SSRL ED&M
DOWNTIME REPORT
2005

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1. Summary

During the 2005 SPEAR SHUTDOWN (August 2 to November 28, 2005) the ED&M Group accomplished a large number of routine downtime maintenance tasks, as well as a significant number of new project and upgrade activities. Some of the more significant activities during the shutdown are highlighted in this Downtime Report.

2. Power Supplies

2.1 BL12 (Chicane) Project Overview

Phase 1 of the new Beam Line 12 Project included splitting the six East and West Straight QF/QD x/y/z magnet power supplies and associated wiring so that each of the QF/QD x/y/z magnet pairs in the East and West Straights is fed by a separate, individually controllable supply.

In addition, a temporary raft of three triplet magnets, 09S-QF1, QD1, and QF2 was installed in the East Straight. The QMS coils on 09S-QD1 were bussed as a quadrupole for beam based alignment. Finally, the 02G-QD1, QD2, QF1, and QF2 magnets were removed from their respective magnet strings and individually powered.

This required a total of 7 power supplies and 13 controllers. A combination of SSRL spares and PCD spares were used on a temporary basis for the controllers. New controllers are being fabricated for the final installation.

Significant changes to the Machine Protection System (MPS) were made to accommodate the new power supplies and changes to the power supply system. See Figure 2.1 for an overview of the configuration.

The power supply racks in B118 were modified to accommodate five power supplies each, instead of the previous four supplies. This required disassembly of the racks and installation of additional circuit breakers, transducers, power supply controllers, and other equipment. Approximately 24 racks were modified. Approximately 32 new cables were installed to power magnets separately from the remainder of the magnet strings which originally powered them and to power other new temporary magnets. The cables were routed in the existing cable trays and new trays were installed as required for these new cables.

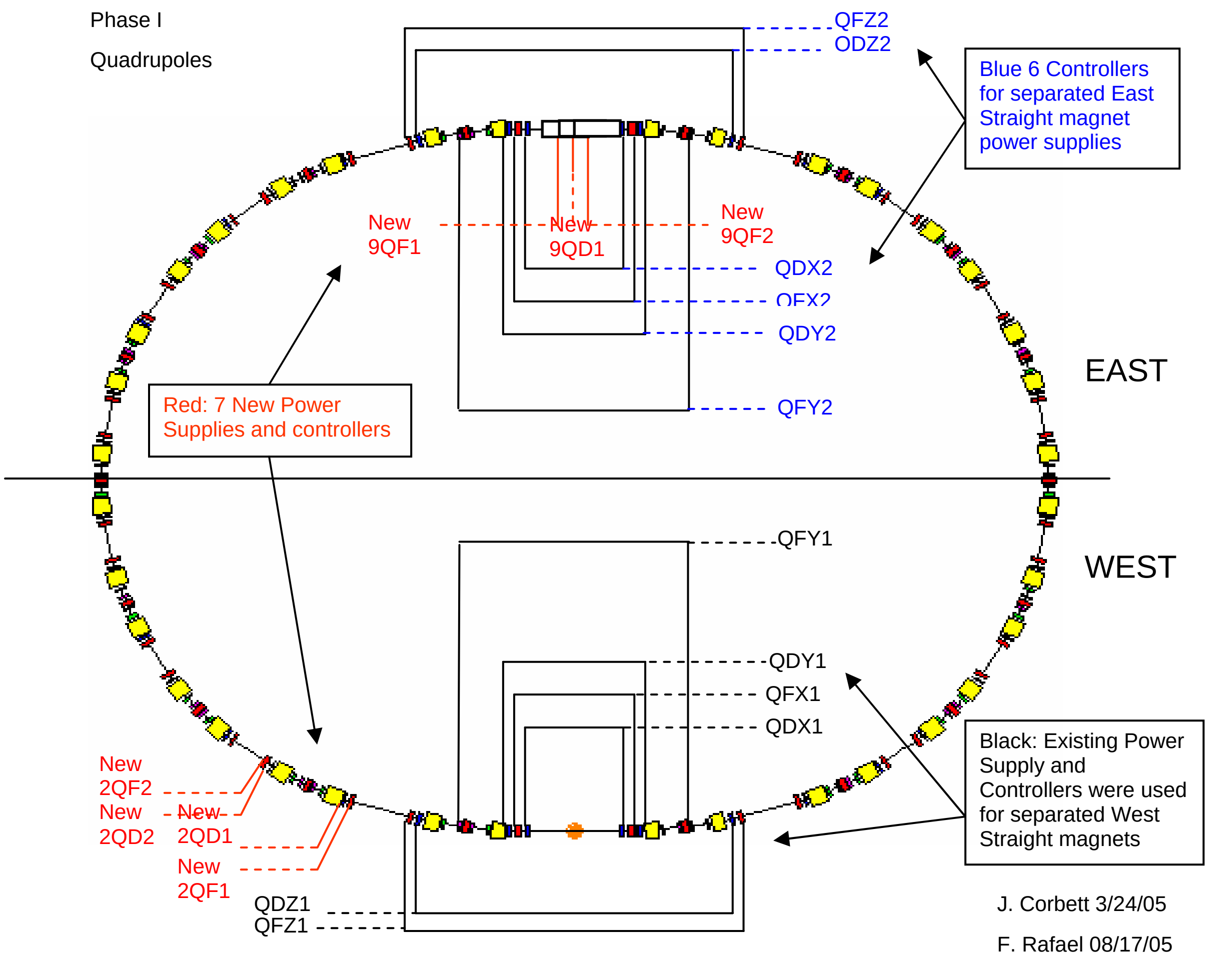
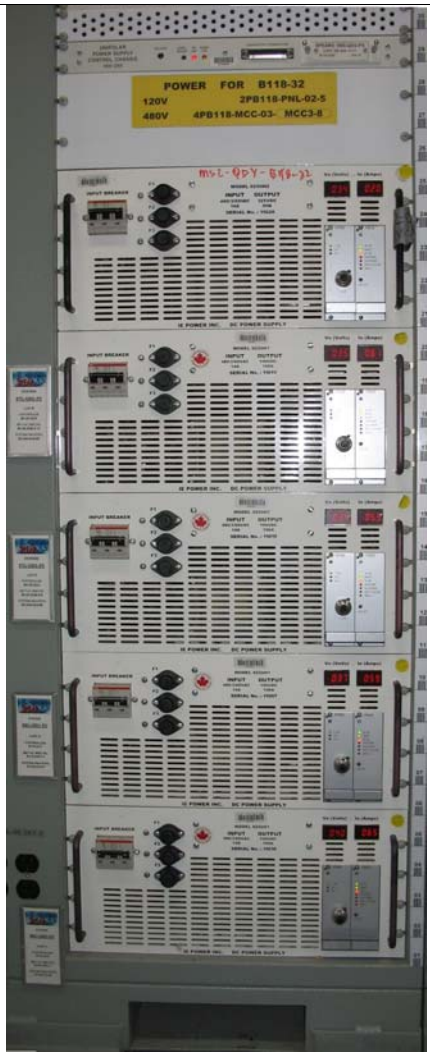


