Accelerator Systems Division Highlights Ending October 10, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: (1) The first 5-MW Thales klystron for the CCL passed all acceptance tests except for the efficiency (52% *vs.* 55%). We are working with Thales to negotiate a conditional acceptance of the tube. We are reconfiguring waveguide to test the 5-MW AFT circulators. (2) We completed the sliding short test on the last two DTL windows. This completes LANL's testing obligation for DTL windows.
Concerns & Actions: (1): We are working with the manufacturer (Titan SureBeam) to resolve the arcing problem in the 5-MW CCL load. Two SureBeam representatives will be at LANL next week.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) The prototype high-voltage converter modulator (HVCM) continues to operate without failure to support full power testing of the 5-MW CCL klystron. (2) We reviewed and approved Dynapower safety enclosure wiring methods and materials. (3) We made safety improvements for LANL operations, performing arc-flash calculations to determine PPE requirements for closing breakers on the prototype and production HVCMs. We also revised procedures for closing breakers safely. (4) We replaced phase "C" IGBT assembly in production converter-modulator.

LOW-LEVEL RF CONTROLS (WBS 1.4.1.3)
Accomplishments: ORNL reported that the LANL Rev B of the final field control module is proving to be highly functional. It immediately began working near the design specs with the firmware from Rev. A. The gains of input channels are the same as those of the first unit. The RF output was reported to be functioning fine.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments - Tank-2: All groups J's have had their welds repaired. The empty J unit being rebuilt (2-12) is profiled on one side and will be processed with the group K units. Cap welding of the PMQ J unit being rebuilt (2-1) is complete. All group M units are finished machined and are in mechanical inspection. One group M unit (2-40) suffered internal contamination with coolant and was shipped to LANL for cleaning and leak checking. After leak checking (at ESCO) the M units will be dispatched to CMI for stem work and plating. All of the L units are machined to final profile and five of the K units have been finished to final profile. Drift tube work is being serviced with day and swing shifts at ESCO; LANL personnel are monitoring both shifts. We forecast that all the work at ESCO will be complete by 10/17/03. LANL shipped the RF waveguide iris to ORNL.
Tank-4: Top hats have had missing pins installed, been re-cleaned, and shipped to ORNL.
Tank-5: Drift tube stems were welded, and straightening is underway. Units will go to plating early next week, with final processing late that week. Top hats have had missing pins installed, been re-cleaned, and shipped to ORNL.
Tank 6: All units with the exception of (6-17) have been final profiled and leak checked are ready for stem welding the re-cleaned PMQ for 6-17 is currently being loaded into the replacement body at CMI; the unit were shipped to ESCO for cap welding. Weld development for this cap weld has been completed at ESCO. Top hats have had missing pins installed, been re-cleaned and shipped to ORNL. Waveguide iris was shipped to ORNL.
Tank 3: Waveguide iris was shipped to ORNL.
EMD DT's: This week's welding repair campaign at Sciaky is going well. All leaking EMD drift tubes appear to be repaired but this will require confirmation with the leak checker at LANL.
Beam Boxes: The tank 4/5 and 5/6 beam boxes were shipped to ORNL. There is some missing inspection information for these boxes; we requested that ORNL measure the boxes for this missing information. Machining is underway at Integrated on the tank 2 and 4 pumping grills and port covers.
Issues and Concerns: (1) While the results this week from Sciaky are excellent, there remains a concern over the permanence of leak repairs to EMD drift tubes. There is further machining required on these units and these operations could trigger a leak. (2) Progress at Integrated Machine is slow. LANL procurement and project controls will support the DTL team to improve the situation. (3) A plan needs to be implemented on servicing final post coupler and slug tuner machining and testing after the LANL DTL recovery team is disbanded.

