Accelerator Systems Division Highlights for the Week Ending April 25, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: (1) We completed 63 hours of the 96 hour heat run on DTL klystron S/N 10. (2) We approved the low power data from CPI for SC linac klystron S/N 18 and authorized shipment. We installed S/N 13 on the test stand and started the 36-hour heat run. Tubes S/N 16, 17, and 18 were shipped on Friday to LANL.
Concerns & Actions: The 5-MW CCL RF system continues to be our biggest concern. (1) We are still investigating the cause for losing vacuum of CCL klystron S/N 2 reported last week. We will send the tube back to the Thales factory for further investigation. We also preformed some tests on the vac ion pump that indicate the tube is up to air. (2) Both the 5-MW circulator and the 5-MW loads need more testing to pass the high power acceptance tests. We installed a new 5-MW circulator in the test stand and are in the process of cleaning the one that was high power tested last week. The circulator that was removed one was full of arc marks and aluminum fluoride (a product of SF_6 when it breaks down from arcing) powder. We inspected the 5-MW water loads and did not see any arc marks or evidence of damage. Nevertheless, both items still need more testing.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) We successfully tested HVCM S/N 5 at Dynapower; (2) The Prototype HV converter-modulator (HVCM) operation supported the 2.5 and 5 MW RF testing at Los Alamos. Unit ran without failure.
Concerns & Actions: Bradley, Reass, Borovina, North, and Bretzke were at Dynapower this week to witness acceptance tests and an improved QA program. While the 5th unit passed, the 6th unit failed its 24-hour heat run resulting in a catastrophic IGBT failure early on 4/25/03 (following running all night). LANL staff are heading back to Dynapower on 4/25/03, and will be in the factory for a critiques and lessons learned on Saturday 4/26/03.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: (1) The first batch of rebuilt Tank-1 drift tubes (Fig. 1) were completed on Saturday 4/19/03 and shipped that day to ORNL. We continued to ship throughout the week, with 20 (of 48) shipped. We expect to ship the remainder next week. These drift tubes are pristine and leak tight. Work began on these units 11/18/02 so we have produced them from "copper bar stock" in 22 weeks. Considerable effort and skill were required to do this; all those involved are to be congratulated. (2) 45 T-1 and T-2 post coupler bodies are ready and tip machining should be completed 4/25/03. (3) The tuning ring for the upstream T-1 end wall was machined; end wall machining is the critical path item and is being given significant attention. (4) ASD and LANL personnel were at GSI Darmstadt to begin copper plating of Tank-5. The first section was completed on 4/24/03. The remaining two will be completed next week.
Concerns & Actions: (1) Production order preferences of BPMs and EMD DT's need to be established in order to meet the IPS delivery date of 11/1/03 for all DTL parts. (2) Issue of producing Tank-3 drift tube drawings is almost moot; we will be losing personnel soon. (3)
Since mid-January we have accrued an average 2 to 3 week slippage on the waveguide fabrication efforts due to slow progress at CMI. While this is not a critical path item yet, we are monitoring progress daily, and setting priorities for CMI.

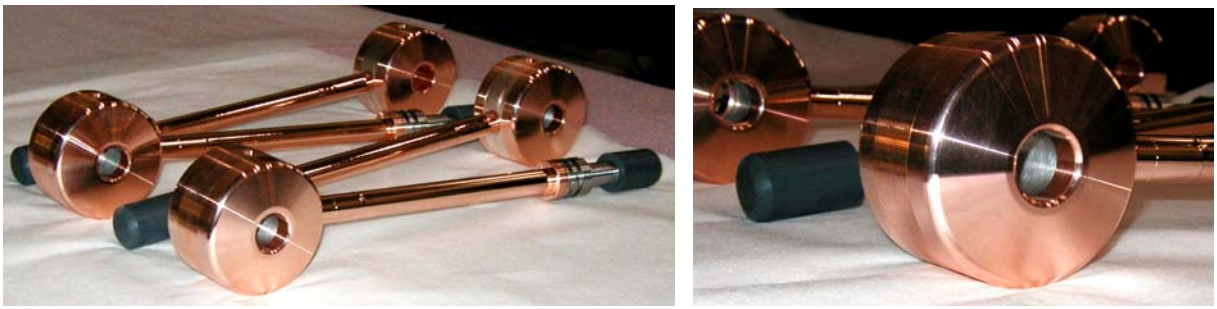


Fig. 1: Rebuilt Tank-1 drift tubes.

