SPEAR 3

Quarterly Progress Report

Stanford Synchrotron Radiation Laboratory

January through March
2002

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A. SPEAR 3 PROJECT SUMMARY

1. Technical Progress

The progress and highlights of each major technical system are summarized below. Additional details are provided in Section B.

Magnets – As of the end of this quarter (March 31, 2002), the status of magnet fabrication is as follows:

Magnet Type	Number Received	% of Total Received
Dipoles	40	100%
Quadrupoles	102	100%
Sextupoles	76	100%
Correctors	40	54%

The final shipment of corrector magnets from IHEP is scheduled for the end of April 2002. This will be a milestone signaling the successful completion of the SLAC-IHEP collaboration for design and production of SPEAR 3 magnets. As part of the collaboration, four IHEP technical staff members joined the SSRL team this quarter to participate in the assembly and alignment of individual magnets on their support rafts.

Vacuum System – During this quarter, the electron beam welding fabrication of the standard cell and matching cell QFC-type vacuum chambers was completed. Two of the 18 units still require vacuum processing which will be completed in April.

Production of the BM-1 type chambers proceeded this quarter. The ramp-up for BM-1 production was interleaved with the ramp-down of the QFC fabrication. All of the cooling bar plate welding for the 14 chambers was completed. Four chamber box welds were finished and three of these units are ready for the final assembly of the extension chamber.

The final design review for the BM-1 and BM-2 matching chambers (eight units) will be held in April. Work is continuing on various straight section chambers, bellows modules, and special chambers that house diagnostic systems.

Magnet-Vacuum Assembly – Production assembly of the 50Q Rafts (QFC vacuum chambers within 50cm quadrupole, two sextupoles, and a corrector magnet) proceeded this quarter. Ten of eighteen rafts were assembled (See Section 1.1) with magnets and vacuum chambers separately supported and aligned.

Power Supplies – At the end of this quarter, all power supplies (200 units of 13 different types) were on order or in fabrication except for one bulk dipole supply. The design of this unit was completed and reviewed with a request for proposals planned for April 2002.

RF System – The manufacturer selected for the RF cavities has used this quarter to evaluate the causes of unsuccessful plating of the cavities (which seals the water cooling channels) for both SPEAR 3 and PEP-II. Assuming a new plan is developed following the successful method used for the initial 26 PEP-II cavities, production will resume next quarter. While this overall circumstance will result in a one-year delay in delivery (to near the end of CY02); this new projected date is still 8 months ahead of the scheduled installation date.

Klystrons for both SPEAR 3 and PEP-II are being repaired locally and production of additional units is underway at SLAC. The Klystron power supply for SPEAR 3 was delivered this quarter.

Instrumentation and Controls – The computer control system software task specifications were refined and software development continued. Control system CPU boards were specified and a first unit of the high resolution ADC module has been received for testing. The first working daughter boards for the fast corrector controllers were received and successfully tested, while the detailed design of the controller motherboard neared completion. Commercial BPM processing units are on order, and custom fast orbit processors are being designed. Specifications for the DCCT, tune monitor, scrapers and synchrotron light monitor instrumentation are in progress. A prototype version of the injection timing controller was configured and tested successfully. Components for the Machine Protection System have been specified and many have been ordered. Detailed design of the Orbit Interlock System is in progress, and the Temperature Monitoring System has been ordered. Magnet raft wiring diagrams are complete and the I&C long-haul cable plant is close to being fully specified.

Cable Plant – The specifications for the inner radius (outside shielding) cable systems are near completion. The phase 2 installation contracts were bid and awarded for work scheduled the last half of this calendar year. Much work on the DC power cable systems has been completed including DC power cable diagrams, power supply building (B118) and West straight section BPM rack layouts with detailed rack profiles and contents.

Installation – While efforts noted above for cable plant and shielding are continuing this year to minimize efforts during the final FY03 shutdown, further details have been developed for the final shutdown period. The FY03 plan has been transferred from Microsoft Project to Primavera in order to provide greater flexibility in the optimization of multishift operations together with greater than 5-day work-weeks. Current efforts are focusing on the identification and inclusion of all tasks.

Accelerator Physics – During this period, the SPEAR 3 Accelerator Physics Group focused on tasks with direct bearing on SPEAR 3 installation and commissioning. These tasks included analysis of magnet measurements for dipole magnets, final diagnostic engineering designs, specification for the M0 mirror in the synchrotron light monitor, software development for application programs and radiation safety.

