Accelerator Systems Division Highlights Ending February 27, 2004

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: (1) The heat run on Thales 5-MW CCL klystron (S/N 1) continued this week. Results are acceptable, although we shortened the run time somewhat because of prototype high voltage converter modulator (HVCM) problems (see below). With concurrence from ORNL, the klystron was removed from the test stand and prepared for shipment to ORNL on 3/4/04. (2) We plan to install another 5 MW tube while we are addressing HVCM issues. (3) 5 MW klystron S/N 6 underwent factory acceptance tests this week. LANL is expecting to receive test data from Thales today for approval. (4) LANL reviewed and approved factory test data from CPI for two more 550-kW SCL klystrons (S/Ns 49 and 50). Three klystrons (S/Ns 48, 49, and 50) are scheduled to ship from CPI to ORNL today. (5) Three more 550-kW SCL klystrons from Thales (S/Ns 8, 10, and 11) arrived at LANL today. The data for the factory acceptance test (FAT) of S/N 12 has been approved by LANL. The FAT of S/N 13 is scheduled for next week.
Concerns & Actions: (1) LANL has a backlog inventory consisting of two Thales 5-MW CCL klystrons and seven Thales 550-kW SCL klystrons that need site acceptance tests at LANL. To recover schedule, two- and three-shift and weekend operation is planned. (2) The next 5-MW CCL circulator testing was postponed due to the HVCM rework. AFT has expressed concerns regarding the Kapton windows. They wish to remove and sand all port 1 and 3 windows. We expect a decision next week as to what AFT wants to do.

HIGH-VOLTAGE CONVETER MODULATOR (HVCM) (WBS 1.4.1.2)
Concerns & Actions: We continue to push the HVCM operations above 125 kV at full pulsewidth and repetition rate, looking for, and mitigating against, weak links in the system before modulators are needed in a time critical operation. (1) The 20 MH filter choke in the LANL production HVCM, failed. This choke filters the 120 kHz ripple from each 10 MW pulse and carries the full 1 MW average power. The choke also sees 140 kV transients at the beginning and end of each pulse. We conjecture that continuous choke arcing, probably due to fabrication error, resulted in a build up of hydrogen gas above the oil. The hydrogen flashed, terminating operations, without catastrophic failures. The only other damage to HVCM was two broken nylon bolts and an electrical connection. Of concern with the electrical connection, the wire pulled loose from the lug. The wire was of insufficient depth into the lug. This resulted in a defective crimp connection. Fortunately, this crimp connection was to the HV socket we were not using. Although a secondary failure from the choke, the faulty crimp indicates all units need to have all crimp connections inspected and verified. Examination of the choke seems to indicate the failure was due to the input wire laying next to or on the wire on the second layer build. The Litz wire, used to carry the high frequency and high RMS current, is good to about 1 kV per turn. To insulate between layers, additional DMD (special Mylar insulating sheeting) is used. The input wire was next to the wire that sees 25 kV transients. Once arcing begins, the stored energy in the chokes rings and causes additional transients. We are fabricating a new choke bobbin and we refit the HVCM with a nanocrystalline choke core. The production metglass core was damaged and cannot be reused. The nano and metglass cores are of different dimension. We have been analyzing the filter choke failure and related events and are developing a number of engineering solutions to prevent any future re-occurrence. Once the analysis is complete, documentation will be generated. (2) Prototype HVCM operation was halted after discovering defective solder joints between the parallel transformer bobbins. The loose wire, unfortunately, caused failure of the adjacent bobbin. We are in the process of re-winding the failed bobbin. The prototype HVCM does not have the same design bobbin or interconnects as the production HVCMs. The solder etched away from the wire and then the wire fell loose, arcing to the adjacent bobbin.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: (1) All components for Tank-2 are at ORNL. (2) All Tank-4 post couplers have been e-beam welded. Final machining is underway. Completed units will be shipped to ORNL next week. (3) Repair of the 210th (and last!) drift tube (S/N 6-17) is nearing completion. It was finished machined. It should be shipped to ORNL next week, after stem straightening, baking, leak checking, and cleaning at CMI and LANL.

