Quarterly Progress Report

Stanford Synchrotron Radiation Laboratory

July through September
2002

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A. SPEAR 3 PROJECT SUMMARY

1. Technical Progress

FY2002 was the third full year of design and fabrication for SPEAR3. The project was reviewed by the DOE in February and July of this year. The executive summary of the July review noted that "The Review Committee found that adequate progress was being made to meet baseline objectives. The SPEAR 3 installation plan can succeed, but is tight in both schedule and cost, and needs to be optimized. The pre-operations/commissioning plan is well defined for this stage of the project. Also, the ES&H aspects of the project are being adequately addressed. The total project cost estimate of $58 million and project completion milestone date of February 2004 appeared reasonable but without much margin for error."

Regarding the installation plan, progress has continued toward the goal of further optimization in order to help insure achievement of the scheduled completion date, insure necessary manpower resources are planned, and optimize the SPEAR 2 removal process as well as SPEAR 3 installation. Contractors have been consulted regarding the scope of rigging and transporting techniques for components. Engineering consultants are being utilized to evaluate methods and procedures that could be used to establish the new tunnel floor. WBS-2 System heads are involved in the planning process to insure that all components are included and properly sequenced in the installation process.

At the end of this FY2002, the project is 75% complete in terms of accomplishments and overall progress. The status of each major technical system is summarized below.

Magnet System – A significant milestone was achieved late April with the final shipment of 20 corrector magnets from the Institute of High Energy Physics (IHEP) in Beijing. This marked the end of a very successful collaboration between SSRL and IHEP. A total of 294 Dipoles, Quadrupoles, Sextupoles, and Correctors were fabricated on schedule. All units met or exceeded the SPEAR 3 magnetic field requirements. Four IHEP staff members arrived at SSRL in April and participated in the installation and alignment of the magnets on their support rafts. While all 46 support rafts for the 14 standard cells of the lattice are on-hand, the order for the remaining 8 rafts for the straight section matching cells was placed in June with expected delivery in October.

Vacuum System – There are 54 major vacuum chambers that must be integrated and aligned with the appropriate magnet rafts. At the end of this FY, 32 units (59%) have been fabricated and a major fraction of these inserted within the magnet rafts. For the remaining units, the welding of main "boxes" for the 14 BM2 units is ~50% complete and the parts for the 8 transition section units are in production. The goal is for completion of all 54 rafts before April 1, 2003.

Other vacuum system components that are in final design procurement or fabrication include matching girder chambers, drift (straight section) chambers, RF chambers, bellows, DCCT, beam stoppers, injection and septum chambers, and isolation valves.

Magnet Power Supplies – All 200 power supply units, except for the bulk dipole unit, are released for fabrication and in various stages of assembly. All will be on site and bench tested by December 2002. Plans are underway for the removal of all existing SPEAR 2 supplies, renovation of the existing power supply building with new reinforced concrete floor, and new AC distribution system. These activities together with installation of the new power supplies will take place during the major installation period scheduled for April-September of 2003.

RF System – Many system components (including waveguide, klystron power supply, low level RF controls and monitoring) together with RF Cavity accessories (coupling box, high order mode loads, tuners, etc) are complete. Cavity fabrication has been delayed by difficulties at the manufacturer. Fabrication methods similar to those used for the original PEP-II units are now underway with deliveries estimated between January and March 2003. The SPEAR 3 purchased Klystron which failed in tests will be repaired or replaced by March 2003.

Instrumentation and Controls – The computer control system hardware and software plan was approved in a final design review. The prototype VME interface to the digital control daughter cards for the corrector power supplies was completed and detailed development of related software has begun. Commercial BPM processing units were received and the design and fabrication of ancillary components is in progress. Detailed specifications of the DCCT, injection monitors, tune monitor and synchrotron light monitor continues. The injector RF signal generator and timing controller is under construction. Detailed design of the Orbit Interlock, Beam Current Interlock, and other protection systems are in progress. Work on I&C interconnection diagrams and equipment rack profiles continues.

Cable Plant – The goal for the cabling systems (power, control, and monitoring) is to complete as much as possible external to the shielding before the major shutdown in FY2003. The cable external tray system is now complete. The tray systems for the East and West straight section areas and for the power supply building are complete. The design for the internal shielding tray system is 80% complete. The Electrical Safety, Seismic Safety, and ES&H committees have approved the planned installations. All cable has been ordered for the external installation which is taking place between August 2002 and March 2003.

Conventional Facilities – As in the case of the cable plant above, the goal is to accomplish most tasks prior to the major system installation. Note that East & West straight sections with associated pits, shielding walls, and entry mazes were accomplished in the normal FY2000 shutdown. West straight section transition area walls and all new west area roof blocks were accomplished in FY2001. This year the Klystron building enclosure was completed in June. The contract for completing the East transition area walls and roof blocks started July 12. This contract completed all planned shielding modifications and includes a new AC distribution system for tunnel power and tunnel lights as well as the required smoke detector system. This final phase was completed October 2, 2002.

Commissioning – James Safranek has been appointed to lead the commissioning effort which follows the final installation activities. The Lehman Review found the preliminary commissioning plans adequate for this stage of the project. Further optimization of the plans and detailed procedures are being developed. Accelerator Physics issues that are important to the commissioning effort are being addressed.

Accelerator Physics – During the fourth quarter of FY2002, the SPEAR3 accelerator physics group concentrated on software application development and finalizing diagnostic specifications. The resource-loaded schedule was updated for the accelerator physics effort to end-of-project.

2. Cost Reporting

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

Table A1
Costs and Obligations
(through September 2002)

	K$	
	Direct	Direct & Indirects
Costs	31,968	36,138
Commitments	2,518	2,669
Total	34,486	38,807