2. Cost Reporting

The total project costs and commitments through March 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 March 2002)

	K$	
	Direct	Direct & Indirects
Costs	25,495	28,790
Commitments	2,462	2,621
Total	27,957	31,411

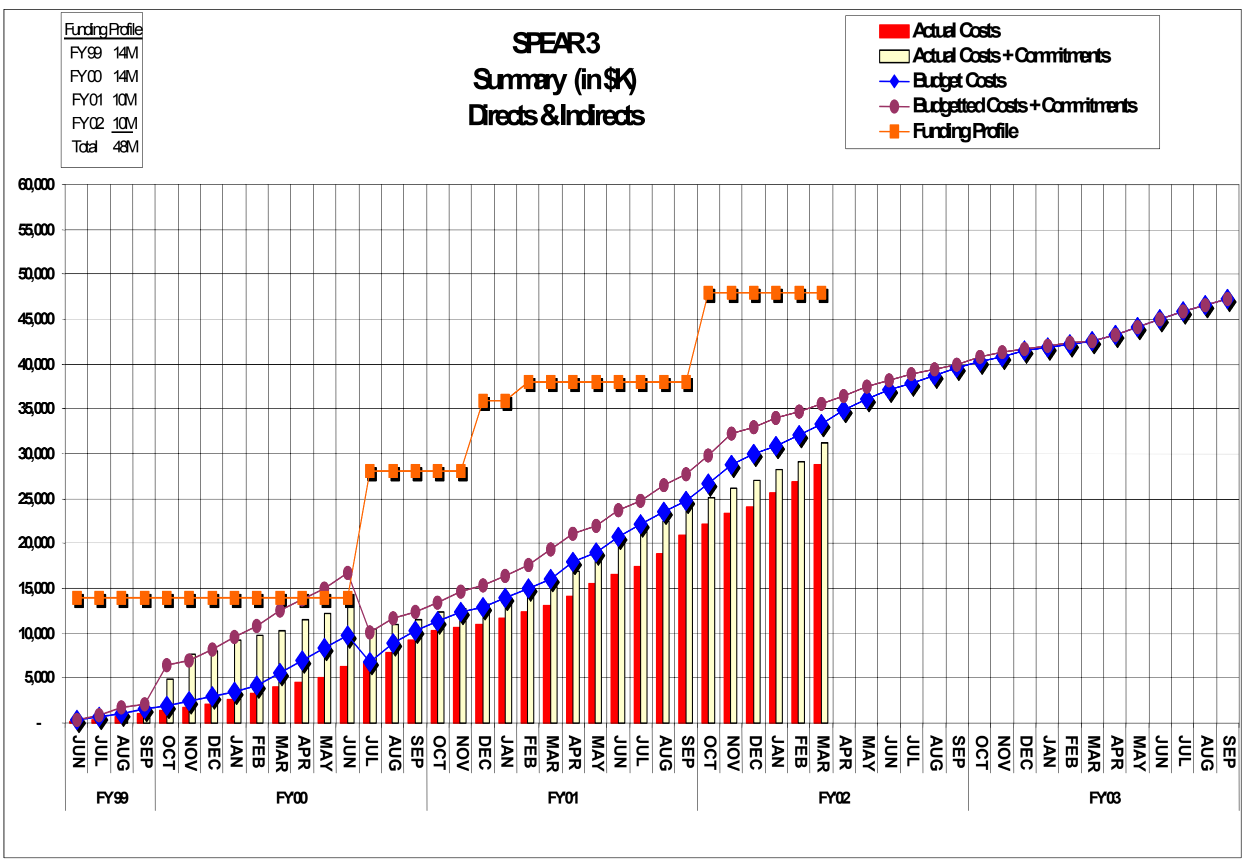


Figure A1

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 prior quarter vacuum system variances in both cost and schedule resulted largely from the problems in establishing production at the e-beam welder as well as design issues. These have been reduced via recent CCB action. The remaining schedule variance is due to delay in the completion of straight section and transition chambers until March 2003

The new Cable Plant group, together with other technical group members, is still in the process of establishing the total new electrical cable requirements and associated costs. Also cable routes and installation schedules are still being revised.

The RF system schedule has been adjusted to a new schedule by the manufacturer as noted above in Section A.

The I&C schedule variance is the result of the accumulation of small slips in several subsystems. Action is underway to minimize further slippage.

