Accelerator Systems Division Highlights for the Week Ending January 24, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments: (1) We started operation of the RF test stand last weekend as planned, running 12-hour shifts over the weekend and 24-hour shifts during the week. (2) Following startup, we completed burn-in testing of two 550-kW, 805-MHz CPI klystrons this week. We now have 4 ready to ship to ORNL. (3) We also started to test 402.5-MHz windows using the Marconi klystron, running up to 1.5 MW. (4) We installed the socket and magnet for the Thales 5-MW klystron in preparation for beginning high-power tests next week. (5) The CPI klystron S/N 8 completed its factory acceptance tests this week. (6) The first superconducting transmitter began its final factory acceptance tests this week. It is expected that the complete test will take approximately 3 weeks.
Concerns & actions: (1) We need to make up for lost testing time caused by the prototype HV converter-modulator shutdown over last two weeks. Now that we are in operation, our strategy is to complete the backlog of windows and 550-kW klystrons and then push the HV operation for the 5-MW klystron.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) The prototype HVCM has run well for the RF-test operations going on since last weekend. (2) Our modeling with new dynamic saturation data shows operation with soft switching. Because of the lower impedance of a 5-MW load, the modeling shows lower IGBT losses than with a single 2.5-MW load. Using modulator operational data with a single 2.5-MW klystron, which give 37-kW loss for 12 IGBTs, the estimate is 30-kW loss with a 5-MW klystron. Consulting with General Atomics (Edward Bowles) on their recent IGBT performance measurements indicates their results agree with ours, giving a better indication that 5-MW operation will match our expected performance. (3) The long-lead dual IGBT cooling base plates were received. (4) Production of boost transformer reinforcing clamps ("popsicle" sticks), which will be used in place of the potted windings, continues at LANL, and they should be ready to ship to Dynapower next week.
Concerns & Actions: (1) Delivery by Dynapower of the second production converter modulator is delayed until next month pending resolution of the boost-transformer casting problem (see #4 above). Meanwhile we continue with installation of the accepted subsystems (safety enclosures, oil tanks, and cooling manifolds.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: (1) Tank-1 cap weld qualification welds were completed successfully; the PMQ field shunting worked well. (2) E-beam welding of prototype Tank-1 endwall tuning weld ring was successfully completed. (3) Twelve Tank-3 drift tubes were sent to ESCO for cap weld ring repairs. ESCO started the ring weld repairs on Thursday on these drift tubes, and by COB Friday they have completed all 12 (15 to go). They plan to work on Saturday if the remaining machined parts arrive from CMI. (4) Eighteen Tank-1 diverters have been successfully through the first brazing stage to install copper sleeve/cup (see figure below). They are currently being fitted to drift-tube bodies. (5) It is projected that the diverter-to-body brazing heat for the first 10 Tank-1 drift tubes will occur Monday or Tuesday of next week. (6) The two halves of the iris/RL waveguide for Tank 1 are at CMI for finish machining of the internal features. (7) The temporary Tank-3 iris/RL waveguide that developed the water-to-vacuum leak during final cleaning has been taken to LANL's MST-6 electrochemistry facility. It will be repaired using the electroless nickel process; we expect it to be returned to us in a week. (8) Machining continues on replacement Tank-1 and Tank-3 drift-tube mount "top hats" (material change from 303 to 304 stainless steel). Sixteen Tank-3 and 15 Tank-1 top hats were sent to the plating vendor, Kaehr, for internal copper plating. (9) The first batch of Tank-3 post couplers will be sent next Monday to ESCO for e-beam welding.
Concerns & Actions: (1) Schedule analysis indicates that the iris/RL waveguide for Tank 1 may be delayed two weeks beyond the required delivery date. Measures are being taken to accelerate the schedule. (2) Because of the faulty cap weld discovered last week, we are closely examining all the bore-tube welds on Tank-3. The cracks will not cause a vacuum leak but may have some RF effects if they are too large. Initial analysis shows that tiny cracks will not be a problem.