COUPLED CAVITY LINAC (WBS 1.4.4)
Accomplishments: (1) Installation of CCL Module 2 is underway at ORNL. N. Bultman is at the site to support installation. (2) One-half of Module-3 is assembled at ACCEL and found to be leak tight. (3) Four (of twelve)

Module-4 segments were stack brazed at ACCEL. (4) Accel continues to make progress on the Module 4 recovery plan where four half-cells are being be rebuilt. ACCEL reports that they are holding the 4/12/04 ship date.
Concerns & Actions: (1) ACCEL has fallen further behind schedule on Module-3. A leak in Segment 10 at the Pacusil braze is hindering further progress. A repair, consisting of milling and a replacement braze with Cusil, is underway. ACCEL reported that the repair would delay the first bead pull on Module 3 by one day, to 3/3/04. LANL expressed skepticism, and asked ACCEL to check whether they can complete module-3 repairs, leak checks and assembly by that date. (2) Approximately 10 of the 47 stainless steel intersegment beam pipes and boxes will need repair due to unacceptable e-beam welds and/or bellows broken during shipment. A warranty claim to the vendor (ESCO) is in progress. ESCO has sufficient spare parts inventory to complete the repairs and still meet the ORNL installation schedule.

PROJECT MANAGEMENT (WBS 1.4.6)
Los Alamos SNS Division will disband in 35 days. We are working with SNS-ORNL on closeout issues. Zero-cost PCR LI 04-010 was accepted this week; it will balance out DTL, CCL, and SCL EMQ work packages prior to the Division closure. Considerable progress in contract novation and transfer was made. Of the 39 contracts identified, 30 have been completed. We expect 5 more (SCL transmitters, CCL and SCL EMQs, E2V and CPI klystrons) to be completed next week.

ASD/JLAB: Cold Linac

Cavity strings M-10 and M-11 have been assembled. Assembly of the M-10 cryomodule is underway.

The M-8 cryomodule is in the test cave, awaiting repair of the 1 MW RF test stand.

ASD/BNL: Ring

Richard Witkover, BNL/SNS Diagnostics, left the Project on Monday to begin a long awaited retirement. While assigned to SNS, Dick was the lead engineer for development and production of the Beam Loss Monitor (BLM) system for the Diagnostics group. Dick had been with BNL for nearly 40 years.

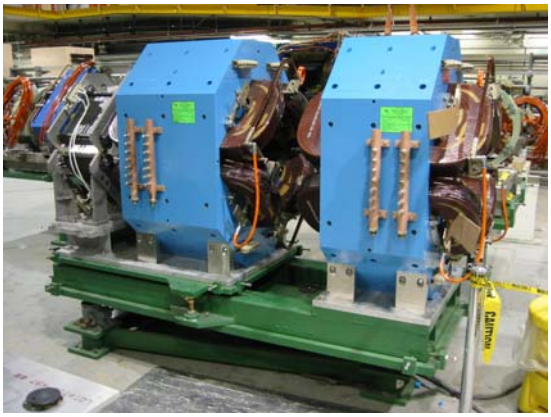
A review of Ring mechanical systems was conducted this week with SNS personnel. Visitors from ASD included G. Murdoch, T. Hunter, M. Hechler and M. Holding. Highlights of the review included a final design review of the extraction Lambertson magnet and a review of the RTBT radiation hardened doublet quad assemblies.

Tom Owens completed his stay at BNL this week helping the BNL/RF team with high level testing.

Diagnostics - resources were re-aligned within the Collider-Accelerator department to permit the four main SNS systems to be prioritized according to the recommendations of the Advisory Committee. A detailed look at the status of all the SNS systems was done, and a second draft of the Ring Diagnostics Production Plan was prepared. We are closing the gaps on schedule/milestone issues.

We received spare coils from NETC for Chicane #2 and #3 magnets.

Half-cell #23 was shipped to SNS/OR on Tuesday. Work is underway on HC 24, Ring doublet and quarter-cell assemblies.



Magnetic measurements: 30Q44 - seven of twelve magnets are now fully measured. Testing of chicane #2 and #3 (together) is underway.

Alpha Magnetics shipped the eighth of nine 26S26 magnets to BNL.

Bid evaluation is complete and BNL Contracts has been authorized to issue a PO for the Ring extraction magnet.

