting period to fully characterize the magnet and the pulser.
As soon as a California Chassis rack (see below) is available, the first production kicker pulser will be assembled and placed into the rack.

BitBus Power Supply Controllers

Parts are still being received for fabrication of the 80 or so Bitbus chassis that will be needed. The actual fabrication is expected to start during the next reporting period.

Racks and Accessories

California Chassis, located outside of Los Angeles was selected to build the 18 double bay racks that will be needed to house the Dipole, Large, Intermediate, Bipolar and TSP power supplies. Receipt of a California Chassis design package for SLAC review is imminent. A "first article" rack will be fabricated and delivered during the next reporting period.

Other Work

B118 Layout
A layout of the Power Supply and Instrumentation and Control (I & C) Racks in B118 was completed as part of a multi-discipline effort. In order to most efficiently utilize B118 floor space, the layout incorporates 3 rows of racks, instead of the 2 row arrangement that is illustrated in the SPEAR 3 Design Report.

Magnet Testing
Electrical testing of the SPEAR 3 dipole, quadrupole and sextupole magnets is about complete. During the next reporting period testing will focus on the corrector magnets.

AC Power Distribution
The SSRL Facilities Group has been contacted and requested to begin work on the design of the AC distribution system that will be needed for the programmatic and auxiliary systems that will be housed in a refurbished Building 118. The goal is to have a facilities person identified and brought on board to begin this effort during the next reporting period.

B118 Floor Refurbishment
The SLAC Site Engineering and Maintenance (SEM) Department has been contacted and is prepared to do the seismic analysis necessary to calculate the thickness of the concrete floor that will be part of the B118 refurbishment effort. The B118 layout drawing, annotated with the weights of the illustrated equipment will be given to SEM along with work order request to start the floor design.

Installation Plans
A meeting was held with the WBS 1.9 Manager to review the installation schedule, particularly with regards to B118 refurbishment, power supply installation in B118 and power system testing as complete and integrated systems. Useful guidelines pertaining the installation and testing priorities and timescale were obtained from this meeting, but not unexpectedly, additional schedule work and coordination will be needed.

1.4 RF System

Cavities

Cavities being fabricated at Accel Instrumentation in Germany. An inspection visit to the company in October showed that a delivery date for the first cavity set for early December 2001 was indeed likely to be achieved. Unfortunately, with the first cavity in the final tuning stages, about 97% complete, some leaks from the cooling channels were discovered on two cavities. The repair method for these leaks has to be developed. This will cause a delay of yet undetermined length to the delivery of all cavities.

Cavity Accessories

- The cavity rafts have been delivered.
- All twelve high order mode loads are completed.
- One ceramic window is complete and two more windows have successfully been brazed.
- Coupling networks are finished except for some anti-multipactor coating.
- Timers had spring fingers are welded in place and aligned ready for final assembly.

Waveguide

A SLAC microwave engineer has throughly reviewed the waveguide system specifications and completed the waveguide procurement package. It has been submitted to the SLAC procurement department.

Low-Level RF

The Low-level RF System design modifications are progressing at the new Electronics and Software Engineering Department at SLAC. A schedule for completion by the end of 2002 has been established.

Klystron High Voltage Power Supply

The new klystron power supply is ready for shipment at the vendor, expected delivery early January 2002. The SLAC provided control circuits are 70% complete. Installation is scheduled for summer 2002.

1.5 Instrumentation and Control Systems

Computer Control System

SPEAR 3 control system software tasks were defined in further detail, including the those for power supply Bitbus control and BPM data acquisition. Control Net driver software is being implemented on an EPICS IOC that will enable an EPICS interface to Allen-Bradley logic controllers used for machine protection. A design review for the complete computer control system plan is scheduled for March, 2001.

SPEAR 3 component nomenclature was finalized and entered into the web-based database. This information is being used to specify the cable plant. Components in the Booster-to-SPEAR transport line will be entered into the database in the next quarter.

The detailed design of the 8-Channel Power Supply Controller continued. The first daughter card printed circuit board was completed, and the final layout of the motherboard is in progress.

Beam Monitoring Systems

The specification of the two-system Beam Position Monitor (BPM) processing system continued. The procurement order for 60 Bergoz button-multiplexed processors was initiated. Signals from these processors will be shared between the orbit monitoring and orbit interlock systems. A second set of wideband, un-multiplexed processors will be developed to electronics and will be used for 1st-turn, turn-by-turn, and high resolution orbit acquisition using programmable digital IF receivers. A design review for the two-system was arranged for January, 2002.