Fig. 1. Drift-tube diverters on the hydrogen furnace base prior to the braze heat

COUPLED-CAVITY LINAC (WBS 1.4.4)

Accomplishments: (1) ACCEL has qualified a brazed flange process to replace the plated flange process for the segment and bridge coupler large end flanges. This alternate process is being implemented on all parts, and the thick-plating option will not be used. The process consists of brazing a sheet of copper material on the face of the machined stainless steel flange and then thin plating a copper surface on the inside diameter and bottom surface of the flange. The unit with the thick copper layer is brazed to the endwall and the copper is machined back to produce the parallel surfaces after the stack braze is completed, the same way the plating was to be machined. (2) Support stand manufacturing for the Module-1 assembly is underway at Backerworks in Albuquerque, and the additional material for the remaining modules has been ordered. This material is destined for Germany to support fabrication of Modules 2-4 stands. ACCEL will produce these through a subcontract to a local firm. Module-1 is schedule critical and thus we are handling that unit closely through our staff here at LANL. (3) Bids are being received on the beam-tube welded assemblies and the wire-scanner beam boxes, and we plan to issue a contract for those components next week.

Concerns & Actions: Because of the difficulty with plating of the end flanges (see #1 above), ACCEL has not yet done the stack braze of the first segment as scheduled. They brazed the endplates for Segment 2 this week and will proceed with stack braze of this segment next week. The amount of available Au/Cu material will allow them to completely braze all flanges (endplate flanges and bridge-coupler flanges) of the first module. Further new material (braze material and copper rings) for the following modules is in house or being purchased. Although this approach shifts brazing of the first segment to the end of January, they believe that this is the safest way to proceed, and they will try to speed up subsequent work to ensure timely delivery. Delivery of the first module may be affected, but the following modules should be on schedule.

PHYSICS & DIAGNOSTICS (WBS 1.4.5)

Accomplishments: (1) *Beam Dynamics.* We have shown that partially chopped beams nominally lie within the transverse acceptance of the linac, so we don't expect to see significant increase in beam loss in the linac from chopping. Investigating further, we have now compared the clear bore transmission of the linac with the acceptance of the HEBT and the stripper foil. In Fig. 2 below, area (a) shows the acceptance of the collimator section of the HEBT as seen at the first collimator aperture. Area (b) shows that this acceptance is further reduced when including all HEBT elements up to the injection foil. Area (c) shows the acceptance of the HEBT starting at the beginning of the collimator and including only particles that pass through the foil. We see that while there is only nominal reduction in the vertical acceptance, there is significant reduction in the horizontal acceptance from the foil.

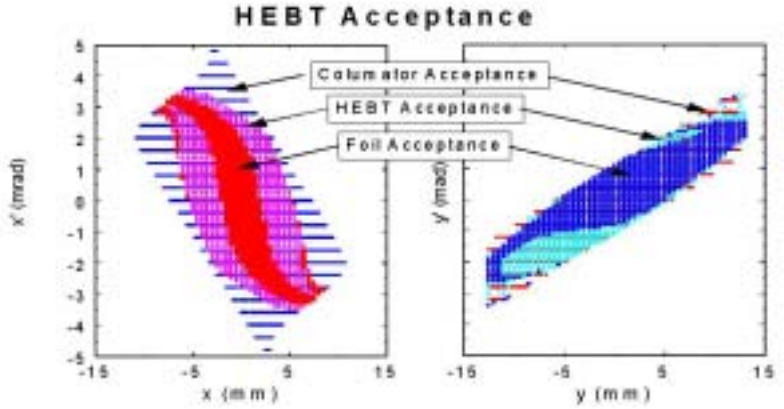


Fig. 2. Acceptance plots in x-x' (left) and y-y' (right) with (a) collimator acceptance, (b) HEBT acceptance downstream of the collimator, and (c) foil acceptance

In Fig. 3 below, we show the beam corresponding to the clear bore transmission through the linac (area c) that would arrive at the collimator, compared with these HEBT (area a) and foil (area b) acceptances. We see from this figure that the vertical acceptance is moderately well matched, indicating that stray beam that may have been deflected vertically has a good chance of hitting the foil. In the horizontal plane, however, the acceptances are not well matched indicating that there is a significant probability that horizontally stray or mis-steered beam will survive the HEBT only to miss the foil. These studies and their interpretation are ongoing.

