Accelerator Systems Division Highlights for the Two Weeks Ending May 23, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: (1) High Power testing of the Thales SC linac klystron S/N 1 is in progress at LANL; (2) Tom Hardek witnessed factory acceptance test of CPI SC linac klystron S/N 23. Also S/N 22 was approved, and S/N 19, 20, 21, and 22 ship to ORNL 5/23. (3) Hardek also was at Ross Corp. to witness the testing/calibration of our test stand voltage divider.
Concerns & Actions: (1) LANL acceptance testing of DTL klystron S/N 10 revealed an efficiency of ~ 51% which is below the 58% specification. The tube will require some tuning. An E2V representative is scheduled to come to LANL the week of 6/2. (2) DTL klystron S/N 11 klystron broke at the E2V factory during the high potting after factory acceptance test. (3) Thales scheduled the factory acceptance tests for CCL klystron S/N 4 staring 6/19, S/N 1 on 6/23, and S/N 3 on 6/26. These klystrons will be using the MEGA gas barrier. Thales is still pursuing a backup solution. LANL will lend Thales an AFT window for use in this solution. (4) We discussed the issue of flaws in the transmitter filament transformer cables with Titan. We determined that they pose no immediate threat to operations but that the flawed cables should be replaced. Titan provided an action plan to procure better quality filament transformer cables and ship connectorized replacements around the first of July.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) Joe Bradley was at Dynapower where he completed acceptance testing of the 6th production high-voltage converter modulator (HVCM) (the 5th 140-kV system), and began acceptance testing on the 7th. (2) While at Dynapower, Joe tested Rogowski coils and fault detection systems in control rack. He re-derived function of control rack interlocks from schematics, and determined proper orientation is essential for Rogowski coils to able to trip C/M off. He also documented check for proper Rogowski insertion in IGBT assembly acceptance test revision, and measured and documented all Rogowski coil outputs at full power to establish a baseline of what the waveforms should look like. (3) Modeling has reconfirmed transformer winding forces are acceptable with a maximum winding force of ~3.2 N/M. This results in an unrestrained movement of 0.014" when related to the pulse width and moment of inertia. The present transformer design is appropriate. The production epoxy bobbins have 1/5 the thermal coefficient of expansion as compared to the prototype polyethylene bobbins. Earlier problems as previously stated have been related to bobbin thermal expansion causing the wire to stretch. (4) The prototype HVCM supported LANL klystron testing as required, with 100% availability. (5) Installation of the LANL production HVCM is nearly completed. Some delays resulted from required re-work due to unsatisfactory vendor assembly. Inspection Discrepancy Reports were generated.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: Tank–1: (1) ORNL staff completed DTL Tank-1 drift tube alignment. (Fig. 1). (2) Jim Stovall and Jim Billen were at ORNL to tune the Tank-1. They completed the job in 2½ days. Final post coupler dimensions are being measured 5/23 and 5/24. Preparations are being made to complete post couplers on 5/27. Present estimates indicate a delivery date to ORNL of 6/10. (3) Slug tuner vendor is ready to receive trimming data.
Tank-4: (1) Group A & B drift tubes are brazed; three units will require re-brazing and one unit developed a water channel weld leak after brazing; this unit will be designated a test article and be sectioned to determine cause of water channel weld leak. (2) Group C & D drift tubes diverter to body brazes is underway. (3) Wave guide equatorial braze complete and unit has been dispatched to CMI for exterior machining
Tank-5: (1) Water channel welding is complete on all drift tube bodies; diverter braze preparation machining of group E underway. (2) Wave guide equatorial braze complete and unit was shipped to CMI for exterior machining (3) Stands for tank 5 are being prepared for shipment; scheduled to ship to ORNL early next week.
Tank-6: (1) Water channel welding is complete or underway on all but one drift tube. (2) Wave guide cooling channel plug joint complete and unit dispatched to CMI for interior cavity machining. (3) Stands for tank 6 being prepared for shipment; scheduled to ship to ORNL early next week
Tank-2: (1) Fabrication of qualifying example drift tube continues at ESCO. (2) Machining of tank two drift tubes and sleeves should begin 5/27 at ESCO. (3) Rough machining of wave guide is almost complete; it is scheduled to go to plating on 5/28 to plate cooling channel plug features.
EMD DT's: Magnet coil winding is scheduled to begin on 5/23.
Concerns & Actions: The water channel weld which occurred in one of that tank four drift tube bodies after diverter brazing prompted a short halt to welding activities at Hanford; welding procedures were modified slightly as a

