

## Accelerator Systems Division Highlights for the Week Ending October 11, 2002

### ASD/LANL: Warm Linac

#### HIGH-POWER RF (WBS 1.4.1.1)

Accomplishments this week: (1) completion of the 96-hour heat run for the fourth Marconi 402.5-MHz, 2.5-MW klystron; (2) completion of factory acceptance of the last transmitter for the normal conducting linac; (3) shipping of fully-tested items including the third 402.5-MHz, 2.5-MW klystron, the first 805-MHz, 550-kW klystron, an 805-MHz, 550-kW water load, and a 402.5-MHz, 2.5-MW circulator; and (4) delivery of eleven 550-kW circulators to ORNL from AFT.

Concerns & actions: (1) installation of untested high power RF equipment at ORNL. To better coordinate our testing program with ORNL, we requested weekly updates to the ORNL 30-day and 90-day installation look-aheads; (2) a 402.5-MHz circulator that has not passed site acceptance tests at LANL. AFT is coming to LANL next week to help troubleshoot situation.

#### HIGH VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)

Accomplishments: (1) successful completion of low- power testing of the first production converter/modulator at Dynapower (Fig. 1) – unit is now being prepared for shipment to ORNL; (2) flawless operation of the LANL prototype converter modulator in support of the 96-hour heat run of the 2.5-MW Marconi klystron at full SNS duty factor.

Concerns & actions: (1) first in-oil acceptance tests to be performed at ORNL rather than at factory (necessary to meet RFQ commissioning schedule) – LANL sending supporting installation and tests at ORNL next week; (2) untested oil tanks were prematurely shipped to ORNL from Dynapower – dye penetrant tests of nine unpainted tanks will be performed at factory (as per spec) prior to oil fill; (3) 1-MW average power tests – pending arrival of 5 MW 805-MHz klystron in November.



Fig. 1: - The first production high-voltage converter modulator.

#### LOW-LEVEL RF CONTROLS (WBS 1.4.1.3)

Accomplishments: (1) ORNL and LBNL personnel were at LANL this week to perform replanning activities. Progress was made in refining systems requirements, assessing current development status, and developing a new common plan that utilizes common firmware language and platforms; (2) the team also worked interface issues with the LANL high-power protect circuitry and LBNL resonance control system, in order to support RFQ commissioning at ORNL next month.

Concerns & Actions: The revised LLRF Systems Requirements Document needs to be completed, signed off (by ASD, Accelerator Physics, Operations, Diagnostics, and Controls), and put under configuration control next week. The LLRF team will have final draft ready for approval early next week.

#### DRIFT-TUBE LINAC (WBS 1.4.1.2)

Accomplishments: (1) Weld qualification samples and tank one and tank three drift tubes incorporating a weld ring repair were prepared for welding at the e-beam weld facility next week; (2) continued to make progress on an acceptable weld design for the remaining tank 2,4,5,6 drift tubes. A full-scale weld sample for the tank-2 drift tubes was evaluated for structural integrity, leak tightness and manufacturability. Following a high aspect ratio deep pass weld for structural integrity, a low aspect ration weld 0.080" deep was made in a full-scale part. The weld was machined back 0.030" to simulate follow-on manufacturing process and was found leak tight. The weld was then machined back an additional 0.030" resulting in a remaining weld depth of 0.020" and was still leak tight. Micrographs of these types of low aspect ration welds in copper show no root porosity; (3) one completed DTL support stand, and two water skids (for DTL-5 and DTL-6) were delivered to SNS-ORNL.