COUPLED CAVITY LINAC (WBS 1.4.4)
Accomplishments: (1) A review of the tuning records for module 1 shows a regular pattern in the cut specification on the tuning ring to bring each accelerating half cell into frequency (tuning range) prior to the first braze. Every

other half cell has a groove machined into its face to receive an alloy wire. Even though the half cell is pressed against a surface plate while measuring its frequency, there is enough RF communication with the groove to reproducibly lower its resonant frequency by ~300 kHz. Following the braze, the accelerating cell is seamless and there is no groove effect consequently the full cavity is low in frequency by 150 kHz but well within dimple-tuning range. Fig 1 shows the tuning ring cut depth, in mm, specified for each half cell in the module. This groove effect has also been observed in the half-cell tuning of segments 7 & 8 of module 2. To avoid delaying the production, segment 7 & 8 tuning rings have been milled following the module 1 procedure. Henceforth a 300 kHz correction will be added to the tuning ring dimension on all grooved half cells. (2) All of the bridge couplers have been tuned and all but about 3 now meet the tuning criteria. The coupling cells are tuned to within ±200 kHz of each other. The segment-to-segment tilt sensitivity lies within ±0.25%/MHz. (3) Figure 2 shows the first complete module mode spectrum measured when driven through the power coupling irises in bridge couplers 3 & 9.

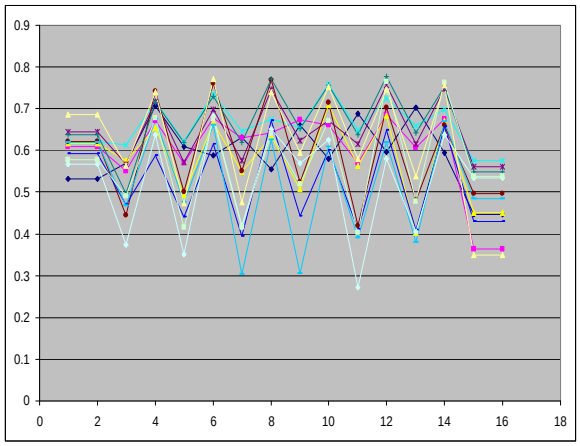


Fig. 1: tuning ring cut depth (mm)

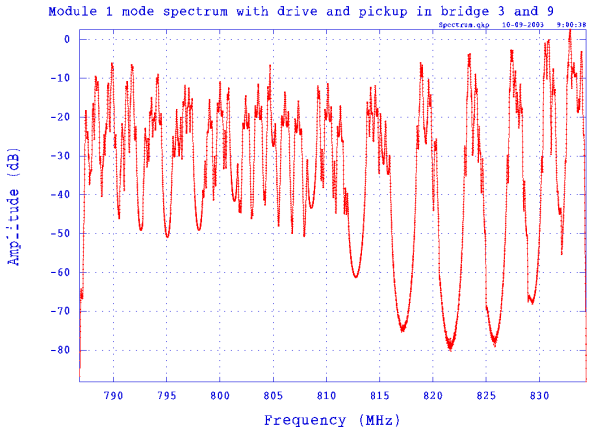


Fig. 2: First complete module-1 mode spectrum

Figure 3 shows the central 23 frequencies of the full mode spectrum when driven at the end accelerating cells. The code Disper gives a very good fit to these modes revealing a positive stop band of ~350 kHz. Our goal is 20 kHz. The resonant frequency of the π/2 mode is 190 kHz low. The next step is to retune all 22 end-accelerating cavities by +1.1 MHz which we hope will correct both errors. (5) Measurements to date do not yet indicate any impending problem. Progress has been steady and our understanding of this complicated structure is improving. While most measurements now seem to be pretty reproducible we still encounter curious inconsistencies the source of which we hope will reveal them self as we converge on a tuned, stable structure.

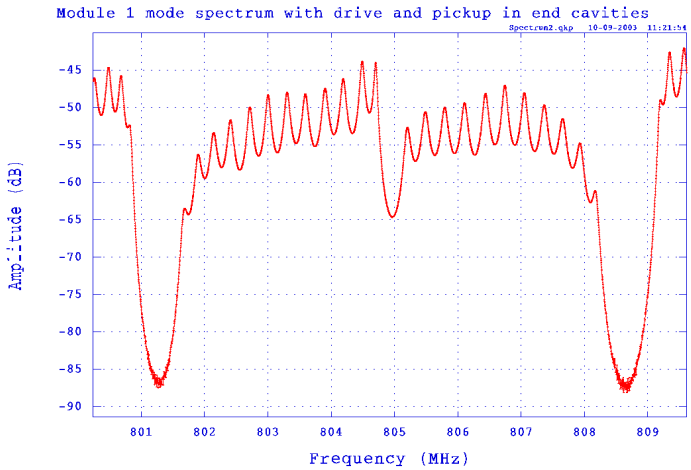


Fig. 3: Full mode spectrum when driven at the end accelerating cells

Concerns & Actions: We expressed our concerns about the manufacturing schedule to ACCEL, and have agreed to begin a weekly status meeting beginning on 10/17. N. Bultman and J. Billen are at Accel to monitor manufacturing and tuning. J. Stovall will join them next week.