COUPLED-CAVITY LINAC (WBS 1.4.4)
Accomplishments: (1) Good progress was made on the support stand fabrication. The welding portion of the job went extremely well and this has resulted in smooth work so far in the final machining step. (2) A proposed repair process is being developed for the CCL cavity plugs. Copper material has been ordered and received and fabrication drawings have been prepared for a prototype run of a dozen plugs of each of the two lengths required. Samples of the purchased copper to be used for plug fabrication have been sent to LTI for confirming micrographic analysis. The prototype production plugs will be evaluated by ACCEL before the repair process begins. The cavity braze test was completed and the design will be tested for tuning range when ACCEL returns from Easter break next week. (3) Bids were received and are being evaluated for the CCL Intersegment Weldments. Contract placement is anticipated next week.

Physics (WBS 1.4.5)
Accomplishments: A report on last week's DTL Tank-3 tuning was issued. Field distributions, cavity-to-waveguide coupling, cavity Q values, RF pickup loop sizing are reported. From the standpoint of low-power tuning, tank 3 is ready for RF conditioning. The field distribution is within ~1.5% of the design. The cavity-to-waveguide coupling factor is set to give no more than about 4% reflected power with no beam current when the cavity is tuned properly.

ASD/JLAB: Cold Linac

Cryomodule M-1 has been cooled and testing has resumed. Problem tuner motors were replaced with units qualified at cryogenic temperatures in the VTA.

Extensive investigation failed to find any trace of a leak from the helium process piping into the insulation vacuum. Assembly of M-2 has resumed and assembly of M-3 continues.

The M-4 string is assembled and under vacuum. One cavity has been qualified for the M-5 string.

Cavity HB-01 achieved 20 MV/m in its test with a helium vessel (specification is 15 MV/m).

Electropolishing and high-pressure rinsing of the high-β prototype has been completed. The cavity will be baked out and tested next week.

ASD/BNL: Ring

J. Sandberg and B. Lambiase traveled to Toronto, Canada, to meet with our Ring dipole PS vendor, IE Power, to review production issues and schedules.

K. Mirabella and W. McGahern traveled to SNS/OR to participate in the dry run for the upcoming DOE Review.

Design engineer, Jim Rank, conducted a Design Review of the Extraction Lambertson Magnet via videoconference. ASD comments are in hand.

Ring half-cells: # 7 was shipped to SNS/OR this week. Work is underway on half-cells # 8, 9 and 10.

The 1st article production 26Q40 quad arrived at BNL this week from Stangenes; it is undergoing incoming inspections prior to field-testing.

Three more of the 41CDM 30 magnets (Alpha) were delivered this week bringing the total on-hand to five.

We completed measurements of all the 27CDM30 correctors (30 total) today.

Magnetic measurements continue on the Ring injection septum magnet.

The 1st article 27CD30 magnet (NETC) has passed all incoming inspections and is being set-up in the mag measure test station for acceptance (field) testing that will begin on Monday. After acceptance by BNL, the remaining production units (19) will be shipped directly to SNS/OR.

Preparations are underway to resume testing of Tesla's 21Q40 (Ph II) quads; the first lot of eight magnets will be shipped to BNL next week. In the meantime, one of the existing Ph I quads is being shimmed to determine overall effectiveness for matching magnets (twelve more are needed).