Figure 2.1 2005 Chicane Configuration Overview -

2.2 SPEAR3 Rack Modification for BL12 Project

18 Racks were rebuilt by Critt Taylor, Greg Johnson, and Ramona Theobald, to accommodate the new power supply configuration. This included installation of a new rack for the DCCTs and modification of the AC distribution in the racks.

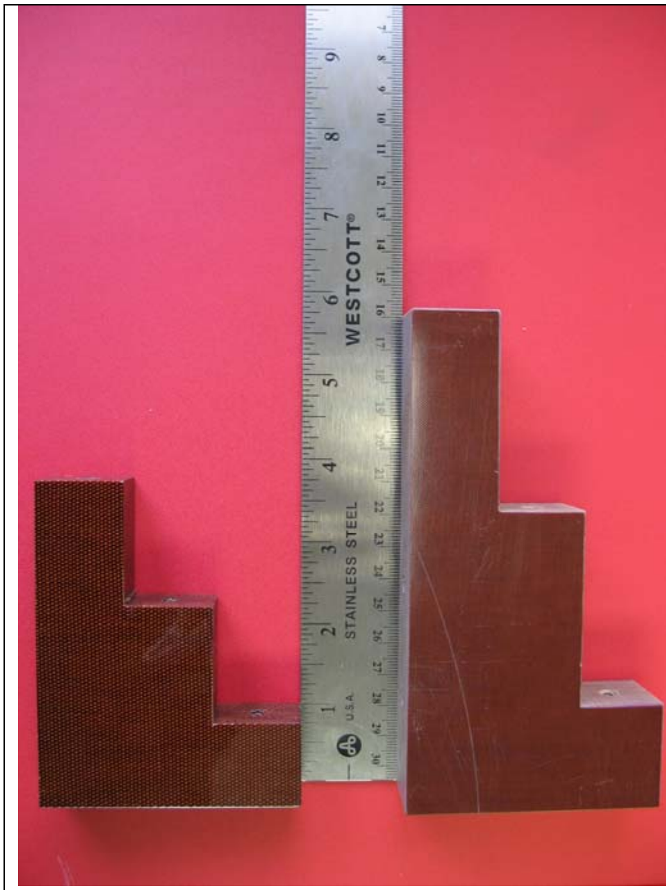
Picture 2.2a Old Rack Configuration for 4 PS stack