precautionary measure and permitted to resume. Two T-4 empty drift tube bodies are being rushed ahead to final profiling in order to check their water channel welds for leaks in a minimum material condition. Also, the leaking drift tube and its pinpointed leak will be sectioned to look for a cause of the leak. Presently a material defect and or weld contamination is suspected rather than a systematic welding procedure flaw.

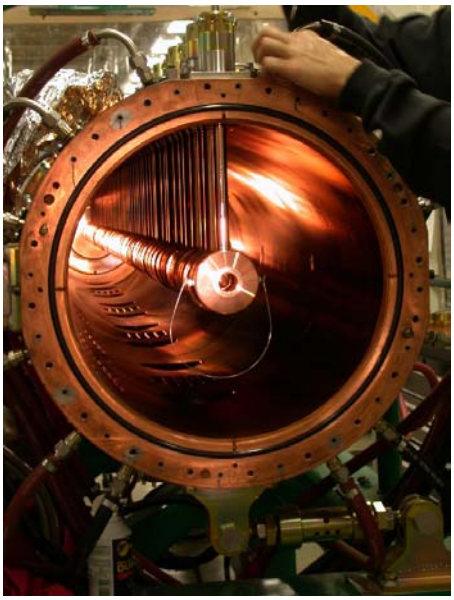

Fig. 1: All 59 drift tubes in Tank-1 are now aligned and the structure has been tuned.

PROJECT MANAGEMENT (WBS 1.4.6)
Thom Mason was at LANL this week where he held an SNS all-hands meeting and met with the Group Leaders. Thom also met with LANSCE leadership to discuss the post-handoff MOA.

ASD/JLAB: Cold Linac

ASD/BNL: Ring

Work is underway to identify projected FY 2003-2005 year-end commitments.

The PCR for the Ring RF Junction Box has been approved.

Danfysik shipped the last group of low field corrector power supplies to SNS/OR this week. In addition, they shipped the remaining three RF Tune PSs; two to BNL and one to SNS/OR.

We shipped half-cell #10 to SNS/OR on May 20th. Work is underway on units #11, 12 and 13.

Carbon Wire Scanner - Shipped twelve HEBT vacuum chamber assemblies to SNS/OR. Completed fabrication of the support structures.

The 1st article 26S26 arrived this week (May 19) from Alpha Magnetics.

BINP (Budker) reported that two shipments (5 magnets each) are now in route to BNL. First lot should arrive by June 1st.

HEBT 12cm Vacuum - Twenty quad chambers are now at ORNL; the remaining twelve quad chambers have been fabricated and are being leak checked. Over 50% of the drift pipes have been fabricated.

Injection kicker ceramic chambers #1 and #2 are being measured together with the kicker magnets.

Quad shimming: seven of the 21Q40 quads have been shimmed; 6 are being measured.

Jim Rank conducted an internal review of the extraction septum magnet assembly. A detail design of the extraction vacuum chamber and the upstream drift pipe continues. Modeling of the RTBT 17D224 "wedge-shaped box" vacuum chamber is underway.

Engineers traveled to APS this week to observe construction progress on the Extraction Kicker PFN.

Controls

1.9.2 Global Controls:

A screen was developed to show an overview of our IOCs' health. This required modification of many IOC's software to use consistent and standard health monitoring software.

Alarm handler configuration files were set up for all MPS PVs so that when MPS trips occur, it will be easier to identify and locate the source of the problem.

Automated monitoring and alert tools were set up for managing the site archiver. The alert system sends e-mail/pages to the system maintainers when alarm conditions occur. The same tools were set up for handling the network status of all IOCs. This technique will be extended further to cover more health monitoring and early warning notifications to Control Systems Personnel.

We have installed another data mirror to support viewing of EDM screens from offsite in a more transparent way.

