Accelerator Systems Division Highlights for the Week Ending May 2, 2003

ASD/LANL: Warm Linac

BREAKING NEWS: On May 1, first RF power was transmitted into DTL Tank 3 in the SNS tunnel. This represents the first integrated test of a number of LANL supplied systems and components for the DTL, including high-power RF, the high-voltage converter modulator, low-level RF high-power protect, EPICS controls, vacuum, and resonant control cooling. The tank conditioned remarkably fast. By May 2, forward RF power levels exceeding 1 MW were achieved. Jim Billen, Charles Pinney, and Jim Stovall were at the site contributing to this effort; many more were also directly involved from remote EPICS stations at LANL. This accomplishment is the product of the dedicated hard work from the entire ORNL-LANL team.

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: We completed: (1) site testing of the 6th RFQ/DTL klystron; (2) factory testing CPI SC linac klystron S/N 20; (3) factory testing SC linac transmitter S/N 3.
Concerns & Actions: The 5-MW CCL RF system continues to be our biggest concern. Thales representatives were at LANL this week to review schedule for factory testing the next 3 tubes and to arrange for shipment of the tube at LANL that lost vacuum.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: The Prototype HV converter-modulator (HVCM) operation supported the 2.5 MW RF testing at Los Alamos.
Concerns & Actions: (1) The prototype HVCM was down for 2 days to repair the capacitor bank headers. The multilam electrical connectors were found to be eroded. Shims were installed to improve the fit. (2) The failure on production HVCM S/N 6 reported last week was investigated at the Dynapower factory by Bill Reass, David Anderson, and Tom Hardek on Saturday 4/26. They believe that loose capacitor bank and switch plate headers likely caused the failure; subsequently, the failure caused the IGBT driver card AC to short circuit. Wiring was not adequately fused at the factory (like it is at LANL and SNS). Additional fusing and 2 kV fire retardant cable has been retrofitted. Dynapower is back on track in assembly. LANL and ASD will have constant presence at Dynapower, Monday through Saturday until production is on schedule with satisfactory quality.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments:
Tank-1: 47 (of 55) drift tubes were shipped. The remaining 8 will ship on 5/6. The upstream end wall was brazed at LANL, and is back at CMI for machining; we expect to ship on 5/6.
Tank-4: Group A drift tubes are being machined for diverter to body brazes; estimated to be complete on 5/5. Group B, C, water channel welds and leak checking are complete. D is undergoing water channel welds at Hanford. The support stand is packed for shipping. Waveguide is at plating vendor for plating of equatorial braze joint.
Tanks-5 & 6: Drift tubes bodies are undergoing water channel machining; some are ready for sleeve installation. EMD and BPM dummy drift tubes have been added to production order. Stands are undergoing final hole pattern drilling at CMI. Waveguide for T-5 internal machining continues. Waveguide for T-6 will depart tomorrow for plating of cooling channel cover plate joint.
Tank-2: Fabrication of qualifying example, drift tube is underway at second vendor. RFQ for the production of the drift tube bodies and sleeves and water channel preparation welding has been issued. Waveguide is in rough machining stage.
Concerns & Actions: With the Tank-1 and 3 efforts coming to conclusion, we anticipate that the DTL recovery team and main vendor (CMI) pace of work will be at a more manageable and sustainable level. This should prevent further slippage of the waveguide machining work; we will watch this closely and we will have to consider other measures to keep schedule if we are not successful. There remains a continuing concern on the part of the EMD drift tube production team that the dipole production maintain schedule.

PROJECT MANAGEMENT (WBS 1.4.6)
PCR LI 03 006, "Implement DTL Recovery Plan" was submitted and accepted on 5/2. A new schedule and budget was identified to complete the DTL Recovery Plan. DTL technical work scope remains essentially unchanged. Work scope associated with HPRF testing, Physics support, and the LANL SNS Division/Project Office have been reduced in order to cover the DTL Recovery costs while minimizing the draw on SNS Project contingency to

$1.8M. The risks associated with reduced HPRF testing was reviewed by an external expert committee led by Ed Knapp on Sat. 4/25 in Chicago.