Picture 2.2b New Rack Configuration for 5 PS stack

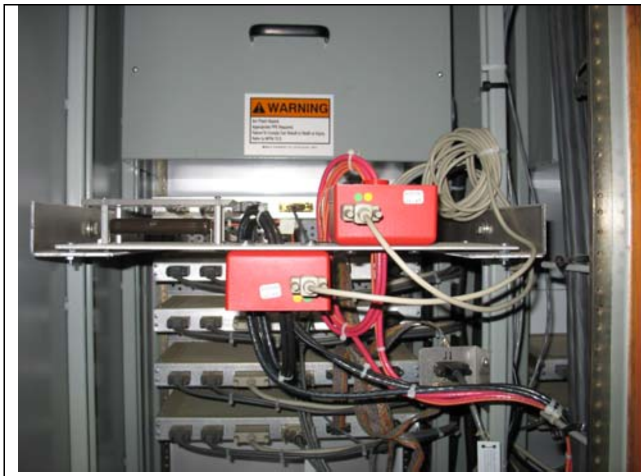
2.3 AC Distribution for BL 12 Project and NEC Upgrades

During the rebuild of the racks for the Chicane Project, it was identified that the AC distribution originally designed for 208 VAC was now being used for 480 VAC, this required 29 racks be rebuilt to meet the NEC requirement for 480 VAC Specification. Critt Taylor, Greg Johnson, and Ramona Theobald did the design and rebuild of the racks. This required the fabrication and installation of new isolation blocks and new mounting hardware to maintain the required clearances, and a new penetration to accommodate the cable for the new power supply while meeting the required cable penetration configuration (less than 80% occupancy).

	
Picture 2.3a New Isolation Blocks Left – 208 VAC Block Right – new 480 VAC Block	Picture 2.3b New cable penetration on AC distribution box.

2.4 New TSP Power Supply

A new TSP power supply was installed. This will allow each TSP switching chassis to be fed from its own power supply. This will help to reduce the time required to flash the TSPs. The installation was done by Critt Taylor and included a new BitBus controller.



Picture 2.4 New TSP power supply installation.

2.5 Start up

For commissioning of the new power supply configurations, two SSRL Accelerator Procedures – Engineering (SAPEs) were prepared. These procedures are “SPEAR Intermediate Power Systems BL12 Phase 1”, SAPE 159, and “Large Power Supply, MS1-QD-PS and MS1-QF-PS, Commissioning Test”, SAPE 173.

Drawings were updated by Gene Ibarra to support the design changes.

SPEAR Intermediate Power Systems BL12 Phase 1, SAPE 159 was performed to safely commission recently-installed Intermediate Power Systems in preparation for operation of BL12 in the Phase 1 temporary configuration operation. 70 Intermediate Power Systems were tested, including 12 reconfigured intermediate power supplies and 14 new BitBus controllers.

“Large Power Supply, MS1-QD-PS and MS1-QF-PS, Commissioning Test”, SAPE 173, tested MS1-QD-PS and MS1-QF-PS since the MS1-QD-PS and MS1-QF-PS magnet strings were modified to remove the girder 2 (02G) magnets. The magnet strings now consist of only girder 3 (03G) and 4 (04G) magnets. Similar testing was done for the MS1-QD-PS and MS1-QF-PS.

The testing included the DC magnet power supplies, BitBus power supply controller, current monitoring transductor, the Machine Protection System (MPS), the magnets and their protective thermal switches. This equipment is located in the SPEAR Ring and in the Booster-to-SPEAR (BTS) tunnel. Power, instrumentation, and control cables that interconnect the above items and runs to all of the above areas were also tested as part of these tests.

The MPS thermal switches on all magnets were tested. The testing was done with using a test box designed by Ray Ortiz which provides for efficient testing of each individual temperature input to the MPS from the raft to the power supply.

2.6 MCOR System

2.6.1 Bandwidth

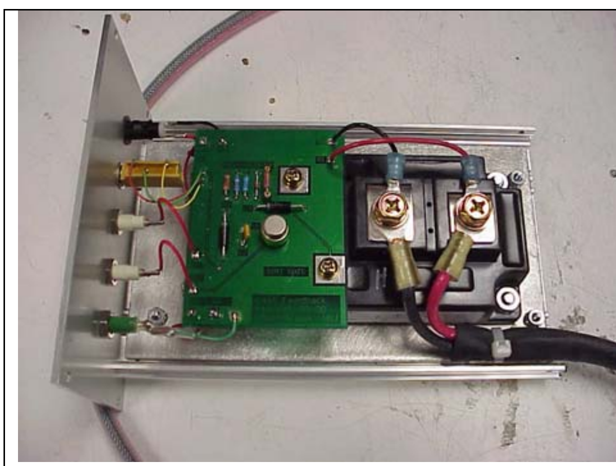
At the June 10, 2005, AP meeting it was decided that the MCOR bandwidth should be increased. The MCOR test stand was used for preliminary testing to determine the new component values to increase the bandwidth. A total of 98 MCOR modules were modified to provide 700 Hz Bandwidth.