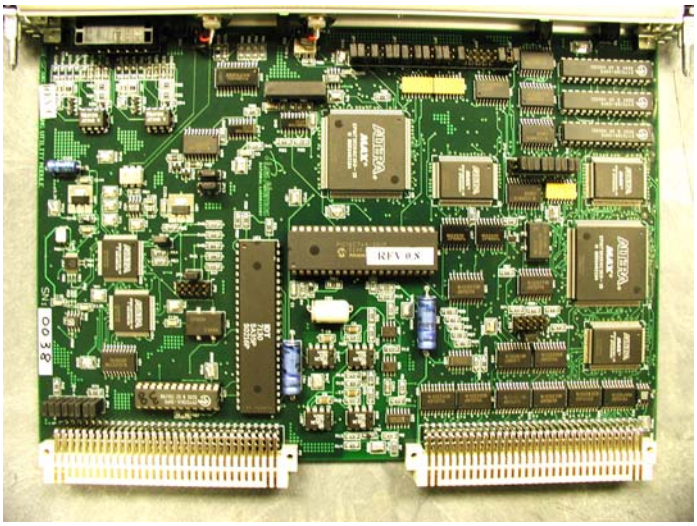
A third set of "Z" bumps are being installed on chicane #4.

Controls

The phase 0.3 PPS was certified on Wednesday (April 23). This is a temporary protection system to support conditioning of DTL3. This configuration is certified as a Radiation Generating Device (RGD). All of the phase 1 PPS racks have been installed in the Linac Klystron gallery with the exception of one rack. It is being relocated because electrical power equipment has been installed in the intended location.

The control system network has given some indication of unreliability. A collaboration with LANL was initiated to help diagnose this problem, and network "sniffers" were installed on the control system network with the help of the ORNL network group.

On Tuesday we found out that a manufacturing error in the V108 Utility module created a situation that could cause board damage if not promptly addressed. All polarized capacitors were installed backwards which could result in board damage, VME Crate damage or adjacent board damage. All of the utility modules in service in the accelerator control system and at 701 Scarboro and in site labs were identified and removed. Repair parts were ordered and four repaired boards were reinstalled in the timing master, DTL 3 LLRF, DTL3 HPRF, and RFQ HPRF. The next boards repaired will be installed as needed; the list includes the LLRF crates for DTL 1 and the RFQ, and in the D-Plate Emittance station. Remaining boards not yet deployed will be repaired at BNL.



The V108 Utility Module. Incorrectly installed polarized tantalum capacitors are indicated.

The thermocouples for DTL Tank 3 have been installed and tested through the control
System. These new Drift Tube thermocouples have been added to the archiver, as have parameters of the DTL vacuum system.

With the assistance of the LANL controls team, work was almost completed on testing of the DTL 3 RCCS and Vacuum systems. This was a heroic effort by all involved, and it will continue, after a few ZZzzzs, next week.

Software for conditioning DTL3 is installed in the LLRF VXI crate. The only sensor configured is the spark detect; the measurement is provided by records in the field control box. Operator training was held on this system, during

which a number of issues wee uncovered. Some of these have been addressed, however the start of conditioning will have to be considered as a software debugging opportunity as well.

Although most work this week centered on preparing DTL 3 for conditioning, much progress was also made on the D-Plate. The D-Plate power supplies controls were installed in EPICS and successfully tested. Motion control of all four actuators was successfully tested. The emittance devices were calibrated to beamline center, although the LVDTs remain to be calibrated. Collision avoidance software was completed, and will be tested early next week. The MPS interface is ready for checkout. The D-Plate work is being documented in a series of documents: an FSD (complete); a test plan (in progress); and some "Quick Troubleshooting Notes" for the emittance system.

The IOC for the Main 4.5 K cold box was installed in the mezzanine racks of the Central Helium Liquefier building. In addition to running the latest version of the database for the cold box, it is also running a simulator for the first turbine. The CHL control room printers were installed.

The last issues on the CF Controls Target Bldg package were finalized this week. Drawings will be posted CFC by May 2. Parts are being ordered for racks and sensors in the Target building and software work is underway. Loop tuning (testing was completed earlier) in the Klystron building is nearly complete – that will finish CF controls work for the FELK.

Installation

Craft Snapshot 4/23/03

ASD craft workers	74.0
Foremen, ES&H, etc	10.0
Less WBS 1.9 controls	4.0
Less absent	4.0
TOTAL	76.0

Four DTL #3 drift tubes were found to be leaking in during final testing before the start of RF conditioning. A field fix and cooling system modification were implemented that will allow conditioning to proceed.

The DTL #3 vacuum and RCCS cooling systems were certified ready for RF conditioning by the LANL team.

