**Accelerator Systems Division Highlights for the Week Ending February 21, 2003**

**ASD/LANL: Warm Linac**

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments this week: (1) The Thales klystron operated in the steady state at 5-MW RF, 1.3 msec, 45 Hz and 9.2 MW peak beam pulse, 60 Hz, 1.3 ms beam pulse and 0.85-ms, 5-MW, 60-Hz RF pulse. (2) CPI 550-kW klystron #10 passed factory acceptance tests; (3) Titan SC linac transmitter passed all tests except for 24-hour heat run. That test started today.
Concerns & Actions: The 5-MW RF load failed at the full SNS duty factor. Consultation with the vendor revealed an improper choice of material for the water seal. Operation is limited at reduced pulse RF width (0.85 ms) until the vendor devises a solution and retrofits the loads. In the mean time, full average power tests (60 Hz and 1.3 ms) will be made using a pair of loads loaned from LANSCE.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) We continue to run at full average power. The prototype HV converter modulator (HVCM) operated with sustained output of 136 kV, 70 A, for several days this week. (2) First production 140-kV HVCM was successfully tested at Dynapower. Tests included full peak power at full pulse width, but not full average power. This unit will be delivered to ORNL in time to support the DTL-3 RF testing schedule. The tests of the next 2 units are scheduled next week. One unit will go to ORNL and the other to LANL.
Concerns & Actions: (1) Late Thursday, the prototype HVCM had a failure of two switch plate assemblies. Initial assessment is that the failure was due to problems during the assembly and insufficient checking of the assembly. After several hours of operation, this led to the failure. The unit is being repaired and current expectations are that it will be back in operation by Tuesday. (2) We received the written report from the review by H. Pfeffer (Fermilab). He likes the HVCM design and the technology advancements of the capacitors and output transformer. He expressed concerns about the output transformer design in terms of long-term reliability. He suggested getting Stangenes to consult on the design. We agree with his assessment and will propose a PCR for consultation.

DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: (1) Fifteen repaired tank-3 drift tubes were completed and shipped to ORNL. Sixteen (of the remaining seventeen) are at LANL and are undergoing final vacuum, magnet, coolant flow test; they should ship to ORNL before the 2/28 milestone date. (2) Tank-3 drive iris vacuum leak was successfully repaired. Unit will be shipped to ORNL next week. (3) All Tank-3 post couplers were successfully welded. (Fig. 1) Final machining is underway. (4) The first eight Tank-1 drift tube cap welds were satisfactorily performed. (Fig. 2) Twenty more are schedule for next week.
Concerns & Actions: (1) Current schedule shows that 32 of 33 of the repaired drift tubes will be shipped by the end of next week. The last unit (the BPM dummy rebuild) might be a few days late but that will not affect installation. Our critical path item is the top hats where we need to re-plate surfaces. We authorized overtime at plating shop so that we can meet schedule, and are in constant communication with ORNL to insure that none of our deliveries impede installation.


Fig. 1: T-3 Post Coupler inspection after welding

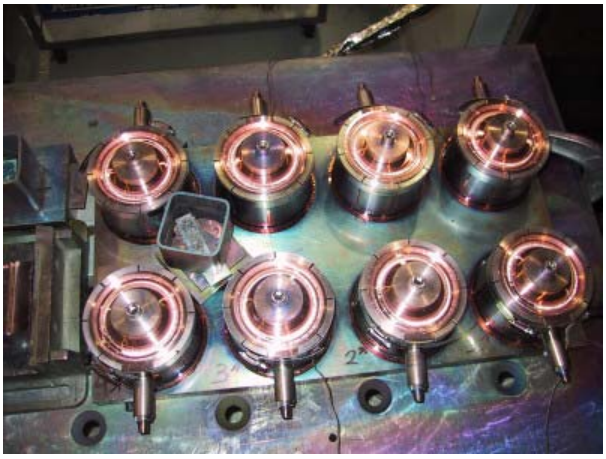
Fig. 2: T-1 drift tubes after cap welds

COUPLED-CAVITY LINAC (WBS 1.4.4)
Accomplishments: (1) N. Bultman was at ORNL to define the CCL assembly and installation with ASD and ACCEL engineers; (2) Legs for the module-1 stand were completed and on the way to stress relief (3) We place the contract placed for the RF monitor loops with Ceramaseal.