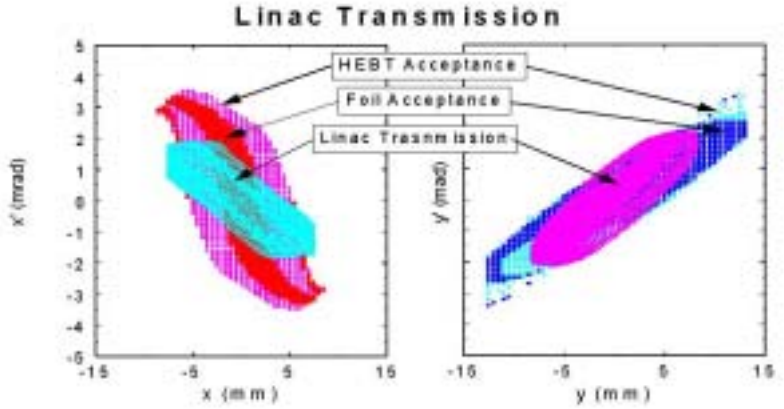


Fig. 3. Linac transmission (c) with HEBT (a) and foil (b) acceptance for x-x' (left) and y-y' (right)

PROJECT MANAGEMENT (WBS 1.4.6)
Don Rej briefed the new LANL director, Pete Nanos, on the SNS project and the status of the actions we are taking to correct fabrication problems.

ASD/JLAB: Cold Linac

ASD/BNL: Ring

Much of this shortened holiday week was devoted to an ASD review of selected Ring systems. From the Project Office, reviewers included T. Hunter, G. Murdoch, M. Hechler and P. Holik. Subjects of review included: HEBT Installation Plan; Status of HEBT Equipment; Ring Installation Plan; Status of Ring Equipment; Ring Lattice Drawing, Survey, Installation Drawings, and Magnet Parameter List; RTBT Target Area and Remote Clamp Design Status; Ring Half-cell Assembly Schedule; Ring Collimators and Moveable Scraper, and HEBT Collimator

Shielding and Base Design; Injection Septum Magnet (dump) and Ring Vacuum Spares. Minutes from the review are being prepared for distribution.

Efforts continue on ETC and schedules for all Ring sub-systems.

A joint, foreign travel trip report was written by R. Lambiase, A. Zaltsman and T. Owens. The primary purpose of the trip to Danfysik was to perform first article acceptance tests of the RF Tuning Power Supply and to check on the status (and resolve production issues) on the SNS low field corrector power supplies.

Field measurements continue on the 21Q40 magnets. A total of seventeen magnets are now fully measured (17/29).

36CDM30 – Testing of the vendor repaired 1st article is complete and the magnet has been rejected once again. The magnet is being returned to NETC for alignment corrections to the magnet core assembly.

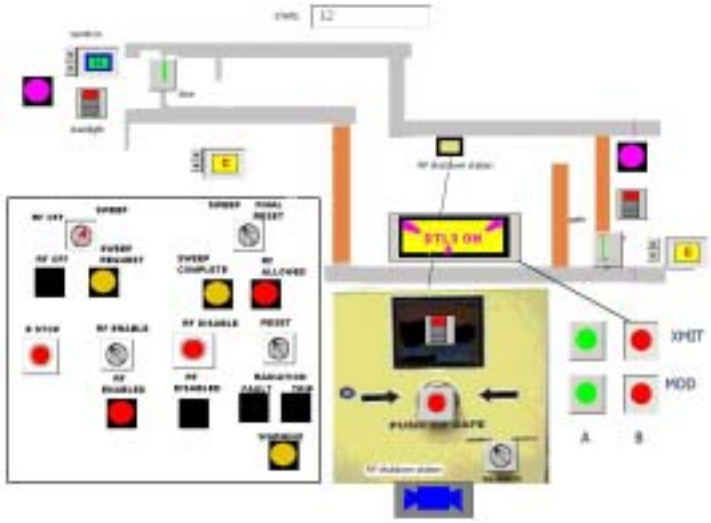
Half-cells – assembly of unit #2 is nearly complete and water flow tests were conducted this week. Assembly of unit #3 is underway. Pre-survey on unit #4 has begun.

Chicane #4 - field mapping is underway w/o "z" bumps to establish a baseline measurement. Precision "z" bumps are in-hand for field tuning.

Weekly meetings continue with our production vendors, including: BINP (quads), Tesla (quads), SDMS (collimators), Alpha Magnetics (sextupoles and corrector magnets) and Stangenes (quads).

