Accelerator Systems Division Highlights Ending November 21, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: (1) A LANL representative is at E2V to witness factory acceptance tests of the 9th (of 11) DTL klystron (S/N 5). To date, tests have gone well. Only the high pot and dimensional tests remain. Tests for the 10th tube (S/N 11) are still scheduled for December 15-19. (2) Another LANL representative is at Thales to witness tests of the 3rd (of 9) 5-MW CCL klystron (S/N 4). To date, tests are going well. Only the average power, x-ray, and collector tests remain. These tests will be completed by 11/28. (3) The 2nd 5-MW tube passed factory acceptance tests and should ship to LANL next week... (4) The 1st 5-MW tube (S/N 3) was shipped from LANL Maintenance on prototype HVCM to replace IGBT bypass capacitors with units to evaluate (possible) improved thermal performance; it is expected to arrive on 11/24. (5) The next 5-MW tube factory acceptance tests are scheduled for the week of Dec 1st. (6) The LANL representative at Thales also witnessed the tests of two SCL 550-kW klystrons (S/Ns 6 and 2). Tests for S/N 6 were successfully completed and the tests for S/N 2 are underway. (7) We successfully completed site acceptance tests at full SNS spec for the 2nd and 3rd 805-MHz, 5-MW Sure-Beam Loads (S/Ns 4 and 6). One of these loads was shipped to ORNL. (8) We successfully completed site acceptance testing of a second 5-MW CCL circulator (S/N 964698) at the full SNS spec. The previously reported failed circulator (S/N 964694) was shipped back to AFT Corp. for repair. (9) Three more CPI 550-kW SCL klystrons (S/Ns 039, 040, 041, and 043) which passed factory acceptance tests are ready for shipment to ORNL next week. (10) LANL staff will be at ORNL for commissioning of the first two SCL transmitters Dec. 8-20. (11) We worked with the transmitter manufacturer (Titan) to develop plan for LANL and ORNL personnel to implement the recommended software and firmware refits to the SCL transmitters. (12) We developed an Interim Work Document (IWD) to service SNS transmitter systems at LANL, to perform waveguide work on the SNS transmitter systems at LANL, to install klystrons in SNS transmitter systems at LANL, to remove klystrons from SNS transmitter systems at LANL, to swap transmitter and converter modulator HV connections at LANL. Worker involvement was effective.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) The production HV converter modulator (HVCM) at LANL was operating well in support of the aforementioned high-power RF component testing. (2) We began maintenance work on the prototype HVCM to replace IGBT bypass capacitors with units to evaluate (possible) improved thermal performance. (3) We reviewed IGBT start pulse configurations to reduce SCL HVCM start pulse current (4 kA down to 3 kA), minimize HV pulse flat top ringing, and eliminate free-wheeling diode oscillations. To achieve the desired results that minimize and eliminate those problems, DSP timing changes are required. These timing algorithms have been sent to Z-Tec to evaluate the ability to make the required programming changes. These changes alter both the "+" and "-" start pulse for each phase. In addition, dead times are timed from the pulse beginning, not the end of the pulse as previously accomplished.
Concerns & Actions: We reviewed electrical test results and performance of the first SCL HVCM (SCL ME-1) dummy load tests. Test results indicate that the 6-pack loading can generate commutation current spikes at the beginning and end of each 25 microsecond IGBT pulse. These commutation pulses result in ~2.75 MW losses into the silicon (twice a pulse), which may result in failure of the IGBTs at high repetition rates. The average power loss for the 6 pack case with full pulse width and 60 Hz should be around 6.5 kW, above our comfort zone. Running into a 12 pack, test results seem to indicate good performance with about 3.7 kW loss per IGBT, within the typical traction use of 4 kW. With 3.7 kW IGBT loss, SCL HVCM efficiency should be about 92%.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: LANL shipped twenty-two finished drift tubes to ORNL this week. They included one for Tank-5, eleven for Tank-6, and ten EMD drift tubes for Tanks 3, 4, 5 and 6. LANL staff will work through the weekend to prepare for more daily shipments next week.
Issues and Concerns: (1) The clogged Cerrobend was flushed out of the first ten EMD drift tubes. Flow rates at a given pressure are somewhat below original specification, but they will meet SNS requirements. A non-conformance report and tech note will be generated to document the situation. (2) Our critical path continues to be the fabrication of Tank-2 PMQ drift tubes. All thirty-six T-2 drift tubes were plated at GAR and returned to ESCO for final profiling. The first four units were finished machined and are at LANL for vacuum tests before being sent

to CMI for stem welding and plating. LANL engineers were stationed at GAR (Danbury CT), ESCO (Oakland), and CMI (Albuquerque) for QA support. The final drift tube is still forecast for a 12/23 delivery to ORNL.