**ASD/JLAB: Cold Linac**

Assembly of cryomodule M-1 assembly will be completed today. The cold mass and space frame have been inserted into the vacuum vessel and attachment of the end cans is underway. Assembly of cryomodule M-2 continues with detailed measurements of cavity RF characteristics.

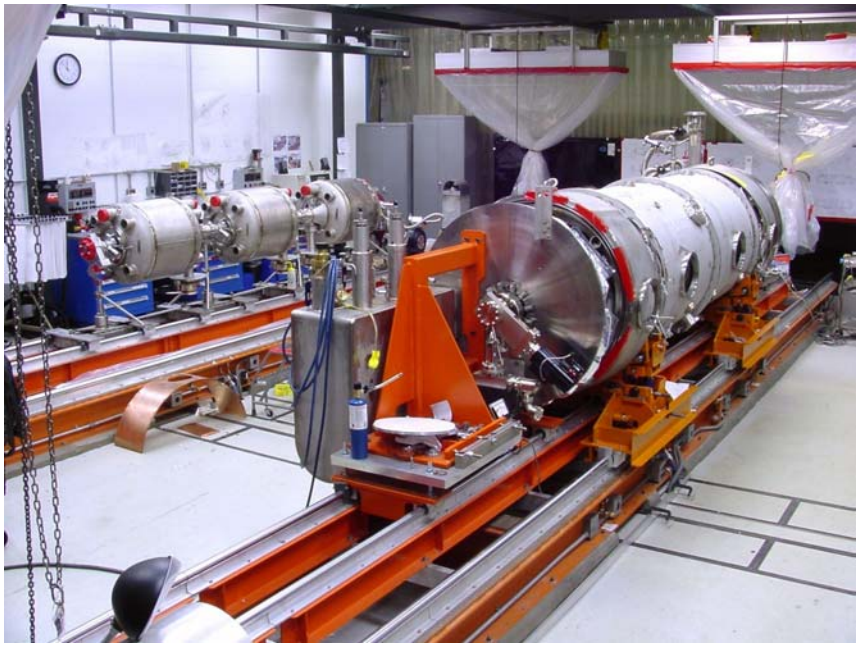

Figure 1. Production Cryomodules M-1 (right) and M-2 in Assembly.

Three cavities have been qualified for the M-3 string. String assembly will begin next week. One cavity has been qualified for the M-4 string.

New acid plumbing and a new pump have been installed in the electropolish cabinet. Final water testing is underway prior to first acid tests next week.

Repairs to the eddy current scanner continue to be ineffective in achieving normal operation. Interactions with the designer/builder continue.

**ASD/BNL: Ring**

Jie Wei presented Cost/Schedule/Performance Review to the SNS Project Office via videoconference.
Work continues on the ETC.

BNL/SNS management and staff participated in the SNS Tech Forum on "SNS Electrical Systems Overview" presented by F. Carden.

Bob Lambiase issued a report on his recent trip to IE Power, Toronto, Canada, where he participated in the acceptance testing of the Medium Range Power Supplies: "The primary purpose of the trip was to measure ripple, stability, and noise performance of the first of the Medium Range Powers Supplies for the SNS Project. Based on this, a decision on whether to ship the unit to ORNL, or not, would be made. Other technical issues related to this

and other SNS and C-AD supplies were also discussed." See Bob's report for all the details. IE Power has been authorized to ship the first article unit to ORNL.

The first article RF Tune power supply (by Danfysik) has finally arrived at BNL Receiving. The unit will be delivered to the RF lab, uncrated and inspected next week.

RF: Testing continues on power amplifier #2. See attached photo.

Field measurements continue on the 21Q40 quads. Twenty-five magnets have been measured to date (25/29).