ASD/JLAB: Cold Linac

ASD/BNL: Ring

Talks have been finalized for the DOE/SNS Review, PAC and HALO'03.

BNL documents released to DCC include:

- Lattice-Global-Coordinates-LATTICE spreadsheet as a controlled document, listing in sequence the HEBT, Ring & RTBT standardized device names with the BNL magnet model numbers and component assembly types.
- Lattice-Global-Coordinates- Assembly-Names spreadsheet as a controlled document, listing the standardized names and magnets in beam sequence for each of the twenty five different component assemblies in the HEBT, Ring & RTBT.
- Posting (read only) of the Lattice-Global-Coordinates Excel workbook in the BNL Spallation Neutron Source document control web site on the "Lattice Component Control Index" page.

Ring half-cells: # 8 is assembled and undergoing final inspections. Our plan is to ship it by 5/19. Work is underway on half-cells #9, 10 and 11.

26Q40 (Stangenes) vendor production continues. We now have 3 of 8 magnets in house; all are in queue for magnetic testing.

The 1st article 27CD30 magnet (NETC) is in the mag measure test station. The magnet has been successfully tested as a horizontal dipole. Bus jumpers are being changed to test it as a vertical dipole. After acceptance by BNL, the remaining production units (19) will be shipped directly to SNS/OR.

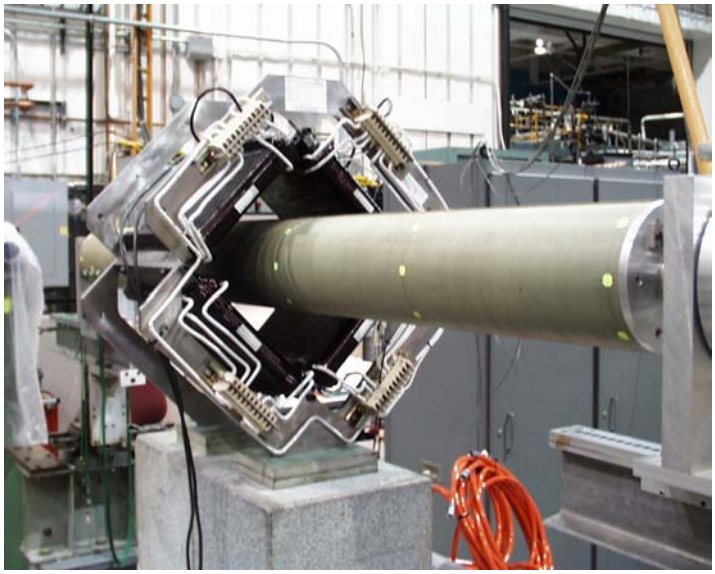
Tesla's revised shipping schedule (Ph. II, 21Q40) calls for 8 units to be shipped to BNL next Tuesday (by sea). In the meantime, two of the existing Ph I quads have been shimmed to determine overall effectiveness for matching the last twelve magnets.

Assembly work continues on the second set of (short) injection kicker magnets.

Design of the HEBT Momentum Dump is complete and the drawings are in Checking.

36Q85 rad hard quad: Winding of the third coil is in progress.

First article 26S26 high field sextupole magnet in final assembly at Alpha.



First article 27CD30 in the BNL mag measure test station.

Controls

This week the first RF power was put into DTL3. The controls team played a large part in this success. Several controls team members, including Charles Pinney from LANL, worked hard making sure the vacuum interlocks were tested, and improvising backup interlock schemes for equipment that was not working according to specification. Initial test of the RCCS temperature control was completed and a sticky 3-way valve was discovered. RCCS flow meters were added to the interlock chain and are ready for testing. The phase 0.3 PPS was certified and operated without problems as the first RF pulses were delivered to DTL3. Considerable D-Plate support was also provided this week.