Controls

A PLC software design review was held this week at SNS. Kelly Mahoney (Jlab), Henry Robertson (Jlab) and Herb Strong (SNS) served as reviewers. The review covered the process for the specification and development of PLC software for the PPS. The primary focus of the review was on the Safety Software Requirements Specification (SSRS or S^2RS)that provides requirements to the respective PLC programmers. The programming techniques used to program each PLC was also covered. The preliminary findings of the committee indicated that the process was generally sound, but recommended some improvements. A response to the committee report will be prepared which will address issues raised prior to the next PLC phase (front end and DTL 1). A simulator has been developed to demonstrate and test these procedures (see below). Keys can be turned, buttons pushed and doors can be "opened" using the mouse, and the correct response is indicated on the simulated panels.



Drawings for the DTL 3 RF control panel (a standalone system from the phase 0 PPS equipment) were approved and have been sent to the vendor for fabrication. Completion of the control panel is scheduled for mid February. The vendor of the phase I PPS PLC equipment is nearing completion of the first three panels. The factory acceptance test is scheduled for February 3rd

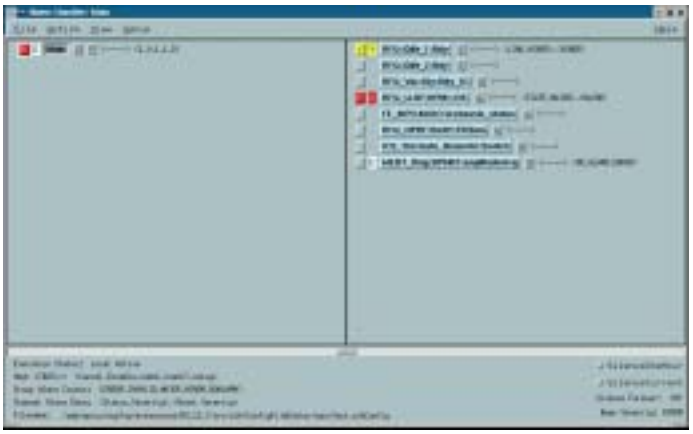
A revised estimate for the ODH system has been completed. The new cost is ~$100,000 over the original estimate. (This had been anticipated in our earlier risk analysis.) The cost increase reflects the additional functionality required by a new hazard analysis for the LINAC and CHL areas.

Testing of production Chipmunks is continuing. Temperature cycling continues to indicate that the electrometer section of the delivered units performs acceptably well. A problem with the quality factor function is under investigation. SNS/ORNL has agreed to provide support to the vendor to test FET transistor leakage values. A vendor visit is planned for next Monday, January 27 to perform this testing.

A Videoconference was held this week to discuss progress and problems with SNS vacuum system controls. There was active participation from the control teams at LANL, BNL, Jlab and ORNL. The status of the Front End, DTL, SCL and Ring vacuum control systems were presented and discussed. There followed a technical discussion of a number of outstanding issues. A follow-on videoconference will be held February 27th.

Eric Bjorklund submitted a draft technical note on “A Method for Measuring the Evenness of Timing System Rep-Rate Patterns (or its Lack.)” This report defines an “ugliness function,” which measures the degree to which a pattern deviates from perfect symmetry.

Yury Eidelman of the BNL controls team implemented the alarm handler configuration tool this week, and demonstrated it to the controls team. This tool will be set up for operations first on the “Top Ten” channels causing downtime and/or operator confusion. The top-level screen is shown below. In due course it will be extended to all relevant channels. Operator training will be required.



The Controls Team continued to wrestle with a number of operational problems. The system caused operational downtime over the weekend due to some improperly executed changes on the previous week's Maintenance Day, as well as due to failures both understood and not understood in the network, servers, vacuum I/O and timing systems.

At BNL preliminary discussion took place on tune measurement and gap cleaning systems. The SNS design builds on RHIC experience, and consists of slightly modified BPM electronics, combined with a pulser that can be triggered via the timing system. The controls interface should be an adaptation of the BPM controls interface. An ICD to formalize this agreement is expected before the time of the March Beam Diagnostics Review.

The Target Building 90% package for CF Controls (246 drawings) posted Friday.