Ring half-cells magnet assembly: work continues on units #2, 3 and 4. We plan to ship HC #2 to SNS/OR on Tuesday, Feb. 25th. Pre-survey has been started on HC unit #5. See photo of unit #2.

We continue to work with Stangenes to resolve "out of tolerance" issues related to the 26Q40 magnet pole pieces. BNL/SNS Engineering has reviewed all pertinent QA measurements related to the pole pieces and has ask Stangenes to confirm all critical data.

An RFQ has been released to Contracts for the Injection Bending Magnet #1. Tech. info was sent to Ted Hunter earlier today.

36Q85 Quad (RTBT): Magnet cores are being inspected and the first rad hard coil is almost fully wound at BNL. See photos.

Magnet spare parts: PCR RI 03 006 - several procurement options are being reviewed against authorized spending and vendor deadlines. This PCR includes a spare injection dump septum magnet, a sextupole magnet (26S26) and coils. Awaiting direction from ASD.


Half Cell 2

RF PA2

36Q85 Coil

36Q85 Cores

**Controls**

Network switches were implemented in Klystron Communications Rooms #3 and #4 to support Conventional Facilities controls checkout. Communications hardware (fanouts, switches, etc.) was installed in the CHL Control Room.

Installation of communications cables continues. Vacuum system MPS input cables were terminated. Termination of MPS connectors for DTL power supplies was started.

The "hot spare" timing system has been assembled and is now working at 701 Scarboro. It is a duplicate of the system running in the Front End Building and will be moved to the site before the next running period.

The sequencer written by Steve Hicks to automatically test MPS chassis has been rewritten and is now operational. This tests all functionality of an MPS chassis in around 3 minutes.

DTL vacuum system cabling documentation is being reviewed by Controls Group staff to help identify remaining holes in the installation design. We will work with the Electrical Group to help finalize the documentation.

A checklist of activities requiring completion before the DTL1 / D-Plate ARR was written and circulated to the controls team.

**Installation**

Craft Snapshot 2/19/03

| | |
|---|---|
| ASD craft workers | 59.0 |
| Foremen, ES&H, etc | 9.0 |
| Less WBS 1.9 controls | 4.0 |
| Less absent | 2.0 |
| TOTAL | 62.0 |

Planning and implementation of ASD personnel from the RATS I Facility to the SNS Site continued.

Technicians in the RF Group completed their move to the CHL/RF Building.

The Ion Group and the Hot Test Stand will start moving on 3 March 2003,

It was decided in the Division Director's Friday Installation Meeting on 21, Feb 2003, to use the Trailer 10-plex lease proposal for the majority of ASD temporary site offices. This concept provides sixty-two new offices to support the move.

DTL Tank #1 will be installed in the tunnel on 15 March 2003,

RF Reference Line and DTL Shielding Wall designs have been co coordinated and installation of the Reference Line will begin this week.

The questions associated with cabling and terminations for the DTL vacuum and cooling cart systems was discussed in the Division Director's Weekly Meeting. It was determined that the up coming LANL site visit should not happen until these integration issues are resolved.

**Accelerator Physics**

**Operations Group**

CLO Planning – Office and Lab planning. A meeting was held last Thursday. Group requirements are being compiled.

Mario's "Lessons Learned" went out for the final round before submission to the tracking system.

An ARR DTL-1 videoconference was held last Friday. The committee agreed with our approach,

David Brown is updating SNS Emergency Procedures

Ted Williams and Shane Passmore are updating the Operations training requirements

We looked at and rejected the LSS training records system

Work on the Conduct of Operations is proceeding

Work with the MIS group continues on Maintenance Planning

A Meeting was held on the RGD requirements for DTL Tank 3. No serious problems with our approach were encountered.

Mario worked with the ORNL SBMS LOTO committee to bring their procedure and ours together. We will do a rewrite on ours for final compatibility.

We met with MIS on document conversion from IMAN to Project Wise.

**Ion Source Group**

Our goal of having three ion sources fully tested and ready by the start of the DTL commissioning has encountered another obstacle: The ion source recently received from LBNL was damaged during shipping. It appears that one of the three support legs became loose allowing the ion source to rattle. Several insulators and the e-dump are badly damaged, a problem which could not be seen before the ion source was completely removed from the box last Thursday.

