Los Alamos National Laboratory
Spallation Neutron Source

Linac BPM, CM, ED/FC, WS, D-plate Systems
Final Design Review

LANL Design Team Responses to the
Review Committee Report

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Work Package Manager:
The Work Package Manager is responsible for generating constructive and specific responses to the review committee's recommendations. Responses should be generated in a timely manner. Responses should incorporate the action to be taken, who is responsible for the action, the time frame by which the action will be completed if required before the Final Design Review, and any impact to the project cost, schedule or scope. Work Package Manager signature means that all responses having no significant impact on project cost, schedule, or scope will be incorporated into the design of the system. Responses that involve a significant impact to project cost, schedule, and scope must include a description of the impact and be approved prior to implementation by the Project Office.

SNS-2 Group Leader:
Reviews responses for overall technical merit, cost effectiveness and reasonableness for implementation. Reviews responses relative to interfaces with other accelerator systems and for potential impact to these systems.

SNS-3 Group Leader:
Reviews responses for overall technical merit, cost effectiveness and reasonableness for implementation. Reviews responses relative to interfaces with other accelerator systems and for potential impact to these systems.

Physics Review:
Reviews responses for impact to physics design.

Project Office Review:
Review responses for impact to project cost, schedule and scope. Approves or disapproves responses which impact project cost, schedule or scope prior to their implementation.

Division Director:
Provide final review and approval of responses prior to distribution.

Responses to the Design Review will be distributed to:

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M. Lynch
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Five linac beam diagnostics were reviewed over a two and a half day period from March 12 – 14, 2002. The five systems were the beam position monitor, the current monitor, the energy degrader / Faraday Cup, the wire scanners, and the D-plate. One individual, Marty Kesselman, traveled from BNL to report on the BNL portion of the current monitor system.

We received the review committee's report on April 3, 2002. We thank the review committee for their insightful observations and suggestions, and their timely response. In this document we shall address each observation and suggestion. Each item that requires action on our part will be tracked to ensure it is addressed and completed in a timely fashion.

Committee Observations and Recommendations

Wire Scanners

LANL wire scanner design team
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Responses prepared by Saeed Assadi, Ross Meyer, M. Plum.

Committee Observation – The wire scanner **actuators** were being designed and supplied by an **industrial vendor**.

Recommendation – ORNL/SNS should insure that LANL procure **ownership** of the actuator designs and drawings and that LANL include those drawings, in some form, as a part of their **deliverable** to ORNL/SNS.

Response: Good idea. We are pursuing this with the vendor.

Committee Observation – There is a concern with **run-to-run variability** in the fabrication of wire scanner actuator **bellows**. These bellows, especially those used in the SCL actuators, are the specific components that pose the greatest risk of machine damage or down time.

Recommendation – It is suggested to purchase all of the SCL bellows, including spares, in **a single procurement from a single production run**. Two pieces from the batch should be tested to 3 times the expected life and all should be subjected to a rigorous inspection program.

Response: This issue has become moot due to the decision to use laser profile monitors rather than carbon wires in the SCL.

Recommendation – There should be an overall **QA traveler** from manufacturing through installation in the machine for the wire scanner and other insertable diagnostic devices. It should include but not be limited to incoming parts inspection, assembly procedures, leak checking of parts and assemblies, and alignment procedures. It is advisable to cycle all of the SCL assemblies under vacuum about 200 times prior to cleaning and shipping.

Response: We agree. It is our policy to have this traveler for all our diagnostics systems.

Committee Observation – There were no independent **limit switches** on the actuators. The indications were that the ones that were there only went to EPICS as status bits. The MPS policy on independent inputs for **MPS** and operations is not clear.

Recommendation – If it is a policy that MPS be independent of Epics, then a **second switch** is required. Run permit system gets the status of the micro switch that is used by the drive electronics. This would be a good backup to the MPS system. However, it would end up being a software interlock.

Response: We have modified our designs to have two independent switches.

Committee Observation – There were no alignment fiducials on the wire scanners to assist in **rotational alignment** at the time of installation.

Recommendation – **Installation procedures** should be developed and agreed to by the appropriate labs to insure that survey/alignment fiducials, including rotational aspects, are adequate and used correctly.

Response: We modified the design to rotationally align the fork. We will work closely with ORNL to ensure proper alignment of the actuator in the field.

