Accelerator Systems Division Highlights for the Week Ending March 7, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments: (1) We accepted the first 550-kW 805-MHz klystron (Fig. 1) at the Thales factory. The tube demonstrated 560 kW RF output @ 20 Hz, 4.6 ms in normal operation. (Thales is testing at long pulse because of failure of original test stand.) The tube also demonstrated in excess of 605 kW in a 24-hour heat run. Some requirements problems were discovered but all were addressed by changes before the completion of test. The second tube is scheduled for factory test 3/10, with the third tube on 3/24, and the 23rd (and last) tube forecast for 12/2/03. All dates support the Integrated Project Schedule. (2) We continued the 5-MW tube and circulator site acceptance tests at LANL
Concerns & Actions: (1) The solution was found for the 5-MW klystron output arcing problem reported previously. We gave Thales permission to use SF_6 in the transition but have required that the transition design be changed to include an additional window to limit the SF_6 to the transition only, be made leak tight, to include all piping consistent with SF_6 system on the circulator for filling and venting, and to be leak tested. (2) The sliding-short waveguide used in 5-MW circulator acceptance tests failed during high-average power tests. We are working with the vendor on the repair. (3) We received improved o-rings from Titan-Surebeam to repair the 5-MW RF load that failed at high average power. (4) The shipment of the first SC linac transmitter was delayed a week to fix problems uncovered during the heat run. Unit is now scheduled to ship next week, more than 3-months ahead of the installation schedule.