Table A2

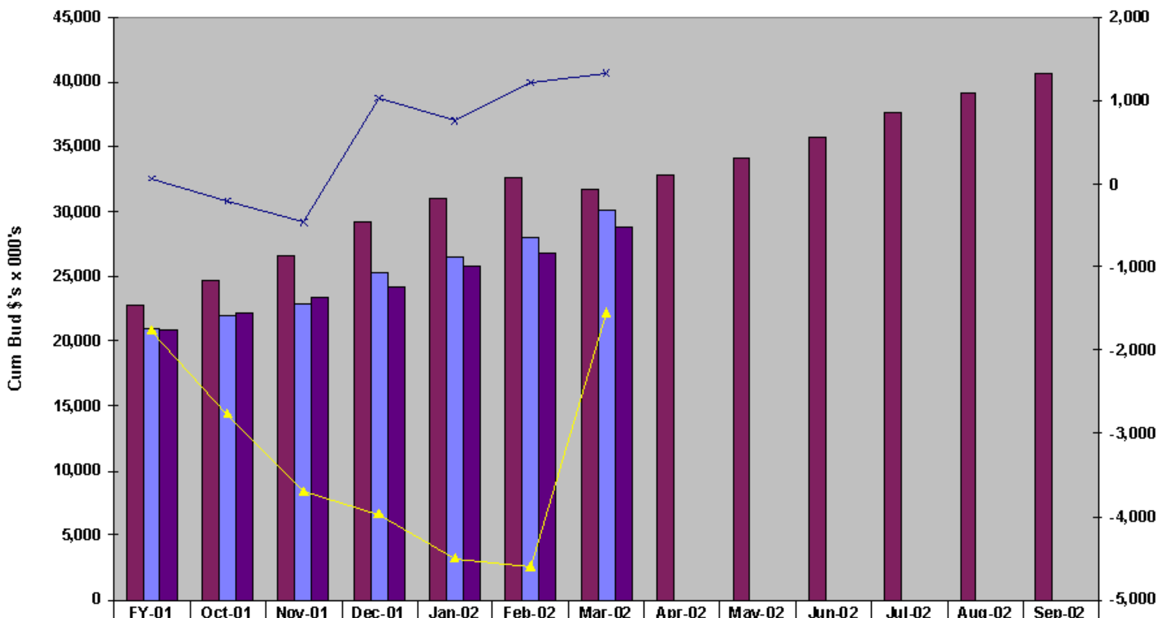
Cost/Schedule Status Report								
	Contract Type/No:		Project Name/No:		Report Period:		Signature:	
			SPEAR3 Project - rev. A ($58M)		2/28/2002	3/31/2002	Title/Date:	5/15/2002
(1)	(2)		(3)		(4)		(5)	
Original	Negotiated		Current		Estimated Cost of		Contract Budget	
Contract	Contract		Target Cost		Authorized Unpriced		Base	
Target Cost	Changes		(1) + (2)		Work		(3) + (4)	
					0		57,995	
Performance Data								
	Cumulative to Date					At Completion		
WBS[2]			Actual					
	Budgeted Cost		Cost	Variance			Latest	
	Work	Work	Work	Schedule	Cost	Budgeted	Revised	Variance
	Scheduled	Performed	Performed				Estimate	
1.1 Magnets and Supports	7,297	7,352	7,316	55	35	8,873		
1.2 Vacuum System	7,046	6,661	6,310	-385	351	13,279		
1.3 Power Supply System	1,818	1,784	993	-34	791	3,514		
1.4 RF System	3,581	3,455	3,305	-126	150	4,624		
1.5 Instruments Control & Protectio	1,550	1,441	1,341	-109	100	3,633		
1.6 Cable Plant	1,604	754	830	-850	-76	2,354		
1.7 Beamline Front Ends	416	400	269	-16	131	1,056		
1.8 Facilities	2,221	2,133	2,364	-89	-232	3,210		
1.9 Installation and Alignment	0	0	0	0	0	3,224		
1.0 Mgmt, Support, & Accelerator	2,546	2,546	2,670	0	-124	4,037		
Gen. and Admin.	3,597	3,597	3,394	0	203	5,907		
Undist. Budget						0		
Sub Total	31,676	30,122	28,793	-1,554	1,329	53,711		
Management Resrv.						4,284		
Total	31,676	30,122	28,793	-1,554	1,329	57,995		

SPEAR 3
Total Program Costs
w/Indirects and Escalation

SPI = 0.95

Status Date: March 2002

CPI = 1.05



	FY-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02
Bud	22,716	24,703	26,588	29,149	30,920	32,597	31,676	32,908	34,182	35,668	37,580	39,157	40,648
Per	20,953	21,935	22,889	25,186	26,420	27,996	30,122						
Act	20,893	22,147	23,353	24,157	25,667	26,781	28,793						
SV	-1,763	-2,767	-3,698	-3,963	-4,500	-4,601	-1,554						
CV	61	-211	-464	1,029	754	1,215	1,329						

Figure A2

B. Detailed Reports

1.1 Magnets and Supports

Magnets

As of the end of this quarter 100% of the main magnets from IHEP have been received along with 40 of the 74 H/V Correctors. The final two shipments of Corrector magnets are scheduled to arrive by the end of June 2002, thus completing the magnet order from IHEP.

Magnetic Measurements & Fiducilization

Measurements and fiducialization of the final 6 109D magnets will occur over the next quarter. This will complete the magnetic measurement portion of the SPEAR3 magnet program.

Supports System & Assembly

Fabrication of the standard cell rafts is complete. SLAC has received 40 of the 46 standard cell rafts as of the end of this quarter with the final 6 rafts due in April 2002. Design of the Matching Cell rafts (8 each) is complete this quarter with fabrication to follow immediately.

Production assembly of the rafts has proceeded well over the quarter with 10 of the 18 50Q rafts complete and in storage (see photo below). Four staff members from IHEP have arrived at SLAC to participate in the assembly of the magnets onto the rafts. They will contribute their magnet expertise to our staff as they learn the final assembly stages of storage ring magnets and vacuum systems.

