Accelerator Systems Division Highlights for the Week Ending February 28, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments this week: (1) CPI 550-kW klystron #11 successfully passed its acceptance test. (2) The first Thales 5 MW klystron continues its tests at Los Alamos. The unit reached full power levels this week (peak and average) and is operating well. It operated for >10-hour shifts at 60 Hz, RF pulse width of 1.25 ms, and RF output of 5 MW peak, with input pulsed-DC of 135 kV and 70 A. Efficiency levels are still under investigation, but they appears to be very close to the specification of 55%. (3) The final test of the first SC linac transmitter unit is currently under way (the 24-hour heat run). The unit is scheduled to ship to ORNL on Saturday.
Concerns & Actions: (1) A new o-ring material was proposed by Titan-Surebeam for the 5-MW load that failed. They are sending us the o-ring, and we will install and test it. In order to continue with the tests of the Thales klystron described above, we are splitting the output RF waveguide into 2 loads borrowed from LANSCE. (2) CPI 550-kW tube #10, which passed last week, failed its vacuum-hold after the ion pump was turned off. The tube is back on the test stand for RF conditioning. Another vacuum-hold test will be conducted over the weekend. (3) Dan Rees and Don Rej met with CPI management. They discussed the importance of the 550-kW klystron production schedule being consistent with the SC linac commissioning in FY05. They also discussed possible impact of increasing the number of 550-KW klystrons from this vendor. Performance and commitment from CPI to date has been good, although component delivery, product yield, and bakeout station and test stand availabilities have posed schedule risks. We agreed to meet again in about three months to reevaluate progress and amend actions, if necessary.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) We continued to support operations and extended heat runs of the Thales 5 MW klystron. Operations this week were at the full average power (135 kV, 70 A, 60 Hz, 1.35 ms beam gate pulse) for >20 hours. (2) Production 140-kV HV Converter Modulator (HVCM) unit #3 was successfully tested at Dynapower and accepted. Unit will be shipped to ORNL on 3/3, following the 24-hour burn-in test. Unit #2 was shipped to ORNL on 2/27. We appreciate the presence at Dynapower by David Anderson and Jim Hicks (ASD); they were instrumental in accomplishing these successes.
Concerns & Actions: (1) Last week we reported that the prototype HVCM had a failure of two switch plate assemblies. We completed the repair, and this unit is back in operation. Repairs consisted mainly of a rebuild of the IGBT switch plate assemblies. The primary evidence (arcing) suggested problems related to mechanical connections. Investigation of failed Mitsubishi assemblies showed loose connections, and a detailed look at the Mitsubishi collector and emitter tab construction showed a thin tab (0.040") and a small captive nut. The Mitsubishi tabs showed significant "cold flow" related problems (thin tab, small nut, small area loading), implying the loose connections were not due to assembly problems, but a poor tab/nut design. The switch plates were rebuilt with Eupec IGBTs that have a more solid tab/nut design. Operations to date with these units show no evidence of the cold flow seen with the Mitsubishi devices. (2) On 2/27, the SCR controller developed a surging problem due to a bad SCR gate trigger board. A spare board was installed, and we were back in operation at full 850-kW average power later in the day.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: (1) Twelve more Tank-3 drift tubes were shipped to ORNL this week, which makes a total of 29 out of 33 required. PMQ drift-tube 3-7 and 3-9 stems are being straightened and will likely ship on 3/3. (2) For the two remaining Tank-3 drift tubes, dummy BPM 3-2 is in route to ESCO for welding, and dummy BPM 3-8 is at CMI for weld preps and caps – projections are these will ship by mid-March. (3) Ten top hats were shipped to ORNL this week. (4) Eight Tank-1 drift-tube bodies are at CMI for final profiling, 21 drift-tube bodies are at ESCO for body/cap welds, and 10 more drift-tube bodies are at CMI for cavity machining. (5) The next-to-last batch of Tank-1 body-to-diverter braze joints were leak checked and sent to CMI. (6) Tank-1 dummy EMD drift tubes are ready for diverter braze (last Tank-1 braze) and will be brazed early next week. (7) The Tank-1 RF drive iris is undergoing centerline braze (heat is underway); a machining error found was determined to be OK from an RF viewpoint, but we are checking the structural impact.
Concerns & Actions: (1) 29 of the 33 Tank-3 drift tubes were shipped on schedule (Feb. 28), but the remaining 4 will be shipped within the next two weeks -- we are following these on a daily basis. (2) As reported last week, our DTL-3 critical path item is the top hats where we need to re-plate surfaces -- we are at Kaehr Plating in Albuquerque