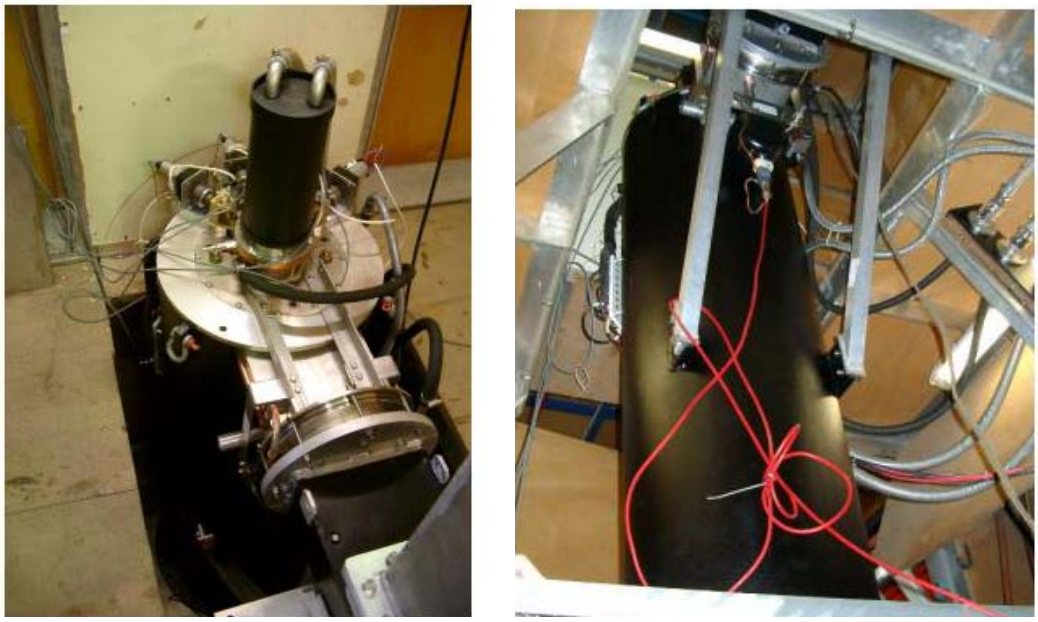


Fig. 1: First Article: 550-kW, 805-MHz Thales Klystron. Left: Top of klystron showing the collector and output window (in testing 'pit' at Thales). Right: Body of klystron in the focusing solenoid mounted on the modulator.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1) The third production HV converter modulator (HVCM) was shipped from Dynapower to ORNL. (2) The prototype HVCM at LANL operated well this week in support of 5-MW system tests.
Concerns & Actions: (1) Bill Reass was at Dynapower this week. Noticeable improvements in QA were observed, as evidenced by a dedicated crew, attention to our punch lists, and overall improved workmanship.
DRIFT-TUBE LINAC (WBS 1.4.2)
Accomplishments: (1) 29 (of 33) Tank-3 drift tubes have been delivered to ORNL. Two more are completed and will be shipped following vacuum outgassing measurements. Forecast ship date is 3/10. The final two drift tubes are the BPM dummies. One is undergoing final profile machining while the last will undergo its cap weld next week.

Delivery forecasts meet the ORNL prep and installation schedule. (2) Tank-1 rebuild are proceeding well. The last diverter-body brazes are complete. We are loading PMQs for next week's cap weld campaign at ESCO. Meanwhile, the first batch of T-1 welded drift tubes are undergoing final machining. (3) We received the report from the Feb 17-21 review by our DTL External Advisory (P. Grand, Chair). Overall report was very positive and supportive of the recovery effort.
Concerns & Actions: (1) The top hat plating adhesion problem (reported in previous reports) was solved. (2) Unsatisfactory threads were discovered in the top hats. They are being reworked over the weekend. Further improvements in vendor QA are being implemented.

COUPLED-CAVITY LINAC (WBS 1.4.4)
Accomplishment: Segment #4 was assembled and tuned, and it is ready for vacuum brazing.

ASD/JLAB: Cold Linac

ASD/BNL: Ring

Our final ETC was submitted to the Project Office.

Talks for the ASAC Review were completed and individual presentations submitted to the Project Office.

Ring half-cells: Unit #3 was shipped to SNS/OR this week. Assembly at BNL continues on units #4 and 5. HC #6 is being pre-surveyed.

Magnetic measurement (acceptance) of the first article 21S26 sextupole continues. Initial test results look good.

Magnetic measurements of the 21Q40 production order (Tesla, Phase I) are complete; all 29 quads have been measured. First shipments of the Phase II quads (n=30) is expected by late April. This extension results from delays by the vendor, as reported this week during our weekly teleconference.

The 21cm magnet test station is being made ready to start measurements on the 21CO26 octupole corrector magnets (n=8).

Testing of the RF Power Amplifier #2 was concluded this week. The PA was successfully tested at 11.8kv, 5 times rep rate for 24 hours.

Alpha Magnetics reportedly shipped the first two 41CDM30 production magnets to BNL this week.

The first article medium range power supply (5ka) was delivered to SNS/OR by our vendor, IE Power.

Stangenes has resumed assembly of the 26Q40 production magnets. We hope to receive a production first article in April. Engineers are planning a QA visit to the vendor's facility in mid March.

Eight of the HEBT 12cm quad chambers have been welded, leak checked and vacuum degassed. Preparations are underway to ship these completed units to SNS/OR.

Work on the Ring doublet chambers continues along with coating of the half-cell chambers and the injection kicker ceramic chambers.

An internal design review of the Extraction/RTBT region was conducted this week. Included were the extraction area L/O of equipment, lattice, extraction kickers, Lambertson magnet, and associated drift pipe assemblies.

Our vendor for the extraction kicker PFN power supplies has reported delays in assembly due to the difficulty in procuring racks from the SNS rack factory.

The BNL/SNS Project Controls Group is working with W. Foyt on SNS Pre-installation Policy & Requirements. Specifically, issues related to "Documentation/Software Associated with Purchased Components delivered directly from vendors to the RATS" on all major BNL procurements have been reviewed.

IPM - In a summary report earlier this week, Peter Cameron announced: "Roger (Connolly) has beautiful data from his beam experiment this evening. See the beam experiments e-log for details. I think he has laid to rest concerns about IPM performance in the loss environment of the SNS. A strong argument can be made that the other improvements (magnets on either side, electric sweep field extending well beyond the MCP,...) will satisfactorily address slow electrons. My conclusion is that IPM is looking very good for SNS."