2.6.2 Over voltage protection

During testing of the Orbit Fast Feedback controls on May 3, 2005, 4 MCOR modules failed at the same time. The damage in to the board was major. Diagnostics performed using the MCOR test stand confirmed that switching just one module from +10 to -10, caused an over voltage of about 1V for 10 ms. The over voltage was close to linear with the number of modules involved and the current changes for both unipolar transition and bipolar transitions.

A proposal was made to add 8x 35000uF capacitors to the existing bulk rails, to limit the over voltage from the energy returned by the eight 0.047H correctors during current changes. During a 30A -> 0A step this would limit the rise in rail voltage from 55 to 63V, assuming a load/transport R of 0.75 ohm per corrector. (About 20% of the returned energy is absorbed by the transport R). 0.75 ohm appears to be the lowest transport resistance [to girder 1], making the calculations slightly conservative. However, this proposal required space that was not available and would be expensive to implement.

An alternative active component based over voltage protection circuit making use of sensor actuated solid state heat sink was designed by Fernando Rafael and Greg Johnson that would protect the power supplies and could be located in the existing chassis space in the back of the racks. A total of 28 over voltage protection circuits were installed to protect the MCOR bulk Power Supplies. See Pictures 2.5a and 2.5b.

	
Picture 2.6a Over Voltage Protection Module	Picture 2.6b MCOR Assembly installed in existing chassis.

2.7 BOOSTER Power Supplies

The Kickers were inspected and Flash Memory was installed in the PLCs. The White circuit tuning was verified.

3 Corrective Actions

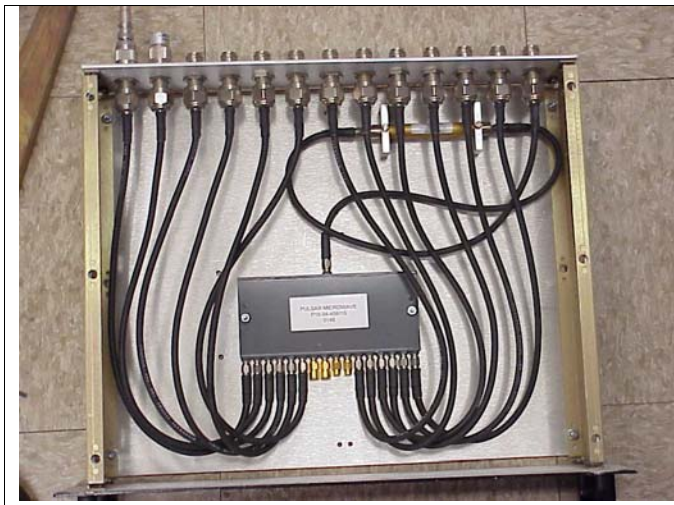
Old abandoned cables originating in Booster Tunnel and hanging outside of enclosure TD140FP02 (near the RF supply), were identified and removed – ASD Corrective Action 44 and 45.

Booster Cable Tray and Wireway Grounding: Significant work grounding the cable trays in the Booster Ring and trays containing AC power was completed. In addition, the cable trays in B140 and Booster Ring have been documented, (ID 444-256-50). Some additional grounding remains to be done at the next opportunity.

4 Controls Projects

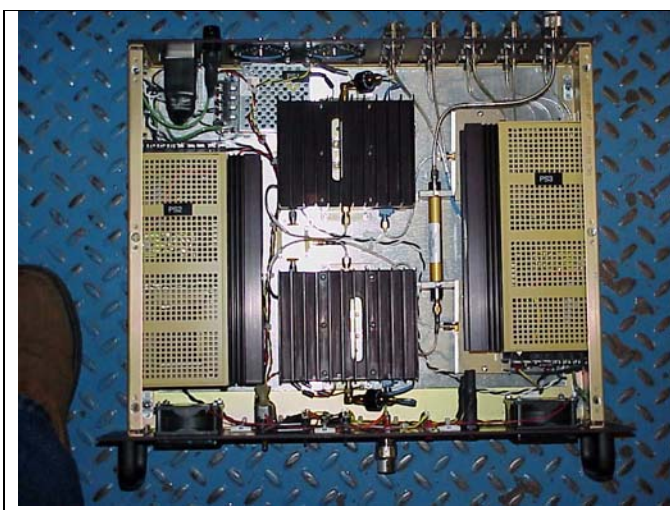
4.1 High Power Test Tone chassis 444-801-60

A new high power Test Tone chassis, incorporating required temperature controls, was designed by John Wachter. This chassis provides a Feedback Test Signal to calibrate SPEAR Orbit Electronics. The Original chassis constructed for SPEAR made use of a low power feedback signal. Since then, a coupler with high directivity was added to the path requiring a high power Test Tone Driver to read back the signal. The new chassis met the design specification for RF output power and chassis cooling. Tests were conducted with manual data evaluation and computer data acquisition.