COUPLED CAVITY LINAC (WBS 1.4.4)
Accomplishments: (1) Module 1 is being shipped this weekend from Frankfurt to Atlanta. Estimated arrival at ORNL is 11/24. (2) ACCEL started assembling Module 2. The support stand is set up (Fig. 1). Cross members will be installed and aligned with the laser tracker on 11/24. Six segments have tuned and will be assembled on the stand starting on 11/25.
Concerns & Actions: (1) The CCL production schedule is being tracked closely. ACCEL has reported that their current projections show Module 2 delivery 2 weeks late (mid January). Discussions with ACCEL management today reemphasized the importance of the delivery of the last (4^{th} module) by 3/31/04. ACCEL claims that they should be able to regain the lost 2 weeks through Module 3 and 4 production. We will continue to status the production schedule to validate this claim. (2) The Dollar-Euro exchange rate hit an all-time high this week; consequently, the last two ACCEL invoices have resulted in a cost variance that needs to be mitigated. Details will be reported to the SNS Project Office in our November risk matrix. (3) Assembly of the intersegment region at LANL has been interrupted by the discovery of noncompliant cooling fittings on the electromagnetic quadrupole magnets. Magnets are being returned to the vendor (Millhouse) for rework. This does not represent a schedule risk for the Project, but the delay does pose a staffing problem for LANL. LANL will still be able to assemble first articles in December, but the remainder will need to be done *in-situ* in the SNS tunnel.

Fig. 1: Preparations for CCL Module-2 assembly at ACCEL.

ASD/JLAB: Cold Linac

ASD/BNL: Ring

Work continues on the BNL/SNS FY04/05 budget details related to labor, procurement and schedule. The BNL/SNS Project Office was quite busy answering questions from staff and fielding management's requests for data regarding items in the DOE closeout report.

Craig Dawson returned from a two day trip to SNS/OR where he assisted the SNS/OR Diagnostics Team in support of BCM commissioning.

R. Lambiase returned from IE Power (Canada) where he revisited several testing issues related to the Main Dipole PS, the 700A and 4kA Medium Range power supplies, and the Injection Bump power supplies.

Extraction kicker PFN: BNL engineers reported on the successful heat run conducted at APS on the first production power supply; sixteen continuous hours at 35kV, 60hz, and operating current. Work on the remaining units is in-progress at APS. The first production article will be trucked 25 miles to BNL for more extensive testing.

Half-cell #14 was shipped to SNS/OR earlier this week. Assembly continues on unit #15.

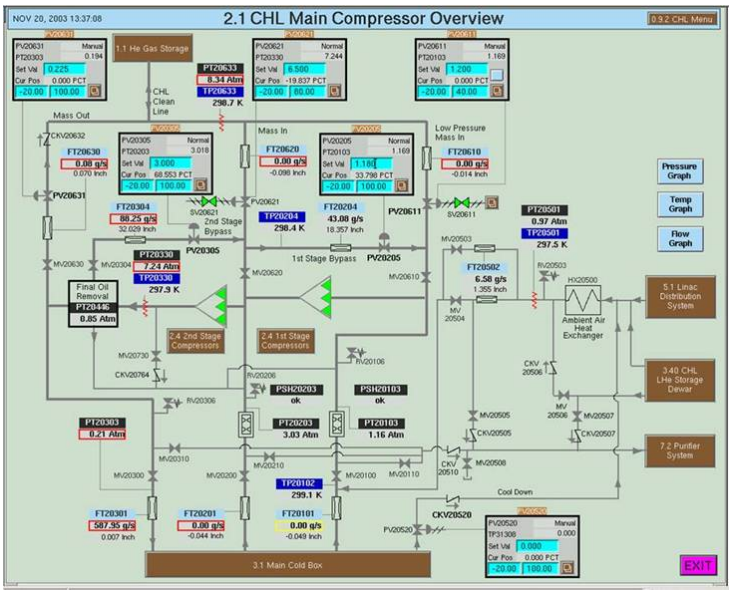
NETC reported the completion of four more 27CD30 magnet assemblies; they plan to ship them to SNS/OR next week (11/24/03). The last three magnets will be shipped to SNS/OR in December.