An order for copper conductor was placed this week for the RTBT rad hard quadrupole coils. The quote is base on a July '03 delivery date.

A recently revised copy of the Ring's "Magnet Progress Schedule, 03/04/03" was sent to members of ASD.

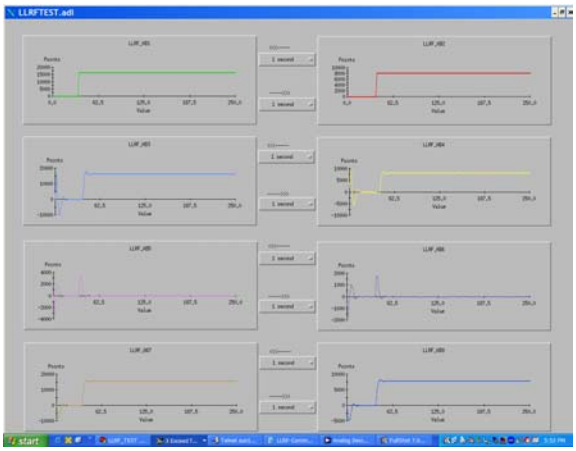
Controls

The operator console for the "hot spare" ion source was moved from the RATS Building to the Front End Building. It and related controls will be assembled and checked out while the hot spare system is rebuilt.

Plans were drawn up for moving the controls for the MEBT magnet power supplies that must be relocated to a new rack (FER26).

The Ring low-level RF DSP system has been interfaced with EPICS. Waveforms that have been configured using the "llrfConfig" application can now be downloaded through the IOC to the LLRF system, as can the DSP application itself. The real-time response of the DSP system can be displayed on MEDM screens. Below is one such screen.

Development of timing system software continues. This week we demonstrated the ability of the timing system to measure the ring revolution period to an accuracy of +/-1 picosecond and then broadcast this value via the Real-Time Data Link (RTDL).



Installation

Craft Snapshot 3/5/03

ASD craft workers	54.0
Foremen, ES&H, etc	9.0
Less WBS 1.9 controls	4.0
Less absent	2.0
TOTAL	57.0

The second HVCM was received from Dynapower on 03MAR03. It was placed in the Klystron Hall and installation begun.

The third HVCM will be received next week. It will be installed in the RFTF.

The shield wall support column was poured in the Front End Building.

The last three section of cryogenic supply transfer line will be moved to the tunnel on Monday, 10MAR03.

Accelerator Physics

Operations Group

We have interviewed two candidates for the Chief Operator position that we have open. We have been informed that we have two additional positions open in FY04.

Mario has been involved with LOTO, in particular LOTO training of ASD personnel and participation in the ORNL-SBMS LOTO policy development group.

Next week Mario will represent SNS at the Workshop on Accelerator Operations

Maintenance Plan; Once again we have received little response from the technical groups in response to the request for a maintenance plan. We have asked for a contact from each group to work with operations to develop the required plan.

ARR Preparation

- The SNS ASD Conduct of Operations, response to DOE Order 5480.19 has been written and is being reviewed.
- We are updating the ASD and SNS Emergency Procedures

- We have been examining out “design Basis” of review documents. Review Documentation not being submitted to DCC. Group Leaders are responsible for submitting review documentation to the DCC as they are considered controlled documents.

Ion Source Group

Survey and Alignment Group

The Survey and Alignment group utilized a two - three person crew for the majority of the week preparing and performing alignment verification of the Ring Injection and LINAC dumps. Considerable time was spent waiting at the job site after being called to perform work. This delay was a result of problems with the installation of the Ring Injection Dump and waiting for water to be pumped from the LINAC dump.

We completed an interim readjustment of interior portion of Front End Linac network to support DTL3 alignment and found substantial deformation in the floor. The deformation appears to be mostly related to re-compression settlement and the associated tunnel floor centerline cracking, but thermal expansion also seems to play a role.