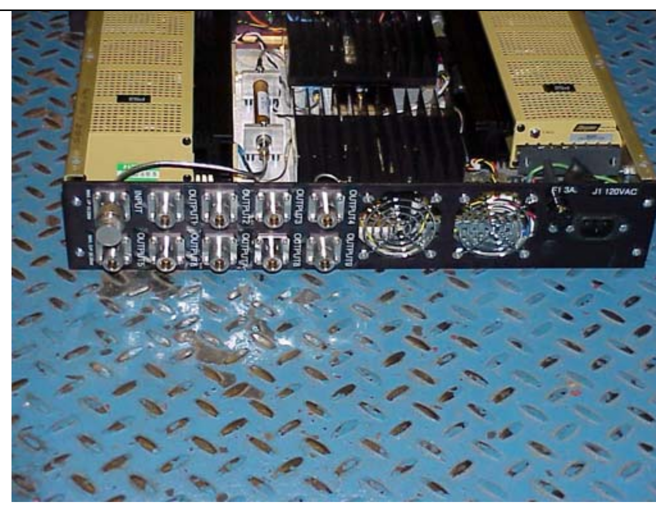


Picture 4.1a Original chassis

Picture 4.1b New Test Tone Chassis, front view



Picture 4.1c New Test Tone Chassis, top view



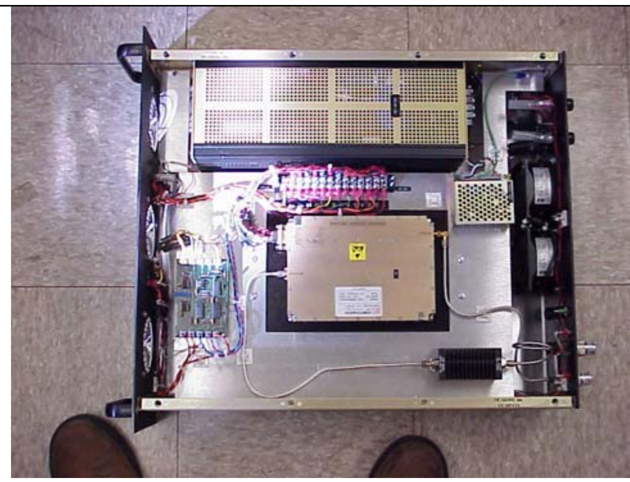
Picture 4.1d New Test Tone Chassis, back view

4.2 Tune Processor Driver 444-808-50

The Tune Kicker modulates the SPEAR pre-injection beam with a very low Frequency and Amplitude signal ~ 10KHz to 500 MHz to fine tune the low density beam at injection. The Original Tune Driver was loaned from ALS and ALS needed their unit returned. A Tune Driver Amplifier was needed for both normal operation and machine physics. After much research for a wide band and mid power amplifier, an EMPOWER amplifier was selected. A chassis was designed by John Wachter with appropriate cooling and Interlock protection to house the amplifier.

The new chassis met the design specification for RF output power and chassis cooling. The chassis interlock function was verified operational at both room temperature and 50 degrees C. Computer data acquisition during an over night burn-in was collected using Labview.

Picture 4.2a New Tune Driver Chassis, front view



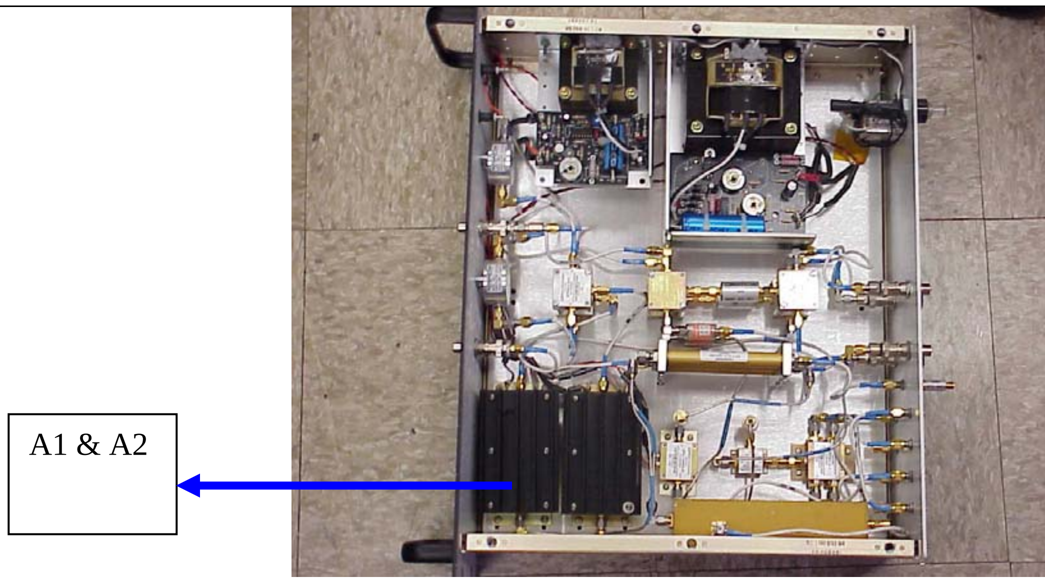
Picture 4.1d New Tune Driver Chassis, top view