Installation

Craft Snapshot 1/21/03

ASD craft workers	45.0
Foremen, ES&H, etc	8.5
Less WBS 1.9 controls	1.0
Less absent	2.0
TOTAL	50.5

Accelerator Physics

Work continues on understanding the MEBT trajectory and relation to ion source alignment.

D. Jeon checked the impact on linac beam dynamics of the field-tilted cavities in the prototype cryomodule. He finds very small impact on emittance growth when the cryomodule is placed in the 1st position.

AP group members continue to be heavily involved in front-end commissioning.

Operations Group

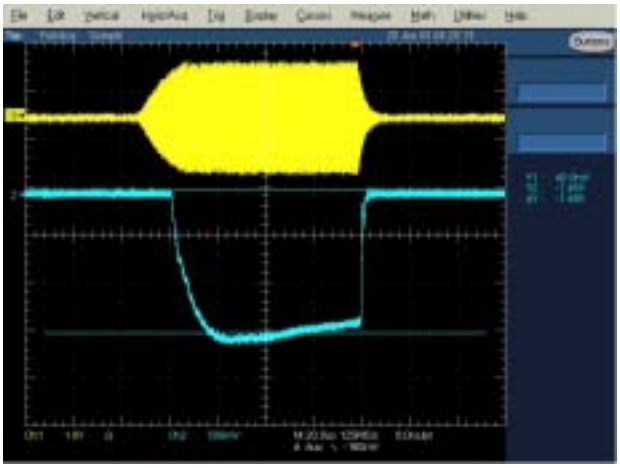
Thursday the 16'th and Friday, the Laser Wire system was installed for a teat run.

Thursday, the 16'th the ion source was opened to look for antenna and cesium dispenser damage and to check for LEBT misalignments. The source that we had been using was found to have internal misalignments. Lens 1 was found to be ~1 mm off center due to a support bolt which came lose and there was about 0.4 mm eccentricity of lens 2. (See Robert Welton's note in the logbook from 13:37 on 19-Jan) The cesium unit was damaged and it was felt that replacement was a better solution than a field repair. The spare ion source was readied for use. The spare source was bench aligned prior to installation.

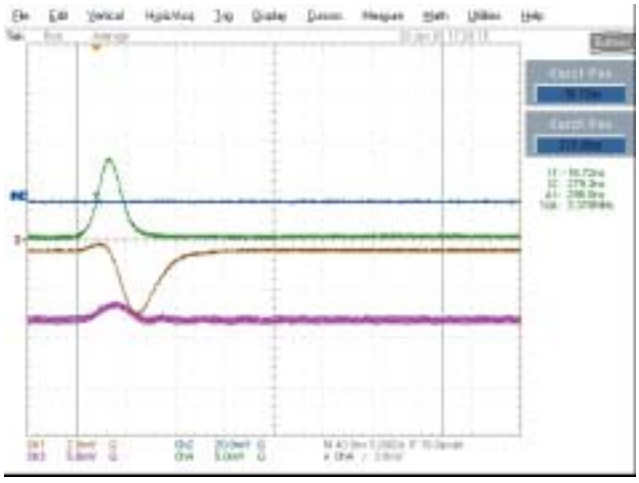
Friday and Saturday were spent working on, replacing and re-cesiating the Ion Source.

Once the Ion Source was on line it was discovered that we were experiencing Control System network problems, which were initially mis-diagnosed as MPS and Timing System problems. These problems continued through most of Sunday.

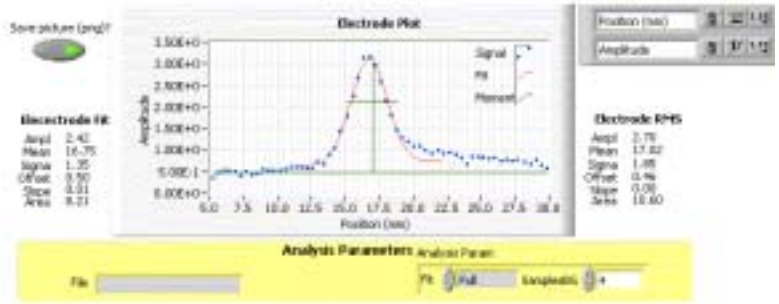
Monday the 20’th, beam was restored to about 31 mA as shown below.