Coating of the vacuum chambers for the Ring collimators #2 & #3 is underway at BNL. We plan to ship the chambers back to SDMS on 12/10 so they can complete the overall assembly before shipping them to SNS/OR in early January.

The large aperture 30Q production test station remains "down" as engineers work to complete upgrades to the power supplies. Top priority will be the resumption of measurements on the shimmed (coils to pole) 30Q magnets from BINP.

Controls

Checkout of all sensors and control devices for the Central Helium Liquefier Main Warm Compressors was completed. This coincided with the completion of the mechanical preparation of the compressors and gas management hardware. On Tuesday and Wednesday, the compressors were started and stopped via the local PLC controls on the compressor skids. Thursday, all 6 of the compressors were controlled from the EPICS screens. The control loops were easily tuned and stable operation was maintained for 4 hours. Overall, the EPICS IOCs and archivers performed flawlessly. Some minor control system PLC and operator interface improvements were noted during the testing. The appropriate changes will be implemented prior to the 160 hour runs scheduled for early December. The SNS CHL team really plays well together. Below is a screen showing all compressors in operation (the 6 green triangles).



The PLC modules for the 4.5 K Cold Box were installed and checkout of that system was started.

Eighty PCM modules for the MPS system arrived and are in acceptance test. Several boards are failing due to bus errors. We are looking into these problems. Bids came back for fabrication of 80 MPS chassis. Total cost will be between $1000 and $1200 per chassis, slightly higher than expected. A PO has already been released for the metal work due to the long lead time. A request has been received to redefine the Source chain for machine protection. This will extend the source chain to equipment at the end of the MEBT. Other MPS inputs are being renamed to change the D-Plate to the CCL Beam stop.

At LANL reviews were held on the warm vacuum, Beckhoff and Ether IP drivers. As a result of the reviews, some changes will be made to the applications and to the Beckhoff driver. Work is proceeding on simplifying the task of database replication for the vacuum and RCCS systems. For HPRF and magnets, this is already easier, as these are

complicated devices that are replicated exactly. The address pipeline problem in the Field Control Module (which creates a conflict with the utility module) has been identified, and the source code is being obtained so it can be fixed.

The LANL team had a review of the archiver approach. An Application Programming Interface (API) was designed and an implementation plan made. XML-RPCs were prototypes to test binding a C++ archive server on one side of the network to a JAVA client on the other.
This worked fine. By Christmas this communication method should have been characterized for performance on SNS data and a plotting package selected to use as a basis.

Xiaosong Geng of the BNL team attended a course on conversion from Allen-Bradley PLC-5 systems to ControlLogix systems. This knowledge and experience will allow the migration of Ring RF ladder logic to the SNS standard. Now that DTL operations have ceased, BNL is preparing for shutdown activities, including migrating to EPICS R3.14.X for all development and deliverables. BLM software which had been updated during the DTL-1 run has now been checked into CVS, but not yet run at ORNL. This software includes more responsive digital I/O and HV PS interfaces, and more choices for BLM signal baseline subtraction. It also includes an EPICS alias facility designed to allow the BLM software to work better with the virtual scope application.

A test plan for Ring Vacuum Controls was completed, as was a test plan and Functional System Description for the Collimator Cooling Water Skids. Cable Block Diagrams for the HEBT Collimator Cooling Water Skids and the SCL Vacuum System were completed, as was the cable pull list for the SCL Vacuum System for Cryomodules 1 – 4.

Installation

Craft Snapshot 11/18/03

ASD craft workers	51.0
Foremen (Pd by 15% OH)	6.0
Direct AMSI management	3.0
Less WBS 1.9 etc	6.0
Less absent	4.0
TOTAL AMSI WORKERS	60.0
TOTAL TO ASD/ORNL WPs	41.0

The 14th Half Cell was received from BNL.

The first usable 5 MW klystron was shipped from LANL.

The CCL #1 Assembly was shipped from AXCEL. It will be received on the SNS site on Monday Nov. 24, 2003.

Three additional pipe fitters will report for work with AIMSI on Monday, Nov. 24, 2003. This additional manpower is required to maintain installation in the klystron hall so that the HVCM 04 Subsystem is completed this FY

Operations Group

Ran beam commissioning operations and achieved a 1 milli-ampere beam with the Front End and DTL Tank 1 systems.

Began preparations for the disassembly of the Diagnostic Plate and installation of DTL Tank 2.