this week along with a LANL MST-6 plating expert attempting to solve the copper plating difficulties. (3) Tank-3 post-coupler tip final machining was delayed because the machine was employed on Tank-1 drift tubes, but we expect to complete these next week. (4) A face ding in rewelded drift tube 3-24 is likely OK, but may require dressing with a diamond file. (5) Electroless-copper repair on leaking drive iris #3A failed – we will attempt a braze repair instead. (6) Our Estimate to Complete for the DTL remains imprecise until contacts are finalized. Negotiations are on going with CMI and others.

COUPLED-CAVITY LINAC (WBS 1.4.4)
Accomplishments: (1) CCL segment #3 was brazed. Two have passed leak tests, and the remaining unit will be tested next week. The first article milestone has now been authorized for payment to ACCEL. (2) A meeting with ACCEL was held this week at LANL to review contractual issues and finalize plans for beginning Module-1 assembly work and for initiating HEBT cavity-manufacturing cost estimates. Additionally, ACCEL will submit a manufacturing plan for the additional support stands as requested based on our discussions of the mechanical requirements. (3) The CCL hot model was shipped this week to ORNL, arriving today. The hot model will be ultimately installed in the SNS RF test facility, but it will be used initially to develop a detailed alignment-mapping scheme to aid in module assembly. (4) The water-flow test cart arrived at ACCEL this week and will be readied for use in testing the half-cell assemblies and the full segments. (5) The leg assemblies for the Module-1 support stand have been delivered to the heat-treating house in Phoenix. Furnace stress relief activities will occur early next week. (6) The drawing modification was completed at LANL for the addition of some required extra target locating holes in the CCL segments to facilitate segment mapping prior to starting module assembly at ACCEL.

PHYSICS, DIAGNOSTICS, CHOPPER (WBS 1.4.5)
Accomplishments: (1) The first draft of the Linac Physics Design Report was reviewed and a schedule agreed on for publication in FY03. (2) Five DTL BPMs were completed and are ready to be installed into drift tubes. (3) All remaining actuators needed for DTL-1 and the D-plate were shipped to ORNL on 2/26 along with the D-Plate adapter spool piece containing the current transformer and BPM. The mechanical assembly drawings needed to install the D-plate into the tunnel were also completed, thus completing the last remaining item needed to meet the 2/28 D-Plate UC milestone. (4) MEBT chopper pulsers #3 & #4 (positive & negative) passed their acceptance tests at DEI on 2/11, witnessed by LANL and ORNL personnel (Fig 1).