ASD/JLAB: Cold Linac

Attempts to repair the 1 MW RF test stand continue. The next test is expected early next week.

The CTF has resumed limited operation after Hurricane Isabel. Several cavities are in VTA dewars at 4 K. Cooldown to 2 K is expected early next week.

Acid operations in the Production Chemistry Room have been suspended following an apparent acid exposure to a technician. The employee did not suffer permanent injury in the event. Operations will resume when an engineered barrier has been deployed to prevent recurrence.

Assembly of the M-7 cryomodule has begun.

ASD/BNL: Ring

Installation drawings for the HEBT momentum collimator are complete and are being reviewed. Mike Hemmer is working to resolve a 3cm discrepancy in lateral off-set.

Preliminary installation drawings for the Ring arc sections have been given to ASD.

An internal schedule for assembly/delivery of half-cells has been sent to ASD.

An internal schedule outlining the design, production and delivery of vacuum components has been sent to ASD.

Injection chicane #3 - field measurements are underway.

All thirteen (13) of the 21S26 magnets have been fully measured.

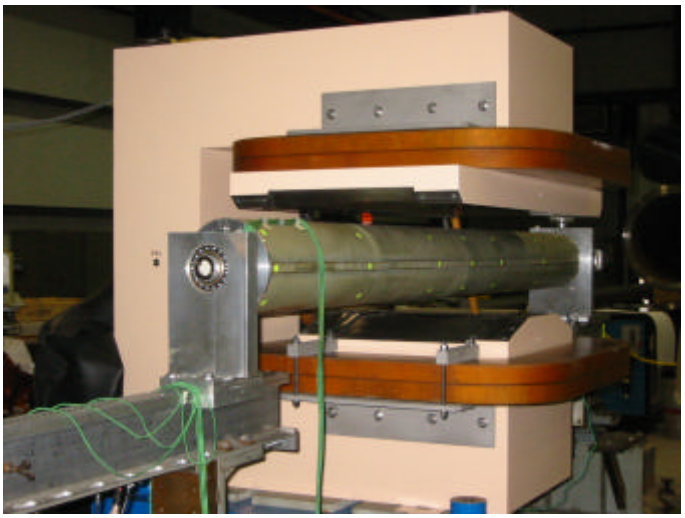
After sixteen days on the road, the first article 26S26 production magnet has not yet arrived at BNL. Alpha Magnetics will put a trace on their shipment.

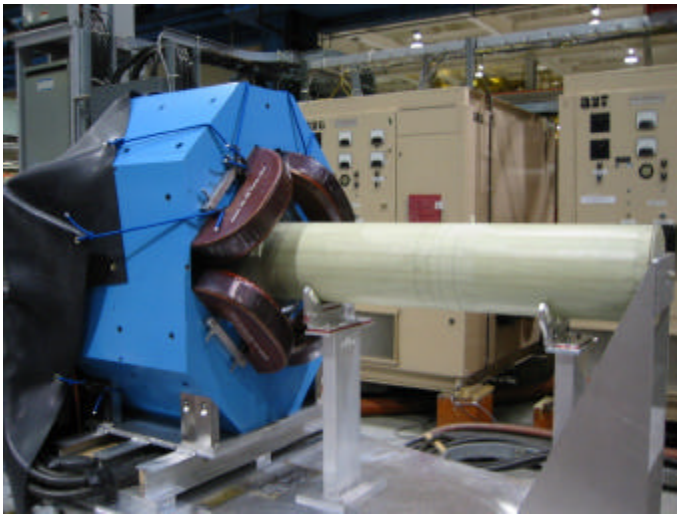
NETC plans to ship four (4) more 27CDM30 magnets to SNS/OR on 10/21.