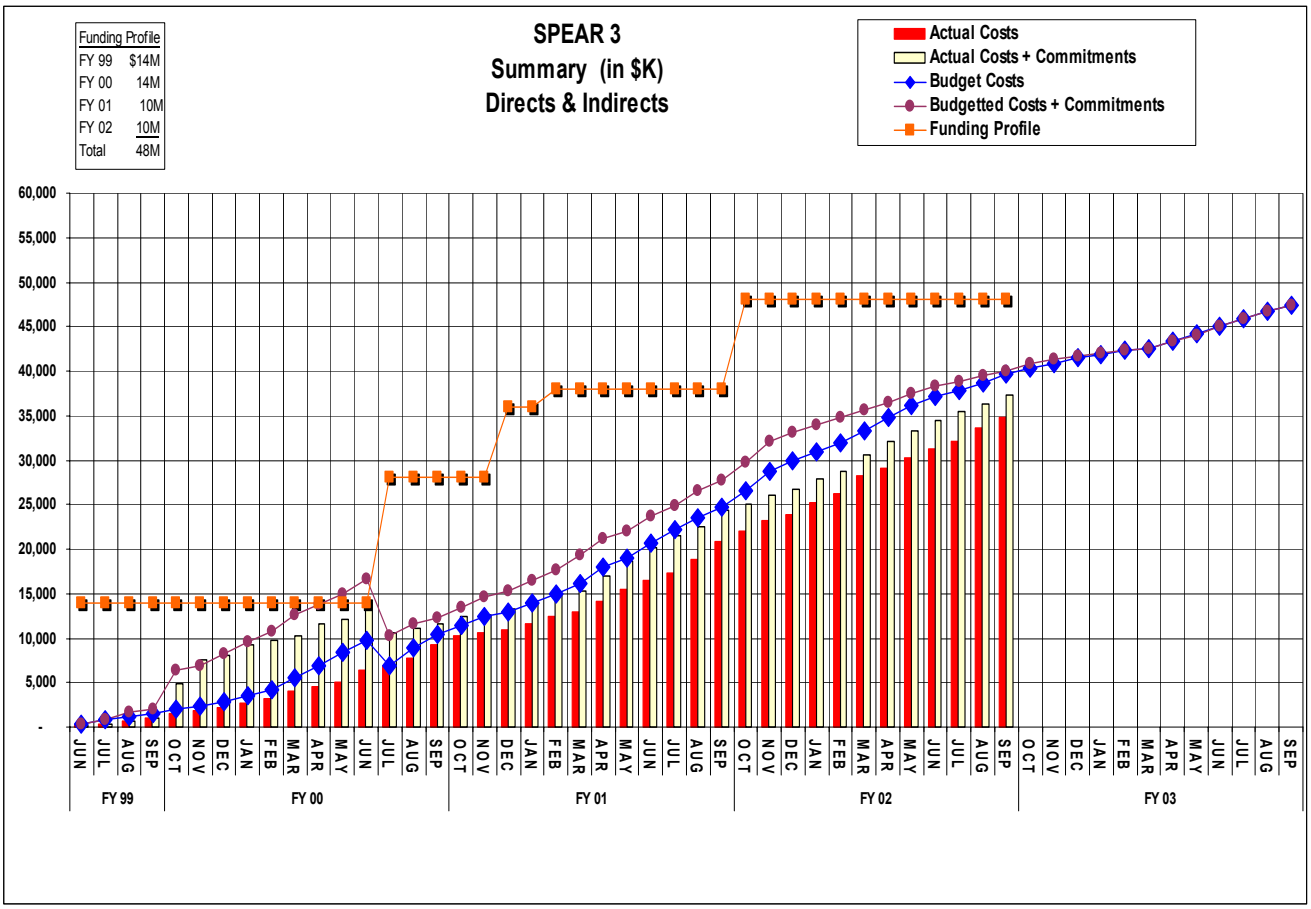


Figure A1

Table A2 provides the project performance data with associated cost and schedule variances at WBS Level 2. The monthly variance record for FY2002 is indicated in Fig. A2. The negative schedule variance is primarily in the vacuum system (See Table A3) and efforts are underway to maintain the required schedule.

Contingency funds were utilized this quarter in the following areas:

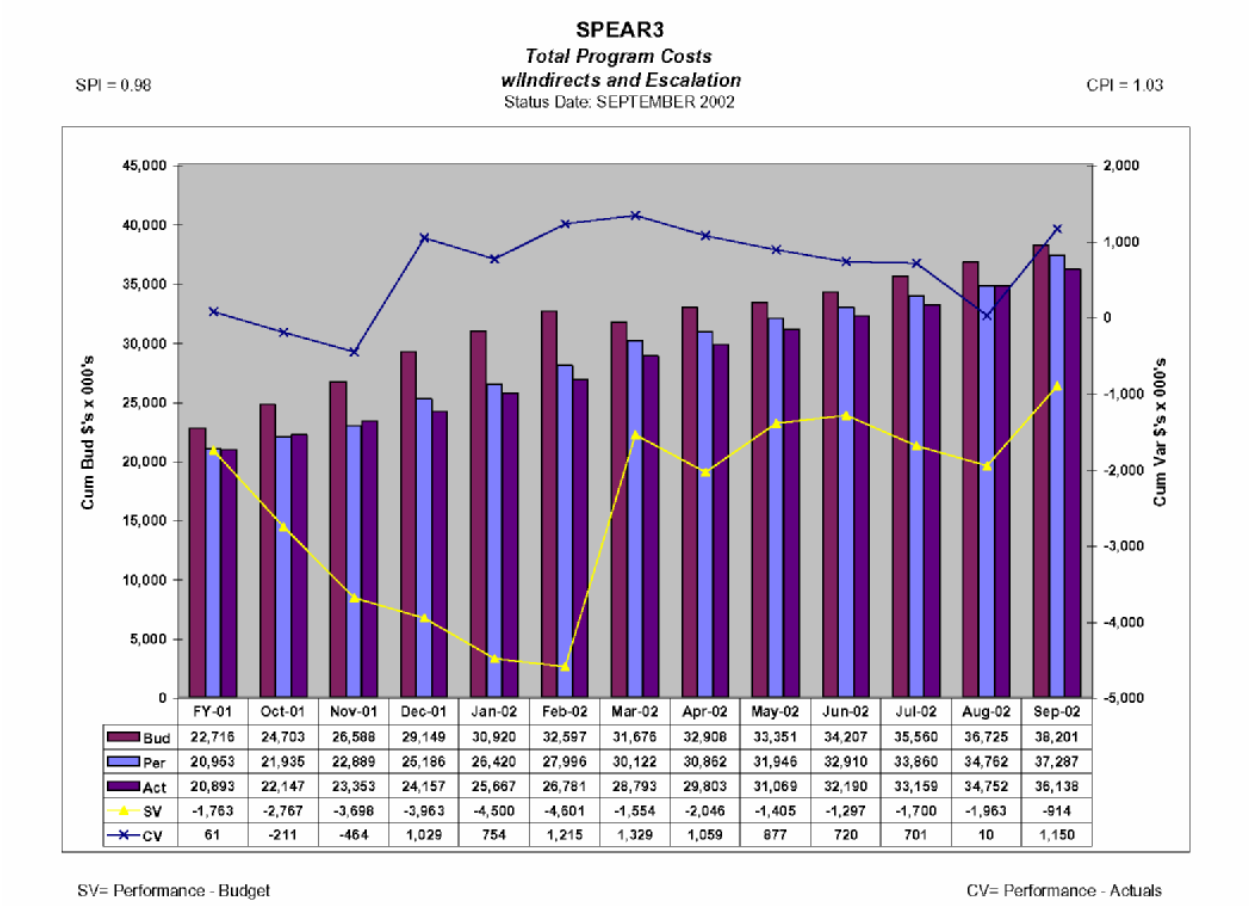
- Magnet Revisions & Supervision 276 K$
- Shielding & Utility Cost above Budget 318 K$
- Cable Plant Rebaseline 290 K$

Total 884 K$

With this utilization, the remaining unused contingency (management reserve) is 3,398 K$ as indicated in Table A2. note that the last two columns indicate current projected costs at completion with associated variances from the current budget. This projection indicates a management reserve of 1,839 K$ at completion.