The damaged parts of the ion source were replaced with parts removed from the ion source which has a big vacuum leak due to a hole drilled too deep during fabrication. This new hybrid source has been mounted on the hot spare stand and pumped down below 1E-6 Torr. After completing installations and loading Cesium, the source will be tested before the hot spare stand is moved to the site.

A high power beam stop was assembled and installed on the hot spare stand. The vacuum group found two leaks in the LEBT tank of the hot spare stand in the 10E-6 range. This is too small to affect operations, but large enough to warrant repair. We plan to fix it when the stand is disassembled for moving it to the site.

The proper alignment of the LEBT and a properly functioning LEBT valve are the goals of a plan that has been put in action. As a first step, our survey group has fiducialized the LEBT tank. Next we will remove the ion source and survey the LEBT position. Then the LEBT will be optically aligned with the RFQ, being followed by another survey. Then the LEBT will be removed and the RFQ entrance will be laser-tracked. Having the LEBT removed gives the vacuum group access to repair the LEBT valve. When the valve is repaired and tested, the LEBT will be reinstalled, re-surveyed, and realigned, if needed. At a later time we will add fiducials on the ion source adapter flange to allow for laser tracking the ion source.

**Mechanical Group**

The first six DTL-3 drift tubes were received in RATS this week. More are expected next week.
The taut wire system that will be used for fiducialization of the DT's has been checked out and is ready for use.

The DTL-1 tank segments have been bolted together in RATS. Drift tube installation testing is planned for next week.

Representatives from LANL and ACCEL where at ORNL this week to discuss CCL-1 assembly, alignment, and installation in the tunnel. The detail steps associated with each of these activities were discussed and general agreement reached.

LANL and ACCEL representatives inspecting CCL-1 tunnel location.

Bernd Griep (ACCEL), Christian Piel (ACCEL), Zukun Chen (LANL), Nathan Bultman (LANL), and Mike Collier (LANL)

**Magnet Task**

**Linac HPRF**

We tested 2nd article HVCM at Dynapower. Unit tested successfully at 140 kV operation for ~1 hour at 0.1 Hz. Unit scheduled to ship from Vermont to ORNL next Monday. Completed installation of ME2 safety enclosure and nearly completed cabling for ME2. Began rebuilding LEBT chopper mixer box for front-end group.

Rework of piping is proceeding in the gallery, the ME2 area that consists of DTL 3 & 4 completed early next week.

Rework of RFQ, DTL 1 & 2 piping complete march 1st.

HVCM arrives next week with another to follow in about a week. New HVCM transformers for ME 1 HVCM to arrive mid March.

Work in the RFTF will resume March 1 with pipe fitters.

A new layout of the CCL RF water connections will save some 500 gpm, we are looking at this and if it does not violate the Thales tune warranty we will go with it.

**Linac LLRF**

ORNL

JLAB Test
Mark Crofford and Mark Champion will travel to JLab on Monday, Feb. 24, to carry out testing of the low level RF control system with the first production cryomodule. Larry Doolittle and Kay Kasemir will travel to JLab mid-week to participate in the testing if the schedule holds.

Reference System
The installation of the reference system will begin the week on Feb. 24. The design of the radiation shield wall between the Front End and DTL1 has progressed to the point that it is impacting the design of the reference line. We had not planned on installing any bends in the 3-1/8 inch rigid line, but will likely be required to install two 90 degree bends and a short intervening straight section in order to accommodate a labyrinth through the shield wall. We do not expect any impact on performance or schedule.

Performance Measurements
Hengjie checked the performance of the RFQ LLRF control chassis in generating RF drive frequencies at frequencies other than 402.5 MHz (see note in LBNL section). We are planning to configure the RFQ system for further performance measurements during the coming weeks.

FPGA Code Development
Craig Swanson has ported the LBNL FPGA code to the new platform under development at LANL. He is verifying the correctness of the translation by means of simulation and discussions with Larry Doolittle and Matt Stettler. He is working with the draft version of the new FPGA specification and will provide feedback to its author, Mark Prokop. This specification is key to setting up the needed FPGA code simulations.