On Monday, after stable beam was restored, testing of the Laser Wire was successfully tested. The following is a snapshot from the first test. Congratulations to all who were involved!

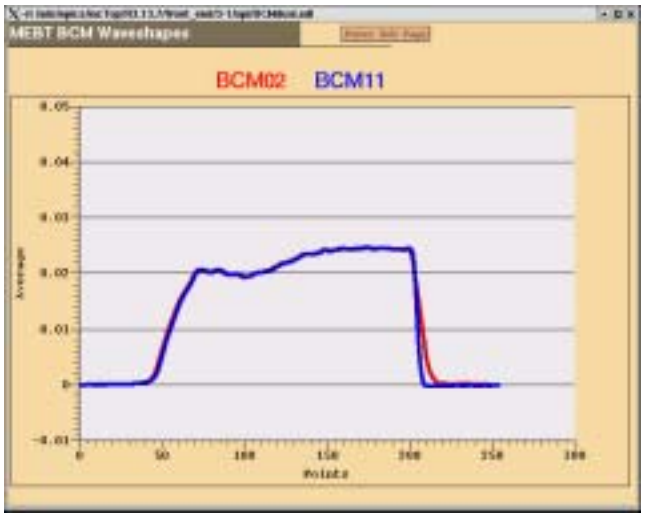


The Laser Wire studies continued and the following beam profile was obtained.



In between periods of Laser Wire study. We studied LEBT and MEBT chopping. However, these studies had to be deferred due the failure of the chopper power supplies.

The BCM electronics was returned from repair. The units were installed and show good agreement as is seen in the following picture.



We also had weather related difficulties this week. Operations staff experienced an overnight ice storm followed by extremely low temperatures that caused difficulties for several nights with the temporary evaporative cooler.

Ion Source Group

Because it was impossible to remove the Cs dispensers from the cesium collar, it was decided to install another LBNL source after it was loaded with Cs. However, it turned out that this source had a gross leak due to an excessively deep-drilled hole. Using a new extraction end, but keeping the original cusp bucket, the source was successfully installed and delivered on the first day up to 38 mA. However, since then the current has been continuously decreasing despite many cesiation efforts. The problem is partly due to the thermo-couple installed inside the vacuum, as well the thermo-couple installed in the hot air exhaust, both of which give obviously wrong results, often fluctuating over several hundred degrees. The standard cesiation procedure also seems to fail, most likely because the plasma-heating rate differs due to a significantly different filter magnet field. If we continue to fail, we will reinstall the original source on Monday morning.

The 13 MHz RF generator suddenly started to show reflected power at the 60% level. After the matching network checked out fine, we inspected and replaced the antenna, because we found that a small part of the porcelain coating chipped, lying inside the source cavity. As the 13 MHz appeared to help we continued to operate despite the high-reflected power, eventually frying a couple of components inside the matching network. The Friday morning maintenance period was used to disassemble, individually check, and reassemble the system. After this procedure the system operate normally, even so no smoking gun was ever found.

The ion source part of the 3 MW upgrade proposal benefited significantly from input provided by LBNL.

Mechanical Group

The cooling manifolds for DTL-3 have been reinstalled on the support frame. Cooling connections to the facility are in progress and are scheduled to be completed next week.

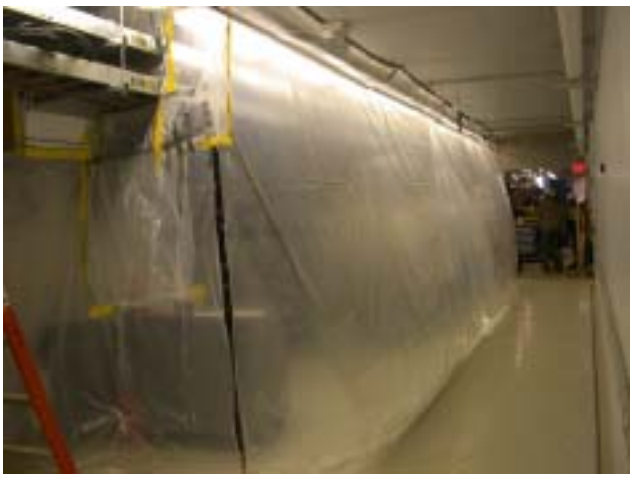
A plastic enclosure with filtered air inlets at each end, has been installed in the tunnel around DTL-3.