To support operation of DTL3, alarm handler configuration files were constructed for the Resonance Cooling Control System (RCCS), the Vacuum System and the RF system. Discussions began on improving the friendliness and the user documentation of the Alarm Handler configuration tool.

Isolation amplifiers were installed and successfully tested on the MEBT Kepco power supplies. This resolves the oscillation problem that was observed during the last run.

All of the PPS PLC racks have been installed in the Linac. Drawings were issued this week to support installation of Oxygen Deficiency Hazard (ODH) cabling in the CHL. Design is 50% complete on the PLC rack for the CHL control room. The PLC equipment for this rack was ordered this week.

Three production Chipmunks have completed the SNS and RICL calibrations this week. These units will be ready to put in service as soon as the travelers are complete. The remaining units are in the process of being calibrated. Six are required for phase 0.4 (Front end and DTL 1 & 3). The two prototypes were picked up by RIS and taken back to the shop to rebuild with the alternative FETs. The original Chipmunk specification is under revision in order to procure the next ten units.

Conventional Controls (CF) loop tuning and startup for the FELK is finished. All the air handlers in the FELK are on automatic and running. There were some mechanical problems with dampers and things on the air handlers, but no problems with controls. The CHL will be started next week. The interface between the Allen Bradley PLC and the Trane Chiller system is now working. This was the last interface issue for CF controls.

Racks for the Ring Service Building are up on the Mezzanine ready to be installed. A design package for Beam Dump TC wiring, terminations, etc is almost complete. It will serve both the Linac and Extraction dumps. The FSD for magnet power supplies has been updated to combine information from the DTL1 & D-Plate FSD and the Magnet Cycling FSD.

At BNL the interface between the V108S utility module and the MPS was tested successfully. This feature allows IOC software to trip the MPS if certain conditions are detected. The BLM software and control screens were checked into the ORNL CVS repository, and the first DTL BLM IOC was shipped to ORNL. This IOC supports enough digitizer channels for the neutron detectors and loss monitors required for the DTL tank 1 run. A second IOC is being assembled that will support the remaining digitizer channels for the complete DTL, and provide space for additional bias high voltage supplies. The second IOC will be used for continued integration testing with diagnostic signal conditioning electronics before being shipped to ORNL.

The promised new test facility network was installed and set up, with the RF test facility the first to be serviced. A strategy for supporting increased RF testing in the Klystron Gallery needs to be developed.

Installation

Craft Snapshot 4/30/03

ASD craft workers	79.0
Foremen, ES&H, etc	11.0
Less WBS 1.9 controls	4.0
Less absent	0.0
TOTAL	86.0

Conditioning started on DTL #3 at 11:26 on Thursday, May 1, 2003.

The DTL #1 tank was re-leak tested. A leak was found in the center o-ring again. It will be replaced.

Fifty of fifty-nine DTL #1 drift tubes have been received.

The HVCM incident at Dynapower was investigated. It was determined that some wiring in the HVCM #2 had to be re-done before DTL #3 conditioning could begin. It was done successfully.

Received RING half-cell #8 magnet assembly and staged it in the HEBT tunnel.

ASD took BOD of the RING Service Building and ASD took BOD of the RING Tunnel on Friday May 2.

Discussions are underway with SNS Procurement to provide direction to contractors that shipments will not be accepted at RATS I after July 7, 2003. This date will be formalized and distributed through procurement and management channels.