Table A2

Cost/Schedule Status Report								
	Contract Type/No:		Project Name/No: SPEAR3 Project - rev. A ($58M)		Report Period: 8/31/2002 9/30/2002		Signature: Title/Date: 10/28/2002	
(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	8,274	8,206	8,008	-68	199	9,149	9,181	-32
1.2 Vacuum System	8,839	8,249	7,843	-590	406	13,279	12,353	926
1.3 Power Supply System	2,515	2,427	1,731	-88	696	3,514	3,182	331
1.4 RF System	3,786	3,727	3,776	-59	-49	4,624	4,692	-68
1.5 Instruments Control & Protection Systems	2,099	1,959	1,944	-140	15	3,633	3,917	-284
1.6 Cable Plant	1,553	1,535	1,488	-17	48	2,597	2,483	113
1.7 Beamline Front Ends	592	628	564	35	64	1,056	1,003	53
1.8 Facilities	3,168	3,182	3,076	14	105	3,509	3,897	-387
1.9 Installation and Alignment	0	0	136	0	-136	3,224	5,165	-1,941
1.0 Mgmt, Support, & Accelerator Physics	2,956	2,956	3,306	0	-350	4,037	4,034	3
Gen. and Admin.	4,418	4,418	4,267	0	151	5,974	6,248	-274
Undist. Budget						0	0	0
Sub Total	38,201	37,287	36,138	-914	1,150	54,597	56,156	-1,559
Management Resrv.						3,398	1,839	1,559
Total	38,201	37,287	36,138	-914	1,150	57,995	57,995	0



	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	33,351	34,207	35,560	36,725	38,201
Per	20,953	21,935	22,889	25,186	26,420	27,996	30,122	30,862	31,946	32,910	33,860	34,762	37,287
Act	20,893	22,147	23,353	24,157	25,667	26,781	28,793	29,803	31,069	32,190	33,159	34,752	36,138
SV	-1,763	-2,767	-3,698	-3,963	-4,500	-4,601	-1,554	-2,046	-1,405	-1,297	-1,700	-1,963	-914
CV	61	-211	-464	1,029	754	1,215	1,329	1,059	877	720	701	10	1,150

Figure A2

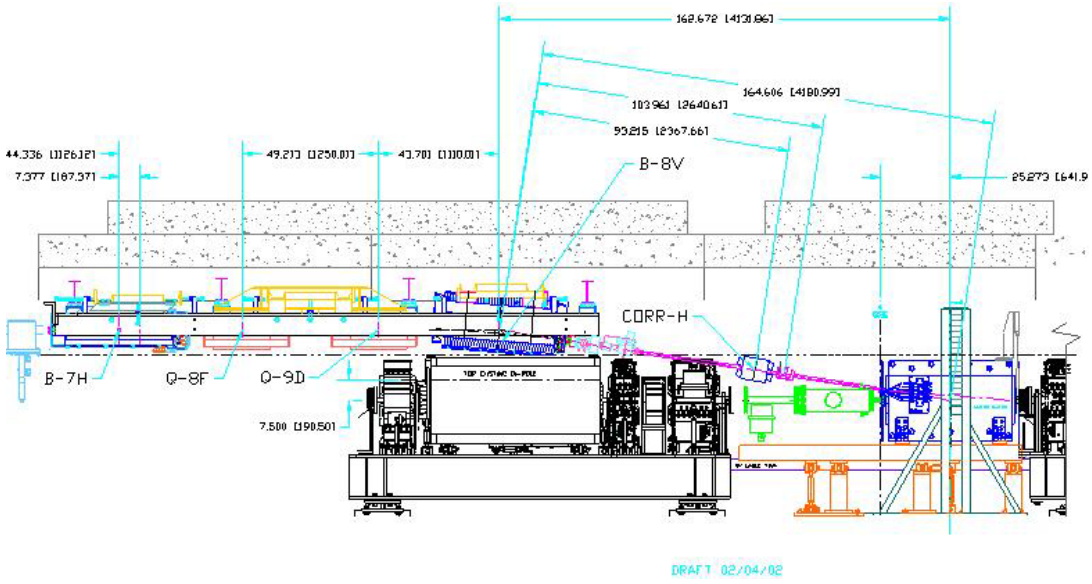
B. Detailed Reports

1.1 Magnets and Supports

Beam Transport System (BTS) Magnets

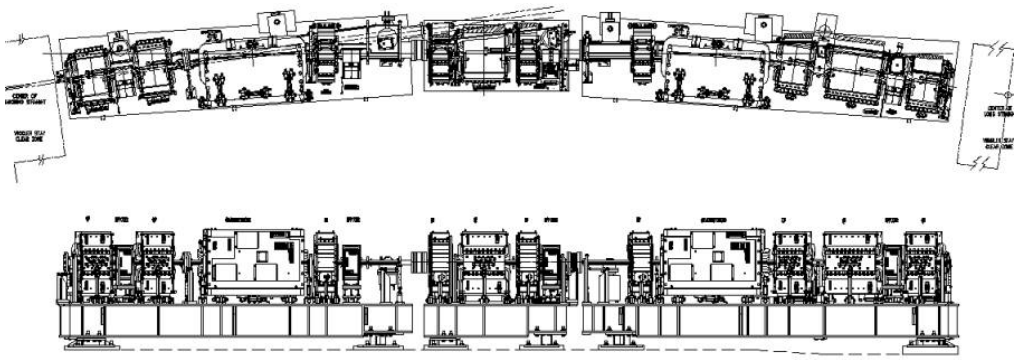
The BTS magnets include two bending, two quadrupole, and one septum magnet. The quadrupole magnets have been refurbished and will be ready for installation next quarter. The bending magnets are in fabrication with the goal of assembling the magnets on raft supports by early 2003.

The septum magnet is in design completion and will have a final design review and begin fabrication next quarter. While the final design review has not been held, two other design reviews have been held and long lead time material has been ordered with some material already delivered.



Supports System & Assembly

Fabrication of the 8 Matching cell support rafts is in progress with delivery expected by early November. The design of the matching cell rafts has progressed fully with completion of the overall girder drawings for matching cells A & B.



LCW Systems

We have ordered and received the LCW headers for the standard cell girders. These headers are ~30 feet long and will be pre-assembled onto their supports and have valves installed. Upon completion of pre-assembly these 16 units will be placed in storage until installation in the ring.

Detailed layouts are being worked on for the low pressure LCW distribution system for the klystron and RF Cavities. It is anticipated that these will be partially fabricated and held for final installation. The HCW (high conductivity water) system for the RF loads is being fabricated and will be installed next quarter as this system is outside of the ring tunnel.

Raft Assembly

Production assembly of the rafts is proceeding with 16 of the 18 type 50Q rafts finished last quarter and 5 of the 14 type 145D Rafts in progress this quarter. All standard cell magnets and rafts are ready for vacuum chamber delivery. The schedule of completion of all 54 rafts before April 2003 is tight and ways to improve the vacuum chamber delivery and raft assembly are being investigated. At this time it will be necessary to receive 6 chambers and complete 6 rafts per month to meet the April completion schedule.

1.2 Vacuum System

The engineering efforts and manufacturing milestones during the past quarter include the following,

- Completing the assembly, welding and vacuum processing of the standard BM1 chambers.
- Started the box and rib welding for the BM-2 chamber.
- Fabrication of the septum chamber components.
- Finalized the design and analysis of the bellows modules.
- Procuring parts for the injection chambers.
- Completed drawings for the matching girder chambers components.
- Finalizing the physics requirements for the beam dump chamber and completed the conceptual design.
- Completing drawings for the PPS stopper chamber components.
- Completed the detail drawings of the straight section rafts.
- Completed the final design of the DCCT chamber.
- Completing the piece part and assembly drawings for the standard bellows and RF Bellows.
- Completing the piece part and assembly drawings for the RF chambers.
- Completed the design of the isolation valve.