Tesla plans to ship eight (8) more 21Q40 magnets and stands to SNS/OR on 10/24.

The BNL/SNS vacuum group is preparing the Ring 2 and 3 collimator beam pipes for TN coating.

Dick Hseuh will be at SNS/OR early next week to discuss vacuum issues and equipment delivery schedules.





Controls

The week of Sept. 29 - Oct. 3 saw a spate of IOC failures that significantly impacted operations. Investigation this week by Ernest Williams (with the help of others) revealed an apparent incompatibility between our IOC utility module and an IOC software application for diagnosing IOC communications status. This software has been rolled back to an earlier version and the problem seems to have gone away. We are now focusing on understanding the precise nature of the incompatibility.

Installation of communications cables for the first three rack rows of the SCL started this week. Our most immediate goal is to be able to support testing when Kay Kasemir arrives the week of Oct. 20. A number of network switches are also being configured and installed to support this test.

Three members of the Controls Group have left to attend the ICALEPCS 2003 conference. Meetings start Sunday Oct. 12.

We have had problems with fan trays on 7 slot VME crates in the past. The vendor has agreed to address the problem. We tested the VME crates that have recently been delivered to the rack factory (DCS) and found them to be fine.

Installation

Craft Snapshot 10/7/03

ASD craft workers	55.0
Foremen, ES&H, etc	9.0
Less WBS 1.9 etc	10.0
Less absent	4.0
TOTAL	50.0

Installation in the SCL_ME01 System continued. The first HVCM in the superconducting linac will be operational by the end of Oct, 03.

Installation and check out continued in the DTL rf system. All DTL RF systems will be operational by the end of Oct, 03.

The concrete support foundation for the HEBT momentum collimator was poured.

Grouting of cryomodule support plates continued.

Preparations are being made to receive the third Medium Beta Cryomodule from JLAB on Wednesday, Oct 15, 03.

RFQ

The Front End systems emerged successfully after the Thursday, October 2nd maintenance shutdown. We ran ~30mA beam through Friday owl shift. The RFQ had been operated at 1ms, 30 Hz, 750kW, which constitutes about half of the nominal average power. In the morning of the next day we experienced massive crash of the control system, when multiple IOCs hanged up. It took several hours to recover control system. We don't know precisely what was going on during that period of time. When operators started to bring back the Front End systems they found that reflected power from the RFQ is too high ~70kW at 100kW forward power. It's usual situation when temperature of the RFQ is away from the nominal therefore operators left the RFQ to heat up at low power and started to bring up the ion source. They found the ions source non operational and next 1.5 days were spent to fix it. Nobody tried to power up the RFQ that time therefore we were unaware of any serious problem. When the ion source was up and running on Saturday operators were unable to bring the RFQ to nominal frequency at our nominal temperature set point. After checking out the RFQ LLRF system we concluded that the RFQ cavity resonates at 402.0 MHz, which is .5MHz lower than nominal 402.5 MHz. Simultaneously we found that the chiller #1 doesn't regulate temperature. The chiller was fixed on Monday, Oct 6th but even at full power it couldn't bring resonant

frequency to the nominal. It became clear that something serious happened. We performed field distribution measurements and found significant deviation from flat distribution toward upstream end. We also found that two power loops on the left side of the RFQ exhibit unusually high reflection. Inspection of the loop #1 and its RF window didn't reveal any problem. The next candidate for inspection was one or several of the pi-mode stabilizing rods. We inspected several of them through tuner openings and finally opened the upstream wall to see entire internal volume of the RFQ. All stabilizers appeared to be intact as well as endwall tuning disk. We were unable to find anything abnormal inside the RFQ cavity. At that moment John Staples of Berkeley came in to help us in troubleshooting. Still there is no clue what have happened to the RFQ. We have list of measurements of the RFQ fields, which may help to pinpoint location of a possible mechanical deformation. This work is going to be done during weekend shifts.

Accelerator Physics

Peak currents of 38 mA were achieved in the front-end and transported through DTL tank1 in the last two weeks.