Controls

In preparation for the upcoming review of post-April SNS scope for the LANSCE Division at LANL, as well as for the upcoming PCR to reconcile BCWS with allocation, there was a concerted effort this week to come to agreement with LANL on remaining budget and work scope for the LANL Controls Team there. Agreement was reached, and the presentation to be given at next week's review was submitted for comment.

Lists of all archive request files, sorted by record type, were prepared and examined. There are many illegal names which cannot be imported into the Oracle database. Work has begun on cleaning these up, but it is a daunting task and compromises will have to be made and priorities established.

Three members of the LANL controls team were at SNS this week to assist with initial testing of the vacuum, RCCS and power supply systems for the CCL.

At LANL, the last channel access method was added to the channel archiver. In this method, "monitors" are used if the archive rate is higher than the "get threshold," where data is being taken too fast to use channel access "gets."

The MPS system has been reconfigured for the new "Source Chain" and "CCL_BS_Chain," which ends after DTL tank 3. New inputs have been wired and the carrier links connected and tested. Inputs will be tested according to the MPS test plan as equipment is brought on line and tested. The FPGA code has been modified and is under test. This changes the inputs to non-latching. The end result is the same functionality because the beam is still latched off, but should be easier for operations.

The order for a new MPS input chassis is proceeding. A prototype was received and tested so production of 80 chassis is proceeding. The redesigned input converter chassis has been installed for PLC inputs that were susceptible to noise during the last run. This chassis has an input filter for noise rejection and its own internal power supply with low pass filters and AC noise rejection. A new master carrier receiver Printed Circuit Board (PCB) is being fabricated. This condenses 7 chassis into one, reducing cabling and chassis for better reliability.

The 65 KV switch driver PCB is being fabricated and is due next week. This will replace the MPS input to the 65 KV supply which takes too long to recover after an MPS trip and is hard on the power supply. The control system continued to support operation of the Front End Test Stand, and more devices were added. Bench testing of the LEBT Power Supply controllers has started.
A fiber receiver board for noise reduction of the Timing signal is being fabricated. Thermocouples and Cesium Control is being laid out and should be completed in a few weeks.

A fiber-to-fiber fan-out module has been tested. A few problems were found in the PCB design and they are being fixed for a second revision of the board. This module is required for the communications infrastructure; however a decision was taken this week NOT to use this module to convert timing inputs for the diagnostic "Network Attached Devices" (NADs) from the originally designed copper to fiber. (See following item.)

107 additional V108S utility modules were shipped to ORNL, as were 34 V294 fan-out modules, and 80 event-link fan-outs configured with fiber optic inputs.

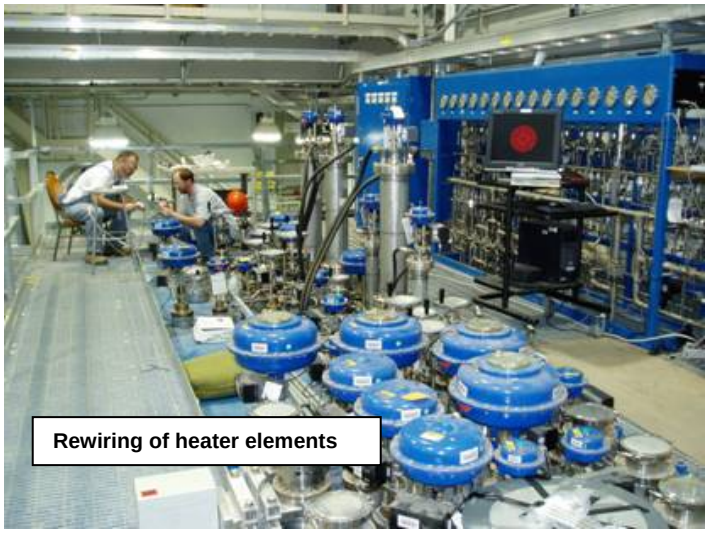
Yongbin Leng traveled from BNL to ORNL to help configure and install two more Beam Loss Monitor (BLM) IOCs, and to upgrade the previously installed BLM IOC to EPICS release 3.14.4. All three IOCs are undergoing extensive testing to shake out any issues in advance of the
DTL run.