Cable harnesses that will connect BPM button assemblies to bulkhead panels on the accelerator support girders have been ordered and first units received. These harnesses will be installed on vacuum chambers during magnet raft pre-assembly, which began in December.

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

The RF/Timing Signal Generator system has been specified and was ordered in December. Work is underway to try a prototype version of the injection timing system using booster RF signal frequency shifting in the next months. A first test of booster frequency-shifting in November was successful.

Protection Systems

The design of the SPEAR 3 vacuum and magnet cooling protection systems is in progress. The programmable logic controllers that will be used for these systems have been received and are presently being configured. The ion pump power supply, ion gauge controller, and water flow switch systems have been specified. The temperature monitoring system has been specified and will reuse CAMAC ADC modules from the SPEAR 2 control system. Rack layouts for machine protection components will be completed in the next quarter.

The design of the Orbit Interlock system is in progress. A plan and design for using a single BPM data acquisition and processing system for both the Orbit Interlock and the orbit monitoring system has been devised. The proposal will be reviewed in January, 2002.

The SLAC Radiation Physics group agreed to an initial injection beam containment plan that will require 3 Average Current Monitors (ACMs) in the BTS line. The Long Ion Chamber (LION) system will not be connected to the Beam Containment Interlock during initial operation. Injection beam power will be limited by the ACMs. Once the LION system is calibrated, it can be connected to the Beam Containment Interlock, and the injection power limit can be raised. This proposal has yet to be approved by the SLAC Radiation Safety Committee.

1.6 Cable Plant

Design of the inner-ring cable tray system (Phase 2) has made considerable progress. The existing tray system (Phase 1-completed last Summer) extends from the East to West just short of the pit areas. The Phase 2 design (now 70% complete) continues to specified entry points around the ring. A review of the installation schedule for Phase 2 was made, with updates supplied, in a presentation to the design team.

The preliminary analysis of structure and anchor bolt sizing was completed for the West Straight and behind B118 designs. The design with structual analysis supporting documentation was presented to the Earthquake Safety Committee and received approval. Also, design for trays needed by the BPM and RF systems residing in or near the E/W Pits is complete but is pending earthquake committee review.

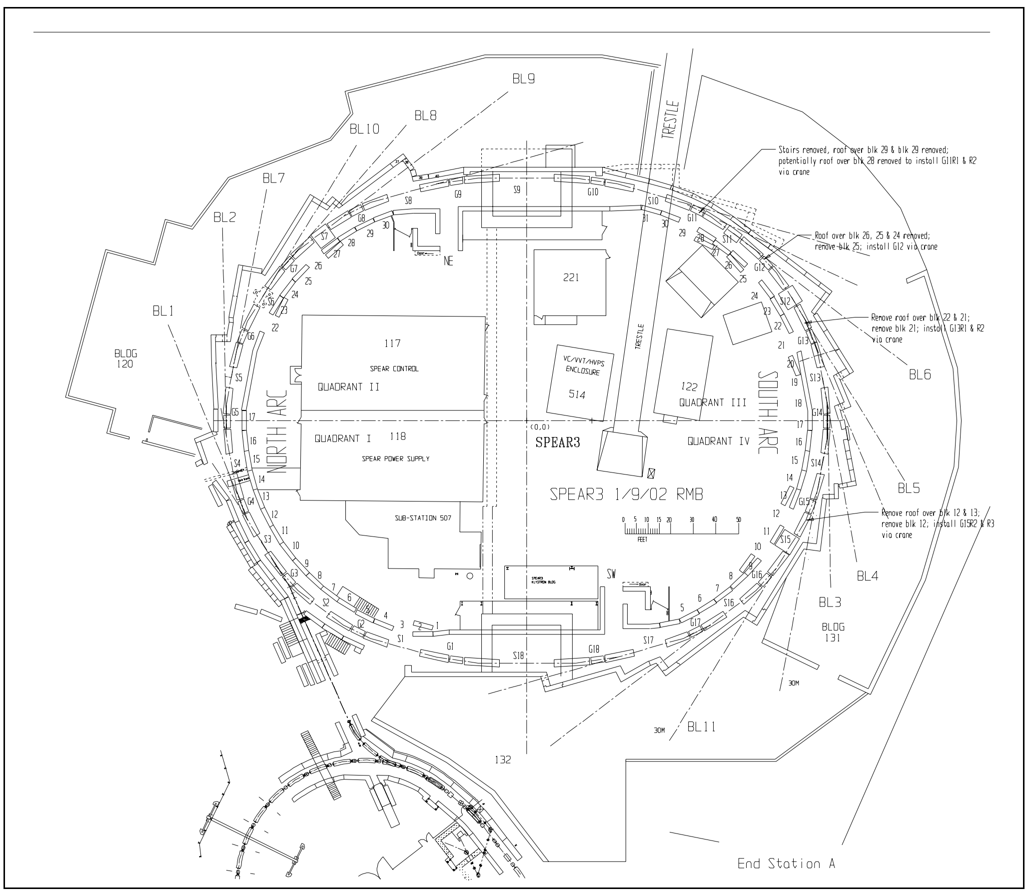
The Cable plant organization has received information on the Beamline Components Database, a crucial definer of the SPEAR3 system to be instrumented. This document provides the specific nomenclatures of beamline devices, typically the cable destination, with details such as device locations in beamline feet.