Began evaluating the operating statistics for the commissioning and extended running period.

Participated in the ORNL Pilot program for the installation of DataStream 7i, the Maintenance Management System.

Accelerator Physics

1 mA average beam current was achieved at DTL tank 1 output at the end of the beam commissioning run. The beam conditions were as follows: 640 microsecond pulse length, 27 mA average macropulse current, and 60 Hz.

Several emittance studies were performed in the last week of the commissioning run. In an attempt to reduce the observed horizontal beam tails, a set of scrapers was installed in the anti-chopper box in the MEBT to allow horizontal scraping of short beam pulses. These were found to be ineffective in reducing the tails, but were observed to reduce the core emittance as expected. Subsequent simulations show that the horizontal halo is aligned along the x-prime axis at the anti-chopper box, so scraping should not be particularly effective. On the other hand, 90 degrees upstream, at the chopper target, horizontal scraping should be effective. In a second experiment, a modified MEBT optics which maintains more nearly equal horizontal and vertical beam sizes was explored. Measurements showed a reduction in horizontal RMS emittance from 0.37 pi –mm-mrad to 0.27 pi-mm-mrad and a reduction in observed horizontal beam tails. Such optics are one component in the halo mitigation strategy that was put forth two years ago, so this experimental test is quite encouraging.

Studies of injected beam debunching in the ring continue. This work is important for understanding the signals that will be observed with the ring 402.5 MHz BPM electronics. Including space-charge within individual linac micro bunches transported in the ring shows debunching occurring on a time scale of 5-10 ring turns.

Ring

Many of the commissioning exercises require measuring betatron oscillations over tens to hundreds of turns around the ring. However, computer models show that the 401.5 MHz beam structure will decohere after about 10 turns in the ring. We must therefore rely on the lower-resolution baseband BPM system for many of our beam measurements that involve single turn injection. At higher beam currents, computer models show that kicking the beam after full injection results in beam oscillations that decohere after just a few turns. Fortunately there appears to be a happy medium, where kicking the beam after a short injection period will produce coherent oscillations that last for over 100 turns.

The conceptual design of a halo monitor to be installed just downstream of the proton beam window is complete. Detailed design work is now in progress. The concept involves pairs of thermocouples located at the top, bottom, left, and right sides of the window, with one pair sticking slightly further than the other into the aperture (8 thermocouples total).

The vacuum window at the ring injection dump has been redesigned to have a larger aperture. Conceptual design work is now in progress to install a halo monitor at this location, which will be similar to the one at the proton beam window. We are also working to explore options to increase the range of steering in the injection dump beam line. The present system allows just +/- 24 mm of position change at the injection dump, but twice that amount would allow us to more confidently steer the beam to the center of the dump. A promising option is to reconfigure the skew quad windings on the injection dump steering magnet to add to the dipole kick.

Good progress is being made on the physics applications needed for ring commissioning. We now have preliminary versions of the tune setting, chromaticity control, and arc phase advance applications.

SCL

A group to address technical aspects of the Cryomodule parameters and measurements has been set up at SNS. With the support of JLab's colleagues, results of the measurements will be timely evaluated. All aspects of the measurements will be considered (including potential effects on the beam), to best make use of Cryomodules within the machine.

The question of magnetic shielding and of potentially magnetized components around Cryomodules has been brought up again and preliminary measurements in the tunnel around installed Cryomodules are planned for next week to better assess the magnitude of stray magnetic fields.

A kickoff meeting for the Superconducting Linac commissioning was held today to start coordinating activities and to bring to everybody's attention the resource, schedule and technical constraints that each subsystem is bound by.

Ion Source Group

A closer investigation of last weeks ion source troubles suggests that the current monitor was centered on the antenna lead with a Delrin centering fixture. We conclude that the RF heated the Delrin piece, which heated the current monitor. When operating at high RF power and duty cycle, the Delrin piece heated the current monitor until it started to leak solder while the Delrin piece essentially vaporized. After the current monitor fell on the bare antenna lead, the lead started to arc sometimes to the shield of the current monitor. Magically the current monitor survived. This problem will be eliminated by implementing a centering pieces made from Teflon.

It is possible that the antenna failure was initiated by the voltage excursions generated by the antenna lead arcing to the current monitor. After the antenna coating was perforated, plasma discharges rapidly melted and vaporized the surrounding porcelain on the antenna. An up to 1 μm thick, nonconductive film was found on the shield that surrounds the extraction aperture. A shift in the plasma potential and/or a high density of heavy ions in the plasma reduced the H- formation by about to orders of magnitude.