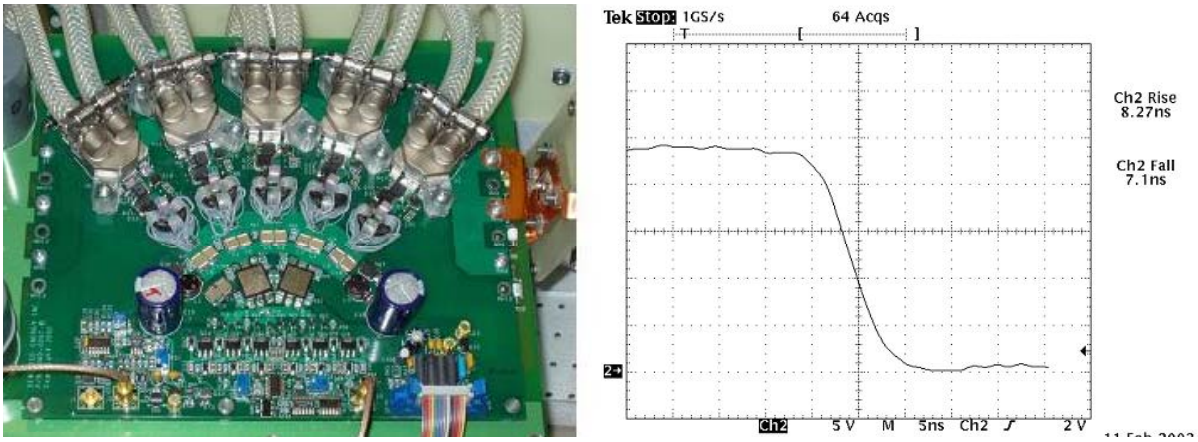


Fig. 1: One-half of the MEBT chopper pulser output switch assembly (left), and typical output pulse fall-time of about 8 ns at 2350 volts (right).

Concerns & Actions: ORNL requested that we build an extra DTL BPM so that the one with slightly warped lobes can be used as a spare. A formal transmittal from ORNL is needed soon to authorize us to proceed with a budgetary estimate. These are long lead-time connectors.

PROJECT MANAGEMENT (WBS 1.4.6)
Accomplishments: John Bretzke visited ORNL to discuss project controls and installation issues with SNS staff and management.

ASD/JLAB: Cold Linac

ASD/BNL: Ring

Work continues on ETC.

BNL was host to an ASD Diagnostic's review team this week. Emphasis was on documentation, handoff and equipment acceptance. The review was held in preparation for upcoming ASAC, Project DR, and DOE.

Presentations are being developed for the ASAC Review.

An addendum is being prepared to update the existing System Requirements Document (SRD) for WBS 1.5, Ring Systems.

Ring half-cell #2 was shipped to SNS/OR this week. Assembly continues at BNL on units #3, 4 and 5.

Magnetic measurement (acceptance) of the first article 21S26 sextupole was started this week.

Magnetic measurements of the 21Q40 Ring quads continues; 27 of 29 are fully measured.

Stangenes has resumed assembly of the 26Q40 production magnets. We hope to receive a production first article in April.

An RFQ is out for the production quantity of radiation hardened copper conductor for the RTBT 36Q85 magnets. Bids are due soon.

A 3D model of the momentum beam dump, detailing the footprint requirements, is being prepared for submittal to ASD.

Ring Primary Collimator: we have been given direction by the BNL/SNS Physics Group to proceed with a uniform aperture (elliptical shape) for the vacuum beam pipe.

Controls

Sheng Peng at BNL has received his H-1 visa at last. Tiffany Grant at ORNL has graduated from the ITT Technical Institute. Congratulations Sheng and Tiffany!!

The Controls Team at ORNL hosted a two-day workshop on EMI, RFI, grounding and shielding, with Mike Thuot and Lloyd Gordon of LANL. The workshop was well attended, and engendered lively discussions. Some plans for noise mitigation are being modified as a result of this workshop.

The Controls Group participated in a successful design review of the communications backbone "blown fiber" installation contract. (Controls has interfaces with this Conventional Facilities contract.) Controls will provide the racks, splice housings, and connector housings for the fiber terminations.

Cabling design continues. Installation documentation was prepared for communications cables in the CHL. Translation of LANL vacuum system cabling design into an ORNL design (to match cables already pulled) is in progress.

Development timing systems are now running in two new offices at 701 Scarboro road, each with dual V206's generating a 16-frame RTDL. The timing Master software has been modified to produce useful information on the following new RTDL frames:

- Ring Revolution period.
- Width of Beam Pulse
- Width of Warm Linac High-Power RF pulse
- Width of Warm Linac Low-Level RF pulse

- Current Pulse "Flavor"
- Previous Pulse veto status

The Joerger counter module is now successfully measuring frequencies from a waveform generator. We are just a cable away from actually measuring the timing system clock frequency.