Cable procurement has become paramount in preparations for the downtime. We are requesting more details from the Systems Engineering Team that provides input to the CAPTAR cable database. We use the database to substantiate early estimates of cable types and connecters required for the installation. With this input the cable plant team have/will determine cable and connector counts, put-ups (reel sizes) , wastage required and tray loading checks for NEC compliance.

1.9 Installation

Progress on the SPEAR 3 installation schedule has been made over the last quarter. Meetings have begun with group leaders to review and obtain input to the overall schedule. Meetings to date include magnets & supports, RF, Power Conversion, Cable Plant, Vacuum, I&C, Facilities and Startup/Commissioning. Upcoming meetings will be held with the Beamlines, Safety, SPEAR 2 hardware, and Survey & Alignment groups. Input from each group and integration of their activities will be included in the overall schedule.

Drawings are being prepared to identify shielding blocks and access points that will be made available during the construction and installation phases of the project. The 54 magnet support rafts shown in the drawing below make up the 18 lattice cells of SPEAR along with 18 straight sections. Each of these elements is being identified in the installation schedule and will be tracked to ensure that the proper installation sequence is followed.



SPEAR3 ring and access locations

2.0 Accelerator Physics

Summary

The SPEAR 3 Accelerator Physics Group addressed many important tasks during this quarter. In particular, field coupling in the corrector magnets, testing of the slow orbit correction system, studies of the new beam line 4 and 7 wiggler and preparations for the on-line control application software were carried out. Progress is also reported in collaboration with the Radiation Physics Group in injection safety and Synchrotron Light Monitor Safety.

Corrector Magnet Field Coupling

An inductance test for the corrector magnets was carried out whereby one coil (horizontal or vertical field) is driven harmonically while the other is monitored for inductive field pick-up. By minimizing the monitor signal on a spectrum analyzer while adjusting transverse position of the coil monolith the fields can be orthogonalized. The technique works (there is a rather pronounced minimum) but in practice re-tightening of the coil wedge blocks moves the coils randomly and the adjustment is lost. By pushing the coils up against the stops, however, about 5 mrad deviation from orthogonal is obtained. The sensitivity is about 10:1, i.e., the iron-dominated vertical field is 10 times less sensitive than the air-dominated horizontal field to coil misalignments. Hence, for a 5 mrad deviation from field orthogonality, the vertical field is probably plumb to about 0.5 mrad, and the horizontal field is level to about 5 mrad. This is acceptable from an accelerator physics point of view.

Regarding alignment, the Alignment Group can resolve deviations from level down to about 2 mrad, but can only adjust the level down to about 5 mrad due to lack of fiducials, tooling balls, accurate struts, etc. Although the precision of level for the horizontal field is not as critical (coupling generates vertical field with horizontal kicks) the plumb-ness of the vertical field is critical because we do not want spurious horizontal fields with vertical kicks. Therefore, an effort will be made to (1) survey all corrector magnets after installation on the magnet support rafts and (2) level all corrector cores to within precision obtained without undo effort, i.e. ~5mrad.