ICS Network service was implemented for the CUB to support control system testing in the CUB.

1.9.3 FE Controls:

IOCs (fe-ctl-ioc1 and fe-ctl-ioc2) were checked out, including correcting time on the latter. This is in preparation for possible use of the front end next week.

1.9.4 Linac Controls:

Work continued on automating LLRF operator control and debugging it on DTL3. This includes a sequencer and a new operator screen. This effort included converting the forward, reflected, and cavity waveforms from the LBNL field control box to phase/magnitude form.

Modifications were made to the Hytec DAC driver to support BNL Beam Loss Monitor implementation.

Yongbin Leng (BNL) and Larry Hoff (BNL) traveled to ORNL to conduct a review of BNL-developed BLM software. The DTL BLM PVs were configured into the XAL framework for use in generic applications.

Both LANL and ORNL controls personnel supported successful integration of the D-Plate View Screen camera controls.

RCCS and vacuum system check out was completed for the D-Plate:
- The RCCS has some alarm setpoints that need to be corrected. LANL will make these corrections soon. There is also a question about the amount of flow that can be achieved through the beam stop on the D-Plate.
- The vacuum controls for the D-plate and view screen actuation are now implemented. There were a few code issues in the PLC that had to be resolved for the view screen control. These were corrected and tested. The collision avoidance box for the D-plate also checked out OK.

The tuning of the RCCS for DTL3 has gone well now that the conventional facilities chilled water temperature has been stabilized. Temperature control of the DTL3 tank is now much more stable. RF power was run at different levels and the RCCS was able to track the frequency error. The RCCS PLC code was changed so that when switching from frequency mode to temperature mode (e.g. when RF shuts off for a set amount of time) then the temperature setpoint will automatically set to the last temperature seen when the RF turned off. This allows the RF to turn back on at the same power level when it tripped off without touching any controls. Once the RF power is up to its setpoint then the operator still has to manually change the mode from temperature mode to RF mode.

LLRF integration testing of the FCM is making progress with most of the registers now being referenced. Work on interrupts remains. The RGA driver is being worked on again. The Beckhoff driver is now available on LINUX. The scope Tool has been released by LANL to ORNL and BNL.

1.9.8 Conventional Facilities Controls

Five Functional System Design Documents for Target Building CF controls were drafted. (I'm sure David Olsen cares) I DO!

Installation

Craft Snapshot 5/21/03

ASD craft workers	86.0
Foremen, ES&H, etc	12.0
Less WBS 1.9 controls	12.0
Less absent	4.0
TOTAL	82.0

DTL #1 drift tube alignment was completed.

DTL #3 operations continued.

HEBT cable tray was completed.

Received RING half-cell magnet assembly #10

All Ring Half Cells received at the site have been stage into the Ring Tunnel. Five, including the prototype, remain in RATS I.

Re-alignment of the MEBT rafts was completed.

QA was moved from RATS I to the Klystron Hall.

The first (Blue) move of personnel from RATS I to the 10-Plex was put on hold due to environmental (mold) concerns in the 10-Plex. The move is now planned for 2 June pending cleaning and drying of the 10-PLex.

Accelerator Physics

AP group members attended PAC 2003 in Portland, presenting 17 papers, including three invited talks.

AP group members attended the HALO 2003 workshop, presenting 4 papers.

The applications programming group are training operators on software in preparation for commissioning.

Operations Group

The main focus of the accelerator Operations Group this week was to continue to prepare for the upcoming accelerator readiness review. We held our second meeting with group and task leaders and lead engineers to assemble test plans to be used for the verification of readiness to operate DTL 1, D-plate and supporting systems.

Also, we continue our efforts to assist in the development of Electrical and Radiation Safety procedures, training and methods, working as part of those Safety Committees.

And we are running Operator shifts to support the DTL-3 RF Processing and testing.

Ion Source Group

Survey and Alignment Group

Mechanical Group

The alignment of the 59 DT's for DTL-1 was completed on May 20. No significant problems were encountered.

DTL-1 DT Alignment

DTL-1 tuning was completed on May 23. Slug tuner and post coupler measurements will be completed by Saturday evening and forwarded to LANL for fabrication.