The V108S utility module test stand, including timing system, reset, and RTDL tests is complete at BNL. Ten of the 23 rev. C utility modules have been tested - the remainder should be finished next week.

The latest revision of the V123S (SNS timing encoder module) has been installed in the timing master IOC at BNL. It will be fully tested after the utility module testing is complete. The first V294 (TTL fanout) module was successfully tested in the BNL timing master system. It has now been installed in a Power Supply IOC, replacing the previous RHIC V194 module, and is functioning perfectly.

A second cut at Ring Control system block diagrams was finished - a third cut will be needed. CF controls racks for the HEBT Service Building were delivered.

Agreement was reached to use HI-Tech as the IOC interface for RS-485 signals.

The Marshalling Panel control system racks for the Medium Beta Cryomodules were received from DCS. These racks house the equipment for monitoring the cryomodule helium pressures and controlling the cryogenic system valves (5 per cryomodule) and coupler window heaters (1 per cavity). The Control System racks for the Central Helium Liquefier Gas Management system were installed in the CHL building. Power has been routed to the CHL control room, mezzanine, and gas management ICS racks.

The development of the initial version of main alarm summary screens for the Central Helium Liquefier equipment has been completed. The screens are being tested with simulated signals.

Installation

Craft Snapshot 2/26/03

ASD craft workers	56.0
Foremen, ES&H, etc	9.0
Less WBS 1.9 controls	3.0
Less absent	2.0
TOTAL	60.0

Installation of the 402.5 MHz Reference Line began this week.

A meeting was held on 24FEB03 with CF to finalize the Front End Building shielding wall support. It was decided in that meeting to pour a concrete support for the stacked brick. That decision is now under review. It appears likely that wall construction will not begin on 03MAR03. The exact impact on DTL #1 Tank installation is not determined, but it is potentially delayed beyond 13 MAR03.

In the Division Director's Weekly Installation Update the RCCS/Vacuum System cabling interfaces between Global Controls, Electrical Group and the Vacuum System were resolved.

The second and third, HVCMs are expected to be shipped from Dynapower to SNS this week.

A decision to proceed with the 10 - plex trailer proposal for ASD site offices was made this week. CF is working on a firm cost estimate that includes site prep and utilities. The preliminary schedule received from CF indicates that the 10 – plex can be installed by 06MAY03.

The first production Dipole Girder arrived from BNL.

It was determined that HB Waveguide delivery cannot be reasonably accelerated. Waveguide installation will be out of parts at the end of the month. Installation will be interrupted until the last HB Waveguide delivers on 19JUN03. At that date there will be all parts available necessary to install complete subsystems.

Accelerator Physics

Applications programming collaborators from COSYlab and LANL were in town this week to discuss software progress and plans.

M. Doleans and S. Kim reported on "ideal" compensation of Lorentz-force detuning. In this compensation scheme, the piezo is driven CW with a forcing function consisting of 60 Hz harmonics, chosen appropriately to exactly cancel the Lorentz force detuning. Good results are achieved with as few as two 60 Hz harmonics.

The group is preparing presentations for ASAC. Henderson, Galambos, Aleksandrov, Cousineau and Holmes will be presenting.

Prototype, MATLAB-based applications for DTL commissioning, including phase-scan, beam-loading scan and emittance analysis have been produced.

Operations Group

CLO Planning – The ASD Office and Lab planning for the CLO is essentially complete. We plan to turn in the ASD office request Thursday.

The Conduct of Operations has been written and is being reviewed for the ARR.

Talks are being prepared for ASAC

We met with Joe Huggins from CF on the support structure for the Block Shielding in the Front End Building-Linac Tunnel interface. The design is complete and the parts ordered.