Installation Support
Mark Crofford and Taylor Davidson are arranging for installation of LLRF components for the DTL and RF Test Stand. All of the DTL VXI crates will be installed at the site next week. The VXI IOCs are in route to ORNL from LANL along with extender cards for the IOCs, timing modules and utility modules. The CDM-replacement cards were received from the vendor this week. This card simply passes timing signals to the backplane of the VXI crate. Termination of Heliax cables for the DTL should begin next week.

LANL

Hardware Platform
Work continues on producing the “Rev 0” of the new hardware platform for the LLRF system. We are still on schedule to begin test and validation of the REV 0 hardware the second half of March.
a) Analog Front-end. Awaiting the delivery of the first two prototype units by the end of February.
b) Digital Front-end: The design including Assembly, Schematic, BOM (Bill of Materials) etc. was released for fabrication to Suntron in Phoenix. The two initial prototypes are expected mid March. To expedite fabrication LANL provided some of the long-lead items.
c) RF Output module: The schematic is complete and frozen. It has been shipped to the reviewers. To meet our scheduled prototype delivery date of mid March, and given the relative simplicity of the board, we will review next week the option of assembling the board in house. That should reduce the turn around time to 1-2 weeks rather than 3-4 weeks if fabricated through a vendor.

As this board shares the clock module with the SNS BPM board that is being tested, we should have additional performance and stability results before the board goes into production.

d) Motherboard: The schematic has been delivered to the CAD team and is being checked for errors. It will be frozen and shipped to reviewers next week. We may also choose the option of fabricating this board in house. This board is about 2 weeks behind schedule but is not on the critical path. The initial testing of the DEF will be done with the SNS BPM PCI carrier; hence this board is not needed until April.

HPM
ORNL (Mark Crofford) has received the three new HPMs, the HPM test set, and the repair parts as requested. We suggested that they ship the two HPMs at ORNL back to LANL to make sure they're updated to the latest modifications, retested, and returned to ORNL. One of them evidently has a bad RF channel that needs repair. Crofford now also has the parts to perform the speedup modification on the HPM at JLAB if required.

Current Count & Status of HPMs and HPM test stands:
One HPM at JLAB (modified for a +5V RF Permit input)
Six HPMs at ORNL - 3 old and 3 new; two old ones are due to come back for repair/checkout and will be returned within a week.
One HPM test stand at ORNL
Two HPM test stands at LANL (one to be shipped to Suntron for production HPM testing)

Modeling and Simulation
Tested two difference resonance calculation methods with the 402.5MHz test cavity at LANL and the LBNL LLRF system. The system also included:
- A network analyzer
- A MATLAB implementation of LBNL's decay-fit
- Sung-il's MATLAB implementation of an extended Kalman-filter method.

Both MATLAB implementations gave virtually the same result. The network analyzer was slightly different mostly because it was difficult to determine the exact maximum of the resonance curve. So we have working tools to calculate the resonance error with live data from LBNL's system. We will try this again at JLAB (higher Q cavity) to see if there are differences in robustness.

The next step would be to report the resonance error from MATLAB to the stepper motor IOC so that we get "resonance control" (shouldn't be more than un-commenting the line in the MATLAB script that writes to the stepper motor IOC). Since we don't expect any of the resonance calculations to work for large resonance errors, the last step would be a scan of the RF drive frequency from MATLAB, plotting the cavity amplitude over the RF drive and looking for a maximum.

Applications Firmware and Software
The interface control document (ICD) specifying the firmware specifications including interface between the hardware, firmware and software was modified with comments from Craig Swanson and will be sent to reviewers early next week. We also discussed with Craig how to verify the VHDL functionality with MATLAB models and the work on the test setup will start next week.

JLAB Test
LANL team helped setup the LLRF and the motor drive software. Kay Kasemir will be at JLAB next week to help with the actual tests.