New Wigglers for Beamlines 4,7

Accelerator Physics personnel worked closely with the Beam Line Development group to quantify magnetic field specifications for new Wigglers for beam lines 4 and 7. The specifications concentrated on line integrals through the magnet array (first and second integral) and quadrupole component evaluated as a function of transverse direction across the magnets. Based on magnet measurements provided by manufacturer (Danphysik), the magnet assembly meets or exceeds all specifications. In accordance with the SPEAR 3 installation schedule, the new wiggler magnets are to be installed during the main 6-month FY2003 shutdown period.

Synchrotron Light Monitor

Extensive studies were performed in conjunction with the Radiation Physics Group to determine radiation levels in the experimental enclosure. Studies show that a series of 5 lead shields ranging from 2” thick to 8” thick will block shower radiation in the unlikely event that electron beam is lost in either the light monitor beam line or in the main accelerator. Similarly, x-ray transmission past the M0 (first high-power) mirror is being studied to determine radiation levels in the experimental enclosure. Radiation Physics Group and X-ray physicists at SSRL have computed conflicting results for radiation. A resolution of the anticipated radiation levels and requisite shielding needs is expected by approximately mid-February.

Application Programs

1. Orbit Program – A SAVE/RESTORE facility was added to the program to allow the user to save work for the short term (in memory) or for the long term (to disk). As with the SAVE/RESTORE facility for SPEAR 2, this facility allows the user to develop orbit correction configurations to be applied on a regular basis or for specific applications at a later date. In conjunction with the RESTORE software, components of the program start-up sequence were modularized to permit software sharing. The Orbit Interlock Verification software, for instance, utilizes the same simulation model and corrector bpm initialization sequences. Both programs also share calling routines to the simulation or online accelerator under control. The shared software is targeted by other small applications and will be targeted by future applications.

2. Channel Access – A new version of the MATLAB Channel Access Toolbox was released and integrated into the orbit control software. The resulting code is more robust and in places simplified. Along with a correction of a minor bug that has resided in the SPEAR 2 database for many years, the Channel Access Toolbox was successfully used to control the orbit in SPEAR 2 for an 8-hour period. Figure 1 is the result of the 8-hour experiment performed in January, 2002. (Vertical scale mm, right scale BPM index, left scale covers 8-hour period).

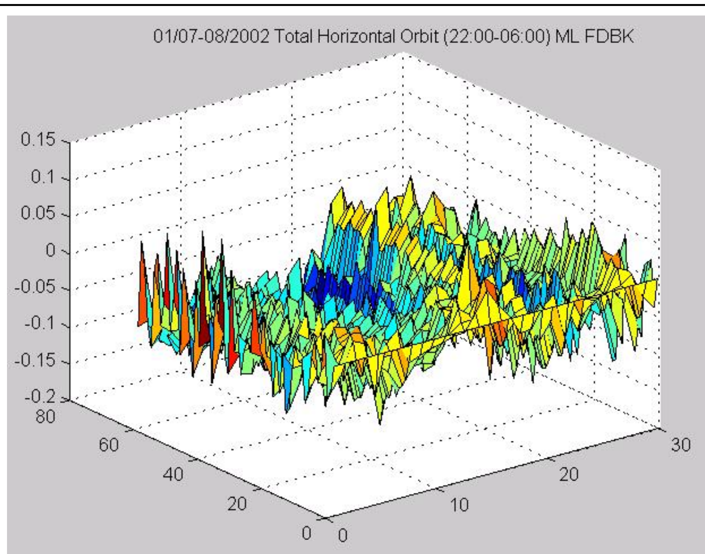


Figure 1: Horizontal Orbit Feedback

3. Accelerator Modeling – Most of the work required to convert the accelerator analysis program LOCO to a MATLAB format is complete. A consultant specializing in MATLAB program development was hired to convert a FORTRAN program used to analyze storage ring optics into the MATLAB environment The new software is in the evaluation phase and only small renovations are expected. LOCO will be an important diagnostic tool for SPEAR 3. Application of the analysis code (LOCO) is identified as a line item on the SPEAR 3 Accelerator Physics

Gannt chart. Completion of this work in the MATLAB environment finishes the task in better standing than originally anticipated (FORTRAN).

Orbit Interlock Verification System

Using the MATLAB Accelerator Toolbox software developed at SSRL, work has begun on the orbit Interlock Verification System (IVS).