Emittance measurements at 38 mA show rms normalized emittances less than 0.3 pi mm-mrad obtained by fitting the beam core.

With greatly reduced noise on the emittance device, we see evidence of some beam tails, not unlike those observed in the front-end. Attempts to investigate these tails are on hold as the RFQ is under investigation.

At this point in the commissioning program we have achieved the design peak current, accelerated a 1 msec beam pulse at 20 mA, measured RMS emittance of beam core at the design current consistent with performance goal. The next step once beam is recovered is to perform the high duty factor test.

Design work is continuing for the laser-stripping injection project which received internal ORNL funding.

J. Galambos is attending the ICALEPCS conference in Korea, reporting on XAL.

Operations Group

Ion Source Group

Less than an hour before the SNS picnic started, a novel ion source failure mode occurred: When operated above 8 kW, the RF power stayed fully reflected, while and the antenna current would first rise but return to zero after about 10-20 us, suggesting a failure in the primary RF connection. To identify the problem two ion source staff members found that the RF amplifier could deliver 30 kW into a dummy load, which questioned the initial hypothesis. During the owl shift another ion source staff member ruled out matching network problems through extensive matching tests below and above 8 kW. An inspection of the ion source revealed an antenna and a cesium collar in pristine conditions. On the 3rd shift after another ion source staff member swapped the RF power cable which reestablished proper ion source operations. It turned out that the RF broke down inside an RF connection, most likely started by an HV discharge. We are now repairing the cable for the Hot Spare Stand and fabricating a spare cable.
The highly coordinated recovery effort allowed for a significantly reduced down period caused by a nontrivial 2 MHz problem. Most importantly, we believe to have improved our problem diagnostic methods, and therefore expect to recover from similar future problems in less than 4 hours.

Survey and Alignment

Target

- Completed present phase of night network measuring campaign required to support target projects.
- Performed Measuring Analysis of Target Cart Liner
- Set Locator Plates

DTL

- Continued DTL 4 drift tube fiducialization

HEBT

- Set/leveled HEBT Collimator Base plates
- Completed layout of momentum collimator rebar
- Continued with HEBT magnet alignment
- Laid out bolt hole pattern for remaining support stands
- Prepared necessary data for the setting of the 21Q40 magnet stands

MISC

- Completed latest epoch of RTBT elevation data.
- Setout the necessary positions to allow for the laser/optic pipe installation to begin.
- Regularly scheduled laser tracker calibrations procedures were completed.
- Measured elevation of three beam dumps. It is noteworthy to mention that the linac dump has continued to settle. The center of the linac dump is now 25mm low with respect to beam. Reports available upon request.

Mechanical Group

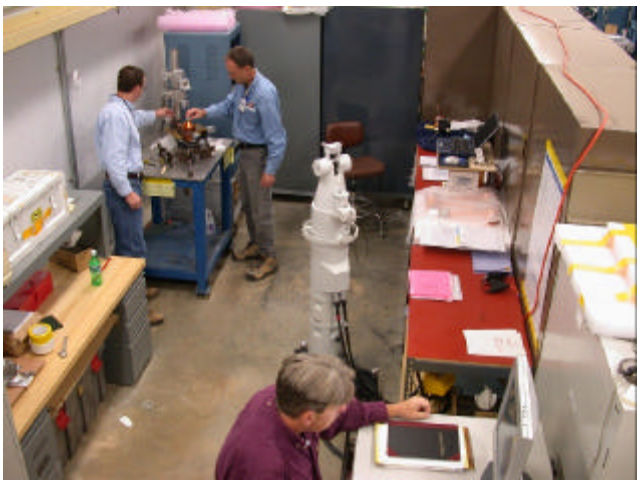
Water Systems Installation

- The DTL Tank 2 water manifold was installed.
- Installation of SCL ME-01 MB 2&3 klystron body cooling lines continues.
- Fabrication of the QMCS manifold continues in the Linac tunnel.
- Installation of the facility supply lines to the QMCS cart in the Klystron gallery started.
- The Klystron gallery DI water system which serves the SCL ME-01 system is being charged and will put into service the first of next week.