Picture 4.2c New Tune Driver Chassis, back view

4.3 Bunch Processor Modification

The original Bunch Processor chassis has been in operation for the past two years and had a two high gain power amplifiers installed in the chassis. Since the original installation, it was determined that that the high gain amplifiers were needed elsewhere and low gain amplifiers would be adequate for this processor. A design change was developed by John Wachter. The low gain amplifiers were installed in a spare bunch processor chassis. The chassis attenuators and cables were revised to compensate for amplifier gain change. This is a diagnostic processor thus there was no impact on system operation.

The chassis was bench tested and met the design requirements. Additional operational testing to insure that the down converter and phase shifter are able to capture very low beam density signals began with injection.



Picture 4.3 Bunch Processor Chassis, amplifier modification

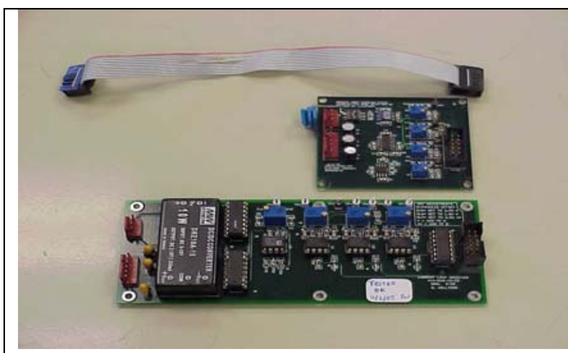
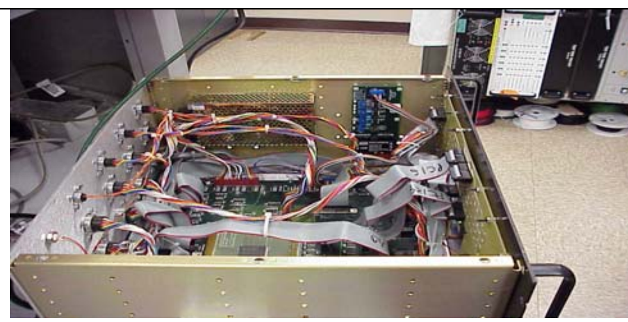
4.4 Orbit Interlock Summary Chassis

The Orbit Interlock Summary Chassis contained an analog board to monitor current from the DCCT, as sent from the Stored Current Interlock chassis. If the cable was broken or disconnected the voltage would drop to zero. This condition was not fail safe.

A new Orbit Interlock Summary Chassis 4-20mA receiver board was designed and built by Reuben Yotam and Scott Walters. This board monitors the loop current and provides independent signals at 18mA and 20mA DCCT currents and when the current loop is broken. It sends the information to the Orbit Interlock Summary Chassis interlock logic Part of the design included the current monitor fanout board designed by John Wachter. The two chassis were connected and the circuit performed as designed.

This modification allows the Orbit Interlock Summary Chassis to monitor three things. The first is DCCT current of less than 18mA. The second is DCCT current of less than 20mA. The third is a failure of the current loop itself. If the current loop is disconnected (or broken) then the comparator will see a negative voltage of -.125 volts and switch the output gates such that it will act like the DCCT current is above 20 mA thus arming the interlock. The two DCCT current states are displayed on the front panel of the Orbit Interlock Summary Chassis and interact with RF enable and BTS stoppers enable.

The system was tested and calibrated after a 24 hour burn-in/warm up. Once the board was tuned, proper voltages were applied and proper operation was verified. The circuit was installed inside the Orbit Interlock Summary Chassis and the complete system was tested using the Stored Current Interlock Chassis (containing the 4 to 20 mA transmitter circuit). The system was installed and the circuit performed as designed.

	
Picture 4.4a New current loop receiver (bottom) and the old analog board it replaced (top)	Picture 4.4b New current loop receiver board mounted in the chassis (far side panel)

4.5 Orbit Interlock Summary Chassis Modifications and Test Chassis

The Orbit Interlock Summary Chassis is part of the MPS system and is used to protect the beam chamber and beamline optics from damage. The FPGA program inside the Orbit Interlock Summary Chassis required revision. This required design of a test chassis to verify the new program worked and modification to the existing in service and spare chassis. Reuben Yotam and Scott Wallters completed the design for the new test chassis and modifications.

The spare chassis had never been tested and was satisfactorily tested using the new test chassis. The working chassis was tested about two years ago and there was incomplete record of how it was tested.