We discovered a conflict between the position of monument 102 and a proposed road. The appropriate parties have been informed, and we are working on a resolution.

Completed fiducialization of 29 drift tubes for DTL3. These are now all converted into ideal coordinates for placement next week.

Completed column line marking for the entire Klystron Gallery.

Observed "dogleg" chamber in place for HEBT dipole 8D533_05 (DH14).

Calculated new coordinates for the RFQ realignment and performing some analysis on drift tube fiducialization.

Mechanical Group

All 29 DT’s that we have in RATS have been fiducialized. Installation and alignment will begin in the tunnel next week.

A DT was installed in the DTL-1 tank in RATS and stiffness and vibration tests were performed. No DT deformation was observed when external loads up the 35 pounds were applied to the mount. Vibration test results are being analyzed.

The DTL-1 tank is being leak checked in RATS and this will continue until the middle of next week.
Late next week the DTL-1 tank will be prepared for transport to the tunnel that will occur on Monday, March 17.

Magnet Task

This week we have measured and fiducialized three 12Q45's. The total measured so far is 16 with 17 left to measure. The CCL first article quad has been returned from the vendor and we are in the process of checking it out.

Also, we received the third Ring 1/2 cell this week.

Linac HPRF

ME2 HVCM was installed into the DTL3/DTL4 location this week, with all cabling completed. ME2 SCR was rebuilt with parts from another unit (still awaiting retrofit kits from Dynapower). We setup a test stand to calibrate IGBT Rogowski monitors. We also rebuilt 3 IGBT switch plate assemblies according to LANL's new assembly procedure and found several more loose screws on the Dynapower-supplied assemblies. We are finishing up new design for LEBT chopper mixer box, incorporating a capacitive divider to be used by MPS for analyzing chopper performance.

Linac LLRF

ORNL

JLAB Test

The first phase of the JLab test was completed this week. Amplitude and phase regulation within the specification of ±1% and ±1deg was demonstrated, as shown in the figures below, after making two significant changes to the FPGA code: 1) increase the feedback loop proportional gain by a factor of two, and 2) increase the length of the feedforward table from 50 to 400 microseconds. Resonance control was demonstrated via two techniques; results are presented in the LANL section of this report.

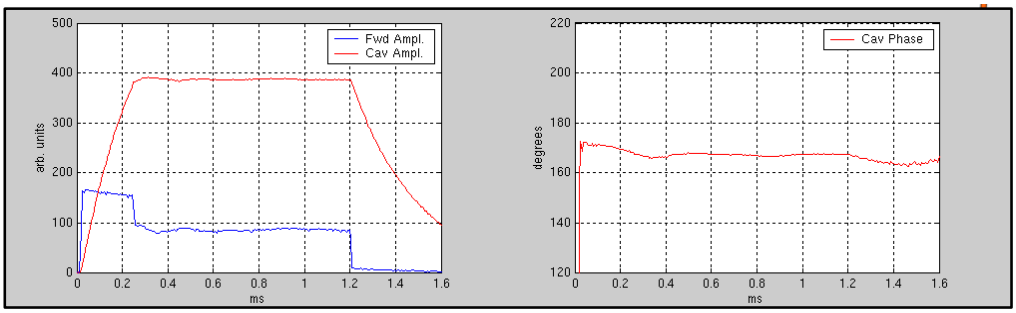


Figure1. Cavity amplitude and phase with feedforward & feedback control.