Ion Source Group

The new hybrid source is being tested on the hot spare stand with a relaxed extraction gap. It produced up to 30.4 mA, which equals the 30 mA current typically reached with a relaxed extraction gap at LBNL. The source ran with a duty cycle up to 6%. The RF power ran up to 59 kW forward with up to 9 kW reflected with no signs of arcing, a great success for Yoon Kang's new RF connection.

Although this test just equals results obtained at LBNL, it is an outstanding success for the hot spare stand where only the RF power and the Hydrogen gas flow are computer controlled. The matching network and the cesium collar temperature are currently controlled with long plastic rods. Changing pulse length, rep rate, and e-dump voltage currently require the high voltage to be switched off, which makes tuning the source cumbersome and time consuming.

Towards end of January we accepted ion source #2 from LBNL under the condition that we would return it at the end of the FE commissioning. To improve our readiness for DTL commissioning LBNL offered to accept the R&D source in return. This is wonderful because it may allow us to have 3 fully tested ion sources ready for DTL commissioning, or at least to have two sources and an almost complete set of spare parts.

Using a transit the survey group found that the RFQ entrance was 2.3 mm higher and 0.9 mm too the right of the nominal beam axis while the RFQ exit was on axis. This was confirmed with the laser tracker, which then was used to realign the RFQ. In addition it was found that the LEBT axis was 1.4 mm away from the RFQ axis, about 35% of the radius of the RFQ entrance aperture. The survey group started to fiducialize the LEBT flange and the ion source adapter flange to simplify future tracking of the LEBT and ion source.

When the LEBT was removed it was found that one of the extraction electrode standoff became unglued and at least two of the lens 2 standoffs broke.

After the LEBT was removed, we found extended signs of unwanted activities in the LEBT chamber. In addition to markings from extended discharges, there are also strange small black marks as if the surface was hit be something.

One of us participated in the grounding and shielding workshop taught by Lloyd Gordon and Mike Thuot. A visit to the hot spare stand and to the site resulted in numerous suggestion that should help to reduce emissions from the ion source and LEBT.

Survey and Alignment Group

Mechanical Group

Water:
All the hard piping rework for the RFQ was completed.
All the hard piping rework for the DTL1 was completed.
The hard piping for DTL2 was completed.
The hard piping for the dummy beam stick was completed.
The hard piping for the ME1 & ME2 HVCM was completed.
The Temporary Tower and chilled Water systems were relocated and are operational.

We have received 23 more DTL-3 drift tubes in RATS this week. The total in hand is 29. The last 4 are expected by the end of the third week in March.

Fifteen DT's have been fiducialized. The process is going smoothly.

The vacuum pumps have been installed on the DTL-1 tank in RATS. Leak testing will begin next week.

The DTL-1 cooling manifold installation is 75% complete in RATS.

Drift tube installation testing is planned for next week.

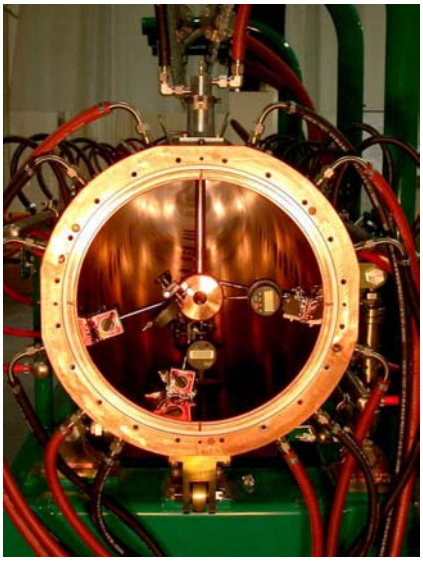
Taut Wire System

Laser Tracker

Drift Tube Fiducialization

DTL 1 Assembly in RATS

DTL 1 Manifold Assembly in RATS



DTL 1 DT Test in RAT

Magnets

We have continued installing beam tube in HEBT dipoles. Five are completed now.

We received the second Half-Cell from BNL.

DTL Quads field check complete - 10 off.

Linac HPRF

2MHz RF ion-source transmission system has been upgraded for reliable high power operation of the ion-source.