Concerns & Action: (1) An internal red team review was initiated this week with a review of the tank one drift tube manufacturing process by Will Fox, Ray Valicenti and Dan Richards with participation by Coronado Machining Inc. and Kaehr Plating Co. personnel. The team determined that some of the drift tubes for tank one had undergone additional welding to repair leaks during the fabrication process and then had to be plated using an acid copper plating process to correct a resulting undersize condition. This raised the concern that some of the drift tube bores were plated and that plating solution could have leaked by the masking and contaminated the interior of the drift tubes. A report on the team's investigation is being prepared; (2) It was determined that the poor quality e-beam welds reported last week were due to 0.005" - 0.008" copper plating on the face of some of the drift tubes in tank one. The faces of eighteen tank one drift tubes were plated by the vendor to address an undersized condition resulting from weld repair of leaks and machining errors; (3) The DTL team has proposed that all drift tubes that have damaged magnets (16 PMQ type drift tubes) and all drift tubes that were plated (18 tank-1 one and 2 tank-3 drift tubes) be completely rebuilt. The remaining tank-1 drift tubes would undergo a ring type weld repair and machined to nominal condition. Ring type weld repairs would have a prescribed set of e-beam passes based on the weld qualification procedure. One additional weld pass would be allowed to address an imperfection in the weld. If the additional pass did not result in an acceptable weld repair the part would be rejected and the drift tube would be rebuilt. A plan to assess the schedule impact of this recommendation as well as the cost is being developed; (4) We identifying all the remaining dove tail o-ring grooves in the tanks and inter-tank beam boxes and developing a groove design to achieve a nominal o-ring compression of 25% or greater to assure an adequate vacuum seal in the absence of vacuum grease.

#### COUPLED-CAVITY LINAC (WBS 1.4.4)

Accomplishments: (1) ACCEL completed final machining on the internal ½ cells for the first segment, and is presently working on the endwalls in preparation for our tuning activities there next week; (2) bridge coupler #44 has been machined and is brazing this week also in preparation for the tuning next week at ACCEL with SNS project staff participating.

#### **ASD/JLAB: Cold Linac**

The cold box was shipped from the vendor as promised on Monday and arrived on site this afternoon.

Cavities MB004 and 005 were received from the vendor. MB006 and 007 were shipped yesterday. High-β cavity drawings have been received for review.

Cavity testing has been delayed by the need to deal with the fallout from a LO/TO incident (with no injuries) in the Vertical Test Area. Resumption of testing is expected next week.

#### **ASD/BNL: Ring**

This week we have had visitors from ASD to discuss the progress and installation plan of the ring and the transport system.

Pre-award meeting of the extraction kicker PFN is done this week. The resulting cost of the PFN's is substantially lower than the base line value.

Total of nine 21Q40 quadrupoles have been measured, and 8 of them are consistent to each other. There is curious trend of increasing transfer function in sequence of measurements. (The first one is lowest and the last one the highest). We will be watching the further measurement closely.

The magnets acceptance criteria has been discussed and decided. The magnets in the first half-cell assembly of course are within the criteria.

26Q40 pole camper has been re machined and ready to be measure and verified.

The poles of the 31 cm quadrupole have been shortened by 0.75 mm in order to reduce duo-decapole component of the harmonics, and ready to be measured. If this scheme works the production of the magnet will be disturbed minimally.

The magnetic measurement group is busy measuring the corrector magnets of various kinds and trying to mesh with the half-cell assembly schedule

The second production RF cavity is turned over to the physics group to measure the longitudinal impedance of the cavity

### **Controls**

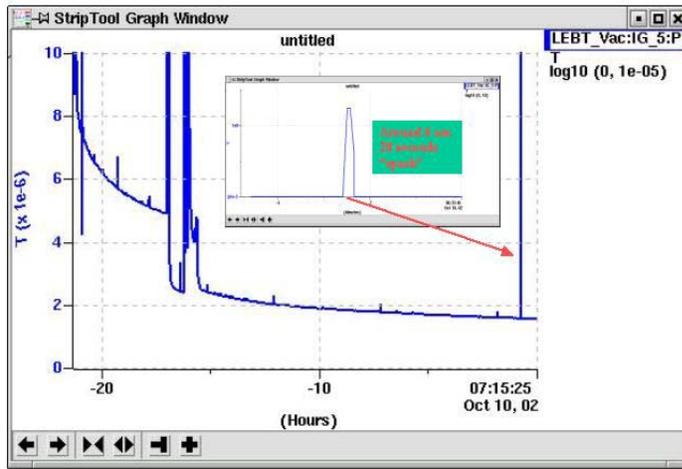
The Controls Team participated actively and intensely in the first week of Ion Source testing at the site, culminating in the striking of the first plasma. To the astonishment of some, EPICS has been used for testing from the outset, and is being appreciated as a helpful tool. The Electronic Logbook is in place and in use. Operators were trained on the Control System. The FE control room is a happening place.