Further progress was at BNL made in interfacing the Ring Low-Level RF (LLRF) Digital Signal Processors (DSPs) to IOC software. The IOC software has now been demonstrated to be able to trigger DSP operations with a worst case latency of 130 microseconds - well within the 1 millisecond time budget required. This success required a change to the V108S (utility module) driver which was done at ORNL. Previous attempts to meet the 1 millisecond specification using EPICS event records had failed in worst case scenarios.

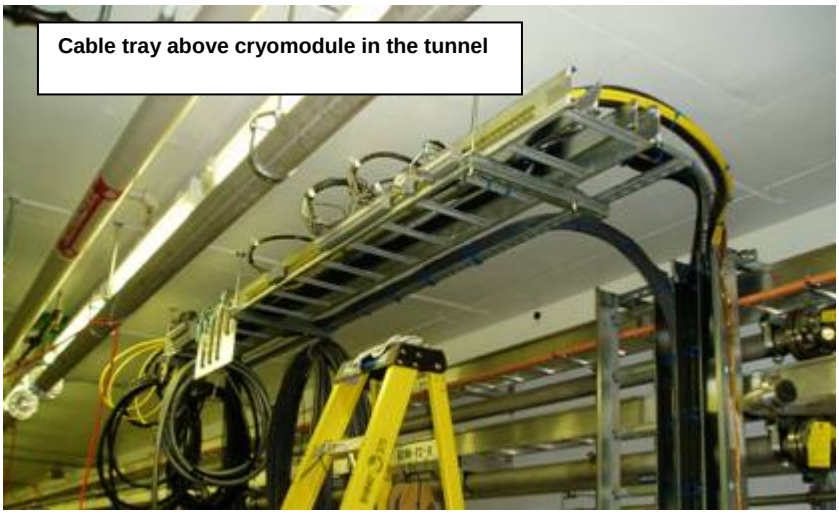
Preliminary results editing and downloading waveforms via EPICS, downloading DSP code and control parameters via EPICS, and reading back "waveforms" of DSP-calculated values at 60Hz via EPICS have all been successful. Some issues have surfaced, possibly caused by contention for the PCI bus with certain VxWorks kernel configurations and the LLRF application software. A more detailed analysis of the PCI bus behavior under these circumstances is under way.

Installation and checkout of the ICS for the CHL main 4.5 K cold box is well underway. Calibration of the ~ 250 devices and checkout of system inputs and outputs is more than 90% complete. Verification of control loop and interlock operation is 30% complete. Wiring problems with the cold box heaters are being corrected. Installation of ICS Cryogenic Control System cables for the first 4 Medium Beta Cryomodules is complete. Termination of the cables is 40 % complete for the first Medium Beta Cryomodule. Some photos of CHL cryogenic controls work follow.

CHL 4.5 K Cold Box ICS



Rewiring of heater elements



Cable tray above cryomodule in the tunnel

ICS Rack in the Klystron Building

Installation

Craft Snapshot 2/24/04

ASD productive craft workers	**56.0**
Foremen (Pd by 15% OH)	6.0
AMSI management (Pd directly)	3.0
TOTAL AMSI WORKERS	65.0
Less WBS 1.9, 1.2 etc	**4.0**
Less absent	**4.0**
TOTAL PD BY ASD/ORNL DB WPs	**48.0**

Accelerator Physics

Realistic simulations of betatron tune measurements, including BPM errors, using both the narrow-band and base-band BPM systems, for both the single-shot and kicked-beam-after-accumulation methods, show fractional tune measurement errors ranging from 0.00034 to 0.0043. The beam decoheres after 50 to 60 turns for both the single-shot and kicked beam cases, primarily due to the injected beam energy spread (due to space charge). The most accurate method is to kick the beam after accumulating for about 50 turns. With this measurement accuracy we can do a nice job tuning the ring.

An updated set of radiation calculations for the end of the RTBT is complete. One outcome is a beam-on dose-rate calculation at the RTBT quad coils. The highest value is 4,400 rem/h on Q30 assuming 2 MW on target.

Dose rate calculations for the ring injection dump area are almost complete. The dose rate at the stripper foil area is dominated by the injected beam losses, and not by backscattering from the injection dump. However, once past the injection dump septum magnet, the dose rate is dominated by the backscattered beam. The dose-rate after turning off the beam for one hour, at the injection stripper foil, is predicted to be about 500 mrem/h assuming 2 MW beam power.