Standard Girder Chambers

BM-1 & BM-2 Standard Chambers

The BM-1 chamber EB welding and assembly continued this quarter. Fourteen chambers were completed, but a leak in one beam position monitor required the project to complete another chamber. The last chamber will be completed by the end of October.

Both bake out stations were modified to allow for two chambers per oven instead of one to reduce schedule delay. Eleven chambers have been baked and are being installed onto the rafts. The bake-out ovens are no longer the critical resource for the fabrication of the standard girder chambers.

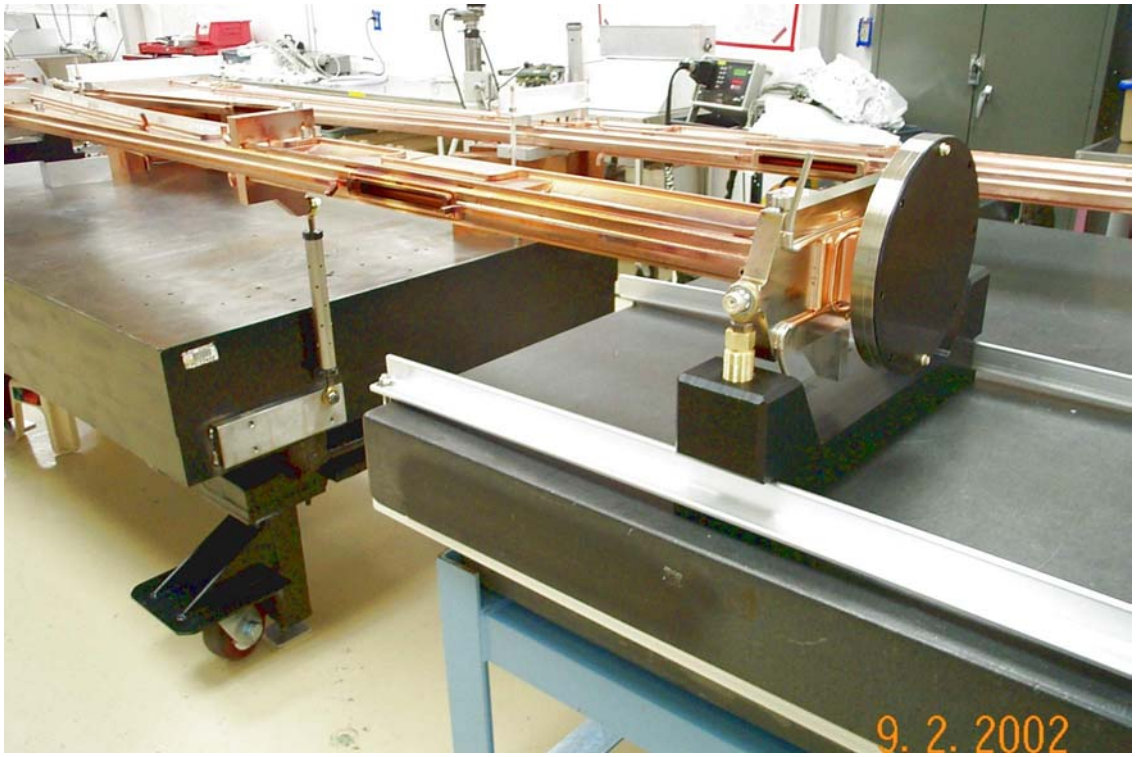
The BM-2 chamber welding continued, but the efficiency of assembly was lower than the assembly of BM-1 main chamber. This was due to delays in the receipt of sub-assemblies from the SLAC Mechanical Fabrication Department (MFD) and inspection and fiducialization of chambers due to SLAC alignment resource limitations. Delivery of brazements and cleaned piece parts did not keep up with the fabrication needs of the BM-2 chambers; therefore production workflow was hindered. The EB welding and final assembly of the BM-2 chambers should be complete by the middle of November. This is approximately 1.5 months behind our baseline schedule. The SPEAR3 project is working with the management staff of MFD to increase their delivery capability of brazed and cleaned parts. We are also investigating other outside resources.

V4 to Exit Port of BM-1 Chamber

BM-1 Chamber Installation

BM-1 Chamber Installation

BM-2 Box Weldment Set-up and Eddy Current Break Weld Set-up



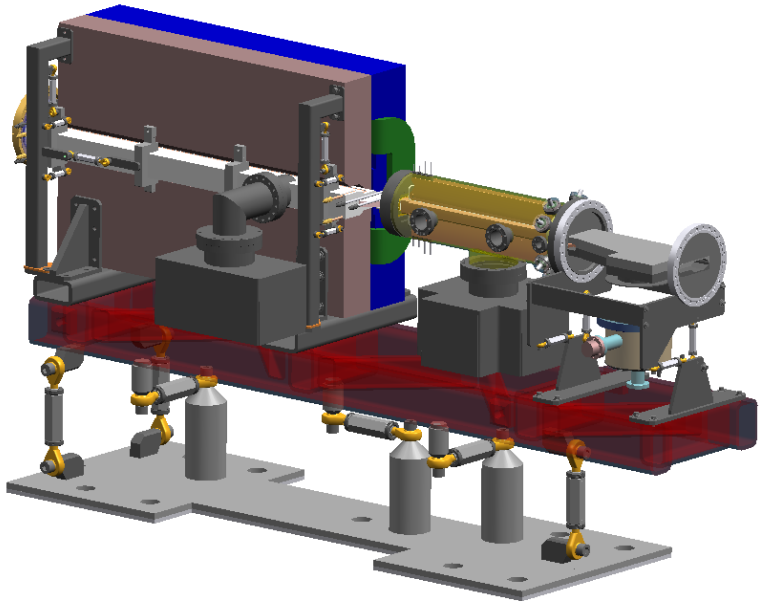
Fiducialization of BM-2 Chamber

Matching BM-1 and BM-2 Chambers

The purchase order for the matching chambers and the majority of piece parts for the matching chambers were placed this quarter. The majority of short plates were received this quarter and machining on the long plates has started. The vendor has indicated that he is having difficulty meeting his production schedule. The SLAC purchasing staff is currently discussing with the vendor how they can make up their schedule delays. Due to the delay of the long plates, the tooling, assembly and EB welding and programming will start in late October on the short plates ahead of their planned schedule in order to reduce the impact due to the delay of the long plates.

Injection System

The majority of septum chamber piece parts for the main chamber has been received and sub-assemblies are underway. The septum magnet/chamber raft design was completed and approved by the earthquake safety committee. The detail drawings for the raft was also completed and procurement will start next quarter. The injection kicker piece part purchase orders are being placed.