The Front End timing system is in place and controlling the source RF. A prototype trigger generator has been tested. This system takes beam request triggers, the RFQ RF Gate / delayed gate, and the Plasma RF gate / delayed gate and sets these gates either in phase or out of phase depending on the beam request. An independent timer monitors the time the two RF gates are in phase and signals a fault and inhibits the gates if the timing is violated. Timing IOCs have also been identified for diagnostics.

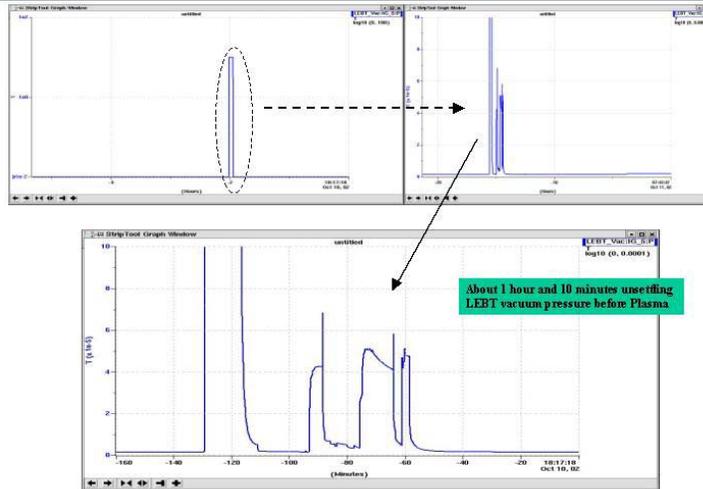
The Fast Protect Latched (FPL) and Fast Protect Auto-Reset (FPAR) signals from the Machine Protection System (MPS) either latch a fault (FPL) or inhibit the gate for the duration of the pulse (FPAR). A PLC status input shuts off all triggers when a PLC trip is asserted. The system also delivers a health input to the PLC.

EPICS and EPICS tools have supported initial pump down of the source and MEBT. Below are two EPICS "Strip tool" records – one showing a false trip (i.e. not due to a vacuum excursion) caught by the EPICS Channel Archiver, and the second showing a LEBT vacuum excursion due to H2 gas injection.

LEBT Vacuum Pressure Reading in Pass 20 Hours



LEBT Vacuum Performance before Plasma 10-10-02



At BNL, all VME modules for the BLM system have been identified and enough units have been ordered to support development and deployment for the DTL test in February. All PLC equipment for Ring and RTBT vacuum systems has been ordered. The PLCs will be configured, programmed, and tested at BNL before being shipped to ORNL for installation. Modules have been ordered to support development of EPICS software for ion pump and gauge controllers

At LANL, testing continued on the Resonance Cooling Control System (RCCS) test stand. Engineering screens are complete. A Residual Gas Analyzer test stand has been set up. Software for the 3-trace Software Oscilloscope, compatible with any EPICS Channel Access waveform, is ready for release. The Power supply application is ready for test of the DTL power supplies. The SCL vacuum signal count is complete and a cost comparison between seven IOCs and seven PLCs is nearly complete. Diagnostic Plate block diagrams have been signed and distributed – signal lists are DTL2 lists with annotations.

**Installation**

As of 10-09-02 the total ASD craft including 1.0 Controls was 68.5

Ring Tunnel Access will be prohibited from Oct 18th to the 28th by the application of the high performance floor coating.

ASD is planning an electrical shut down for Oct 18th and 19th. An effort is in process to move this shut down to Saturday the 19<sup>th</sup> and have a planned CF shut down at the same time.

HVCM check out with resistive load is scheduled for the week of Oct 21st.

### **Accelerator Physics**

Using the LTRACE code D. Jeon finds the following linac output energy and phase jitter for two different RF control cases:

0.5%/0.5 degree: +/- 1.5 MeV, +/- 3 degrees

1.0%/1.0 degree: +/- 3.0 MeV, +/- 6 degrees.

After the Energy corrector cavity, the energy jitter is reduced to

0.5%/0.5 degree: +/- 0.2 MeV

1.0%/1.0 degree: +/- 0.3 MeV

J. Holmes has been studying the impact of increased energy jitter in the ring and sees no increase in beam-in-gap for 0.2 MeV vs. 0.4 MeV energy jitter. These simulations are being further refined by reproducing results with PARMILA and understanding further the ring limitations.