Committee Observation – It was not clear if there are **positive mechanisms** to insure that each device can be locked out of the beam line.

Recommendation – There should be a mechanism on each insertable device to provide the capability to **manually crank** it out of the beam path, **visually inspect** that it is out, and **"lock the system"** in that position. This should be provided on all intercepting devices.

Response: The design has been modified to add a screw driver slot at the end of the lead screw to allow the actuator to be manually withdrawn from the beam line. The actuator can be locked out by simply removing the control cable, which will prevent the brake from being released.

Committee Observation – Although the designs for **hard stops** appear conservative, a definitive analysis of the mechanical stop strength had not been completed on all of the devices:

Recommendation – All of the different configurations **should be verified** that there is no potential for damage if the limit switch does not cause the motor to stop. Insure that there is an adequate margin of safety margin in this determination.

Response: Now that the SCL wire scanners are no longer needed, all the wire scanner actuators have the same basic design. The arm connecting the ball lead screw nut and the shaft inside the bellows travels inside a slotted cylinder. Any attempt to move this arm beyond normal operating range will be interrupted by the ends of the slot in the cylinder and prevent the actuator from moving beyond its limits.

Committee Observation – Light entering the **optical ports** in the SCL beam boxes may **interfere** with the operation of the **SRF Coupler Arc detectors**.

Recommendation – This issue needs to be investigated. Communication between appropriate parties at SNS and JLab should be established to **understand if a problem exists** and, if so, what solutions are possible.

Response: There is no conflict between spark detector and the Laser-wire. The Laser-wire runs at 1064 nm Wavelength and the spark detector is using LEDs at visible light range. Optical filters may be necessary. Tests are planned at the ORNL laser-room before December-2002.

Committee Observation – The **stepper motor drives** selected for this system use pulse width modulation to regulate the current and perform waveform shaping. There is a strong possibility of **interference** between noise generated by stepper motor systems and proper operation of the **cryogenic diode temperature monitoring** system in the SCL. It may be insufficient to separate cables within a given cable tray and might require that you shift to a "linear" style stepper motor drive.

Recommendation – The subject of **interference** between these systems **should be addressed**. Make sure that the electronics **testing** includes energizing the stepper motor as well as the LVDT. Consider separate **cable runs** and spacing between high noise and low noise cables.

Response: Tests at LBL and on the bench show very little interference between the stepper motor and the LVDT. Nevertheless, we are investigating the possibility of changing to the linear driver. A prototype linear driver system will be assembled and tested.

Committee Observation – During the discussion there were various times when there seemed to be some **confusion** regarding the **beam pulse repetition rate and pulse width** limits and requirements for wire scanner operation.

Recommendation – **Document** the pulse rep rate and width for wire scanning operation. Assure that it is written down and understood by all.

Response: The pulse width requirement (50 us for the DTL and CCL wire scanners) is documented in the Design Criteria Document SNS-104050000-DC-0001-R00. There is no rep rate requirement. The ability of the wires to withstand 50 us pulse lengths and up to 10 Hz rep rate is shown, for example, in the Final Design Review presentation by M. Plum.

Committee Observation – The committee is pleased with the preliminary results that have been obtained from **laser wire** scanner tests. We are concerned that there was no corresponding wire measurement of the same 200MeV beam to validate the laser wire data.

Recommendation – The laser wire development and testing activity should certainly continue to **proceed at a high priority** with the effort leading to an understanding of the performance level that may be achievable. The people who are doing the development have the best understanding of the problems. We fully support the idea of keeping all of the laser electronics out of the beam enclosure should SNS choose to apply the laser wire concept.

Response: Noted.

Energy Degrader/Faraday Cups

<u>LANL energy degrader / Faraday Cup design team</u>

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Responses prepared by M. Plum.

Committee Observation – When performing RF amplitude and phase scans some large fraction of the **proton beam will be off-energy**. Some of these protons will deposit their energy in the energy degrader. There is the possibility that the power handling capability of the energy degrader will be exceeded. This is a **critical concern**.

Recommendation – Extensive **calculations** of where (x, y, and z) the off-energy protons deposit their energy are needed. It may be required to reduce the peak beam current and/or the range of scans to avoid over-heating.

Response: Particle tracking simulations are underway to address these issues.

Committee Observation – In some cases the energy degrader / faraday cup and the wire scanner can **mechanically interfere**.