The D-plate was aligned in its tunnel location.

The DTL #3 temporary shielding wall was completed.

The PPS system for DTL #3 RF conditioning was certified.

DTL #1 shield structural support installation was started.

The trailer 10-plex is being installed on site. The first RATS I group will be moved to the site trailers on 15MAY03.

The second (#7) Ring half-cell was received and stored in the HEBT tunnel.

A total of fifteen (15) DTL #1 drift tubes have been fiducialized. Installation of DTL #1 drift tubes will begin next week.

A hold was placed on DTL #3 RF conditioning pending an investigation of a HVCM failure during testing at the vendor.

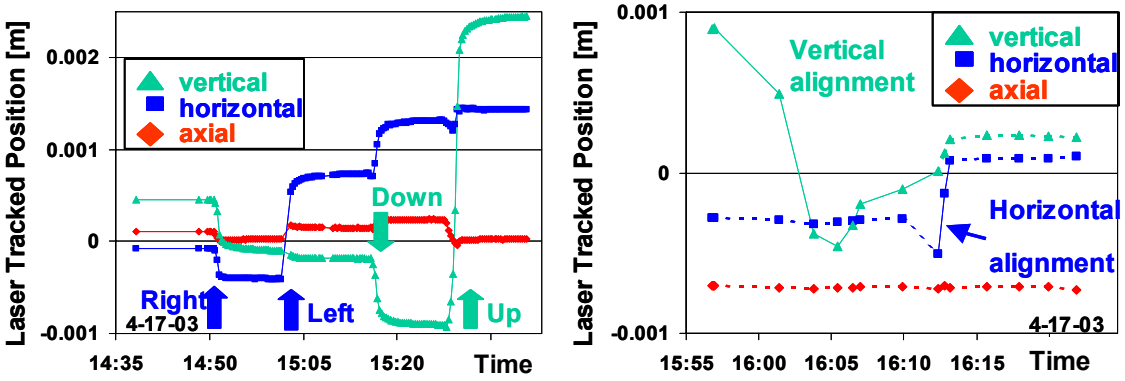
Accelerator Physics

Operations Group

Ion Source Group

The ion source has been reinstalled on the front end to start vacuum conditioning of the ion source, LEBT and RFQ.

The Laser tracker data obtained on 4-17-03 have been analyzed, giving significant insight into the LEBT positioning mechanism: After establishing stability around 14:50, the LEBT was moved about 0.2 mm to the right where it settled within a few minutes. This move, however, triggered the LEBT to fall down by about 0.6 mm over the next 15 minutes as one can see in the left figure. After about 10 minutes the LEBT was moved about 1 mm to the left, but the LEBT kept moving to the left by another 0.2 mm over the next 10 minutes. After about 15 minutes the LEBT was moved down by about 0.5 mm, and it kept moving down another 0.2 mm over the next 10 minutes. This move, however, triggered the LEBT to move further to the left by another 0.6 mm over the next 10 minutes. As the last move, as advised by LBNL, the LEBT was moved up by 3mm, while it moved another 0.1 mm further to the left. The LEBT, however, kept moving up by another 0.4 mm over the next 10 minutes while holding its horizontal position.



Experience shows that after overcoming the initial backlash caused by a reversal, both cranks are very hard to turn, independent of the direction. The left figure shows that the down movement is not governed by freefall. Gravity is preloading the system, while the net force, dominated by the spring force of the positioning mechanism, causes the movement, just as being taught in Physics 101. That explains why terminating the positioning process with an upward move, as we were mentored, makes no significant difference.

The data in the left figure clearly demonstrate the spring-like nature of the LEBT X-Y positioning mechanism. Turning a positioning crank, winds up its spring, and the LEBT starts to move once the spring force overcomes the frictional force. After stopping to turn the crank, the wound up spring keeps the LEBT moving at a decreasing rate as the spring slowly de-energizes. The LEBT comes to rest when the spring force equilibrates with the frictional force.