Accelerator Physics

Operations Group

Ion Source Group

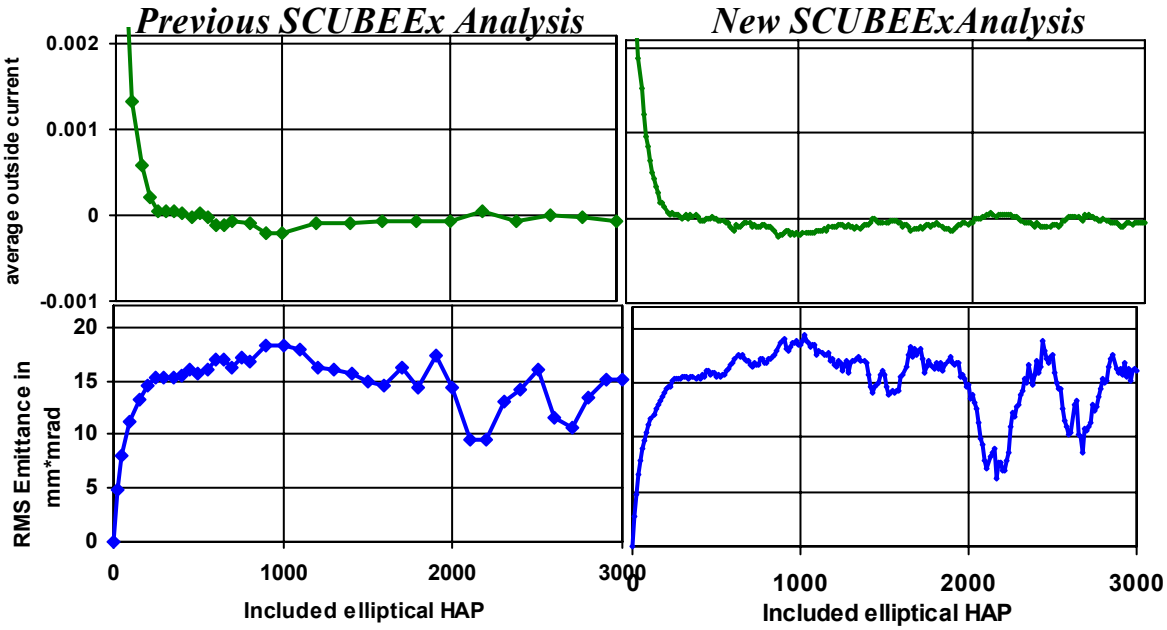
The Ion Source, LEBT and RFQ have been pumped down to approximately 3x10^-6 Torr. After locating the positions where ion source fiducials will be added, the ion source was removed to be tested on the hot spare stand. The ion source port was sealed with a blank off before the system was re-evacuated.

Vacuum Gauge IG5 has been electrically isolated from the LEBT chamber by replacing the KF-40 clamp and center ring with plastic ones. This should eliminate the hang-ups experienced during FE commissioning.

After the standard checkout, the hot spare stand has been successfully energized.

Yoon Kang's new 2 MHz power connection was successfully tested delivering up to 81 kW into a dummy load.

Robert Welton has upgraded the emittance analysis program. The main new feature is a "do loop" that can for hundreds of slowly shrinking exclusion ellipses evaluate the average outside current, the unbiased Twiss parameters, and the unbiased rms emittance. Previously these values could only be evaluated for one single ellipse at a time. This has enabled a greatly improved resolution for the self-consistent, unbiased rms-emittance estimation, enhancing its robustness and trustworthiness. The upgraded program has been used to reevaluate previously analyzed emittance data. The new results show in much greater detail the quasi-random variations of the bias estimated from the average outside current, as well as of the resulting self-consistent, unbiased rms-emittance estimates. No significant surprises were found because the previous estimations used a relatively fine grid established through a labor intensive, painstakingly slow, manual process.



The Ion Source presentation has been submitted for the DOE review. The final version has significantly profited from comments and suggestion obtained in the dry run and from Rod Keller.