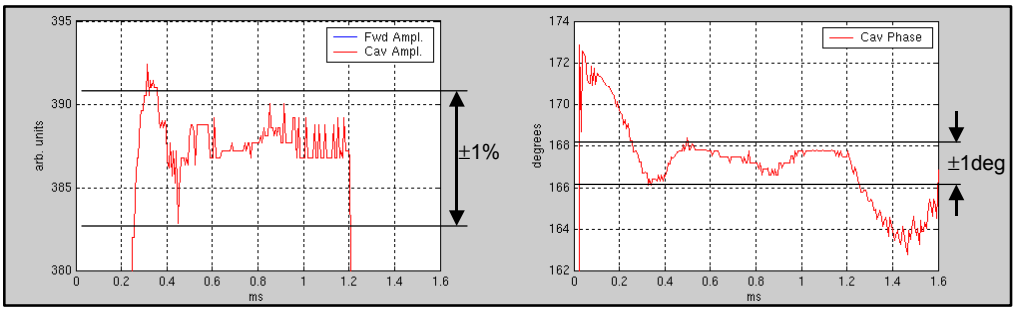


Figure 2. Magnified version of Figure 1.

Reference System

The installation of the 402.5 MHz reference line in the tunnel progressed significantly this week. The hanger installation is complete and the coaxial line installation is about 85% complete.

Figure 3. Reference line tunnel installation.

Performance Measurements and Analysis
Hengjie has analyzed Larry's noise characterization of the 50 MHz cavity and reference inputs of the RFQ/DTL LLRF controller and has sent a copy of his analysis to Larry for consideration. The analysis is in general agreement with Larry's characterization.

Miscellaneous
A team videoconference was held on Wednesday with attendance from JLab, ORNL, LBNL and LANL.

LANL

Hardware Platform
Work continues on producing the "Rev 0" of the new hardware platform for the LLRF system.

a) Analog Front-end (AFE). We are awaiting the arrival of the boards from Bergoz.
b) Digital Front-end (DFE). The board is being assembled. It will be shipped on 3/11 and at LANL 3/12, as expected.
c) RF Output (RFO). We received quotes from board manufacturer and released the design to fabrication. The expected delivery date is still 3/27/03.
d) Motherboard: The schematic is complete and has been sent out to reviewers. The anticipated release date to fab and assembly is still next week. We may also choose the option of fabricating this board in house with a completion date of 3/28.
e) DFE Test Board: This is a simpler version of the DFE To help with testing the AFE and the RFO boards. The board will go to fabrication and assembly next week with a completion date of 3/28.
f) We are still on course to have a system ready for test with the DTL at ORNL in June.

HPM

- Work continues on the REV F of HPM. The first draft of the schematic has been sent to ECAD. We plan to send the schematics out for review next week.

Applications Firmware and Software

- The interface control document (ICD) specifying the firmware specifications including interface between the hardware, firmware and software was shipped to the LLRF collaboration.
- Resonance Control
    - We successfully demonstrated resonance control at JLAB. The least squares fit-to-decay-curve method of calculating resonance worked very nicely for keeping the cavity on resonance at full RF power.

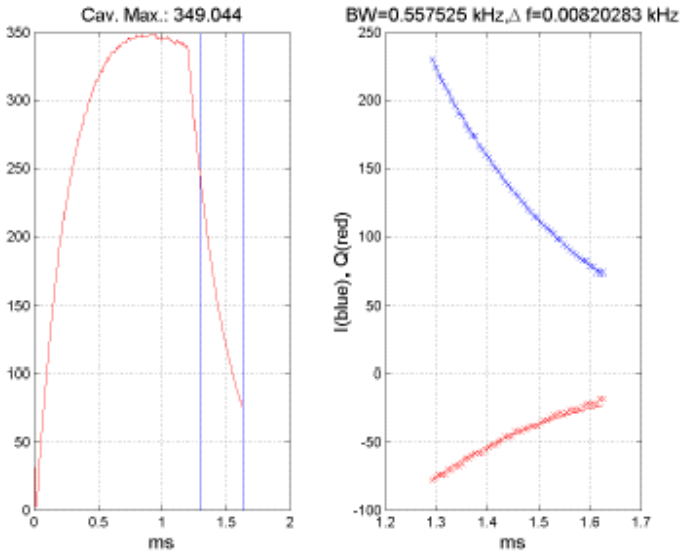


Figure 1: Typical example of resonance error calculation via Decay-Fit. Left: Measured cavity amplitude, right: I and Q of the field during decay (marks) and fitted curve (lines).