LBNL

Ongoing activities:
Larry measured the noise behavior of our interim LLRF chassis, which will drive RFQ and DTL. Preliminary results show single sample noise within a pulse of about 0.7 bits rms, plus 1.3 ps rms clock jitter. Pulse-to-pulse phase noise is more complex, depending on the strategy for phase rezeroing from reference signal. A formal tech note detailing the results is underway. This information is vital input to Hengjie's system phase noise analysis, and confirmation that the design is worth cloning on the LANL "RFO" card.

We also tested Carl Lionberger's build of full IOC core software for StrongARM (nanoEngine) Linux. This seems to work well enough that it will replace the previous xcas-base server software.

Another major success is with the system at JLAB. After struggling with the usual firewalls, Larry finally connected to the LLRF chassis we shipped to JLab. It appears intact. Ernie, Carl, and Larry are working on the installation the latest versions of all the software. In general, the system is ready to support the cryomodule tests next week.

We also provided a recipe for testing the output channel behavior at off-center frequencies. It works OK, but could be better with an FPGA code revision. This was tested in the test stand at Berkeley confirming the +/- 640 kHz operating range.

Last, we reviewed the DFE schematics from LANL. The LANL team has done a very good job and has addressed all most important concerns from previous reviews. We feel comfortable with the hardware production.

Our vendor appears to have resolved its software problems with the files we provided for component placement and should start loading the boards soon. However, we have not received a delivery date yet.

The next chassis is still under fabrication (awaiting front panel machining and painting, but already ready with the connectorized components) and we are preparing to build an additional one to be used in the DTL3 conditioning.

**Electrical Systems Group**

A field engineer repaired all 176 Danfysik corrector power supplies that required an upgraded relay output circuit at RATS this week from Danfysik. 20 power supplies have been fully tested. These power supplies will be installed shortly in the klystron gallery for use with DTL 1 corrector magnets when they are installed in DTL 1 drift tubes.

All of the CCL shunt power systems have been delivered by Alpha Power Supplies - 8 to LANL and the remainder of 32 + spares to ORNL.

All parts have been ordered for the front-end quad power supply upgrades.

Roy Cutler attended a ORNL meeting to set uniform new LOTO procedures throughout the lab.

**Survey and Alignment Group**

**Cryogenics Group**

The LN2 Dewar vacuum pressure is still holding at about 40 microns. We are preparing to bump the motors on the warm helium compressor skids. Installation of the south wall piping and cold box room piping is nearing completion. The contractor is estimating 3/14/03 as his completion date weather permitting.

Work continues on the warm gas piping and welding of the 8" upstream return module line. WE have completed 7 of the 8" welds.

Transfer lines: The last return module HB19/20 is in the assembly tooling and approximately 40% completed. The end can HB21 is also in the assembly tooling fixture and is 20 % completed. Work continues on the CHL return expansion can.

**Beam Diagnostics**

BNL Beam Diagnostics Progress Report:

General: Preparations continue for the upcoming Design Review, scheduled for March 25th and 26th. Preparations are underway for ASAC Review. BNL will host a visit from ORNL Diagnostics on the 24th thru 26th of February.

1.5.7.1 BPM: Assembly of 21cm PUEs continues. Continue to check the baseband prototype board. Minor errors are being corrected, both on the board and in schematic/layout for the next rev. Additional manpower is being applied to timing module development. Al components for next batch of PCI interface cards are in house with exception of Quicklogic gate arrays. Continuing calibration system design. New translation stages are being mated to the wire scanner frame to bring the mapper back on line.

1.5.7.3 BLM: The first channel of the BLM AFE was stuffed. The initial tests look good. The 16-channel MPS interface was sent out for PCB design. A spare ISEG VHQ module was given to controls for testing with the 2300 processor and EPICS drivers. We have received the 10 BLM detectors from LND. Manufacturer's test results look promising. In-house testing is underway with our Cesium source. About half of the SHV cable ends were received and shipped to ORNL. Work on building the AFE test stand and updating the BLM brochure continues.