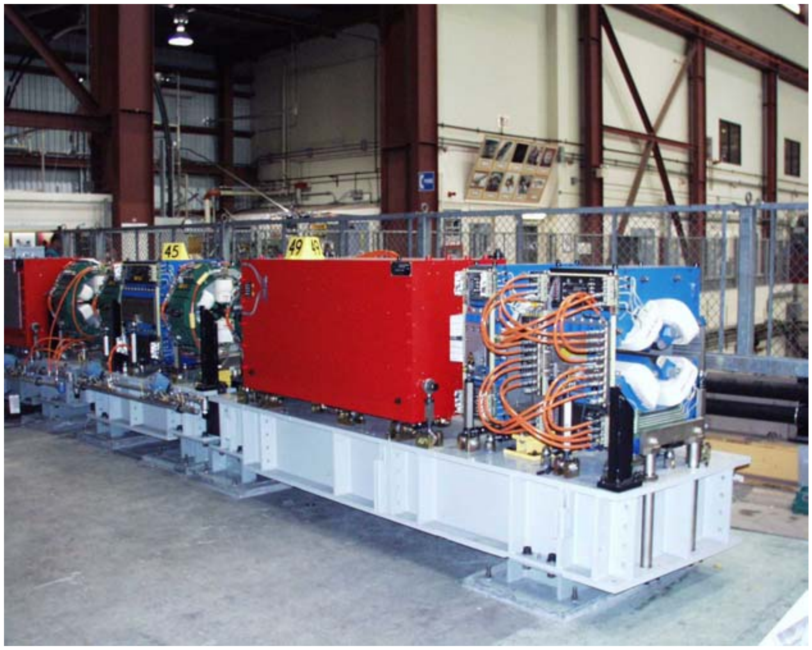
Completed 50Q Rafts in storage waiting for installation into SPEAR

Assembly of the next style of rafts after the 50Qs, 145D-Type 2, has begun this quarter. All Type 2 rafts have been received, QC'd and magnet installation is beginning. These rafts will be pre-assembled with vacuum chamber supports, magnet supports, 2 quadrupole magnets, and one sextupole magnet, then moved to storage until vacuum chambers are available for installation.

Assembly of the 145D-Type 2 rafts in process at B750

Colleague from IHEP preparing a Sextupole magnet for raft mounting. Note in background are water manifolds for the 145D-Type 2 rafts waiting for assembly.

At present we have one complete standard cell girder from which we can prepare inter-raft layouts. This girder consists of the 145D-Type 1 raft prototype, production 50Q raft, and production 145D-Type 2 raft (see photo below). This setup will be used for alignment verification, LCW connections, and electrical connections between rafts among other activities.



Standard Cell; 145D-T1 raft far left, 50Q raft (#45), and 145D-T2 raft (#49)

1.2 Vacuum System

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

- Complete standard QFC chamber assembly.
- Assembly, welding and vacuum processing of the matching QFC chambers and standard BM1 chamber.
- BM-2 chamber halves received.
- BM-2 piece part fabrication complete.
- Begin septum chamber piece part fabrication.
- Finalized the design and analysis of the bellows modules.
- Produce detail drawings of the injection kicker and related chambers.
- Received the final lot of standard girder supports
- Finalized the design of the matching girder chambers.

Standard Girder Chambers

<u>QFC Standard and Matching Chambers</u>
During this last quarter the electron beam welding fabrication of the standard and matching QFC chambers was completed. Weld tests were performed on removing and replacing the beam position monitors (BPMs) and the BPMs in three QFC chambers were successfully repaired. Two chambers still need vacuum processing and will be completed in April.
Procedures and standards were developed for ultrasonic testing of the welds. All except one of the QFC chambers that were examined passed the ultrasound test for weld penetration. The chamber that did not pass the test was the first chamber welded with the deep penetration weld. This chamber will be repaired in the future and will become a designated spare.

<u>BM-1 & BM-2 Standard Chambers</u>
Production of the first BM-1 chamber continued this quarter. The ramp up for the BM-1 production was interleaved with the ramp down of the QFC work. All of the cooling bar plate welding was completed this quarter. Four box welds were finished and three of the BM-1 chambers are ready for the final assembly of the extension chamber. The BM-1 chamber electron beam assembly should be complete by July. The BM-2 chamber production will begin this May.

Matching BM-1 and BM-2 Chambers

The final design review for the matching chambers will be held on April 12, 2002. The copper plate procurement was completed this quarter and the long lead items will be purchased in April.

Figure 2.1: BM-1 Chamber Production

Injection System

The septum chamber piece parts for the main chamber were ordered this quarter. The remainder of the detail piece part drawings for the integrated septum bellows, chamber/magnet supports, raft, and transition section will be complete in April.

The injection kicker chamber/magnet piece part detail drawings were completed. Fabrication of the kickers should be complete by this Fall.

Diagnostics

Progress was made on the diagnostic system for SPEAR3 as follows:

- Conceptual design of the DCCT chamber started,
- Finalizing the design of the PPS beam stoppers and scrapers,
- Finalizing the conceptual design of the tune monitors,
- Defining the physics parameters for the tune drivers,
- Developing a layout for the diagnostic straight chambers.