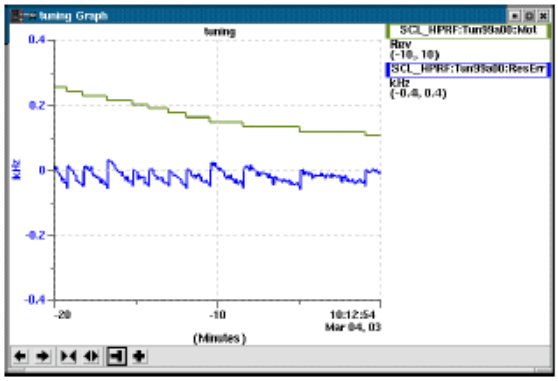


Figure 3: Resonance Control adjusts stepper motor position (upper line), restricting Δf (lower line) to stay within the configured deadband of ± 0.05 kHz.

- Larry Doolittle and Kay Kasemir also implemented a "burst mode" approach for measuring the resonance frequency when it is too far off resonance for the "Decay Fit" method to function properly. As can be seen from the graphs, the method works very nicely even when the resonance

error is 15 times the bandwidth!

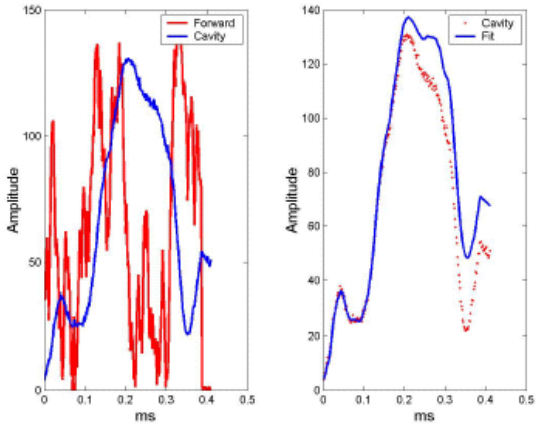


Figure 1: Example of "burst-type" forward waveform and resulting cavity field together with result of curve fit. The resonance error according to the fit is $\Delta f = 3.029$ kHz.

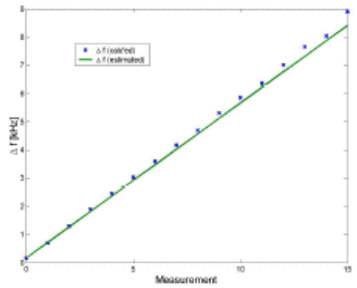


Figure 2: Comparison of estimated resonance error Δf based on stepper motor position to the resonance error calculated from the burst mode cavity fit.

Testing
Work continues on setting up a VHDL test facility using MATLAB. This included defining the requirements, defining the format for MATLAB stimulus and response files as well as the parameters for simulation.

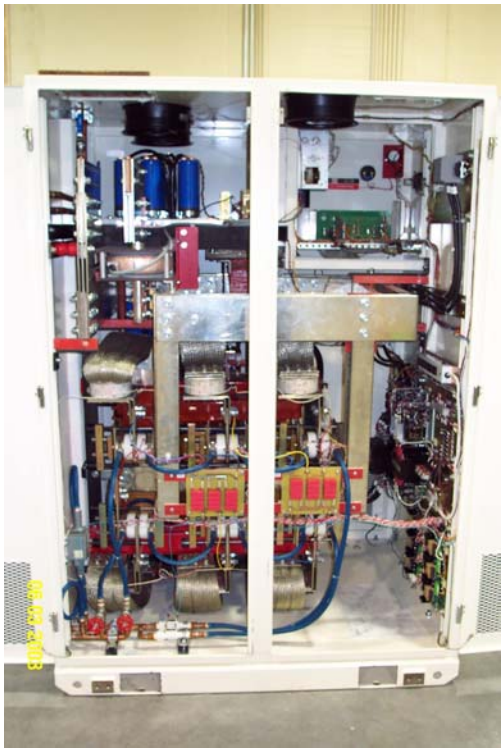
Concerns
The next 3 months are critical to the success of the project. If we have a functioning unit in June, then it will be just work to refine the package by October, when we proceed to full production. The concern is keeping the team focused and engaged during this critical period.