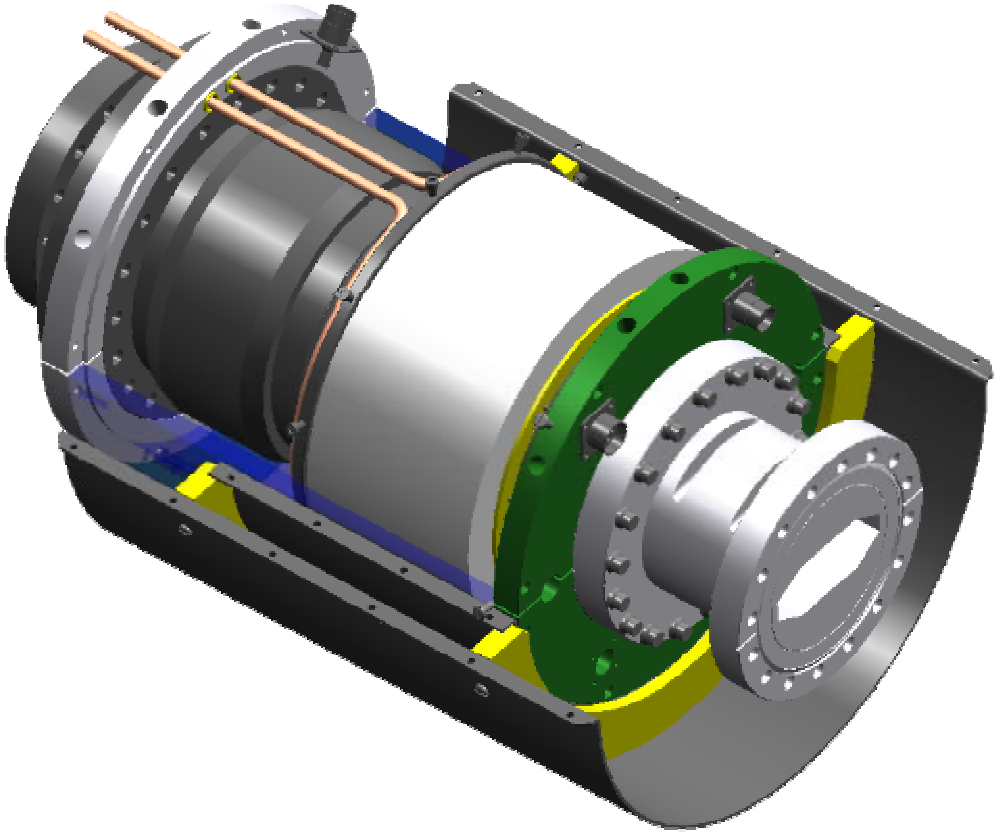
Septum/injection Kicker Raft

SeptumTransition Piece Parts

Diagnostics

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

- The final design was completed for the DCCT chamber. A final design review is scheduled for October and detail drawings will be completed by November.
- PPS beam stopper detail drawings were completed and procurement will start next quarter.
- A final decision on using the existing design of the beam position monitors for the tune monitors was made.
- The layout for the diagnostic straight chambers including future devices was completed.



DCCT

1.3 Magnet Power Supplies

Unipolar Power Supplies

Dipole Power Supply

Alpha Scientific is fabricating the 1500V, 800A Dipole Bulk Power Supply. SLAC power conversion personnel have made several trips to Alpha Scientific to discuss the bulk power supply requirements and to expedite design progress. Bulk power supply cabinet structural drawings were received. These were forwarded to the seismic analysis group for certification evaluation. Alpha Scientific is working on the schematic diagrams, calculations and other design drawing package items. SLAC is pressing for a mid-October submittal; however, the components that were specified by SLAC for use in the power supply have been ordered. They have started fabrication of the low-risk parts of the power supply. The goal is to have the power supply on-site by the end of the calendar year.

Power Conversion Department personnel completed assembly of six buck regulator chopper modules. The first three chopper modules exhibited IGBT failures at 300A output during initial bench testing. It was observed that there was an IGBT turnoff voltage spike that would grow with increasing output current. At 300A the spike was 1200V. This is at the reverse voltage breakdown rating of the IGBT. Close scrutiny of the chopper module heat-sink assembly revealed that the external snubber diodes across the IGBT were an incorrect part. The snubber

diodes were replaced with the correct parts. All six choppers satisfactorily tested to their 400A output current rating. The chopper modules will now be installed in the Dipole Power Supply Rack along with previously assembled chopper module controllers, and other system components.

Large Power Supplies

IE Power delivered the 6 large (130kW) power supplies that will power the QD, QF, QFC, QFC, SD and SF magnet strings. Two of the 6 power supplies have been tested on-site. Initial long-term (24-hour) stability testing of both power supplies showed occasional, larger than desired, deviations in output current. The problem was traced to a faulty amplifier type in the voltage feedback loop. A better amplifier was found and substituted. Subsequent stability tests on the first two power supplies were completed successfully. The other four power supplies will be tested during October and November.

Intermediate Power Supplies

IE Power has fabricated and assembled 2.5kW and 15 kW prototypes. These two power supplies are currently in test. After successful prototype test completion, the remaining power supplies will be assembled and tested. This will occur during the next reporting period. IE Power did have some heating problems with the three 30V, 500A power supplies that are intended to be series-connected in each of the B7H and B8V systems. It was agreed that instead they will design and build 4, 45V, 500A, 22.55kW units. These would now be series-connected as pairs in each of the B7H and B8V systems.

Bipolar Power Supplies

All 150 bipolar power supplies have been bench tested. They are being assembled and wired into the SPEAR 3 racks. Metal oxide varistors (MOV) were purchased for installation at the output terminals of the quadrupole modulation system (QMS) switching chassis. Fabrication of the QMS chassis is scheduled for completion the end of November. The chassis will then be mounted into the QMS power supply rack.

Pulsed Power Supplies

Kicker Pulsers

The K1, K2 and K3 pulsers are about 90% assembled. All three systems will undergo extensive interlock, control and power testing during the next reporting period. The Power Conversion Department is attempting to obtain the refurbished prototype kicker magnet for final pulser testing. Cable will be used for testing if the magnet is unavailable. Testing will also include remote operation from the SPEAR computer.

Three thousand feet of the kicker power cable needed for the installation contract was shipped on September 26th from Times Microwave, located on the east coast. The cable will arrive by the first week in October. This delivery will support the installation contract.

Racks and Accessories

Racks

Work continues on the power supply racks, specifically wiring and the mounting of equipment ancillary to the power supplies. The intent is to have the racks wired and fully assembled by the end of the calendar year.

B118 Refurbishment

AC Power Distribution

Specifications were written for purchase of the following equipment:

- Two 4000A switchboards
- Five 480V motor control centers
- 480V:208V/120V distribution transformers
- 480V:208V/120V distribution and lighting panel-boards

A switchboard purchase order was placed. Bids were received and evaluated for the other equipment listed above. Purchase orders for this equipment will be issued during the next reporting period.

The design of the lights in Building 118 is being finalized. The goal is to tie up all loose ends and to purchase the light fixtures.

It is envisaged that a fixed-price contract will be issued for the installation of the AC distribution equipment and services in B118 as well as for the installation of the magnet power supplies and I & C racks. An installation specification to detail this work is in preparation.

Refurbishment Planning

Planning for the refurbishment of B118 has started and includes the work needed to remove and replace the floor, overhead lighting and cable/raceway systems.

1.4 RF System

Cavities

The RF Cavities being fabricated at ACCEL INSTR. in Germany have experienced delays due to electro-forming problems. The previously formed copper had to be removed. A new, different platiing process has been approved after evaluation of a qualification sample. The electro-forming has started again and is expected to take 45 days on the first batch of two cavities. A second chemical bath is being set-up to plate the other two cavities in parallel.