Solid-state drivers of the RF power amplifiers for the MEBT rebuncher cavities have been upgraded and bench tested for more stable higher power operation.

Linac LLRF

ORNL

JLAB Test
Mark Crofford and Mark Champion were at JLab preparing for and carrying out tests of the low level RF control system with the first production medium-beta cryomodule. During their checkout of the control system, they found and corrected an incorrect entry in the EPICS llrf.db file. More seriously, while operating the control system with a 1 W amplifier and a cavity at 2K, they discovered a hardware problem with the digital board. A replacement board was sent overnight from LBNL. The replacement board exhibited a different hardware problem, which was repaired by reflowing several solder connections. The low power tests were carried out on cavity 1 and were essential for confirming proper operation of the control system. Meanwhile high power RF conditioning of cavity 3 was performed on Friday with accelerating gradients of ~20 MV/m being reached during the afternoon. Open and closed-loop operation of cavity 3 at a gradient of ~10 MV/m was carried out for the first time on Saturday, Mar. 01.

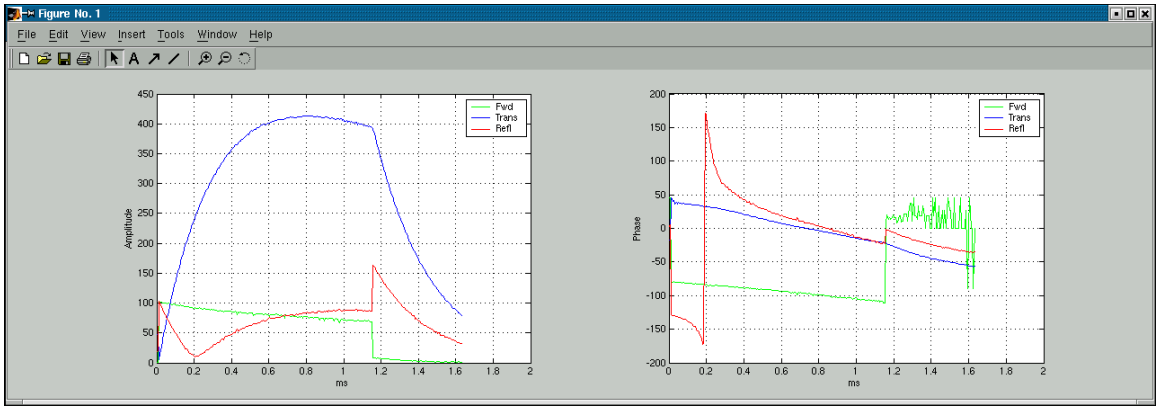


Figure 1. Open Loop control on Cavity 3 of first production SNS medium-beta cryomodule. Operating parameters: 10.9 MV/m accelerating gradient, 30 Hz rep rate, and 1.15 ms pulse length.

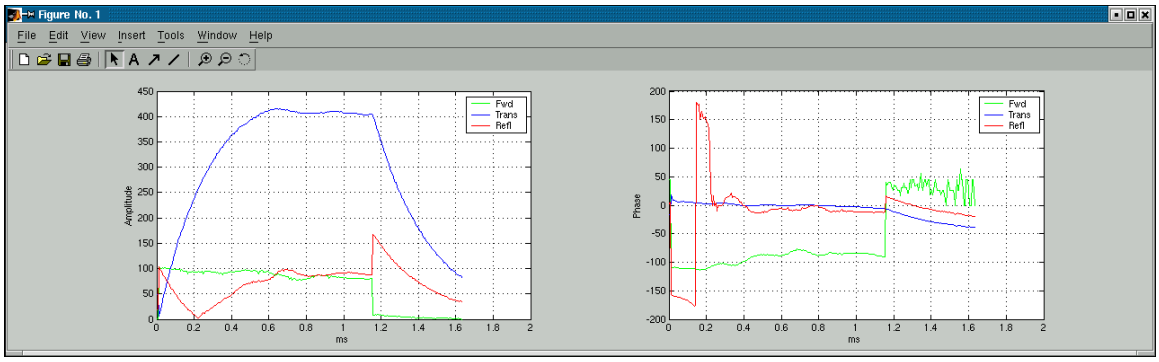


Figure 2. Closed Loop control on Cavity 3 of first production SNS medium-beta cryomodule. Operating parameters: 10.9 MV/m accelerating gradient, 30 Hz rep rate, and 1.15 ms pulse length.