Recommendation – Need **interlocks** on the energy degrader / faraday cup for both fully in and fully out. At least one and perhaps two interlocked micro switches for each case.

Response: The design has been modified to include two independent micro-switches at the in limit and three at the out limit. Two switches at the out limit will be wired in series to provide a redundant signal to the MPS. The ED/FC and wire scanner actuators will be interlocked using the other switches and the controlling electronics.

Committee Observation – Without cooling water the average **temperature** of the energy degrader / faraday cup may exceed acceptable limits.

Recommendations – Put an **interlocked flow switch** on the cooling water return circuit and consider a temperature monitor.

Response: An interlocked flow switch is in fact part of the installation plan.

Committee Observation – The state of hardware and software has been known to **startup in unpredictable states**. This is a **general concern** about machine and device safety.

Recommendation – **Check and assure** acceptable device states during and immediately following power-up, reboot, etc.

Response: Noted. This will be thoroughly checked on the prototype system.

Beam Position Monitors

Mechanical and Pick-up

LANL BPM design team
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Responses prepared by J. Bernardin, Gary Johnson, M. Plum, John Power, Jim Stovall.

Committee Observation – Cold cooling water may cause **condensation** inside the drift tube around the DTL BPM and compromise long-term reliability of the BPM cable connections. This could be a **critical issue**.

Recommendation – Consider ways to **avoid this eventuality**. Committee is uncertain whether sealing the volume or assuring positive ventilation is the answer to this concern.

Response: The beam tunnel dew point will be maintained at 55 °F, regardless of whether the beam is on or off. The beam tunnel air temperature will be maintained at 75 ± 2 °F (beam on) and 72 ± 5 °F (beam off). The water cooling temperature is nominally 68 °F, and the lowest water delivery temp (as designed) is 59 °F. It is therefore unlikely that there will be any condensation inside the drift tubes. However, if there is, once the accelerating structure is warmed up to operating temperature, the drift tube will dry out and cease to be a problem.

Committee Observation – Drift tube assembly procedures result in **welding** operations on the stems **after BPM cables are installed** in the stems. This has the potential to damage the cables when they are no longer accessible inside the drift tube assembly.

Recommendation – **Minimize** the **welding and machining** operations to the DTL drift tube assembly after the BPM and cables are installed. Consider welding the cooling tubes before installing the cables.

Response: The assembly procedures have been changed so that all stem welds are performed before the cables are inserted.

Committee Observation – Otherwise, the **general mechanical design** of the BPMs is viewed as **excellent**.

Recommendation – **Proceed** without delay in the BPM mechanical fabrication.

Response: Noted.

Recommendation – **Installation procedures** should be developed and agreed to by the appropriate labs to insure survey/alignment fiducials are adequate and used correctly.

Response: We have collaborated with the ORNL alignment team to develop and agree to the fiducials on the BPM pickups.

Committee Observation – LANL is planning to **map each DTL drift tube/BPM** assembly with a taut wire. This step should find mechanical or electrical problems before installation.

Recommendation – It is advisable to **map** BPMs **at several frequencies** to evaluate the BPM performance and to verify the measurement apparatus.

Response: This is now part of our mapping plan.

Recommendation – A comprehensive **error budget** is recommended to insure the overall position accuracy does not exceed 1%. The allowable error should be allocated between detector, alignment, cable, electronic, calibration, and noise induced errors.

Response: The error budget is being studied and developed. A draft budget is shown below. The errors are stated in units of mm. It is expected that as a better understanding of the error sources is developed the budget will be refined. There are some measurements yet to be performed to determine how well we can meet this budget.

BPM Positional Error Budget

ERRORS (mm)	BPMs DTL (12.5 mm radius)	CCL (15 mm radius)	SCL (35 mm radius)
Detector	0.075	0.075	0.15
Alignment	0.05	0.06	0.125
Cable	0.02	0.025	0.06
Electronics	0.05	0.055	0.15
Calibration	0.055	0.074	0.19
Noise	0.04	0.065	0.15
Total (RSOS)	0.125	0.150	0.350
Total Allowable	0.125	0.150	0.350

Reference clock

Committee Observation – The BPM system is used to make **phase measurements** that are not clearly defined and are thus **difficult to review**. It was stated that it is necessary/desirable to measure the phase between the beam and the cavity voltage. The BPM electronics is specified and designed to measure phase between the beam and a reference clock. The phase between the reference clock and the cavity voltage is in the domain of the LLRF group and was not discussed. It is not clear to the committee how these measurements are to be correlated.