Survey and Alignment Group

Mechanical Group

RING Systems Installation activities

- Installation of the HEBT SB cable tray was completed.
- Installation of the HEBT SB transformers continued.
- Installation of the HEBT SB AC distribution continued.
- Installation of the HEBT tunnel cable tray continued.
- Received RING half-cell #8 magnet assembly and staged it in the HEBT tunnel.
- ASD took BOD of the RING Service Building on Friday May 2.
- ASD took BOD of the RING Tunnel on Friday May 2.

Water Systems Installation

- Installation of the RFTF piping continued.
- Installation of the D-Plate tunnel water system was begun.
- Repairs on the RCCS 2 water skid were begun.
- Fabricated manifold for the portable chiller used to cool the 4 suspect drift tubes on DTL 3.

- Continued work on repairing monitoring sensors for DTL 3.
- Continued support on the injection beam dump piping.
- Nine of the DTL 3 flowmeters were returned to the manufacturer for evaluation.

Magnet Task

We have completed measurements on several 16CD20's.

We have staged two HEBT dipoles and inserted the beam pipe that fits between them. Fit looks good.

We have also mapped several DTL Tank 1 PMQ's.

HPRF

Completed the termination and checkout of fiber-optic timing links between the IOC and the DTL 5 & 6 transmitters.

All electrical cables pulled for DTL 5 & 6 transmitters, termination in progress.

Installed 402.5 MHz klystron on DTL5 HV tank and connected ion pump.

Signed off on DTL3 RF system readiness and supported DTL3 RF power testing.

LLRF

ORNL

The installation and checkout of the DTL3 RF control system is complete. High power testing of DTL3 began on May 01; the ORNL team is actively supporting this effort. The DTL1 RF control system installation is nearly finished and is on track to support DTL1 testing and commissioning.

Mark Crofford spent the week of April 21 at LBNL assisting with the checkout of the DTL1 RF control chassis and the troubleshooting and repair of the spare MEBT RF control chassis.

Craig Swanson will be at LANL the week of May 05 to assist with testing of the new Field Control Module.

LANL

Work continues on producing the “Rev 0” of the new hardware platform for the LLRF system. The hardware platform consists of the following boards:

Analog Front End (AFE): This board has passed all the unit tests and is ready for integration with other hardware components.

Digital Front End (DFE): Following a minor change to the prototype board we have been able to successfully program the onboard FPGA chip. Craig Swanson of ORNL was at LANL to assist with board testing. The board is largely tested without any identified problems and is currently undergoing further unit testing to measure the noise characteristics of the components. Next week we will begin integration testing of the RFO and the DFE boards. These tests are expected to be completed by May 12.

RF Output (RFO): Testing of the first assembled RFO began last week. All testing is currently being done on the RFO circuit by itself, without the DFE test board, as per the test plan. No major problems have been observed so far. The RFO consists of four sub-circuits which are: 1) clock generator, 2) DAC IF generator, 3) RF Mixer and output, and 4) Interface circuits. Each of these sub circuits has been tested. The IF DAC digital operation has not been tested, but the same DAC has been successfully used in Larry Doolittle's IF chain. The output gain of the DAC IF driver has been adjusted and the impedance match to the mixer verified. The output match of the mixer was

optimized for both the 402.5 and 805 MHz cases. Additional small improvements may be possible in the future (giving a dB or two more output power). Verified the operation of the variable gain control and mapped out it's transfer function. This will need to be repeated with the serial interface circuit during the integration testing. Studied the output spectral response, which lead to re-characterizing the BPF and re-soldering the filter to the circuit board. This fixed most of the spectral pollution that had been observed earlier. Changed the output amplifier to a different one that had 7 dB more gain than the original. This gives enough output for the 402.5 MHz case, but may be a few dB low for the 805 operation. We may add an addition amplifier to the next revision. Testing of the output power at 805 MHz as well as the IF DAC operation are the remaining items in the unit test plan. In the platform integration phase all of the computer control functions will be tested. This will involve using the DFE FPGA code and the DFE operation.