Operations

Ion Source Group

The ion source on the hot spare stand keeps delivering close to 40 mA being operated with a 6% duty cycle. Friday 2-27-04 started the 16th equivalent day of operation without any source maintenance except for cesiation cycles. The hydrogen flow had to be increased to 42 sccm to maintain stable operation.

We started to collaborate with the Laboratori Nazionali di Legnaro on emittance analysis.

Survey and Alignment Group

The team fiducialized the repaired drift tube and installed the same drift tube into DTL 2. We also installed three other drift tubes that were removed for further testing. Survey and alignment received a request to perform random spot checks on individual drift tubes in DTL 2. Drift tube alignment in DTL 2 is now complete.

The team optically set one 21Q40 CCL magnet in magnet measurement.

S & A aligned the CCL 2 stands in elevation so that shims could be made for the individual stands.

The bolt hole pattern for CCL 3 and 4 was laid out. This action allows the CCL team to drill and locate the CCL base plates as they deem necessary.

Fiducialized CCL BPM47 for analysis.

S&A marked out the new tank center location of the vacuum tank for beam line 2TU. This new location was located with respect to the updated drawing supplied by the 2TU Engineer. This updated drawing was required as a result of "poured in place concrete pedestals" were laid out and poured without taking into account the rotation of the core vessel from ideal along with machining errors in the core vessel flange. The Engineer made slight modifications to the beam line arc so as to bring the tank center back to its' original designed location. From there we located the new tank center. Our point deviated from the site surveyor's point slightly. As a check, we set over our point with an optical instrument, sighted the end point of the "poured in place pedestals" layout line. We then swept the instrument's line of sight along the continuation of the layout line and took notice of any deviations of that layout line. Deviations were no more than 0.5 millimeters.

In conjunction with the layout of the 2TU tank center, S&A chalked out reference lines along the beam line and perpendicular to the beam line intersecting at the tank center. These reference lines will be utilized by the tank installer.

Calculated data for the setup of half cells jacks in Super Periods B and C.

Continued preparing data for the setout of the upper and lower straight section of the ring.

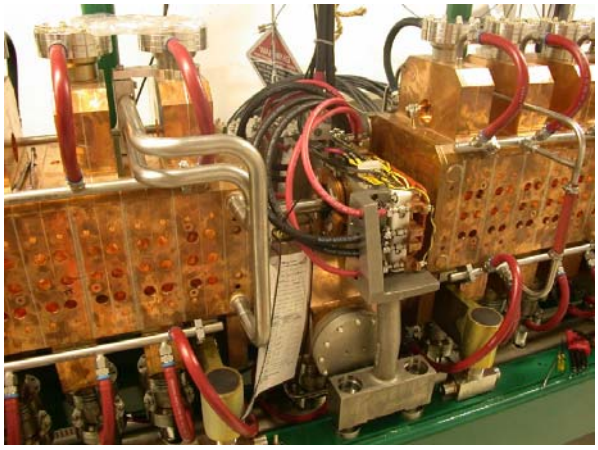
Mechanical Group

We have finished the entire repair and internal alignment on DTL 2 and it is now installed in the beamline. We are doing an external alignment of the tanks to allow installation of the beam boxes. All of the final post couplers are installed, final field tuning is complete, and iris sizing in progress.

Cable preparation continues for all three tanks.

Post couplers for DTL 4 were welded this week and sent for final machining. They should be shipped to ORNL late next week.

CCL-1 inter-segment no. 9 was installed.



CCL-1 Inter-Segment #9

CCL-2 segment installation and tuning began this week. This will be completed next week.

CCL-2 Segment on Support Frame

Water Systems Installation

- Installation of DI water piping on SCL ME-03 continued.
- Installation of DI water piping on SCL ME-04 continued.
- Installation of DI water piping to CCL1 module continued with the preliminary flushing of the system.
- Installation of the MEBT high power circulator load piping was completed.
- The flushing of the RF DI water system continued.