The new test chassis included BL stoppers “in” test board and a 4-20mA transmitter box. The test chassis contains 18 differential pair transmitters that simulate hardware inside the BPLD chassis. With a channel switch in the up position, a summary of BPLD OK is simulated on the summary chassis. From there a “first event” of each BPLD channel is simulated. The BL stoppers “in” test board simulates a relay closure from a BL MPS PLC. With a dip switch in the “on” position it sends a 24 volt signal back into the summary chassis to meet certain logic conditions inside the FPGA. The 4-20mA transmitter box simulates the Stored Current Interlock Chassis current loop signal. The transmitter box is connected to a variable power supply and converted from a voltage to a current. The Current Loop Receiver board converts this current to a voltage that is amplified and monitored by the limit detectors described above.

Reuben Yotam created a test procedure; using the procedure, the chassis documents and the above test chassis both the working and spare chassis were tested on the bench. Scott worked with Reuben and Clemens Wermelskirchen to verify the VME interface when the chassis was installed in the rack.

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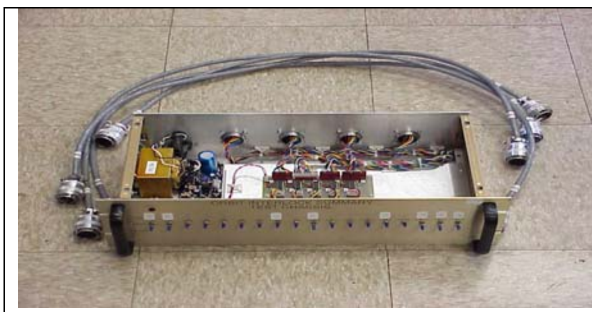
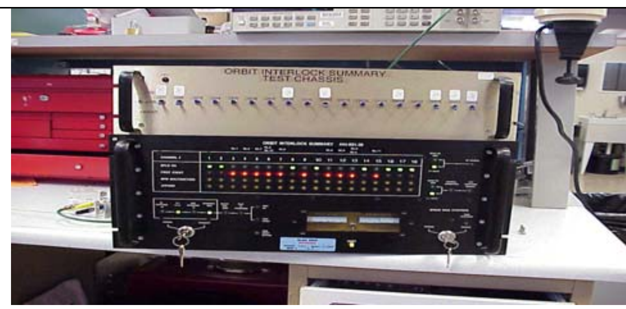
<tr><td></td><td>
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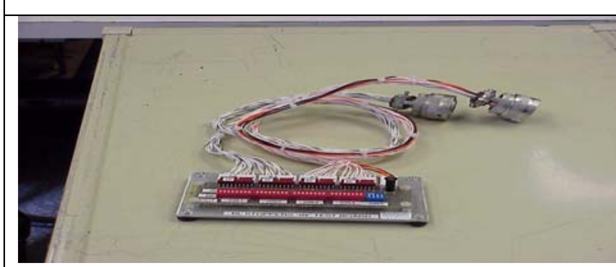
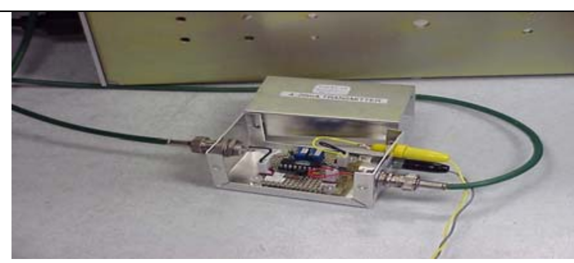
<tr><td>Picture 4.5a Orbit Interlock Test chassis and cables</td><td>Picture 4.5b Test chassis and the summary chassis</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Picture 4.5c BL stoppers “in” test board</td><td>Picture 4.5d 4-20mA transmitter box</td></tr>
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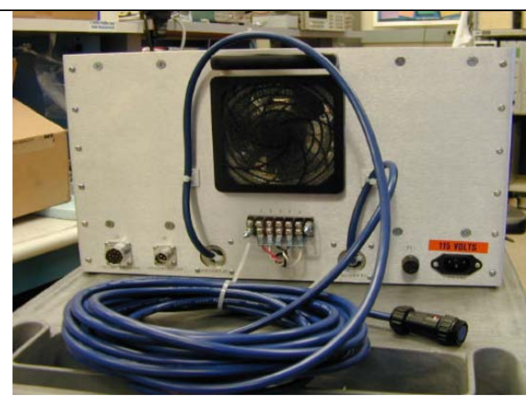
5. Insertion Device Controls

5.1 BL12 Manual Motion Control Unit

The Manual Motion Control Unit for the BL12 Insertion Device was designed and built by Tom Dao, Scott Wallters, and Ramona Theobald. It is currently being used by Neomax Corp. in Japan for fabricating the insertion device.

The Manual Motion Control Unit consists of a stepper motor driver, two encoder converters, +5VDC and +24 VDC power supplies, a logic board, two display boards indicating LEDs, and associated wiring, cables and accessories. For a more detailed description and operation of the BL 12 Manual Control Unit, please see the associated Operating Procedure. The unit was tested with an encoder, a spare stepper motor, and a limit switch board using a joystick.