Straight Section

Work on the straight section drift chamber design and masking was restarted late this quarter. Work in this area was postponed due to manpower needs in other areas. Also, the conceptual design for the support system is being developed. A review for these chambers should be held late next quarter.

Bellows Module

Detailed analysis along with detail drawings for both the standard girder and straight section bellows is near completion. A final design review will be held in early May. Procurement of long lead items will also be placed in early May.

RF Seal

The design for the seals that bridge the gaps between the chambers was finalized. The seal design will be reviewed with the bellows modules.

1.3 Power Supplies

Unipolar Power Supplies

Dipole Power Supply

The SLAC fabrication shops are currently ordering and receiving chopper module metal parts. 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. Since all the electronic parts are already on-site, assembly can start after receipt of all metalwork.

Three chopper module controllers have been fabricated, bench tested and successfully tested with an actual chopper module. The 3 chopper module controllers are now in storage.

A successful design review for the proposed bulk power supply design was held and a request for proposal (RFP) will be issued to industry during the next reporting period.

Large Power Supplies

IE Power has begun fabrication of the 6 large (approximately 13kW) power supplies that will power the QD, QF, QFC, SD and SF magnet strings. Factory testing is slated for the next quarter.

Intermediate Power Supplies

IE Power has begun fabrication of the 82 Intermediate Power Supplies and factory testing is scheduled for August 2002.

Titanium Sublimation Pump (TSP) Power System

The system design is complete and all parts are on order or have been received. Assembly of the switching chassis has begun.

Bipolar Power Supplies

Corrector Power Supplies

Bira Systems, Incorporated has fabricated all 150 bipolar power supplies. BiRa was on-site and has bench tested 80 of the 150 power supplies. Testing of the remainder will be completed during the next reporting period.

Quadrupole Modulation System (QMS)

The system design is complete and all parts are on order or have been received. The switching chassis is currently in assembly.

Pulsed Power Supplies

Kicker Pulsers

Testing the 10-stack kicker Pulser into the prototype kicker magnet and mock vacuum chamber was successfully completed with all Pulser and magnet design parameters having been verified. However, there is still some ringing in the front and tail ends of the kicker pulse. Power Conversion Department engineers are working on the ringing and have a few solutions in mind.

Assembly of the first kicker Pulser into the recently delivered First Article California Chassis rack has begun. Testing of a complete rack-based system is scheduled during the next reporting period.

BitBus Power Supply Controllers

Motherboards for the 80 BitBus controllers were fabricated and successfully powered. The motherboards will be assembled into their chassis and functionally bench tested during the next reporting period.

Racks and Accessories

Racks

California Chassis' rack design package was approved and SLAC received the "First Article" rack. The rack is functionally acceptable, but some of the details in their seismic qualification report are still undergoing SLAC review. If the seismic review is satisfactorily completed by mid-April, all 18 double-bay racks should be on-site by the end of May.

Other Work

General

AC Power Distribution

A work order was issued to contract the SLAC Site Engineering and Maintenance (SEM) Department to design of the B118 electrical distribution system. SEM is currently in the process of hiring a design consultant. The actual design will start during the next reporting period.

B118 Floor Refurbishment

The SLAC Site Engineering and Maintenance (SEM) Department has completed the seismic analysis and thickness of the new concrete floor that will be part of the B118 refurbishment effort. The analysis shows that the floor must be at least 7” thick.

1.4 RF System

Cavities

The RF Cavities being fabricated at Accel in Germany experienced major delay since the electroplated covers for cooling channels were found to be delaminating. Accel is still evaluating the failure of the plating and is considering removal of the already deposited copper on 4 cavities and initiating a new different plating process. This can push delivery into fall 2002, still leaving enough time to assemble and test the cavities before installation in August 2003.

Cavity Accessories

Cavity raft coupling box, HOM Loads, and tuners are ready for final assembly to the cavities. One ceramic window is completed, two are ready for final coating with titanium nitrite, and one more is brazed but not tuned.

Waveguide

The waveguide system has been ordered with delivery due in April 2002. The SPEAR 3 circulator has been received and awaits final acceptance testing in May, tied to availability of the 1.2MW test stand.

Low-Level RF

The Low-level RF System design modifications are close to completion at the Electronics & Software Engineering Department at SLAC. First prototype boards are being fabricated. A schedule for completion by the end of 2002 has been established.

Klystron High Voltage Power Supply

The new klystron power supply has been delivered in January 2002. The SLAC provided control circuits are 75% complete and will be available for installation in the power supply in summer 2002.

1.5 Instrumentation and Control Systems

Computer Control System

SPEAR 3 control system software task definition is nearly complete. Work on the BPM data acquisition and corrector power supply control software continues, and development of the EPICS driver for power supply Bitbus controllers commenced. Control Net driver software that will enable an EPICS interface to Allen-Bradley logic is being implemented. The complete computer control system plan, which employs the legacy control system together new EPICS implementations, was reviewed by the internal software group, and the plan to use RTEMS in place of VxWorks as the real-time operating system for EPICS was reviewed and validated by an external review panel.