Radiation Safety

The accelerator physics group continued to analyze electron beam loss scenarios during injection for the Radiation Physics Group ("Injection Beam Loss Angles in SPEAR 3"). The basic finding is that injected charge from the SPEAR Booster can be incident on the vacuum chamber walls at a maximum angle of approximately 20 mrad (1 degree). The document is under review by the Radiation Safety Board for approval. Pending approval, the Radiation Physics group will proceed with safety and shielding studies. Note that an important decision was made to use current monitors in the BTS (Booster to SPEAR) transport lines. The current monitors will limit current to 1.6 nA for a total beam power of 5 W at 3 GeV. This decision relieves the SPEAR 3 operations staff from the requirement of using distributed LION (Long Ion Chamber) diagnostics in the personnel protection system (PPS).

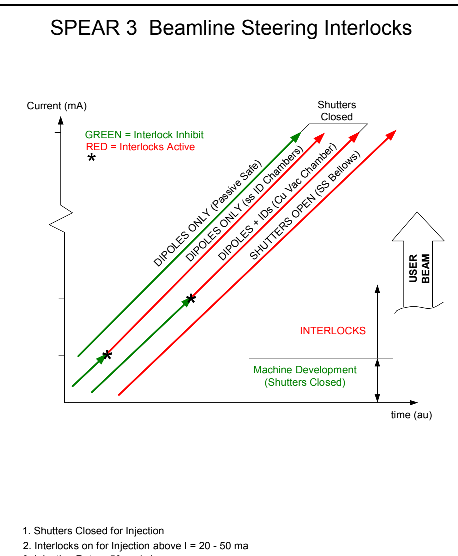


Figure 2: Orbit Interlock Scenarios

Machine Protection from Synchrotron Radiation

A review was held to assess the present proposal for machine protection against mis-steered synchrotron radiation beams. The primary fault scenarios are: (1) dipole magnet radiation striking the inside of an insertion device chamber above ~20 mA (TBD), (2) insertion device radiation striking the main copper vacuum chamber above ~50 mA and (3) and dipole or insertion device radiation passing down the photon beam line at any current. The figure to the right shows schematically the operational scenario for the SPEAR 3 interlock system. The proposed plan of the BPM processor serving electron beam position data to both the orbit interlock and orbit feedback system was accepted by the review committee. Development of software for the orbit interlock verification system has proceeded on target. Since 'online' SPEAR 3 data is not available, the simulation mode is used to produce electron beam 'bumps' across beam line source points and monitor motion at adjacent BPMs. Algorithms for both dipole beam lines and insertion beam lines have been tested. Discussions between the hardware and software developers have been carried out to integrate the software functionality with the hardware architecture. Investigations are also underway to determine the depth of tests that can be carried out with hardware/software communication prior to SPEAR 3 turn-on.

SPEAR 3 Accelerator Physics Start-Up Schedule

In conjunction with the SSRL Operations Group, the SPEAR 3 Accelerator Physics Group has begun to identify and plan major start-up tasks. The Operations Group will establish the schedule prior to beam availability in the main SPEAR 3 accelerator (power supply checks, vacuum turn-on, water turn-on, machine protection test schedule, personnel protection, etc). The Accelerator Physics Group is developing the schedule that will commence with beam-to-SPEAR (injection tuning, interlock checks, orbit steering, optics validation, vacuum processing, etc). A preliminary schedule for both tasks will be available in the Spring of 2002 with a more detailed schedule to be produced by Summer of 2002.

Booster-to-SPEAR Accelerator Physics Studies

The electron beam transport line leading from the Booster to SPEAR (BTS) is presently under study to verify power supply calibration factors and optimize beam optics for SPEAR 2. These steps are necessary since the BTS optics must be modified on a controlled manner to deliver beam to SPEAR 3. Initial studies indicate that most of the magnets behave as expected but further work is needed to fully understand beam optics and transport. Simulation studies with the optics code "MAD" (Methodical Accelerator Design) and on-line studies with 2.3 and 3.0 GeV electron beam in the BTS will continue through out this operations cycle (to 7/02).

Conferences

Personnel from the SPEAR 3 Accelerator Physics Group attended the ICALEPS (Control System) and ABS (Automated Beam Steering) conferences in San Jose during December, 2001. One paper, 'MATLAB Channel Access Toolbox in MATLAB was submitted to the ICALEPS conference.