Recommendation – **Requirements**, requirements, requirements. Get them clearly defined.

Response: Although it may not have been apparent during the design review, the requirements are clearly defined in the Design Criteria Document. An early concept for the BPM system included the capability to measure beam phase relative to the cavity, but this never became a requirement, and it is not in the Design Criteria Document.

Committee Observation – The **2.5-MHz phase reference signal** provided by the LLRF group electronics currently has 2° of variation at 50KHz. The diagnostic reference clock design for the BPM system appears as though it will work, but only once this problem is resolved. This is a **critical issue**.

Response: We have changed the reference system design to distribute the 2.5-MHz directly from the master oscillator over standard cables to the various diagnostics locations. This eliminates additional jitter from re-synchronization. The temperature stability of the 2.5-MHz reference line is not an issue.

Committee Observation – The **reference clock system** seems **overly complicated** and prone to error. It requires 2.5, 40, 50, 352.5, 402.5, 755, and 805MHz clocks. The LLRF uses some of these frequencies derived independently from the same 2.5MHz source. Some of these frequencies exist on the main RF reference line in the tunnel, but are apparently not being made directly available for diagnostics purposes.

Response: Noted. We are constrained to use the signals we have access to.

Electronics

Committee Observation – It is **not clear that a final design approval of the electronics is appropriate** at this point, since the final hardware design is not absolutely complete pending solution of a few problems and a few additional revisions. Software functional specifications should be written to assure workable diagnostics for commissioning and to solidify plans for the operational phase. These are **possibly critical concerns for both BCM and BPM** electronics systems.

Response: We have now operated the prototype BPM system at Berkeley sufficiently to verify the operation of the design and characterize the problems. We are addressing the observed deficiencies in the next revision of the hardware and software.

Committee Observation – **Spurious signals** at 10 MHz put the BPM system at or near performance limits. This problem may stem from the proximity of the analogue front end and the digital circuitry. It may be advantageous to physically isolate these functions. This is a **critical issue**.

Response: The major source of the 10-MHz spurious signal has been proven to be from the prototype AFE due to LO coupling. There is lesser contribution from the prototype DFE. Both of these circuits are being re-designed to reduce these signals.

Recommendation – The **on-line calibration procedure** should be developed and evaluated with real cables and hardware. Coupling between the plates, VSWR of the analogue front end, reflections from the BPM, and the effects of external noise need to be considered. It may be necessary to calibrate one plate at a time because of coupling between the plates.

Response: It will be necessary to calibrate each BPM channel (plate) separately to reduce the effect of channel-to-channel coupling, and this can be done with the current hardware design. The VSWR of the next generation AFE is being improved, but it may still be necessary to add in fixed calibration offsets to each channel to obtain the ultimate system accuracy. The testing at Berkeley gave us *valuable experience with the real-world hardware operation of the calibration system.*

Recommendation – The **BPM receiver should be mapped** over it's full working range of positions and intensities, preferably with signals of the same spectral content as will be presented to the electronics by the beam. Both the mean and standard deviation of measured positions should be examined.

Response: Agreed. We will do the best we can do with the instrumentation we have.

Recommendation – The **VSWR** at the **analogue front end** should be checked to insure it does not affect accuracy or calibration of the BPM system.

Response: Agreed. See additional comments above on the calibration.

Committee Observation – Modifications may be necessary for the **analogue front end** and resultant vendor delays could be a problem.

Recommendation – **Consider visiting the vendor** to facilitate a satisfactory solution.

Response: We visited the vendor last July. This was very valuable in determining the course of action to modify the AFE design. It may be useful to have one more visit prior to production of the AFEs in quantity. The delivery schedule seems reasonable to us and the vender.

Committee Observation – BPM measurements required for **commissioning** should be defined to facilitate software development. **Version control of the software** between the beam and the control room is important.

Response: Noted. Commissioning plans are begin continually refined, and we are monitoring these changes to ensure compatibility with the BPM system.

Committee Observation – **Personnel** are being **stretched between operational tests and construction/development**. This offers the benefit of rapid feedback on the diagnostics systems' performance at the risk of design and fabrication schedule delays.

Recommendation – **Don't lose sight of** important **schedule** milestones.

Response: Noted.