The detailed design of the 8-Channel Power Supply Controller is nearing completion. First units of the daughter boards that mount on individual power supply modules have been received and are undergoing an extensive performance evaluation. The motherboard design is scheduled to be complete in the next quarter.

The VME PowerPC CPUs that will be used for the 8-Channel Power Supply Controllers and for EPICS crate controllers (IOCs) were ordered (30 each). Other VME interface components, including ADC, DAC, and digital I/O modules are being specified. In particular, a prototype 8-channel, 16-bit ADC module having external trigger capability that could be used for precision BPM data digitization has been received and is being tested.

The computer control Ethernet network has been specified and reviewed. This system includes long-haul, high-speed fiber connections, network switches and hubs, and copper Ethernet connections from hubs and switches to local control components.

Beam Monitoring Systems

The specification of the two-system Beam Position Monitor (BPM) processing system was completed. The purchase order for 60 4-button-multiplexed processors was received by Bergoz, Inc., and fabrication of these units has begun. The detailed specification of a parallel-button BPM processor continued. This processor will be used for first-turn, turn-by-turn, and averaged, high-resolution orbit acquisition. A hardware interconnection diagram for the 2-processor system was completed. The software needed to control and integrate data acquired by the two systems is in progress. Detailed specification of the hardware rack layout for the processing system is in progress. The design review for the integrated system was postponed to the next quarter.

Cable harnesses that connect BPM button assemblies to bulkhead panels on the accelerator support girders are being installed. The specification of jumper cables between BPM processors and patch panels in the processing areas (where long-haul BPM cables are terminated) will begin next quarter.

Specifications for the DCCT, tune monitor, scrapers and synchrotron light monitor instrumentation are in progress.

Quadrupole Modulation System

The design of the Quadrupole Modulation System was assigned to an engineer within the SLAC Power Conversion Group. System components have been ordered and fabrication has begun.

Timing System

The RF/Timing Signal Generator system is presently being fabricated by Wenzel, Inc., and is scheduled for delivery during the next quarter. A prototype version of the injection timing system using booster RF signal frequency shifting was built and successfully tested. The final version of this system is now being designed.

Protection Systems

The designs of the SPEAR 3 vacuum and magnet cooling protection systems are nearly complete. The programmable logic controllers and most interface components for these systems have been received and are presently being configured. Ion pump power supplies and ion gauge controllers have been specified and their rack locations identified. Detailed rack profiles for machine protection components will be completed and reviewed in the next quarter. Specification of long-haul cables will be completed in the next quarter.

The detailed design of the Orbit Interlock system continues. The plan for using a single BPM data acquisition and processing system for both the Orbit Interlock and the orbit monitoring system was reviewed and approved by an external review committee.

1.6 Cable Plant

Design of the inner-ring cable tray system (Phase 2) was initiated. The Tray Supports-Fabrication Specification (the hardware) and Cable Tray Installation Contracts (the Davis-Bacon Labor) were bid and awarded. Bids were completed after clearances obtained from relevant ES&H and Safety oversight committees.

SLAC Cable plant Design Group provided detailed wiring diagrams of each type Magnet Raft for use by SPEAR personnel to facilitate pre-wiring the individual raft "pigtails" prior to entering storage. This documentation also forms the basis of contract package documentation for the soon to follow Bulk Long-Haul Cable Installation which will immediately follow the installation of trays.

Much work in the Power Supply/ DC Power Cable Systems has been completed. This work includes: the DC Power Cable Single-Line diagrams, power supply building (118) and West-BPM Rack layouts along with their respective rack profiles detailing the individual rack contents.

In lieu of complete submission of all CAPTAR system cable input data SPEAR system engineering requested and received agreement from the Cableplant Group to specify type and total length of a sub-set of total cable required based on engineering estimates prior to CAPTAR submission while "cable coding" proceeded. The Cableplant Group will insure that all cables installed meet appropriate codes. Obtaining cable in large quantities can prove daunting when procurement and supplier/vendor batch-run schedules may apply. Early procurement is necessary to meet scheduling. The qualifiers were that SPEAR System Engineers with Cableplant Group assistance would:

- Estimate cable put-ups (amount of cable length on a reel) with optimization as a focal point.
- Provide total length required and put-up sizes.
- Procure materials.

SPEAR engineering staff assigned to producing cable coding, which details the installation, have been supported in their coding efforts by the Cable plant Group. Continued effort will be applied to this task until completion. Also cost estimates have been updated from that which was originally estimated to that which is more clearly defined at this time. These updates to the costing were supplied to SPEAR3 Management.