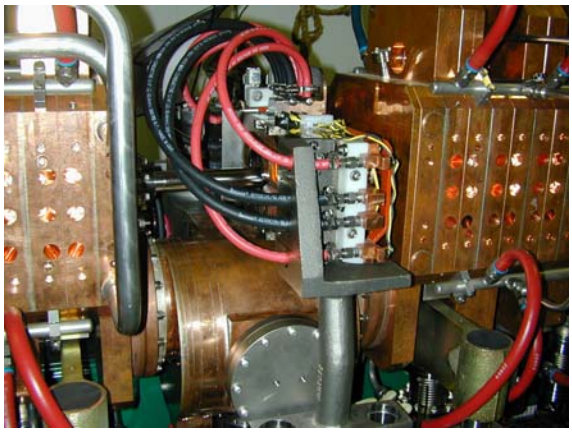
Ring Systems Installation activities

- The RING Half-Cell #23 was received and staged in the tunnel.
- The RING Half-Cell units # C2, C3, and C8 were installed into their positions.
- The support pads for Arc B Half-Cells were surveyed.
- The HEBT momentum collimator was uncrated and staged for installation.
- The HEBT beamline continues to pump down and is in the E-9 Torr vacuum range.
- The Linac Dump beamline was pumped down and is in the E-9 Torr vacuum range.
- The HEBT beamline from QH20 to QH30 was pumped down and is in the E-9 Torr vacuum range.
- Installation of the PPS system conduit continued in the HEBT.

Magnet Task

We continue to map CCL Quads. An effort is underway to make assembly of the Quads more repeatable. Previous experience indicated that they were not repeatable.

We are assembling and working out “bugs” CCL intersegment #9 which we hope to be installed today. Nathan Bultman is here helping with that. The attached photo show the magnet installed. When spherical washers are obtained then alignment of the assembly can proceed.



We have also continued measurements of 21Q40's. We now have three sets of three matched to 0.1%. We need two sets of four.

We also went to BNL this week and participated in the ELS design review which went quite well. Other issues at BNL are:

- Two sextuples remain to be delivered from the vendor (Alpha)
- NETC has two injection magnets on the delivery schedule
- The 36Q's are coming together and BNL believes that measurement of the 36Q's is not in their baseline. They will only measure one of them. The same is the case with the 36CD's. They don't want to measure them either.

Electrical Group

We tested 185 A and 390 A ring power supplies on test stand

Installation of DTL-ME1 and DTL-ME2, with all the repairs and modifications, was completed early Monday. DTL-ME3 has had the modifications performed on the oil tank (which was installed today), and we expect to install the modified switch plate assemblies early next week. We will shift our focus to CCL-ME2 so as to have those upgrades complete prior to the arrival of the 2nd Thales klystron projected for late next week. All the modifications are draining our resources, but we did manage to get CCL-ME3 completely checked out late last week.

Orders have gone out for all parts to support installation of a single harmonic trap set on the HVCM output to reduce 20 and 40 kHz ripple. Preparations for ASAC review, DOE Electrical R&D Safety meeting, and a university talk have consumed a considerable portion of my week.

HPRF

CCL-1 RF System – all of the waveguide flanges were disassembled, cleaned and re-torqued. Saturation curves were measured at cathode voltages from 100 kV to 135kV to determine the optimum operating point (126kV). This reduces the load on the converter modulator and increases the resolution of the LLRF controls. Calibration of the klystron output forward power was performed. The EPICS readout will be accurate to 1% when operating within a MW of the nominal operating point. HPRF & LLRF are ready for CCL-1 conditioning

Three CCL HV tanks were prepared in anticipation of 5MW klystrons being shipped from LANL. Work on the CCL-2 RF waveguide system has started.

Replacement waveguide from MCI to arrive 5-Mar

LLRF

Cryosystem Group

The oil processor has been placed in service and 110 gallons of oil is being processed.

The wiring to the charcoal bed heaters in the 4.5K cold box has been replaced and the beds are on heat and purge.

Warm helium compressor #4 has been operated this week and the oil dehydrated. The compressor started on the first attempt. The current transformers in the switch gear still show a phase unbalance. The transformers will be replaced.

The cryogenic readiness review committee has stated that the uncoded liquid nitrogen vessel in the 2.1K cold box is unacceptable by ORNL work smart standards and is recommending that the vessel be replaced with an ASME coded vessel.

The warm gas piping has been completed.

Work continues on the fabrication of the 7 “U” tubes required to perform the 4.5K cold box acceptance test.

Beam Diagnostics