Recommendation – **After the BPMs are installed** in the Linac, the coupling between plates through the signal cables should be documented at each location to facilitate calibration and diagnosing future problems.

Response: Noted.

Recommendation – Proceed to **define testing and acceptance criteria** for the production electronics. SNS/ORNL should identify any measurement data and test or calibration set-ups that are to be delivered along with electronics systems. SNS/ORNL needs to plan and understand how they will maintain and verify the integrity of systems once they take ownership. This is a concern for **all electronics systems**, not just BPMs!

Response: Agreed. This is an existing action item for SNS/ORNL.

Beam Current Monitors

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Responses prepared by Jim Billen, Marty Kesselman, M. Plum.

Committee Observation – It was learned that the **BCM units** are to be **used as inputs for machine protection purposes**. This is a **critical concern**. The philosophy of individual diagnostics having their own dedicated microprocessor seems to be at odds with the objectives of a machine protection interlock. At LANSCE, for an extreme example, an interlocked current monitor takes the form of a black box straddling the beam pipe with a relay contact as virtually the only output.

Recommendation – **Machine protection inputs should be as simple as possible** to facilitate periodic (even real-time) validation. At a minimum, a watchdog timer that verifies that the CPU is alive will be needed.

Response: Agree! The BCM electronics has never been considered as an input to the machine protection system. The need to add another apparatus that can use current as a sensed variable was one under discussion at the time of the *review. Such an apparatus would be a stand-alone device and would be dedicated to the task. The more general current monitoring system presented at the FDR is for beam information.*

Committee Observation – It is **not clear that a final design approval is appropriate** at this point, since the final hardware design is not absolutely complete pending solution of a few problems and an additional revision for the BCM electronics. Software functional specifications should be written to assure workable diagnostics for commissioning and to solidify plans for the operational phase. These are **possibly critical concerns for both BCM and BPM** electronics systems.

Response: The software is under development. The hardware design is quite complete, and the second revision to artwork has been completed. This new board has been fabricated, and board population is in process. We are hopeful that most of the first artwork bugs would have been corrected, and expect to see a significant improvement in noise rejection.

A set of operational specifications, and calibrator use has been written and was included with the prototype apparatus shipped to LBNL in February 2002.
Dual channel operation was not functional at the time of the FDR due to difficulties encountered with the LANL "digital interface". This board was received only a few days before shipment and there was insufficient time to pursue the problems we had encountered. We were left with no spare to continue our development. Work on software has already started (by others) at LBNL while the system was waiting for beam and a dual channel version was readily made operational.

Recommendation – Given the **schedule** pressure, the electronics **design** and revision zero software need to be **completed soon**.

Response: Noted.

Committee Observation – The **vacuum out-gassing** associated with the **DTL BCM cables** was identified, and work should continue to solve this problem. This is a **critical concern**.

Response: Noted. Solid-core Kapton-coated wires have been tested and found to exceed our vacuum requirements. We are now in the process of modifying the transformers to use these wires.

Committee Observation – The large bore **CCL beam current monitor** core with the ceramic break in the clamshell housing will **resonate,** most likely in the frequency range of hundreds of megahertz. Since pillbox-type modes are most likely, it shouldn't be too difficult to model this together with any proposed solutions. This concern ties into the question of required system bandwidth.

Recommendation – A **strategy** for either **damping the modes or reshaping** the clamshell, consistent with the broadband measurement requirements, should be developed.

Response: Superfish computer model simulations of the CCL current monitor predict a resonance at 2.5 MHz that will couple to the beam. However, at this frequency the resonance characteristics are dominated by the ferrite ring and the ceramic in the vacuum electrical break. The metal housing around the transformer makes a negligible contribution. For example, a 1-cm increase in the housing diameter changes the resonant frequency of the 2.5-MHz mode by less than 1 kHz. Furthermore, the signal winding on the transformer will effectively carry energy at this frequency out of the transformer and prevent any resonance build up.

There are also many higher frequency resonances, but they have small net magnetic flux in the ferrite because of multiple field reversals, which tends to cancel out any contribution to the signal. These modes also have very little field on axis and, therefore, cannot be strongly excited by the beam. Furthermore, the bandwidth of the CM electronics is just 7 MHz, so any signal sources above this frequency can be effectively filtered out with a low-pass filter.

Energy deposition calculations also show there is very little power in these higher modes, so transformer heating should not be a problem.