1.7 Beam Line Front Ends

In this quarter, the detailed design of all major components required for the bend magnet beam line front ends were released and fabrication initiated. The detailed design of the high power moveable masks for the ID beam line 5, 7, and 10 front ends was 90% completed and procurement of some components (e.g., ion pumps, controllers, valves, etc) initiated. The detailed design of the BL7 fixed mask was 90% completed and the conceptual design of the BL10 fixed mask was initiated.

1.8 Facilities

The construction package including design drawing and technical specifications for a monolith reinforced concrete roof over the East Pit, extension of an existing concrete wall in East Pit toward the Trestle, cast-in-place removable concrete roof blocks, new AC power distribution, and lighting and fire alarm systems for the entire SPEAR ring was completed at the end of March. The first subcontractors site walk is scheduled to be on 4/29/02 and the second site walk is scheduled to be 5/13/02. The bid opening will be on 5/28/02. The construction work will commence on 7/15/02 and is scheduled for completion by the end of September.

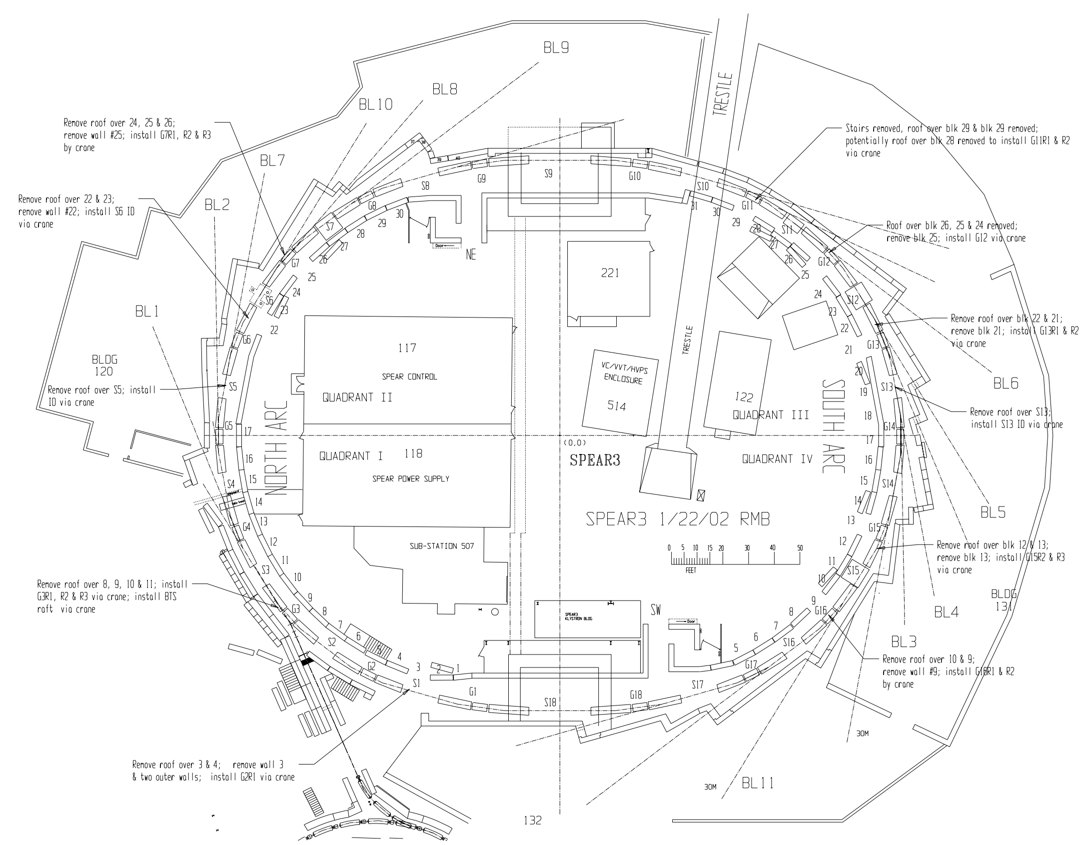
The klystron building construction package to construct a metal enclosure in B132 was also completed in March. The subcontractors' site walk is scheduled to be on 4/15/02 and the bid opening is on 4/24/02. The work will commence on 4/29/02 and the completion date is 5/29/02.

1.9 Installation

Further work has been done on the installation plan for SPEAR3 over the past quarter. A decision was made to move the entire installation plan from Microsoft Project to Primavera software, which is the software used for the SPEAR3 project planning and reporting. This decision was made based upon our needs to iterate the time calendars for tasks and resources to ensure the shortest overall duration of the downtime is achieved. This will require investigation of multiple shift work, 6 day or 7 day workweeks, 10-hour days, or a combination of all of these as well as track the costs of such planning.

An in-house design review is planned for early June to review the installation details. Knowledgeable staff from SLAC and other local laboratories will take part in addressing the adequacy of the schedule.

Other planning work will include site visits from vendors to evaluate the rigging and excavation portions of the schedule. Input from these experts in their fields will help validate the schedule planned for these activities. Drawings are being prepared to identify shielding blocks, access points, and hardware that will be removed to assist contractors in evaluating this overall effort to remove the ~350 tons of SPEAR2 hardware.