The results also show that the frictional force is velocity dependent, at least in the range of 10^{-5} m/s: moving the LEBT in one direction significantly reduces the frictional force, which allows the transverse positioning mechanism to relax least partially. A second displacement allows the transverses mechanism to almost completely relax, as one can see in the stable vertical position after the left move and the stable horizontal position after moving up.
This positioning system is difficult to operate because it strongly depends on its history and lacks direct readouts. Improving lubrication, as suggested, would reduce the problem but not eliminate it. Therefore we designed a system with a spring constant increased by orders of magnitude, eliminating the entire problem.
However, until the new system is fabricated and installed, the LEBT has to be aligned with the existing system. The right-hand figure shows the alignment within 0.2 mm achieved on the same day. At 16:12, after 6 movements, the LEBT was vertically on axis. Two horizontal movements brought the LEBT within less than 0.1 mm of the axis, where it stayed because the crank was turned backwards for several turns. Unfortunately, we failed to backup the vertical crank and therefore the LEBT moved up by 0.2 mm. Next time, however, the gained knowledge will allow an even better alignment.

Survey and Alignment Group

Network: Continued with exterior leveling campaign and network re-observation. Our objective is to rebuild our Global Survey Network to facilitate FE and DT Alignment. Unfortunately, the newly constructed linac wall has severely impeded our ability to upgrade the state of the Global Survey Network. As a result alignment will continue in the local network mode. In summary, alignment will be somewhat compromised. Without connections through the FE/Linac area, we cannot properly control azimuths. Alignment tolerances can probably be achieved although FE orientation may not be globally correct (1 - 2 mm range)

D-Plate alignment is commencing well although impaired by the vast number of people work in close confines. Our instrumentation setups have been bumped on numerous occasions resulting in timely delays.

We have begun layout of magnet centers and magnet stands in the HEBT Tunnel. This task will continue for several more days.

We have completed the layout of new survey monuments in the target area. These are scheduled to be drilled on Tuesday of next week.

Have completed the fiducialization of all 15 drift tubes for Tank 1 presently here. We will complete the rest once they are shipped from LANL.

We have completed mapping of the half-cells in the RATS. We will next compare our data with that received from BNL.

We are in the process of performing a mock-up of two HEBT Dipoles in the RATS. Essentially, two magnets have been to proper global coordinates.

Mechanical Group

HEBT-Ring Installation:
- Installation of the HEBT SB cable tray continued.
- Installation of the HEBT SB transformers continued.
- Installation of the HEBT SB AC distribution continued.
- Received RING half-cell #7 magnet assembly and staged it in the HEBT tunnel.
- Installation of the HEBT tunnel cable tray started.

Water System:
- Started the RFTF DI system pump and leak checked lines to the HVCM and SCR cabinets.
- Performed final leak checks and repairs on the DTL-3 RCCS system in the tunnel.
- Removed 6 non-functioning flowmeters on the DTL 3 RCCS system for manufacturer repair.
- Install cooling lines to the DTL 5/6 system circulator.
- The CCL manifolds for CCL 2,3, and 4 were inspected and accepted.
- Provided DB support on the linac beam dump.

Magnet Task

We have completed measurements on 4-16CD20'.

DTL Tank 3 PMQ measurements are completed.

We are in the process of measuring DTL Tank 1 PMQ's

In the process of staging two HEBT dipoles it was discovered that alignment of the dipoles couldn't be done because of a problem with the slider plate on the stand. We are fixing that problem on all nine stands.

HPRF

LLRF

Electrical Group

Installation of the RFTF HVCM is now complete, with checkout slated to begin next week. 13.8 kV power was energized yesterday in the RFTF and HEBT transformer locations. Certification of the PPS system for DTL-ME2 was completed, and the unit is now being used to operate the DTL-3 klystron and for conditioning studies on the DTL-3 structure. Some minor design modifications have been implemented on the 3 HVCM units at ORNL that should prevent future possible breakdown problems. Acceptance testing of the next 2 HVCM was performed this week at Dynapower, and the units should ship to ORNL next week. An IGBT lifting table will be assembled today and will be used on all future IGBT installation and maintenance operations.