DTL-1 Tuning Team

Water Systems

- Conventional Facilities completed the switch over from manual to automatic mode on the Tower Water System temperature control valves. Both the DI and Glycol systems will now be able to provide a constant supply temperature to the equipment.
- Glycol was added to the DTL circulator load system. This increased the concentration from approximately 38% to 45%.
- The Camlok gasket seals on the 4" D-Plate couplings were replaced.
- Installed a compressed airline to the QA-lab in the Klystron Gallery.
- Continued piping to equipment on DTL-5 and 6. Work in this area is expected to conclude next week.
- Installation of the copper cooling lines on waveguides continues.

HEBT-Ring-RTBT

- Installation of the HEBT tunnel cable tray has been completed through the HEBT.
- Installation of the RING tunnel cable tray has been started.
- Received RING half-cell magnet assembly #10 and staged it in the RING tunnel.
- All the Ring Half-cell magnet assemblies on site are now staged in the RING tunnel.
- Installation of the HEBT 12Q45 support stands has been completed to the electrical break. Approximately 75% of the 12Q45 stands are now installed.
- The HEBT 8D533 and 8D406 Dipole magnet assemblies have been transported from the RATS facility to up on site and staged in the RING tunnel.
- The HEBT diagnostic chamber hardware was received from BNL.

Magnet Task

This week we packed up in readiness to move up on site.

We also loaded 9 HEBT dipoles and transferred them to the Beam Tunnel.

We have also installed 10 beam tubes into 12Q45 assemblies.

JG attended the Magnet Measurement Workshop given at SLAC.

Electrical Group

Started checkout of RFTF modulator this week, and expect to begin high voltage testing into resistive load and beamstick next week. Received DTL-ME3 (DTL5 and DTL6 klystron supply) last week and will begin installing week of 2Jun03. Finalized HVCM checkout plan, safe operating procedure, and LO/TO documentation in preparation for ARR. Finished modification to IGBT Switch Plate Assembly lifting fixture. Installed new current diagnostics on DTL-ME1, and verified calibration and performance of LANL Rogowski probes. DTL-ME2 has been running well periodically throughout the week to support LLRF and RCCS testing, and will be removed for inspection of rectifier assemblies after completion of heat run next week.

HPRF

LLRF

Reference System

The Reference System is ready to support operation for RFQ, MEBT Rebuncher, DTL1, and DTL3 systems, and it will be ready to support the remaining 402.5 MHz systems (DTL2,DTL4-6) upon completion of transport cable phase matching (2 days of work) and construction of Downconversion/Distribution chassis (about one week of work). It appears that the craft workers will complete installation work of the Reference Temperature Control System next week. We will then need a day or two to checkout the system, and if everything is good the craft workers will then install the insulation (where there is access to the line). Our two craft workers will then install the pressurization/dehydration system (presently running in temporary RFQ location). Following that they will install a 30 amp circuit to the master oscillator rack (MAO:DTL6CAB01) to support the UPS for our frequency reference.

Next is cabling for 10MHz/50MHz distribution. The craft workers will then be finished with the 402.5 MHz section Reference System work and can begin on the conduit/cable and temperature system installation in the CCL section. Hengjie and Chip have done some preliminary work to support the multiplexed cavity/reference test on the RFQ. Upon completion of a few measurements, they will be able to determine required coupling values for 805 MHz reference line directional couplers and pulsed power amplifier requirements.

User Interface Improvements

Hengjie and Mark Crofford have been working with Carl Lionberger and Pam Gurd to provide improved user interfaces for the LLRF control system. New screens for the control chassis and HPM are under test. The control chassis screens not only provide for a new interface, but also have underlying "intelligence" that should make life easier for operations staff.

Training

Hengjie and Mark Crofford gave an operator training class on May 23.

New Hardware Development

The Major activity of this week was the start of the integration testing of the entire LLRF system including hardware, firmware and software. Work continues on completing "Rev 0" of the new hardware platform for the LLRF system. The hardware platform consists of the following boards:

Analog Front-end (AFE). This board has passed all the unit tests and is ready for integration with other hardware components. We have placed an order for three more AFEs in anticipation of delivering systems to LBNL and ORNL.