Committee Observation – A **bake-out procedure for the transition region** mechanical assembly should be finalized to assure that the core temperature stays within safe bounds.

Response: We agree.

Committee Observation – The flexibility in terms of **adjustable gains** raises the operational question of how to incorporate calibration data into the final process variables.

Recommendation – The interaction between the gain switching amplifier and the software that converts to real mA **needs to be made clear**. This unit is predominantly to be used for the ring, and it is important to understand how gain changes made during the course of ring stacking interacts with the offset and droop compensation software. Timing and synchronization of gain switching during this process needs to be defined.

Response: This point was not clearly explained to the committee. The gain will be controlled by an 8 bit digital word. This word will have only one of it's bits high. The location of the high bit will determine which gain path is operational. This 8 bit word is loaded together with digitizer output data into the output FIFOs.

These data comprise the digital information presented to the PC. Therefore, together with each digitized output word there is a corresponding "gain" word to identify the multiplier necessary for conversion of the data to "real" units. Appropriate DC offset measurements at different gains will be programmed just prior to pulse acquisition, and gain calibration information must be stored and retrieved to properly scale/process the data.

Committee Observation – The **bandwidth requirements for the BCM system** seemed to vary depending on who was asked. Clearly, the 7 MHz BW is important for most bread and butter solutions and it appears to be reasonably well in hand. However, the plan for dealing with higher frequencies needs to be finalized, whether it turns out to be a scope, fast waveform digitizer, or something else.

Response: This is quickly coming to a final state. The controls people here at BNL are purchasing 4 channel LeCroy scopes (500MHz), along with a multiplexer that will permit the digitization of selected signals at high speed. The controls software to control these scopes is already tested. In the case of the Ring and RTBT, a resistive divider will provide a wide-band output suited to high-speed digitization. In the case of the MEBT, Linac and HEBT, a 100MHz buffer amplifier can provide a signal suitable for most tests. For those requiring still higher bandwidth, a transformer can be dedicated to the fast digitizer acquisition system.

Committee Observation – The **calibration winding** on the cores (10 turns) may be a **path for noise** to enter the system, so care is needed in handling this.

Response: Agree! The calibration winding cabling suggested by the committee as shielded twisted pair is a good one. We are recommending the use of twinax (Belden 9463 Blue Hose, 78 Ohm) for this cable. As pointed out at the FDR, should it prove necessary, the winding could be opened by a relay and a termination of 50 Ohms applied, close to the winding, when the system is not calibrating. This would be a last resort.

Committee Observation – The strategy for dealing with the **large dynamic range** in the ring drives a considerably different design than that necessitated by the linac / transport lines. It is not clear that a huge advantage is to be gained by trying to unify the two diagnostics into the same electronics design and package.

Response: See next.

Recommendation – If a **workable Linac unit** can be made available earlier, it may be worthwhile to proceed separately with Linac BCM fabrication to meet the Linac schedule and to buy time to work out the bugs in the ring design.

Response: The circuit board used for this system includes separate configurations for the MEBT/Linac/HEBT and the Ring/RTBT. The configurations are jumper selected on the board. Thus, the more complicated gain switching is *jumpered-out for the low level signals expected in the earlier stages of the SNS. In fact this is the configuration delivered to LBNL. The system utilizes a common circuit board, and the jumpers are set when the system is installed in a specific location. All other aspects of the BCM system are software programmable.*

It should also be noted that the 100MHz buffer amplifier used to provide a wide-band output in the MEBT/Linac/HEBT is also jumpered-out for the Ring/RTBT. It is replaced with a wide-band resistive divider since the signals are expected to be large.

D-Plate

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Responses prepared by M. Plum.

General Comments

It is obvious that since the July review considerable progress has been made on D-Plate systems integration issues. D-Plate installation and operation has been integrated into the Linac installation/commissioning plan and schedule, equipment hand-off issues between LANL and ORNL are being addressed, facility utilities like water and vacuum systems required for D-Plate operation are now apparently being planned with D-Plate requirements in mind, and most D-Plate subsystems have progressed to the final design stage. A commissioning leader, Eugene Tanke, has been named and Saeed Assadi has been assigned D-Plate assembly, test, and integration responsibility.

Observation – **Good progress** appears to have been made **integrating** the D-Plate into the Linac installation and commissioning schedule.