A new schedule calls for delivery of the 4 units between January and March 2003 with this project having been raised to highest priority at the vendor. The schedule leaves sufficient time to assemble and test the cavities before installation in Aug. 2003.

Waveguide

The SPEAR3 circulator has been installed in the new klystron building B132 and installation of the waveguide has progressed to the wall of the Spear tunnel ahead of schedule (see picture below).

Low-level RF

The Low-level RF System design modifications are completed at the Electronics & Software Engineering Department at SLAC. Prototype boards have been fabricated and are presently being tested. Completion is expected by the end of year 2002.

Work on software changes for SPEAR3 is ongoing at this time.

1.5 Instrumentation and Control Systems

Computer Control System

A final design review of the computer control system was held August 12 at which the network topology, hardware component choices, and software tasks and implementation schedule were presented. The review committee determined that the control system plan was complete and will achieve performance goals, although they stressed that we consider having "hot" backup computers and to reduce our planned reliance on centralized SLAC computing services. They also felt that more software development manpower is needed to complete the job on time; SSRL has consequently opened a position for a new programmer. Meanwhile, a detailed, resource-loaded schedule for remaining software tasks has been created and software and control system infrastructure development is ongoing.

The first VME interface motherboard for the 8-Channel Power Supply Controller has been built and is now being tested and debugged. Basic slow control of the 8 power supplies within an MCOR crate has been established using this board. Development of software for fast (4 kHz) control and production of 175 controller daughter boards will proceed in the next quarter.

The test of the triggerable 8-channel, 16-bit ADC IP module selected for precision BPM signal digitization has been delayed to the beginning of the next quarter when an external timing signal generator will be available.

Detailed interconnection diagrams for the computer control system are in production.

Beam Monitoring Systems

60 4-button-multiplexed BPM processing modules and related crates were received from Bergoz, Inc. (See figure below). The detailed specification and testing of components for a parallel-button BPM processor continued. An order for a commercial company to build 24 or more of these processors will be issued in the next quarter. The design of interconnection components needed between the BPM processing system and the VME data acquisition is nearly complete. The specification of BPM long-haul and jumper cables will be completed in the next quarter. Equipment racks for the BPM system have been ordered.

Tune monitor, synchrotron light monitor instrumentation, and injection monitor control designs as well as detailed interconnection diagrams for all beam monitoring systems are in progress.

BPM processing system and packing crates received from Bergoz, Inc.

Quadrupole Modulation System

The Quadrupole Modulation System switchyard will be controlled by CAMAC digital interface components. Design of QMS was assigned to an engineer within the SLAC Power Conversion Group and fabrication is complete.

Timing System

Delivery of the RF/Timing Signal Generator system from Wenzel was expected this quarter, but was delayed for a design revision where temperature control will be added for some critical components. Delivery of the system is expected by the end of October 2002.

Fabrication of the Booster RF Signal Generator and phase shifting unit is nearly complete. The design of the Injection Timing Controller, which communicates with the Booster RF Signal Generator, has begun; delivery of this unit is expected February 2003.

Protection Systems

The programmable logic controllers and most interface components for the vacuum and magnet water protection interlock systems have been received and are presently being configured. Procurement of ion pump power supplies has commenced; ion gauge controllers will be purchased in the next quarter. Detailed interconnection diagrams for machine protection components are in production.

The detailed design of the Orbit Interlock system continues. A prototype circuit for detecting beam mis-steering conditions was fabricated and successfully tested.

Toroid assemblies and processing modules needed for the Average Current Monitor (ACM) system were fabricated and will be tested during the next SPEAR operation period. The design has begun of a Beam Current Interlock that prevents beam lines not rated for high current operation from being opened above specified beam current levels.

The revised Personnel Protection System to be used for SPEAR 3 will be reviewed by the SLAC Radiation Safety Committee in the next quarter.

1.6 Cable Plant

Cable Installation Bid Package, Phase 1 start date began as scheduled on August 13th. This contract installs the majority of the long haul cables and the remaining cable tray that awaited completion of shield wall modifications. The contract ($290.3K) is on schedule and approximately 35% complete at the end of this quarter.

Specifications and detail drawings for the B116 (East Pit) Canopy Roof Cover for the tray/cable penetration are complete. Seismic Committee written approval of the Canopy design was approved 10/4/02. The approved drawing package was sent out for fabrication and installation bids on 10/9/02.

Ordering of the cables required for Phase 1 installation was completed. This task detailed, costed and purchased thirty-six types of cables totaling approximately two hundred thousand feet. Total cost of cable purchase under WBS 1.6.3 is $235,000. Cable purchasing for the Phase 1 installation is now approximately complete at 98% of material received, labeled and stored. Cables have been released to the contractor as required.

The designer of ring interior tray systems has made considerable progress incorporating changes made to the shield wall penetrations. The “aisle side” tray design is complete with the “tray drops” near completion. Tray loading has been revised with the inclusion of the latest cable information.

Connector ordering has begun with the purchase of the various DC cable lugs that attach to the magnets.

A review and update of the Cable plant installation schedule for 2002-2003 was made and forwarded to project management.

1.7 Beam Line Front Ends

Assembly of the front end masks and injection stoppers for the dipole beam line front ends continues. The assembly of these components has not proceeded quite as fast as planned since higher priority summer shutdown tasks diverted some vacuum technician and braze shop resources. With the summer shutdown nearly complete and the resources again available, these assemblies should be completed this fall well in advance of the SPEAR3 installation shutdown.

As noted in the prior quarterly report, the Glidcop A1-25 billet used for the insertion device beam line fixed masks was discovered during machining to contain manufacturing flaws. After characterization, these flaws were considered sufficiently serious to require rejection of the billet. Replacement material was obtained and the fixed mask fabrication effort restarted. The associated schedule setback will preclude completion of the ID beam line front end assembly effort in the fall; however, barring a recurrence of another major setback, the insertion device beam line front end components will be ready for the scheduled installation in SPEAR.

1.8 Facilities

The construction work for a monolith reinforced concrete roof over East Pit, an extension of an existing concrete wall in East Pit toward the Trestle, cast-in-place removable concrete roof blocks, new AC power distribution, lighting and fire alarm for the entire SPEAR ring commenced on 7/15/02. On 9/30/02, the beneficial occupancy was accomplished. The effort was completed on 10/2/02, 2 days ahead of schedule.

1.9 Installation

Progress has continued on the installation plan for SPEAR3 over the past quarter. An internal review was held in June 2002 to review the status and logistics of the overall installation plan and schedule. Input from this meeting was used to prepare for the DOE review held in July.

To help solidify the schedule, vendors were contacted and participated in a walkthrough of SPEAR to evaluate the scope of the rigging and concrete work of the installation plan. With input from both rigging and concrete contractors the schedule was modified to reflect their input to both schedule and technique used to remove and install new equipment. Following this contractor input, SSRL made a decision to remove all but one straight section to allow removal of the SPEAR2 girders in one piece as opposed to cutting the girder in two and removing them around existing Insertion Devices in the ring. This resulted in shortening the overall schedule.

Removal of the SPEAR2 girders, and subsequent installation of SPEAR3 Rafts, from a single point in the ring at the Girder 3 location alleviates a potential impact between the ring and power supply building (B118) work. The B118 work will be done concurrently with the ring work and access to B118 can now be done via the trestle without impact of ring removal activities.