Further testing of the LLRF control system will be carried out next week. Larry Doolittle and Alex Ratti of LBNL will arrive at JLab on Sunday night, 3/02. Kay Kasemir of LANL will arrive on 3/03.

Reference System
The installation of the reference system began this week. The tunnel hangers have been installed; the installation of hangers in the vicinity of the RFQ and DTL1-2 is in progress. Reference system highlights include:
a. Rigid line rebuild components finalized with Connecticut Microwave.
b. Finalized reference RF bend position in DTL1 shield wall.
c. Received quote from RFS, preparing order.
d. Differential Phase Measurements: took data at temp = 90F, 80F, changed setpoint to 85F.
e. Temperature Control System: Received Omega temperature controllers with embedded Ethernet interface, configured and set up one on in RATS.
f. Communicated with controls group regarding temperature controller requirements, meeting scheduled for Mar. 3 at 9:30 am in 701 building.

Performance Measurements and Analysis
a. Tested the off-resonant frequency output function on the RFQ LLRF control chassis and verified the offset frequency of DDS up to 100 kHz on the 50 MHz output.
b. Received the test report and data on the jitter and internal noise performance of the LBNL LLRF control chassis. We are currently studying LBNL test report, and double-checking the analysis and results.

Installation
Termination of Heliax cables for the DTL LLRF systems are scheduled to begin Mar. 03.

Miscellaneous
a. The funding PCR for FY03 through FY05 has been approved. It follows the Estimate to Complete that was agreed upon in December by Hamid, Alex and Mark.
b. A team videoconference was held on Wednesday with attendance from JLab, ORNL, LBNL and LANL.
c. Several members of the ORNL team attended a Grounding and Shielding workshop on Feb. 27-28.

LANL

Hardware Platform
Work continues on producing the “Rev 0” of the new hardware platform for the LLRF system.

a. Analog Front-end (AFE): Bergoz is expected to ship the prototype units 2/28/03.
b. Digital Front-end (DFE): The board is being fabricated now and will go to assembly next Tuesday. Suntron has received the long-lead parts kit that was shipped from LANL and is auditing the parts for assembly next week. According to Suntron we are still on track for a 3/12/03 delivery (two days ahead of the original schedule of 3/14!)

c. RF Output (RFO): We received review comments from two external reviewers and these were incorporated in the design. The board layout will be complete on Monday morning. In light of the fact that this board has a mix of analog and digital components and to ensure proper routing, this board has been done completely by hand. We will send out requests for quotation from Suntron and our normal board suppliers on Monday. We will use the quotes to decide whether to assemble the boards in house or to use Suntron. We are still on track to meet our scheduled release-to-fabrication date of 3/5/03. The expected delivery date is still 3/27/03.
d. Motherboard: All parts are placed on the board and we are working to finish last-minute schematic revisions. The review material will be sent out on Monday. There may be an issue with limited front panel space for required connectors and LED's. The anticipated release date to fab and assembly is 3/12/03. We may also choose the option of fabricating this board in house.
e. DFE Test Board: To help with testing the AFE and the RFO boards we have decided to build a simpler (bare-bone) version of the DFE. This will use a much simpler FPGA and will lack many of the components of the DFE. The board will also be quieter in terms of noise to help with the validation of the AFE & RFO. The schematic will be ready on Monday 3/3 and the design will be released to assembly by 3/12. To expedite the delivery (and to reduce cost) we will assemble this board in house.