HEBT global coordinates have been updated to take into account the measured magnetic lengths. This has the effect of moving the trajectory in the center of the HEBT dipoles by about 2mm. All quadrupole locations remain within 10's of microns.

### **Operations Group**

Prepared for the ARR to be held the week of October 14

Conducted Operations Training Sessions

Prepared Operations Procedures for the SNS OPM

Participated in the design studies of the RTBT Shielding

Participated in the PPS and MPS Design Reviews

Worked with XFD on Accelerator shutdown in a Seismic event

### **Ion Source Group**

We started to implement the accelerated ion source and LEBT checkout and conditioning plan which should allow us to demonstrate ion beam production capability with the FE ion source before 10-28-02. Thanks to the dedicated support from many groups and people we have so far succeeded to stay practically on schedule, although many obstacles had to be overcome, numerous problems had to be corrected, and several deficiencies had to be dealt with. By the end of Tuesday we were able to successfully measure on all LEBT electrodes the voltage of approximately 1 kV applied by EPICS, which completed the critical part of the integral LEBT checkout. The planned chopper testing, which is not critical, requires more work and therefore is postponed.

After an extensive checkout of the ion source utilities, an EPICS controlled 13 MHz plasma was briefly generated by the end of Thursday. The 2 MHz installation has been completed, but its checkout is postponed till next week when it becomes a part of the RF condition process.

Paul Gibson and Teresa Toomey found a work-around to install our spare Glassman supply, while Syd Murray installed a complete safety interlock as in our hot spare stand. This precautionary effort became critical after DTI informed us on Thursday that our 65 kV supply is not yet tested and will not ship till end of next week.

This allowed us to test and condition the ion source voltage starting on Friday noon. The most serious problem is silent discharges in unknown locations, which occasionally destroy the micro-relays used in the safety chain. By Friday evening we reached 62 kV.

Saturday morning was used to condition both lenses successfully to 45 kV. In addition it was found that lens 1 can easily carry 40 kV with lens 2 switched off, a situation needed for controlled, low-duty cycle beam dumping on the LEBT gate valve when operating as an RGD.

Having some time left on Saturday we revisited the source high voltage. The safety chain problem was previously encountered with the hot spare stand where it conditioned away. Shortly after noon on Saturday, we succeeded to apply 65 kV to the source for a full 10 minutes. The effort was stopped due to a shortage of spare relays.

### **Mechanical Group**

This week the Power Supply Group finished testing MEBT quadrupole power supplies, two were found to be DOA. The spare was installed for one.

All interlocks, power supplies, and control systems for the ion source/LEBT have been tested.

A temporary solution to the, still being repaired, DTI 65kV power supply was devised and implemented. We are beginning to try high potting the Ion Source and LEBT.

We have temporarily solved all water issues and now have DI to the Ion Source and appropriate flows in most locations. RFQ chillers are not on as yet.

A compressor was installed and plumbed in to provide temporary air to the FES.

The LEBT chamber was pumped to  $1.5 \times 10^{-6}$  Torr even with a leaking LEBT valve and with the RFQ only roughed out. This lasted until we lost a turbo pump.

RFQ cryopumps are operational have not been fully tested.

The Ion Source Group with much assistance from all others including RF and Controls Groups were able to make a 13MHz starter plasma glow in the ion source Thursday afternoon.

### **Magnet Systems**

#### **Vacuum Systems**

#### **RF Group**

Installation of the RF Grounding system for first three transmitters (RFQ, DTL 1&2) and the first HVCM started.

Installation of the water system between the cooling cart and its RFQ klystron continues. Installation of the water system between the cooling cart and the DTL1 klystron began.

Electric power was available to the first two HPRF transmitters. The third transmitter has power to the electric panel but requires additional termination before AC power is authorized to the rack.

Tracked down and cleared communication and interlock faults on RFQ & DTL1 transmitters. Both transmitters now come up to "Stand-by" mode and are ready for checkout by LANL HPRF personnel during the week of 10/21.

Water connections from klystron cooling cart to equipment proceeding for DTL1 & 2.

LANL people her week of the 21st, for transmitter check RFQ, DTL1 & 2.

Requested DI water in klystron gallery on the 16th to check for water leaks.

Installation of HVCM in progress, but going slowly. Next week is remaining.