The installation of SPEAR3 components has been integrated with all activities to determine the manpower loading and the impact of small spaces within the ring confines. The sequence of component installation has been considered and is described below. Workdays are defined as 10 hours per day for all activities. Utilizing 5 days/week, this yields a 6 month overall installation schedule. Over the next quarter we will be optimizing the schedule in preparation for contract bid and awards and the upcoming start of the installation.

Installation sequence in the ring

- Excavate & install new floor in ring tunnel
- Establish new monuments around ring
- Survey and set raft & straight base plates; drill mounting holes for LCW, FE, & ID mounting
- Install LCW assemblies
- Install rafts, straights, cable trays & Front Ends
- Install BTS raft
- Install cabling & connect
- Install vacuum bellows, gauges, masks, leak check
- Final magnet & vacuum system alignment survey
- Lock ring for checkouts

SPEAR3 Raft Installation Sequence

Parallel crews

Crew 1- 7/25/03	Crew 2 – 7/25/03
G12 (BL6 FE)	G11
Roof over G12	S11 (BL6 ID)
G13 (BL5 FE)	Roof over S11
G14 (BL4 FE)	G10
S13 (BL4 ID)	S10
Roof over S13	G9
G15	S10
S14 (BL3 FE)	G8
G16 (BL11 FE)	S9 (East straight)
S15 (BL11 ID)	G7 (BL8 & 10 FE)
Roof over S15	G6 (BL7 FE)
G17	S7 (BL9 ID) (BL8 FE)
S16	S6 (BL10 ID)
G18	Roof over S6 & 7
S17	G5 (BL2 FE)
G1	S5 (BL7 ID)
S18 (RF Cavities)	Roof over S5
G2	G4 (BL1 FE)
S1 & S2	G3
Walls & roof at G2 & S1	S3 (Septum)
	BTS Raft
	Roof over G3 & S3

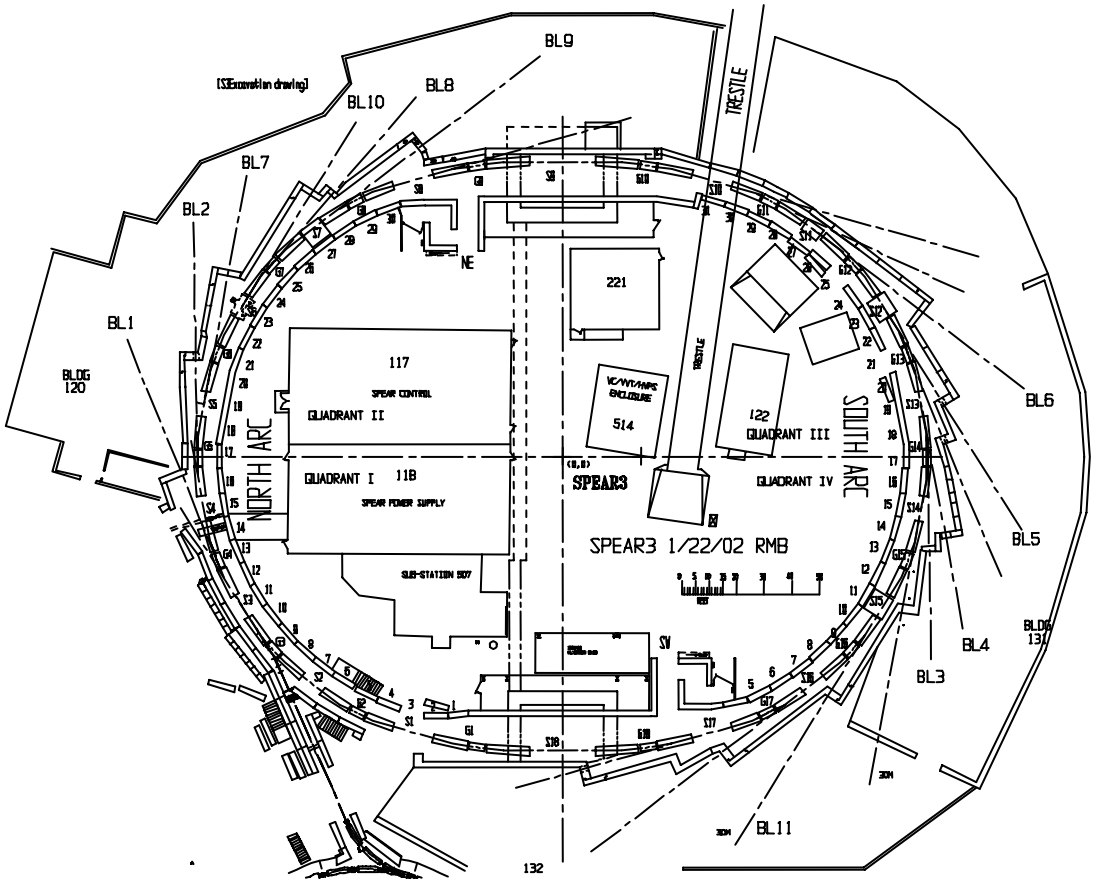
The table above describes the installation plan for the SPEAR3 rafts, straight sections and beamline front ends. The installation will be done in two directions beginning at Girder 12 (G12) location in the ring and working clockwise and counter clockwise.

The SPEAR3 rafts, complete with magnets and vacuum chamber, will be rolled around the ring and installed onto their pre-aligned supports as shown in the above pictures. The rafts will be rolled on a commercially available device that has been tested at SSRL.

The overall installation time line is described in the table below. These dates reflect the most current schedule at 10 hours per day for all activities and two-shift operation for vacuum integration work. It is expected that these dates will shift somewhat as the detailed activities are reviewed and finalized.

SPEAR3 Installation timeline

- Begin April 2003
- SPEAR2 remove : March 31 – Apr 28
- B118 renovation: March 31 – Sept 26
- Pour concrete floor: April 29 – June 04
- Install new monuments: June 04 – June 24
- Install mounting plates & holes: June 25 – July 17
- Install Girders & Straights: July 17 – Aug 15
- Install cable plant: July 28 – September 04
- Install vacuum hardware: July 23 – August 18
- Leakcheck ring/beamlines- pumpdown : August 12 – September 11
- Final Survey: September 11 – September 19
- Lock Ring-Installation complete: September 9, 2003



Updated SPEAR3 ring and access locations drawing

2.1 Accelerator Physics

During the fourth quarter of FY2002, the SPEAR 3 accelerator physics group concentrated on software application development and finalizing diagnostic specifications. The resource-loaded schedule was updated for the accelerator physics effort to end-of-project.

Software Application Development

The MATLAB 'middleware' project was continued with development in the area of higher level application programs. The middleware provides easy and flexible access to control system parameters from the MATLAB environment: the higher level application programs utilize the middleware directly. Program developments were made in the following areas:

1. System Identification - The MATLAB version of the response matrix analysis program 'LOCO' was further refined to correctly analyze small coupling errors and energy deviations induced by horizontal corrector kicks. The new version of LOCO is presently used at both LBL and SRC to analyze storage ring light source data.

2. Quadrupole Modulation - The LBL quadrupole modulation program was imported and re-vamped for application on SPEAR 3. In particular, the program was modified to connect to the middlelayer software and provide a parabolic fit (vs. linear) to measured data for improved accuracy. A 'database' file was developed for SPEAR 3 to specify which correctors, corrector strengths, quadrupole modulation amplitude and BPM to be associated with each quadrupole under test. A graphical display was developed to choose system parameters and activate the measurement. Data is automatically stored in a pre-defined file format.