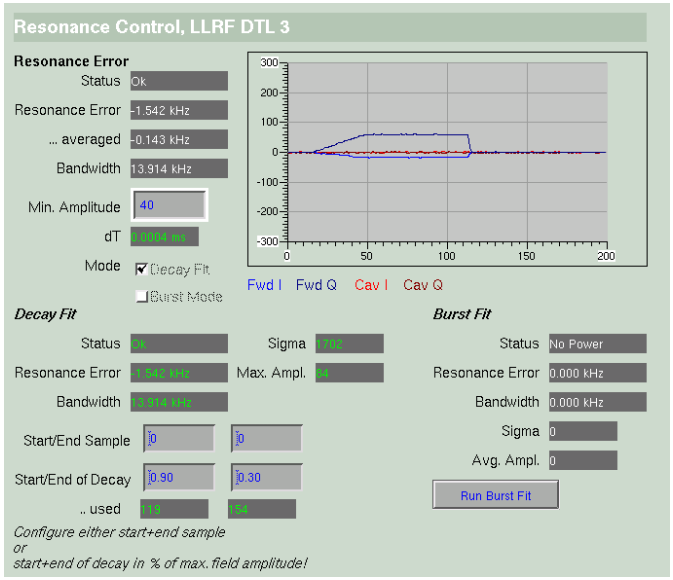
VXI Motherboard: The assembly of the first two prototype boards was completed on April 21. In stand-alone mode they have passed all the tests. The board also responds well with EPICS testing, that is A16 access looks good and A24 mapping produces no error. We will begin integration testing with the DFE daughter card Monday May 5.

We are approaching the final steps of unit testing all of the hardware components. So far we have not identified any "show-stopping" problems with any of the boards. With only minor tweaks they have performed very close to or exceeded the specifications. The next phase is integration of the hardware components as well as the integration of hardware, firmware and software. We are still on course to have a system ready for testing with the DTL at ORNL in June.

Work continues on the final REV of this board. It will be released to fabrication and assembly the week of May 19. Paul Stein of BNL (formerly of LBNL), who designed the original firmware, completed the modifications to the PLD code and delivered to LANL. We expect to receive a unit for testing beginning of June. Work is also continuing on complete system and user documentation.

Sung-il Kwon attended a Xilinx workshop on testing and simulating VHDL firmware in conjunction with MATLAB model. With this capability, we can test the VHDL implementation of our controllers including the klystron local loop controller, beam loading estimator and feedforward controller and the phase and amplitude PI controller.

Work was also done this week on the LLRF and RCCS integration. In conjunction with DTL3 commissioning, we successfully tested the resonance error determination software on the ORNL DTL3 LLRF IOC. As per the snapshot below, it could determine the error as ~ -1.5kHz, the computed bandwidth of ~14kHz would make sense according to Lloyd Young. The RCCS software will be shortly modified to properly correct the reported error.



LBNL

The main highlight is that we completed the move of our LLRF lab to its final, much more adequate location. The new lab will allow us to continue firmware development and test stand operations, while fabricating the balance of the DTL systems and supporting the final hardware under development at Los Alamos. In preparation for this, I will request SNS to loan us a VXI crate from the batch purchased last year for LLRF so that we can use it in testing the final hardware.

With the move, we have now completely re-installed the cavity test stand, and verified the closed loop operation of the system.

Larry also completed his first attempt at the firmware necessary to operate a cavity off-frequency in open loop mode. This is needed to support the testing of the DTL tank n.3 to high duty factor. The code is complete and has been synthesized. Its testing will begin on Monday, on the cavity test stand; the code could be released shortly after that if the testing is successful.

The procurement of the parts for the final production run is proceeding well. The filter's manufacturer RLC, responsible for the only long lead items in the process, reports to be on time for the promised delivery in early June.

A review of the half-year expenses confirms that we have slightly under-spent our budget according to our original spending plan. All in all, the expense reports show that we are on schedule and within budget.