Omegabond 101 has been selected to epoxy the cooling tubes to the outside of the DTL tanks. Installation testing indicated that (1) this epoxy flows well enough to flow through the small clearance gaps along the side of the

cooling channels, (2) it is viscous enough to allow cooling channels to be installed from below (required for DTL-3), and (3) bubbles under the cooling channel are not a problem. Available radiation life data for similar epoxies indicates that lifetime should not be a problem.

DTL-3 with Cooling Manifolds

DTL-3 Plastic Enclosure



DTL-3 Plastic Enclosure

Magnet Task

This week we mapped HEBT 12Q45 #19. We are preparing to map the next 12Q45.

We are setting up the DTL/CCL R175QN45 for mapping.

Re-brazing of the 8D406 spare coils was completed.

We also traveled to BNL to review progress on BNL magnet production.

Linac HPRF

The lead caps for the 402.5 MHz klystrons were modified to fit and for easier installation. An X-ray measurement will be taken to verify their effectiveness. The HPRF system cables were pulled and terminated in the RF test facility (RFTF). The ground plane layout for the RFTF was completed and made available to the installation team. The overhead crane in the RFTF was certified allowing klystron installation. Water piping for cooling the DTL 3&4 klystrons continues and should be completed by end of January.

Linac LLRF

FE Commissioning Support:

The first 2nd generation LLRF control chassis was installed and tested on the RFQ RF system this week. The first attempt revealed a few lingering bugs. These were eliminated and the chassis was successfully commissioned during the owl shift of Jan. 26. Much thanks to Larry Doolittle, Ernest Williams, Hengjie Ma and Mark Crofford for all their hard work.

A new digital board was installed in the MEBT Rebuncher #3 LLRF control chassis.

Reference System:

Chip Piller and Taylor Davidson have been busy with reference line performance measurements. Chip will give an Accelerator Systems Division seminar on the reference system on Jan. 30.

We held a teleconference with Wenzel Inc. this week to discuss their proposal for a frequency reference synthesizer. They have quoted a system that appears to be capable of meeting our requirements.

JLAB Test:

The LLRF control chassis that will be used for the JLab test will be shipped from LBNL to JLab on Jan. 31. Two people from the ORNL team will visit JLab the following week to install the hardware and cabling necessary to support the test, which is tentatively scheduled for the week of Feb. 24. The test will be carried out by a combination of ORNL and LBNL personnel. Mark Crofford will visit LBNL next week to help with the testing of the LLRF control chassis that will be used for the JLab test.

LBNL:

Assembly of additional 2nd generation LLRF control chassis is in progress.

The control chassis to be used for the cryomodule test at JLab will be shipped Jan. 31.

Larry Doolittle visited ORNL Jan. 23-26. The primary goal of Larry's visit was to assist with the installation and testing of a 2nd generation LLRF control chassis on the RFQ RF system.

Electrical Systems Group

Ken Rust and Roy Cutler, along with several members of the BNL SNS project, attended a final design review for the extraction kicker magnet power supplies at the vendor, APS, in Hicksville, NY. They also met with the vendor's

subcontractors who are fabricating the kicker power supply PFN tanks. Drawing and circuit diagrams were reviewed and all pending change requests were finalized. Schedules were presented by the vendor and approved.

Paul Holik traveled to BNL to discuss upcoming ring installation issues with members of the BNL SNS design team.

Members of the group participated in formulating the SNS upgrade proposal.

In support of operations, the Electrical Systems group upgraded Front End Power Supply rack cooling by installing additional blowers. Hopefully, this will ease the quad power supply overheating problems. A more permanent fix is under study

A temporary fix has been found for the Front-End steering supply oscillation problem. Loading causes this problem by the control system ADCs. The manufacturer of the ADCs recognizes the problem, and suggested the solution we have implemented independently. The controls group plans a more elegant fix in the future.

CCL rack row 8 completed without vacuum racks. Vacuum racks for CCL will be delivered on site Monday.

AC distribution in CCL area completed up to row 2.

Survey and Alignment Group

Cryogenics Group

CHL: Progress on the south wall piping has been slow due to the foul weather. The electricians are wiring the primary feeds to the compressor motors. The vacuum space on the LN2 Dewar has been vented to atmosphere with Gn2 and we are changing out defective valve seals.