Digital Front-end (DFE). The board is largely tested without any identified problems and is currently undergoing further unit testing to measure the noise characteristics of the components. These tests are anticipated to be completed by the end of next week

RF Output (RFO). Testing of the first assembled RFO continued last week. Phase locking of the RFO to an external 50-MHz reference was demonstrated. The RFO was programmed via the DFE on both the VXI and PCI platforms. The ADC clocks can now be properly locked to the system reference. We can now use the external reference to drive the RFO, looping it through to the AFE input and attempt to get the resulting ADC data into LabVIEW, where the complete jitter of the PLL circuit can be measured. The resulting jitter measurement is independent of all external sources, and is a first for this measurement (at LANL), including the BPM systems. The VXI system is currently configured such that a 50-MHz is passing through the AFE to the DFE for testing of the waveform acquisition programming in the DFE.
Control of the RFO DAC via the DFE was demonstrated on the PCI platform. This is the first operation of the on-board IF generation. Full amplitude and phase adjustment was observed, over at least a 20 dB range. More characterization needs to be done, but it is obvious that the amplitude and phase linearity is excellent, as expected. Phase locking and IF generation were the last two features to be tested that affect the RF performance of the RFO.

VXI Motherboard. This board has been successfully tested in stand-alone mode as well as with EPICS and with no identified problems. We are now in the process of producing two more boards for shipping to other labs.

HPM Board. The final REV of this board was released to fabrication and assembly this week as expected. We expect to receive a unit for testing beginning of June. The first draft of the complete system and user documentation has also been released.

Integration Testing

Work was started on the integration testing of the entire LLRF system. The team included engineers and physicists from LANL, LBNL and ORNL.

Larry Doolittle of LBNL installed a new version of the Berkeley LLRF system at LANL and successfully demonstrated phase and amplitude control of the 402.5 MHz test cavity. The goal has been to use this as a benchmark for testing the LANL LLRF system.
The integration test included assembling all the daughter cards on the VXI carrier, successfully passing a 50 MHz signal from the AFE through the DFE and essentially demonstrating the electrical and signal processing of the system. Next we demonstrated open-loop manual control of the test cavity including the DDS feature whereby the drive frequency can be varied. The application software and EPICS displays were also loaded on the IOC and the server and successfully demonstrated the operation of the history buffers and the interrupt system handling by the IOC and the FPGA. The system response to various input parameters were studied and all appeared to be consistent with expected behavior.
Encouraged by the rapid success of the manual control of the system, we then attempted closed loop operation of the cavity with and without feedforward. We fell short of full automatic control of phase and amplitude but seem to be very close to achieving that milestone.
In summary, this was a spectacularly successful first attempt at system integration and all indications are that we are still on course to have a system ready for testing with the DTL at ORNL in June.

Planning

Alex Ratti, Mark Champion and Hamid Shoaee met at LANL to plan the system tests at ORNL and at JLAB in June and July. We also discussed production issues and agreed to develop a procurement, testing and Q/A document in one month.

LLRF 1-Month Schedule

The plan is to continue integration testing at LBNL while the final hardware tests take place at LANL. Work is in progress to ship a VXI crate to LBNL and to assemble a complete LLRF system next week at LANL for shipment also to LBNL. Engineers from LANL and ORNL will meet at Berkeley the week of June 1 to complete the system integration and to successfully demonstrate phase and amplitude control on a test cavity. We plan to have four completed systems by the third week of June, one at LBNL, one at ORNL and two at LANL. We will demonstrate closed loop control in June at ORNL and possibly at JLAB as well.

Cryo Systems Group

CHL: The charcoal absorber heater has been repaired and the vessel is now at 228 Deg F. The instrument air piping is now being pressure tested. The installation of the LN2 transfer line is 50% completed.

Tunnel: The clam shells for the 8" line of the down stream return modules have been welded in place and cold shocking and leak testing are now taking place. Work on the warm gas piping is continuing on the east side of the transfer line "T" section.

RATS: The fabrication of the warm gas piping manifolds is progressing well, the assemblies are 50% completed.

Beam Diagnostics