We have learned of a modulator incident at Dynapower that occurred today (4/25/03). During the acceptance test of the first CCL modulator, there was a flash through of the IGBT modules. This resulted in a large arc that initiated a fire within the modulator safety enclosure. The enclosure contained the energy release as per design and Dynapower personnel extinguished the fire. However, the cause of this event is as yet unknown and Dynapower has suspended for safety reasons all testing and assembly until the cause of this event is resolved. Based upon these events, the Electrical Systems Group recommends that we not operate the DTL 3 modulator (which is identical to the failed CCL modulator) until the cause of this event is discovered and corrected.

LANL personnel and Dave Anderson are traveling to Dynapower to examine the damaged modulator on Saturday, 4/26/03. It is hoped that this may all be resolved soon so we can run the modulator on Monday, 4/28/03.

Power Supplies:

Testing is proceeding on the 5000A, 18V Ring Medium power supply in RATS.

The first three (of 14) CCL quadrupole power supplies were delivered on 4/24/03 to RATS.

Testing of the DTL 3 corrector power supplies at RATS is complete and these power supplies are ready for installation in the Klystron gallery. DTL 4 corrector power supplies are under test in RATS.

FE - All AC installation complete, ready for front end commissioning run, documentation redlined.

DTL - installation completed up to DTL3, ready for DTL3 conditioning, documentation of all systems being redlined.

CCL - small progress in DC cable installation

HEBT SB - 90% cable tray erected, transformers and AC panels in place in the west half of the building

HEBT tunnel - straight section toward the HEBT entrance - cable tray 80% done, cable pulls will commence next week.

The successful completion of the installation of all thirty three Thermocouples on DTL3 Girder are have been tested, and are now fully functional as not only an analog function in the Epics Data Base/ Linac Operating system for DTL3. To create a BarGraph display and history time plot of temperature, but also as an Interlock scheme.
If any one Thermocouple fails, the AND Logic/ Sum of the (33) Ungrounded type "E" Thermocouples will now create an Interlock trip, and is also Summed through software controls as an AND Function in conjunction with the water flow to turn off the RF in the event of overheating the DTL3 tank. (An MPS function). We continue with the cable to be installed for DTL1.

Cryo Systems Group

CHL: Work continues on installation of the instrument air and LN2 piping. The Oil pump on the first stage compressor was inspected for particles. This pump turns freely and has no visible particulate matter.

Tunnel: Work continues on the installation of the warm gas piping. A sub assembly fabrication station has been set up in the RATS building to assemble the relief and cool down drops from the main headers. Once fabricated these drops will be installed in the tunnel.

RATS: WE are assembling the valve actuators for the transfer lines.

Beam Diagnostics

BNL SNS Beam Diagnostics Progress Report:

General: Preparing for DOE Review

1.5.7.1 BPM: Work continues on the base-band design. Layout is backlogged in Instrumentation Section, RF board is being sent out for layout. Assembling the 6 additional 30cm BPMs for brazing.

1.5.7.2 IPM: Additional Controls Group manpower has been assigned to IPM Controls. Commercially available 8 channel 10/25MS/s PCI digitizer cards have been located from a commercial vendor; will be evaluated as an alternative to the baseband BPM board. Received quote from Burle for the wide MCP assembly. Collector card is in layout, evaluating rad-hard board materials (in conjunction with LANL, who also need rad hard boards for the target harp). Progressing with shaped sweep field design.

1.5.7.3 BLM: System testing and software integration has started using the prototype AFE chassis. This is the result of a valiant effort last weekend. Initial results are encouraging, as we work with Controls using a digital control and readback application. Assembly and testing of the 8ch AFE test stand continues. Making corrections to the AFE chassis PCB backplane checkprints. Plan is to deliver (in person) first 8 channels of BLM to ORNL the week of May 5th. MPS comparator/interface prototype blank boards are expected next week. The ISEG HV bias order will be placed as soon as all required approvals are received. Mechanical assembly is underway for completing end-caps for the detectors to be shipped to ORNL for DTL commissioning. LND provided an acceptable quote for a complete BLM ion chamber, which includes end cap assembly, costs. BNL will procure most of the end cap parts and deliver them to LND. Checking and finalizing production drawings.