1.5.7.4 BCM: Four circuit boards being stuffed have been delayed due to Holiday and snow. Expect delivery early next week. Received raw materials for the HEBT BCM transformer spacer. Continued working on shop drawings.

1.5.7.5 Tune: Assembly of prototype stripline modules was completed, and modules were delivered to engineering lab for resonant pickup/kicker studies.

1.5.7.6 Wire Scanners: HEBT WS Beam Box finished bellows assembly drawings are being checked.

LANL Beam Diagnostics Progress Report:

BPM pickups: Work continues to test and map the SCL BPMs. Approximately 23 out of 34 have been mapped so far.

BPM electronics: Work continues to test the new PCI motherboard. The power supply circuitry has checked out OK. The clock multiplier circuit check out is on hold until a new regulator arrives. Four new 2U rack-mount PCs have been loaded with Windows 2000 and LabVIEW. An additional PC was also ordered to allow testing of the new timing card.

WS actuators: The DTL-1 actuator is ready to ship with the exception of a one wire limit switch modification for the new collision avoidance system being built by ORNL.

WS electronics: Two PCs and two signal processors, needed for DTL-1 and the D-plate, were shipped to ORNL on 19/Feb. The driver chassis for these systems are ready to ship except for the modifications for the new collision avoidance system.

D-plate: The slit and harp stepper motor actuators are ready to ship except for the one-wire modifications for the new collision avoidance system (i.e., same modification as the above wire scanner actuator). Work continues to prepare the mechanical drawing package for release.

ED/FC: The vacuum sealing problem mentioned last week has been solved, and both the DTL-1 and D-plate units are now vacuum tight. They should be ready for shipping next week. A system test with an actuator, the electronics chassis, and the PC worked well. As designed, the actuator retracts when air pressure is disconnected, and the actuator stays retracted when power is cut off to the actuator, when the PC power is cut off, when the PC is rebooted, and when LabVIEW starts up.

ORNL Beam Diagnostics Progress Report:

D-plate: D-plate diagnostics cables are all terminated with the exception of the loss monitor signal cables. Paul Holik has ordered those cables. We expect to have them in 4-6 weeks. Bunch Shape Monitor (BSM) device will be installed on the D-plate subject to readiness. Our Russian collaborators have requested from us to allow them to terminate their cables when they arrive. ORNL's responsibility is to pull the cables; EE group is in the process of installing the BSM cables. Andy Webster has refined the Anti-collision circuit for the actuators. The LANL's engineers and Mike Plum have accepted the design. Peter Ladd's group will install the Macor insulator and replace the greasy o-ring on the D-plate on Monday Feb-24-2003. The alignment group will check the fiducialization of the

external markers with respect to the internal geometric axis also on Monday. The Mechanical group is ready for the water-cooling connection on March-4-2003. Peter Ladd led two meetings on the D-plate vacuum and fast valve installation. Johnny Tang from the controls has successfully demonstrated the control's logic. The following Figure shows the setup:

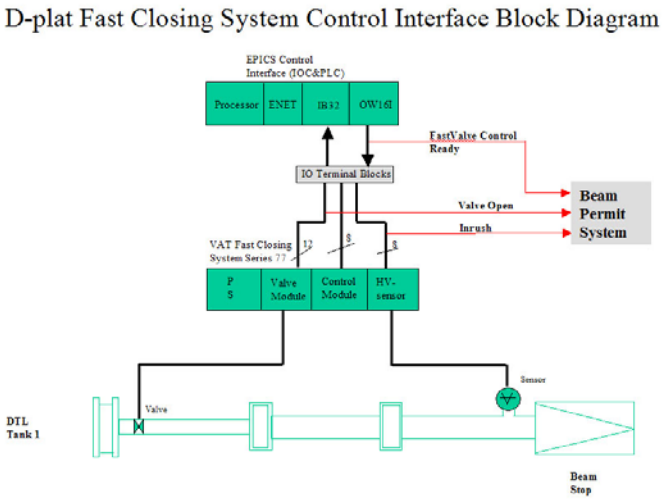


Figure 2-- Fast valve

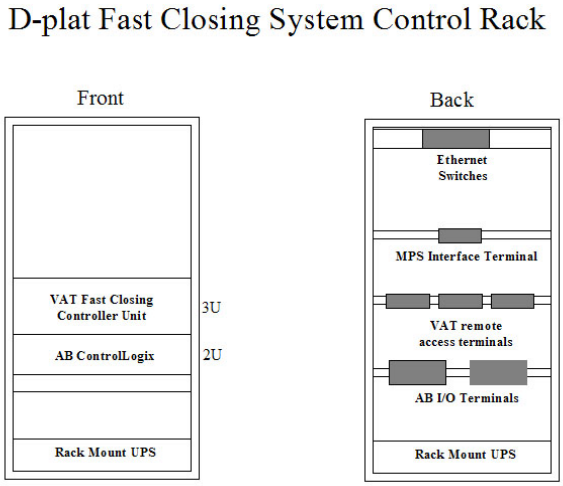


Figure 3-- Rack assignment for the fast valve.

Software: Wim Blokland and Dave Thompson are adding more features to the shared memory software. Wim also updated the template structure documentation. He added Channel Access Client routines to the demo operation.

Template. The following two figures show the server side and a successful client side reading and writing to the shared memory of the NADs.

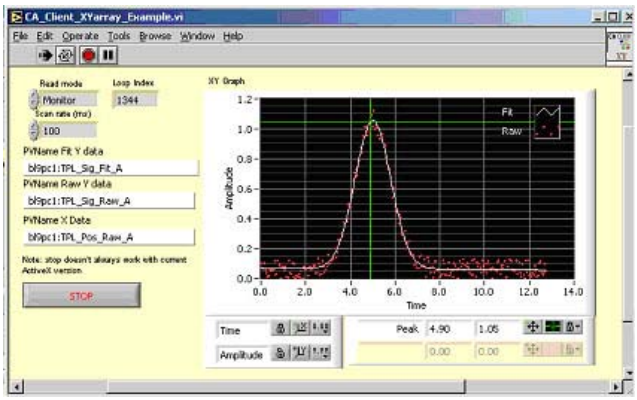


Figure 4-- Client side

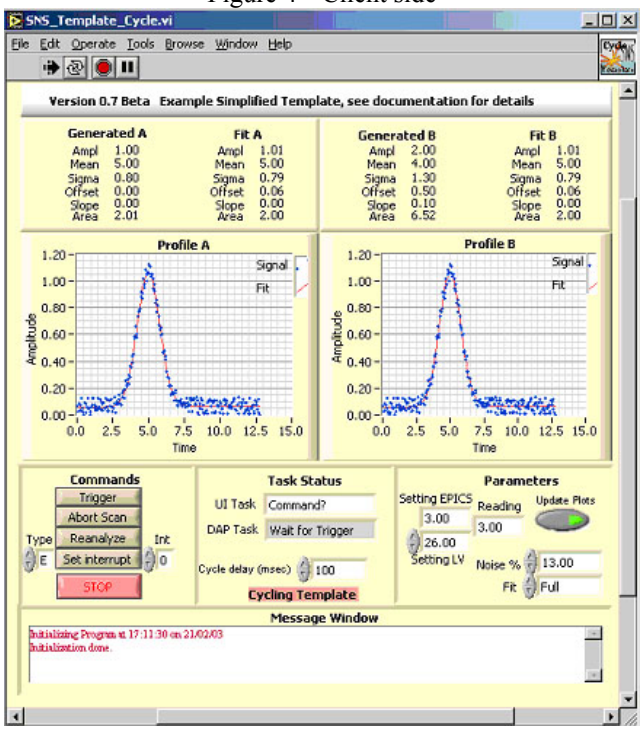


Figure 5-- Server side

Other Electronics: Jim Pogge and Craig Deibele are working on the oscillator box for the diagnostic reference input.

D-plate Emittance Electronics: The controls and the diagnostic group are ready to test their electronics upon the arrival and installation of the slit and harp actuators. The digitizer and the motor drive rack are online at the Front-end building. Delphy is adding error-checking and status indicators to the software.