Pieces arrive from DynaPower so it will be a very busy time in the gallery.

Check out of epics and transmitters will take place soon and when LANL people are here.

### **Electrical Systems Group**

Ken Rust and BNL engineers attended a pre-award meeting at a proposed vendor's facility to discuss the extraction kicker magnet power supply contract.

Front end MEBT magnet power supply check out continues. Corrector check out is complete, but several problems have been discovered with the quadrupole power supplies. Two of the nine quadrupole power supplies were found to be inoperative (one apparently had problems at Berkeley and the other shows signs of physical damage (installation/shipping?). Both units were returned to the manufacturer for repair. As only one spare was purchased for these supplies, the final MEBT quad will be unpowered until repaired supplies are returned (2-3 weeks). There may also be a problem with cable sizing on some supplies.

Updated Group FY03 work packages completed and submitted to ASD management.

Assembled 100-foot test section of 3-1/8" rigid coaxial line for tests of reference line hangars and dehydration/pressurization system.

Installed fire retardant 7/8" coaxial transmission lines for MEBT rebuncher cavities. The lines have all been terminated and phase matched.

Measured performance of SP4T RF coaxial switch units and found phase repeatability to be quite good, variation less than 1 ps.

Received first dual channel amplifier for reference line, measured 1dB power compression points of 13 W @ 402.5 MHz and 19 W @ 805 MHz.

Setup Berkeley LLRF MEBT system in preparation for IQ modulator linearity testing.

13.8kV feeder and pad mounted HV switches for the klystron modulator transformer were inspected with K/J, CF and their contractors. Punch lists was generated and after the second inspection on Thursday, the circuit can be energized when requested

Dynapower retrofitted two first modulator transformers with auxiliary fan assemblies provided

Initial work on UPS power distribution was started after CF contractor installed UPS

### **Survey and Alignment Group**

#### **Cryogenics Group**

CHL: The cold box is installed in the CHL

Tunnel: THE final supply module was installed in the east end. All the 2.5" pipes are connected and cold shocking has begun.

Transfer Line: Work continues on the west and east supply transfer line end boxes. The warm gas piping headers are 75% installed.

### **Beam Diagnostics**

LANL Beam Diagnostics Progress report:

BPM pickups: Fabrication continues on the DTL BPM pickups. The new DTL-3 drift tubes will be ready for BPMs soon. We received the CCL pickups back from ISYS with the corrected electrode pins. They will be retested soon. Fabrication continues on the SCL BPM pickups.

BPM electronics: The new digital front-end card now has the new FPGA's mounted to it. The results are excellent, with just 1 bit rms noise on the 14-bit ADCs. A test PC board was built to test a new component layout scheme for the clock multiplier circuit on the PCI motherboard, designed to reduce noise on the 40 MHz digitization frequency. It worked very well, and will be used guide the new layout of the PCI motherboard.

WS actuators: We received two more wire scanner actuators, needed for the D-plate and DTL-1. Testing is in progress on the 2nd-generation prototypes received last week, and so far the results look very good. The 3-inch prototype has been cycled 2000 times with an 8-lb weight (to simulate vacuum loading).

WS electronics: We now have a nice LabView code that simplifies cycling tests of the actuators.

D-plate: Fabrication continues at local machine shops, and assembly continues here at LANL. The one outstanding procurement of major concern is the beam stop. Delivery could be as early as next week (18/Oct), after radiography and water pressure tests are performed in Albuquerque and witnessed by LANL staff. We received two more actuators, in addition to the two mentioned for the wire scanner system above. These are destined for the D-plate harps. The remaining two actuators, needed for the slits, should be shipped today (10/Oct). The steering magnet has been mapped and is ready to be mounted to the D-plate. We are working with LANL shipping personnel to prepare for shipping the D-plate to ORNL.

ORNL Beam Diagnostics Progress report:

We are preparing for the visit of partner labs engineers for MEBT diagnostic commissioning. Craig Swanson got the ETC PCI board onto the 64bit 33 MHz slot on Rick Riedel's motherboard. The board is working well. The analog circuitry for the most part has been tested for the EL and the PLL is working correctly. The fpga has no board design problems and seems very stable. However the pci core that we bought from Altera was crashing the software because of a bad pinout file provided by Altera. This problem is resolved after correct software was received from Altera.