Updated SPEAR3 ring and access locations drawing

2.1 Accelerator Physics

Dipole Magnet Supply Current and Radial Alignment

Specification of the power supply current for the dipole magnet string is important to achieve the correct energy match with the injection system and to provide correct electron beam energy for the users. SPEAR 3 contains both 145 cm and 109 cm long dipole magnets with a gradient component on the same power supply. In order to find the correct supply current and radial alignment for each length of magnet, field measurements including fringe effects were simulated in electron beam trajectory-integration codes. The procedure is as follows:

1. Dipole string current
    a. Determine distance from virtual quad centerline to 50 mm line
    b. Determine distance from 50 mm line to vertex (from engineering drawings)
    c. Determine beam entrance position at edge of fringe (follow line from vertex)
    d. Compute 'k' for symmetric trajectory in 145 dipole including fringe field
2. 109 magnet radial alignment
    a. Determine 'k'-value from step 1
    b. Determine entrance x-value for symmetry in 109 dipole including fringe field
    c. Determine distance from entrance to vertex (straight line)
    d. Determine distance from vertex to 50 mm line

Based on simulations in both EXCEL and MATLAB, the dipole string current, radial alignment positions and sensitivities to current and alignment were determined and documented for installation and turn-on.

Diagnostic Systems

A series of meetings were held to pair up lead accelerator physicists with lead engineers on each diagnostic system (DCCT, tune driver, tune receiver, scraper, PPS stoppers, SLM) and to determine cross-sectional dimensions for each diagnostic and the empty straight sections. Each diagnostic system was evaluated to ensure system integrity. At this point all components have moved through the conceptual design phase and are entering detailed engineering design.

Synchrotron Light Monitor

A review was held for the M0 mirror in the synchrotron light monitor diagnostic beamline. Since the last review a double-bounce system M1/M2 was added in the diagnostics room for radiation safety. M1/M2 will reside in a locked Pb-coated box. M3/M4 (Cassegrain system) have been slightly re-designed to accommodate for the change in path length. A raw-Si mirror is a less efficient transmitter of s-polarization and can become oxidized. The M0 mirror remains a 9-degree incidence mirror with Rhodium coating to efficiently reflect both polarizations in the 6 eV range (200 nm). A 50 Angstrom $Si0_2$ binding layer will be used below the 500-600 Angstrom Rh layer. Power interception by the cold finger, power incident on the M0 mirror, image transmission and thermal studies were reviewed at previous meetings. The main topic of this review was M0 surface quality. The balance of the SLM system has moved past conceptual design and is ready for detailed drawing and construction phase.

Application Programs

Tests were conducted on the SPEAR 2 storage ring during accelerator physics runs to verify performance of both the orbit feedback system and a new application program designed to generate closed orbit 'bumps'. Both systems performed to specification. The 'bump' program was developed to be general in application so that other magnet types can be included. A test of software sliders designed to orthogonally control the horizontal and vertical tune was tested with beam.

A project was initiated to develop 'middleware' for SPEAR 3 software application programs written in MATLAB. The middleware program modules will allow machine physicists and software developers to quickly access on-line data, process the data and set the on-line magnets to new desired values. The middleware is being developed in conjunction with the ALS at Berkeley, primarily by a consultant who previously worked in the accelerator physics and controls group at the ALS. Completion date for the middleware project is expected to be approximately June 1, 2002.

Orbit Interlock Verification System

Work progressed on the orbit Interlock Verification System (IVS) software. With this software, interlocks for each beamline can be tested independently or a script can be made to test beamlines sequentially. The software directs pre-described orbit 'bumps' to probe positions in x-x' or y-y' phase space for interlock integrity. Comprehensive log files describing goals and performance of the IVS are maintained for each trial. Testing with the new 'middleware' communication system will commence in Q3, FY2003.

Radiation Safety

The study of "Injection Beam Loss Angles in SPEAR 3" was finalized for basic beam-loss scenarios and extended to the case where a dipole magnet accidentally develops an electrical short. Six shorted dipole magnet types in SPEAR 3 were studied (two standard cell, 4 matching cell). For several cases, the injected beam travels in the direction straight down the photon beam line – a case already studied and presented to the radiation physics panel. In the remaining cases, the injected beam strikes readily identifiable photon beam absorbers making radiation shower studies and design of shielding for radiation control straightforward. The decision to use current monitors in the BTS (Booster to SPEAR) transport line to limit current to 1.6 nA (total beam power of 5 W at 3 GeV) was presented to management. The maximum injection rate at 5 W is 125 mA/minute.

SPEAR 3 Accelerator Physics Start-Up Schedule

The accelerator physics group continued to plan and identify major start-up and commissioning tasks. The SPEAR 3 commissioning schedule begins with beam-to-SPEAR and extends through initial photon beam delivery to users. During the second quarter of FY2002, much of the effort in the area of accelerator physics software development was directed toward developing modules for fast commissioning and data analysis.