Electrical Systems Group

The first article of the ring power supplies was delivered from the vendor, IE Power, on 3/5/03. The power supply, shown below, is a 5040 A, 18 V supply. The remaining 77 power supplies on this order are all scheduled to be delivered in the next 8 months.

Tunnel wiring for DTL 3 for the Water system (RCCS) and Vacuum system was completed on 3/6/03. All wiring for DTL 3 water and vacuum are scheduled to be completed next week. Water and vacuum wiring for DTL 1 will start next week.

An updated RF spares list was prepared for the project office.



DTL3 tank and trunk cable termination in the tunnel reflecting changes and improvements were finished yesterday.

CHL AC panels for low voltage compressors installed.

CHL supported with P/I measurement and rotation check of 2500Hp 4.1kV compressor motors finished yesterday

DC cabling for high power magnets in RING systems ordered for three staged deliveries beginning April 2003.

All DTL-3 thermocouples, Copper and Constantan, Type E, are on order with the manufacturer/Vendor, OMEGA. They say two weeks they'll be here. Just in time when Gary Johnson puts water to the tank. All temperature compensated wires for the TC's are also on order from OMEGA.

Also I am working closely with Bill Devan and Coles, of the Controls Group to interface all TC's in the DTL, to the Klystron Gallery to the rack/ racks that will take the Analog / Raw Data value mill volts, and convert to a time history Plot/ Bar Graph/ Analog signal. This signal will also be converted to Digital control, for the RF Interlock; to turn the RF Off should the water temp get to hot. To me this is all part of an MPS interlock function. The interface chosen by controls is called a Beckhoff I/O. All thermocouple wires will Interface to this I/O.

Cryogenics Group

We have completed bumping the 2500 HP second stage motors. This completes the bumping of all electrical motors on the warm compressor skids in the CHL.

We have completed the first of eight 10" welds on the upstream return modules.

We have completed the fabrication of all the tunnel transfer line components and will ship the last 4 components to the tunnel on 3/10/03. Work on the return expansion can is going well and we anticipate meeting the delivery date of 4/15/03

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.

1.5.7.1 BPM: Recent welding problem with the recently delivered 12cm HEBT BPM PUEs has been resolved by removing the ceramic blanket on the PUEs. Continue to check the baseband prototype board. Investigating the possibility of relaxing first turn AP requirements to permit baseband system to meet the spec. Continue work on RF (400MHz) daughter card. Made S21 BPM measurements to study calibration techniques

1.5.7.2 IPM: An experiment was performed at RHIC to test the radiation immunity of the new IPM design. A large transverse bump was placed in the beam upstream of the IPMs causing beam loss and downstream radiation spray of the IPMs. The old design with the MCP in the beam-pipe registered large backgrounds, which made the detector unusable for profile measurement. However the new design, with the MCP in a radiation-shielded alcove, registered no radiation-induced background and continued to measure beam profiles during the entire test. In fact it accurately registered the beam size decreasing during the test caused by beam scrapping against the beam pipe. Additional testing with a vertical bump to bring the beam tail in proximity with the horizontal MCP will hopefully confirm the claim that the new design is extremely robust in the presence of beam loss. An analysis has started of the higher multipole components of the magnetic field of the IPM magnets. These results will be given to the beam optics people to evaluate the effect the magnets will have on beam aberrations. Work on electron detector continues. Preliminary drawings & sketches were submitted to the mechanical design room to generate final drawings of the modified (ANL) electron detector now being tested in RHIC. These drawings will be passed on to C. Deibele so he can simulate electro-magnetic response characteristics. Discussions continue with Controls on the details of the PC components to be used for this system. During a RHIC study, (110 bunches, total intensity of 82e9 Au+79) we believe the first glimpse of electron cloud was seen; further studies are planned.