Recommendation – Make sure to **schedule sufficient time** for D-Plate removal and recovery including any anticipated radiation cool-down time that may be required.

Response: Noted.

Observation – The D-Plate is planned to be in-situ for Tank 1 commissioning purposes for three months. **First beam** to the D-Plate is scheduled for February 2003.

Observation – During this review the beam power handling capability of many but not all of the D-Plate beam instrumentation devices were specifically identified. In response to a question as to how these limitations would be operationally enforced during D-Plate utilization, it was stated that the **MPS system is expected be in place and fully operational** to protect instruments during D-Plate operation.

Observation – D-Plate operation will be an excellent early systems test of **all accelerator systems** including Controls, Utilities, RF, MPS, Safety, Operations, and Diagnostics. It requires all these systems groups to understand the technical and schedule requirements and to be "on board" with the plan at an early stage.

Recommendation – It is important for the Linac/D-Plate commissioning team to stay in constant **communication** with the Controls and MPS groups to assure that appropriate interfaces and requirements are communicated and implemented in a smooth and timely manner.

Response: Noted. Periodic coordination video conferences have been initiated to facilitate the coordination issues.

Observation – A **separate, dedicated engineering review** was held for D-Plate beam stop mechanical issues. This **committee applauds** that action.

Observation – LANL and ORNL appear to have closed the loop on D-Plate assembly and **survey/alignment issues**.

Recommendation – Assure that wire scanners and other actuators make solid **metal-to-metal seal contact** to establish a positive and stable alignment configuration.

Response: Noted.

Observation – Although no detailed fabrication schedule was presented for D-Plate components, it appears that some are on a **tight time schedule** to meet the late Summer 2002 schedule for delivery to ORNL. It was argued that required components could be fast-tracked through local shops by LANL. Progress may be constrained by available LANL manpower, especially mechanical designers.

Recommendation – **Keep a close eye on the schedule**. If the D-Plate should for some reason be late relative to the rest of the Linac, the opportunity to gain any benefit from the D-Plate may be lost.

Response: Noted.

Observation – There appears to be no protection against **burning or damaging** a D-Plate **halo scraper segment** with the beam. The halo scraper aperture is quite large relative to the normal beam size, but even a small fraction of the total beam power could damage a scraper segment.

Recommendation – The committee offers no design change recommendation, only a **caution** to "pay attention" when beam operation takes place. Loss of a halo segment will probably not be disastrous, but would reduce the utility of the halo diagnostic.

Response: Noted.

Observation – The beam stop appears to be well characterized for handling 7.5 MeV beam, however during commissioning there will be times that it may receive **lower energy beam**, e.g. during Tank 1 phase scans. Presumably this mode of operation will or can be done at less than maximum beam pulse length and repetition rate.

Recommendation – We do not expect this to be a problem for the beam stop, but suggest that it may be advisable to make a quick **assessment** of the beam stop's ability to handle lower energy beam. If required, a MPS mode may need to be defined to protect the beam stop under this "off-normal", but certain to be experienced, condition.

Response: High power beam will not be delivered to the beam stop until the beam is well characterized and we are sure that the beam is on energy and tuned suitably for the beam stop. During high power operations the beam parameters will be carefully monitored to ensure the beam stop is not damaged.

Observation – A requirement was mentioned for a **differential beam current interlock** between the Tank 1 output beam current toroid and the isolated D-Plate beam stop. This interlock is to insure that excessive beam power is not lost anywhere on the D-Plate upstream of the beam stop. It was obvious that no one had been assigned responsibility for implementation of this particular feature.

Recommendation – Refine the **requirements definition and assign responsibility** for implementation of this feature.

Response: Noted. Saeed Assadi is working to resolve this issue.

Observation – The electronics presented for D-Plate systems without counterparts in the final Linac appeared to be **simple and appropriate**.

Appendix

<u>Review Committee</u>
Robert Webber, FNAL, Chairman
Jim Crisp, FNAL
Glen Decker, ANL
Ron Johnson, SLAC
Tom Powers, TJNAF
Mark Wiseman, TJNAF

<u>Speakers at the review</u>
Roger Connolly (BNL)
Steve Ellis
Marty Kesselman (BNL)
Jim O'Hara
Ross Meyer
Mike Plum
John Power
Chris Rose

<u>Non-LANL guests</u>
Tom Shea, ORNL

<u>Labs attending via video conference</u>
BNL
ORNL