Two important accomplishments completed since my last report. Larry completed the debugging of the digital board that was showing erratic behavior. This was found to be caused by one bad nano-engine that was returned to the factory. The defective nano-engine was part of the MEBT system that has been returned from SNS for repairs.

The spare MEBT system has also been repaired with the assistance of Mark Crofford.

Electrical Group

Ben Cole will be joining the group on 5/5/03 as a field engineer for the HEBT and Ring electrical installation.

In the weekly modulator teleconference with Dynapower, it was learned that the recently enhanced QA/QC effort discovered that the high voltage rectifier assemblies that were assembled at Dynapower included some sub-assemblies that were not correct. The problem is that some rectifier board components were not soldered in place as required, but only inserted in place in the boards. This leads to intermittent contacts that may fail. This problem was found in all rectifier assemblies at Dynapower, so the three units currently at SNS: DTL ME1, DTL ME2, and RFTF ME, may also have this problem. The rectifier assemblies are bolted together and mounted in the oil tank. Removal and replacement of an assembly would take 12-16 hours. Inspection of boards at this time takes several days based on disassembly of the rectifier stacks and reassembly. LANL and Dynapower will try to develop an inspection procedure using a bore scope that does not require rectifier stack disassembly. Meanwhile, Dynapower will ship a replacement, inspected rectifier stack to SNS for arrival by 5/9/03 so it may be retrofitted into DTL ME2. Operation of DTL ME2 can continue with present power limitations, but there is a risk of failure until these components can be replaced. A decision on the remaining 2 SNS units, whether to replace the rectifier units or inspect in-house, will be made next week.

DTL 4 and 5 corrector power supplies have been tested at RATS in preparation for installation next week in the klystron gallery.

The 5000A, 18V ring medium power supply was tested at RATS with a ring dipole magnet to 3500A. Full current testing was not performed due to the need for a larger circuit breaker and disconnects - with the move from RATS to the site in two weeks, the cost of these building modifications was deferred. Additional testing will take place in the klystron gallery where full ac power breakers are installed.

MEBT corrector power supplies controls were modified by the Controls Group to eliminate the high frequency oscillations caused by loading of the power supply by the low-impedance control system ADC. These power

supplies were retested and recalibrated by the Electrical Systems Group. The oscillations have been eliminated and the power supplies are fully operational.

HEBT SB tray grounding finished, straight portion of the HEBT as well. Preparations for straight section pulls completed and cable pulls will commence on Monday. DTL 1 and DTL 2 thermocouple pulls done, partly terminated.

After a visit to Dynapower over the weekend, it was determined that the fire inside the safety enclosure was a result of undersized conductors and oversized breakers on the ac circuitry. We subsequently upgraded the wiring inside the DTL-ME2 HVCM safety enclosure and IGBT switch plate assemblies to prevent a re-occurrence at ORNL. Other units are scheduled for similar upgrades. The SNS Electrical Safety Committee reviewed the modification and authorized restart of the unit. An apparently faulty gate drive PCB was also changed due to other faults experienced last week, and the unit in now operational and supporting DTL3 conditioning efforts. The LEBT chopper mixer box is nearly complete, with testing on the capacitive divider completed this week (see attached waveform). The two repaired LEBT pulser units arrived this week, and will be installed next week.

Cryo Systems Group

CHL: Work continues on the installation of the instrument air and LN2 piping. The purifier-piping contract has been released to the contractor. This is the last large piping package for installation. The shipping braces have been removed from the purifier cold box. The 7000-liter helium dewar and the support structure for the dewar have arrived from the vendors.

Tunnel: The final 12" outer vacuum jacket weld has been made on the upstream return modules. This completes the installation of the upstream return modules.

RATS: WE are 50% completed on the assembly of the transfer line valve actuators. WE continue to transfer equipment and tools to the RATS 2, CHL and storage areas.

Beam Diagnostics