The Hot Spare Stand is currently upgraded with improved insulators for lens 2 and alignment brackets. These brackets will allow aligning the LEBT and ion source with the mock RFQ entrance aperture before measuring the emittance of the beam injected into the RFQ.

Survey and Alignment

Mechanical Group

Ring Systems Installation

- The HEBT collimators (2) and the associated shielding were installed.
- The HEBT momentum collimator installation was started
- The RING half-cell #14 was received.
- Installation of the DC cable pulling from the Ring Service building to the tunnel continued.

Water Systems Installation

- Installation of piping from SCL ME-02, TRCC-03 cart to the circulators and loads continued
- Modification of the piping to the two air handling units in the Linac tunnel was completed, pressure/leak tested and returned to operation.

Magnet Task

We have completed mapping and fiducialization of two HEBT 21Q40's. We are assembling one of these along with a 27CD30 and beam tube. This assembly will be transported to the tunnel and trial fit into the HEBT bam line.

We continue to map CCL Quadrupoles.

We have also received four more 27CD30's from the vendor.

Electrical Group

Ring Heavy magnet cabling complete. Started installation of corrector cables for C and D arcs.

Performed acceptance tests at IE Power of 4000 A and 700 A 1st article power supplies. Power supplies passed acceptance tests.

Completed the testing and installation of all CCL power supplies.

Operated DTL-ME3 for a couple of days at full average power. Nearly completed pre-installation activities on CCL-ME4 basket assembly. All modulator through CCL-ME3 and SCL-ME1 are presently installed, with CCL-ME2 awaiting final checkout and –ME3 awaiting switch plate assembly installation. Continued to develop in-house HVCM simulation models. Finished fabrication of parts for automatic interlock/bypass function on HVCM, and will be installing and testing the prototype on the RFTF modulator.

HPRF

WR-1150 waveguides between the first six klystrons (MB 1&2) and their respective circulators that were removed for pipefitter access were replaced. Fine alignment was done with varying waveguide shim sizes. Flange bolt torque checking remains. Installation of the second set of six waveguides has begun. Electrical cable pulls for the transmitter controlling the six klystrons powering MB 3&4 have made good progress and should be complete by 11/25.

Six arc detector chassis were mounted in the MB 1&2 LLRF RFC rack and fibers were connected. This arrangement eliminates the need to fabricate long interconnecting cables between the transmitter racks and the RFC, and consolidates components of the HPM protection function.

Drawings were submitted to the machine shop for fabrication of air-waveguide fittings to support the CCL waveguide cooling requirement.

Phase measurements on the CCL-1 waveguides were performed and the data is being used to fabricate fixed posts to permanently center the relative phases to mid-range of the installed waveguide adjustable phase shifter.

Rob Peglow visited Los Alamos to observe the disassembly and removal of the 5 MW klystron in preparation for its shipment to SNS. The process was videotaped as a learning tool for the riggers and RF personnel on site.

LLRF

We reviewed our production plans with LBNL and LANL by videoconference on Monday. Curt Hovater of JLab and Chris Ziomek of ZTEC were also in attendance. The discussion was practical in nature and focused on production logistics and contractual issues. One of the strongest conclusions was to proceed with the full production of the High Power Protection Module (HPM) with Suntron, the company that has done all of the prototype and small runs for LANL.

Much effort was spent on resolving the DMA data transfer problem with the Field Control Module (FCM). It appears the problem lies, at least partially, in the VXI interface portion of the FCM carrier board. This may have implications for the HPM since it uses the same circuitry. One of the recently received HPMs will be returned to LANL for further investigation. The fix will probably require a FPGA code change; we do not anticipate any changes to the circuitry, but until this problem is solved, there is increased risk in proceeding with the FCM carrier board production.

We continued the installation work on the SCL and are ready to proceed with installation of the VXI crates, which will allow Controls to set up the IOCs, Utility and Timing modules.

Cryosystem Group

The week was spent starting up the warm compressor skids. We managed to start and run all six (6) warm compressors at the same time. The skids were run in the partially unloaded state and raised to operating temperatures. The 168 hour acceptance runs will start the first week in December.

The shield to vacuum leak was found in the expansion can for MB4. The down stream expansion bellows was leaking at the up stream weld. The replacement parts are on order and should arrive in time to be installed next week.

Beam Diagnostics