3. History Buffers - A middleware routine 'GETHIST' was developed to access archived SPEAR data via MATLAB. The new routine allows accelerator physicists to load stored data into an environment where it can easily be manipulated (numerically processed, filtered, FFT, etc) and plotted (2D, 3D) to derive trends in accelerator performance.

4. Hardware/Physics Unit conversions - A protocol was developed and implemented in the MATLAB middleware that allows physicists to convert between 'hardware' units (Amps, Volts, etc) and 'physics' units (normalized gradients, etc). The standard calls for all 'set' actions to be in hardware units and all 'get' actions to retrieve hardware units. The conversion between hardware and physics units relies on MATLAB 'inline' functions that can be quite general with a corresponding set of coefficients for the inline functions (e.g. power series with power series coefficients).

5. Virtual Accelerator Server - To date all application development in MATLAB has depended on use of the 'simulator' mode of operation that routes all get/set calls through the MATLAB Accelerator Toolbox for numerical computations. In the 'online' mode, calls are broadcast over ETHERNET in the EPICS Channel Access protocol. Since program behavior can be significantly different in the 'simulation' and 'online' modes of operation, a Virtual Accelerator Server was developed and has undergone testing with SPEAR 3 application programs. The new module operates as an EPICS Channel Access Server that receives and serves get/set calls from the external world. On a fixed clock, the Virtual Accelerator Server also updates accelerator model values, recomputes key accelerator parameters and serves the result for active Channel Access Clients.

6. Power supply control - The middleware library was expanded to include new functions that utilize 'steppv' (vs. setpv), a module that allows the user to 'step' accelerator control parameters without the need to know the present setpoint.

7. SPEAR 3 Set-Up File - The SPEAR 3 set-up file 'SPEAR3INIT' was upgraded to include hardware/physics conversion functions and to provide specifications for essential data file handling. Basic accelerator parameters were added to the file for easy reference (e.g. key betafunctions, lifetimes, etc). The main SPEAR3 model file was updated to reflect as-built locations of corrector magnets and BPMs.

8. Response Matrix Measurements - Application programs were developed to streamline response matrix measurements including corrector-to-bpm, quadrupole-to-tune and sextupole-to-chromaticity response. The application programs use structures to store data internally for easy data manipulation and display. The data structures are also used to save measurement results for future analysis. Dispersion measurement routine was developed utilizing a similar format.

9. Interlock Verification - Progress was made on converting the interlock verification application program to the middleware standard. Pending final adjustments to the response matrix formalism, final conversions will be made soon. Algorithm development included specification of corrector magnet 'bumps' to be used for each beamline, introduction of error tolerance for robust operation in a noisy environment and expansion of graphical features for easy display. Program documentation and written user instructions are in progress.

10. Diurnal Orbit Regulation - A new MATLAB timer feature has been integrated into an diurnal (slow) orbit feedback program to maintain beam position with ~1Hz correction cycle. The feedback program includes a graphical control panel for easy use by SPEAR operators. Tests will be conducted on SPEAR 2 in operational mode prior to deployment on SPEAR 3.

11. Control Sliders - The MATLAB control sliders were converted to the middleware standard and embellished for more robust operation.

Metrology

The final specification for magnet centers for SPEAR 3 was released and cross-checked with Metrology. This specification includes callouts for the distance between dipole magnet vertex points, center line and beam trajectory (hyperbolic orbit).

DCCT (Direct-Current/Current Monitor)

The decision was made to proceed with the PEP-II style DCCT with simplifications to expedite the fabrication process. Loss factors, impedance and power load to the device were analyzed for operational parameters anticipated in SPEAR 3. Since impedance measurements were made at LBL for the PEP-II device, similar measurements will not be repeated. The final design review is slated for late October, 2002.

Synchrotron Light Monitor

During the Summer 2002 SPEAR 2 downtime, equipment racks were cleared from the building 120 control room for conversion to the synchrotron light monitor diagnostic room. The penetration in the shielding wall passed earthquake and radiation safety reviews. A contract was established to refurbish the room including new floor, wall repair and door. An optical bench on long term loan from LCLS will be installed in November. Summer students working in conjunction with Accelerator Physicists generated MATLAB application programs to communicate with the Xibion camera module and to compute beam size parameters based on pixilated data. Orders were placed for the MO, M3 and M4 main mirrors as well as key quartz windows.

Booster-to-SPEAR Transport Line

Accelerator Physicists working in conjunction with Engineering staff converged on magnet design, support and diagnostic locations for the Booster-to-SPEAR transport line upgrades for 3 GeV operation. Studies of the optimal optics configuration for injection into SPEAR 3 continue.

Beam-Stay-Clear

Representatives from the Beamline Development Group, Laboratory Management and Accelerator Physicists met to establish policy on the minimum vacuum chamber gap for initial insertion devices in SPEAR 3. Based on analysis of Design Report studies and extrapolation to smaller chamber dimensions, the minimum gap is now 11 mm (total gap) including full analysis of all weld/deflection/alignment error tolerances (old figure 12 mm).

Stopper Operational Scenarios

The dual-stopper design for the main ring passed a final design review and is in fabrication stage. Pending further review, we seek permission to use the stopper as an operational beam dump (similar to SPEAR 2). In order to pass review, we have demonstrated (1) the stopper can withstand the full 1.2 kJ (500mA) beam power, and (2) the stopper can withstand 5 W injected power. The remaining issue concerns a fault scenario whereby one stopper becomes stuck in travel with high current circulating in SPEAR. To address this issue we have proposed a 'timer' feature that aborts beam if the stoppers are not full 'in' or full 'out' within a specified time interval (~10 sec).

Resource-Loaded Schedule

In response to recommendation of the July, 2002 Lehman Review Committee, the resource-loaded schedule for the Accelerator Physics Group has been updated with more granularity for work to be performed between October, 2002 - October, 2003.

2.2 Environmental Safety & Health

With the FY2002 shutdown now finished, the structural changes to shielding required to accommodate SPEAR3 are now complete. Work finished this year includes completion of the East Pit lateral wall and roof shielding and an upgrade to the Beamline 4-5 high bay, which also eliminated one of the SPEAR2 weak spots. We continue to work closely with SLAC Radiation Physics group in order to complete our initial objective, which was to comprehensively assess all shielding and design parameters. We are still hopeful that radiation protection issues for the SPEAR3 accelerator will be completed later this year, allowing us time to concentrate on the beamlines.

The Safety Analysis Document is progressing and a complete draft should be ready for review by the New Year. We are also focusing on the Accelerator Readiness Review, which will address the following:

- Identification of equipment and systems having safety importance – Hardware Readiness.
- Identification of procedures necessary for safe operation – Procedure Readiness.
- Identification of personnel necessary for safe operation and define minimum training requirements – Training Readiness.

We will submit an initial plan to DOE by the new year.

Other efforts are ongoing into providing and organizing resources for the SPEAR3 installation, including radiation control technicians, safety personnel and “processes” that allow clear two way communication of ES&H goals, between SPEAR3/SSRL management and everyone out in the field.