1.5.7.3 BLM: We are in process of writing a sole source justification, required QA documents, and device specification to prepare for the purchase of all the BLM ion chamber detectors from LND, Inc. A prototype BLM detector end-cap assembly has built & tested, successful hold-off to 5kV. Next we will optimize the design for cost and manufacturing convenience. Further tests on the first two channels of the AFE PCB were successful; we are now populating the remaining 6 channels. We submitted the requisition for all the remaining parts to populate all the required AFE modules. The MPS comparator pcb, as well as the AFE backplane design continues. Construction of the AFE test stand, and AFE chassis also continues. Analog interface cables to feed the ICS110BL 24 bit digitizer were ordered.

1.5.7.4 BCM: Considering design problems related to the BCM Calibrators, especially those associated with the Ring and RTBT.

1.5.7.7 BIG/Coherent Tune: Two phone conferences with Dr. Marcel Gaudreau & Dr. Floyd Arntz of Diversified Technologies regarding the pulser specs. Received a quote from Tera Technologies (local rep for Lambda) on power supplies. Waiting for quote from Universal Voltronics, which should be in early next week. Preliminary draft of system Acceptance Criteria generated. Received comments on pulser from an ORNL pulsed power specialist. Investigation continues into gated photomultiplier solutions for the gap cleaner detector.

1.5.7.8 VFM: A video synch board was ordered from Dage-MTI for testing in our system mock-up stand.

ORNL Beam Diagnostics Progress Report:

Laser Profile Monitor: We are preparing a “to-do list” prior to moving out of the RATS. The SCL laser was successfully tested at RATS again after the MEBT test. The laser design team is putting together the final fabrication drawings and manufacturing of the SCL system (laser diagnostics, data acquisition, laser room and the transport-line). Kerry Potter is leading the design effort. Dan Stout is the SCL integration liaison. He is talking to Mike Hechler about the possible mechanical collision stop for the HEBT crane with the laser-mirror box. The Laser

design team is benefiting from John Kristy, Mike Hechler, and Paul Gibson support as we are going into the final implementation phase.

D-plate: We have all the actuators from the LANL diagnostic team. We are thankful to BNL diagnostic team to provide us with a crucial vacuum feed-through that is required for the D-plate (it is replacing the broken one). We are concerned about the lead-time to get any part to be either for spare or for replacement of damaged components. We are also concerned that at least one or two of the actuators have be disassembled prior to moving in/ removing the D-plate into the tunnel. This creates considerable risk to the present schedule.
We have requested assembly drawings and advice from LANL to correct the out of specification (misalignment) of the actuators to the D-plate. The Alignment group has helped us a lot for the last five days to align the D-plate to the AP requirements. We appreciate their support.

Software: Wim Blokland is leading the effort to get the D-plate data acquisition and PVs ready. He has received the Faraday Cup and Energy degrader applications from LANL. He has to add the EPICS support to make them available to the users. Wim also produced a simple database generator template for the diagnostic team.

Diagnostic Installations: Dave Purcell and Andy Webster are leading this effort. Wire scanner PCs and motor drives were installed. Stacy is leading the cable terminations. She is correcting or installing the diagnostic cable terminations as required.
The EE, Vacuum group and the Controls group will install, terminate and integrate all cables associated with water, vacuum and air to the D-plate. The DTL area manager will plan their activities separately from the diagnostic group but integrates all.
Anti-Chopper Diagnostics: From now on called the D-box. The mechanical and the diagnostic group are designing and making prototypes of the aperture limit, Phosphor screen, Fast Faraday Cup and two slits for the inline emittance scanner. Tom Rosebery is the designer working with Saeed and other diagnostic group members on that. We will have a presentation on our progress by Mid-April.

Timing: universal card has been reworked and the layout errors are corrected. Testing continues.