1.5.7.4 BCM: A BCM system was shipped to ORNL 4-23-03. ORNL verified that calibration-winding cables are twinax, will mate properly to the BNO connectors. Additional LANL-style PCI cards are in fabrication. Delivery of HEBT beam-line components (both BCM and wire scanners) has been delayed by vacuum firing backlog in Vacuum Group. Communicated this problem to ORNL, arrived at a mutually satisfactory delivery schedule. Finished eradiating all the aluminum parts, welding 5 vacuums break to beam pipes and bellow assemblies. Units will be baked out and welded to the flanges. Finished the support design for the HEBT supports, started working on production drawings for the Ring BCM. An order has been placed for the vacuum breaks.

1.5.7.6 Carbon Wire Scanner: Finished welding 12 WS beam box assemblies. Continued baking out completed units. Finished up the support structure design and ordered materials and shipping boxes.

1.5.7.7 BIG: A number of issues with our spec have cropped up from Diversified Technologies perspective. They would like BNL to procure the HV supplies, and the switch timing has been requested to be changed to 250ns from a dual mode (695ns and 250ns). Work on the formal spec continues. After hi-pot testing of the 7/8 Heliax/HVN combination, the decision has been made to use 1-1/4” Heliax with 1-5/8" EIA flange connectors. A custom vacuum feedthrough is being designed to mate with the EIA connector. A sample EIA connector has been requested.

LANL SNS Beam Diagnostics Progress Report:

BPM pickups: The last 2 SCL pickups were shipped to ORNL early this week. This completes the SCL BPM deliveries. There are now just 3 BPMs still to be finished -- DTL BPMs #9, #10, and #11. These should be finished by mid-May.

BPM electronics: Three members of the diagnostics team were at ORNL last week to install 3 ea. BPM chassis for the D-plate, conduct phase measurement tests, resolve shared memory DLL issues, and to work on the PCI timing card. The BPM chassis were successfully installed. Phase noise measurements were successfully made on the DTL and MEBT systems. The differential phase measurement was not completed due to lack of time. Work continues to fabricate new electronics to replace the prototype units now installed in the MEBT.

WS electronics: The two Phytron linear driver chassis have been shipped to ORNL. The PCs for the DTL and CCL wire scanner systems have also been shipped to ORNL directly from the vendor. Work continues to fabricate 27 each signal processor chassis.

ED/FC: Work continues on ED/FC electronics chassis #2 (a total of 3 will be built). Bid packages are still out on the remaining ED/FC actuators.

D-plate: A member of the diagnostics team will travel to ORNL next week to assist with the D-plate installation activities.

Harp: Work began on the layout of the harp wire planes.

ORNL SNS Beam Diagnostics Progress Report:

D-Plate: The D-plate is assembled in the tunnel and QA testing has started. We have gathered "repeatability" data on the actuators (we will publish that after feature analysis). The vertical tests and horizontal tests of the emittance scanners were performed. The actuator micro-switch distances are recorded with respect to the beam-pipe center. The plan is to finish the wiring of the diagnostics by Monday (April-28-2003) followed by the vacuum and pump installation on Tuesday, Water and air for the next two day.

D-box: AP group, Mechanical and Diagnostic group met on Tuesday to plan on the D-box implementation schedule. We hope to have one actuator ready for the MEBT startup at the end on May.

Oscillator Box: Craig Deibele's solution meets and exceeds the Roscoe box. As such, we have the first of two proposals that meet the specifications. Jim Pogge is working on the low cost version.

Timing/Software: Tom traveled to JLab to review the architecture of their test systems and progress on digital receiver electronics. He also presented a seminar on SNS diagnostic systems based on Wim's Labview template. Developers of the cryomodule test facility software are very interested in this Labview code that incorporates the SNS shared memory interface to EPICS. We may collaborate on development and testing of the code. Code and documentation was left for their review. John Musson, Curt Hovator and Tom discussed JLab's evaluation of a single chip vector receiver from Analog Devices. They have developed a utility module that replaces obsolete vector voltmeters and loaned one to the SNS diagnostics group for our evaluation. They do not plan to use this chip for precision instrumentation. Craig Swanson worked at LANL last week with Lisa Day and Matt Stettler. They have completed a first version of gate array code and support software for the embedded timing circuit. It can now be integrated within the PC based instruments.