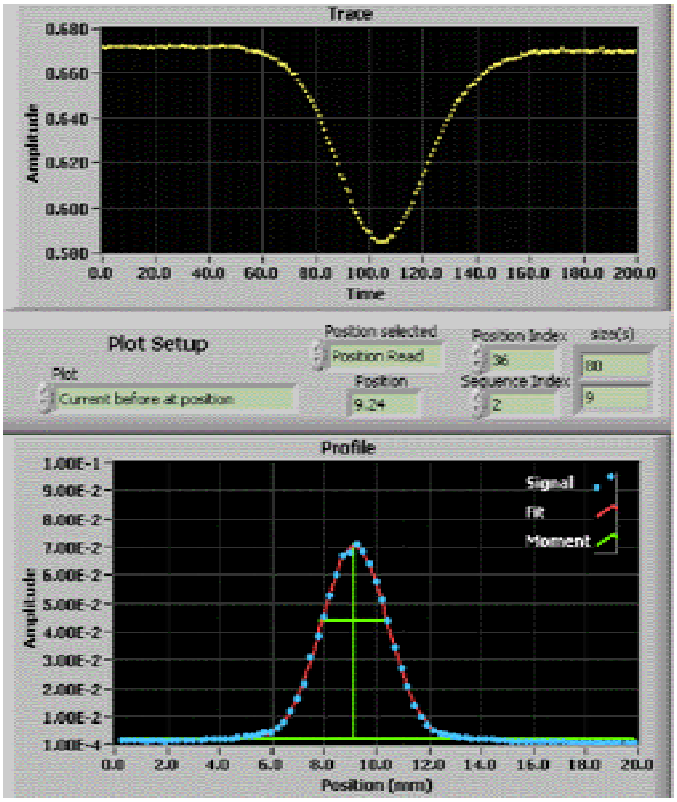
Tunnel: The 6" pipes on the west return modules have been welded. We are in the process of evacuating and cold shocking the welds.

Transfer Lines: Work continues on the supply expansion can. Return modules HB15/16 and HB17/18 are 30% completed.

Beam Diagnostics

ORNL Beam Diagnostics Progress Report:

Laser Profile Monitor: This has been an excellent week for the ORNL diagnostic group. Two systems under development were successfully implemented in a short time. (1) Fast Faraday cup is a result of the collaboration of ORNL [Craig Deibele] and Legnaro [Marco Poggi]). Fast Faraday cup produced the first longitudinal bunch length. (2) The laser profile monitor; it produced exceptional horizontal and vertical profiles. The Laser profile monitor team successfully integrated the first article SCL system at the end of the MEBT. The electron collector signal to noise ratio is exceptionally good (~20 times better than using differential current measurements). The following picture shows a typical profile measured by the laser system. The top trace shows the signal from electron collector and the bottom figure shows the profile.



Dan Stout measured the vibration at various parts of the laser-wire system. He reports the oscillations are less than one micrometer at all frequencies <1 kHz).

The repaired BNL electronics for the MEBT BCMs is back. We installed it per operators' request.

Matt Stettler and Lisa Day help us with the BPM systems and the diagnostic timing software. The DMA portion of the PCI card works now.

LANL Beam Diagnostics Progress Report:

BPM pickups: Work is in progress to map 10 each SCL BPMs and to deliver them to ORNL by the end of January.

BPM electronics: Two members of the diagnostics team are at ORNL this week to work on the BPM PC with the new IOC core and the new PCI RTDL / Event Link timing card.

WS actuators: The D-plate actuator was installed on the D-plate last week. Work continues to prepare the DTL-1 unit.

WS electronics: Work continues to fabricate and test the signal processors for the DTL-1 and D-plate wire scanner systems. The new LabJack unit that monitors critical voltages in the signal processor and connects to the USB port on the PC is working nicely.

D-plate: A member of the diagnostics team traveled to ORNL last week to install water-cooling hoses, water fittings, the steering magnet, and the first actuator. Work continues to prepare the slit and harp actuator assemblies.

ED/FC: Work continues on the ED/FC electronics. We have successfully communicated with the electronics chassis from a PC running LabView, and work on the user interface and connection to EPICS has begun.