Ring Systems Installation

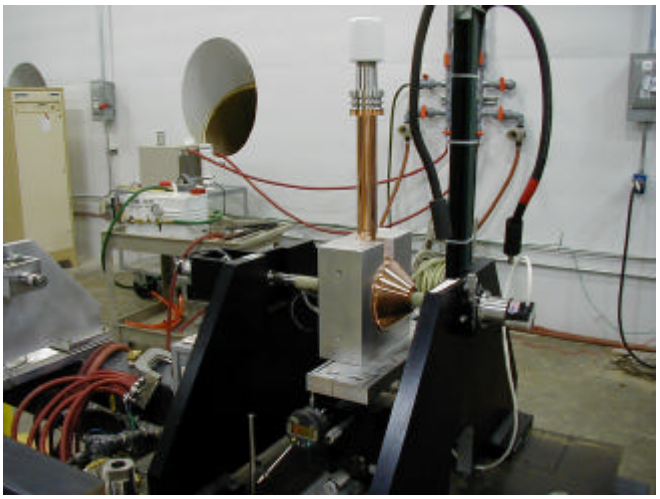
- The baseplates for HEBT collimators #1 and #2 were grouted.
- The support base for the HEBT momentum collimator was poured.
- Installation of HEBT beamline diagnostic and drift pipe chambers continues.

All 21 PMQ and empty DT's for DTL-4 have been received at ORNL. The 4 EMD and 2 BPM DT's which will bring the total to 27 are expected by mid November. Fiducialization, magnet mapping, and leak testing of the DT's, which is done before installation, is in progress.



DTL-4 Drift Tube Fiducialization in the FE Building

DTL-4 Drift Tubes in the FE Building



DTL-4 Drift Tube Magnet Mapping

The detail schedule of DTL installation activities has been updated consistent with our current installation sequence, where DTL-2 is the next tank installed and DTL-2 and -3 are commissioned together. The schedule indicates that the delivery of the EMD DT's for DTL-1, -2 and-3 are the critical path components. These will likely be the last DT's delivered and they must be installed in DTL-1 and DTL-2 before the DTL-2 tank is placed on the beam line. The DTL-2 tank can be moved on the beam line ~ 5 weeks after the delivery of the last EMD. The EMD delivery schedule is currently being developed and projections are expected next week.

Magnet Task

Electrical Group

Operation continues on DTL-ME1 and –ME2, with 60 Hz operation (single klystron) in process on –ME2. DTL-ME3 was operated at full average power, and extensive temperature measurements were taken to determine the suitability for long term operation. Cooling upgrades were performed and arc barriers installed, and the unit has been operated for ~40 hours at 60 Hz, 1.35 ms pulses, at 125 kV (~700 kW of average power). Operation shall continue until the arrival of Ztec and LANL representatives the week of 20Oct, at which time we will work on defining the closed loop operation control margins. CCL-ME1 was checked out to full peak power (140 kV) this week, and is awaiting the arrival of a klystron to complete the checkout process. CCL-ME2 modulator tank was put in place and filled with oil. CCL-ME3 and –ME4 are being prepped for installation. SCL-ME1 is nearly ready to

begin checkout, with the only holdup at the moment being the final installation of instrumentation cables and providing AC power to the rack. The last two SCL modulators arrived from Dynapower this week.

DTL and CCL cable pulls are completed that no major D/B involvement is expected. Termination of accelerator equipment cables will be completed upon beam line equipment installation.

Ring main dipole transformers and switchgear were installed - see attached photographs

Ring quadrupole series string have the first ring service building power supply to tunnel magnets pulls started - attached photograph shows Don Russell, who is the foreman and also the president of the local union, and part of his crew pulling the first quadrupole feeder from the tunnel into the ring service building.

Completed testing of all linac corrector supplies and 10 of the 16 corrector power supplies to be installed in the HEBT service building. All DTL and CCL linac corrector supplies have been installed in the klystron gallery.

Tested 4 of the 14 CCL quadrupole power supplies and installed 3 in the linac gallery.

Tested one SCL quadrupole power supply.

Repaired and replaced 2 front end quadrupole power supplies. Ordered and received an additional spare for these supplies (now have 2 spares plus one local control only spare for 11 installed supplies).

Witnessed acceptance tests at vendor and installed main ring power supply transformers and switchgear.