Below are pictures of the new BL12 Manual Motion Control Unit and Insertion Device.

	
Picture 5.1a BL12 Manual Motion Control Unit – Front View	Picture 5.1b BL12 Manual Motion Control Unit – Top View Left Side
	
Picture 5.1c BL12 Manual Motion Control Unit – Top View Right Side	Picture 5.1d BL12 Manual Motion Control Unit – Rear View

	
Picture 5.1e BL12 Insertion Device in Production in Japan – Front View	Picture 5.1f BL12 Insertion Device in Production in Japan – Rear View

5.2 Modify BL5, BL6 and BL10 Motor Driver Chassis

BL10, BL6, and BL5 motor driver chassis required modification because of exposed live terminals identified during a 2005 Beam Line safety inspection. When the chassis were removed and inspected a number of additional electrical code issues were identified. The chassis did not meet current OSHA, National Electric Code (NEC), and SLAC Electrical Safety requirements.

Tom Dao and Scott Wallters repackaged the existing motor driver into two chassis bolted together to allow proper clearances. A power switch, fuse, and LED indication were incorporated to improve protection and facilitate safety during future maintenance activities. Each chassis was tested during the startup Insertion Device Check Out task. These newly repackaged chassis are fully enclosed, with proper labeling, fuse protection, and modular AC cords. In addition they have passed the Electrical Equipment Inspection Program inspection for electrical safety, in accordance with SLAC requirements for all custom and modified equipment..

Below are the typical pictures of the Motor Drive chassis for BL5, BL6 and BL10 before modification. As can be seen from the pictures, some of the potential hazards were:

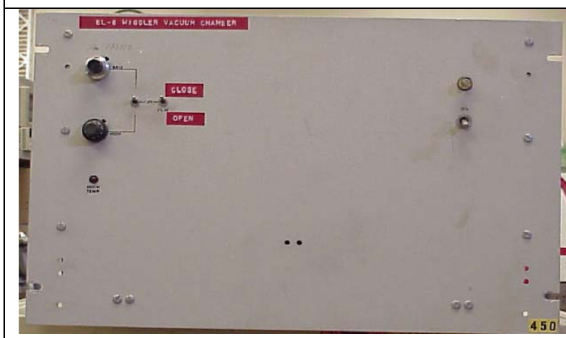
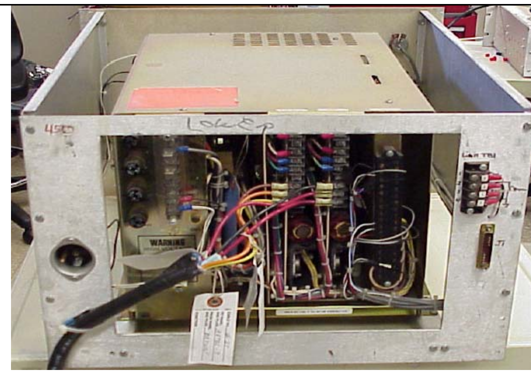
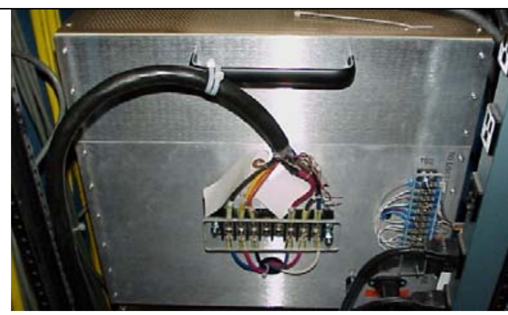
a. Open rear panel with the exposed 120 VAC and exposed motor wires which contain high voltage and current.

b. 120 VAC wires were too small and didn’t meet NEC requirement.

c. There was no ground wire.

d. There were no top and rear panels on the chassis allowing tools or conductive objects to accidentally fall into the chassis, causing an electrical short or arc.

e. The adjustable pots and switches didn’t work, potentially confusing the operator
f. The “Power” indicator light didn’t work, (when the chassis was powered the light still indicated it was OFF.
g. There were no handles installed on the front of the chassis so it was very difficult to safely remove or install it , (the chassis weighs over 50 pounds).

Before	
	
Picture 5.2a Typical Motor Driver before Modifications – Front View	Picture 5.2b Typical Motor Driver before Modifications – Rear View
After	
	
Picture 5.2c Typical Motor Driver for BL5, BL6 and BL10 after Modifications – Front View	Picture 5.2d Typical Motor Driver for BL5, BL6 and BL10 after Modifications – Rear View

5.3 Other ID Control Tasks

In addition to the two major tasks above, there were other tasks accomplished as listed below:

a. Supported MSG on BL5 chamber replacement work.
b. Wired new proximity switches on BL5 Insertion Device.
c. Checked out BL4, BL5, BL6, BL7, BL9, BL10 and BL11 Insertion Devices.
d. Participated in the Conceptual Design for BL13 Insertion Device.