After the release of the schematics, during the first half of March we will work on readying the SNS diagnostics PCI board to serve as a test bed for the DFE and the DFE test board. We still anticipate to test the hardware platform through the first week of April and to start firmware/hardware integration the remainder of April. In May we will have full system integration tests with the VXI motherboard and will test the entire package with a dummy test cavity at LANL. We are still planning on having a system ready for test with the DTL at ORNL in June.

HPM
a. Two HPM REV Ds returned from ORNL have been updated to the latest mods and firmware. They have been calibrated and retested will be shipped.
b. REV D Acceptance Test Procedure (ATP) and ATP Data Sheet have been reviewed and released.
c. Work was also started on the REV F (and hopefully the final REV!) of HPM. A specifications list for this REV has been generated and sent to reviewers for comments. We plan to send the schematics out for review by 3/10.

Applications Firmware and Software
a. Performed a detailed comparative analysis of the Extended Kalman filter and least square method for resonance calculation.
b. Work continued on improving resonance calculation. This included adding an "error" calculation to Larry's fit, hoping to use it as a quality control for the calculated values. This will be tested next week at JLAB. The resonance calculation was also implemented in C and was verified with the MATLAB version. This was added to the LLRF IOC, which will be the ultimate platform for the computation.
c. We also tested the resonance control algorithms with 20 kHz 3 dB bandwidth Normal conducting test cavity. The tested algorithms were the least Square (Doolittle) and the extended Kalman filter (Kwon). The cavity resonance frequency was tuned with a network analyzer. The test results are that for resonance frequency error within +/- 3dB bandwidth, the two algorithms yield similar results. However, when the resonance frequency error is outside the +/- 3dB bandwidth the results are not good. We will try to verify this at JLAB. This may indicated the need to apply resonance frequency hunting by programming the RF driving frequency.
d. The interface control document (ICD) specifying the firmware specifications including interface between the hardware, firmware and software was completed.
e. Work was also started on setting up a VHDL test facility using MATLAB. This included defining the requirements, defining the format for MATLAB stimulus and response files as well as the parameters for simulation.

Testing
We continue to work with LBNL's LLRF system in our test cavity lab. This is a very useful setup and has been used for a number of experiments, e.g., investigating the interrelationships between various system parameters, and the steps required to set up the system properly. It has allowed us to test different resonance control algorithms, experiment with noise levels, etc. We are also continuing the development of test plans for individual boards as well as for system integration and validation.

Concerns
At the end of the 5th month of the fiscal year we have spent ½ of our budget. Several factors have contributed to this including many refinements of the HPM boards, HPM test stands, higher cost for purchased software than originally planned, as well as higher production cost for prototype hardware. While many of the additional costs are one-time and do not scale for the rest of the year, budget remains a concern.

Electrical Systems Group

Work will start next week in installing DTL 1 and 2 corrector power supplies in the klystron gallery.

The first article ring medium power supply, 5000A 20V, has been shipped by the manufacturer to SNS and is due to arrive next week.

Ken Rust visited Alpha Power Supplies in CA, the vendor for the SCL Power Supplies, to observe 1st testing. Power supplies easily met all technical standards; some clean up work is need for controls.

A High Voltage training (NTT) class sponsored by the Electrical Group was given to 20 members of the division.

HEBT and Ring Service Building AC panels, transformers and cabling and DC cabling specifications have been completed and are ready to order.

CHL compressor 4.1 kV motors were polarization index tested successfully to verify integrity of the motor windings.

CHL 480V motors were phase rotation tested. This involves briefly powering the motors to determine rotation direction. Tests were successful.

Cryogenics Group

CHL: We are electrically testing the warm compressor motors prior to energizing them to check for proper rotation. The piping contractor is starting his high-pressure acceptance testing of the south wall piping.

Tunnel: The last 8" clamshell was welded on the upstream return transfer lines. We will be cold shocking and leak testing next week.

Transfer lines: WE have completed return HB19/20. The east end can (HB21) is 80% completed. The return end can is 40% completed.

Beam Diagnostics