Witnessed acceptance tests at vendor first article 185 A ring medium power supply.

HPRF

Moved two SCL 3-klystron HV tanks to the MB-3 & 4 positions in the gallery. These are the second half of the MB_SCL_ME-1 system. The water systems for these six klystrons are now being piped in. The cable pull drawings have been submitted and cable pulls (wire and fiber) will start for the transmitters next week.

Mounted 12 klystrons on four SCL HV tanks in preparation for transport from the RFTF to the Klystron Gallery. Once completed, space will be freed up in the RFTF for test and development work.

Installed and removed WR2100 waveguide transitions in support of temperature vs. frequency measurements of the DTL1 and DTL3 linacs and separate RFQ measurements. Installed N-type transitions on waveguides for systems DTL 4, 5, & 6 in preparation for klystron forward power calibrations.

LLRF

Five Rev B Field Control Modules (FCMs) have been received recently and are under test at LBNL, LANL and ORNL. They are fully functional as received, i.e., the revisions to the VXI carrier board, Digital Front End (DFE) and RF Output boards appear to have remedied the few problems that were discovered during the testing of the Rev A FCMs. The DFE Field Programmable Gate Array (FPGA) has been programmed successfully via all paths: the DFE JTAG interface, the VXI backplane, and the VXI carrier board PROMs. The Analog Front End (AFE) is undergoing detailed study to ensure it meets linearity requirements. A significant reduction in 2^{nd} and 3^{rd} harmonic content has been achieved by replacing the op amp on the 50 MHz cavity and reference channels. A minor design revision is planned for the AFE prior to going out for production. It appears the revision can be accomplished without changing the board layout.

The EPICS sequencer that has served as the user interface on the RFQ and DTL is being adapted to the FCM in preparation for installing a FCM in either DTL1 or 3. Our goal is to maximize the operational experience with the FCM to make sure there are no latent problems in the design or implementation. We plan to install and operate a FCM in the coming week, operations schedule permitting. We also plan to carry out a test of the FCM at JLab with a superconducting cavity in the near future. The schedule for this test is dependent on the cryomodule testing schedule at JLab.

We are working with SNS Procurement to order the electronic components needed for production of the FCM and the High Power Protect Module (HPM). Due to long lead times, we are ordering the parts now even though we're not yet ready to begin the production. This requires that we provide parts kits to the vendor that fabricates and populates the circuit boards. We anticipate letting the contract for production of the FCM and HPM in November. Our planning calls for a first production of 20 units followed by a final production run of ~100 units. We continue to base our schedule on the plan that was formulated in October 2002. All of the systems required for DTL1-6 are already installed.

We continue to support linac operations as necessary.

The installation of the LLRF systems for DTL1-6 is essentially complete. Heliax cable installation and termination in the CCL and SCL is in progress. The installation of the 805 MHz reference line hangers is in progress. One quote has been received for the 805 MHz reference line; a 2^{nd} quote is imminent. The parts for the downconversion/distribution chassis have been ordered and a fabricator is being sought for the production of ~40 chassis for the SCL. First articles for the intra-rack coaxial cables (bulkhead type-N to PKZ) have been received and tested; the vendor has been given approval to complete the order.

Larry Doolittle and Alex Ratti visited ORNL last week. Larry worked with the ORNL team on DTL operations issues. The principle accomplishment was upgrading the DTL1 system to provide for robust phase zeroing. This

ensures the phase settings of the system do not change quadrants upon power cycling or rebooting the LLRF control system. Alex, Mark and Hamid (via telephone) discussed the FY04 work plan with regard to schedule, distribution of work, and tight FY04 budgets.

Sung-il Kwon of LANL will visit ORNL next week to perform system characterization measurements on DTL1 and/or DTL3 and to perform adaptive feedforward tests.

Cryosystem Group

The CHL purifier and RS compressor have been commissioned.

The CHL vacuum skid vacuum pumps are operating.

We are preparing to load the conditioned oil into the helium warm compressors.

We have backfilled the supply and return primary and shield lines and found no detectable helium in the insulating vacuum.

The “U” tube fabrication has been stopped and all the recourses committed to commissioning the CHL.

Beam Diagnostics